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Poplar River Bilateral Monitoring
Annual report of the governments of Canada, United States,

1986 ANNUAL REPORT

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to the

GOVERNMENTS OF CANADA, UNITED STATES,

SASKATCHEWAN AND MONTANA

by the

POPLAR RIVER BILATERAL MONITORING COMMITTEE

COVERING CALENDAR YEAR 1986

June, 1987

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POPLAR RIVER BILATERAL MONITORING COMMITTEE

REPORT TO GOVERNMENTS OF CANADA, UNITED STATES,

SASKATCHEWAN AND MONTANA

FOR

CALENDAR YEAR 1986

JUNE, 1987

POPLAR RIVER BILATERAL MONITORING COMMITTEE

Department of State
Washington, D.C., United States

Department of External Affairs
Ottawa, Ontario, Canada

Governor's Office, State of Montana
Helena, Montana, United States

Saskatchewan Environment
Regina, Saskatchewan, Canada

Gentlemen:

During 1986, the Poplar River Bilateral Monitoring Committee continued to fulfill the responsibilities assigned by the governments under the Poplar River Cooperative Monitoring Arrangement dated September 23, 1980. Water quantity, water quality, and air quality relevant to the International Boundary were monitored in accordance to the 1986 Technical Monitoring Schedule. The monitoring data were exchanged on a quarterly basis. Herein is the report of activities of 1986 and the proposed monitoring schedule for 1987.

The report summarizes current conditions relative to pre-project conditions and compares current conditions to guidelines for specific parameter values that were developed by the International Joint Commission under the 1977 Reference from Canada and the United States. References are made to State, Provincial or Federal standards or objectives where these are relevant. After examination and evaluation of the monitoring information for 1986, the Committee finds that the measured conditions are within the norms of the accepted objectives.

During 1986, monitoring continued with only minor changes in site locations and schedules from 1985. Two new mining areas to the east and north of Cookson Reservoir are being assessed for future development. The impact statement is currently under review within the Saskatchewan Government and will be available to the Committee in the summer of 1987. Upon review of the report, the Committee may recommend modifications to the Technical Monitoring Schedules.

On March 12, 1987, the Cooperative Monitoring Arrangement was extended by the governments for a period of four years under the provision of Article 5, Terms of the Arrangement.

Yours sincerely,

J. R. Knapton
Chairman, United States Section

for G. W. Howard
Chairman, Canadian Section

R. E. Driear
Member, United States Section

W. D. Gummer
Member, Canadian Section

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLES OF CONTENTS (continued)

1986 HIGHLIGHTS

In 1986 the power station operated for the third full year. The two 300 megawatt coal-fired units generated 3,968,400 gross megawatt hours of electricity, down 13 percent from 1985. Because the number of plant startups decreased, the consumption of oil decreased 1,897 tonnes or 27 percent from 1985.

Monitoring information collected in both Canada and the United States was exchanged on a quarterly basis. In general the sampling locations, frequency of collection, and parameters met the requirements identified in the Technical Monitoring Schedules set forth in the 1985 annual report. An exception was continuous air quality monitoring in Montana where there was an interruption because of inadequate funding and a relocation of the primary monitoring site.

The United States received a continuous flow in the East Poplar River throughout the year. However, during 58 days of the summer minimum flow did not meet the 0.085 cubic meter per second recommended by the International Joint Commission. Efforts will be made in 1987 to remedy the operational and information exchange problems that resulted in these minimum flow requirements not being met.

The concentrations of boron and total dissolved solids on the East Poplar River were below the long-term and short-term objectives recommended to Government by the International Joint Commission. There were no exceedances of other water quality objectives recommended by the International Poplar River Water Quality Board to the International Joint Commission. Continued efforts at quality control showed improved water quality data comparability between Canadian and United States laboratories.

The outer limit of the cone of depression from coal seam dewatering remained about the same distance north of the International Boundary and total pumpage decreased 29 percent.

The total estimate of seepage from the ash lagoons and polishing ponds was 0.746 litre per second, well below the seepage limits proposed by the International Poplar River Water Quality Board. The leachate front was calculated to have advanced 6.11 metres towards Cookson Reservoir since the ponds were first filled.

Plant stack emissions did not cause or contribute to violation of Montana, United States or Saskatchewan ambient air quality standards.

INTRODUCTION

The Poplar River Bilateral Monitoring Committee was authorized for an initial period of 5 years by the Governments of Canada and the United States under the Poplar River Cooperative Monitoring Arrangement dated September 23, 1980. A copy of the Arrangement is attached to this report as Annex 1. On March 12, 1987 the Arrangement was extended by the Governments for an additional period of 4 years.

The Committee is composed of representatives of the Government of the United States of America, State of Montana, Government of Canada and Province of Saskatchewan. In addition to the representatives of Governments, two ex-officio members who are local representatives of the State of Montana and Province of Saskatchewan participate in the activities of the Committee. During 1986, the members and ex-officio members of the Committee were:

Mr. J. R. Knapton
U.S. Geological Survey
Chairman, United States Section

Mr. G. W. Howard
Saskatchewan Environment and Public Safety
Acting Chairman, Canadian Section

Mr. R. E. Driear
Governor's Office
Member, United States Section

Mr. W. D. Gummer
Environment Canada
Member, Canadian Section

Mr. C. W. Tande
Daniels County Commissioner
Ex-Officio Member, Montana

Mr. J. R. Totton
Reeve, R.M. of Hart Butte
Ex-Officio Member, Saskatchewan

The monitoring programs are in response to potential impacts of a transboundary nature resulting from Saskatchewan Power Corporation's coal-fired thermal generating station and ancillary operations near Coronach, Saskatchewan. Monitoring is conducted in Canada and the United States at or near the International Boundary for quantity and quality of both surface water and ground water and for air quality. Participants from both countries, including Federal, Provincial, and State agencies, are involved in monitoring.

A responsibility of the Committee includes an ongoing quarterly exchange of data acquired through the monitoring programs. The exchange of monitoring information was initiated with the first quarter of 1981, and is an expansion of the informal quarterly information exchange program initiated between Canada and the United States in 1976. Special reports dealing with aspects of monitoring and monitoring results requested by the Committee are sometimes published. Any such reports are reviewed annually by the Committee. Reports reviewed by the Committee during 1986 are identified in Annex 3. Exchanged data and reports are available for public viewing at the agencies of the participating governments or from Committee members.

The Committee also is responsible for an annual report to Governments which summarizes the monitoring results, evaluates apparent trends, and compares the data to objectives or standards recommended by the International Joint Commission (IJC) to Governments, or relevant State, Provincial, or Federal standards. The Committee reports to Governments on a calendar year basis, with the report for 1986 being the sixth report in the series. The Committee is also responsible for drawing to the attention of Governments definitive changes in monitored parameters which may require immediate attention.

Another responsibility of the Committee is to review the adequacy of the monitoring programs in both countries and make recommendations to Governments on the Technical Monitoring Schedules. The Schedules are updated annually for new and discontinued programs and for modifications in sampling frequencies, parameter lists, and analytical techniques of ongoing programs. The Technical Monitoring Schedules listed in the annual report (Annex 2) are given for the forthcoming year. The Committee will continue to review and propose changes to the Technical Monitoring Schedules as information requirements change.

POPLAR RIVER POWER STATION

Operation

The two units were operated for the full reporting period. The 1986 operating statistics for the two units are shown in Table 1:

Table 1. 1986 Operating Statistics for Generating Units No. 1 and No. 2

	Unit 1	Unit 2
Hours of Operation	7 751	7 726
Gross MWhr Generated	2 003 500	1 964 900
Availability (hours) (percent)	93.0	92.4
Capacity Factor (percent)	76.5	75.9
Number of Start Ups	9	9
Coal Consumed (tonnes)	1 684 385	1 657 643
Oil Consumed (tonnes)	992	1 005
Hours in Period	8 760	8 760

The average sulphur content of the coal in 1986 was 0.55 percent. Analyses were conducted by the Poplar River Power Station Laboratory. Analyses of monthly duplicate coal samples by an independent laboratory according to ASTM procedure D3176 provided, on average, 9 percent lower sulphur. The sulphur content of the No. 2 fuel oil was 0.08 percent.

Two spills occurred in 1986, both involving the ash handling system.

On October 4, 1986, an ash line ruptured spilling a maximum of 8,619 m^3 of ash recirculation water and approximately 180 m^3 of ash into a containment area between the Poplar River Power Station and the ash lagoons. The water overflowed the control structure resulting in a 6,119 m^3 maximum discharge to Cookson Reservoir. Analyses of the reservoir waters indicated rapid and complete mixing as no change in water quality was evident. Cleanup measures were implemented. Subsequent thickness testing of the ash lines indicated that the bottoms of the lines were wearing as a result of erosion. The ash lines between the plant and the ash lagoons have since been rotated 180 degrees to extend life and prevent spills.

On October 17, 1986, a seam on a buried section of the recirculation line failed, spilling approximately 2,000 m^3 of ash recirculation water into the same area as the previous spill. The spill was contained upstream of the control structure. No recirculation water entered the reservoir and cleanup measures were implemented. Routine water quality monitoring of the runoff waters collected by the control structure is an ongoing practice prior to their release.

Construction

Seven concrete and steel V-notched weirs were constructed in surface runoff channels downstream of the Morrison Dam and spillway. The weirs, completed in June 1986, replaced old plywood and earth structures which had deteriorated beyond use. The weir flows are routinely measured and recorded to monitor seepages from Morrison Dam.

The Ash Lagoon No. 3 North water return structure was completed in July 1986. The concrete and wooden stoplogged structure will permit the controlled flow of clear waters from Ash Lagoon No. 3 North to the Polishing Pond.

Mining

Coal mining continued to the west of Girard Creek and will move in a northwesterly direction until 1989 or later. Prairie Coal Limited has completed an environmental assessment of two new mining areas to the east and north of Cookson Reservoir (Figure 1). The impact statement addressed such things as ground water, surface water and reclamation. The impact statement is currently under review within Government and will be made public in Saskatchewan and Montana, with review comments, in the summer of 1987.

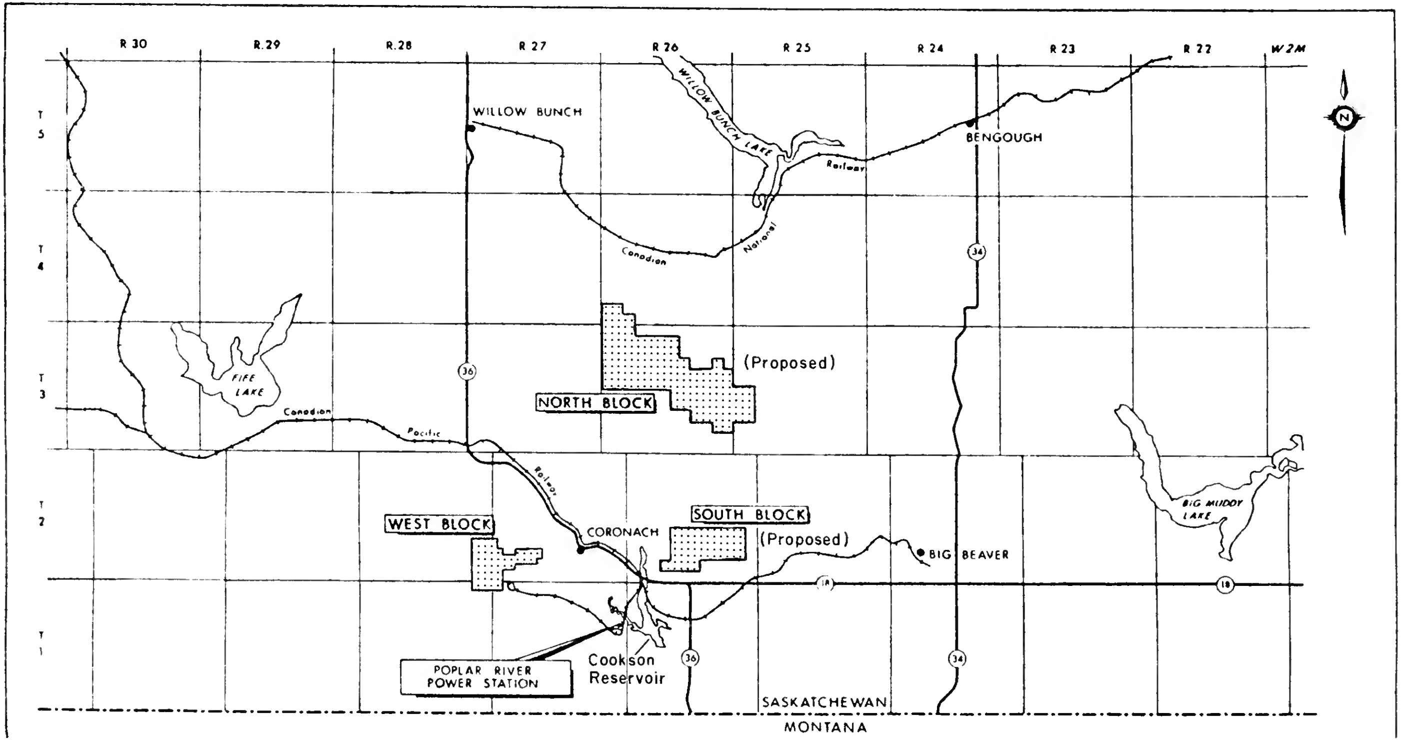


Figure 1. Poplar River Mine--Location Map.

SURFACE WATER QUANTITY

Streamflow

Streamflow in the Poplar River basin was near normal during 1986, assuming the recorded flow of the Poplar River at the International Boundary is a good indicator of basin runoff conditions. The March to October recorded flow volume at that gauge was 17,100 cubic decametres (dam^3), or 105 percent of the long-term average. A comparison of the flows of 1986 with those of the 1951-80 median flow is shown in Figure 2.

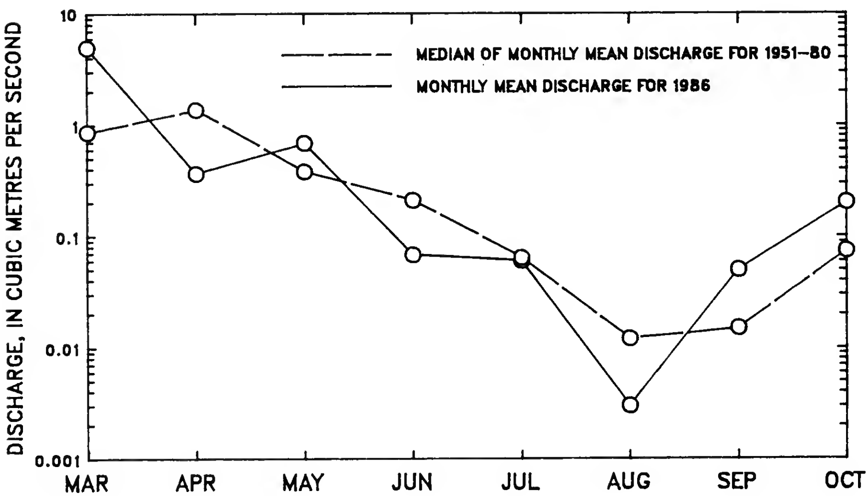


Figure 2.--Discharge during 1986 Compared with Median Discharge for 1951-80 for the Poplar River at International Boundary

The recorded flow volume of the East Poplar River at the International Boundary for 1986 was 9,450 dam^3, or 77 percent of the mean annual flow since the completion of Morrison Dam in 1975.

Reservoir Storage

Cookson Reservoir was near the full-supply level throughout the year, with contents increasing from 37,600 dam^3 on January 1 to a maximum of 45,600 dam^3 on March 3. Elevations and contents for selected dates are given in Table 2.

Table 2. Cookson Reservoir Storage Statistics for 1986

Date (1986)	Elevation (metres)	Contents (cubic decametres)
January 1	752.222	37 600
March 3	753.278	45 600
December 31	752.448	39 200
Full-Supply Level	753.000	43 400

Storage increased during the year by 1,600 dam^3 owing to above normal precipitation in the fall and base flows in Girard Creek which are maintained by dewatering operations at the Poplar River Mine. These flows assisted in offsetting the evaporative losses and releases from the reservoir.

Reservoir storage statistics (contents) figures given in the 1985 annual report were incorrect. The correct statistics are given in Table 3.

Table 3. Cookson Reservoir Storage Statistics for 1985 (Corrected)

Date (1985)	Elevation (metres)	Contents (cubic decametres)
January 1	752.149	37 000
April 19	752.805	41 900
December 31	752.222	37 600
Full-Supply Level	753.000	43 400

Apportionment

In 1976 the International Souris-Red Rivers Engineering Board, through its Poplar River Task Force, completed an investigation and made a recommendation to the Governments of Canada and the United States regarding an apportionment of waters of the Poplar River Basin. Although not officially adopted by the two countries, the Poplar River Bilateral Monitoring Committee has ascribed to the Apportionment Recommendation in each of its annual reports. Annex 4 contains the Apportionment Recommendation.

Minimum Flows

The recorded runoff volume of the Poplar River at the International Boundary from March 1 to May 31, 1986 was 16,100 dam^3. For the purposes of interpreting the apportionment recommendations of the IJC, the recorded flow is assumed to be the natural flow. Based on these recommendations, this volume entitled the United States to a minimum discharge of 0.085 cubic metre per second (m^3/s) from June 1 to August 31, 1986 and 0.057 m^3/s from September 1, 1986 to May 31, 1987 on the East Poplar River at the International Boundary. The minimum flow of 0.028 m^3/s for the first 5 months of 1986 had previously been determined on the basis of the March 1 to May 31, 1985 Poplar River flow volume.

The recorded flow of the East Poplar River at the International Boundary inadvertently fell below the recommended minimum of 0.085 m^3/s on several days. One reason for the shortage was that the Water Survey of Canada and the U.S. Geological Survey have been experiencing problems with developing an accurate low-flow rating at the hydrometric station. The Water Survey of Canada resealed the weir structure in August 1986 to eliminate a leakage problem and is planning to improve the metering section in 1987 and, subsequently, make additional measurements to aid in rating definition. The Saskatchewan Water Corporation has been asked to review operating procedures towards avoiding similar occurrences in the future. Communication and data exchange procedures between various agencies will also be improved during 1987.

A hydrograph of flow in the East Poplar River at the International Boundary and the minimum flow as recommended by the IJC is shown in Figure 3.

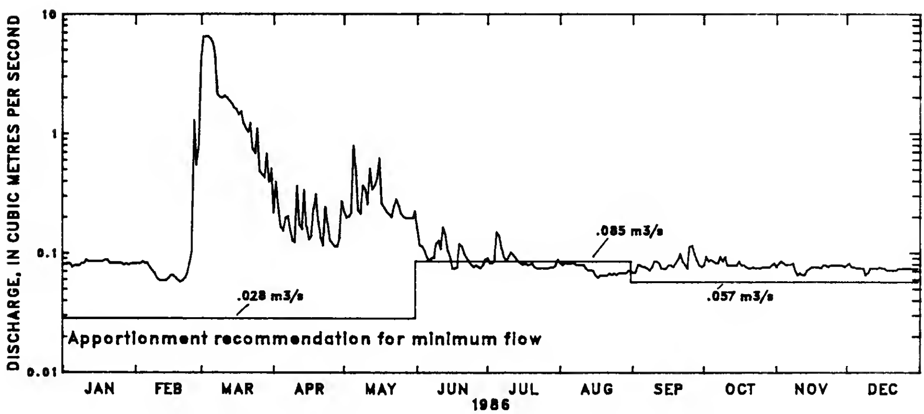


Figure 3. Hydrograph of Water Discharge of the East Poplar River at the International Boundary and Recommended Minimum Flow.

On-Demand Release

Based on the apportionment recommendations of the IJC, the United States is entitled to an on-demand volume of 1,230 dam^3 at any time from June 1, 1986 to May 31, 1987. As of December 31, 1986 Montana had not requested this release. The on-demand volume entitlement for 1985 of 617 dam^3 was requested on April 7, 1986, to be delivered May 1-31. A volume of 789 dam^3 was delivered during this period.

SURFACE WATER QUALITY

East Poplar River

The 1981 report by the IJC to Governments recommended:

> *For the March to October period, the maximum flow-weighted concentrations should not exceed 3.5 mg/L for boron and 1,500 mg/L for total dissolved solids for any three consecutive months in the East Poplar River at the International Boundary.*
>
> *For the March to October period, the long-term average of flow-weighted concentrations should be 2.5 mg/L or less for boron, and 1,000 mg/L or less for total dissolved solids in the East Poplar River at the International Boundary.*

Comparison of the East Poplar River water quality with the proposed short-term objectives for total dissolved solids (TDS) and boron is tested by calculating the 3-month (90-day) moving flow-weighted concentration for each, advancing one month at a time while dropping the first month of the three-month period. Prior to 1982, this comparison was based on instantaneous samples. Since the beginning of 1982, daily TDS and boron concentrations have been computed from a regression relationship with specific conductance. However, the data from both instantaneous samples and from calculation of TDS and boron are presented.

The Poplar River Bilateral Monitoring Committee has adopted the approach that, for the purposes of comparison with the proposed IJC long-term objectives, the TDS and boron data are best plotted graphically as a 5-year flow-weighted moving average which is advanced 1 month at a time.

Each point represents the flow-weighted concentration for a 5-year period, with 2 1/2 years on either side of the plotted point. It should be emphasized that the data base is comprised of all data collected during the 12 months of all years.

Total Dissolved Solids

The proposed short-term objective for TDS is 1,500 mg/L. A plot of the 3-month moving flow-weighted concentration is shown in Figure 4a. No exceedences of this objective have been observed over the 1975-85 period of record. The relationship between TDS and specific conductance generated from the data collected to the end of 1986 is as follows:

$$TDS = [0.640 \times \text{specific conductance}] + 10.533 \quad (R^2 = 0.87)$$

The long-term, 5-year moving flow-weighted concentrations for TDS are shown in Figure 4b. TDS concentrations calculated for the 5-year periods ending in 1986 remained below the proposed long-term objective of 1,000 mg/L. Analyzed TDS concentrations during 1986 ranged from 725 mg/L (March 7) to 1,223 mg/L (November 13). Analyzed TDS and regression-generated TDS for the period of record are presented in Figure 5.

Boron

During 1986, boron concentrations in the East Poplar River at the International Boundary varied from 0.85 mg/L (March 7) to 2.65 mg/L (November 13). The moving 3-month flow-weighted boron concentrations for the period of record are shown in Figure 6a. The short-term objective of 3.5 mg/L boron has not been exceeded in the period 1975-86. The moving 5-year flow-weighted concentrations are presented in Figure 6b. As with TDS, the 5-year weighted concentrations remained well below the proposed long-term objective of 2.5 mg/L boron.

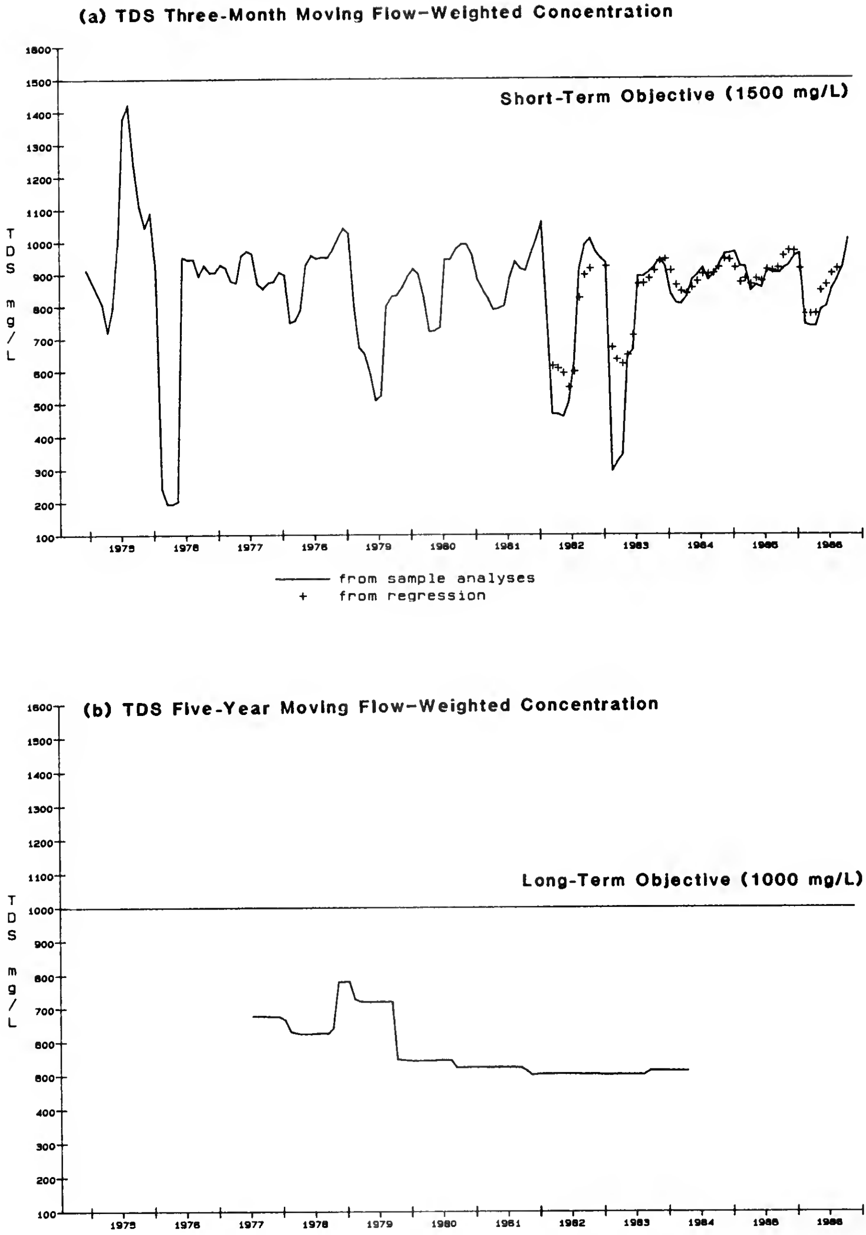
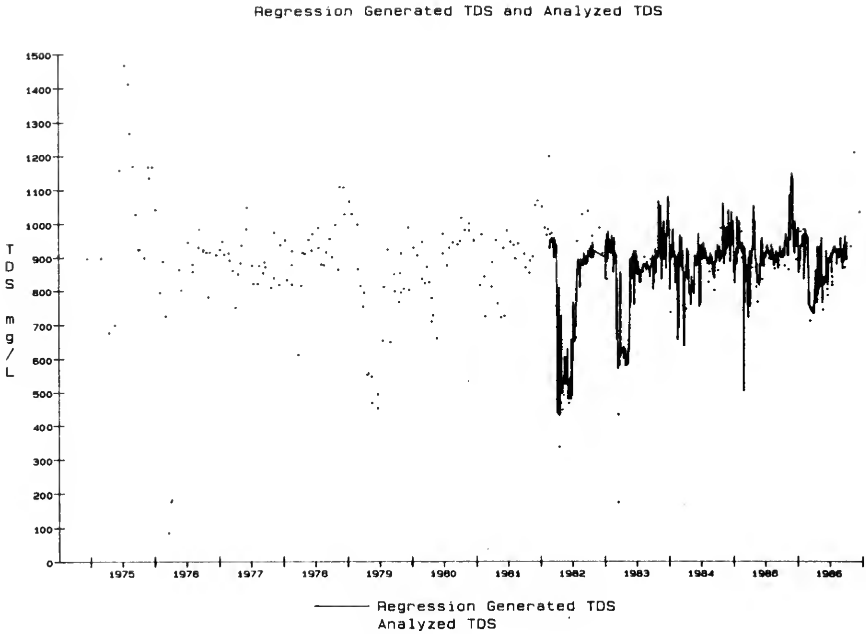


Figure 4. East Poplar River at International Boundary:
(a) TDS Three-Month Moving Flow-Weighted Concentration,
(b) TDS Five-Year Moving Flow-Weighted Concentration.



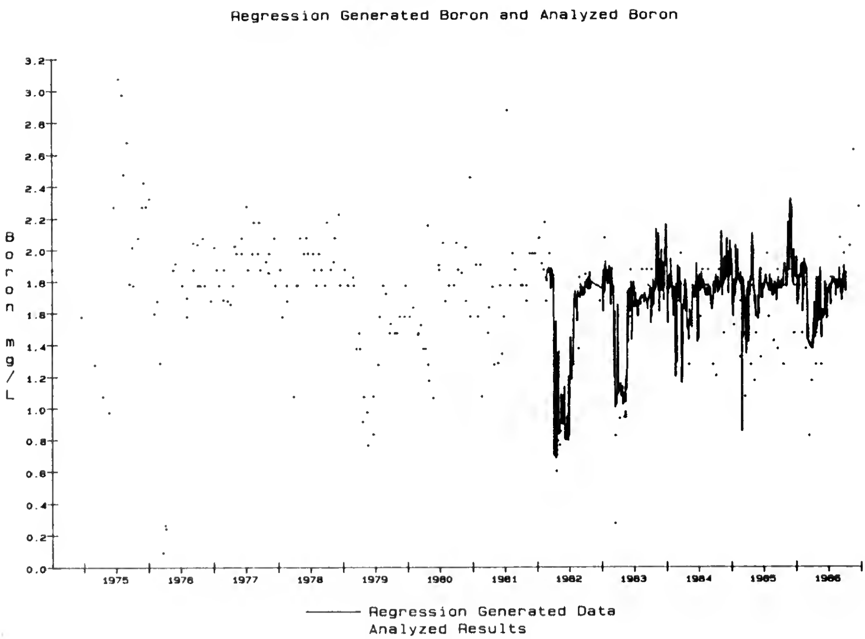
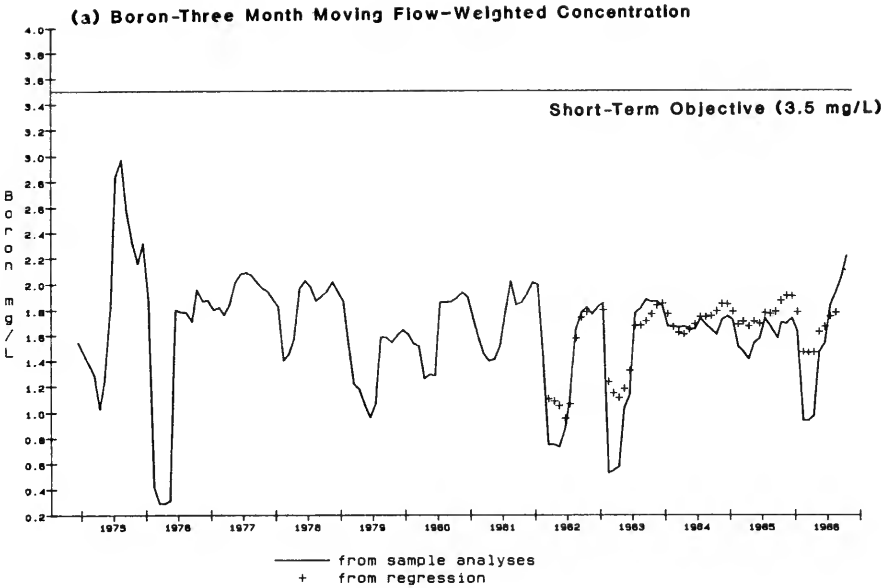


Figure 5. East Poplar River at International Boundary: Instantaneous and Regression-Generated TDS and Boron Concentrations 1975-86.



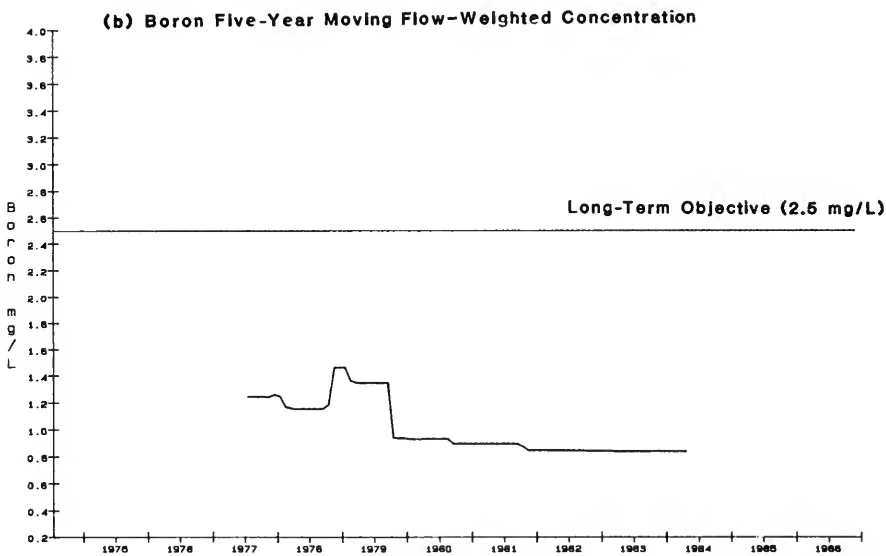


Figure 6. East Poplar River at International Boundary:
(a) Boron Three-Month Moving Flow-Weighted Concentration,
(b) Boron Five-Year Moving Flow-Weighted Concentration.

The relationship between boron and specific conductance at the sampling location during 1975-86 may be described by the equation:

$$\text{Boron} = [0.00145 \times \text{specific conductance}] - 0.268 \quad (R^2 = 0.73)$$

Analyzed and regression generated boron concentrations for the period of record are presented in Figure 5.

Other Water Quality Characteristics

Table 4 contains the multi-purpose water quality objectives recommended by the International Poplar River Water Quality Board to the IJC. No exceedences of the multi-purpose objectives occurred in 1986.

Girard Creek and Cookson Reservoir

Saskatchewan Environment and Public Safety reported water quality at four locations in the Poplar River Basin during 1986: Girard Creek south of Coronach, Cookson Reservoir at Highway 36, Cookson Reservoir near Morrison Dam, and East Poplar River just below Morrison Dam. These sites were sampled in February, May, August and November.

A review of the data from these sites showed boron concentrations varied from 0.72 to 1.75 mg/L, and TDS from 460 to 950 mg/L during 1986. All other variables were also present at concentrations within the recommended water quality objectives for the East Poplar River (Table 4).

Table 4
Recommended Water Quality Objectives and Excursions,
1986 Sampling Program,
East Poplar River at the International Boundary
(units in mg/L except as otherwise noted)

Parameter	Objective	No. of samples USA	No. of samples Canada	Excursions
Objectives recommended by IJC to Governments				
Boron - total	3.5, 2.5 (1)	14	14	Nil
Total dissolved solids	1500, 1000 (1)	14	14	Nil
Objectives recommended by Board to IJC				
Aluminum - dissolved	0.1	5	13	Nil
Ammonia - un-ionized (as N)	0.2	14	14	Nil
Cadmium - total	0.0012	2	13	Nil
Chromium - total	0.05	2	13	Nil
Copper - dissolved	0.005	2	--	Nil
Copper - total	1.0	4	13	Nil
Fluoride - dissolved	1.5	14	14	Nil
Lead - total	0.03	4	13	Nil
Mercury - dissolved	0.0002	--	13	Nil
Mercury - whole fish (mg/kg)	0.5	--	--	--
Nitrate (as N)	10.0	14	14	Nil
Oxygen - dissolved	4.0, 5.0 (2)	14	12	Nil
Sodium adsorption ratio	10.	14	14	Nil
Sulphate - dissolved	800.	14	14	Nil
Zinc - total	0.03	4	13	Nil
Water temperature (°C)	30. (3)	14	12	Nil
pH (pH units)	6.5 (4)	14	12	Nil
Coliform				
fecal (no./100 mL)	2,000.	--	10	Nil
total (no./100 mL)	20,000.	--	10	Nil

(1) Five-year average of flow-weighted concentrations (March to October) should be <2.5 mg/L boron and <1 000 mg/L TDS. Three-month average of flow-weighted concentrations should be <3.5 mg/L boron and <1 500 mg/L TDS.
(2) 5.0 mg/L (minimum April 10 to May 15), 4.0 mg/L (minimum remainder of year).
(3) Natural temperature (April 10 to May 15), <30 degrees Celsius (remainder of year).
(4) Less than 0.5 pH units above natural, minimum pH = 6.5.

Personnel from Environment Canada and Saskatchewan Environment and Public Safety undertook a field investigation on July 7, 1986 of the Girard Creek and East Poplar River water quantity and quality monitoring sites located above Cookson Reservoir. On the basis of this investigation, the water quality station on Girard Creek was relocated downstream to a point between Coronach and Cookson Reservoirs to provide a better estimate of the quality of water entering the reservoir. Although it was considered desirable to have the quantity and quality stations co-located, the need could not justify the high cost of relocating the Girard Creek hydrometric station from its current location above Coronach Reservoir.

It was noted that flow in the East Poplar River at the hydrometric station 15 km above Cookson Reservoir is typically near zero with the exception of a 3- to 4-week period during the spring. Water quality monitoring samples will not normally be collected at this hydrometric station, but will continue to be collected quarterly in the upper end of Cookson Reservoir at Highway 36.

Quality Control

Quality control sampling was conducted at the East Poplar River at the International Boundary on July 8, 1986. Sets of triplicate samples were collected and submitted to eight Canadian and United States laboratories for analyses. In addition, reference water samples were exchanged and submitted to the respective Federal laboratories and the Saskatchewan Research Council.

A review of the data from the triplicate sample splits shows the United States and Canadian results to be similar for most of the water quality variables. Results reported by the participating laboratories are subject to variability owing to differing analytical techniques. Following are areas where discrepancies were present:

specific conductance	Environment Canada measurements (laboratory and field) were about 5 percent higher than the mean for all laboratories
phosphorous (ortho)	Apparent disagreement between U.S. Geological Survey and Saskatchewan results
chloride	Saskatchewan Provincial Health Laboratory concentrations higher than other laboratories
SiO_2	Saskatchewan Research Council reports silica results as Si while other labs report silica as SiO_2
TDS	Environment Canada and U.S. Geological Survey results differ by about two percent. Saskatchewan Research Council results non-comparable (analyses done gravimetrically)
metals	Substantial differences between Saskatchewan Research Council and other participating laboratories for nickel, copper, vanadium
boron	Results generally comparable; Environment Canada and U.S. Geological Survey results differ by about 8 percent

Table 5 lists the analytical results of the above measurements made by the laboratories.

The results of analyses of the United States standard reference sample (Table 6) showed good agreement between laboratories for most variables. The Saskatchewan Research Council results for sulphate, chloride, and TDS varied from those reported by the other laboratories. Boron results from Environment Canada were not reported due to interference. Environment Canada pH (laboratory) was significantly above the multi-laboratory mean.

Table 5
Selected Analytical Results of Quality Control Split Samples, June 8, 1986

EC: Environment Canada Laboratories (Burlington and Saskatoon)
USGS: U.S. Geological Survey Laboratory
MINES: Montana Bureau of Mines and Geology
HEALTH: Montana Department of Health and Environmental Sciences
SASK: Saskatchewan Provincial Health Laboratory and Saskatchewan Research Council
SPC: Saskatchewan Power (analyses performed by Chemex Laboratories)

Lab/Time	Specific conductance (field)	Specific conductance (lab)	P Ortho mg/L	Chlor-ride mg/L	SiO_2 mg/L	TDS mg/L
EC-1130	--	1320	--	5.40	8.70	840
EC-1145	1373	1330	--	5.40	8.70	857
EC-1200	--	1330	--	5.30	8.70	854
USGS-1130	--	1230	<0.01	4.90	8.50	830
USGS-1145	--	1230	<.01	4.80	8.50	830
USGS-1200	1320	1230	<.01	4.80	8.50	830
MINES-1200	--	1313	--	5.20	9.30	850
HEALTH-1200	--	1249	--	5.70	8.40	818
SASK-1130	--	1260	.030	10.00	3.90	1182#
SASK-1145	--	1250	.040	10.00	3.90	1196#
SASK-1200	--	1260	.040	10.00	3.90	1161#
SPC-1200	--	1200	.012	5.94	7.24	870#
MEAN	1347	1267	--	6.50	7.40	926

Lab/Time	Ni total mg/L	Cu total mg/L	Zn total mg/L	V total mg/L	Al diss mg/L	Cr total mg/L	B diss mg/L
EC-1130	0.001	<0.001	0.002	0.0011	<0.1	<0.001	1.85
EC-1145	.001	.002	.001	.0012	<.1	<.001	1.80
EC-1200	.001	<.001	<.001	.0013	<.1	<.001	1.85
USGS-1130	.003	.003	.020	--	<.01	<.01	1.70
USGS-1145	.002	.004	.010	--	<.01	<.01	1.70
USGS-1200	.002	.002	.010	--	<.01	<.01	1.70
MINES-1200	--	--	--	--	--	--	1.67
HEALTH-1200	--	--	--	--	--	--	1.75
SASK-1130	.009*	.012*	.016*	<.01*	--	--	1.90
SASK-1145	.011*	.010*	.008*	.0100*	.03	.006*	1.90
SASK-1200	.009*	.006*	.011*	.0100*	.03	.006*	1.90
SPC-1200	<.001	.002	.003	<.001	.08	.006*	1.79
MEAN	--	--	--	--	--	--	1.79

Analyzed gravimetrically
* Analytical method reported as "dissolved"
Note that analytical methods were variable between laboratories. For purposes of brevity, column headings are the method description used by the majority of laboratories.

Table 6
Analytical Results of Water Quality Standards Exchanged

Constituent	Mean concentration mg/L	Labs no.	USGS analysis	Env Canada analysis	Sask Research Analysis
United States Standard Reference Water Sample No. 76					
SiO_2	9.76	33	10	9.99	3.7 (as Si)
Ca	187	46	190	183	191
Mg	120	44	120	121	121
Na	159	41	159	154	158
K	10.0	41	9.6	9.18	10
Alk (as $CaCO_3$)	303.4	38	296	306	--
SO_4	929	44	910	898	995
Cl	26.6	40	25	26.0	32
F	1.07	34	1.1	0.95	1.0
Sp. Cond. (lab)	2094 μS/cm	38	2099	2121	--
pH (lab)	8.28 units	45	8.4	8.7	--
B	399 μg/L	17	430	INT	380
B DC Plasma	425 μg/L	--	--	--	--
Hardness (total)	--	--	970	955	--
T.D.S	--	--	1599	1586	1900 (gravimetric)
Sodium %	--	--	25	26	--
SAR (ratio)	--	--	2	2	--
Alk (phen.)	--	--	NR	19.5	--
Canada Standard Reference Water Sample Cat-02					
SiO_2	1.29	50	1.4	1.32	0.5 (as Si)
Ca	28.26	84	29	28.1	28
Mg	7.40	75	7.9	7.3	7
Na	4.56	79	4.7	4.7	4.4
K	3.15	77	3.3	3.14	3.2
Alk (as $CaCO_3$)	78.93	74	80	80.6	--
SO_4	16.23	79	17	16.4	17
Cl	11.86	81	10	12.4	15
F	0.08	33	0.20	0.09	0.08
Sp. Cond. (lab)	227.8 μS/cm	71	232	234	--
pH (lab)	7.91 units	69	7.8	8.15	--
B	1500 μg/L	--	1500	1550	NR
Hardness (total)	103.3	48	100	100	--
T.D.S	--	--	120	121.8	147 (gravimetric)
Sodium %	--	--	9	8.9	--
SAR (ratio)	--	--	0.2	0.2	--

Analyses of the Canada reference standard (Table 6) again showed good agreement, with the exception of Saskatchewan Research Council results for chloride and TDS, and the U.S. Geological Survey result for fluoride.

The results of the quality control work conducted in 1986 show improved data comparability between Environment Canada and the U.S. Geological Survey over similar work done in 1985. It was noted in the 1985 Annual Report that Environment Canada monthly monitoring results for boron in the East Poplar River tended to be consistently lower than those reported by the U.S. Geological Survey laboratory. This trend continued through the first quarter of 1986. Improved compatability between the two laboratories was apparent in the second quarter 1986 boron results. During the third and fourth quarters, this trend showed a reversal, with the U.S. Geological Survey boron concentrations being slightly less than those of Environment Canada. It should be understood, however, that monthly samples collected by the two agencies are from different water, often collected several days apart.

GROUND WATER QUANTITY

Saskatchewan

Coal Mine Dewatering

Owing to coal mine dewatering activities, a total of 5,032 dam^3 (4,080 acre-feet) of ground water was discharged during 1986. This amounts to 29 percent less pumpage than in the previous year. A summary of the monthly pumpages from all the coal dewatering wells is shown in Table 7.

Table 7
1986 Monthly Pumpages from Mine Dewatering Activities

Month	Pumpages Total (dam^3)	Pumpages Rate (L/s)
January	524	196
February	479	198
March	536	200
April	462	178
May	346	129
June	456	176
July	481	180
August	420	157
September	323	124
October	332	124
November	305	118
December	368	137
TOTAL	5 032 dam^3 (4 080 acre-feet)	

The ground water was discharged at 16 locations during 1986. Fourteen discharges were to Girard Creek, one was directly into Cookson Reservoir and one was into a tributary of Goose Creek. No water from this last discharge reached the main stem of Goose Creek.

Water Levels

Two piezometric pressure maps, dated June and December 1986, were prepared by Prairie Coal Ltd.[1] Figure 7 was compiled from the December map and shows the cone of depression formed by the pressure contours in the Hart coal seam. The southern extent of the cone of depression at the end of 1986 is unchanged from its position in the previous year. The position of the 1-metre contour therefore remains at 1.8 kilometres north of the International Boundary.

Poplar River Mine Relocation

Prairie Coal Ltd. plans to relocate mining activity from the existing West Block to the proposed South Block and subsequently to the proposed North Block shown in Figure 1. Preliminary studies for the relocation have been concluded and the Environmental Impact Assessment is under review by provincial agencies. The required land purchases are 95 percent complete and detailed surveys and design of the rail line and loadout facilities are in progress. Movement of the dragline to the South Block is scheduled for the summer of 1989.

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[1] Effective December 1, 1984, ownership and operation of the Poplar River Mine were transferred from the Saskatchewan Power Corporation to Prairie Coal Ltd.

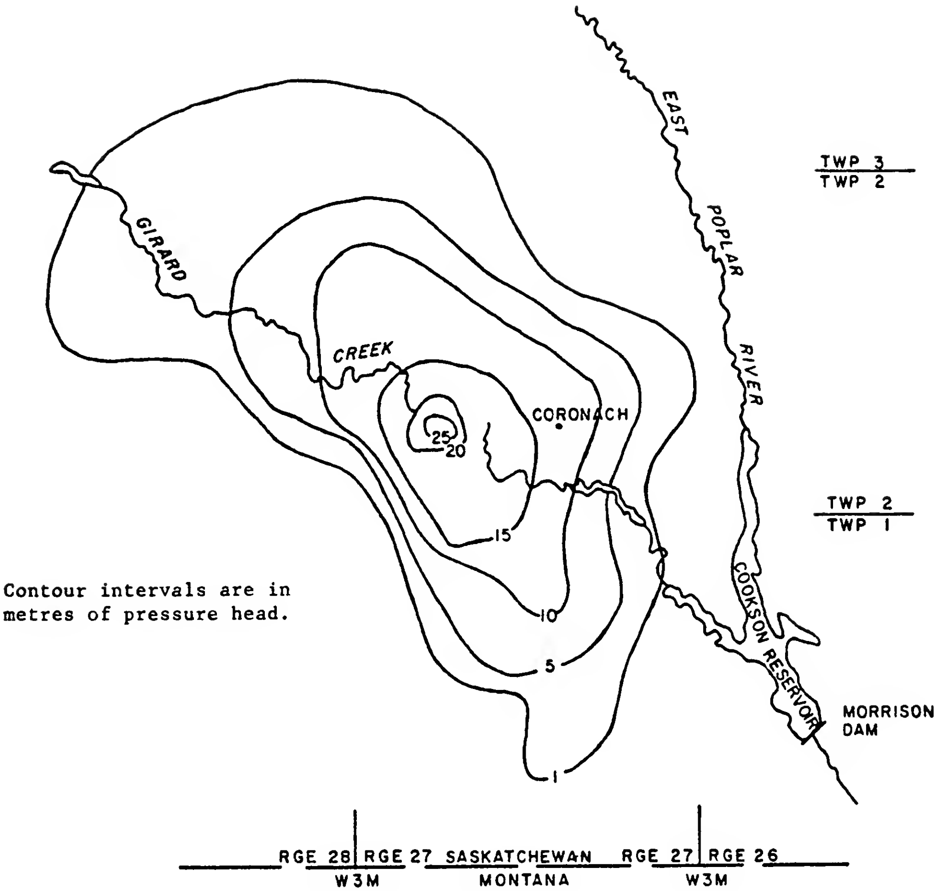


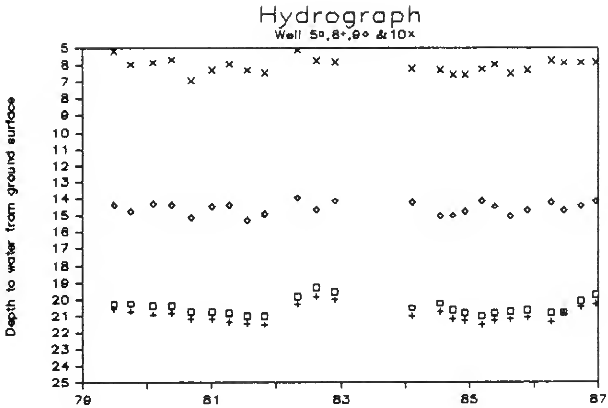
Figure 7. Cone of Depression in the Hart Coal Seam from Dewatering Activities as of December, 1986.

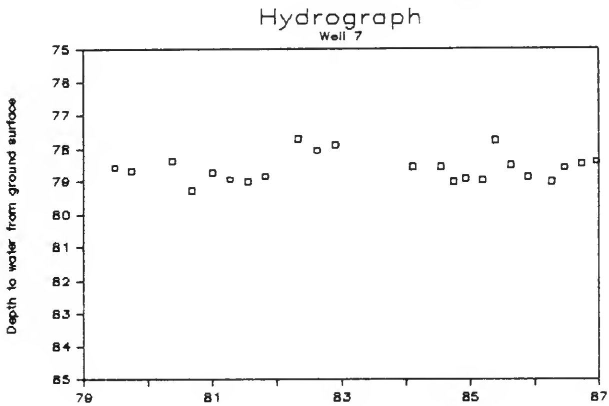
Montana

Locations of the Montana monitoring wells are shown in the Technical Monitoring Schedules.

Figure 8 depicts the water level changes since the inception of the monitoring program in wells 6, 7, and 10 which are completed respectively in Hart Coal, Hart Coal, and both Hart Coal and alluvium. Recorded water level fluctuations in the three wells are less than 2 feet (0.6 m) over the period of record. The minor fluctuations are mainly attributed to regional climatic conditions rather than an impact resulting from the mining of coal to supply the Coronach Generating Facility. Considering the variability of annual precipitation for the period 1979 through 1986 [maximum 18.23 inches (463 mm), minimum 8.89 inches (226 mm); NOAA data for Scobey, MT] the water level fluctuations have been fairly minor. Although some fluctuation has occurred, a trend of changing water level has not been established. Instead, the monitoring results show minor changes with respect to an apparently constant reference level in the coal aquifer wells.

Water levels from wells 5, 9, and 17, which are completed to varying depths in alluvium, Fort Union, and alluvium, respectively, are also presented in Figure 8 for comparison. The shallow alluvial well (5) and the Fort Union well (9) had water level fluctuations of less than 2 feet (0.6 m) over the 6 1/2 year period of record. The recently completed deep alluvial well (17) had a water level decline of 2.12 feet (0.65 m) between late September and mid-December of 1986. This well is located 3 miles south of the International Border in a recharge area. The change is believed to represent a slightly greater than average seasonal variation but further monitoring is necessary to verify this interpretaton.





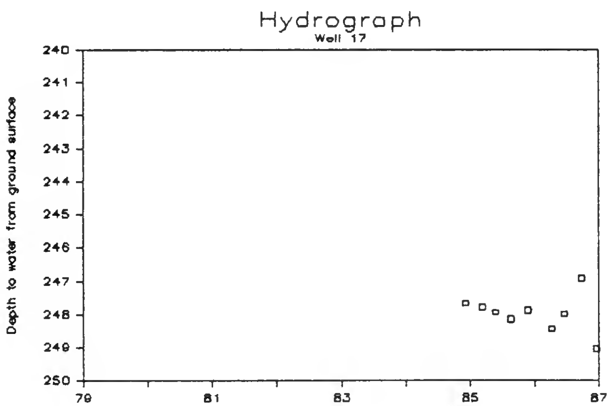


Figure 8. Water Levels of Selected Wells in the United States.

GROUND WATER QUALITY

Saskatchewan

Ground water sampling continued in 1986 at the locations specified in the Technical Monitoring Schedules.

Water Quality in the Tills

Waters from the tills are of generally poorer natural quality than those from the gravels. The ground water quality data for total dissolved solids, shown in Figure 9, have demonstrated this during the past 6 years. Higher and more variable TDS concentrations are associated with piezometers completed in till, whereas concentrations in Empress-completed piezometers have rarely exceeded 1,200 mg/L.

Piezometer C712B, at location 2a just north of the Polishing Pond, was observed to have an increased concentration of uranium in 1984 to mid-1985. This condition generally continued during 1986. With the exception of one sample, taken in October 1985, the readings remained above 550 µg/L. Other ions in the piezometer water do not show patterns that are similar to that of uranium.

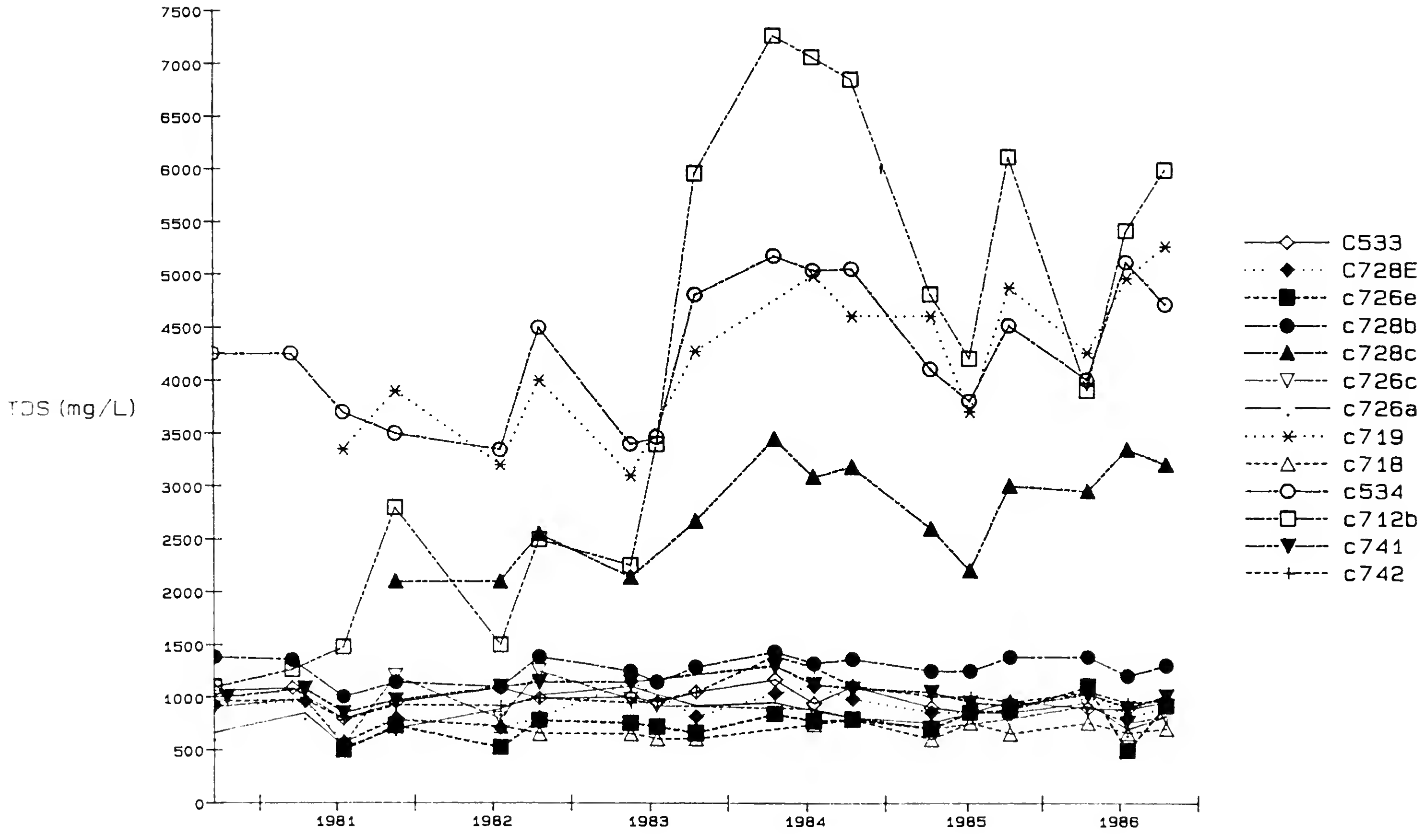


Figure 9. Total Dissolved Solids Concentrations: East Poplar River Monitoring Piezometers.

At locations 2b (piezometer C718) and 2c (piezometer C719), near the north end of the Polishing Pond, there have been no consistent water quality trends during the period of record. Although these two sites are close to each other, and are both screened in till, there are large differences in the chemical makeup of their waters. Most notable is the sulphate concentration in C719, which is some 18 times larger than that in C718. The uranium level in C719 peaked in April 1986 at 460 μg/L; no long term trend in the uranium values from that piezometer is apparent.

At location 8a, west of cell No. 1 of the Ash Lagoon, piezometers C726A and C726C are completed in till. Although there are consistent differences in the quality of water from these two piezometers, no trends are evident.

At location 9a at the west end of the Polishing Pond, piezometer C728A has remained dry since 1980. Piezometers C728B and C728C show no consistent trends during the period of record. The uranium concentrations in both piezometers were fairly stable during 1986. At the end of 1984, an increasing trend in uranium concentration appeared to be developing in C728C, after showing an increase in the dissolved constituents. However, the 1985 and 1986 data show that the uranium levels have stabilized within the range 20 to 40 μg/L. Piezometer C728D has remained dry.

Piezometer C534 is screened in till to the south of the Ash Lagoon. Ground-water quality is inferior in comparison with locations 8a and 9a. Total dissolved solids concentrations are near 4,500 mg/L. There is no evidence of long-term trends in water quality.

Water Quality in the Empress Gravels

Figure 9 shows that there are no significant trends in total dissolved solids in the Empress Gravels. At location 8a, piezometer C726E showed a decrease in TDS concentration in July 1986, but returned to a higher level in October of that year.

At location 9a, the water quality in piezometer C728E is similar to that of C726E. Boron values are generally slightly larger, and the uranium concentration is generally less than the detection limit, with the exception of the 3.0 μg/L value obtained in October, 1986.

At piezometer C533, south of the Ash Lagoon, the chloride concentrations have stabilized, and no other chemical parameters have increased consistently. Uranium and boron have remained relatively stable since the beginning of monitoring in all the Empress-completed piezometers (C533, C534, C726E, and C728E).

The higher hydraulic conductivity of the Empress Gravels allows a much greater volume of water to flow through them than through the tills. The amount of leakage from the overlying tills is therefore very small compared to the through-flow in the Empress Gravels. Because of this, the dilution effect would be large enough that water quality effects are not expected from the Ash Lagoons or the Polishing Pond. As a consequence, there is no verifiable water quality change in the gravels attributable to seepage from the lagoons.

Montana

Ground water quality during 1986 was essentially unchanged in 19 of the 21 monitoring wells. This condition is believed to be the representative condition for the area being monitored. Figure 10 shows the field specific conductance values for the same wells discussed in the water level section. These data show considerable scatter; the scatter is attributed in part to the difficulty in developing wells after installation, in part to differing quantities of water pumped from the wells prior to measuring the specific conductance, and in part to some natural variability within the aquifer being sampled. However, data from some wells show so much variability that the well construction is questioned. The Fort Union well (no. 9) fits into this category. This well is reported to be open to the formation from 53 to 203 feet (16.2 to 61.9 m) below the land surface; measured depths include 49 and 140 feet (14.9 and 42.7 m) as well as 208 feet (63.4 m) suggesting that the size of slots in the casing may be too large within parts of the unit.

In 1986, wells 4 and 22 had substantial changes in water chemistry. Well 4, located east of the Poplar River, is reported to be completed in the Fox Hills-Hell Creek aquifer. Figure 10 shows the specific conductance data from this well. The specific conductance, which has been averaging 2,540 μS/cm fell to 1,206 μS/cm in the 1986 sample (Figure 10). The lower conductance was accompanied by at least a 50 percent decrease in the major constituents sodium, bicarbonate, chloride, and sulfate. The calcium content in 1986 (13.6 mg/L) is essentially unchanged; however, the strontium content more than tripled to 0.92 mg/L. This indicates that shallow alluvial water or surface runoff has entered the well, and that ion exchange reactions have occurred to decrease the concentration of alkaline earths in the water. The dilution, compared with previous samples, is also supported by the decrease in boron content from a previous average value of 1,760 to 760 μg/L.

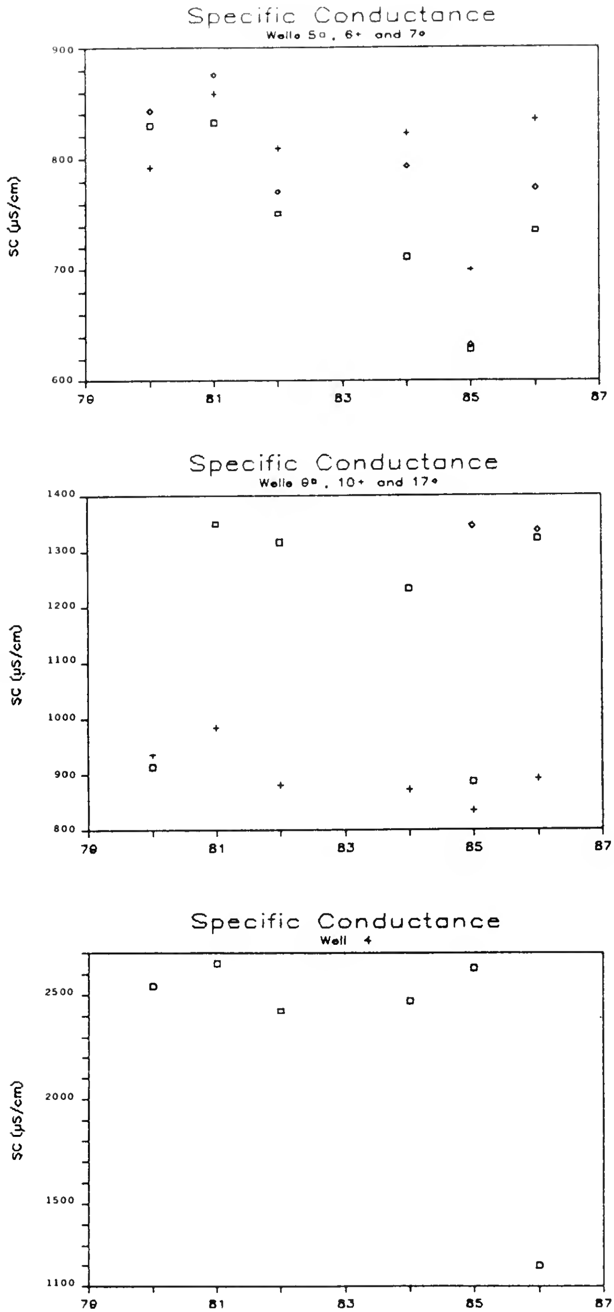


Figure 10. Specific Conductance Measurements in Selected Wells within the United States.

Interestingly, the water level in well 4 was not altered by the dilution in water chemistry. The casing for this well had been broken at the ground surface and the well is located in a depression. Hence, we suspect that the dilution was caused by surface water entering the well.

The 1986 water chemistry sample from well 22 was also distinctly different from that of the 1985 sample (only two samples are available). This well is reported to be completed in the Flaxville Gravel and screened from 59 to 68 feet (18.0 to 20.7 m); the specific conductance decreased from 1,300 to 600 µS/cm, sodium decreased from 174 to 21.7 mg/L, sulphate decreased from 307 to 25.2 mg/L, boron decreased from 1,280 to 91 µg/L, and nitrate increased from 0.16 to 4.65 mg/L. The water level rose about 4 feet (1.2 m).

A casing separation was noted at the "bell" joint slightly below land surface elevation. These casing problems will be corrected and a bentonite slurry will be puddled into the annular space around both casings this year to prevent a future recurrence of this problem.

ASH LAGOON QUALITY AND QUANTITY

The ash lagoon system at the Poplar River Power Station continues to be operated on a closed system basis with no discharges to surface waters. During 1986, most of the sluiced ash was directed to the north end of Ash Lagoon No. 1. The normal operation has been the use of Ash Lagoon No. 1, Ash Lagoon No. 2 and the Polishing Pond in series operation. Water from the Polishing Pond is returned to the plant for ash sluicing. During 1986, maximum and minimum water depths in Ash Lagoon Nos. 1 and 2 and the Polishing Pond ranged between 5.2 and 5.5, 4.0 and 4.7, and 3.9 and 4.7 m, respectively.

Pending the issuance by Saskatchewan Environment and Public Safety of a permit, Saskatchewan Power plans to direct the sluiced ash to Ash Lagoon No. 3N.

Seepage calculations were made in 1986 using the methods developed by T.A. Prickett, P.E., of Urbana, Illinois. Results of the calculations for Ash Lagoons Nos. 1 and 2 and the Polishing Pond are shown in Table 8.

Table 8. SPC-PRPS Ash System, 1986 Calculated Seepage Rates

Source	Rate (L/s)
Polishing Pond	0.250
Ash Lagoon No. 1	0.153
Ash Lagoon No. 2	0.343
TOTAL SEEPAGE	0.746

The 1986 calculated seepage was approximately the same as that calculated for 1985. The calculated total seepage is well below the seepage limits (5.0 L/s to Cookson Reservoir and 2.0 L/s to the East Poplar River) proposed in 1979 by the International Poplar River Water Quality Board of the International Joint Commission. The permeability of the Ash Lagoons Nos. 1 and 2 and Polishing Pond liners was calculated and found to be the same order of magnitude (2 to 11 x 10^{-9} cm/s) as originally calculated by T.A. Prickett.

The advancement of the seepage front towards the reservoir in the oxidized till was calculated to be 6.11 m since the ponds were initially filled, which is an increase of 1.88 m since 1985. The seepage front in the Empress formation was calculated to have advanced 777 m southeast of the lagoons, an increase of 147 m since 1985. However, examination of Empress formation and till water chemistry have not shown significant changes attributable to lagoon seepage. Thus, leachate flow into Cookson Reservoir and into the East Poplar River has not been measurable.

Saskatchewan Environment and Public Safety requires that the Saskatchewan Power Corporation maintain the stability of the ash lagoon system dykes. In addition to the regular visual inspections, an annual investigation by a geotechnical engineer was conducted in October, 1986. The freeboard requirements were exceeded during a short time in March of 1986 to minimize any ash blowing problems from Ash Lagoon No. 1. This matter has been remedied and satisfactory freeboard maintenance has been subsequently practiced.

Two inclinometers were installed in 1986 on the north side of dyke G between the dyke and the cooling water canal to provide additional information on dyke stability. A discharge structure between Ash Lagoon No. 3N and the Polishing Pond was also constructed during the year.

Saskatchewan Power continues to experiment with the surcharging of dry ash into the lagoons. The present procedure involves several ash discharge points along the north and west sides of Ash Lagoon No. 1. The coarse bottom ash material is selectively collected at the discharge points and spread over the finer materials previously laid down. The result should be a surface that is not wind erodible and could support vegetation. It would be graded to a 5 percent slope from the dyke to the middle of the lagoon.

Saskatchewan Power has, since May 1983, undertaken analyses of filtered ash lagoon water samples to obtain appropriate information on potential leachate quality. Generally, the water quality data show increases in the Ash Lagoons and the Polishing Ponds for sodium, potassium, sulphate, total dissolved solids, fluoride, boron, molybdenum, and strontium; and notable variability in the levels for uranium, and vanadium. In addition, there were some decreases noted for other measured variables such as lead, mercury, and recently, zinc. The changes are to be expected in a closed system of this type.

AIR QUALITY

Saskatchewan

As a result of new construction at the Coronach site, the monitoring station was dismantled in September 1986 and could not be relocated until the beginning of 1987.

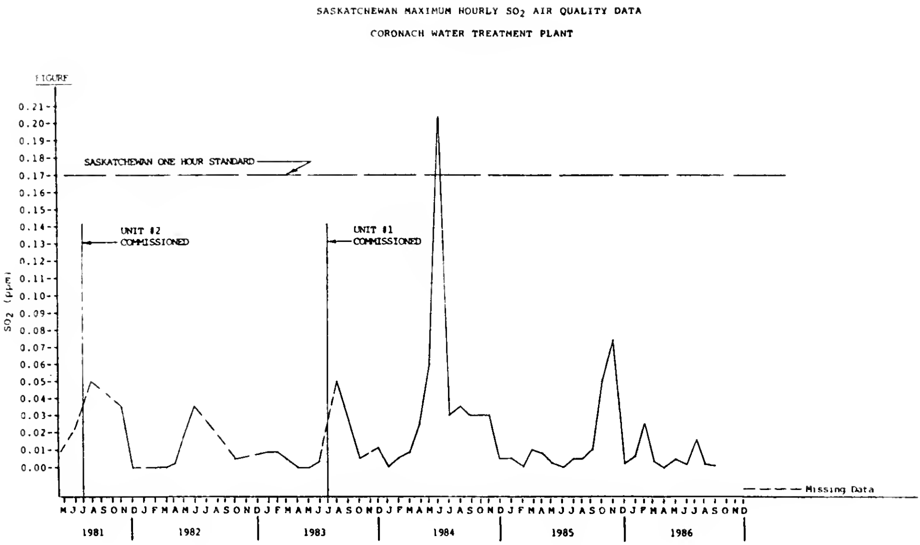
Ambient sulphur dioxide monitoring began at Coronach in July 1979. To date, few detectable concentrations have been recorded at this site. There were no recorded violations of Saskatchewan's hourly or 24-hour standards of 17.0 pphm and 6.0 pphm, respectively (Figure 11). The highest value of 2.4 pphm occurred on February 8 at 0800 hours. Weather information for this day indicates winds blowing from the northern quadrants, which would indicate the power plant was not the source. The highest 24-hour value of 0.4 pphm occurred on July 29. Weather data indicates winds blowing from the northern quadrants 46 percent of the time. As well, there were no recorded violations at Saskatchewan Power Corporation's monitoring station near the Montana border. The highest value of 4.2 pphm occurred on December 2, 1986 at 1500 hours. Weather information indicates winds blowing from the north, which would indicate the power plant as the probable source.

Suspended particulate concentrations at Coronach showed a variance in 1986 similar to that of 1985. Saskatchewan's 24-hour average standard of 120 micrograms per cubic metre ($\mu g/m^3/24$ hours) was not exceeded. The annual geometric mean rose from 24.8 $\mu g/m^3$ in 1985 to 25.2 $\mu g/m^3$ in 1986 and continues to be well below the Saskatchewan standard of 70.0 $\mu g/m^3$. Suspended particulate concentrations at Saskatchewan Power Corporation's monitoring station exceeded Saskatchewan's 24-hour average standard on two occasions on two occasions in 1986. The highest recorded value of 161.9 $\mu g/m^3$ occurred on December 10. Weather data for this date indicate winds were blowing from the western quadrants for 65 percent of the time, which would suggest that the power plant was not the source. Windblown dust from fields west of the monitoring station was the most probable cause. The annual geometric mean of 28.0 $\mu g/m^3$ is well below the provincial standard.

In-stack monitoring results showed a variance in 1986 similar to that of 1985. Daily nitrogen oxide concentrations ranged from 276 to 2,161 milligrams per cubic metre (mg/m^3) with an average yearly concentration of 898 mg/m^3 as compared to 757 mg/m^3 in 1985. Ongoing improvements to the sample conditioning system improved the operation of the nitrogen oxides monitor considerably. The monitor was available 82 percent of the time in 1986 as compared to 38 percent of the time in 1985. Daily sulphur dioxide concentrations ranged from 1,445 to 4,677 mg/m^3, with an average yearly concentration of 2,688 mg/m^3 as compared to 2,660 mg/m^3 in 1985. The sulphur dioxide monitor was available 85 percent of the time in 1986.

Sulphur dioxide emissions consisted of 9.2×10^{-3} tonnes per megawatt hour due to firing on coal and 8.1×10^{-5} tonnes per megawatt hour due to firing on oil. Total coal consumption for 1986 was 3,342,028 tonnes and oil consumption was 1,997 tonnes.

Average daily opacity readings ranged from 1 to 100 percent, with a yearly average of 16 percent as compared to 19 percent in 1985. Saskatchewan's opacity standard is 40 percent. In most instances, opacity violations occur during process startup, shutdown or when one of the precipitators experiences a power trip.



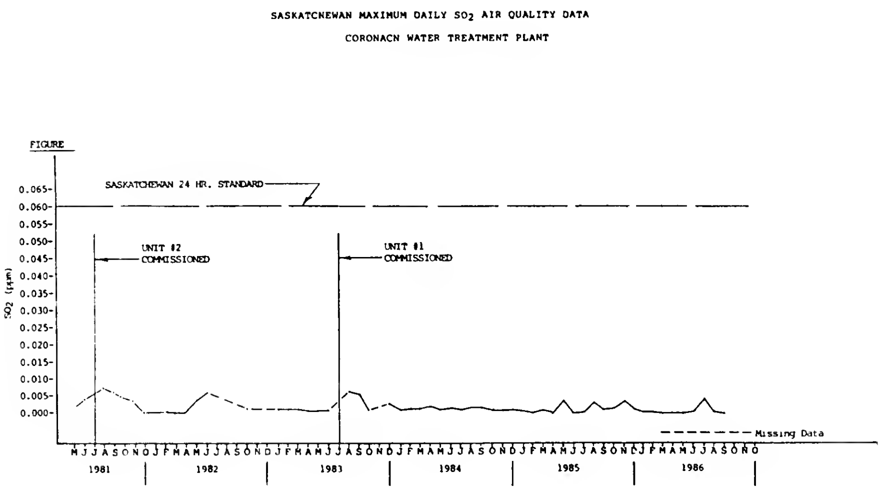


Figure 11. Sulphur Dioxide Air Quality Data - Coronach Water Treatment Plant.

Montana

The State of Montana operated one primary air monitoring site and eight additional sulfation rate sites in the Poplar River area of Montana during 1986. The parameters monitored included: sulphur dioxide, total suspended particulate, sulfation rate, wind speed, wind direction, and temperature. The primary air monitoring site was established in September 1986 and is expected to continue through June 1987. The 1985 Montana Legislature provided funding for one site for 1 year. The site is located at the Don Marlenee Ranch, which is approximately 4 miles south of the border and 1 mile east of Highway 13. No continuous monitoring was conducted between July 1985 and August 1986, but sulfation rate analyses at selected sites were conducted during the interim. The monitoring results are summarized in table 9.

During the last half of 1986, sulphur dioxide concentrations remained less than both Montana and United States ambient air quality standards. The maximum 1-hour concentration of 7.5 pphm was recorded at the Marlenee Ranch site during October. This concentration is 15 percent of the Montana standard. The highest 24-hour concentration of 0.6 pphm occurred during November. Most of the higher sulphur dioxide concentrations occurred with northwest winds, indicating that the Saskatchewan Power Corporation generating facilities were the source.

The Montana and United States standards for total suspended particulates were not exceeded at the monitoring site. The highest 24-hour concentration was 140 $\mu g/m^3$, recorded on November 10, 1987. The annual geometric and arithmetic means for the 4 months the site ran in 1986 were 18.7 $\mu g/m^3$ and 28.9 $\mu g/m^3$, respectively. The levels of total suspended particulates observed during 1986 are low and representative of rural Montana.

Table 9
Summary of 1986 Montana Air Quality Monitoring Results

Sulphur Dioxide (pphm)

Site	Highest 1-hr	Highest 3-hr	Highest 24-hr	Annual Avg.
Marlenee Ranch	7.5	4.2	0.6	0.0*

Sulfation Rate (mg/100 cm^2/day)

Site	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
International Boundary	--	--	--	--	--	--	--	--	--	--	--	--
Richardson	--	--	--	--	0.00	--	--	--	--	--	--	--
Hanrahan	--	--	--	--	--	0.00	--	--	--	--	--	--
Microwave Tower	--	--	--	0.01	--	--	--	--	--	--	--	--
Flaxville	0.02	--	--	--	--	--	--	--	--	--	--	--
TV Tower Hill	--	--	0.01	--	--	--	--	--	--	--	--	--
Scobey Downtown	--	0.02	--	--	--	--	--	--	--	--	--	--
Four Buttes	--	--	--	.00	--	--	--	--	--	--	--	--

Total Suspended Particulate (μg/m^3)

Site	Highest 24-hr	2nd Hightest 24-hr	Geometric Mean	Arithmetic Mean
Marlenee Ranch	140	45	18.7	28.9

*Annual average based on four months of data.

During 1986, the Montana Department of Health and Environmental Sciences continued to operate an extended network of lead dioxide sulfation plates in the Poplar River area. The sulfation plate network includes the existing primary monitoring site and eight additional locations: International Boundary, Richardson, Hanrahan Ranch, Microwave Tower, Flaxville, TV Tower Hill, Scobey Downtown and Four Buttes. The objective of the sulfation plate network is to obtain a broad geographical indication of sulphur dioxide concentrations and to investigate the relationship between sulfation rate and sulphur dioxide concentrations.

During 1986, the highest monthly sulfation rate was 0.02 milligram per 100 centimetres squared per day (mg/100 cm^2/day) at Flaxville and Scobey Downtown. These readings, which occurred during January and February, are low.

ANNEX 1

POPLAR RIVER

COOPERATIVE MONITORING ARRANGEMENT

CANADA - UNITED STATES

September 23, 1980

POPLAR RIVER

COOPERATIVE MONITORING ARRANGEMENT

I. PURPOSE

This Arrangement will provide for the exchange of data collected as described in the attached Technical Monitoring Schedules in water quality, water quantity and air quantity monitoring programs being conducted in Canada and the United States at or near the International Boundary in response to the Saskatchewan Power Corporation development. This Arrangement will also provide for the dissemination of the data in each country and will assure its comparability and assist in its technical interpretation.

The Arrangement will replace and expand upon the quarterly information exchange program instituted between Canada and the United States in 1976.

II. PARTICIPATING GOVERNMENTS

Governments and government agencies participating in the Arrangement are:

Government of Canada: Environment Canada
Government of the Province of Saskatchewan: Saskatchewan Environment and Public Safety
Government of the United States of America: U.S. Geological Survey
Government of the State of Montana: Executive Office

III. POPLAR RIVER MONITORING COMMITTEE: TERMS OF REFERENCE

A binational committee called the Poplar River Bilateral Monitoring Committee will be established to carry out responsibilities assigned to it under this Arrangement. The Committee will operate in accordance with the following terms of reference:

A. Membership

The Committee will be composed of four representatives, one from each of the participating Governments. It will be jointly chaired by the Government of Canada and the Government of the United States. There will be a Canadian Section and a United States Section. The participating Governments will notify each other of any changes in membership on the Committee. Cochairmen may by mutual agreement invite agency technical experts to participate in the work of the Committee.

The Governor of the State of Montana may also appoint a chief elective official of local government to participate as an ex-officio member of the Committee in its technical deliberations. The Saskatchewan Minister of the Environment may also appoint a similar local representative.

B. Functions of the Committee

The role of the Committee will be to fulfill the purpose of the Arrangement by ensuring the exchange of monitored data in accordance with the attached Technical Monitoring Schedules, and its collation and technical interpretation in reports to Governments on implementation of the Arrangement. In addition, the Committee will review the existing monitoring systems to ensure their adequacy and may recommend to the Canadian and United States Governments any modifications to improve the Technical Monitoring Schedules.

1. Information Exchange

Each Cochairman will be responsible for transmitting to his counterpart Cochairman on a regular, and not less than quarterly basis, the data provided by the cooperative monitoring agencies in accordance with the Technical Monitoring Schedules.

2. Reports

(a) The Committee will prepare a joint Annual Report to the participating governments, and may at any time prepare joint Special Reports.

(b) Annual Reports will

i) summarize the main activities of the Committee in the year under Report and the data which has been exchanged under the Arrangement;

ii) draw to the attention of the participating governments any definitive changes in the monitored parameters, based on collation and technical interpretation of exchanged data (i.e. the utilization of summary, statistical and other appropriate techniques);

iii) draw to the attention of the participating governments any recommendations regarding the adequacy or redundancy of any scheduled monitoring operations and any proposals regarding modifications to the Technical Monitoring Schedules, based on a continuing review of the monitoring programs including analytical methods to ensure their comparability.

c) Special Reports may, at any time, draw to the attention of participating governments definitive changes in monitored parameters which may require immediate attention.

d) Preparation of Reports

Reports will be prepared following consultation with all committee members and will be signed by all Committee members. Reports will be separately forwarded by the Committee Cochairmen to the participating governments. All annual and special reports will be so distributed.

3. Activities of Canadian and United States Sections

The Canadian and United States section will be separately responsible for:

(a) dissemination of information within their respective countries, and the arrangement of any discussion required with local elected officials;

(b) verification that monitoring operations are being carried out in accordance with the Technical Monitoring Schedules by cooperating monitoring agencies;

(c) receipt and collation of monitored data generated by the cooperating monitoring agencies in their respective countries as specified in the Technical Monitoring Schedules;

(d) if necessary, drawing to the attention of the appropriate government in their respective countries any failure to comply with a scheduled monitoring function on the part of any cooperating agency under the jurisdiction of that government, and requesting that appropriate corrective action be taken.

IV. PROVISION OF DATA

In order to ensure that the Committee is able to carry out the terms of this Arrangement, the participating governments will use their best efforts to have cooperating monitoring agencies, in their respective jurisdictions provide on an ongoing basis all scheduled monitored data for which they are responsible.

V. TERMS OF THE ARRANGEMENT

The Arrangement will be effective for an initial term of five years and may be amended by agreement of the participating governments. It will be subject to review at the end of the initial term and will be renewed thereafter for as long as it is required by the participating governments.

ANNEX 2

POPLAR RIVER

COOPERATIVE MONITORING ARRANGEMENT

TECHNICAL MONITORING SCHEDULES

1987

CANADA - UNITED STATES

June 1987

TABLE OF CONTENTS

PREAMBLE

The Technical Monitoring Schedule lists those water quantity, water quality and air quality monitoring locations and parameters which form the basis for information exchange and reporting to Governments. The structure of the Committee responsible for ensuring the exchange takes place is described in the Poplar River Cooperative Monitoring Arrangement.

The monitoring locations and parameters listed herein have been reviewed by the Poplar River Bilateral Monitoring Committee and represent the basic technical information needed to identify any definitive changes in water quantity, water quality and air quality at the International Boundary. The Schedule was initially submitted to Governments for approval as an attachment to the 1981 report to Governments. Changes in the sampling locations and parameters may be made by Governments based on the recommendations of the Committee.

Significant additional information is being collected by agencies on both sides of the International Boundary, primarily for project management or basin-wide baseline data purposes. This additional information is usually available upon request from the collecting agency and forms part of the pool of technical information which may be drawn upon by Governments for specific study purposes. Examples of additional information are water quantity, water quality, groundwater and air quality data collected at points in the Poplar River basin not of direct concern to the Committee. In addition, supplemental information on parameters such as vegetation, soils, fish and waterfowl populations and aquatic vegetation is also being collected on either a routine or specific studies basis by various agencies.

POPLAR RIVER

COOPERATIVE MONITORING ARRANGEMENT

TECHNICAL MONITORING SCHEDULES

1987

CANADA

STREAMFLOW MONITORING

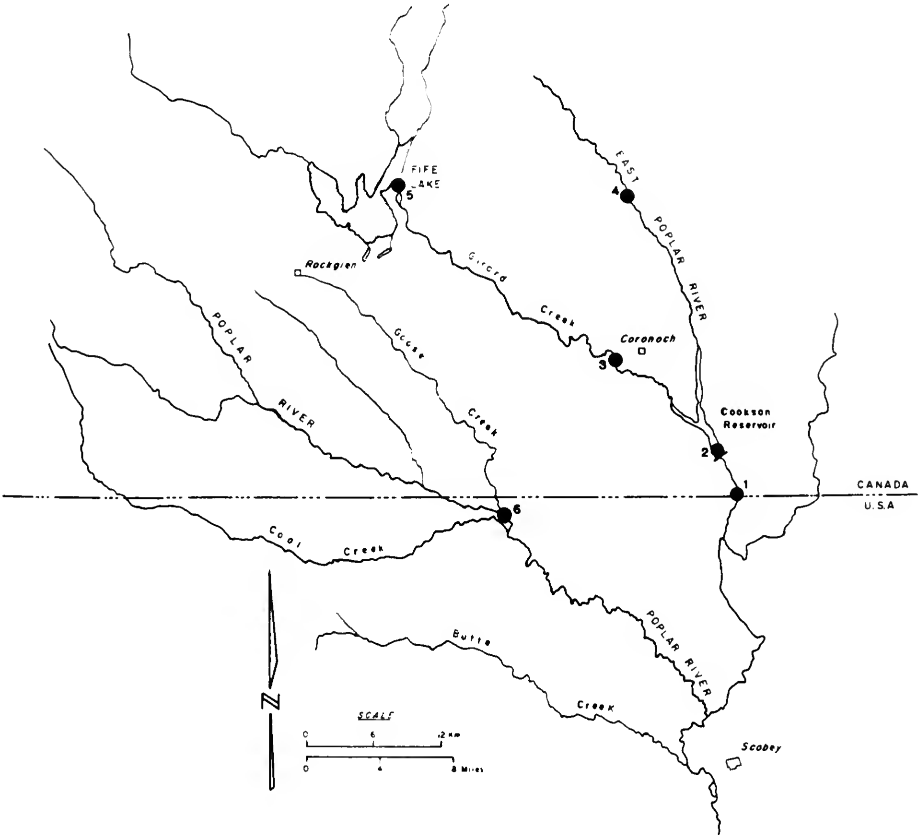
Responsible Agency: Environment Canada

Daily mean discharge or levels and instantaneous monthly extremes as normally published in surface water data publications.

No. on Map	Station No.	Station Name
1.	11AE003 (06178500)	East Poplar River at International Boundary
2.	11AE013	Cookson Reservoir near Coronach
3.	11AE015	Girard Creek near Coronach Cookson Reservoir
*4.	11AE014	East Poplar River above Cookson Reservoir
5.	**Fife Lake Overflow	
*6.	11AE008 (06178000)	Poplar River at International Boundary

* - International gauging station

** - Miscellaneous measurements of outflow to be made by Sask Water during periods of outflow only.



HYDROMETRIC GAUGING STATIONS (CANADA)

SURFACE WATER QUALITY MONITORING

Sampling Locations

Responsible Agency: Saskatchewan Environment and Public Safety

No. on Map	Station No.	Station Name
1	01SK02000002	Fife Lake Overflow
2	00SK02000007	Girard Creek at Coronach Reservoir Outflow
3	05SK02000008	Upper End of Cookson Reservoir at Highway 36
4	05SK02000004	Cookson Reservoir near Dam
5	00SK02000003	East Poplar River at culvert immediately below Cookson Reservoir

Responsible Agency: Environment Canada

No. on Map	Station No.	Station Name
6	00SA11AE0008	East Poplar River at International Boundary

Parameters

Responsible Agency: Saskatchewan Environment and Public Safety

ESQUADAT* Code	Parameter	Analytical Method	Sampling Frequency Station No: 1	2	3	4	5
10151	Alkalinity-pheno	Pot. Titration	OF	Q	Q	Q	Q
10101	Alkalinity-tot	Pot. Titration	OF	Q	Q	Q	Q
13004	Aluminum tot	AA-direct		A	A	A	A
33004	Arsenic-tot	Flameless-A.A.		A	A	A	A
06201	Bicarbonates	Calculated	OF	Q	Q	Q	Q
05451	Boron-tot	ICPA	W	Q	Q	Q	Q
48002	Cadmium-tot	AA-Solvent extract (MIBK)		A	A	A	A
20103	Calcium	AA-Direct	OF	Q	Q	Q	Q
06052	Carbon-tot Inorg	IR	OF	Q	Q	Q	Q
06005	Carbon-tot Org	IR	OF	Q	Q	Q	Q
06301	Carbonates	Calculated	OF	Q	Q	Q	Q
17203	Chloride	Colourimetery	OF	Q	Q	Q	Q
06711	Chlorophyll 'a'	Colourimetery		Q	Q	Q	Q
24004	Chromium-tot	AA-direct		A	A	A	A
36012	Coliform-fec	MF	OF	Q	Q	Q	Q
36002	Coliform-tot	MF	OF	Q	Q	Q	Q
02041	Conductivity	Conductivity meter	W	Q	Q	Q	Q
29005	Copper-tot	AA-Solvent extract (MIBK)		A	A	A	A
09105	Flouride	Specific ion electrode		A	A	A	A
82002	Lead-tot	AA-Solvent extract (MIBK)		A	A	A	A
12102	Magnesium	AA-direct	OF	Q	Q	Q	Q
80011	Mercury-tot	Flameless AA		A	A	A	A
42005	Molybdenum	AA-Solvent Extract (MIBK)		A	A	A	A
07015	N-TKN	Colourimetry	OF	Q	Q	Q	Q
10401	NFR	Gravimetric	OF	Q	Q	Q	Q
10501	NFR (F)	Gravimetric	OF	Q	Q	Q	Q
28002	Nickel-tot	AA-Solvent extract (MIBK)	OF	Q	Q	Q	Q
07110	Nitrate + NO_2	Colourimetry	OF	Q	Q	Q	Q
06521	Oil and Grease	Pet. Ether Extraction		A	A	A	A
08102	Oxygen-diss	Meter	OF	Q	Q	Q	Q
15406	Phosphorus-tot	Colourimetry	OF	Q	Q	Q	Q
19103	Potassium	Flame Photometery	OF	Q	Q	Q	Q
34005	Selenium-Ext	Hydride Generation		A	A	A	A
11002	Sodium	Flame Photometry	OF	Q	Q	Q	Q
16306	Sulphate	Colourimetry	OF	Q	Q	Q	Q
10451	TDS	Gravimetric	OF	Q	Q	Q	Q
0206YZ	Temperature	Thermometer	OF	Q	Q	Q	Q
23004	Vanadium-tot	AA-Direct		A	A	A	A
30005	Zinc-tot	AA-Solvent extract (MIBK)		A	A	A	A
10301	pH	Electrometric	W	Q	Q	Q	Q

*Computer storage and retrieval system - Saskatchewan Environment and Public Safety.

Symbols: W - Weekly during overflow; OF - once during each period of overflow greater than 2 weeks' duration; Q - quarterly; A - annually in the fall; AA - atomic absorption; IR - infrared; Pot - potentiometric; NFR - nonfilterable residue NFRF - nonfilterable residue, fixed.

AA - Solvent Extract (MIBK): Sample digested with HNO_3 and extracted with methyl isobutyl ketone.

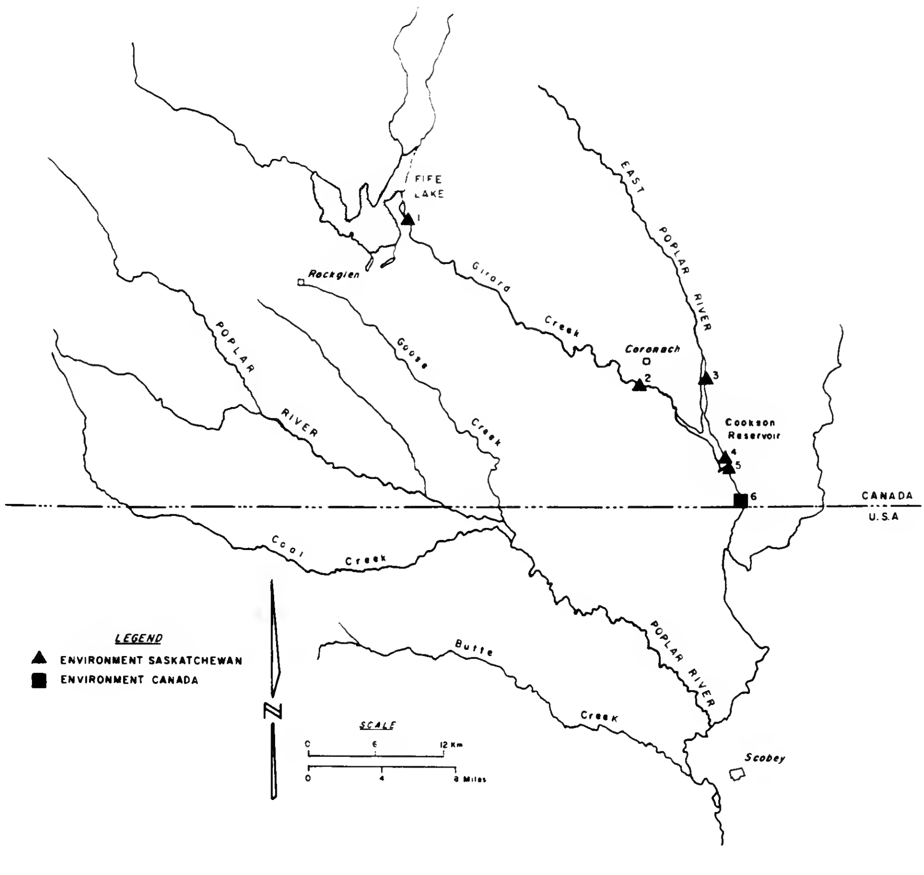
ICPA - Plasma emission.

MF - membrane filtration.

Responsible Agency: Environment Canada

NAQUADAT* Code	Parameter	Analytical Method	Sampling Frequency Station No: 6
10151	Alkalinity-pheno	Potentiometric	M
10106	Alkalinity-tot	IR Detector	M
13102	Aluminum-Diss.	AA-Direct	M
13302	Aluminum-Ext.	AA-Direct	M
07569	Ammonia-Free	Calculated	M
07506	Ammonia-tot	Electrometric	M
33108	Arsenic-diss	Plasma	M
56001	Barium-tot	AA Direct	M
06201	Bicarbonates	Calculated	M
05105	Boron-diss	Carminic Acid	M
48002	Cadmium-tot	AA Solv. Ext.	M
20103	Calcium	AA-Direct	M
06902	Carbon-partic	Elemental Analyzer	M
06002	Carbon-tot Org	Calculated	M
06301	Carbonates	Calculated	M
17206	Chloride	Colourimetric	M
06717	Chlorophyll a	Spectrophotometric	M
24003	Chromium-tot	AA-Solv. Ext.	M
27002	Cobalt-tot	AA Solv. Ext.	M
36012	Coliform-fec	MF	M
36002	Coliform-tot	MF	M
02021	Colour	Comparator	M
02041	Conductivity	Wheatstone Bridge	M
29005	Copper-tot	AA-Solv. Ext.	M
06604	Cyanide	UV-Colourimetric	M
09106	Fluoride	Electrometric	M
10602	Hardness	Calculated	M
08501	Hydroxide	Calculated	M
26104	Iron-diss	AA-direct	M
82002	Lead-tot	AA-Solv. Ext.	M
12102	Magnesium	AA-direct	M
25104	Manganese-diss	AA-direct	M
80011	Mercury-tot	Flameless AA	M
07902	N-particulate	Elemental Analyzer	M
07651	N-tot diss	UV Colourimetric	M
10401	NFR	Gravimetric	M
28002	Nickel-tot	AA-Solv. Ext.	M
07110	Nitrate	Colourimetric	M
07603	Nitrogen-tot	Calculated	M
180XX	Organo Chlorines	GC	M
08101	Oxygen-diss	Winkler	M
15901	P-particulate	Calculated	M
15103	P-tot diss	Colourimetric	M
06535	Phenolics	Colourimetric	M
185XX	Phenoxy Herbicides	GC	M
15406	Phosphorus-tot	Colourimetric	M
19103	Potassium	Flame Emission	M
18599	Picloram	GC	M
11250	Percent Sodium	Calculated	M
00210	Sat Index	Calculated	M
34108	Selenium-diss	Plasma	M
14102	Silica	Colourimetric	M
11103	Sodium	Flame Emission	M
00211	Stab Index	Calculated	M
16306	Sulphate	Colourimetric	M
00201	TDS	Calculated	M
02061	Temperature	Alcohol	M
02073	Turbidity	Nephelometric	M
23002	Vanadium-tot	AA-Solv. Ext.	M
30005	Zinc-tot	AA-Solv. Ext.	M
10301	pH	Electrometric	M
92111	Uranium	Flurometric	MC

*Computer storage and retrieval system - Environment Canada
Symbols: M-Monthly; AA-atomic absorption; MF-membrane filtration; UV-ultraviolet; NFR-nonfilterable residue; GC-gas chromatography; MC-Monthly Composite; IR-infrared



SURFACE WATER QUALITY MONITORING STATIONS (CANADA)

GROUND WATER QUALITY MONITORING

Sampling Locations

Responsible Agency: Saskatchewan Environment and Public Safety

Station	SPC Piezometer No.	Station Description: Sampling Elevation (m)	Station Description: Material
8a	C726A	746.338	unoxidized till
	C726C	752.739	oxidized till
8a	C726E	738.725	Empress gravel
9a	C728A	753.405	oxidized till
	C728B	743.265	unoxidized till
	C728C	747.645	mottled till
	C728D	752.305	oxidized till
9a	C728E	739.912	Empress gravel
2a	C712B	746.112	oxidized till
2b	C718	748.385	mottled till
2c	C719	747.715	oxidized till
C533	C533	740.441	Empress gravel
C534	C534	753.499	till
18	C741**	735.153	Empress gravel
21	C742**	741.800	Empress gravel

Parameters

Responsible Agency: Saskatchewan Environment and Public Safety

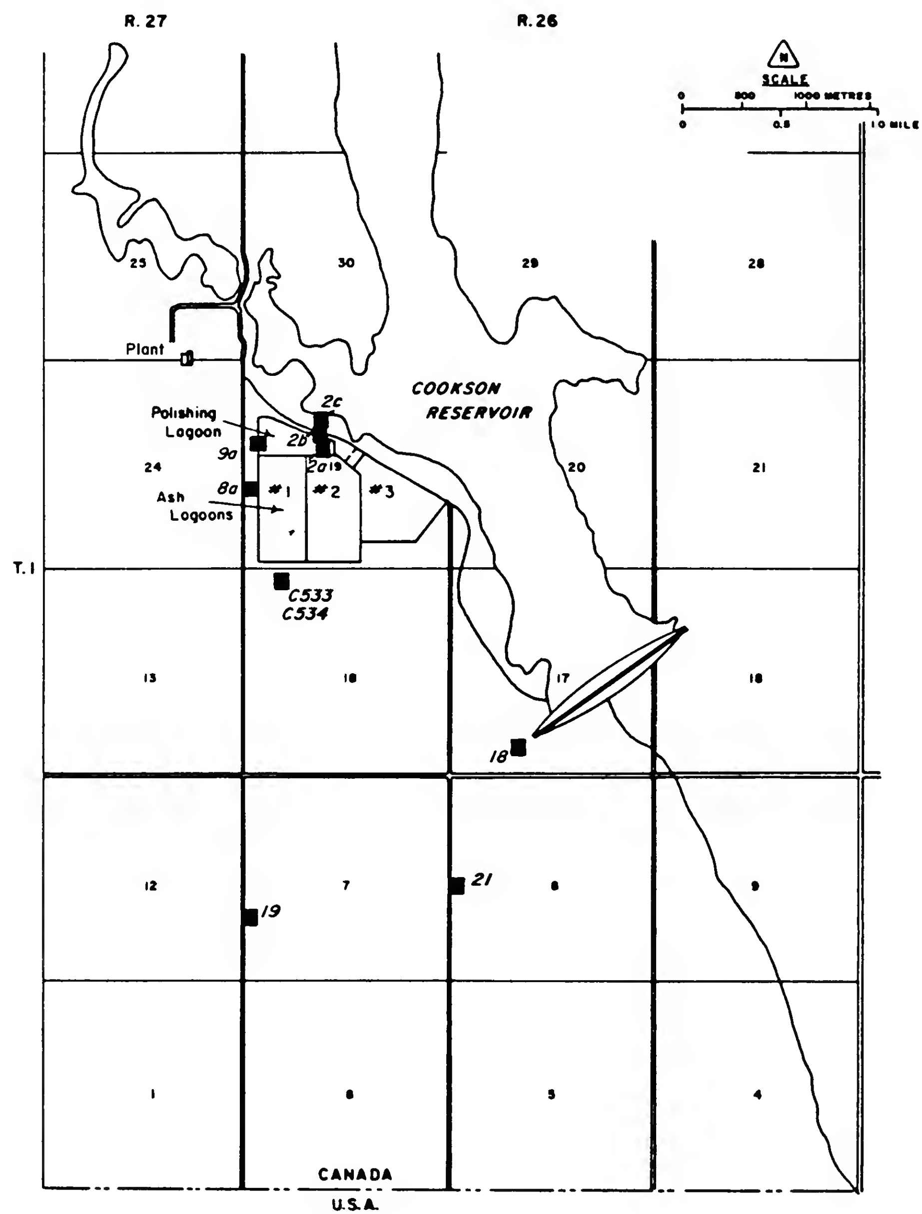
ESQUADAT* Code	Parameter	Analytical Method	Sampling Frequency Station No: Piezometers
10101	Alkalinity-tot	Pot-Titration	A
13105	Aluminum-Diss	AA-Direct	3**
33104	Arsenic-Diss	Flameless AA	A
56104	Barium-Diss	AA-Direct	A
06201	Bicarbonates	Calculated	A
05106	Boron-diss	Colourimetry	3**
48102	Cadmium-Diss	AA-Solvent Extract (MIBK)	A
20103	Calcium-Diss	AA-direct	A
06301	Carbonates	Calculated	A
17203	Chloride-Diss	Colourimetry	A
24104	Chromium-Diss	AA-Direct	A
27102	Colbalt-Diss	AA-Solvent Extract (MIBK)	A
02011	Colour	Comparator	A
02041	Conductivity	Conductivity meter	3**
29105	Copper-Diss	AA-Solvent Extract (MIBK)	A
09105	Fluoride-Diss	Specific Ion Electrode	A
26014	Iron-Diss	AA-Direct	A
82103	Lead-Diss	AA-Solvent Extract (MIBK)	A
12102	Magnesium-Diss	AA-Direct	A
25104	Manganese-Diss	AA-Direct	A
80111	Mercury-Diss	Flameless AA	A
42102	Molybdenum-Diss	AA-Solvent extract (N-Butyl acetate)	A
10301	pH	Electrometric	3**
19103	Potassium-Diss	Flame Photometry	A
34105	Selenium-Diss	Hydride generation	A
14102	Silica-Diss	Colourimetry	A
11103	Sodium-Diss	Flame Photometry	A
38101	Strontium-Diss	AA-Direct	3**
16306	Sulphate-Diss	Colourimetry	3**
10451	TDS	Gravimetric	3**
92111	Uranium-Diss	Fluorometry	3**
23104	Vanadium-Diss	AA-Direct	A
97025	Water Level		A
30105	Zinc-Diss	AA-Solvent Extract (MIBK)	A

No zinc or iron for piezometers C533 or C534.

*Computer Storage and Retrieval System - Saskatchewan Environment and Public Safety.

Symbols: AA - atomic absorption. A - Annually. 3 - Three times per year
AA-Solvent Extract (MIBK): sample acidified and extracted with Methyl Isobutyl Ketone.

**Analyze annually only for piezometer Nos. C741 and C742.



GROUND WATER QUALITY MONITORING (CANADA)

GROUND WATER PIEZOMETERS TO MONITOR

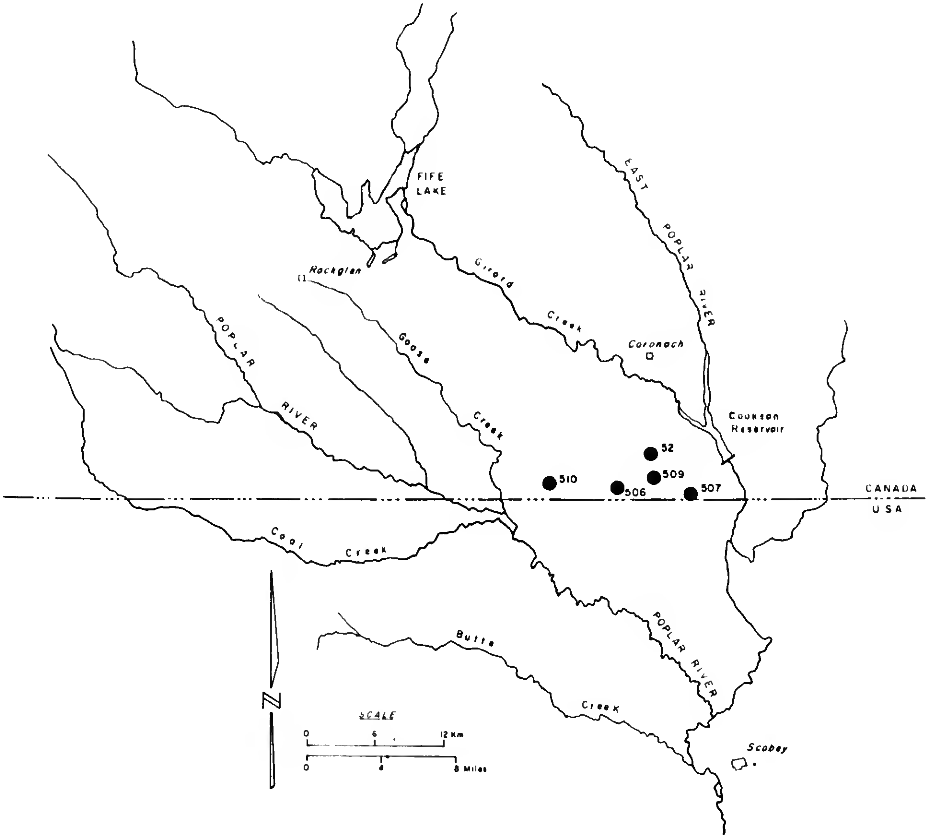
POTENTIAL DRAWDOWN DUE TO COAL

SEAM DEWATERING

Responsible Agency: Saskatchewan Water Corporation

Measurement Frequency: Quarterly

SPC Piezometer No.	Station Number	Location	Sampling Elevation (m)	Perforation Zone (depth in metres)
52	52	NW14-1-27W3	738.43	43 - 49 (in coal)
506	506A	SW4-1-27W3	748.27	81 - 82 (in coal)
507	507	SW6-1-26W3	725.27	34 - 35 (in coal)
509	509	NW11-1-27W3	725.82	76 - 77 (in coal)
510	510	NW1-1-28W3	769.34	28 - 29 (in layered coal and clay)



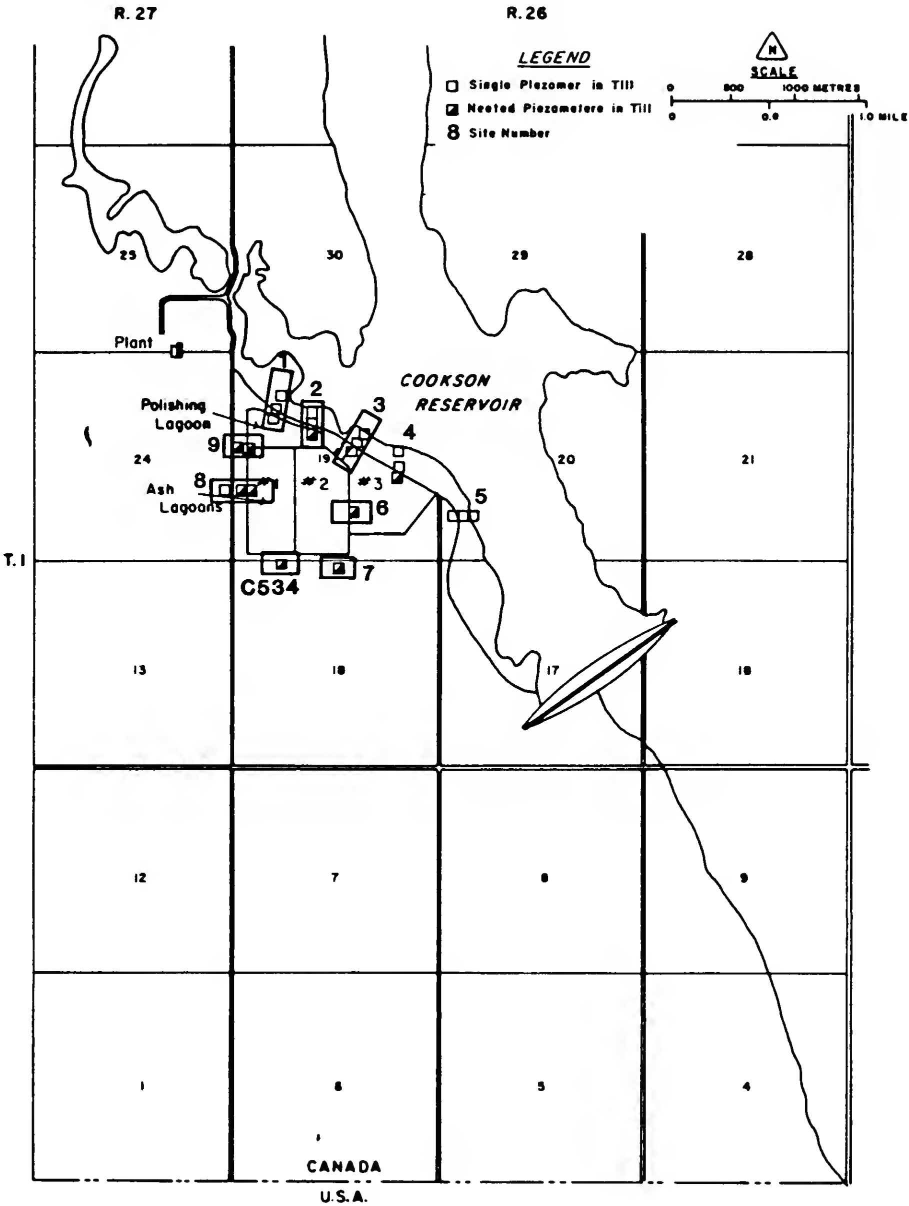
GROUNDWATER PIEZOMETERS TO MONITOR POTENTIAL DRAWDOWN DUE TO COAL SEAM DEWATERING

GROUND WATER PIEZOMETER LEVEL MONITORING - ASH LAGOON AREA

SCHEDULE A - PIEZOMETERS IN TILL

Responsible Agency: Saskatchewan Environment and Public Safety

Station	SPC Piezometer No.	Frequency of Measurement
1a	C716	All piezometer levels are measured quarterly
1b	C717	
1c	C711	
$2a_1$	C712A	
$2a_2$	C712B	
$2a_3$	C712C	
$2a_4$	C712D	
2b	C718	
2c	C719	
3a	C713	
3b	C720	
3c	C721	
$6a_1$	C763A	
$6a_2$	C763B	
$6a_3$	C763C	
$6a_4$	C763D	
$7a_1$	C729A	
$7a_2$	C729B	
$7a_3$	C729C	
$7a_4$	C729D	
C534	C534	
$8a_1$	C730A	
$8a_2$	C730B	
$8a_3$	C730C	
$8a_4$	C730D	
$8b_1$	C727A	
$8b_2$	C727B	
$8b_3$	C727C	
$8c_1$	C726A	
$8c_2$	C726B	
$8c_3$	C726C	
$8c_4$	C726D	
8d	C748	
$9a_1$	C764A	
$9a_2$	C764B	
$9a_3$	C764C	
$9a_4$	C764D	
$9b_1$	C728A	
$9b_2$	C728B	
$9b_3$	C728C	
$9b_4$	C728D	



PIEZOMETER INSTALLATION SITES - SCHEDULE "A" PIEZOMETERS IN TILL

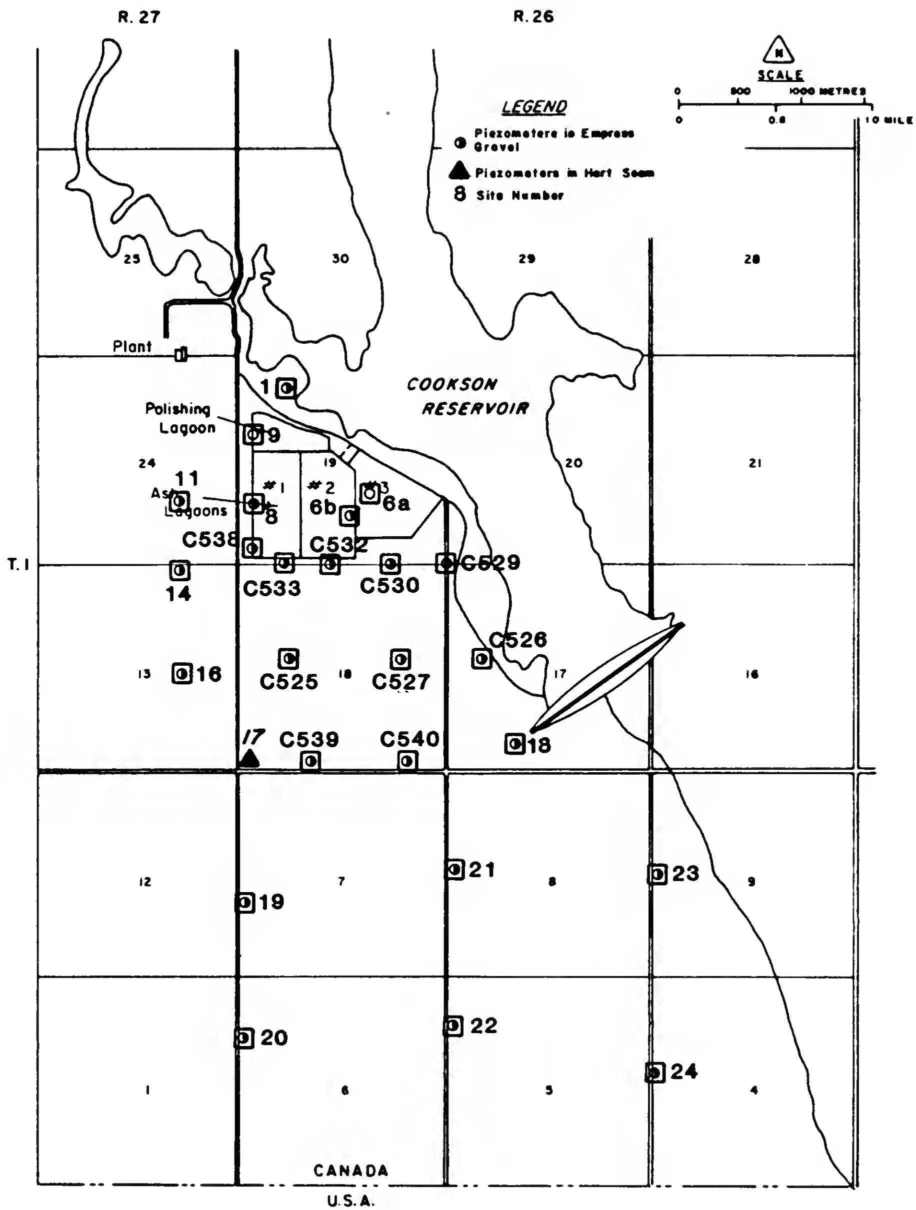
GROUND WATER PIEZOMETER LEVEL MONITORING - ASH LAGOON AREA AND

INTERNATIONAL BOUNDARY AREA

SCHEDULE B - PIEZOMETERS IN EMPRESS GRAVEL

Responsible Agency: Saskatchewan Environment and Public Safety

Station Immediate Ash Lagoon Area	SPC Piezometer No.	Frequency of Measurement
1	C731	All piezometers are monitored quarterly
6a	C763E	
6b	C765A	
C529	C529	
C530	C530	
C532	C532	
C533	C533	
C538	C538	
8	C730E	
9	C728E	
West of Ash Lagoon Area		
11	C743	
14	C740	
16	C756	
South of Ash Lagoon Area		
C525	C525	
C526	C526	
C527	C527	
C539	C539	
C540	C540	
18	C741	
19	C735	
20	C736	
21	C742	
22	C733	
23	C732	
24	C734	



PIEZOMETER INSTALLATION SITES - SCHEDULE "B" PIEZOMETERS IN EMPRESS GRAVEL

AMBIENT AIR QUALITY MONITORING

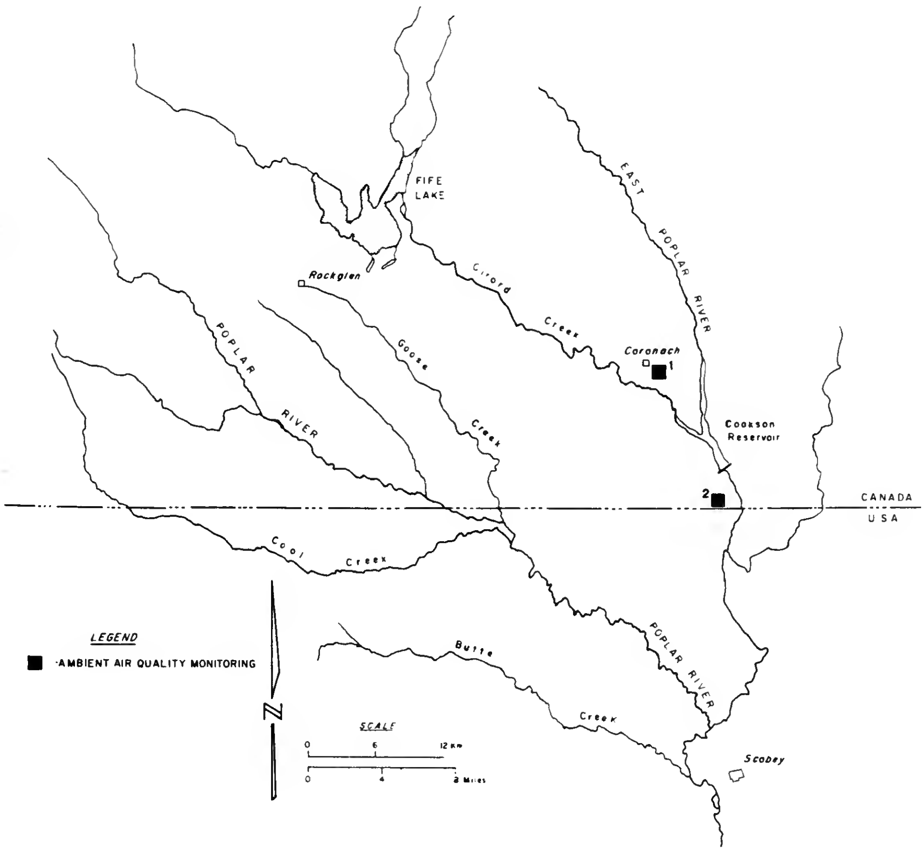
Responsible Agency: Saskatchewan Environment and Public Safety

No. on Map	Location	Parameters	Reporting Frequency
1	Coronach	Sulphur Dioxide	Continuous monitoring with hourly averages as summary statistics.
		Wind speed and direction	Continuous monitoring with hourly averages as summary statistics.
		Total Suspended Particulates	24-hour samples on a 6-day cycle, corresponding to the National Air Pollution Surveillance Sampling Schedule.
2	International Boundary*	Sulphur Dioxide	Continuous monitoring with hourly averages as summary statistics.
		Total Suspended Particulates	24-hour samples on 6-day cycle, corresponding to the National Air Pollution Surveillance Sampling Schedule.

METHODS

Sulphur Dioxide	Saskatchewan Environment and Public Safety Colourimetric Titration, Pulsed Fluorescence
Total Suspended Particulates	Saskatchewan Environment and Public Safety High Volume Method

*The station operated by Saskatchewan Power.



AMBIENT AIR QUALITY MONITORING (CANADA)

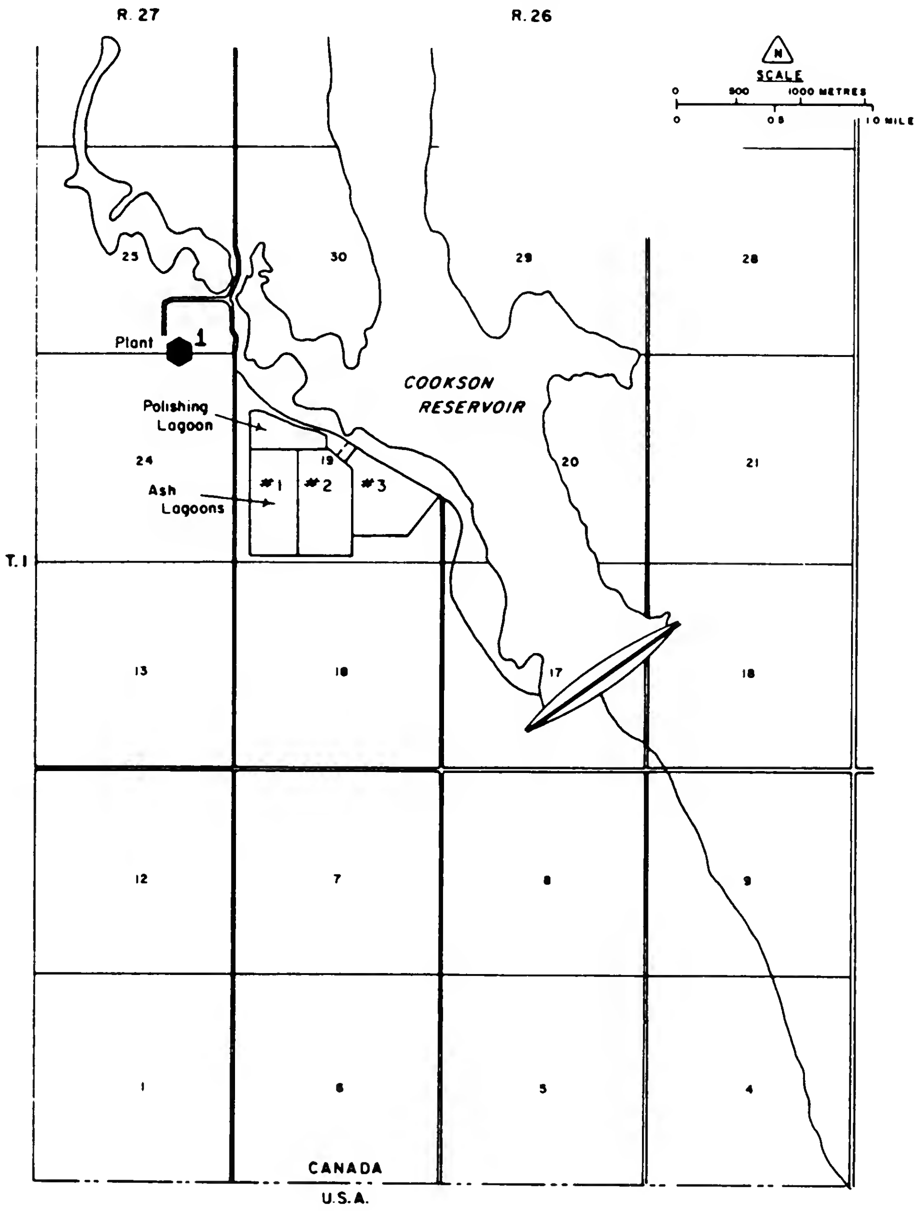
SOURCE EMISSION MONITORING

Responsible Agency: Saskatchewan Environment and Public Safety

No. on Map	Station Location	Parameters	Sampling Frequency
1	At Poplar River Power Plant	Sulphur Dioxide Nitrogen Dioxide, Opacity.	Continuous reported as Hourly Averages

METHODS

Sulphur Dioxide	Saskatchewan Environment and Public Safety - Ultraviolet Absorption
Nitrogen Dioxide	Saskatchewan Environment and Public Safety - Chemiluminescence
Opacity	Saskatchewan Environment and Public Safety - Optical



SOURCE EMISSION MONITORING

POPLAR RIVER

COOPERATIVE MONITORING ARRANGEMENT

TECHNICAL MONITORING SCHEDULES

1987

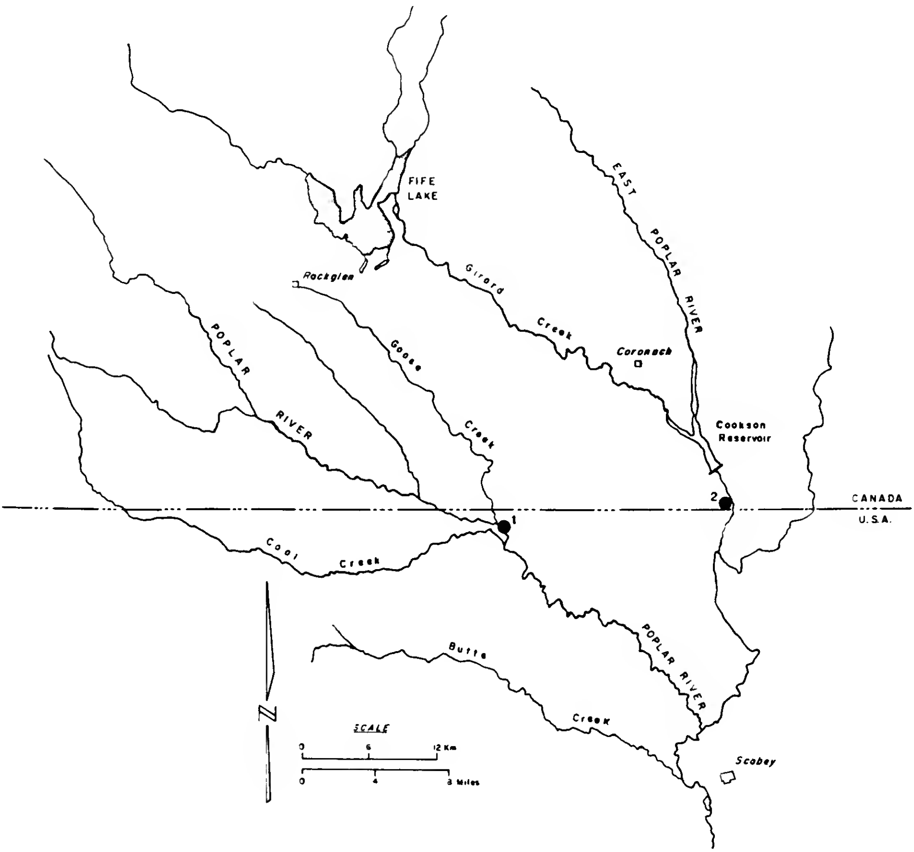
UNITED STATES

STREAMFLOW MONITORING

Responsible Agency: United States Geological Survey

No. on Map	Station Number	Station Name
*1	06178000 (11AE008)	Poplar River at International Boundary
*2	06178500 (11AE003)	East Poplar River at International Boundary

* International gauging station



HYDROMETRIC GAUGING STATIONS (UNITED STATES)

SURFACE WATER QUALITY MONITORING

Station Location

Responsible Agency: U.S. Geological Survey

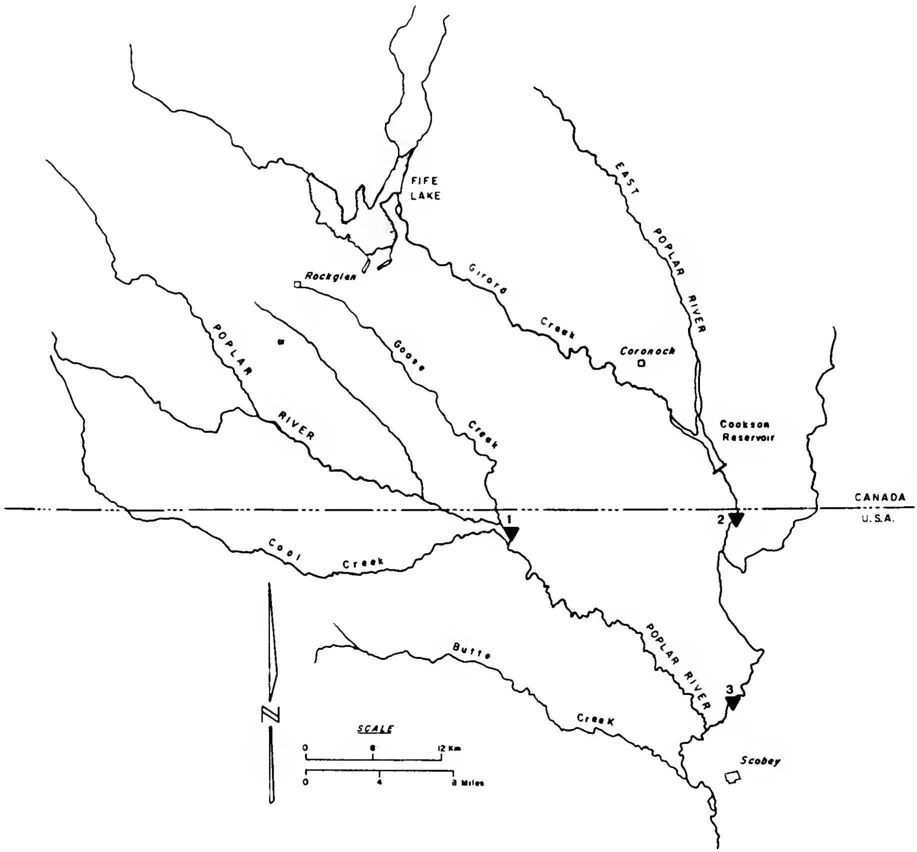
No. on Map	USGS Station No.	Station Name
1	06178000	Poplar River at International Boundary
2	06178500	East Poplar River at International Boundary
3	06179000	East Poplar River near Scobey

PARAMETERS

WATSTORE* Code	Parameter	Analytical method	Sampling Frequency No. 1	2	3
90410	Alkalinity-lab	Elect. Titration	M	M	M
01106	Aluminum-diss	AA	SA	SA	SA
00610	Ammonia-tot	Colorimetric	M	M	M
00625	Ammonia+Org N-tot	Colorimetric	M	M	M
01000	Arsenic-diss	AA, hydride	SA	SA	SA
01002	Arsenic-tot	AA, hydride	A	A	A
01010	Beryllium-diss	AA	SA	SA	SA
01012	Beryllium-tot/rec	AA-Persulfate	A	A	A
01020	Boron-diss	ICP	M	M	M
01025	Cadmium-diss	AA	SA	SA	SA
01027	Cadmium-tot/rec	AA-persulfate	A	A	A
00915	Calcium	AA	M	M	M
00680	Carbon-tot Org	Wet Oxidation	SA	SA	SA
00940	Chloride-diss	Ion chromatography	M	M	M
01030	Chromium-diss	AA	SA	SA	SA
01034	Chromium-tot/rec	AA-persulfate	A	A	A
00080	Color	Electrometric, visual	M	M	M
00095	Conductivity	Wheatstone Bridge	M	D	M
01040	Copper-diss	AA	SA	SA	SA
01042	Copper-tot/rec	AA-persulfate	A	A	A
00061	Discharge-inst	Direct measur.	M	M	M
00950	Fluoride	Electrometric	M	M	M
01046	Iron-diss	AA	M	M	M
01045	Iron-tot/rec	AA-persulfate	A	A	A
01049	Lead-diss	AA	SA	SA	SA
01051	Lead-tot/rec	AA-persulfate	A	A	A
00925	Magnesium-diss	AA	M	M	M
01056	Manganese-diss	AA	SA	SA	SA
01055	Manganese-tot/rec	AA-persulfate	A	A	A
01065	Nickel-diss	AA	SA	SA	SA
01067	Nickel tot/rec	AA-persulfate	A	A	A
00615	Nitrite-tot	Colorimetric	M	M	M
00630	Nitrate+Nitrite-tot	Colorimetric	M	M	M
00300	Oxygen-diss	Winkler/meter	M	M	M
70507	Phos, Ortho-tot	Colorimetric	M	M	M
00400	pH	Electrometric	M	M	M
00665	Phophorous-tot	Colorimetric	M	M	M
00935	Potassium-diss	AA	M	M	M
00931	SAR	Calculated	M	M	M
80154	Sediment-conc.	Filtration-gravimetric	M	M	M
80155	Sediment-load	Calculeted	M	M	M
01145	Selenium-diss	AA, hydride	SA	SA	SA
01147	Selenium tot/rec	AA, hydride	A	A	A
00955	Silica	Colorimetric	M	M	M
00930	Sodium	AA	M	M	M
00945	Sulfate-diss	Colorimetric	M	M	M
70301	Total Dissolved Solids	Calculated	M	M	M
00010	Temp Water	Toluene	M	M	M
00020	Temp Air	Toluene	M	M	M
00076	Turbidity	Nephelometric	M	M	M
80020	Uranium-diss	Fluorimetric	-	MC	-
01090	Zinc-diss	AA	SA	SA	SA
01092	Zinc-tot/rec	AA-persulfate	A	A	A

*Computer storage and retrieval system - USGS

Symbols: C-continuous; D-daily; M-monthly; MC-monthly composite; A-annually at high flow; SA-semi-annually at low and high flow; AA-atomic absorption; tot-total; rec-recoverable; diss-diesolved



SURFACE WATER QUALITY MONITORING STATIONS (UNITED STATES)

GROUND WATER QUALITY MONITORING

Station Locations

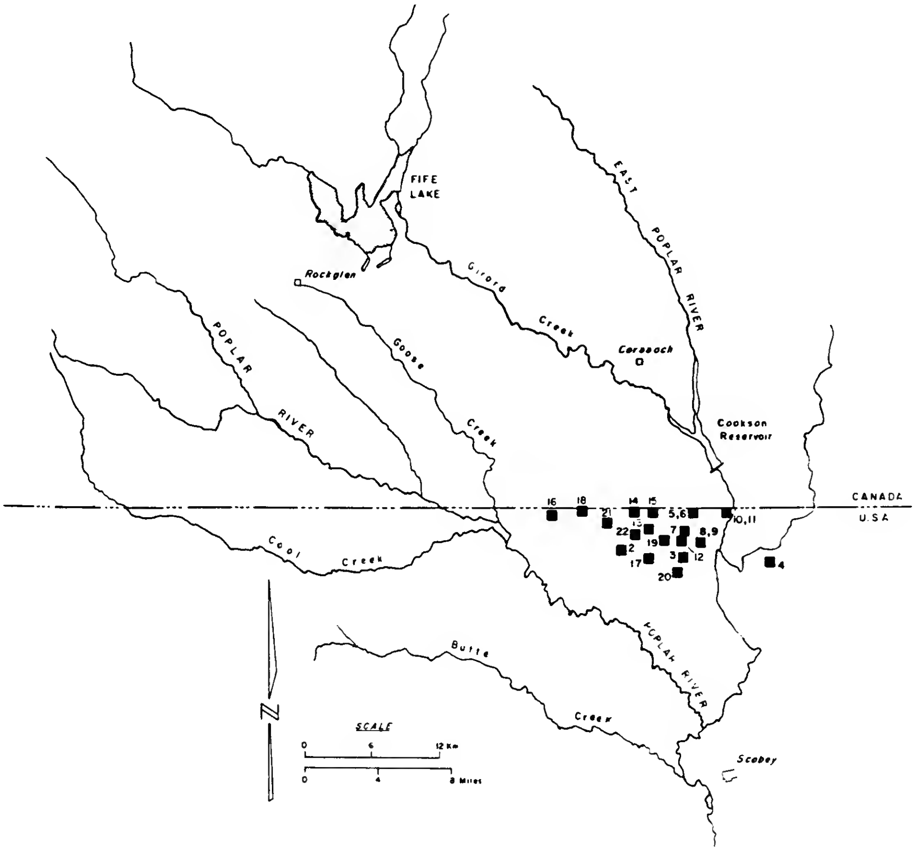
Responsible Agency: Montana Bureau of Mines and Geology

Map Number	Well Location	Total Depth (m)	Casing Diameter (cm)	Aquifer	Perforation Zone (m)
2	37N47E17DABB	79	3.8 PVC	Hart Coal	76-79
3	37N47E23AADD	36	3.8 PVC	Hart Coal	33-36
4	37N48E23BBCC	104	3.8 PVC	Fox Hills-Hell Creek	102-104
5	37N47E1ABBB1	16	10.2 PVC	Alluvium	10-15
6	37N47E1ABBB2	25	10.2 PVC	Hart Coal	19-25
7	37N47E12BBBB	45	10.2 PVC	Hart Coal	39-45
8	37N47E13AADD	14	10.2 PVC	Alluvium	10-13
9	37N47E13ADAA01	43			
		63	10.2 PVC	Fort Union	16-62
10	37N48E5BABB	13	10.2 PVC	Alluvium-Coal	7-13
11	37N48E5AAAA	67	15.2 STEEL	Fox Hills-Hell Creek	65-67
12	37N47E Sec 11 DDDD	26	5.08	Hart Coal	15-18
13	37N47E Sec 3 CCCC	62.5	10.2	Hart Coal	56-59
14	37N47E Sec 4 BBAB	82.6	10.2	Hart Coal	75-78
15	37N47E Sec 3 BBAA	89	10.2	Hart Coal	83-86
16	37N46E Sec 3 ABAB	26	10.2		24-25
17	37N47E Sec 16 DDDD	88	10.6	Hart Coal	80-83
18	37N46E Sec 1 BBBA	90	10.2	Hart Coal	80-82
19	37N47E Sec 15 AAAB	59	10.2	Hart Coal	54-56
20	37N47E Sec 24 CCCC	22	5.08		19-22
21	37N47E Sec 6 DBAA	106	10.2	Hart Coal	100-103
22	37N47E Sec 9 CBCC	21	10.2		18-21

Parameters

Storet* Code	Parameter	Analytical Method	Sampling Frequency Station No.
00440	Bicarbonates	Electrometric Titration	Sample collection is semi-annually for all locations identified above.
01020	Boron-diss	Emission Plasma ICP	
00915	Calcium	Emission Plasma	
00445	Carbonates	Electrometric Titration	The analytical method descriptions are those of the Montana Bureau of Mines and Geology Laboratory where the samples are analyzed.
00940	Chloride	Ion Chromatography	
00095	Conductivity	Wheatstone Brdg	
01040	Copper-diss	Emission Plasma, ICP	
00950	Fluoride	Ion Chromatography	
01046	Iron-diss	Emission Plasma, ICP	
01049	Lead-diss	Emission Plasma, ICP	
01130	Lithium-diss	Emission Plasma, ICP	
00925	Magnesium	Emission Plasma, ICP	
01056	Manganese-diss	Emission Plasma, ICP	
01060	Molybdenum	Emission Plasma, ICP	
00630	Nitrate	Ion Chromatography	
00400	pH	Electrometric	
00935	Potassium	Emission Plasma, ICP	
01145	Selenium-diss	AA	
00955	Silica	Emission Plasma, ICP	
00930	Sodium	Emission Plasma, ICP	
01080	Strontium-diss	Emission Plasma, ICP	
00445	Sulphate	Ion Chromatography	
22703	Uranium	Fusion Flurometric	
00190	Zinc-diss	Emission Plasma, ICP	
70301	TDS	Calculated	

*Computer storage and retrieval system - United States Geological Survey
Symbols: AA-Atomic Absorption; ICP-Inductively Coupled Plasma Unit

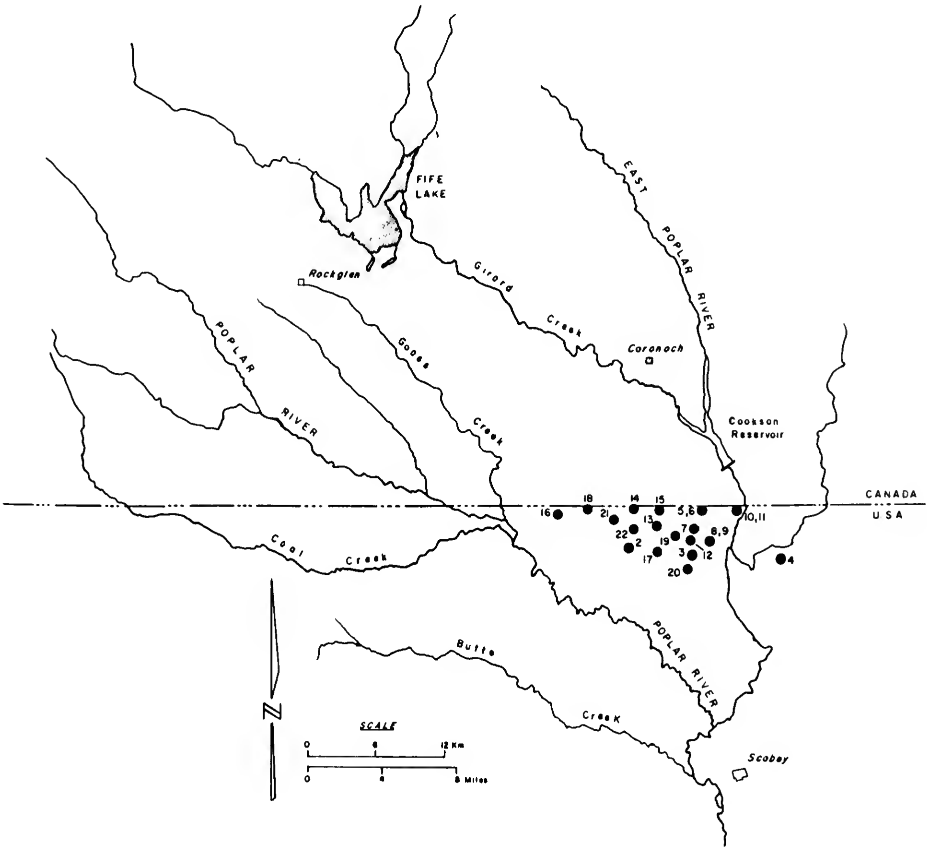


GROUND WATER QUALITY MONITORING (UNITED STATES)

GROUND WATER LEVELS TO MONITOR POTENTIAL DRAWDOWN DUE TO COAL SEAM DEWATERING

Responsible Agency: Montana Bureau of Mines and Geology

No. on Map	Sampling
2 to 22	Determine water levels quarterly



GROUNDWATER PIEZOMETERS TO MONITER POTENTIAL DRAWDOWN DUE TO COAL SEAM DEWATERING

AMBIENT AIR QUALITY MONITORING

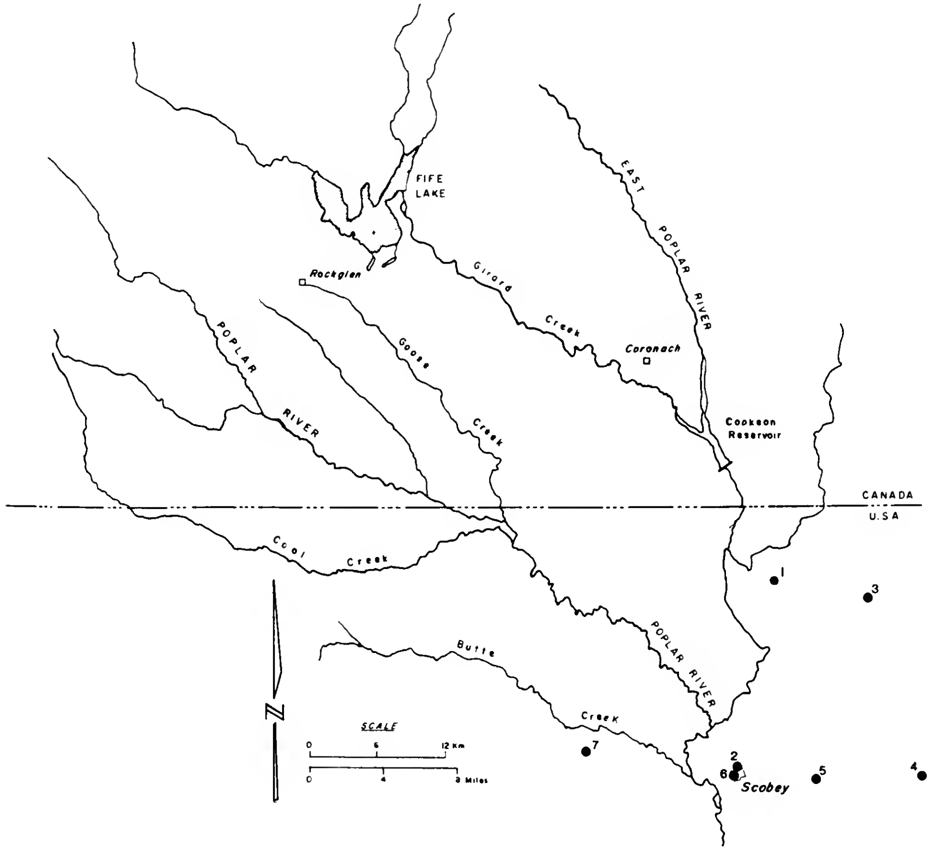
Responsible Agency: State of Montana
Air Quality Bureau

No. on Map	Location*	Parameters	Sampling Frequency and Reporting
1	Don Marlenee Ranch	Sulphur dioxide	Hourly averages
		Suspended particulates	24-hour averages
		Wind speed	Hourly averages
		Wind direction	Hourly averages
		Temperature	Hourly averages
		Sulfation rate	Monthly averages
2	Scobey - Richardson	Sulfation rate	Monthly averages
3	Microwave Tower	Sulfation rate	Monthly averages
4	Flaxville	Sulfation rate	Monthly averages
5	TV Tower Hill	Sulfation rate	Monthly averages
6	Scobey-Downtown	Sulfation rate	Monthly averages
7	Four Buttes	Sulfation rate	Monthly averages

METHODS

Sulfur Dioxide	EPA Equivalent Method EQSA-0276-009
Total Suspended Particulates	EPA Reference Method CFR Title 40 Part 50, Appendix B (State of Montana QA Manual Section 1.1.10 and 1.2.10), 24-hour sample once/6 days
Sulfation Rate	Methods of Air Sampling and Analysis, 2nd Edition, "Tentative Method of Analysis of the Sulfation Rate of the Atmosphere (Lead Dioxide Plate Method - Turbidimetric Analysis)," p. 691.

*Continuous monitoring site (#1) will operate through the end of June 1987. Sulfation plate network may be reduced in size to 3-4 sites.



AMBIENT AIR QUALITY MONITORING (UNITED STATES)

ANNEX 3

REPORTS REVIEWED DURING 1986

BY THE POPLAR RIVER BILATERAL MONITORING COMMITTEE

REPORTS REVIEWED DURING 1986 BY THE POPLAR RIVER BILATERAL MONITORING COMMITTEE

1. Munro, D.J., 1985, Report on Mercury in Cookson Reservoir [Saskatchewan]: Regina, Saskatchewan, Environment Canada, Water Quality Branch, WQB-WNR-85-02, pp. 25.

ANNEX 4

RECOMMENDED FLOW APPORTIONMENT

IN THE POPLAR RIVER BASIN

BY THE INTERNATIONAL SOURIS-RED RIVERS ENGINEERING BOARD,

POPLAR RIVER TASK FORCE (1976)

*RECOMMENDED FLOW APPORTIONMENT
IN THE POPLAR RIVER BASIN

The aggregate natural flow of all streams and tributaries in the Poplar River Basin crossing the International Boundary shall be divided equally between Canada and the United States subject to the following conditions:

1. The total natural flow of the West Fork Poplar River and all its tributaries crossing the International Boundary shall be divided equally between Canada and the United States but the flow at the International Boundary in each tributary shall not be depleted by more than 60 percent of its natural flow.

2. The total natural flow of all remaining streams and tributaries in the Poplar River Basin crossing the International Boundary shall be divided equally between Canada and the United States. Specific conditions of this division are as follows:

   a) Canada shall deliver to the United States a minimum of 60 percent of the natural flow of the Middle Fork Poplar River at the International Boundary, as determined below the confluence of Goose Creek and Middle Fork.

   b) The delivery of water from Canada to the United States on the East Poplar River shall be determined on or about the first day of June of each year as follows:

      i) When the total natural flow of the Middle Fork Poplar River, as determined below the confluence of Goose Creek, during the immediately preceding March 1st to May 31st period does not exceed 4,690 cubic decametres (3,800 acre-feet), then a continuous minimum flow of 0.028 cubic metres per second (1.0 cubic feet per second) shall be delivered to the United States on the East Poplar River at the International Boundary throughout the suceeding 12 month period commencing June 1st. In addition, a volume of 370 cubic decametres (300 acre-feet) shall be delivered to the United States upon demand at any time during the 12 month period commencing June 1st.

      ii) When the total natural flow of the Middle Fork Poplar River, as determined below the confluence of Goose Creek, during the immediately preceding March 1st to May 31st period is greater than 4,690 cubic decametres (3,800 acre-feet), but does not exceed 9,250 cubic decametres 7,500 acre-feet), then a continuous minimum flow of 0.057

*Canada-United States, 1976, Joint studies for flow apportionment, Poplar River Basin, Montana-Saskatchewan: Main Report, International Souris-Red Rivers Board, Poplar River Task Force, 43 pp.

cubic metres per second (2.0 cubic feet per second) shall be delivered to the United States on the East Poplar River at the International Boundary during the succeeding period June 1st through August 31st. A minimum delivery of 0.028 cubic metres per second (1.0 cubic feet per second) shall then be maintained from September 1st through to May 31st of the following year. In addition, a volume of 617 cubic decametres (500 acre-feet) shall be delivered to the United States upon demand at any time during the 12-month period commencing June 1st.

iii) When the total natural flow of the Middle Fork Poplar River, as determined below the confluence of Goose Creek, during the immediately preceding March 1st to May 31st period is greater than 9,250 cubic decametres (7,500 acre-feet), but does not exceed 14,800 cubic decametres (12,000 acre-feet), then a continuous minimum flow of 0.085 cubic metres per second (3.0 cubic feet per second) shall be delivered to the United States on the East Poplar River at the International Boundary during the succeeding period June 1st through August 31st. A minimum delivery of 0.057 cubic metres per second (2.0 cubic feet per second) shall then be maintained from September 1st through to May 31st of the following year. In addition, a volume of 617 cubic decametres (500 acre-feet) shall be delivered to the United States upon demand at any time during the 12 month period commencing June 1st.

iv) When the total natural flow of the Middle Fork Poplar, as determined below the confluence of Goose Creek, during the immediately preceding March 1st to May 31st period exceeds 14,800 cubic decametres (12,000 acre-feet) then a continuous minimum flow of 0.085 cubic metres per second (3.0 cubic feet per second) shall be delivered to the United States on the East Poplar River at the International Boundary during the suceeding period June 1st through August 31st. A minimum delivery of 0.057 cubic metres per second (2.0 cubic feet per second) shall then be maintained from September 1st through to May 31st of the following year. In addition, a volume of 1,230 cubic decametres (1,000 acre-feet) shall be delivered to the United States upon demand at any time during the 12-month period commencing June 1st.

c) The natural flow at the International Boundary in each of the remaining individual tributaries shall not be depleted by more than 60 percent of its natural flow.

3. The natural flow and division periods for apportionment purposes shall be determined, unless otherwise specified, for periods of time commensurate with the uses and requirements of both countries.

ANNEX 5

METRIC CONVERSIONS

METRIC CONVERSION FACTORS

ac	=	4,047 m^2 = 0.4047 ha
ac-ft	=	1,233.5 m^3 = 1.2335 dam^3
C°	=	1.8 F°
cm	=	0.3937 in.
cm^2	=	0.155 in^2
dam^3	=	1,000 m^3 = 0.8107 ac-ft
ft^3	=	28.3171 x $10^{-3} m^3$
ha	=	10,000 m^2 = 2.471 ac
hm	=	100 m = 328.08 ft
hm^3	=	1 x 10^6 m^3
I.gpm	=	0.0758 L/s
in	=	2.54 cm
kg	=	2.20462 lb = 1.1 x 10^{-3} tons
km	=	0.62137 miles
km^2	=	0.3861 mi^2
L	=	0.3532 ft^3 = 0.21997 I. gal = 0.26420 U.S. gal
L/s	=	0.035 cfs = 13.193 I.gpm = 15.848 U.S. gpm
m	=	3.2808 ft
m^2	=	10.7636 ft^2
m^3	=	1,000 L = 35.3144 ft^3 = 219.97 I. gal = 264.2 U.S. gal
m^3/s	=	35.314 cfs
mm	=	0.00328 ft
tonne	=	1,000 kg = 1.1023 ton (short)
U.S. gpm	=	0.0631 L/s

For Air Samples

ppm = 100 pphm = 1000 X (Molecular Weight of substance/24.45) mg/m^3