Report to

THE INTERNATIONAL JOINT COMMISSION

on

THE DIVISION OF THE WATERS OF

ST. MARY AND MILK RIVERS

by

J. S. CRAGWALL, Jr.

representing United States

and

D. A. DAVIS

representing Canada

1977

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March 8, 1978

INTERNATIONAL JOINT COMMISSION
WASHINGTON, D.C. and OTTAWA, ONTARIO

GENTLEMEN:

In compliance with the provisions of Clause VIII (c) of your order of October 4, 1921, directing the division of the waters of St. Mary and Milk Rivers between the United States and Canada, we are transmitting herewith a report on the operations during the irrigation season ended October 31, 1977.

Respectfully submitted,

J. S. Cragwall, Jr.,
Accredited Officer of the United States

D. A. Davis
Accredited Officer of Her Majesty

SYNOPSIS

During the 1977 irrigation season, the natural runoff of the St. Mary and Milk Rivers was well below normal, being 55% and 25% respectively of the average long term runoff.

The natural runoff of the St. Mary River was 406,000 cubic decametres (330,000 acre-feet) of which Canada received 281,000 cubic decametres (228,000 acre-feet) which is 102% of the Canadian allotment under the 1909 Boundary Waters Treaty.

The natural runoff of the Milk River was 37,100 cubic decametres (30,100 acre-feet), of which the United States allotment was 25,800 cubic decametres (20,900 acre-feet) under the Treaty. Canadian usage was felt to be above her allotment in mid-summer and an agreement was reached whereby 710 cubic decametres (570 acre-feet) of Canada's share of the St. Mary River water was diverted into the Milk River for use by irrigators in Alberta.

The natural runoff of Lodge Creek, Battle Creek and Frenchman River was extremely low being 3%, 17% and 14% respectively of the average long term runoff. The combined natural runoff of these tributaries was 19,800 cubic decametres (16,100 acre-feet) of which the United States received 12,500 cubic decametres (10,100 acre-feet) which is 126% of its allotment under the Treaty.

Although the flows delivered across the International Boundary by both countries were deficient for a number of periods during the irrigation season, the deficits were soon refunded by subsequent deliveries and each country received its allotted share for the irrigation season. The problems that developed due to the low runoff were soon resolved by close liaison and co-operation between the field representatives of both countries.

TABLE OF CONTENTS

LIST OF TABLES

ENGLISH TO METRIC (SI) CONVERSION

The 1977 Report to the International Joint Commission on the Division of the Waters of the St. Mary and Milk Rivers uses dual units (metric and English) as a transition to future reports which will be entirely in metric units.

The two English units that have been used in previous reports are cfs-days and acre-feet.

A cfs-day is the equivalent volume of one cubic foot per second flowing for 24 hours (60 x 60 x 24) or 86,400 cubic feet.

An acre-foot is the volume of water covering one acre to the depth of one foot and is equal to 43,560 cubic feet.

One cfs-day is equal to 1.9835 acre-feet.

The metric (SI) unit replacing the English units is the cubic decametre (dam^3) and is the volume contained in a cube 10m x 10m x 10m or 1,000 cubic metres.

One cubic metre is equal to 35.315 cubic feet

One cubic decametre is equal to 35,315 cubic feet.

An acre-foot is equal to 1.2335 cubic decametres.

A cfs-day is equal to 2.4466 cubic decametres.

INTRODUCTION

Article VI of the Boundary Waters Treaty of 1909 between Great Britain and the United States governs the apportionment of the waters of the St. Mary and Milk Rivers. To comply with this Treaty, representatives of the United States and Canada collected and compiled on a co-operative basis, hydrometric data at forty-three international gauging stations. Additional gauging stations were operated independently by Canada or the United States to obtain data on diversions, reservoir contents, return flows, and index runoff. The majority of this additional information is used to improve the accuracy of natural flow computations.

This report summarizes the natural flow computations during 1977, enlarges on the apportionment of the natural flow and explains any unusual occurrences throughout the year as well as any modifications which have been made or are contemplated for increasing the accuracy of the natural flow computations. Summarized natural flow tables are included in the report proper, whereas the detailed natural flow computations are included in Appendix A. The daily discharge data for 1977 are included in Appendix B.

In accordance with the metric conversion schedule established by the International Joint Commission, the 1977 report uses metric (SI) units first, followed by English units in parentheses. Tables are shown, for example Table 1, by the results in metric (SI) units first, followed by the respective English unit table, Table 1-A. The format for Appendices A and B of the report remain unchanged for 1977, using English units only.

Mr. D.A. Davis, Acting Director, Western & Northern Region, Inland Waters Directorate, as Accredited Officer of Her Majesty, was represented in the field by Mr. R. D. May, District Engineer, Calgary, Alberta and Mr. J. L. Fowler, Acting District Engineer, Regina, Saskatchewan. Mr. J. S. Cragwall, Jr., Chief Hydrologist, United States Geological Survey, as Accredited Officer of the United States was represented in the field by Mr. G. M. Pike, District Chief, Helena, Montana. This report has been prepared jointly by personnel of the Water Survey of Canada and the United States Geological Survey under the supervision of Messrs. R. D. May, J. L. Fowler and G. M. Pike.

During the 1977 irrigation season the natural runoff of the St. Mary River, Milk River and the principal Eastern Tributaries of the Milk River was well below normal, being 55% and 25% of the average long term natural flows for the St. Mary and Milk Rivers respectively. The corresponding natural runoff values for the Eastern Tributaries were 3% for Lodge Creek, 17% for Battle Creek and 14% for the Frenchman River. The flow across the boundary for the Eastern Tributaries was deficient within a number of apportionment periods. Despite the extreme low runoff no serious problems in apportionment of flows were encountered during the 1977 irrigation season.

The annual conference between the staffs of the field representatives was held in Regina, Saskatchewan on January 31 - February 1, 1978. Streamflow records collected jointly by Canada and the United States were reviewed and approved. Mutual problems and changes in computational procedures were discussed and a schedule of field operations for 1978 adopted.

The extremely low runoff in 1977 emphasized the need for a reliable and accurate method of computing Milk River natural flows and correspondingly, the need for regular interim apportionment reports. The Accredited Officers have instructed the field representatives to carry out a study program to develop a better methodology for determination of natural flow of the Milk River at Eastern Crossing, with an interim report scheduled for January 1979.

ST. MARY RIVER

During the irrigation season (April 1 to October 31), Canada's share of the natural flow of the St. Mary River at the International Boundary is, as stipulated by the 1921 Order, three-quarters of the natural flow up to a total flow of 666 cubic feet per second[1], with flows above that amount to be divided equally between Canada and the United States. During the non-irrigation season the entire flow is to be divided equally between the two countries.

To comply with the above order, representatives of both countries made semi-monthly computations of the daily natural flow of St. Mary River during the 1977 irrigation season. Regular interim reports of these computations were sent to all agencies involved in the management and use of the flow of the St. Mary River, in order to keep them informed of the amount of water available, as well as to ensure that any appropriation by the United States in excess of her share could be adjusted by a subsequent delivery of an equivalent amount at the earliest opportunity.

No tentative computations and interim reports are made during the non-irrigation season, as normally the only usage by the United States during this period is storage in Lake Sherburne.

A significant deficit delivery from the United States occurred during the division period June 16 to 30. The United States representative phoned the Canadian representative immediately upon receipt of the interim division computations and indicated that arrangements had been made to refund the deficit. The deficit was made up during the July 1 to 15 division period.

Because of water use demands in excess of Canada's share in the Milk River Basin an ad hoc agreement was reached, whereby a 0.28 m^3/s (10cfs) deficit delivery was made on the St. Mary River for Canadian use in the Milk River Basin. This arrangement was in effect from August 3 to 31, 1977. This accounts for a large portion of the deficit delivery recorded during August. More detail on this

[1] 666 cubic feet per second converts to 18.9 cubic metres per second.

arrangement is given in the Milk River section of this report.

Lake Sherburne, the only storage reservoir in the St. Mary River Basin in the United States, is used to store the United States share of flows for diversion to the Milk River. This water is later utilized by the United States, after passing through Canada, for irrigation in the lower Milk River valley.

Storage in Lake Sherburne was 10,400 cubic decametres (8,450 acre-feet) on October 31, 1976, and had increased to 21,800 cubic decametres (17,700 acre-feet) just prior to the irrigation season on March 31, 1977. The storage reached a maximum of 31,700 cubic decametres (25,700 acre-feet) on May 11, and had declined to 21,500 cubic decametres (17,400 acre-feet) by the end of the irrigation season on October 31st.

Water was diverted from the St. Mary River into the St. Mary Canal from April 26 to September 15. The total recorded flow past the gauging station on the St. Mary Canal at St. Mary Crossing was 126,000 cubic decametres (102,000 acre-feet). Any seepage from the canal between the point of diversion and the crossing of the St. Mary River is assumed to return to the river and eventually become available to Canada.

The total natural flow of the St. Mary River at the International Boundary for the period November 1, 1976 to October 31, 1977 was 453,000 cubic decametres (368,000 acre-feet), of which 406,000 cubic decametres (330,000 acre-feet) occurred during the irrigation season, April 1 to October 31, 1977. For the irrigation season, the Canadian and United States shares were 275,000 cubic decametres (223,000 acre-feet) and 131,000 cubic decametres (106,000 acre-feet), respectively. A total runoff of 281,000 cubic decametres (228,000 acre-feet) was recorded at the International Boundary which is 102% of the Canadian share. The computed natural flow during the irrigation season was 55 percent of the average of the previous seventy-four years of record.

In order to provide advance information on the probable runoff in the St. Mary River basin, the fifty-sixth annual International Snow Survey

was conducted on April 27 and 28, 1977.

Table 1, which follows, summarizes the apportionment of the waters of the St. Mary River.

TABLE 1

SUMMARY OF DIVISION OF ST. MARY RIVER AND DIVERSION TO MILK RIVER

1977

Quantities in Cubic Decametres

MONTH	ST. MARY RIVER AT INTERNATIONAL BOUNDARY				EXCESS RECEIVED BY CANADA	CHANGE IN STORAGE LAKE SHERBURNE	TOTAL AVAILABLE FOR DIVERSION	ST. MARY CANAL AT ST. MARY CROSSING	MILK RIVER* AT EASTERN CROSSING
	RECORDED FLOW	NATURAL FLOW	U.S.A. SHARE	CANADA SHARE					
APR	17,359	25,002	6,642	18,359	- 1,000	6,155	487	1,488	11,428
MAY	64,009	98,998	36,848	62,150	1,859	- 6,662	43,510	41,652	33,275
JUN	61,423	99,316	37,419	61,898	- 475	-10,464	47,883	48,358	47,408
JUL	41,629	54,986	15,319	39,667	1,962	- 1,028	16,346	14,384	19,862
AUG	36,845	51,358	13,476	37,882	- 1,037	556	12,920	13,958	14,019
SEP	42,349	53,645	15,769	37,877	4,473	5,376	10,393	5,921	8,356
OCT	17,110	23,190	5,804	17,386	- 276	6,080	- 276	0	2,731
TOTAL IRRIGATION SEASON	280,724	406,495	131,278	275,220	5,505	14	131,264	125,760	137,079
PERIOD NOVEMBER TO OCTOBER	316,097	453,391	154,727	298,667					

DIVISION PERIOD AT INTERNATIONAL BOUNDARY	NATURAL FLOW	CANADA SHARE	RECEIVED BY CANADA	RECEIVED BY CANADA	
				ABOVE SHARE	BELOW SHARE
Apr 1 - Apr 15	8,380	6,288	5,527		761
Apr 16 - Apr 30	16,622	12,072	11,832		240
May 1 - May 15	53,091	32,665	34,937	2,273	
May 16 - May 31	45,906	29,484	29,071		413
Jun 1 - Jun 15	58,354	35,297	35,554	257	
Jun 16 - Jun 30	40,961	26,599	25,868		732
Jul 1 - Jul 15	26,374	19,022	20,084	1,062	
Jul 16 - Jul 31	28,611	20,644	21,545	900	
Aug 1 - Aug 15	24,011	17,757	16,813		944
Aug 16 - Aug 31	27,346	20,123	20,030		93
Sep 1 - Sep 15	33,215	22,726	26,171	3,445	
Sep 16 - Sep 30	20,429	15,149	16,177	1,028	
Oct 1 - Oct 15	12,681	9,507	9,703	196	
Oct 16 - Oct 31	10,508	7,878	7,406		472

25803

* Milk River at Eastern Crossing is the natural flow of the Milk River plus the diversion from the St. Mary River basin, less unaccounted canal losses.

TABLE 1A

SUMMARY OF DIVISION OF ST. MARY RIVER AND DIVERSION TO MILK RIVER

1977

Quantities in Acre-Feet

MONTH	ST. MARY RIVER AT INTERNATIONAL BOUNDARY				EXCESS RECEIVED BY CANADA	CHANGE IN STORAGE LAKE SHERBURNE	TOTAL AVAILABLE FOR DIVERSION	ST. MARY CANAL AT ST. MARY CROSSING	MILK RIVER* AT EASTERN CROSSING
	RECORDED FLOW	NATURAL FLOW	U.S.A. SHARE	CANADA SHARE					
APR	14,073	20,269	5,385	14,884	- 811	4,990	395	1,206	9,265
MAY	51,892	80,258	29,873	50,385	1,507	- 5,401	35,274	33,767	26,976
JUN	49,796	80,516	30,336	50,181	- 385	- 8,483	38,819	39,204	38,434
JUL	33,749	44,577	12,419	32,158	1,591	- 833	13,252	11,661	16,102
AUG	29,870	41,636	10,925	30,711	- 841	451	10,474	11,316	11,365
SEP	34,332	43,490	12,784	30,707	3,626	4,358	8,426	4,800	6,774
OCT	13,871	18,800	4,705	14,095	- 224	4,929	- 224	0	2,214
TOTAL IRRIGATION SEASON	227,583	329,546	106,427	223,121	4,463	11	106,416	101,954	111,130
PERIOD NOVEMBER TO OCTOBER	256,260	367,565	125,437	242,130					

DIVISION PERIOD AT INTERNATIONAL BOUNDARY	NATURAL FLOW	CANADA SHARE	RECEIVED BY CANADA	RECEIVED BY CANADA	
				ABOVE SHARE	BELOW SHARE
Apr 1 - Apr 15	6,793	5,098	4,481		617
Apr 16 - Apr 30	13,476	9,787	9,592		195
May 1 - May 15	43,042	26,482	28,324	1,842	
May 16 - May 31	37,216	23,903	23,568		335
Jun 1 - Jun 15	47,308	28,616	28,824	208	
Jun 16 - Jun 30	33,208	21,565	20,972		593
Jul 1 - Jul 15	21,382	15,422	16,283	861	
Jul 16 - Jul 31	23,195	16,737	17,467	730	
Aug 1 - Aug 15	19,466	14,396	13,631		765
Aug 16 - Aug 31	22,170	16,314	16,239		75
Sep 1 - Sep 15	26,928	18,425	21,217	2,792	
Sep 16 - Sep 30	16,562	12,282	13,115	833	
Oct 1 - Oct 15	10,280	7,708	7,867	159	
Oct 16 - Oct 31	8,519	6,387	6,004		383

* Milk River at Eastern Crossing is the natural flow of Milk River plus the diversion from the St. Mary River basin, less unaccounted canal losses.

THE MILK RIVER

The 1921 Order on the division of flow of the Milk River is the converse to that of the St. Mary River. That is, the United States is entitled to three-quarters of the natural flow up to a total flow of 666 cubic feet per second[1], with any flows above this amount to be divided equally between the two countries. During the non-irrigation season (November 1, to March 31), the entire flow is to be divided equally.

No actual apportionment of the Milk River has been made in the past, as Canadian usage has always been considered to be less than her share. However, sprinkle irrigation systems have become economically viable and as a result more and more water is being used by Canadian irrigators. In 1977 several inspection trips, by field representatives of Canada and the United States, were made. These inspections indicated that usage by Canada could approach 2,500 cubic decametres (2,000 acre-feet) during the irrigation season.

The problem became acute during 1977 when interim estimates of Milk River natural flow showed periods when there was no natural flow. Canadian usage during periods of low natural flow was also felt to be above her share. Canadian users required water to complete their irrigations and for municipal water supply for the towns of Milk River and Coutts, Alberta and Sweetgrass, Montana; with this need being met by arrangement whereby an additional $0.28 m^3/s$ (10 cfs) was diverted from the St. Mary River Basin to the Milk River Basin for use by Canadians. This arrangement stayed in effect for the period August 3 to 31 and represents a total volume of 710 cubic decametres (570 acre-feet)

This year's extremely low runoff emphasized the need for a reliable and accurate method of computing the Milk River natural flow and correspondingly the need for regular interim reports on the apportionment of flow of the Milk River. The present procedure for estimating natural flow is based on some assumptions and procedures which can greatly affect the accuracy of the computations. The Accredited Officers have requested the field representatives to develop, during 1978, a reliable natural flow computation procedure for subsequent use beginning in the 1979 irrigation season.

[1] 666 cubic feet per second converts to 18.9 cubic metres per second

The computed natural flow of the Milk River at its eastern crossing of the International Boundary during the period March 1 to October 31, was 37,100 cubic decametres (30,100 acre-feet). This is 25% of the average natural flow of the previous sixty-five years of records. The United States and Canadian shares were 25,800 cubic decametres (20,900 acre-feet) and 11,400 cubic decametres (9,230 acre-feet), respectively. The computations for determining the natural flow of the Milk River at its eastern crossing are given in Table 8 in Appendix A.

An international gauging station was again operated in 1977 on the South Fork Milk River near Babb, Montana for the purpose of studying the utilization of water in the Milk River basin within the Blackfoot Indian Reservation. No flow was recorded at either South Fork Milk River near Babb nor at Milk River at the Western Crossing of the International Boundary during nearly all of July and August, however, there were no complaints by Canadian ranchers about water shortages.

A miscellaneous suspended sediment data collection program was conducted on the Milk River from 1974 to 1976. Preparation of a report summarizing the results is scheduled for 1978.

EASTERN TRIBUTARIES OF MILK RIVER

The waters of the eastern tributaries of the Milk River were divided in accordance with the Order of the International Joint Commission dated October 4, 1921, which stipulates under Rule III that "The natural flow of the eastern (otherwise known as the Saskatchewan or northern) tributaries of the Milk River at the points where they cross the International Boundary shall be divided equally between the two countries". This order might well be interpreted as requiring that the division of water be made on a continuing basis. It was recognized that there is a physical limitation because of the transit time in the flow system so compilation of the natural flows at the International Boundary are done by ten-day periods, the smallest practical time increment.

Prior to 1937, Canadian usage on the eastern tributaries consisted of private irrigators and the Canadian share of the natural flow was not fully utilized. The construction of three major reservoirs by the government of Canada on the Frenchman River during the late 1930's made an operational division of flow necessary on this tributary in 1937.

The re-development by the government of several private irrigation projects and the construction of the Vidora project during the early 1950's resulted in increased utilization in Canada of Battle Creek water and made an operational division of flow on this tributary necessary in 1957.

Construction of a major government reservoir and irrigation project on Lodge Creek in 1960 made an operational division of flow on this tributary necessary in 1961.

The three tributaries, Lyons, Whitewater and Rock Creeks, are monitored but do not have sufficient usage in Canada at this time to warrant an operational division of flow.

Operation of the gauging stations on Woodpile Coulee, East Fork Battle Creek and McEachern Creek was suspended this year after fifty years of monitoring. Water use development in each of these basins will be reviewed annually and the gauging stations re-activated should development

progress to a point where a considerable portion of the natural flow is being utilized by Canada.

During the runoff season March 1 to October 31, representatives of both countries make ten-day computations of the natural flows of Lodge Creek, Battle Creek and Frenchman River to determine each country's share, so that any usage by Canada in excess of her share can be adjusted at the earliest opportunity by a subsequent delivery to the United States of an equivalent amount. Regular interim reports on the progress of the division of the natural flows of Lodge Creek, Battle Creek and Frenchman River at the International Boundary were made to interested agencies throughout the runoff season. No division of flow is made during the winter period as there is usually very little flow or use and it is impracticable to obtain streamflow records during this period.

The total quantity of water delivered to the United States during the period March 1 to October 31, 1977 by the six monitored tributaries listed in Table 2 of this report was 18,000 cubic decametres (14,600 acre-feet). Despite the extremely low runoff and numerous periods with deficits in deliveries, there were no serious problems in apportionment and the total quantity of water delivered to the United States during the season was in excess of its allotted share. The historical summaries for these tributaries are listed in Table 16 of Appendix A.

TABLE 2

RECORDED RUNOFF OF EASTERN TRIBUTARIES
OF MILK RIVER AT INTERNATIONAL BOUNDARY
FOR PERIOD MARCH TO OCTOBER 1977

(quantities in cubic decametres)

Month	Lodge Creek	Battle Creek	Lyons Creek	White-water Creek	French-man River	Rock Creek
Mar	38	1,210	0	39	839	874
Apr	197	761	0	58	1,678	2,048
May	623	781	0	19	3,293	841
Jun	31	545	0	10	694	189
Jul	0	5	0	1	726	465
Aug	0	0	0	1	861	15
Sep	0	0	0	4	57	366
Oct	0	25	0	11	120	560
TOTAL	889	3,327	0	143	8,268	5,358

TABLE 2-A

RECORDED RUNOFF OF EASTERN TRIBUTARIES
OF MILK RIVER AT INTERNATIONAL BOUNDARY
FOR PERIOD MARCH TO OCTOBER 1977

(quantities in acre-feet)

Month	Lodge Creek	Battle Creek	Lyons Creek	White-water Creek	French-man River	Rock Creek
Mar	31	981	0	32	680	709
Apr	160	617	0	47	1,360	1,660
May	505	633	0	15	2,670	682
Jun	25	442	0	8	563	153
Jul	0	4	0	1	589	377
Aug	0	0	0	1	698	12
Sep	0	0	0	3	46	297
Oct	0	20	0	9	97	454
TOTAL	721	2,697	0	116	6,703	4,344

Estimates of unmeasured diversions to private irrigation projects in the Lodge, Battle and Frenchman basins in Saskatchewan were provided by the Saskatchewan Department of the Environment, and for the Lodge basin in Alberta by the Department of the Environment, and for the Lodge basin in Alberta by the Department of Regional Economic Expansion, PFRA. These estimates are based on reports received from the operators of individual projects and by field inspections. An additional charge is made for domestic projects in the Battle and Frenchman basins based on the results of studies carried out by Canada on domestic project usage.

For the interim reports prepared at the end of apportionment periods an estimate of minor diversion projects usage is made based on a correlation between annual natural flows and reported usages for previous years. The natural flow for the current year is estimated from computed natural flow to date and an estimate of runoff volume for the remainder of the year dependent on runoff conditions. At the end of the year, the actual flow is known and a final estimate of minor diversions is made based on reported usage, consequently there is some discrepancy between interim and final division computations. Lists of reported and estimated diversions for 1977 are contained in Appendix B.

A return flow of 35%, based on a 1972-76 study, was used for the Gaff Ditch diversion from Battle Creek. The return flows from Vidora, Richardson, McKinnon and Nashlyn canals varied throughout the season and have been computed from the flow records at the supplementary gauging stations on Battle Creek. The Squaw Coulee gauging station recorded no return flow from the 2630 cubic decametres (2130 acre-feet) diversion by Spangler Ditch from Lodge Creek.

A supplementary gauging station was operated during 1977 on Shepherd Ditch, a private diversion on Battle Creek located downstream from Gaff Ditch. A total diversion of 577 cubic decametres (468 acre-feet) was recorded at this station during 1977.

A concrete control weir was built by Canada on Battle Creek at International Boundary during the fall of 1977. The construction of this weir should improve the record quality at this station.

LODGE CREEK

The computed natural runoff of Lodge Creek at the International Boundary for the period March 1 to October 31, 1977 was 1,240 cubic decametres (1,000 acre-feet) or 3% of the average natural runoff of the previous twenty-seven years of record. Each country was entitled to fifty percent of the natural runoff. A total runoff of 891 decametres (722 acre-feet) was recorded at the international boundary which is 144% of the United States share.

Deficit deliveries were recorded in five of the twenty-four division periods during the season.

The division of the Lodge Creek natural flow is summarized in Table 3. The detailed computation of the natural flow is given in Table 10 and the historical summary in Table 11, of Appendix A.

TABLE 3

SUMMARY OF LODGE CREEK DIVISION

1977

(quantities in cubic decametres)

Division Period at International Boundary	Natural Flow	U.S.A. Share	Received by U.S.A.	Received by U.S.A.	
				Above Share	Below Share
Mar 1 - Mar 10	0	0	0	0	
Mar 11 - Mar 20	14	7	15	8	
Mar 21 - Mar 31	14	7	24	17	
Apr 1 - Apr 10	120	60	17		43
Apr 11 - Apr 20	226	113	10		103
Apr 21 - Apr 30	86	43	171	128	
May 1 - May 10	4	2	61	59	
May 11 - May 20	156	78	436	358	
May 21 - May 31	218	109	125	16	
Jun 1 - Jun 10	52	26	30	4	
Jun 11 - Jun 20	2	1	2	1	
Jun 21 - Jun 30	46	23	0		23
Jul 1 - Jul 10	0	0	0	0	
Jul 11 - Jul 20	248	124	0		124
Jul 21 - Jul 31	0	0	0	0	
Aug 1 - Aug 10	0	0	0	0	
Aug 11 - Aug 20	0	0	0	0	
Aug 21 - Aug 31	0	0	0	0	
Sep 1 - Sep 10	0	0	0	0	
Sep 11 - Sep 20	0	0	0	0	
Sep 21 - Sep 30	50	25	0		25
Oct 1 - Oct 10	0	0	0	0	
Oct 11 - Oct 20	0	0	0	0	
Oct 21 - Oct 31	0	0	0	0	
TOTAL-cubic decametres	1236	618	891		

TABLE 3-A

SUMMARY OF LODGE CREEK DIVISION

1977

(quantities in cfs days)

Division Period at International Boundary	Natural Flow	U.S.A. Share	Received by U.S.A.	Received by U.S.A.	
				Above Share	Below Share
Mar 1 - Mar 10	0	0	0	0	
Mar 11 - Mar 20	6	3	6	3	
Mar 21 - Mar 31	6	3	10	7	
Apr 1 - Apr 10	49	24	7		17
Apr 11 - Apr 20	92	46	4		42
Apr 21 - Apr 30	35	18	70	52	
May 1 - May 10	2	1	25	24	
May 11 - May 20	64	32	178	146	
May 21 - May 31	89	44	51	7	
Jun 1 - Jun 10	21	11	12	1	
Jun 11 - Jun 20	1	0	1	1	
Jun 21 - Jun 30	19	10	0		10
Jul 1 - Jul 10	0	0	0	0	
Jul 11 - Jul 20	101	51	0		51
Jul 21 - Jul 31	0	0	0	0	
Aug 1 - Aug 10	0	0	0	0	
Aug 11 - Aug 20	0	0	0	0	
Aug 21 - Aug 31	0	0	0	0	
Sep 1 - Sep 10	0	0	0	0	
Sep 11 - Sep 20	0	0	0	0	
Sep 21 - Sep 30	20	10	0		10
Oct 1 - Oct 10	0	0	0	0	
Oct 11 - Oct 20	0	0	0	0	
Oct 21 - Oct 31	0	0	0	0	
TOTAL - cfs days	505	253	364		
- acre-feet	1002	501	722		

BATTLE CREEK

The computed natural runoff of Battle Creek at the International Boundary for the period March 1 to October 31, 1977 was 5,840 cubic decametres (4,740 acre-feet) or 17 percent of the average natural runoff of the previous thirty-seven years of record. Each country was entitled to 50% of the natural runoff. A total runoff of 3,330 cubic decametres (2,700 acre-feet) was recorded at the international boundary which is 114% of the United States share.

Deficit deliveries were recorded in six of the twenty-four division periods during the season.

The division of the Battle Creek natural flow is summarized in Table 4. The detailed computation of the natural flow is given in Table 12 and the historical summary in Table 13 of Appendix A.

TABLE 4

SUMMARY OF BATTLE CREEK DIVISION

1977

(quantities in cubic decametres)

Division Period at International Boundary	Natural Flow	U.S.A. Share	Received by U.S.A.	Received by U.S.A.	
				Above Share	Below Share
Mar 1 - Mar 14	848	424	668	244	
Mar 15 - Mar 25	854	427	445	18	
Mar 26 - Apr 4	460	230	154		76
Apr 5 - Apr 14	1290	645	553		92
Apr 15 - Apr 24	528	264	122		142
Apr 25 - May 4	344	172	49		123
May 5 - May 14	292	146	29		117
May 15 - May 25	438	219	313	94	
May 26 - Jun 4	242	121	568	447	
Jun 5 - Jun 14	118	59	257	198	
Jun 15 - Jun 24	156	78	122	44	
Jun 25 - Jul 4	24	12	20	8	
Jul 5 - Jul 14	0	0	2	2	
Jul 15 - Jul 25	220	110	0		110
Jul 26 - Aug 4	0	0	0	0	
Aug 5 - Aug 14	0	0	0	0	
Aug 15 - Aug 25	0	0	0	0	
Aug 26 - Sep 4	0	0	0	0	
Sep 5 - Sep 14	0	0	0	0	
Sep 15 - Sep 24	0	0	0	0	
Sep 25 - Oct 4	0	0	0	0	
Oct 5 - Oct 14	0	0	0	0	
Oct 15 - Oct 25	0	0	0	0	
Oct 26 - Oct 31	30	15	25	10	
TOTAL-cubic decametres	5844	2922	3327		

TABLE 4A

SUMMARY OF BATTLE CREEK DIVISION

1977

(quantities in cfs days)

Division Period at International Boundary	Natural Flow	U.S.A. Share	Received by U.S.A.	Received by U.S.A.	
				Above Share	Below Share
Mar 1 - Mar 14	347	173	273	100	
Mar 15 - Mar 25	349	175	182	7	
Mar 26 - Apr 4	188	94	63		31
Apr 5 - Apr 14	527	263	226		37
Apr 15 - Apr 24	216	108	50		58
Apr 25 - May 4	141	71	20		51
May 5 - May 14	119	59	12		47
May 15 - May 25	179	90	128	38	
May 26 - Jun 4	99	49	232	183	
Jun 5 - Jun 14	48	24	105	81	
Jun 15 - Jun 24	64	32	50	18	
Jun 25 - Jul 4	10	5	8	3	
Jul 5 - Jul 14	0	0	1	1	
Jul 15 - Jul 25	90	45	0		45
Jul 26 - Aug 4	0	0	0	0	
Aug 5 - Aug 14	0	0	0	0	
Aug 15 - Aug 25	0	0	0	0	
Aug 26 - Sep 4	0	0	0	0	
Sep 5 - Sep 14	0	0	0	0	
Sep 15 - Sep 24	0	0	0	0	
Sep 25 - Oct 4	0	0	0	0	
Oct 5 - Oct 14	0	0	0	0	
Oct 15 - Oct 25	0	0	0	0	
Oct 26 - Oct 31	12	6	10	4	
TOTAL - cfs days	2389	1194	1360		
- acre-feet	4739	2369	2698		

FRENCHMAN RIVER

The computed natural runoff of the Frenchman River at the International Boundary for the period March 1 to October 31, 1977 was 12,700 cubic decametres (10,300 acre-feet) or 14% of the average runoff of the previous thirty-seven years of record. Each country was entitled to 50% of the natural runoff. A total runoff of 8,270 cubic decametres (6,700 acre-feet) was recorded at the international boundary which is 130% of the United States share.

Deficit deliveries were recorded in six of the twenty-four division periods during the season.

The division of the Frenchman River natural flow is summarized in Table 5. The detailed computation of the natural flow is given in Table 14 and the historical summary in Table 15 of Appendix A.

TABLE 5

SUMMARY OF FRENCHMAN RIVER DIVISION

1977

(quantities in cubic decametres)

Division Period at International Boundary	Natural Flow	U.S.A. Share	Received by U.S.A.	Received by U.S.A.	
				Above Share	Below Share
Mar 1 - Mar 10	790	395	279		116
Mar 11 - Mar 20	1362	681	281		400
Mar 21 - Mar 31	1108	554	277		277
Apr 1 - Apr 10	934	467	758	291	
Apr 11 - Apr 20	3558	1779	653		1126
Apr 21 - Apr 30	524	262	267	5	
May 1 - May 10	0	0	1211	1211	
May 11 - May 20	830	415	1035	620	
May 21 - May 31	1506	753	1047	294	
Jun 1 - Jun 10	432	216	242	26	
Jun 11 - Jun 20	162	81	139	58	
Jun 21 - Jun 30	226	113	313	200	
Jul 1 - Jul 10	0	0	159	159	
Jul 11 - Jul 20	136	68	201	133	
Jul 21 - Jul 31	0	0	367	367	
Aug 1 - Aug 10	78	39	306	267	
Aug 11 - Aug 20	578	289	391	102	
Aug 21 - Aug 31	160	80	162	82	
Sep 1 - Sep 10	0	0	32	32	
Sep 11 - Sep 20	0	0	0	0	
Sep 21 - Sep 30	0	0	25	25	
Oct 1 - Oct 10	122	61	73	12	
Oct 11 - Oct 20	118	59	10		49
Oct 21 - Oct 31	108	54	39		15
TOTAL-cubic decametres	12732	6366	8267		

TABLE 5A

SUMMARY OF FRENCHMAN RIVER DIVISION

1977

(quantities in cfs days)

Division Period at International Boundary	Natural Flow	U.S.A. Share	Received by U.S.A.	Received by U.S.A.	
				Above Share	Below Share
Mar 1 - Mar 10	323	162	114		48
Mar 11 - Mar 20	557	278	115		163
Mar 21 - Mar 31	453	226	113		113
Apr 1 - Apr 10	382	191	310	119	
Apr 11 - Apr 20	1454	727	267		460
Apr 21 - Apr 30	214	107	109	2	
May 1 - May 10	0	0	495	495	
May 11 - May 20	339	170	423	253	
May 21 - May 31	616	308	428	120	
Jun 1 - Jun 10	177	88	99	11	
Jun 11 - Jun 20	66	33	57	24	
Jun 21 - Jun 30	92	46	128	82	
Jul 1 - Jul 10	0	0	65	65	
Jul 11 - Jul 20	56	28	82	54	
Jul 21 - Jul 31	0	0	150	150	
Aug 1 - Aug 10	32	16	125	109	
Aug 11 - Aug 20	236	118	160	42	
Aug 21 - Aug 31	65	33	66	33	
Sep 1 - Sep 10	0	0	13	13	
Sep 11 - Sep 20	0	0	0	0	
Sep 21 - Sep 30	0	0	10	10	
Oct 1 - Oct 10	50	25	30	5	
Oct 11 - Oct 20	48	24	4		20
Oct 21 - Oct 31	44	22	16		6
TOTAL - cfs days	5204	2602	3379		
- acre-feet	10322	5161	6702		

APPENDICES

Appendices A and B are submitted with this report under separate cover. Appendix A contains the natural flow computations for the St. Mary River, Milk River, Lodge Creek, Battle Creek and Frenchman River. It also contains historical summaries of the natural flows, recorded runoff, United States shares and Canadian shares of the St. Mary River; historical summaries of natural flows, United States and Canadian shares and recorded runoff of Milk River; historical summaries of natural and recorded runoff of Lodge Creek, Battle Creek and Frenchman River; the historical summary of the March to October runoff of the Eastern Tributaries of the Milk River and the month-end contents of the major reservoirs in the Lodge, Battle and Frenchman basins for 1977.

Appendix B contains the daily discharge data for thirty-six international gauging stations operated jointly by the United States and Canada, and six stations used in the natural flow computations which are operated by Canada. The details of the minor diversions in Canada are also contained in Appendix B.

INTERNATIONAL GAUGING STATIONS OPERATED JOINTLY

BY

CANADA AND UNITED STATES

ST. MARY AND MILK RIVER DRAINAGE BASINS

1977

Map Index	Stream and Location
	ST. MARY RIVER BASIN
05AE027	St. Mary River at International Boundary
05AE036	Lake Sherburne at Sherburne, Montana
05AE033	Swiftcurrent Creek at Sherburne, Montana
05AE029	St. Mary Canal at St. Mary Crossing near Babb, Montana
	MILK RIVER BASIN
11AA025	Milk River at Western Crossing of International Boundary
11AA005	Milk River at Milk River
11AA031	Milk River at Eastern Crossing of International Boundary
11AA033	South Fork Milk River near Babb, Montana
11AA032	North Fork Milk River above St. Mary Canal near Browning, Montana
11AA001	North Milk River near International Boundary
	LODGE CREEK TRIBUTARY BASIN
11AB089	Altawan Reservoir near Govenlock
11AB083	Lodge Creek below McRae Creek at International Boundary
11AB086	Walburger Coulee below Diversions
11AB060	Spangler Ditch near Govenlock
11AB009	Middle Creek near Alberta Boundary
11AB080	Middle Creek Reservoir
11AB001	Middle Creek below Middle Creek Reservoir
	BATTLE CREEK TRIBUTARY BASIN
11AB027	Battle Creek at International Boundary
11AB102	Gaff Ditch near Merryflat
11AB078	Cypress Lake West Inflow Canal
11AB085	Cypress Lake West Inflow Canal Drain
11AB077	Cypress Lake West Outflow Canal

BATTLE CREEK TRIBUTARY BASIN (continued)

11AB084	Vidora Ditch near Consul
11AB058	Richardson Ditch near Consul
11AB044	McKinnon Ditch near Consul
11AB018	Nashlyn Canal near Consul
11AB075	Lyons Creek at International Boundary

FRENCHMAN RIVER TRIBUTARY BASIN

11AC055	Eastend Reservoir
11AC001	Frenchman River below Eastend Reservoir
11AC063	Val Marie West Reservoir
11AC056	Val Marie Reservoir
11AC041	Frenchman River at International Boundary
11AC060	Cypress Lake East Outflow Canal
11AC037	Cypress Lake
11AC064	Belanger Creek Diversion to Cypress Lake
11AC052	Eastend Canal
11AC066	Val Marie West Pumping Canal
11AC065	Val Marie West Gravity Canal
11AC054	Val Marie Main Canal
11AC025	Denniel Creek near Val Marie
11AC062	Frenchman River below Val Marie Reservoir

WHITEWATER CREEK TRIBUTARY BASIN

11AD001	Whitewater Creek near International Boundary

ROCK CREEK TRIBUTARY BASIN

11AE009	Rock Creek below Horse Creek near International Boundary

GAUGING STATIONS OPERATED INDEPENDENTLY BY EITHER CANADA OR UNITED STATES IN THE ST. MARY AND MILK RIVER DRAINAGE BASINS 1977

Map Index	Stream and Location	Operated By
	ST. MARY RIVER BASIN	
5-0175*	St. Mary River near Babb, Montana	U.S.A.
05AE025*	St. Mary Reservoir near Spring Coulee	Canada
05AE006*	St. Mary River near Lethbridge	Canada
5-0140*	Grinnell Creek near Many Glacier, Montana	U.S.A.
5-0145*	Swiftcurrent Creek at Many Glacier, Montana	U.S.A.
05AE005*	Rolph Creek near Kimball	Canada
05AE002*	Lee Creek at Cardston	Canada
05AE026*	Canadian St. Mary Canal near Spring Coulee	Canada
05AE021*	Magrath Irrigation District Canal near Spring Coulee	Canada
05AE016*	Pothole Creek at Russell's Ranch	Canada
05AE038*	Pothole Turnout near Magrath	Canada
	MILK RIVER BASIN - SOUTHERN TRIBUTARIES	
11AA029*	Miners Coulee near International Boundary	Canada
11AA028*	Bear Creek near International Boundary	Canada
	LODGE CREEK TRIBUTARY BASIN	
11AB082*	Lodge Creek at Alberta Boundary	Canada
11AB091	Michele Reservoir near Elkwater	Canada
11AB092	Greasewood Reservoir near Elkwater	Canada
11AB104	Massy Reservoir near Elkwater	Canada
11AB094	Bare Creek Reservoir near Elkwater	Canada
11AB097	Cressday Reservoir near Cressday	Canada
11AB098	Jaydot Reservoir near Jaydot	Canada
11AB099	Mitchell Reservoir near Elkwater	Canada
11AB113	Middle Creek Reservoir Main Outlet	Canada

Map Index	Stream and Location	Operated by
	LODGE CREEK TRIBUTARY BASIN (contined)	
11AB008*	Middle Creek above Lodge Creek	Canada
11AB114	Middle Creek Reservoir Bedford Outlet	Canada
11AB115	Middle Creek Reservoir Flood Spillway	Canada
11AB108*	Middle Creek near Govenlock	Canada
11AB103	Squaw Coulee near Willow Creek	Canada
	BATTLE CREEK TRIBUTARY BASIN	
11AB117*	Battle Creek at Alberta Boundary	Canada
11AB100*	Battle Creek above Cypress Lake West Outflow Canal	Canada
11AB096*	Battle Creek near Consul	Canada
11AB101*	Battle Creek below Nashlyn Project	Canada
11AB095	Adams Lake	Canada
11AB090	Reesor Reservoir	Canada
11AB020*	Shepherd Ditch near Consul	Canada
	FRENCHMAN RIVER TRIBUTARY BASIN	
11AC068	Val Marie Pump No. 1	Canada
11AC069	Val Marie Pump No. 2	Canada

* Data not included in this report or appendices


ALBERTA
SASKATCHEWAN
MONTANA
CANADA
UNITED STATES OF AMERICA
BOUNDARY OF DRAINAGE BASIN
Bow River
SOUTH SASKATCHEWAN RIVER
Oldman River
Lethbridge
Magrath
St. Mary Reservoir
Canadian St. Mary Canal
Jensen Reservoir
Cardston
Milk River
Verdigris Lake
Verdigris Coulee
Van Cleeve Coulee
Police Cr.
Deer Cr.
Macdonald Cr.
Mimms Coulee
Breed Creek
Bear Cr.
Red Creek
Lee Creek
St. Mary R.
Ralph Cr.
St. Mary Canal
Milk River
Shanks Creek
Swift Current Cr.
L. Sherburne
Duck L.
Middle Fk
Lower St. Mary Lake
St. Mary Lake
South Fk
Milk R.
GLACIER NAT. PARK
Grinnell Creek
ROCKY MOUNTAINS
SWEET GRASS HILLS
Little Sage Cr.
Sage Creek
Big Sandy Creek
Fresno Reservoir
Havre
Lost River
Milk River
Reesor Reservoir
Adams Lake
CYPRESS HILLS
Mitchell Reservoir
Michele Reservoir
Massy Reservoir
Greasewood Reservoir
Bare Creek Reservoir
Cressday Reservoir
Middle Creek Reservoir
Altawan Reservoir
Jaydot
Govenlock
Consul
Middle Cr.
Bare Creek
Lodge Cr.
Woodpile Coulee
Lyons Cr.
Battle Creek
East Fork Battle Creek
Red Rock Coulée
Chinook
Harlem
Thirty Mile Creek
Wayne Creek
Savoy Creek
Woody Island Coulée
Dodson Dam
Dodson
Malta
Peoples Creek
Beaver Creek
Cypress Lake
Eastend Reservoir
Eastend
FRENCHMAN
Val Marie West Reservoir
Val Marie Reservoir
Val Marie
Dennie Cr.
WOOD MOUNTAIN
Horse Creek
McEschern Creek
N. Fork Whitewater Cr.
Cottonwood Coulee
East Fork Whitewater Cr.
Whitewater Cr.
Cottonwood Creek
Nelson Reservoir
Frenchman Reservoir
RIVER
Rock Creek
Porcupine Creek
05AE016
05AE006
05AE025
05AE021
05AE026
05AE038
05AE002
05AE005
05AE027
05AE029
05AE033
05AE036
5-0145
5-0140
5-0175
11AA001
11AA005
11AA025
11AA028
11AA029
11AA031
11AA032
11AA033
11AB117
11AB090
11AB095
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11AB092
11AB104
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11AB099
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11AB080
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11AB082
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11AB089
11AB060
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11AB103
11AB083
11AB085
11AB078
11AB100
11AB102
11AB058
11AB020
11AB096
11AB108
11AB101
11AB027
11AB075
11AB018
11AB084
11AB044
11AB077
11AC037
11AC064
11AC060
11AC055
11AC001
11AC052
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11AC065
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11AC063
11AC025
11AC056
11AC062
11AC041
11AD001
11AE009
08
113°
112°
111°
110°
109°
108°
107°
50°
49°
48°
LEGEND
International gauging station
Other gauging station
International reservoir station
Reservoir
MAP OF ST. MARY AND MILK RIVER DRAINAGE BASINS
SCALE OF MILES
10 0 10 20 30
1977

HD
1694
.A2
R424
1977

Report to the International Joint Commission on the division and use of the waters of the St. Mary and Milk Rivers...