

TECHNICAL REPORT TO THE
PPWB COMMITTEE ON HYDROLOGY

NATURAL FLOW

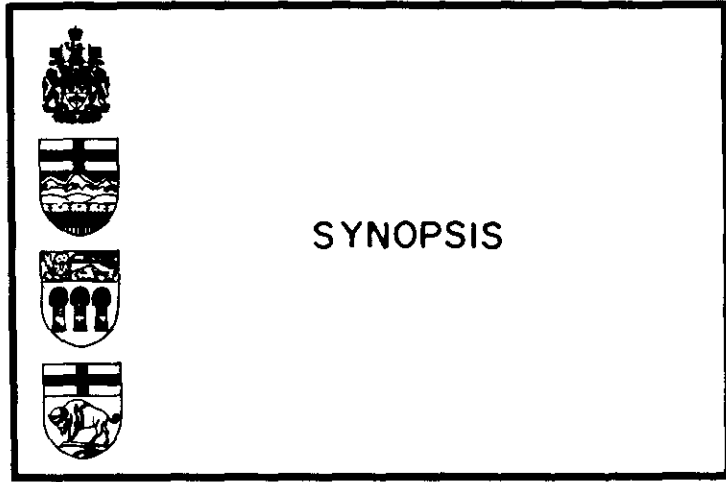
RED DEER RIVER
AT SASKATCHEWAN – MANITOBA BOUNDARY

JULY 1988

PPWB REPORT #102

PREPARED BY:

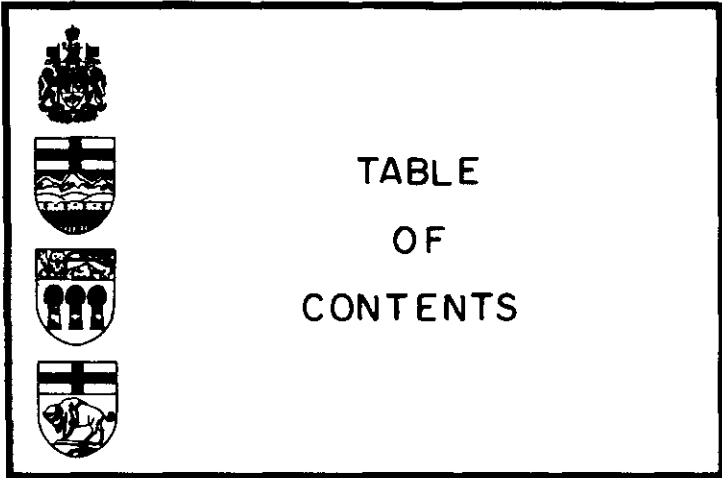
HYDROLOGY DIVISION
PRAIRIE FARM REHABILITATION ADMINISTRATION
AGRICULTURE CANADA



The average annual natural flow of Red Deer River at the Saskatchewan-Manitoba boundary is 592 000 dam³ on a water year basis or 590 000 dam³ on a calendar year basis. Average annual consumptive water use in the Saskatchewan portion of the basin now amounts to approximately 1740 dam³, 0.3% of the average annual natural flow. Man-made drainage projects within the Saskatchewan portion of the basin currently increase the natural effective drainage area by 936 km², or 11.1%, at the interprovincial boundary. It is estimated that this increased effective drainage area contributes an average annual flow volume of 47 100 dam³. The cumulative net effect of consumptive water use and man-made drainage is to increase the average annual flow at the interprovincial boundary by 45 400 dam³, or 7.7%.

The present (1986) level of consumptive use (including drainage) in the Saskatchewan portion of the Red Deer River basin would not, on an annual basis, have exceeded Saskatchewan's 50% share of the natural flow at the Saskatchewan-Manitoba boundary at any time during the 74-year period 1912-13 to 1985-86. In fact, as a direct result of drainage improvements, Saskatchewan would have increased the annual flow at the natural condition by a minimum of 1.9% (corresponds to the water balance period 1954-55). The average annual quantity of water which would have been delivered to Manitoba in excess of 50% of natural flow would have amounted to 342 000 dam³.

At the present time, the existing hydrometric network provides adequate hydrometric data for calculating the natural flow of Red Deer River at the Saskatchewan-Manitoba boundary. Ideally, a hydrometric gauging station at the interprovincial boundary would provide a more accurate estimate of natural flow. However, an accurate estimate of natural flow at the boundary is not required until water uses in the Saskatchewan portion of the basin become significant. Monitoring of apportionment is not required at the present time because the uses in the Saskatchewan portion of the basin are minimal and drainage projects actually increase the flow above what would have occurred under natural conditions.



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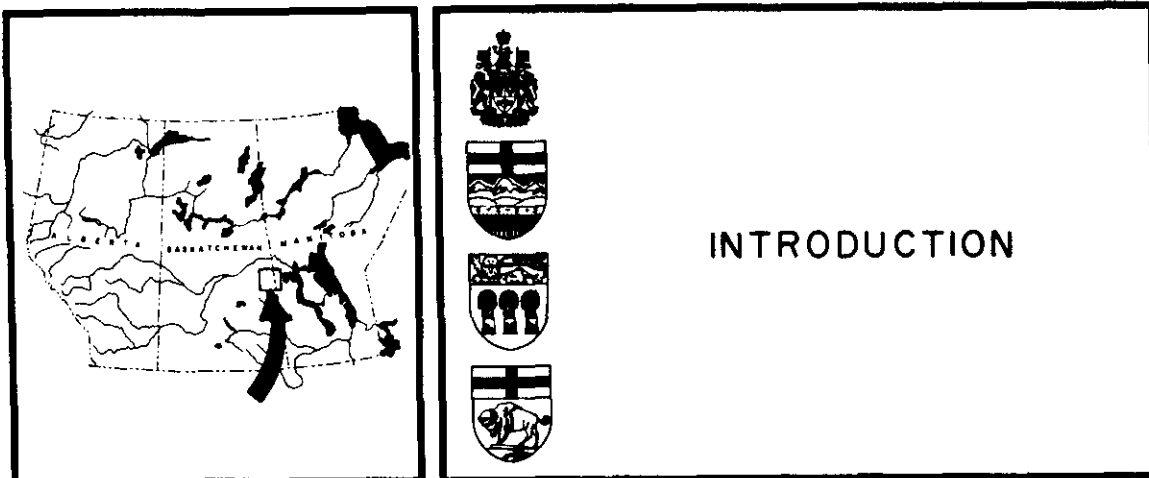
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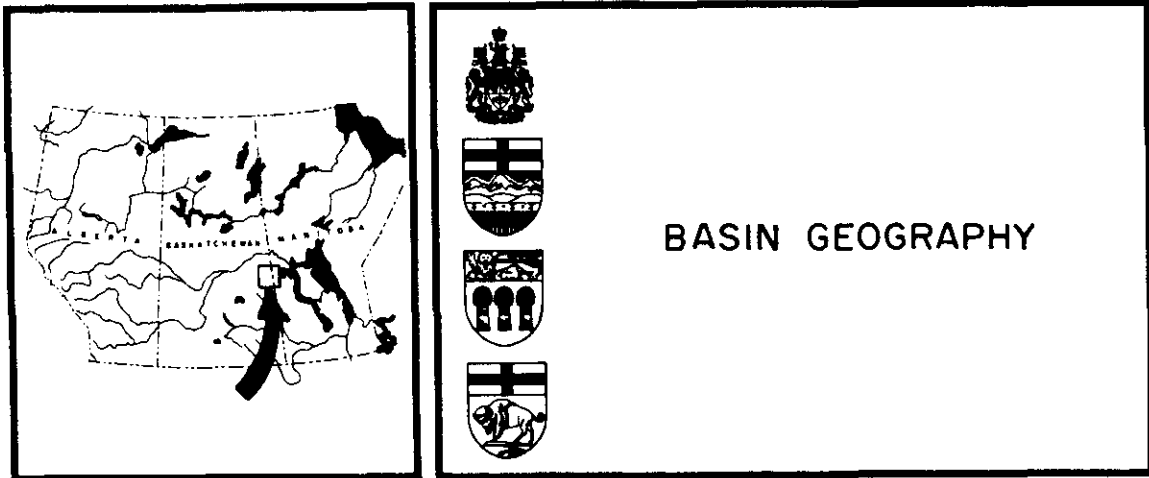
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The Red Deer River natural flow study is one of a series of natural flow studies conducted for the Prairie Provinces Water Board. Following completion of the Prairie Provinces Water Board's study on determination of natural flow of the North Saskatchewan, South Saskatchewan, Saskatchewan, Churchill, and Qu'Appelle River basins in 1977, the Board agreed to have other interprovincial basins studied to determine if monitoring of flow for apportionment might be required. Eighteen interprovincial basins, including the Red Deer River basin, were initially identified and assigned a priority. Two additional basins, Beaver River and Overflowing River, were subsequently added to the list. The Board agreed that the basins would be studied in order of priority as funds and time became available.

This report on 'Natural Flow, Red Deer River at Saskatchewan-Manitoba Boundary' describes the basin geography, water use and drainage development within the basin, and the derivation of historic natural flows at the Saskatchewan-Manitoba boundary. The present (1986) level of use is analyzed in conjunction with natural flows to determine the potential for apportionment deficits now and in the foreseeable future. The procedure to be used for the future calculation of natural flow is also provided, and the adequacy of the existing hydrometric network for the determination of natural flow at the interprovincial boundary is assessed.



The Red Deer River originates at the outflow channel of Nut Lake in east-central Saskatchewan, west of the Porcupine Hills, approximately 31 km north of the Town of Kelvington, Saskatchewan (see Figure 1). The river flows approximately 20 km northward before being joined by the Barrier River, one of two major tributaries. From the junction with Barrier River, the Red Deer River turns eastward, running along the southern edge of the Pasquia Hills. Immediately south of the Town of Hudson Bay, Saskatchewan, the Red Deer River is joined by its second major tributary, the Etomami River. From this juncture, the Red Deer River flows in an easterly direction for approximately 50 km before passing into Manitoba. After entering Manitoba, the river continues flowing east for approximately 18 km where it discharges into Red Deer Lake. Outflow from Red Deer Lake in Manitoba passes through Lake Winnipegosis, Lake Manitoba, and Lake Winnipeg and flows on to Hudson Bay.

Most of the drainage basin is classified as forest area with aspen and spruce cover. In the portion of the basin below the Town of Hudson Bay, the vegetation changes to swampy areas of peat bog, muskeg, stunted trees and some spruce, aspen and poplar growth.

The topography of the area provides reasonably well-drained conditions throughout the basin (i.e. current effective to gross drainage area ratio is in the order of 0.8). However, in certain portions of the basin, runoff is retarded by several small lakes. Consequently,

the unit runoff in these areas is probably somewhat lower than for the rest of the basin.

The natural (i.e. before any man-made drainage works) gross and effective drainage areas of the Red Deer River basin at the Saskatchewan-Manitoba boundary are 11 800 km² and 8425 km², respectively. None of the flow in the Red Deer River at the boundary originates in Manitoba. A table of gross and effective drainage areas⁽¹⁾ for key points in the basin is provided in Figure 1. Appendix C, Table C-1 lists the gross and effective drainage areas at the present (1986) level of drainage development for all Water Survey of Canada hydrometric gauging stations located in the Red Deer River basin.

The Red Deer River is classified as a perennial stream. Snowmelt in the spring contributes to high flows which rapidly give way to a generally diminishing base flow, resulting from marsh drainage and groundwater contribution, which persists through the remainder of the year. The median and mean annual natural runoff volumes of Red Deer River at the Saskatchewan-Manitoba boundary are 473 900 dam³ and 592 500 dam³, respectively. These values were determined from the array of natural flows at the interprovincial boundary as presented in Appendix B, Table B-5.



Water Use Projects

Five relatively major consumptive water use projects are located within the natural effective drainage area in the Saskatchewan portion of the Red Deer River basin.

1. Merle Lake - SE25-41-13-W2
Storage Capacity at FSL = 109 dam³
2. McArthur East Lake - SW25-41-17-W2
Storage Capacity at FSL = 88.0 dam³
3. Greenwater Lake - NW13-41-11-W2
Storage Capacity at FSL = 54 621 dam³
4. Round Lake - NE18-39-10-W2
Storage Capacity at FSL = 15 930 dam³
5. Salkeld Lake - SE32-37-12-W2
Storage Capacity at FSL = 232 dam³

Merle Lake (Water Rights #14819) is licensed for an annual diversion of 31 dam³. Constructed in 1984 by Ducks Unlimited, the structure raises the level of existing Merle Lake from the natural FSL capacity of 42.2 dam³ to 109 dam³. The simulated average annual reduction in outflow volume from Merle Lake resulting from the increase in FSL over the period 1984 to 1986 was 31.4 dam³. (Over the simulated period 1912 to 1986, the existing project would have reduced the average annual outflow volume by 11.1 dam³.)

McArthur East Lake (Water Rights #13738) is licensed for an annual diversion of 56 dam³. Constructed in 1980 by Ducks Unlimited, the structure creates a lake with a storage of 88.0 dam³ at FSL. The simulated average annual reduction in streamflow caused by the project over the period 1980 to 1986 was 66.7 dam³. (Over the simulated period 1912 to 1986, the existing project would have reduced the average annual outflow volume by 40.6 dam³.)

Greenwater Lake (Water Rights #4111) is licensed for an annual diversion of 3700 dam³. The first of two structures built on the outlet of Greenwater Lake was constructed in 1964. This structure raised the lake storage at FSL from 37 254 dam³ (natural conditions) to 54 621 dam³. In 1973, a second (existing) structure was built downstream of the first dam but it did not change the storage at FSL. The simulated average annual reduction in outflow volume from Greenwater Lake caused by the increase in FSL over the period 1964 to 1986 was 2027 dam³. (Over the simulated period 1912 to 1986, the existing project would have reduced the average annual outflow volume by 1033 dam³.)

Round Lake (Water Rights #12223) is licensed for an annual diversion of 1554 dam³. In 1958, PFRA constructed an outlet control structure on Round Lake which raised the lake storage at FSL from 8736 dam³ (natural conditions) to 12 960 dam³. In 1974, the outlet control structure was modified which resulted in the lake storage at FSL increasing to 15 930 dam³. The simulated average annual reduction in outflow volume from Round Lake caused by the increase in FSL over the period 1958 to 1986 was 319 dam³. (Over the simulated period 1912 to 1986, the existing project would have reduced the average annual outflow volume by 146 dam³.)

Salkeld Lake (Water Rights #7002 and #12826) has no licensed annual diversion. In 1960, Ducks Unlimited constructed an outlet control structure which raised the lake storage at FSL from 460 dam³ (natural conditions) to 1034 dam³. In the years following construction of the dam, local area farmers complained of flooding, which was seen locally as being caused by the Ducks Unlimited structure. In 1966, the outlet channel of Salkeld Lake was dredged and was connected with a channel

excavated around the embankment and into the lake, which dropped the lake storage at FSL to its current (1986) volume of 232 dam³. The simulated average annual reduction in outflow volume from Salkeld Lake caused by the changes in FSL over the period 1960 to 1986 was -19.2 dam³ which meant that the annual spill volume from Salkeld Lake over the 27-year period was, on average, 19.2 dam³ more than had the lake remained in its natural state. (Over the simulated period 1912 to 1986, the existing project would have increased the average annual outflow volume by 96.1 dam³.)

Several licensed and unauthorized minor water use projects are located within the effective drainage area in the Saskatchewan portion of the Red Deer River basin. Information on licensed minor water use projects was obtained from the Saskatchewan Water Corporation. Unauthorized water use projects were identified on aerial photographs and then investigated during a June, 1987 field trip. This field assessment involved quantitatively estimating the amount of use (including evaporation losses) for all man-made storages and interviewing local residents to determine the period of time each project had been in operation.

Four towns (Kelvington, Lintlaw, Porcupine Plain and Rose Valley) in the Saskatchewan portion of the Red Deer River basin obtain their water from wells, but discharge their sewage effluent into tributaries of the Red Deer River. The effluent volumes from these towns and the Town of Hudson Bay (which obtains its water supply from the Fir River Reservoir) were considered significant enough for inclusion in calculation of natural flows. (Effluent from other communities in the basin, as indicated in Appendix A, Table A-1, was not considered to be significant.) Monthly effluent discharges from each town's sewage system were estimated from water consumption records and historic system operation. Effluent discharge from these lagoons was assumed to have occurred year round with the monthly distribution set equal to the monthly municipal pumpage (when pumpage records were available). When no town pumpage or lagoon release records existed, town pumpage was estimated based on the water right allocation, and effluent discharge was assumed to occur uniformly over 12 months.

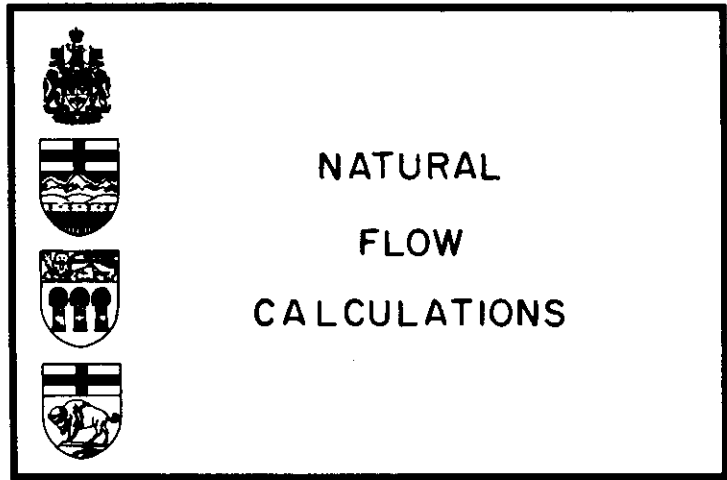
An itemized list of all historic water uses within the effective drainage area of the Red Deer River basin is provided in Appendix A, Table A-1.

Drainage Projects

The Red Deer River basin is interspersed with numerous regions of flat, wet and generally poorly-drained areas. As more areas within the basin were developed over the years to accommodate an increasing farming population, the need to deal with the problem of inadequate surface water drainage arose. The historical solution to this problem has been the construction of both crude and sophisticated drainage ditches. All ditches that drained areas within the Red Deer River basin were considered to affect natural monthly flow volumes of the Red Deer River at the interprovincial boundary. The effect of these drainage projects was assumed to vary from year to year depending upon the magnitude of the annual runoff.

For purposes of this study, all drainage projects which altered the natural effective or gross drainage area were considered. Appendix A, Table A-3 lists all drainage projects that affect the flow of the Red Deer River basin at the Saskatchewan-Manitoba boundary. From Table A-3, the total increase in effective drainage area to the boundary from all drainage projects (as of 1986) was 936 km², which represents an 11.1% increase in the natural effective drainage area. The total increase in gross drainage area to the boundary from all drainage projects (as of 1986) was 26.5 km², which represents a 0.22% increase in the natural gross drainage area.

The increase in flow volume of the Red Deer River at the interprovincial boundary resulting from all upstream drainage projects far exceeds all depletions (within the effective drainage area) due to water uses. Hence, the net effect of basin water uses and drainage projects is to increase the overall yield from the Red Deer River basin at the Saskatchewan-Manitoba boundary.



Natural flow, the quantity of water which would have been recorded under natural conditions (i.e. prior to the effect of human interference or intervention), was derived by adjusting recorded flow for both historic water uses using the Project Depletion Method(2) and for historic drainage projects. The natural flows were transferred, as appropriate, from the gauging station Red Deer River near Hudson Bay (05LC002) to the gauging station Red Deer River near Erwood (05LC001), and the resultant partial array was extended to cover the 75-year historic period 1912 to 1986. The natural flows were then transferred to the Saskatchewan-Manitoba boundary using annual contributing drainage area ratios.

The hydrometric gauging station, Red Deer River near Hudson Bay (05LC002), was established in 1913 and operated for seven years until 1919. It was reactivated in 1950 and operated for four years until 1953. In 1954, the station was moved 18 km downstream and since then, it has been operated as the hydrometric gauging station Red Deer River near Erwood (05LC001). The arrays of recorded monthly mean flows for these two stations are shown in Appendix B, Tables B-1 and B-2.

A hydrometric gauging station, Red Deer River near the Mouth, Lake Winnipegosis (05LC004), was established in 1956 and has been operated since then. However, this station was not used in the present study because it is located downstream of a major water body, Red Deer Lake, which significantly affects the flows.

Historic upstream water uses within the natural effective drainage area of the Red Deer River basin, as shown in Appendix A, Table A-1, were determined on an annual basis as a function of estimated water use (including evaporation) and available inflow. The estimated annual water uses varied from year to year because of the variable net evaporation and the limitation of restricting annual water use in any given year to available flow. All of the water use projects in Table A-1 are within the natural effective drainage area of the Red Deer River basin above the hydrometric gauging station Red Deer River near Erwood (05LC001) and thus were used in the natural flow calculations.

The variable estimated monthly water uses for all projects located above each of the two hydrometric gauging stations were lagged downstream and added to the appropriate recorded monthly mean flows of the gauging stations. The effect of historic drainage projects was then taken into account by dividing the flow array at each gauging station (after all water uses had been added) by an array of ratios representing the percentage increase (in each year of the period 1912-86) in contributing drainage area at the respective gauging station. [For example, there was no record of any drainage projects affecting the natural effective drainage area before 1940. However, in 1986, the effective drainage area of 05LC001 was 8555 km², a 12.1% increase over the natural effective drainage area of 7633 km².] The resulting natural monthly mean flows for the station 05LC002 were transferred downstream to the hydrometric station 05LC001 using annual contributing drainage area ratios to produce an array of natural monthly mean flows of Red Deer River near Erwood (05LC001) for the years 1913 to 1919 and 1950 to 1986. Natural monthly mean flows for periods of missing record in the years 1912 to 1986 were estimated from recorded and natural flows in adjacent drainage basins.

For the months March to November, missing natural monthly mean flows of Red Deer River near Erwood (05LC001) were estimated using the regression equations presented in Appendix B, Table B-3. Priorities were assigned to the regression equations on the basis of the adjusted (to account for degrees of freedom) coefficient of correlation, the

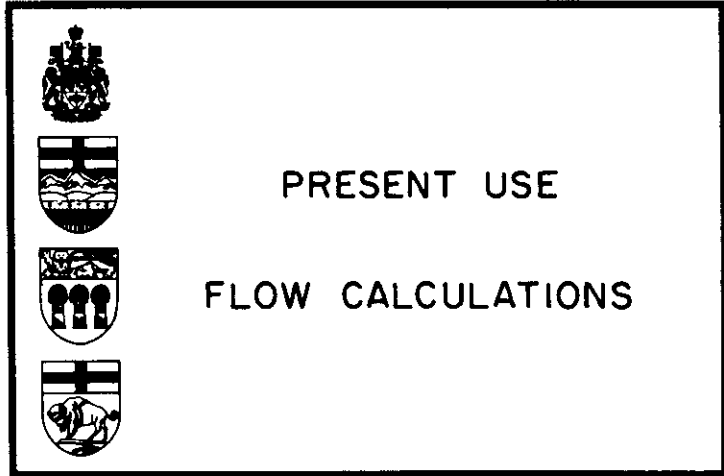
adjusted standard error of estimate, the magnitude of the intercept, and the overall hydrologic validity of each equation. The regression equation assigned priority No. 1 was used to estimate as many missing values as possible, then the regression equations assigned priorities No. 2, 3, 4 and 5 were used to estimate values which had not been estimated from higher priority regression equations. The variables used in these regression equations were selected on the basis of hydrologic similarity and their potential for providing estimates of flow for periods of missing data.

For the months December to February, missing natural flows of Red Deer River near Erwood (05LC001) were derived by regression analysis with estimated natural flows⁽³⁾ of Swan River near Minitonas (05LE006). (The station Assiniboine River at Brandon (05MH001) had previously been used to estimate missing winter flows for the base station, Swan River near Minitonas, because it was the only station in the vicinity that had naturalized winter flows which covered the period of missing winter data.) The summed winter flows for periods of missing record at 05LC001 were first estimated from the regression equation, and then distributed to each month as a fixed percentage of the estimated flows, based on the 1913-14 and 1973-86 recorded period at 05LC002 and 05LC001: 49% to December, 28% to January and 23% to February.

Natural flows of Red Deer River at the Saskatchewan-Manitoba boundary for all months in the period 1912-86 were determined using only the natural flows derived for the hydrometric gauging station Red Deer River near Erwood (05LC001). The natural monthly flows derived for this gauging station were transferred to the interprovincial boundary by annual contributing drainage area ratios. The resulting natural monthly mean flows for Red Deer River at the Saskatchewan-Manitoba boundary for the water years 1912-13 to 1985-86 are shown in Appendix B, Table B-5.

Caution should be exercised by users who may wish to utilize this data base in conducting other studies. Such data users should recognize the limitations of the estimates which were made. The

estimates have been published because it is unlikely that better estimates of streamflow can be generated based on the present level of hydrologic expertise in estimating missing streamflow data. These estimates provide an adequate means of evaluating the effect of present consumptive water use in Saskatchewan on flows of Red Deer River at the Saskatchewan-Manitoba boundary over the 74-year historic period 1912-13 to 1985-86.

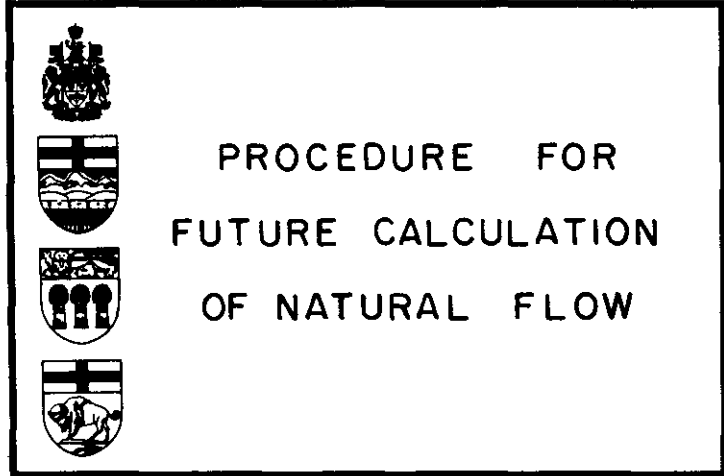


An analysis was made to determine whether present (1986) use flow (including drainage) of the Red Deer River at the Saskatchewan-Manitoba boundary would have been less than 50% of the natural flow, under the terms of the 1969 Master Agreement on Apportionment, in the period 1912-13 to 1985-86. A monthly array of uses was created, assuming that all current water uses and drainage projects upstream of the Saskatchewan-Manitoba boundary were in existence for the entire study period. (All licensed and unauthorized projects were located in Saskatchewan.) The existing water uses within the natural effective drainage area of the Red Deer River basin upstream of the interprovincial boundary were determined for the study period on an annual basis as a function of estimated water use (including evaporation) and available inflow. The estimated annual water uses varied from year to year because of the variable net evaporation and the limitation of restricting annual water use in any given year to available flow. The net increase in flow brought about by the existing (as of 1986) drainage projects within the Red Deer River basin was developed as an array of flow at the interprovincial boundary over the study period. This array of excess flow was subtracted from the array of current water uses upstream of the Saskatchewan-Manitoba boundary to form an array of monthly water use and drainage project contribution (Appendix A, Table A-5). This array of monthly uses and drainage contributions was subtracted from the natural flows at the interprovincial boundary to produce an estimate of monthly flows

(Appendix B, Table B-6) which would have been recorded at the Saskatchewan-Manitoba boundary during the period 1912-13 to 1985-86 had the present (1986) level of use and drainage been in effect for the entire period.

An array of one-half the natural flow at the interprovincial boundary was then subtracted from the array of natural flows adjusted for present use (Appendix B, Table B-6). The residual monthly flows (Appendix B, Table B-7) provide a picture of the balance-of-flow situation for the Red Deer River over the 74-year historic period 1912-13 to 1985-86. With the exception of two months (September, 1961 and March, 1962), Manitoba would have received at least 50% of the natural flow on a monthly basis during the entire period.

Table B-7 indicates that Saskatchewan would have always passed at least 50% of the natural flow of the Red Deer River at the interprovincial boundary on an annual basis during the 74-year period. In fact, Saskatchewan would have increased the annual natural flow by a minimum of 1.9% (corresponds to the water balance period 1954-55) under the present (1986) level of development, and Manitoba would have received an average annual volume of 342 000 dam³ in excess of its 50% share, or 107.7% of the natural flow.



If it becomes necessary to formally monitor the apportionment of streamflow in the Red Deer River basin, natural flow calculations would have to be performed on a regular basis to ensure that Manitoba receives its share of the flow. Natural flows of Red Deer River would be computed using the Project Depletion Method, based on the generalized equation:

$$Q_{\text{Nat}} = (Q_{\text{Rec}} + \text{ND}) / (\text{NCD})$$

where:

Q_{Nat} is the natural flow at the hydrometric station,

Q_{Rec} is the recorded flow at the hydrometric station,

ND is the net depletion of streamflow at upstream water use projects, and

NCD is a factor to account for the net contribution to streamflow due to upstream drainage projects.

The net depletion of streamflow at upstream water use projects (ND) may be computed as the sum of:

1. water withdrawal for human or livestock use, less the portion of this withdrawal which is returned to the stream or reservoir,
2. net evaporation (gross evaporation minus precipitation) from the reservoir, and
3. change in reservoir storage over the specified time interval; an increase in storage is considered a positive

(+) net depletion while a decrease in storage is considered a negative (-) net depletion.

The factor (NCD) which accounts for the net contribution to streamflow at the hydrometric gauging station due to upstream drainage projects is computed as the ratio of the current contributing drainage area of the gauging station (as influenced by drainage projects) to the natural contributing drainage area of the hydrometric gauging station. The contributing drainage areas vary from year to year depending upon the magnitude of the annual runoff.

For purposes of the Red Deer River natural flow study, monthly recorded flows of Red Deer River near Erwood (05LC001) were adjusted for upstream minor water uses (including evaporation losses), municipal sewage effluent discharges, storage and evaporation in major projects, and upstream drainage works. The estimation of effluent discharges required various assumptions regarding operation of sewage lagoons serving the Towns of Hudson Bay, Kelvington, Lintlaw, Porcupine Plain and Rose Valley. Similarly, estimation of streamflow depletion from major projects required monthly simulation of Merle Lake, McArthur East Lake, Greenwater Lake, Round Lake and Salkeld Lake. Historic monthly water uses were lagged to account for the time of travel from the point of use to the hydrometric gauging station. The present (1986) level of consumptive water use in Saskatchewan was determined to be only 0.29% of the average annual natural flow of Red Deer River at the Saskatchewan-Manitoba boundary.

Future calculations of natural flow need not be conducted in such detail until monitoring for apportionment is required. Simplifications can be made to the calculation procedure without unduly affecting the accuracy of the resulting natural flows. The 1986 level of minor water use, sewage effluent discharge and major project use can be used each year until basin water use increases significantly, the lag time of monthly water uses can be ignored, and the return period for recorded annual runoff can be obtained from a linear relationship.

Table 1 illustrates the recommended procedure for calculating natural flows of Red Deer River at the Saskatchewan-Manitoba boundary

for the 1985-86 water balance period. The calculated annual natural flow at the interprovincial boundary of 587 300 dam³ is within 1% of the 593 000 dam³ annual natural flow determined using the detailed calculation procedure.

Table 1
Natural Flow Calculations for 1985-86
Red Deer River at the Saskatchewan-Manitoba Boundary

Month	Recorded Flow at 05LC001		Net Depletion of Streamflow			Partial Natural Flow ⁽⁴⁾ at 05LC001 (dam ³)	Natural Flow		Sask-Man ⁽⁶⁾ Boundary (m ³ /s)
	(m ³ /s)	(dam ³)	Minor Uses ⁽¹⁾ (dam ³)	Effluent ⁽²⁾ Discharge (dam ³)	Major Projects ⁽³⁾ (dam ³)		05LC001 ⁽⁵⁾ (dam ³)	(m ³ /s)	
April	93.4	242 092.8	188.8	-45.0	3 320.0	245 556.6	222 223.2	85.734	94.307
May	68.5	183 470.4	72.4	-47.0	592.0	184 087.8	166 595.3	62.200	68.420
June	26.0	67 392.0	96.5	-43.8	-1 376.6	66 068.1	59 790.1	23.067	25.374
July	9.59	25 685.9	128.1	-43.2	-791.5	24 979.3	22 605.7	8.440	9.284
August	8.51	22 793.2	114.9	-40.7	-325.9	22 541.5	20 399.5	7.616	8.378
September	3.30	8 553.6	61.9	-38.2	-90.4	8 486.9	7 680.5	2.963	3.259
October	7.01	18 775.6	69.1	-38.8	-39.3	18 766.6	16 983.3	6.341	6.975
November	3.07	7 957.4	48.6	-41.1	-20.2	7 944.7	7 189.8	2.774	3.051
December	1.24	3 321.2	51.6	-44.2	-12.2	3 316.4	3 001.3	1.121	1.233
January	1.13	3 026.6	53.5	-45.1	-7.0	3 028.0	2 740.3	1.023	1.125
February	0.622	1 504.7	50.2	-42.4	-3.8	1 508.7	1 365.3	0.564	0.620
March	1.41	3 776.5	52.9	-46.5	-110.1	3 672.8	3 323.8	1.241	1.365
TOTAL (dam ³)		588 349.9	988.5	-516.0	1 135.0	589 957.4	533 898.1		587 287.9

(1) 1986 level of minor water use (including gross diversions by municipal surface water users).

(2) Estimated 1985-86 effluent discharge from the Towns of Kelvington, Lintlaw, Porcupine Plain, Rose Valley and Hudson Bay. (Effluent from other communities in the basin as indicated in Appendix A, Table A-1, was not considered to be significant.)

(3) Estimated as the average net depletion of streamflow resulting from the simulated current operation of Merle Lake, McArthur East Lake, Greenwater Lake, Round Lake and Salkeld Lake over the period 1912-86.

(4) Calculated as the sum of recorded flow and net depletion of streamflow due to minor uses, effluent discharge and major projects.

(5) Calculated by dividing the partial natural flow⁽⁴⁾ at 05LC001 by a contributing drainage area (CDA) ratio of 1.105 to remove the effect of current (1986) drainage projects on the flow regime above 05LC001. This CDA ratio, which will vary annually, is determined using the following three-step procedure.

Step 1. The return period corresponding to the calculated partial natural flow volume is determined by interpolating a straight-line relationship on lognormal probability paper between values of 500 000 dam³ at a 2-year return period and 1 400 000 dam³ at a 500-year return period. (These coordinates were determined from a frequency analysis of calculated partial natural flows for water years based on the period 1973-74 to 1985-86.) In this example, an annual volume of 589 957.4 dam³ corresponds to a return period of 3.2 years.

Step 2. The CDA corresponding to the calculated return period (from step 1) is determined for both natural and present drainage conditions by interpolating appropriate straight-line relationships on lognormal probability paper. For the natural condition, an effective drainage area (EDA) of 7633 km² is associated with a 2-year return period, and a gross drainage area (GDA) of 10 963 km² is associated with a 500-year return period. For the present drainage condition, an EDA of 8553 km² is associated with a 2-year return period, and a GDA of 11 019 km² is associated with a 500-year return period. (The EDA and GDA values for the drainage condition should be changed if future drainage development affects the EDA and/or GDA.) For calculated return periods of less than 2 years or greater than 500 years, the respective EDA and GDA values are used. In this example, a natural CDA of 8100 km² and a present drainage condition CDA of 8950 km² were determined to correspond to the calculated return period of 3.2 years.

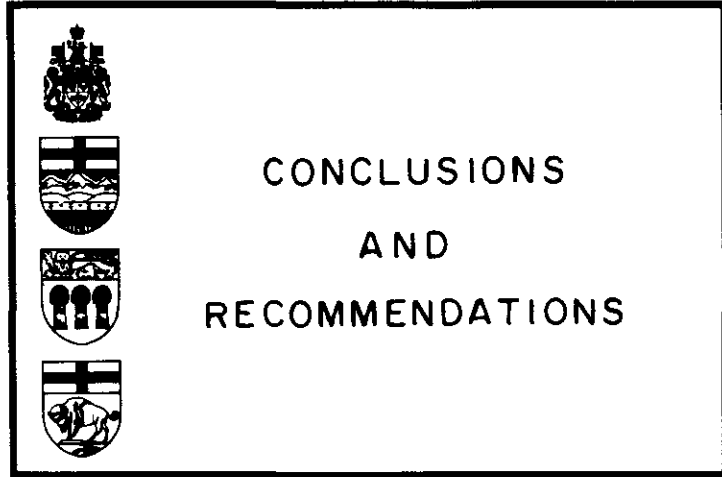
Step 3. The CDA ratio is calculated by dividing the present drainage condition CDA value by the natural CDA value as determined in step 2. In this example, a CDA ratio of 1.105 was determined by dividing 8950 km² by 8100 km².

(6) Calculated by multiplying the natural flow⁽⁵⁾ at 05LC001 by a natural contributing drainage area (CDA) ratio of 1.100. This CDA ratio, which will vary annually, is determined using the following three-step procedure.

Step 1. The return period corresponding to the calculated partial natural flow volume is determined by interpolating a straight-line relationship on lognormal probability paper between values of 425 000 dam³ at a 2-year return period and 3 600 000 dam³ at a 500-year return period. (These coordinates were determined from a frequency analysis of calculated and estimated natural flows at 05LC001 for water years based on the period 1912-13 to 1985-86.) In this example, an annual volume of 533 898.1 dam³ corresponds to a return period of 2.6 years.

Step 2. The natural CDA corresponding to the calculated return period (from step 1) is determined for Red Deer River at both 05LC001 and at the Saskatchewan-Manitoba Boundary by interpolating appropriate straight-line relationships on lognormal probability paper. For 05LC001, a natural effective drainage area (EDA) of 7633 km² is associated with a 2-year return period, and a natural gross drainage area (GDA) of 10 963 km² is associated with a 500-year return period. At the interprovincial boundary, a natural EDA of 8425 km² is associated with a 2-year return period, and a natural GDA of 11 800 km² is associated with a 500-year return period. For calculated return periods of less than 2 years or greater than 500 years, the respective EDA and GDA values are used. In this example, a CDA of 8000 km² at 05LC001 and 8800 km² at the Saskatchewan-Manitoba boundary were determined to correspond to the calculated return period of 2.6 years.

Step 3. The CDA ratio is calculated by dividing the natural CDA at the Saskatchewan-Manitoba boundary by the natural CDA at 05LC001 as determined in step 2. In this example, a CDA ratio of 1.100 was determined by dividing 8800 km² by 8000 km².

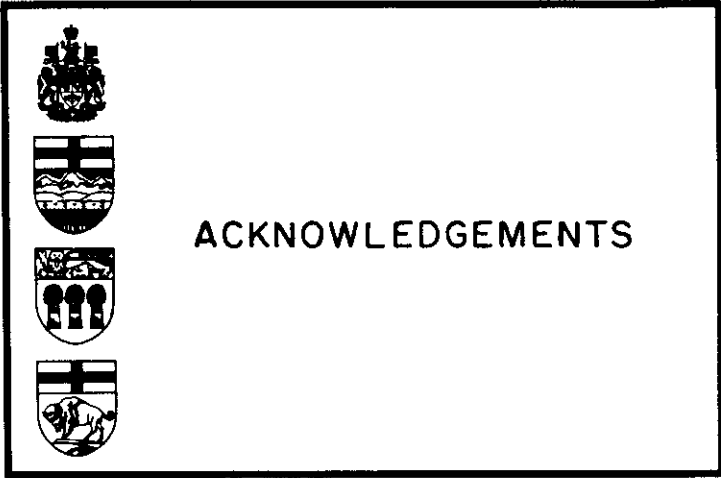


CONCLUSIONS

1. The average annual consumptive water use (including drainage works) in the Saskatchewan portion of the Red Deer River basin now increases the average annual natural flow of Red Deer River at the Saskatchewan-Manitoba boundary by 7.7%.
2. Under present (1986) conditions, at least 50% of the natural flow of Red Deer River at the Saskatchewan-Manitoba boundary would have been passed to Manitoba in all but two months of the 74-year period 1912-13 to 1985-86. In fact, as a direct result of drainage improvements, Saskatchewan would have increased the annual natural flow by a minimum of 1.9% (corresponds to the water balance period 1954-55). The average annual quantity of water which would have been delivered to Manitoba in excess of 50% of natural flow during the 74-year period would have been 342 000 dam³.
3. The existing hydrometric network is adequate for calculating the natural flow of Red Deer River at the Saskatchewan-Manitoba boundary at the present time. Ideally, a hydrometric gauging station at the interprovincial boundary would provide a more accurate estimate of natural flow. However, an accurate estimate of natural flow at the boundary is not required until water uses in the Saskatchewan portion of the basin become significant.

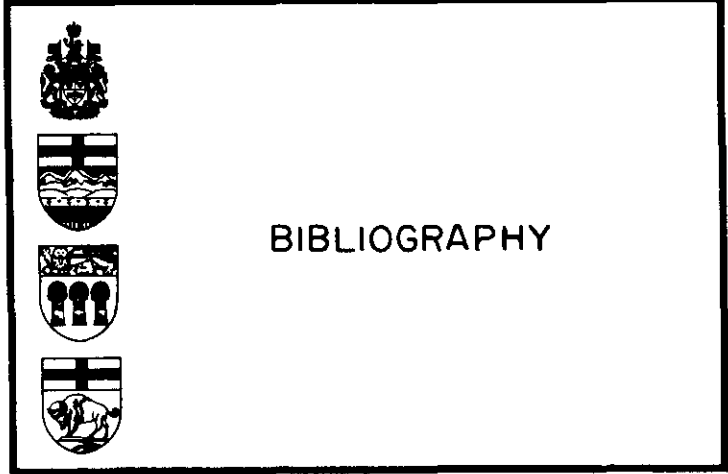
RECOMMENDATIONS

1. Based on the present (1986) level of development in the Saskatchewan portion of the Red Deer River basin, monitoring of apportionment should not be implemented at this time.
2. If monitoring of apportionment becomes necessary, a hydrometric gauging station may be required at the Saskatchewan-Manitoba boundary to provide a continuous record of the flows.



The Red Deer River natural flow study was conducted by B. J. Bell and D. A. Kiely of the Hydrology Division of the Prairie Farm Rehabilitation Administration. The study was carried out under the direction of F. R. J. Martin, Manager of the Hydrology Division. The final text was reviewed by R. L. Kellow, Executive Director of the Prairie Provinces Water Board, and other members of the Committee on Hydrology.





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APPENDIX A
WATER USE
RED DEER RIVER BASIN
AT THE
SASKATCHEWAN - MANITOBA
BOUNDARY

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Table A-1

WATER USE PROJECTS WITHIN THE NATURAL
EFFECTIVE DRAINAGE AREA OF THE RED DEER RIVER BASIN

Project Number	Land Location	Province	Project Status	Water Rights File Number	First Year of Operation	Purpose	Capacity (dam ³)	Estimated Annual Depletion* (dam ³)	Comments
1	NE07-45-03-W2	Sask.	Licensed	00519	1929	Municipal	180	336	Town of Hudson Bay
2	SW08-45-07-W2	Sask.	Licensed	03868	1940	Municipal	-	49.0	Town of Prairie River
3	NW09-38-12-W2	Sask.	Licensed	04107	1941	Domestic	4.0	2.0	
4	NW13-41-11-W2	Sask.	Licensed	04111	1964	Recreation	54 621	2 027	Greenwater Lake
5	NW30-39-10-W2	Sask.	Licensed	04338	1943	Domestic	3.0	1.0	Cancelled in 1965
6	NW06-39-10-W2	Sask.	Licensed	04339	1943	Domestic	3.0	1.0	Cancelled in 1972
7	SE05-43-11-W2	Sask.	Licensed	04664	1944	Domestic	19.0	8.0	
8	SE23-36-11-W2	Sask.	Licensed	05087	1948	Domestic	3.0	2.0	Washed out in 1972
9	SE32-37-12-W2	Sask.	Licensed	07002,12826	1960	Wildlife	232	-19.2	Seikeld Lake
10	NW11-42-17-W2	Sask.	Licensed	07791	1959	Domestic	8.0	2.0	
11	SW32-38-12-W2	Sask.	Licensed	08162	1960	Domestic	2.0	2.0	
12	NW24-36-11-W2	Sask.	Licensed	08857	1962	Domestic	12.0	5.0	
13	SE05-45-03-W2	Sask.	Licensed	09665	1963	Industrial	180	136	
14	NE36-38-11-W2	Sask.	Licensed	09911	1964	Domestic	9.0	5.0	Washed out in 1972
15	SE25-44-04-W2	Sask.	Licensed	09913	1964	Irrigation	-	60.0	
16	NE10-42-14-W2	Sask.	Licensed	10189	1965	Domestic	11.0	4.0	
17	SW27-44-03-W2	Sask.	Licensed	10574	1966	Industrial	180	116	
18	SE19-40-17-W2	Sask.	Licensed	11190	1969	Domestic	14.0	6.0	
19	NE04-45-02-W2	Sask.	Licensed	11562	1971	Domestic	5.0	2.0	
20	SE26-40-16-W2	Sask.	Licensed	11593	1971	Irrigation	-	21.0	
21	SW04-42-08-W2	Sask.	Unauthorized		1962	Municipal	2.2	2.8	Town of Caragana
22	SW04-42-08-W2	Sask.	Licensed	11710	1971	Municipal	11.0	13.5	Town of Caragana
23	SW08-45-07-W2	Sask.	Licensed	11711	1971	Municipal	14.0	12.9	Replaced WR #3868 in 1971
24	NE08-44-07-W2	Sask.	Licensed	11926	1972	Domestic	5.0	2.0	
25	SW15-39-11-W2	Sask.	Licensed	12022	1973	Domestic	7.0	3.0	
26	SE11-45-02-W2	Sask.	Licensed	12209	1967	Municipal	26.7	21.1	Town of Erwood
27	NE18-39-10-W2	Sask.	Licensed	12223	1958	Multi-Purpose	15 930	319	Round Lake
28	SW36-41-07-W2	Sask.	Licensed	12374	1975	Municipal	31.0	10.9	Village of Weekes
29	NW22-40-05-W2	Sask.	Licensed	13571	1979	Municipal	25.0	22.2	Village of Reserve
30	SW25-41-17-W2	Sask.	Licensed	13738	1980	Wildlife	88.0	66.7	McArthur East Lake
31	SW03-40-11-W2	Sask.	Licensed	14360	1982	Municipal	54 621	76.0	Greenwater Provincial Park
32	NW03-42-04-W2	Sask.	Licensed	14431	1983	Municipal	9.0	6.5	Village of Clemenceau
33	NW03-42-12-W2	Sask.	Licensed	14596	1983	Irrigation	-	73.0	
34	SE25-41-13-W2	Sask.	Licensed	14819	1984	Wildlife	109	31.4	Merle Lake
35	SW21-41-16-W2	Sask.	Unauthorized		1945		2.0	1.5	Cancelled in 1986
36	NE16-36-09-W2	Sask.	Unauthorized		1962		3.0	1.8	Washed out in 1972
37	SW02-38-11-W2	Sask.	Unauthorized		1945		3.0	1.8	
38	SW21-41-12-W2	Sask.	Unauthorized		1956		34.0	7.2	
39	SE08-37-11-W2	Sask.	Unauthorized		1962	Municipal**	-	-74.4	Town of Kelvington
40	SE09-36-09-W2	Sask.	Licensed	762,763,1124	1969	Municipal**	-	-14.2	Town of Lintlaw
41	NW08-42-09-W2	Sask.	Licensed	995,1654	1964	Municipal**	-	-56.1	Town of Porcupine Plain
42	NW21-38-13-W2	Sask.	Licensed	111	1962	Municipal**	-	-58.5	Town of Rose Valley

* Estimated average annual net depletion to streamflow, including evaporation
 ** Groundwater projects which discharge to surface water

Table A-2

RED DEER RIVER BASIN AT THE SASKATCHEWAN-MANITOBA BOUNDARY
TOTAL HISTORIC WATER USE - m³/s

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	CJ.DAMS
1912	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1913	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1914	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1915	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1916	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1917	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1918	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1919	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1920	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1921	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1922	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1923	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1924	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1925	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1926	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1927	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1928	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1929	0.010	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.010	341
1930	0.011	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.010	341
1931	0.011	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.010	343
1932	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.010	0.011	0.011	0.011	0.010	341
1933	0.011	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.010	342
1934	0.011	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.010	343
1935	0.011	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.010	342
1936	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.010	343
1937	0.011	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.010	343
1938	0.011	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.010	341
1939	0.011	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.010	342
1940	0.012	0.013	0.012	0.013	0.012	0.013	0.013	0.012	0.013	0.012	0.012	0.012	390
1941	0.012	0.013	0.012	0.014	0.012	0.013	0.013	0.012	0.013	0.012	0.012	0.012	394
1942	0.012	0.013	0.012	0.014	0.013	0.013	0.013	0.012	0.013	0.013	0.012	0.012	394
1943	0.012	0.013	0.012	0.014	0.013	0.013	0.013	0.012	0.013	0.012	0.012	0.012	397
1944	0.012	0.013	0.012	0.019	0.014	0.013	0.013	0.012	0.013	0.013	0.012	0.012	412
1945	0.012	0.013	0.012	0.020	0.015	0.012	0.013	0.012	0.013	0.012	0.012	0.012	416
1946	0.012	0.013	0.012	0.018	0.014	0.013	0.013	0.012	0.013	0.012	0.012	0.012	410
1947	0.012	0.013	0.012	0.019	0.014	0.012	0.013	0.012	0.013	0.012	0.012	0.012	411
1948	0.012	0.013	0.012	0.018	0.014	0.013	0.013	0.012	0.013	0.012	0.012	0.012	411
1949	0.012	0.013	0.012	0.020	0.015	0.012	0.013	0.012	0.013	0.013	0.012	0.012	418
1950	0.012	0.013	0.012	0.020	0.015	0.013	0.013	0.012	0.013	0.013	0.012	0.012	416
1951	0.012	0.013	0.012	0.019	0.014	0.013	0.013	0.012	0.012	0.012	0.012	0.012	410
1952	0.012	0.013	0.012	0.017	0.013	0.013	0.013	0.012	0.012	0.013	0.012	0.012	406
1953	0.012	0.013	0.012	0.021	0.015	0.012	0.013	0.012	0.012	0.013	0.012	0.012	417
1954	0.012	0.013	0.012	0.018	0.014	0.012	0.013	0.012	0.012	0.013	0.012	0.012	406
1955	0.012	0.013	0.012	0.016	0.013	0.013	0.013	0.012	0.013	0.012	0.012	0.012	405
1956	0.012	0.013	0.012	0.013	0.022	0.016	0.013	0.012	0.013	0.012	0.012	0.012	426
1957	0.012	0.013	0.012	0.022	0.015	0.013	0.013	0.012	0.013	0.012	0.012	0.012	424
1958	0.012	0.013	0.012	0.022	0.015	0.013	0.013	0.012	0.013	0.012	0.012	0.012	425
1959	0.012	0.013	0.012	0.025	0.016	0.013	0.013	0.012	0.013	0.012	0.012	0.012	433
1960	0.012	0.013	0.012	0.457	0.354	0.168	0.074	0.023	0.013	0.013	0.012	0.012	3053
1961	0.012	0.013	0.012	0.028	0.019	0.015	0.015	0.015	0.015	0.013	0.012	0.012	476
1962	0.009	0.009	0.008	0.168	0.069	0.013	0.012	0.011	0.013	0.010	0.009	0.008	887
1963	0.010	0.011	0.010	0.085	0.032	0.000	0.010	0.013	0.015	0.014	0.011	0.010	584
1964	0.004	0.004	0.003	0.962	1.267	0.305	0.022	0.012	0.007	0.006	0.003	0.003	6850
1965	0.004	0.004	0.003	0.461	1.012	1.908	0.943	0.143	0.008	0.007	0.004	0.003	11848
1966	0.005	0.006	0.005	1.845	0.761	-0.044	-0.264	-0.211	-0.038	0.008	0.005	0.005	5424
1967	0.005	0.006	0.005	0.007	0.148	-0.020	-0.001	0.020	0.011	0.007	0.005	0.005	529
1968	0.004	0.003	-0.039	0.014	0.009	0.013	0.000	0.009	0.006	0.005	0.003	0.003	76
1969	0.005	0.005	0.005	0.054	0.018	0.015	0.001	0.012	0.009	0.004	0.005	0.005	362
1970	0.005	0.005	0.004	0.260	0.931	0.325	0.012	0.011	0.011	0.007	0.004	0.004	4174
1971	0.005	0.005	0.004	0.836	0.164	-0.042	0.126	-0.065	-0.017	0.008	0.005	0.005	2699
1972	0.003	0.003	0.003	2.472	0.990	-0.996	-0.849	-0.309	-0.038	0.006	0.003	0.003	3332
1973	0.004	0.004	0.004	0.000	0.011	-0.038	0.067	-0.184	-0.060	0.002	0.003	0.003	-487
1974	0.004	0.004	0.003	3.550	1.127	-0.877	-1.089	-0.692	-0.345	-0.064	0.000	0.004	4145
1975	0.004	0.004	0.004	1.630	0.851	-0.844	-0.705	-0.192	-0.014	0.006	0.004	0.004	1944
1976	0.005	0.005	0.005	1.106	-0.094	-0.480	-0.376	-0.079	0.007	0.009	0.006	0.004	256
1977	0.004	0.004	0.003	-0.013	0.013	0.022	0.018	0.018	0.006	0.006	0.004	0.003	232
1978	0.003	0.003	0.001	-0.006	-0.006	0.009	0.007	0.015	0.011	0.008	0.002	0.002	126
1979	0.003	0.003	0.003	2.234	2.200	-0.448	-0.596	-0.102	0.009	0.010	0.003	0.003	8740
1980	0.003	0.003	0.002	0.042	0.021	0.024	0.024	0.017	0.014	0.009	0.003	0.002	430
1981	0.003	0.005	-0.029	0.053	0.018	0.014	0.017	0.013	0.012	-0.005	0.002	0.003	275
1982	0.003	0.004	0.003	0.063	0.018	0.021	0.016	0.019	0.012	0.009	0.003	0.003	454
1983	0.003	0.003	0.003	0.176	0.067	0.212	0.563	0.163	0.021	0.008	0.003	0.003	3243
1984	0.003	0.004	0.007	1.021	0.325	-0.162	-0.048	-0.031	0.010	0.004	0.002	0.003	3142
1985	0.003	0.003	0.003	2.277	0.036	-0.772	-0.413	-0.067	0.004	0.011	0.003	0.003	2790
1986	0.003	0.003	-0.006	0.973	-0.106	-0.378	-0.176	-0.006	0.012	0.010	0.003	0.003	842
MIN	0.000	0.000	-0.039	-0.013	-0.106	-0.996	-1.089	-0.692	-0.345	-0.064	0.000	0.000	-487
MAX	0.012	0.013	0.012	3.550	2.200	1.908	0.943	0.163	0.021	0.014	0.012	0.012	11848
MEAN	0.007	0.007	0.005	0.283	0.142	-0.022	-0.030	-0.013	0.001	0.007	0.007	0.006	1045

Table A-3

DRAINAGE PROJECTS WITHIN THE RED DEER RIVER BASIN
AT THE SASKATCHEWAN-MANITOBA BOUNDARY

Land Location	Water Rights File Number		First Year Natural Drainage Affected	Increase in Gross Drainage Area (km ²)	Increase in Effective Drainage Area (km ²)
	C&D*	Drainage License			
NE08-43-02-W2	-	-	1940	0	52.3
NW07-43-05-W2	-	-	1942	0	21.9
24-37-12-W2	-	-	1942	0	21.6
NW18-36-08-W2	-	-	1947	0	7.8
NW05-36-10-W2	-	-	1947	0	26.2
NW33-42-02-W2	37971	-	1954	0	25.0
NE10-44-02-W2	-	-	1955	0	9.9
NE21-40-13-W2	37399	7729	1955	0	151.9
NE28-38-13-W2	37443	-	1955	0	50.2
E½07-40-12-W2	-	-	1955	0	5.4
NW06-39-11-W2	44097	-	1955	0	10.6
NE14-40-13-W2	44713	11881	1955	0	12.4
NE23-41-14-W2	37572	-	1957	0	16.8
NW15-44-09-W2	37835	-	1957	0	8.0
NW28-43-02-W2	-	-	1958	0	10.4
NW19-43-10-W2	37880	-	1958	0	2.1
SE06-42-16-W2	37441	-	1959	0	121.9
NW27-38-12-W2	-	-	1960	0	1.3
NE34-44-10-W2	-	-	1960	0	11.7
SW21-37-13-W2	-	7002	1961	0	9.2
NE19-38-10-W2	39566	8353	1961	0	13.1
SW02-38-10-W2	-	-	1961	0	24.5
NW27-42-06-W2	-	-	1964	0	9.1
E½06-39-11-W2	-	-	1965	0	2.5
SW14-38-13-W2	37443	-	1968	0	18.7
SE04-36-10-W2	-	-	1968	0	23.1
SW21-43-09-W2	39880	-	1968	0	4.4
NW23-43-09-W2	39879	-	1968	0	11.1
SE05-40-17-W2	-	-	1968	0	2.6
SE21-40-17-W2	-	-	1968	0	20.7
NE14-38-16-W2	-	-	1968	-20.7	0
SW11-40-15-W2	41415	-	1969	30.0	11.4
NE09-41-17-W2	-	12112	1971	0	9.3
SW02-44-10-W2	-	-	1972	0	6.7
SW01-44-09-W2	-	-	1972	0	5.7
NE24-40-18-W2	-	-	1972	0	0.6
SW04-41-17-W2	-	-	1972	0	4.4
SW13-36-10-W2	-	-	1973	0	16.6
NW28-42-05-W2	-	-	1973	0	8.4
SE30-36-11-W2	-	-	1973	0	38.4
S½13-39-11-W2	-	12124	1973	0	0.8
SW27-42-05-W2	-	-	1975	0	6.4
NW02-42-09-W2	E5-98**	-	1976	0	9.8
NE13-38-14-W2	-	-	1976	0	2.8
NE16-42-09-W2	44525	-	1980	0	5.9
SE07-40-12-W2	-	-	1980	0	8.8
NE10-37-11-W2	E5-122**	-	1981	0	2.1
NW05-45-02-W2	-	-	1982	17.2	17.2
NW22-42-09-W2	44851	-	1982	0	3.0
NW05-44-09-W2	E5-3**	-	1982	0	4.7
NW01-44-09-W2	-	-	1982	0	3.3
NW11-41-18-W2	-	13875	1982	0	19.2
NW24-41-18-W2	-	13739	1982	0	17.4
SE32-41-17-W2	-	13737 & 13738	1982	0	14.8
SW19-41-15-W2	-	15083	1986	0	11.7

* Refers to the project plan file number assigned by C&D Branch of the Saskatchewan Department of Agriculture (currently the Saskatchewan Water Corporation).

** The 'E5' prefix is a designation assigned to individual drainage projects by the C&D Branch of the Saskatchewan Department of Agriculture.

Table A-4

RED DEER RIVER BASIN AT THE SASKATCHEWAN-MANITOBA BOUNDARY
 TOTAL HISTORIC INCREASE IN FLOW DUE TO DRAINAGE PROJECTS - m³/s

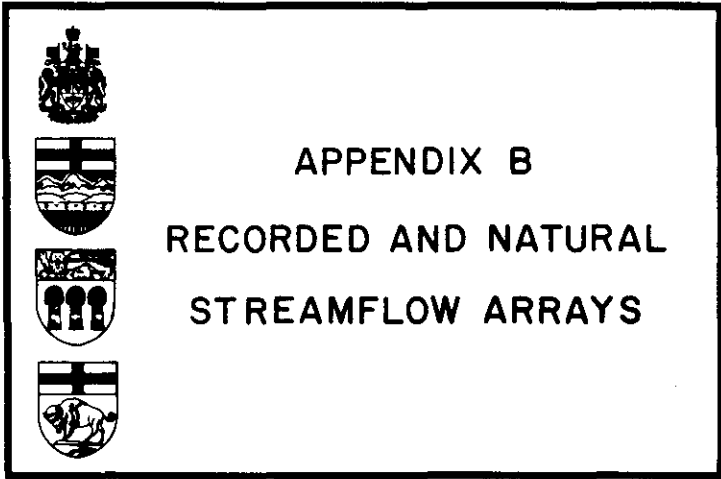
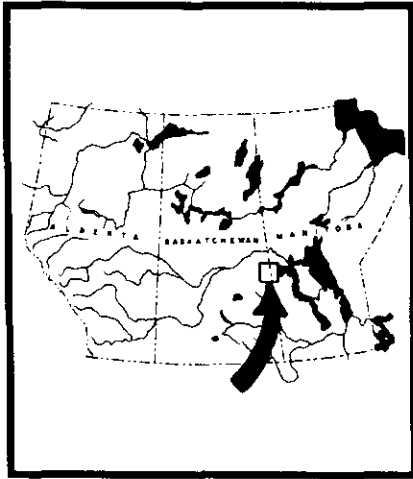
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	CJ.DAMS
1912	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1913	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1914	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1915	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1916	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1917	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1918	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1919	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1920	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1921	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1922	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1923	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1924	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1925	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1926	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1927	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1928	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1929	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1930	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1931	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1932	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1933	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1934	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1935	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1936	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1937	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1938	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1939	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1940	0.000	0.000	0.000	0.023	0.070	0.111	0.004	0.003	0.002	0.003	0.002	0.001	317
1941	0.001	0.000	0.001	0.044	0.085	0.119	0.004	0.002	0.003	0.004	0.002	0.000	441
1942	0.001	0.001	0.001	0.258	0.326	0.182	0.089	0.081	0.097	0.049	0.027	0.004	2944
1943	0.002	0.002	0.002	0.378	0.368	0.268	0.107	0.060	0.040	0.035	0.019	0.004	3385
1944	0.002	0.002	0.002	0.094	0.157	0.094	0.080	0.042	0.035	0.029	0.016	0.003	1468
1945	0.002	0.002	0.002	0.187	0.202	0.133	0.091	0.057	0.049	0.028	0.016	0.004	2036
1946	0.002	0.002	0.002	0.297	0.186	0.123	0.082	0.034	0.029	0.046	0.026	0.006	2194
1947	0.005	0.004	0.004	0.659	0.482	0.242	0.204	0.061	0.172	0.159	0.087	0.020	5520
1948	0.009	0.008	0.007	0.785	1.192	0.207	0.128	0.159	0.083	0.051	0.028	0.009	7045
1949	0.007	0.005	0.005	0.289	0.288	0.428	0.141	0.102	0.056	0.051	0.028	0.010	3708
1950	0.006	0.005	0.005	0.429	0.420	0.213	0.133	0.256	0.054	0.062	0.034	0.019	4319
1951	0.007	0.006	0.006	0.322	0.781	0.269	0.227	0.151	0.324	0.452	0.096	0.025	7054
1952	0.019	0.015	0.015	0.773	0.727	0.257	0.211	0.103	0.036	0.034	0.038	0.015	5910
1953	0.005	0.004	0.004	0.208	0.432	0.646	0.765	0.409	0.434	0.095	0.071	0.024	8174
1954	0.006	0.005	0.005	0.118	0.583	0.918	0.249	0.154	0.227	0.163	0.088	0.009	6643
1955	0.049	0.040	0.037	2.208	6.749	1.478	0.425	0.123	0.045	0.076	0.041	0.035	29941
1956	0.025	0.021	0.021	0.706	5.792	1.745	1.188	0.271	0.188	0.150	0.081	0.042	27165
1957	0.027	0.022	0.022	4.230	5.124	0.989	0.307	0.091	0.136	0.064	0.035	0.033	29297
1958	0.024	0.020	0.020	1.177	0.609	0.314	0.414	0.035	0.168	0.370	0.203	0.007	8902
1959	0.005	0.004	0.004	1.510	1.503	0.784	1.261	0.201	0.609	0.784	0.431	0.115	19119
1960	0.059	0.048	0.104	4.890	4.272	2.403	0.553	0.240	0.019	0.048	0.026	0.010	33303
1961	0.007	0.006	0.006	0.920	1.017	0.173	0.011	0.006	0.002	0.018	0.010	0.005	6256
1962	0.003	0.002	0.001	2.300	2.389	0.320	0.051	0.030	0.123	0.114	0.063	0.008	14231
1963	0.004	0.004	0.016	1.265	0.488	0.362	0.504	0.150	0.194	0.117	0.064	0.038	8422
1964	0.022	0.018	0.021	1.308	3.378	0.269	0.136	0.135	0.680	0.598	0.329	0.129	18586
1965	0.057	0.047	0.025	1.386	2.875	6.872	2.676	0.811	0.582	0.610	0.327	0.104	43044
1966	0.058	0.048	0.045	5.099	4.412	3.342	2.115	0.737	0.395	0.250	0.133	0.117	44078
1967	0.088	0.072	0.108	0.352	9.324	1.818	0.275	0.225	0.017	0.054	0.029	0.011	32932
1968	0.007	0.006	0.249	1.489	0.893	1.129	1.918	0.583	0.779	0.454	0.250	0.072	20652
1969	0.042	0.034	0.089	4.734	1.295	0.359	0.209	0.153	0.051	0.751	0.413	0.077	21496
1970	0.037	0.031	0.069	2.391	5.615	2.378	3.470	0.432	0.184	0.457	0.248	0.268	41277
1971	0.183	0.150	0.090	6.103	2.247	0.764	0.845	0.436	0.129	0.899	0.494	0.204	32914
1972	0.088	0.072	0.061	6.773	10.375	1.392	0.395	0.129	0.060	0.133	0.070	0.000	51633
1973	0.000	0.000	0.022	1.314	1.831	5.312	4.481	0.840	0.294	0.262	0.230	0.198	38977
1974	0.086	0.085	0.090	5.607	9.554	3.496	0.477	0.383	0.731	0.730	0.258	0.160	57106
1975	0.164	0.164	0.167	3.952	8.240	3.702	0.894	0.210	0.419	0.736	0.303	0.120	50311
1976	0.109	0.144	0.113	5.596	2.178	5.295	2.425	0.450	0.103	0.135	0.036	0.009	43463
1977	0.007	0.003	0.004	0.786	1.054	0.453	0.215	0.467	0.929	0.666	0.348	0.166	13438
1978	0.069	0.029	0.026	4.818	3.551	1.009	0.480	1.233	1.009	1.420	0.858	0.218	38755
1979	0.059	0.024	0.030	4.997	11.525	5.011	0.639	0.120	0.055	0.086	0.162	0.101	60206
1980	0.065	0.079	0.082	2.050	0.586	0.121	0.419	0.561	0.611	0.815	0.179	0.075	14841
1981	0.027	0.010	0.169	1.012	0.849	0.330	0.379	0.216	0.062	0.925	0.620	0.047	12263
1982	0.016	0.007	0.013	1.995	1.600	2.556	0.420	0.314	0.224	0.347	0.084	0.029	19951
1983	0.078	0.062	0.051	2.911	3.616	3.788	5.125	0.769	1.068	0.641	0.461	0.198	49540
1984	0.083	0.089	0.115	4.714	6.614	6.033	0.885	0.090	0.059	0.510	0.408	0.221	52106
1985	0.108	0.091	0.097	8.457	6.034	2.226	0.812	0.747	0.292	0.620	0.271	0.110	52211
1986	0.112	0.062	0.138	7.536	4.285	1.539	0.607	0.374	0.103	0.350	0.163	0.118	40389
MIN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
MAX	0.183	0.164	0.249	8.457	11.525	6.872	5.125	1.233	1.068	1.420	0.858	0.268	60206
MEAN	0.025	0.021	0.033	1.459	1.816	0.957	0.500	0.176	0.159	0.206	0.109	0.043	14506

Table A-5

RED DEER RIVER BASIN AT THE SASKATCHEWAN-MANITOBA BOUNDARY
 TOTAL WATER USE AND DRAINAGE PROJECT CONTRIBUTION
 AT THE PRESENT (1986) LEVEL OF DEVELOPMENT - m³/s

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	CU.DAMS
1912	-0.039	-0.031	-0.042	-1.373	-5.171	-5.245	-1.652	-1.091	-4.153	-3.104	-1.707	-0.341	-63063
1913	-0.119	-0.097	-0.087	0.659	-2.388	-2.742	-8.511	-3.056	-1.601	-0.744	-0.410	-0.172	-51233
1914	-0.217	-0.153	-0.090	-4.267	-9.034	-4.076	-1.425	-0.414	-0.260	-0.258	-0.185	-0.074	-53984
1915	0.003	0.007	0.003	-0.908	-0.445	-0.510	-2.469	-0.532	-0.272	-0.268	-0.120	-0.011	-14636
1916	-0.012	-0.008	-0.011	-1.255	-8.518	-11.195	-4.212	-1.887	-0.716	-0.940	-0.765	-0.007	-77880
1917	-0.004	-0.002	-0.007	-1.211	-11.943	-5.631	-4.767	-0.911	-0.448	-0.238	-0.128	-0.064	-67269
1918	-0.050	-0.039	-0.042	-2.136	-1.684	-4.358	-4.362	-2.626	-0.681	-0.818	-0.449	-0.079	-45731
1919	-0.042	-0.033	-0.037	-1.831	-4.200	-3.177	-3.107	-1.828	-1.681	-1.980	-1.088	-0.011	-50276
1920	0.000	0.001	-0.004	-3.924	-12.903	-4.971	-2.146	-0.826	-0.404	-0.517	-0.276	-0.087	-68962
1921	-0.037	-0.029	-0.029	-2.524	-4.667	-5.211	-4.086	-5.665	-3.068	-2.896	-1.630	-0.356	-79798
1922	-0.172	-0.125	-0.101	-1.522	-12.991	-4.148	-2.477	-2.151	-1.078	-0.646	-0.309	-0.059	-68402
1923	-0.020	-0.014	-0.015	-0.565	-4.892	-6.657	-4.836	-2.132	-0.652	-0.353	-0.156	-0.061	-53819
1924	-0.125	-0.101	-0.099	-2.289	-5.026	-2.514	-1.195	-4.319	-0.833	-0.884	-0.485	-0.091	-47566
1925	-0.028	-0.021	-0.023	-5.281	-3.856	-9.101	-5.045	-1.300	-0.713	-0.523	-0.284	-0.048	-68899
1926	-0.042	-0.033	-0.037	-6.703	-4.426	-4.926	-1.332	-0.329	-0.356	-0.999	-0.547	-0.123	-52083
1927	-0.028	-0.021	-0.022	-1.761	-7.921	-7.309	-4.199	-2.380	-2.290	-1.623	-0.895	-0.187	-57632
1928	-0.176	-0.132	-0.117	-1.467	-4.463	-2.091	-5.608	-1.491	-0.580	-0.399	-0.218	-0.001	-44441
1929	0.003	0.004	-0.005	-1.448	-2.565	-1.328	-1.174	-0.225	-0.206	-0.191	-0.104	-0.089	-19364
1930	-0.048	-0.038	-0.041	-2.884	-3.189	-3.718	-2.830	-0.458	-0.407	-0.315	-0.172	-0.056	-37280
1931	-0.029	-0.022	-0.027	-2.551	-1.604	-0.261	-0.443	-0.163	-0.429	-0.774	-0.425	-0.028	-17769
1932	-0.013	-0.009	-0.016	-3.163	-2.492	-1.086	-2.252	-0.497	-0.387	-0.333	-0.181	-0.082	-27736
1933	-0.038	-0.030	-0.033	-2.552	-5.271	-7.479	-3.631	-0.776	-0.702	-0.691	-0.379	-0.087	-57069
1934	-0.045	-0.035	-0.037	-2.143	-11.144	-4.185	-2.325	-0.482	-0.225	-0.320	-0.176	-0.047	-56094
1935	-0.029	-0.022	-0.028	-1.857	-3.749	-9.227	-3.279	-0.707	-0.276	-0.449	-0.246	-0.104	-52491
1936	-0.053	-0.043	-0.046	-4.557	-7.323	-4.605	-2.197	-0.353	-0.021	-0.227	-0.125	-0.043	-51666
1937	-0.023	-0.017	-0.023	-1.472	-3.877	-1.416	-0.231	-0.053	-0.029	-0.184	-0.101	-0.013	-19655
1938	-0.004	-0.002	-0.010	-2.349	-4.098	-0.876	-0.301	-0.206	-0.108	-0.176	-0.097	-0.041	-21846
1939	-0.021	-0.015	-0.021	-1.365	-3.368	-0.877	-0.598	-0.205	-0.096	-0.176	-0.097	-0.014	-18145
1940	-0.005	-0.003	-0.010	-0.999	-3.136	-0.482	-0.119	-0.088	-0.060	-0.130	-0.070	-0.041	-13637
1941	-0.021	-0.015	-0.021	-1.567	-3.592	-1.039	-0.240	-0.061	-0.130	-0.185	-0.101	-0.013	-18462
1942	-0.004	-0.002	-0.009	-3.173	-4.624	-2.889	-1.562	-1.147	-1.517	-0.742	-0.391	-0.058	-42482
1943	-0.030	-0.023	-0.028	-4.005	-5.313	-4.573	-1.947	-0.945	-0.575	-0.508	-0.279	-0.053	-48135
1944	-0.027	-0.021	-0.027	-1.321	-2.274	-1.341	-1.147	-0.576	-0.497	-0.408	-0.224	-0.041	-20880
1945	-0.021	-0.015	-0.021	-2.671	-2.941	-1.932	-1.315	-0.806	-0.707	-0.406	-0.223	-0.046	-29259
1946	-0.023	-0.018	-0.023	-3.517	-2.510	-1.947	-1.247	-0.478	-0.410	-0.672	-0.369	-0.079	-29703
1947	-0.040	-0.031	-0.035	-4.893	-4.428	-2.650	-2.370	-0.767	-1.682	-1.520	-0.834	-0.182	-51173
1948	-0.081	-0.065	-0.065	-4.910	-10.736	-3.135	-2.151	-1.884	-0.842	-0.472	-0.260	-0.080	-65306
1949	-0.056	-0.045	-0.047	-2.654	-2.812	-4.609	-1.527	-0.978	-0.522	-0.479	-0.264	-0.095	-36509
1950	-0.051	-0.040	-0.043	-3.691	-3.742	-2.203	-1.437	-2.500	-0.510	-0.593	-0.325	-0.173	-40410
1951	-0.064	-0.051	-0.050	-1.923	-6.712	-3.116	-2.719	-1.655	-3.063	-4.518	-1.160	-0.393	-67280
1952	-0.265	-0.195	-0.165	-4.905	-6.587	-3.374	-2.616	-1.148	-0.357	-0.319	-0.362	-0.137	-53908
1953	-0.043	-0.034	-0.034	-1.683	-3.573	-6.447	-7.512	-4.200	-4.318	-0.938	-0.676	-0.220	-78348
1954	-0.033	-0.026	-0.024	0.389	-2.130	-6.329	-2.504	-1.717	-1.957	-1.271	-0.642	-0.087	-42998
1955	-0.131	-0.101	-0.089	-2.604	-14.993	-4.940	-2.228	-0.769	-0.185	-0.177	-0.093	-0.078	-69976
1956	-0.056	-0.045	-0.046	-1.680	-13.058	-4.767	-3.571	-0.884	-0.474	-0.359	-0.193	-0.098	-66955
1957	-0.055	-0.043	-0.129	-6.970	-11.337	-3.480	-1.589	-0.562	-0.378	-0.142	-0.074	-0.071	-65545
1958	-0.049	-0.038	-0.097	-2.604	-1.540	-0.757	-0.919	-0.042	-0.366	-0.831	-0.455	-0.010	-20273
1959	-0.002	0.000	-0.062	-2.631	-2.675	-1.388	-2.233	-0.331	-1.082	-1.403	-0.770	-0.201	-33717
1960	-0.096	-0.077	-0.176	-6.505	-6.791	-4.771	-1.283	-0.431	-0.011	-0.071	-0.040	-0.012	-53283
1961	-0.005	-0.003	-0.316	-1.448	-1.648	-0.249	0.024	0.037	0.021	-0.020	-0.011	-0.002	-9546
1962	0.002	0.003	0.005	-3.704	-3.890	-0.495	-0.050	-0.018	-0.183	-0.179	-0.096	-0.006	-22682
1963	-0.001	0.001	-0.020	-1.981	-0.753	-0.510	-0.774	-0.214	-0.298	-0.178	-0.099	-0.056	-12828
1964	-0.029	-0.022	-0.028	-2.023	-5.420	-0.403	-0.186	-0.191	-1.079	-0.952	-0.524	-0.202	-29265
1965	-0.083	-0.067	-0.034	-2.030	-3.726	-10.247	-4.088	-1.238	-0.899	-0.943	-0.507	-0.157	-63134
1966	-0.085	-0.068	-0.065	-5.477	-6.241	-5.829	-3.916	-1.399	-0.644	-0.378	-0.203	-0.177	-64505
1967	-0.133	-0.108	-0.167	-0.499	-14.220	-3.010	-0.511	-0.325	-0.007	-0.076	-0.041	-0.011	-50849
1968	-0.004	-0.002	-0.351	-2.080	-1.267	-1.590	-2.726	-0.807	-1.103	-0.642	-0.352	-0.098	-29071
1969	-0.053	-0.042	-0.120	-5.929	-1.557	-0.472	-0.274	-0.182	-0.054	-1.057	-0.578	-0.103	-27293
1970	-0.046	-0.036	-0.091	-2.865	-7.187	-3.541	-5.105	-0.622	-0.239	-0.627	-0.341	-0.368	-55814
1971	-0.249	-0.203	-0.120	-6.922	-3.147	-1.574	-1.353	-0.735	-0.194	-1.245	-0.685	-0.280	-43882
1972	-0.111	-0.090	-0.076	-6.338	-12.865	-2.907	-1.386	-0.461	-0.107	-0.165	-0.088	0.006	-65029
1973	0.007	0.007	-0.020	-1.613	-2.409	-6.897	-5.901	-1.126	-0.366	-0.322	-0.285	-0.245	-50556
1974	-0.099	-0.098	-0.105	-4.462	-10.683	-5.374	-1.509	-0.940	-1.107	-0.922	-0.311	-0.191	-68110
1975	-0.197	-0.196	-0.201	-3.466	-9.382	-5.388	-1.774	-0.425	-0.523	-0.902	-0.369	-0.143	-60622
1976	-0.128	-0.171	-0.134	-5.760	-2.760	-7.012	-3.357	-0.617	-0.109	-0.151	-0.035	-0.004	-53057
1977	-0.002	0.004	0.001	-0.914	-1.293	-0.524	-0.229	-0.542	-1.140	-0.814	-0.426	-0.200	-16026
1978	-0.079	-0.029	-0.027	-5.933	-4.395	-1.231	-0.565	-1.499	-1.236	-1.751	-1.059	-0.265	-47569
1979	-0.065	-0.022	-0.030	-3.784	-11.726	-6.491	-1.355	-0.237	-0.053	-0.092	-0.190	-0.116	-63800
1980	-0.072	-0.089	-0.094	-2.447	-0.690	-0.114	-0.475	-0.657	-0.729	-0.985	-0.212	-0.086	-17494
1981	-0.026	-0.004	-0.226	-1.161	-1.011	-0.377	-0.432	-0.239	-0.059	-1.130	-0.751	-0.051	-14441
1982	-0.011	-0.001	-0.009	-2.164	-1.775	-2.843	-0.444	-0.322	-0.236	-0.378	-0.088	-0.026	-21766
1983	-0.080	-0.062	-0.051	-3.058	-3.962	-4.012	-5.153	-0.692	-1.168	-0.705	-0.509	-0.215	-51899
1984	-0.085	-0.091	-0.125	-4.187	-6.978	-6.821	-1.022	-0.067	-0.052	-0.557	-0.445	-0.237	-54347
1985	-0.113	-0.094	-0.102	-7.102	-6.658	-3.240	-1.312	-0.894	-0.317	-0.674	-0.295	-0.116	-55051
1986	-0.117	-0.061	-0.156	-7.389	-4.862	-2.085	-0.847	-0.419	-0.101	-0.376	-0.174	-0.125	-43909
MIN	-0.265	-0.203	-0.351	-7.389	-14.993	-11.195	-8.511	-5.665	-4.318	-4.518	-1.707	-0.393	-79798
MAX	0.007	0.007	0.005	0.659	-0.445	-0.114	0.024	0.037	0.021	-0.020	-0.011	0.006	-9546
MEAN	-0.059	-0.047	-0.065	-2.986	-5.323	-3.575	-2.235	-0.985	-0.724	-0.712	-0.376	-0.107	-65381

Note: A negative value indicates that the total drainage contribution was greater than the total water use.



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Table B-1

RED DEER RIVER NEAR HUDSON BAY - 05LC002
RECORDED FLOW - m³/s

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	CU.DAMS
1912	-	-	-	-	-	-	-	-	-	-	-	-	-
1913	-	-	-	-	-	-	-	-	-	-	-	-	-
1914	1.980	1.420	0.850	51.000	85.200	29.800	7.590	56.400	27.300	14.600	9.060	3.960	-
1915	0.028	0.000	0.028	7.800	3.760	4.300	20.100	4.550	2.250	2.250	1.700	0.708	493298
1916	-	-	-	-	170.000	181.000	58.000	26.400	10.500	15.300	12.700	-	-
1917	-	-	-	19.800	150.000	60.000	47.200	7.390	4.690	2.820	-	-	-
1918	-	-	-	18.400	13.200	33.900	34.200	20.900	5.560	6.690	-	-	-
1919	-	-	-	17.600	36.700	24.700	24.400	14.900	13.700	-	-	-	-
1920	-	-	-	-	-	-	-	-	-	-	-	-	-
1921	-	-	-	-	-	-	-	-	-	-	-	-	-
1922	-	-	-	-	-	-	-	-	-	-	-	-	-
1923	-	-	-	-	-	-	-	-	-	-	-	-	-
1924	-	-	-	-	-	-	-	-	-	-	-	-	-
1925	-	-	-	-	-	-	-	-	-	-	-	-	-
1926	-	-	-	-	-	-	-	-	-	-	-	-	-
1927	-	-	-	-	-	-	-	-	-	-	-	-	-
1928	-	-	-	-	-	-	-	-	-	-	-	-	-
1929	-	-	-	-	-	-	-	-	-	-	-	-	-
1930	-	-	-	-	-	-	-	-	-	-	-	-	-
1931	-	-	-	-	-	-	-	-	-	-	-	-	-
1932	-	-	-	-	-	-	-	-	-	-	-	-	-
1933	-	-	-	-	-	-	-	-	-	-	-	-	-
1934	-	-	-	-	-	-	-	-	-	-	-	-	-
1935	-	-	-	-	-	-	-	-	-	-	-	-	-
1936	-	-	-	-	-	-	-	-	-	-	-	-	-
1937	-	-	-	-	-	-	-	-	-	-	-	-	-
1938	-	-	-	-	-	-	-	-	-	-	-	-	-
1939	-	-	-	-	-	-	-	-	-	-	-	-	-
1940	-	-	-	-	-	-	-	-	-	-	-	-	-
1941	-	-	-	-	-	-	-	-	-	-	-	-	-
1942	-	-	-	-	-	-	-	-	-	-	-	-	-
1943	-	-	-	-	-	-	-	-	-	-	-	-	-
1944	-	-	-	-	-	-	-	-	-	-	-	-	-
1945	-	-	-	-	-	-	-	-	-	-	-	-	-
1946	-	-	-	-	-	-	-	-	-	-	-	-	-
1947	-	-	-	-	-	-	-	-	-	-	-	-	-
1948	-	-	-	-	-	-	-	-	-	-	-	-	-
1949	-	-	-	-	-	-	-	-	-	-	-	-	-
1950	-	-	-	-	-	-	-	20.300	4.270	4.930	-	-	-
1951	-	-	-	-	88.500	30.400	25.700	17.100	36.700	51.200	10.900	-	-
1952	-	-	-	-	63.600	22.500	18.400	8.960	3.170	3.000	3.340	-	-
1953	-	-	-	29.600	61.500	92.100	109.000	58.300	61.800	13.500	10.100	-	-
1954	-	-	-	-	-	-	-	-	-	-	-	-	-
1955	-	-	-	-	-	-	-	-	-	-	-	-	-
1956	-	-	-	-	-	-	-	-	-	-	-	-	-
1957	-	-	-	-	-	-	-	-	-	-	-	-	-
1958	-	-	-	-	-	-	-	-	-	-	-	-	-
1959	-	-	-	-	-	-	-	-	-	-	-	-	-
1960	-	-	-	-	-	-	-	-	-	-	-	-	-
1961	-	-	-	-	-	-	-	-	-	-	-	-	-
1962	-	-	-	-	-	-	-	-	-	-	-	-	-
1963	-	-	-	-	-	-	-	-	-	-	-	-	-
1964	-	-	-	-	-	-	-	-	-	-	-	-	-
1965	-	-	-	-	-	-	-	-	-	-	-	-	-
1966	-	-	-	-	-	-	-	-	-	-	-	-	-
1967	-	-	-	-	-	-	-	-	-	-	-	-	-
1968	-	-	-	-	-	-	-	-	-	-	-	-	-
1969	-	-	-	-	-	-	-	-	-	-	-	-	-
1970	-	-	-	-	-	-	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN	0.028	0.000	0.028	7.800	3.760	4.300	7.590	2.200	2.250	2.250	1.020	0.142	122593
MAX	1.980	1.420	0.850	51.000	170.000	181.000	109.000	58.300	61.800	51.200	12.700	3.960	493298
MEAN	1.004	0.710	0.439	24.033	74.718	53.189	38.288	21.582	15.657	11.664	6.974	1.603	307945

Table B-2

RED DEER RIVER NEAR ERWOOD - 05LC001
RECORDED FLOW - m³/s

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	CJ.DAMS
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
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1929
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1935
1936
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1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954	183.000	288.000	78.100	48.200	71.300	51.000	.	.	.
1955	.	.	.	.	232.000	50.800	14.600	4.200	1.540	2.600	.	.	.
1956	.	.	.	19.000	156.000	47.000	32.000	7.290	5.040	4.020	.	.	.
1957	.	.	1.420	104.000	126.000	24.300	7.540	2.220	3.330	1.560	.	.	.
1958	.	.	0.870	23.000	11.900	6.130	8.090	0.664	3.280	7.230	.	.	.
1959	.	.	0.584	23.700	23.600	12.300	19.800	3.150	9.560	12.300	.	.	.
1960	.	.	1.820	85.300	74.600	42.000	9.630	4.190	0.322	0.833	.	.	.
1961	.	.	2.820	13.200	14.600	2.470	0.141	0.067	0.021	0.253	.	.	.
1962	.	.	0.000	32.900	34.300	4.590	0.719	0.418	1.760	1.630	.	.	.
1963	.	.	0.221	18.100	6.990	5.210	7.230	2.140	2.770	1.670	.	.	.
1964	.	.	.	.	46.700	3.580	1.910	1.910	9.650	8.480	.	.	.
1965	.	.	0.453	24.300	50.400	121.000	47.000	14.400	10.400	10.900	.	.	.
1966	.	.	0.816	90.700	79.500	60.800	38.700	13.600	7.210	4.530	.	.	.
1967	.	.	1.530	4.980	132.000	25.800	3.890	3.170	0.235	0.756	.	.	.
1968	.	.	3.220	19.000	11.400	14.400	24.500	7.440	9.940	5.790	.	.	.
1969	.	.	1.120	59.600	16.300	4.510	2.640	1.920	0.629	9.460	.	.	.
1970	.	.	1.010	34.800	81.400	34.600	50.900	6.330	2.690	6.700	.	.	.
1971	.	.	1.120	75.200	27.900	9.560	10.400	5.520	1.620	11.200	.	.	.
1972	.	.	0.970	105.000	164.000	23.200	7.090	2.340	0.987	2.110	.	.	.
1973	.	.	0.248	15.000	20.900	60.700	51.100	9.790	3.400	2.990	2.620	2.260	.
1974	1.340	1.330	1.410	84.200	149.000	55.800	8.570	6.680	11.800	11.500	4.040	2.500	891945
1975	2.200	2.200	2.240	51.400	110.000	50.700	12.700	2.990	5.640	9.890	4.070	1.610	674474
1976	1.280	1.690	1.330	64.900	25.900	63.000	29.000	5.380	1.210	1.580	0.418	0.096	512903
1977	0.075	0.033	0.040	8.820	11.800	5.060	2.390	5.210	10.400	7.460	3.900	1.860	150354
1978	0.770	0.322	0.292	54.000	39.800	11.300	5.370	13.800	11.300	15.900	9.610	2.440	434146
1979	0.919	0.372	0.458	75.300	177.000	78.500	10.500	1.950	0.846	1.330	2.520	1.570	927152
1980	0.710	0.865	0.900	22.600	6.450	1.310	4.600	6.180	6.740	9.000	1.970	0.831	163511
1981	0.289	0.109	1.890	11.100	9.350	3.620	4.160	2.370	0.670	10.200	6.830	0.514	134923
1982	0.158	0.070	0.135	20.400	16.400	26.200	4.290	3.200	2.290	3.550	0.861	0.290	204181
1983	0.842	0.666	0.550	31.500	39.300	41.000	55.200	8.240	11.600	6.970	5.020	2.150	535943
1984	0.993	1.060	1.370	55.200	78.700	72.200	10.600	1.040	0.692	6.090	4.870	2.630	618943
1985	1.220	1.030	1.100	93.400	68.500	26.000	9.590	8.510	3.300	7.010	3.070	1.240	588747
1986	1.130	0.622	1.410	75.500	43.700	16.000	6.330	3.800	1.040	3.540	1.650	1.200	409321
MIN	0.075	0.033	0.000	4.980	6.450	1.310	0.141	0.067	0.021	0.253	0.418	0.096	134923
MAX	2.200	2.200	3.220	105.000	232.000	288.000	78.100	48.200	71.300	51.000	9.610	2.630	927152
MEAN	0.917	0.801	1.081	46.537	68.769	39.141	17.554	6.312	6.461	7.274	3.675	1.514	480503

Table B-3

**RED DEER RIVER NEAR ERWOOD - 05LC001
REGRESSION EQUATIONS USED TO ESTIMATE NATURAL MONTHLY MEAN FLOW**

Month ¹	Years	Regression Equation	Correlation Coefficient	Standard Error of Estimate ⁵	Priority Number
March	1913, 1916-56, 1964	$Q_E^{2,6} = 169 + .9664 \text{ February}$	.947	28.0	1
April	1912, 1934-44, 1947-50 1913, 1916, 1920-29, 1932, 1951-52, 1954-55, 1964	$Q_E^3 = .36 (15.156 + .4756 \text{ B2MH})$	.791	44.8	4
		$Q_E = 3.241 + 1.3592 \text{ BLE6} + .0075 \text{ BME1}$	.873	38.6	1
		$Q_E = 5.744 + 1.1891 \text{ BLE6}$	.782	47.4	2
May	1933 1930-31, 1945-46	$Q_E = 10.031 + .6394 \text{ BME1}$	.758	50.9	3
		$Q_E = 20.086 + .5163 \text{ BMH1}$	.786	53.8	4
June	1912, 1937-42 1913, 1920-36 1943 1944-50	$Q_E = 5.840 + 2.6249 \text{ BLE6}$	.858	46.6	2
		$Q_E = 21.410 + .9957 \text{ BME1}$	.817	49.6	3
		$Q_E = 16.096 + 4.9209 \text{ AMC1}$	.945	36.2	1
July	1912, 1937-42 1913, 1920-36 1943 1944-50	$Q_E = .655 \text{ BMH1 (graphical fit)}$	-	-	4
		$Q_E = -3.065 + 3.2866 \text{ BLE6}$	.960	36.9	1
		$Q_E = .416 + 1.8206 \text{ BME1}$	.838	72.4	3
		$Q_E = 10.154 + 5.9337 \text{ AMC1}$	.975	30.3	2
August	1912, 1937-41 1920-32 1933-36 1942-49	$Q_E = .40 \text{ BMH1 (graphical fit)}$	-	-	5
		$\log Q_E = .3024 + .8601 \log \text{ BLE6} + .2403 \log \text{ BME1}$	.935	40.5/68.2	1
		$Q_E = 4.123 + 2.0930 \text{ BLE6}$	.869	55.5	2
		$Q_E^4 = 8.459 + .9843 \text{ BME1}$	.827	58.6	4
September	1912, 1937-41 1920-32 1933-36 1942-49	$Q_E = 8.855 + 1.6163 \text{ BMD4}$	.865	63.7	3
		$Q_E = .33 \text{ BMH1 (graphical fit)}$	-	-	4
		$\log Q_E = .1787 + .8306 \log \text{ BLE6} + .4522 \log \text{ BME1}$	.934	39.6/65.6	1
October	1912, 1936-42, 1945 1919-31 1932-35 1943-44, 1946-49	$Q_E = .015 + 3.0093 \text{ BLE6}$	.834	77.9	2
		$Q_E = 3.524 + .9383 \text{ BME1}$	.856	70.6	3
		$\log Q_E = -.6457 + 1.2453 \log \text{ BMH1}$	.688	69.5/227	4
November	1912, 1917-50, 1954-72	$\log Q_E = 26.54 + .7906 \log \text{ BLE6} + .3047 \log \text{ BME1}$	.933	43.6/77.5	1
		$Q_E = -1.245 + 3.1524 \text{ BLE6}$	.872	84.5	2
		$Q_E = -.499 + 1.9687 \text{ BME1}$	.788	103	3
December	1912, 1936-42, 1945 1919-31 1932-35 1943-44, 1946-49	$Q_E = .44 \text{ BMH1 (graphical fit)}$	-	-	4
		$\log Q_E = .2752 + .9136 \log \text{ BLE6} + .1571 \log \text{ BME1}$	.925	36.1/56.6	1
		$Q_E = -1.157 + 2.7424 \text{ BLE6}$	.826	75.6	2
January	1912, 1917-50, 1954-72	$Q_E = -1.123 + 1.8725 \text{ BME1}$	.812	82.2	3
		$Q_E^6 = .55 \text{ October (graphical fit)}$	-	-	1

¹ Missing natural monthly mean flows for the months December to February of the years 1912, 1915-72 were estimated using the following procedure:

- Summed missing winter flows for the months December to February were first estimated by regression analysis with the corresponding summed winter flows for BLE6. $Q_E^6 = -.900 + 1.6890 (\text{Dec.} + \text{Jan.} + \text{Feb.}) \text{ BLE6}$, with the lower end of the regression line manually adjusted to intersect the origin ($r = .707$, $SE = 52.0\%$).
- Estimated summed winter flows were then distributed to the individual winter months using the following percentages:
 December = 49% of Q_E
 January = 28% of Q_E
 February = 23% of Q_E

January to March monthly flows for 1912 were estimated as the average monthly flows for the period 1913-86.

² Estimated monthly flows in dam³ were subsequently converted to m³/s for presentation in Table B-4.

³ Grouped April-May regression; the multiplier .36 is the average April proportion (36%) of the sum of April and May natural monthly mean flows of 05LC001.

⁴ The lower end of the regression line was manually adjusted to intersect the origin.

⁵ Standard error of estimate expressed as a percentage of mean of the dependent variable for the regressed period. For logarithmic relationships, both the lower/upper bounds are given.

⁶ Estimated monthly values were used as the independent variable beyond the recorded period.

LIST OF SYMBOLS

- B2MH Summed April + May natural flow of Assiniboine River at Brandon (05MH001), in m³/s, as developed for the November, 1980 PPWB Assiniboine River natural flow report⁽⁴⁾.
- BLE6 Natural flow of Swan River near Minnetonka (05LE006), in m³/s, as presented in Table B-5 of the September, 1985 PPWB Swan River natural flow report⁽³⁾.
- BME1 Natural flow of Assiniboine River near Russell (05ME001), in m³/s, as presented in Table B-5 of the November, 1980 PPWB Assiniboine River natural flow report⁽⁴⁾.
- BMH1 Natural flow of Assiniboine River at Brandon (05MH001), in m³/s, as developed for the November, 1980 PPWB Assiniboine River natural flow report⁽⁴⁾.
- AMC1 Recorded flow of Assiniboine River at Sturgis (05MC001), in m³/s.
- BMD4 Natural flow of Assiniboine River near Kamsack (05MD004), in m³/s, as presented in Table B-4 of the November, 1980 PPWB Assiniboine River natural flow report⁽⁴⁾.

Table B-4

RED DEER RIVER NEAR ERWOOD - 05LC001
NATURAL FLOW - m³/s

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	CU.DAMS
1912	0.664	0.550	0.697	53.582	114.060	85.150	24.200	19.908	59.423	44.640	24.442	4.947	1127189
1913	2.827	2.322	2.090	94.889	87.033	43.644	186.320	56.943	27.563	14.741	9.147	3.995	1407859
1914	1.998	1.433	0.838	51.466	85.978	30.072	7.659	2.220	2.271	2.571	1.716	0.714	497804
1915	0.028	0.000	0.028	7.876	3.797	4.342	20.297	4.595	2.312	2.273	1.030	0.143	123794
1916	0.387	0.252	0.291	24.428	171.402	182.492	58.478	24.618	10.587	15.446	10.805	0.223	1328115
1917	0.187	0.105	0.155	19.972	151.564	60.522	47.611	7.454	4.731	2.845	1.566	0.808	788497
1918	0.462	0.379	0.394	18.574	13.323	34.223	34.524	21.098	5.613	6.753	3.716	0.699	368859
1919	0.999	0.328	0.350	17.767	37.047	24.934	26.651	13.041	13.830	16.221	8.922	0.142	421763
1920	0.981	0.067	0.124	78.790	186.880	51.542	14.103	4.863	3.864	6.558	3.647	1.189	929935
1921	0.400	0.558	0.558	48.094	60.449	71.607	49.384	79.233	42.729	41.548	22.647	2.969	1219098
1922	2.266	1.843	1.689	110.030	285.620	45.705	24.533	26.239	14.449	10.816	5.949	1.273	1399655
1923	0.727	0.398	0.545	90.600	135.330	137.320	102.360	38.256	8.734	7.821	4.302	1.872	1500001
1924	1.070	0.858	0.858	23.718	40.950	17.095	7.697	34.913	6.884	7.883	4.006	0.795	386823
1925	0.434	0.373	0.389	121.100	46.163	103.400	55.247	12.494	8.668	6.963	3.830	0.718	943111
1926	0.410	0.337	0.357	72.374	35.464	34.373	7.232	1.483	2.863	8.397	4.618	1.081	442662
1927	0.618	0.507	0.506	72.031	165.018	113.360	57.012	29.846	33.142	24.306	13.368	1.895	1344210
1928	1.083	0.890	0.868	17.890	38.207	15.071	44.163	10.760	4.497	3.320	1.826	0.058	367787
1929	0.933	0.027	0.047	13.541	22.820	9.230	8.834	2.019	1.800	1.626	0.894	0.776	163039
1930	0.443	0.364	0.381	27.395	27.865	29.049	21.012	3.088	3.342	2.635	1.449	0.503	309396
1931	0.287	0.236	0.269	25.838	13.384	1.228	3.458	1.560	3.608	4.388	3.513	0.279	158353
1932	0.159	0.131	0.182	31.697	19.883	6.414	16.880	3.625	3.170	2.773	1.325	0.798	229720
1933	0.410	0.337	0.357	34.449	53.841	63.906	28.182	5.299	6.267	6.410	3.526	0.258	536538
1934	0.490	0.403	0.415	26.908	114.740	65.402	18.164	4.196	2.279	3.171	1.744	0.511	552408
1935	0.292	0.240	0.273	15.660	29.952	76.270	25.251	4.983	2.248	3.744	2.059	0.900	425180
1936	0.314	0.422	0.445	52.024	66.186	34.373	14.371	2.359	0.246	2.037	1.120	0.420	461377
1937	0.240	0.197	0.235	12.578	30.826	11.332	2.112	0.729	8.356	1.584	0.871	0.137	161741
1938	0.089	0.075	0.127	19.883	34.284	8.515	3.232	1.884	0.962	1.522	0.837	0.387	189466
1939	0.221	0.181	0.221	13.982	29.587	6.491	4.260	1.805	0.921	1.527	0.840	0.185	159221
1940	0.095	0.078	0.134	8.687	25.766	4.120	1.584	1.020	0.580	1.131	0.622	0.387	117172
1941	0.221	0.181	0.221	16.582	31.498	7.205	1.540	0.783	1.216	1.393	0.876	0.154	163181
1942	0.088	0.072	0.128	30.931	39.088	21.812	16.485	9.760	11.652	5.896	3.243	0.519	352700
1943	0.297	0.244	0.276	43.296	44.031	32.109	12.828	7.247	4.768	4.230	2.327	0.486	405481
1944	0.278	0.228	0.269	11.294	18.818	11.228	9.818	4.994	4.185	3.420	1.881	0.787	175872
1945	0.321	0.181	0.221	22.437	24.216	15.928	10.956	6.857	5.849	3.486	1.873	0.428	243919
1946	0.243	0.201	0.239	35.548	22.297	14.899	9.862	4.118	3.461	3.568	3.058	0.693	262832
1947	0.386	0.385	0.347	53.736	39.323	19.787	16.643	4.966	14.005	12.935	7.114	1.595	450003
1948	0.911	0.749	0.740	78.372	118.940	20.457	12.798	15.861	8.282	3.861	2.773	0.900	702876
1949	0.314	0.432	0.432	22.497	22.641	33.652	11.117	8.000	4.419	4.008	2.204	0.825	291567
1950	0.472	0.387	0.401	33.705	33.024	16.741	10.471	20.165	4.252	4.907	2.899	1.487	339598
1951	0.832	0.684	0.660	36.341	88.254	30.323	28.637	17.062	36.605	51.062	10.880	2.822	796594
1952	1.613	1.325	1.261	67.199	63.225	88.377	19.301	8.918	3.163	2.994	3.332	1.299	513684
1953	0.742	0.610	0.596	29.598	61.465	98.039	108.828	58.265	61.765	13.882	10.104	3.377	1164255
1954	1.930	1.585	1.447	34.797	182.524	287.242	77.904	48.083	71.122	50.876	27.556	2.847	2078765
1955	1.627	1.336	1.229	73.877	225.861	49.465	14.225	4.101	1.512	2.543	1.365	1.159	1001985
1956	0.662	0.544	0.555	18.372	150.764	45.431	30.934	7.056	4.882	3.896	2.106	1.101	707057
1957	0.629	0.317	1.380	100.266	121.464	23.435	7.280	2.152	3.222	1.516	0.819	0.789	694500
1958	0.451	0.370	0.836	21.831	11.298	5.825	7.683	0.641	3.122	6.868	3.765	0.129	165178
1959	0.074	0.060	0.557	22.162	22.059	11.501	18.507	2.954	8.942	11.501	6.325	1.692	280562
1960	0.967	0.794	1.722	80.662	70.459	39.643	9.121	3.959	0.315	0.795	0.434	0.168	549294
1961	0.596	0.409	2.626	12.267	13.555	2.304	0.145	0.076	0.033	0.247	0.136	0.065	83424
1962	0.037	0.031	0.007	30.674	31.862	4.268	0.678	0.398	1.644	1.521	0.837	0.103	189763
1963	0.059	0.048	0.214	16.868	6.507	4.831	6.715	1.997	2.582	1.562	0.859	0.504	112306
1964	0.288	0.237	0.278	17.207	44.434	3.542	1.788	1.780	8.945	7.860	4.323	1.700	244458
1965	0.971	0.798	0.434	23.560	48.879	116.849	45.490	13.793	9.890	10.365	5.354	1.785	731855
1966	1.909	0.629	0.783	88.407	76.485	57.941	36.665	12.779	6.852	4.329	2.311	2.021	764186
1967	1.155	0.949	1.424	4.628	122.650	23.913	3.614	2.961	0.228	0.708	0.388	0.143	433175
1968	0.883	0.688	2.915	17.440	10.461	13.218	22.467	6.831	9.121	5.314	2.923	0.648	241879
1969	0.484	0.398	1.030	54.634	14.940	4.145	2.417	1.771	0.584	8.667	4.767	0.892	248079
1970	0.310	0.419	0.941	32.542	76.417	32.358	47.228	5.885	2.505	6.222	3.378	3.646	561734
1971	2.983	1.711	1.028	69.604	25.623	8.708	9.638	4.977	1.472	10.253	5.639	2.330	375362
1972	1.331	1.094	0.925	102.363	156.796	21.030	5.966	1.955	0.913	2.012	1.063	0.000	780309
1973	0.000	0.000	0.228	13.589	18.944	54.952	46.359	8.687	3.037	2.711	2.376	2.050	403225
1974	1.283	1.274	1.350	84.038	143.197	52.400	7.149	5.742	10.957	10.936	3.860	2.391	855944
1975	2.046	2.046	2.082	49.318	102.827	46.196	11.162	2.619	5.227	9.185	3.782	1.498	627863
1976	1.169	1.541	1.213	60.073	23.380	56.840	26.029	4.834	1.107	1.444	0.385	0.091	466545
1977	0.071	0.034	0.039	7.959	10.680	4.593	2.177	4.726	9.405	6.748	3.528	1.684	136110
1978	0.699	0.294	0.265	48.803	35.969	10.222	4.860	12.487	10.223	14.379	8.688	2.208	392528
1979	0.893	0.364	0.446	75.241	173.548	75.455	9.623	1.811	0.829	1.298	2.444	1.524	906566
1980	0.643	0.783	0.814	20.432	5.837	1.204	4.173	5.591	6.094	8.128	1.780	0.752	147924
1981	0.264	0.103	1.677	10.067	8.447	3.279	3.768	2.149	0.615	9.195	6.164	0.467	121960
1982	0.144	0.066	0.123	18.290	14.669	23.433	3.848	2.877	2.057	3.181	0.772	0.262	182876
1983	0.763	0.604	0.499	28.594	35.514	37.200	50.335	7.557	10.485	6.296	4.532	1.943	486550
1984	0.912	0.974	1.261	51.519	72.281	65.925	9.669	0.982	0.641	5.578	4.460	2.410	569413
1985	1.115	0.942	1.005	87.373	62.338	22.998	8.389	7.712	3.013	6.402	2.802	1.133	539389
1986	1.011	0.558	1.252	68.304	38.833	13.945	5.503	3.393	0.938	3.168	1.475	1.073	366051
MIN	0.000	0.000	0.007	4.628	3.797	1.204	0.145	0.076	0.033	0.247	0.136	0.000	83424
MAX	2.827	2.322	2.915	121.100	285.620	287.242	186.320	79.233	71.122	51.062	27.556	4.947	2078765
MEAN	0.664	0.550	0.697	42.093	65.752	38.988	22.806	10.461	8.588	8.012	4.275	1.159	538263

Note: 1. Shaded area denotes natural flow data derived by regression analysis as indicated in Table B-3. Caution should be exercised in using these flows.

2. Cross-hatched area denotes natural flow data derived by transferring natural flows from Red Deer River near Hudson Bay (05LC002) using annual contributing drainage area ratios.

Table B-5

RED DEER RIVER AT THE SASKATCHEWAN-MANITOBA BOUNDARY
NATURAL FLOW - m³/s

	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	CU.DAMS
1912-13	58.521	124.574	92.999	26.431	17.372	64.900	48.536	26.695	5.403	3.071	2.522	2.270	1246011
1913-14	103.078	94.548	47.412	202.407	61.860	29.943	16.013	9.937	4.343	2.201	1.578	0.945	1521250
1914-15	56.687	94.700	33.123	8.436	2.445	2.501	2.612	1.890	0.787	0.031	0.000	0.031	536225
1915-16	8.693	4.191	4.792	22.402	5.071	2.552	2.508	1.137	0.158	0.335	0.275	0.317	138899
1916-17	26.624	186.809	198.897	63.735	29.010	11.538	16.813	13.956	0.243	0.139	0.115	0.170	1446176
1917-18	21.887	165.813	66.325	52.176	8.169	5.184	3.117	1.716	0.885	0.510	0.418	0.435	866537
1918-19	20.500	14.707	37.770	38.104	23.286	6.195	7.454	4.101	0.771	0.440	0.362	0.386	406657
1919-20	19.609	40.889	27.520	27.185	16.601	15.264	17.903	9.847	0.157	0.089	0.073	0.136	463195
1920-21	86.192	204.436	56.384	15.428	5.298	4.227	7.174	3.946	1.301	0.742	0.609	0.600	1021577
1921-22	74.273	87.749	78.323	53.867	86.422	46.606	45.309	24.920	4.329	2.467	2.027	1.837	1341080
1922-23	119.688	310.692	49.717	22.335	30.718	15.717	11.765	6.471	1.385	0.788	0.648	0.634	1511464
1923-24	98.251	168.432	170.590	110.994	41.483	9.471	8.481	4.665	2.030	1.181	0.970	0.947	1629274
1924-25	26.178	45.197	18.868	8.495	38.534	7.598	8.038	4.421	0.877	0.496	0.408	0.425	422262
1925-26	132.410	50.474	113.057	60.407	13.661	9.478	7.613	4.188	0.785	0.452	0.372	0.394	1030901
1926-27	79.833	39.119	37.916	7.977	1.636	3.158	9.262	5.094	1.192	0.673	0.552	0.551	489732
1927-28	78.436	177.506	123.441	62.082	32.282	36.089	26.467	14.557	2.064	1.195	0.982	0.958	1467361
1928-29	19.745	42.169	16.634	48.743	11.885	4.963	3.664	2.015	0.064	0.036	0.030	0.096	398125
1929-30	14.945	25.186	10.187	9.750	2.228	1.997	1.795	0.987	0.856	0.489	0.402	0.421	182927
1930-31	30.236	30.755	32.061	23.191	3.408	3.689	2.908	1.599	0.555	0.317	0.260	0.297	340347
1931-32	28.517	14.772	1.355	4.037	1.722	3.982	7.050	3.877	0.308	0.175	0.145	0.201	173871
1932-33	34.984	21.945	7.079	18.630	4.001	3.499	3.061	1.683	0.792	0.451	0.371	0.393	255331
1933-34	37.921	59.267	70.346	31.022	5.833	6.899	7.056	3.881	0.944	0.539	0.443	0.456	591188
1934-35	29.592	126.186	38.933	19.976	4.617	2.506	3.487	1.918	0.562	0.322	0.265	0.301	606087
1935-36	17.284	33.058	84.179	27.870	5.500	2.481	4.132	2.273	0.993	0.567	0.465	0.491	470958
1936-37	57.352	72.965	37.893	16.504	2.601	0.271	2.246	1.235	0.463	0.265	0.217	0.259	506562
1937-38	13.882	34.023	12.507	2.331	0.805	0.393	1.748	0.961	0.173	0.098	0.081	0.140	177417
1938-39	21.857	37.842	9.398	3.567	2.079	1.062	1.680	0.924	0.427	0.244	0.200	0.244	210070
1939-40	15.432	32.655	7.164	4.680	1.992	1.017	1.685	0.927	0.182	0.105	0.086	0.148	174835
1940-41	9.588	28.438	4.547	1.748	1.126	0.640	1.248	0.687	0.427	0.244	0.200	0.244	130220
1941-42	18.059	34.764	7.952	1.700	0.776	1.342	1.758	0.967	0.170	0.097	0.079	0.139	179138
1942-43	34.139	43.141	24.074	11.793	10.772	12.860	6.507	3.579	0.573	0.328	0.269	0.305	390795
1943-44	49.993	48.597	35.439	14.158	7.999	5.262	4.669	2.568	0.536	0.307	0.252	0.297	447631
1944-45	12.465	20.769	12.392	10.615	5.512	4.619	3.775	2.076	0.427	0.244	0.200	0.244	193653
1945-46	24.764	26.727	17.580	12.092	7.568	6.456	3.759	2.067	0.472	0.270	0.222	0.264	269391
1946-47	39.234	24.609	16.223	10.885	4.545	3.820	6.137	3.375	0.765	0.437	0.358	0.383	291183
1947-48	59.257	43.363	21.732	18.355	5.476	15.444	14.264	7.845	1.759	1.000	0.822	0.812	500090
1948-49	86.047	130.589	22.680	14.051	17.414	9.093	5.535	3.045	0.988	0.567	0.466	0.477	768721
1949-50	25.051	24.989	37.142	12.270	8.830	4.877	4.424	2.433	0.911	0.521	0.427	0.443	321694
1950-51	37.200	36.449	18.477	11.557	22.256	4.693	5.415	2.979	1.608	0.911	0.749	0.723	377390
1951-52	39.809	96.676	33.217	28.084	18.690	40.098	55.935	11.919	3.091	1.776	1.459	1.389	878555
1952-53	73.950	69.622	24.639	20.152	9.820	3.483	3.297	3.669	1.430	0.810	0.666	0.651	559013
1953-54	32.306	67.088	100.459	118.891	63.596	67.414	14.737	11.029	3.686	2.086	1.713	1.564	1279171
1954-55	39.768	197.261	310.435	84.194	51.966	76.864	54.984	29.781	3.077	1.778	1.460	1.343	2244583
1955-56	80.733	246.822	54.056	15.545	4.481	1.652	2.779	1.492	1.267	0.727	0.597	0.609	1088157
1956-57	20.164	165.471	49.862	33.951	7.745	5.359	4.277	2.311	1.208	0.691	0.568	1.516	778240
1957-58	110.123	133.405	25.739	7.996	2.363	3.539	1.665	0.900	0.867	0.498	0.408	0.923	760288
1958-59	24.095	12.470	6.429	8.480	0.708	3.446	7.580	4.155	0.142	0.082	0.066	0.614	179538
1959-60	24.460	24.347	12.694	20.426	3.260	9.869	12.694	6.981	1.867	1.064	0.873	1.895	317745
1960-61	88.737	77.512	43.611	10.034	4.355	0.346	0.875	0.477	0.185	0.106	0.087	2.898	602422
1961-62	13.540	14.961	2.543	0.160	0.084	0.037	0.272	0.150	0.072	0.041	0.034	0.008	84030
1962-63	33.855	35.166	4.711	0.748	0.439	1.814	1.678	0.924	0.114	0.065	0.053	0.236	210163
1963-64	18.618	7.182	5.332	7.411	2.204	2.850	1.724	0.948	0.556	0.318	0.262	0.307	125346
1964-65	18.991	49.042	3.909	1.973	1.965	9.873	8.676	4.771	1.876	1.065	0.876	0.476	273725
1965-66	25.849	53.628	128.201	49.910	15.133	10.851	11.372	6.094	1.936	1.107	0.909	0.859	804174
1966-67	96.960	83.885	63.547	40.212	14.015	7.515	4.748	2.535	2.217	1.274	1.047	1.572	840807
1967-68	5.106	135.329	26.386	3.987	3.267	0.251	0.781	0.428	0.160	0.092	0.075	3.217	476851
1968-69	19.249	11.546	14.589	24.797	7.540	10.067	5.865	3.226	0.936	0.534	0.439	1.137	263451
1969-70	60.299	16.490	4.575	2.668	1.954	0.645	9.566	5.261	0.985	0.561	0.461	1.034	273654
1970-71	35.777	84.014	35.574	51.922	6.470	2.754	6.841	3.714	4.008	2.299	1.888	1.135	625950
1971-72	76.822	28.280	9.611	10.637	5.494	1.625	11.316	6.224	2.572	1.459	1.199	1.014	410151
1972-73	112.222	171.899	23.056	6.540	2.144	1.001	2.206	1.165	0.000	0.000	0.000	0.252	866513
1973-74	14.998	20.909	60.651	51.166	9.588	3.352	2.992	2.622	2.263	1.405	1.395	1.478	455462
1974-75	92.018	156.794	57.375	7.828	6.287	11.997	11.974	4.227	2.619	2.248	2.248	2.288	943714
1975-76	54.185	112.974	50.755	12.264	2.877	5.742	10.092	4.155	1.646	1.288	1.699	1.337	683524
1976-77	66.207	25.767	62.643	28.687	5.328	1.220	1.592	0.424	0.101	0.078	0.037	0.043	503305
1977-78	8.784	11.787	5.069	2.402	5.216	10.380	7.448	3.894	1.859	0.771	0.324	0.293	153443
1978-79	53.864	39.699	11.282	5.364	13.782	11.283	15.870	9.589	2.436	0.978	0.398	0.488	434489
1979-80	82.348	189.942	82.583	10.532	1.982	0.908	1.420	2.674	1.667	0.710	0.864	0.899	993787
1980-81	22.551	6.442	1.329	4.605	6.171	6.726	8.971	1.964	0.830	0.291	0.113	1.851	162802
1981-82	11.110	9.323	3.619	4.158	2.372	0.679	10.149	6.803	0.515	0.159	0.073	0.136	129562
1982-83	20.187	16.190	25.864	4.247	3.175	2.270	3.510	0.852	0.289	0.841	0.666	0.549	206208
1983-84	31.504	39.129	40.986	55.458	8.326	11.552	6.937	4.994	2.141	1.002	1.071	1.386	539812
1984-85	56.622	79.440	72.454	10.626	1.079	0.704	6.131	4.902	2.649	1.227	1.037	1.106	625491
1985-86	96.149	68.600	25.308	9.232	8.487	3.316	7.045	3.083	1.247	1.116	0.616	1.382	592988
MIN	5.106	4.191	1.329	0.160	0.084	0.037	0.272	0.150	0.000	0.000	0.000	0.008	84030
MAX	132.410	310.692	310.435	202.407	86.422	76.864	55.935	29.781	5.403	3.071	2.522	3.217	2244583
MEAN	45.815	72.461	43.056	25.233	11.556	9.510	8.852	4.727	1.273	0.728	0.603	0.766	592467

Note: Caution should be exercised in using this data base for other studies.

Table B-6

RED DEER RIVER AT THE SASKATCHEWAN-MANITOBA BOUNDARY
 FLOWS AT THE PRESENT (1986) LEVEL OF UPSTREAM DEVELOPMENT
 (INCLUDING DRAINAGE) - m³/s

	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	CU. DAMS
1912-13	59.894	129.744	98.244	28.083	18.463	69.054	51.641	28.402	5.744	3.191	2.619	2.358	1309568
1913-14	102.419	96.935	50.154	210.918	64.916	31.544	16.758	10.347	4.515	2.418	1.732	1.035	1572890
1914-15	60.954	103.734	37.199	9.861	2.859	2.761	2.870	2.075	0.861	0.028	0.000	0.028	588998
1915-16	9.602	4.636	5.302	24.871	5.603	2.824	2.776	1.257	0.170	0.346	0.283	0.328	153651
1916-17	27.879	195.327	210.093	67.947	30.897	12.255	17.753	14.721	0.250	0.144	0.117	0.177	1524013
1917-18	23.099	177.756	71.956	56.943	9.080	5.633	3.355	1.845	0.949	0.560	0.458	0.477	934112
1918-19	22.636	16.391	42.127	42.466	25.911	6.875	8.271	4.550	0.851	0.483	0.395	0.423	452338
1919-20	21.440	45.090	30.707	30.292	18.429	16.945	19.883	10.935	0.168	0.088	0.072	0.139	513184
1920-21	90.116	217.339	61.355	17.574	6.124	4.631	7.691	4.222	1.387	0.778	0.637	0.629	1090778
1921-22	76.796	92.416	83.534	57.953	92.088	49.674	48.205	26.550	4.685	2.639	2.152	1.938	1421667
1922-23	121.210	323.682	53.865	24.812	32.868	16.795	12.412	6.780	1.443	0.808	0.663	0.649	1578960
1923-24	98.816	173.324	177.247	115.830	43.615	10.123	8.833	4.821	2.091	1.306	1.071	1.046	1683817
1924-25	28.467	50.223	21.382	9.690	42.853	8.431	8.923	4.907	0.969	0.524	0.429	0.449	469164
1925-26	137.690	54.330	122.158	65.451	14.961	10.190	8.136	4.471	0.833	0.495	0.405	0.431	1099903
1926-27	86.536	43.545	42.842	9.310	1.965	3.514	10.262	5.641	1.316	0.701	0.573	0.573	541708
1927-28	80.197	185.427	130.750	66.280	34.662	38.379	28.091	15.452	2.251	1.372	1.114	1.075	1543922
1928-29	21.212	46.632	18.725	54.351	13.376	5.543	4.063	2.233	0.065	0.034	0.026	0.101	441448
1929-30	16.393	27.752	11.515	10.924	2.454	2.203	1.986	1.091	0.946	0.537	0.439	0.461	202622
1930-31	33.119	33.943	35.779	26.021	3.867	4.096	3.223	1.771	0.611	0.345	0.282	0.324	377500
1931-32	31.068	16.376	1.616	4.480	1.885	4.411	7.824	4.302	0.336	0.188	0.154	0.217	191540
1932-33	38.147	24.437	8.165	20.883	4.498	3.886	3.393	1.864	0.874	0.489	0.401	0.426	283228
1933-34	40.473	64.538	77.826	34.653	6.609	7.600	7.747	4.260	1.032	0.583	0.478	0.494	648297
1934-35	31.735	137.330	43.118	22.301	5.099	2.731	3.807	2.094	0.609	0.351	0.287	0.329	662083
1935-36	19.141	36.807	93.407	31.149	6.207	2.757	4.581	2.519	1.098	0.620	0.508	0.536	523615
1936-37	61.909	80.288	42.498	18.701	2.954	0.293	2.473	1.359	0.506	0.288	0.235	0.282	558020
1937-38	15.354	37.899	13.923	2.562	0.858	0.422	1.933	1.062	0.186	0.103	0.083	0.150	196950
1938-39	24.206	41.939	10.274	3.868	2.285	1.170	1.856	1.020	0.468	0.264	0.215	0.265	232022
1939-40	16.797	36.024	8.042	5.278	2.197	1.113	1.862	1.024	0.196	0.110	0.089	0.158	192880
1940-41	10.587	31.574	5.029	1.868	1.214	0.700	1.378	0.757	0.468	0.264	0.215	0.265	143957
1941-42	19.626	38.356	8.992	1.940	0.837	1.472	1.943	1.068	0.183	0.101	0.081	0.149	197493
1942-43	37.311	47.766	26.963	13.355	11.919	14.378	7.249	3.971	0.630	0.358	0.292	0.333	433445
1943-44	53.998	53.910	40.011	16.105	8.943	5.837	5.177	2.848	0.590	0.334	0.273	0.324	495556
1944-45	13.786	23.044	13.734	11.763	6.088	5.116	4.183	2.300	0.468	0.264	0.215	0.265	214482
1945-46	27.435	29.668	19.511	13.407	8.374	7.163	4.166	2.291	0.519	0.294	0.240	0.286	298668
1946-47	42.752	27.119	18.170	12.132	5.023	4.230	6.809	3.744	0.844	0.477	0.390	0.418	320997
1947-48	64.150	47.791	24.382	20.725	6.244	17.125	15.784	8.679	1.941	1.081	0.888	0.878	551540
1948-49	90.957	141.324	25.815	16.203	19.298	9.936	6.007	3.304	1.068	0.624	0.511	0.524	833858
1949-50	27.704	27.800	41.551	13.796	9.808	5.400	4.903	2.697	1.006	0.572	0.468	0.485	357966
1950-51	40.892	40.191	20.680	12.994	24.757	5.203	6.008	3.304	1.781	0.975	0.800	0.773	417878
1951-52	41.732	103.389	36.333	30.803	20.346	43.161	60.453	13.079	3.484	2.041	1.654	1.553	947047
1952-53	78.854	76.209	28.013	22.768	10.968	3.840	3.616	4.031	1.568	0.853	0.700	0.685	611571
1953-54	33.989	70.661	106.906	126.402	67.796	71.732	15.675	11.704	3.906	2.119	1.739	1.588	1357446
1954-55	39.379	199.391	316.763	86.698	53.682	78.822	56.255	30.423	3.164	1.909	1.561	1.432	2288201
1955-56	83.337	261.815	58.996	17.774	5.250	1.837	2.956	1.585	1.345	0.782	0.642	0.655	1157683
1956-57	21.844	178.529	54.629	37.523	8.629	5.833	4.636	2.504	1.306	0.746	0.611	1.645	845405
1957-58	117.093	144.742	29.218	9.584	2.925	3.916	1.807	0.973	0.937	0.546	0.447	1.020	825718
1958-59	26.699	14.009	7.186	9.399	0.750	3.812	8.411	4.611	0.152	0.084	0.066	0.677	199502
1959-60	27.091	27.021	14.081	22.659	3.591	10.951	14.097	7.751	2.069	1.160	0.951	2.071	352212
1960-61	95.242	84.303	48.382	11.317	4.787	0.357	0.946	0.517	0.197	0.111	0.090	3.214	655648
1961-62	14.988	16.609	2.792	0.135	0.047	0.016	0.293	0.161	0.074	0.039	0.031	0.003	92684
1962-63	37.560	39.056	5.206	0.798	0.457	1.998	1.858	1.020	0.120	0.066	0.052	0.256	232925
1963-64	20.599	7.934	5.842	8.185	2.418	3.149	1.902	1.047	0.612	0.347	0.284	0.335	138329
1964-65	21.014	54.462	4.313	2.159	2.155	10.952	9.627	5.295	2.079	1.148	0.942	0.510	303258
1965-66	27.879	57.354	138.448	53.998	16.372	11.750	12.315	6.600	2.094	1.191	0.977	0.924	867398
1966-67	102.437	90.125	69.376	44.128	15.413	8.159	5.127	2.737	2.393	1.408	1.155	1.738	905811
1967-68	5.606	149.550	29.395	4.499	3.592	0.259	0.857	0.469	0.171	0.095	0.077	3.568	527591
1968-69	21.329	12.813	16.179	27.522	8.346	11.169	6.506	3.578	1.034	0.587	0.481	1.257	292132
1969-70	66.228	18.047	5.047	2.942	2.136	0.699	10.623	5.839	1.088	0.606	0.497	1.125	300836
1970-71	38.643	91.200	39.115	57.027	7.092	2.993	7.468	4.055	4.377	2.548	2.091	1.255	682791
1971-72	83.744	31.426	11.185	11.990	6.228	1.819	12.560	6.909	2.851	1.571	1.290	1.090	453283
1972-73	118.560	184.764	25.963	7.927	2.605	1.108	2.371	1.253	0.000	0.000	0.000	0.272	910884
1973-74	16.611	23.317	67.547	57.068	10.714	3.718	3.314	2.908	2.508	1.505	1.493	1.583	506787
1974-75	96.480	167.477	62.749	9.337	7.228	13.104	12.896	4.538	2.809	2.445	2.445	2.489	1012578
1975-76	57.651	122.357	56.143	14.038	3.302	6.265	10.994	4.524	1.789	1.416	1.869	1.471	743734
1976-77	71.967	28.527	69.654	32.044	5.945	1.329	1.742	0.459	0.105	0.080	0.033	0.042	555225
1977-78	9.699	13.080	5.594	2.632	5.758	11.520	8.262	4.320	2.059	0.850	0.353	0.319	169830
1978-79	59.797	44.094	12.513	5.929	15.281	12.519	17.621	10.648	2.701	1.043	0.420	0.518	482013
1979-80	86.132	201.668	89.074	11.887	2.219	0.961	1.512	2.865	1.784	0.782	0.954	0.992	1057947
1980-81	24.998	7.132	1.443	5.081	6.828	7.454	9.926	2.176	0.916	0.317	0.118	2.077	180314
1981-82	12.272	10.334	3.996	4.590	2.611	0.738	11.279	7.554	0.566	0.170	0.074	0.145	143374
1982-83	22.351	17.966	28.706	4.691	3.497	2.506	3.889	0.941	0.315	0.921	0.727	0.600	228416
1983-84	34.562	43.091	44.998	60.611	9.017	12.720	7.642	5.503	2.355	1.088	1.161	1.510	592002
1984-85	60.809	86.418	79.275	11.649	1.146	0.757	6.687	5.347	2.886	1.341	1.131	2.208	679852
1985-86	103.250	75.257	28.548	10.544	9.380	3.633	7.720	3.378	1.363	1.234	0.677	1.538	648116
MIN	5.606	4.636	1.443	0.135	0.047	0.016	0.293	0.161	0.000	0.000	0.000	0.003	92684
MAX	137.690	323.682	316.763	210.918	92.088	78.822	60.453	30.423	5.744	3.191	2.619	3.568	2288201
MEAN	48.742	77.790	46.652	27.487	12.549	10.243	9.569	5.106	1.380	0.788	0.651	0.832	637876

Note: Caution should be exercised in using this data base for other studies.





Table B-7

RED DEER RIVER BASIN BALANCE OF FLOW TABLE FOR APPORTIONMENT
AT THE PRESENT (1986) LEVEL OF DEVELOPMENT (INCLUDING DRAINAGE) - m³/s

	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	CU. DAMS
1912-13	30.634	67.457	51.744	14.868	9.777	36.604	27.372	15.055	3.042	1.655	1.358	1.222	686562
1913-14	50.880	49.661	26.448	109.715	33.986	16.573	8.751	5.379	2.344	1.318	0.942	0.563	812265
1914-15	32.611	56.384	20.637	5.643	1.636	1.510	1.564	1.130	0.467	0.012	0.000	0.012	320886
1915-16	5.255	2.540	2.906	13.670	3.068	1.548	1.522	0.689	0.091	0.179	0.146	0.170	84202
1916-17	14.567	101.922	110.644	36.080	16.392	6.485	9.347	7.743	0.129	0.074	0.060	0.092	800923
1917-18	12.155	94.849	38.794	30.855	4.995	3.040	1.796	0.986	0.507	0.305	0.260	0.260	500843
1918-19	12.386	9.037	23.243	23.414	14.269	3.778	4.545	2.499	0.465	0.263	0.214	0.230	249010
1919-20	11.635	24.645	16.947	16.699	10.128	9.313	10.931	6.012	0.090	0.044	0.035	0.072	281587
1920-21	47.020	115.121	33.163	9.860	3.475	2.518	4.104	2.249	0.737	0.408	0.333	0.329	579990
1921-22	39.660	48.542	44.372	31.019	48.876	26.371	25.550	14.090	2.521	1.405	1.138	1.020	751126
1922-23	61.366	168.337	29.007	13.645	17.510	8.937	6.529	3.544	0.751	0.414	0.339	0.332	823227
1923-24	49.691	89.108	91.952	60.333	22.873	5.387	4.593	2.489	1.076	0.715	0.586	0.573	869180
1924-25	15.378	27.624	11.948	5.442	23.586	4.632	4.904	2.696	0.530	0.276	0.225	0.236	258033
1925-26	71.486	29.093	65.630	35.248	8.130	5.452	4.330	2.378	0.441	0.269	0.219	0.234	584453
1926-27	46.619	23.985	23.884	5.321	1.147	1.935	5.630	3.094	0.719	0.364	0.297	0.298	296843
1927-28	40.979	96.674	69.029	35.239	18.521	20.334	14.857	8.173	1.219	0.774	0.623	0.596	810242
1928-29	11.339	25.547	10.408	29.979	7.434	3.061	2.231	1.226	0.033	0.016	0.011	0.053	242386
1929-30	8.921	15.159	6.421	6.049	1.339	1.205	1.089	0.597	0.517	0.292	0.239	0.251	111159
1930-31	18.001	18.566	19.748	14.426	2.162	2.252	1.769	0.972	0.333	0.187	0.152	0.175	207328
1931-32	16.810	8.990	0.939	2.461	1.024	2.420	4.299	2.363	0.182	0.101	0.082	0.117	104605
1932-33	20.655	13.464	4.625	11.567	2.498	2.136	1.863	1.023	0.478	0.264	0.215	0.229	155562
1933-34	21.513	34.905	42.653	19.142	3.692	4.151	4.219	2.319	0.560	0.314	0.256	0.265	352704
1934-35	16.939	74.237	23.651	12.313	2.791	1.478	2.064	1.135	0.328	0.190	0.155	0.178	359040
1935-36	10.499	20.278	51.317	17.214	3.457	1.516	2.515	1.383	0.601	0.337	0.275	0.291	288137
1936-37	33.233	43.806	23.552	10.449	1.653	0.157	1.350	0.742	0.274	0.155	0.126	0.153	304740
1937-38	8.413	20.888	7.669	1.396	0.455	0.225	1.058	0.581	0.100	0.053	0.042	0.080	108242
1938-39	13.278	23.019	5.575	2.084	1.246	0.639	1.016	0.558	0.255	0.142	0.115	0.143	126987
1939-40	9.081	19.696	4.460	2.938	1.201	0.604	1.019	0.560	0.105	0.057	0.046	0.084	105462
1940-41	5.793	17.355	2.756	0.993	0.651	0.380	0.754	0.414	0.255	0.142	0.115	0.143	78847
1941-42	10.596	20.974	5.016	1.090	0.449	0.801	1.064	0.585	0.098	0.053	0.042	0.079	107924
1942-43	20.242	26.195	14.926	7.458	6.533	7.947	3.996	2.181	0.344	0.194	0.158	0.180	238049
1943-44	29.002	29.611	22.292	9.026	4.944	3.206	2.842	1.563	0.322	0.181	0.147	0.175	271841
1944-45	7.553	12.659	7.538	6.455	3.332	2.806	2.295	1.262	0.255	0.142	0.115	0.143	117656
1945-46	15.053	16.305	10.721	7.361	4.590	3.935	2.286	1.257	0.283	0.159	0.129	0.155	163973
1946-47	23.135	14.814	10.058	6.690	2.750	2.320	3.741	2.057	0.461	0.259	0.211	0.226	175405
1947-48	34.522	26.110	13.516	11.548	3.505	9.403	8.652	4.757	1.062	0.581	0.476	0.471	301496
1948-49	47.933	76.030	14.475	9.177	10.591	5.389	3.240	1.782	0.574	0.340	0.278	0.285	449497
1949-50	15.179	15.306	22.980	7.662	5.393	2.961	2.691	1.480	0.550	0.312	0.254	0.264	197220
1950-51	22.292	21.966	11.441	7.215	13.628	2.856	3.301	1.815	0.977	0.520	0.426	0.411	229184
1951-52	21.827	55.050	19.724	16.761	11.001	23.112	32.485	7.120	1.938	1.153	0.924	0.859	507769
1952-53	41.879	41.398	15.694	12.692	6.058	2.099	1.967	2.196	0.853	0.448	0.367	0.359	332065
1953-54	17.836	37.117	56.677	66.957	35.998	38.025	8.306	6.190	2.063	1.076	0.882	0.806	717860
1954-55	19.495	100.760	161.546	44.601	27.700	40.389	28.763	15.533	1.626	1.020	0.831	0.761	1165907
1955-56	42.970	138.404	31.968	10.001	3.010	1.011	1.567	0.839	0.712	0.419	0.343	0.351	613604
1956-57	11.762	95.794	29.698	20.547	4.757	3.153	2.498	1.348	0.702	0.400	0.327	0.887	456285
1957-58	62.031	78.039	16.349	5.587	1.743	2.147	0.974	0.523	0.504	0.298	0.243	0.558	445574
1958-59	14.651	7.774	3.972	5.159	0.396	2.089	4.621	2.533	0.081	0.043	0.033	0.369	109733
1959-60	14.861	14.848	7.734	12.446	1.961	6.017	7.750	4.260	1.135	0.628	0.514	1.124	193339
1960-61	50.873	45.547	26.576	6.300	2.609	0.184	0.508	0.278	0.104	0.058	0.046	1.765	354437
1961-62	8.218	9.128	1.521	0.055	0.005	-0.003	0.156	0.086	0.038	0.018	0.014	-0.001	50669
1962-63	20.632	21.473	2.850	0.424	0.238	1.091	1.018	0.558	0.063	0.033	0.025	0.138	127843
1963-64	11.290	4.343	3.176	4.479	1.316	1.724	1.040	0.573	0.334	0.188	0.153	0.182	75656
1964-65	11.518	29.941	2.358	1.172	1.173	6.016	5.289	2.909	1.140	0.616	0.505	0.272	166396
1965-66	14.954	30.540	74.347	29.043	8.805	6.325	6.629	3.553	1.125	0.638	0.523	0.494	465310
1966-67	53.957	48.183	37.602	24.022	8.406	4.402	2.753	1.470	1.285	0.770	0.632	0.952	485407
1967-68	3.052	81.885	16.203	2.505	1.959	0.133	0.467	0.255	0.091	0.049	0.039	1.960	289165
1968-69	11.705	7.040	8.885	15.124	4.576	6.136	3.574	1.965	0.566	0.320	0.261	0.688	160407
1969-70	36.079	9.802	2.759	1.608	1.159	0.377	5.840	3.209	0.595	0.326	0.266	0.608	164009
1970-71	20.754	49.194	21.328	31.066	3.857	1.616	4.048	2.198	2.373	1.398	1.147	0.688	369815
1971-72	45.333	17.286	6.379	6.672	3.482	1.007	6.903	3.797	1.565	0.841	0.690	0.583	248208
1972-73	62.449	98.815	14.435	4.656	1.533	0.607	1.268	0.670	0.000	0.000	0.000	0.146	487627
1973-74	9.112	12.863	37.222	31.484	5.920	2.042	1.818	1.597	1.377	0.802	0.796	0.844	279057
1974-75	50.471	89.080	34.061	5.423	4.084	7.105	6.909	2.424	1.500	1.321	1.320	1.345	540721
1975-76	30.559	65.869	30.766	7.906	1.864	3.394	5.948	2.446	0.966	0.772	1.020	0.802	401971
1976-77	38.864	15.644	38.333	17.700	3.281	0.719	0.947	0.247	0.054	0.041	0.014	0.020	303574
1977-78	5.307	7.186	3.059	1.430	3.150	6.330	4.538	2.373	1.130	0.465	0.191	0.173	93109
1978-79	32.865	24.245	6.872	3.247	8.390	6.878	9.686	5.853	1.483	0.554	0.221	0.274	264769
1979-80	44.958	106.697	47.783	6.621	1.228	0.507	0.802	1.527	0.950	0.427	0.521	0.543	561053
1980-81	13.722	3.911	0.778	2.778	3.742	4.091	5.471	1.194	0.501	0.171	0.061	1.152	98913
1981-82	6.716	5.673	2.187	2.511	1.425	0.399	6.204	4.152	0.308	0.091	0.037	0.077	78593
1982-83	12.258	9.871	15.774	2.567	1.910	1.371	2.134	0.515	0.171	0.500	0.394	0.325	125312
1983-84	18.810	23.526	24.505	32.882	4.855	6.944	4.173	3.006	1.285	0.587	0.626	0.818	322097
1984-85	32.498	46.698	43.048	6.336	0.606	0.604	3.622	2.896	1.562	0.727	0.613	0.655	367107
1985-86	55.176	40.958	15.894	5.928	5.137	1.975	4.197	1.836	0.739	0.675	0.369	0.847	351622
MIN	3.052	2.540	0.778	0.055	0.005	-0.003	0.156	0.086	0.000	0.000	0.000	-0.001	50669
MAX	71.486	168.337	161.546	109.715	48.876	40.389	32.485	15.533	3.042	1.655	1.358	1.960	1165907
MEAN	25.834	41.560	25.124	14.871	6.771	5.488	5.143	2.742	0.743	0.424	0.349	0.449	341643

Note: See report section entitled "Present Use Flow Calculations" for information on the derivation of this table. Positive values indicate the quantity of water passed on to Manitoba in excess of 50% of natural flow. Negative values indicate a monthly 'deficit' in supplying 50% of natural flow.



APPENDIX C

RED DEER RIVER BASIN

HYDROMETRIC NETWORK

LIST OF TABLES

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Table C-1

RED DEER RIVER BASIN
DRAINAGE AREAS TO HYDROMETRIC GAUGING STATIONS
AT THE PRESENT (1986) LEVEL OF DRAINAGE DEVELOPMENT

WSC Hydrometric Gauging Station		Period of Record	Drainage Area* (km ²)	
Number	Name		Gross	Effective
05LA002	Barrier River near McKague	1964-76	1 067	556
05LA003	Duck Creek near Kelvington	1967-86	210	171
05LA004	Pipestone Creek near Rose Valley	1965-86	934	550
05LA005	Red Deer River near Archerwill	1964-86	1 869	1 133
05LA006	Barrier River below Barrier Lake	1977-86	1 318	763
05LA007	Kipabiskau Lake near McKague	1965-86	1 042	531
05LB001	Etomami River near Reserve	1955-65	1 103	989
05LB002	Etomami River near Bertwell	1955-86	2 045	1 847
05LB003	Fir River near Hudson Bay	1959-70	499	499
05LB004	Loiselle Creek near Hudson Bay	1956-86	84.4	82.6
05LB005	Red Deer River near Steen	1964-86	3 796	2 301
05LB006	Shand Creek near Dillabough	1956-86	655	572
05LB007	Fir River near Hudson Bay	1970-86	511	511
05LB008	MacNab Creek near Somme	1956-86	87.5	76.9
05LB009	Greenwater Creek near Chelan	1956-79	219	150
05LB010	Prairie River near Prairie River	1959-86	355	344
05LB011	Greenwater Lake near Chelan	1964-86	157	103
05LB012	Marean Lake near Chelan	1977-86	42.7	28.2
05LC001	Red Deer River near Erwood	1954-86	11 018	8 555
05LC002	Red Deer River near Hudson Bay	1913-19, 1950-53	10 868	8 407
05LC003	Red Deer Lake near Barrows	1913-14, 1962-86	14 223	11 760
05LC004	Red Deer River near the Mouth, Lake Winnipegosis	1954-86	14 542	12 079

* Obtained from Addendum No. 3 (dated January, 1988) to PFRA Hydrology Report #104.