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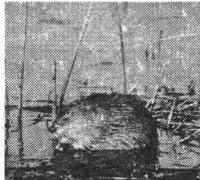
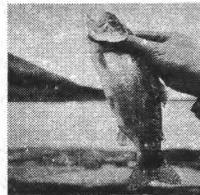


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Northern River Basins Study



NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 95
**ASSESSMENT AND VALIDATION
 OF MODELLING UNDER-ICE
 DISSOLVED OXYGEN
 USING DOSTOC,
 ATHABASCA RIVER, 1988 TO 1994**



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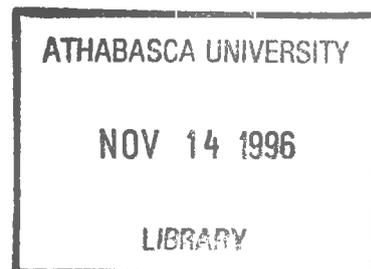
by

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National Hydrology Research Institute,
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PREFACE:

The Northern River Basins Study was initiated through the "Canada-Alberta-Northwest Territories Agreement Respecting the Peace-Athabasca-Slave River Basin Study, Phase II - Technical Studies" which was signed September 27, 1991. The purpose of the Study is to understand and characterize the cumulative effects of development on the water and aquatic environment of the Study Area by coordinating with existing programs and undertaking appropriate new technical studies.

This publication reports the method and findings of particular work conducted as part of the Northern River Basins Study. As such, the work was governed by a specific terms of reference and is expected to contribute information about the Study Area within the context of the overall study as described by the Study Final Report. This report has been reviewed by the Study Science Advisory Committee in regards to scientific content and has been approved by the Study Board of Directors for public release.

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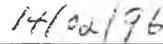
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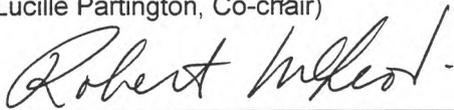
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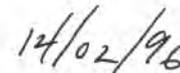
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ASSESSMENT AND VALIDATION OF MODELLING UNDER-ICE DISSOLVED OXYGEN USING DOSTOC, ATHABASCA RIVER, 1988 TO 1994

STUDY PERSPECTIVE

One of the questions posed by the Northern River Basins Study Board relates to determining the factors controlling dissolved oxygen concentrations in the Peace, Athabasca and Slave rivers. Dissolved oxygen concentrations in rivers are controlled by a variety of factors including the decomposition of organic material, photosynthesis and respiration of river biota, inputs of groundwater or tributary water, and inputs of oxygen-consuming effluent from industrial and municipal discharges. Recent concern has focused on the role of natural versus man-made factors in contributing to the decrease in dissolved oxygen in the Athabasca River during winter. The objective of this project was to examine the existing dissolved oxygen (DO) model and recommend improvements to modelling under-ice DO concentrations in the Athabasca River.

Previous efforts by the NRBS to model under-ice DO levels in the Athabasca River used the Dissolved Oxygen STOChastic (DOSTOC) simulation model. Discrepancies between observed and predicted DO concentrations indicated a need for re-evaluating the approaches used. In this study, the structure of the DOSTOC model and input data used for modelling were reviewed and the model was run using the best available values for input data and process rates.

DOSTOC was run using Athabasca River data from the winters of 1988 to 1994 for the reach from upstream of Hinton to upstream of Grand Rapids. The new DOSTOC model used revised rates and ratios for converting five-day biological oxygen demand (BOD_5) to ultimate BOD values, measured values for sediment oxygen demand and sedimentation, and a temperature correction from 20°C to 0°C for pulp mill BOD rates. Results showed that the model was reasonably successful at predicting DO for the 1990 to 1994 winters. For these years, most ($\geq 62\%$) of the observed values were within the 90% confidence limits of the model due to the accuracy of the predictions. For the 1988-1993 winters, DO concentrations in the Athabasca River decreased linearly from Hinton to Grand Rapids. Although DO levels recovered briefly below some outfalls, concentrations declined linearly over large distances (800+ km) along the Athabasca River.

This improved DO model will provide the tool to set industrial and municipal licenses for BOD loading, and to evaluate the impact on water quality of flow regime and changes in industrial and municipal discharges. Additionally, information from this project will be used in studies of DO requirements for fish, and monitoring nutrient and contaminant impacts on these river ecosystems. Although there are certain limitations to this DO model, these could be addressed by moving to a model capable of two-dimensional simulation after more data are collected for DO concentrations within mixing zones. Development of a simulation model to accurately predict DO concentrations in northern rivers will depend upon an improved database and a better understanding of the natural factors controlling DO in these systems.

Related Study Questions

- 2) *What is the current state of water quality in the Peace, Athabasca and Slave River basins, including the Peace-Athabasca Delta?*
- 5) *Are the substances added to the rivers by natural and man-made discharges likely to cause deterioration of the water quality?*
- 7) *What concentrations of dissolved oxygen are required seasonally to protect the various life stages of fish, and what factors control dissolved oxygen in the rivers?*
- 13a) *What predictive tools are required to determine the cumulative effects of man-made discharges on the water and aquatic environment?*

REPORT SUMMARY

Dissolved oxygen concentrations in rivers are controlled by a variety of factors including oxidation of organic material, photosynthesis and respiration of river biota, inputs of oxygen-enriched or -depleted groundwater or tributary water, and inputs of oxygen-consuming effluent from industries and municipal sewage treatment facilities. One of the aims of the Northern River Basins Study is to determine the factors controlling dissolved oxygen concentrations in the Peace, Athabasca and Slave river systems. Analysis of long-term data sets showed that late winter DO concentrations in the Athabasca River appeared to decrease following the 1957 start-up of the North Western Pulp and Paper (now Weldwood of Canada Ltd.) bleached kraft mill in Hinton, but have since begun to recover. More recent water quality surveys by Alberta Environmental Protection have shown that during winter, dissolved oxygen concentrations in the Athabasca River decrease from approximately 12 mg/L upstream of the Town of Hinton to as low as 6.5 mg/L upstream of Grand Rapids. With the increase in pulp mill developments in the basin from one mill prior to 1988 to the present five mills, public and government concern has focused on the role of natural versus man-made factors in contributing to the decrease in dissolved oxygen in the Athabasca River.

The aim of this study was to examine the existing model approach and make recommendations for improved modelling of under-ice dissolved oxygen (DO) concentrations in the Athabasca River. Previous efforts to model under-ice DO concentrations in the Athabasca River employed the dissolved oxygen simulation model DOSTOC. Calibration runs were undertaken using winter 1988 and 1989 data (Macdonald and Hamilton 1989); validation runs were undertaken with winter 1990-1992 data (Macdonald and Radermacher 1992, 1993; unpublished data). Discrepancies between observed and predicted DO concentrations for 1992 and 1993 highlighted the need for a review and assessment of approaches for modelling under-ice DO in the Athabasca River. In this report, the structure of the DOSTOC model and input data used for modelling were reviewed (Chapters 3 and 4) and the model was run stochastically using the best available values for input data and process rates (Chapter 5). This included revised rates and ratios for converting five day BOD to ultimate BOD values, measured values for sediment oxygen demand and sedimentation, and a temperature correction from 20 to 0 °C for pulp mill BOD decay rates. Our results showed that the model was reasonably successful at predicting DO ($0.74 \leq r^2 \leq 0.92$ for the 1990 to 1994 winters). For these years, most ($\geq 62\%$) of the observed values lay within the 90% confidence limits of the model. This was due to accuracy of the predictions as well as to the confidence limits of $\sim \pm 0.7$ mg/L associated with the model. The poorer predictions in 1988 and 1989 may relate to the limited data on tributary and sewage treatment plant inputs and mainstem DO concentrations and, in 1989, to the large and erratic BOD loadings from Millar Western Pulp Ltd. which had likely not equilibrated with instream processes.

To assess rates of change in DO in the Athabasca River in relation to effluent loading and to compare these rates with other rivers throughout the world, regression equations were developed relating DO concentration to river distance (Chapter 6). Our results showed that for the 1988-1993 winters, DO concentrations in the Athabasca River decreased linearly from upstream of Hinton to upstream of Grand Rapids ($r^2 \geq 0.60$, $P < 0.0005$). While the typical sag curve followed by a

recovery in DO concentrations was observed below some outfalls, DO concentrations declined linearly over large distances (i.e. 100's of kilometers). Comparison of DO decay rates for the Athabasca River between Hinton and Grand Rapids with other ice-covered rivers throughout the world showed that rates for the Athabasca River were generally less than those for other ice-covered rivers receiving effluent.

In conclusion, our results showed that for recent years (1990 - 1994), DO concentrations in the Athabasca River can be reasonably simulated with the simulation model DOSTOC based on our current understanding of the river and its DO dynamics. In the Athabasca River, where effluent comprises less than 2% of the winter discharge, natural instream processes may play an important role in determining river-water DO concentrations. The development of a simulation model to accurately predict DO concentrations in the Athabasca River (as well as other rivers in the Northern Rivers Basin) will likely depend upon an improved database and a better understanding of the natural factors controlling DO kinetics in these systems. With respect to data deficiencies, we recommend: (1) more frequent measures of BOD decay rates, $BOD_u:BOD_5$ ratios and BOD loads for sewage treatment facilities, (2) examination of cross-channel variability in SOD, (3) laboratory measurements of temperature correction coefficients, (4) re-evaluation of the Leopold Maddock coefficients and (5) measurement of photosynthetic rate. We recommend implementation of WASP or another dynamic model to address questions regarding temporal variability in DO in the Athabasca River. However, since other DO-related parameters may not be measured with the same frequency, the information gained by dynamic modelling may be offset by the increased uncertainty in loading rates, decay rates and other time-variable parameters.

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1.0 INTRODUCTION

Dissolved oxygen is essential for all aquatic organisms with aerobic respiration. In rivers which experience ice cover, depression of dissolved oxygen during winter is a common occurrence. Severe oxygen depletions had been noted as early as the mid-1940's in streams and rivers in Russia (Hynes 1970 after Mosevich 1974, Mossewitsch 1961) while in North America, one of the earlier accounts dates from the 1960's for rivers in Alaska (Schallock and Lotspeich 1974). The cause of dissolved oxygen depletion under ice-cover is generally attributed to three factors: (1) lack of reaeration due to ice cover, (2) inputs of oxygen-depleted groundwater, and (3) oxidation of organic material. However, while the importance of these factors in controlling under-ice depletion has long been recognized, little information is available on the relative roles of these factors and the impact that anthropogenic (i.e. man-made) loading of organic material may have in further depleting winter dissolved oxygen concentrations. Given the large-scale developments planned and underway in many northern rivers throughout the world (e.g. mining, timber harvesting, pulp mills, gas and oil extraction, and changes in landuse patterns), the factors controlling natural declines in dissolved oxygen under-ice need to be identified and quantified in order to improve predictions of the impact of development on winter dissolved oxygen concentrations.

The aim of this report was to examine the existing model approach and make recommendations for improved modelling of under-ice dissolved oxygen (DO) concentrations in the Athabasca River. This work forms part of the Northern River Basins Study (NRBS), a joint study between the governments of Canada, Alberta and the Northwest Territories. The aim of the NRBS is to gather comprehensive information on water quality, fish and fish habitat, riparian vegetation and wildlife, hydrology and use of aquatic resources for the Peace, Athabasca and Slave River basins in order to predict and assess the cumulative effects of development on the water and aquatic environment of these basins within Alberta and the Northwest Territories. This includes the development of water quality models to predict the impacts of pollutants on river chemistry and biota.

Concern about DO levels in the Athabasca River dates from the 1950's when the first pulp mill (formerly North Western Pulp and Power, now Weldwood of Canada Ltd. in Hinton, AB) became operational. While late winter (February/March) DO concentrations upstream of the mill outfall have remained relatively constant since 1958 (11.6 ± 0.1 ; mean \pm SE, $n = 23$), concentrations immediately upstream of Whitecourt and Smith appeared depressed during the 20 years following the fall 1957 start-up of the mill (Figure 1.1). However, since 1977, DO concentrations downstream of Hinton appear to have increased. These changes in DO concentrations downstream of Hinton are related to a decrease in BOD loads to the river during the past 40 years, despite the increase from one to five pulpmills (Table 1.1).

In addition to water quality monitoring, more recent studies of DO in the Athabasca River have expanded to include simulation modelling of DO dynamics. Water quality models are important tools for estimating the impact of nutrient, contaminant and biochemical oxygen demand (BOD) loadings on water and sediment chemistry, and biota in rivers. Often, these models represent the best information available to decision makers in assessing the effects of existing and future loading scenarios. Previous efforts to model DO in the Athabasca River included: (1) an initial attempt using the model WQRRS (Water Quality for River and Reservoir Systems) (Charles Howard and Associates 1984), (2) an initial assessment of the model DOSTOC for use on the Athabasca River (Hamilton et al.

1988), (3) calibration of DOSTOC to winter 1988 and 1989 data (Macdonald and Hamilton 1989), (4) verification of the 1989 calibration using winter 1990 data (Macdonald and Radermacher 1992), and (5) verification of the 1989 calibration using winter 1991 and 1992 data (Macdonald and Radermacher 1993). In March 1993, a workshop was organized by the NRBS to review and assess available modelling approaches for estimating the impact of BOD and nutrient loadings on the water quality of the Peace and Athabasca river systems (Culp and Chambers 1994). Recommendations from this workshop included: (1) a review of sediment oxygen demand and its implementation in water quality models, (2) assessment of the robustness of model fits, and (3) the use of two or more independent teams to undertake modelling in order to offset the subjectivity that comes into play when modelling complex systems with parameter-rich models. In this report, we address the above-mentioned concerns. We reviewed the operation and implementation of the dissolved oxygen simulation model DOSTOC, including the modelling of sediment oxygen demand (Chapters 3 and 4). In particular, we focused on validating model input parameters for use in DOSTOC as well as any subsequent DO modelling efforts. Stochastic model runs for the Athabasca River were undertaken for the 1988-93 winters (Chapter 5). Dissolved oxygen decay rates for the Athabasca River were then compared with those for other ice-covered rivers throughout the world to evaluate relative impacts of man-made pollutants on under-ice DO (Chapter 6). On the basis of our findings, we present recommendations for future directions to improve DO modelling of the Athabasca River (Chapter 7).

Figure 1.1

Late winter (February/March) dissolved oxygen (DO) concentrations in the Athabasca River immediately upstream of Hinton, Whitecourt, Smith and Athabasca for five time periods (1955, 1958-1966, 1967-1976, 1977-1988 and 1989-1995) corresponding to changes in pulpmill BOD₅ loading. For each site, bars sharing the same letter are not significantly different ($P < 0.05$; Student-Newman-Keul's test); * indicates periods not included in statistical analyses due to insufficient data ($n \leq 2$).

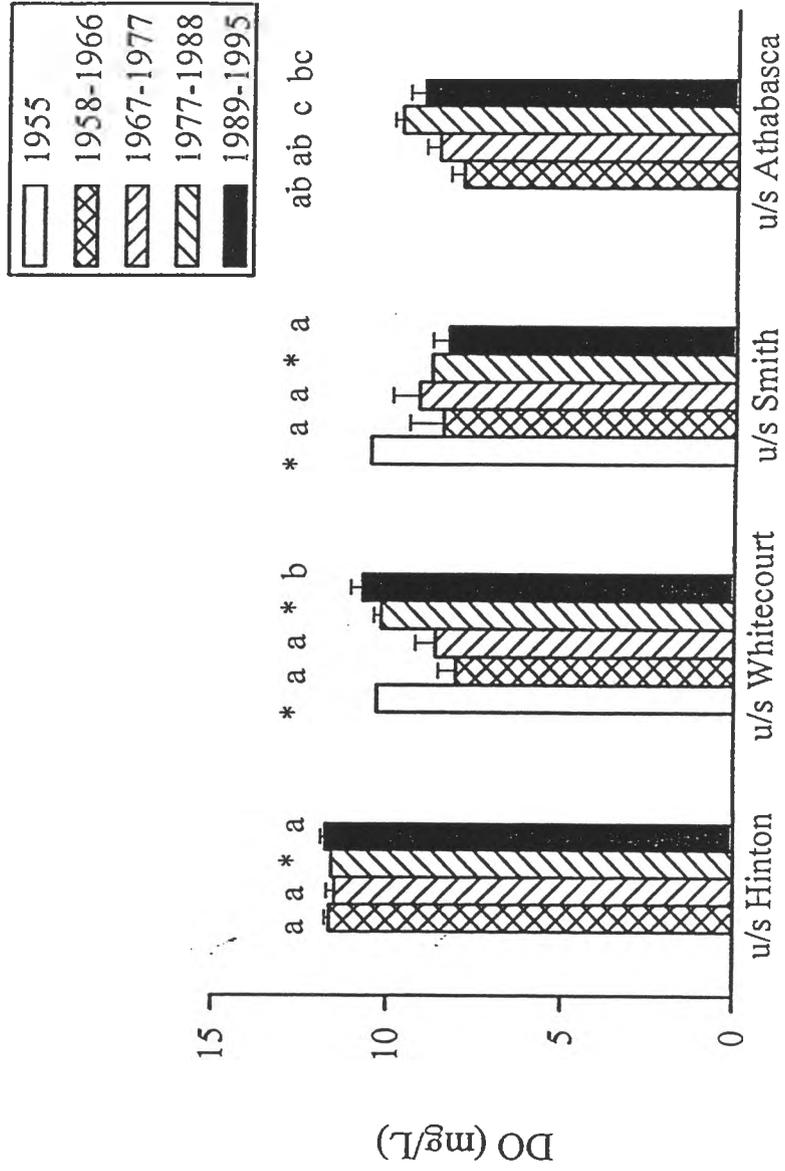


Table 1.1 Permitted and actual BOD loads from pulp mills discharging to the Athabasca River and its tributaries. (1958 - 1988 permitted loads from Anderson (1989); 1989 - 1993 permitted loads from I. Mackenzie, Alberta Environmental Protection; actual loads from NRBS *Northdat* data base (AGRA Earth and Environmental 1994)). Up until 1988, Weldwood of Canada Ltd. was the only pulp mill in the Athabasca basin. (Actual BOD₅ loads were calculated as the average of annual means and are presented as mean ± SE (n).)

| | Permitted | Actual (kg/d) |
|-----------|---|-----------------------|
| 1958-1966 | 1958-1965: 10545 kg/d 1965-1966: 13636 kg/d winter 22727 kg/d rest of year | ~ 24000 |
| 1967-1976 | 13636 kg/d winter 22727 kg/d rest of year | 11344 ± 841 (n=10) |
| 1977-1988 | 1977-1980: 8.7 kg BOD/Adt ¹ @ 520 Adt/d and not to exceed 4524 kg/d BOD 1980-1988: 6600 kg/d BOD | 3361 ± 88 (n=10) |
| 1989-1993 | Weldwood of Canada Ltd.: 7 kg BOD/Adt ² @ 565 Adt/d (1989) and 1100 Adt/d (1990-1992) 3 kg BOD/Adt ² @ 1100 Adt/d (1993) Millar Western Pulp Ltd.: 7.5 kg BOD/Adt ² @ 680 Adt/d (1989- 1992) 3.0 kg BOD/Adt ² @ 680 Adt/d (1993) Alberta Newsprint Co.: 3.0 kg BOD/Adt ² @ 700 Adt/d (as of Aug. 1990) Slave Lake Pulp Corp.: 3.0 kg BOD/Adt ² @ 350 Adt/d (as of Dec. 1990) Alberta Pacific Forest Industries Inc.: 1.5 kg BOD/Adt ² @ 1500 Adt/d (as of Sept. 1993) | 4858 ± 606 (n=6) |

¹Air dried tonne

²These are monthly averages. Daily maximum values are up to twice the monthly average. Prior to 1993, permitted BOD loads varied with flow such that at, for example, 7Q10 flows loads were restricted to 3 kg/Adt.

2.0 SITE DESCRIPTION AND SAMPLING

2.1 SITE DESCRIPTION

The Athabasca River originates in the Rocky Mountains of west-central Alberta, Canada and flows northeast across Alberta to Lake Athabasca where it joins with the Peace River to form the Slave River (Figure 2.1). The latter flows into Great Slave Lake which drains via the Mackenzie River to the Beaufort Sea. The Athabasca River is not regulated. Mean daily flows at the Town of Athabasca average 440 m³/s (1952-1988) with peak flows occurring in June after mountain snow-pack melt (1046 m³/s June monthly mean, 1952-1988) and lowest flows in February (92 m³/s February monthly mean, 1952-1988) (Environment Canada 1989).

During the study period (January 1988 to March 1993), three chemi-thermomechanical pulp mills and one kraft pulp mill operated in the Athabasca basin (Table 2.1). The mills discharged effluent for which the five-day biochemical oxygen demand (BOD₅) load totalled 6569, 6548, 4465, 4872, 3838 and 2852 kg/d in 1988, 1989, 1990, 1991, 1992 and 1993, respectively (calculated from Table 4.3). With the exception of the kraft mill which commenced operation in Hinton in 1957, all have come on-line since August 1988. The mill at Hinton also expanded and improved operations in 1990 with production increasing from approximately 550 to 1100 air-dried t/d pulp and BOD₅ loading decreasing from approximately 4000 to 2500 kg/d. In addition to pulp mill activity, there are five municipalities and one oil sands project that discharge continuously to the Athabasca River or its tributaries (Table 2.2). Three communities (Fort Assiniboine, Fort Mackay and Smith) discharge sewage from lagoons to the Athabasca River once or twice yearly (fall and, in the case of Fort Assiniboine and Smith, spring). Approximately 40 other communities discharge sewage periodically (fall and sometimes spring) to rivers, creeks and lakes in the Athabasca drainage basin while Lac la Biche has continuous discharge to Field Lake. Other activities in the basin include four active coal mines, at least 53 gas plants, another oil sands project and 12 gravel-washing enterprises; however, all have little or no discharge.

Figure 2.1 Map of the Northern River Basins Study area showing the drainage area of the Athabasca, Peace and Slave rivers.

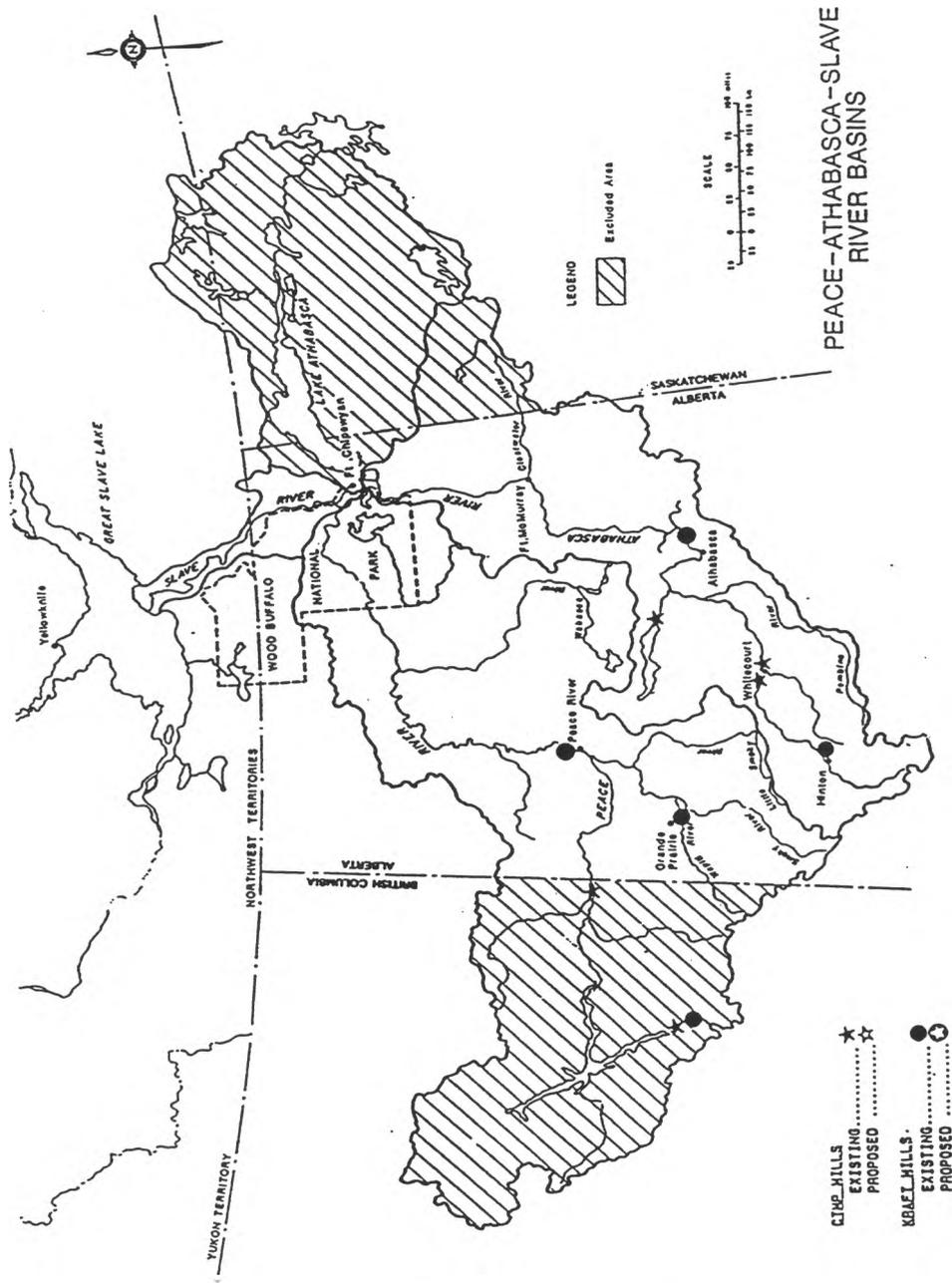


Table 2.1 Average (1988-1993) production and operating characteristics of pulp mills in the Athabasca drainage basin. (Data obtained from NRBS *Northdat* data base (AGRA Earth and Environmental 1994). N/A indicates that data is not available and "not op" indicates the mill was not operational.)

| Company | Location (Receiving River) | Mill Type | Start Up | Effluent Treatment | Prod ¹ (Adt/d) 1988 | Prod (Adt/d) 1989 | Prod (Adt/d) 1990 | Prod (Adt/d) 1991 | Prod (Adt/d) 1992 | Prod (Adt/d) 1993 |
|--|----------------------------|---------------------------|---------------------|------------------------------------|--------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Weldwood of Canada Ltd. | Hinton (Athabasca) | Kraft Pulp | 1957 Expansion 1990 | ASB ² | 551 | 493 | 714 | 983 | 1045 | 1044 |
| Alberta Newsprint Co. | Whitecourt (Athabasca) | CTMP ³ & Paper | Aug. 1990 | Extended Aeration AST ⁴ | not op | not op | 337 | 493 | 588 | 614 |
| Millar Western Pulp Ltd. | Whitecourt (Athabasca) | CTMP | Aug. 1988 | Extended Aeration AST | 161 | 460 | 576 | 606 | 608 | 532 |
| Slave Lake Pulp Corp. | Slave Lake (Lesser Slave) | CTMP | Dec. 1990 | AST | not op | not op | not op | 213 | 322 | 326 |
| Alberta-Pacific Forest Industries Inc. | Athabasca (Athabasca) | Kraft Pulp | Sept. 1993 | ASB | not op | not op | not op | not op | not op | N/A |

¹Prod=average annual production in air dried tonnes per day (Adt/d)

²Aerated Stabilization Basin

³Chemi-thermomechanical pulp

⁴Activated Sludge Treatment

Table 2.2 Continuously discharging effluents from municipal and other sources to the Athabasca River or its tributaries. (Hinton municipal effluent is discharged with Weldwood of Canada Ltd. effluent.) Discharge and BOD₅ values represent the mean of three instantaneous samples collected during the 1990-92 Alberta Environment winter water quality surveys unless otherwise noted. N/A means data are unavailable.

(a) Municipal sources

| Source | Treatment | Receiving Water | Discharge (m ³ /d) | BOD ₅ (mg/L) |
|----------------|----------------|---------------------|-------------------------------|-------------------------|
| Jasper | Aerated lagoon | Athabasca River | 5,700 ¹ | N/A |
| Whitecourt | Mechanical | Athabasca River | 3,456 | 20.7 |
| Slave Lake | Aerated lagoon | Lesser Slave Lake | 2,534 | 21.4 |
| Athabasca | Aerated lagoon | Athabasca River | 893 | 13.2 |
| Fort McMurray | Aerated lagoon | Athabasca River | 12,874 | 15 |
| Fort Chipewyan | Lagoon | Riviere des Rochers | N/A | N/A |

(b) Other Sources

| Source | Receiving Water | Discharge (m ³ /d) | BOD ₅ (mg/L) |
|---|-----------------|-------------------------------|-------------------------|
| Suncor Inc. Athabasca Oil Sands Project | Athabasca River | 27,504 | 8.2 |

¹after Sentar Consultants Ltd. (1994).

2.2 FIELD SAMPLING AND ANALYTICAL METHODS

Water quality surveys of the Athabasca River were conducted by Alberta Environment during the 1989-1993 winters (9 January - 15 February 1989; 13 February - 16 March 1989; 14 February - 21 March 1990; 7 February - 14 March 1991; 30 January - 10 March 1992; 11 February - 16 March 1993) from upstream of the Town of Hinton (0.1 km upstream of the Weldwood of Canada Ltd. pumphouse, UTM coordinates 11 460950E 5917950N) to Lake Athabasca (Athabasca River at Big Point Channel, UTM coordinates 12 511200E 6496100N), a distance of 1243 river kilometers. Approximately 70 stations, including mainstem, tributary and effluent (i.e. before the effluent enters the river) discharges, were sampled in a downstream order at time intervals corresponding to the water time-of-travel as determined by previous dye studies (see Noton and Shaw 1989 for sampling details). In addition, two shorter 556 km surveys were conducted in February and March 1988 from upstream of Hinton to the Town of Athabasca; a 379 km survey was conducted in January and February 1989 from Windfall Bridge to Athabasca. These surveys included approximately 25 mainstem, tributary and effluent-discharge stations. All samples were analyzed for BOD₅ and DO. River samples were generally collected from holes drilled through the ice in the centre of the channel. Tributaries were sampled near their confluence with the Athabasca River except for the Lesser Slave River which was sampled at the river mouth as well at three additional locations along its length. Effluent samples were collected upstream of the discharge point for every industry and municipality discharging to the river. Pulp mill samples were 24 h composites; all other industrial and municipal samples were grab samples. River and tributary samples for Winkler DO analysis were collected in duplicate with a displacement-type APHA sampler (APHA 1985); instream samples for BOD₅ were collected as a grab below the ice surface. DO samples were fixed on site and titrated within 24 h following the azide-Winkler method (APHA 1985); the results of duplicate DO samples were averaged. BOD₅ samples were collected in glass bottles, stored at 4 °C and analyzed within 24 h at Chemex Labs Alberta Inc. following APHA (1985).

3.0 DOSTOC MODEL DESCRIPTION

3.1 INTRODUCTION

The dissolved oxygen simulation model DOSTOC (Dissolved Oxygen STOChastic model) has been widely used during the past six years by Alberta Environment to predict impacts of anthropogenic loadings on water quality in rivers. The model was developed in 1987 for the Planning Division of Alberta Environment and has been described in detail by HydroQual Consultants Inc. and Gore & Storrie Ltd. (1987) and Zielinski (1988). DOSTOC is a steady-state, one-dimensional model based on the system of ordinary differential equations developed by Streeter and Phelps (1925). Their original equations were modified to include the major sources and sinks of oxygen in river processes, including atmospheric reaeration, consumption of DO as a result of the conversion of NH_4^+ to NO_3 (nitrogenous oxygen demand, NOD), consumption of DO by degradation of organic material (biochemical oxygen demand, BOD), production/consumption of DO as a result of plant photosynthesis and respiration, and consumption of DO at the streambed by benthic organisms and chemical processes (sediment oxygen demand, SOD).

3.2 VARIABLES IN DOSTOC

Table 3.1 Variables in DOSTOC.

| Variable | Definition | Units |
|------------------|---|---------------|
| t | travel time | days |
| X | biochemical oxygen demand | mg/L |
| Y | dissolved oxygen concentration | mg/L |
| Z | nitrogenous oxygen demand | mg/L |
| D_s | saturation concentration of oxygen | mg/L |
| R | loss rate of DO due to respiration | mg/L/day |
| P_m | maximum photosynthetic rate | mg/L/day |
| t_s | time of sunrise (relative to travel time) | |
| f | fraction of day with sunshine | |
| S_{BOD} | non-point source loads of BOD | tonnes/km/day |
| S_{NOD} | non-point source loads of NOD | tonnes/km/day |
| S_{DO} | non-point source loads of DO | tonnes/km/day |
| k_1 | BOD decay rate | per day |
| k_2 | reaeration rate | per day |
| k_3 | sedimentation and absorption loss rate for BOD | per day |
| k_4 | NOD decay rate | per day |
| $W_i(t)$ | Gaussian white noise with zero mean and variance of 1 | |
| D_i | Standard deviation of noise W_i | |

3.3 GENERAL EQUATIONS

The governing differential equations are given as (Zielinski 1988):

$$\frac{dX}{dt} = -(k_1 + k_3)X(t) + S_{BOD} \quad \text{Equation 3.1}$$

$$\frac{dY}{dt} = k_2[D_s - Y(t)] - k_1X(t) - k_4Z(t) - R + P(t) + S_{DO} \quad \text{Equation 3.2}$$

$$\frac{dZ}{dt} = -k_4Z(t) + S_{NOD} \quad \text{Equation 3.3}$$

Photosynthetic variation is expressed as:

$$(P_m + w_5(t)) \sin\left[\frac{\pi}{f}(t + t_s)\right] \quad \text{Equation 3.4}$$

for $(t \leq (f - t_s))$ or $t \geq (1 - t_s)$ and $(t_s \geq 0)$ or 0 ; otherwise 0 .

3.4 STOCHASTIC EQUATIONS

In the stochastic version of the Streeter-Phelps equations, all the rate constants and source and sink terms are assumed to be stochastic, while the initial conditions are treated as random variables. The distinction between stochastic and random variables is outlined by Zielinski (1991). The transformed equations are then given as (Zielinski 1988):

$$\frac{dX}{dt} = -(k_1 + w_1(t) + k_3 + w_3(t))X(t) + S_{BOD} + w_7(t) \quad \text{Equation 3.5}$$

$$\frac{dY}{dt} = (k_2 + w_2(t))(D_s - Y(t)) - (k_1 + w_1(t))X(t) - (k_4 + w_4(t))Z(t) - (R + w_6(t)) + w_8 \quad \text{Equation 3.6}$$

$$\frac{dZ}{dt} = -(k_4Z(t) + w_4(t)) + S_{NOD} + w_9(t) \quad \text{Equation 3.7}$$

The uncertainty in both the inputs and the coefficients is represented by Gaussian white noise and the explicit solutions for the set of Ito differential equations can be derived using the method of moments described by Zielinski (1988, Appendix A) and where solutions for the mean and the variance of X, Y and Z are derived. An example solution for the first moment or mean of the BOD equation ($E(X)$) is given as (Zielinski 1993):

$$E(X) = \left(X_0 - \frac{S_{BOD}}{(k_1 + k_3)}\right) e^{-(k_1 + k_3)t} + \frac{S_{BOD}}{(k_1 + k_3)} \quad \text{Equation 3.8}$$

where X_0 is the initial BOD concentration (mg/L). The expression for the second moment of BOD, $E(X^2)$, and the variances and co-variances of DO and NOD are more complex and also given by Zielinski (1988). They are all closed form solutions and the values of these statistical characteristics are easily calculated for any given travel time (t) and make up the core of the DOSTOC model. The variance is given by:

$$V(X) = E(X^2) - [E(X)]^2 \quad \text{Equation 3.9}$$

where $E(X^2)$ is the second moment of the BOD equation and is given as:

$$E(X^2) = A_1 (e^{-(k_1 + k_3)t} - e^{-(k_1 + k_3 + w_1 + w_3)t}) + (X_0^2 + A_2) e^{-(k_1 + k_3 + w_1 + w_3)t} - A_2 \quad \text{Equation 3.10}$$

where

$$A_1 = \frac{2S_{BOD} \left[X_0 - \left(\frac{S_{BOD}}{(k_1 + k_3)} \right) \right]}{(k_1 + k_3 - w_1 - w_3)} \quad \text{Equation 3.10a}$$

$$A_2 = \frac{S_{BOD}^2 + w_1(k_1 + k_3)}{(w_1 + w_3)(k_1 + k_3) - (k_1 + k_3)^2} \quad \text{Equation 3.10b}$$

Because the DOSTOC model is based on the series of equations given above, then the assumptions inherent in the Streeter-Phelps equations also apply to every reach defined in the model. In terms of hydraulic characteristics, the solution to the equations implies that longitudinal dispersion is neglected and mixing is instantaneous and complete. Also, the velocity for each river reach in the model is assumed constant and uniform and model implementation requires that rate constants and other parameters remain constant within each reach.

4.0 DOSTOC INPUT PARAMETERS

4.1 INTRODUCTION

DOSTOC runs were undertaken for 1988 (1-11 February and 4-9 March), 1989 (9 January-15 February and 13 February-16 March), 1990 (14 February - 21 March), 1991 (7 February -14 March), 1992 (30 January - 10 March), and 1993 (11 February-16 March) for the reach from upstream of Hinton to upstream of Grand Rapids. Input data files for February and March 1988, January and February 1989, 1990, 1991, 1992 and 1993 are given in Appendix B.

The following sections detail the structure of the input files and the data sources used. Summaries of the DOSTOC input file format and data sources are provided in Tables 4.1 and 4.2, respectively.

4.2 HYDRAULIC STRUCTURE AND HYDROLOGY

Group 1 defines the hydraulic structure of the modelled river. We maintained the hydraulic structure developed by Macdonald and Hamilton (1989) except for reaches below each pulp mill. The reach immediately downstream of each pulp mill was set as a 0.8 km open-water reach and the remaining distance of the original (Macdonald and Hamilton 1989) reach was added to the following reach. As well, to account for the high settling rates found in the first 40 km below Weldwood of Canada Ltd. at Hinton (70% of incoming sediment deposited within the first 20 km downstream of the outfall and 78% within the first 70 km downstream; Krisnappen *et al.* 1995), the first 40 km downstream beyond the 0.8 km open-water lead was divided into 5 km reaches. Therefore NRT, the total number of reaches, was 54. One tributary was modelled (the Lesser Slave River; NTRIB = 1). Other point source inflows such as effluent discharges or tributaries were treated as point sources. MAXTR, the maximum number of reaches on any given tributary was set to four (i.e., four reaches on the Lesser Slave River). MAXRI, the number of mainstem river reaches, was set to 50. MAXPT, the number of reaches on the longest path of reaches (i.e., mainstem reaches or tributary plus mainstem), was also equal to 50. NSTP is the number of point-source discharges: 18 tributaries were included for every year plus four effluent outfalls (Weldwood of Canada Ltd., Whitecourt STP, Athabasca STP, and Slave Lake STP) in 1988, five effluent outfalls (Millar Western Pulp Ltd. in addition to the previous four) in 1989, and seven effluent outfalls (Alberta Newsprint Co. and Slave Lake Pulp Corp. in addition to the previous five) in 1991, 1992 and 1993. Finally, NVAR is the number of moments to be computed (see Section 3.4 for details).

Group 2 is organized into six columns and contains one line of data for each reach. The mainstem reaches are numbered first followed by the tributaries and all reaches are defined sequentially from upstream to downstream. IRCH is the reach number. IUP1 is the preceding reach number (IRCH-1). IUP2 is zero for any reach that does not receive a tributary or the last reach number on the intersecting tributary. X is the length of the reach in kilometers (data supplied by

Table 4.1 Summary table of the DOSTOC input file structure. The first line in the "structure" description indicates the section in the text where detailed information can be found.

| Group | Structure |
|-------|--|
| 1 | Section 4.2 - Hydraulic Structure and Hydrology This group contains one line of data with seven variables: NRT (total number of reaches), NTRIB (number of tributaries), MAXTR (maximum number of reaches on given tributary), MAXRI (number of mainstem reaches), MAXPT (number of reaches on the longest path of reaches), NSTP (number of point source discharges) and NVAR (number of moments). |
| 2 | Section 4.2 - Hydraulic Structure and Hydrology This group contains one line of data for each reach with six variables: IRCH (reach number), UP1 (preceeding reach number), UP2 (indicates location at which tributaries join the mainstem), X (reach length), Q (discharge at the upper end of the reach) and QLD (discharge of the point-source inflow). |
| 3 | This group contains one line of data for each point-source inflow with 2 variables: STNAM (point-source inflow name) and INST (mainstem reach where point source is located). |
| 4 | River name for plot file. |
| 5 | Tributary name to be modelled and reach number which is downstream of the tributary confluence. |
| 6 | Section 4.3 - Water Quality for the Mainstem This group contains one line of data for each reach with nine variables: XLD1 (BOD _u for point-source inflows), XLD2 (DO for mills and tributaries), XLD3 (BOD _u for tributaries), XLD4 (standard deviation of BOD _u for point-source inflows), XLD5 (standard deviation of DO for point-source inflows), XLD6 (standard deviation of BOD _u for tributaries) and XLD7, X:LD8 and XLD9 (correlation coefficients for all point-source inflows). |
| 7 | Section 4.3 - Water Quality for Headwaters This group contains one line of data for each headwater with nine variables: X01 (BOD _u), X02 (DO), X03 (NOD), X04(standard deviation of BOD _u), X05 (standard deviation of DO), X06 (standard deviation of NOD), X07 (BOD-DO correlation coefficient), X08 (BOD-NOD correlation coefficient) and X09 (DO-NOD correlation coefficient). |
| 8 | Section 4.4 - Water Quality Rates This group contains one line of data for each reach with 10 variables: XK1 (BOD decay rates for mills and STP's), XK2 (reaeration rates), XK3 (BOD sedimentation rates), XM1 (diffuse source inflow), XM2 (diffuse source inflow), XM3 (diffuse source inflow), XRES (SOD), XDS (saturation dissolved oxygen concentration), and XP (maximum daily photosynthetic rate). |
| 9 | This group contains only one line and is the average river temperature for the simulation. For these runs, this was set to 0°C. |
| 10 | Section 4.5 - Travel Time This group contains one line of data for each reach with six variables: REFQ (reference flow), T (time of travel), HEXN (Leopold-Maddock coefficient for depth), VEXN (Leopold-Maddock coefficient for velocity) and RFDGR (reference temperature). |
| 11 | This group contains one line for each river or tributary and is the file name for the output file(s). |

Table 4.2 Summary table of sources of data for DOSTOC runs.

| Parameter | Source of Data |
|------------------------------------|---|
| Atmospheric reaeration | 0.001 day ⁻¹ for ice-covered reaches; 0.911 day ⁻¹ at reference temperature of 20°C and reference flow of 50 m ³ /s (after Macdonald <i>et al.</i> 1989). |
| BOD decay rate | Mean annual decay rates for mill effluent obtained from each pulp mill. Decay rates set to 0.026 day ⁻¹ for sewage effluent and 0.026 day ⁻¹ for tributaries and headwater. |
| BOD sedimentation rate | Sedimentation was calculated using Krisnappen <i>et al.</i> (1995) transport rates from below Hinton. In the absence of data for settling rates below other mills on the Athabasca River, the Hinton values were applied to all other mills. |
| BOD ₅ | Industrial, sewage, headwater and tributary data (expressed as mg/L) collected during the Alberta Environment winter water quality surveys. |
| BOD ₀ :BOD ₅ | Mill effluent ratios obtained from the pulp mills. Ratio set to 7.80 for sewage and to 8.03 for tributaries and headwater at reference temperature of 20°C. |
| Diffuse loading | No data; set to 0 tonnes/km/day. |
| DO | Collected during the Alberta Environment winter water quality surveys (expressed as mg/L). |
| Nitrogenous oxygen demand (NOD) | No data; set to 0 mg/L/day. |
| Effluent discharge | Obtained from the industries and the sewage facilities (expressed as m ³ /s). |
| River discharge | Obtained from Technical Services Division, Alberta Environment and Water Survey of Canada (expressed as m ³ /s). |
| Sediment oxygen demand (SOD) | SOD (g/m ² /d) was measured <i>in situ</i> during the 1989, 1990, 1992, 1993, 1994, and 1995 winters (Casey and Noton 1989; Casey 1990; Monenco Inc. 1992; HBT AGRA Ltd. 1993a,b; HBT Agra Ltd. 1994; Noton 1995). Mean SOD (g/m ² /d) from these years were plotted and values chosen at the midway point of each modelled reach. Areal SOD (g/m ² /d) was converted to volumetric SOD (mg/L/d) by multiplying by the average water depth. Since SOD was measured <i>in situ</i> at 0°C, all values were temperature corrected to 20°C to fit the model requirements. |
| Time of travel | The Athabasca River was divided into nine hydraulic reaches (Macdonald and Hamilton 1989) and Leopold-Maddock coefficients were derived for each reach from HEC-2 simulations using under-ice time-of-travel and river cross-sections measured by Andres <i>et al.</i> (1989) and Haufe and Croome (1980). The Leopold-Maddock coefficients were then used to estimate reach-average travel time (days) and reach average depth (m). |

Alberta Research Council). Q is the discharge (m^3/s) at the upper end of the reach and equals the sum of the total flow from the reach immediately upstream (channel and point-source inflow) plus the tributary flow to the reach plus the diffuse source inflow to the reach. It does not include the effluent inflow to the reach since the volume of water taken in by sewage treatment plants (STP's) and industries is equal to the volume discharged. The last column in this group is QLD which is the point-source inflow to the reach (m^3/s) from mills and sewage treatment plants (Table 4.3) and tributaries (Table 4.4). Effluent and tributary discharge data were obtained as part of the Alberta Environment winter water quality surveys. For any year where discharge was not available long term means were used (Tables 4.3 and 4.4). Discharge, upstream of Grand Rapids, differed between DOSTOC (calculated by summing discharge upstream of Hinton and all measured tributary sources) and Alberta Environment winter water quality surveys (measured or balanced) by an average of 11% (range 5 - 16%).

4.3 WATER QUALITY

Group 6 contains the water quality data for each modelled reach. The first column, XLD1, is mean ultimate BOD (BOD_u ; mg/L) of point-source inflows and includes all mills and other industries, as well as STP's. Five-day BOD values (BOD_5) for the mills were obtained from Alberta Environment winter water quality surveys (Table 4.5). BOD_u was estimated by fitting a first order curve through BOD data points collected over 120 days. The BOD_u value of the first order projection is the oxygen demand required to convert organic material to relatively stable end products, notably cell walls of micro-organisms. This estimated BOD_u value was used to calculate $\text{BOD}_u:\text{BOD}_5$ ratios for each mill for each year. The measured BOD_5 values were then converted to BOD_u values by multiplying by the calculated $\text{BOD}_u:\text{BOD}_5$ ratio for each mill for each year (Table 4.6). For STP's, BOD_5 values were obtained from the Alberta Environment winter water quality surveys (Table 4.7) and multiplied by a $\text{BOD}_u:\text{BOD}_5$ ratio of 7.80 (mean of two samples for Grande Prairie STP; March 1 1991). For any year where BOD_5 or $\text{BOD}_u:\text{BOD}_5$ ratios were missing, long-term means were used.

The second column, XLD2, contains DO data obtained from the Alberta Environment winter water quality surveys for mills (Table 4.5), STP's (Table 4.7) and tributaries (Table 4.8). For any year for which a tributary or industry were missing DO data, long-term mean values were used.

XLD3 is the third column and contains BOD_u values (mg/L) for the tributaries. These values were obtained by multiplying the BOD_5 values measured during the Alberta Environment winter water quality surveys (Table 4.9) by a $\text{BOD}_u:\text{BOD}_5$ ratio of 8.03 (mean of 12 samples from four sites in the Athabasca basin; Table 4.10). For any given year for which a tributary was missing BOD_5 data, long-term mean BOD_5 values were used.

The next column, XLD4, is the standard deviation (SD) of the BOD_u values for point-source inflows. For the mills, this was determined by multiplying the BOD_u values in column XLD1 by the ratio of the SD:mean for the BOD_5 data for each mill for each year (Table 4.6). For other industries and STP's, XLD4 was obtained by multiplying the BOD_u values in column XLD1 by the SD:mean ratio for BOD_u data collected during the Alberta Environment winter water quality surveys (Table 4.7).

Table 4.3 Discharge (m³/s) for mills and sewage treatment plants on the Athabasca River. Data collected during Alberta Environment winter water quality surveys. ("not op." means the mill was not operational; N/A means data are not available.)

| Point source | Feb 1988 | Mar 1988 | Feb 1989 | Mar 1989 | Winter 1990 | Winter 1991 | Winter 1992 | Winter 1993 | Mean |
|--------------------------|----------|----------|----------|----------|-------------|-------------|-------------|-------------|-------|
| Mills: | | | | | | | | | |
| Weldwood of Canada Ltd. | 0.926 | 0.973 | 0.97 | 1.02 | 0.784 | 1.09 | 1.11 | 1.216 | 1.002 |
| Alberta Newsprint | not op. | 0.192 | 0.23 | 0.181 | 0.201 |
| Millar Western Pulp Ltd. | not op. | not op. | 0.141 | 0.124 | 0.136 | 0.144 | 0.14 | 0.110 | 0.133 |
| Slave Lake Pulp | not op. | 0.033 | 0.03 | 0.048 | 0.037 |
| STP's: | | | | | | | | | |
| Whitecourt | N/A | N/A | N/A | 0.035 | 0.041 | 0.039 | 0.04 | 0.035 | 0.038 |
| Athabasca | N/A | N/A | 0.012 | 0.012 | 0.011 | 0.010 | 0.01 | 0.013 | 0.011 |
| Slave Lake | N/A | N/A | N/A | N/A | 0.032 | 0.026 | 0.03 | 0.028 | 0.029 |

Table 4.4 Discharge (m³/s) measured at the headwaters and at the mouths of tributaries discharging to the Athabasca and Lesser Slave rivers. Data collected by Alberta Environment during their winter water quality surveys.

| Tributary | Feb 1988 | Mar 1988 | Jan 1989 | Mar 1989 | Winter 1990 | Winter 1991 | Winter 1992 | Winter 1993 | Mean |
|----------------------|----------|----------|----------|----------|-------------|-------------|-------------|-------------|-------|
| Athabasca: | | | | | | | | | |
| AR u/s of Hinton | 25.10 | 31.40 | 31.30 | 28.00 | 33.00 | 51.70 | 47.20 | 28.70 | 34.60 |
| Oldman Cr. | 0.91 | 1.33 | 0.70 | 0.95 | 1.10 | | | | 1.00 |
| Spring 1 | | | 0.02 | 0.03 | | | | | 0.02 |
| Berland R. | 6.43 | 7.69 | 5.67 | 5.52 | 8.90 | 12.20 | 12.30 | 7.89 | 8.31 |
| Spring 2 | | | 0.02 | 0.02 | 0.02 | | | | 0.02 |
| Marsh Head Cr. | | | 0.07 | 0.17 | 0.30 | 0.32 | 0.36 | 0.13 | 0.23 |
| Pine Cr. | | | 0.02 | 0.31 | | | | | 0.17 |
| Spring 3 | | | 0.02 | 0.02 | | | | | 0.02 |
| Two Cr. | | | 0.01 | 0.01 | | | | | 0.01 |
| Windfall Cr. | 0.49 | 0.48 | 0.00 | 0.50 | 0.90 | | | | 0.47 |
| Sakwatamau | | | | | 0.90 | 0.93 | 1.22 | 0.64 | 0.92 |
| McLeod R. | 3.69 | 7.50 | 4.76 | 4.63 | 10.10 | 10.30 | 11.00 | 5.13 | 6.69 |
| Freeman R. | 0.12 | 0.15 | 0.48 | 0.59 | 0.80 | 0.02 | | | 0.36 |
| Pembina R. | | 1.37 | 2.80 | 2.91 | 6.80 | 5.78 | 4.96 | 1.56 | 3.74 |
| La Biche R. | | | 0.93 | 0.43 | 2.30 | 1.89 | 1.26 | 0.07 | 1.15 |
| Calling R. | | | 0.01 | 0.02 | 0.10 | 0.03 | 0.05 | 0.02 | 0.04 |
| Pelican R. | | | 0.46 | 0.15 | 0.80 | 0.29 | 0.45 | 0.06 | 0.37 |
| House R. | | | | 0.27 | 1.60 | 1.14 | 1.43 | 0.11 | 0.91 |
| Buffalo R. | | | | 0.01 | | | | | 0.01 |
| Horse R. | | | 0.39 | 0.39 | | | | | 0.39 |
| Clearwater R. | 35.60 | 42.30 | 49.20 | 46.30 | 58.60 | 41.20 | 48.80 | 41.70 | 45.50 |
| Steepbank R. | | | 0.29 | 0.27 | | | | | 0.29 |
| Muskeg R. | | | | 0.50 | 0.40 | 0.26 | 0.49 | 0.49 | 0.43 |
| Mackay R. | | | | 0.63 | | | | | 0.63 |
| Ells R. | | | | 0.67 | 1.80 | 0.01 | 1.75 | 1.30 | 1.11 |
| Firebag R. | | | 9.33 | 6.73 | 10.20 | 9.81 | 9.89 | 6.63 | 8.77 |
| Richardson R. | | | 10.60 | 10.10 | | 14.50 | 12.00 | 10.10 | 11.46 |
| Lesser Slave: | | | | | | | | | |
| LSR near lake | | | 25.10 | 22.70 | 37.00 | 17.70 | 15.60 | 13.00 | 21.90 |
| at mouth | 12.30 | 12.60 | | | 43.70 | 17.50 | 15.10 | 14.10 | 19.30 |

Table 4.5 Mill BOD₅ and dissolved oxygen (DO) concentrations (mg/L) from Alberta Environment winter water quality surveys. ("not op" means the mill was not operational at the time of the survey; N/A means the data are not available; "winter" is February/March)

| Pulp Mill | Feb 1988 | Mar 1988 | Jan 1989 | Feb 1989 | Mar 1989 | Winter 1990 | Winter 1991 | Winter 1992 | Winter 1993 |
|--|-------------|-------------|-------------|------------|-------------|--------------|-------------|-------------|-------------|
| Weldwood of Canada Ltd. BOD ₅ DO | 56.0 6.3 | 31.7 5.6 | 30.0 N/A | N/A N/A | 20.9 N/A | 53.1 10.1 | 25.0 7.2 | 26.3 6.5 | 20.9 6.2 |
| Alberta Newsprint Co. BOD ₅ DO | not op | not op | not op | not op | not op | not op | 6.1 6.2 | 10.9 7.4 | 31.2 8.2 |
| Millar Western Pulp Ltd. BOD ₅ DO | not op | not op | 630 N/A | 501 7.8 | 557 7.3 | 30.5 4.6 | 35.1 3.8 | 20.1 5.4 | 12.9 6.0 |
| Slave Lake Pulp Corp. BOD ₅ DO | not op | not op | not op | not op | not op | not op | 109 6.4 | 23.7 5.9 | 85.6 6.3 |

Table 4.6 Summary of annual means (X), standard deviations (SD), ratio of standard deviation to mean (SD/X) and number of samples (n). Data for mill discharge (m³/d), BOD₅ (mg/L) and dissolved oxygen (DO, mg/L) from *Northdat* (AGRA Earth and Environmental 1994). BOD_u:BOD₅ ratios from Macdonald and Radermacher (1993) for 1990-1992 and from Macdonald and Hamilton (1989) for 1988 and 1989. ("not op" means the mill was not operating; N/A means data are not available.)

| Pulp Mill | 1988 | | | 1989 | | | 1990 | | | 1991 | | | 1992 | | | 1993 | | | | | | | | |
|---|--------|-------|------|------|--------|--------|------|-----|--------|--------|------|-----|---------------------|--------|------|------|--------|--------|------|-----|--------|-------|------|-----|
| | X | SD | SD/X | n | X | SD | SD/X | n | X | SD | SD/X | n | X | SD | SD/X | n | X | SD | SD/X | n | | | | |
| Weidwood of Canada Ltd. Discharge BOD ₅ BOD _u :BOD ₅ DO | 84730 | 13860 | 0.16 | 366 | 90108 | 15206 | 0.17 | 365 | 102456 | 18231 | 0.18 | 361 | 10 ⁶ 687 | 15104 | 0.14 | 365 | 108443 | 12794 | 0.12 | 360 | 105840 | 1559 | 0.15 | 364 |
| | 47.96 | 18.36 | 0.38 | 156 | 28.91 | 13.91 | 0.48 | 197 | 23.15 | 12.92 | 0.56 | 322 | 23.77 | 12.95 | 0.54 | 360 | 21.44 | 6.37 | 0.30 | 360 | 18.33 | 5.63 | 0.31 | 364 |
| | 4.5 | 0.06 | 0.01 | 3 | 3.5 | 0.74 | 0.27 | 4 | 2.6 | 0.74 | 0.27 | 4 | 5.3 | 2.3 | 0.43 | 4 | 2.8 | 0.35 | 0.13 | 3 | N/A | N/A | N/A | N/A |
| | N/A | | | | N/A | 1.1 | 0.18 | 221 | 6.2 | 1.1 | 0.18 | 221 | 6.3 | 0.9 | 0.14 | 360 | 6.2 | 1.3 | 0.21 | 31 | N/A | N/A | N/A | N/A |
| Alberta Newsprint Co. Discharge BOD ₅ BOD _u :BOD ₅ DO | not op | | | | not op | | | | 12395 | 3877 | 0.31 | 160 | 15669 | 3477 | 0.22 | 365 | 17302 | 2581 | 0.15 | 366 | 14929 | 1716 | 0.11 | 365 |
| | | | | | | | | | 9.00 | 6.64 | 0.74 | 150 | 10.07 | 15.06 | 1.50 | 364 | 12.98 | 14.05 | 1.08 | 361 | 7.73 | 6.11 | 0.79 | 349 |
| | | | | | | | | | N/A | | | 7 | 9.2 | 5.4 | 0.59 | 7 | 9.8 | 0.07 | 0.01 | 2 | N/A | N/A | N/A | N/A |
| | | | | | | | | | 7.15 | 1.18 | 0.17 | 153 | 6.75 | 1.16 | 0.17 | 361 | 6.5 | 0.83 | 0.13 | 243 | N/A | N/A | N/A | N/A |
| Millar Western Pulp Ltd. Discharge BOD ₅ BOD _u :BOD ₅ DO | 10999 | 3938 | 0.36 | 144 | 12873 | 2639 | 0.21 | 361 | 13400 | 5668 | 0.42 | 363 | 12684 | 1957 | 0.15 | 362 | 11555 | 2523 | 0.22 | 357 | 10844 | 1837 | 0.17 | 360 |
| | 227.79 | 127.6 | 0.56 | 144 | 306.31 | 175.78 | 0.57 | 360 | 77.47 | 48.36 | 0.62 | 361 | 89.1 | 39.6 | 0.44 | 360 | 49.39 | 18.83 | 0.38 | 357 | 30.05 | 14.05 | 0.47 | 360 |
| | 3.5 | 0.81 | 0.23 | 11 | 4.4 | 0.8 | 0.2 | 12 | 9.2 | 11.79 | 1.3 | 9 | 6.7 | 2.8 | 0.41 | 8 | 6.9 | 3.7 | 0.54 | 6 | N/A | N/A | N/A | N/A |
| | 8.61 | 2.23 | 0.26 | 111 | 6.18 | 2.28 | 0.37 | 352 | 4.66 | 0.93 | 0.20 | 362 | 4.58 | 1.18 | 0.26 | 362 | 5.35 | 0.99 | 0.19 | 357 | 5.75 | 0.92 | 0.16 | 360 |
| Slave Lake Pulp Corp. Discharge BOD ₅ BOD _u :BOD ₅ DO | not op | | | | not op | | | | 2374 | 1008 | 0.42 | 27 | 3882 | 1046 | 0.27 | 365 | 4756 | 1408 | 0.30 | 366 | 5598 | 1186 | 0.21 | 365 |
| | | | | | | | | | 397.26 | 463.25 | 1.17 | 19 | 251.67 | 303.28 | 1.21 | 360 | 150.91 | 272.98 | 1.81 | 365 | 84.07 | 47.17 | 0.56 | 365 |
| | | | | | | | | | N/A | | | | N/A | | | | 6.1 | 3.5 | 0.57 | 16 | N/A | N/A | N/A | N/A |
| | | | | | | | | | N/A | | | | 4.89 | 1.84 | 0.38 | 363 | 5.32 | 1.06 | 0.20 | 362 | 5.73 | 1.07 | 0.19 | 363 |
| Alberta Pacific Forest Industries Inc. Discharge BOD ₅ BOD _u :BOD ₅ DO | not op | | | | not op | | | | not op | | | | not op | | | | not op | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |

Table 4.7 BOD₅ and dissolved oxygen (DO) concentrations (mg/L) for Suncor and sewage treatment plants (STP) discharging into the Athabasca River. (Data collected by Alberta Environment during their winter water quality surveys.) ("N/A" means that data are not available; data N/A for 1988.)

| | Jan 1989 | Feb 1989 | Mar 1989 | Winter 1990 | Winter 1991 | Winter 1992 | Winter 1993 | Mean | SD | SD/Mean |
|----------------------------------|-------------|-------------|-------------|----------------|----------------|----------------|----------------|------|------|---------|
| Whitecourt STP | | | | | | | | | | |
| BOD ₅ | 6.4 | 5.3 | 8.1 | 20.5 | 7.6 | 17.6 | 24.0 | 12.8 | 7.7 | 0.6 |
| DO | 3.2 | 4.7 | 4.4 | 5.7 | 5.9 | 5.7 | 6.0 | 5.1 | 1.0 | 0.2 |
| Athabasca STP | | | | | | | | | | |
| BOD ₅ | N/A | N/A | 15.3 | 9.5 | 108 | 13.7 | 13.0 | 31.9 | 42.5 | 1.3 |
| DO | 1.5 | N/A | N/A | N/A | N/A | 5.7 | 0.6 | 2.6 | 2.7 | 1.0 |
| Slave Lake STP | | | | | | | | | | |
| BOD ₅ | 6.4 | 7.3 | 18.7 | 23.3 | 19.8 | 21 | 16.8 | 16.1 | 6.7 | 0.4 |
| DO | 7.2 | 7.3 | 0 | 0.74 | 4.1 | 0 | 2.0 | 3.0 | 3.2 | 1.1 |
| Fort McMurray STP | | | | | | | | | | |
| BOD ₅ | 18.9 | N/A | 71.2 | 9.1 | N/A | 15.0 | 9.8 | 24.8 | 26.2 | 1.1 |
| DO | N/A | N/A | 14.2 | 13.0 | 10.5 | 11.0 | 12.5 | 12.2 | 1.5 | 0.1 |
| Suncor | | | | | | | | | | |
| BOD ₅ | 4.3 | N/A | 1.9 | 3.6 | 9.7 | 11.2 | 0.7 | 5.2 | 4.3 | 0.9 |
| DO | N/A | N/A | 3.9 | 2.6 | 5.5 | 2.4 | 4.5 | 3.8 | 1.3 | 0.3 |
| Syncrude | | | | | | | | | | |
| BOD ₅ | N/A | N/A | N/A | N/A | N/A | N/A | 5.6 | | | |
| DO | N/A | N/A | N/A | N/A | N/A | N/A | 13.1 | | | |

Table 4.8 Dissolved oxygen concentrations (mg/L) measured at the headwaters and at the mouths of tributaries discharging to the Athabasca and Lesser Slave Rivers. (Data collected by Alberta Environment during their winter water quality surveys.)

| Tributary | Feb 1988 | Mar 1988 | Jan 1989 | Feb 1989 | Mar 1989 | Winter 1990 | Winter 1991 | Winter 1992 | Winter 1993 | Mean | SD | SD/ Mean |
|----------------------------|----------|----------|----------|----------|----------|-------------|-------------|-------------|-------------|-------|------|----------|
| Athabasca: | | | | | | | | | | | | |
| AR u/s of Hinton | 11.69 | 11.59 | 11.65 | | 11.14 | 11.57 | 11.99 | 12.47 | 11.86 | 11.75 | 0.38 | 0.032 |
| Oldman Cr. | 13.18 | 12.38 | 12.36 | | 12.84 | 12.80 | | | | 12.71 | 0.35 | 0.028 |
| Spring 1 | | | 11.63 | | 11.55 | | | | | 11.59 | 0.06 | 0.005 |
| Berland R. | 10.56 | 10.66 | 8.61 | | 9.61 | 9.81 | 11.05 | 11.03 | 9.99 | 10.17 | 0.83 | 0.082 |
| Spring 2 | | | 11.7 | | 12.01 | 11.87 | | | | 11.86 | 0.16 | 0.013 |
| Marsh Head Cr. | | | 10.46 | | 11.70 | 11.97 | 12.30 | 12.61 | 12.06 | 11.85 | 0.75 | 0.063 |
| Pine Cr. | | | 10.51 | | 12.09 | | | | | 11.30 | 1.12 | 0.099 |
| Spring 3 | | | 10.74 | | 11.29 | | | | | 11.02 | 0.39 | 0.035 |
| Two Cr. | | | 7.67 | | 10.47 | | | | | 9.07 | 1.98 | 0.218 |
| Windfall Cr. | 12.51 | 11.47 | 9.12 | | 10.78 | 11.30 | | | | 11.04 | 1.24 | 0.112 |
| Sakwatamau | | | | | | 9.96 | 9.08 | 11.15 | 8.10 | 9.57 | 1.30 | 0.136 |
| McLeod R. | 5.54 | 9.71 | 5.28 | 4.94 | 5.95 | 8.41 | 9.09 | 9.39 | 6.27 | 7.18 | 1.94 | 0.270 |
| Freeman R. | 8.65 | 8.98 | 5.56 | | 9.45 | 8.69 | 10.14 | | | 8.58 | 1.58 | 0.184 |
| Pembina R. | 2.21 | 7.81 | 2.77 | 1.49 | 1.46 | 3.29 | 2.50 | 4.14 | 1.82 | 3.05 | 1.98 | 0.649 |
| La Biche R. | | | 1.46 | | 3.17 | 4.86 | 2.74 | 5.52 | | 3.55 | 1.64 | 0.462 |
| Calling R. | | | 10.78 | | 11.63 | 11.56 | | 12.61 | 5.12 | 10.34 | 2.99 | 0.289 |
| Pelican R. | | | 12.53 | | 13.02 | 12.33 | 12.82 | 12.91 | 10.12 | 12.29 | 1.09 | 0.089 |
| House R. | | | 10.65 | | 9.70 | 11.55 | 9.88 | 12.36 | 10.52 | 10.78 | 1.01 | 0.094 |
| Buffalo R. | | | | | 13.18 | | | | | 13.18 | 0 | 0 |
| Horse R. | | | 13.2 | | 12.98 | | | | | 13.09 | 0.16 | 0.012 |
| Clearwater R | 12.2 | 12.90 | 12.39 | | 12.53 | 11.92 | 13.03 | 13.20 | 12.50 | 12.58 | 0.43 | 0.034 |
| Steepbank R. | | | 13.27 | | 13.18 | | | | | 13.23 | 0.06 | 0.005 |
| Muskeg R. | | | 10.58 | | 5.98 | 11.23 | 5.67 | 9.25 | 4.01 | 7.79 | 2.96 | 0.380 |
| Mackay R. | | | 12.06 | | 11.83 | | | | | 11.95 | 0.16 | 0.013 |
| Ells R. | | | 12.95 | | 12.70 | 10.90 | 8.33 | 12.64 | 9.77 | 11.22 | 1.88 | 0.168 |
| Firebag R. | | | 5.71 | | 5.29 | 6.32 | 6.12 | 6.74 | 4.52 | 5.78 | 0.80 | 0.138 |
| Richardson R. | | | 5.92 | | 6.79 | 7.91 | 6.22 | 8.93 | 8.05 | 7.30 | 1.18 | 0.162 |
| Lesser Slave: | | | | | | | | | | | | |
| LSR near lake | 10.31 | 13.75 | 13.10 | 13.29 | 13.02 | 13.50 | 13.26 | 12.58 | 13.14 | 12.88 | 1.02 | 0.079 |
| at Mitsue | | | 13.27 | | 12.77 | 13.01 | 12.94 | 12.15 | 12.93 | 12.85 | 0.38 | 0.030 |
| u/s Ottawa R. | | | | | | | 12.92 | | | 12.92 | 0 | 0 |
| 0.5 km u/s Driftwood River | | | 12.97 | | 12.68 | 12.67 | 12.46 | 11.32 | 12.34 | 12.41 | 0.57 | 0.046 |
| at Mouth | 13.03 | 11.17 | 12.26 | 12.19 | 12.06 | 12.36 | 11.81 | 10.28 | 11.66 | 11.87 | 0.79 | 0.067 |

Table 4.9 BOD₅ concentrations (mg/L) measured at the headwaters and at the mouths of tributaries discharging to the Athabasca and Lesser Slave Rivers. (Data collected by Alberta Environment during their winter water quality surveys.)

| Tributary | Feb 1988 | Mar 1988 | Jan 1989 | Feb 1989 | Mar 1989 | Winter 1990 | Winter 1991 | Winter 1992 | Winter 1993 | Mean | SD | SD/ Mean |
|----------------------------|----------|----------|----------|----------|----------|-------------|-------------|-------------|-------------|------|------|----------|
| Athabasca: | | | | | | | | | | | | |
| AR u/s of Hinton | 2.17 | 1.5 | 1.2 | | 1.0 | 0.37 | 0.17 | 0.7 | 0.8 | 0.99 | 0.64 | 0.65 |
| Oldman Cr. | 2.6 | 2.2 | 1.0 | | 0.7 | 1.2 | | | | 1.54 | 0.82 | 0.53 |
| Spring 1 | | | 1.1 | | 1.0 | | | | | 1.05 | 0.07 | 0.07 |
| Berland R. | 1.4 | 1.2 | 0.9 | | 1.0 | 0.85 | 0.4 | 0.7 | 1.0 | 0.93 | 0.30 | 0.32 |
| Spring 2 | | | 0.1 | | 0.7 | 0.9 | | | | 0.57 | 0.42 | 0.74 |
| Marsh Head Cr. | | | 0.8 | | 0.7 | 0.7 | 0.9 | 0.4 | <0.1 | 0.58 | 0.33 | 0.57 |
| Pine Cr. | | | 0.3 | | 0.5 | | | | | 0.40 | 0.14 | 0.35 |
| Spring 3 | | | 0.2 | | 0.6 | | | | | 0.40 | 0.28 | 0.70 |
| Two Cr. | | | 1.2 | | 0.7 | | | | | 0.95 | 0.35 | 0.37 |
| Windfall Cr. | 0.7 | 2.0 | 1.3 | | 0.4 | 0.7 | | | | 1.02 | 0.64 | 0.63 |
| Sakwatamau | | | | | | 0.5 | 0.6 | 0.7 | <0.1 | 0.45 | 0.31 | 0.69 |
| McLeod R. | 0.97 | 2.0 | 1.6 | 0.33 | 0.8 | | 0.9 | 0.4 | <0.1 | 0.88 | 0.66 | 0.75 |
| Freeman R. | 1.0 | 1.4 | 0.5 | 1.9 | 1.2 | 0.2 | <0.1 | | | 0.89 | 0.68 | 0.76 |
| Pembina R. | 1.1 | 1.5 | 0.5 | 0.3 | 1.4 | 0.7 | <0.1 | 0.5 | 1.3 | 0.81 | 0.53 | 0.65 |
| La Biche R. | | | 0.9 | | 2.1 | 0.4 | 0.8 | 0.9 | | 1.02 | 0.64 | 0.63 |
| Calling R. | | | 0.8 | | 0.6 | 0.27 | | 0.6 | 1.5 | 0.75 | 0.46 | 0.61 |
| Pelican R. | | | 3.1 | | 1.6 | 3.29 | 0.7 | 4.4 | 3.6 | 2.78 | 1.37 | 0.49 |
| House R. | | | 0.9 | | 0.6 | 0.26 | 0.9 | 1.2 | <0.1 | 0.64 | 0.45 | 0.70 |
| Buffalo R. | | | | | 0.7 | | | | | 0.70 | 0 | 0 |
| Horse R. | | | 1.2 | | 0.4 | | | | | 0.80 | 0.57 | 0.71 |
| Clearwater R. | | | 0.9 | | 0.35 | 0.2 | 0.6 | 0.2 | 0.4 | 0.44 | 0.27 | 0.61 |
| Steepbank R. | | | 1.3 | | 0.8 | | | | | 1.05 | 0.35 | 0.33 |
| Muskeg R. | | | 1.7 | | 0.6 | 0.6 | 1.5 | 0.5 | 0.7 | 0.93 | 0.52 | 0.56 |
| Mackay R. | | | 1.5 | | 0.8 | | | | | 1.15 | 0.49 | 0.43 |
| Ells R. | | | 0.9 | | 0.6 | 0.6 | 1.2 | 0.3 | 0.2 | 0.63 | 0.37 | 0.59 |
| Firebag R. | | | 1.75 | | 0.8 | 0.5 | 1.1 | 0.7 | 1.3 | 1.03 | 0.46 | 0.45 |
| Richardson R. | | | 1.2 | | 0.7 | 0.6 | 1.1 | 0.9 | 1.0 | 0.92 | 0.23 | 0.25 |
| Lesser Slave: | | | | | | | | | | | | |
| LSR near lake | 1.0 | 1.3 | 1.0 | 0.6 | 0.4 | 0.6 | | 0.3 | 1.3 | 0.81 | 0.39 | 0.48 |
| at Mitsue | | | 1.1 | | 0.4 | 0.8 | 0.5 | 0.4 | 1.5 | 0.78 | 0.44 | 0.56 |
| u/s Ottawa R. | | | | | | | | | | | | |
| 0.5 km u/s Driftwood River | | | 0.8 | | 0.1 | 0.8 | 1.0 | 1.0 | 1.4 | 0.85 | 0.43 | 0.51 |
| at Mouth | 2.8 | 1.2 | 0.9 | 0.9 | 0.3 | 0.87 | 1.0 | 1.2 | 1.8 | 1.22 | 0.71 | 0.58 |

Table 4.10 BOD decay rates (k; per day, 20°C), BOD_u and BOD₅ concentrations (mg/L), and BOD_u:BOD₅ ratios (Ratio) for sites upstream of industrial outfalls. (Samples collected by Alberta Environment during their winter water quality surveys and analyzed by CHEMEX Laboratories.)

| Site | Bottle 1 | | | | Bottle 2 | | | | Means | | | | | |
|--|----------|------------------|------------------|-------|----------|------------------|------------------|-------|--------|------------------|------------------|-------|--------|---------|
| | k | BOD _u | BOD ₅ | Ratio | k | BOD _u | BOD ₅ | Ratio | k | BOD _u | BOD ₅ | Ratio | SD | SD/Mean |
| Athabasca R. u/s Hinton (Jan 30/92) | 0.0385 | 1.56 | 0.276 | 5.657 | 0.0350 | 1.70 | 0.278 | 6.131 | 0.0368 | 1.63 | 0.277 | 5.89 | 0.0018 | 0.0476 |
| Athabasca R. u/s Hinton (Jan 30/92) | 0.0259 | 2.07 | 0.263 | 7.876 | 0.0311 | 2.01 | 0.296 | 6.783 | 0.0285 | 2.04 | 0.28 | 7.33 | 0.0026 | 0.0909 |
| McLeod R. Near Mouth (Feb 4/92) | 0.0239 | 2.52 | 0.301 | 8.368 | 0.0233 | 2.50 | 0.293 | 8.535 | 0.0236 | 2.51 | 0.297 | 8.45 | 0.0003 | 0.0129 |
| McLeod R. Near Mouth (Feb 4/92) | 0.0287 | 1.98 | 0.274 | 7.25 | 0.0296 | 1.78 | 0.252 | 7.06 | 0.0291 | 1.88 | 0.263 | 7.16 | 0.0005 | 0.0158 |
| Lesser Slave R. at Mitsue Bridge (Feb 11/92) | 0.0230 | 4.33 | 0.501 | 8.628 | 0.0247 | 5.20 | 0.636 | 8.168 | 0.0238 | 4.77 | 0.569 | 8.40 | 0.0009 | 0.0357 |
| Lesser Slave R. at Mitsue Bridge (Feb 11/92) | 0.0238 | 4.80 | 0.571 | 8.406 | 0.0257 | 4.96 | 0.627 | 7.918 | 0.0247 | 4.88 | 0.599 | 8.16 | 0.0010 | 0.0384 |
| Clearwater R. Near Mouth (Feb 25/92) | 0.0183 | 3.79 | 0.373 | 10.15 | 0.0330 | 4.60 | 0.713 | 6.452 | 0.0257 | 4.20 | 0.543 | 8.30 | 0.0073 | 0.2855 |
| Clearwater R. Near Mouth (Feb 25/92) | 0.0227 | 3.78 | 0.434 | 8.706 | 0.0228 | 3.82 | 0.440 | 8.674 | 0.0228 | 3.80 | 0.437 | 8.69 | 0.0001 | 0.0024 |
| Athabasca R. u/s Hinton (Feb 7/91) | 0.0198 | 2.95 | 0.306 | 9.620 | 0.0250 | 2.72 | 0.336 | 8.09 | 0.0224 | 2.84 | 0.321 | 8.86 | 0.0026 | 0.1155 |
| Athabasca R. u/s Hinton (Feb 7/91) | 0.0232 | 2.27 | 0.265 | 8.560 | 0.0192 | 2.16 | 0.219 | 9.848 | 0.0212 | 2.22 | 0.242 | 9.20 | 0.0020 | 0.0958 |
| Lesser Slave R. at Mitsue Bridge (Feb 19/91) | 0.0219 | 6.32 | 0.707 | 8.936 | 0.0240 | 6.34 | 0.760 | 8.334 | 0.0215 | 6.33 | 0.734 | 8.63 | 0.0004 | 0.0207 |
| Lesser Slave R. at Mitsue Bridge (Feb 19/91) | 0.0276 | 6.73 | 0.899 | 7.486 | 0.0294 | 6.67 | 0.940 | 7.09 | 0.0285 | 6.70 | 0.919 | 7.29 | 0.0009 | 0.0330 |
| Grand Mean | | | | | | | | | 0.026 | | | 8.03 | 0.0017 | 0.066 |

The standard deviation of DO for point-source inflows is given in column XLD5. For tributaries, this was determined as the product of the DO value in XLD2 and the long-term SD:mean ratio (Table 4.8). For the mills, this was determined by multiplying the DO value in column XLD2 by the average annual SD:mean ratio (Table 4.6) for each mill for each year. For other industries and STP's, the SD was obtained by multiplying the DO values in column XLD2 by the long-term SD:mean ratio for DO data collected during the Alberta Environment winter synoptic surveys (Table 4.7).

The sixth column in Group 6 is XLD6 which is the standard deviation for the BOD_u of the point-source tributaries. These values were calculated by multiplying the value of BOD_u for the tributaries (XLD3) by the long-term SD:mean ratio (Table 4.9). The next three columns, XLD7, XLD8, and XLD9, are the correlation coefficients for all of the point-source inflows. These were set to zero because no data were available.

Group 7 contains one line for the headwater of the mainstem and each modelled tributary. Because only one mainstem and tributary were modelled, there are only two lines of data. The headwater of the Athabasca River is considered to be AR upstream of Hinton (UTM coordinates 11 460950E, 5917950N) and the headwater of the Lesser Slave River is the LSR near Lesser Slave Lake (UTM coordinates 11 642200E, 6130900N). The first column, X01, is BOD_u from point-sources to the headwaters. Since there is no point-source loading to the headwater, this was set to zero. The second column, X02, is the mean DO concentration at the headwaters. These numbers were obtained from the Alberta Environment winter water quality surveys (Table 4.7). The third column, X03, is the mean BOD_u for the mainstem and modelled tributary headwaters. BOD_5 values were obtained from the Alberta Environment winter water quality surveys (Table 4.9) and converted to BOD_u values by multiplying by a BOD_u : BOD_5 ratio of 8.03 (Table 4.10). The next column, X04, is the standard deviation of the mean BOD_u for the headwater and since the X1 value is zero, this value is also zero. The standard deviations for the headwater DO values, column X05, were calculated as the product of the DO concentration (X02) and the long term SD:mean ratios (Table 4.8). The standard deviations for the BOD_u values, X06, were calculated as the product of the BOD_u value (X03) and the long term SD:mean BOD_5 ratio (Table 4.9). The next three columns X07, X08 and X09 are all correlation coefficients and were set to zero as there were no data available.

4.4 WATER QUALITY RATES

Group 8 gives the rates used in the model. There is one line for each modelled reach and eleven columns. The first column is the reach number. The second column (XK1) is BOD decay rate for the pulp mills or STP's at the reference temperature. The mill values are shown in Table 4.11; a value of 0.026 (per day, 20°C) was used for STP's (mean of two samples for Grande Prairie STP, March 1 1991). The BOD decay rate for each mill or STP is entered at the reach where the effluent is released into the river. The value remains constant until the next mill's or STP's effluent is encountered after which the rate for the new mill or STP is used. The exception is at reach 41, where the Lesser Slave River enters the Athabasca River. Here the BOD decay rates for Lesser Slave STP (reach 51) or, once operational (1991, 1992 and 1993), the Lesser Slave Pulp Corp. (reach 52) and Whitecourt STP (reach 27) were averaged and used for the remaining reaches in the

Table 4.11 Annual means and standard deviations (SD) for mill BOD decay rate coefficients (per day, 20°C). Data summarized from Macdonald and Radermacher (1993, Tables 2.4-2.8) for 1990-1992 and from Macdonald and Hamilton (1989) for 1989. Data are not available for 1988 and 1993. (N/A means data are not available; "not op " means the mill was not operational at the time of the survey.)

| Pulp Mill | 1989 | | 1990 | | 1991 | | 1992 | | All Years | | |
|--------------------------|--------|--------|--------|--------|-------|-------|-------|-------|-----------|-------|---------|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | SD/Mean |
| Weldwood of Canada Ltd. | 0.036 | 0.002 | 0.035 | 0.008 | 0.034 | 0.008 | 0.036 | 0.014 | 0.035 | 0.001 | 0.029 |
| Alberta Newsprint Co. | not op | not op | not op | not op | 0.035 | 0.024 | 0.028 | 0.004 | 0.032 | 0.005 | 0.156 |
| Millar Western Pulp Ltd. | 0.048 | 0.012 | 0.018 | 0.009 | 0.019 | 0.006 | 0.017 | 0.005 | 0.026 | 0.015 | 0.577 |
| Slave Lake Pulp Corp. | not op | not op | not op | not op | N/A | N/A | 0.018 | 0.006 | N/A | N/A | N/A |

Athabasca River.

The third column, XK2, is the reaeration rate at reference flow and reference temperature. Macdonald *et al.* (1989) concluded that the under-ice reaeration coefficient was not significantly different from zero. A rate of 0.001 day⁻¹ was then entered for all under-ice reaches. The first reach below each mill was designated as open water and an open-water value of 0.911 day⁻¹ was used. This value is the result of correcting the value of 0.74 day⁻¹ at 0°C and 32 m³/s from Macdonald *et al.* (1989) to the reference temperature (20°C) and flow (50 m³/s). The procedure for correcting the 0.74 day⁻¹ reaeration rate for temperature and flow is shown in Box 4.1. Using equation 4.4 :

$$k_{2_{new}} = 0.74 \text{ day}^{-1} \left(\frac{32 \text{ m}^3/\text{s}}{50 \text{ m}^3/\text{s}} \right)^{\frac{3}{2}(0.512) - \frac{1}{2}(0.344)} 1.024^{20-0}$$

the reaeration coefficient of 0.74 day⁻¹ at 0°C and 32 m³/s is calculated to be 0.911 day⁻¹ at 20°C and 50 m³/s.

The fourth column, XK3, is the BOD sedimentation rate (d⁻¹) at the reference temperature. BOD sedimentation rate is loss of BOD from the water column by sedimentation of particulate organic matter. Sedimentation of BOD was estimated using data from Krisnappan *et al.* (1995) on under-ice transport of suspended particles downstream of the Weldwood of Canada Ltd. outfall. Suspended sediment load (tonnes/d) was plotted against distance (km) from the outfall (Figure 4.1) and curve fit to the equation:

$$Load^d = 0.0149 + 0.0076 \text{ Distance}^{0.5} \tag{Equation 4.5}$$

$(r^2 = 0.99; P < 0.01; n = 4)$

Sediment load was calculated for the downstream end of each reach. The deposition rate (per day, d⁻¹) was then calculated as the difference in sediment weight (tonnes) between adjacent reaches (reach (i) - reach (i-1)) divided by the upstream sediment weight (reach i-1). These rates were converted to a flow of 50 m³/s and temperature of 0°C, following the procedures outline in Box 4.1, to meet the model requirements. The Hinton rates were applied to other mills along the Athabasca River due to the lack of sedimentation data for the other mills.

The fifth column, XK4, is the BOD decay rate for the tributaries. This was set to 0.026 day⁻¹ (mean of 12 samples for four sites in the Athabasca basin; Table 4.10).

The next three columns, XM1, XM2 and XM3 are the diffuse source inflows to each reach (tonnes/km/day). There are no data on diffuse loads to the Athabasca River and these values were set to zero. However, as the simulations were run on winter data when air temperatures are less than 0°C, it is unlikely that diffuse loadings from overland run-off contributed a substantial BOD load. Diffuse loadings from groundwater were also likely minor in most years as the sum of discharges from the headwater and gauged tributaries averaged 86% (1989 - 1993; range 66 - 106%) of the discharge measured in the river 960 km downstream of the headwaters.

Box 4.1 Procedure For Correcting the Reaeration Rate

The O'Connor and Dobbins reaeration constant is given by:

$$k_{2_{ref}} = \frac{294(D_y V_{ref})^{\frac{1}{2}}}{H_{ref}^{\frac{3}{2}}} = (294 D_y^{\frac{1}{2}}) V_{ref}^{\frac{1}{2}} H_{ref}^{-\frac{3}{2}} \quad \text{Equation 4.1}$$

where D_y is the molecular diffusion coefficient for oxygen (m^2/day), V_{ref} is the mean reference stream velocity (m/s) and H_{ref} is the average reference depth of flow (m). Correcting for temperature, we obtain:

$$k_{2_{new}} = (294 D_y^{\frac{1}{2}}) V_{new}^{\frac{1}{2}} H_{new}^{-\frac{3}{2}} \theta^{T_{new} - T_{ref}} \quad \text{Equation 4.2}$$

where θ is the temperature correction factor which, for reaeration, is 1.024 (HydroQual Consultants Inc. and Gore & Storrie Ltd. 1987) and T_{ref} and T_{new} are the reference and new temperatures, respectively ($^{\circ}C$). The Leopold-Maddock velocity equations are:

$$V = aQ^b \quad V_{new} = aQ_{new}^b \quad V_{ref} = aQ_{ref}^b$$

where a is the Leopold-Maddock coefficient for velocity, b is the Leopold-Maddock exponent for velocity and Q_{ref} and Q_{new} are the reference and new flow values, respectively (m^3/s). Dividing the two equations (V_{new}/V_{ref}) gives:

$$V_{new} = V_{ref} \left(\frac{Q_{new}}{Q_{ref}} \right)^b$$

The same can be done with the Leopold-Maddock equation for average depth. The result is:

$$H_{new} = H_{ref} \left(\frac{Q_{new}}{Q_{ref}} \right)^d$$

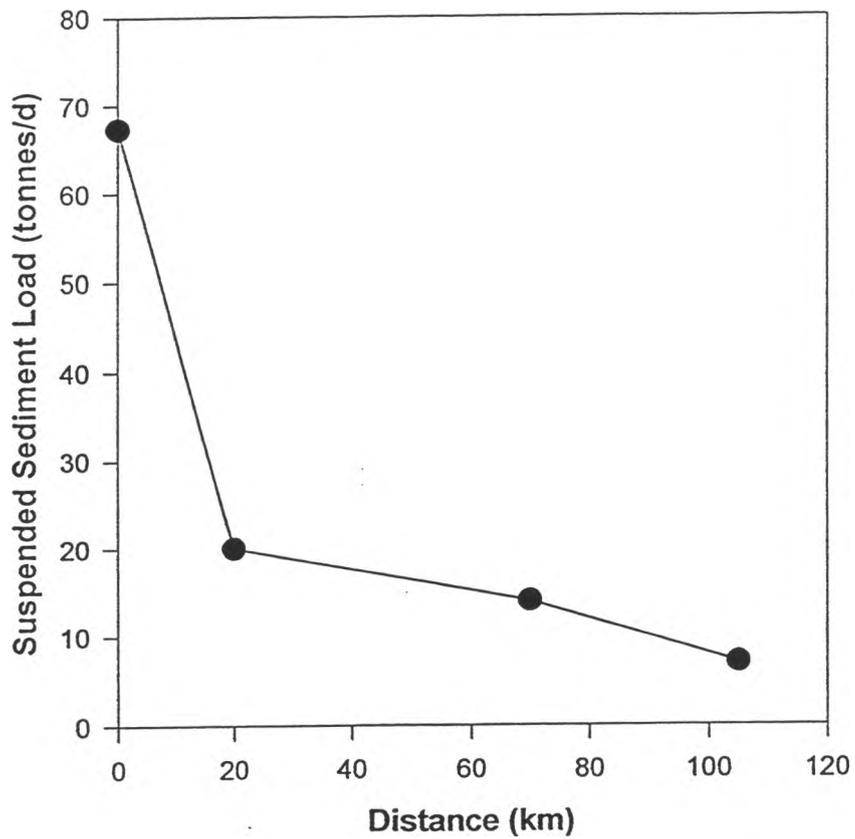
where d is the Leopold-Maddock exponent for average depth. Substituting into equation 4.1 gives:

$$k_{2_{new}} = (294 D_y^{\frac{1}{2}}) V_{ref}^{\frac{1}{2}} \left(\frac{Q_{new}}{Q_{ref}} \right)^{\frac{b}{2}} \left(\frac{Q_{new}}{Q_{ref}} \right)^{-3\frac{d}{2}} H_{ref}^{-\frac{3}{2}} \theta^{T_{new} - T_{ref}} \quad \text{Equation 4.3}$$

The temperature and flow corrected reaeration constant is therefore:

$$k_{2_{new}} = k_{2_{ref}} \left(\frac{Q_{ref}}{Q_{new}} \right)^{\frac{3}{2} - \frac{b}{2}} \theta^{T_{new} - T_{ref}} \quad \text{Equation 4.4}$$

Figure 4.1 Suspended sediment load (tonnes/d) below Weldwood of Canada Ltd. at Hinton (Krisnappan *et al.* 1995).



The next column, XRES, is designated for sediment oxygen demand (SOD). SOD (expressed as g/m²/day O₂ consumption) was measured *in situ* during the 1989, 1990, 1992, 1993, 1994, and 1995 winters. For detailed methods and results see Casey and Noton 1989; Casey 1990; Moneco Inc. 1992; HBT AGRA Ltd. 1993a, b; HBT AGRA Ltd. 1994; Noton 1995. Comparison of January and February data for incubation times of less than 48 h showed that there was no significant difference in SOD between years ($P > 0.1$) (Figure 4.2). SOD versus distance was plotted using only those sites with more than one year of data and for all reaches, SOD values at the midpoint of each reach were extrapolated from the graph (Figure 4.2). Measurements of SOD at four sites between river kilometers 235 and 556 showed that SOD was relatively constant at 0.137 ± 0.024 mg/m²/day (mean \pm SD, n=5) and, for lack of further downstream data, this value was assigned to all sites downstream of kilometer 235. To meet the requirements of the model, areal SOD rates (mg/m²/day) were converted to volumetric values (mg/L/day) by dividing by the average water depth of each reach. The depth of each reach was calculated using the equation:

$$D = cQ^d \quad \text{Equation 4.6}$$

where D is depth (m), c and d are Leopold-Maddock coefficients and Q is the reference flow (50 m³/s) (Table 4.12). For example, the second reach in Group 10 of the DOSTOC input file has a HEXN value of 0.516. Thus d equals 0.516. The corresponding value for c is 0.126 (MacDonald and Hamilton 1989). The result is a depth value of 0.949 m. The SOD per unit area value for that particular reach is 0.310 g/m²/day. Dividing this value by the depth gives an SOD value of 0.327 mg/L/day at a temperature of 0°C. As SOD rates were measured *in situ* at water temperatures of approximately 0°C, SOD rates did not need to be temperature corrected. However, as all other rates in the model were entered at 20°C then corrected to 0°C, SOD was corrected to 20°C (following a procedure similar to that outlined in Box 4.1) and then back corrected during the model run to 0°C (Table 4.12).

The last two columns, XDS and XP, are the saturation DO concentration at the reference temperature (RFDGR, 20°C) and the typical basin atmospheric pressure, and the maximum daily photosynthetic rate at the reference temperature, respectively. The saturation DO concentration was calculated for specific sites based on the elevation measurements from Kellerhals *et al.* (1972), following the method described in Wetzel (1983). For reaches without elevation data, the DO values were extrapolated from adjacent upstream and downstream reaches with known saturation DO concentrations. Data were not available for maximum daily photosynthetic rate and all values were set to zero.

Figure 4.2. Sediment oxygen demand (SOD) in the Athabasca River for the 1989, 1990, 1992, 1993, 1994 and 1995 winters (Casey and Noton 1989; Casey 1990; Monenco Inc. 1992; HBT AGRA Ltd. 1993a, b; HBT AGRA Ltd. 1994; Noton, 1995).

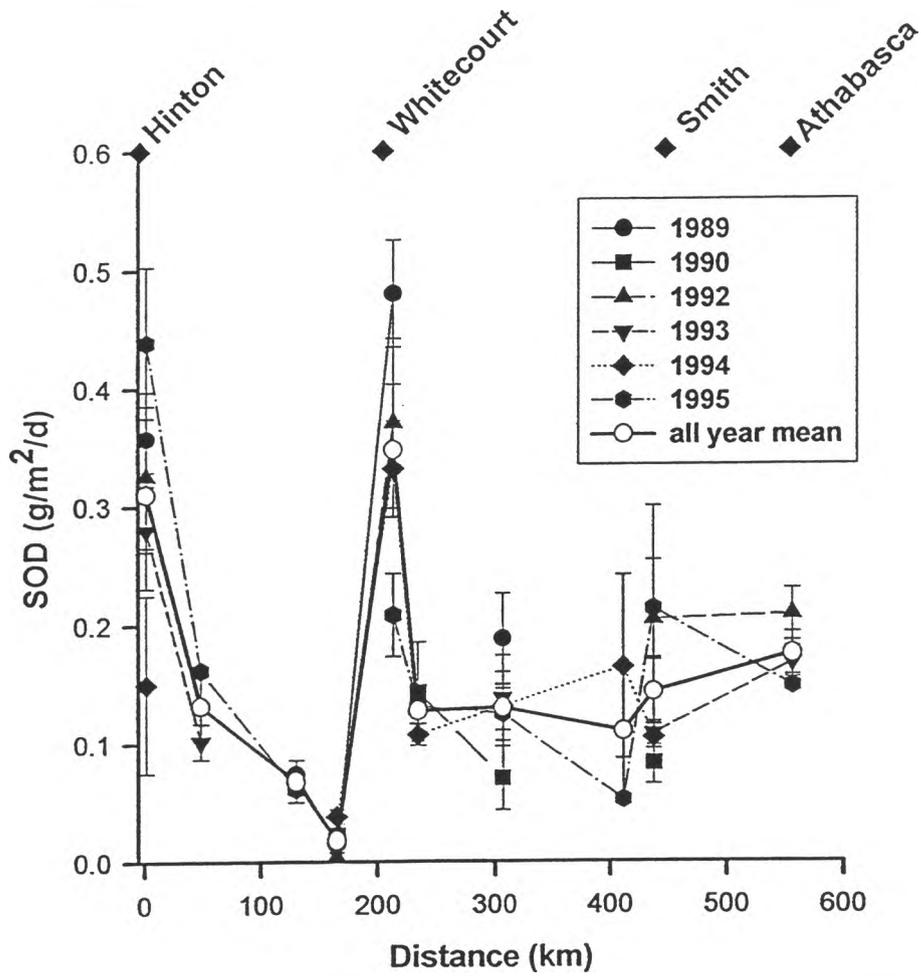


Table 4.12 Sediment oxygen demand (SOD) for input into DOSTOC. ("c" and "d" are Leopold-Maddock coefficients.)

| Reach | Reference Flow (m ³ /s) | c | d | Depth (m) | SOD (g/m ² /day) | SOD at 0°C (mg/L/d) | SOD at 20°C (mg/L/d) |
|-------|------------------------------------|-------|-------|-----------|-----------------------------|---------------------|----------------------|
| 1 | 50 | 0.126 | 0.516 | 0.949 | 0.000 | 0.000 | 0.000 |
| 2 | 50 | 0.126 | 0.516 | 0.949 | 0.310 | 0.327 | 1.151 |
| 3 | 50 | 0.126 | 0.516 | 0.949 | 0.296 | 0.312 | 1.099 |
| 4 | 50 | 0.126 | 0.516 | 0.949 | 0.276 | 0.291 | 1.025 |
| 5 | 50 | 0.126 | 0.516 | 0.949 | 0.256 | 0.270 | 0.951 |
| 6 | 50 | 0.126 | 0.516 | 0.949 | 0.236 | 0.249 | 0.877 |
| 7 | 50 | 0.126 | 0.516 | 0.949 | 0.218 | 0.230 | 0.810 |
| 8 | 50 | 0.126 | 0.516 | 0.949 | 0.202 | 0.213 | 0.750 |
| 9 | 50 | 0.126 | 0.516 | 0.949 | 0.184 | 0.194 | 0.683 |
| 10 | 50 | 0.126 | 0.516 | 0.949 | 0.138 | 0.145 | 0.513 |
| 11 | 50 | 0.116 | 0.550 | 0.997 | 0.118 | 0.118 | 0.417 |
| 12 | 50 | 0.116 | 0.550 | 0.997 | 0.098 | 0.098 | 0.346 |
| 13 | 50 | 0.116 | 0.550 | 0.997 | 0.084 | 0.084 | 0.297 |
| 14 | 50 | 0.094 | 0.540 | 0.777 | 0.074 | 0.095 | 0.335 |
| 15 | 50 | 0.094 | 0.540 | 0.777 | 0.068 | 0.087 | 0.308 |
| 16 | 50 | 0.083 | 0.551 | 0.716 | 0.058 | 0.081 | 0.285 |
| 17 | 50 | 0.083 | 0.551 | 0.716 | 0.042 | 0.059 | 0.207 |
| 18 | 50 | 0.083 | 0.551 | 0.716 | 0.030 | 0.042 | 0.148 |
| 19 | 50 | 0.083 | 0.551 | 0.716 | 0.018 | 0.025 | 0.089 |
| 20 | 50 | 0.083 | 0.551 | 0.716 | 0.018 | 0.025 | 0.089 |
| 21 | 50 | 0.083 | 0.551 | 0.716 | 0.018 | 0.025 | 0.089 |
| 22 | 50 | 0.083 | 0.551 | 0.716 | 0.338 | 0.472 | 1.662 |
| 23 | 50 | 0.106 | 0.463 | 0.649 | 0.338 | 0.521 | 1.836 |
| 24 | 50 | 0.106 | 0.463 | 0.649 | 0.338 | 0.521 | 1.836 |
| 25 | 50 | 0.107 | 0.536 | 0.871 | 0.338 | 0.388 | 1.367 |
| 26 | 50 | 0.107 | 0.536 | 0.871 | 0.240 | 0.276 | 0.971 |
| 27 | 50 | 0.107 | 0.536 | 0.871 | 0.137 | 0.157 | 0.554 |
| 28 | 50 | 0.107 | 0.536 | 0.871 | 0.137 | 0.157 | 0.554 |
| 29 | 50 | 0.107 | 0.536 | 0.871 | 0.137 | 0.157 | 0.554 |
| 30 | 50 | 0.107 | 0.536 | 0.871 | 0.137 | 0.157 | 0.554 |
| 31 | 50 | 0.107 | 0.536 | 0.871 | 0.137 | 0.157 | 0.554 |
| 32 | 50 | 0.107 | 0.536 | 0.871 | 0.137 | 0.157 | 0.554 |
| 33 | 50 | 0.107 | 0.536 | 0.871 | 0.137 | 0.157 | 0.554 |
| 34 | 50 | 0.107 | 0.536 | 0.871 | 0.137 | 0.157 | 0.554 |
| 35 | 50 | 0.107 | 0.536 | 0.871 | 0.137 | 0.157 | 0.554 |
| 36 | 50 | 0.163 | 0.523 | 1.261 | 0.137 | 0.109 | 0.383 |
| 37 | 50 | 0.163 | 0.523 | 1.261 | 0.137 | 0.109 | 0.383 |
| 38 | 50 | 0.163 | 0.523 | 1.261 | 0.137 | 0.109 | 0.383 |
| 39 | 50 | 0.125 | 0.512 | 0.926 | 0.137 | 0.148 | 0.521 |
| 40 | 50 | 0.125 | 0.512 | 0.926 | 0.137 | 0.148 | 0.521 |
| 41 | 50 | 0.127 | 0.512 | 0.941 | 0.137 | 0.146 | 0.513 |

| | | | | | | | |
|----|----|--------|-------|-------|-------|-------|-------|
| 42 | 50 | 0.127 | 0.512 | 0.941 | 0.137 | 0.146 | 0.513 |
| 43 | 50 | 0.0778 | 0.592 | 0.788 | 0.137 | 0.174 | 0.612 |
| 44 | 50 | 0.0778 | 0.592 | 0.788 | 0.137 | 0.174 | 0.612 |
| 45 | 50 | 0.0778 | 0.592 | 0.788 | 0.137 | 0.174 | 0.612 |
| 46 | 50 | 0.0778 | 0.592 | 0.788 | 0.137 | 0.174 | 0.612 |
| 47 | 50 | 0.0778 | 0.592 | 0.788 | 0.137 | 0.174 | 0.612 |
| 48 | 50 | 0.0778 | 0.592 | 0.788 | 0.137 | 0.174 | 0.612 |
| 49 | 50 | 0.0548 | 0.598 | 0.569 | 0.137 | 0.241 | 0.849 |
| 50 | 50 | 0.0548 | 0.598 | 0.569 | 0.137 | 0.241 | .0849 |
| 51 | 50 | 0.245 | 0.555 | 2.148 | 0.018 | 0.008 | 0.030 |
| 52 | 50 | 0.245 | 0.555 | 2.148 | 0.018 | 0.008 | 0.030 |
| 53 | 50 | 0.245 | 0.555 | 2.148 | 0.018 | 0.008 | 0.030 |
| 54 | 50 | 0.175 | 0.536 | 1.534 | 0.018 | 0.012 | 0.041 |

4.5 TRAVEL TIME

The next group, Group 10, consists of one line of data for each reach and six columns. The first column is the reach number. The second column is the reference flow, REFQ (50 m³/s). The third column is the time of travel for the reach at the reference flow (days) taken directly from Macdonald and Hamilton (1989) with the exception of reaches immediately following a pulp mill. An 0.8 km open-water reach was set below each mill. Velocities for the open-water reaches were determined from Leopold-Maddock relations. The velocity was then divided into the reach distance to obtain the open-water reach travel time. Any remaining travel time was added to the travel time of the following reach. HEXN and VEXN are the Leopold-Maddock coefficients for depth and velocity, respectively, and were taken directly from Macdonald and Hamilton (1989).

The reach hydraulic characteristics in DOSTOC were estimated using the Leopold and Maddock (1953) relationships for velocity, depth and river width versus flow for a given reach. The under-ice time-of-travel for the reach from Hinton to the Town of Athabasca (Andres *et al.* 1989) were set to measured values. Discharge for the Athabasca River and selected tributaries was measured by Technical Services Division, Alberta Environment or Water Survey of Canada. The water surface profile model (HEC-2) as implemented by Thompson and Fitch (1989) was used to determine the hydraulic parameters for each cross-section by calibrating the reach roughness parameters to the measured data. The HEC-2 model was then used to produce profiles for a series of flows from which the Leopold-Maddock coefficients could then be determined. The ice-covered Leopold-Maddock coefficients used in the model are given in Table 4.13 for each hydraulic reach identified by Thompson and Fitch (1989).

The last column in this group is RFDGR, which is the reference temperature for the rates and coefficients. This value was set to 20°C for all years and all reaches. The equations for correcting for flow and temperature, and all correction factors are found in Appendix 3 of HydroQual Consultants Inc. and Gore & Storrie Ltd. (1987).

4.6 COEFFICIENT NOISE PARAMETERS

Coefficient noise parameters are entered as values between 0 and 1 and represent a fraction of the variance of the coefficient. The same values were used for all stochastic runs and based on best estimates of variance:

- BOD decay rate (per day) = 0.40
- reaeration rate (per day) = 0.0
- sedimentation and absorption (per day) = 0.0
- NOD (renamed BOD for tributaries) decay rate (per day) = 0.07
- photosynthetic rate (mg/L/d) = 0.0
- respiration (renamed SOD) rate (mg/L/d) = 0.0
- BOD for diffuse source inflows = 0.0
- DO for diffuse source inflows = 0.0
- NOD for diffuse source inflows (BOD for tributaries) = 0.0

Table 4.13 Ice-covered Leopold-Maddock coefficients from Hinton to Athabasca (after Thompson and Fitch 1989).

| Reach | Description | Length (km) | HEXN | VEXN |
|-------|------------------------------|-------------|-------|-------|
| A | Hinton-Obed Ferry | 39.1 | 0.516 | 0.353 |
| B | Obed - HBC Bridge | 63.7 | 0.550 | 0.346 |
| C | HBC Bridge - Beaman | 37.5 | 0.540 | 0.266 |
| D | Beaman - Whitecourt | 64.4 | 0.551 | 0.326 |
| E | Whitecourt - Blue Ridge | 25.3 | 0.463 | 0.362 |
| F | Blue Ridge - Ft. Assiniboine | 66.4 | 0.536 | 0.274 |
| G | Ft. Assiniboine - Vega | 44.0 | 0.523 | 0.288 |
| H | Vega - Pembina River | 43.4 | 0.512 | 0.350 |
| I | Pembina - Athabasca | 163.2 | 0.512 | 0.260 |

Coefficient noise parameters were set to zero if data were not available. The coefficient noise parameter for mill BOD decay rate was determined as the average of the SD:mean values for all years for all mills (Table 4.11). The coefficient noise parameter for BOD decay for tributaries was calculated as the SD:mean value for the mean decay rates for 12 samples collected from four sites in the Athabasca basin (Table 4.10).

Uncertainty in the modelling process is represented by three equation noise parameters. This includes an additional stochastic term accounting for randomness resulting from random fluctuations in the inputs and the modelling process itself. As data for these noise parameters do not exist, these noise parameters were set to zero.

The final input prompt asks for the simulation step distance. This is the incremental distance over which the model calculates the DO concentration and was set to 1 km.

4.7 WINTER OF 1994

All rates used for DOSTOC were calculated using the best available data from the winter water quality surveys of 1988 - 1993. As a check of these rates, the winter 1994 data were run initially without including Alberta Pacific Forest Industries Inc. and then the input file was adjusted to include AIPac. Input data files for each of these 1994 runs are provided in Appendix B.

As a check of the rates used in previous (1988-1993) runs, the first input data file for 1994 (Alberta Pacific Forest Industries Inc. not included) was constructed following the same calculation procedures as previously outlined (Sections 4.1 - 4.6) using data collected during the Alberta Environment 1994 winter water quality survey. Long-term means calculated from 1988 - 1993 were used for any variables missing for the 1994 winter.

To evaluate the impact on the Athabasca River of another mill coming on line in 1994 Alberta Pacific Forest Industries Inc. was added as a point source (operation began fall of 1993). From the Alberta Environment winter water quality survey flow (m^3/s), DO (mg/L) and BOD₅ (mg/L) were 0.558, 7.0 and 5.5, respectively for AIPac for the winter of 1994. The input file structure was adjusted to account for settling reaches below the mill (as in Section 4.2). Therefore, in Group 1, the total number of reaches (NRT) was set to 58 and MAXRI and MAXPT were set to 54. NSTP included 18 tributaries, and eight effluent outfalls (Weldwood of Canada Ltd., Millar Western Pulp Ltd., Alberta Newsprint Co., Slave Lake Pulp Corp., AIPac, Whitecourt STP, Athabasca STP and Slave Lake STP). Groups 2, 3, 6, 7 and 10 were adjusted accordingly to reflect the addition of Alberta Pacific Forest Industries Inc. and the 1994 data. Data for these groups came from the 1994 Alberta Environment winter water quality surveys and calculations followed the same methods as described in sections 4.2, 4.3 and 4.5. Groups 4 and 5 remained the same as for all previous runs.

For Group 8 (Water Quality Rates; Section 4.4) rates were adjusted downstream of Alberta Pacific Forest Industries Inc. to account for the effluent outfall. Since data are limited for AIPac, average BOD decay from Weldwood of Canada Ltd. was used for XK1 (Table 4.11). Reaeration (XK2) was set to 0.911 d^{-1} for the open water area below the mill and 0.001 d^{-1} for the remaining ice covered areas. Sedimentation rate (XK3) was calculated as in Section 4.4. Since SOD measurements have not been made below the Alberta Pacific Forest Industries Inc. outfall and since both Weldwood of Canada Ltd. and Alberta Pacific Forest Industries Inc. are of the same processing

type (kraft mills), areal SOD data downstream of Weldwood of Canada Ltd. was used for SOD below the Alberta Pacific mill and adjusted to volumetric as in Section 4.4.

5.0 DOSTOC MODEL RESULTS

5.1 INTRODUCTION

DOSTOC was run using Athabasca River data from the 1988 (February and March), 1989 (January and March), 1990, 1991, 1992, 1993 and 1994 winters for the reach from upstream of Hinton to upstream of Grand Rapids. Estimates of standard error:

$$rms = \sqrt{\frac{1}{n} \sum (DO_{predicted} - DO_{observed})^2} \quad \text{Equation 5.1}$$

and coefficients of determination:

$$r^2 = 1 - \frac{\sum (DO_{predicted} - DO_{observed})^2}{\sum (DO_{observed} - DO_{average})^2} \quad \text{Equation 5.2}$$

were used to assess goodness of fit of the model runs where $DO_{predicted}$ is the dissolved oxygen concentration (mg/L) predicted by DOSTOC, $DO_{observed}$ is the observed dissolved oxygen concentration (mg/L) and $DO_{average}$ is the mean dissolved oxygen concentration (mg/L) for the observed data. The coefficient of determination or the Nash-Sutcliffe coefficient is a goodness of fit criteria recommended by the ASCE Task Committee on Definition of Criteria for Evaluation of Watershed Models (ASCE 1993) for continuous hydrograph modelling. It has been adapted here to estimate goodness of fit for the DO simulation.

5.2 DETERMINISTIC SOLUTION

When DOSTOC was implemented for 1988 to 1994, correlation coefficients relating predicted and observed DO concentrations varied from 0.51 in February 1988 to 0.92 in 1991 (Table 5.1; Figures 5.1 to 5.8). The best model fits ($r^2 = 0.89$ and 0.92) were obtained with the years 1990 and 1991. The model results were surprisingly good since no calibration was performed on the model: all input measurements and rates were laboratory or *in situ* measurements for the Athabasca River and its tributaries, industries and STP's. The only exceptions were the temperature correction factors of 1.075, 1.024, 1.047, 1.075 and 1.065 which were used to adjust the BOD decay rates for pulp mills and STP's, reaeration rates, BOD sedimentation rates, BOD decay rates for tributaries and sediment oxygen demand rates, respectively (HydroQual Consultants Inc. and Gore & Storrie Ltd. 1987), from the values measured at 20 to 0°C. The poorest predictions were for January and March 1988. This may be due to the fact that sewage treatment plant outfalls (Whitcourt, Slave Lake and Athabasca) were not sampled in 1988 and that only 14 to 16 mainstem and eight tributaries

Table 5.1 Statistical results of model simulations undertaken in this study and by Macdonald and Hamilton (1989) and Macdonald and Radermacher (1992). (RMS is the residual mean square and r^2 is the coefficient of determination; N/A means data are not available.) (Values for Macdonald and Hamilton's (1989) and Macdonald and Radermacher's (1992) studies were calculated by comparing predicted DO concentrations from DOSTOC simulations run using their input files (provided in their reports) and observed DO concentrations.)

| Year | This study | | After Macdonald and Radermacher (1992, 1993) | |
|----------|------------|-------|--|-------|
| | RMS | r^2 | RMS | r^2 |
| Feb 1988 | 0.62 | 0.51 | 0.35 | 0.85 |
| Mar 1988 | 0.50 | 0.53 | 0.44 | 0.64 |
| Jan 1989 | 0.66 | 0.79 | 0.04 | 0.91 |
| Mar 1989 | 1.06 | 0.56 | 0.05 | 0.09 |
| 1990 | 0.30 | 0.89 | 0.44 | 0.76 |
| 1991 | 0.34 | 0.92 | N/A | N/A |
| 1992 | 0.53 | 0.74 | N/A | N/A |
| 1993 | 0.69 | 0.81 | N/A | N/A |
| 1994 | 0.65 | 0.78 | N/A | N/A |

Figure 5.1 Dissolved oxygen (DO) concentrations in the Athabasca River, AB for February 1988 and deterministic results predicted using the simulation model DOSTOC.

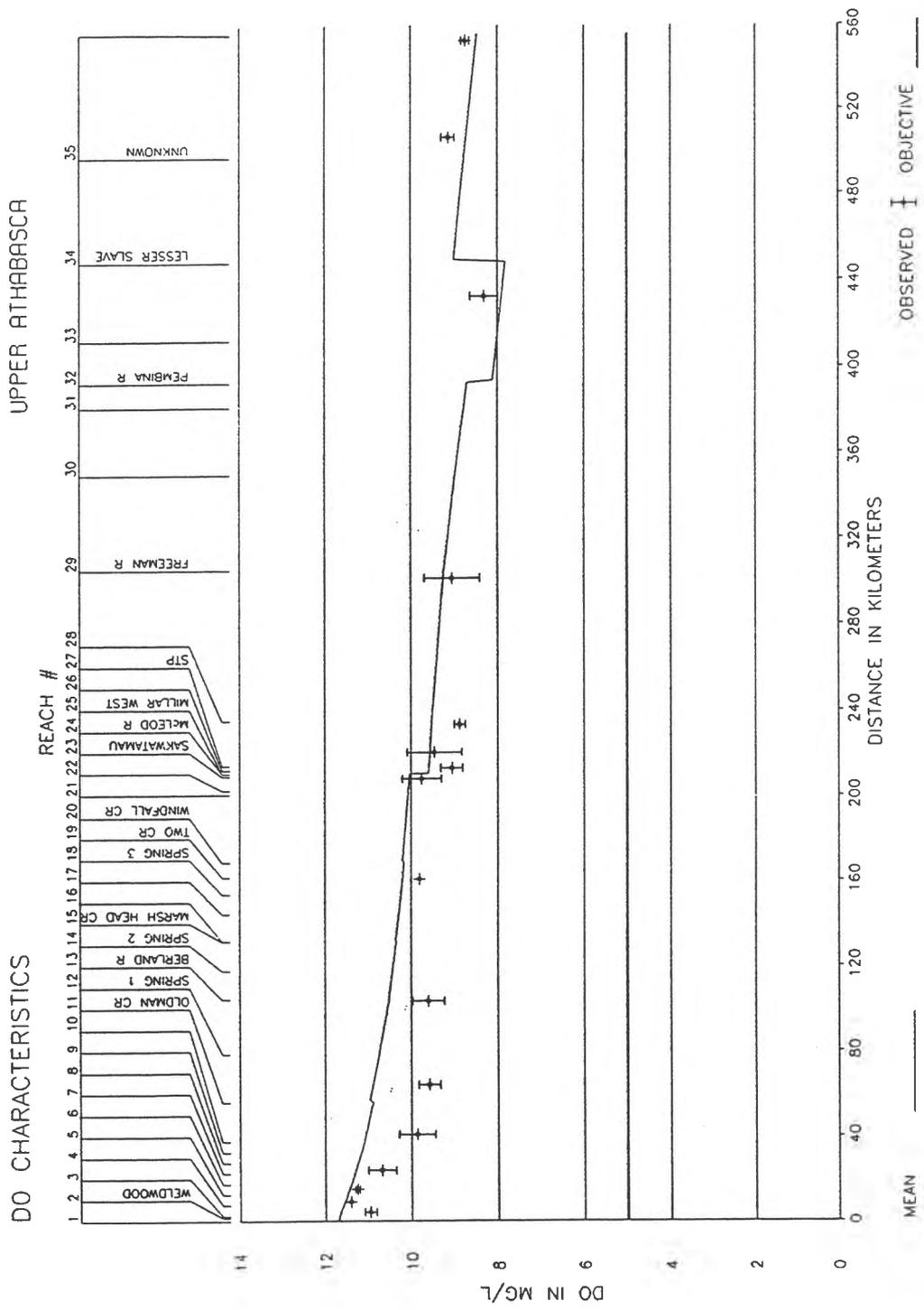


Figure 5.2 Dissolved oxygen (DO) concentrations in the Athabasca River, AB for March 1988 and deterministic results predicted using the simulation model DOSTOC.

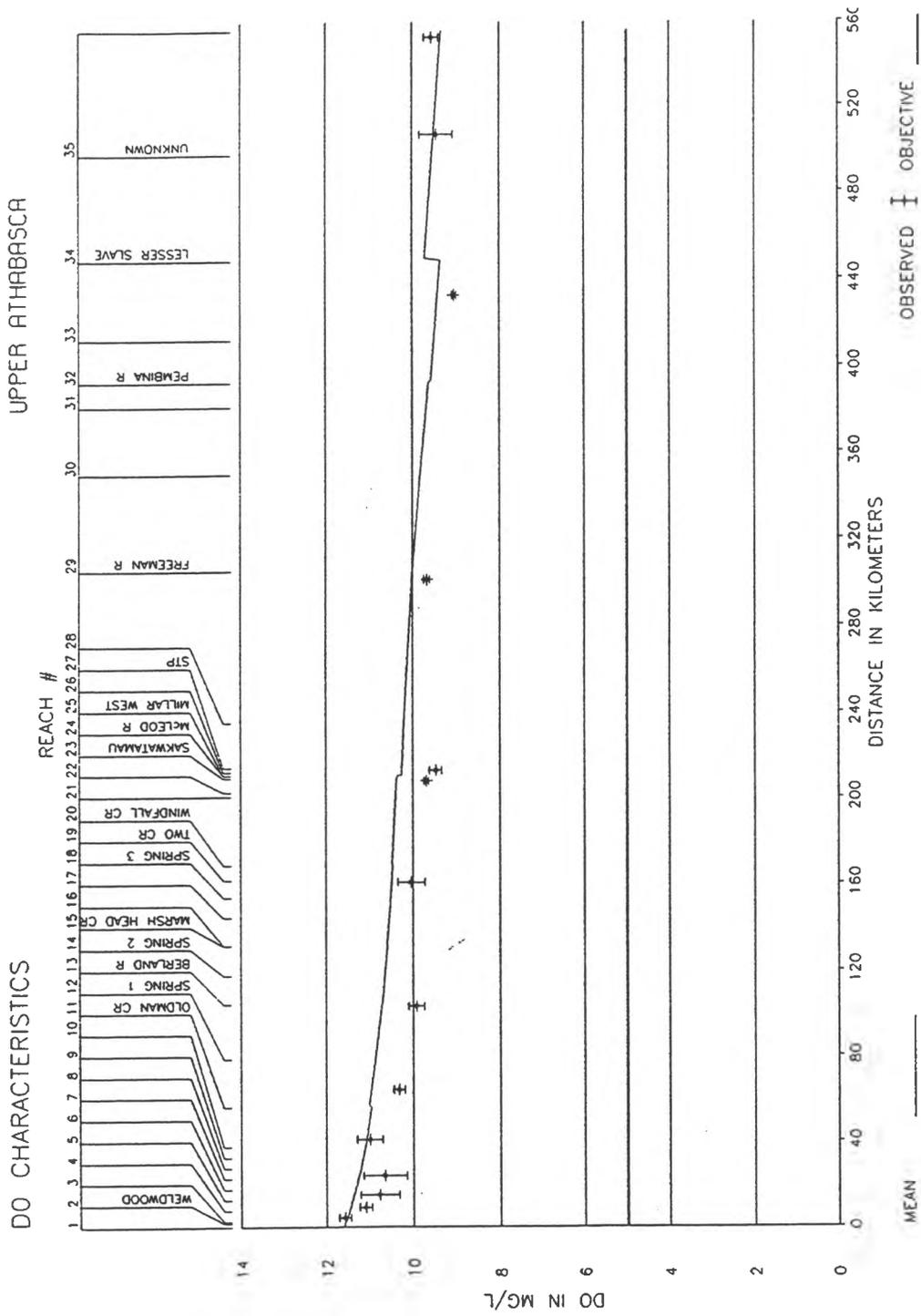


Figure 5.3 Dissolved oxygen (DO) concentrations in the Athabasca River, AB for January 1989 and deterministic results predicted using the simulation model DOSTOC.

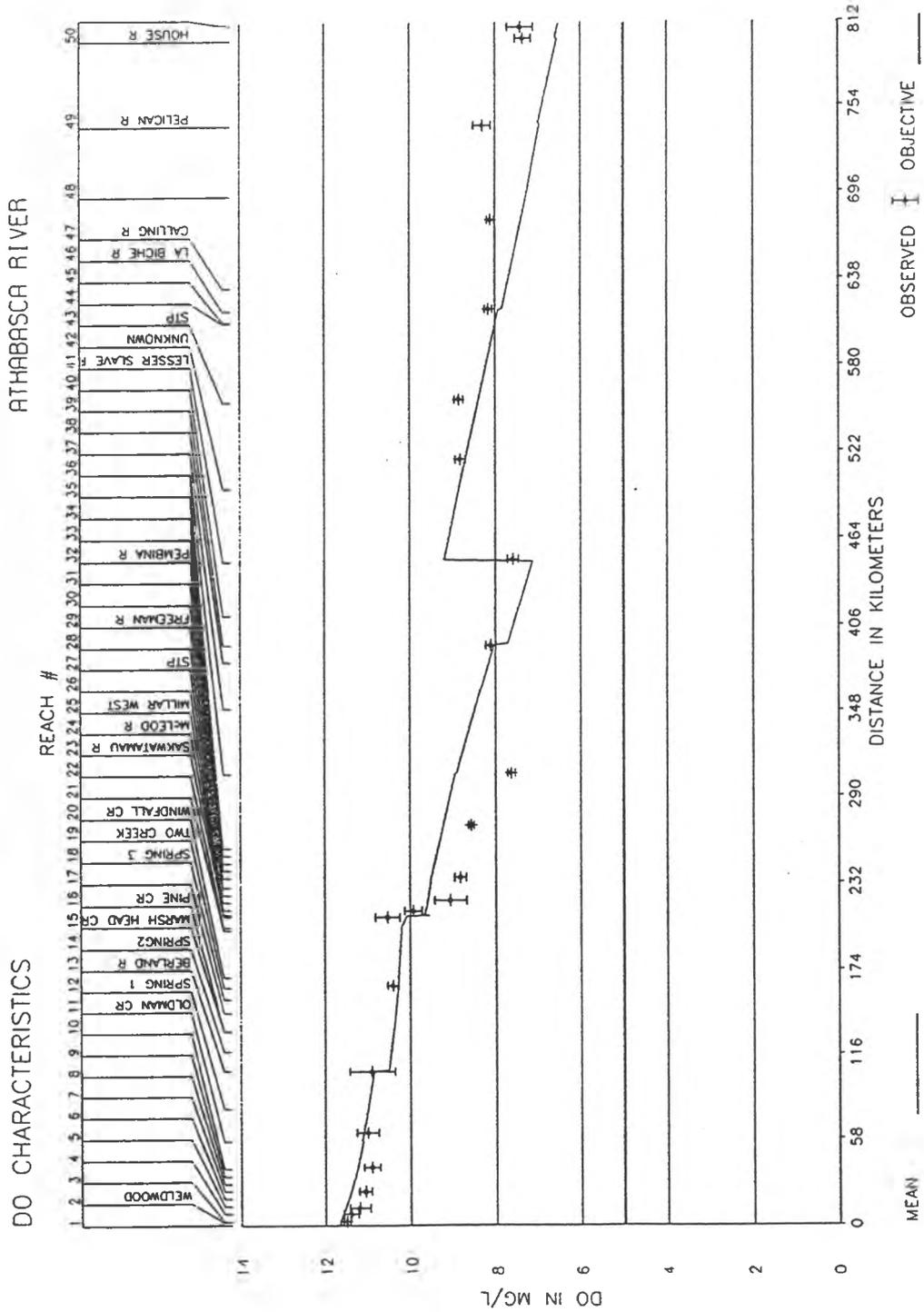


Figure 5.4 Dissolved oxygen (DO) concentrations in the Athabasca River, AB for March 1989 and deterministic results predicted using the simulation model DOSTOC.

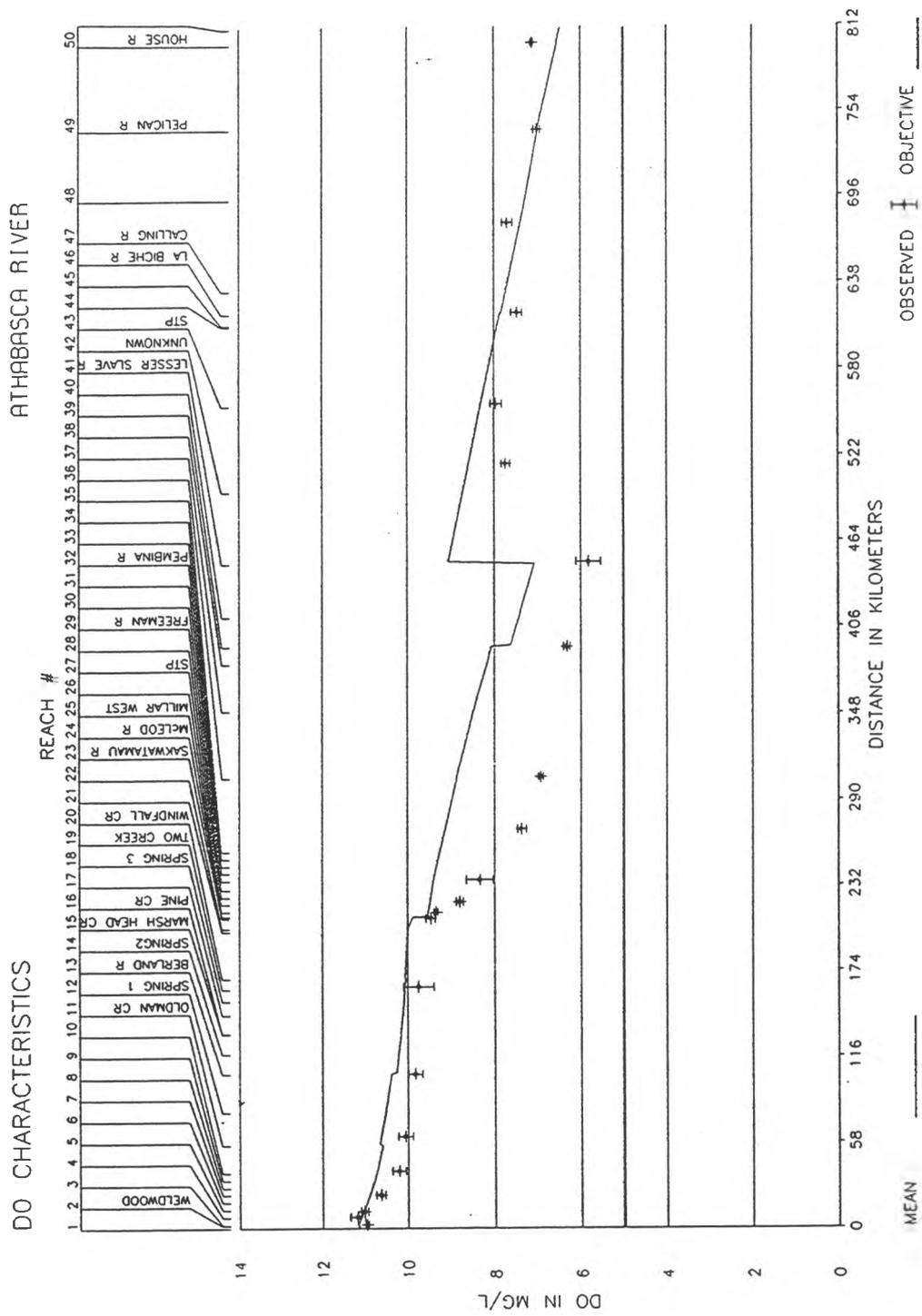


Figure 5.5 Dissolved oxygen (DO) concentrations in the Athabasca River, AB for February - March 1990 and deterministic results predicted using the simulation model DOSTOC.

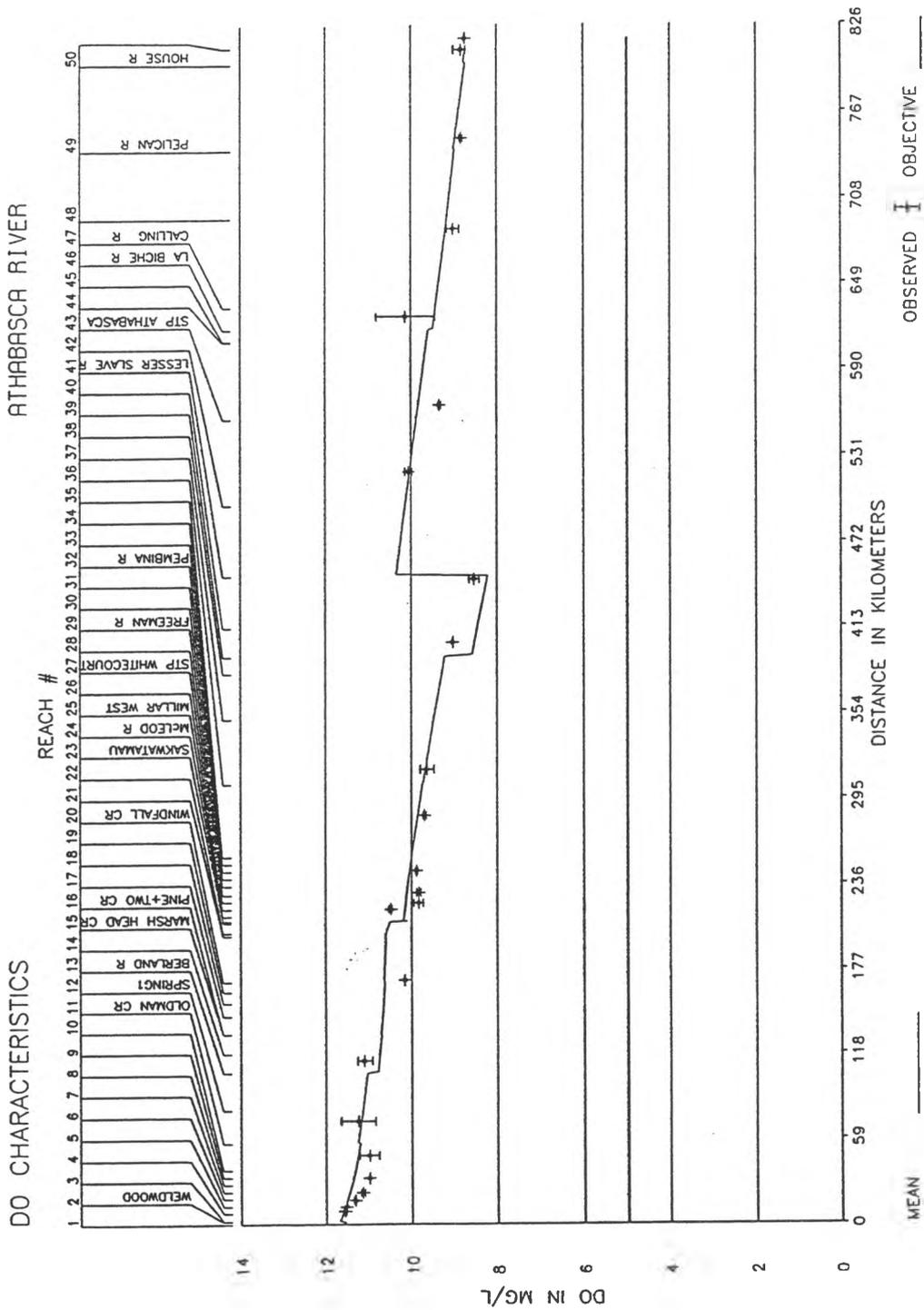


Figure 5.6 Dissolved oxygen (DO) concentrations in the Athabasca River, AB for February - March 1991 and deterministic results predicted using the simulation model DOSTOC.

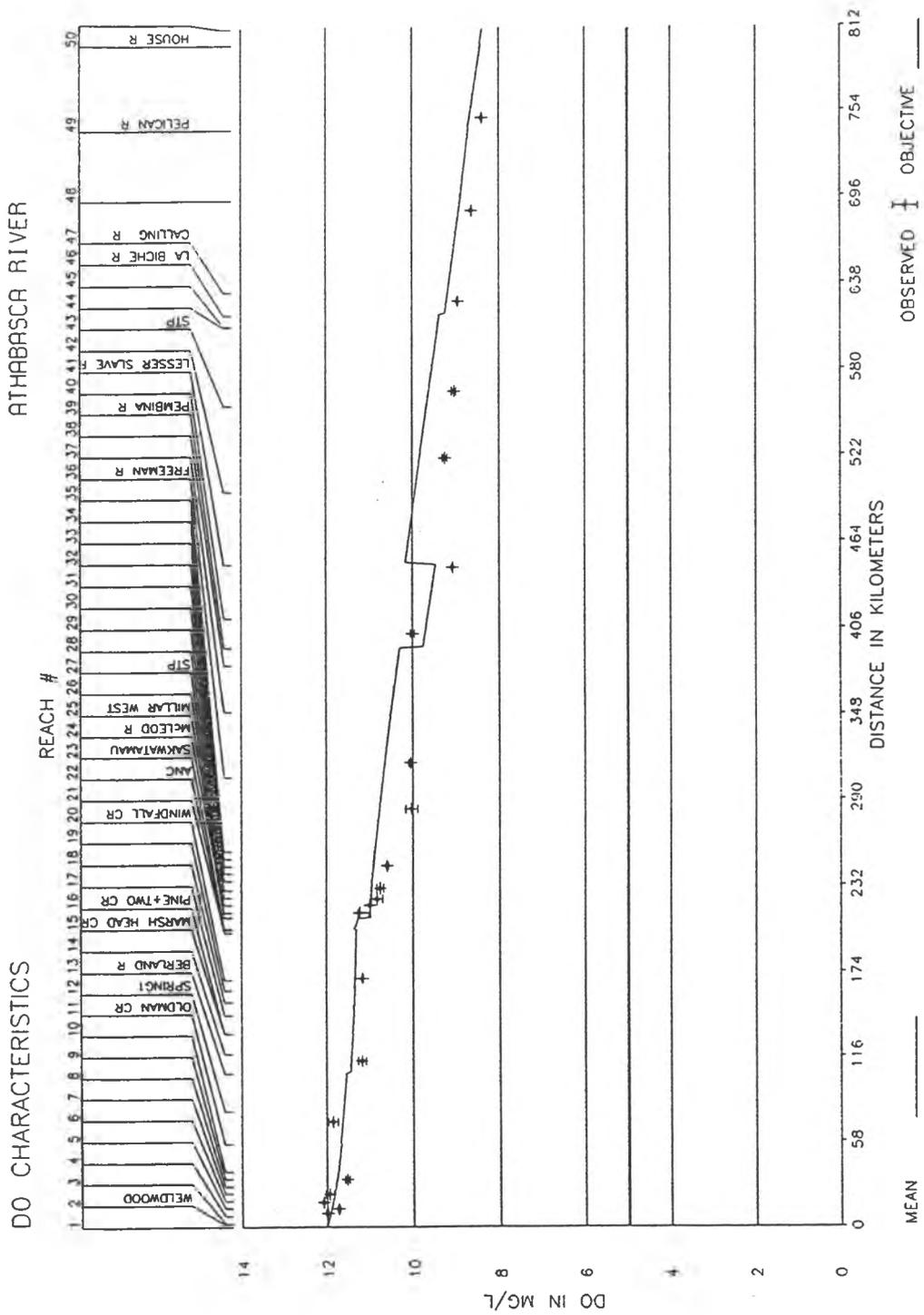


Figure 5.7 Dissolved oxygen (DO) concentrations in the Athabasca River, AB for February - March 1992 and deterministic results predicted using the simulation model DOSTOC.

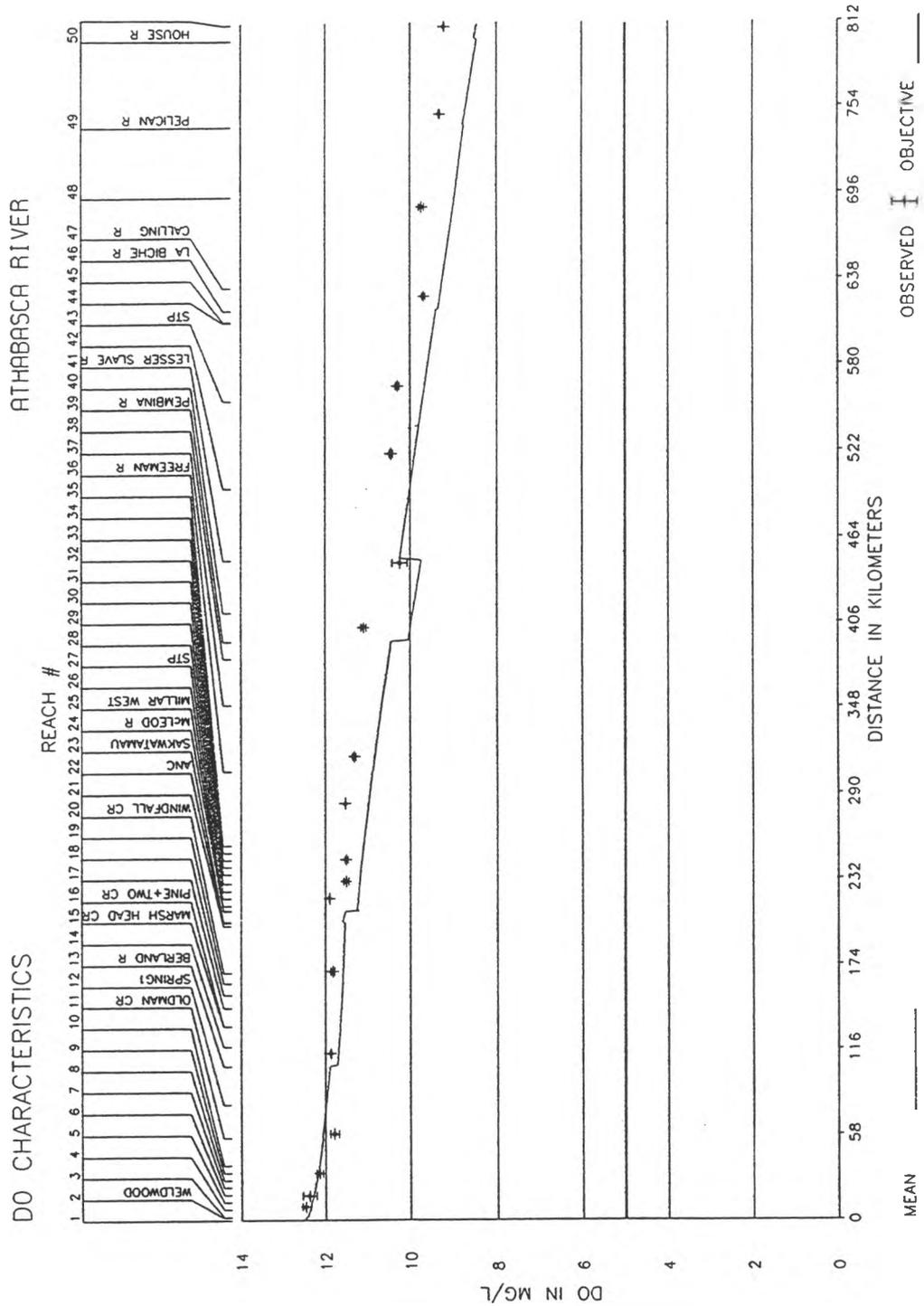


Figure 5.8 Dissolved oxygen (DO) concentrations in the Athabasca River, AB for February - March 1993 and deterministic results predicted using the simulation model DOSTOC.

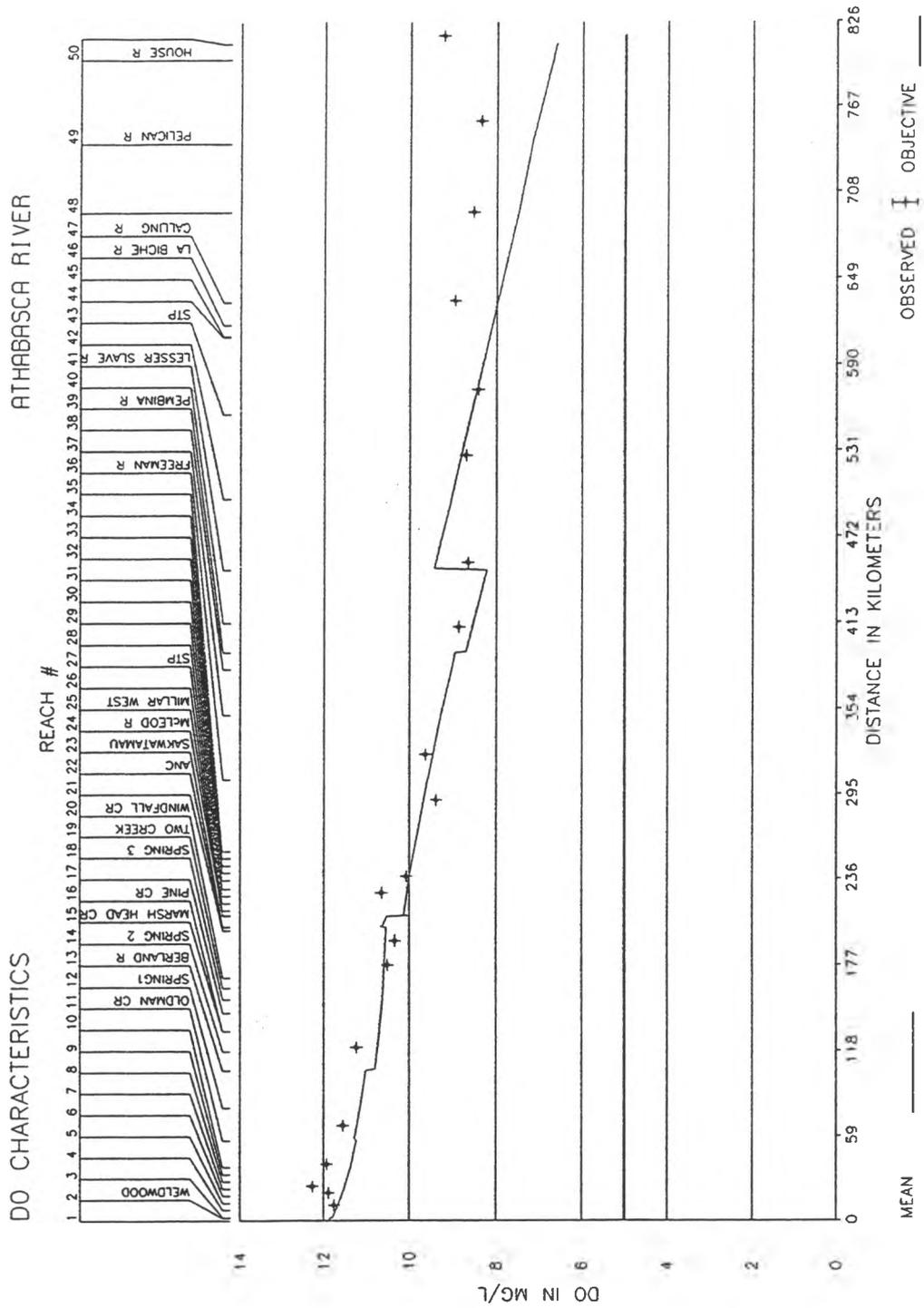
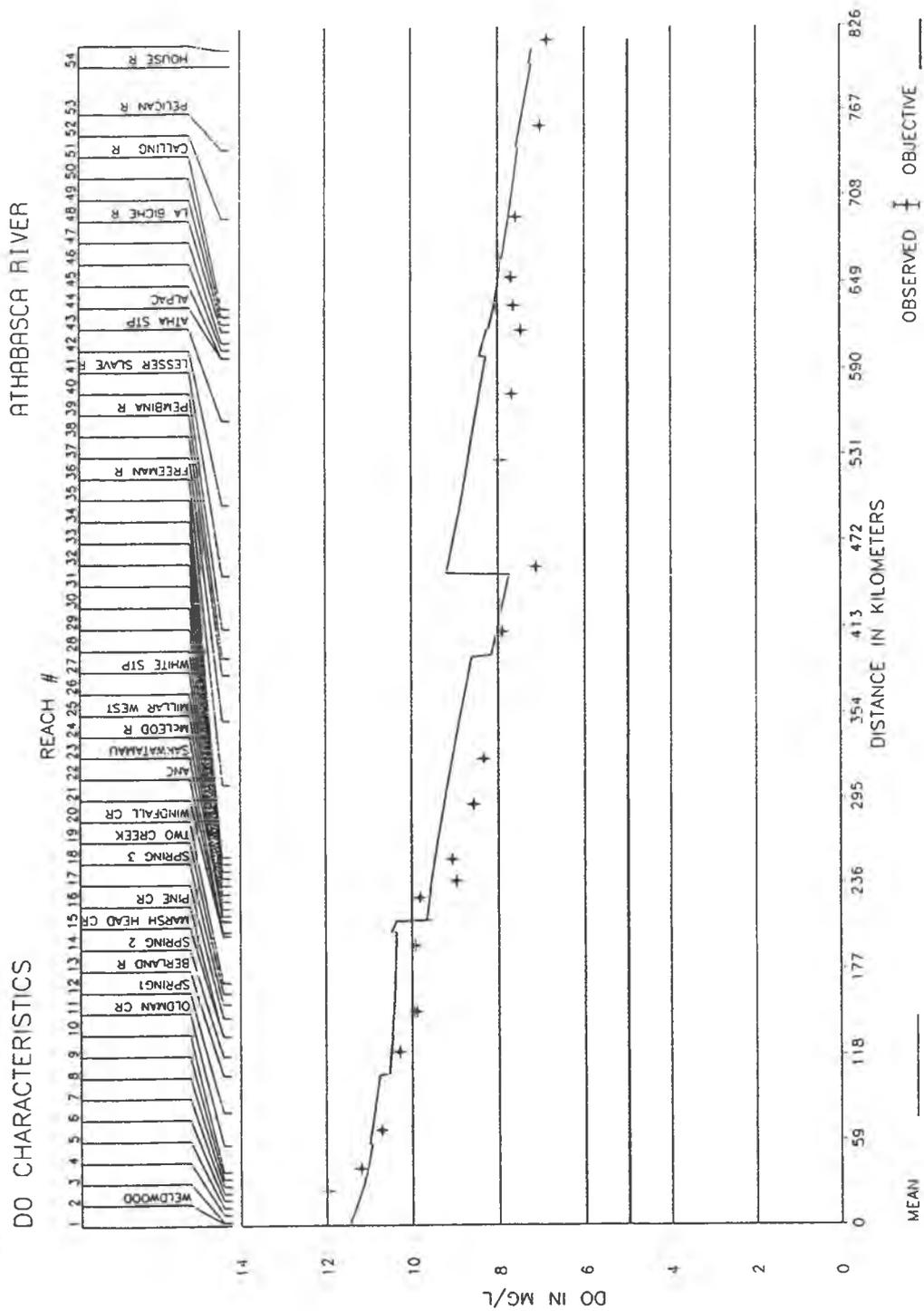


Figure 5.9 Dissolved oxygen (DO) concentrations in the Athabasca River, AB for February - March 1994 and deterministic results predicted using the simulation model DOSTOC.



were sampled in 1988 compared to the 19 to 24 mainstem and 15 to 26 tributary collections made in 1989 to 1994. The low correlation coefficient ($r^2 = 0.56$) for March 1989 may be due to erratic and high BOD loadings from the new Millar Western Pulp Ltd. mill which were likely not in equilibrium with natural river processes that affect DO concentrations.

Our model runs appear to better simulate the 1990, 1991 and 1992 data than those by Macdonald and Radermacher (1992, 1993). While correlation coefficient and RMS statistics are not available for Macdonald and Radermacher's (1993) 1991 and 1992 simulations, visual comparisons suggest that our simulations better fit the observed data for these years. For 1990, our DOSTOC simulation gave a better fit ($r^2 = 0.89$) to the observed data than Macdonald and Radermacher's (1992) approach ($r^2 = 0.76$). Macdonald and Radermacher's (1992, 1993) predictions for 1990 - 1992 underestimated DO concentrations for the first 175 km (1990 and 1992) or 450 km (1991) of the river. For 1988 and 1989, Macdonald and Hamilton's (1989) simulations better fit the observed data (Table 5.1). The better fit given by Macdonald and Hamilton (1989) for 1988 and 1989 is not surprising since they calibrated DOSTOC for the Athabasca River with the 1988 and 1989 data. The terms used for calibrating the model were SOD and BOD sedimentation rate; ice-covered reaeration rates were also differed in 1988 (0.03 day^{-1} at 0°C and $50 \text{ m}^3/\text{s}$) from the value of 0.001 day^{-1} (at 0°C and $50 \text{ m}^3/\text{s}$) used in other years (Table 5.2). Differences in input data and process rates explain discrepancies between our simulations and those of Macdonald and Hamilton (1989) and Macdonald and Radermacher (1992, 1993) (Table 5.2). The most significant discrepancies were the use of longer open-water reaches below mill outfalls, higher BOD decay rates, lower $\text{BOD}_u:\text{BOD}_5$ ratios for sewage, tributary and headwater sources, and higher BOD sedimentation rates by Macdonald and Hamilton (1989) and Macdonald and Radermacher (1992, 1993). The longer open-water reaches and lower $\text{BOD}_u:\text{BOD}_5$ ratios would result in increased DO concentrations in the river whereas the higher BOD decay and sedimentation rates would decrease river-water DO concentrations. The higher BOD decay rates of Macdonald and Hamilton (1989) and Macdonald and Radermacher (1992, 1993) result from not correcting BOD decay rates measured at 20°C to the river temperature of 0°C . Comparison of selected model simulations with and without temperature corrections showed that models that were not temperature corrected were less successful at predicting river DO concentrations (Appendix C).

As a test to assess the impact of mill effluent on DO concentrations in the Athabasca River, two trials were completed: (1) mill input was removed from the 1990 - 1994 input files, the simulations were re-run and the DO concentrations upstream of Grand Rapids were compared in the presence and absence of mills, and (2) the winter of 1994 simulation was first run without the Alberta Pacific Forest Products Inc. effluent input and then re-run with the effluent included. Removal of mill input (for all mills, QLD in Group 2 was set to $0.000 \text{ m}^3/\text{s}$ and BOD_u and DO values in Group 6 were removed) for the 1990-1994 runs showed an increase in DO of, on average, 0.25 mg/L upstream of Grand Rapids (approximately 800 km downstream of Hinton). Comparison of the two 1994 runs showed that DO concentrations increased by 0.08 mg/L upstream of Grand Rapids with the addition of Alberta Pacific Forest Industries Inc. effluent with little change in r^2 between the two runs ($r^2 = 0.78$ and 0.79 , with and without Alberta Pacific Forest Industries Inc. effluent, respectively).

Table 5.2 Comparison of input data and process rates that differ between this report and Macdonald and Hamilton (1989) or Macdonald and Radermacher (1992, 1993). All rates have been corrected to the same temperature (0°C) and flow (50 m³/s).

| Parameter | This Report | Macdonald (1989, 1992, 1993) |
|---|---|--|
| Atmospheric Reaeration | -0.8 km open-water reach established below each mill -open-water reaeration rate of 0.57 day ⁻¹ -under-ice reaeration rate of 0.0006 day ⁻¹ | -open-water reaches of: (1) 8.5 and 22.5 km d/s Hinton in Feb. and March 1988, respectively; (2) 1.5 km d/s Millar Western Pulp Ltd. in 1989 and 12.2, 8.5 and 12.2 km d/s Hinton in Jan., Feb. and Mar. 1989, respectively in 1989; (3) 12.2 and 1.5 km d/s Hinton and Millar Western Pulp Ltd., respectively, in 1990, 1991 and 1992. -open-water reaeration rate of 0.58 and 1.63 day ⁻¹ d/s Hinton and Millar Western Pulp Ltd., respectively -under-ice reaeration rate of 0.001 day ⁻¹ for all years except 1988 when 0.03 day ⁻¹ |
| BOD Decay Rates | 0.006 day ⁻¹ | 0.05 day ⁻¹ |
| 1. Sewage | 0.006 day ⁻¹ | 0.02 day ⁻¹ |
| 2. Tributaries and Headwaters | values obtained from mills (Table 4.8) and temperature corrected from 20 to 0 °C. | 0.035 day ⁻¹ for Weldwood of Canada Ltd. in 1988 and 1989. 0.05 day ⁻¹ for Millar Western Pulp Ltd. in 1989. Values obtained from mills for 1990-1992. (All BOD decay rates were measured at 20°C. These values were not temperature corrected to the river temperature of 0°C.) |
| 3. Pulp Mills | 7.80 | 2.0 |
| BOD _u :BOD ₅ ratios | 8.03 | 6.4 |
| 1. Sewage | values obtained from mills (Table 4.4) | 5.0 for Weldwood of Canada Ltd. in 1988 and 1989. 4.0 for Millar Western Pulp Ltd. in 1989. Values obtained from mills for 1990-1992. |
| 2. Tributaries and Headwaters | | |
| 3. Pulp Mills | | |

Table 5.2 con't

| Parameter | This Report | Macdonald (1989, 1992, 1993) |
|-----------------------------|--|---|
| BOD sedimentation rate | Rates estimated from Krisnappen <i>et al.</i> (1995) were 0.574, 0.553 and 0.407 day ⁻¹ for immediately d/s Hinton, Alberta Newsprint Co. and Millar Western Pulp Ltd., respectively. | In 1988 and 1989, this rate decreased from 0.15 day ⁻¹ for 12.2 km d/s Hinton to 0.05 day ⁻¹ for 54-107 km d/s Hinton, and from 0.7- 1.3 day ⁻¹ for 1.5 km d/s Millar Western Pulp Ltd. to 0.3-0.6 day ⁻¹ for 95-171 km d/s Millar Western Pulp Ltd. In 1990-1992, 0.01 day ⁻¹ for 130 km d/s Hinton and 0.2 day ⁻¹ for 238 km d/s Millar Western Pulp Ltd. Other reaches for all years were 0.000 day ⁻¹ . |
| Sediment Oxygen Demand | Data from 1989-1995 SOD surveys. Values for all years were 0.327, 0.472, 0.388 and 0.008 mg/L/day immediately d/s Hinton, Alberta Newsprint Co., Millar Western Pulp Ltd. and Slave Lake Pulp Corp., respectively. | For all years, SOD below each mill was set to decrease linearly in relation to BOD loading. For 1988 and 1989, 0.65 and 0.85 mg/L/day immediately d/s Hinton and Millar Western Pulp Ltd., respectively. For 1990, 0.25 and 0.40 mg/L/day immediately d/s Hinton and Millar Western Pulp Ltd., respectively. For 1991, 0.9, 0.02, 0.42 and 0.06 mg/L/day immediately d/s Hinton, Alberta Newsprint Co., Millar Western Pulp Ltd. and Slave Lake Pulp Corp., respectively. For 1992, 0.96, 0.03, 0.15 and 0.04 mg/L/day immediately d/s Hinton, Alberta Newsprint Co., Millar Western Pulp Ltd. and Slave Lake Pulp Corp., respectively. |
| Reference Temperature | 20°C | 0°C |
| DO Saturation Concentration | 12.98 to 13.62 mg/L depending upon elevation | 13 mg/L |

5.3 STOCHASTIC SOLUTION

The stochastic solution for the series of differential equations in DOSTOC can be obtained directly and a direct analytical solution for mean and variance of predicted DO can be found. This is derived in detail by Zielinski (1988) using the method outlined by Soong (1973). Two series of stochastic runs were made. The first examined the true variability of the DO simulations by using estimated variances obtained from the available data. The available data was limited to variance values (expressed as standard deviation) for BOD_u and DO concentrations and decay rates (estimated as a percentage of the mean) (Tables 4.5, 4.6, 4.7, 4.8, 4.9 and 4.10). The stochastic runs are shown in Figures 5.10 to 5.18. In 1990 and 1991, the observed DO values were all within the 90% confidence limits set by the stochastic analysis. For January 1989, 1992 and 1993 the model simulations were a reasonable fit to the observed data with 17 of 23, 18 of 19 and 17 of 20 observed DO values, respectively within the 90% confidence limits. DO concentrations for February 1988, March 1988, March 1989 and 1994 were not as well simulated, with only 12 of 16, 11 of 14, 12 of 22 and 13 of 21 observed DO values, respectively, falling inside the 90% confidence limits.

The model was re-run for the 1991 data set to assess the range of confidence limits that would be obtained for three different noise coefficient scenarios. In these three runs, all nine stochastic terms (which do not include the three equation noise parameters) were set to 0.3, 0.5 or 1.0. The resulting plots are shown in Figures 5.19, 5.20 and 5.21. Obviously the larger the uncertainty, the larger the confidence limits. This has interesting implications since all estimated decay rates, particularly values for BOD_u , may have uncertainty associated with them at 50 to 100% of their mean values. Although true estimates of variance are difficult to ascertain, uncertainty due to changing flows and temperature correction does not make our 50 and 100% scenarios unreasonable. In the case of 100% variance (Figure 5.24), the downstream 90% confidence limit is approximately 6 mg/l dissolved oxygen.

5.4 RESIDUAL ANALYSIS

A residual is the difference between the value predicted by an equation and the true value of the variable in the population (Zar 1984). Patterns in residuals may be an indication that there is a calculation error or that an additional important variable should be added to the regression model (Zar 1984). Linear regression was run on predicted versus observed DO from each of the DOSTOC runs and residuals were calculated using Minitab (Minitab Inc. 1994). Residuals were plotted against distance to observe patterns which would indicate whether DOSTOC was adequately explaining all the variables associated with the underlying Streeter-Phelps equations (Figures 5.22, 5.23 and 5.24). The pattern in residuals shows that DOSTOC is over-predicting DO concentrations downstream of Alberta Newsprint Co. and Millar Western Pulp Ltd. for all model runs and for 7 of the 9 model runs downstream of Weldwood of Canada Ltd. DOSTOC under predicted DO concentrations from approximately 500 km to upstream of Grand Rapids for 6 of the 9 runs (February and March 1988, January and March 1989, 1993 and 1994). This may be due to an increase or levelling off of DO in this reach of the Athabasca River. In the case of 1993, Noton and Allan (1994) noted an increase in DO due thinning of the ice cover (see discussion Chapter 7,

5.4 DISCUSSION

Our DOSTOC simulations were based on the best available estimates of the various model inputs. In contrast to previous modelling efforts (e.g. Macdonald and Hamilton 1989, Macdonald and Radermacher 1992, 1993), field measurements of SOD and BOD sedimentation were included in our model runs, BOD decay rates were temperature corrected, BOD decay rates and $BOD_u:BOD_5$ ratios for STP's were set at 0.026 (per day, 20°C) and 7.80, respectively, and BOD decay rates and $BOD_u:BOD_5$ ratios for headwaters and tributaries treated as point sources were set at 0.026 (per day, 20°C) and 8.03, respectively. Likewise, estimates of variance were based on best available data. The model results indicate that reasonable simulation can be expected for the reach between Hinton and Grand Rapids for the more recent (1990 - 1994) data sets. Poorer predictions in early years (1988 and March 1989) may relate to the limited data on tributary and STP inputs and mainstem DO concentrations for 1988 and in March 1989, to the large and erratic BOD loadings from Millar Western Pulp Ltd. which had likely not equilibrated with instream processes. The fact that, over the large scale (i.e., 100's of kilometers), the model successfully predicted DO concentrations for the 1990 to 1994 winters is encouraging given that discharge of the Athabasca River at Athabasca (1 km upstream of Highway 813 bridge) varied from 60 m³/s in 1993 to 107 m³/s in 1990. Nevertheless, the model consistently over-estimated DO concentrations in the sag zones below Millar Western Pulp Ltd. and/or Alberta Newsprint Co. for every winter and below Weldwood of Canada Ltd. in some winters. The failure of DOSTOC to accurately model the sag zones may be due to the fact that because of insufficient data, NOD was not included in the model. While the model was not "calibrated" in the typical sense (i.e. rates were not optimized to improve the fit of the model), it is premature to conclude that the model should "validate" well under other operating scenarios. Increases in the uncertainty of decay rates will result in very wide confidence margins for predicted DO values and easily limit the usefulness of the model. The uncertainty in the predicted DO values due to uncertainty in model rates demonstrates the difficulty in determining accurate simulations. Uncertainty in decay rates, reaeration rates and loadings should be assessed as accurately as possible in order to obtain a truer representation of the river system.

Figure 5.10 Dissolved oxygen (DO) concentrations predicted for the Athabasca River, AB for February 1988 using the simulation model DOSTOC run stochastically with best available estimates of standard deviation for BOD and DO concentrations and SOD decay rates.

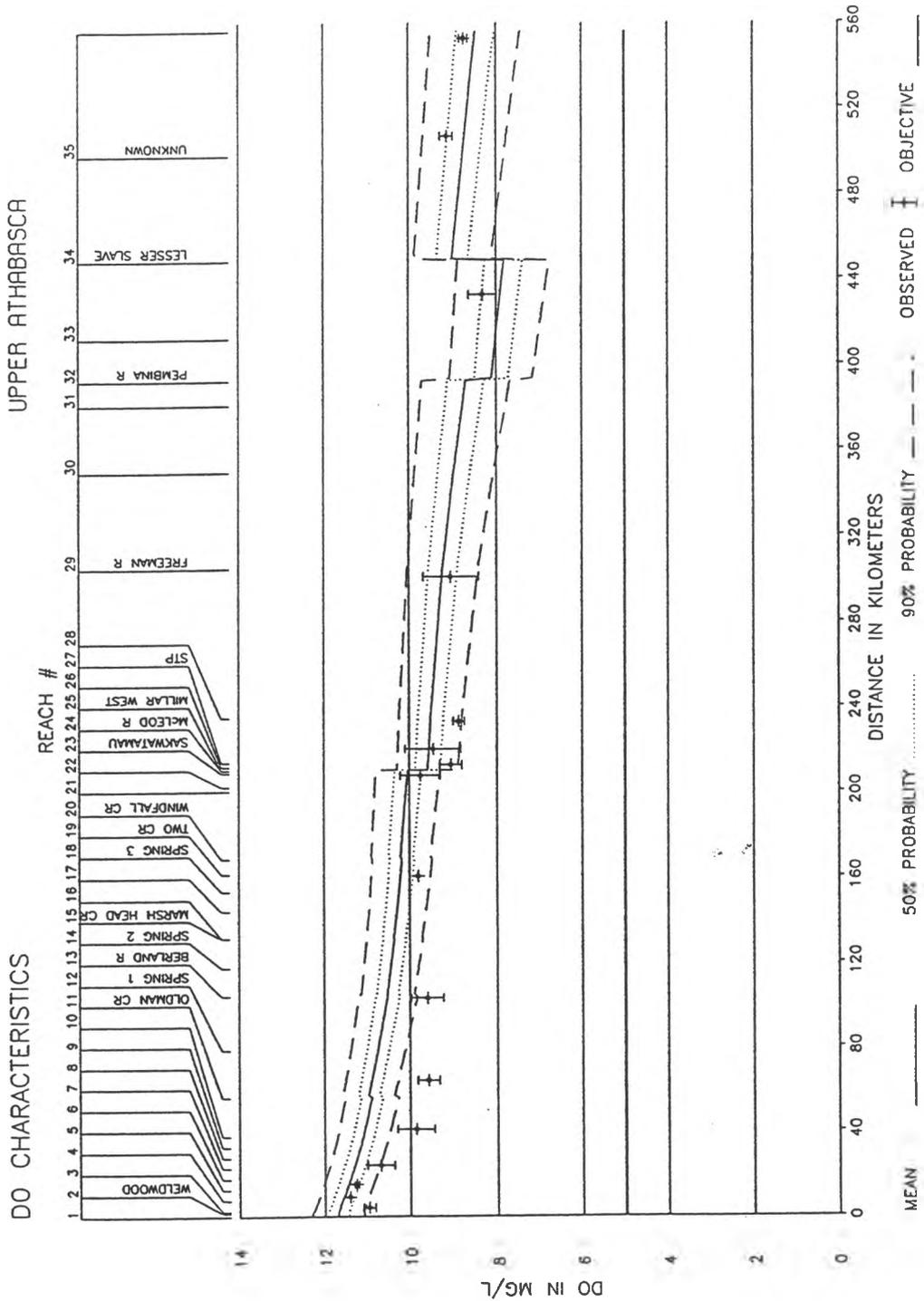


Figure 5.11 Dissolved oxygen (DO) concentrations predicted for the Athabasca River, AB for March 1988 using the simulation model DOSTOC run stochastically with best available estimates of standard deviation for BOD loadings and BOD and SOD decay rates.

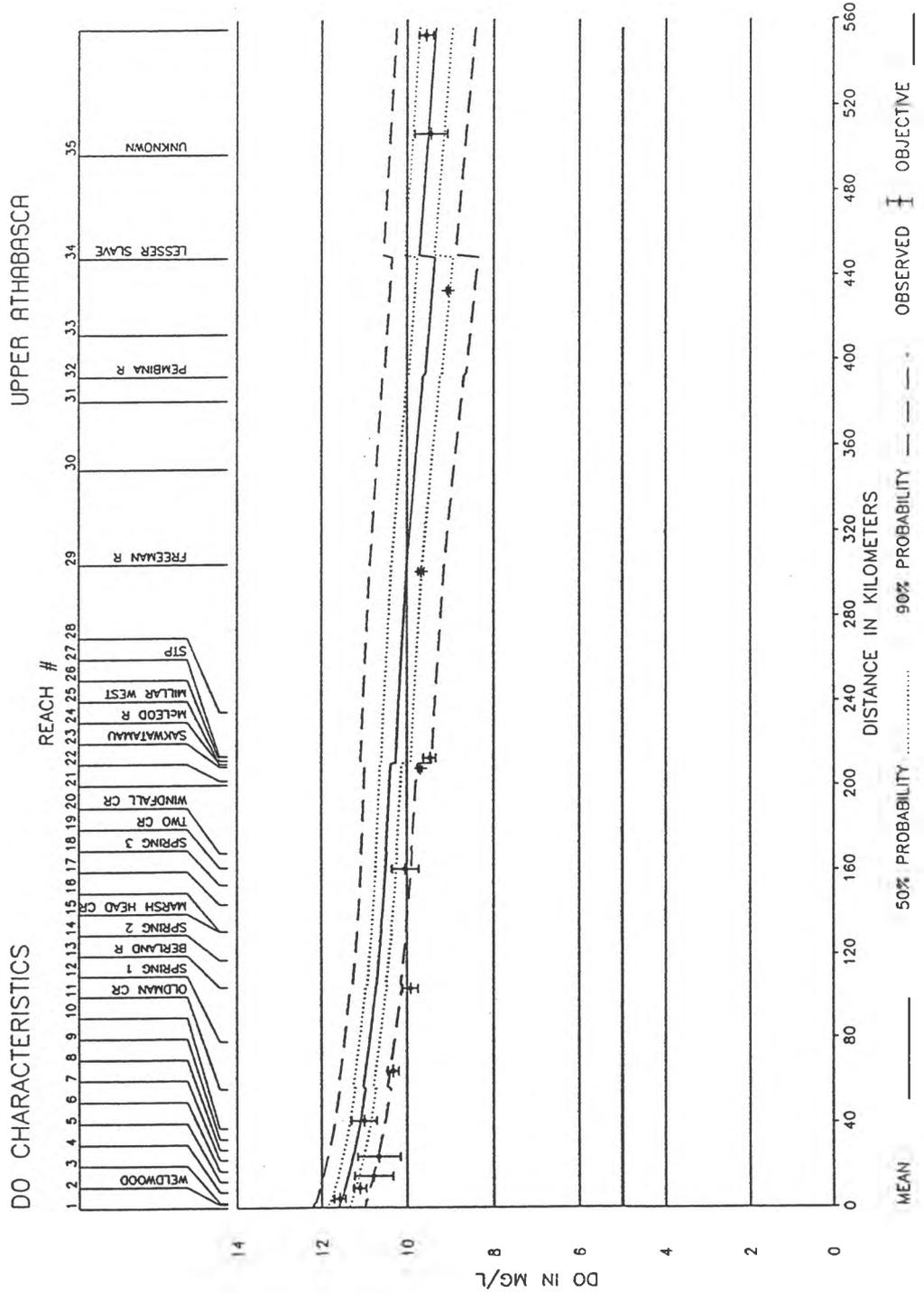


Figure 5.12 Dissolved oxygen (DO) concentrations predicted for the Athabasca River, AB for January 1989 using the simulation model DOSTOC run stochastically with best available estimates of standard deviation for BOD loadings and BOD and SOD decay rates.

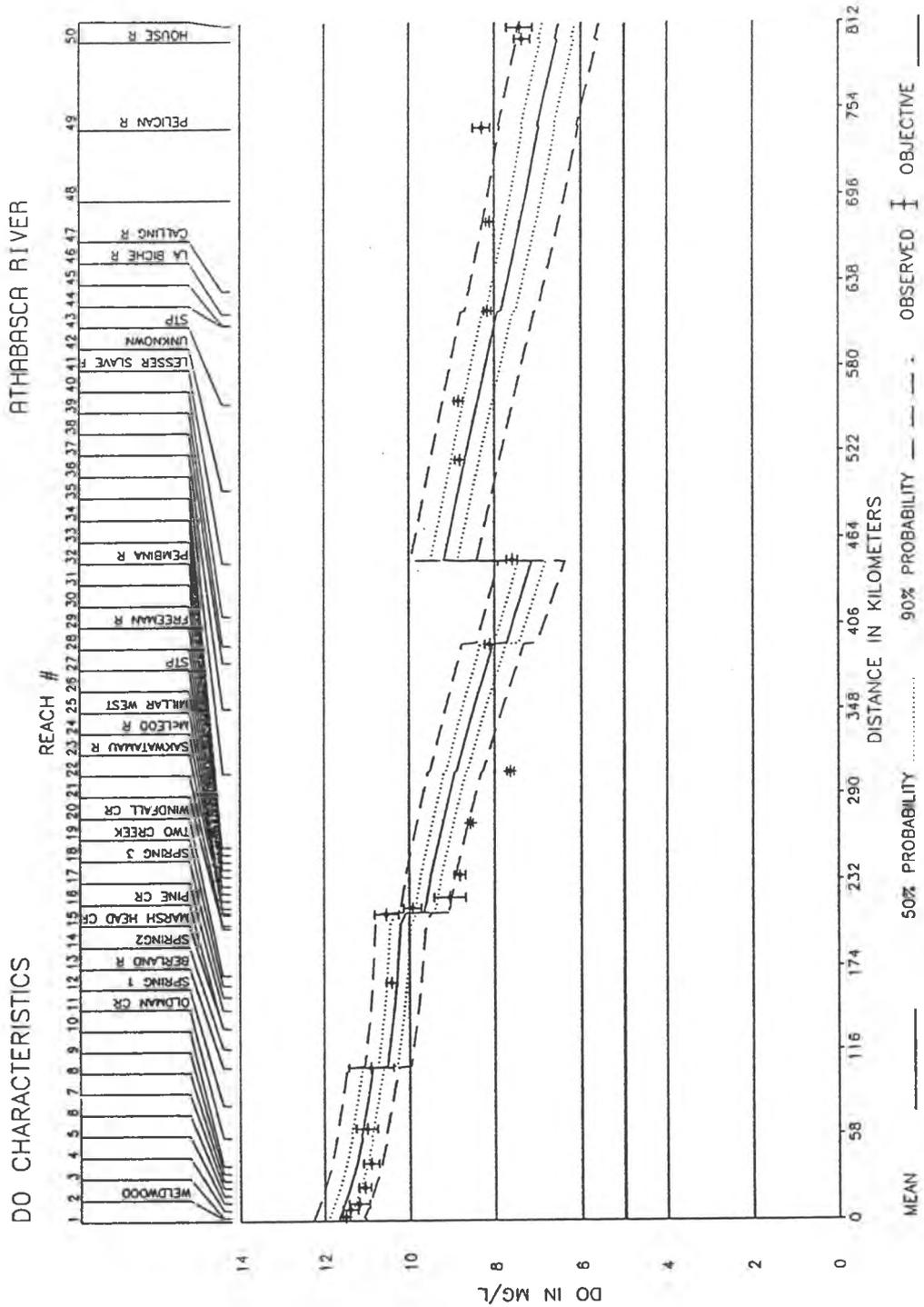


Figure 5.13 Dissolved oxygen (DO) concentrations predicted for the Athabasca River, AB for March 1989 using the simulation model DOSTOC run stochastically with best available estimates of standard deviation for BOD loadings and BOD and SOD decay rates.

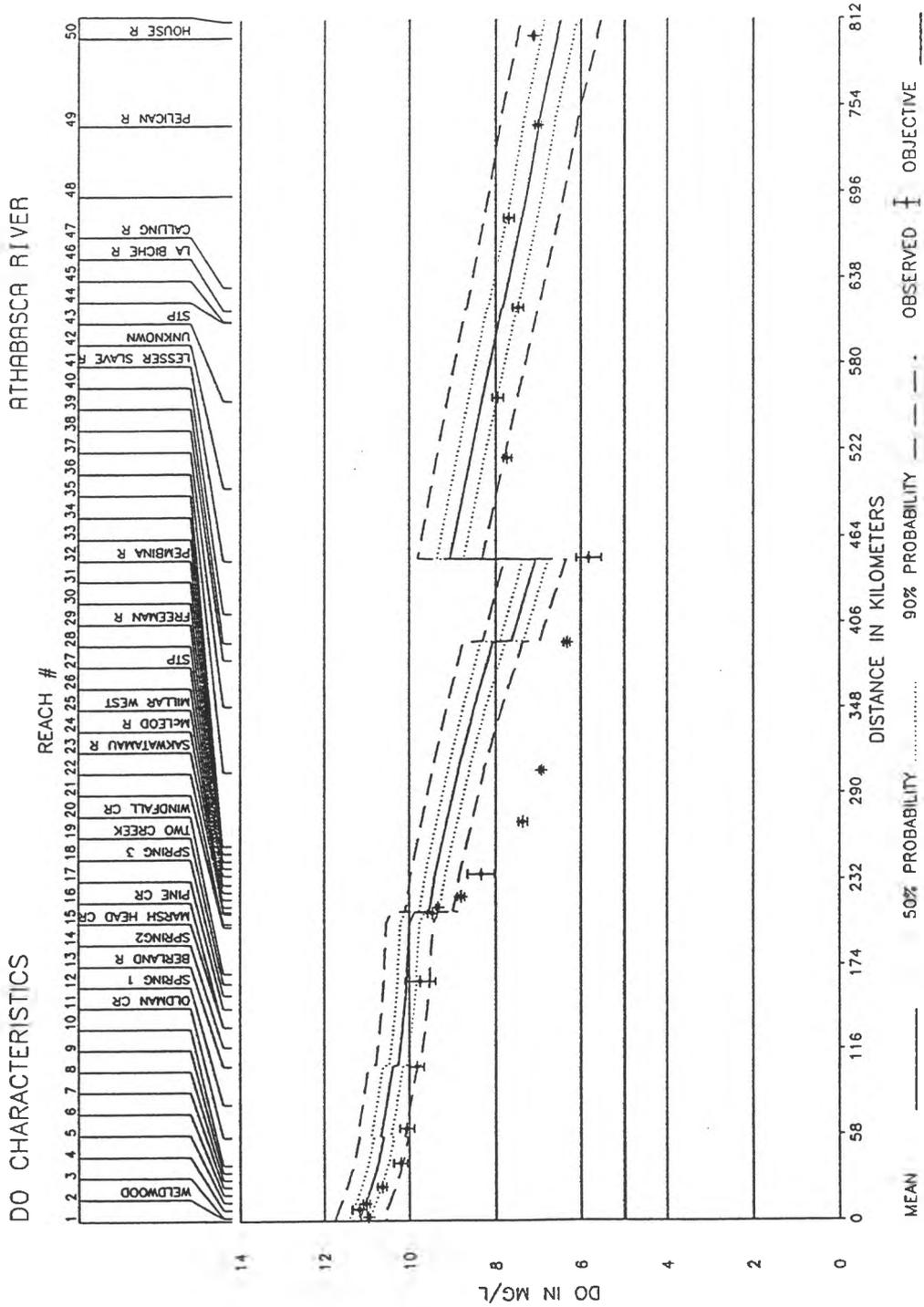


Figure 5.14 Dissolved oxygen (DO) concentrations predicted for the Athabasca River, AB for February - March 1990 using the simulation model DOSTOC run stochastically with best available estimates of standard deviation for BOD loadings and BOD and SOD decay rates.

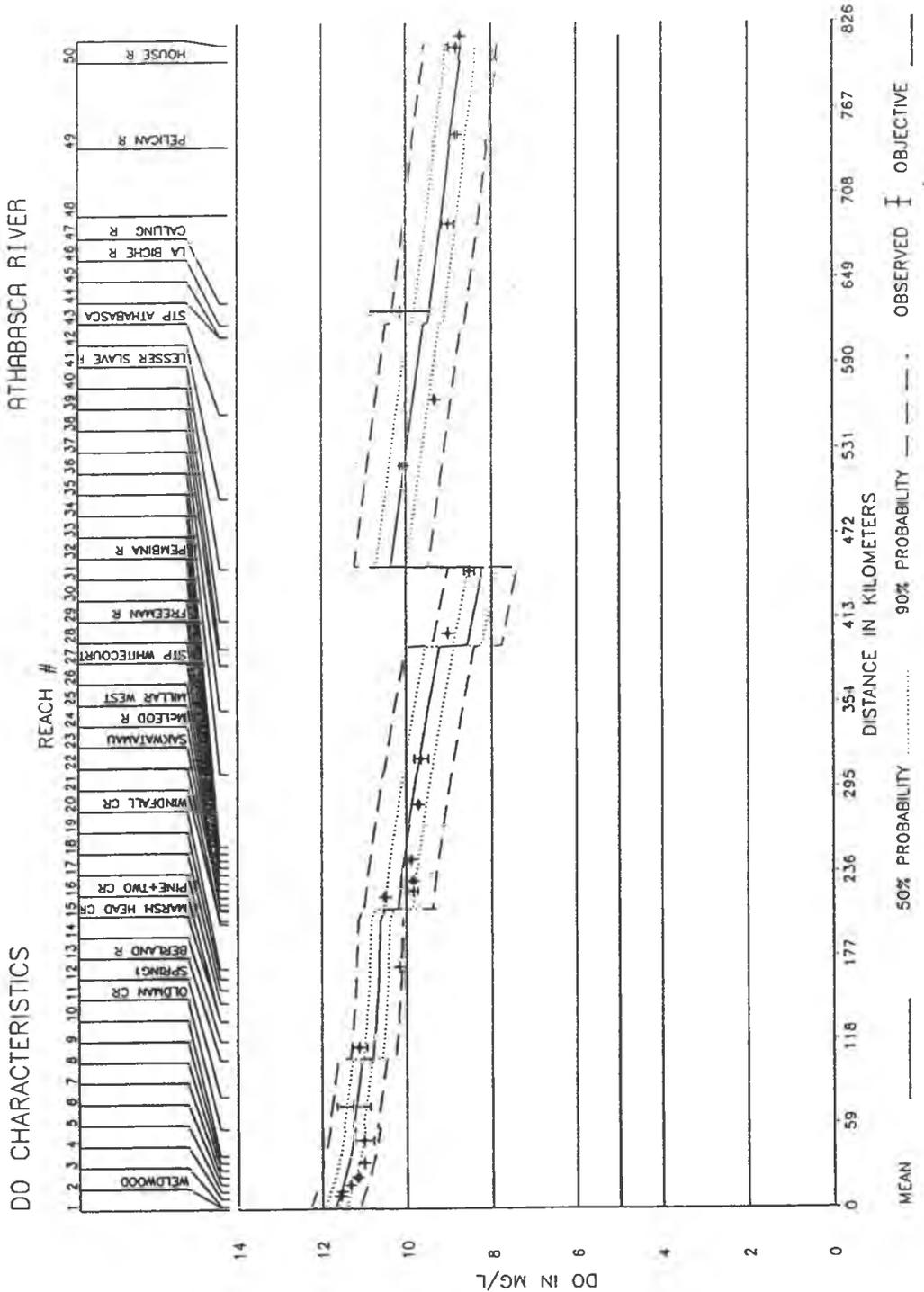


Figure 5.15 Dissolved oxygen (DO) concentrations predicted for the Athabasca River, AB for February - March 1991 using the simulation model DOSTOC run stochastically with best available estimates of standard deviation for BOD loadings and BOD and SOD decay rates.

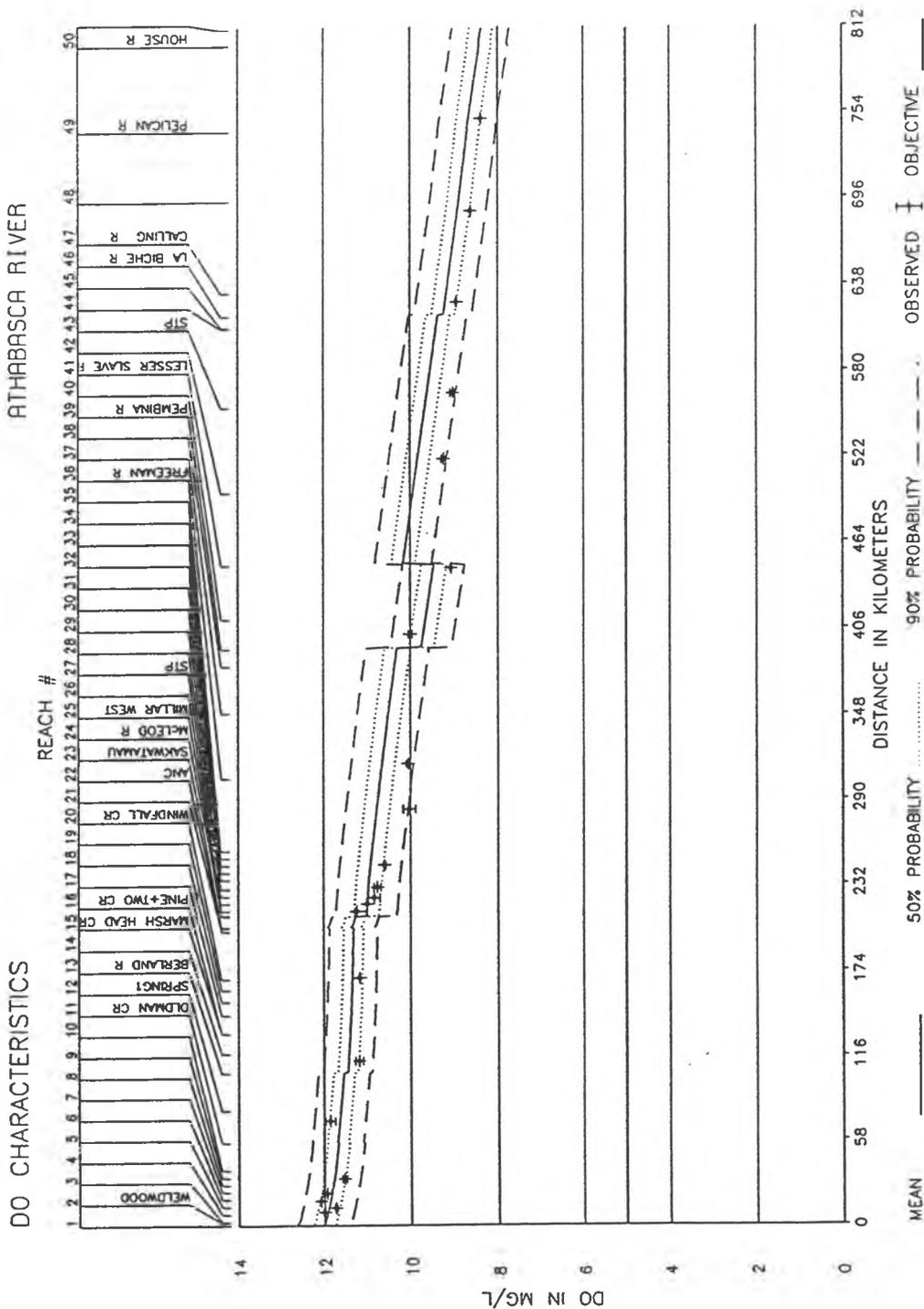


Figure 5.16 Dissolved oxygen (DO) concentrations predicted for the Athabasca River, AB for February - March 1992 using the simulation model DOSTOC run stochastically with best available estimates of standard deviation for BOD loadings and BOD and SOD decay rates.

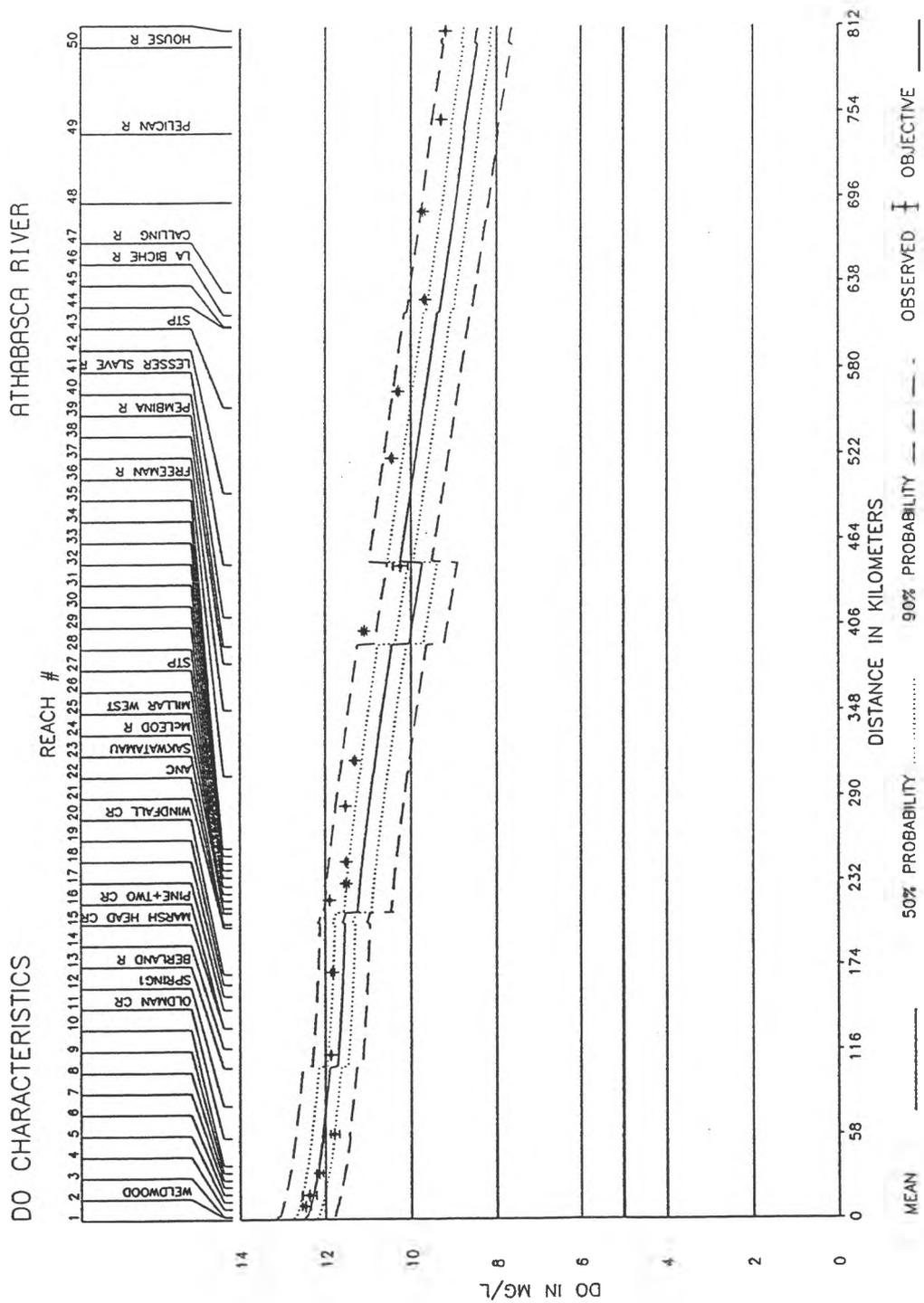


Figure 5.17 Dissolved oxygen (DO) concentrations predicted for the Athabasca River, AB for February - March 1993 using the simulation model DOSTOC run stochastically with best available estimates of standard deviation for BOD loadings and BOD and SOD decay rates.

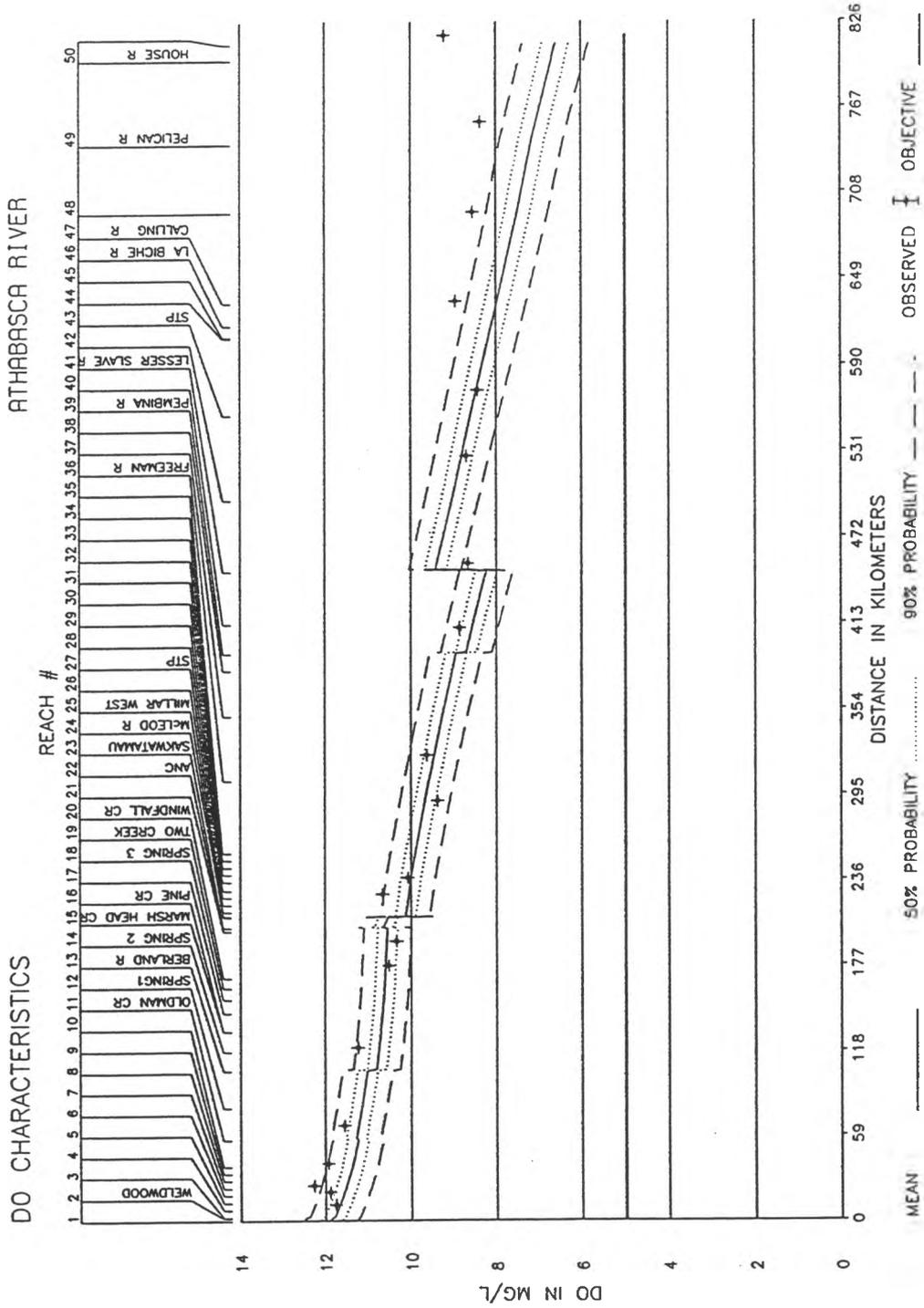


Figure 5.18 Dissolved oxygen (DO) concentrations predicted for the Athabasca River, AB for February - March 1994 using the simulation model DOSTOC run stochastically with best available estimates of standard deviation for BOD loadings and BOD and SOD decay rates.

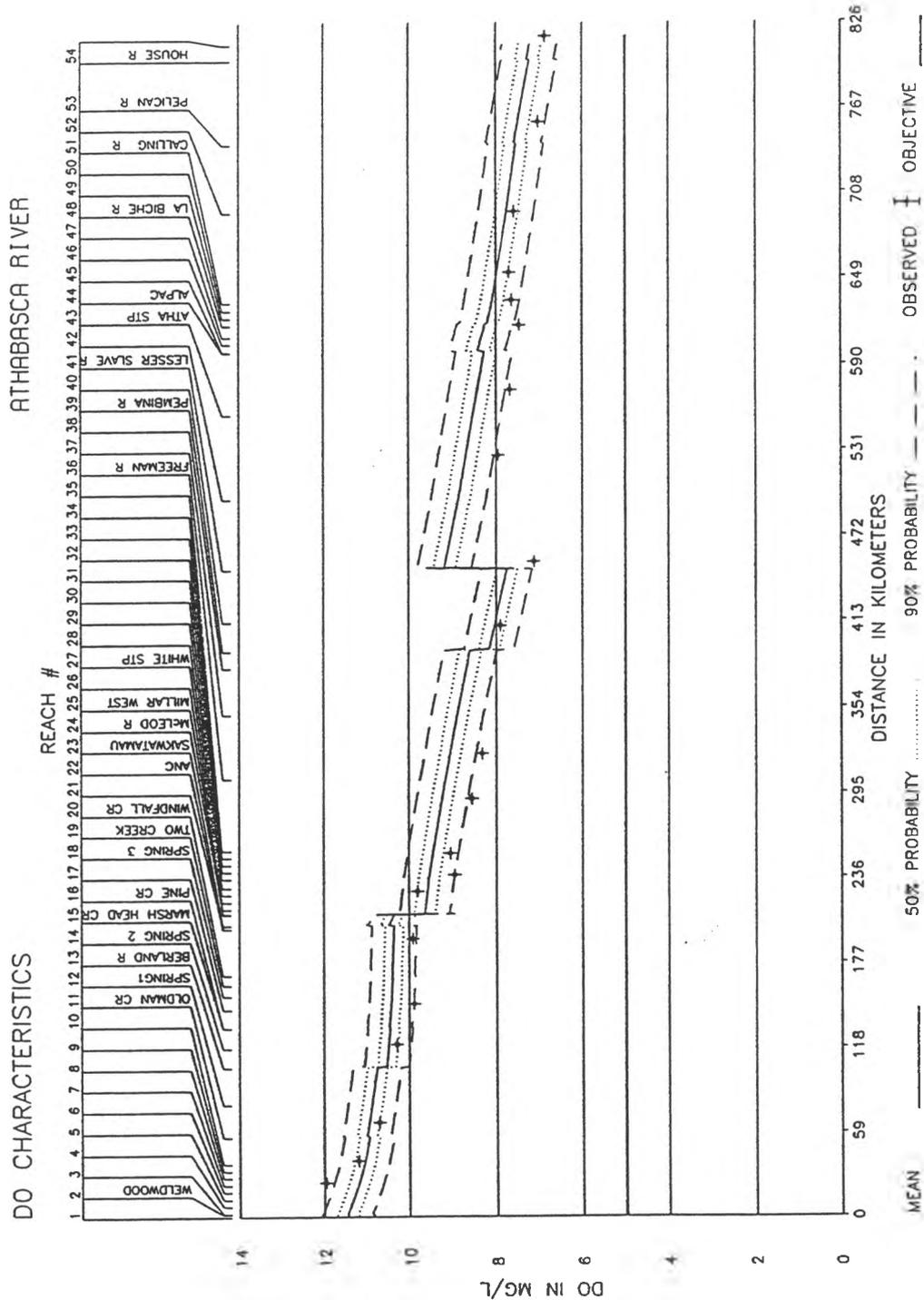


Figure 5.19 Stochastic results for 1991 with noise coefficients set to 0.3.

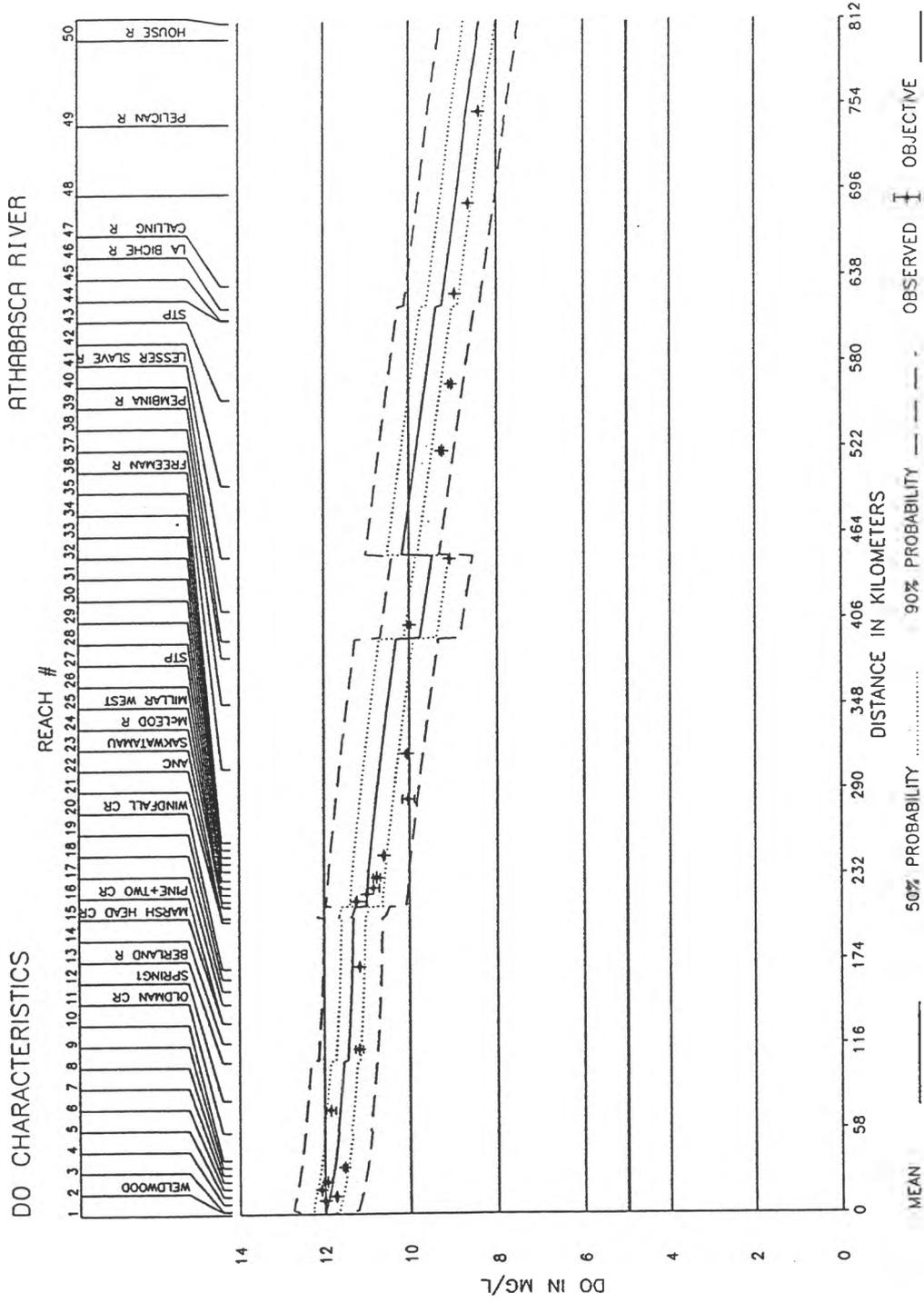


Figure 5.20 Stochastic results for 1991 with noise coefficients set to 0.5.

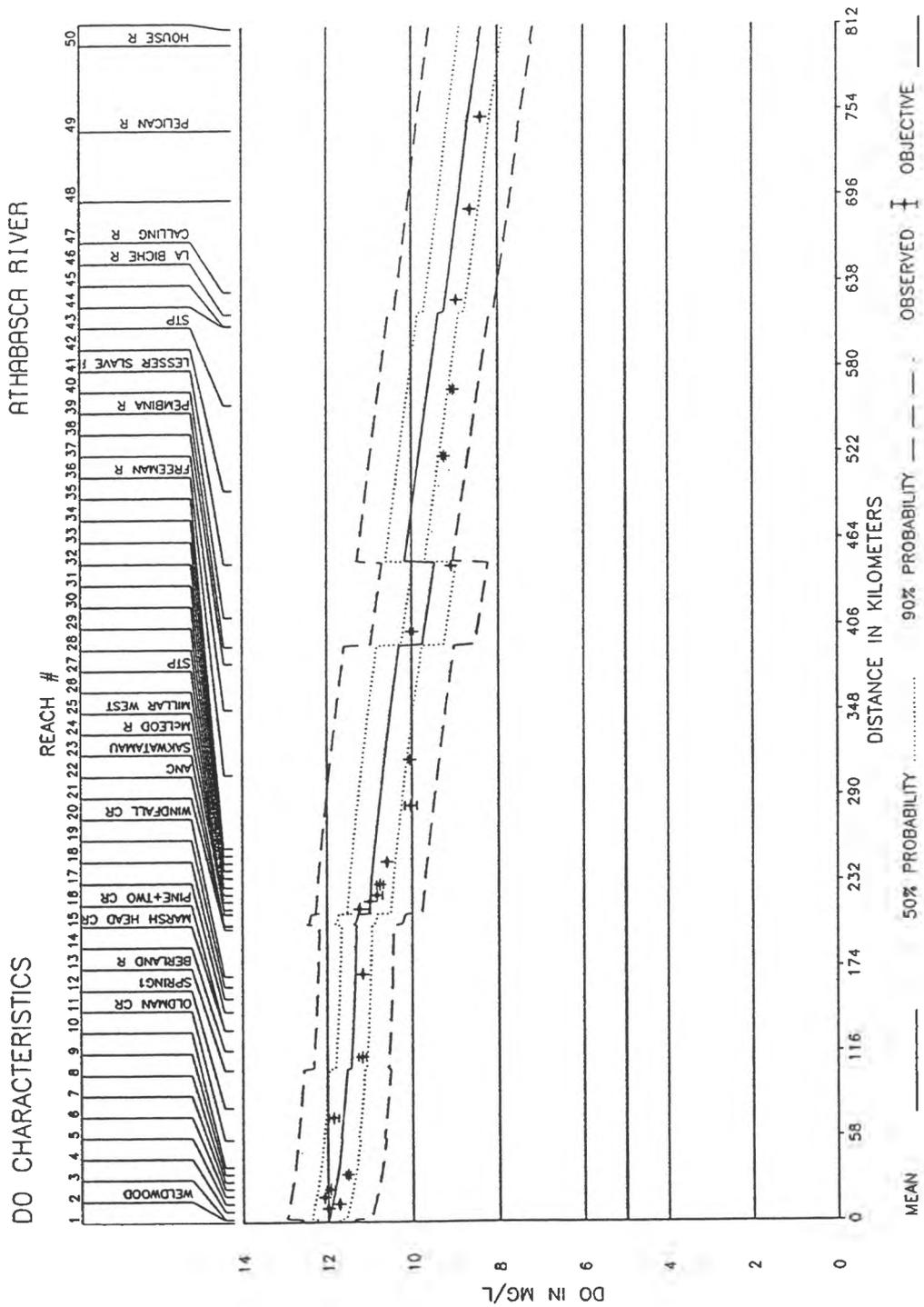


Figure 5.21 Stochastic results for 1991 with noise coefficients set to 1.0.

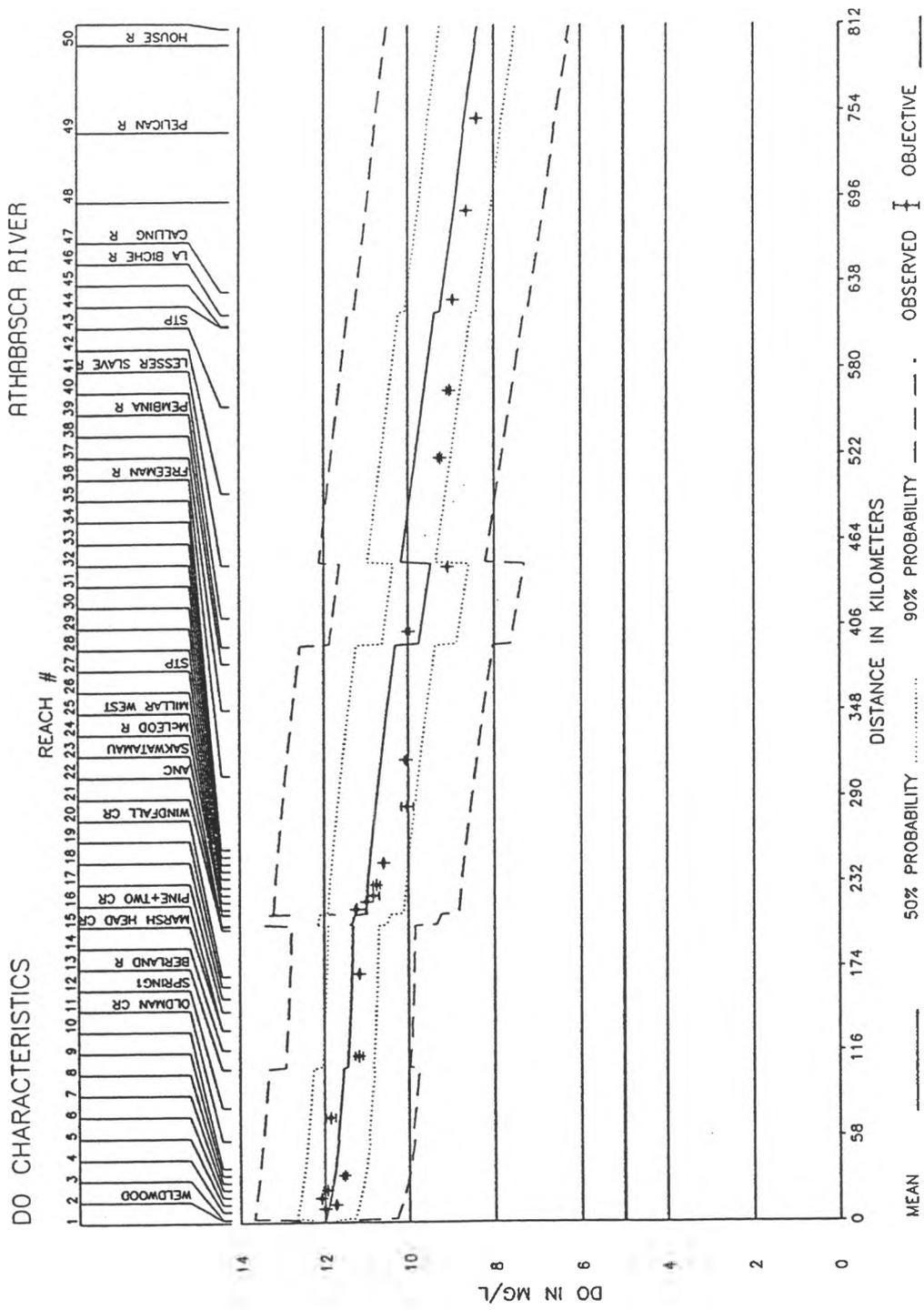


Figure 5.22 Residual analysis results for February and March 1988 and January and March 1989. W indicates the location of Weldwood of Canada Ltd. effluent input and MW indicates the location of Millar Western Pulp Ltd. effluent input.

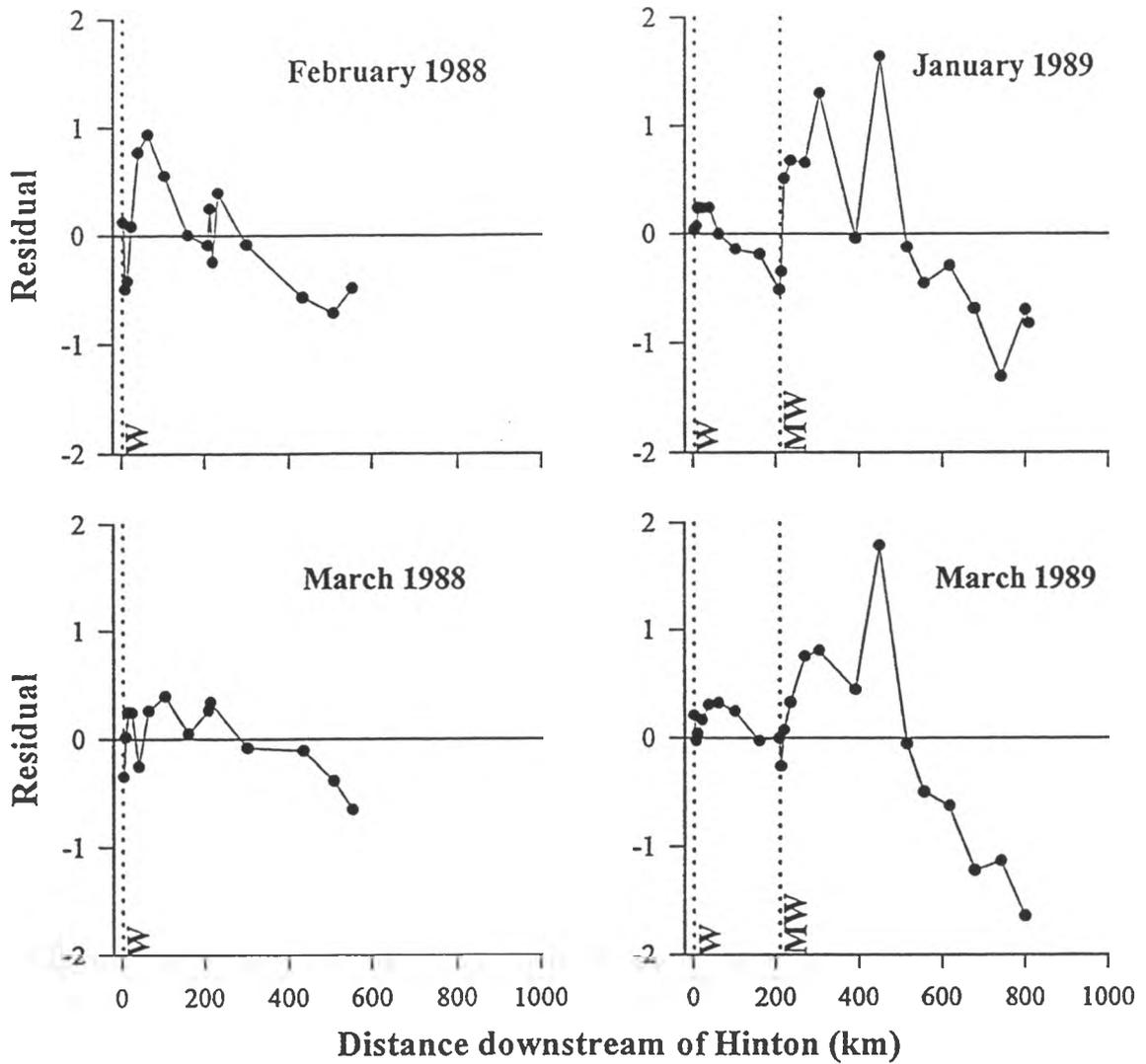


Figure 5.23 Residual analysis results for the winters of 1990, 1991, 1992 and 1993. W indicates the location of Weldwood of Canada Ltd. effluent input, MW indicates the location of Millar Western Pulp Ltd. effluent input and ANC indicates the location of Alberta Newsprint Co. effluent input.

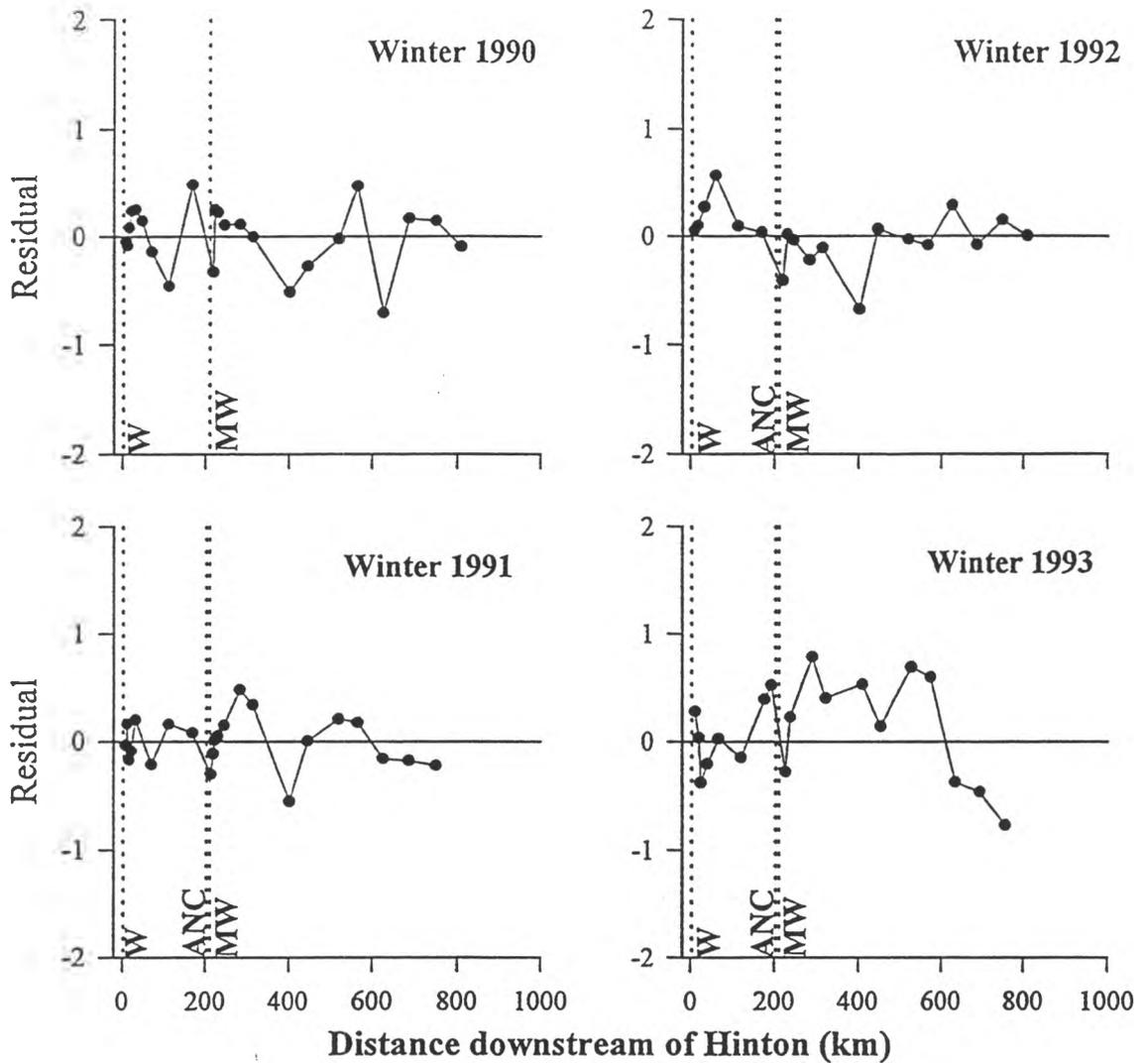
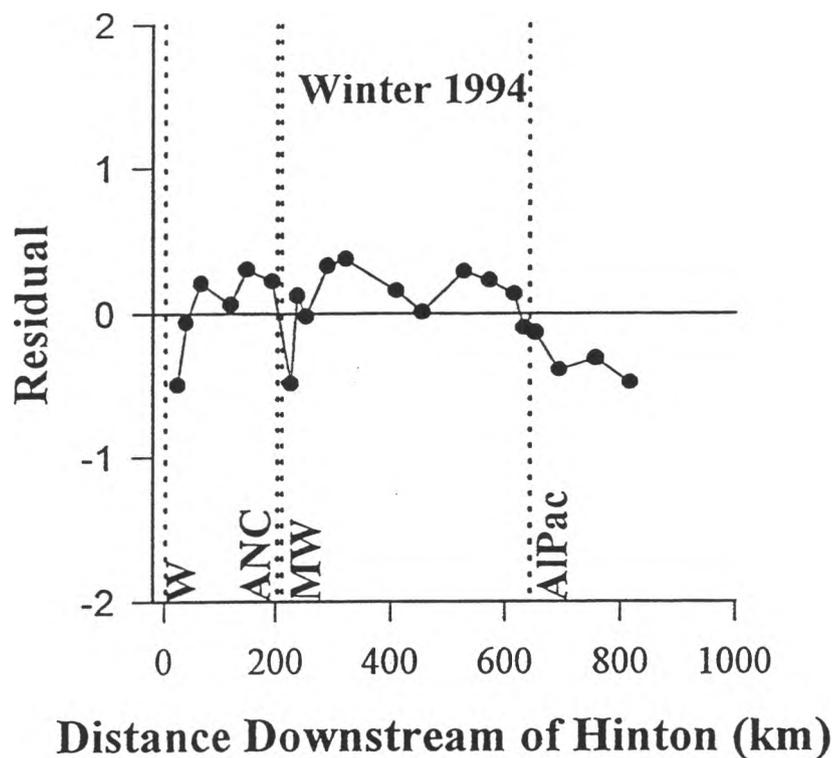


Figure 5.24 Residual analysis results for the winter of 1994. W indicates the location of Weldwood of Canada Ltd. effluent input, MW indicates the location of Millar Western Pulp Ltd. effluent input, ANC indicates the location of Alberta Newsprint Co. effluent input and AIPac indicates the location of Alberta Pacific Forest Industries Inc. effluent input.



6.0 COMPARISONS WITH OTHER WORLD RIVERS

6.1 INTRODUCTION

Dissolved oxygen concentrations in the Athabasca River under ice-cover decreased, on average, from 12 mg/L near the headwaters (i.e. upstream of the Town of Hinton) to a minimum of 5.8 to 9.5 mg/L upstream of Grand Rapids (Alberta Environment winter water quality surveys, 1989-1993). During the 1989-93 winter water quality surveys, BOD₅ loads to the river ranged from approximately 3000 to >10,000 kg/d (Table 6.1). In this chapter, we examine the decrease in DO with distance for the Athabasca River in relation to effluent load. Linear equations relating DO concentrations to river distance were developed by least squares regression and compared for each year to determine the effect of differences in effluent load on the rate of decrease in DO. The decline in DO with distance for the Athabasca River was then compared with values obtained from the literature for other ice-covered rivers throughout the world. This information will assist in evaluating the impact of anthropogenic (i.e. man-made) sources of BOD on dissolved oxygen dynamics in ice-covered rivers.

6.2 METHODS

Data were analyzed with the Statistical Analysis System (SAS Institute Inc. 1990). Regression equations relating DO concentrations to river distance were developed for the Athabasca River for: (1) a 22-48 river km reach upstream of Jasper for the 1974 to 1977 winters, (2) a 45 river km reach from immediately upstream of Jasper to the national park border for the 1974 to 1977 winters, (3) a 808 river km reach from upstream of Hinton to upstream of Grand Rapids for the 1988-1993 winters, and (4) a 393 river km reach from downstream of Grand Rapids to Lake Athabasca for the 1989-1993 winters. For the two reaches downstream of Hinton, differences among years in the relationship between DO and distance were examined with ANCOVA with year as the factor and distance as the covariate.

Regression equations relating DO concentration to river distance were developed for other ice-covered rivers throughout the world using data obtained from the literature. River distance was used instead of river travel time since this information was not available for all rivers. Each river included in the analysis had DO measurements from a minimum of three stations on each sampling occasion. Rates of change in DO (mg/L DO/km) were compared to the dilution of the effluent in the river by regression analysis.

Table 6.1 Point-source BOD loads (kg/d) to the Athabasca River between Hinton and Grand Rapids. "Mills" include Weldwood of Canada Ltd., Millar Western Pulp Ltd. (from 1989), Alberta Newsprint Co. (from 1991) and Slave Lake Pulp Corp. (from 1991). "Other" includes Whitecourt, Athabasca and Slave Lake town sewage. "Winter" is February/March. (Data from Alberta Environment from their winter water quality surveys.)

| | Mills | Other |
|---------------|--------------|--------------|
| February 1988 | 4480 | N/A |
| March 1988 | 2665 | N/A |
| January 1989 | 10189 | N/A |
| March 1989 | 7809 | N/A |
| Winter 1990 | 3955 | 726 |
| Winter 1991 | 3203 | 164 |
| Winter 1992 | 3041 | 127 |
| Winter 1993 | 3133 | 128 |

6.3 RESULTS

6.3.1 Longitudinal patterns in DO

DO concentrations in the headwaters of the Athabasca River (i.e. upstream of the Town of Jasper) ranged from 11.5 to 12.8 mg/L for the 1975-1976 winters (Fig. 6.1). There was no significant change ($P > 0.1$) in DO concentrations along the 45 km reach extending from immediately upstream of the Town of Jasper to the park boundary, despite an effluent load to the river of 5700 m³/d from the town. However, concentrations often decreased approximately 20 km downstream of Jasper at a site located immediately downstream of the confluence of the Athabasca and Snaring rivers. There was also no significant change ($P > 0.3$ except January 1975 when $P=0.08$) in DO concentrations with distance for the reach upstream of the Town of Jasper.

Downstream of the national park, DO concentrations for the 1988-1993 winters decreased from between 11.7 and 12.5 mg/L upstream of Hinton to 5.83 mg/L near Smith in March 1989 or to between 7.1 and 9.5 mg/L upstream of Grand Rapids in January 1989 and the 1990-1993 winters (Figures 6.2 and 6.3). Downstream of Grand Rapids, DO concentrations were greater (11.4 to 12.7 mg/L) than upstream of Hinton but decreased to between 10.0 and 11.2 mg/L over a distance of 394 km. Pulp mill BOD₅ loads totalled 3791 kg/d in 1988 when only one mill was operating. With the introduction of a new mill in August 1988, mill BOD₅ loading increased to 8999 kg/d in winter 1989 but decreased to 3955 kg/d in winter 1990 due to improved operations at both mills. BOD₅ loadings totalled 3203, 3037 and 3133 kg/d in the winters of 1991, 1992 and 1993, respectively, when four mills were operating. Sags in DO were observed below the mill at Hinton for most winters and below the Millar Western Pulp Ltd. mill at Whitecourt during the 1989 start-up winter. In contrast, municipal BOD₅ loads were small except for Fort McMurray which discharged an average of 319 kg/d (Table 6.1). Loads for tributaries without effluent discharges ranged from < 1 to 3825 kg/d BOD₅, with the Clearwater River (discharging at Fort McMurray) representing the largest tributary load. BOD₅ loads were also high for the Lesser Slave River (discharging at Smith), however recent values are attributable in part to the Slave Lake Pulp Corp. which began operations in December 1990 and discharged 311, 61 and 355 kg/d BOD₅ during the 1991, 1992 and 1993 winter surveys, respectively, to the Lesser Slave River 50 km upstream of its confluence with the Athabasca River.

Figure 6.1 Dissolved oxygen (DO) concentrations in the Athabasca River for the 93 km reach within Jasper National Park.

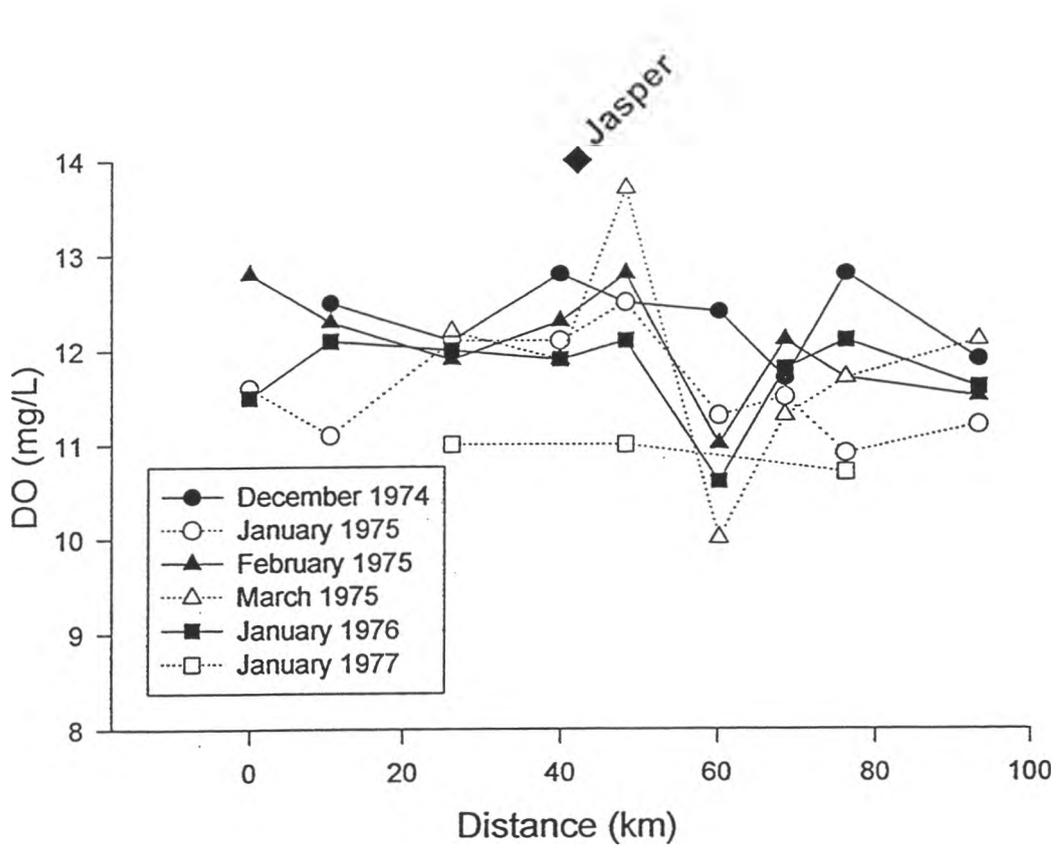


Figure 6.2 BOD₅ loads to and dissolved oxygen (DO) concentrations in the Athabasca River from upstream of Hinton to Athabasca for the 1988 winter and to Lake Athabasca for the 1989 winter. Note change in BOD₅ scale between Figures 6.2 and 6.3.

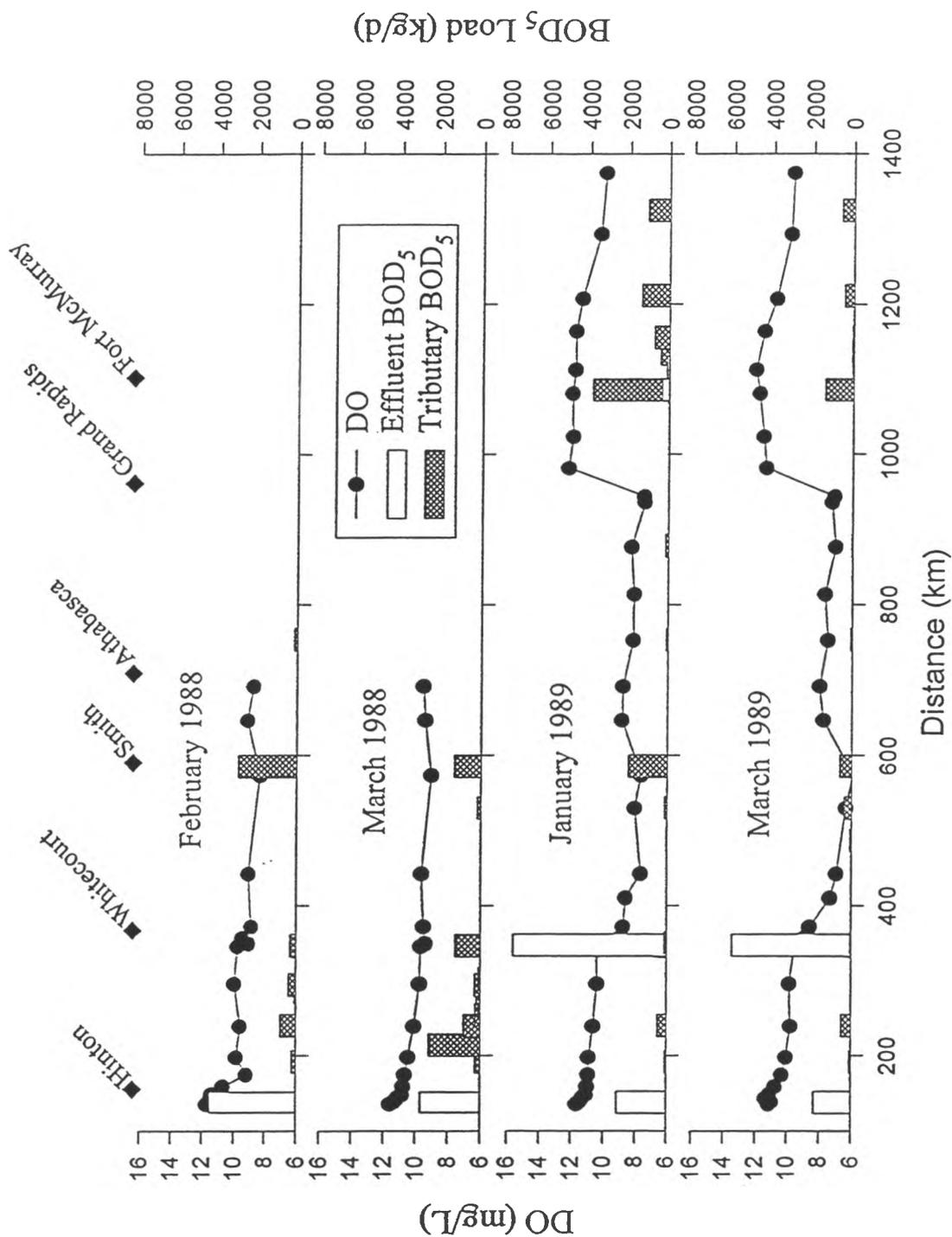
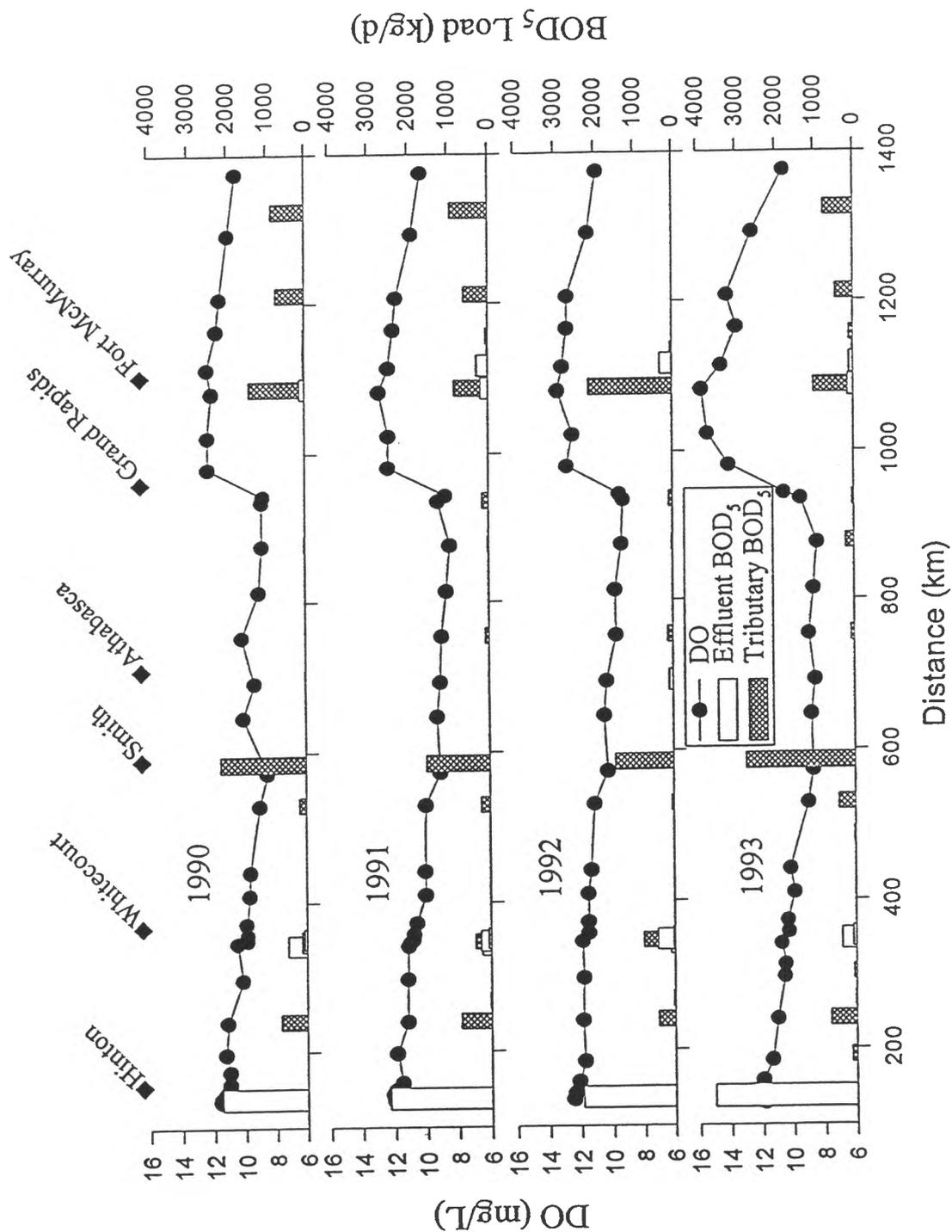


Figure 6.3 BOD₅ loads to and dissolved oxygen (DO) concentrations in the Athabasca River from upstream of Hinton to Lake Athabasca for the 1990-1993 winters. Note the change in BOD₅ scale between figures 6.2 and 6.3.



6.3.2 Empirical Modelling

Athabasca River

DO concentrations in the Athabasca River decreased linearly between Hinton and Grand Rapids and below Grand Rapids to Lake Athabasca (Table 6.2). Despite oxygen sags followed by recovery zones below the Weldwood of Canada Ltd. (Hinton) and, on occasion, Millar Western Pulp Ltd. (Whitecourt) mills, the coefficients of determination for all sixteen relationships were surprisingly good ($r^2 \geq 0.60$) and highly significant ($P < 0.0005$). There was no significant difference ($P > 0.1$; ANCOVA) between years in the slope of the DO versus distance regression lines for the reach between Hinton and Grand Rapids reach, despite the total load of BOD from pulp mills varying from 2665 kg/d (March 1988) to 10189 kg/d (January 1989).

DO concentrations also declined linearly ($r^2 \geq 0.60$, $P \leq 0.01$) with distance for the 400 km reach downstream of Grand Rapids (Table 6.2). There was no significant difference ($P > 0.2$; ANCOVA) among years in the slope of the DO versus distance regression lines for the reach between Hinton and Grand Rapids reach, despite inter-annual differences in BOD loading from the pulp mills in the upstream reach.

Comparisons of predicted versus observed values for linear regression and DOSTOC (Section 5) models showed that despite running the DOSTOC model with the best available data for process rates and input parameters, the linear regression and DOSTOC models gave similar fits to the data (Table 6.3). Four of the eight data sets were better modelled by linear regression (January and March 1988, March 1989, 1992), two gave similar fits for DOSTOC simulation and regression analysis (January 1989 and 1991) while another two data sets were better modelled by DOSTOC (1990 and 1993). While the typical sag followed by a recovery in DO concentrations was observed immediately below some outfalls (e.g. 1989; Figure 5.3) our observation that, DO declined linearly over 100's of kilometers suggests that over large distances, the effect of current loadings to the Athabasca River is overshadowed by natural loads or natural instream processes that consume or replenish oxygen. Over shorter distances (i.e. less than 10-20 km), oxygen depleting processes associated with effluent loading may be more important.

World Rivers

Regression analysis of DO concentration versus distance for ice-covered rivers throughout the world showed that DO decreased linearly for most (9 of 13) river reaches receiving anthropogenic point-source loading (Table 6.4). One exception was the TuMen, China where effluent comprised, on average, 28% of the winter flow and the change in DO concentrations was non-linear (i.e. a sag followed by a recovery) on two of six dates. Three other rivers also received effluent and showed no significant ($P > 0.1$) longitudinal changes in DO: the Athabasca River, Alberta, from upstream of Jasper to Hinton on all dates; the Lesser Slave River, Alberta, on two occasions; and the Peace River, Alberta. For the nine river reaches not receiving point-source loading of anthropogenic waste, five showed no significant change ($P > 0.1$) or a possible increase ($0.05 < P < 0.1$) in DO concentrations with distance while the other four showed a significant decrease ($P < 0.05$) in DO with distance.

Regression analysis of data for ice-covered rivers throughout the world showed that the

Table 6.2 Regression equations relating dissolved oxygen (DO, mg/L) concentration to river distance (km) for the Athabasca River for the reach between Hinton and Grand Rapids and below Grand Rapids to Lake Athabasca.

| Date | Hinton to Grand Rapids | below Grand Rapids to Lake Athabasca |
|-------|--|---|
| Feb88 | -0.0044 Distance + 10.62 ($r^2 = 0.60$; $P = 0.0003$; $n = 17$) | data not available |
| Mar88 | -0.0035 Distance + 10.80 ($r^2 = 0.68$; $P < 0.0001$; $n = 16$) | data not available |
| Jan89 | -0.0045 Distance + 10.84 ($r^2 = 0.75$; $P < 0.0001$; $n = 24$) | -0.0059 Distance + 17.57 ($r^2 = 0.88$; $P = 0.0005$; $n = 8$) |
| Mar89 | -0.0050 Distance + 10.31 ($r^2 = 0.66$; $P < 0.0001$; $n = 24$) | -0.0055 Distance + 16.80 ($r^2 = 0.70$; $P = 0.01$; $n = 8$) |
| 1990 | -0.0031 Distance + 11.03 ($r^2 = 0.74$; $P < 0.0001$; $n = 24$) | -0.0048 Distance + 16.56 ($r^2 = 0.91$; $P = 0.0002$; $n = 8$) |
| 1991 | -0.0044 Distance + 11.76 ($r^2 = 0.92$; $P < 0.0001$; $n = 24$) | -0.0058 Distance + 17.77 ($r^2 = 0.80$; $P = 0.003$; $n = 8$) |
| 1992 | -0.0039 Distance + 12.38 ($r^2 = 0.96$; $P < 0.0001$; $n = 20$) | -0.0049 Distance + 17.39 ($r^2 = 0.60$; $P = 0.023$; $n = 8$) |
| 1993 | -0.0038 Distance + 11.44 ($r^2 = 0.66$; $P < 0.0001$; $n = 20$) | -0.0104 Distance + 24.47 ($r^2 = 0.70$; $P = 0.01$; $n = 8$) |

Table 6.3

Comparison of residual mean square (RMS) and r^2 values for DOSTOC simulation and linear regression models for dissolved oxygen in the Athabasca River from Hinton to Grand Rapids, Alberta.

| Year | DOSTOC | | Linear Regression | |
|----------|--------|-------|-------------------|-------|
| | RMS | r^2 | RMS | r^2 |
| Jan 1988 | 0.62 | 0.51 | 0.67 | 0.60 |
| Mar 1988 | 0.50 | 0.53 | 0.46 | 0.68 |
| Jan 1989 | 0.66 | 0.79 | 0.74 | 0.75 |
| Mar 1989 | 1.06 | 0.56 | 0.99 | 0.66 |
| 1990 | 0.30 | 0.89 | 0.51 | 0.74 |
| 1991 | 0.34 | 0.92 | 0.35 | 0.92 |
| 1992 | 0.53 | 0.74 | 0.21 | 0.96 |
| 1993 | 0.65 | 0.81 | 0.80 | 0.66 |

Table 6.4 Rate of change in DO (DO Change) for ice-covered rivers throughout the world (n = 3 minimum for each river on each sampling occasion). Also given are drainage area, winter discharge, effluent load for all point sources located upstream and in the study reach, and distance of the study reach. (Data from the study or, if discharge and drainage area were not supplied, from the Water Survey Canada station nearest the downstream end of the study reach.) (NS indicates not significant at P > 0.1; N/A indicates data not available).

| River | Drainage Area (km ²) | Distance (km) | Date | Discharge (m ³ /s) | Effluent (m ³ /d x10 ⁴) | DO Change (mg/L/km) |
|---|----------------------------------|---------------|-------|-------------------------------|--|---------------------|
| Non-impacted Rivers | | | | | | |
| Athabasca, Alberta - u/s of Jasper (Environment Canada unpubl. data) | 9780 | 38 | Dec74 | 20 | 0 | NS |
| | | | Jan75 | 13 | 0 | 0.0227 |
| | | | Feb75 | 12 | 0 | NS |
| | | | Mar75 | 10 | 0 | NS |
| | | | Jan76 | 15 | 0 | NS |
| Beaver, Alberta -u/s of Sand River confluence (Babin andTrew 1985) | 4,710 | 27 | Dec84 | 0.7 | 0 | -0.083 |
| Nordenskiold, Yukon (Whitfield and McNaughton 1986) | 6,370 | 30 | Jan83 | 3.6 | 0 | NS |
| | | | Feb83 | 3.5 | 0 | NS |
| | | | Mar83 | 2.7 | 0 | NS |
| North Saskatchewan River, Alberta - u/s of Rocky Mountain House (Anderson et al 1986, Noton 1990) | 11,000 | 122 | Feb86 | 49 | 0 | -0.0065 |
| Ogilvie, Yukon (Schreier et al. 1980) | 7,220 | 30 | Mar78 | 1.0 | 0 | NS |
| Red Deer, Alberta - u/s of Red Deer (Bouthillier and Simpson 1972) | 11,600 | 45 | Jan71 | 8.5 | 0 | NS |
| Sand, Alberta (Babin andTrew 1985) | 4,910 | 47 | Dec84 | 4.3 | 0 | -0.0082 |
| Swift, Yukon (Schreier et al. 1980) | 3,870 | 20 | Dec77 | 13 | 0 | NS |
| | | | Mar78 | 8.6 | 0 | NS |
| Takhini, Yukon (Whitfield and McNaughton 1986) | 6,990 | 60 | Jan83 | 17 | 0 | NS |
| | | | Feb83 | 15 | 0 | -0.0227 |
| | | | Mar83 | 12 | 0 | -0.0150 |

| River | Drainage Area (km ²) | Distance (km) | Date | Discharge (m ³ /s) | Effluent (m ³ /d x 10 ⁴) | DO change (mg/L/km) |
|---|----------------------------------|---------------|---------|-------------------------------|--|---------------------|
| Impacted Rivers | | | | | | |
| Athabasca, Alberta - Jasper to u/s Hinton (Environment Canada unpubl. data) | 9790 | 45 | Dec74 | 57 | 0.57 (only one 1988 measurement available) | NS |
| | | | Jan75 | 33 | | NS |
| | | | Feb75 | 28 | | NS |
| | | | Mar75 | 34 | | NS |
| | | | Jan76 | 30 | | NS |
| Athabasca, Alberta - Hinton to Grand Rapids (this study) | 74,600 | 808 | Feb88 | 55 | 9.3 | -0.0044 |
| | | | Mar88 | 72 | 9.7 | -0.0035 |
| | | | Jan89 | 87 | 10.9 | -0.0045 |
| | | | Feb89 | 70 | 11.0 | -0.0045 |
| | | | Mar89 | 75 | 11.2 | -0.0050 |
| | | | 1990 | 119 | 9.3 | -0.0031 |
| | | | 1991 | 107 | 13.6 | -0.0044 |
| | | | 1992 | 88 | 14.1 | -0.0039 |
| Athabasca, Alberta - d/s Grand Rapids (this study) | 159,000 | | Jan89 | 136 | 15.3 | -0.0059 |
| | | | Mar89 | 138 | 14.6 | -0.0055 |
| | | | 1990 | 203 | 13.5 | -0.0048 |
| | | | 1991 | 152 | 17.9 | -0.0058 |
| | | | 1992 | 135 | 17.7 | -0.0049 |
| | | | 1993 | 129 | 18.9 | -0.0104 |
| Beaver, Alberta/Saskatchewan-d/s Sand River confluence (Babin and Trew 1985) | 20,500 | 374 | Dec84 | 4.2 | N/A | -0.0070 |
| Lesser Slave, Alberta (Noton and Shaw 1989 and Alberta Environment, unpublished data) | 15,100 | 71 | Jan89 | 25 | 0.3 | NS |
| | | | Mar89 | 23 | 0.3 | -0.0123 |
| | | | 1990 | 44 | 0.3 | -0.0154 |
| | | | 1991 | 18 | 0.5 | NS |
| | | | 1992 | 15 | 0.5 | -0.0323 |
| 1993 | 14 | 0.6 | -0.0211 | | | |
| North Saskatchewan, Alberta - between Rocky Mountain House and Devon (Anderson et al. 1986, Noton 1990) | 28,000 | 216 | Feb86 | 90 | 0.32 | -0.0060 |
| North Saskatchewan, Alberta - between Devon and AB/SK border (Anderson et al. 1986, Noton 1990) | 47,700 | 382 | Feb86 | 95 | 47.6 | -0.0126 |

| River | Drainage Area (km ²) | Distance (km) | Date | Discharge (m ³ /s) | Effluent (m ³ /dx10 ⁴) | DO change (mg/L/km) |
|--|----------------------------------|---------------|--|--|--|--|
| Peace, Alberta-between Peace River and Fort Vermillion ¹ (Shaw et al. 1990) | 223,000 | 442 | Mar89 | 1300 | 8.6 | NS |
| Red Deer, Alberta - between Red Deer and AB/SK border (Bouthillier and Simpson 1972) | 44,700 | 85 | Jan71 | 8.5 | 1.1 | -0.0877 |
| Smoky, Alberta (Noton 1992) | 50,300 | 182 | Mar89 Feb90 | 23.4 78.6 | 8.0 7.1 | -0.0122 -0.0078 |
| TuMen, China (Ranjie and Huimin 1987) | 33,168 | 37 | Dec80 Dec80 Jan81 Jan81 Feb81 Feb81 Mar81 Mar81 | 8.4 9.2 7.3 7.3 7.8 9.1 7.3 8.6 | 20 (only one measurement available) CHECK! | -0.0623 -0.2138 -0.1519 -0.2060 NS -0.1861 NS -0.1254 |
| Wapiti, Alberta (Noton 1992) | 11,300 | 44 | Mar89 Feb90 | 7 14 | 7.8 6.9 | -0.0805 -0.0533 |
| Yukon, Alaska (Schallock and Lotspeich 1974) | 854,692 | 1674 | Mar71 | 759 | n/a | -0.0052 |

¹Data excluded from upstream of Peace River as this reach is ice-free for much of the winter and from downstream of Fort Vermilion as reaeration occurs at Vermilion Chutes.

rate of change in DO (non-significant ($P > 0.1$) rates excluded) was inversely related to the dilution of the effluent in the river such that:

$$DO \text{ change} = -0.522 \text{ Dilution} - 0.008 \quad \text{Equation 6.1}$$

$(r^2 = 0.75; P < 0.0001; n = 38)$

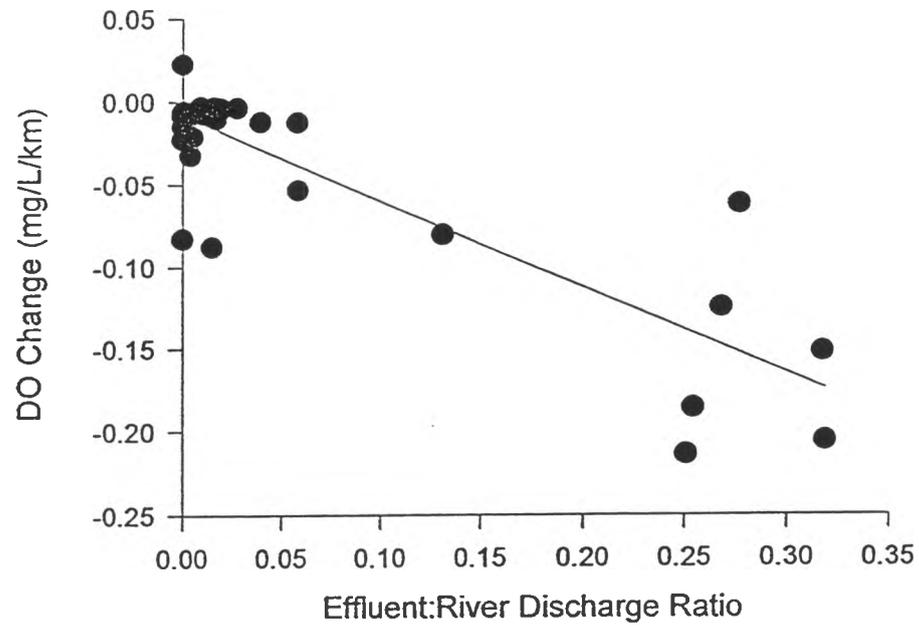
where DO change is the rate of change in DO with distance (mg/L/km) and Dilution is the effluent:river discharge ratio (Fig. 6.4). While most of the data were clustered at dilution ratios of less than 0.06, removal of the most polluted river from the analysis (i.e. the TuMen River where the dilution ratio was 0.25 - 0.32 and the rate of change in DO was -0.062 to -0.214 mg/L/km) still resulted in a significant relationship ($P=0.01$) although the r^2 value was reduced to 0.19.

6.4 DISCUSSION

Examination of spatial patterns in DO for the 1988-1993 winters showed that DO concentrations in the Athabasca River decreased from 11.8 ± 0.3 mg/L upstream of any mill outfalls to 8.5 ± 0.5 mg/L over a distance of 808 river km. Thereafter, concentrations returned to near-saturation values (12-14 mg/L) as a result of reaeration in an open-water zone of turbulent mixing and then decreased to 6 to 11 mg/L (1989-1993) near the mouth. DO sags followed by recovery zones occurred immediately below some mill outfalls in certain years (e.g. below Weldwood of Canada Ltd. (Hinton) for most years and below Millar Western Pulp Ltd. (Whitecourt) following its 1989 start-up; Figures 6.2 and 6.3). However, over a scale of 100's of kilometers, DO concentrations decreased linearly ($r^2 \geq 0.60$, $P \leq 0.01$) for reaches receiving effluent. In contrast, DO concentrations in the relatively pristine headwaters showed no significant change ($P > 0.1$) with distance. These observations suggest that while effluent loading to the downstream reaches of the Athabasca River resulted in small-scale (10's of kilometres) sag and recovery zones, it also contributed to large-scale (100's of kilometres) linear declines in DO. It is not possible from our data to estimate what proportion of the large-scale decline in DO is caused by to oxygen consumption due to break-down of effluent versus natural organic material produced in the river or watershed. While the lack of any significant change in DO concentrations upstream of the mills suggests that the mill effluent was a major determinant of the downstream decline in DO, the upper reach of the river drained a smaller area, had lower flows and likely had lower inputs of natural organic material than the lower reaches. Thus, natural as well as anthropogenic inputs likely contributed to the decline in DO concentrations in reaches receiving effluents. Surprisingly, there was no significant difference ($P > 0.1$) between sampling dates in large-scale declines in DO concentrations with distance despite BOD₅ loading from pulp mills ranging from 2665 kg/d in March 1988 to 10189 kg/d in January 1989.

Since the slopes of the DO versus relationships did not differ ($P > 0.1$) between years for the Hinton-Grand Rapids reach or the reach downstream of Grand Rapids, we combined the data to give a pooled regression equation. To allow for significant differences ($P < 0.001$) among years in the intercepts (i.e., the most upstream DO concentration) of the individual regression

Figure 6.4 DO change (expressed as the rate of change in DO with distance) in relation to the dilution of the effluent in the river (i.e. the effluent:river discharge ratio) for rivers throughout the world.



lines, the intercept of the pooled regression equation was set to zero by subtracting the DO concentration of the most upstream site from each of the downstream values. The pooled regression equations are:

$$DO = -0.0039 \text{ Distance} + \text{Upstream DO (Hinton to Grand Rapids)} \quad \text{Equation 6.2}$$

$$DO = -0.0062 \text{ Distance} + \text{Upstream DO (d/s Grand Rapids)} \quad \text{Equation 6.3}$$

where DO is the DO concentration (mg/L) for a given river distance (Distance, km) and Upstream DO is the DO concentration (mg/L) at the most upstream site. DO concentrations in the Athabasca River between Hinton and Grand Rapids decreased significantly ($r^2=0.65$, $P < 0.0001$, $n=171$) with distance for the 1988-93 winters with the rate of decline averaging -0.004 mg/L DO/km. Downstream of Grand Rapids, DO concentrations decreased at -0.006 mg/L DO/km for the 1989-93 winters ($r^2=0.65$, $P < 0.0001$, $n=48$). These results show that for the reaches of the Athabasca River receiving mill effluent, DO decay over 100's of kilometres is approximately linear and can be represented by a simple linear equation.

Regression analysis of DO concentration versus distance for ice-covered rivers throughout the world showed that DO decreased linearly ($P < 0.05$) for all rivers receiving anthropogenic point-source loading with the exception of the Athabasca River between Jasper and Hinton on all five occasions, the Lesser Slave River, Alberta on two of six occasions, the Peace River, Alberta and the TuMen River, China on two of eight occasions. With the exception of the TuMen River where effluent comprised approximately 29% of the winter flow and DO decreased non-linearly on two of eight dates, the other impacted rivers for which DO concentrations did not change significantly ($P > 0.1$) had effluent:river dilution ratios of less than 0.35%. In contrast, only three of 34 cases of significant declines in DO occurred when effluent:river dilutions ratios were less than 0.35% (i.e., North Saskatchewan River in February 1986, and the Lesser Slave River in March 1989 and 1990). Unlike the impacted rivers, rivers without point-source loading of anthropogenic waste usually showed no significant change ($P > 0.1$) or an increase ($P < 0.05$) in DO along their length (13 of 18 cases). These rivers were generally small with drainage basins less than 12,000 km² and winter flows less than 60 m³/s. In addition to differences in the rate of DO decline between impacted and non-impacted rivers, DO decline also differed within rivers that had relatively unimpacted headwaters and downstream reaches receiving industrial and municipal waste. Thus, DO concentrations in the upstream reaches of the Athabasca, Red Deer and North Saskatchewan rivers did not change significantly ($P > 0.1$) or declined more slowly with distance than downstream of the municipalities of Hinton, Red Deer and Edmonton where DO decreased by -0.004 , -0.09 and -0.01 mg/L/km, respectively (Table 6.4). In contrast to the increase in DO decline rates with distance that was observed for the Athabasca, Red Deer and North Saskatchewan rivers, DO decline rates in the Beaver River were greater in the pristine headwaters, however Babin and Trew (1985) noted that the upper Beaver was more biologically productive than lower reaches which received effluent loading. Moreover, regression analysis of data for ice-covered rivers throughout the world showed that the rate of DO decline was inversely related ($r^2 = 0.75$; $P < 0.0001$) to the dilution of the effluent in the river. Thus, the rate of DO decay in an ice-covered river can be predicted with moderate success from dilution of the effluent in the river water.

In conclusion, our results indicate that effluents from pulp mills cause sag and recovery zones below outfalls in the Athabasca River and contribute to the linear decay in DO concentrations along the 800 km reach below the most upstream mill. Our assessment that effluents contribute to large-scale (i.e. 100's of kilometres) declines in DO concentrations in the Athabasca River is consistent with our observation that DO concentrations decreased linearly for 34 of 44 cases of impacted rivers throughout the world whereas significant declines in DO concentrations were found in only five of 18 cases of rivers not receiving effluent. Comparison of rates of change in DO for the Athabasca River with other ice-covered rivers also showed that rates for the Athabasca River were generally less than those for other ice-covered rivers receiving effluent. Moreover, regression analysis of data for ice-covered rivers throughout the world showed that the rate of DO decline can be predicted with moderate success ($r^2 = 0.75$; $P < 0.0001$) from the dilution of the effluent in the river. Our approach of using regression analysis to assess large-scale (100's of kilometres) changes in DO provided a useful tool for predicting year-to-year variation in DO concentrations in the Athabasca River in response to upstream DO variability. While regression models cannot be used to forecast river DO concentrations under different loading scenarios (e.g. introduction of new sources of BOD loading such as the start-up of another industry) and, hence, cannot be used for risk assessment and licensing of discharges to the river, they facilitate comparison of DO declines for ice-covered rivers throughout the world. Our observation as well as those of Schallock and Lotspeich (1974) that DO concentrations in ice-covered rivers decrease with distance downstream raise concern about safeguarding oxygen levels in boreal and arctic rivers. Since these rivers generally flow north and anthropogenic activity, with its associated with change in loadings, usually commences at the more southerly headwaters, pollutants will be transmitted to more pristine lower reaches which, in the case of BOD loading, would result in greater depressions in under-ice DO concentrations. Given this, considerable effort is required to assess and develop appropriate regulations to ensure that BOD loading does not impair winter oxygen conditions in rivers which experience ice cover.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

(1) Start-up of a bleached kraft mill at Hinton, Alberta, Canada in 1957 was associated with the lowest recorded late-winter (February-March) DO concentrations for the Athabasca River (Figure 1.1). The relatively constant February-March DO concentrations upstream of the mill for the past 40 yr (11.6 ± 0.1 ; mean \pm S.E.; $n=23$) compared to the record low values observed during the 20 yr following start-up suggest that release of initially 24000 kg/d BOD₅ which was reduced to approximately 11000 kg/d BOD₅ by the late 1960's was responsible for the decrease in DO concentrations in the Athabasca River downstream of the Hinton mill. More recent reductions in BOD₅ loading (3361 kg/d in 1977-1988 and 4858 kg/d in 1989-1993) have coincided with increases ($P < 0.05$) in late-winter DO concentrations at two of three downstream sites.

(2) Examination of longitudinal changes in DO concentration in the Athabasca River from upstream of Hinton to Grand Rapids (808 river kilometers) showed that over 100's of kilometers, DO concentrations declined linearly ($P \leq 0.02$) for the 1988 to 1993 winters (Table 6.2). In contrast, there was no significant change ($P \geq 0.1$) in DO concentration with distance for a 45 km reach upstream of Jasper. These results suggest that while effluent loading resulted in small-scale (10's of kilometers) sag and recovery zones, it is also contributed to large-scale (100's of kilometers) linear declines in DO. However, the rate of decrease in DO in the Athabasca River with distance is less than that of many ice-covered rivers around the world that receive effluent.

(3) When the dissolved oxygen simulation model DOSTOC was implemented using laboratory or *in situ* measurements for all input data except the temperature correction factor, the model simulated DO conditions in the Athabasca River, on a large-scale, reasonably well ($0.72 < r^2 < 0.92$) for the 1990 to 1994 winters and for January 1989 (Table 7.1). For 1990 to 1994 and January 1989, most ($\geq 62\%$) of the observed DO concentrations were within the 90% confidence limits set by the stochastic analysis. The model was less successful at predicting January and March 1988 and March 1989 conditions ($0.51 < r^2 < 0.56$) with up to 32% of the observed DO values outside the 90% confidence limits (Table 7.1). Removing mill input for the 1990 - 1994 runs showed an increase in DO of, on average, 0.25 mg/L upstream of Grand Rapids (approximately 800 km downstream of Hinton). Thus, over longer distances mill effluent input has limited impact on the DO concentrations in the Athabasca River. However, on a small-scale (10's of kilometers below mill input), analysis of residual patterns indicate that DOSTOC over-predicted DO concentrations always (7 of 7 runs) downstream of Millar Western Pulp Ltd. and Alberta Newsprint Co. and for 7 of 9 runs downstream of Weldwood of Canada Ltd. The failure of DOSTOC to accurately model DO in the Athabasca River for all years, and particularly for sag zones below mills may be due to : (a) deficiencies in the input data and (b) limitations of a static model.

Table 7.1 Comparisons for each year of the number of measured points falling in the 90% confidence interval (CI), the discharge range for the sampling period (upstream of Hinton to Grand Rapids) and the modelled r^2 .

| Year | Percentage in 90% CI | Discharge range (m ³ /s) | DOSTOC r^2 |
|---------------|----------------------|-------------------------------------|--------------|
| February 1988 | 75 | 25-54 | 0.51 |
| March 1988 | 79 | 30-64 | 0.53 |
| January 1989 | 74 | 31-73 | 0.79 |
| March 1989 | 68 | 28-68 | 0.56 |
| 1990 | 100 | 33-109 | 0.89 |
| 1991 | 100 | 51-102 | 0.92 |
| 1992 | 995 | 47-96 | 0.74 |
| 1993 | 85 | 28-60 | 0.72 |
| 1994 | 62 | 28-74 | 0.79 |

(4) The input data used in the 1988-1993 DOSTOC simulations included measured values for atmospheric reaeration, BOD decay, BOD_u concentrations (converted from BOD_5 values by multiplication by a $BOD_u:BOD_5$ ratio), headwater and tributary DO concentrations, effluent and river discharge, sediment oxygen demand and sedimentation. The least reliable data appeared to be:

- (a) SOD rates which were based on near-shore measurements which were then extrapolated to the entire channel,
- (b) Leopold Maddock coefficients which were calculated using the HEC-2 model for under-ice discharges ranging from 50-200 m^3/s and then used to calculate travel time and mean water depths,
- (c) BOD decay rates and $BOD_u:BOD_5$ ratios for STP's which were based on two measurements for effluent from the Grande Prairie STP,
- (d) reaeration rates which were measured on only one occasion (March 1989; Macdonald *et al.* 1989),
- (d) temperature correction coefficients which were obtained from HydroQual Ltd. and Gore and Storie (1987) and not derived for the Athabasca basin (i.e., SOD temperature correction coefficients span a range of 1.02 to 1.13; Bowie *et al.* 1985),
- (e) photosynthetic rates, which are currently not known for the Athabasca River and, as was noted by Noton and Allan (1995), water-column algal biomass can be high during late winter and may contribute to DO to the water column through photosynthesis, and
- (f) limited data on tributary and STP inputs and mainstem DO concentrations for the January and March 1988 runs.

(5) With respect to deficiencies in travel time estimates, it is interesting to note that the better simulations tended to occur in years with higher discharge (i.e., January 1989, 1990, 1991, 1992 and 1994 when discharges averaged 73, 109, 102, 96 and 74 m^3/s , respectively, at Grand Rapids; Table 7.1). At present this observation is difficult to test conclusively due to limited data for years when all mills were operating under relatively stable conditions. However, this observation suggests that there may be a problem with the Leopold Maddock coefficients which were determined from Hec-2 model runs (Thompson and Fitch 1989) based on only one under-ice dye study (Andres *et al.* 1989) and calculated using discharges only in the 50-200 m^3/s range. Mean discharge of the Athabasca River at Hinton is 35.7 ± 1.7 , 31.9 ± 1.0 and 31.2 ± 1.1 m^3/s (1962-1993, mean \pm S.E; Environment Canada 1993) for January, February and March, respectively. Discharge remains below 50 m^3/s for approximately 200 km downstream of Hinton for all the years of study (Figure 7.1). This is an important area since three mills discharge effluent into this approximately 200 km reach: Weldwood of Canada Ltd., Alberta Newsprint Co. and Millar Western Pulp Ltd. Comparison of velocities calculated using Andres *et al.* (1989) dye tracing data and those estimated using the Leopold Maddock coefficients from DOSTOC with Andres *et al.* (1989) discharge showed significant differences ($P < 0.05$), (Figure 7.2). This has important implications, particularly for the 200 km downstream of Hinton, for the calculation of both travel time and volumetric SOD, which is determined from mean depth (see Section 4.4).

(6) With respect to data deficiencies in photosynthetic rate, Noton and Allan (1994) noted thinning of the ice cover and diurnal DO fluctuations of up to 2 mg/L during March 1993. We suspect that the levelling off of DO concentrations downstream of the confluence of the Lesser Slave River in 1993 may be due to photosynthetic production of oxygen (Figure 5.8). The measured light transmission through the ice at this time was much higher (21-54% of incoming PAR) than in other years (1% or less) and planktonic chlorophyll *a* concentrations were also elevated (Figure 7.3) (Noton and Allan 1994). The nature of a static model like DOSTOC is that a "snap shot" of the river water quality is followed along the length of the river with the assumption that the physical variables (in this case ice and snow cover) remain the same. DOSTOC does not have the parameters necessary to model the dynamic nature of the ice cover which, in 1993, appears to be significant. Information is scarce about biological activity under ice conditions, particularly for lotic systems, but it may be significant (e.g., concentrations of algae at the ice-water interface in Hudson Bay increased by 10 to 100 fold with a reduction in snow cover (Runge and Ingram 1988)).

(7) The poorer DOSTOC predictions in 1989 likely relate to the large and erratic BOD loadings from Millar Western Pulp Ltd. which had not likely equilibrated with instream processes. Currently, we do not have enough data to model non-equilibrium systems and so impacts on the Athabasca River caused by large sporadic events remain poorly understood.

(8) The 90% confidence limits about the DOSTOC predictions averaged approximately 0.7 mg/L when variance values (expressed as standard deviation) from long-term means were applied to the BOD loadings and BOD and SOD decay rates. Under a scenario of 100% variance (i.e. uncertainty of 100 % of mean values for all nine stochastic terms), the 90% confidence limits averaged ± 1.9 mg/L about the mean. Although true estimates of variance are difficult to ascertain, uncertainty due to changing flows, temperature correction and decay rates does not make the 100% scenario unreasonable. In the case of 100% variance, the downstream 90% confidence limit is approximately 6 mg/L (Figure 5.19).

7.2 RECOMMENDATIONS

(1) Data Deficiencies

- Additional measures of STP BOD decay rates and $BOD_u:BOD_5$ ratios are required to verify the values currently used in the modelling. In addition, discrepancies between BOD_5 values measured by mills, in commercial laboratories and at the Alberta Environmental Centre must be resolved. It should also be noted that BOD determination is an empirical test and that BOD results obtained in a BOD bottle may have little or no relationship with the oxygen demand of a stream. Nevertheless, the widespread use of BOD measurements for many years and the lack of a quick simple technique for obtaining realistic measurements of oxygen utilization by microbial decomposition of organic matter have resulted in the use of BOD in water quality simulation models to predict DO. Future models may rely upon other estimates of oxygen utilization, such as estimates of organic material and rates of microbial oxygen consumption and cell production associated with this material.

Figure 7.1 Discharge from the DOSTOC runs for 1988 to 1994. Data from Alberta Environment Water Quality Surveys.

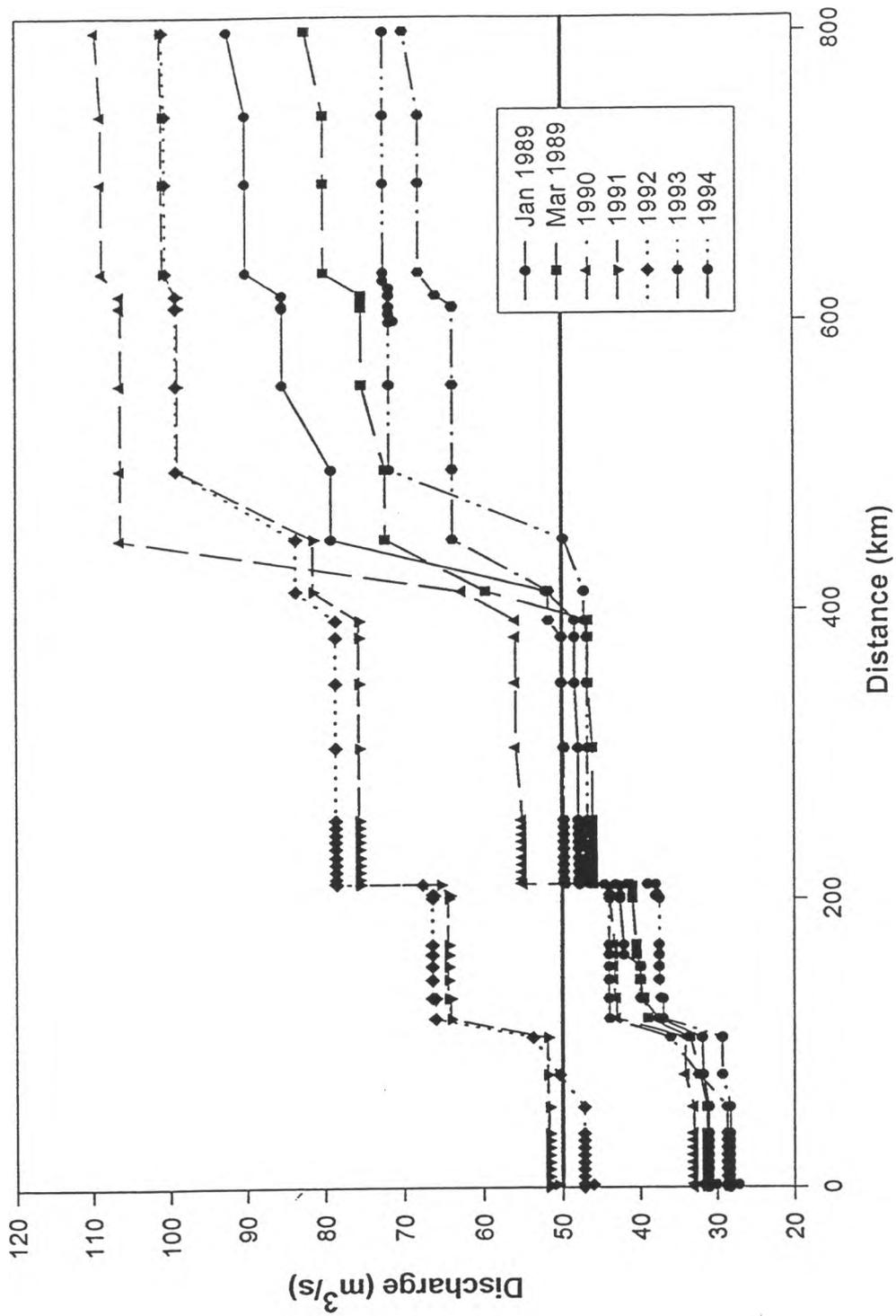


Figure 7.2 Discharge (m^3/s) and mean channel velocity (m/s). Discharge and measured velocity from Andres *et al.* (1989). Estimated velocity was calculated using Andres *et al.* (1989) discharge and Leopold Maddock coefficients from the DOSTOC model.

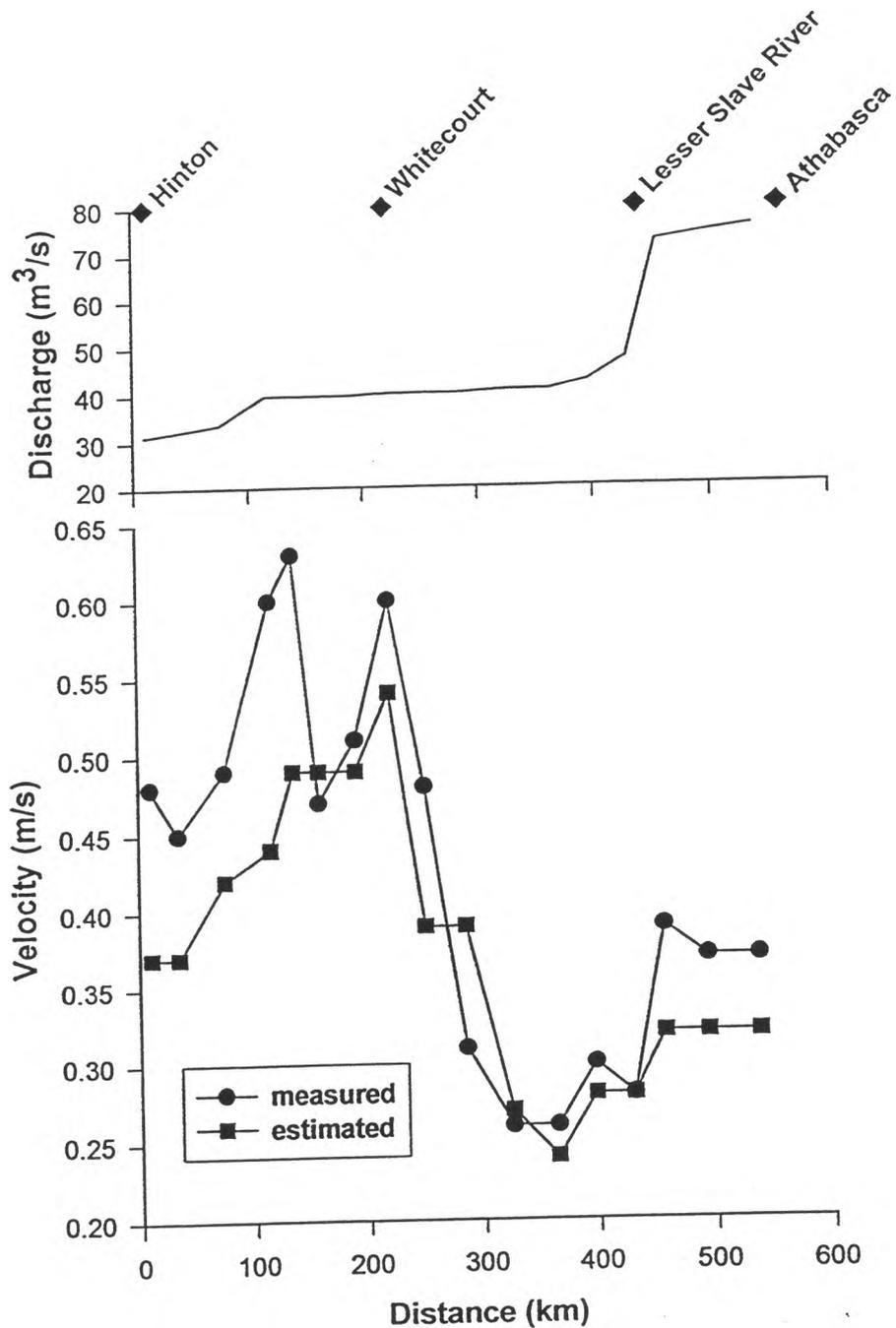
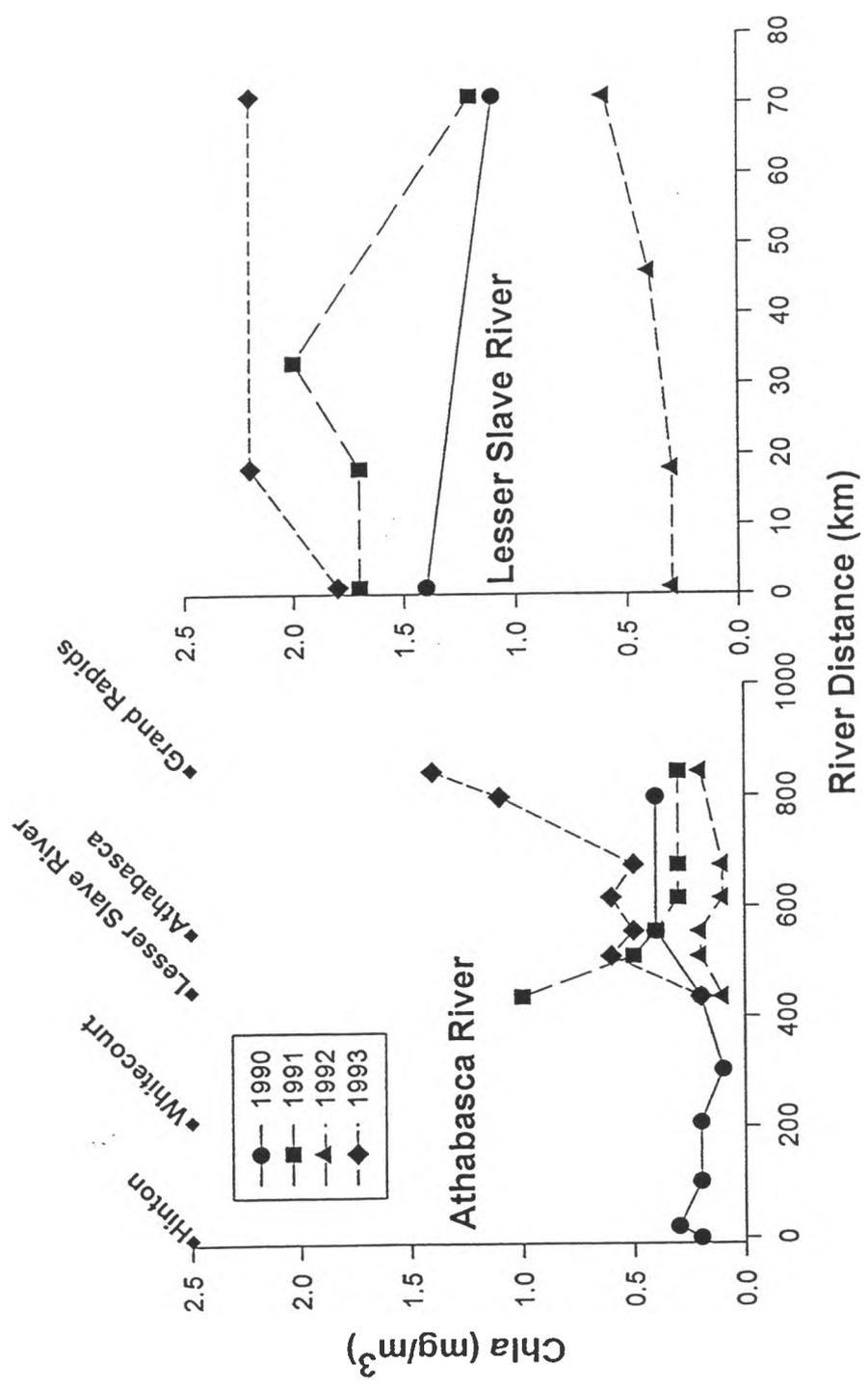


Figure 7.3 Planktonic chlorophyll *a* (chl_a) concentrations (mg/m³) in the Athabasca and Lesser Slave rivers 1990-1993. Data from Alberta Environment winter water quality surveys.



- Cross-channel variability in SOD should be examined and the relationship between sedimentation and SOD should be assessed, particularly below mill outfalls and tributary inflows.
- Laboratory comparisons of effluent and tributary/headwater BOD decay rates at 20 and 0 °C are required.
- Sedimentation rates should be measured below all mills to determine if settling rates are the same for different effluent types. Also, a determination of whether the sedimentation rates measured for all material (organic and inorganic) applies to only oxygen-consuming material is needed.
- The Leopold Maddock coefficients should be re-evaluated for discharges similar to the long-term averages discharges at Hinton and another under-ice time of travel study should be conducted to verify the results of Andres *et al.* (1989) and provide further data for re-assessing the Leopold Maddock coefficients.
- Photosynthetic rates below ice and snow cover of differing thicknesses should be measured during years when this is deemed significant and the influence of this parameter on the DO modelling should be evaluated.

(2) Model Deficiencies

- Implementation of WASP (Water Quality Analysis Simulation Program) or another dynamic model) would address questions regarding temporal variability in the decrease in DO in the Athabasca River with distance (i.e., the changing relationship between upstream and downstream DO concentrations as the winter progresses). We recommend that a dynamic model be implemented using the input parameters we validated for DOSTOC and the continuous DO data for nine sites on the Athabasca River (six sites monitored by Alberta Environmental Protection (winter, 1990-present) and three sites monitored by Environment Canada (year-round, 1992-present). However, unlike data from the Alberta Environmental Protection winter water quality surveys, these larger data sets of continuous DO measures are not collected in conjunction with measurements of industrial, municipal and tributary BOD loads and other parameters that are used in the models. The information gain from dynamic modelling of DO in the Athabasca River must be weighted by the increase in uncertainty in loading rates, decay rates and other time-variable parameters.
- Concerns about DO concentrations in mixing zones could be addressed by moving to a model capable of 2-dimensional simulation (i.e., changes across the channel as well as longitudinally down the channel). However, there is currently only limited data on DO concentrations within mixing zones.

8.0 ACKNOWLEDGEMENTS

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APPENDIX A
TERMS OF REFERENCE

NORTHERN RIVER BASINS STUDY

TERMS OF REFERENCE

Project 2231-C1: Development and Validation of Under-Ice Dissolved Oxygen Models

I. Objective

The objective of this project is to test and make recommendations for an accurate water quality simulation model to predict under-ice dissolved oxygen (DO) in the Athabasca River. This model is needed in order to set industrial and municipal discharge licenses for BOD loading and to evaluate the impact of changes in industrial/municipal discharges and flow regimes on water quality.

II. Requirements

1. Install and run DOSTOC dissolved oxygen water quality simulation model for data collected from winter water quality surveys undertaken in 1988, 1989, 1990, 1991, 1992 and 1993. Compare results of deterministic model runs with results previously obtained by independent consultants.
2. Undertake stochastic model runs and assess whether the observed data lie within the confidence limits of the model.
3. Verify rate coefficients with literature values and values measured for the Athabasca River.
4. Assess the utility of DOSTOC in predicting DO in the Athabasca River in winter. Identify problems and possible solutions.
5. Present results as a report to the NRBS.

III. Reporting Requirements

1. Prepare a comprehensive report outlining the results of the work undertaken in II above.
2. Ten copies of the draft report are to be submitted to the Component Coordinator by March 15th, 1994.
3. Three weeks after the receipt of review comments on the draft report, the contractor is to submit ten cerlox bound copies and two unbound, camera-ready originals or the final report to the Component Coordinator. An electronic copy of the report, in Word Perfect 5.1 format, is to be submitted to the Project Liaison Officer along with the final report. The final report

is to contain a table of contents, list of figures (if appropriate) list of tables, acknowledgements, executive summary and an appendix containing the Terms of Reference for this contract.

IV. Project Administration

The Scientific Authority for this project is:

Dr. Patricia Chambers
Nutrients Component Leader
National Hydrology Research Institute
11 Innovation Blvd.
Saskatoon, Saskatchewan
S7N 3H5
phone: (306) 975-5592
fax: (306) 975-5143

Questions pertaining to this project of a scientific nature should be directed to her.

The NRBS Study Office Component Coordinator for this project is:

Greg Wagner
Office of the Science Director
Northern River Basins Study
690 Standard Life Centre
10405 Jasper Avenue
Edmonton, Alberta
T5J 3N4
phone: (403) 427-1742
fax: (403) 422-3055

Administrative questions related to this project should be directed to him.

APPENDIX B
DOSTOC INPUT FILES

1-11 FEBRUARY 1988

UPPER ATHABASCA - FEBRUARY 1988

| NRT | NTRIB | MAXTR | MAXRI | MAXPT | NSTP | NVAR |
|-----|-------|-------|-------|-------|------|------|
| 35 | 0 | 0 | 35 | 35 | 18 | 9 |

GROUP 2 (ONE LINE FOR EACH REACH)

| IRCH | UP1 | IUP2 | X | Q | QLD | SOURCE NAME |
|------|-----|------|------|--------|-------|----------------|
| 1 | 0 | 0 | 1.7 | 25.1 | 0.000 | |
| 2 | 1 | 0 | 0.8 | 24.176 | 0.924 | WELWOOD OPEN |
| 3 | 2 | 0 | 5.0 | 25.1 | 0.000 | |
| 4 | 3 | 0 | 5.0 | 25.1 | 0.000 | |
| 5 | 4 | 0 | 5.0 | 25.1 | 0.000 | |
| 6 | 5 | 0 | 5.0 | 25.1 | 0.000 | |
| 7 | 6 | 0 | 5.0 | 25.1 | 0.000 | |
| 8 | 7 | 0 | 5.0 | 25.1 | 0.000 | |
| 9 | 8 | 0 | 5.0 | 25.1 | 0.000 | |
| 10 | 9 | 0 | 18.6 | 25.1 | 0.000 | |
| 11 | 10 | 0 | 22.5 | 25.1 | 0.908 | OLDMAN CR. |
| 12 | 11 | 0 | 25.8 | 26.008 | 0.022 | SPRING 1 |
| 13 | 12 | 0 | 13.3 | 26.03 | 6.43 | BERLAND R |
| 14 | 13 | 0 | 13.8 | 32.46 | 0.018 | SPRING 2 |
| 15 | 14 | 0 | 0.2 | 32.48 | 0.225 | MARSH CR |
| 16 | 15 | 0 | 12.7 | 32.705 | 0.165 | PINE CR |
| 17 | 16 | 0 | 9.2 | 32.87 | 0.000 | |
| 18 | 17 | 0 | 8.0 | 32.87 | 0.018 | SPRING 3 |
| 19 | 18 | 0 | 7.0 | 32.89 | 0.012 | TWO CREEK |
| 20 | 19 | 0 | 32.0 | 32.88 | 0.49 | WINDFALL |
| 21 | 20 | 0 | 2.0 | 33.37 | 0.000 | |
| 22 | 21 | 0 | 6.7 | 33.37 | 0.000 | |
| 23 | 22 | 0 | 1.1 | 33.37 | 0.923 | SAKWATAMAU |
| 24 | 23 | 0 | 0.1 | 34.29 | 3.68 | MCLEOD R |
| 25 | 24 | 0 | 1.5 | 37.99 | 0.000 | |
| 26 | 25 | 0 | 2.1 | 37.99 | 0.000 | |
| 27 | 26 | 0 | 21.1 | 37.93 | 0.037 | WHITE STP |
| 28 | 27 | 0 | 70.0 | 37.99 | 0.000 | |
| 29 | 28 | 0 | 44.6 | 37.99 | 0.118 | FREEMAN R |
| 30 | 29 | 0 | 31.5 | 38.09 | 0.000 | |
| 31 | 30 | 0 | 11.5 | 38.09 | 0.000 | |
| 32 | 31 | 0 | 20.0 | 38.09 | 3.74 | PEMBINA R |
| 33 | 32 | 0 | 36.1 | 41.83 | 0.000 | |
| 34 | 33 | 0 | 48.7 | 41.83 | 12.3 | LESSER SLAVE R |
| 35 | 34 | 0 | 58.4 | 54.13 | 0.000 | UNKNOWN |

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

| STNAM | INST |
|-----------|------|
| WELWOOD | 2 |
| OLDMAN CR | 11 |

SPRING 1 12
 BERLAND R 13
 SPRING 2 14
 MARSH HEAD CR 15
 PINE CR 16
 SPRING 3 18
 TWO CR 19
 WINDFALL CR 20
 SAKWATAMAU 23
 McLEOD R 24
 MILLAR WEST 25
 STP 27
 FREEMAN R 29
 PEMBINA R 32
 LESSER SLAVE 34
 UNKNOWN 35

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. 7 CHARACTERS)

RNAM

 UPPER ATHABASCA

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

TNAM INTR

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

REACH XLD1 XLD2 XLD3 XLD4 XLD5 XLD6 XLD7 XLD8 XLD9

| | | | | | | | | | |
|----|-------|-------|-------|-------|------|-------|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 255.6 | 6.3 | 0 | 97.13 | 1.13 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 13.18 | 20.87 | 0 | 0.37 | 11.07 | 0 | 0 | 0 |
| 12 | 0 | 11.59 | 8.03 | 0 | 0.06 | 0.56 | 0 | 0 | 0 |
| 13 | 0 | 10.56 | 11.24 | 0 | 0.87 | 3.60 | 0 | 0 | 0 |
| 14 | 0 | 11.86 | 4.58 | 0 | 0.16 | 3.39 | 0 | 0 | 0 |
| 15 | 0 | 11.85 | 4.66 | 0 | 0.75 | 2.66 | 0 | 0 | 0 |
| 16 | 0 | 11.30 | 3.21 | 0 | 1.12 | 1.12 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 11.02 | 3.21 | 0 | 0.39 | 2.25 | 0 | 0 | 0 |
| 19 | 0 | 9.07 | 7.63 | 0 | 1.98 | 2.82 | 0 | 0 | 0 |
| 20 | 0 | 12.51 | 5.62 | 0 | 1.40 | 3.54 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|----|-------|-------|-------|------|------|-------|---|---|---|
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 0 | 9.57 | 3.61 | 0 | 1.30 | 2.49 | 0 | 0 | 0 |
| 24 | 0 | 5.54 | 7.79 | 0 | 1.50 | 5.84 | 0 | 0 | 0 |
| 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 99.84 | 5.1 | 0 | 59.9 | 1.00 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 8.65 | 8.03 | 0 | 1.59 | 6.10 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 2.21 | 8.83 | 0 | 1.43 | 5.74 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | 13.03 | 22.48 | 0 | 0.87 | 13.03 | 0 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

GROUP 7 (ONE LINE FOR EACH HEADWATER)

| | X01 | X02 | X03 | X04 | X05 | X06 | X07 | X08 | X09 |
|-------|-----|-------|-------|-----|-------|-------|-----|-----|-----|
| ***** | | | | | | | | | |
| | 0.0 | 11.69 | 17.43 | 0 | 0.374 | 11.33 | 0 | 0 | 0 |

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

| REACH | XK1 | XK2 | XK3 | XK4 | XM1 | XM2 | XM3 | XRES | XDS | XP |
|-------|-------|-------|------|------|-----|-----|------|-------|-------|------|
| 1 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.001 | 12.98 | .001 |
| 2 | 0.035 | 0.911 | .574 | .026 | .00 | .00 | .000 | 1.151 | 13.02 | .001 |
| 3 | 0.035 | 0.001 | .630 | .026 | .00 | .00 | .000 | 1.099 | 13.04 | .001 |
| 4 | 0.035 | 0.001 | .304 | .026 | .00 | .00 | .000 | 1.025 | 13.04 | .001 |
| 5 | 0.035 | 0.001 | .211 | .026 | .00 | .00 | .000 | 0.951 | 13.04 | .001 |
| 6 | 0.035 | 0.001 | .164 | .026 | .00 | .00 | .000 | 0.877 | 13.04 | .001 |
| 7 | 0.035 | 0.001 | .135 | .026 | .00 | .00 | .000 | 0.810 | 13.04 | .001 |
| 8 | 0.035 | 0.001 | .115 | .026 | .00 | .00 | .000 | 0.750 | 13.04 | .001 |
| 9 | 0.035 | 0.001 | .100 | .026 | .00 | .00 | .000 | 0.683 | 13.04 | .001 |
| 10 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.513 | 13.06 | .001 |
| 11 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.417 | 13.07 | .001 |
| 12 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.346 | 13.11 | .001 |
| 13 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.297 | 13.15 | .001 |
| 14 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.335 | 13.17 | .001 |
| 15 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.308 | 13.19 | .001 |
| 16 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.285 | 13.21 | .001 |
| 17 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.207 | 13.25 | .001 |
| 18 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.148 | 13.27 | .001 |
| 19 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.29 | .001 |
| 20 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.30 | .001 |
| 21 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.33 | .001 |
| 22 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.37 | .001 |
| 23 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.37 | .001 |
| 24 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.37 | .001 |
| 25 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.40 | .001 |
| 26 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.43 | .001 |
| 27 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.46 | .001 |
| 28 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.49 | .001 |

| | | | | | | | | | | |
|----|-------|-------|------|------|-----|-----|------|-------|-------|------|
| 29 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.50 | .001 |
| 30 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.60 | .001 |
| 31 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.61 | .001 |
| 32 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.61 | .001 |
| 33 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.62 | .001 |
| 34 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.62 | .001 |
| 35 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.66 | .001 |

GROUP 9 (AVERAGE RIVER TEMPERATURE)

TEMPER

0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH NUMBER)

| REACH | REFQ | T | HEXN | VEXN | RFDGR |
|-------|------|-------|------|------|-------|
| 1 | 50 | .045 | .516 | .353 | 20 |
| 2 | 50 | .018 | .516 | .353 | 20 |
| 3 | 50 | .127 | .516 | .353 | 20 |
| 4 | 50 | .127 | .516 | .353 | 20 |
| 5 | 50 | .127 | .516 | .353 | 20 |
| 6 | 50 | .127 | .516 | .353 | 20 |
| 7 | 50 | .127 | .516 | .353 | 20 |
| 8 | 50 | .127 | .516 | .353 | 20 |
| 9 | 50 | .127 | .516 | .353 | 20 |
| 10 | 50 | .448 | .516 | .353 | 20 |
| 11 | 50 | .543 | .550 | .346 | 20 |
| 12 | 50 | .622 | .550 | .346 | 20 |
| 13 | 50 | .297 | .550 | .346 | 20 |
| 14 | 50 | .308 | .540 | .266 | 20 |
| 15 | 50 | .004 | .540 | .266 | 20 |
| 16 | 50 | .284 | .551 | .326 | 20 |
| 17 | 50 | .202 | .551 | .326 | 20 |
| 18 | 50 | .176 | .551 | .326 | 20 |
| 19 | 50 | .154 | .551 | .326 | 20 |
| 20 | 50 | .704 | .551 | .326 | 20 |
| 21 | 50 | .044 | .551 | .326 | 20 |
| 22 | 50 | .147 | .551 | .326 | 20 |
| 23 | 50 | .022 | .463 | .362 | 20 |
| 24 | 50 | .002 | .463 | .362 | 20 |
| 25 | 50 | .029 | .536 | .274 | 20 |
| 26 | 50 | .041 | .536 | .274 | 20 |
| 27 | 50 | .414 | .536 | .274 | 20 |
| 28 | 50 | 1.940 | .536 | .274 | 20 |
| 29 | 50 | 1.799 | .523 | .288 | 20 |
| 30 | 50 | 1.426 | .512 | .350 | 20 |
| 31 | 50 | .463 | .512 | .260 | 20 |
| 32 | 50 | .805 | .512 | .260 | 20 |
| 33 | 50 | 1.453 | .512 | .260 | 20 |
| 34 | 50 | 1.960 | .512 | .260 | 20 |
| 35 | 50 | 2.350 | .512 | .260 | 20 |

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)

FNAM

ATHAF88

4-9 MARCH 1988

UPPER ATHABASCA - MARCH 1988

| NRT | NTRIB | MAXTR | MAXRI | MAXPT | NSTP | NVAR |
|-----|-------|-------|-------|-------|------|------|
| 35 | 0 | 0 | 35 | 35 | 18 | 9 |

GROUP 2 (ONE LINE FOR EACH REACH)

| IRCH | UP1 | IUP2 | X | Q | QLD | SOURCE NAME |
|------|-----|------|------|--------|-------|----------------|
| 1 | 0 | 0 | 1.7 | 30.1 | 0.000 | |
| 2 | 1 | 0 | 0.8 | 30.026 | 0.974 | WELDWOOD OPEN |
| 3 | 2 | 0 | 5.0 | 31.0 | 0.000 | |
| 4 | 3 | 0 | 5.0 | 31.0 | 0.000 | |
| 5 | 4 | 0 | 5.0 | 31.0 | 0.000 | |
| 6 | 5 | 0 | 5.0 | 31.0 | 0.000 | |
| 7 | 6 | 0 | 5.0 | 31.0 | 0.000 | |
| 8 | 7 | 0 | 5.0 | 31.0 | 0.000 | |
| 9 | 8 | 0 | 5.0 | 31.0 | 0.000 | |
| 10 | 9 | 0 | 18.6 | 31.0 | 0.000 | |
| 11 | 10 | 0 | 22.5 | 31.0 | 1.33 | OLDMAN CR. |
| 12 | 11 | 0 | 25.8 | 32.33 | 0.022 | SPRING 1 |
| 13 | 12 | 0 | 13.3 | 32.35 | 7.69 | BERLAND R |
| 14 | 13 | 0 | 13.8 | 40.04 | 0.018 | SPRING 2 |
| 15 | 14 | 0 | 0.2 | 40.06 | 0.225 | MARSH CR |
| 16 | 15 | 0 | 12.7 | 40.29 | 0.165 | PINE CR |
| 17 | 16 | 0 | 9.2 | 40.45 | 0.000 | |
| 18 | 17 | 0 | 8.0 | 40.45 | 0.018 | SPRING 3 |
| 19 | 18 | 0 | 7.0 | 40.47 | 0.012 | TWO CREEK |
| 20 | 19 | 0 | 32.0 | 40.48 | 0.479 | WINDFALL |
| 21 | 20 | 0 | 2.0 | 40.96 | 0.000 | |
| 22 | 21 | 0 | 6.7 | 40.96 | 0.000 | |
| 23 | 22 | 0 | 1.1 | 40.96 | 0.923 | SAKWATAMAU |
| 24 | 23 | 0 | 0.1 | 41.88 | 7.50 | McLEOD R |
| 25 | 24 | 0 | 1.5 | 49.38 | 0.000 | |
| 26 | 25 | 0 | 2.1 | 49.38 | 0.000 | |
| 27 | 26 | 0 | 21.1 | 49.34 | 0.037 | WHITE STP |
| 28 | 27 | 0 | 70.0 | 49.38 | 0.000 | |
| 29 | 28 | 0 | 44.6 | 49.38 | 0.151 | FREEMAN R |
| 30 | 29 | 0 | 31.5 | 49.49 | 0.000 | |
| 31 | 30 | 0 | 11.5 | 49.49 | 0.000 | |
| 32 | 31 | 0 | 20.0 | 49.49 | 1.37 | PEMBINA R |
| 33 | 32 | 0 | 36.1 | 50.86 | 0.000 | |
| 34 | 33 | 0 | 48.7 | 50.86 | 12.6 | LESSER SLAVE R |
| 35 | 34 | 0 | 58.4 | 63.46 | 0.000 | UNKNOWN |

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

| STNAM | INST |
|-----------|------|
| WELDWOOD | 2 |
| OLDMAN CR | 11 |

SPRING 1 12
 BERLAND R 13
 SPRING 2 14
 MARSH HEAD CR 15
 PINE CR 16
 SPRING 3 18
 TWO CR 19
 WINDFALL CR 20
 SAKWATAMAU 23
 McLEOD R 24
 MILLAR WEST 25
 STP 27
 FREEMAN R 29
 PEMBINA R 32
 LESSER SLAVE 34
 UNKNOWN 35

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. 7 CHARACTERS)

RNAM

 UPPER ATHABASCA

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

TNAM INTR

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

| REACH | XLD1 | XLD2 | XLD3 | XLD4 | XLD5 | XLD6 | XLD7 | XLD8 | XLD9 |
|-------|--------|-------|-------|-------|------|-------|------|------|------|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 127.80 | 5.6 | 0 | 48.56 | 1.01 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 12.38 | 17.67 | 0 | 0.35 | 9.36 | 0 | 0 | 0 |
| 12 | 0 | 11.59 | 8.43 | 0 | 0.06 | 0.59 | 0 | 0 | 0 |
| 13 | 0 | 10.66 | 9.64 | 0 | 0.87 | 3.08 | 0 | 0 | 0 |
| 14 | 0 | 11.86 | 4.58 | 0 | 0.15 | 3.39 | 0 | 0 | 0 |
| 15 | 0 | 11.85 | 4.66 | 0 | 0.75 | 2.66 | 0 | 0 | 0 |
| 16 | 0 | 11.30 | 3.21 | 0 | 1.19 | 1.12 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 11.02 | 3.21 | 0 | 0.39 | 2.25 | 0 | 0 | 0 |
| 19 | 0 | 9.7 | 7.63 | 0 | 2.11 | 2.82 | 0 | 0 | 0 |
| 20 | 0 | 11.47 | 16.06 | 0 | 1.28 | 10.12 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|----|-------|-------|-------|------|------|-------|---|---|---|
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 0 | 9.57 | 3.61 | 0 | 1.30 | 2.49 | 0 | 0 | 0 |
| 24 | 0 | 9.71 | 16.06 | 0 | 2.62 | 12.05 | 0 | 0 | 0 |
| 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 99.84 | 5.1 | 0 | 59.9 | 1.00 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 8.98 | 11.24 | 0 | 1.65 | 8.54 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 7.81 | 12.05 | 0 | 5.07 | 7.83 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | 11.17 | 9.64 | 0 | 0.74 | 5.59 | 0 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

GROUP 7 (ONE LINE FOR EACH HEADWATER)

| X01 | X02 | X03 | X04 | X05 | X06 | X07 | X08 | X09 |
|-----|-------|-------|-----|-------|------|-----|-----|-----|
| 0.0 | 11.59 | 12.05 | 0 | 0.371 | 7.83 | 0 | 0 | 0 |

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

| REACH | XK1 | XK2 | XK3 | XK4 | XM1 | XM2 | XM3 | XRES | XDS | XP |
|-------|-------|-------|------|------|-----|-----|------|-------|-------|------|
| 1 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.001 | 12.98 | .001 |
| 2 | 0.035 | 0.911 | .574 | .026 | .00 | .00 | .000 | 1.151 | 13.02 | .001 |
| 3 | 0.035 | 0.001 | .630 | .026 | .00 | .00 | .000 | 1.099 | 13.04 | .001 |
| 4 | 0.035 | 0.001 | .304 | .026 | .00 | .00 | .000 | 1.025 | 13.04 | .001 |
| 5 | 0.035 | 0.001 | .211 | .026 | .00 | .00 | .000 | 0.951 | 13.04 | .001 |
| 6 | 0.035 | 0.001 | .164 | .026 | .00 | .00 | .000 | 0.877 | 13.04 | .001 |
| 7 | 0.035 | 0.001 | .135 | .026 | .00 | .00 | .000 | 0.810 | 13.04 | .001 |
| 8 | 0.035 | 0.001 | .115 | .026 | .00 | .00 | .000 | 0.750 | 13.04 | .001 |
| 9 | 0.035 | 0.001 | .100 | .026 | .00 | .00 | .000 | 0.683 | 13.04 | .001 |
| 10 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.513 | 13.06 | .001 |
| 11 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.417 | 13.07 | .001 |
| 12 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.346 | 13.11 | .001 |
| 13 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.297 | 13.15 | .001 |
| 14 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.335 | 13.17 | .001 |
| 15 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.308 | 13.19 | .001 |
| 16 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.285 | 13.21 | .001 |
| 17 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.207 | 13.25 | .001 |
| 18 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.148 | 13.27 | .001 |
| 19 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.29 | .001 |
| 20 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.30 | .001 |
| 21 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.33 | .001 |
| 22 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.37 | .001 |
| 23 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.37 | .001 |
| 24 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.37 | .001 |
| 25 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.40 | .001 |
| 26 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.43 | .001 |
| 27 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.46 | .001 |
| 28 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.49 | .001 |

| | | | | | | | | | | |
|----|-------|-------|------|------|-----|-----|------|-------|-------|------|
| 29 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.50 | .001 |
| 30 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.60 | .001 |
| 31 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.61 | .001 |
| 32 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.61 | .001 |
| 33 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.62 | .001 |
| 34 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.62 | .001 |
| 35 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .000 | 0.089 | 13.66 | .001 |

GROUP 9 (AVERAGE RIVER TEMPERATURE)

TEMPER

0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH NUMBER)

| REACH | REFQ | T | HEXN | VEXN | RFDGR |
|-------|------|-------|------|------|-------|
| 1 | 50 | .045 | .516 | .353 | 20 |
| 2 | 50 | .018 | .516 | .353 | 20 |
| 3 | 50 | .127 | .516 | .353 | 20 |
| 4 | 50 | .127 | .516 | .353 | 20 |
| 5 | 50 | .127 | .516 | .353 | 20 |
| 6 | 50 | .127 | .516 | .353 | 20 |
| 7 | 50 | .127 | .516 | .353 | 20 |
| 8 | 50 | .127 | .516 | .353 | 20 |
| 9 | 50 | .127 | .516 | .353 | 20 |
| 10 | 50 | .448 | .516 | .353 | 20 |
| 11 | 50 | .543 | .550 | .346 | 20 |
| 12 | 50 | .622 | .550 | .346 | 20 |
| 13 | 50 | .297 | .550 | .346 | 20 |
| 14 | 50 | .308 | .540 | .266 | 20 |
| 15 | 50 | .004 | .540 | .266 | 20 |
| 16 | 50 | .284 | .551 | .326 | 20 |
| 17 | 50 | .202 | .551 | .326 | 20 |
| 18 | 50 | .176 | .551 | .326 | 20 |
| 19 | 50 | .154 | .551 | .326 | 20 |
| 20 | 50 | .704 | .551 | .326 | 20 |
| 21 | 50 | .044 | .551 | .326 | 20 |
| 22 | 50 | .147 | .551 | .326 | 20 |
| 23 | 50 | .022 | .463 | .362 | 20 |
| 24 | 50 | .002 | .463 | .362 | 20 |
| 25 | 50 | .029 | .536 | .274 | 20 |
| 26 | 50 | .041 | .536 | .274 | 20 |
| 27 | 50 | .414 | .536 | .274 | 20 |
| 28 | 50 | 1.940 | .536 | .274 | 20 |
| 29 | 50 | 1.799 | .523 | .288 | 20 |
| 30 | 50 | 1.426 | .512 | .350 | 20 |
| 31 | 50 | .463 | .512 | .260 | 20 |
| 32 | 50 | .805 | .512 | .260 | 20 |
| 33 | 50 | 1.453 | .512 | .260 | 20 |
| 34 | 50 | 1.960 | .512 | .260 | 20 |
| 35 | 50 | 2.350 | .512 | .260 | 20 |

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)

FNAM

ATHAM88

9 JANUARY - 15 FEBRUARY 1989

ATHABASCA RIVER JAN 89 GROUP 1

| NRT | NTRIB | MAXTR | MAXRI | MAXPT | NSTP | NVAR |
|-----|-------|-------|-------|-------|------|------|
| 54 | 1 | 4 | 50 | 50 | 23 | 9 |

GROUP 2 (ONE LINE FOR EACH REACH)

| IRCH | UP1 | IUP2 | X | Q | QLD | SOURCE NAME |
|------|-----|------|------|-------|-------|------------------|
| 1 | 0 | 0 | 1.7 | 31.1 | 0.000 | |
| 2 | 1 | 0 | 0.8 | 30.13 | 0.970 | WELDWOOD<OPEN |
| 3 | 2 | 0 | 5.0 | 31.1 | 0.000 | |
| 4 | 3 | 0 | 5.0 | 31.1 | 0.000 | |
| 5 | 4 | 0 | 5.0 | 31.1 | 0.000 | |
| 6 | 5 | 0 | 5.0 | 31.1 | 0.000 | |
| 7 | 6 | 0 | 5.0 | 31.1 | 0.000 | |
| 8 | 7 | 0 | 5.0 | 31.1 | 0.000 | |
| 9 | 8 | 0 | 5.0 | 31.1 | 0.000 | |
| 10 | 9 | 0 | 18.6 | 31.1 | 0.000 | |
| 11 | 10 | 0 | 22.5 | 31.1 | 0.700 | OLDMANCR |
| 12 | 11 | 0 | 25.8 | 31.8 | 0.015 | SPRING1 |
| 13 | 12 | 0 | 13.3 | 31.82 | 5.670 | BERLAND R |
| 14 | 13 | 0 | 13.8 | 37.49 | 0.02 | SPRING2 |
| 15 | 14 | 0 | 0.2 | 37.51 | 0.066 | MARSH CR |
| 16 | 15 | 0 | 12.7 | 37.58 | 0.019 | PINE CR |
| 17 | 16 | 0 | 9.2 | 37.60 | 0.000 | |
| 18 | 17 | 0 | 8.0 | 37.60 | 0.015 | SPRING3 |
| 19 | 18 | 0 | 7.0 | 37.61 | 0.010 | TWO CREEK |
| 20 | 19 | 0 | 32.0 | 37.62 | 0.000 | WINDFALL |
| 21 | 20 | 0 | 2.0 | 37.62 | 0.000 | |
| 22 | 21 | 0 | 6.7 | 37.62 | 0.000 | |
| 23 | 22 | 0 | 1.1 | 37.62 | 0.923 | SAKWATAMAU |
| 24 | 23 | 0 | 0.1 | 38.54 | 4.760 | MCLEOD R |
| 25 | 24 | 0 | 0.8 | 43.16 | 0.141 | MILLAR WEST<OPEN |
| 26 | 25 | 0 | 2.8 | 43.30 | 0.000 | |
| 27 | 26 | 0 | 5.0 | 43.26 | 0.038 | WHITE STP |
| 28 | 27 | 0 | 5.0 | 43.30 | 0.000 | |
| 29 | 28 | 0 | 5.0 | 43.30 | 0.000 | |
| 30 | 29 | 0 | 6.1 | 43.30 | 0.000 | |
| 31 | 30 | 0 | 5.0 | 43.30 | 0.000 | |
| 32 | 31 | 0 | 5.0 | 43.30 | 0.000 | |
| 33 | 32 | 0 | 5.0 | 43.30 | 0.000 | |
| 34 | 33 | 0 | 5.0 | 43.30 | 0.000 | |
| 35 | 34 | 0 | 50.0 | 43.30 | 0.000 | |
| 36 | 35 | 0 | 44.6 | 43.30 | 0.480 | FREEMAN R |
| 37 | 36 | 0 | 31.5 | 43.78 | 0.000 | |
| 38 | 37 | 0 | 11.5 | 43.78 | 0.000 | |
| 39 | 38 | 0 | 20.0 | 43.78 | 2.8 | PEMBINA |
| 40 | 39 | 0 | 36.1 | 46.58 | 0.000 | |
| 41 | 40 | 54 | 48.7 | 71.68 | 0.000 | LESSER SLAVE |

| | | | | | | |
|----|----|---|------|-------|-------|-----------|
| 42 | 41 | 0 | 58.4 | 71.68 | 0.000 | UNKNOWN |
| 43 | 42 | 0 | 53.0 | 71.67 | 0.012 | ATHAB STP |
| 44 | 43 | 0 | 1.0 | 71.68 | 0.000 | |
| 45 | 44 | 0 | 7.4 | 71.68 | 0.000 | |
| 46 | 45 | 0 | 15.5 | 71.68 | 0.927 | LA BICHE |
| 47 | 46 | 0 | 61.5 | 72.61 | 0.006 | CALLING |
| 48 | 47 | 0 | 47.3 | 72.61 | 0.000 | |
| 49 | 48 | 0 | 58.3 | 72.61 | 0.46 | PELICAN |
| 50 | 49 | 0 | 10.8 | 73.07 | 0.91 | HOUSE |
| 51 | 0 | 0 | 8.0 | 25.1 | 0.0 | |
| 52 | 51 | 0 | 1.0 | 25.1 | 0.0 | |
| 53 | 52 | 0 | 24.7 | 25.1 | 0.0 | |
| 54 | 53 | 0 | 19.8 | 25.1 | 0.0 | |

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

| STNAM | INST |
|----------------|------|
| ***** | |
| WELDWOOD | 2 |
| OLDMAN CR | 11 |
| SPRING 1 | 12 |
| BERLAND R | 13 |
| SPRING2 | 14 |
| MARSH HEAD CR | 15 |
| PINE CR | 16 |
| SPRING 3 | 18 |
| TWO CREEK | 19 |
| WINDFALL CR | 20 |
| SAKWATAMAU R | 23 |
| McLEOD R | 24 |
| MILLAR WEST | 25 |
| STP | 27 |
| FREEMAN R | 29 |
| PEMBINA R | 32 |
| LESSER SLAVE R | 41 |
| UNKNOWN | 42 |
| STP | 43 |
| LA BICHE R | 46 |
| CALLING R | 47 |
| PELICAN R | 49 |
| HOUSE R | 50 |

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. 7 CHARACTERS)

| RNAM |
|-----------------|
| ***** |
| ATHABASCA RIVER |

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

| TNAM | INTR |
|--------------|------|
| ***** | |
| LESSER SLAVE | 41 |

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

REACH XLD1 XLD2 XLD3 XLD4 XLD5 XLD6 XLD7 XLD8 XLD9

| | | | | | | | | | |
|----|--------|-------|-------|--------|------|------|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 105.00 | 7.0 | 0 | 50.40 | 1.26 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 12.36 | 8.03 | 0 | 0.35 | 4.26 | 0 | 0 | 0 |
| 12 | 0 | 11.63 | 8.83 | 0 | 0.06 | 0.62 | 0 | 0 | 0 |
| 13 | 0 | 8.61 | 7.23 | 0 | 0.71 | 2.31 | 0 | 0 | 0 |
| 14 | 0 | 11.7 | 0.80 | 0 | 0.15 | 0.59 | 0 | 0 | 0 |
| 15 | 0 | 10.46 | 6.42 | 0 | 0.66 | 3.66 | 0 | 0 | 0 |
| 16 | 0 | 10.51 | 2.41 | 0 | 1.04 | 0.84 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 10.74 | 1.61 | 0 | 0.38 | 1.13 | 0 | 0 | 0 |
| 19 | 0 | 7.67 | 9.64 | 0 | 1.67 | 3.57 | 0 | 0 | 0 |
| 20 | 0 | 9.12 | 10.44 | 0 | 1.02 | 6.58 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 0 | 9.57 | 3.61 | 0 | 1.30 | 2.49 | 0 | 0 | 0 |
| 24 | 0 | 5.28 | 12.85 | 0 | 1.43 | 9.64 | 0 | 0 | 0 |
| 25 | 2772.0 | 5.80 | 0 | 554.4 | 2.15 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 49.92 | 3.2 | 0 | 29.95 | 0.64 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | 0 | 5.56 | 4.02 | 0 | 1.02 | 3.06 | 0 | 0 | 0 |
| 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 0 | 2.77 | 4.02 | 0 | 1.80 | 2.61 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 248.82 | 1.5 | 0 | 323.47 | 1.5 | 0 | 0 | 0 | 0 |
| 44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | 0 | 1.46 | 7.23 | 0 | 0.67 | 4.55 | 0 | 0 | 0 |
| 47 | 0 | 10.78 | 6.42 | 0 | 3.12 | 3.92 | 0 | 0 | 0 |
| 48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|----|---|-------|-------|---|------|-------|---|---|---|
| 49 | 0 | 12.53 | 24.89 | 0 | 1.12 | 12.20 | 0 | 0 | 0 |
| 50 | 0 | 10.65 | 7.23 | 0 | 1.00 | 5.06 | 0 | 0 | 0 |
| 51 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

GROUP 7 (ONE LINE FOR EACH HEADWATER)

| X01 | X02 | X03 | X04 | X05 | X06 | X07 | X08 | X09 |
|-----|-------|------|-----|-------|------|-----|-----|-----|
| 0.0 | 11.65 | 9.64 | 0 | 0.373 | 6.27 | 0 | 0 | 0 |
| 0.0 | 13.10 | 8.03 | 0 | 1.03 | 3.85 | 0 | 0 | 0 |

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

| REACH | XK1 | XK2 | XK3 | XK4 | XM1 | XM2 | XM3 | XRES | XDS | XP |
|-------|-------|-------|------|------|-----|-----|-----|-------|-------|------|
| 1 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.001 | 12.98 | .001 |
| 2 | 0.036 | 0.911 | .574 | .026 | .00 | .00 | .00 | 1.151 | 13.02 | .001 |
| 3 | 0.036 | 0.001 | .630 | .026 | .00 | .00 | .00 | 1.099 | 13.04 | .001 |
| 4 | 0.036 | 0.001 | .304 | .026 | .00 | .00 | .00 | 1.025 | 13.04 | .001 |
| 5 | 0.036 | 0.001 | .211 | .026 | .00 | .00 | .00 | 0.951 | 13.04 | .001 |
| 6 | 0.036 | 0.001 | .164 | .026 | .00 | .00 | .00 | 0.877 | 13.04 | .001 |
| 7 | 0.036 | 0.001 | .135 | .026 | .00 | .00 | .00 | 0.810 | 13.04 | .001 |
| 8 | 0.036 | 0.001 | .115 | .026 | .00 | .00 | .00 | 0.750 | 13.04 | .001 |
| 9 | 0.036 | 0.001 | .100 | .026 | .00 | .00 | .00 | 0.683 | 13.04 | .001 |
| 10 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.06 | .001 |
| 11 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.417 | 13.07 | .001 |
| 12 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.346 | 13.11 | .001 |
| 13 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.297 | 13.15 | .001 |
| 14 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.335 | 13.17 | .001 |
| 15 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.308 | 13.19 | .001 |
| 16 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.285 | 13.21 | .001 |
| 17 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.207 | 13.25 | .001 |
| 18 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.148 | 13.27 | .001 |
| 19 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.29 | .001 |
| 20 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.30 | .001 |
| 21 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.33 | .001 |
| 22 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 1.662 | 13.37 | .001 |
| 23 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 1.836 | 13.37 | .001 |
| 24 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 1.836 | 13.37 | .001 |
| 25 | 0.048 | 0.911 | .553 | .026 | .00 | .00 | .00 | 1.367 | 13.40 | .001 |
| 26 | 0.048 | 0.001 | .456 | .026 | .00 | .00 | .00 | 0.971 | 13.43 | .001 |
| 27 | 0.026 | 0.001 | .372 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 28 | 0.026 | 0.001 | .235 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 29 | 0.026 | 0.001 | .175 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 30 | 0.026 | 0.001 | .165 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 31 | 0.026 | 0.001 | .114 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 32 | 0.026 | 0.001 | .098 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 33 | 0.026 | 0.001 | .088 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 34 | 0.026 | 0.001 | .079 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 35 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.554 | 13.49 | .001 |

| | | | | | | | | | | |
|----|-------|-------|------|------|-----|-----|-----|-------|-------|------|
| 36 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.50 | .001 |
| 37 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.60 | .001 |
| 38 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.61 | .001 |
| 39 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.61 | .001 |
| 40 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.62 | .001 |
| 41 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.62 | .001 |
| 42 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.66 | .001 |
| 43 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.70 | .001 |
| 44 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.72 | .001 |
| 45 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.73 | .001 |
| 46 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.75 | .001 |
| 47 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.75 | .001 |
| 48 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.79 | .001 |
| 49 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.849 | 13.82 | .001 |
| 50 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.849 | 13.85 | .001 |
| 51 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 52 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 53 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 54 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.041 | 13.62 | .001 |

GROUP 9 (AVERAGE RIVER TEMPERATURE)
 TEMPER

 0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH NUMBER)
 REACH REFQ T HEXN VEXN RFGDR

| REACH | REFQ | T | HEXN | VEXN | RFGDR |
|-------|------|------|------|------|-------|
| 1 | 50 | .045 | .516 | .353 | 20 |
| 2 | 50 | .018 | .516 | .353 | 20 |
| 3 | 50 | .127 | .516 | .353 | 20 |
| 4 | 50 | .127 | .516 | .353 | 20 |
| 5 | 50 | .127 | .516 | .353 | 20 |
| 6 | 50 | .127 | .516 | .353 | 20 |
| 7 | 50 | .127 | .516 | .353 | 20 |
| 8 | 50 | .127 | .516 | .353 | 20 |
| 9 | 50 | .127 | .516 | .353 | 20 |
| 10 | 50 | .448 | .516 | .353 | 20 |
| 11 | 50 | .543 | .550 | .346 | 20 |
| 12 | 50 | .622 | .550 | .346 | 20 |
| 13 | 50 | .297 | .550 | .346 | 20 |
| 14 | 50 | .308 | .540 | .266 | 20 |
| 15 | 50 | .004 | .540 | .266 | 20 |
| 16 | 50 | .284 | .551 | .326 | 20 |
| 17 | 50 | .202 | .551 | .326 | 20 |
| 18 | 50 | .176 | .551 | .326 | 20 |
| 19 | 50 | .154 | .551 | .326 | 20 |
| 20 | 50 | .704 | .551 | .326 | 20 |
| 21 | 50 | .044 | .551 | .326 | 20 |
| 22 | 50 | .147 | .551 | .326 | 20 |
| 23 | 50 | .022 | .463 | .362 | 20 |

| | | | | | |
|----|----|-------|------|------|----|
| 24 | 50 | .002 | .463 | .362 | 20 |
| 25 | 50 | .016 | .536 | .274 | 20 |
| 26 | 50 | .046 | .536 | .274 | 20 |
| 27 | 50 | .104 | .536 | .274 | 20 |
| 28 | 50 | .104 | .536 | .274 | 20 |
| 29 | 50 | .104 | .536 | .274 | 20 |
| 30 | 50 | .104 | .536 | .274 | 20 |
| 31 | 50 | .138 | .536 | .274 | 20 |
| 32 | 50 | .138 | .536 | .274 | 20 |
| 33 | 50 | .138 | .536 | .274 | 20 |
| 34 | 50 | .138 | .536 | .274 | 20 |
| 35 | 50 | 1.390 | .536 | .274 | 20 |
| 36 | 50 | 1.799 | .523 | .288 | 20 |
| 37 | 50 | 1.426 | .512 | .350 | 20 |
| 38 | 50 | .463 | .512 | .260 | 20 |
| 39 | 50 | .805 | .512 | .260 | 20 |
| 40 | 50 | 1.453 | .512 | .260 | 20 |
| 41 | 50 | 1.960 | .512 | .260 | 20 |
| 42 | 50 | 2.350 | .512 | .260 | 20 |
| 43 | 50 | 2.009 | .592 | .295 | 20 |
| 44 | 50 | .038 | .592 | .295 | 20 |
| 45 | 50 | .280 | .592 | .295 | 20 |
| 46 | 50 | .587 | .592 | .295 | 20 |
| 47 | 50 | 2.331 | .592 | .295 | 20 |
| 48 | 50 | 1.524 | .592 | .295 | 20 |
| 49 | 50 | 1.878 | .598 | .335 | 20 |
| 50 | 50 | .348 | .598 | .335 | 20 |
| 51 | 50 | .180 | .555 | .351 | 20 |
| 52 | 50 | .023 | .555 | .351 | 20 |
| 53 | 50 | .557 | .555 | .351 | 20 |
| 54 | 50 | .471 | .536 | .289 | 20 |

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)

FNAM

ATHAJ89

LSRJ89

13 FEBRUARY - 16 MARCH 1989

ATHABASCA RIVER MARCH 1989 GROUP 1

| NRT | NTRIB | MAXTR | MAXRI | MAXPT | NSTP | NVAR |
|-----|-------|-------|-------|-------|------|------|
| 54 | 1 | 4 | 50 | 50 | 23 | 9 |

GROUP 2 (ONE LINE FOR EACH REACH)

| IRCH | UP1 | IUP2 | X | Q | QLD | SOURCE NAME |
|------|-----|------|------|-------|-------|------------------|
| 1 | 0 | 0 | 1.7 | 28 | 0.000 | |
| 2 | 1 | 0 | 0.8 | 26.98 | 1.02 | WELDWOOD<OPEN |
| 3 | 2 | 0 | 5.0 | 28.0 | 0.000 | |
| 4 | 3 | 0 | 5.0 | 28.0 | 0.000 | |
| 5 | 4 | 0 | 5.0 | 28.0 | 0.000 | |
| 6 | 5 | 0 | 5.0 | 28.0 | 0.000 | |
| 7 | 6 | 0 | 5.0 | 28.0 | 0.000 | |
| 8 | 7 | 0 | 5.0 | 28.0 | 0.000 | |
| 9 | 8 | 0 | 5.0 | 28.0 | 0.000 | |
| 10 | 9 | 0 | 18.6 | 28.0 | 0.000 | |
| 11 | 10 | 0 | 22.5 | 28.0 | 0.950 | OLDMANCR |
| 12 | 11 | 0 | 25.8 | 28.95 | 0.030 | SPRING1 |
| 13 | 12 | 0 | 13.3 | 28.98 | 5.520 | BERLAND R |
| 14 | 13 | 0 | 13.8 | 34.5 | 0.015 | SPRING2 |
| 15 | 14 | 0 | 0.2 | 34.52 | 0.173 | MARSH CR |
| 16 | 15 | 0 | 12.7 | 34.69 | 0.031 | PINE CR |
| 17 | 16 | 0 | 9.2 | 35.00 | 0.000 | |
| 18 | 17 | 0 | 8.0 | 35.00 | 0.020 | SPRING3 |
| 19 | 18 | 0 | 7.0 | 35.02 | 0.014 | TWO CREEK |
| 20 | 19 | 0 | 32.0 | 35.03 | 0.503 | WINDFALL |
| 21 | 20 | 0 | 2.0 | 35.53 | 0.000 | |
| 22 | 21 | 0 | 6.7 | 35.53 | 0.000 | |
| 23 | 22 | 0 | 1.1 | 35.53 | 0.923 | SAKWATAMAU |
| 24 | 23 | 0 | 0.1 | 36.45 | 4.630 | MCLEOD R |
| 25 | 24 | 0 | 0.8 | 40.96 | 0.124 | MILLAR WEST<OPEN |
| 26 | 25 | 0 | 2.8 | 41.08 | 0.000 | |
| 27 | 26 | 0 | 5.0 | 41.04 | 0.035 | WHITE STP |
| 28 | 27 | 0 | 5.0 | 41.08 | 0.000 | |
| 29 | 28 | 0 | 5.0 | 41.08 | 0.000 | |
| 30 | 29 | 0 | 6.1 | 41.08 | 0.000 | |
| 31 | 30 | 0 | 5.0 | 41.08 | 0.000 | |
| 32 | 31 | 0 | 5.0 | 41.08 | 0.000 | |
| 33 | 32 | 0 | 5.0 | 41.08 | 0.000 | |
| 34 | 33 | 0 | 5.0 | 41.08 | 0.000 | |
| 35 | 34 | 0 | 50.0 | 41.08 | 0.000 | |
| 36 | 35 | 0 | 44.6 | 41.08 | 0.590 | FREEMAN R |
| 37 | 36 | 0 | 31.5 | 41.67 | 0.000 | |
| 38 | 37 | 0 | 11.5 | 41.67 | 0.000 | |
| 39 | 38 | 0 | 20.0 | 41.67 | 2.91 | PEMBINA |
| 40 | 39 | 0 | 36.1 | 44.58 | 0.000 | |
| 41 | 40 | 54 | 48.7 | 67.28 | 0.000 | LESSER SLAVE |

| | | | | | | |
|----|----|---|------|-------|-------|-----------|
| 42 | 41 | 0 | 58.4 | 67.28 | 0.0 | UNKNOWN |
| 43 | 42 | 0 | 53.0 | 67.27 | 0.012 | ATHAB STP |
| 44 | 43 | 0 | 1.0 | 67.28 | 0.000 | |
| 45 | 44 | 0 | 7.4 | 67.28 | 0.000 | |
| 46 | 45 | 0 | 15.5 | 67.28 | 0.426 | LA BICHE |
| 47 | 46 | 0 | 61.5 | 67.71 | 0.022 | CALLING |
| 48 | 47 | 0 | 47.3 | 67.73 | 0.000 | |
| 49 | 48 | 0 | 58.3 | 67.73 | 0.154 | PELICAN |
| 50 | 49 | 0 | 10.8 | 67.88 | 0.272 | HOUSE |
| 51 | 0 | 0 | 8.0 | 22.7 | 0 | |
| 52 | 51 | 0 | 1.0 | 22.7 | 0 | |
| 53 | 52 | 0 | 24.7 | 22.7 | 0 | |
| 54 | 53 | 0 | 19.8 | 22.7 | 0 | |

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

| STNAM | INST |
|----------------|-------|
| ***** | ***** |
| WELDWOOD | 2 |
| OLDMAN CR | 11 |
| SPRING 1 | 12 |
| BERLAND R | 13 |
| SPRING2 | 14 |
| MARSH HEAD CR | 15 |
| PINE CR | 16 |
| SPRING 3 | 18 |
| TWO CREEK | 19 |
| WINDFALL CR | 20 |
| SAKWATAMAU R | 23 |
| McLEOD R | 24 |
| MILLAR WEST | 25 |
| STP | 27 |
| FREEMAN R | 29 |
| PEMBINA R | 32 |
| LESSER SLAVE R | 41 |
| UNKNOWN | 42 |
| STP | 43 |
| LA BICHE R | 46 |
| CALLING R | 47 |
| PELICAN R | 49 |
| HOUSE R | 50 |

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. 7 CHARACTERS)

| RNAM |
|-----------------|
| ***** |
| ATHABASCA RIVER |

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

| TNAM | INTR |
|--------------|-------|
| ***** | ***** |
| LESSER SLAVE | 41 |

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

| REACH | XLD1 | XLD2 | XLD3 | XLD4 | XLD5 | XLD6 | XLD7 | XLD8 | XLD9 |
|-------|--------|-------|-------|--------|------|-------|------|------|------|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 73.15 | 7.0 | 0 | 35.11 | 1.26 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 12.84 | 5.62 | 0 | 0.36 | 2.98 | 0 | 0 | 0 |
| 12 | 0 | 11.55 | 8.03 | 0 | 0.06 | 0.56 | 0 | 0 | 0 |
| 13 | 0 | 9.61 | 8.03 | 0 | 0.79 | 2.57 | 0 | 0 | 0 |
| 14 | 0 | 12.01 | 5.62 | 0 | 0.16 | 4.16 | 0 | 0 | 0 |
| 15 | 0 | 11.70 | 5.62 | 0 | 0.74 | 3.20 | 0 | 0 | 0 |
| 16 | 0 | 12.09 | 4.02 | 0 | 1.20 | 1.41 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 11.29 | 4.82 | 0 | 0.40 | 3.37 | 0 | 0 | 0 |
| 19 | 0 | 10.47 | 5.62 | 0 | 2.28 | 2.08 | 0 | 0 | 0 |
| 20 | 0 | 10.78 | 3.21 | 0 | 1.21 | 2.02 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 0 | 9.57 | 3.61 | 0 | 1.30 | 2.49 | 0 | 0 | 0 |
| 24 | 0 | 5.95 | 6.42 | 0 | 1.61 | 4.82 | 0 | 0 | 0 |
| 25 | 2450.8 | 7.3 | 0 | 1370.0 | 2.70 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 63.2 | 4.4 | 0 | 37.9 | 0.88 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | 0 | 9.45 | 9.64 | 0 | 1.74 | 7.32 | 0 | 0 | 0 |
| 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 0 | 1.46 | 11.24 | 0 | 0.95 | 7.31 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 119.3 | 2.6 | 0 | 155.1 | 2.7 | 0 | 0 | 0 | 0 |
| 44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | 0 | 3.17 | 16.86 | 0 | 1.46 | 10.62 | 0 | 0 | 0 |
| 47 | 0 | 11.63 | 4.82 | 0 | 3.36 | 2.94 | 0 | 0 | 0 |
| 48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|----|---|-------|-------|---|------|------|---|---|---|
| 49 | 0 | 13.02 | 12.85 | 0 | 1.16 | 6.30 | 0 | 0 | 0 |
| 50 | 0 | 9.7 | 4.82 | 0 | 0.91 | 3.37 | 0 | 0 | 0 |
| 51 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

GROUP 7 (ONE LINE FOR EACH HEADWATER)

| | X01 | X02 | X03 | X04 | X05 | X06 | X07 | X08 | X09 |
|-------|-----|-------|------|-----|-------|------|-----|-----|-----|
| ***** | | | | | | | | | |
| | 0.0 | 11.14 | 8.03 | 0 | 0.356 | 5.22 | 0 | 0 | 0 |
| | 0.0 | 13.02 | 3.21 | 0 | 1.03 | 1.54 | 0 | 0 | 0 |

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

| REACH | XK1 | XK2 | XK3 | XK4 | XM1 | XM2 | XM3 | XRES | XDS | XP |
|-------|-------|-------|------|------|-----|-----|-----|-------|-------|------|
| ***** | | | | | | | | | | |
| 1 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.001 | 12.98 | .001 |
| 2 | 0.036 | 0.911 | .574 | .026 | .00 | .00 | .00 | 1.151 | 13.02 | .001 |
| 3 | 0.036 | 0.001 | .630 | .026 | .00 | .00 | .00 | 1.099 | 13.04 | .001 |
| 4 | 0.036 | 0.001 | .304 | .026 | .00 | .00 | .00 | 1.025 | 13.04 | .001 |
| 5 | 0.036 | 0.001 | .211 | .026 | .00 | .00 | .00 | 0.951 | 13.04 | .001 |
| 6 | 0.036 | 0.001 | .164 | .026 | .00 | .00 | .00 | 0.877 | 13.04 | .001 |
| 7 | 0.036 | 0.001 | .135 | .026 | .00 | .00 | .00 | 0.810 | 13.04 | .001 |
| 8 | 0.036 | 0.001 | .115 | .026 | .00 | .00 | .00 | 0.750 | 13.04 | .001 |
| 9 | 0.036 | 0.001 | .100 | .026 | .00 | .00 | .00 | 0.683 | 13.04 | .001 |
| 10 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.06 | .001 |
| 11 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.417 | 13.07 | .001 |
| 12 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.346 | 13.11 | .001 |
| 13 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.297 | 13.15 | .001 |
| 14 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.335 | 13.17 | .001 |
| 15 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.308 | 13.19 | .001 |
| 16 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.285 | 13.21 | .001 |
| 17 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.207 | 13.25 | .001 |
| 18 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.148 | 13.27 | .001 |
| 19 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.29 | .001 |
| 20 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.30 | .001 |
| 21 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.33 | .001 |
| 22 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 1.662 | 13.37 | .001 |
| 23 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 1.836 | 13.37 | .001 |
| 24 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 1.836 | 13.37 | .001 |
| 25 | 0.048 | 0.911 | .553 | .026 | .00 | .00 | .00 | 1.367 | 13.40 | .001 |
| 26 | 0.048 | 0.001 | .456 | .026 | .00 | .00 | .00 | 0.971 | 13.43 | .001 |
| 27 | 0.026 | 0.001 | .372 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 28 | 0.026 | 0.001 | .235 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 29 | 0.026 | 0.001 | .175 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 30 | 0.026 | 0.001 | .165 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 31 | 0.026 | 0.001 | .114 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 32 | 0.026 | 0.001 | .098 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 33 | 0.026 | 0.001 | .088 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 34 | 0.026 | 0.001 | .079 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 35 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.554 | 13.49 | .001 |

| | | | | | | | | | | |
|----|-------|-------|------|------|-----|-----|-----|-------|-------|------|
| 36 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.50 | .001 |
| 37 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.60 | .001 |
| 38 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.61 | .001 |
| 39 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.61 | .001 |
| 40 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.62 | .001 |
| 41 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.62 | .001 |
| 42 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.66 | .001 |
| 43 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.70 | .001 |
| 44 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.72 | .001 |
| 45 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.73 | .001 |
| 46 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.75 | .001 |
| 47 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.75 | .001 |
| 48 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.79 | .001 |
| 49 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.849 | 13.82 | .001 |
| 50 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.849 | 13.85 | .001 |
| 51 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 52 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 53 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 54 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.041 | 13.62 | .001 |

GROUP 9 (AVERAGE RIVER TEMPERATURE)

TEMPER

0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH NUMBER)

REACH REFQ T HEXN VEXN RFGDR

| | | | | | |
|----|----|------|------|------|----|
| 1 | 50 | .045 | .516 | .353 | 20 |
| 2 | 50 | .018 | .516 | .353 | 20 |
| 3 | 50 | .127 | .516 | .353 | 20 |
| 4 | 50 | .127 | .516 | .353 | 20 |
| 5 | 50 | .127 | .516 | .353 | 20 |
| 6 | 50 | .127 | .516 | .353 | 20 |
| 7 | 50 | .127 | .516 | .353 | 20 |
| 8 | 50 | .127 | .516 | .353 | 20 |
| 9 | 50 | .127 | .516 | .353 | 20 |
| 10 | 50 | .448 | .516 | .353 | 20 |
| 11 | 50 | .543 | .550 | .346 | 20 |
| 12 | 50 | .622 | .550 | .346 | 20 |
| 13 | 50 | .297 | .550 | .346 | 20 |
| 14 | 50 | .308 | .540 | .266 | 20 |
| 15 | 50 | .004 | .540 | .266 | 20 |
| 16 | 50 | .284 | .551 | .326 | 20 |
| 17 | 50 | .202 | .551 | .326 | 20 |
| 18 | 50 | .176 | .551 | .326 | 20 |
| 19 | 50 | .154 | .551 | .326 | 20 |
| 20 | 50 | .704 | .551 | .326 | 20 |
| 21 | 50 | .044 | .551 | .326 | 20 |
| 22 | 50 | .147 | .551 | .326 | 20 |
| 23 | 50 | .022 | .463 | .362 | 20 |

| | | | | | |
|----|----|-------|------|------|----|
| 24 | 50 | .002 | .463 | .362 | 20 |
| 25 | 50 | .016 | .536 | .274 | 20 |
| 26 | 50 | .046 | .536 | .274 | 20 |
| 27 | 50 | .104 | .536 | .274 | 20 |
| 28 | 50 | .104 | .536 | .274 | 20 |
| 29 | 50 | .104 | .536 | .274 | 20 |
| 30 | 50 | .104 | .536 | .274 | 20 |
| 31 | 50 | .138 | .536 | .274 | 20 |
| 32 | 50 | .138 | .536 | .274 | 20 |
| 33 | 50 | .138 | .536 | .274 | 20 |
| 34 | 50 | .138 | .536 | .274 | 20 |
| 35 | 50 | 1.390 | .536 | .274 | 20 |
| 36 | 50 | 1.799 | .523 | .288 | 20 |
| 37 | 50 | 1.426 | .512 | .350 | 20 |
| 38 | 50 | .463 | .512 | .260 | 20 |
| 39 | 50 | .805 | .512 | .260 | 20 |
| 40 | 50 | 1.453 | .512 | .260 | 20 |
| 41 | 50 | 1.960 | .512 | .260 | 20 |
| 42 | 50 | 2.350 | .512 | .260 | 20 |
| 43 | 50 | 2.009 | .592 | .295 | 20 |
| 44 | 50 | .038 | .592 | .295 | 20 |
| 45 | 50 | .280 | .592 | .295 | 20 |
| 46 | 50 | .587 | .592 | .295 | 20 |
| 47 | 50 | 2.331 | .592 | .295 | 20 |
| 48 | 50 | 1.524 | .592 | .295 | 20 |
| 49 | 50 | 1.878 | .598 | .335 | 20 |
| 50 | 50 | .348 | .598 | .335 | 20 |
| 51 | 50 | .180 | .555 | .351 | 20 |
| 52 | 50 | .023 | .555 | .351 | 20 |
| 53 | 50 | .557 | .555 | .351 | 20 |
| 54 | 50 | .471 | .536 | .289 | 20 |

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)
 FNAM

 ATHAM89
 LSRM89

14 FEBRUARY - 21 MARCH 1990

ATHABASCA RIVER WINTER 1990GROUP 1

| NRT | NTRIB | MAXTR | MAXRI | MAXPT | NSTP | NVAR |
|-----|-------|-------|-------|-------|------|------|
| 54 | 1 | 4 | 50 | 50 | 19 | 9 |

GROUP 2 (ONE LINE FOR EACH REACH)

| IRCH | UP1 | UP2 | X | Q | QLD | SOURCE NAME |
|------|-----|-----|------|--------|--------|---------------|
| 1 | 0 | 0 | 1.7 | 33.0 | 0.000 | |
| 2 | 1 | 0 | 0.8 | 32.216 | 0.784 | WELWOOD<OPEN |
| 3 | 2 | 0 | 5.0 | 33.0 | 0.000 | |
| 4 | 3 | 0 | 5.0 | 33.0 | 0.000 | |
| 5 | 4 | 0 | 5.0 | 33.0 | 0.000 | |
| 6 | 5 | 0 | 5.0 | 33.0 | 0.000 | |
| 7 | 6 | 0 | 5.0 | 33.0 | 0.000 | |
| 8 | 7 | 0 | 5.0 | 33.0 | 0.000 | |
| 9 | 8 | 0 | 5.0 | 33.0 | 0.000 | |
| 10 | 9 | 0 | 18.6 | 33.0 | 0.000 | |
| 11 | 10 | 0 | 22.5 | 33.0 | 1.100 | OLDMAN CR |
| 12 | 11 | 0 | 25.8 | 34.1 | 0.022 | SPRING 1 |
| 13 | 12 | 0 | 13.3 | 34.12 | 8.900 | BERLAND R |
| 14 | 13 | 0 | 13.8 | 43.0 | 0.019 | SPRING 2 |
| 15 | 14 | 0 | 0.2 | 43.02 | 0.300 | MARSH CR |
| 16 | 15 | 0 | 12.7 | 43.32 | 0.165 | PINECR |
| 17 | 16 | 0 | 9.2 | 43.49 | 0.000 | |
| 18 | 17 | 0 | 8.0 | 43.49 | 0.018 | SPRING 3 |
| 19 | 18 | 0 | 7.0 | 43.50 | 0.012 | TWO CREEK |
| 20 | 19 | 0 | 32.0 | 43.52 | 0.900 | WINDFALL |
| 21 | 20 | 0 | 2.0 | 44.42 | 0.000 | |
| 22 | 21 | 0 | 6.7 | 44.42 | 0.000 | |
| 23 | 22 | 0 | 1.1 | 44.42 | 0.900 | SAKWATAMAU |
| 24 | 23 | 0 | 0.1 | 45.32 | 10.100 | McLEOD R |
| 25 | 24 | 0 | 0.8 | 55.28 | 0.136 | MILLARW.<OPEN |
| 26 | 25 | 0 | 2.8 | 55.42 | 0.000 | |
| 27 | 26 | 0 | 5.0 | 55.38 | 0.041 | WHITE STP |
| 28 | 27 | 0 | 5.0 | 55.42 | 0.000 | |
| 29 | 28 | 0 | 5.0 | 55.42 | 0.000 | |
| 30 | 29 | 0 | 6.1 | 55.42 | 0.000 | |
| 31 | 30 | 0 | 5.0 | 55.42 | 0.000 | |
| 32 | 31 | 0 | 5.0 | 55.42 | 0.000 | |
| 33 | 32 | 0 | 5.0 | 55.42 | 0.000 | |
| 34 | 33 | 0 | 5.0 | 55.42 | 0.000 | |
| 35 | 34 | 0 | 50.0 | 55.42 | 0.000 | |
| 36 | 35 | 0 | 44.6 | 55.42 | 0.800 | FREEMAN R |
| 37 | 36 | 0 | 31.5 | 56.22 | 0.000 | |
| 38 | 37 | 0 | 11.5 | 56.22 | 0.000 | |
| 39 | 38 | 0 | 20.0 | 56.22 | 6.800 | PEMBINA |
| 40 | 39 | 0 | 36.1 | 63.02 | 0.000 | |
| 41 | 40 | 54 | 48.7 | 106.72 | 0.000 | LESSER SLAVE |

| | | | | | | |
|----|----|---|------|--------|-------|-----------|
| 42 | 41 | 0 | 58.4 | 106.72 | 0.000 | |
| 43 | 42 | 0 | 53.0 | 106.71 | 0.011 | ATHAB STP |
| 44 | 43 | 0 | 1.0 | 106.72 | 0.000 | |
| 45 | 44 | 0 | 7.4 | 106.72 | 0.000 | |
| 46 | 45 | 0 | 15.5 | 106.72 | 2.300 | LA BICHE |
| 47 | 46 | 0 | 61.5 | 109.02 | 0.100 | CALLING |
| 48 | 47 | 0 | 47.3 | 109.12 | 0.000 | |
| 49 | 48 | 0 | 58.3 | 109.12 | 0.800 | PELICAN |
| 50 | 49 | 0 | 10.8 | 109.92 | 1.600 | HOUSE |
| 51 | 0 | 0 | 8.0 | 43.7 | 0.032 | SL STP |
| 52 | 51 | 0 | 1.0 | 43.7 | 0.000 | |
| 53 | 52 | 0 | 24.7 | 43.7 | 0.000 | |
| 54 | 53 | 0 | 19.8 | 43.7 | 0.000 | |

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

| STNAM | INST |
|----------------|-------|
| ***** | ***** |
| WELDWOOD | 2 |
| OLDMAN CR | 11 |
| SPRING1 | 12 |
| BERLAND R | 13 |
| MARSH HEAD CR | 15 |
| PINE+TWO CR | 16 |
| WINDFALL CR | 20 |
| SAKWATAMAU | 23 |
| McLEOD R | 24 |
| MILLAR WEST | 25 |
| STP WHITECOURT | 27 |
| FREEMAN R | 29 |
| PEMBINA R | 32 |
| LESSER SLAVE R | 41 |
| STP ATHABASCA | 43 |
| LA BICHE R | 46 |
| CALLING R | 47 |
| PELICAN R | 49 |
| HOUSE R | 50 |

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. SEVEN CHARACTERS)

| RNAM |
|-----------------|
| ***** |
| ATHABASCA RIVER |

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

| TNAM | INTR |
|--------------|-------|
| ***** | ***** |
| LESSER SLAVE | 41 |

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

| REACH | XLD1 | XLD2 | XLD3 | XLD4 | XLD5 | XLD6 | XLD7 | XLD8 | XLD9 |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| ***** | ***** | ***** | ***** | ***** | ***** | ***** | ***** | ***** | ***** |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|----|--------|-------|-------|--------|------|-------|---|---|---|
| 2 | 138.06 | 10.1 | 0 | 77.31 | 1.82 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 12.8 | 9.64 | 0 | 0.36 | 5.11 | 0 | 0 | 0 |
| 12 | 0 | 11.59 | 8.43 | 0 | 0.06 | 0.59 | 0 | 0 | 0 |
| 13 | 0 | 9.81 | 6.83 | 0 | 0.80 | 2.18 | 0 | 0 | 0 |
| 14 | 0 | 11.87 | 7.23 | 0 | 0.15 | 5.35 | 0 | 0 | 0 |
| 15 | 0 | 11.97 | 5.62 | 0 | 0.75 | 3.20 | 0 | 0 | 0 |
| 16 | 0 | 11.30 | 3.21 | 0 | 1.12 | 1.12 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 11.02 | 3.21 | 0 | 0.39 | 2.25 | 0 | 0 | 0 |
| 19 | 0 | 9.07 | 7.63 | 0 | 1.98 | 2.82 | 0 | 0 | 0 |
| 20 | 0 | 11.3 | 5.62 | 0 | 1.27 | 3.54 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 0 | 9.96 | 4.02 | 0 | 1.35 | 2.77 | 0 | 0 | 0 |
| 24 | 0 | 8.41 | 7.70 | 0 | 2.27 | 5.30 | 0 | 0 | 0 |
| 25 | 280.60 | 4.60 | 0 | 173.97 | 0.92 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 159.9 | 5.7 | 0 | 95.9 | 1.14 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | 0 | 8.69 | 1.61 | 0 | 1.60 | 1.22 | 0 | 0 | 0 |
| 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 0 | 3.29 | 5.62 | 0 | 2.14 | 3.65 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 74.10 | 2.6 | 0 | 96.3 | 2.7 | 0 | 0 | 0 | 0 |
| 44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | 0 | 4.86 | 3.21 | 0 | 2.25 | 2.02 | 0 | 0 | 0 |
| 47 | 0 | 11.56 | 2.17 | 0 | 3.34 | 1.32 | 0 | 0 | 0 |
| 48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 49 | 0 | 12.33 | 26.42 | 0 | 1.10 | 12.95 | 0 | 0 | 0 |
| 50 | 0 | 11.55 | 2.09 | 0 | 1.09 | 1.46 | 0 | 0 | 0 |
| 51 | 181.74 | 0.74 | 0 | 72.70 | 0.81 | 0 | 0 | 0 | 0 |
| 52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|----|---|---|---|---|---|---|---|---|---|
| 53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

GROUP 7 (ONE LINE FOR EACH HEADWATER)

| X01 | X02 | X03 | X04 | X05 | X06 | X07 | X08 | X09 |
|-----|-------|------|-----|-------|------|-----|-----|-----|
| 0.0 | 11.57 | 2.97 | 0 | 0.370 | 1.93 | 0 | 0 | 0 |
| 0.0 | 13.50 | 4.82 | 0 | 1.07 | 2.31 | 0 | 0 | 0 |

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

| REACH | XK1 | XK2 | XK3 | XK4 | XM1 | XM2 | XM3 | XRES | XDS | XP |
|-------|-------|-------|------|------|-----|-----|-----|-------|-------|------|
| 1 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.001 | 12.98 | .001 |
| 2 | 0.035 | 0.911 | .574 | .026 | .00 | .00 | .00 | 1.151 | 13.02 | .001 |
| 3 | 0.035 | 0.001 | .630 | .026 | .00 | .00 | .00 | 1.099 | 13.04 | .001 |
| 4 | 0.035 | 0.001 | .304 | .026 | .00 | .00 | .00 | 1.025 | 13.04 | .001 |
| 5 | 0.035 | 0.001 | .211 | .026 | .00 | .00 | .00 | 0.951 | 13.04 | .001 |
| 6 | 0.035 | 0.001 | .164 | .026 | .00 | .00 | .00 | 0.877 | 13.04 | .001 |
| 7 | 0.035 | 0.001 | .135 | .026 | .00 | .00 | .00 | 0.810 | 13.04 | .001 |
| 8 | 0.035 | 0.001 | .115 | .026 | .00 | .00 | .00 | 0.750 | 13.04 | .001 |
| 9 | 0.035 | 0.001 | .100 | .026 | .00 | .00 | .00 | 0.683 | 13.04 | .001 |
| 10 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.06 | .001 |
| 11 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.417 | 13.07 | .001 |
| 12 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.346 | 13.11 | .001 |
| 13 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.297 | 13.15 | .001 |
| 14 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.335 | 13.17 | .001 |
| 15 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.308 | 13.19 | .001 |
| 16 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.285 | 13.21 | .001 |
| 17 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.207 | 13.25 | .001 |
| 18 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.148 | 13.27 | .001 |
| 19 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.29 | .001 |
| 20 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.30 | .001 |
| 21 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.33 | .001 |
| 22 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 1.662 | 13.37 | .001 |
| 23 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 1.836 | 13.37 | .001 |
| 24 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 1.836 | 13.37 | .001 |
| 25 | 0.018 | 0.911 | .553 | .026 | .00 | .00 | .00 | 1.367 | 13.40 | .001 |
| 26 | 0.018 | 0.001 | .456 | .026 | .00 | .00 | .00 | 0.971 | 13.43 | .001 |
| 27 | 0.026 | 0.001 | .372 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 28 | 0.026 | 0.001 | .235 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 29 | 0.026 | 0.001 | .175 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 30 | 0.026 | 0.001 | .165 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 31 | 0.026 | 0.001 | .114 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 32 | 0.026 | 0.001 | .098 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 33 | 0.026 | 0.001 | .088 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 34 | 0.026 | 0.001 | .079 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 35 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.554 | 13.49 | .001 |
| 36 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.50 | .001 |
| 37 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.60 | .001 |
| 38 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.61 | .001 |
| 39 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.61 | .001 |

| | | | | | | | | | | |
|----|-------|-------|------|------|-----|-----|-----|-------|-------|------|
| 40 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.62 | .001 |
| 41 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.62 | .001 |
| 42 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.66 | .001 |
| 43 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.70 | .001 |
| 44 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.72 | .001 |
| 45 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.73 | .001 |
| 46 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.75 | .001 |
| 47 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.75 | .001 |
| 48 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.79 | .001 |
| 49 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.849 | 13.82 | .001 |
| 50 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.849 | 13.85 | .001 |
| 51 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 52 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 53 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 54 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.041 | 13.62 | .001 |

GROUP 9 (AVERAGE RIVER TEMPERATURE)
 TEMPER

 0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH#)
 REACH REFQ T HEXN VEXN RFDGR

| REACH | REFQ | T | HEXN | VEXN | RFDGR |
|-------|------|------|------|------|-------|
| 1 | 50 | .045 | .516 | .353 | 20 |
| 2 | 50 | .018 | .516 | .353 | 20 |
| 3 | 50 | .127 | .516 | .353 | 20 |
| 4 | 50 | .127 | .516 | .353 | 20 |
| 5 | 50 | .127 | .516 | .353 | 20 |
| 6 | 50 | .127 | .516 | .353 | 20 |
| 7 | 50 | .127 | .516 | .353 | 20 |
| 8 | 50 | .127 | .516 | .353 | 20 |
| 9 | 50 | .127 | .516 | .353 | 20 |
| 10 | 50 | .448 | .516 | .353 | 20 |
| 11 | 50 | .543 | .550 | .346 | 20 |
| 12 | 50 | .622 | .550 | .346 | 20 |
| 13 | 50 | .297 | .550 | .346 | 20 |
| 14 | 50 | .308 | .540 | .266 | 20 |
| 15 | 50 | .004 | .540 | .266 | 20 |
| 16 | 50 | .284 | .551 | .326 | 20 |
| 17 | 50 | .202 | .551 | .326 | 20 |
| 18 | 50 | .176 | .551 | .326 | 20 |
| 19 | 50 | .154 | .551 | .326 | 20 |
| 20 | 50 | .704 | .551 | .326 | 20 |
| 21 | 50 | .044 | .551 | .326 | 20 |
| 22 | 50 | .147 | .551 | .326 | 20 |
| 23 | 50 | .022 | .463 | .362 | 20 |
| 24 | 50 | .002 | .463 | .362 | 20 |
| 25 | 50 | .016 | .536 | .274 | 20 |
| 26 | 50 | .046 | .536 | .274 | 20 |
| 27 | 50 | .104 | .536 | .274 | 20 |

| | | | | | |
|----|----|-------|------|------|----|
| 28 | 50 | .104 | .536 | .274 | 20 |
| 29 | 50 | .104 | .536 | .274 | 20 |
| 30 | 50 | .104 | .536 | .274 | 20 |
| 31 | 50 | .138 | .536 | .274 | 20 |
| 32 | 50 | .138 | .536 | .274 | 20 |
| 33 | 50 | .138 | .536 | .274 | 20 |
| 34 | 50 | .138 | .536 | .274 | 20 |
| 35 | 50 | 1.390 | .536 | .274 | 20 |
| 36 | 50 | 1.799 | .523 | .288 | 20 |
| 37 | 50 | 1.426 | .512 | .350 | 20 |
| 38 | 50 | .463 | .512 | .260 | 20 |
| 39 | 50 | .805 | .512 | .260 | 20 |
| 40 | 50 | 1.453 | .512 | .260 | 20 |
| 41 | 50 | 1.960 | .512 | .260 | 20 |
| 42 | 50 | 2.350 | .512 | .260 | 20 |
| 43 | 50 | 2.009 | .592 | .295 | 20 |
| 44 | 50 | .038 | .592 | .295 | 20 |
| 45 | 50 | .280 | .592 | .295 | 20 |
| 46 | 50 | .587 | .592 | .295 | 20 |
| 47 | 50 | 2.331 | .592 | .295 | 20 |
| 48 | 50 | 1.524 | .592 | .295 | 20 |
| 49 | 50 | 1.878 | .598 | .335 | 20 |
| 50 | 50 | .348 | .598 | .335 | 20 |
| 51 | 50 | .180 | .555 | .351 | 20 |
| 52 | 50 | .023 | .555 | .351 | 20 |
| 53 | 50 | .557 | .555 | .351 | 20 |
| 54 | 50 | .471 | .536 | .289 | 20 |

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)

FNAM

ATHA90

LSR90

7 FEBRUARY-14 MARCH 1991

ATHABASCA RIVER WINTER 1991 GROUP 1

| NRT | NTRIB | MAXTR | MAXRI | MAXPT | NSTP | NVAR |
|-----|-------|-------|-------|-------|------|------|
| 54 | 1 | 4 | 50 | 50 | 20 | 9 |

GROUP 2 (ONE LINE FOR EACH REACH)

| IRCH | UP1 | UP2 | X | Q | QLD | SOURCE NAME |
|------|-----|-----|------|--------|--------|---------------|
| 1 | 0 | 0 | 1.7 | 51.7 | 0.000 | |
| 2 | 1 | 0 | 0.8 | 50.61 | 1.09 | WELDWOOD<OPEN |
| 3 | 2 | 0 | 5.0 | 51.7 | 0.000 | |
| 4 | 3 | 0 | 5.0 | 51.7 | 0.000 | |
| 5 | 4 | 0 | 5.0 | 51.7 | 0.000 | |
| 6 | 5 | 0 | 5.0 | 51.7 | 0.000 | |
| 7 | 6 | 0 | 5.0 | 51.7 | 0.000 | |
| 8 | 7 | 0 | 5.0 | 51.7 | 0.000 | |
| 9 | 8 | 0 | 5.0 | 51.7 | 0.000 | |
| 10 | 9 | 0 | 18.6 | 51.7 | 0.000 | |
| 11 | 10 | 0 | 22.5 | 51.7 | 1.00 | OLDMAN CR |
| 12 | 11 | 0 | 25.8 | 52.7 | 0.022 | SPRING 1 |
| 13 | 12 | 0 | 13.3 | 52.72 | 12.2 | BERLAND R |
| 14 | 13 | 0 | 13.8 | 64.92 | 0.018 | SPRING 2 |
| 15 | 14 | 0 | 0.2 | 64.94 | 0.323 | MARSH CR |
| 16 | 15 | 0 | 12.7 | 65.26 | 0.165 | PINECR |
| 17 | 16 | 0 | 9.2 | 65.43 | 0.000 | |
| 18 | 17 | 0 | 8.0 | 65.43 | 0.018 | SPRING 3 |
| 19 | 18 | 0 | 7.0 | 65.45 | 0.012 | TWO CREEK |
| 20 | 19 | 0 | 32.0 | 65.46 | 0.474 | WINDFALL |
| 21 | 20 | 0 | 2.0 | 65.93 | 0.000 | |
| 22 | 21 | 0 | 0.8 | 65.74 | 0.192 | ANC |
| 23 | 22 | 0 | 7.0 | 65.93 | 0.934 | SAKWATAMAU |
| 24 | 23 | 0 | 0.1 | 66.86 | 10.300 | McLEOD R |
| 25 | 24 | 0 | 0.8 | 77.02 | 0.144 | MILLARW.<OPEN |
| 26 | 25 | 0 | 2.8 | 77.16 | 0.000 | |
| 27 | 26 | 0 | 5.0 | 77.12 | 0.039 | WHITE STP |
| 28 | 27 | 0 | 5.0 | 77.16 | 0.000 | |
| 29 | 28 | 0 | 5.0 | 77.16 | 0.000 | |
| 30 | 29 | 0 | 6.1 | 77.16 | 0.000 | |
| 31 | 30 | 0 | 5.0 | 77.16 | 0.000 | |
| 32 | 31 | 0 | 5.0 | 77.16 | 0.000 | |
| 33 | 32 | 0 | 5.0 | 77.16 | 0.000 | |
| 34 | 33 | 0 | 5.0 | 77.16 | 0.000 | |
| 35 | 34 | 0 | 50.0 | 77.16 | 0.000 | |
| 36 | 35 | 0 | 44.6 | 77.16 | 0.015 | FREEMAN R |
| 37 | 36 | 0 | 31.5 | 77.18 | 0.000 | |
| 38 | 37 | 0 | 11.5 | 77.18 | 0.000 | |
| 39 | 38 | 0 | 20.0 | 77.18 | 5.78 | PEMBINA |
| 40 | 39 | 0 | 36.1 | 82.96 | 0.000 | |
| 41 | 40 | 54 | 48.7 | 100.46 | 0.000 | LESSER SLAVE |

| | | | | | | |
|----|----|---|------|--------|-------|-----------|
| 42 | 41 | 0 | 58.4 | 100.46 | 0.000 | |
| 43 | 42 | 0 | 53.0 | 100.45 | 0.010 | ATHAB STP |
| 44 | 43 | 0 | 1.0 | 100.46 | 0.000 | |
| 45 | 44 | 0 | 7.4 | 100.46 | 0.000 | |
| 46 | 45 | 0 | 15.5 | 100.46 | 1.89 | LA BICHE |
| 47 | 46 | 0 | 61.5 | 102.34 | 0.030 | CALLING |
| 48 | 47 | 0 | 47.3 | 102.37 | 0.000 | |
| 49 | 48 | 0 | 58.3 | 102.37 | 0.295 | PELICAN |
| 50 | 49 | 0 | 10.8 | 102.67 | 1.140 | HOUSE |
| 51 | 0 | 0 | 8.0 | 17.5 | 0.026 | SL STP |
| 52 | 51 | 0 | 0.8 | 17.2 | 0.033 | SLPC |
| 53 | 52 | 0 | 24.9 | 17.5 | 0.000 | |
| 54 | 53 | 0 | 19.8 | 17.5 | 0.000 | |

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

| STNAM | INST |
|----------------|-------|
| ***** | ***** |
| WELDWOOD | 2 |
| OLDMAN CR | 11 |
| SPRING1 | 12 |
| BERLAND R | 13 |
| MARSH HEAD CR | 15 |
| PINE+TWO CR | 16 |
| WINDFALL CR | 20 |
| ANC | 22 |
| SAKWATAMAU | 23 |
| McLEOD R | 24 |
| MILLAR WEST | 25 |
| STP | 27 |
| FREEMAN R | 36 |
| PEMBINA R | 39 |
| LESSER SLAVE R | 41 |
| STP | 43 |
| LA BICHE R | 46 |
| CALLING R | 47 |
| PELICAN R | 49 |
| HOUSE R | 50 |

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. SEVEN CHARACTERS)

| RNAM |
|-----------------|
| ***** |
| ATHABASCA RIVER |

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

| TNAM | INTR |
|--------------|-------|
| ***** | ***** |
| LESSER SLAVE | 41 |

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

| REACH | XLD1 | XLD2 | XLD3 | XLD4 | XLD5 | XLD6 | XLD7 | XLD8 | XLD9 |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| ***** | ***** | ***** | ***** | ***** | ***** | ***** | ***** | ***** | ***** |

| | | | | | | | | | |
|----|--------|-------|-------|---------|------|------|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 132.50 | 7.2 | 0 | 71.55 | 1.01 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 12.71 | 12.37 | 0 | 0.35 | 6.55 | 0 | 0 | 0 |
| 12 | 0 | 11.59 | 8.43 | 0 | 0.06 | 0.59 | 0 | 0 | 0 |
| 13 | 0 | 11.05 | 3.21 | 0 | 0.91 | 1.03 | 0 | 0 | 0 |
| 14 | 0 | 11.86 | 4.58 | 0 | 0.16 | 3.39 | 0 | 0 | 0 |
| 15 | 0 | 12.3 | 7.23 | 0 | 0.77 | 4.12 | 0 | 0 | 0 |
| 16 | 0 | 11.30 | 3.21 | 0 | 1.12 | 1.12 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 11.02 | 3.21 | 0 | 0.39 | 2.25 | 0 | 0 | 0 |
| 19 | 0 | 9.07 | 7.63 | 0 | 1.98 | 2.82 | 0 | 0 | 0 |
| 20 | 0 | 11.04 | 8.19 | 0 | 1.24 | 5.16 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 56.12 | 6.20 | 0 | 84.18 | 1.05 | 0 | 0 | 0 | 0 |
| 23 | 0 | 9.08 | 4.82 | 0 | 1.23 | 3.32 | 0 | 0 | 0 |
| 24 | 0 | 9.09 | 7.23 | 0 | 2.45 | 5.42 | 0 | 0 | 0 |
| 25 | 235.17 | 3.75 | 0 | 103.47 | 0.98 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 59.28 | 5.9 | 0 | 35.57 | 1.18 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | 0 | 10.14 | 0.80 | 0 | 1.87 | 0.61 | 0 | 0 | 0 |
| 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 0 | 2.50 | 0.80 | 0 | 1.62 | 0.52 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 842.40 | 2.6 | 0 | 1095.12 | 2.70 | 0 | 0 | 0 | 0 |
| 44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | 0 | 2.74 | 6.42 | 0 | 1.27 | 4.05 | 0 | 0 | 0 |
| 47 | 0 | 10.34 | 6.02 | 0 | 2.99 | 3.67 | 0 | 0 | 0 |
| 48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 49 | 0 | 12.82 | 5.62 | 0 | 1.14 | 2.75 | 0 | 0 | 0 |
| 50 | 0 | 9.88 | 7.23 | 0 | 0.93 | 5.06 | 0 | 0 | 0 |
| 51 | 154.44 | 4.08 | 0 | 61.78 | 4.48 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|----|--------|------|---|--------|------|---|---|---|---|
| 52 | 664.90 | 6.42 | 0 | 804.53 | 2.43 | 0 | 0 | 0 | 0 |
| 53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

GROUP 7 (ONE LINE FOR EACH HEADWATER)

| | X01 | X02 | X03 | X04 | X05 | X06 | X07 | X08 | X09 |
|-------|-----|-------|------|-----|-------|-------|-----|-----|-----|
| ***** | | | | | | | | | |
| | 0.0 | 11.99 | 1.37 | 0 | 0.384 | 0.891 | 0 | 0 | 0 |
| | 0.0 | 13.26 | 6.50 | 0 | 1.05 | 3.12 | 0 | 0 | 0 |

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

| REACH | XK1 | XK2 | XK3 | XK4 | XM1 | XM2 | XM3 | XRES | XDS | XP |
|-------|-------|-------|------|------|-----|-----|-----|-------|-------|------|
| ***** | | | | | | | | | | |
| 1 | 0.034 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.001 | 12.98 | .001 |
| 2 | 0.034 | 0.911 | .574 | .026 | .00 | .00 | .00 | 1.151 | 13.02 | .001 |
| 3 | 0.034 | 0.001 | .630 | .026 | .00 | .00 | .00 | 1.099 | 13.04 | .001 |
| 4 | 0.034 | 0.001 | .304 | .026 | .00 | .00 | .00 | 1.025 | 13.04 | .001 |
| 5 | 0.034 | 0.001 | .211 | .026 | .00 | .00 | .00 | 0.951 | 13.04 | .001 |
| 6 | 0.034 | 0.001 | .164 | .026 | .00 | .00 | .00 | 0.877 | 13.04 | .001 |
| 7 | 0.034 | 0.001 | .135 | .026 | .00 | .00 | .00 | 0.810 | 13.04 | .001 |
| 8 | 0.034 | 0.001 | .115 | .026 | .00 | .00 | .00 | 0.750 | 13.04 | .001 |
| 9 | 0.034 | 0.001 | .100 | .026 | .00 | .00 | .00 | 0.683 | 13.04 | .001 |
| 10 | 0.034 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.06 | .001 |
| 11 | 0.034 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.417 | 13.07 | .001 |
| 12 | 0.034 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.346 | 13.11 | .001 |
| 13 | 0.034 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.297 | 13.15 | .001 |
| 14 | 0.034 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.335 | 13.17 | .001 |
| 15 | 0.034 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.308 | 13.19 | .001 |
| 16 | 0.034 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.285 | 13.21 | .001 |
| 17 | 0.034 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.207 | 13.25 | .001 |
| 18 | 0.034 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.148 | 13.27 | .001 |
| 19 | 0.034 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.29 | .001 |
| 20 | 0.034 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.30 | .001 |
| 21 | 0.034 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.33 | .001 |
| 22 | 0.035 | 0.911 | .553 | .026 | .00 | .00 | .00 | 1.662 | 13.37 | .001 |
| 23 | 0.035 | 0.001 | .700 | .026 | .00 | .00 | .00 | 1.836 | 13.37 | .001 |
| 24 | 0.035 | 0.001 | .014 | .026 | .00 | .00 | .00 | 1.836 | 13.37 | .001 |
| 25 | 0.019 | 0.911 | .407 | .026 | .00 | .00 | .00 | 1.367 | 13.40 | .001 |
| 26 | 0.019 | 0.001 | .342 | .026 | .00 | .00 | .00 | 0.971 | 13.43 | .001 |
| 27 | 0.026 | 0.001 | .298 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 28 | 0.026 | 0.001 | .198 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 29 | 0.026 | 0.001 | .153 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 30 | 0.026 | 0.001 | .149 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 31 | 0.026 | 0.001 | .103 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 32 | 0.026 | 0.001 | .091 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 33 | 0.026 | 0.001 | .081 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 34 | 0.026 | 0.001 | .074 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 35 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.554 | 13.49 | .001 |
| 36 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.50 | .001 |
| 37 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.60 | .001 |
| 38 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.61 | .001 |

| | | | | | | | | | | |
|----|-------|-------|-------|------|-----|-----|-----|-------|-------|------|
| 39 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.61 | .001 |
| 40 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.62 | .001 |
| 41 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.62 | .001 |
| 42 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.66 | .001 |
| 43 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.70 | .001 |
| 44 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.72 | .001 |
| 45 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.73 | .001 |
| 46 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.75 | .001 |
| 47 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.75 | .001 |
| 48 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.79 | .001 |
| 49 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.849 | 13.82 | .001 |
| 50 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.849 | 13.85 | .001 |
| 51 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 52 | 0.018 | 0.911 | .556 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 53 | 0.018 | 0.001 | 1.048 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 54 | 0.018 | 0.001 | .339 | .026 | .00 | .00 | .00 | 0.041 | 13.62 | .001 |

GROUP 9 (AVERAGE RIVER TEMPERATURE)

TEMPER

0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH#)

| REACH | REFQ | T | HEXN | VEYN | RFDGR |
|-------|------|------|------|------|-------|
| 1 | 50 | .045 | .516 | .353 | 20 |
| 2 | 50 | .018 | .516 | .353 | 20 |
| 3 | 50 | .127 | .516 | .353 | 20 |
| 4 | 50 | .127 | .516 | .353 | 20 |
| 5 | 50 | .127 | .516 | .353 | 20 |
| 6 | 50 | .127 | .516 | .353 | 20 |
| 7 | 50 | .127 | .516 | .353 | 20 |
| 8 | 50 | .127 | .516 | .353 | 20 |
| 9 | 50 | .127 | .516 | .353 | 20 |
| 10 | 50 | .448 | .516 | .353 | 20 |
| 11 | 50 | .543 | .550 | .346 | 20 |
| 12 | 50 | .622 | .550 | .346 | 20 |
| 13 | 50 | .297 | .550 | .346 | 20 |
| 14 | 50 | .308 | .540 | .266 | 20 |
| 15 | 50 | .004 | .540 | .266 | 20 |
| 16 | 50 | .284 | .551 | .326 | 20 |
| 17 | 50 | .202 | .551 | .326 | 20 |
| 18 | 50 | .176 | .551 | .326 | 20 |
| 19 | 50 | .154 | .551 | .326 | 20 |
| 20 | 50 | .704 | .551 | .326 | 20 |
| 21 | 50 | .044 | .551 | .326 | 20 |
| 22 | 50 | .018 | .551 | .326 | 20 |
| 23 | 50 | .151 | .463 | .362 | 20 |
| 24 | 50 | .002 | .463 | .362 | 20 |
| 25 | 50 | .016 | .536 | .274 | 20 |
| 26 | 50 | .046 | .536 | .274 | 20 |

| | | | | | |
|----|----|-------|------|------|----|
| 27 | 50 | .104 | .536 | .274 | 20 |
| 28 | 50 | .104 | .536 | .274 | 20 |
| 29 | 50 | .104 | .536 | .274 | 20 |
| 30 | 50 | .104 | .536 | .274 | 20 |
| 31 | 50 | .138 | .536 | .274 | 20 |
| 32 | 50 | .138 | .536 | .274 | 20 |
| 33 | 50 | .138 | .536 | .274 | 20 |
| 34 | 50 | .138 | .536 | .274 | 20 |
| 35 | 50 | 1.390 | .536 | .274 | 20 |
| 36 | 50 | 1.799 | .523 | .288 | 20 |
| 37 | 50 | 1.426 | .523 | .288 | 20 |
| 38 | 50 | 0.463 | .523 | .288 | 20 |
| 39 | 50 | 0.805 | .512 | .260 | 20 |
| 40 | 50 | 1.453 | .512 | .260 | 20 |
| 41 | 50 | 1.960 | .512 | .260 | 20 |
| 42 | 50 | 2.350 | .512 | .260 | 20 |
| 43 | 50 | 2.009 | .592 | .295 | 20 |
| 44 | 50 | 0.038 | .592 | .295 | 20 |
| 45 | 50 | 0.280 | .592 | .295 | 20 |
| 46 | 50 | 0.587 | .592 | .295 | 20 |
| 47 | 50 | 2.331 | .592 | .295 | 20 |
| 48 | 50 | 1.524 | .592 | .295 | 20 |
| 49 | 50 | 1.878 | .598 | .335 | 20 |
| 50 | 50 | 0.348 | .598 | .335 | 20 |
| 51 | 50 | 0.180 | .555 | .351 | 20 |
| 52 | 50 | 0.018 | .555 | .351 | 20 |
| 53 | 50 | 0.561 | .555 | .351 | 20 |
| 54 | 50 | 0.471 | .536 | .289 | 20 |

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)

FNAM

ATHA91

LSR91

30 JANUARY - 10 MARCH 1992

ATHABASCA RIVER - WINTER 1992 GROUP 1

| NRT | NTRIB | MAXTR | MAXRI | MAXPT | NSTP | NVAR |
|-----|-------|-------|-------|-------|------|------|
| 54 | 1 | 4 | 50 | 50 | 20 | 9 |

GROUP 2 (ONE LINE FOR EACH REACH)

| IRCH | UP1 | IUP2 | X | Q | QLD | SOURCE NAME |
|------|-----|------|------|-------|--------|---------------|
| 1 | 0 | 0 | 1.7 | 47.2 | 0.000 | |
| 2 | 1 | 0 | 0.8 | 46.09 | 1.11 | WELDWOOD<OPEN |
| 3 | 2 | 0 | 5.0 | 47.2 | 0.000 | |
| 4 | 3 | 0 | 5.0 | 47.2 | 0.000 | |
| 5 | 4 | 0 | 5.0 | 47.2 | 0.000 | |
| 6 | 5 | 0 | 5.0 | 47.2 | 0.000 | |
| 7 | 6 | 0 | 5.0 | 47.2 | 0.000 | |
| 8 | 7 | 0 | 5.0 | 47.2 | 0.000 | |
| 9 | 8 | 0 | 5.0 | 47.2 | 0.000 | |
| 10 | 9 | 0 | 18.6 | 47.2 | 0.000 | |
| 11 | 10 | 0 | 22.5 | 47.2 | 1.0 | OLDMAN CR |
| 12 | 11 | 0 | 25.8 | 48.20 | 0.022 | SPRING 1 |
| 13 | 12 | 0 | 13.3 | 48.22 | 12.3 | BERLAND R |
| 14 | 13 | 0 | 13.8 | 60.52 | 0.018 | SPRING 2 |
| 15 | 14 | 0 | 0.2 | 60.54 | 0.359 | MARSH CR |
| 16 | 15 | 0 | 12.7 | 60.90 | 0.165 | PINECR |
| 17 | 16 | 0 | 9.2 | 61.06 | 0.000 | |
| 18 | 17 | 0 | 8.0 | 61.06 | 0.018 | SPRING 3 |
| 19 | 18 | 0 | 7.0 | 61.08 | 0.012 | TWO CREEK |
| 20 | 19 | 0 | 32.0 | 61.09 | 0.474 | WINDFALL |
| 21 | 20 | 0 | 2.0 | 61.57 | 0.000 | |
| 22 | 21 | 0 | 0.8 | 61.34 | 0.230 | ANC |
| 23 | 22 | 0 | 7.0 | 61.57 | 1.22 | SAKWATAMAU |
| 24 | 23 | 0 | 0.1 | 62.79 | 11.000 | McLEOD R |
| 25 | 24 | 0 | 0.8 | 73.65 | 0.140 | MILLARW.<OPEN |
| 26 | 25 | 0 | 2.8 | 73.79 | 0.000 | |
| 27 | 26 | 0 | 5.0 | 73.75 | 0.04 | WHITE STP |
| 28 | 27 | 0 | 5.0 | 73.79 | 0.000 | |
| 29 | 28 | 0 | 5.0 | 73.79 | 0.000 | |
| 30 | 29 | 0 | 6.1 | 73.79 | 0.000 | |
| 31 | 30 | 0 | 5.0 | 73.79 | 0.000 | |
| 32 | 31 | 0 | 5.0 | 73.79 | 0.000 | |
| 33 | 32 | 0 | 5.0 | 73.79 | 0.000 | |
| 34 | 33 | 0 | 5.0 | 73.79 | 0.000 | |
| 35 | 34 | 0 | 50.0 | 73.79 | 0.000 | |
| 36 | 35 | 0 | 44.6 | 73.79 | 0.357 | FREEMAN R |
| 37 | 36 | 0 | 31.5 | 74.15 | 0.000 | |
| 38 | 37 | 0 | 11.5 | 74.15 | 0.000 | |
| 39 | 38 | 0 | 20.0 | 74.15 | 4.96 | PEMBINA |
| 40 | 39 | 0 | 36.1 | 79.11 | 0.000 | |
| 41 | 40 | 54 | 48.7 | 94.71 | 0.000 | LESSER SLAVE |

| | | | | | | |
|----|----|---|------|-------|-------|-----------|
| 42 | 41 | 0 | 58.4 | 94.71 | 0.000 | |
| 43 | 42 | 0 | 53.0 | 94.70 | 0.010 | ATHAB STP |
| 44 | 43 | 0 | 1.0 | 94.71 | 0.000 | |
| 45 | 44 | 0 | 7.4 | 94.71 | 0.000 | |
| 46 | 45 | 0 | 15.5 | 94.71 | 1.26 | LA BICHE |
| 47 | 46 | 0 | 61.5 | 95.97 | 0.047 | CALLING |
| 48 | 47 | 0 | 47.3 | 96.02 | 0.000 | |
| 49 | 48 | 0 | 58.3 | 96.02 | 0.450 | PELICAN |
| 50 | 49 | 0 | 10.8 | 96.47 | 1.430 | HOUSE |
| 51 | 0 | 0 | 8.0 | 15.6 | 0.030 | SL STP |
| 52 | 51 | 0 | 0.8 | 15.57 | 0.030 | SLPC |
| 53 | 52 | 0 | 24.9 | 15.6 | 0.000 | |
| 54 | 53 | 0 | 19.8 | 15.6 | 0.000 | |

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

| STNAM | INST |
|----------------|-------|
| ***** | ***** |
| WELDWOOD | 2 |
| OLDMAN CR | 11 |
| SPRING1 | 12 |
| BERLAND R | 13 |
| MARSH HEAD CR | 15 |
| PINE+TWO CR | 16 |
| WINDFALL CR | 20 |
| ANC | 22 |
| SAKWATAMAU | 23 |
| McLEOD R | 24 |
| MILLAR WEST | 25 |
| STP | 27 |
| FREEMAN R | 36 |
| PEMBINA R | 39 |
| LESSER SLAVE R | 41 |
| STP | 43 |
| LA BICHE R | 46 |
| CALLING R | 47 |
| PELICAN R | 49 |
| HOUSE R | 50 |

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. SEVEN CHARACTERS)

| RNAM |
|-----------------|
| ***** |
| ATHABASCA RIVER |

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

| TNAM | INTR |
|--------------|-------|
| ***** | ***** |
| LESSER SLAVE | 41 |

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

| REACH | XLD1 | XLD2 | XLD3 | XLD4 | XLD5 | XLD6 | XLD7 | XLD8 | XLD9 |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| ***** | ***** | ***** | ***** | ***** | ***** | ***** | ***** | ***** | ***** |

| | | | | | | | | | |
|----|--------|-------|-------|--------|------|-------|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 73.64 | 6.5 | 0 | 22.09 | 1.37 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 12.71 | 12.37 | 0 | 0.36 | 6.55 | 0 | 0 | 0 |
| 12 | 0 | 11.59 | 8.43 | 0 | 0.06 | 0.59 | 0 | 0 | 0 |
| 13 | 0 | 11.03 | 5.62 | 0 | 0.90 | 1.80 | 0 | 0 | 0 |
| 14 | 0 | 11.86 | 4.58 | 0 | 0.16 | 3.39 | 0 | 0 | 0 |
| 15 | 0 | 12.61 | 3.21 | 0 | 0.79 | 1.83 | 0 | 0 | 0 |
| 16 | 0 | 11.30 | 3.21 | 0 | 1.12 | 1.12 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 11.02 | 3.21 | 0 | 0.39 | 2.25 | 0 | 0 | 0 |
| 19 | 0 | 9.07 | 7.63 | 0 | 1.98 | 2.82 | 0 | 0 | 0 |
| 20 | 0 | 11.04 | 8.19 | 0 | 1.24 | 5.16 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 106.82 | 7.40 | 0 | 115.37 | 0.96 | 0 | 0 | 0 | 0 |
| 23 | 0 | 11.15 | 5.62 | 0 | 1.52 | 3.88 | 0 | 0 | 0 |
| 24 | 0 | 9.39 | 3.21 | 0 | 2.54 | 2.41 | 0 | 0 | 0 |
| 25 | 138.69 | 5.40 | 0 | 52.70 | 1.03 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 137.28 | 5.65 | 0 | 82.37 | 1.13 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | 0 | 8.58 | 7.15 | 0 | 1.58 | 5.43 | 0 | 0 | 0 |
| 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 0 | 4.14 | 4.02 | 0 | 2.69 | 2.61 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 106.86 | 5.72 | 0 | 138.92 | 5.72 | 0 | 0 | 0 | 0 |
| 44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | 0 | 5.52 | 7.23 | 0 | 2.55 | 4.55 | 0 | 0 | 0 |
| 47 | 0 | 12.61 | 4.82 | 0 | 3.64 | 2.94 | 0 | 0 | 0 |
| 48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 49 | 0 | 12.91 | 35.33 | 0 | 1.15 | 17.31 | 0 | 0 | 0 |
| 50 | 0 | 12.36 | 9.64 | 0 | 1.16 | 6.75 | 0 | 0 | 0 |
| 51 | 163.80 | 0.0 | 0 | 65.52 | 0.0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|----|--------|-----|---|--------|------|---|---|---|---|
| 52 | 144.57 | 5.9 | 0 | 261.67 | 1.18 | 0 | 0 | 0 | 0 |
| 53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

GROUP 7 (ONE LINE FOR EACH HEADWATER)

| X01 | X02 | X03 | X04 | X05 | X06 | X07 | X08 | X09 |
|-----|-------|------|-----|-------|------|-----|-----|-----|
| 0.0 | 12.47 | 5.62 | 0 | 0.399 | 3.65 | 0 | 0 | 0 |
| 0.0 | 12.58 | 2.41 | 0 | 0.994 | 1.16 | 0 | 0 | 0 |

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

| REACH | XK1 | XK2 | XK3 | XK4 | XM1 | XM2 | XM3 | XRES | XDS | XP |
|-------|-------|-------|------|------|-----|-----|-----|-------|-------|------|
| 1 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.001 | 12.98 | .001 |
| 2 | 0.036 | 0.911 | .574 | .026 | .00 | .00 | .00 | 1.151 | 13.02 | .001 |
| 3 | 0.036 | 0.001 | .630 | .026 | .00 | .00 | .00 | 1.099 | 13.04 | .001 |
| 4 | 0.036 | 0.001 | .304 | .026 | .00 | .00 | .00 | 1.025 | 13.04 | .001 |
| 5 | 0.036 | 0.001 | .211 | .026 | .00 | .00 | .00 | 0.951 | 13.04 | .001 |
| 6 | 0.036 | 0.001 | .164 | .026 | .00 | .00 | .00 | 0.877 | 13.04 | .001 |
| 7 | 0.036 | 0.001 | .135 | .026 | .00 | .00 | .00 | 0.810 | 13.04 | .001 |
| 8 | 0.036 | 0.001 | .115 | .026 | .00 | .00 | .00 | 0.750 | 13.04 | .001 |
| 9 | 0.036 | 0.001 | .100 | .026 | .00 | .00 | .00 | 0.683 | 13.04 | .001 |
| 10 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.06 | .001 |
| 11 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.417 | 13.07 | .001 |
| 12 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.346 | 13.11 | .001 |
| 13 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.297 | 13.15 | .001 |
| 14 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.335 | 13.17 | .001 |
| 15 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.308 | 13.19 | .001 |
| 16 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.285 | 13.21 | .001 |
| 17 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.207 | 13.25 | .001 |
| 18 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.148 | 13.27 | .001 |
| 19 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.29 | .001 |
| 20 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.30 | .001 |
| 21 | 0.036 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.33 | .001 |
| 22 | 0.028 | 0.911 | .553 | .026 | .00 | .00 | .00 | 1.662 | 13.37 | .001 |
| 23 | 0.028 | 0.001 | .700 | .026 | .00 | .00 | .00 | 1.836 | 13.37 | .001 |
| 24 | 0.028 | 0.001 | .014 | .026 | .00 | .00 | .00 | 1.836 | 13.37 | .001 |
| 25 | 0.017 | 0.911 | .407 | .026 | .00 | .00 | .00 | 1.367 | 13.40 | .001 |
| 26 | 0.017 | 0.001 | .342 | .026 | .00 | .00 | .00 | 0.971 | 13.43 | .001 |
| 27 | 0.026 | 0.001 | .298 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 28 | 0.026 | 0.001 | .198 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 29 | 0.026 | 0.001 | .153 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 30 | 0.026 | 0.001 | .149 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 31 | 0.026 | 0.001 | .103 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 32 | 0.026 | 0.001 | .091 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 33 | 0.026 | 0.001 | .081 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 34 | 0.026 | 0.001 | .074 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 35 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.554 | 13.49 | .001 |
| 36 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.50 | .001 |
| 37 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.60 | .001 |
| 38 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.61 | .001 |

| | | | | | | | | | | |
|----|-------|-------|-------|------|-----|-----|-----|-------|-------|------|
| 39 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.61 | .001 |
| 40 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.62 | .001 |
| 41 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.62 | .001 |
| 42 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.66 | .001 |
| 43 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.70 | .001 |
| 44 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.72 | .001 |
| 45 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.73 | .001 |
| 46 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.75 | .001 |
| 47 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.75 | .001 |
| 48 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.79 | .001 |
| 49 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.849 | 13.82 | .001 |
| 50 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.849 | 13.85 | .001 |
| 51 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 52 | 0.018 | 0.911 | .556 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 53 | 0.018 | 0.001 | 1.048 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 54 | 0.018 | 0.001 | .339 | .026 | .00 | .00 | .00 | 0.041 | 13.62 | .001 |

GROUP 9 (AVERAGE RIVER TEMPERATURE)
TEMPER

0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH#)

| REACH | REFQ | T | HEXN | VEYN | RFDGR |
|-------|------|------|------|------|-------|
| 1 | 50 | .045 | .516 | .353 | 20 |
| 2 | 50 | .018 | .516 | .353 | 20 |
| 3 | 50 | .127 | .516 | .353 | 20 |
| 4 | 50 | .127 | .516 | .353 | 20 |
| 5 | 50 | .127 | .516 | .353 | 20 |
| 6 | 50 | .127 | .516 | .353 | 20 |
| 7 | 50 | .127 | .516 | .353 | 20 |
| 8 | 50 | .127 | .516 | .353 | 20 |
| 9 | 50 | .127 | .516 | .353 | 20 |
| 10 | 50 | .448 | .516 | .353 | 20 |
| 11 | 50 | .543 | .550 | .346 | 20 |
| 12 | 50 | .622 | .550 | .346 | 20 |
| 13 | 50 | .297 | .550 | .346 | 20 |
| 14 | 50 | .308 | .540 | .266 | 20 |
| 15 | 50 | .004 | .540 | .266 | 20 |
| 16 | 50 | .284 | .551 | .326 | 20 |
| 17 | 50 | .202 | .551 | .326 | 20 |
| 18 | 50 | .176 | .551 | .326 | 20 |
| 19 | 50 | .154 | .551 | .326 | 20 |
| 20 | 50 | .704 | .551 | .326 | 20 |
| 21 | 50 | .044 | .551 | .326 | 20 |
| 22 | 50 | .018 | .551 | .326 | 20 |
| 23 | 50 | .151 | .463 | .362 | 20 |
| 24 | 50 | .002 | .463 | .362 | 20 |
| 25 | 50 | .016 | .536 | .274 | 20 |
| 26 | 50 | .046 | .536 | .274 | 20 |

| | | | | | |
|----|----|-------|------|------|----|
| 27 | 50 | .104 | .536 | .274 | 20 |
| 28 | 50 | .104 | .536 | .274 | 20 |
| 29 | 50 | .104 | .536 | .274 | 20 |
| 30 | 50 | .104 | .536 | .274 | 20 |
| 31 | 50 | .138 | .536 | .274 | 20 |
| 32 | 50 | .138 | .536 | .274 | 20 |
| 33 | 50 | .138 | .536 | .274 | 20 |
| 34 | 50 | .138 | .536 | .274 | 20 |
| 35 | 50 | 1.390 | .536 | .274 | 20 |
| 36 | 50 | 1.799 | .523 | .288 | 20 |
| 37 | 50 | 1.426 | .523 | .288 | 20 |
| 38 | 50 | 0.463 | .523 | .288 | 20 |
| 39 | 50 | 0.805 | .512 | .260 | 20 |
| 40 | 50 | 1.453 | .512 | .260 | 20 |
| 41 | 50 | 1.960 | .512 | .260 | 20 |
| 42 | 50 | 2.350 | .512 | .260 | 20 |
| 43 | 50 | 2.009 | .592 | .295 | 20 |
| 44 | 50 | 0.038 | .592 | .295 | 20 |
| 45 | 50 | 0.280 | .592 | .295 | 20 |
| 46 | 50 | 0.587 | .592 | .295 | 20 |
| 47 | 50 | 2.331 | .592 | .295 | 20 |
| 48 | 50 | 1.524 | .592 | .295 | 20 |
| 49 | 50 | 1.878 | .598 | .335 | 20 |
| 50 | 50 | 0.348 | .598 | .335 | 20 |
| 51 | 50 | 0.180 | .555 | .351 | 20 |
| 52 | 50 | 0.018 | .555 | .351 | 20 |
| 53 | 50 | 0.561 | .555 | .351 | 20 |
| 54 | 50 | 0.471 | .536 | .289 | 20 |

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)

FNAM

ATHA92

LSR92

11 FEBRUARY - 16 MARCH 1993

ATHABASCA RIVER - WINTER 1993 GROUP 1

| NRT | NTRIB | MAXTR | MAXRI | MAXPT | NSTP | NVAR |
|-----|-------|-------|-------|-------|------|------|
| 54 | 1 | 4 | 50 | 50 | 23 | 9 |

GROUP 2 (ONE LINE FOR EACH REACH)

| IRCH | UP1 | UP2 | X | Q | QLD | SOURCE NAME |
|------|-----|-----|------|-------|-------|---------------|
| 1 | 0 | 0 | 1.7 | 28.7 | 0.000 | |
| 2 | 1 | 0 | 0.8 | 27.48 | 1.216 | WELWOOD<OPEN |
| 3 | 2 | 0 | 5.0 | 28.7 | 0.000 | |
| 4 | 3 | 0 | 5.0 | 28.7 | 0.000 | |
| 5 | 4 | 0 | 5.0 | 28.7 | 0.000 | |
| 6 | 5 | 0 | 5.0 | 28.7 | 0.000 | |
| 7 | 6 | 0 | 5.0 | 28.7 | 0.000 | |
| 8 | 7 | 0 | 5.0 | 28.7 | 0.000 | |
| 9 | 8 | 0 | 5.0 | 28.7 | 0.000 | |
| 10 | 9 | 0 | 18.6 | 28.7 | 0.000 | |
| 11 | 10 | 0 | 22.5 | 28.7 | 1.00 | OLDMAN CR |
| 12 | 11 | 0 | 25.8 | 29.7 | 0.022 | SPRING 1 |
| 13 | 12 | 0 | 13.3 | 29.72 | 7.8 | BERLAND R |
| 14 | 13 | 0 | 13.8 | 37.52 | 0.018 | SPRING 2 |
| 15 | 14 | 0 | 0.2 | 37.54 | 0.126 | MARSH CR |
| 16 | 15 | 0 | 12.7 | 37.54 | 0.165 | PINECR |
| 17 | 16 | 0 | 9.2 | 37.71 | 0.000 | |
| 18 | 17 | 0 | 8.0 | 37.71 | 0.018 | SPRING 3 |
| 19 | 18 | 0 | 7.0 | 37.72 | 0.012 | TWO CREEK |
| 20 | 19 | 0 | 32.0 | 37.74 | 0.474 | WINDFALL |
| 21 | 20 | 0 | 2.0 | 38.21 | 0.000 | |
| 22 | 21 | 0 | 0.8 | 38.03 | 0.181 | ANC |
| 23 | 22 | 0 | 7.0 | 38.21 | 0.639 | SAKWATAMAU |
| 24 | 23 | 0 | 0.1 | 38.85 | 5.13 | MCLEOD R |
| 25 | 24 | 0 | 0.8 | 43.88 | 0.110 | MILLARW.<OPEN |
| 26 | 25 | 0 | 2.8 | 43.99 | 0.000 | |
| 27 | 26 | 0 | 5.0 | 43.96 | 0.035 | WHITE STP |
| 28 | 27 | 0 | 5.0 | 43.99 | 0.000 | |
| 29 | 28 | 0 | 5.0 | 43.99 | 0.000 | |
| 30 | 29 | 0 | 6.1 | 43.99 | 0.000 | |
| 31 | 30 | 0 | 5.0 | 43.99 | 0.000 | |
| 32 | 31 | 0 | 5.0 | 43.99 | 0.000 | |
| 33 | 32 | 0 | 5.0 | 43.99 | 0.000 | |
| 34 | 33 | 0 | 5.0 | 43.99 | 0.000 | |
| 35 | 34 | 0 | 50.0 | 43.99 | 0.000 | |
| 36 | 35 | 0 | 44.6 | 43.99 | 0.357 | FREEMAN R |
| 37 | 36 | 0 | 31.5 | 44.35 | 0.000 | |
| 38 | 37 | 0 | 11.5 | 44.35 | 0.000 | |
| 39 | 38 | 0 | 20.0 | 44.35 | 1.56 | PEMBINA |
| 40 | 39 | 0 | 36.1 | 45.91 | 0.000 | |
| 41 | 40 | 54 | 48.7 | 45.91 | 0.000 | LESSER SLAVE |

| | | | | | | |
|----|----|---|------|-------|-------|-----------|
| 42 | 41 | 0 | 58.4 | 60.01 | 0.000 | |
| 43 | 42 | 0 | 53.0 | 59.99 | 0.013 | ATHAB STP |
| 44 | 43 | 0 | 1.0 | 60.01 | 0.000 | |
| 45 | 44 | 0 | 7.4 | 60.01 | 0.000 | |
| 46 | 45 | 0 | 15.5 | 60.01 | 0.067 | LA BICHE |
| 47 | 46 | 0 | 61.5 | 60.08 | 0.023 | CALLING |
| 48 | 47 | 0 | 47.3 | 60.10 | 0.000 | |
| 49 | 48 | 0 | 58.3 | 60.10 | 0.063 | PELICAN |
| 50 | 49 | 0 | 10.8 | 60.16 | 0.11 | HOUSE |
| 51 | 0 | 0 | 8.0 | 13.0 | 0.028 | SLP STP |
| 52 | 51 | 0 | 0.8 | 13.8 | 0.048 | SLPC |
| 53 | 52 | 0 | 24.9 | 14.1 | 0.000 | |
| 54 | 53 | 0 | 19.8 | 14.1 | 0.000 | |

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

| STNAM | INST |
|----------------|------|
| ***** | |
| WELDWOOD | 2 |
| OLDMAN CR | 11 |
| SPRING1 | 12 |
| BERLAND R | 13 |
| SPRING 2 | 14 |
| MARSH HEAD CR | 15 |
| PINE CR | 16 |
| SPRING 3 | 18 |
| TWO CREEK | 19 |
| WINDFALL CR | 20 |
| ANC | 22 |
| SAKWATAMAU | 23 |
| McLEOD R | 24 |
| MILLAR WEST | 25 |
| STP | 27 |
| FREEMAN R | 36 |
| PEMBINA R | 39 |
| LESSER SLAVE R | 41 |
| STP | 43 |
| LA BICHE R | 46 |
| CALLING R | 47 |
| PELICAN R | 49 |
| HOUSE R | 50 |

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. SEVEN CHARACTERS)

| RNAM |
|-----------------|
| ***** |
| ATHABASCA RIVER |

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

| TNAM | INTR |
|--------------|------|
| ***** | |
| LESSER SLAVE | 41 |

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

| REACH | XLD1 | XLD2 | XLD3 | XLD4 | XLD5 | XLD6 | XLD7 | XLD8 | XLD9 |
|-------|--------|-------|-------|--------|------|------|------|------|------|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 78.05 | 6.2 | 0 | 16.39 | 1.12 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 12.71 | 12.37 | 0 | 0.36 | 6.56 | 0 | 0 | 0 |
| 12 | 0 | 11.59 | 8.43 | 0 | 0.06 | 0.59 | 0 | 0 | 0 |
| 13 | 0 | 9.99 | 8.03 | 0 | 0.82 | 2.57 | 0 | 0 | 0 |
| 14 | 0 | 11.86 | 0.57 | 0 | 0.15 | 0.42 | 0 | 0 | 0 |
| 15 | 0 | 12.06 | 0.80 | 0 | 0.76 | 0.46 | 0 | 0 | 0 |
| 16 | 0 | 11.30 | 3.21 | 0 | 1.11 | 1.12 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 11.02 | 3.21 | 0 | 0.39 | 2.24 | 0 | 0 | 0 |
| 19 | 0 | 9.07 | 7.63 | 0 | 1.98 | 2.82 | 0 | 0 | 0 |
| 20 | 0 | 11.04 | 8.19 | 0 | 1.24 | 5.16 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 296.40 | 8.20 | 0 | 234.16 | 1.31 | 0 | 0 | 0 | 0 |
| 23 | 0 | 8.10 | 0.80 | 0 | 1.10 | 0.55 | 0 | 0 | 0 |
| 24 | 0 | 6.27 | 0.80 | 0 | 1.69 | 0.59 | 0 | 0 | 0 |
| 25 | 78.69 | 6.0 | 0 | 36.98 | 0.96 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 187.20 | 5.95 | 0 | 112.32 | 1.19 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | 0 | 8.58 | 7.15 | 0 | 1.58 | 5.43 | 0 | 0 | 0 |
| 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 0 | 1.82 | 10.43 | 0 | 1.18 | 7.04 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 101.40 | 0.60 | 0 | 131.82 | 0.60 | 0 | 0 | 0 | 0 |
| 44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | 0 | 3.55 | 8.19 | 0 | 1.64 | 5.16 | 0 | 0 | 0 |
| 47 | 0 | 5.12 | 12.05 | 0 | 1.48 | 7.35 | 0 | 0 | 0 |
| 48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|----|--------|-------|-------|--------|------|-------|---|---|---|
| 49 | 0 | 10.12 | 28.91 | 0 | 0.90 | 14.17 | 0 | 0 | 0 |
| 50 | 0 | 10.52 | 0.80 | 0 | 0.99 | 0.56 | 0 | 0 | 0 |
| 51 | 131.04 | 2.0 | 0 | 52.42 | 2.2 | 0 | 0 | 0 | 0 |
| 52 | 524.60 | 6.3 | 0 | 293.78 | 1.20 | 0 | 0 | 0 | 0 |
| 53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

GROUP 7 (ONE LINE FOR EACH HEADWATER)

| | X01 | X02 | X03 | X04 | X05 | X06 | X07 | X08 | X09 |
|-------|-----|-------|-------|-----|-------|------|-----|-----|-----|
| ***** | | | | | | | | | |
| | 0.0 | 11.86 | 6.42 | 0 | 0.380 | 4.18 | 0 | 0 | 0 |
| | 0.0 | 13.14 | 10.44 | 0 | 1.04 | 5.01 | 0 | 0 | 0 |

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

| REACH | XK1 | XK2 | XK3 | XK4 | XM1 | XM2 | XM3 | XRES | XDS | XP |
|-------|-------|-------|------|------|-----|-----|-----|-------|-------|------|
| 1 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.001 | 12.98 | .001 |
| 2 | 0.035 | 0.911 | .574 | .026 | .00 | .00 | .00 | 1.151 | 13.02 | .001 |
| 3 | 0.035 | 0.001 | .630 | .026 | .00 | .00 | .00 | 1.099 | 13.04 | .001 |
| 4 | 0.035 | 0.001 | .304 | .026 | .00 | .00 | .00 | 1.025 | 13.04 | .001 |
| 5 | 0.035 | 0.001 | .211 | .026 | .00 | .00 | .00 | 0.951 | 13.04 | .001 |
| 6 | 0.035 | 0.001 | .164 | .026 | .00 | .00 | .00 | 0.877 | 13.04 | .001 |
| 7 | 0.035 | 0.001 | .135 | .026 | .00 | .00 | .00 | 0.810 | 13.04 | .001 |
| 8 | 0.035 | 0.001 | .115 | .026 | .00 | .00 | .00 | 0.750 | 13.04 | .001 |
| 9 | 0.035 | 0.001 | .100 | .026 | .00 | .00 | .00 | 0.683 | 13.04 | .001 |
| 10 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.06 | .001 |
| 11 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.417 | 13.07 | .001 |
| 12 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.346 | 13.11 | .001 |
| 13 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.297 | 13.15 | .001 |
| 14 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.335 | 13.17 | .001 |
| 15 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.308 | 13.19 | .001 |
| 16 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.285 | 13.21 | .001 |
| 17 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.207 | 13.25 | .001 |
| 18 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.148 | 13.27 | .001 |
| 19 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.29 | .001 |
| 20 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.30 | .001 |
| 21 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.33 | .001 |
| 22 | 0.032 | 0.911 | .553 | .026 | .00 | .00 | .00 | 1.662 | 13.37 | .001 |
| 23 | 0.032 | 0.001 | .700 | .026 | .00 | .00 | .00 | 1.836 | 13.37 | .001 |
| 24 | 0.032 | 0.001 | .014 | .026 | .00 | .00 | .00 | 1.836 | 13.37 | .001 |
| 25 | 0.026 | 0.911 | .407 | .026 | .00 | .00 | .00 | 1.367 | 13.40 | .001 |
| 26 | 0.026 | 0.001 | .342 | .026 | .00 | .00 | .00 | 0.971 | 13.43 | .001 |
| 27 | 0.026 | 0.001 | .298 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 28 | 0.026 | 0.001 | .198 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 29 | 0.026 | 0.001 | .153 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 30 | 0.026 | 0.001 | .149 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 31 | 0.026 | 0.001 | .103 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 32 | 0.026 | 0.001 | .091 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 33 | 0.026 | 0.001 | .081 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 34 | 0.026 | 0.001 | .074 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 35 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.554 | 13.49 | .001 |

| | | | | | | | | | | |
|----|-------|-------|-------|------|-----|-----|-----|-------|-------|------|
| 36 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.50 | .001 |
| 37 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.60 | .001 |
| 38 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.61 | .001 |
| 39 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.61 | .001 |
| 40 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.62 | .001 |
| 41 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.62 | .001 |
| 42 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.66 | .001 |
| 43 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.70 | .001 |
| 44 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.72 | .001 |
| 45 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.73 | .001 |
| 46 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.75 | .001 |
| 47 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.75 | .001 |
| 48 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.79 | .001 |
| 49 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.849 | 13.82 | .001 |
| 50 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.849 | 13.85 | .001 |
| 51 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 52 | 0.018 | 0.911 | .556 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 53 | 0.018 | 0.001 | 1.048 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 54 | 0.018 | 0.001 | .339 | .026 | .00 | .00 | .00 | 0.041 | 13.62 | .001 |

GROUP 9 (AVERAGE RIVER TEMPERATURE)
TEMPER

0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH#)
REACH REFQ T HEXN VEXN RFDGR

| | | | | | |
|----|----|------|------|------|----|
| 1 | 50 | .045 | .516 | .353 | 20 |
| 2 | 50 | .018 | .516 | .353 | 20 |
| 3 | 50 | .127 | .516 | .353 | 20 |
| 4 | 50 | .127 | .516 | .353 | 20 |
| 5 | 50 | .127 | .516 | .353 | 20 |
| 6 | 50 | .127 | .516 | .353 | 20 |
| 7 | 50 | .127 | .516 | .353 | 20 |
| 8 | 50 | .127 | .516 | .353 | 20 |
| 9 | 50 | .127 | .516 | .353 | 20 |
| 10 | 50 | .448 | .516 | .353 | 20 |
| 11 | 50 | .543 | .550 | .346 | 20 |
| 12 | 50 | .622 | .550 | .346 | 20 |
| 13 | 50 | .297 | .550 | .346 | 20 |
| 14 | 50 | .308 | .540 | .266 | 20 |
| 15 | 50 | .004 | .540 | .266 | 20 |
| 16 | 50 | .284 | .551 | .326 | 20 |
| 17 | 50 | .202 | .551 | .326 | 20 |
| 18 | 50 | .176 | .551 | .326 | 20 |
| 19 | 50 | .154 | .551 | .326 | 20 |
| 20 | 50 | .704 | .551 | .326 | 20 |
| 21 | 50 | .044 | .551 | .326 | 20 |
| 22 | 50 | .018 | .551 | .326 | 20 |
| 23 | 50 | .151 | .463 | .362 | 20 |

| | | | | | |
|----|----|-------|------|------|----|
| 24 | 50 | .002 | .463 | .362 | 20 |
| 25 | 50 | .016 | .536 | .274 | 20 |
| 26 | 50 | .046 | .536 | .274 | 20 |
| 27 | 50 | .104 | .536 | .274 | 20 |
| 28 | 50 | .104 | .536 | .274 | 20 |
| 29 | 50 | .104 | .536 | .274 | 20 |
| 30 | 50 | .104 | .536 | .274 | 20 |
| 31 | 50 | .138 | .536 | .274 | 20 |
| 32 | 50 | .138 | .536 | .274 | 20 |
| 33 | 50 | .138 | .536 | .274 | 20 |
| 34 | 50 | .138 | .536 | .274 | 20 |
| 35 | 50 | 1.390 | .536 | .274 | 20 |
| 36 | 50 | 1.799 | .523 | .288 | 20 |
| 37 | 50 | 1.426 | .523 | .288 | 20 |
| 38 | 50 | 0.463 | .523 | .288 | 20 |
| 39 | 50 | 0.805 | .512 | .260 | 20 |
| 40 | 50 | 1.453 | .512 | .260 | 20 |
| 41 | 50 | 1.960 | .512 | .260 | 20 |
| 42 | 50 | 2.350 | .512 | .260 | 20 |
| 43 | 50 | 2.009 | .592 | .295 | 20 |
| 44 | 50 | 0.038 | .592 | .295 | 20 |
| 45 | 50 | 0.280 | .592 | .295 | 20 |
| 46 | 50 | 0.587 | .592 | .295 | 20 |
| 47 | 50 | 2.331 | .592 | .295 | 20 |
| 48 | 50 | 1.524 | .592 | .295 | 20 |
| 49 | 50 | 1.878 | .598 | .335 | 20 |
| 50 | 50 | 0.348 | .598 | .335 | 20 |
| 51 | 50 | 0.180 | .555 | .351 | 20 |
| 52 | 50 | 0.018 | .555 | .351 | 20 |
| 53 | 50 | 0.561 | .555 | .351 | 20 |
| 54 | 50 | 0.471 | .536 | .289 | 20 |

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)

FNAM

ATHA93

LSR93

10 FEBRUARY - 16 MARCH 1994 AlPac included

ATHABASCA RIVER - WINTER 1994 AlPac included GROUP 1

| NRT | NTRIB | MAXTR | MAXRI | MAXPT | NSTP | NVAR |
|-----|-------|-------|-------|-------|------|------|
| 58 | 1 | 4 | 54 | 54 | 24 | 9 |

GROUP 2 (ONE LINE FOR EACH REACH)

| IRCH | UP1 | UP2 | X | Q | QLD | SOURCE NAME |
|------|-----|-----|------|-------|--------|---------------|
| 1 | 0 | 0 | 1.7 | 28.3 | 0.000 | |
| 2 | 1 | 0 | 0.8 | 27.19 | 1.1134 | WELDWOOD<OPEN |
| 3 | 2 | 0 | 5.0 | 28.3 | 0.000 | |
| 4 | 3 | 0 | 5.0 | 28.3 | 0.000 | |
| 5 | 4 | 0 | 5.0 | 28.3 | 0.000 | |
| 6 | 5 | 0 | 5.0 | 28.3 | 0.000 | |
| 7 | 6 | 0 | 5.0 | 28.3 | 0.000 | |
| 8 | 7 | 0 | 5.0 | 28.3 | 0.000 | |
| 9 | 8 | 0 | 5.0 | 28.3 | 0.000 | |
| 10 | 9 | 0 | 18.6 | 28.3 | 0.000 | |
| 11 | 10 | 0 | 22.5 | 28.3 | 1.00 | OLDMAN CR |
| 12 | 11 | 0 | 25.8 | 29.3 | 0.022 | SPRING 1 |
| 13 | 12 | 0 | 13.3 | 29.32 | 7.66 | BERLAND R |
| 14 | 13 | 0 | 13.8 | 36.98 | 0.018 | SPRING 2 |
| 15 | 14 | 0 | 0.2 | 37.0 | 0.300 | MARSH CR |
| 16 | 15 | 0 | 12.7 | 37.3 | 0.165 | PINECR |
| 17 | 16 | 0 | 9.2 | 37.47 | 0.000 | |
| 18 | 17 | 0 | 8.0 | 37.47 | 0.018 | SPRING 3 |
| 19 | 18 | 0 | 7.0 | 37.48 | 0.012 | TWO CREEK |
| 20 | 19 | 0 | 32.0 | 37.5 | 0.474 | WINDFALL |
| 21 | 20 | 0 | 2.0 | 37.97 | 0.000 | |
| 22 | 21 | 0 | 0.8 | 37.80 | 0.174 | ANC<OPEN |
| 23 | 22 | 0 | 7.0 | 37.97 | 1.020 | SAKWATAMAU |
| 24 | 23 | 0 | 0.1 | 38.99 | 7.80 | McLEOD R |
| 25 | 24 | 0 | 0.8 | 46.68 | 0.1148 | MILLARW.<OPEN |
| 26 | 25 | 0 | 2.8 | 46.79 | 0.000 | |
| 27 | 26 | 0 | 5.0 | 46.75 | 0.0373 | WHITE STP |
| 28 | 27 | 0 | 5.0 | 46.79 | 0.000 | |
| 29 | 28 | 0 | 5.0 | 46.79 | 0.000 | |
| 30 | 29 | 0 | 6.1 | 46.79 | 0.000 | |
| 31 | 30 | 0 | 5.0 | 46.79 | 0.000 | |
| 32 | 31 | 0 | 5.0 | 46.79 | 0.000 | |
| 33 | 32 | 0 | 5.0 | 46.79 | 0.000 | |
| 34 | 33 | 0 | 5.0 | 46.79 | 0.000 | |
| 35 | 34 | 0 | 50.0 | 46.79 | 0.000 | |
| 36 | 35 | 0 | 44.6 | 46.79 | 0.357 | FREEMAN R |
| 37 | 36 | 0 | 31.5 | 47.15 | 0.000 | |
| 38 | 37 | 0 | 11.5 | 47.15 | 0.000 | |
| 39 | 38 | 0 | 20.0 | 47.15 | 2.64 | PEMBINA |
| 40 | 39 | 0 | 36.1 | 49.79 | 0.000 | |
| 41 | 40 | 58 | 48.7 | 49.79 | 0.000 | LESSER SLAVE |

| | | | | | | |
|----|----|---|------|-------|--------|------------|
| 42 | 41 | 0 | 58.4 | 71.78 | 0.000 | |
| 43 | 42 | 0 | 43.0 | 71.76 | 0.0146 | ATHAB STP |
| 44 | 43 | 0 | 0.8 | 71.23 | 0.548 | ALPac<OPEN |
| 45 | 44 | 0 | 5.0 | 71.78 | 0.000 | |
| 46 | 45 | 0 | 5.0 | 71.78 | 0.000 | |
| 47 | 46 | 0 | 7.6 | 71.78 | 0.000 | |
| 48 | 47 | 0 | 5.0 | 71.78 | 0.678 | LA BICHE |
| 49 | 48 | 0 | 5.0 | 72.46 | 0.000 | |
| 50 | 49 | 0 | 5.5 | 72.46 | 0.000 | |
| 51 | 50 | 0 | 61.5 | 72.46 | 0.049 | CALLING |
| 52 | 51 | 0 | 47.3 | 72.51 | 0.000 | |
| 53 | 52 | 0 | 58.3 | 72.5 | 0.652 | PELICAN |
| 54 | 53 | 0 | 10.8 | 74.38 | 1.23 | HOUSE |
| 55 | 0 | 0 | 8.0 | 21.9 | 0.0338 | SLP STP |
| 56 | 55 | 0 | 0.8 | 21.93 | 0.0577 | SLPC |
| 57 | 56 | 0 | 24.9 | 21.99 | 0.000 | |
| 58 | 57 | 0 | 19.8 | 21.99 | 0.000 | |

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

STNAM INST

| | |
|----------------|----|
| WELDWOOD | 2 |
| OLDMAN CR | 11 |
| SPRING1 | 12 |
| BERLAND R | 13 |
| SPRING 2 | 14 |
| MARSH HEAD CR | 15 |
| PINE CR | 16 |
| SPRING 3 | 18 |
| TWO CREEK | 19 |
| WINDFALL CR | 20 |
| ANC | 22 |
| SAKWATAMAU | 23 |
| McLEOD R | 24 |
| MILLAR WEST | 25 |
| WHITE STP | 27 |
| FREEMAN R | 36 |
| PEMBINA R | 39 |
| LESSER SLAVE R | 41 |
| ATHA STP | 43 |
| ALPAC | 44 |
| LA BICHE R | 48 |
| CALLING R | 51 |
| PELICAN R | 53 |
| HOUSE R | 54 |

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. SEVEN CHARACTERS)

RNAM

ATHABASCA RIVER

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

TNAM INTR

LESSER SLAVE 41

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

REACH XLD1 XLD2 XLD3 XLD4 XLD5 XLD6 XLD7 XLD8 XLD9

| | | | | | | | | | |
|----|--------|-------|-------|--------|------|------|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 30.78 | 7.2 | 0 | 13.24 | 1.30 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 12.71 | 12.37 | 0 | 0.36 | 6.55 | 0 | 0 | 0 |
| 12 | 0 | 11.59 | 8.43 | 0 | 0.06 | 0.59 | 0 | 0 | 0 |
| 13 | 0 | 9.67 | 0.80 | 0 | 0.79 | 0.26 | 0 | 0 | 0 |
| 14 | 0 | 11.86 | 4.58 | 0 | 0.15 | 3.39 | 0 | 0 | 0 |
| 15 | 0 | 12.39 | 2.41 | 0 | 0.78 | 1.37 | 0 | 0 | 0 |
| 16 | 0 | 11.30 | 3.21 | 0 | 1.12 | 1.12 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 11.02 | 3.21 | 0 | 0.39 | 2.25 | 0 | 0 | 0 |
| 19 | 0 | 9.07 | 7.63 | 0 | 1.98 | 2.82 | 0 | 0 | 0 |
| 20 | 0 | 11.04 | 8.19 | 0 | 1.24 | 5.16 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 122.55 | 7.30 | 0 | 126.23 | 1.17 | 0 | 0 | 0 | 0 |
| 23 | 0 | 9.40 | 1.61 | 0 | 1.28 | 1.11 | 0 | 0 | 0 |
| 24 | 0 | 5.51 | 4.02 | 0 | 1.49 | 3.01 | 0 | 0 | 0 |
| 25 | 392.23 | 4.2 | 0 | 200.37 | 1.01 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 283.92 | 4.00 | 0 | 170.35 | 0.80 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | 0 | 8.58 | 7.15 | 0 | 1.58 | 5.43 | 0 | 0 | 0 |
| 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 0 | 0.43 | 1.61 | 0 | 0.28 | 1.05 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 101.40 | 4.74 | 0 | 131.82 | 4.74 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|----|--------|-------|-------|--------|------|------|---|---|---|
| 44 | 34.98 | 7.00 | 0 | 27.63 | 1.47 | 0 | 0 | 0 | 0 |
| 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 47 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 48 | 0 | 3.59 | 4.02 | 0 | 1.66 | 2.53 | 0 | 0 | 0 |
| 49 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 51 | 0 | 9.33 | 4.02 | 0 | 2.70 | 2.45 | 0 | 0 | 0 |
| 52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53 | 0 | 12.74 | 16.06 | 0 | 1.13 | 7.87 | 0 | 0 | 0 |
| 54 | 0 | 10.48 | 3.21 | 0 | 0.99 | 2.25 | 0 | 0 | 0 |
| 55 | 151.32 | 5.32 | 0 | 60.52 | 5.85 | 0 | 0 | 0 | 0 |
| 56 | 102.05 | 7.2 | 0 | 121.44 | 1.87 | 0 | 0 | 0 | 0 |
| 57 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 58 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

GROUP 7 (ONE LINE FOR EACH HEADWATER)

| | X01 | X02 | X03 | X04 | X05 | X06 | X07 | X08 | X09 |
|-------|-----|-------|------|-----|------|------|-----|-----|-----|
| ***** | 0.0 | 11.45 | 4.82 | 0 | 0.37 | 3.13 | 0 | 0 | 0 |
| | 0.0 | 12.21 | 0.80 | 0 | 0.96 | 0.39 | 0 | 0 | 0 |

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

| REACH | XK1 | XK2 | XK3 | XK4 | XM1 | XM2 | XM3 | XRES | XDS | XP |
|-------|-------|-------|------|------|-----|-----|-----|-------|-------|------|
| 1 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.001 | 12.98 | .001 |
| 2 | 0.035 | 0.911 | .574 | .026 | .00 | .00 | .00 | 1.151 | 13.02 | .001 |
| 3 | 0.035 | 0.001 | .630 | .026 | .00 | .00 | .00 | 1.099 | 13.04 | .001 |
| 4 | 0.035 | 0.001 | .304 | .026 | .00 | .00 | .00 | 1.025 | 13.04 | .001 |
| 5 | 0.035 | 0.001 | .211 | .026 | .00 | .00 | .00 | 0.951 | 13.04 | .001 |
| 6 | 0.035 | 0.001 | .164 | .026 | .00 | .00 | .00 | 0.877 | 13.04 | .001 |
| 7 | 0.035 | 0.001 | .135 | .026 | .00 | .00 | .00 | 0.810 | 13.04 | .001 |
| 8 | 0.035 | 0.001 | .115 | .026 | .00 | .00 | .00 | 0.750 | 13.04 | .001 |
| 9 | 0.035 | 0.001 | .100 | .026 | .00 | .00 | .00 | 0.683 | 13.04 | .001 |
| 10 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.06 | .001 |
| 11 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.417 | 13.07 | .001 |
| 12 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.346 | 13.11 | .001 |
| 13 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.297 | 13.15 | .001 |
| 14 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.335 | 13.17 | .001 |
| 15 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.308 | 13.19 | .001 |
| 16 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.285 | 13.21 | .001 |
| 17 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.207 | 13.25 | .001 |
| 18 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.148 | 13.27 | .001 |
| 19 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.29 | .001 |
| 20 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.30 | .001 |
| 21 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.33 | .001 |
| 22 | 0.032 | 0.911 | .553 | .026 | .00 | .00 | .00 | 1.662 | 13.37 | .001 |
| 23 | 0.032 | 0.001 | .700 | .026 | .00 | .00 | .00 | 1.836 | 13.37 | .001 |
| 24 | 0.032 | 0.001 | .014 | .026 | .00 | .00 | .00 | 1.836 | 13.37 | .001 |
| 25 | 0.026 | 0.911 | .407 | .026 | .00 | .00 | .00 | 1.367 | 13.40 | .001 |
| 26 | 0.026 | 0.001 | .342 | .026 | .00 | .00 | .00 | 0.971 | 13.43 | .001 |

| | | | | | | | | | | |
|----|-------|-------|-------|------|-----|-----|-----|-------|-------|------|
| 27 | 0.026 | 0.001 | .298 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 28 | 0.026 | 0.001 | .198 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 29 | 0.026 | 0.001 | .153 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 30 | 0.026 | 0.001 | .149 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 31 | 0.026 | 0.001 | .103 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 32 | 0.026 | 0.001 | .091 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 33 | 0.026 | 0.001 | .081 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 34 | 0.026 | 0.001 | .074 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 35 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.554 | 13.49 | .001 |
| 36 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.50 | .001 |
| 37 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.60 | .001 |
| 38 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.61 | .001 |
| 39 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.61 | .001 |
| 40 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.62 | .001 |
| 41 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.62 | .001 |
| 42 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.66 | .001 |
| 43 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.70 | .001 |
| 44 | 0.035 | 0.991 | .553 | .026 | .00 | .00 | .00 | 1.254 | 13.72 | .001 |
| 45 | 0.035 | 0.001 | .607 | .026 | .00 | .00 | .00 | 1.198 | 13.72 | .001 |
| 46 | 0.035 | 0.001 | .293 | .026 | .00 | .00 | .00 | 1.117 | 13.72 | .001 |
| 47 | 0.035 | 0.001 | .282 | .026 | .00 | .00 | .00 | 1.036 | 13.72 | .001 |
| 48 | 0.035 | 0.001 | .140 | .026 | .00 | .00 | .00 | 0.955 | 13.72 | .001 |
| 49 | 0.035 | 0.001 | .119 | .026 | .00 | .00 | .00 | 0.881 | 13.73 | .001 |
| 50 | 0.035 | 0.001 | .111 | .026 | .00 | .00 | .00 | 0.818 | 13.75 | .001 |
| 51 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.75 | .001 |
| 52 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.79 | .001 |
| 53 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.849 | 13.82 | .001 |
| 54 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.849 | 13.85 | .001 |
| 55 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 56 | 0.018 | 0.911 | .556 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 57 | 0.018 | 0.001 | 1.048 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 58 | 0.018 | 0.001 | .339 | .026 | .00 | .00 | .00 | 0.041 | 13.62 | .001 |

GROUP 9 (AVERAGE RIVER TEMPERATURE)

TEMPER

0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH#)

REACH REFQ T HEXN VEXN RFDGR

| | | | | | |
|----|----|------|------|------|----|
| 1 | 50 | .045 | .516 | .353 | 20 |
| 2 | 50 | .018 | .516 | .353 | 20 |
| 3 | 50 | .127 | .516 | .353 | 20 |
| 4 | 50 | .127 | .516 | .353 | 20 |
| 5 | 50 | .127 | .516 | .353 | 20 |
| 6 | 50 | .127 | .516 | .353 | 20 |
| 7 | 50 | .127 | .516 | .353 | 20 |
| 8 | 50 | .127 | .516 | .353 | 20 |
| 9 | 50 | .127 | .516 | .353 | 20 |
| 10 | 50 | .448 | .516 | .353 | 20 |

| | | | | | |
|----|----|-------|------|------|----|
| 11 | 50 | .543 | .550 | .346 | 20 |
| 12 | 50 | .622 | .550 | .346 | 20 |
| 13 | 50 | .297 | .550 | .346 | 20 |
| 14 | 50 | .308 | .540 | .266 | 20 |
| 15 | 50 | .004 | .540 | .266 | 20 |
| 16 | 50 | .284 | .551 | .326 | 20 |
| 17 | 50 | .202 | .551 | .326 | 20 |
| 18 | 50 | .176 | .551 | .326 | 20 |
| 19 | 50 | .154 | .551 | .326 | 20 |
| 20 | 50 | .704 | .551 | .326 | 20 |
| 21 | 50 | .044 | .551 | .326 | 20 |
| 22 | 50 | .018 | .551 | .326 | 20 |
| 23 | 50 | .151 | .463 | .362 | 20 |
| 24 | 50 | .002 | .463 | .362 | 20 |
| 25 | 50 | .016 | .536 | .274 | 20 |
| 26 | 50 | .046 | .536 | .274 | 20 |
| 27 | 50 | .104 | .536 | .274 | 20 |
| 28 | 50 | .104 | .536 | .274 | 20 |
| 29 | 50 | .104 | .536 | .274 | 20 |
| 30 | 50 | .104 | .536 | .274 | 20 |
| 31 | 50 | .138 | .536 | .274 | 20 |
| 32 | 50 | .138 | .536 | .274 | 20 |
| 33 | 50 | .138 | .536 | .274 | 20 |
| 34 | 50 | .138 | .536 | .274 | 20 |
| 35 | 50 | 1.390 | .536 | .274 | 20 |
| 36 | 50 | 1.799 | .523 | .288 | 20 |
| 37 | 50 | 1.426 | .523 | .288 | 20 |
| 38 | 50 | 0.463 | .523 | .288 | 20 |
| 39 | 50 | 0.805 | .512 | .260 | 20 |
| 40 | 50 | 1.453 | .512 | .260 | 20 |
| 41 | 50 | 1.960 | .512 | .260 | 20 |
| 42 | 50 | 2.350 | .512 | .260 | 20 |
| 43 | 50 | 1.634 | .592 | .295 | 20 |
| 44 | 50 | 0.030 | .592 | .295 | 20 |
| 45 | 50 | 0.190 | .592 | .295 | 20 |
| 46 | 50 | 0.190 | .592 | .295 | 20 |
| 47 | 50 | 0.289 | .592 | .295 | 20 |
| 48 | 50 | 0.190 | .592 | .295 | 20 |
| 49 | 50 | 0.190 | .592 | .295 | 20 |
| 50 | 50 | 0.209 | .592 | .295 | 20 |
| 51 | 50 | 2.331 | .592 | .295 | 20 |
| 52 | 50 | 1.524 | .592 | .295 | 20 |
| 53 | 50 | 1.878 | .598 | .335 | 20 |
| 54 | 50 | 0.348 | .598 | .335 | 20 |
| 55 | 50 | 0.180 | .555 | .351 | 20 |
| 56 | 50 | 0.018 | .555 | .351 | 20 |
| 57 | 50 | 0.561 | .555 | .351 | 20 |
| 58 | 50 | 0.471 | .536 | .289 | 20 |

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)
 FNAM

ATHA94
LSR94

10 FEBRUARY - 16 MARCH 1994 AlPac not included

ATHABASCA RIVER - WINTER 1994 GROUP 1

| NRT | NTRIB | MAXTR | MAXRI | MAXPT | NSTP | NVAR |
|-----|-------|-------|-------|-------|------|------|
| 54 | 1 | 4 | 50 | 50 | 23 | 9 |

GROUP 2 (ONE LINE FOR EACH REACH)

| IRCH | UP1 | UP2 | X | Q | QLD | SOURCE NAME |
|------|-----|-----|------|-------|--------|----------------|
| 1 | 0 | 0 | 1.7 | 28.3 | 0.000 | |
| 2 | 1 | 0 | 0.8 | 27.19 | 1.1134 | WELDDWOOD<OPEN |
| 3 | 2 | 0 | 5.0 | 28.3 | 0.000 | |
| 4 | 3 | 0 | 5.0 | 28.3 | 0.000 | |
| 5 | 4 | 0 | 5.0 | 28.3 | 0.000 | |
| 6 | 5 | 0 | 5.0 | 28.3 | 0.000 | |
| 7 | 6 | 0 | 5.0 | 28.3 | 0.000 | |
| 8 | 7 | 0 | 5.0 | 28.3 | 0.000 | |
| 9 | 8 | 0 | 5.0 | 28.3 | 0.000 | |
| 10 | 9 | 0 | 18.6 | 28.3 | 0.000 | |
| 11 | 10 | 0 | 22.5 | 28.3 | 1.00 | OLDMAN CR |
| 12 | 11 | 0 | 25.8 | 29.3 | 0.022 | SPRING 1 |
| 13 | 12 | 0 | 13.3 | 29.32 | 7.66 | BERLAND R |
| 14 | 13 | 0 | 13.8 | 36.98 | 0.018 | SPRING 2 |
| 15 | 14 | 0 | 0.2 | 37.0 | 0.300 | MARSH CR |
| 16 | 15 | 0 | 12.7 | 37.3 | 0.165 | PINECR |
| 17 | 16 | 0 | 9.2 | 37.47 | 0.000 | |
| 18 | 17 | 0 | 8.0 | 37.47 | 0.018 | SPRING 3 |
| 19 | 18 | 0 | 7.0 | 37.48 | 0.012 | TWO CREEK |
| 20 | 19 | 0 | 32.0 | 37.5 | 0.474 | WINDFALL |
| 21 | 20 | 0 | 2.0 | 37.97 | 0.000 | |
| 22 | 21 | 0 | 0.8 | 37.80 | 0.174 | ANC |
| 23 | 22 | 0 | 7.0 | 37.97 | 1.020 | SAKWATAMAU |
| 24 | 23 | 0 | 0.1 | 38.99 | 7.80 | McLEOD R |
| 25 | 24 | 0 | 0.8 | 46.68 | 0.1148 | MILLARW. <OPEN |
| 26 | 25 | 0 | 2.8 | 46.79 | 0.000 | |
| 27 | 26 | 0 | 5.0 | 46.75 | 0.0373 | WHITE STP |
| 28 | 27 | 0 | 5.0 | 46.79 | 0.000 | |
| 29 | 28 | 0 | 5.0 | 46.79 | 0.000 | |
| 30 | 29 | 0 | 6.1 | 46.79 | 0.000 | |
| 31 | 30 | 0 | 5.0 | 46.79 | 0.000 | |
| 32 | 31 | 0 | 5.0 | 46.79 | 0.000 | |
| 33 | 32 | 0 | 5.0 | 46.79 | 0.000 | |
| 34 | 33 | 0 | 5.0 | 46.79 | 0.000 | |
| 35 | 34 | 0 | 50.0 | 46.79 | 0.000 | |
| 36 | 35 | 0 | 44.6 | 46.79 | 0.357 | FREEMAN R |
| 37 | 36 | 0 | 31.5 | 47.15 | 0.000 | |
| 38 | 37 | 0 | 11.5 | 47.15 | 0.000 | |
| 39 | 38 | 0 | 20.0 | 47.15 | 2.64 | PEMBINA |
| 40 | 39 | 0 | 36.1 | 49.79 | 0.000 | |
| 41 | 40 | 54 | 48.7 | 49.79 | 0.000 | LESSER SLAVE |

| | | | | | | |
|----|----|---|------|-------|--------|-----------|
| 42 | 41 | 0 | 58.4 | 71.78 | 0.000 | |
| 43 | 42 | 0 | 53.0 | 71.76 | 0.0146 | ATHAB STP |
| 44 | 43 | 0 | 1.0 | 71.78 | 0.000 | |
| 45 | 44 | 0 | 7.4 | 71.78 | 0.000 | |
| 46 | 45 | 0 | 15.5 | 71.78 | 0.678 | LA BICHE |
| 47 | 46 | 0 | 61.5 | 72.46 | 0.049 | CALLING |
| 48 | 47 | 0 | 47.3 | 72.51 | 0.000 | |
| 49 | 48 | 0 | 58.3 | 72.5 | 0.652 | PELICAN |
| 50 | 49 | 0 | 10.8 | 74.38 | 1.23 | HOUSE |
| 51 | 0 | 0 | 8.0 | 21.9 | 0.0338 | SLP STP |
| 52 | 51 | 0 | 0.8 | 21.93 | 0.0577 | SLPC |
| 53 | 52 | 0 | 24.9 | 21.99 | 0.000 | |
| 54 | 53 | 0 | 19.8 | 21.99 | 0.000 | |

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

| STNAM | INST |
|----------------|------|
| ***** | |
| WELDWOOD | 2 |
| OLDMAN CR | 11 |
| SPRING1 | 12 |
| BERLAND R | 13 |
| SPRING 2 | 14 |
| MARSH HEAD CR | 15 |
| PINE CR | 16 |
| SPRING 3 | 18 |
| TWO CREEK | 19 |
| WINDFALL CR | 20 |
| ANC | 22 |
| SAKWATAMAU | 23 |
| McLEOD R | 24 |
| MILLAR WEST | 25 |
| STP | 27 |
| FREEMAN R | 36 |
| PEMBINA R | 39 |
| LESSER SLAVE R | 41 |
| STP | 43 |
| LA BICHE R | 46 |
| CALLING R | 47 |
| PELICAN R | 49 |
| HOUSE R | 50 |

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. SEVEN CHARACTERS)

| RNAM |
|-----------------|
| ***** |
| ATHABASCA RIVER |

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

| TNAM | INTR |
|--------------|------|
| ***** | |
| LESSER SLAVE | 41 |

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

| REACH | XLD1 | XLD2 | XLD3 | XLD4 | XLD5 | XLD6 | XLD7 | XLD8 | XLD9 |
|-------|--------|-------|-------|--------|------|------|------|------|------|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 30.78 | 7.2 | 0 | 13.24 | 1.30 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 12.71 | 12.37 | 0 | 0.36 | 6.55 | 0 | 0 | 0 |
| 12 | 0 | 11.59 | 8.43 | 0 | 0.06 | 0.59 | 0 | 0 | 0 |
| 13 | 0 | 9.67 | 0.80 | 0 | 0.79 | 0.26 | 0 | 0 | 0 |
| 14 | 0 | 11.86 | 4.58 | 0 | 0.15 | 3.39 | 0 | 0 | 0 |
| 15 | 0 | 12.39 | 2.41 | 0 | 0.78 | 1.37 | 0 | 0 | 0 |
| 16 | 0 | 11.30 | 3.21 | 0 | 1.12 | 1.12 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 11.02 | 3.21 | 0 | 0.39 | 2.25 | 0 | 0 | 0 |
| 19 | 0 | 9.07 | 7.63 | 0 | 1.98 | 2.82 | 0 | 0 | 0 |
| 20 | 0 | 11.04 | 8.19 | 0 | 1.24 | 5.16 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 122.55 | 7.30 | 0 | 126.23 | 1.17 | 0 | 0 | 0 | 0 |
| 23 | 0 | 9.40 | 1.61 | 0 | 1.28 | 1.11 | 0 | 0 | 0 |
| 24 | 0 | 5.51 | 4.02 | 0 | 1.49 | 3.01 | 0 | 0 | 0 |
| 25 | 392.23 | 4.2 | 0 | 200.37 | 1.01 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 283.92 | 4.00 | 0 | 170.35 | 0.80 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | 0 | 8.58 | 7.15 | 0 | 1.58 | 5.43 | 0 | 0 | 0 |
| 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 0 | 0.43 | 1.61 | 0 | 0.28 | 1.05 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 101.40 | 4.74 | 0 | 131.82 | 4.74 | 0 | 0 | 0 | 0 |
| 44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | 0 | 3.59 | 4.02 | 0 | 1.66 | 2.53 | 0 | 0 | 0 |
| 47 | 0 | 9.33 | 4.02 | 0 | 2.70 | 2.45 | 0 | 0 | 0 |
| 48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|----|--------|-------|-------|--------|------|------|---|---|---|
| 49 | 0 | 12.74 | 16.06 | 0 | 1.13 | 7.87 | 0 | 0 | 0 |
| 50 | 0 | 10.48 | 3.21 | 0 | 0.99 | 2.25 | 0 | 0 | 0 |
| 51 | 151.32 | 5.32 | 0 | 60.52 | 5.85 | 0 | 0 | 0 | 0 |
| 52 | 102.05 | 7.2 | 0 | 121.44 | 1.87 | 0 | 0 | 0 | 0 |
| 53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

GROUP 7 (ONE LINE FOR EACH HEADWATER)

| | X01 | X02 | X03 | X04 | X05 | X06 | X07 | X08 | X09 |
|-------|-----|-------|------|-----|------|------|-----|-----|-----|
| ***** | 0.0 | 11.45 | 4.82 | 0 | 0.37 | 3.13 | 0 | 0 | 0 |
| | 0.0 | 12.21 | 0.80 | 0 | 0.96 | 0.39 | 0 | 0 | 0 |

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

| REACH | XK1 | XK2 | XK3 | XK4 | XM1 | XM2 | XM3 | XRES | XDS | XP |
|-------|-------|-------|------|------|-----|-----|-----|-------|-------|------|
| 1 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.001 | 12.98 | .001 |
| 2 | 0.035 | 0.911 | .574 | .026 | .00 | .00 | .00 | 1.151 | 13.02 | .001 |
| 3 | 0.035 | 0.001 | .630 | .026 | .00 | .00 | .00 | 1.099 | 13.04 | .001 |
| 4 | 0.035 | 0.001 | .304 | .026 | .00 | .00 | .00 | 1.025 | 13.04 | .001 |
| 5 | 0.035 | 0.001 | .211 | .026 | .00 | .00 | .00 | 0.951 | 13.04 | .001 |
| 6 | 0.035 | 0.001 | .164 | .026 | .00 | .00 | .00 | 0.877 | 13.04 | .001 |
| 7 | 0.035 | 0.001 | .135 | .026 | .00 | .00 | .00 | 0.810 | 13.04 | .001 |
| 8 | 0.035 | 0.001 | .115 | .026 | .00 | .00 | .00 | 0.750 | 13.04 | .001 |
| 9 | 0.035 | 0.001 | .100 | .026 | .00 | .00 | .00 | 0.683 | 13.04 | .001 |
| 10 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.06 | .001 |
| 11 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.417 | 13.07 | .001 |
| 12 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.346 | 13.11 | .001 |
| 13 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.297 | 13.15 | .001 |
| 14 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.335 | 13.17 | .001 |
| 15 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.308 | 13.19 | .001 |
| 16 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.285 | 13.21 | .001 |
| 17 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.207 | 13.25 | .001 |
| 18 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.148 | 13.27 | .001 |
| 19 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.29 | .001 |
| 20 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.30 | .001 |
| 21 | 0.035 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.089 | 13.33 | .001 |
| 22 | 0.032 | 0.911 | .553 | .026 | .00 | .00 | .00 | 1.662 | 13.37 | .001 |
| 23 | 0.032 | 0.001 | .700 | .026 | .00 | .00 | .00 | 1.836 | 13.37 | .001 |
| 24 | 0.032 | 0.001 | .014 | .026 | .00 | .00 | .00 | 1.836 | 13.37 | .001 |
| 25 | 0.026 | 0.911 | .407 | .026 | .00 | .00 | .00 | 1.367 | 13.40 | .001 |
| 26 | 0.026 | 0.001 | .342 | .026 | .00 | .00 | .00 | 0.971 | 13.43 | .001 |
| 27 | 0.026 | 0.001 | .298 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 28 | 0.026 | 0.001 | .198 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 29 | 0.026 | 0.001 | .153 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 30 | 0.026 | 0.001 | .149 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 31 | 0.026 | 0.001 | .103 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 32 | 0.026 | 0.001 | .091 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 33 | 0.026 | 0.001 | .081 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 34 | 0.026 | 0.001 | .074 | .026 | .00 | .00 | .00 | 0.554 | 13.46 | .001 |
| 35 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.554 | 13.49 | .001 |

| | | | | | | | | | | |
|----|-------|-------|-------|------|-----|-----|-----|-------|-------|------|
| 36 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.50 | .001 |
| 37 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.60 | .001 |
| 38 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.383 | 13.61 | .001 |
| 39 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.61 | .001 |
| 40 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.62 | .001 |
| 41 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.62 | .001 |
| 42 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.513 | 13.66 | .001 |
| 43 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.70 | .001 |
| 44 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.72 | .001 |
| 45 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.73 | .001 |
| 46 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.75 | .001 |
| 47 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.75 | .001 |
| 48 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.612 | 13.79 | .001 |
| 49 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.849 | 13.82 | .001 |
| 50 | 0.022 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.849 | 13.85 | .001 |
| 51 | 0.026 | 0.001 | .001 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 52 | 0.018 | 0.911 | .556 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 53 | 0.018 | 0.001 | 1.048 | .026 | .00 | .00 | .00 | 0.030 | 13.62 | .001 |
| 54 | 0.018 | 0.001 | .339 | .026 | .00 | .00 | .00 | 0.041 | 13.62 | .001 |

GROUP 9 (AVERAGE RIVER TEMPERATURE)

TEMPER

0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH#)

| REACH | REFQ | T | HEXN | VEYN | RFDGR |
|-------|------|------|------|------|-------|
| 1 | 50 | .045 | .516 | .353 | 20 |
| 2 | 50 | .018 | .516 | .353 | 20 |
| 3 | 50 | .127 | .516 | .353 | 20 |
| 4 | 50 | .127 | .516 | .353 | 20 |
| 5 | 50 | .127 | .516 | .353 | 20 |
| 6 | 50 | .127 | .516 | .353 | 20 |
| 7 | 50 | .127 | .516 | .353 | 20 |
| 8 | 50 | .127 | .516 | .353 | 20 |
| 9 | 50 | .127 | .516 | .353 | 20 |
| 10 | 50 | .448 | .516 | .353 | 20 |
| 11 | 50 | .543 | .550 | .346 | 20 |
| 12 | 50 | .622 | .550 | .346 | 20 |
| 13 | 50 | .297 | .550 | .346 | 20 |
| 14 | 50 | .308 | .540 | .266 | 20 |
| 15 | 50 | .004 | .540 | .266 | 20 |
| 16 | 50 | .284 | .551 | .326 | 20 |
| 17 | 50 | .202 | .551 | .326 | 20 |
| 18 | 50 | .176 | .551 | .326 | 20 |
| 19 | 50 | .154 | .551 | .326 | 20 |
| 20 | 50 | .704 | .551 | .326 | 20 |
| 21 | 50 | .044 | .551 | .326 | 20 |
| 22 | 50 | .018 | .551 | .326 | 20 |
| 23 | 50 | .151 | .463 | .362 | 20 |

| | | | | | |
|----|----|-------|------|------|----|
| 24 | 50 | .002 | .463 | .362 | 20 |
| 25 | 50 | .016 | .536 | .274 | 20 |
| 26 | 50 | .046 | .536 | .274 | 20 |
| 27 | 50 | .104 | .536 | .274 | 20 |
| 28 | 50 | .104 | .536 | .274 | 20 |
| 29 | 50 | .104 | .536 | .274 | 20 |
| 30 | 50 | .104 | .536 | .274 | 20 |
| 31 | 50 | .138 | .536 | .274 | 20 |
| 32 | 50 | .138 | .536 | .274 | 20 |
| 33 | 50 | .138 | .536 | .274 | 20 |
| 34 | 50 | .138 | .536 | .274 | 20 |
| 35 | 50 | 1.390 | .536 | .274 | 20 |
| 36 | 50 | 1.799 | .523 | .288 | 20 |
| 37 | 50 | 1.426 | .523 | .288 | 20 |
| 38 | 50 | 0.463 | .523 | .288 | 20 |
| 39 | 50 | 0.805 | .512 | .260 | 20 |
| 40 | 50 | 1.453 | .512 | .260 | 20 |
| 41 | 50 | 1.960 | .512 | .260 | 20 |
| 42 | 50 | 2.350 | .512 | .260 | 20 |
| 43 | 50 | 2.009 | .592 | .295 | 20 |
| 44 | 50 | 0.038 | .592 | .295 | 20 |
| 45 | 50 | 0.280 | .592 | .295 | 20 |
| 46 | 50 | 0.587 | .592 | .295 | 20 |
| 47 | 50 | 2.331 | .592 | .295 | 20 |
| 48 | 50 | 1.524 | .592 | .295 | 20 |
| 49 | 50 | 1.878 | .598 | .335 | 20 |
| 50 | 50 | 0.348 | .598 | .335 | 20 |
| 51 | 50 | 0.180 | .555 | .351 | 20 |
| 52 | 50 | 0.018 | .555 | .351 | 20 |
| 53 | 50 | 0.561 | .555 | .351 | 20 |
| 54 | 50 | 0.471 | .536 | .289 | 20 |

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)

FNAM

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Appendix C
**Discussion of runs using no temperature
correction for BOD**

No temperature correction for BOD

In discussions about the DOSTOC model there has been some concern about temperature corrections for the model parameters. Currently the model parameters are not all measured at the same temperature (i.e. SOD measured at 0°C while BOD₅ is measured at 20°C). Thus it becomes necessary to mathematically correct the parameters to the appropriate temperature to meet the DOSTOC model requirements. Results here (un-temperature corrected BOD₅ values) are provided for comparison purposes with the model runs (Chapter 5) where BOD₅ was temperature corrected. Input files are provided at the end of this appendix.

Predicted DO concentrations were usually 2 to 3 mg/L lower at Grand Rapids for simulations that were not temperature corrected (Table C.1, Figures C.1 to C.5). These findings suggest that water temperature strongly affects model predictions and that correction of BOD decay rates from the laboratory (20°C) to the river temperature needs to be included in subsequent modelling.

Table C.1 Statistical results of model simulations with and without temperature corrections for BOD decay, for selected years. Temperature corrected runs had BOD decay rates adjusted to 0°C (the river temperature) from the temperature at which the analyses were performed (Tables 4.9-4.14). Runs that were not temperature corrected used 20°C BOD decay rates even though the river temperature was 0°C.

| Year | Temperature Corrected (0°C) | | Not Temperature Corrected (20°C) | |
|----------|-----------------------------|----------------|----------------------------------|----------------|
| | RMS | r ² | RMS | r ² |
| Feb 1988 | 0.62 | 0.51 | 0.84 | 0.11 |
| Mar 1988 | 0.50 | 0.53 | 0.71 | 0.05 |
| Jan 1989 | 0.66 | 0.79 | 1.26 | 0.22 |
| Mar 1989 | 1.06 | 0.56 | 2.02 | -0.60 |
| 1993 | 0.69 | 0.81 | 0.76 | 0.66 |

Figure C.1 - Dissolved oxygen (DO) concentrations in the Athabasca River, AB for February 1988 and deterministic results predicted using the simulation model DOSTOC without temperature correction for BOD decay.

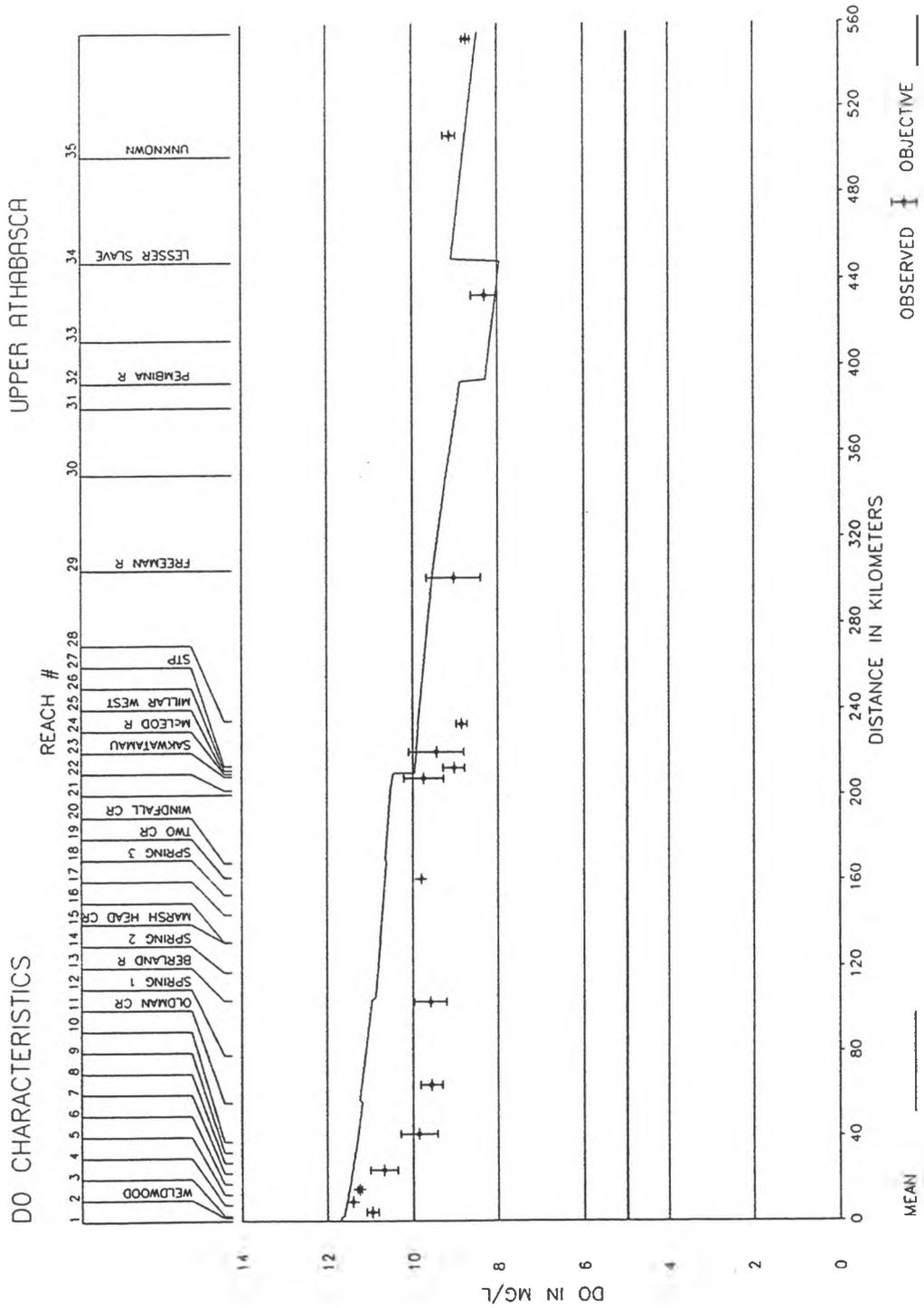


Figure C.2 - Dissolved oxygen (DO) concentrations in the Athabasca River, AB for March 1988 and deterministic results predicted using the simulation model DOSTOC without temperature correction for BOD decay.

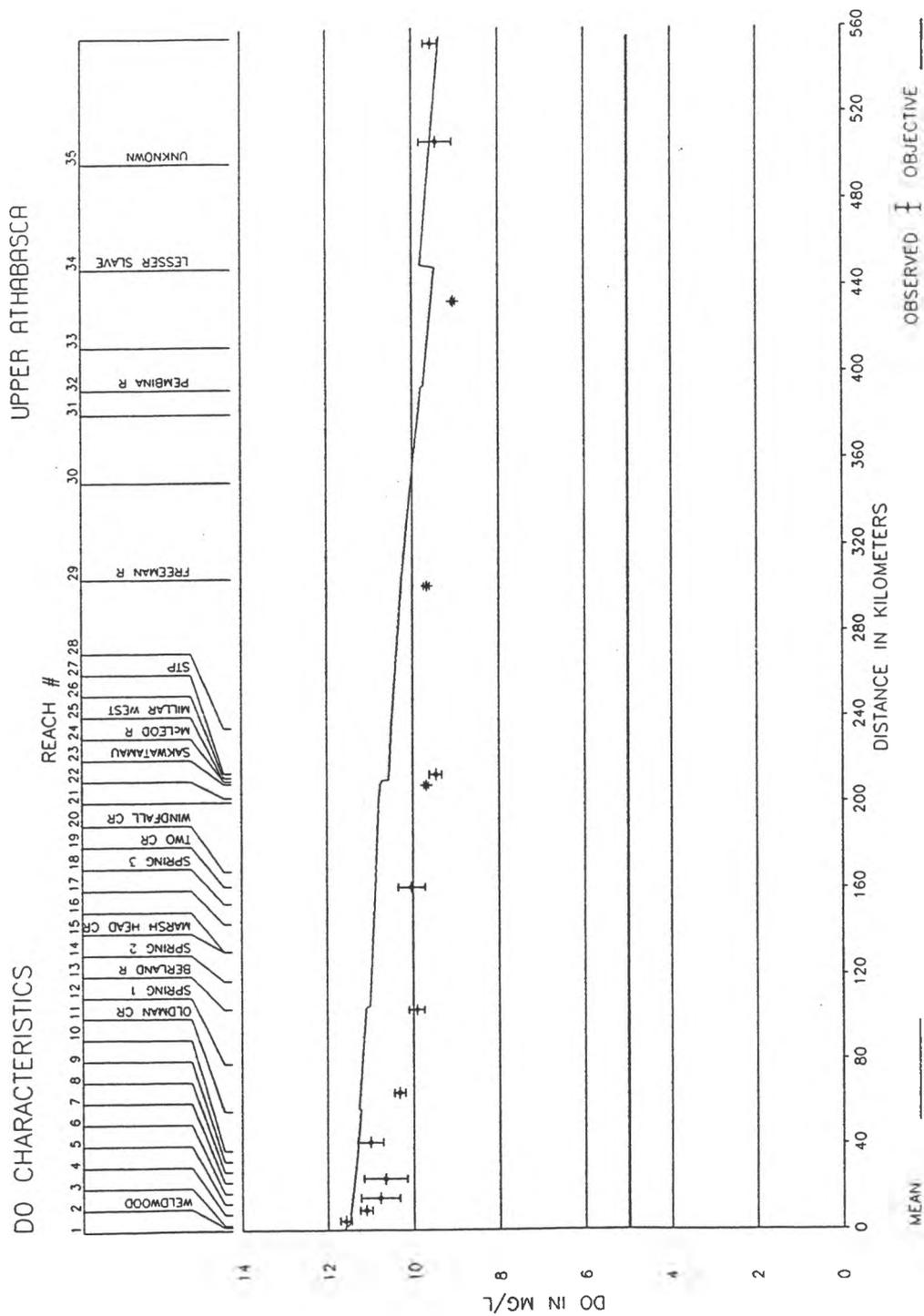


Figure C.3 - Dissolved oxygen (DO) concentrations in the Athabasca River, AB for January 1989 and deterministic results predicted using the simulation model DOSTOC without temperature correction for BOD decay.

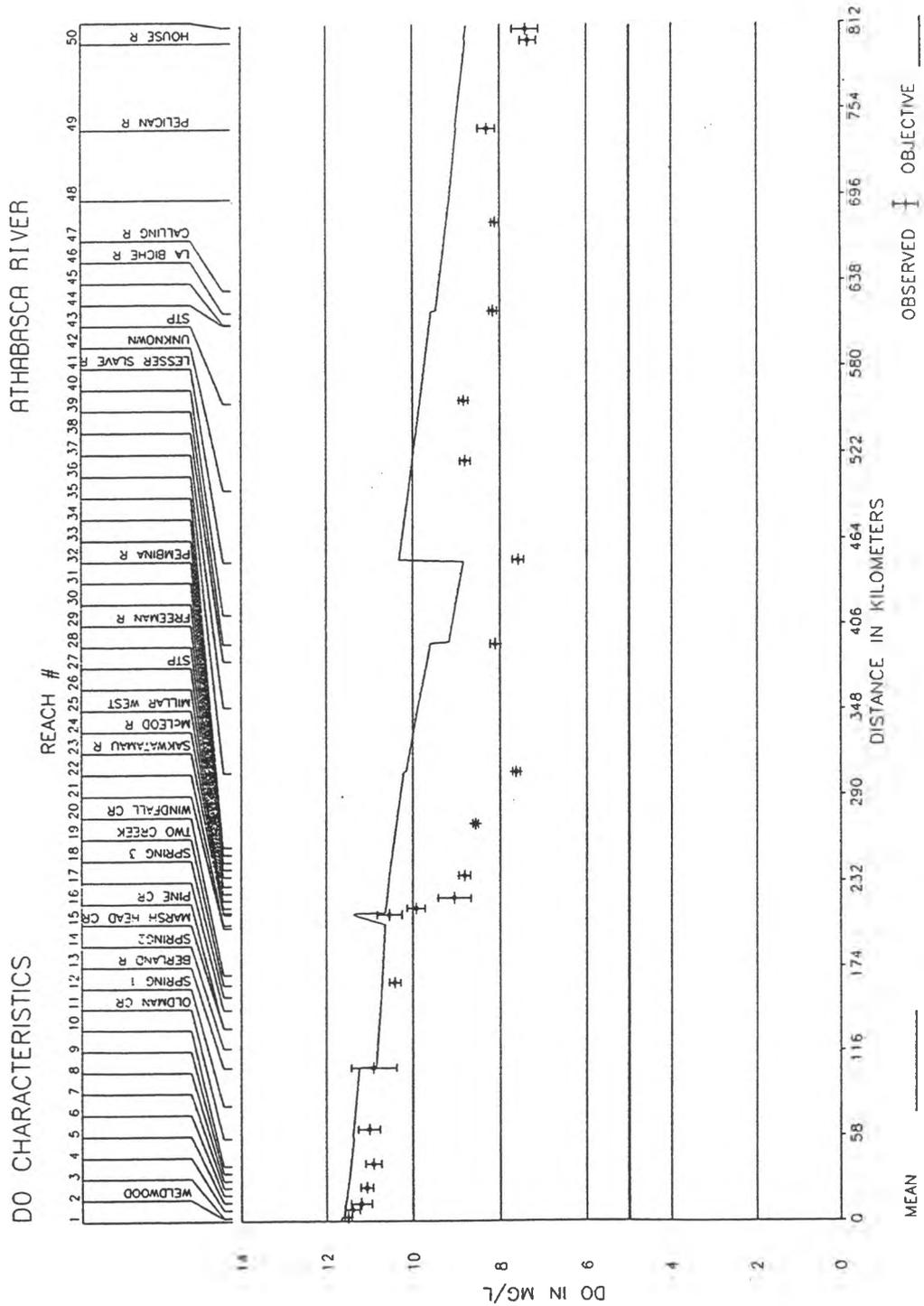


Figure C.4 - Dissolved oxygen (DO) concentrations in the Athabasca River, AB for March 1989 and deterministic results predicted using the simulation model DOSTOC without temperature correction for BOD decay.

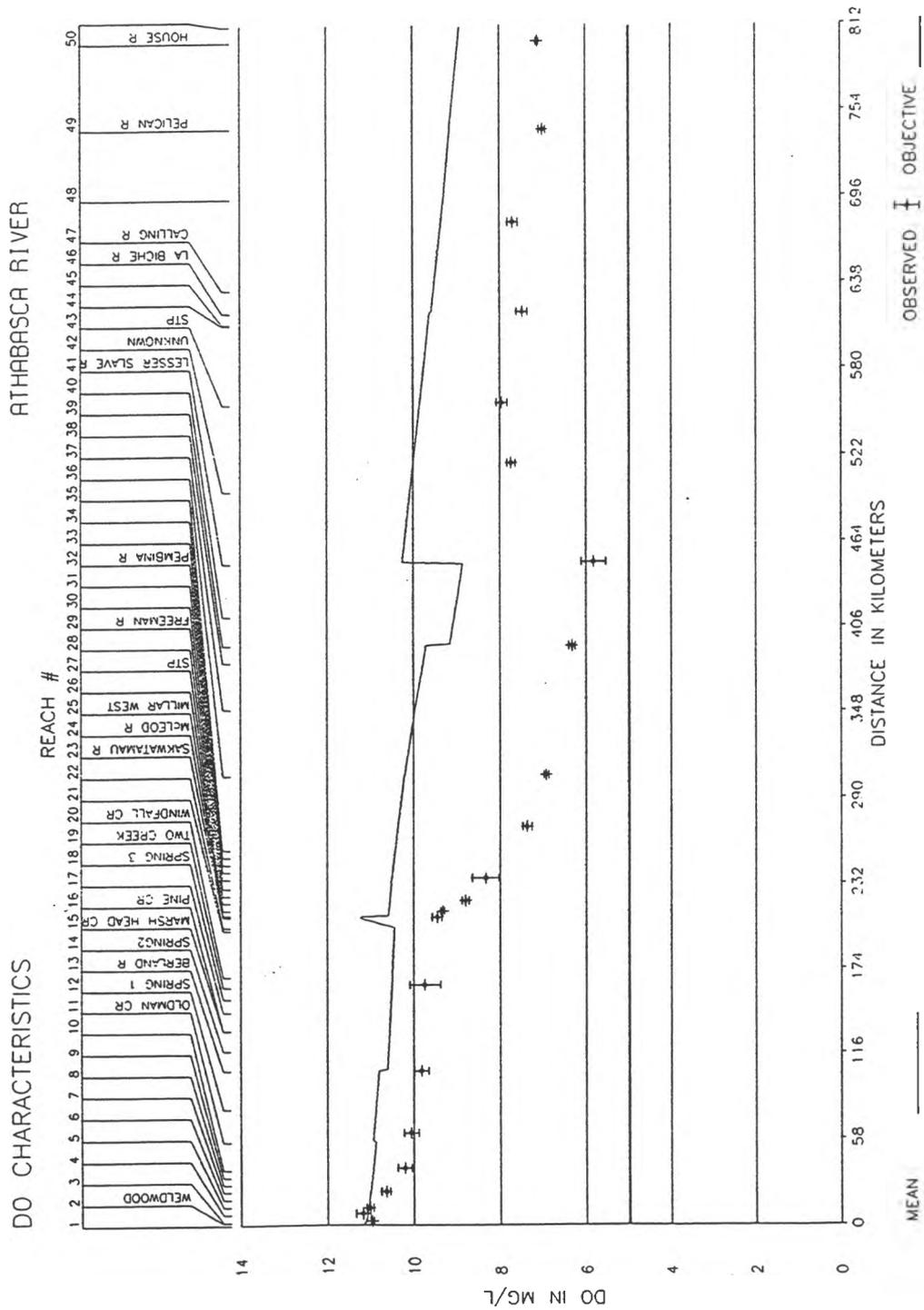
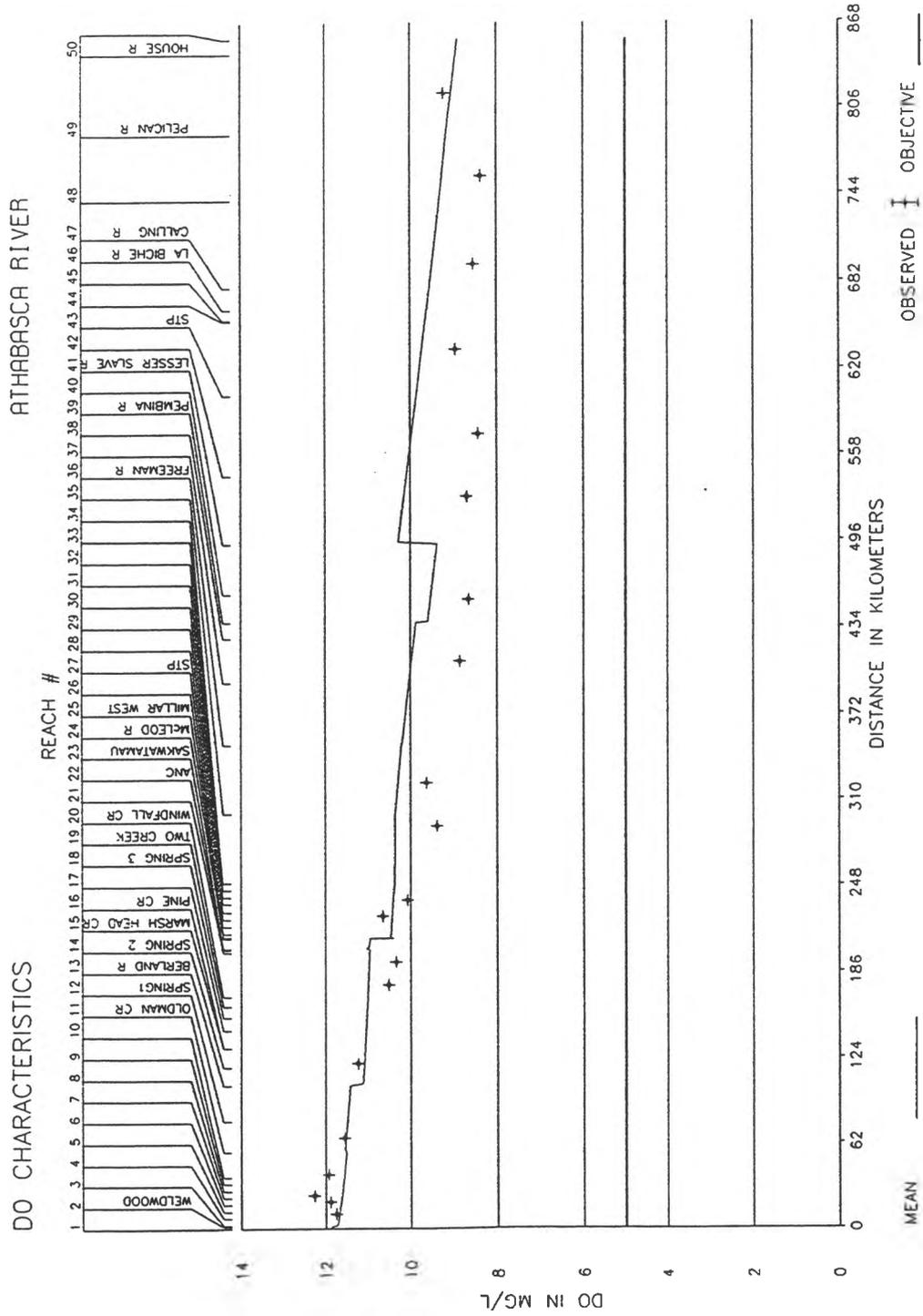


Figure C.5 - Dissolved oxygen (DO) concentrations in the Athabasca River, AB for February - March 1993 and deterministic results predicted using the simulation model DOSTOC without temperature correction for BOD decay.



February 1988 - no temperature correction for BOD

UPPER ATHABASCA - FEBRUARY 1988

| NRT | NTRIB | MAXTR | MAXRI | MAXPT | NSTP | NVAR |
|-----|-------|-------|-------|-------|------|------|
| 35 | 0 | 0 | 35 | 35 | 18 | 9 |

GROUP 2 (ONE LINE FOR EACH REACH)

| IRCH | UP1 | IUP2 | X | Q | QLD | SOURCE NAME |
|------|-----|------|------|--------|-------|----------------|
| 1 | 0 | 0 | 1.7 | 25.1 | 0.000 | |
| 2 | 1 | 0 | 0.8 | 24.176 | 0.924 | WELDWOOD OPEN |
| 3 | 2 | 0 | 5.0 | 25.1 | 0.000 | |
| 4 | 3 | 0 | 5.0 | 25.1 | 0.000 | |
| 5 | 4 | 0 | 5.0 | 25.1 | 0.000 | |
| 6 | 5 | 0 | 5.0 | 25.1 | 0.000 | |
| 7 | 6 | 0 | 5.0 | 25.1 | 0.000 | |
| 8 | 7 | 0 | 5.0 | 25.1 | 0.000 | |
| 9 | 8 | 0 | 5.0 | 25.1 | 0.000 | |
| 10 | 9 | 0 | 18.6 | 25.1 | 0.000 | |
| 11 | 10 | 0 | 22.5 | 25.1 | 0.908 | OLDMAN CR. |
| 12 | 11 | 0 | 25.8 | 26.008 | 0.022 | SPRING 1 |
| 13 | 12 | 0 | 13.3 | 26.03 | 6.43 | BERLAND R |
| 14 | 13 | 0 | 13.8 | 32.46 | 0.018 | SPRING 2 |
| 15 | 14 | 0 | 0.2 | 32.48 | 0.225 | MARSH CR |
| 16 | 15 | 0 | 12.7 | 32.705 | 0.165 | PINE CR |
| 17 | 16 | 0 | 9.2 | 32.87 | 0.000 | |
| 18 | 17 | 0 | 8.0 | 32.87 | 0.018 | SPRING 3 |
| 19 | 18 | 0 | 7.0 | 32.89 | 0.012 | TWO CREEK |
| 20 | 19 | 0 | 32.0 | 32.88 | 0.49 | WINDFALL |
| 21 | 20 | 0 | 2.0 | 33.37 | 0.000 | |
| 22 | 21 | 0 | 6.7 | 33.37 | 0.000 | |
| 23 | 22 | 0 | 1.1 | 33.37 | 0.923 | SAKWATAMAU |
| 24 | 23 | 0 | 0.1 | 34.29 | 3.68 | MCLEOD R |
| 25 | 24 | 0 | 1.5 | 37.99 | 0.000 | |
| 26 | 25 | 0 | 2.1 | 37.99 | 0.000 | |
| 27 | 26 | 0 | 21.1 | 37.93 | 0.037 | WHITE STP |
| 28 | 27 | 0 | 70.0 | 37.99 | 0.000 | |
| 29 | 28 | 0 | 44.6 | 37.99 | 0.118 | FREEMAN R |
| 30 | 29 | 0 | 31.5 | 38.09 | 0.000 | |
| 31 | 30 | 0 | 11.5 | 38.09 | 0.000 | |
| 32 | 31 | 0 | 20.0 | 38.09 | 3.74 | PEMBINA R |
| 33 | 32 | 0 | 36.1 | 41.83 | 0.000 | |
| 34 | 33 | 0 | 48.7 | 41.83 | 12.3 | LESSER SLAVE R |
| 35 | 34 | 0 | 58.4 | 54.13 | 0.000 | UNKNOWN |

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

| STNAM | INST |
|-----------|------|
| WELDWOOD | 2 |
| OLDMAN CR | 11 |

SPRING 1 12
 BERLAND R 13
 SPRING 2 14
 MARSH HEAD CR 15
 PINE CR 16
 SPRING 3 18
 TWO CR 19
 WINDFALL CR 20
 SAKWATAMAU 23
 McLEOD R 24
 MILLAR WEST 25
 STP 27
 FREEMAN R 29
 PEMBINA R 32
 LESSER SLAVE 34
 UNKNOWN 35

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. 7 CHARACTERS)

RNAM

 UPPER ATHABASCA

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

TNAM

INTR

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

| REACH | XLD1 | XLD2 | XLD3 | XLD4 | XLD5 | XLD6 | XLD7 | XLD8 | XLD9 |
|-------|-------|-------|-------|-------|------|-------|------|------|------|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 255.6 | 6.3 | 0 | 97.13 | 1.13 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 13.18 | 20.87 | 0 | 0.37 | 11.07 | 0 | 0 | 0 |
| 12 | 0 | 11.59 | 8.03 | 0 | 0.06 | 0.56 | 0 | 0 | 0 |
| 13 | 0 | 10.56 | 11.24 | 0 | 0.87 | 3.60 | 0 | 0 | 0 |
| 14 | 0 | 11.86 | 4.58 | 0 | 0.16 | 3.39 | 0 | 0 | 0 |
| 15 | 0 | 11.85 | 4.66 | 0 | 0.75 | 2.66 | 0 | 0 | 0 |
| 16 | 0 | 11.30 | 3.21 | 0 | 1.12 | 1.12 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 11.02 | 3.21 | 0 | 0.39 | 2.25 | 0 | 0 | 0 |
| 19 | 0 | 9.07 | 7.63 | 0 | 1.98 | 2.82 | 0 | 0 | 0 |
| 20 | 0 | 12.51 | 5.62 | 0 | 1.40 | 3.54 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|----|-------|-------|-------|------|------|-------|---|---|---|
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 0 | 9.57 | 3.61 | 0 | 1.30 | 2.49 | 0 | 0 | 0 |
| 24 | 0 | 5.54 | 7.79 | 0 | 1.50 | 5.84 | 0 | 0 | 0 |
| 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 99.84 | 5.1 | 0 | 59.9 | 1.00 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 8.65 | 8.03 | 0 | 1.59 | 6.10 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 2.21 | 8.83 | 0 | 1.43 | 5.74 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | 13.03 | 22.48 | 0 | 0.87 | 13.03 | 0 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

GROUP 7 (ONE LINE FOR EACH HEADWATER)

| X01 | X02 | X03 | X04 | X05 | X06 | X07 | X08 | X09 |
|-----|-------|-------|-----|-------|-------|-----|-----|-----|
| 0.0 | 11.69 | 17.43 | 0 | 0.374 | 11.33 | 0 | 0 | 0 |

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

| REACH | XK1 | XK2 | XK3 | XK4 | XM1 | XM2 | XM3 | XRES | XDS | XP |
|-------|-------|--------|------|------|-----|-----|------|-------|-------|------|
| 1 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.001 | 12.98 | .001 |
| 2 | 0.035 | 0.567 | .229 | .026 | .00 | .00 | .000 | 0.327 | 13.02 | .001 |
| 3 | 0.035 | 0.0006 | .252 | .026 | .00 | .00 | .000 | 0.312 | 13.04 | .001 |
| 4 | 0.035 | 0.0006 | .121 | .026 | .00 | .00 | .000 | 0.291 | 13.04 | .001 |
| 5 | 0.035 | 0.0006 | .084 | .026 | .00 | .00 | .000 | 0.270 | 13.04 | .001 |
| 6 | 0.035 | 0.0006 | .065 | .026 | .00 | .00 | .000 | 0.249 | 13.04 | .001 |
| 7 | 0.035 | 0.0006 | .054 | .026 | .00 | .00 | .000 | 0.230 | 13.04 | .001 |
| 8 | 0.035 | 0.0006 | .046 | .026 | .00 | .00 | .000 | 0.213 | 13.04 | .001 |
| 9 | 0.035 | 0.0006 | .040 | .026 | .00 | .00 | .000 | 0.194 | 13.04 | .001 |
| 10 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.145 | 13.06 | .001 |
| 11 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.118 | 13.07 | .001 |
| 12 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.098 | 13.11 | .001 |
| 13 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.084 | 13.15 | .001 |
| 14 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.095 | 13.17 | .001 |
| 15 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.087 | 13.19 | .001 |
| 16 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.081 | 13.21 | .001 |
| 17 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.059 | 13.25 | .001 |
| 18 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.042 | 13.27 | .001 |
| 19 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.025 | 13.29 | .001 |
| 20 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.025 | 13.30 | .001 |
| 21 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.025 | 13.33 | .001 |
| 22 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.472 | 13.37 | .001 |
| 23 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.521 | 13.37 | .001 |
| 24 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.521 | 13.37 | .001 |
| 25 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.388 | 13.40 | .001 |
| 26 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.276 | 13.43 | .001 |
| 27 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.46 | .001 |
| 28 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.49 | .001 |

| | | | | | | | | | | |
|----|-------|--------|------|------|-----|-----|------|-------|-------|------|
| 29 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.50 | .001 |
| 30 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.60 | .001 |
| 31 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.61 | .001 |
| 32 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.61 | .001 |
| 33 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.62 | .001 |
| 34 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.62 | .001 |
| 35 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.66 | .001 |

GROUP 9 (AVERAGE RIVER TEMPERATURE)

TEMPER

0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH NUMBER)

| REACH | REFQ | T | HEXN | VEXN | RFDGR |
|-------|------|-------|------|------|-------|
| 1 | 50 | .045 | .516 | .353 | 20 |
| 2 | 50 | .018 | .516 | .353 | 20 |
| 3 | 50 | .127 | .516 | .353 | 20 |
| 4 | 50 | .127 | .516 | .353 | 20 |
| 5 | 50 | .127 | .516 | .353 | 20 |
| 6 | 50 | .127 | .516 | .353 | 20 |
| 7 | 50 | .127 | .516 | .353 | 20 |
| 8 | 50 | .127 | .516 | .353 | 20 |
| 9 | 50 | .127 | .516 | .353 | 20 |
| 10 | 50 | .448 | .516 | .353 | 20 |
| 11 | 50 | .543 | .550 | .346 | 20 |
| 12 | 50 | .622 | .550 | .346 | 20 |
| 13 | 50 | .297 | .550 | .346 | 20 |
| 14 | 50 | .308 | .540 | .266 | 20 |
| 15 | 50 | .004 | .540 | .266 | 20 |
| 16 | 50 | .284 | .551 | .326 | 20 |
| 17 | 50 | .202 | .551 | .326 | 20 |
| 18 | 50 | .176 | .551 | .326 | 20 |
| 19 | 50 | .154 | .551 | .326 | 20 |
| 20 | 50 | .704 | .551 | .326 | 20 |
| 21 | 50 | .044 | .551 | .326 | 20 |
| 22 | 50 | .147 | .551 | .326 | 20 |
| 23 | 50 | .022 | .463 | .362 | 20 |
| 24 | 50 | .002 | .463 | .362 | 20 |
| 25 | 50 | .029 | .536 | .274 | 20 |
| 26 | 50 | .041 | .536 | .274 | 20 |
| 27 | 50 | .414 | .536 | .274 | 20 |
| 28 | 50 | 1.940 | .536 | .274 | 20 |
| 29 | 50 | 1.799 | .523 | .288 | 20 |
| 30 | 50 | 1.426 | .512 | .350 | 20 |
| 31 | 50 | .463 | .512 | .260 | 20 |
| 32 | 50 | .805 | .512 | .260 | 20 |
| 33 | 50 | 1.453 | .512 | .260 | 20 |
| 34 | 50 | 1.960 | .512 | .260 | 20 |
| 35 | 50 | 2.350 | .512 | .260 | 20 |

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)

FNAM

ATHAF88

March 1988 - no temperature correction for BOD

UPPER ATHABASCA - MARCH 1988

| NRT | NTRIB | MAXTR | MAXRI | MAXPT | NSTP | NVAR |
|-----|-------|-------|-------|-------|------|------|
| 35 | 0 | 0 | 35 | 35 | 18 | 9 |

GROUP 2 (ONE LINE FOR EACH REACH)

| IRCH | UP1 | IUP2 | X | Q | QLD | SOURCE NAME |
|------|-----|------|------|--------|-------|----------------|
| 1 | 0 | 0 | 1.7 | 30.1 | 0.000 | |
| 2 | 1 | 0 | 0.8 | 30.026 | 0.974 | WELDWOOD OPEN |
| 3 | 2 | 0 | 5.0 | 31.0 | 0.000 | |
| 4 | 3 | 0 | 5.0 | 31.0 | 0.000 | |
| 5 | 4 | 0 | 5.0 | 31.0 | 0.000 | |
| 6 | 5 | 0 | 5.0 | 31.0 | 0.000 | |
| 7 | 6 | 0 | 5.0 | 31.0 | 0.000 | |
| 8 | 7 | 0 | 5.0 | 31.0 | 0.000 | |
| 9 | 8 | 0 | 5.0 | 31.0 | 0.000 | |
| 10 | 9 | 0 | 18.6 | 31.0 | 0.000 | |
| 11 | 10 | 0 | 22.5 | 31.0 | 1.33 | OLDMAN CR. |
| 12 | 11 | 0 | 25.8 | 32.33 | 0.022 | SPRING 1 |
| 13 | 12 | 0 | 13.3 | 32.35 | 7.69 | BERLAND R |
| 14 | 13 | 0 | 13.8 | 40.04 | 0.018 | SPRING 2 |
| 15 | 14 | 0 | 0.2 | 40.06 | 0.225 | MARSH CR |
| 16 | 15 | 0 | 12.7 | 40.29 | 0.165 | PINE CR |
| 17 | 16 | 0 | 9.2 | 40.45 | 0.000 | |
| 18 | 17 | 0 | 8.0 | 40.45 | 0.018 | SPRING 3 |
| 19 | 18 | 0 | 7.0 | 40.47 | 0.012 | TWO CREEK |
| 20 | 19 | 0 | 32.0 | 40.48 | 0.479 | WINDFALL |
| 21 | 20 | 0 | 2.0 | 40.96 | 0.000 | |
| 22 | 21 | 0 | 6.7 | 40.96 | 0.000 | |
| 23 | 22 | 0 | 1.1 | 40.96 | 0.923 | SAKWATAMAU |
| 24 | 23 | 0 | 0.1 | 41.88 | 7.50 | MCLEOD R |
| 25 | 24 | 0 | 1.5 | 49.38 | 0.000 | |
| 26 | 25 | 0 | 2.1 | 49.38 | 0.000 | |
| 27 | 26 | 0 | 21.1 | 49.34 | 0.037 | WHITE STP |
| 28 | 27 | 0 | 70.0 | 49.38 | 0.000 | |
| 29 | 28 | 0 | 44.6 | 49.38 | 0.151 | FREEMAN R |
| 30 | 29 | 0 | 31.5 | 49.49 | 0.000 | |
| 31 | 30 | 0 | 11.5 | 49.49 | 0.000 | |
| 32 | 31 | 0 | 20.0 | 49.49 | 1.37 | PEMBINA R |
| 33 | 32 | 0 | 36.1 | 50.86 | 0.000 | |
| 34 | 33 | 0 | 48.7 | 50.86 | 12.6 | LESSER SLAVE R |
| 35 | 34 | 0 | 58.4 | 63.46 | 0.000 | UNKNOWN |

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

| STNAM | INST |
|-----------|------|
| WELDWOOD | 2 |
| OLDMAN CR | 11 |

SPRING 1 12
 BERLAND R 13
 SPRING 2 14
 MARSH HEAD CR 15
 PINE CR 16
 SPRING 3 18
 TWO CR 19
 WINDFALL CR 20
 SAKWATAMAU 23
 McLEOD R 24
 MILLAR WEST 25
 STP 27
 FREEMAN R 29
 PEMBINA R 32
 LESSER SLAVE 34
 UNKNOWN 35

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. 7 CHARACTERS)

RNAM

 UPPER ATHABASCA

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

TNAM INTR

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

REACH XLD1 XLD2 XLD3 XLD4 XLD5 XLD6 XLD7 XLD8 XLD9

| | | | | | | | | | |
|----|--------|-------|-------|-------|------|-------|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 127.80 | 5.6 | 0 | 48.56 | 1.01 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 12.38 | 17.67 | 0 | 0.35 | 9.36 | 0 | 0 | 0 |
| 12 | 0 | 11.59 | 8.43 | 0 | 0.06 | 0.59 | 0 | 0 | 0 |
| 13 | 0 | 10.66 | 9.64 | 0 | 0.87 | 3.08 | 0 | 0 | 0 |
| 14 | 0 | 11.86 | 4.58 | 0 | 0.15 | 3.39 | 0 | 0 | 0 |
| 15 | 0 | 11.85 | 4.66 | 0 | 0.75 | 2.66 | 0 | 0 | 0 |
| 16 | 0 | 11.30 | 3.21 | 0 | 1.19 | 1.12 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 11.02 | 3.21 | 0 | 0.39 | 2.25 | 0 | 0 | 0 |
| 19 | 0 | 9.7 | 7.63 | 0 | 2.11 | 2.82 | 0 | 0 | 0 |
| 20 | 0 | 11.47 | 16.06 | 0 | 1.28 | 10.12 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|----|-------|-------|-------|------|------|-------|---|---|---|
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 0 | 9.57 | 3.61 | 0 | 1.30 | 2.49 | 0 | 0 | 0 |
| 24 | 0 | 9.71 | 16.06 | 0 | 2.62 | 12.05 | 0 | 0 | 0 |
| 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 99.84 | 5.1 | 0 | 59.9 | 1.00 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 8.98 | 11.24 | 0 | 1.65 | 8.54 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 7.81 | 12.05 | 0 | 5.07 | 7.83 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | 11.17 | 9.64 | 0 | 0.74 | 5.59 | 0 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

GROUP 7 (ONE LINE FOR EACH HEADWATER)

| X01 | X02 | X03 | X04 | X05 | X06 | X07 | X08 | X09 |
|-----|-------|-------|-----|-------|------|-----|-----|-----|
| 0.0 | 11.59 | 12.05 | 0 | 0.371 | 7.83 | 0 | 0 | 0 |

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

| REACH | XK1 | XK2 | XK3 | XK4 | XM1 | XM2 | XM3 | XRES | XDS | XP |
|-------|-------|--------|------|------|-----|-----|------|-------|-------|------|
| 1 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.001 | 12.98 | .001 |
| 2 | 0.035 | 0.567 | .229 | .026 | .00 | .00 | .000 | 0.327 | 13.02 | .001 |
| 3 | 0.035 | 0.0006 | .252 | .026 | .00 | .00 | .000 | 0.312 | 13.04 | .001 |
| 4 | 0.035 | 0.0006 | .121 | .026 | .00 | .00 | .000 | 0.291 | 13.04 | .001 |
| 5 | 0.035 | 0.0006 | .084 | .026 | .00 | .00 | .000 | 0.270 | 13.04 | .001 |
| 6 | 0.035 | 0.0006 | .065 | .026 | .00 | .00 | .000 | 0.249 | 13.04 | .001 |
| 7 | 0.035 | 0.0006 | .054 | .026 | .00 | .00 | .000 | 0.230 | 13.04 | .001 |
| 8 | 0.035 | 0.0006 | .046 | .026 | .00 | .00 | .000 | 0.213 | 13.04 | .001 |
| 9 | 0.035 | 0.0006 | .040 | .026 | .00 | .00 | .000 | 0.194 | 13.04 | .001 |
| 10 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.145 | 13.06 | .001 |
| 11 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.118 | 13.07 | .001 |
| 12 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.098 | 13.11 | .001 |
| 13 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.084 | 13.15 | .001 |
| 14 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.095 | 13.17 | .001 |
| 15 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.087 | 13.19 | .001 |
| 16 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.081 | 13.21 | .001 |
| 17 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.059 | 13.25 | .001 |
| 18 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.042 | 13.27 | .001 |
| 19 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.025 | 13.29 | .001 |
| 20 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.025 | 13.30 | .001 |
| 21 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.025 | 13.33 | .001 |
| 22 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.472 | 13.37 | .001 |
| 23 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.521 | 13.37 | .001 |
| 24 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.521 | 13.37 | .001 |
| 25 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.388 | 13.40 | .001 |
| 26 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.276 | 13.43 | .001 |
| 27 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.46 | .001 |
| 28 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.49 | .001 |

| | | | | | | | | | | |
|----|-------|--------|------|------|-----|-----|------|-------|-------|------|
| 29 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.50 | .001 |
| 30 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.60 | .001 |
| 31 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.61 | .001 |
| 32 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.61 | .001 |
| 33 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.62 | .001 |
| 34 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.62 | .001 |
| 35 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .000 | 0.157 | 13.66 | .001 |

GROUP 9 (AVERAGE RIVER TEMPERATURE)

TEMPER

0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH NUMBER)

REACH REFQ T HEXN VEXN RFDGR

| | | | | | |
|----|----|-------|------|------|----|
| 1 | 50 | .045 | .516 | .353 | 20 |
| 2 | 50 | .018 | .516 | .353 | 20 |
| 3 | 50 | .127 | .516 | .353 | 20 |
| 4 | 50 | .127 | .516 | .353 | 20 |
| 5 | 50 | .127 | .516 | .353 | 20 |
| 6 | 50 | .127 | .516 | .353 | 20 |
| 7 | 50 | .127 | .516 | .353 | 20 |
| 8 | 50 | .127 | .516 | .353 | 20 |
| 9 | 50 | .127 | .516 | .353 | 20 |
| 10 | 50 | .448 | .516 | .353 | 20 |
| 11 | 50 | .543 | .550 | .346 | 20 |
| 12 | 50 | .622 | .550 | .346 | 20 |
| 13 | 50 | .297 | .550 | .346 | 20 |
| 14 | 50 | .308 | .540 | .266 | 20 |
| 15 | 50 | .004 | .540 | .266 | 20 |
| 16 | 50 | .284 | .551 | .326 | 20 |
| 17 | 50 | .202 | .551 | .326 | 20 |
| 18 | 50 | .176 | .551 | .326 | 20 |
| 19 | 50 | .154 | .551 | .326 | 20 |
| 20 | 50 | .704 | .551 | .326 | 20 |
| 21 | 50 | .044 | .551 | .326 | 20 |
| 22 | 50 | .147 | .551 | .326 | 20 |
| 23 | 50 | .022 | .463 | .362 | 20 |
| 24 | 50 | .002 | .463 | .362 | 20 |
| 25 | 50 | .029 | .536 | .274 | 20 |
| 26 | 50 | .041 | .536 | .274 | 20 |
| 27 | 50 | .414 | .536 | .274 | 20 |
| 28 | 50 | 1.940 | .536 | .274 | 20 |
| 29 | 50 | 1.799 | .523 | .288 | 20 |
| 30 | 50 | 1.426 | .512 | .350 | 20 |
| 31 | 50 | .463 | .512 | .260 | 20 |
| 32 | 50 | .805 | .512 | .260 | 20 |
| 33 | 50 | 1.453 | .512 | .260 | 20 |
| 34 | 50 | 1.960 | .512 | .260 | 20 |
| 35 | 50 | 2.350 | .512 | .260 | 20 |

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)

FNAM

ATHAM88

January 1989 - no temperature correction for BOD

ATHABASCA RIVER JAN 89 GROUP 1

| NRT | NTRIB | MAXTR | MAXRI | MAXPT | NSTP | NVAR |
|-----|-------|-------|-------|-------|------|------|
| 54 | 1 | 4 | 50 | 50 | 23 | 9 |

GROUP 2 (ONE LINE FOR EACH REACH)

| IRCH | UP1 | IUP2 | X | Q | QLD | SOURCE NAME |
|------|-----|------|------|-------|-------|------------------|
| 1 | 0 | 0 | 1.7 | 31.1 | 0.000 | |
| 2 | 1 | 0 | 0.8 | 30.13 | 0.970 | WELDDWOOD<OPEN |
| 3 | 2 | 0 | 5.0 | 31.1 | 0.000 | |
| 4 | 3 | 0 | 5.0 | 31.1 | 0.000 | |
| 5 | 4 | 0 | 5.0 | 31.1 | 0.000 | |
| 6 | 5 | 0 | 5.0 | 31.1 | 0.000 | |
| 7 | 6 | 0 | 5.0 | 31.1 | 0.000 | |
| 8 | 7 | 0 | 5.0 | 31.1 | 0.000 | |
| 9 | 8 | 0 | 5.0 | 31.1 | 0.000 | |
| 10 | 9 | 0 | 18.6 | 31.1 | 0.000 | |
| 11 | 10 | 0 | 22.5 | 31.1 | 0.700 | OLDMANCR |
| 12 | 11 | 0 | 25.8 | 31.8 | 0.015 | SPRING1 |
| 13 | 12 | 0 | 13.3 | 31.82 | 5.670 | BERLAND R |
| 14 | 13 | 0 | 13.8 | 37.49 | 0.02 | SPRING2 |
| 15 | 14 | 0 | 0.2 | 37.51 | 0.066 | MARSH CR |
| 16 | 15 | 0 | 12.7 | 37.58 | 0.019 | PINE CR |
| 17 | 16 | 0 | 9.2 | 37.60 | 0.000 | |
| 18 | 17 | 0 | 8.0 | 37.60 | 0.015 | SPRING3 |
| 19 | 18 | 0 | 7.0 | 37.61 | 0.010 | TWO CREEK |
| 20 | 19 | 0 | 32.0 | 37.62 | 0.000 | WINDFALL |
| 21 | 20 | 0 | 2.0 | 37.62 | 0.000 | |
| 22 | 21 | 0 | 6.7 | 37.62 | 0.000 | |
| 23 | 22 | 0 | 1.1 | 37.62 | 0.923 | SAKWATAMAU |
| 24 | 23 | 0 | 0.1 | 38.54 | 4.760 | MCLEOD R |
| 25 | 24 | 0 | 0.8 | 43.16 | 0.141 | MILLAR WEST<OPEN |
| 26 | 25 | 0 | 2.8 | 43.30 | 0.000 | |
| 27 | 26 | 0 | 5.0 | 43.26 | 0.038 | WHITE STP |
| 28 | 27 | 0 | 5.0 | 43.30 | 0.000 | |
| 29 | 28 | 0 | 5.0 | 43.30 | 0.000 | |
| 30 | 29 | 0 | 6.1 | 43.30 | 0.000 | |
| 31 | 30 | 0 | 5.0 | 43.30 | 0.000 | |
| 32 | 31 | 0 | 5.0 | 43.30 | 0.000 | |
| 33 | 32 | 0 | 5.0 | 43.30 | 0.000 | |
| 34 | 33 | 0 | 5.0 | 43.30 | 0.000 | |
| 35 | 34 | 0 | 50.0 | 43.30 | 0.000 | |
| 36 | 35 | 0 | 44.6 | 43.30 | 0.480 | FREEMAN R |
| 37 | 36 | 0 | 31.5 | 43.78 | 0.000 | |
| 38 | 37 | 0 | 11.5 | 43.78 | 0.000 | |
| 39 | 38 | 0 | 20.0 | 43.78 | 2.8 | PEMBINA |
| 40 | 39 | 0 | 36.1 | 46.58 | 0.000 | |

| | | | | | | |
|----|----|----|------|-------|-------|--------------|
| 41 | 40 | 54 | 48.7 | 71.68 | 0.000 | LESSER SLAVE |
| 42 | 41 | 0 | 58.4 | 71.68 | 0.000 | UNKNOWN |
| 43 | 42 | 0 | 53.0 | 71.67 | 0.012 | ATHAB STP |
| 44 | 43 | 0 | 1.0 | 71.68 | 0.000 | |
| 45 | 44 | 0 | 7.4 | 71.68 | 0.000 | |
| 46 | 45 | 0 | 15.5 | 71.68 | 0.927 | LA BICHE |
| 47 | 46 | 0 | 61.5 | 72.61 | 0.006 | CALLING |
| 48 | 47 | 0 | 47.3 | 72.61 | 0.000 | |
| 49 | 48 | 0 | 58.3 | 72.61 | 0.46 | PELICAN |
| 50 | 49 | 0 | 10.8 | 73.07 | 0.91 | HOUSE |
| 51 | 0 | 0 | 8.0 | 25.1 | 0.0 | |
| 52 | 51 | 0 | 1.0 | 25.1 | 0.0 | |
| 53 | 52 | 0 | 24.7 | 25.1 | 0.0 | |
| 54 | 53 | 0 | 19.8 | 25.1 | 0.0 | |

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

| STNAM | INST |
|----------------|------|
| ***** | |
| WELDWOOD | 2 |
| OLDMAN CR | 11 |
| SPRING 1 | 12 |
| BERLAND R | 13 |
| SPRING2 | 14 |
| MARSH HEAD CR | 15 |
| PINE CR | 16 |
| SPRING 3 | 18 |
| TWO CREEK | 19 |
| WINDFALL CR | 20 |
| SAKWATAMAU R | 23 |
| McLEOD R | 24 |
| MILLAR WEST | 25 |
| STP | 27 |
| FREEMAN R | 29 |
| PEMBINA R | 32 |
| LESSER SLAVE R | 41 |
| UNKNOWN | 42 |
| STP | 43 |
| LA BICHE R | 46 |
| CALLING R | 47 |
| PELICAN R | 49 |
| HOUSE R | 50 |

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. 7 CHARACTERS)

| RNAM |
|-----------------|
| ***** |
| ATHABASCA RIVER |

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

| TNAM | INTR |
|--------------|------|
| ***** | |
| LESSER SLAVE | 41 |

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

REACH XLD1 XLD2 XLD3 XLD4 XLD5 XLD6 XLD7 XLD8 XLD9

| | | | | | | | | | |
|----|--------|-------|-------|--------|------|------|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 105.00 | 7.0 | 0 | 50.40 | 1.26 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 12.36 | 8.03 | 0 | 0.35 | 4.26 | 0 | 0 | 0 |
| 12 | 0 | 11.63 | 8.83 | 0 | 0.06 | 0.62 | 0 | 0 | 0 |
| 13 | 0 | 8.61 | 7.23 | 0 | 0.71 | 2.31 | 0 | 0 | 0 |
| 14 | 0 | 11.7 | 0.80 | 0 | 0.15 | 0.59 | 0 | 0 | 0 |
| 15 | 0 | 10.46 | 6.42 | 0 | 0.66 | 3.66 | 0 | 0 | 0 |
| 16 | 0 | 10.51 | 2.41 | 0 | 1.04 | 0.84 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 10.74 | 1.61 | 0 | 0.38 | 1.13 | 0 | 0 | 0 |
| 19 | 0 | 7.67 | 9.64 | 0 | 1.67 | 3.57 | 0 | 0 | 0 |
| 20 | 0 | 9.12 | 10.44 | 0 | 1.02 | 6.58 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 0 | 9.57 | 3.61 | 0 | 1.30 | 2.49 | 0 | 0 | 0 |
| 24 | 0 | 5.28 | 12.85 | 0 | 1.43 | 9.64 | 0 | 0 | 0 |
| 25 | 2772.0 | 5.80 | 0 | 554.4 | 2.15 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 49.92 | 3.2 | 0 | 29.95 | 0.64 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | 0 | 5.56 | 4.02 | 0 | 1.02 | 3.06 | 0 | 0 | 0 |
| 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 0 | 2.77 | 4.02 | 0 | 1.80 | 2.61 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 248.82 | 1.5 | 0 | 323.47 | 1.5 | 0 | 0 | 0 | 0 |
| 44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | 0 | 1.46 | 7.23 | 0 | 0.67 | 4.55 | 0 | 0 | 0 |
| 47 | 0 | 10.78 | 6.42 | 0 | 3.12 | 3.92 | 0 | 0 | 0 |
| 48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|----|---|-------|-------|---|------|-------|---|---|---|
| 49 | 0 | 12.53 | 24.89 | 0 | 1.12 | 12.20 | 0 | 0 | 0 |
| 50 | 0 | 10.65 | 7.23 | 0 | 1.00 | 5.06 | 0 | 0 | 0 |
| 51 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

GROUP 7 (ONE LINE FOR EACH HEADWATER)

| | X01 | X02 | X03 | X04 | X05 | X06 | X07 | X08 | X09 |
|-------|-----|-------|------|-----|-------|------|-----|-----|-----|
| ***** | | | | | | | | | |
| | 0.0 | 11.65 | 9.64 | 0 | 0.373 | 6.27 | 0 | 0 | 0 |
| | 0.0 | 13.10 | 8.03 | 0 | 1.03 | 3.85 | 0 | 0 | 0 |

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

| REACH | XK1 | XK2 | XK3 | XK4 | XM1 | XM2 | XM3 | XRES | XDS | XP |
|-------|-------|--------|------|------|-----|-----|-----|-------|-------|------|
| 1 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.001 | 12.98 | .001 |
| 2 | 0.036 | 0.567 | .229 | .026 | .00 | .00 | .00 | 0.327 | 13.02 | .001 |
| 3 | 0.036 | 0.0006 | .252 | .026 | .00 | .00 | .00 | 0.312 | 13.04 | .001 |
| 4 | 0.036 | 0.0006 | .121 | .026 | .00 | .00 | .00 | 0.291 | 13.04 | .001 |
| 5 | 0.036 | 0.0006 | .084 | .026 | .00 | .00 | .00 | 0.270 | 13.04 | .001 |
| 6 | 0.036 | 0.0006 | .065 | .026 | .00 | .00 | .00 | 0.249 | 13.04 | .001 |
| 7 | 0.036 | 0.0006 | .054 | .026 | .00 | .00 | .00 | 0.230 | 13.04 | .001 |
| 8 | 0.036 | 0.0006 | .046 | .026 | .00 | .00 | .00 | 0.213 | 13.04 | .001 |
| 9 | 0.036 | 0.0006 | .040 | .026 | .00 | .00 | .00 | 0.194 | 13.04 | .001 |
| 10 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.145 | 13.06 | .001 |
| 11 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.118 | 13.07 | .001 |
| 12 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.098 | 13.11 | .001 |
| 13 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.084 | 13.15 | .001 |
| 14 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.095 | 13.17 | .001 |
| 15 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.087 | 13.19 | .001 |
| 16 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.081 | 13.21 | .001 |
| 17 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.059 | 13.25 | .001 |
| 18 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.042 | 13.27 | .001 |
| 19 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.025 | 13.29 | .001 |
| 20 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.025 | 13.30 | .001 |
| 21 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.025 | 13.33 | .001 |
| 22 | 0.036 | 0.567 | .001 | .026 | .00 | .00 | .00 | 0.472 | 13.37 | .001 |
| 23 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.37 | .001 |
| 24 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.37 | .001 |
| 25 | 0.048 | 0.0006 | .229 | .026 | .00 | .00 | .00 | 0.388 | 13.40 | .001 |
| 26 | 0.048 | 0.0006 | .189 | .026 | .00 | .00 | .00 | 0.276 | 13.43 | .001 |
| 27 | 0.026 | 0.0006 | .154 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 28 | 0.026 | 0.0006 | .097 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 29 | 0.026 | 0.0006 | .073 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 30 | 0.026 | 0.0006 | .068 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 31 | 0.026 | 0.0006 | .047 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 32 | 0.026 | 0.0006 | .041 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 33 | 0.026 | 0.0006 | .036 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 34 | 0.026 | 0.0006 | .033 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 35 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.157 | 13.49 | .001 |

| | | | | | | | | | | |
|----|-------|--------|------|------|-----|-----|-----|-------|-------|------|
| 36 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.109 | 13.50 | .001 |
| 37 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.109 | 13.60 | .001 |
| 38 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.109 | 13.61 | .001 |
| 39 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.148 | 13.61 | .001 |
| 40 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.148 | 13.62 | .001 |
| 41 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.146 | 13.62 | .001 |
| 42 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.146 | 13.66 | .001 |
| 43 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.70 | .001 |
| 44 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.72 | .001 |
| 45 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.73 | .001 |
| 46 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.75 | .001 |
| 47 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.75 | .001 |
| 48 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.79 | .001 |
| 49 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.241 | 13.82 | .001 |
| 50 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.241 | 13.85 | .001 |
| 51 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.008 | 13.62 | .001 |
| 52 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.008 | 13.62 | .001 |
| 53 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.008 | 13.62 | .001 |
| 54 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.012 | 13.62 | .001 |

GROUP 9 (AVERAGE RIVER TEMPERATURE)
TEMPER

0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH NUMBER)
REACH REFQ T HEXN VEXN RFGDR

| REACH | REFQ | T | HEXN | VEXN | RFGDR |
|-------|------|------|------|------|-------|
| 1 | 50 | .045 | .516 | .353 | 20 |
| 2 | 50 | .018 | .516 | .353 | 20 |
| 3 | 50 | .127 | .516 | .353 | 20 |
| 4 | 50 | .127 | .516 | .353 | 20 |
| 5 | 50 | .127 | .516 | .353 | 20 |
| 6 | 50 | .127 | .516 | .353 | 20 |
| 7 | 50 | .127 | .516 | .353 | 20 |
| 8 | 50 | .127 | .516 | .353 | 20 |
| 9 | 50 | .127 | .516 | .353 | 20 |
| 10 | 50 | .448 | .516 | .353 | 20 |
| 11 | 50 | .543 | .550 | .346 | 20 |
| 12 | 50 | .622 | .550 | .346 | 20 |
| 13 | 50 | .297 | .550 | .346 | 20 |
| 14 | 50 | .308 | .540 | .266 | 20 |
| 15 | 50 | .004 | .540 | .266 | 20 |
| 16 | 50 | .284 | .551 | .326 | 20 |
| 17 | 50 | .202 | .551 | .326 | 20 |
| 18 | 50 | .176 | .551 | .326 | 20 |
| 19 | 50 | .154 | .551 | .326 | 20 |
| 20 | 50 | .704 | .551 | .326 | 20 |
| 21 | 50 | .044 | .551 | .326 | 20 |
| 22 | 50 | .147 | .551 | .326 | 20 |
| 23 | 50 | .022 | .463 | .362 | 20 |

| | | | | | |
|----|----|-------|------|------|----|
| 24 | 50 | .002 | .463 | .362 | 20 |
| 25 | 50 | .016 | .536 | .274 | 20 |
| 26 | 50 | .046 | .536 | .274 | 20 |
| 27 | 50 | .104 | .536 | .274 | 20 |
| 28 | 50 | .104 | .536 | .274 | 20 |
| 29 | 50 | .104 | .536 | .274 | 20 |
| 30 | 50 | .104 | .536 | .274 | 20 |
| 31 | 50 | .138 | .536 | .274 | 20 |
| 32 | 50 | .138 | .536 | .274 | 20 |
| 33 | 50 | .138 | .536 | .274 | 20 |
| 34 | 50 | .138 | .536 | .274 | 20 |
| 35 | 50 | 1.390 | .536 | .274 | 20 |
| 36 | 50 | 1.799 | .523 | .288 | 20 |
| 37 | 50 | 1.426 | .512 | .350 | 20 |
| 38 | 50 | .463 | .512 | .260 | 20 |
| 39 | 50 | .805 | .512 | .260 | 20 |
| 40 | 50 | 1.453 | .512 | .260 | 20 |
| 41 | 50 | 1.960 | .512 | .260 | 20 |
| 42 | 50 | 2.350 | .512 | .260 | 20 |
| 43 | 50 | 2.009 | .592 | .295 | 20 |
| 44 | 50 | .038 | .592 | .295 | 20 |
| 45 | 50 | .280 | .592 | .295 | 20 |
| 46 | 50 | .587 | .592 | .295 | 20 |
| 47 | 50 | 2.331 | .592 | .295 | 20 |
| 48 | 50 | 1.524 | .592 | .295 | 20 |
| 49 | 50 | 1.878 | .598 | .335 | 20 |
| 50 | 50 | .348 | .598 | .335 | 20 |
| 51 | 50 | .180 | .555 | .351 | 20 |
| 52 | 50 | .023 | .555 | .351 | 20 |
| 53 | 50 | .557 | .555 | .351 | 20 |
| 54 | 50 | .471 | .536 | .289 | 20 |

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)
 FNAME

ATHAJ89
 LSRJ89

March 1989 - no temperature correction for BOD

ATHABASCA RIVER MARCH 1989 GROUP 1

| NRT | NTRIB | MAXTR | MAXRI | MAXPT | NSTP | NVAR |
|-----|-------|-------|-------|-------|------|------|
| 54 | 1 | 4 | 50 | 50 | 23 | 9 |

GROUP 2 (ONE LINE FOR EACH REACH)

| IRCH | UP1 | IUP2 | X | Q | QLD | SOURCE NAME |
|------|-----|------|------|-------|-------|------------------|
| 1 | 0 | 0 | 1.7 | 28 | 0.000 | |
| 2 | 1 | 0 | 0.8 | 26.98 | 1.02 | WELDWOOD<OPEN |
| 3 | 2 | 0 | 5.0 | 28.0 | 0.000 | |
| 4 | 3 | 0 | 5.0 | 28.0 | 0.000 | |
| 5 | 4 | 0 | 5.0 | 28.0 | 0.000 | |
| 6 | 5 | 0 | 5.0 | 28.0 | 0.000 | |
| 7 | 6 | 0 | 5.0 | 28.0 | 0.000 | |
| 8 | 7 | 0 | 5.0 | 28.0 | 0.000 | |
| 9 | 8 | 0 | 5.0 | 28.0 | 0.000 | |
| 10 | 9 | 0 | 18.6 | 28.0 | 0.000 | |
| 11 | 10 | 0 | 22.5 | 28.0 | 0.950 | OLDMANCR |
| 12 | 11 | 0 | 25.8 | 28.95 | 0.030 | SPRING1 |
| 13 | 12 | 0 | 13.3 | 28.98 | 5.520 | BERLAND R |
| 14 | 13 | 0 | 13.8 | 34.5 | 0.015 | SPRING2 |
| 15 | 14 | 0 | 0.2 | 34.52 | 0.173 | MARSH CR |
| 16 | 15 | 0 | 12.7 | 34.69 | 0.031 | PINE CR |
| 17 | 16 | 0 | 9.2 | 35.00 | 0.000 | |
| 18 | 17 | 0 | 8.0 | 35.00 | 0.020 | SPRING3 |
| 19 | 18 | 0 | 7.0 | 35.02 | 0.014 | TWO CREEK |
| 20 | 19 | 0 | 32.0 | 35.03 | 0.503 | WINDFALL |
| 21 | 20 | 0 | 2.0 | 35.53 | 0.000 | |
| 22 | 21 | 0 | 6.7 | 35.53 | 0.000 | |
| 23 | 22 | 0 | 1.1 | 35.53 | 0.923 | SAKWATAMAU |
| 24 | 23 | 0 | 0.1 | 36.45 | 4.630 | MCLEOD R |
| 25 | 24 | 0 | 0.8 | 40.96 | 0.124 | MILLAR WEST<OPEN |
| 26 | 25 | 0 | 2.8 | 41.08 | 0.000 | |
| 27 | 26 | 0 | 5.0 | 41.04 | 0.035 | WHITE STP |
| 28 | 27 | 0 | 5.0 | 41.08 | 0.000 | |
| 29 | 28 | 0 | 5.0 | 41.08 | 0.000 | |
| 30 | 29 | 0 | 6.1 | 41.08 | 0.000 | |
| 31 | 30 | 0 | 5.0 | 41.08 | 0.000 | |
| 32 | 31 | 0 | 5.0 | 41.08 | 0.000 | |
| 33 | 32 | 0 | 5.0 | 41.08 | 0.000 | |
| 34 | 33 | 0 | 5.0 | 41.08 | 0.000 | |
| 35 | 34 | 0 | 50.0 | 41.08 | 0.000 | |
| 36 | 35 | 0 | 44.6 | 41.08 | 0.590 | FREEMAN R |
| 37 | 36 | 0 | 31.5 | 41.67 | 0.000 | |
| 38 | 37 | 0 | 11.5 | 41.67 | 0.000 | |
| 39 | 38 | 0 | 20.0 | 41.67 | 2.91 | PEMBINA |
| 40 | 39 | 0 | 36.1 | 44.58 | 0.000 | |
| 41 | 40 | 54 | 48.7 | 67.28 | 0.000 | LESSER SLAVE |

| | | | | | | |
|----|----|---|------|-------|-------|-----------|
| 42 | 41 | 0 | 58.4 | 67.28 | 0.0 | UNKNOWN |
| 43 | 42 | 0 | 53.0 | 67.27 | 0.012 | ATHAB STP |
| 44 | 43 | 0 | 1.0 | 67.28 | 0.000 | |
| 45 | 44 | 0 | 7.4 | 67.28 | 0.000 | |
| 46 | 45 | 0 | 15.5 | 67.28 | 0.426 | LA BICHE |
| 47 | 46 | 0 | 61.5 | 67.71 | 0.022 | CALLING |
| 48 | 47 | 0 | 47.3 | 67.73 | 0.000 | |
| 49 | 48 | 0 | 58.3 | 67.73 | 0.154 | PELICAN |
| 50 | 49 | 0 | 10.8 | 67.88 | 0.272 | HOUSE |
| 51 | 0 | 0 | 8.0 | 22.7 | 0 | |
| 52 | 51 | 0 | 1.0 | 22.7 | 0 | |
| 53 | 52 | 0 | 24.7 | 22.7 | 0 | |
| 54 | 53 | 0 | 19.8 | 22.7 | 0 | |

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

| STNAM | INST |
|----------------|-------|
| ***** | ***** |
| WELDWOOD | 2 |
| OLDMAN CR | 11 |
| SPRING 1 | 12 |
| BERLAND R | 13 |
| SPRING2 | 14 |
| MARSH HEAD CR | 15 |
| PINE CR | 16 |
| SPRING 3 | 18 |
| TWO CREEK | 19 |
| WINDFALL CR | 20 |
| SAKWATAMAU R | 23 |
| MCLEOD R | 24 |
| MILLAR WEST | 25 |
| STP | 27 |
| FREEMAN R | 29 |
| PEMBINA R | 32 |
| LESSER SLAVE R | 41 |
| UNKNOWN | 42 |
| STP | 43 |
| LA BICHE R | 46 |
| CALLING R | 47 |
| PELICAN R | 49 |
| HOUSE R | 50 |

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. 7 CHARACTERS)

| RNAM |
|-----------------|
| ***** |
| ATHABASCA RIVER |

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

| TNAM | INTR |
|--------------|-------|
| ***** | ***** |
| LESSER SLAVE | 41 |

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

REACH XLD1 XLD2 XLD3 XLD4 XLD5 XLD6 XLD7 XLD8 XLD9

| | | | | | | | | | |
|----|--------|-------|-------|--------|------|-------|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 73.15 | 7.0 | 0 | 35.11 | 1.26 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 12.84 | 5.62 | 0 | 0.36 | 2.98 | 0 | 0 | 0 |
| 12 | 0 | 11.55 | 8.03 | 0 | 0.06 | 0.56 | 0 | 0 | 0 |
| 13 | 0 | 9.61 | 8.03 | 0 | 0.79 | 2.57 | 0 | 0 | 0 |
| 14 | 0 | 12.01 | 5.62 | 0 | 0.16 | 4.16 | 0 | 0 | 0 |
| 15 | 0 | 11.70 | 5.62 | 0 | 0.74 | 3.20 | 0 | 0 | 0 |
| 16 | 0 | 12.09 | 4.02 | 0 | 1.20 | 1.41 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 11.29 | 4.82 | 0 | 0.40 | 3.37 | 0 | 0 | 0 |
| 19 | 0 | 10.47 | 5.62 | 0 | 2.28 | 2.08 | 0 | 0 | 0 |
| 20 | 0 | 10.78 | 3.21 | 0 | 1.21 | 2.02 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 0 | 9.57 | 3.61 | 0 | 1.30 | 2.49 | 0 | 0 | 0 |
| 24 | 0 | 5.95 | 6.42 | 0 | 1.61 | 4.82 | 0 | 0 | 0 |
| 25 | 2450.8 | 7.3 | 0 | 1370.0 | 2.70 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 63.2 | 4.4 | 0 | 37.9 | 0.88 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | 0 | 9.45 | 9.64 | 0 | 1.74 | 7.32 | 0 | 0 | 0 |
| 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 0 | 1.46 | 11.24 | 0 | 0.95 | 7.31 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 119.3 | 2.6 | 0 | 155.1 | 2.7 | 0 | 0 | 0 | 0 |
| 44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | 0 | 3.17 | 16.86 | 0 | 1.46 | 10.62 | 0 | 0 | 0 |
| 47 | 0 | 11.63 | 4.82 | 0 | 3.36 | 2.94 | 0 | 0 | 0 |
| 48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|----|---|-------|-------|---|------|------|---|---|---|
| 49 | 0 | 13.02 | 12.85 | 0 | 1.16 | 6.30 | 0 | 0 | 0 |
| 50 | 0 | 9.7 | 4.82 | 0 | 0.91 | 3.37 | 0 | 0 | 0 |
| 51 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

GROUP 7 (ONE LINE FOR EACH HEADWATER)

| | X01 | X02 | X03 | X04 | X05 | X06 | X07 | X08 | X09 |
|-------|-----|-------|------|-----|-------|------|-----|-----|-----|
| ***** | | | | | | | | | |
| | 0.0 | 11.14 | 8.03 | 0 | 0.356 | 5.22 | 0 | 0 | 0 |
| | 0.0 | 13.02 | 3.21 | 0 | 1.03 | 1.54 | 0 | 0 | 0 |

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

| REACH | XK1 | XK2 | XK3 | XK4 | XM1 | XM2 | XM3 | XRES | XDS | XP |
|-------|-------|--------|------|------|-----|-----|-----|-------|-------|------|
| 1 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.001 | 12.98 | .001 |
| 2 | 0.036 | 0.567 | .229 | .026 | .00 | .00 | .00 | 0.327 | 13.02 | .001 |
| 3 | 0.036 | 0.0006 | .252 | .026 | .00 | .00 | .00 | 0.312 | 13.04 | .001 |
| 4 | 0.036 | 0.0006 | .121 | .026 | .00 | .00 | .00 | 0.291 | 13.04 | .001 |
| 5 | 0.036 | 0.0006 | .084 | .026 | .00 | .00 | .00 | 0.270 | 13.04 | .001 |
| 6 | 0.036 | 0.0006 | .065 | .026 | .00 | .00 | .00 | 0.249 | 13.04 | .001 |
| 7 | 0.036 | 0.0006 | .054 | .026 | .00 | .00 | .00 | 0.230 | 13.04 | .001 |
| 8 | 0.036 | 0.0006 | .046 | .026 | .00 | .00 | .00 | 0.213 | 13.04 | .001 |
| 9 | 0.036 | 0.0006 | .040 | .026 | .00 | .00 | .00 | 0.194 | 13.04 | .001 |
| 10 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.145 | 13.06 | .001 |
| 11 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.118 | 13.07 | .001 |
| 12 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.098 | 13.11 | .001 |
| 13 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.084 | 13.15 | .001 |
| 14 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.095 | 13.17 | .001 |
| 15 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.087 | 13.19 | .001 |
| 16 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.081 | 13.21 | .001 |
| 17 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.059 | 13.25 | .001 |
| 18 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.042 | 13.27 | .001 |
| 19 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.025 | 13.29 | .001 |
| 20 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.025 | 13.30 | .001 |
| 21 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.025 | 13.33 | .001 |
| 22 | 0.036 | 0.567 | .001 | .026 | .00 | .00 | .00 | 0.472 | 13.37 | .001 |
| 23 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.37 | .001 |
| 24 | 0.036 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.521 | 13.37 | .001 |
| 25 | 0.048 | 0.0006 | .229 | .026 | .00 | .00 | .00 | 0.388 | 13.40 | .001 |
| 26 | 0.048 | 0.0006 | .189 | .026 | .00 | .00 | .00 | 0.276 | 13.43 | .001 |
| 27 | 0.026 | 0.0006 | .154 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 28 | 0.026 | 0.0006 | .097 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 29 | 0.026 | 0.0006 | .073 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 30 | 0.026 | 0.0006 | .068 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 31 | 0.026 | 0.0006 | .047 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 32 | 0.026 | 0.0006 | .041 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 33 | 0.026 | 0.0006 | .036 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 34 | 0.026 | 0.0006 | .033 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 35 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.157 | 13.49 | .001 |

| | | | | | | | | | | |
|----|-------|--------|------|------|-----|-----|-----|-------|-------|------|
| 36 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.109 | 13.50 | .001 |
| 37 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.109 | 13.60 | .001 |
| 38 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.109 | 13.61 | .001 |
| 39 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.148 | 13.61 | .001 |
| 40 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.148 | 13.62 | .001 |
| 41 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.146 | 13.62 | .001 |
| 42 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.146 | 13.66 | .001 |
| 43 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.70 | .001 |
| 44 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.72 | .001 |
| 45 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.73 | .001 |
| 46 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.75 | .001 |
| 47 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.75 | .001 |
| 48 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.79 | .001 |
| 49 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.241 | 13.82 | .001 |
| 50 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.241 | 13.85 | .001 |
| 51 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.008 | 13.62 | .001 |
| 52 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.008 | 13.62 | .001 |
| 53 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.008 | 13.62 | .001 |
| 54 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.012 | 13.62 | .001 |

GROUP 9 (AVERAGE RIVER TEMPERATURE)
TEMPER

0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH NUMBER)
REACH REFQ T HEXN VEXN RFGDR

| REACH | REFQ | T | HEXN | VEXN | RFGDR |
|-------|------|------|------|------|-------|
| 1 | 50 | .045 | .516 | .353 | 20 |
| 2 | 50 | .018 | .516 | .353 | 20 |
| 3 | 50 | .127 | .516 | .353 | 20 |
| 4 | 50 | .127 | .516 | .353 | 20 |
| 5 | 50 | .127 | .516 | .353 | 20 |
| 6 | 50 | .127 | .516 | .353 | 20 |
| 7 | 50 | .127 | .516 | .353 | 20 |
| 8 | 50 | .127 | .516 | .353 | 20 |
| 9 | 50 | .127 | .516 | .353 | 20 |
| 10 | 50 | .448 | .516 | .353 | 20 |
| 11 | 50 | .543 | .550 | .346 | 20 |
| 12 | 50 | .622 | .550 | .346 | 20 |
| 13 | 50 | .297 | .550 | .346 | 20 |
| 14 | 50 | .308 | .540 | .266 | 20 |
| 15 | 50 | .004 | .540 | .266 | 20 |
| 16 | 50 | .284 | .551 | .326 | 20 |
| 17 | 50 | .202 | .551 | .326 | 20 |
| 18 | 50 | .176 | .551 | .326 | 20 |
| 19 | 50 | .154 | .551 | .326 | 20 |
| 20 | 50 | .704 | .551 | .326 | 20 |
| 21 | 50 | .044 | .551 | .326 | 20 |
| 22 | 50 | .147 | .551 | .326 | 20 |
| 23 | 50 | .022 | .463 | .362 | 20 |

| | | | | | |
|----|----|-------|------|------|----|
| 24 | 50 | .002 | .463 | .362 | 20 |
| 25 | 50 | .016 | .536 | .274 | 20 |
| 26 | 50 | .046 | .536 | .274 | 20 |
| 27 | 50 | .104 | .536 | .274 | 20 |
| 28 | 50 | .104 | .536 | .274 | 20 |
| 29 | 50 | .104 | .536 | .274 | 20 |
| 30 | 50 | .104 | .536 | .274 | 20 |
| 31 | 50 | .138 | .536 | .274 | 20 |
| 32 | 50 | .138 | .536 | .274 | 20 |
| 33 | 50 | .138 | .536 | .274 | 20 |
| 34 | 50 | .138 | .536 | .274 | 20 |
| 35 | 50 | 1.390 | .536 | .274 | 20 |
| 36 | 50 | 1.799 | .523 | .288 | 20 |
| 37 | 50 | 1.426 | .512 | .350 | 20 |
| 38 | 50 | .463 | .512 | .260 | 20 |
| 39 | 50 | .805 | .512 | .260 | 20 |
| 40 | 50 | 1.453 | .512 | .260 | 20 |
| 41 | 50 | 1.960 | .512 | .260 | 20 |
| 42 | 50 | 2.350 | .512 | .260 | 20 |
| 43 | 50 | 2.009 | .592 | .295 | 20 |
| 44 | 50 | .038 | .592 | .295 | 20 |
| 45 | 50 | .280 | .592 | .295 | 20 |
| 46 | 50 | .587 | .592 | .295 | 20 |
| 47 | 50 | 2.331 | .592 | .295 | 20 |
| 48 | 50 | 1.524 | .592 | .295 | 20 |
| 49 | 50 | 1.878 | .598 | .335 | 20 |
| 50 | 50 | .348 | .598 | .335 | 20 |
| 51 | 50 | .180 | .555 | .351 | 20 |
| 52 | 50 | .023 | .555 | .351 | 20 |
| 53 | 50 | .557 | .555 | .351 | 20 |
| 54 | 50 | .471 | .536 | .289 | 20 |

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)

FNAM

ATHAM89

LSRM89

Winter 1993 - no temperature correction for BOD

ATHABASCA RIVER - WINTER 1993 GROUP 1

| NRT | NTRIB | MAXTR | MAXRI | MAXPT | NSTP | NVAR |
|-----|-------|-------|-------|-------|------|------|
| 54 | 1 | 4 | 50 | 50 | 23 | 9 |

GROUP 2 (ONE LINE FOR EACH REACH)

| IRCH | UP1 | UP2 | X | Q | QLD | SOURCE NAME |
|------|-----|-----|------|-------|-------|---------------|
| 1 | 0 | 0 | 1.7 | 28.7 | 0.000 | |
| 2 | 1 | 0 | 0.8 | 27.48 | 1.216 | WELWOOD<OPEN |
| 3 | 2 | 0 | 5.0 | 28.7 | 0.000 | |
| 4 | 3 | 0 | 5.0 | 28.7 | 0.000 | |
| 5 | 4 | 0 | 5.0 | 28.7 | 0.000 | |
| 6 | 5 | 0 | 5.0 | 28.7 | 0.000 | |
| 7 | 6 | 0 | 5.0 | 28.7 | 0.000 | |
| 8 | 7 | 0 | 5.0 | 28.7 | 0.000 | |
| 9 | 8 | 0 | 5.0 | 28.7 | 0.000 | |
| 10 | 9 | 0 | 18.6 | 28.7 | 0.000 | |
| 11 | 10 | 0 | 22.5 | 28.7 | 1.00 | OLDMAN CR |
| 12 | 11 | 0 | 25.8 | 29.7 | 0.022 | SPRING 1 |
| 13 | 12 | 0 | 13.3 | 29.72 | 7.8 | BERLAND R |
| 14 | 13 | 0 | 13.8 | 37.52 | 0.018 | SPRING 2 |
| 15 | 14 | 0 | 0.2 | 37.54 | 0.126 | MARSH CR |
| 16 | 15 | 0 | 12.7 | 37.54 | 0.165 | PINECR |
| 17 | 16 | 0 | 9.2 | 37.71 | 0.000 | |
| 18 | 17 | 0 | 8.0 | 37.71 | 0.018 | SPRING 3 |
| 19 | 18 | 0 | 7.0 | 37.72 | 0.012 | TWO CREEK |
| 20 | 19 | 0 | 32.0 | 37.74 | 0.474 | WINDFALL |
| 21 | 20 | 0 | 2.0 | 38.21 | 0.000 | |
| 22 | 21 | 0 | 0.8 | 38.03 | 0.181 | ANC |
| 23 | 22 | 0 | 7.0 | 38.21 | 0.639 | SAKWATAMAU |
| 24 | 23 | 0 | 0.1 | 38.85 | 5.13 | McLEOD R |
| 25 | 24 | 0 | 0.8 | 43.88 | 0.110 | MILLARW.<OPEN |
| 26 | 25 | 0 | 2.8 | 43.99 | 0.000 | |
| 27 | 26 | 0 | 5.0 | 43.96 | 0.035 | WHITE STP |
| 28 | 27 | 0 | 5.0 | 43.99 | 0.000 | |
| 29 | 28 | 0 | 5.0 | 43.99 | 0.000 | |
| 30 | 29 | 0 | 6.1 | 43.99 | 0.000 | |
| 31 | 30 | 0 | 5.0 | 43.99 | 0.000 | |
| 32 | 31 | 0 | 5.0 | 43.99 | 0.000 | |
| 33 | 32 | 0 | 5.0 | 43.99 | 0.000 | |
| 34 | 33 | 0 | 5.0 | 43.99 | 0.000 | |
| 35 | 34 | 0 | 50.0 | 43.99 | 0.000 | |
| 36 | 35 | 0 | 44.6 | 43.99 | 0.357 | FREEMAN R |
| 37 | 36 | 0 | 31.5 | 44.35 | 0.000 | |
| 38 | 37 | 0 | 11.5 | 44.35 | 0.000 | |
| 39 | 38 | 0 | 20.0 | 44.35 | 1.56 | PEMBINA |
| 40 | 39 | 0 | 36.1 | 45.91 | 0.000 | |
| 41 | 40 | 54 | 48.7 | 45.91 | 0.000 | LESSER SLAVE |

| | | | | | | |
|----|----|---|------|-------|-------|-----------|
| 42 | 41 | 0 | 58.4 | 60.01 | 0.000 | |
| 43 | 42 | 0 | 53.0 | 59.99 | 0.013 | ATHAB STP |
| 44 | 43 | 0 | 1.0 | 60.01 | 0.000 | |
| 45 | 44 | 0 | 7.4 | 60.01 | 0.000 | |
| 46 | 45 | 0 | 15.5 | 60.01 | 0.067 | LA BICHE |
| 47 | 46 | 0 | 61.5 | 60.08 | 0.023 | CALLING |
| 48 | 47 | 0 | 47.3 | 60.10 | 0.000 | |
| 49 | 48 | 0 | 58.3 | 60.10 | 0.063 | PELICAN |
| 50 | 49 | 0 | 10.8 | 60.16 | 0.11 | HOUSE |
| 51 | 0 | 0 | 8.0 | 13.0 | 0.028 | SLP STP |
| 52 | 51 | 0 | 0.8 | 13.8 | 0.048 | SLPC |
| 53 | 52 | 0 | 24.9 | 14.1 | 0.000 | |
| 54 | 53 | 0 | 19.8 | 14.1 | 0.000 | |

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

| STNAM | INST |
|----------------|------|
| ***** | |
| WELDWOOD | 2 |
| OLDMAN CR | 11 |
| SPRING1 | 12 |
| BERLAND R | 13 |
| SPRING 2 | 14 |
| MARSH HEAD CR | 15 |
| PINE CR | 16 |
| SPRING 3 | 18 |
| TWO CREEK | 19 |
| WINDFALL CR | 20 |
| ANC | 22 |
| SAKWATAMAU | 23 |
| McLEOD R | 24 |
| MILLAR WEST | 25 |
| STP | 27 |
| FREEMAN R | 36 |
| PEMBINA R | 39 |
| LESSER SLAVE R | 41 |
| STP | 43 |
| LA BICHE R | 46 |
| CALLING R | 47 |
| PELICAN R | 49 |
| HOUSE R | 50 |

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. SEVEN CHARACTERS)

| RNAM |
|-----------------|
| ***** |
| ATHABASCA RIVER |

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

| TNAM | INTR |
|--------------|------|
| ***** | |
| LESSER SLAVE | 41 |

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

| REACH | XLD1 | XLD2 | XLD3 | XLD4 | XLD5 | XLD6 | XLD7 | XLD8 | XLD9 |
|-------|--------|-------|-------|--------|------|------|------|------|------|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 78.05 | 6.2 | 0 | 16.39 | 1.12 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 12.71 | 12.37 | 0 | 0.36 | 6.56 | 0 | 0 | 0 |
| 12 | 0 | 11.59 | 8.43 | 0 | 0.06 | 0.59 | 0 | 0 | 0 |
| 13 | 0 | 9.99 | 8.03 | 0 | 0.82 | 2.57 | 0 | 0 | 0 |
| 14 | 0 | 11.86 | 0.57 | 0 | 0.15 | 0.42 | 0 | 0 | 0 |
| 15 | 0 | 12.06 | 0.80 | 0 | 0.76 | 0.46 | 0 | 0 | 0 |
| 16 | 0 | 11.30 | 3.21 | 0 | 1.11 | 1.12 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 11.02 | 3.21 | 0 | 0.39 | 2.24 | 0 | 0 | 0 |
| 19 | 0 | 9.07 | 7.63 | 0 | 1.98 | 2.82 | 0 | 0 | 0 |
| 20 | 0 | 11.04 | 8.19 | 0 | 1.24 | 5.16 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 296.40 | 8.20 | 0 | 234.16 | 1.31 | 0 | 0 | 0 | 0 |
| 23 | 0 | 8.10 | 0.80 | 0 | 1.10 | 0.55 | 0 | 0 | 0 |
| 24 | 0 | 6.27 | 0.80 | 0 | 1.69 | 0.59 | 0 | 0 | 0 |
| 25 | 78.69 | 6.0 | 0 | 36.98 | 0.96 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 187.20 | 5.95 | 0 | 112.32 | 1.19 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | 0 | 8.58 | 7.15 | 0 | 1.58 | 5.43 | 0 | 0 | 0 |
| 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 0 | 1.82 | 10.43 | 0 | 1.18 | 7.04 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 101.40 | 0.60 | 0 | 131.82 | 0.60 | 0 | 0 | 0 | 0 |
| 44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | 0 | 3.55 | 8.19 | 0 | 1.64 | 5.16 | 0 | 0 | 0 |
| 47 | 0 | 5.12 | 12.05 | 0 | 1.48 | 7.35 | 0 | 0 | 0 |
| 48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|----|--------|-------|-------|--------|------|-------|---|---|---|
| 49 | 0 | 10.12 | 28.91 | 0 | 0.90 | 14.17 | 0 | 0 | 0 |
| 50 | 0 | 10.52 | 0.80 | 0 | 0.99 | 0.56 | 0 | 0 | 0 |
| 51 | 131.04 | 2.0 | 0 | 52.42 | 2.2 | 0 | 0 | 0 | 0 |
| 52 | 524.60 | 6.3 | 0 | 293.78 | 1.20 | 0 | 0 | 0 | 0 |
| 53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

GROUP 7 (ONE LINE FOR EACH HEADWATER)

| | X01 | X02 | X03 | X04 | X05 | X06 | X07 | X08 | X09 |
|-------|-----|-------|-------|-----|-------|------|-----|-----|-----|
| ***** | 0.0 | 11.86 | 6.42 | 0 | 0.380 | 4.18 | 0 | 0 | 0 |
| | 0.0 | 13.14 | 10.44 | 0 | 1.04 | 5.01 | 0 | 0 | 0 |

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

| REACH | XK1 | XK2 | XK3 | XK4 | XM1 | XM2 | XM3 | XRES | XDS | XP |
|-------|-------|--------|------|------|-----|-----|-----|-------|-------|------|
| 1 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.001 | 12.98 | .001 |
| 2 | 0.035 | 0.567 | .229 | .026 | .00 | .00 | .00 | 0.327 | 13.02 | .001 |
| 3 | 0.035 | 0.0006 | .252 | .026 | .00 | .00 | .00 | 0.312 | 13.04 | .001 |
| 4 | 0.035 | 0.0006 | .121 | .026 | .00 | .00 | .00 | 0.291 | 13.04 | .001 |
| 5 | 0.035 | 0.0006 | .084 | .026 | .00 | .00 | .00 | 0.270 | 13.04 | .001 |
| 6 | 0.035 | 0.0006 | .065 | .026 | .00 | .00 | .00 | 0.249 | 13.04 | .001 |
| 7 | 0.035 | 0.0006 | .054 | .026 | .00 | .00 | .00 | 0.230 | 13.04 | .001 |
| 8 | 0.035 | 0.0006 | .046 | .026 | .00 | .00 | .00 | 0.213 | 13.04 | .001 |
| 9 | 0.035 | 0.0006 | .040 | .026 | .00 | .00 | .00 | 0.194 | 13.04 | .001 |
| 10 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.145 | 13.06 | .001 |
| 11 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.118 | 13.07 | .001 |
| 12 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.098 | 13.11 | .001 |
| 13 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.084 | 13.15 | .001 |
| 14 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.095 | 13.17 | .001 |
| 15 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.087 | 13.19 | .001 |
| 16 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.081 | 13.21 | .001 |
| 17 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.059 | 13.25 | .001 |
| 18 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.042 | 13.27 | .001 |
| 19 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.025 | 13.29 | .001 |
| 20 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.025 | 13.30 | .001 |
| 21 | 0.035 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.025 | 13.33 | .001 |
| 22 | 0.032 | 0.567 | .229 | .026 | .00 | .00 | .00 | 0.472 | 13.37 | .001 |
| 23 | 0.032 | 0.0006 | .290 | .026 | .00 | .00 | .00 | 0.521 | 13.37 | .001 |
| 24 | 0.032 | 0.0006 | .006 | .026 | .00 | .00 | .00 | 0.521 | 13.37 | .001 |
| 25 | 0.026 | 0.567 | .169 | .026 | .00 | .00 | .00 | 0.388 | 13.40 | .001 |
| 26 | 0.026 | 0.0006 | .142 | .026 | .00 | .00 | .00 | 0.276 | 13.43 | .001 |
| 27 | 0.026 | 0.0006 | .124 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 28 | 0.026 | 0.0006 | .082 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 29 | 0.026 | 0.0006 | .063 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 30 | 0.026 | 0.0006 | .062 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 31 | 0.026 | 0.0006 | .043 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 32 | 0.026 | 0.0006 | .038 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 33 | 0.026 | 0.0006 | .033 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 34 | 0.026 | 0.0006 | .031 | .026 | .00 | .00 | .00 | 0.157 | 13.46 | .001 |
| 35 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.157 | 13.49 | .001 |

| | | | | | | | | | | |
|----|-------|--------|------|------|-----|-----|-----|-------|-------|------|
| 36 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.109 | 13.50 | .001 |
| 37 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.109 | 13.60 | .001 |
| 38 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.109 | 13.61 | .001 |
| 39 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.148 | 13.61 | .001 |
| 40 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.148 | 13.62 | .001 |
| 41 | 0.022 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.146 | 13.62 | .001 |
| 42 | 0.022 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.146 | 13.66 | .001 |
| 43 | 0.022 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.70 | .001 |
| 44 | 0.022 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.72 | .001 |
| 45 | 0.022 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.73 | .001 |
| 46 | 0.022 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.75 | .001 |
| 47 | 0.022 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.75 | .001 |
| 48 | 0.022 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.174 | 13.79 | .001 |
| 49 | 0.022 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.241 | 13.82 | .001 |
| 50 | 0.022 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.241 | 13.85 | .001 |
| 51 | 0.026 | 0.0006 | .001 | .026 | .00 | .00 | .00 | 0.008 | 13.62 | .001 |
| 52 | 0.018 | 0.567 | .391 | .026 | .00 | .00 | .00 | 0.008 | 13.62 | .001 |
| 53 | 0.018 | 0.0006 | .738 | .026 | .00 | .00 | .00 | 0.008 | 13.62 | .001 |
| 54 | 0.018 | 0.0006 | .238 | .026 | .00 | .00 | .00 | 0.012 | 13.62 | .001 |

GROUP 9 (AVERAGE RIVER TEMPERATURE)
 TEMPER

 0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH#)

| REACH | REFQ | T | HEXN | VEYN | RFDGR |
|-------|------|------|------|------|-------|
| 1 | 50 | .045 | .516 | .353 | 20 |
| 2 | 50 | .018 | .516 | .353 | 20 |
| 3 | 50 | .127 | .516 | .353 | 20 |
| 4 | 50 | .127 | .516 | .353 | 20 |
| 5 | 50 | .127 | .516 | .353 | 20 |
| 6 | 50 | .127 | .516 | .353 | 20 |
| 7 | 50 | .127 | .516 | .353 | 20 |
| 8 | 50 | .127 | .516 | .353 | 20 |
| 9 | 50 | .127 | .516 | .353 | 20 |
| 10 | 50 | .448 | .516 | .353 | 20 |
| 11 | 50 | .543 | .550 | .346 | 20 |
| 12 | 50 | .622 | .550 | .346 | 20 |
| 13 | 50 | .297 | .550 | .346 | 20 |
| 14 | 50 | .308 | .540 | .266 | 20 |
| 15 | 50 | .004 | .540 | .266 | 20 |
| 16 | 50 | .284 | .551 | .326 | 20 |
| 17 | 50 | .202 | .551 | .326 | 20 |
| 18 | 50 | .176 | .551 | .326 | 20 |
| 19 | 50 | .154 | .551 | .326 | 20 |
| 20 | 50 | .704 | .551 | .326 | 20 |
| 21 | 50 | .044 | .551 | .326 | 20 |
| 22 | 50 | .018 | .551 | .326 | 20 |
| 23 | 50 | .151 | .463 | .362 | 20 |

| | | | | | |
|----|----|-------|------|------|----|
| 24 | 50 | .002 | .463 | .362 | 20 |
| 25 | 50 | .016 | .536 | .274 | 20 |
| 26 | 50 | .046 | .536 | .274 | 20 |
| 27 | 50 | .104 | .536 | .274 | 20 |
| 28 | 50 | .104 | .536 | .274 | 20 |
| 29 | 50 | .104 | .536 | .274 | 20 |
| 30 | 50 | .104 | .536 | .274 | 20 |
| 31 | 50 | .138 | .536 | .274 | 20 |
| 32 | 50 | .138 | .536 | .274 | 20 |
| 33 | 50 | .138 | .536 | .274 | 20 |
| 34 | 50 | .138 | .536 | .274 | 20 |
| 35 | 50 | 1.390 | .536 | .274 | 20 |
| 36 | 50 | 1.799 | .523 | .288 | 20 |
| 37 | 50 | 1.426 | .523 | .288 | 20 |
| 38 | 50 | 0.463 | .523 | .288 | 20 |
| 39 | 50 | 0.805 | .512 | .260 | 20 |
| 40 | 50 | 1.453 | .512 | .260 | 20 |
| 41 | 50 | 1.960 | .512 | .260 | 20 |
| 42 | 50 | 2.350 | .512 | .260 | 20 |
| 43 | 50 | 2.009 | .592 | .295 | 20 |
| 44 | 50 | 0.038 | .592 | .295 | 20 |
| 45 | 50 | 0.280 | .592 | .295 | 20 |
| 46 | 50 | 0.587 | .592 | .295 | 20 |
| 47 | 50 | 2.331 | .592 | .295 | 20 |
| 48 | 50 | 1.524 | .592 | .295 | 20 |
| 49 | 50 | 1.878 | .598 | .335 | 20 |
| 50 | 50 | 0.348 | .598 | .335 | 20 |
| 51 | 50 | 0.180 | .555 | .351 | 20 |
| 52 | 50 | 0.018 | .555 | .351 | 20 |
| 53 | 50 | 0.561 | .555 | .351 | 20 |
| 54 | 50 | 0.471 | .536 | .289 | 20 |

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)

FNAM

ATHA93

LSR93

