THE EFFECT OF THE DICKSON DAM ON WATER QUALITY AND ZOOBENTHOS OF THE RED DEER RIVER

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OVERVIEW

The objective of this report is to summarize results of a five-year study conducted on the Red Deer River to assess the effects of impounding the river behind Dickson Dam. It also presents results of a study on Gleniffer Lake, the reservoir created when the dam was constructed in 1983. Results from three long-term monitoring sites on the river are also included.

The Red Deer River is a major tributary of the South Saskatchewan River. It originates in the Rocky Mountains within Banff National Park and flows eastward to its confluence with the South Saskatchewan River near the Alberta-Saskatchewan border.

In the mid-1970's, Alberta Environment began studies to assess the feasibility of damming the river to augment low winter flows, thereby providing a reliable, year-round water supply for future industrial and municipal growth. It was expected that creation of a reservoir upstream of Red Deer would have additional benefits, including flood control, improved water quality of the river and the creation of a recreational resource.

Historically, the principal concern with respect to water quality of the Red Deer River was the low levels of dissolved oxygen during the winter. It was anticipated that increased flows from the reservoir during the winter would be sufficient to maintain dissolved oxygen concentrations in the river above 5 mg/L, the Alberta Surface Water Quality Objective concentration.

In 1983 the Planning Division of Alberta Environment coordinated studies to assess the environmental effects of the dam on the river. The Environmental Assessment Division initiated a five-year study to monitor the effects of flow regulation on water quality in the Red Deer River and to document the water quality of Gleniffer Lake.

During the five-year study water and biological samples were collected biweekly or monthly from the Red Deer River at one site upstream and four sites downstream of Gleniffer Lake. These data were used to evaluate water quality changes along the Red Deer River. Samples were also taken from Gleniffer Lake to describe its limnology, document changes in fertility and assess the retention and release of constituents by processes within the lake. Monthly chemical and biological data from three long-term river monitoring sites (upstream of Red Deer, at Drumheller and at the Alberta-Saskatchewan border) were used to determine whether the river's water quality changed after Glennifer Lake was filled.

At full storage level (948 m above sea level), Gleniffer Lake has a surface area of 17.6 km^2, is 11 km long and 2 km wide, and contains 205 million cubic meters of water. The reservoir is 33 m deep at its deepest point. In the spring of most years the reservoir is drawn down approximately 7 to 9 m, then is allowed to refill during mountain runoff. The residence time of water in the reservoir is short and averages 70 days. In years of high flow in the Red Deer River it can be as short as 30 days.

Gleniffer Lake is a well-buffered, oligotrophic, freshwater reservoir. The west end of the lake is frequently mixed by winds and inflowing river currents; it tends to be weakly thermally stratified during July and August and remains well oxygenated throughout the summer. The deeper central and eastern basins of the reservoir tend to be thermally stratified during the summer and the hypolimnetic water undergoes some oxygen depletion. Nutrient and chlorophyll *a* levels in the reservoir are low, and there is no evidence for leaching of nutrients or other inorganic substances from the flooded soils. Since 1984 however, concentrations of dissolved organic carbon have increased in the reservoir and in the river below the dam. This increase may be a result of leaching from flooded soils and breakdown of plant material.

Flow regulation has affected a number of physical, chemical, and biological variables in the Red Deer River. The main influence of the dam has been on the redistribution of discharge throughout the year; post-impoundment flow rates are lower during the summer and higher during the winter compared to pre-impoundment flow rates.

Hypolimnetic discharge from the deeper waters of Gleniffer Lake has reduced seasonal and daily temperature fluctuations in the section of the river from the dam to at least Innisfail, 20 km below the dam. Water temperatures immediately downstream of the dam are 1-3°C higher in winter and up to 6°C lower in summer compared to the site immediately upstream. But there have been no statistically significant changes between pre- (1978-83) and post-impoundment (1984-89) median levels of either flow or temperature at the Red Deer long-term monitoring site.

Flow regulation has increased the dissolved oxygen content of the Red Deer River. Median post-impoundment dissolved oxygen concentrations are significantly higher than pre-impoundment levels as far downstream as Drumheller. As expected, minimum winter dissolved oxygen concentrations have increased along the entire length of the river, although post-impoundment concentrations below 5 mg/L are still recorded occasionally downstream of the city of Red Deer, including at the Alberta-Saskatchewan border.

As in many reservoirs, particulate matter settles out in Gleniffer Lake. Consequently, turbidity and levels of non-filterable residue and constituents that adsorb to particulate matter (e.g. some nutrients, metals, and trace elements) are lower immediately below the dam than above the reservoir. However, that reduction appears to be confined to a short distance below the dam. Further downstream, concentrations of many particle-bound substances increase rapidly to levels comparable to those recorded upstream of Gleniffer Lake.

Flow regulation has resulted in lower levels of calcium, magnesium, bicarbonate, sulphate, total dissolved solids, conductance, alkalinity and hardness as far downstream as the Alberta-Saskatchewan border. Calcium carbonate and magnesium carbonate co-precipitation within Gleniffer Lake is the probable cause for decreased levels of most of these variables, although the cause for the decline in sulphate concentrations is not well understood. In addition, seasonal fluctuations of these variables have been reduced by the regulation of flow.

Populations of phytoplankton and attached algae are considerably higher immediately downstream of the dam than at a site upstream of Gleniffer Lake. Increased algal growth below the dam is probably a result of the more stable post-impoundment temperatures and flow regime, and reduced turbidity in the Red Deer River.

Flow regulation has noticeably altered the zoobenthic communities of the Red Deer River, particularly at the site 4 km downstream of the dam. At that site, total invertebrate numbers have increased dramatically, whereas the diversity of zoobenthic organisms has decreased. Oligochaetes (aquatic earthworms) and chironomids (midges) have become numerically important, and numbers of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) have declined. Changes in the Red Deer River zoobenthos are attributed to habitat and food base alteration, and temperature and water quality changes that are a result of flow regulation.

Post-impoundment changes in water chemistry, as indicated by trend analyses, were often small, and as a consequence, statistical differences in data from the long-term monitoring sites may not be detectable for some time. Indeed, as the reservoir matures, downstream water quality may continue to change gradually well beyond the 5-year time frame of this study.

Data concerning mercury accumulation in fish tissue are not reported herein, but are presented in reports produced by the Alberta Environmental Centre (Alberta Environmental Center 1984; 1989).

ACKNOWLEDGMENTS

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Water samples were analyzed at Chemex Labs Alberta Ltd., the Alberta Provincial Laboratory of Public Health, the Millwoods facility of EQMB (M. McCutcheon), and the Alberta Environmental Centre (F. Dieken and D. Smillie).

Zoobenthos sampling, sorting, and identification was carried out by W. Anderson, J. Willis, M. Mychajluk, R. Saunders, and A. Nimmo.

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1.0 INTRODUCTION

The Red Deer River is a major tributary of the South Saskatchewan River. It originates in the Rocky Mountains within Banff National Park and flows eastward to its confluence with the South Saskatchewan River near the Alberta-Saskatchewan border (Figure 1). There are two cities along the river, Red Deer in the central part of the province, and Drumheller to the south and east.

In the mid-1970s, Alberta Environment began studies to assess the feasibility of damming the river to augment low winter flows, thereby providing a reliable, year-round water supply for future industrial and municipal growth. It was expected that creation of a reservoir upstream of Red Deer would have additional benefits, including an improvement in the water quality of the river and the creation of a recreational resource (Alberta Environment 1975). Historically, the principal concern with respect to the water quality of the Red Deer River was the low levels of dissolved oxygen during the winter (Hrabar 1974). Dissolved oxygen concentrations began to decline in the river below Sundre and continued to decline downstream to the Alberta-Saskatchewan border. The Dickson Dam was completed in the summer of 1983 and is operated by Alberta Environment; Gleniffer Lake is the reservoir behind the dam. It was anticipated that increased flows from the reservoir during the winter would be sufficient to maintain dissolved oxygen concentrations in the river above 5 mg/L, the Alberta Surface Water Quality Objective concentration (Alberta Environment 1977).

The objective of this report is to document the effects of flow regulation on water quality and benthic invertebrate communities of the Red Deer River. Data collected from 1978 to 1989 at three long-term monitoring sites on the river and from 1983 to 1988 at sites upstream and downstream of, and within Gleniffer Lake were evaluated to assess the effect of the dam on the physical, chemical, and biological characteristics of the river.

2.0 METHODS

2.1 STUDY DESIGN

The effect of the Dickson Dam on water quality of the Red Deer River was investigated using (1) data collected from 1978 to 1989 at long-term monitoring sites upstream of the city of Red Deer, near Drumheller, and near the Alberta-Saskatchewan border at Bindloss; and (2) synoptic survey data collected from 1983 to 1988 at sites upstream

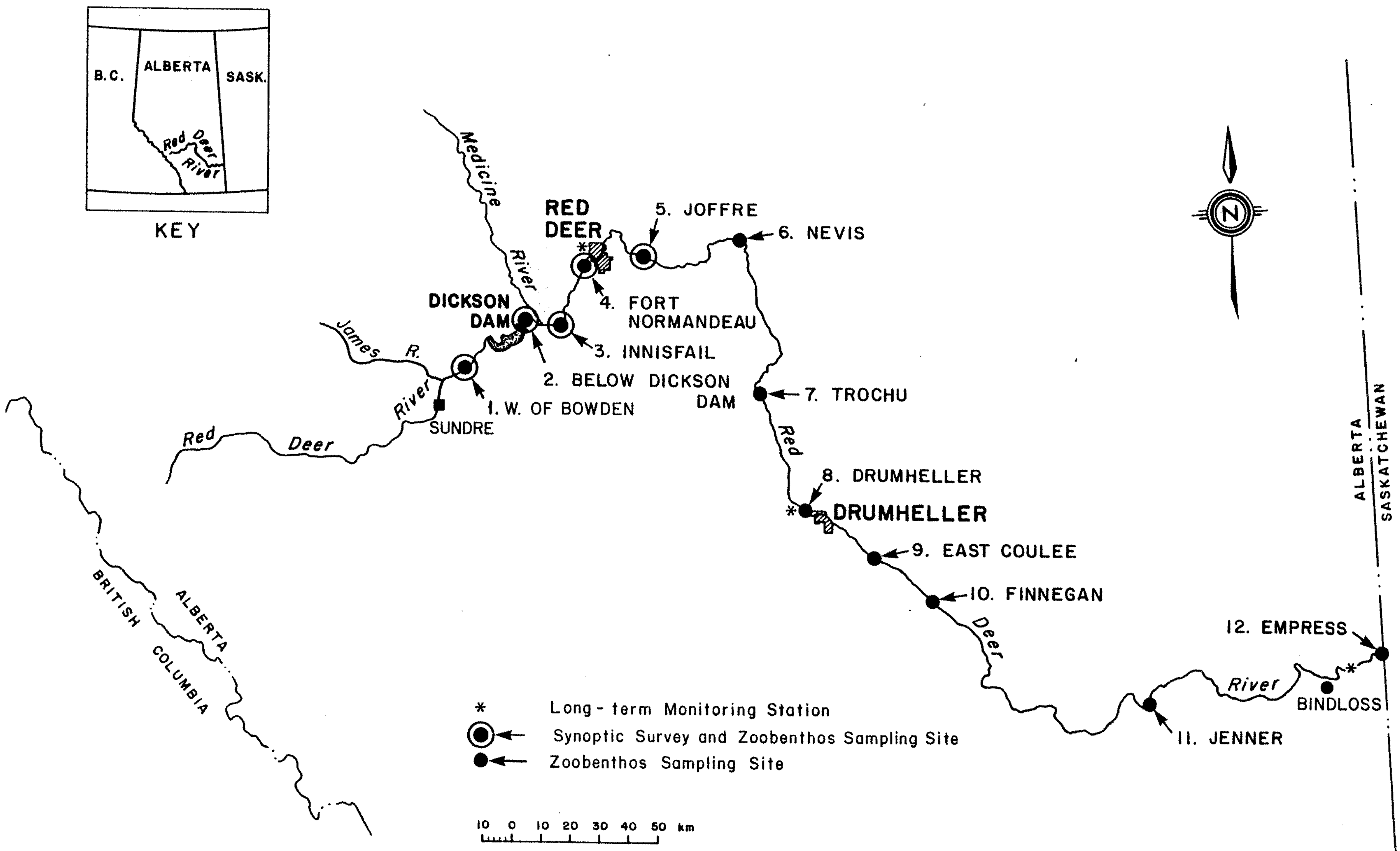


Figure 1. Sampling Sites on the Red Deer River.

and downstream of, and within Gleniffer Lake. In addition, yearly benthic invertebrate surveys were conducted in the Red Deer River from 1974 to 1977. These data were used for comparisons of longitudinal trends in selected variables with the 1983-88 zoobenthic data.

Data from the long-term monitoring sites were evaluated graphically and statistically to determine whether the river's water quality changed after Gleniffer Lake was filled. The 1983-88 synoptic survey data were used to describe the limnology of Gleniffer Lake, document trophic upsurge within the lake, assess retention and release of constituents by processes within Gleniffer Lake, and identify the extent of the dam's effect with respect to the river's water quality and zoobenthos.

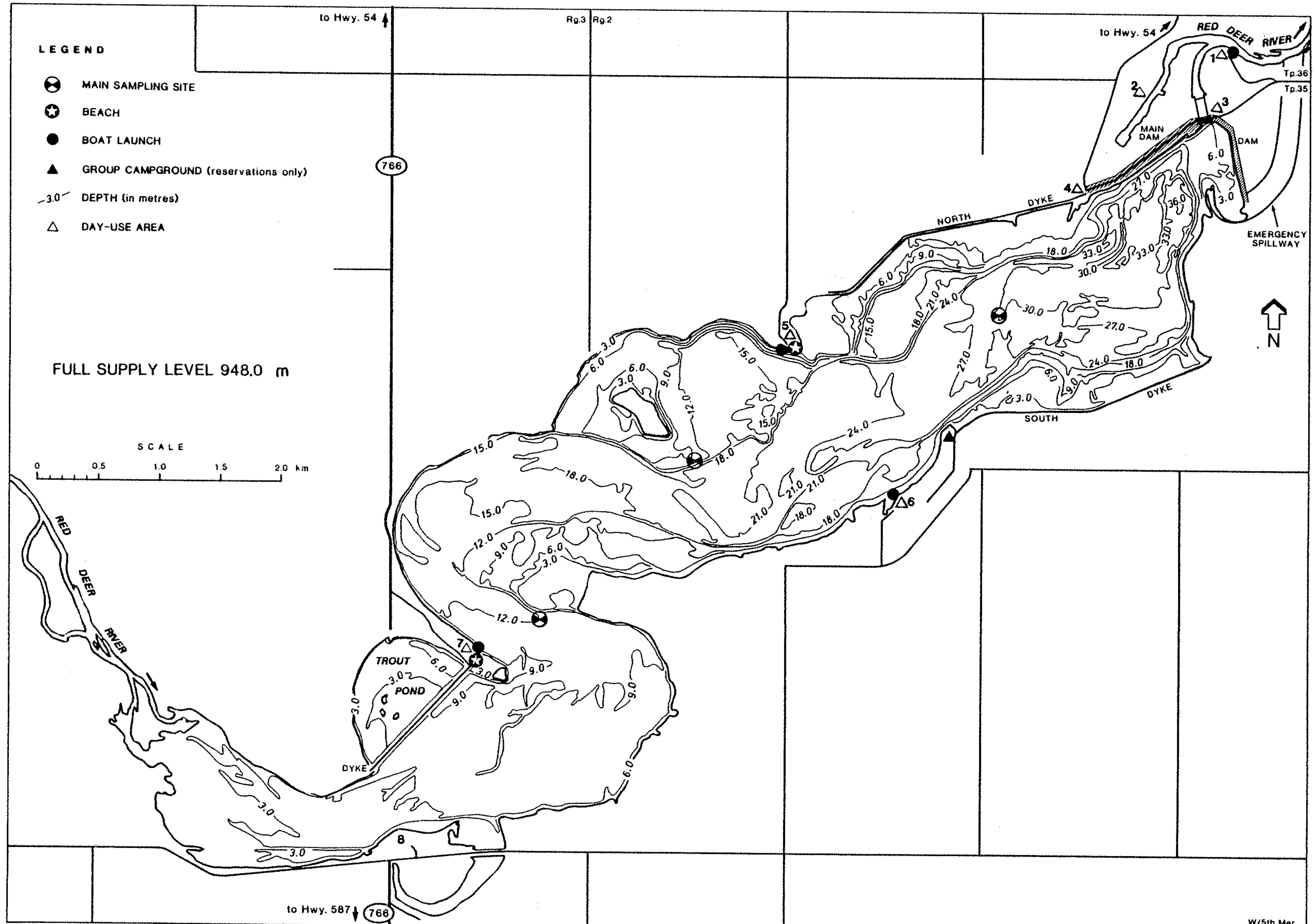
2.2 FIELD METHODS

2.2.1 Water Quality

In 1983, the former Water Quality Control Branch (now the Environmental Quality Monitoring Branch) of Alberta Environment initiated a field study to monitor the effect of the Dickson Dam on water quality of the Red Deer River. Samples were collected from five synoptic survey sampling sites on the river (Figure 1). Distances and NAQUADAT codes for these sites are listed in Appendix I.

They were collected from April 1983 through March 1988, biweekly to monthly from April to October, and monthly to bimonthly during the other months. Water samples were collected as subsurface grab samples by wading into the main flow channel. Each sample was subsampled, put directly into a specially prepared sample bottle, and preserved and handled according to recommended procedures (Appendix II). Samples were kept on ice in the field and transported to the laboratory within 24 hours.

Gleniffer Lake was also sampled during the 1983-88 synoptic surveys. Water samples were collected from three regions in the lake, corresponding to the shallow western basin, the central basin, and the deep eastern basin of the reservoir (Figure 2). Within each basin, euphotic samples were collected from 10 different sites by slowly lowering a weighted Tygon tube to the desired depth. The euphotic zone was defined as the interval from the surface of the water to a depth of 1% of surface penetrating irradiance. Water collected in the tube was emptied into a pre-rinsed, opaque container. At one site in each of the three regions (Figure 2), water was collected at 1-m intervals, from the surface to 1 m above the lake bottom, using a Van Dorn bottle or peristaltic pump. Temperature, dissolved oxygen,



(Source: Atlas of Alberta Lakes)

Figure 2. Gleniffer Lake bathymetry and sampling sites.

specific conductance, and pH were measured at 1-m intervals at the same location. All lake water samples were preserved and handled according to recommended procedures (Appendix II).

2.2.2 *Biological Samples*

Water samples were collected for bacterial analyses during most of the synoptic surveys. Samples were stored in 250 mL sterilized glass or polypropylene bottles. The Provincial Laboratory of Public Health analyzed the samples for numbers of total and fecal coliforms and fecal streptococci.

River samples were collected for planktonic chlorophyll *a* analysis during each synoptic survey. Surface grab samples were obtained as described in Section 2.2.1. For each sample, a measured volume of water was filtered through a Whatman GF/C filter; powdered magnesium carbonate was added during filtration. Filters were then wrapped in aluminum foil and frozen until analysis.

Samples were collected for epilithic chlorophyll *a* analysis from near the river bank at all sampling locations during most of the open-water synoptic surveys. At each site, ten stones were randomly collected along a transect perpendicular to the shoreline. A 16 cm^2 template was placed on each rock. The plant material enclosed by the template was removed by scraping or brushing, and the rock then rinsed with distilled water until all visible epilithic growth was removed. The total volume of slurry obtained from all stones collected from one sampling location was recorded, and then the slurry was homogenized and filtered as for planktonic chlorophyll *a* samples. All chlorophyll *a* analyses were carried out at the Millwoods facility of the Environmental Quality Monitoring Branch (EQMB).

Benthic invertebrates were sampled at five river sites in the immediate vicinity of Gleniffer Lake and at the two long-term monitoring sites at Drumheller and Empress (Table 1, Figure 1). Additional sites downstream of Red Deer were sampled in the spring and fall of 1983. In selecting sampling sites for zoobenthos, attempts were made to standardize substrate, flow velocity, and sampling depth, all of which are known to influence benthic invertebrate distribution. Samples were usually collected at depths between 30 and 40 cm in moderately fast flowing water.

Zoobenthic samples were taken using a modified Neill cylinder sampler with a sampling area of 0.1 m^2, (Neill 1938) and a collecting net with a mesh aperture of 0.210 mm.

Table 1. Names and locations of benthic invertebrate sampling sites on the Red Deer River.

YEAR	SITE NO.	SITE NAME	DISTANCE FROM MOUTH OF RIVER (km)
1983	1	West of Bowden	634
	2	Dickson Dam (1 km below the dam)	580
	3	Innisfail	561
	4	Fort Normandeau (upstream of Red Deer)	533
	5	Joffre	488
	6	Nevis	440
	7	Trochu	375
	8	Drumheller	319
	9	East Coulee	296
	10	Finnegan	255
	11	Jenner	136
	12	Empress	20
All Other Years	1	West of Bowden	634
	2	Dickson Dam (1 km below the dam)	580
	3	Innisfail	561
	4	Fort Normandeau (upstream of Red Deer)	533
	5	Joffre	488
	8	Drumheller	319
	12	Empress	20

Five replicate samples were collected at each site. Care was taken to press the cylinder securely into the substrate to prevent the loss of specimens through gaps between the cylinder and the substrate. Large stones collected in the cylinder were cleaned individually by gently rubbing and rinsing inside the cylinder. A narrow shovel was used to agitate the substrate for approximately one minute. Samples taken from 1974 to 1977 were sorted live at the sampling site; samples taken from 1983 to 1987 were preserved in 4% formaldehyde immediately after collection.

2.3 LABORATORY METHODS

2.3.1 Water Quality

For each survey, a comprehensive group of physical, chemical, and biological variables was analyzed (Appendix II). Water temperature, specific conductance, and dissolved oxygen levels were measured *in situ* at each sampling site and on all sampling occasions using a pre-calibrated Model 4041 Hydrolab meter. All water quality data collected during the 1983-88 synoptic surveys are stored in Alberta Environment's NAQUADAT database.

2.3.2 Zoobenthos

Zoobenthic samples were stained with Rose Bengal upon return to the laboratory (Mason and Yevich 1967). Samples were screened through coarse and fine sieves, with mesh apertures of 2 and 0.213 mm, respectively. The coarse fractions (residue on 2 mm screen) and fine fractions (residue on 0.213 mm screen) of each sample were sorted under a dissecting microscope (magnification range 6 to 50X). The fine fraction of samples that contained large numbers of organisms was subsampled using the Imhoff cone method (Wrona et al. 1982). Specimens were counted and identified according to Baumann et al. (1977), Edmunds et al. (1976), Merritt and Cummins (1984), Pennak (1978), and Wiggins (1977).

2.4 DATA TREATMENT

2.4.1 Long-term Data

The most complete, long-term water quality data sets for the Red Deer River are from Alberta Environment's monitoring stations at Hwy. #2 above the city of Red Deer and at Drumheller (this station was moved farther upstream to the Morrin Bridge in 1987), and from the Prairie Provinces Water Board (PPWB) station near the Alberta-Saskatchewan border at Bindloss (upstream of Empress). From all three long-term monitoring stations, the data are most complete for the 1978-89 period; consequently, the evaluation of changes in river water quality focused on these data. The long-term monitoring station data were subdivided into two sets, corresponding to conditions before (January 1978 to April 1983) and after (January 1984 to December 1989) Gleniffer Lake was filled (summer of 1983). These data were evaluated graphically and statistically to assess changes in river water quality corresponding to flow regulation of the Red Deer River.

Most parametric and non-parametric statistical tests for long-term trends require data that are independently distributed. Water quality data, however, are often time dependent, either because of seasonality or serial correlation, or both (Montgomery and Reckhow 1984). Seasonality implies that the value of a variable exhibits fluctuations based on the time of year. Seasonality increases the variance in the data, which decreases the power of many statistical tests. Thus, if seasonality is a factor to be considered, either the data should be deseasonalized before analyzing for trends, or statistical tests that account for seasonality should be used. Seasonal trends in the flow-dependent constituents were assessed graphically by inspection of box and whisker plots of concentrations versus month. Box and whisker plots show the median, minimum, and maximum values (whiskers) and the interquartile values (box), and provide an indication of seasonal change in the constituent concentrations. In addition to the box and whisker plots, seasonality was tested statistically using the Kruskal-Wallis test (Loftis et al. 1989).

Serial correlation occurs when the value of a data point is dependent upon the value of previous data points (after seasonality and trend have been removed). Serial correlation was determined using a correlogram (Loftis et al. 1989).

For each constituent, the pre- and post-impoundment data were analyzed separately for seasonality and serial correlation. If serial correlation was present, quarterly rather than monthly data were used to test for changes.

For those variables that are flow-dependent, flow regulation might be expected to cause seasonal changes in river water quality due to increased flows in winter and decreased flows in summer. To identify flow-dependent variables, a best-fit regression of concentration as a function of discharge was calculated for each variable, using data from January 1978 to

April 1983. If the slope of the regression was significantly different from 0 ($P<0.05$), the variable was considered to be flow dependent.

The Mann-Whitney U-test was used to determine whether the median levels of variables monitored at the long-term sites differed significantly between the periods before and after the filling of Gleniffer Lake, i.e. to test for a step change in water quality caused by the dam. If the concentrations of a constituent varied seasonally, the data were deseasonalized before computing the U statistic (Loftis et al. 1989). A quantitative, non-parametric (seasonal Hodges-Lehman) estimate of the difference in medians was calculated for those variables with significant differences between the pre- and post-impoundment periods (Hirsch 1988).

In addition to testing for overall differences between pre- and post-impoundment periods, data from the long-term monitoring sites were analyzed for seasonal differences that may have occurred as a result of the Dickson Dam. For each month, the data were subdivided into pre- and post-impoundment periods, and differences between the two periods were determined using the Mann-Whitney test.

Changes in river water quality that may have occurred after the filling of Gleniffer Lake were evaluated using data from both the long-term monitoring sites and the 1983-88 synoptic surveys. For both data sets, time series plots were inspected to identify potential trends. In addition, differences in the data collected from January 1984 to December 1989 at the long-term monitoring sites were tested statistically using either the Seasonal Kendall test (if seasonality was a factor) or the Kendall test (if seasonality was not a factor) (Hirsch et al. 1982; Berryman et al. 1988). The null hypothesis for the Kendall tests is that the constituent concentrations are independent of time. These are non-parametric tests and are not dependent on normally distributed data. A limited number of missing values or values below the analytical detection limit (i.e. censored data) violate no assumptions of the Kendall tests.

All data were analyzed on an IBM compatible, 386 personal computer using (1) a LOTUS 1-2-3 program to test for flow-dependency; (2) WQSTAT II, a water-quality statistics program to assess seasonality, serial correlation, and long-term trends (Loftis et al. 1989); and (3) STATGRAPHICS, a statistical package that was used to test for monthly differences between pre- and post-impoundment data (STSC Inc. 1987).

2.4.2 *Synoptic Survey Data*

Data from the 1983-88 synoptic surveys were used to qualitatively assess the effect of the Dickson Dam on the water quality of the Red Deer River. Data collected from Gleniffer Lake were used to describe the limnology of the reservoir, to assess lake mixing patterns, and to document ongoing changes in the lake's water quality after the reservoir was filled. Water quality at the sites immediately upstream and downstream of the lake was examined to determine whether retention and release of constituents was occurring within the lake. Data collected from all sites were evaluated graphically to assess longitudinal patterns and to identify the potential extent of the effect of the Dickson Dam on the water quality of the Red Deer River.

2.4.3 *Zoobenthos*

Analysis of the zoobenthic data included assessment of simple community descriptors such as the mean total number of invertebrates per site, mean number of taxa per site, the contribution of major taxonomic groups to total invertebrate numbers, and the longitudinal distribution of individual taxa. Data from the spring of 1983 are the only pre-impoundment data that are methodologically consistent with post-impoundment data, although qualitative comparisons were made between data collected in 1973-1977 and those from 1983-1987.

3.0 BASIN CHARACTERISTICS

The Red Deer River is a major tributary of the South Saskatchewan River. It originates in the Rocky Mountains within Banff National Park and flows northeasterly through foothills and parkland to the city of Red Deer. Near Nevis, the Red Deer River turns sharply to the south, flows through grassland to Dinosaur Provincial Park, then continues eastward to the Alberta-Saskatchewan border and its confluence with the South Saskatchewan River (Figure 1). With the exception of the mountain and foothills regions, most of the Red Deer River Basin is cultivated.

The climate of the Red Deer River Basin is continental and is characterized by cold winters and warm summers. There are decreases in precipitation and winter temperatures and increases in evaporation and summer temperatures along a gradient from the headwaters in the mountains to the eastern portion of the basin (Environment Canada 1982).

Prior to the filling of Gleniffer Lake, flows in the Red Deer River were highly variable (Figure 3). Snowmelt from the plains region contributed most of the spring runoff (April and May), and mountain snowmelt and rainfall increased flows in late spring and early summer. Winter flows were often extremely low. Gleniffer Lake began filling in the summer of 1983. Prior to this, about 20% of the area was stripped of topsoil (A. Nilson 1990, pers. comm.). The dam is a multi-zoned earthfill structure, 40 m high and 650 m long. Two tunnels under the dam can provide a continuous water flow of 16 m^3/s and can pass a maximum flow of 84 m^3/s. The service spillway can handle a flood that would occur once in 10,000 years. The operating strategy of the dam is to fill the reservoir rapidly in the spring and then to maintain a fairly constant water level throughout the summer to maximize recreational use (Nguyen 1980). The reservoir is filled to capacity by fall and releases of water were designed to occur at a minimum of 16 m^3/s during the winter, so that the lowest reservoir levels occur in March and April (Alberta Environment, n.d.).

The main influence of the Dickson Dam on flows in the Red Deer River has been the redistribution of discharge throughout the year. Flow regulation has resulted in lower mean monthly flows during summer and higher mean monthly flows during winter (Figure 4). Relatively high flood peaks still occur occasionally, however, and winter post-impoundment flows at the city of Red Deer have often been lower than the minimum projected flow of 16 m^3/s (Figure 3). These low flows generally occur between December and March, and the lowest daily flow since the onset of flow regulation (8.98 m^3/s) was recorded in December 1988.

From its headwaters to the city of Red Deer, the Red Deer River's channel bed is predominantly gravel, with rock outcrops in the channel; the bank consists of sand and gravel. Along the lower reaches of the river from Drumheller to the South Saskatchewan River, the channel bed is sand and gravel on top of easily erodible shales and the bank is gravel, sand, silt, and easily erodible rock (Kellerhals et al. 1972). The change in channel bed and bank materials is coincident with a change in bedrock geology, from the Paskapoo Formation, a calcareous, sandstone, siltstone, and mudstone unit, to the more easily erodible Horseshoe Canyon, Bearpaw, and Oldman formations, which consist of varying amounts of feldspathic sandstone, clayey siltstone, mudstone, shales, and bentonite beds (Green 1972).

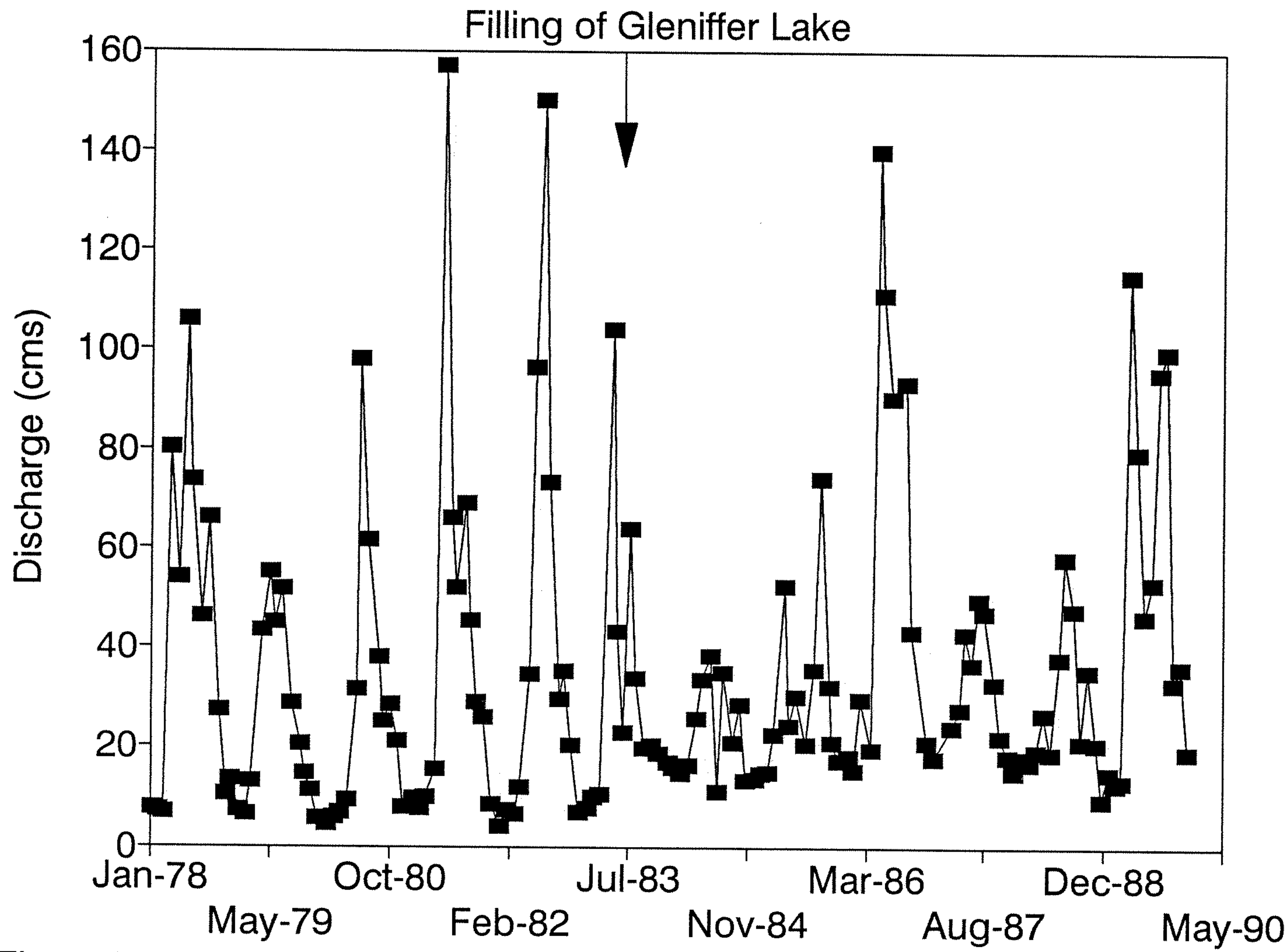


Fig. 3. Flows at Red Deer on the dates when the long-term monitoring station was sampled, 1978-89.

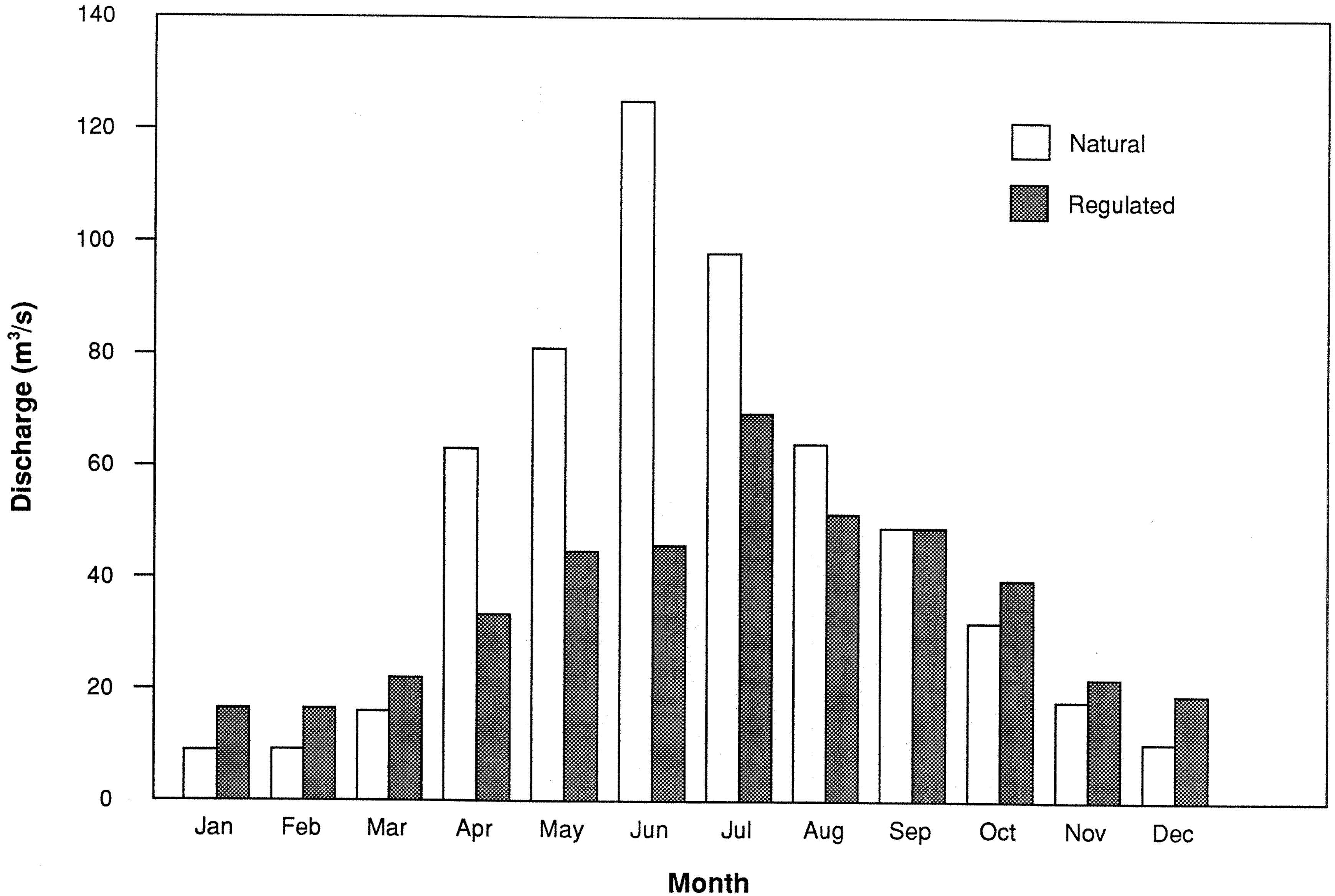


Figure 4. Mean monthly natural (1912-82) and regulated (1984-88) flows in the Red Deer River at the city of Red Deer.

4.0 RESULTS AND DISCUSSION

4.1 GENERAL DATA EVALUATION

Water quality data from the long-term monitoring sites are summarized in Appendices III and IV, and from the synoptic survey sites in Appendix V; the zoobenthic data are summarized in Appendix VI. The complete water quality and zoobenthic data sets are stored in electronic databases and are available upon request from the Environmental Quality Monitoring Branch, Alberta Environment.

The results of the statistical tests for flow-dependency, overall and monthly changes between pre- and post-impoundment median levels of water quality variables, and trends in river water quality in the years following the filling of Gleniffer Lake are tabulated and presented in this section.

4.1.1 Flow Dependency

Flow dependency was assessed using data collected from January 1978 to April 1983 at the long-term monitoring site above Red Deer. At that site, concentrations of most solutes decreased with increasing flow and concentrations of most particulate variables increased with increasing flow (Table 2). These findings are consistent with those observed in other Alberta rivers (Shaw et al. 1990).

The Dickson Dam strongly influences the seasonal flow pattern of the Red Deer River. Thus, it would be expected to affect seasonal fluctuations in concentrations of those variables that are flow-dependent. For the flow-dependent dissolved constituents, post-impoundment concentrations would be expected to be lower during the winter months because of higher flows. In contrast, for flow-dependent particulate variables, post-impoundment concentrations might be lower during spring and summer runoff because the flood peaks are reduced.

4.1.2 Pre- and Post-impoundment Differences

At the long-term monitoring site upstream of the city of Red Deer (Table 3), post-impoundment median levels of dissolved oxygen in the Red Deer River were significantly higher than pre-impoundment levels, whereas post-impoundment levels of total dissolved solids, most major ions and associated variables, particulate phosphorus, silica, and total

Table 2. Regressions of concentrations (X) versus discharge (Q, m^3/s) for flow-dependent variables at the long-term monitoring site upstream of the city of Red Deer.

VARIABLE	REGRESSION	r^2	*df*
α-BHC	$\ln X = -8.32 + 0.551\ nQ$	0.45	18
Alkalinity	$X = 275.4 - 30.91\ nQ$	0.71	58
Bicarbonate	$X = 148.4 + 200.8/(1+0.0316Q)$	0.72	58
Calcium	$\ln X = 4.40 - 0.141nQ$	0.67	61
Colour	$\ln X = 0.75 + 0.531nQ$	0.32	62
Conductivity	$\ln X = 6.60 - 0.181nQ$	0.85	61
Fecal coliforms	$\ln X = -0.06 + 0.661nQ$	0.19	60
Fecal streptococci	$\ln X = 0.29 + 0.77Q$	0.15	59
Hardness	$\ln X = 5.84 - 0.171nQ$	0.81	61
Magnesium	$\ln X = 3.52 - 0.211nQ$	0.79	62
pH	$X = 8.30 - 2.53/Q$	0.23	62
Particulate nitrogen	$X = 0.036 + 0.00045Q + 1.21 \times 10\text{-}7Q^2$	0.43	59
Particulate phosphorus	$X = 0.014 + 0.00018Q + 6.99 \times 10\text{-}6Q^2$	0.44	56
Silica	$X = 6.80 - 0.060Q + 0.00047Q^2$	0.31	61
Sodium	$X = 8.84 - 0.067Q + 0.00035Q^2$	0.26	62
Sulphate	$X = 65.5 - 9.21nQ$	0.84	62
Non-filterable residue	$\ln X = -1.12 + 0.931nQ$	0.41	60
Temperature	$\ln X = -1.39 + 0.951nQ$	0.76	60
Total dissolved solids	$\ln X = 5.98 - 0.181nQ$	0.85	59
Total phosphorus	$X = 0.013 + 0.00043Q + 4.06 \times 10\text{-}6Q^2$	0.30	60
Turbidity	$\ln X = -1.32 + 0.901nQ$	0.49	62

Notes:

Regressions were computed using data collected from January 1978 to April 1983, before Gleniffer Lakes was filled. For all regressions, $P<0.01$.

Units for X are in mg/L except for conductivity (µS/cm), turbidity (NTU), and bacteria (#/100 mL)

Chloride, fluoride, potassium, and total dissolved phosphorus levels and total numbers of coliforms were all independent of flow.

Table 3. Results of Mann-Whitney tests for changes between pre- and post-impoundment median levels of water quality variables and of Kendall tests for trends from 1984-89 at the long-term monitoring site upstream of the city of Red Deer.

VARIABLE	CHANGES IN MEDIAN (Mann-Whitney test)	SEASONAL CHANGES	TREND AFTER 1984 (Kendall test)
Significant Changes in Medians			
Alkalinity	-11.3 mg/L*	↓Dec-Mar,↑May,Jun	None
Bicarbonate	-14.7 mg/L*	↓Nov-Feb,↑May	None
Calcium	-3.8 mg/L**	↓Mar,Oct,Nov	None
Dissolved oxygen	+1.0 mg/L*	↑Jan-Mar,May,Jun	+0.16 mg/L/yr**
Hardness	-20.9 mg/L**	↓Sep-Mar	None
Magnesium	-3.1 mg/L**	↓Sep-Mar	None
Particulate phosphorus	-0.004 mg/L*	↓Feb,Jul	+0.001 mg/L/yr**
pH	-0.17 units	↓Mar,Aug,Oct-Nov	-0.04 units/yr*
Silica	-0.90 mg/L**	↓Dec-Mar	+0.30 mg/L/yr**
Specific conductance	-38.8 µS/cm**	↓Aug-Mar	None
Sulphate	-3.5 mg/L**	↓Nov-Mar	-1.4 mg/L/yr*
Total coliforms	-8.0 #/100 mL**	↓Feb	+5.5 #/100 mL/yr**
Total dissolved solids	-19.7 mg/L**	↓Oct-Mar	None
No Significant Changes in Medians			
α-BHC	n.s.	↓Jul-Sep	None
Chloride	n.s.	↓Nov-Jan,↑May-Jun	None
Colour	n.s.	None	+1.0 RCU/yr**
Dissolved organic carbon	n.s.	None	+0.031 mg/L/yr**
Fluoride	n.s.	None	None
Fecal coliforms	n.s.	None	None
Fecal streptococci	n.s.	↑Nov	-4.0 #/100 mL/yr**
Flow	n.s.	↑Dec-Mar,↓Jul	None
Particulate nitrogen	n.s.	↑Feb	None
Potassium	n.s.	↑May-Jun,↓Dec	None
Sodium	n.s.	↓Dec-Feb,↑May	None
Non-filterable residue	n.s.	↓Jan,Oct,↑Mar	+0.33 mg/L/yr*
Total dissolved phosphorus	n.s.	None	None
Total phosphorus	n.s.	None	+0.001 mg/L/yr**
Turbidity	n.s.	↑Mar,↓May,Jul	+0.001 NTU/yr**
Water temperature	n.s.	↑Apr	None

Notes:
↑ Post-impoundment median level for that month is significantly (P<0.10) greater than pre-impounded levels.
↓ Post-impoundment median level for that month is significantly (P<0.20) lower than pre-impounded levels.
* P<0.10
** P<0.05

coliforms were significantly lower than pre-impoundment levels. At the Drumheller site (Table 4), similar changes were found, with the exceptions of increases in pH, decreases in sodium and total phosphorus levels and no changes in silica and total coliform levels. At Bindloss (Table 5), there were negative changes between pre- and post-impoundment periods for a number of variables, and the changes were often inconsistent with those observed at Red Deer. It appears that changes in water quality at Bindloss were often associated with increased flows during the winter months.

4.1.3 Trend Tests

During the 1984-89 interval only, levels of dissolved oxygen, silica, colour, dissolved organic carbon, non-filterable residue, particulate phosphorus, and total coliforms increased significantly, and levels of pH, sulphate, fecal streptococci decreased significantly at the long-term site upstream of the city of Red Deer (Table 3). Similar trends for these variables were not observed at the other two long-term monitoring sites (Tables 4, 5).

4.2 GLENIFFER LAKE

At full storage level (948 m), Gleniffer Lake has a surface area of 17.6 km^2, is 11 km long and 2 km wide, and contains 205 x 10^6 m^3 of water. Its steep sides drop sharply to a wide, flat bottom that is 33 m deep at its deepest point. When the water level in the reservoir is drawn down, as occurs in the spring of most years, considerable mud flats are exposed. The typical drawdown is 7-9 m. As would be expected for a reservoir, the residence time of the water in Gleniffer Lake is short, averaging 70 days. In years of high flows in the Red Deer River, the residence time can be as short as 30 days (Mitchell and Prepas 1990).

Gleniffer Lake is a well-buffered, oligotrophic, freshwater reservoir. There is an increase in water clarity from the shallow west end where the Red Deer River enters the lake to the deeper east end near the Dickson Dam (Table 6). There is, however, little difference in ionic composition among the different basins.

The west end of Gleniffer Lake is frequently mixed by winds and inflowing river currents; it tends to be weakly thermally stratified during July and August, remaining well oxygenated throughout the summer (Figure 5). The deeper central and eastern basins of the reservoir tend to be thermally stratified during summer and the hypolimnetic water

Table 4. Results of Mann-Whitney tests for changes between pre- and post-impoundment median levels of water quality variables and of Kendall tests for trends from 1984-89 at the long-term monitoring site near Drumheller.

VARIABLE	CHANGES IN MEDIAN (Mann-Whitney test)	SEASONAL CHANGES	TREND AFTER 1984 (Kendall test)
Significant Changes in Medians			
Alkalinity	-10.7 mg/L*	↓Dec-Jan	None
Bicarbonate	-19.5 mg/L**	↓Dec-Jan	+4.6 mg/L/yr*
Calcium	-4.6 mg/L**	↓Oct-Feb,Jun	+1.4 mg/L/yr**
Dissolved oxygen	+0.4 mg/L*	↑Jan	None
Hardness	-22.5 mg/L**	↓Oct-Feb,Aug	+1.8 mg/L/yr**
Magnesium	-1.9 mg/L**	↓Aug-Jan	None
Particulate phosphorus	-0.004 mg/L*	↓Jul,Nov	None
pH	+0.08 units**	↑Jan-Feb	None
Sodium	-1.8 mg/L**	↓Jan-Mar,Nov,↑Jun	None
Specific conductance	-46.0 µS/cm**	↓Oct-Mar,Aug	None
Sulphate	-3.0 mg/L**	↓Feb,Mar,Nov,↑Jun	-1.0 mg/L/yr*
Total dissolved solids	-19.8 mg/L**	↓Oct-Jan,Mar	None
Total phosphorus	-0.015 mg/L**	↓Jan,Jul	None
No Significant Changes in Medians			
α-BHC	n.s.	None	None
Chloride	n.s.	↓Dec-Feb,↑Jun-Aug	+0.067 mg/L/yr*
Dissolved organic carbon	n.s.	↓Aug	+0.33 mg/L/yr**
Fecal coliforms	n.s.	None	None
Fecal streptococci	n.s.	↑Aug	-5.8 #/100 mL/yr**
Flow	n.s.	↑Dec-Feb,↓Jun-Jul	None
Fluoride	n.s.	↑Apr,Dec	None
Particulate nitrogen	n.s.	↓Jul	None
Potassium	n.s.	↑Jun,↓Dec-Feb,Mar	None
Silica	n.s.	↓Jan	None
Non-filterable residue	n.s.	↓Jul,↑Jan	None
Total coliforms	n.s.	↑Aug	None
Total dissolved phosphorus	n.s.	↓Jan	None
Turbidity	n.s.	↓Jul	None
Water temperature	n.s.	None	+0.10 °C/yr*

Notes:
↑ Post-impoundment median level for that month is significantly ($P<0.10$) greater than pre-impounded levels.
↓ Post-impoundment median level for that month is significantly ($P<0.20$) lower than pre-impounded levels.
* $P<0.10$
** $P<0.05$

Table 5. Results of Mann-Whitney tests for changes between pre- and post-impoundment median levels of water quality variables and of Kendall tests for trends from 1984-89 at the long-term monitoring site near Bindloss.

VARIABLE	CHANGES IN MEDIAN (Mann-Whitney test)	SEASONAL CHANGES	TREND AFTER 1984 (Kendall test)
Significant Changes in Medians			
Calcium	-1.7 mg/L*	↓Jan-Feb,↑Apr	None
Chloride	-0.1 mg/L*	↓Dec-Feb,↑Jun-Jul	None
Chlorophyll *a*	-0.001 mg/L**	↓Apr,Oct	None
Cyanide	-0.0001 mg/L**	↑Apr	None
Dissolved organic carbon	-0.80 mg/L**	↓Jan-Apr	None
Dissolved nitrogen	-0.110 mg/L**	↓Jan-Apr,Jun	None
Fluoride	+0.0001 mg/L**	↑Jun-Jul	None
Hardness	-11.6 mg/L**	↓Jan-Feb,↑Apr	None
Magnesium	-1.4 mg/L**	↓Dec-Feb,↑Apr	None
$(NO_2^- + NO_3^-)$-N	-0.020 mg/L**	↓Apr,Jun	None
Particulate nitrogen	-0.020*	↓Apr	None
Particulate organic carbon	-0.10 mg/L*	None	None
Particulate phosphorus	-0.004 mg/L*	↓Apr	-0.003 mg/L/yr*
Potassium	-0.2 mg/L**	↓Jan-Feb	None
Silica	-1.5 mg/L**	↓Jan-Apr,Jun	None
Sodium	-3.8 mg/L**	↓Dec-Mar,↑Jul	None
Specific conductance	-20.0 µS/cm*	↓Dec-Mar,Oct	None
Sulphate	-6.3 mg/L**	↓Jan-Mar,↑Jun	None
Total dissolved solids	-16.5 mg/L**	↓Dec-Mar,Oct,↑Apr,Jun	None
Total phosphorus	-0.007 mg/L**	↓Apr	None
Water temperature	0.2 °C**	↑Apr	None
No Significant Changes in Medians			
Alkalinity	n.s.	↓Jan,↑Apr	None
Bicarbonate	n.s.	↓Jan,↑Apr	None
Boron	n.s.	↑Nov	None
Dissolved oxygen	n.s.	None	+0.19 mg/L/yr*
Fecal coliforms	n.s.	None	None
Flow	n.s.	↑Dec-Feb,Jun	+0.9 m^3/s/yr*
pH	n.s.	↓Nov	None
Non-filterable residue	n.s.	↓Apr	None
Total coliforms	n.s.	↑Dec	None
Total dissolved phosphorus	n.s.	↓Apr	None
Turbidity	n.s.	↓Apr	None

Notes:
↑ Post-impoundment median level for that month is significantly ($P<0.10$) greater than pre-impounded levels.
↓ Post-impoundment median level for that month is significantly ($P<0.20$) lower than pre-impounded levels.
* $P<0.10$ ** $P<0.05$

Table 6. Median levels of selected water quality variables determined from euphotic composite samples collected from the western, central, and eastern basins of Gleniffer Lake, May to October, 1983-87.

VARIABLE	WEST	CENTRAL	EAST
Secchi depth	2.25	3.25	3.8
Turbidity	2.1	1.7	1.2
Non-Filterable residue	2.4	2.0	2.7
pH	8.27	8.26	8.30
Total alkalinity	153.0	150.0	150.0
Specific conductance	350.0	349.0	347.0
Total dissolved solids	195.0	193.0	192.0
Total hardness	180.0	175.0	175.0
Bicarbonate	180.0	183.0	179.0
Sulphate	36.0	37.0	36.0
Chloride	0.9	0.9	0.9
Calcium	48.5	47.3	47.4
Magnesium	14.4	14.4	14.6
Sodium	4.0	4.0	4.0
Potassium	0.9	1.0	1.0
Total dissolved phosphorus	0.004	0.004	0.004
Total phosphorus	0.010	0.010	0.009
$(NO_2^- + NO_3^-)$-N	0.030	0.027	0.028
NH_4-N	0.010	0.012	0.013
Total nitrogen	0.323	0.279	0.304
Silica	4.6	4.5	4.4
Aluminum (extractable)	0.045	0.030	0.030
Manganese (extractable)	0.009	0.005	0.004
Mercury (total)	<0.0001	<0.0001	<0.0001
Iron (extractable)	0.03	0.04	0.04
Lead (extractable)	0.003	0.002	0.003
Zinc (extractable)	0.004	0.003	0.003
Dissolved organic carbon	2.3	2.4	2.7
Total organic carbon	3.0	3.4	3.7
Phenolic material	0.001	0.001	0.001
Chlorophyll *a*	0.001	0.001	0.001

Note:
Units are in mg/L except for Secchi depth (m), turbidity (NTU), pH (pH units), and specific conductance (µS/cm).

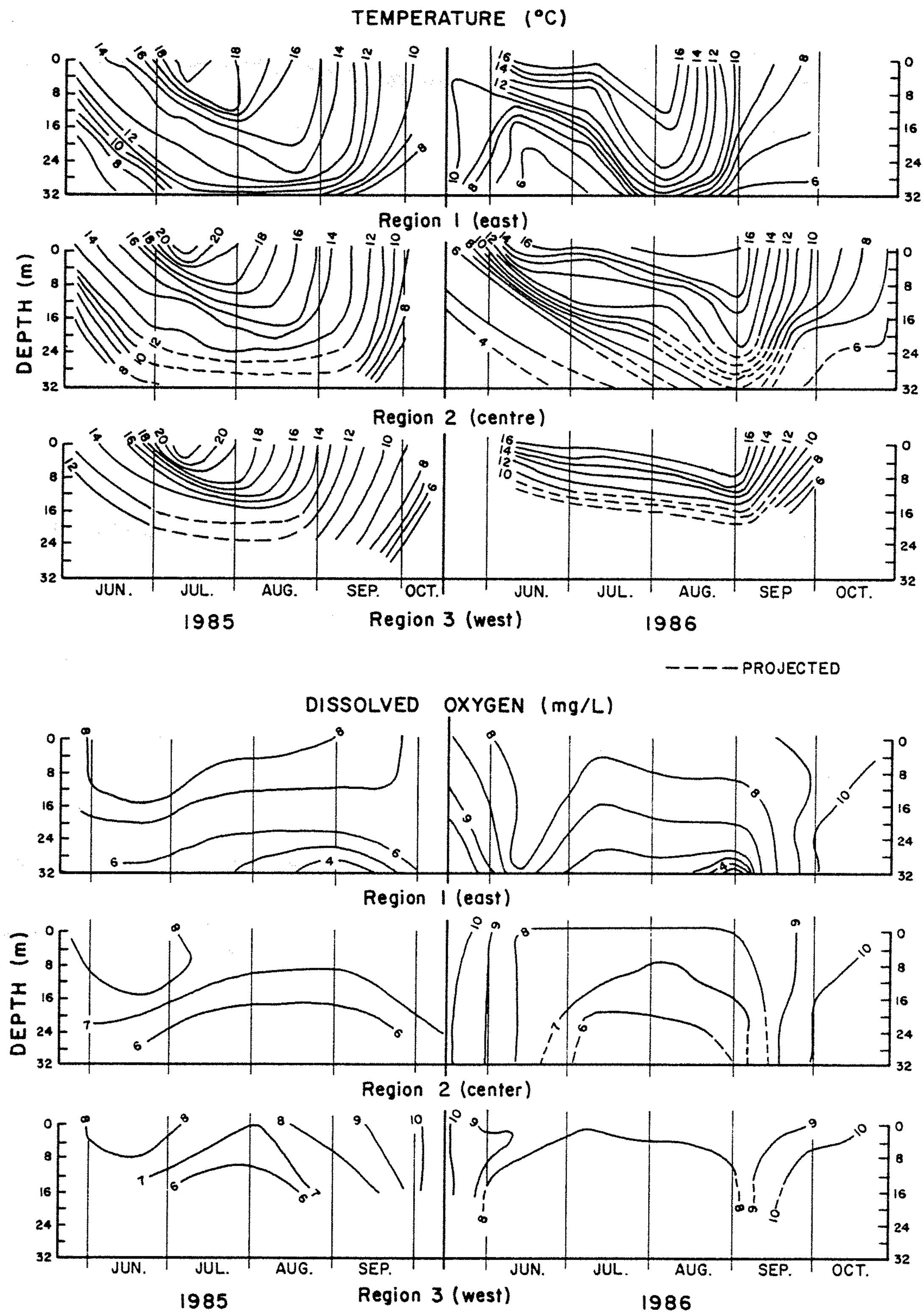


Figure 5. Temperature and dissolved oxygen isopleths, Gleniffer Lake, 1985-1986.

undergoes some oxygen depletion. There is, however, considerable year-to-year variation in the extent of thermal stratification and oxygen depletion, e.g. in 1984, hypolimnetic water within 5 m of the lake bottom was anoxic by late July, whereas in 1987, oxygen concentrations remained above 5 mg/L throughout the year.

Water clarity in Gleniffer Lake is variable. Secchi disk readings taken from May to October 1983-87 in the eastern basin ranged from 0.6 to 8.8 m (median 3.8 m) (Figure 6). The low readings were generally associated with inflows of turbid water from the Red Deer River during spring and summer, rather than from increased algal biomass.

Euphotic chlorophyll *a* concentrations were quite variable from 1983 to 1987, ranging from 0.12 to 13.3 µg/L (median 1.3 µg/L) (Figure 6). There was a peak in chlorophyll *a* concentrations during the fall of 1983. These high algal levels, however, were not associated with corresponding increases in nutrients (Figure 7), which might have been expected if nutrients were being leached from the newly flooded soils.

Concentrations of total nitrogen, total phosphorus, and silica were highly variable from year to year (Figure 7). The high levels of total nitrogen recorded in the fall of 1984 were related to high nitrogen loads from the Red Deer River. There is little evidence of leaching of nutrients or inorganic solutes from the lake bottom following the filling of Gleniffer Lake (Figures 7, 8). Dissolved organic carbon (DOC) concentrations, however, increased from 1983 to 1987 (Figure 8). Part of the increase was a result of higher DOC concentrations in the influent river water, although leaching of organic solutes from the flooded soils may have also contributed to the rise in DOC levels in the reservoir (Section 4.3.6).

4.3 RED DEER RIVER WATER QUALITY

4.3.1 Water Temperature

The release of water from the lower depths of reservoirs can have an effect on water temperatures immediately below a dam, particularly if the reservoir becomes thermally stratified as does Gleniffer Lake. The effect of the Dickson Dam on water temperatures in the Red Deer River is readily apparent by comparing river temperatures at a site immediately upstream of the reservoir to those immediately downstream of the reservoir (Figure 9). Temperatures at the downstream site are 1-3 °C higher in winter and up to 6 °C lower in summer compared to the upstream site. In addition, during the summer, mean daily

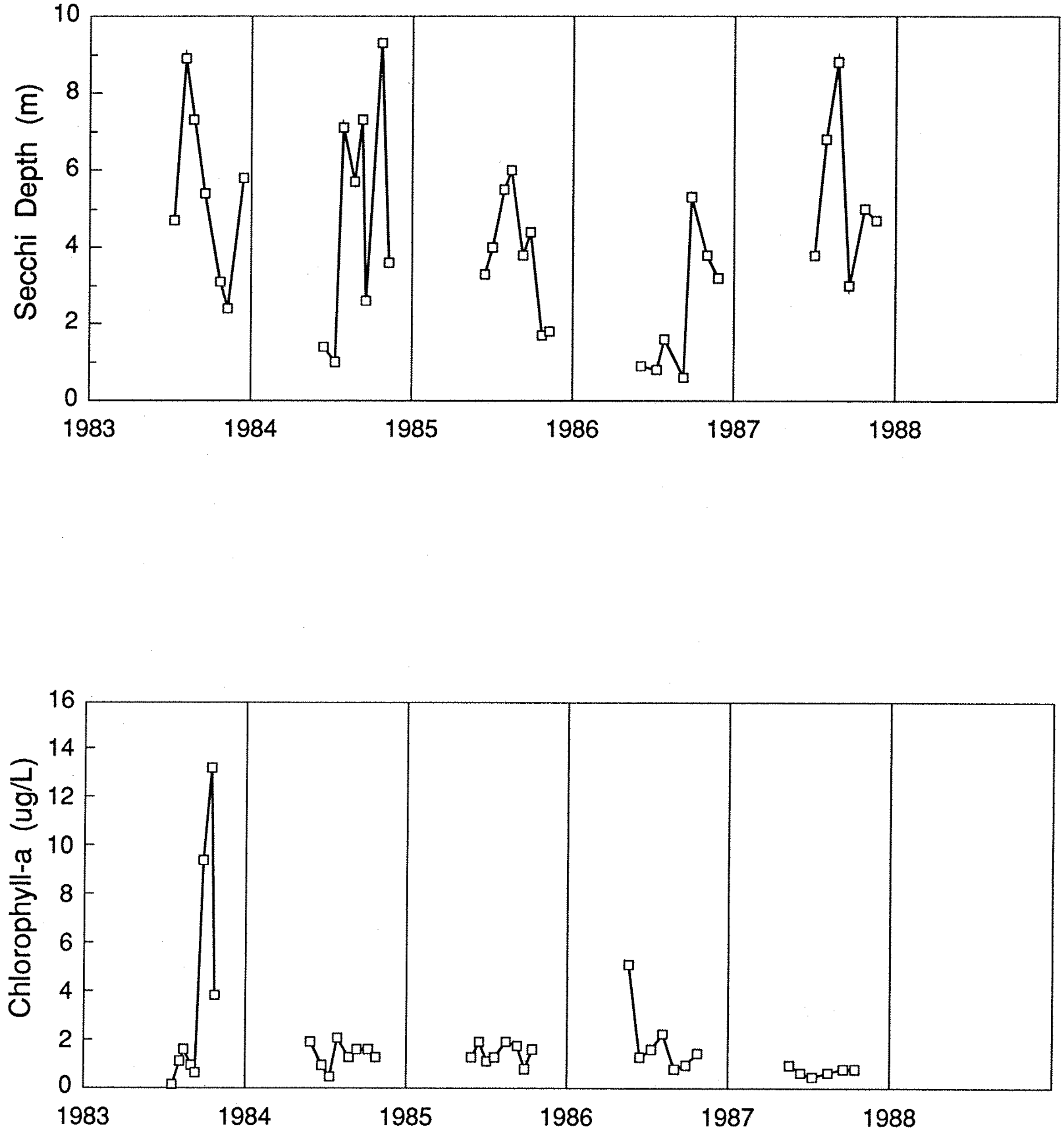


Fig. 6. Secchi depth and chlorophyll levels in Gleniffer Lake, central basin.

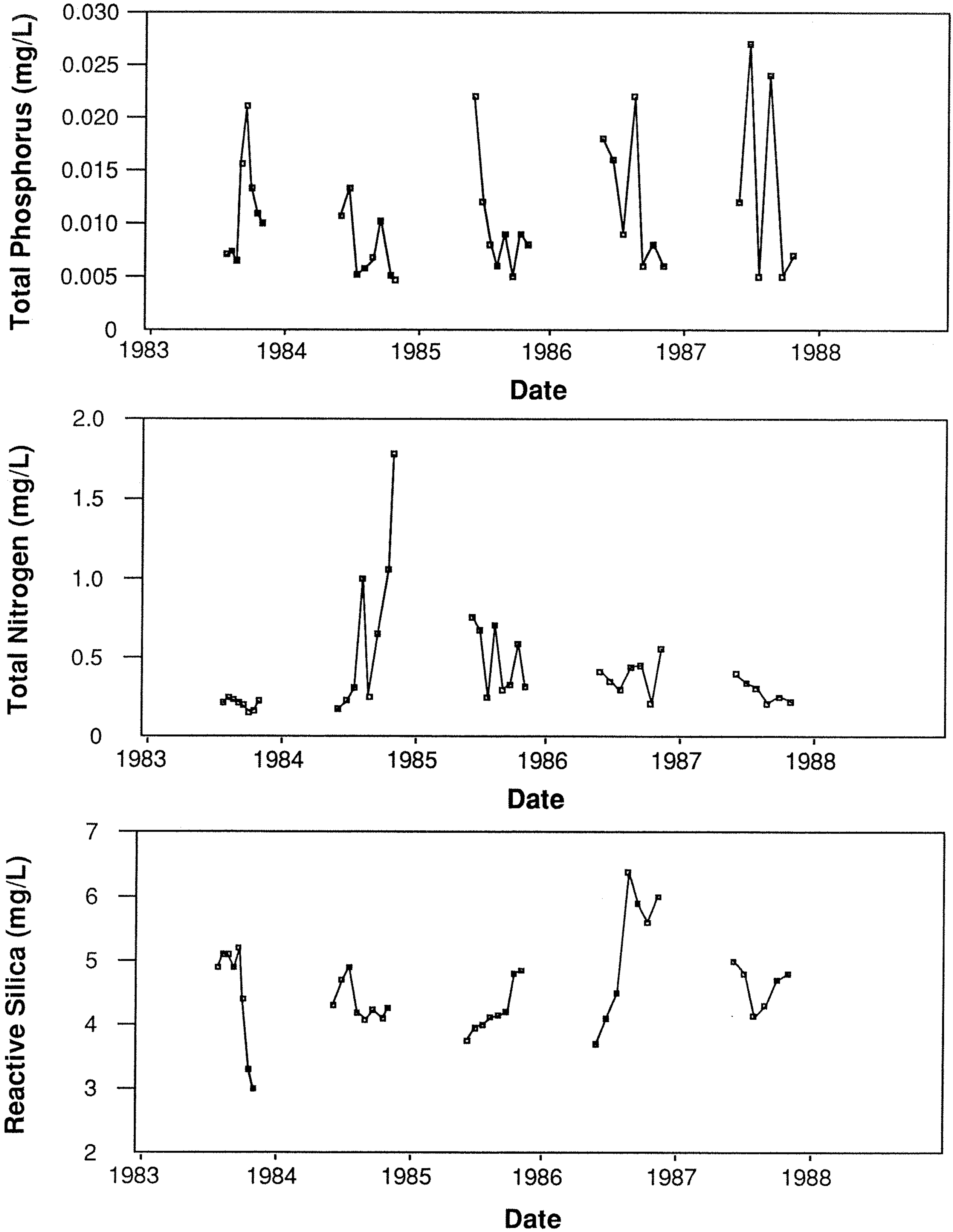


Figure 7. Phosphorus, nitrogen, and silica concentrations in Gleniffer Lake (central basin), 1983-88.

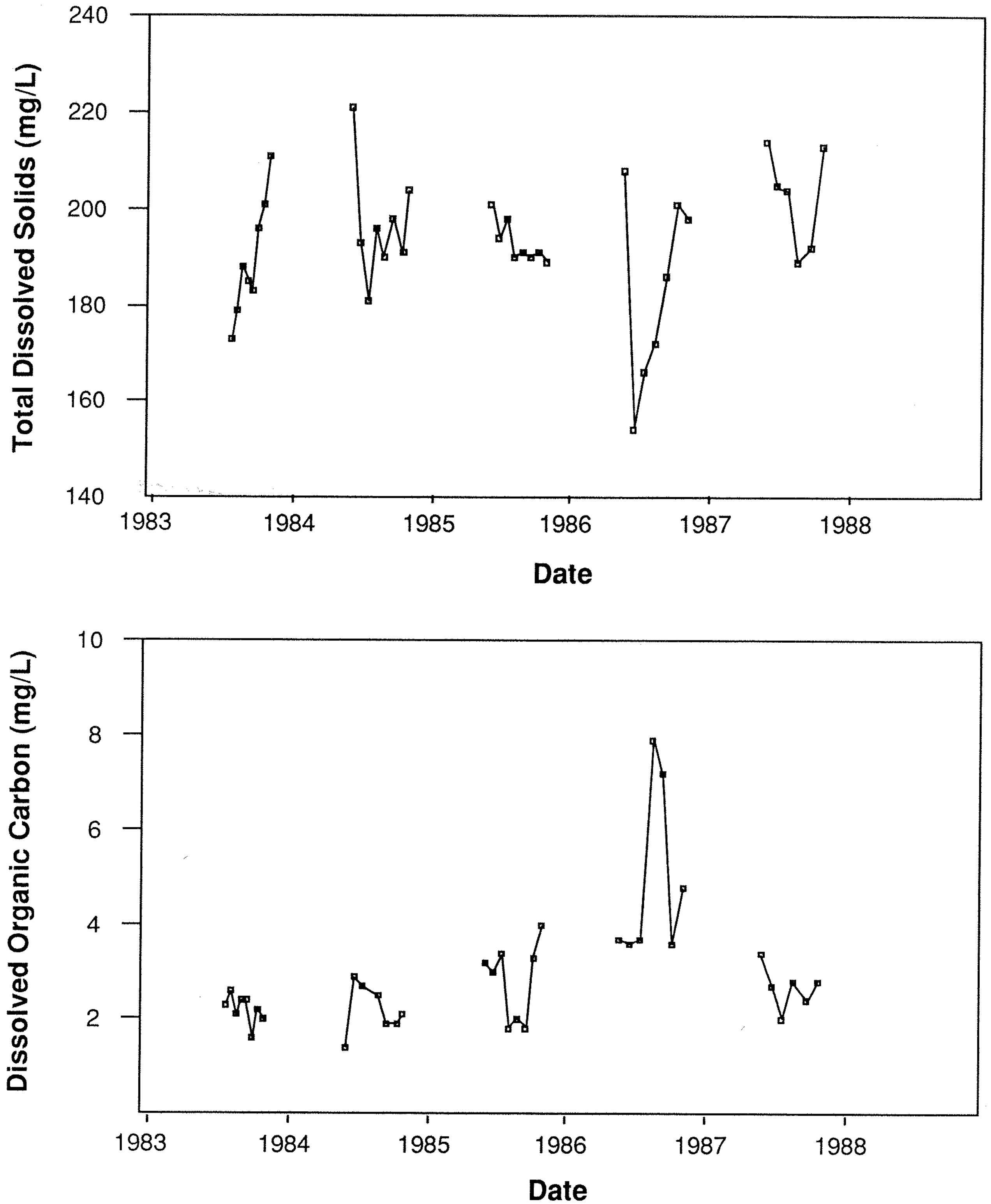


Figure 8. TDS and DOC concentrations in Gleniffer Lake (central basin), 1983-88.

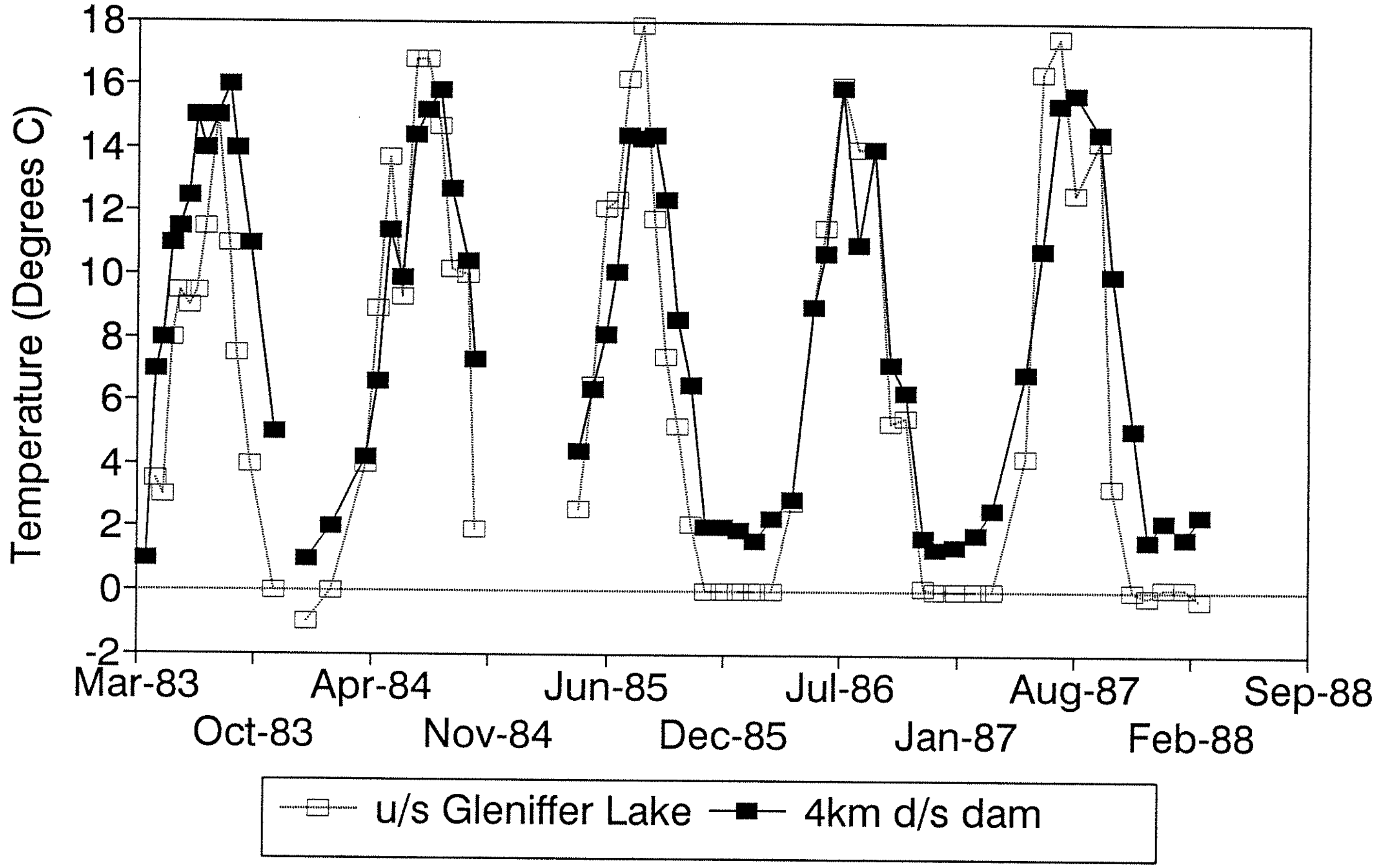


Fig. 9. Water temperatures above and below Gleniffer Lake, 1983-88.

water temperatures immediately downstream of Gleniffer Lake are much less variable than temperatures upstream of the reservoir (Trimbee and Sosiak 1988).

The effect of the dam on river water temperatures extends at least as far downstream as Innisfail, 20 km from the dam, as is evident from lower peak temperatures at that site compared to the site at Ft. Normandeau (Figure 10). Trimbee and Sosiak (1988) noted that the Dickson Dam also affected water temperatures at a site 27 km downstream of the dam in winter, but not in summer. There appears to be little effect on water temperatures at Ft. Normandeau, 48 km from the dam (Figure 10). At that site, maximum summer temperatures are similar to those recorded at Joffre.

Analysis of data from the long-term monitoring station at Red Deer supports the synoptic survey findings regarding water temperatures at Ft. Normandeau, which is very close to the long-term site at Red Deer. At Red Deer (and at the other long-term sites), there were no significant differences in median water temperatures between pre- and post-impoundment periods (Tables 3-5, Figure 11). The only significant monthly difference between pre- and post-impoundment periods was for April, when post-impoundment temperatures were higher than pre-impoundment temperatures. This same finding was detected coincidentally at the Alberta/Saskatchewan border site (but not at Drumheller), which suggests that the change may have been a result of factors other than flow regulation.

From 1984 to 1989, water temperatures at the long-term monitoring sites at Red Deer and Bindloss did not change significantly; however, temperatures at Drumheller increased by 0.1 °C/yr (Tables 3-5). The lack of a minor temperature change at Red Deer suggests that the change detected at Drumheller was a result of factors other than flow regulation.

4.3.2 Dissolved Oxygen

Historically, the principal concern with respect to the water quality of the Red Deer River was low dissolved oxygen concentrations during the winter. Improvements in the city of Red Deer's wastewater treatment plant from 1969 to 1973 substantially improved winter dissolved oxygen concentrations downstream of Red Deer (Trimbee and Sosiak 1988), but levels occasionally fell below the Alberta Surface Water Quality Objective of 5 mg/L, especially near the Alberta/Saskatchewan border. It was anticipated that increased winter

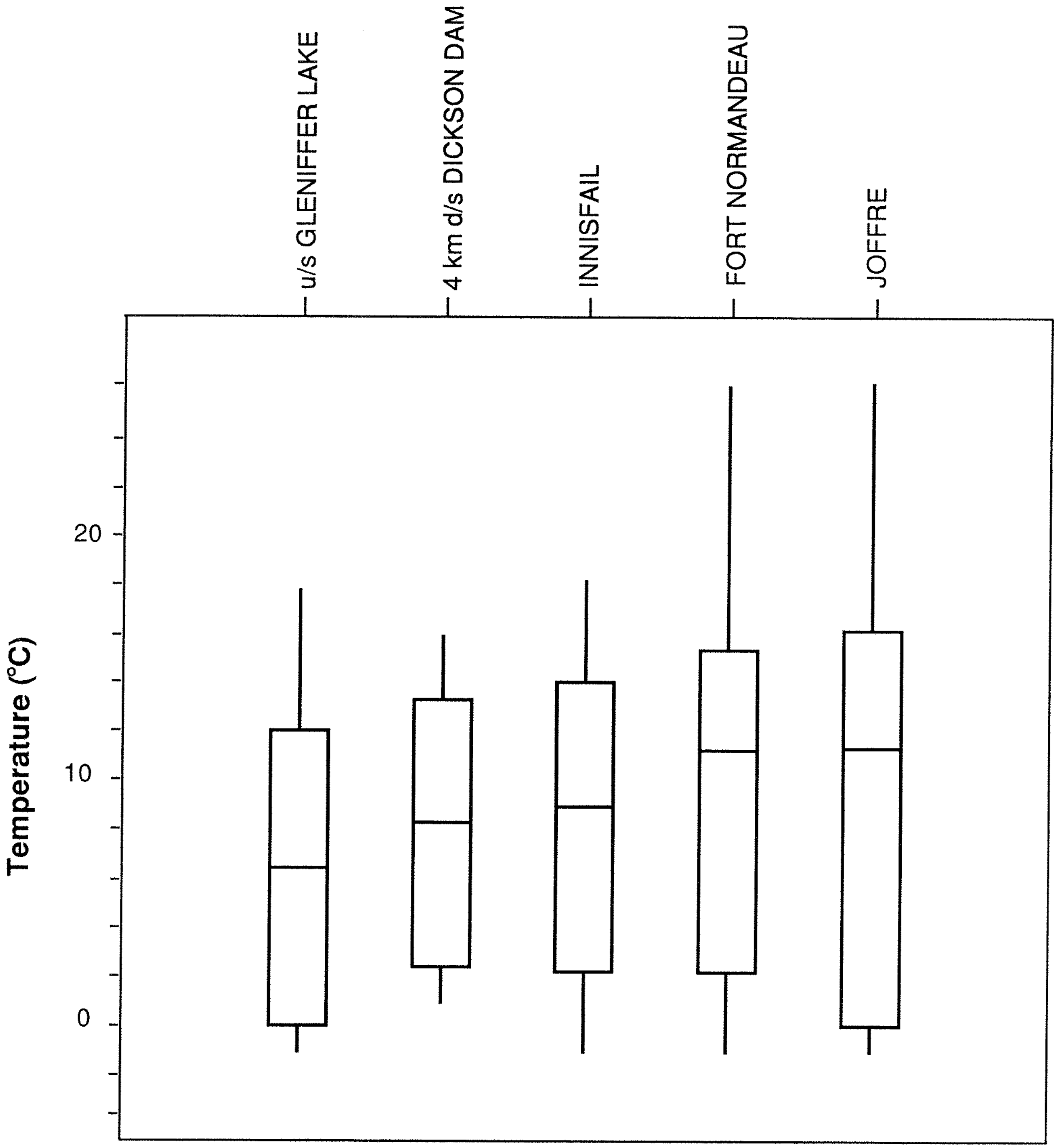


Figure 10. Water temperatures in the Red Deer River, 1983-88 synoptic surveys.

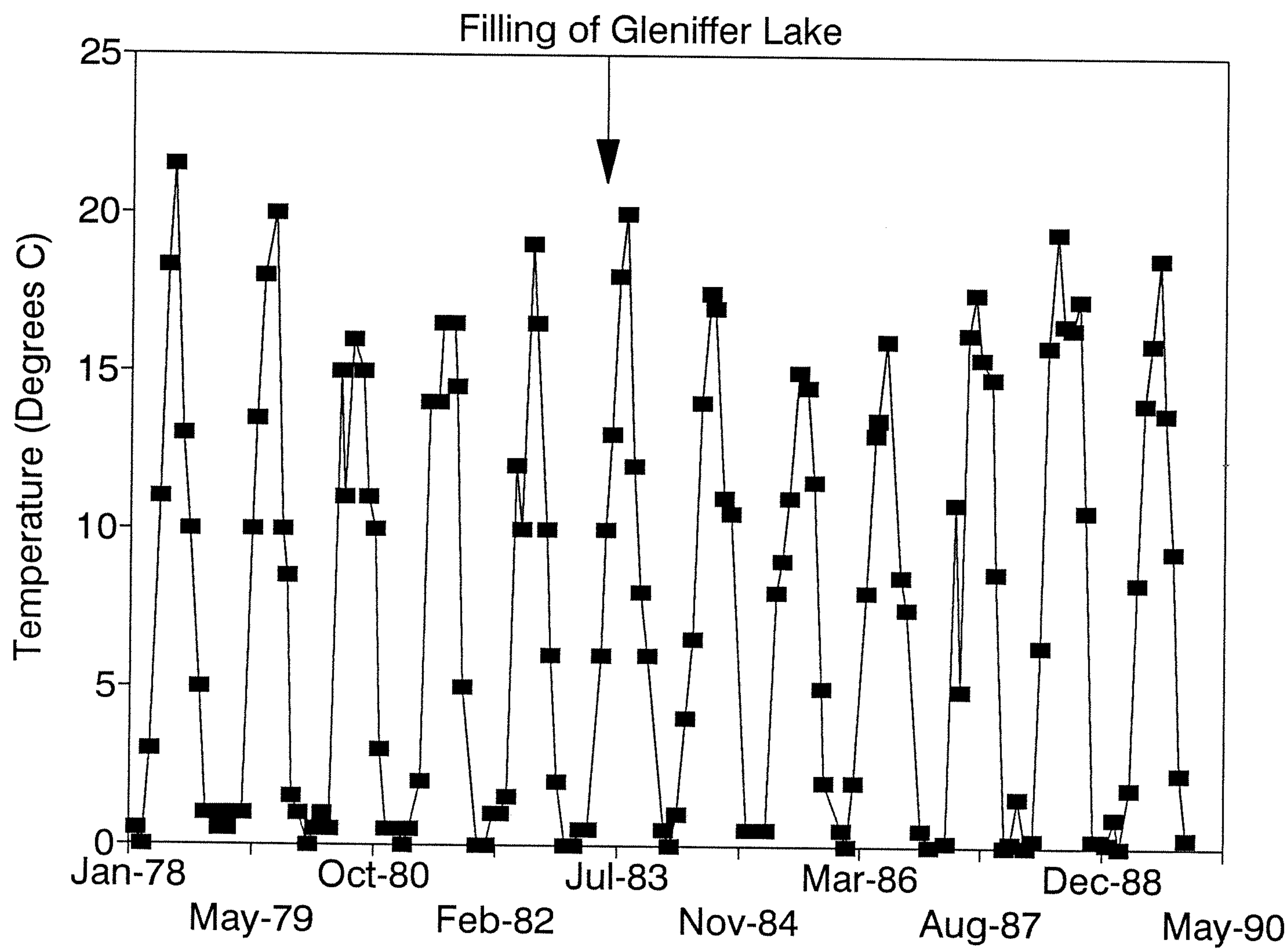


Fig. 11. Temperatures at the Red Deer long-term monitoring site, 1978-89.

flows following completion of the dam would be sufficient to maintain dissolved oxygen concentrations above 5 mg/L.

Upstream of Gleniffer Lake, dissolved oxygen concentrations remain near saturation throughout the year; the highest levels were recorded in winter and the lowest levels in summer. Concentrations of dissolved oxygen increased slightly immediately downstream of the dam (Figure 12) as a result of reaeration within the two riparian flow tunnels or occasionally over the spillway in summer. During the synoptic surveys, median levels of dissolved oxygen remained high as far downstream as Joffre. But dissolved oxygen concentrations at Joffre were lowest in winter and highest in summer, unlike that at other sites. That pattern was a consequence of photosynthesis and respiration associated with high epilithic algal and macrophyte populations at Joffre (Section 4.3.8).

Analysis of the long-term monitoring station data supports the findings of the synoptic surveys that dissolved oxygen concentrations in the Red Deer River have increased as a result of flow augmentation. Post-impoundment, median dissolved oxygen concentrations have increased significantly at the long-term monitoring sites at Red Deer and Drumheller, by 1.0 and 0.4 mg/L, respectively (Tables 3, 4; Figures 13, 14). There has been no significant change in dissolved oxygen concentrations at Bindloss (Table 5; Figure 15).

Post-impoundment dissolved oxygen concentrations were significantly higher than pre-impoundment levels for the months of January, February, March, May, and June at the Red Deer site and during January at Drumheller (Tables 3, 4). There have been no significant monthly changes in dissolved oxygen concentrations at Bindloss (Table 5). At Red Deer, dissolved oxygen concentrations remained near the saturation point throughout the year, the highest levels being recorded during winter and the lowest during summer. The pattern is different at the other two sites where both pre- and post-impoundment dissolved oxygen concentrations were lowest in winter and highest in summer.

The Dickson Dam has maintained dissolved oxygen concentrations in the river above 5.0 mg/L at the long-term monitoring site upstream of the city of Red Deer (Figure 13). At Drumheller and Bindloss, however, post-impoundment winter lows of 3.9 and 2.6 mg/L, respectively, have been recorded (Figures 14, 15). These lows are, however, higher than the minimum pre-impoundment (1978-83) dissolved oxygen levels of 0.4 and 0.9 mg/L recorded at Drumheller and Bindloss, respectively.

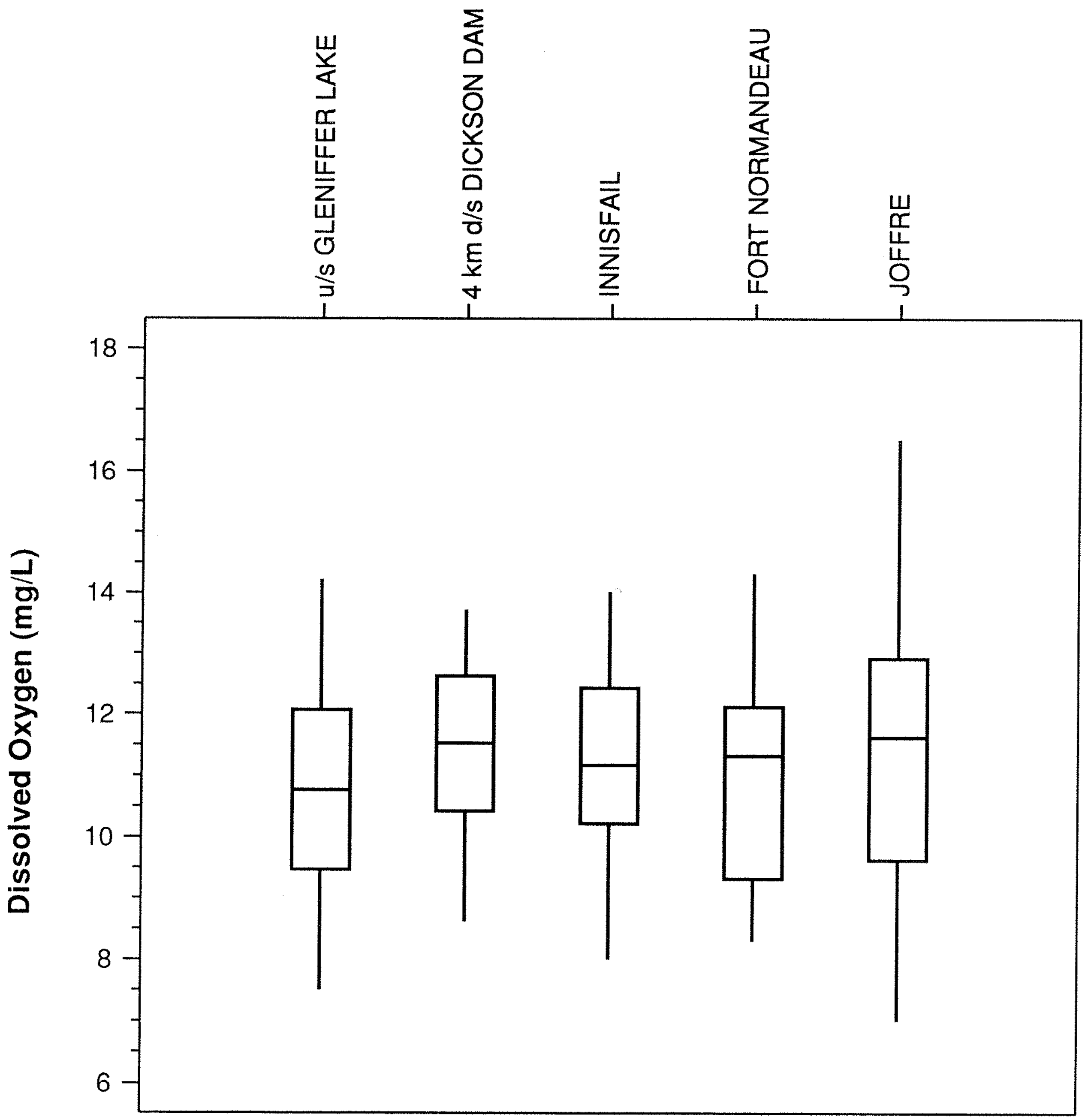


Figure 12. Dissolved oxygen levels in the Red Deer River, 1983-88 synoptic surveys.

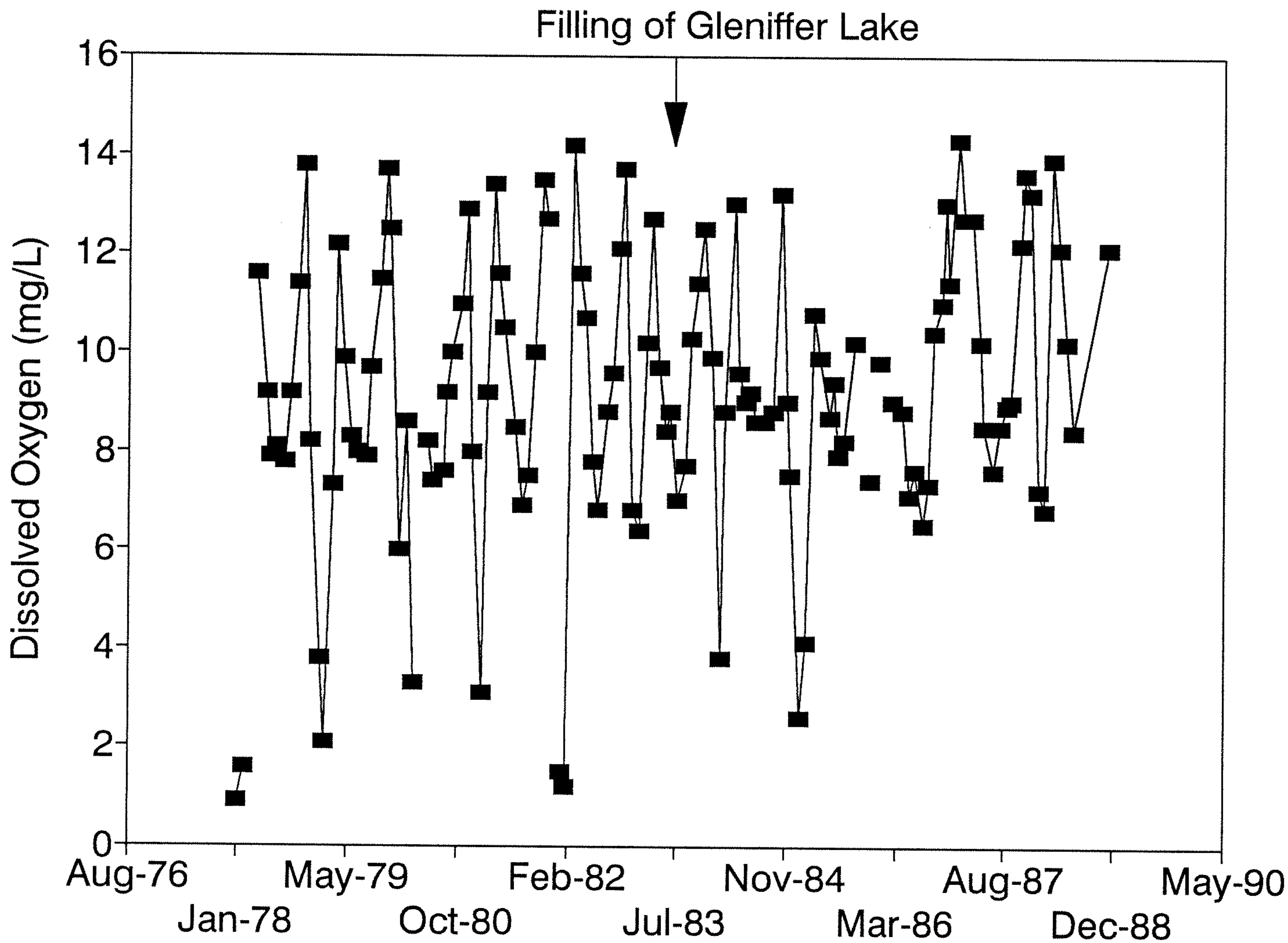


Fig. 13. Dissolved oxygen at the Red Deer long-term monitoring site, 1978-89.

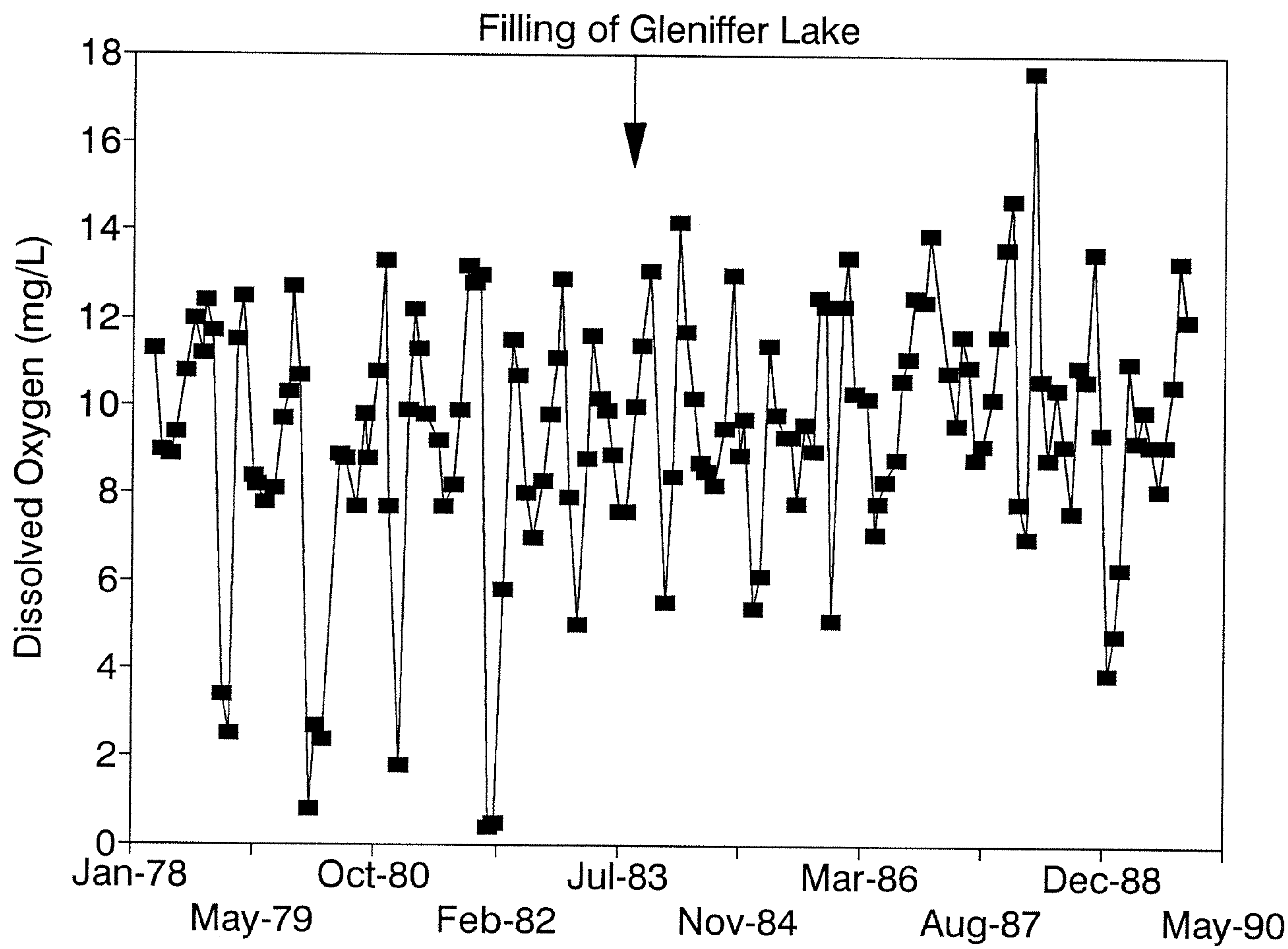


Fig. 14. Dissolved oxygen at the Drumheller long-term monitoring site, 1978-89.

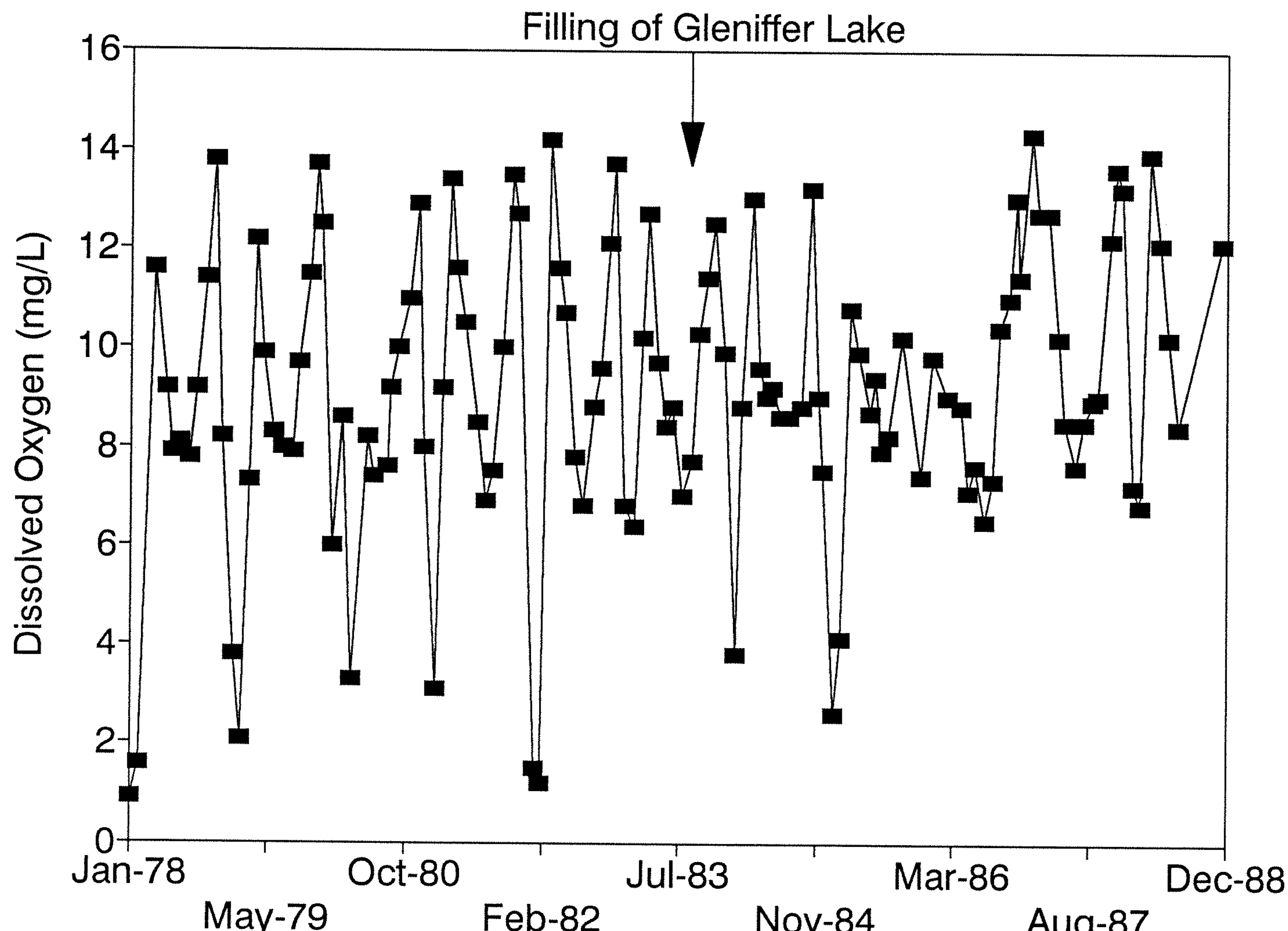


Fig. 15. Dissolved oxygen at the Bindloss long-term monitoring site, 1978-89.

Since the filling of Gleniffer Lake, the trends in dissolved oxygen concentrations at the Red Deer and Bindloss sites have shown significant increases of 0.16 and 0.19 mg/L/yr, respectively; there was no trend detected for Drumheller (Tables 3-5). It is not clear whether the trends detected at Red Deer and Bindloss are related to flow regulation or are a result of other factors. Note that at Bindloss the upward trend may be too small to be detected by the Mann-Whitney test.

4.3.3 Non-filterable Residue (Suspended Solids) and Turbidity

A common effect of impoundments is that particulate material settles out in the reservoir, and suspended solids concentrations are reduced in the river downstream of the dam (Baxter and Glaude 1980). Retention of suspended solids by Gleniffer Lake is apparent from inspection of a time-series plot of concentrations recorded at sites immediately upstream and downstream of the reservoir (Figure 16). Suspended solids concentrations (also called non-filterable residue or NFR) at the downstream site were generally lower than at the upstream site, which suggests that particulate material was settling out in the reservoir. The 1983-88 synoptic survey data indicates that suspended solids concentrations were reduced as far downstream as Joffre, as shown by the reduced maximum and median values at all sites downstream of the dam compared to the upstream site (Figure 17). As in most other rivers, suspended solids levels in the Red Deer River are strongly correlated to flow (long-term site at Red Deer: r=0.73, df=143, P<0.001); similar correlations were observed for turbidity.

In contrast to the findings of the synoptic surveys, median levels of suspended solids and turbidity did not differ significantly between pre- and post-impoundment periods at any of the long-term monitoring sites (Tables 3-5). Inspection of the time series plots supports the results of the statistical difference tests; there was no clear decrease in suspended solids concentrations following the filling of Gleniffer Lake (Figures 18, 19). The lack of a change between pre- and post-impoundment levels of suspended solids and turbidity at the Drumheller and Bindloss sites is not surprising, because there is a rapid increase in the levels of these variables from Trochu to Drumheller as a result of changes in basin geology (Cross 1988). The lack of a significant decrease in levels of suspended solids and turbidity at the Red Deer site is, however, unexpected based on analysis of the 1983-88 synoptic survey data. These contradictory findings may be partly a result of differences in

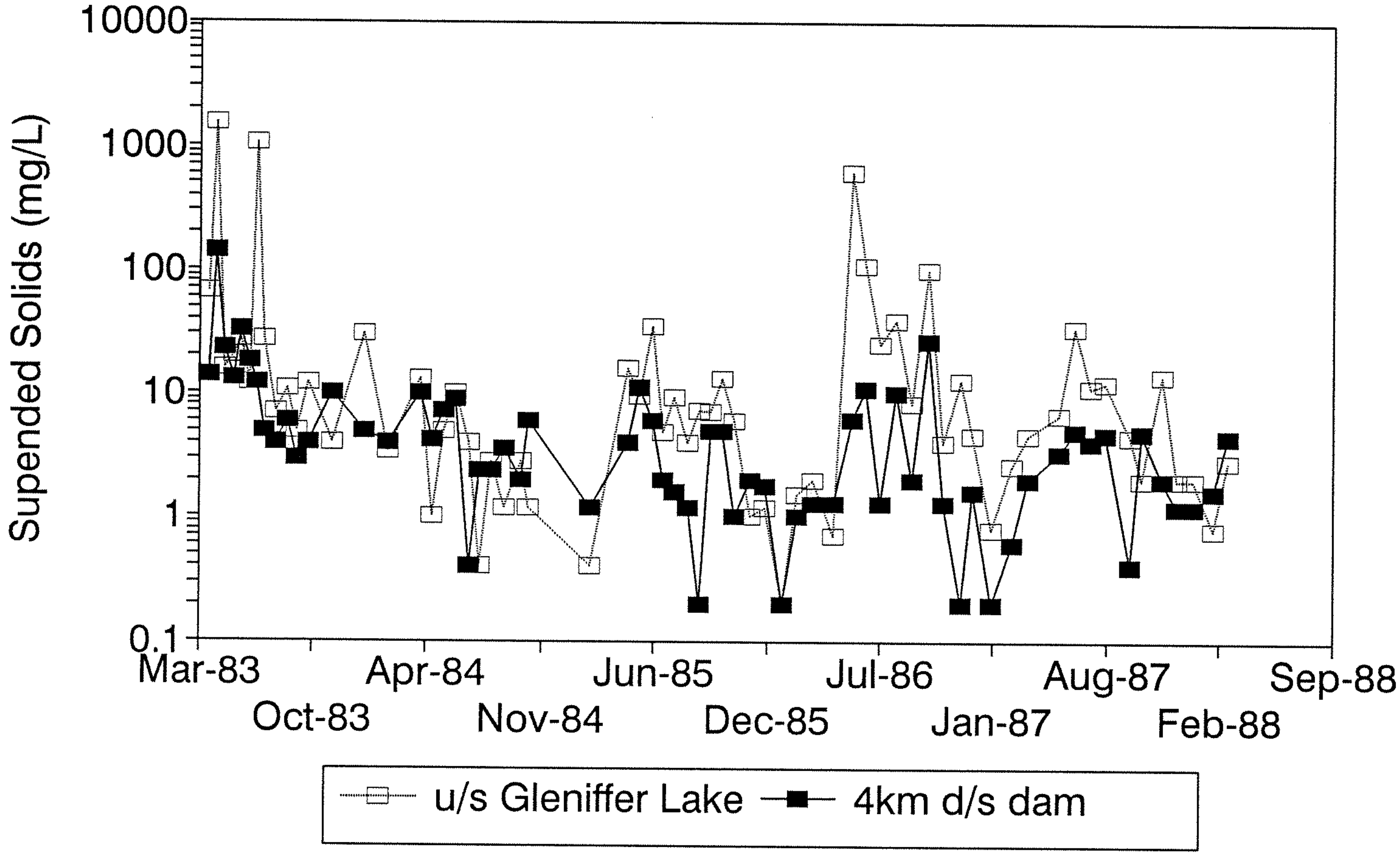


FIg. 16. Suspended solids above and below Gleniffer Lake, 1983-88.

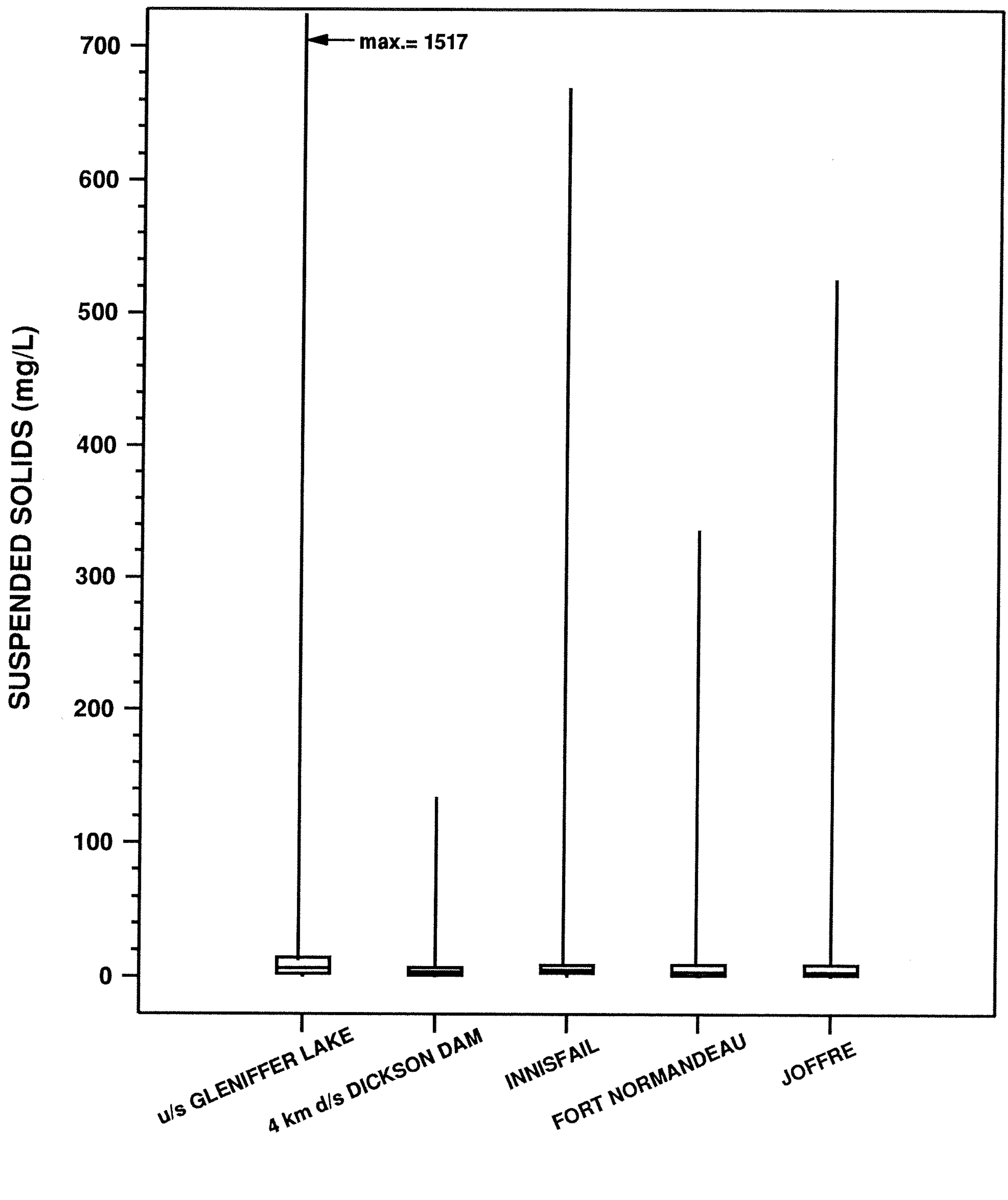


Figure 17. Suspended solids concentrations in the Red Deer River, 1983-88 synoptic surveys.

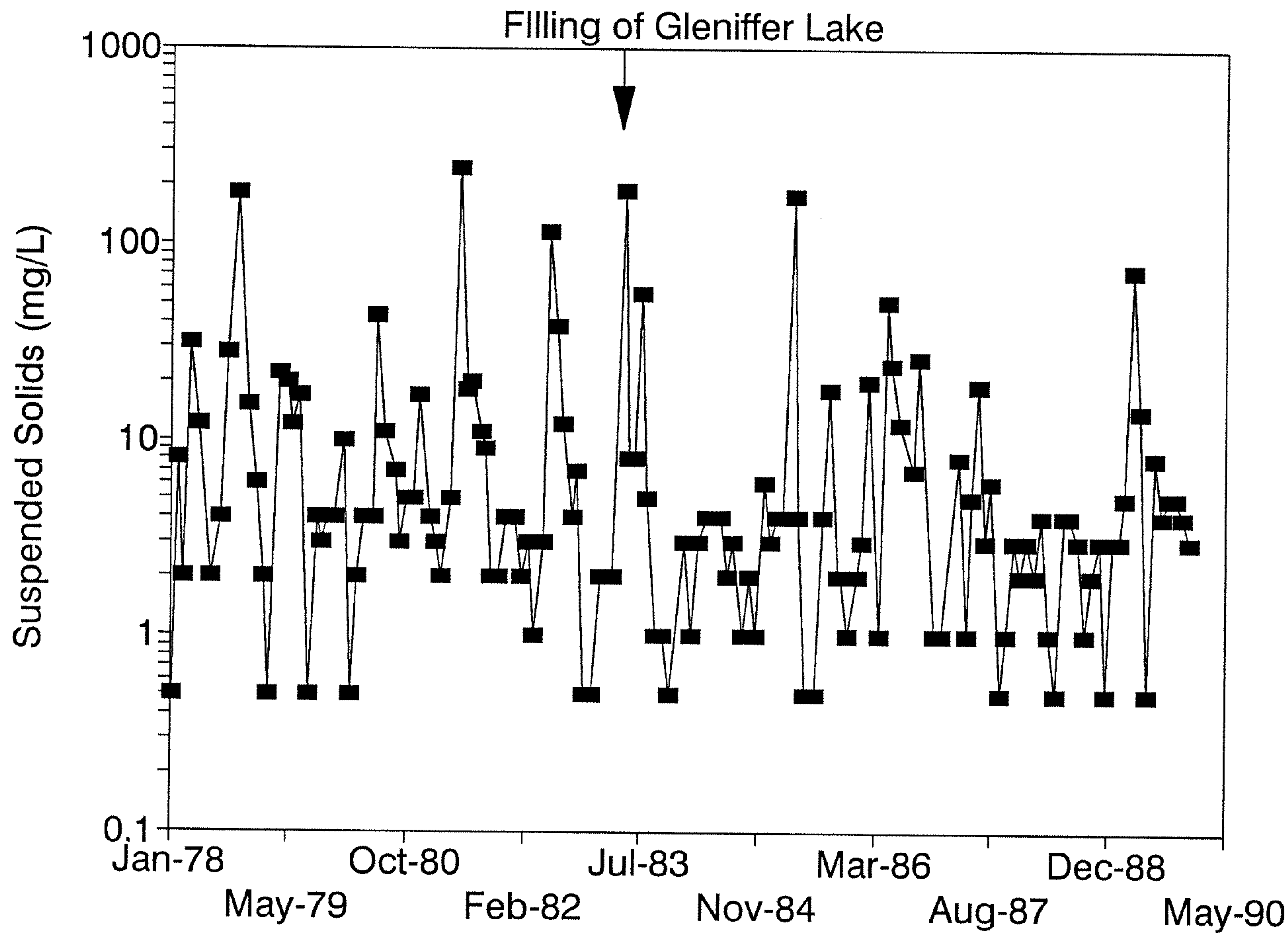


Fig. 18. Suspended solids at the Red Deer long-term monitoring site, 1978-89.

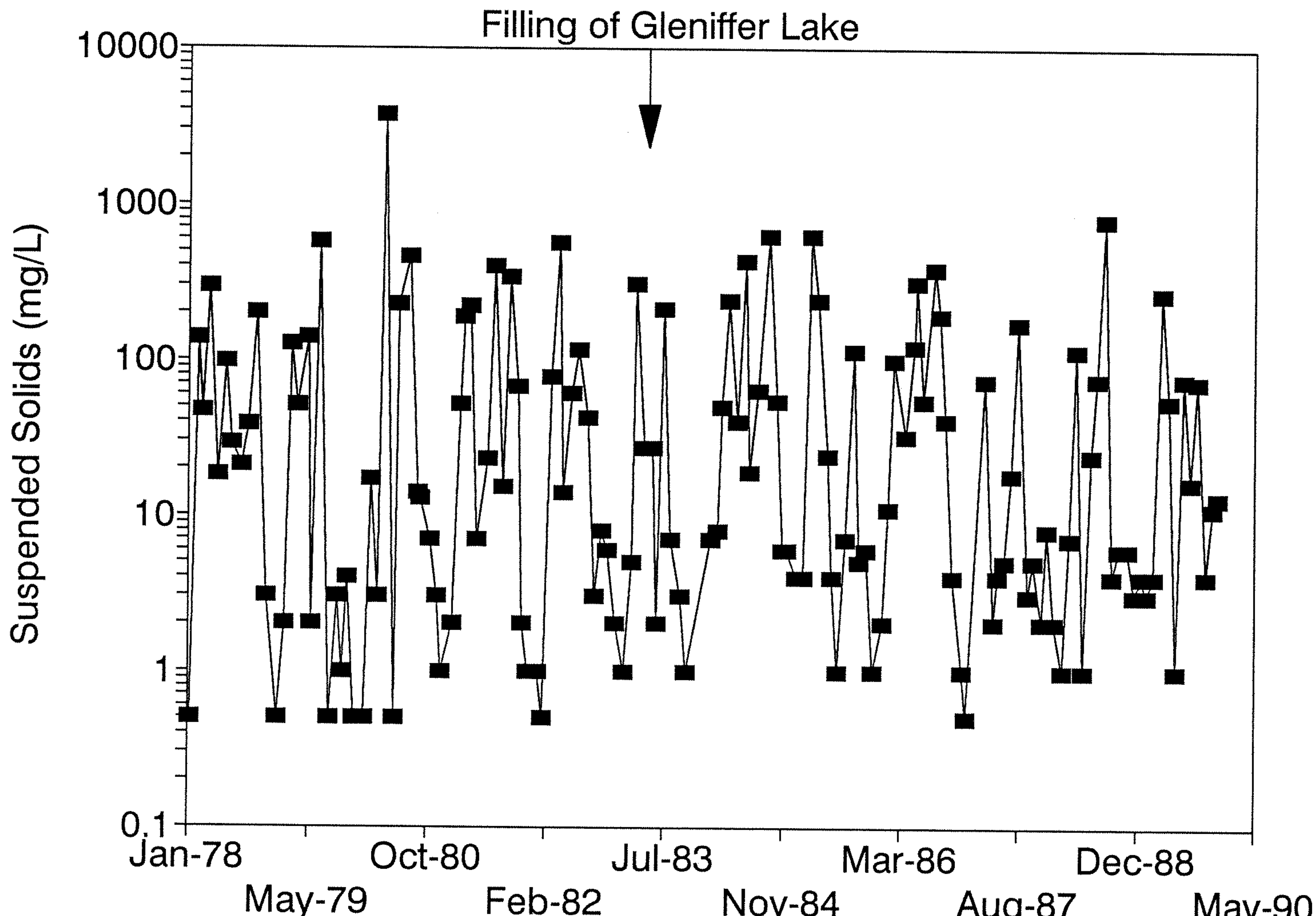


Fig. 19. Suspended solids at the Drumheller long-term monitoring site, 1978-89.

sampling design between the two studies (the synoptic data are primarily from spring and summer) and of the low suspended solids concentrations in the Red Deer River. Suspended solids concentrations increase with increasing flow (Table 2), and the highest levels are associated with spring and summer runoff. Except for periods of high flow, concentrations of suspended solids in the Red Deer River are fairly low, e.g. the median concentration calculated for the site upstream of Gleniffer Lake during the 1983-88 synoptic surveys was only 6.6 mg/L. Therefore, the effect of the reservoir on concentrations of suspended solids would be restricted largely to reducing spring and summer peaks associated with runoff events.

Changes between pre- and post-impoundment monthly suspended solids levels were inconsistent between sites. At Red Deer, post-impoundment levels of suspended solids were higher than pre-impoundment levels during the months of January and October and were lower in March (Table 3). At Drumheller, post-impoundment levels were higher than pre-impoundment levels in January and lower in July (Table 4), and at Bindloss, post-impoundment levels during April were lower than pre-impoundment levels (Table 5).

At the long-term monitoring site upstream of the city of Red Deer, concentrations of suspended solids increased significantly (0.3 mg/L/yr; Table 3) during 1984-89, even though there was no significant change in the median level. No trends were detected at the other long-term monitoring sites. In summary, it would appear that the only major reduction in suspended solids concentrations has occurred at the site 4 km downstream of the dam. These patterns may change over a longer period of time.

4.3.4 Nutrients

One concern associated with the construction of impoundments is that plant nutrients and inorganic solutes may be leached from the flooded soils and released as flooded vegetation decays. Such increases in nutrients may lead to increases in populations of phytoplankton and attached algae (Baxter and Glaude 1980). Although this may have occurred to some extent in Gleniffer Lake, total nitrogen (TN) and total phosphorus (TP) concentrations at the synoptic survey site 4 km downstream of the lake are similar to levels upstream of the lake (Figure 20). There were very slight or no increases in median levels of NO_2+NO_3-N, NH_4-N, and total dissolved phosphorus at the site 4 km downstream of the dam compared to the site upstream of the reservoir (Appendix IV). Nutrient release from the

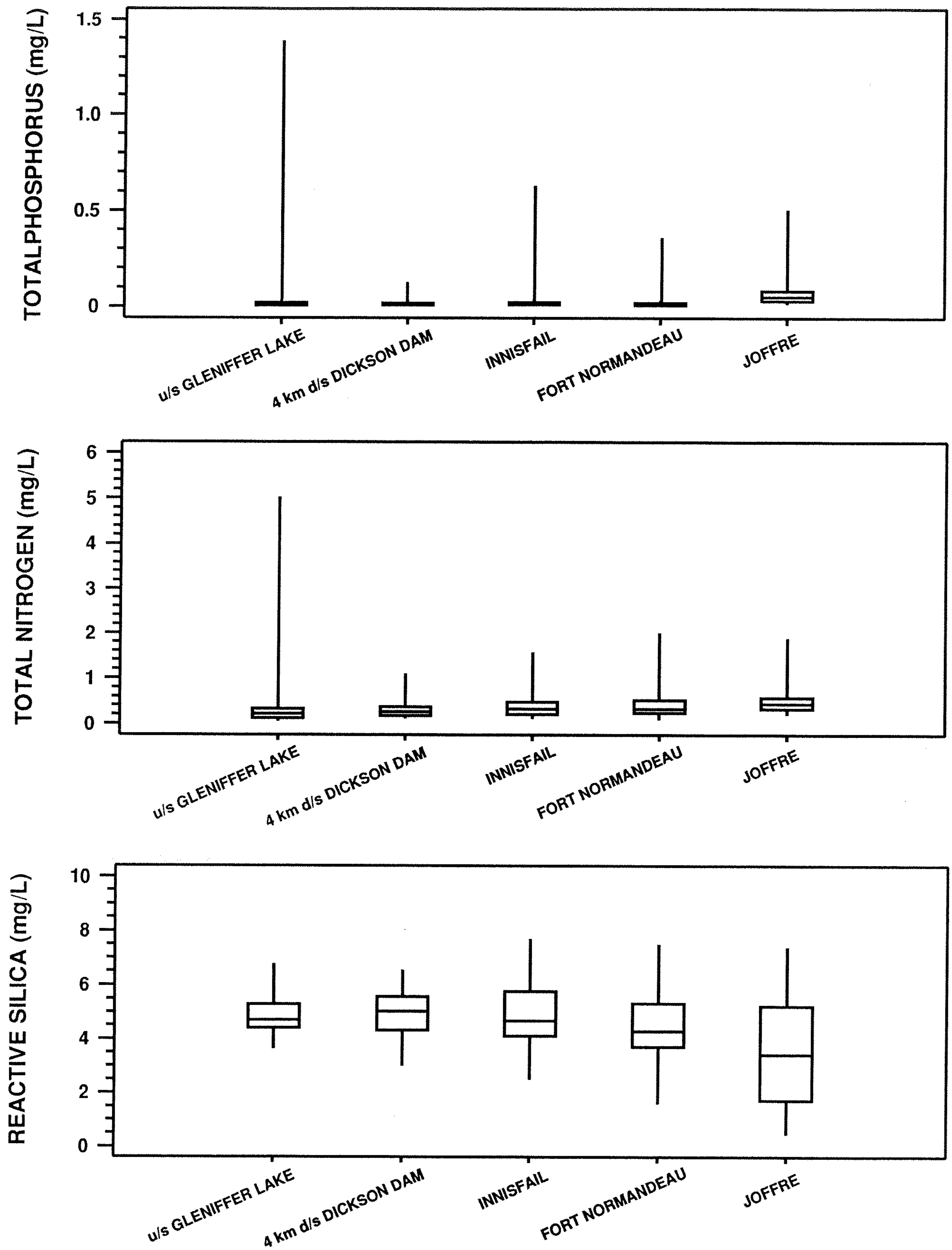


Figure 20. Nutrient concentrations in the Red Deer River, 1983-88 synoptic surveys.

flooded soils may have been reduced as a result of removal of some of the topsoil before the land was flooded.

Based on synoptic data, Gleniffer Lake reduces peak concentrations of TN and TP at sites downstream of the dam (Figure 20). The high nutrient values upstream of the reservoir corresponded to high concentrations of suspended solids associated with spring and summer runoff events. The reduction in peak nutrient levels results from adsorption of phosphorus and nitrogen to particulate material, which settles out in the reservoir.

Concentrations of total nitrogen and total phosphorus were particularly high at Joffre. This is related to nutrient loading from the City of Red Deer's wastewater treatment plant. Interestingly, the lowest levels of silica were also recorded at Joffre, probably as a result of uptake by diatoms.

At the Red Deer and Drumheller long-term monitoring stations, changes in analytical methods, detection limits, and fractions analyzed restricted the evaluation of nutrients to TP, total dissolved phosphorus (TDP), particulate phosphorus (PP), particulate nitrogen (PN), and reactive silica. At the long-term monitoring site upstream of the city of Red Deer, there were no significant changes between pre- and post-impoundment periods in median concentrations of PN, TDP, and TP (Figure 21); however, post-impoundment levels of PP and reactive silica were significantly lower than pre-impoundment levels (Table 3, Figure 22). At Drumheller, post-impoundment concentrations of TP and PP were significantly lower than pre-impoundment levels, and there were no significant changes in concentrations of TDP, PN, silica, and the other nutrient fractions that were tested (Table 4). Farther downstream at Bindloss, post-impoundment concentrations of all nutrient fractions except TDP were significantly lower than pre-impoundment concentrations (Table 5).

Following the filling of Gleniffer Lake, no significant trends were observed in the concentrations of any of the nitrogen or phosphorus fractions analyzed at the Red Deer site (Table 3). In addition, there have been no consistent changes between monthly pre- and post-impoundment median levels of nitrogen or phosphorus fractions. In contrast, silica concentrations increased significantly from 1984 to 1989 (Table 3; Figure 22). Silica levels decreased during the winter months, as would be expected for a flow-dependent solute (Table 2).

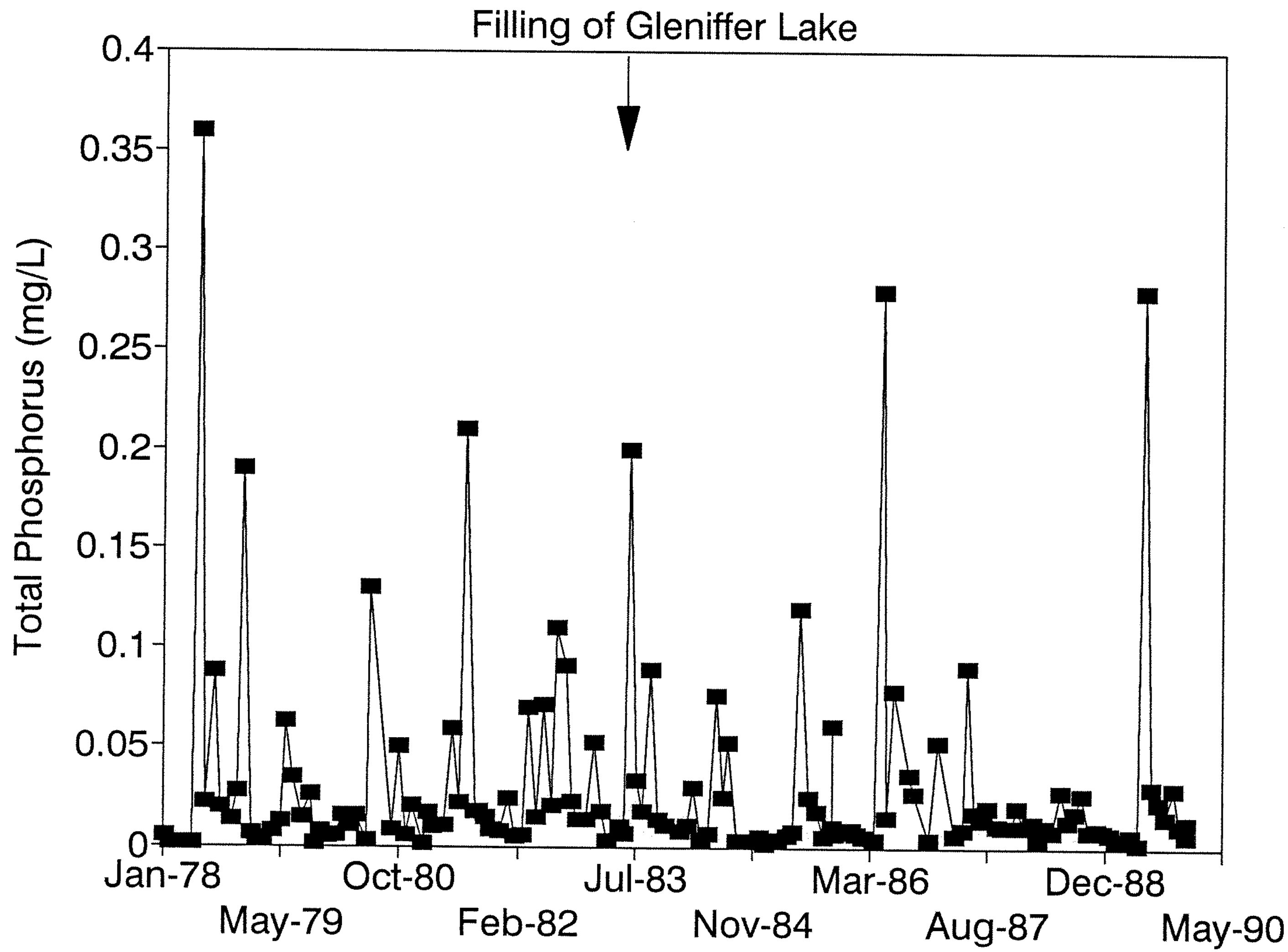


Fig. 21. Total phosphorus at the Red Deer long-term monitoring site, 1978-89.

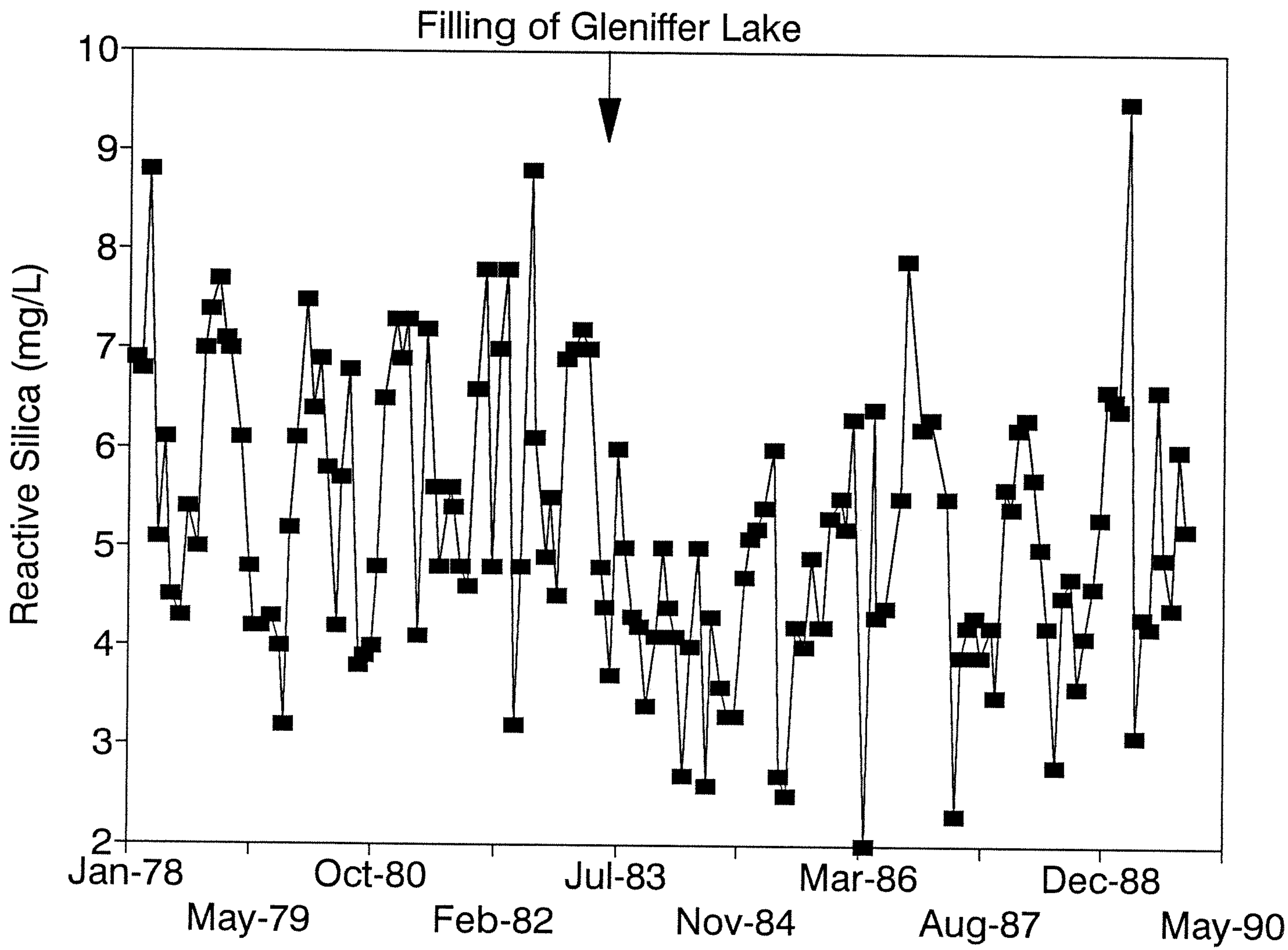


Fig. 22. SIlica levels at the Red Deer long-term monitoring site, 1978-89.

4.3.5 Inorganic Constituents

Inorganic solutes may be leached from flooded soils and released from decaying vegetation following filling of a reservoir. This, however, does not appear to be the case at Gleniffer Lake because levels of total dissolved solids (TDS) and other inorganic solutes are lower at the sites downstream of the dam compared to the site upstream of the reservoir (Figure 23; Appendix IV). The synoptic survey data show a decrease in median levels of TDS and the other flow-dependent variables (with the exception of pH) at least as far downstream as Joffre.

Analysis of the long-term monitoring site data supports the synoptic survey findings of a decrease in the levels of many inorganic solutes coincident with impoundment of the Red Deer River (Tables 3-5). For many of the variables, post-impoundment levels were lower than pre-impoundment levels at all three long-term monitoring sites (e.g. above Red Deer, Figures 24 and 25, and Bindloss). The probable cause of the decrease in these variables is related to $CaCO_3$ precipitation within Gleniffer Lake. The Red Deer River is supersaturated with $CaCO_3$ (H. Hamilton 1990, pers. comm.), and the pH of Gleniffer Lake (range 8-8.4) tends to be higher than in the inflowing water of the Red Deer River (range 7.1-8.6). Therefore, this increase in pH may be sufficient to precipitate $CaCO_3$ and coprecipitate $MgCO_3$. This would explain decreases in levels of calcium, magnesium, bicarbonate, total dissolved solids, conductance, hardness, and alkalinity. It does not, however, provide an explanation for a change in sulphate levels.

Total dissolved solids, specific conductance, alkalinity, pH, hardness, calcium, bicarbonate, magnesium, sodium, and sulphate levels were all flow-dependent in the Red Deer River at the Red Deer site (Table 2). Except for pH, levels of these variables decreased with increasing flow. As would be expected for flow-dependent variables, there were significant seasonal changes between pre- and post-impoundment periods; concentrations were significantly lower during most winter months and higher in the summer months (Tables 3-5).

Few trends in levels of inorganic variables were evident downstream of Gleniffer Lake after it filled in 1983. At Red Deer, pH and sulphate levels decreased; at Drumheller, sulphate concentrations decreased and chloride concentrations increased. There were no significant trends observed at the Bindloss site (Tables 3-5). Decreases in sulphate concentrations may be related to flow regulation, as post-impoundment levels were

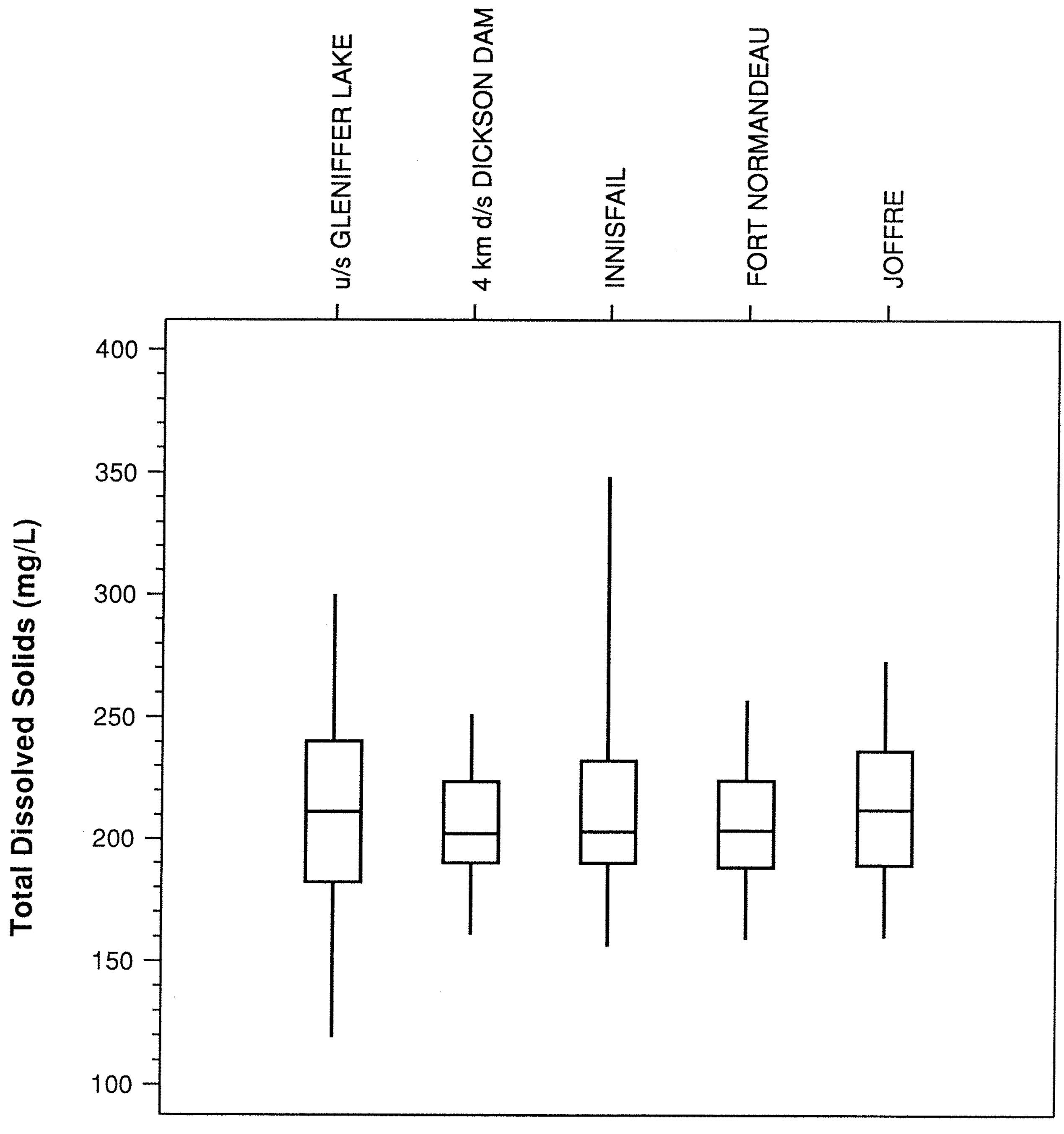


Figure 23. TDS concentrations in the Red Deer River, 1983-88 synoptic surveys.

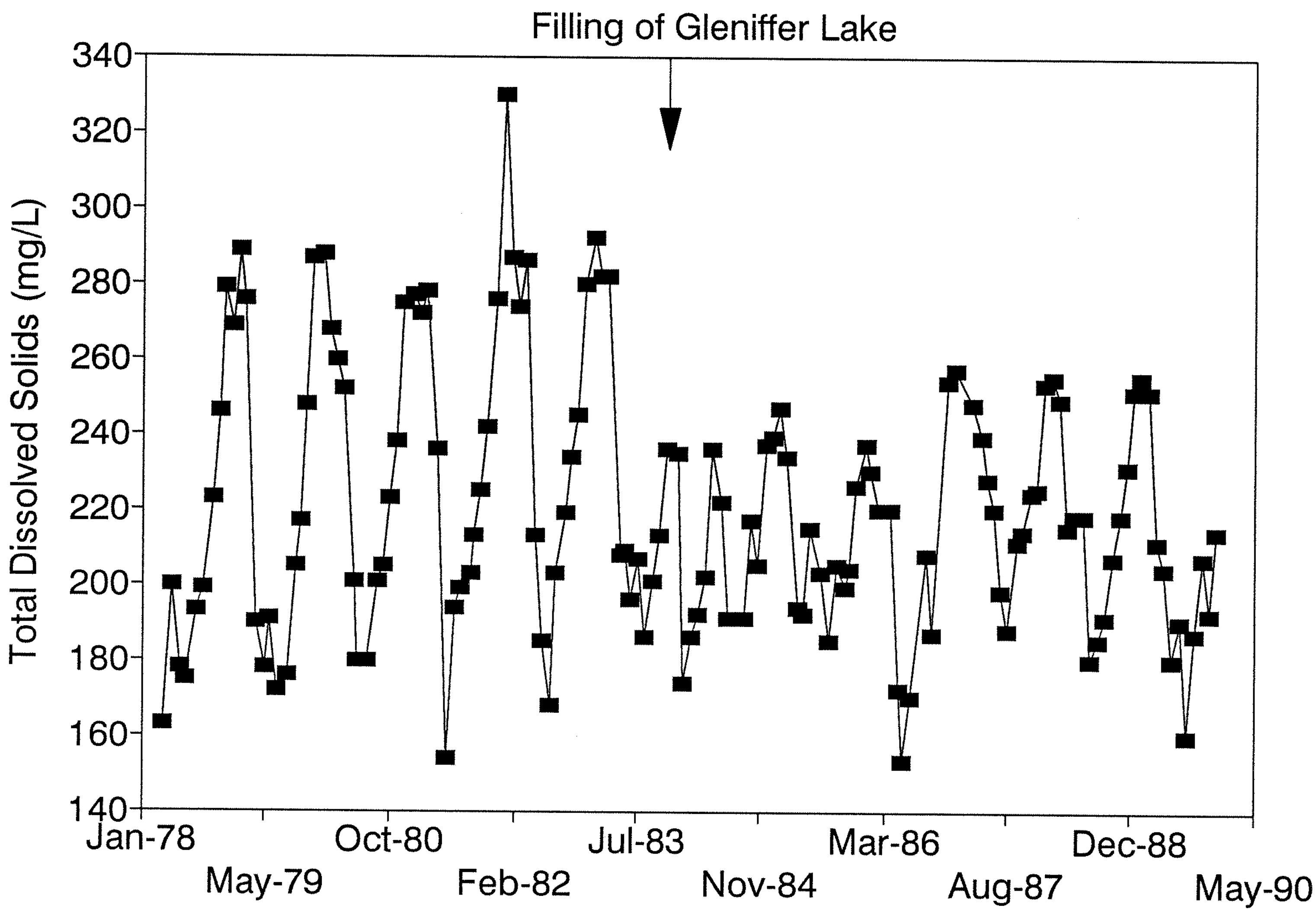


Fig. 24. TDS levels at the Red Deer long-term monitoring site, 1978-89.

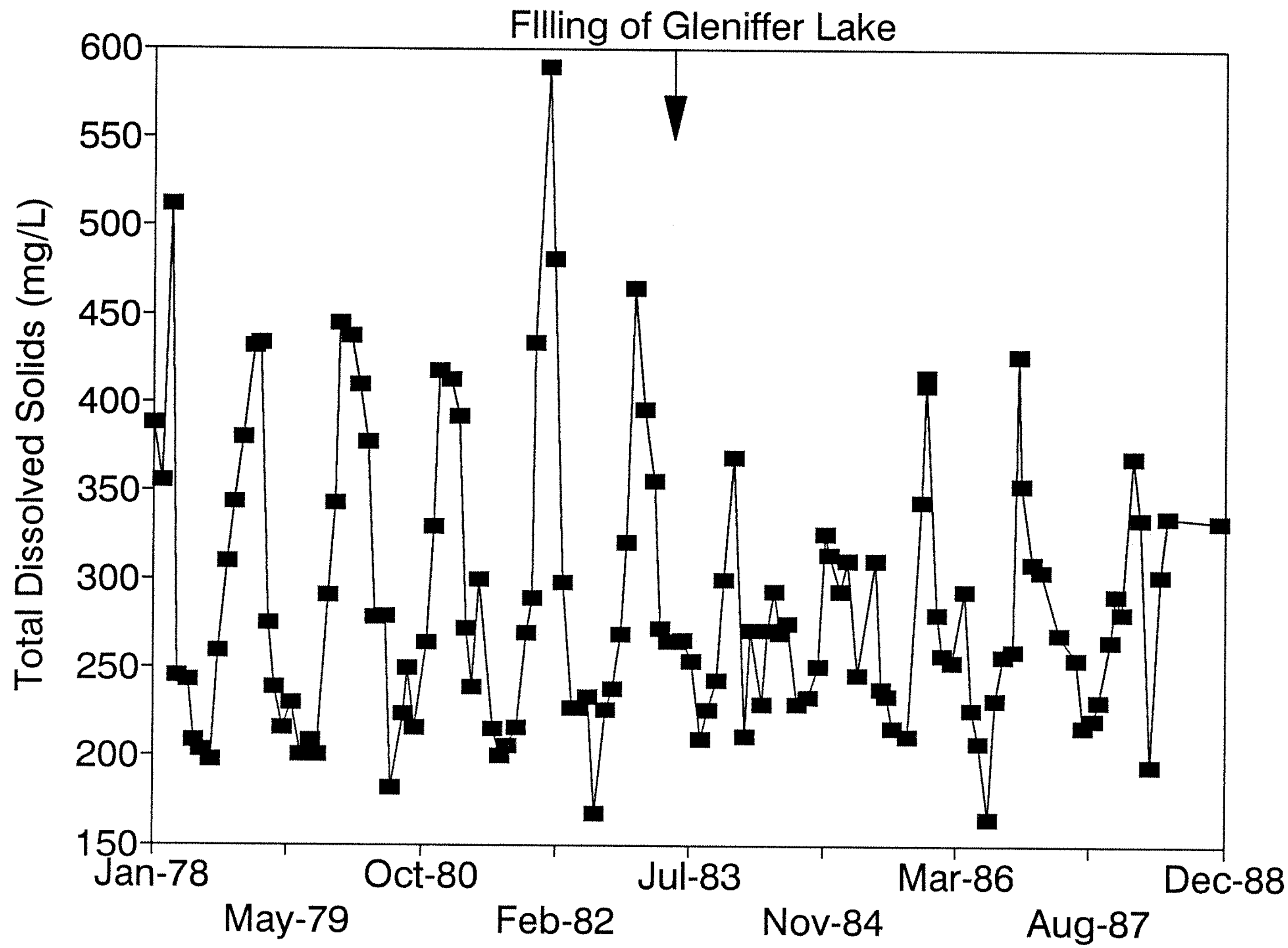


Fig. 25. TDS levels at the Bindloss long-term monitoring site, 1978-89.

lower than pre-impoundment levels; however, the cause of the reduced sulphate levels is not known.

There were too few metal and trace element data from the long-term sites to determine whether there were changes between pre- and post-impoundment periods, and the 1983-88 survey data are mostly restricted to three sites: upstream of Gleniffer Lake, 4 km below the dam, and at Ft. Normandeau. Except for iron and manganese concentrations, which increased in the river as it neared Ft. Normandeau (Table 7), median levels of metals and trace elements were not greatly affected by the dam. It is obvious, however, that the reservoir greatly reduces peak concentrations of most constituents (Table 7). The reduction in peak values is related to settling out in the reservoir of particulate matter, onto which metal ions and trace elements are adsorbed.

4.3.6 Organic Constituents

Concentrations of dissolved organic carbon (DOC) in the euphotic zone of Gleniffer Lake have increased since the reservoir was filled (Figure 8). At least part of this increase is attributable to ongoing loading from the Red Deer River. Concentrations of DOC immediately downstream of the dam, however, are higher than those upstream of the reservoir, which suggests that DOC may be leaching into the lake from flooded soils and/or decaying vegetation (Figure 26). This increase was particularly noticeable from July 1986 to February 1988. Even though median levels of DOC downstream of the dam are higher than at the upstream site, the maximum concentrations recorded at the downstream sites are lower than at the upstream site (Figure 27).

Measurements of dissolved organic carbon concentrations from the long-term monitoring sites at Red Deer and Drumheller support the hypothesis of a release of DOC from within the reservoir (Figure 28). There is a significant trend toward increasing DOC concentrations at both sites (Tables 3, 4) since the reservoir was filled in 1983. There were, however, no significant changes in the overall or monthly median DOC concentrations between pre- and post-impoundment periods, possibly because of the small trend increments.

Phenolic compounds and tannin and lignin were the only other organic constituents measured during the synoptic surveys. There were no increases in median levels of these variables at the site downstream of the dam compared to the site upstream of the reservoir (Appendix IV).

Table 7. Median and range (in parentheses) of metal and trace element concentrations at several locations on the Red Deer River, 1983-88 synoptic surveys.

VARIABLE	u/s DICKSON DAM	4 km d/s DICKSON DAM	FT. NORMANDEAU
Aluminum (extr.)	0.05 (<0.02-9.91)	0.05 (<0.02-0.25)	0.048 (<0.02-1.4)
Arsenic (total)	0.0004 (<0.0002-0.019)	0.0005 (0.0002-0.002)	<0.0005 (<0.0002-0.0029)
Chromium (total)	0.003 (<0.001-0.039)	0.003 (<0.001-0.01)	0.003 (<0.001-0.01)
Copper (total)	0.003 (<0.001-0.044)	0.002 (<0.001-0.008)	0.002 (<0.001-0.008)
Cobalt (total)	<0.001 (<0.001-0.018)	<0.001 (b.d.)	<0.001 (<0.001-0.004)
Lead (extr.)	<0.003 (<0.003-0.012)	<0.003 (0.001-0.005)	<0.003 (<0.003-0.015)
Manganese (extr.)	<0.01 (<0.004-0.280)	<0.01 (<0.001-0.036)	0.01 (<0.001-0.32)
Molybdenum (total)	<0.001 (<0.001-0.052)	<0.001 (b.d.)	<0.001 (<0.001-0.005)
Mercury (total)	<0.0001 (<0.0001-0.065)	<0.0001 (0.0001-0.0002)	<0.0001 (<0.0001-0.0002)
Iron (extr.)	<0.01 (<0.01-8.68)	0.06 (<0.01-0.86)	0.09 (<0.01-3.92)
Lead (extr.)	<0.003 (0.001-0.012)	<0.003 (0.001-0.005)	<0.003 (<0.002-0.015)
Nickel (extr.)	<0.001 (<0.001-0.10)	<0.001 (<0.001-0.004)	<0.001 (<0.001-0.012)
Selenium (total)	<0.0002 (<0.0002-0.01)	<0.0002 (b.d.)	<0.0002 (b.d.)
Zinc (total)	0.012 (<0.001-0.187)	0.003 (<0.001-0.024)	0.003 (<0.001-0.027)

Notes:
Units are in mg/L.
extr. - extractable
b.d. - all values below analytical detection limits

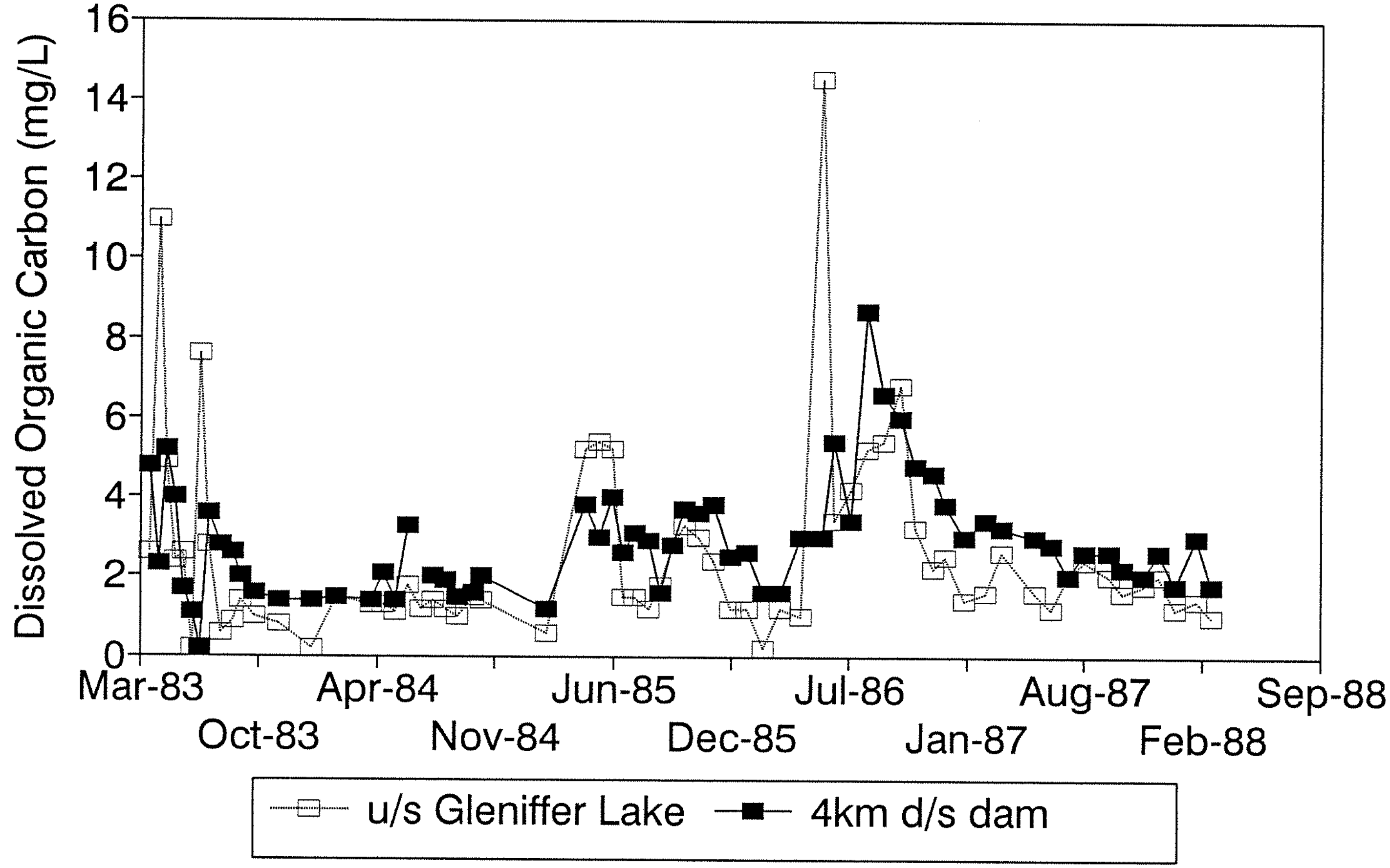


Fig. 26. DOC levels above and below Gleniffer Lake, 1983-88.

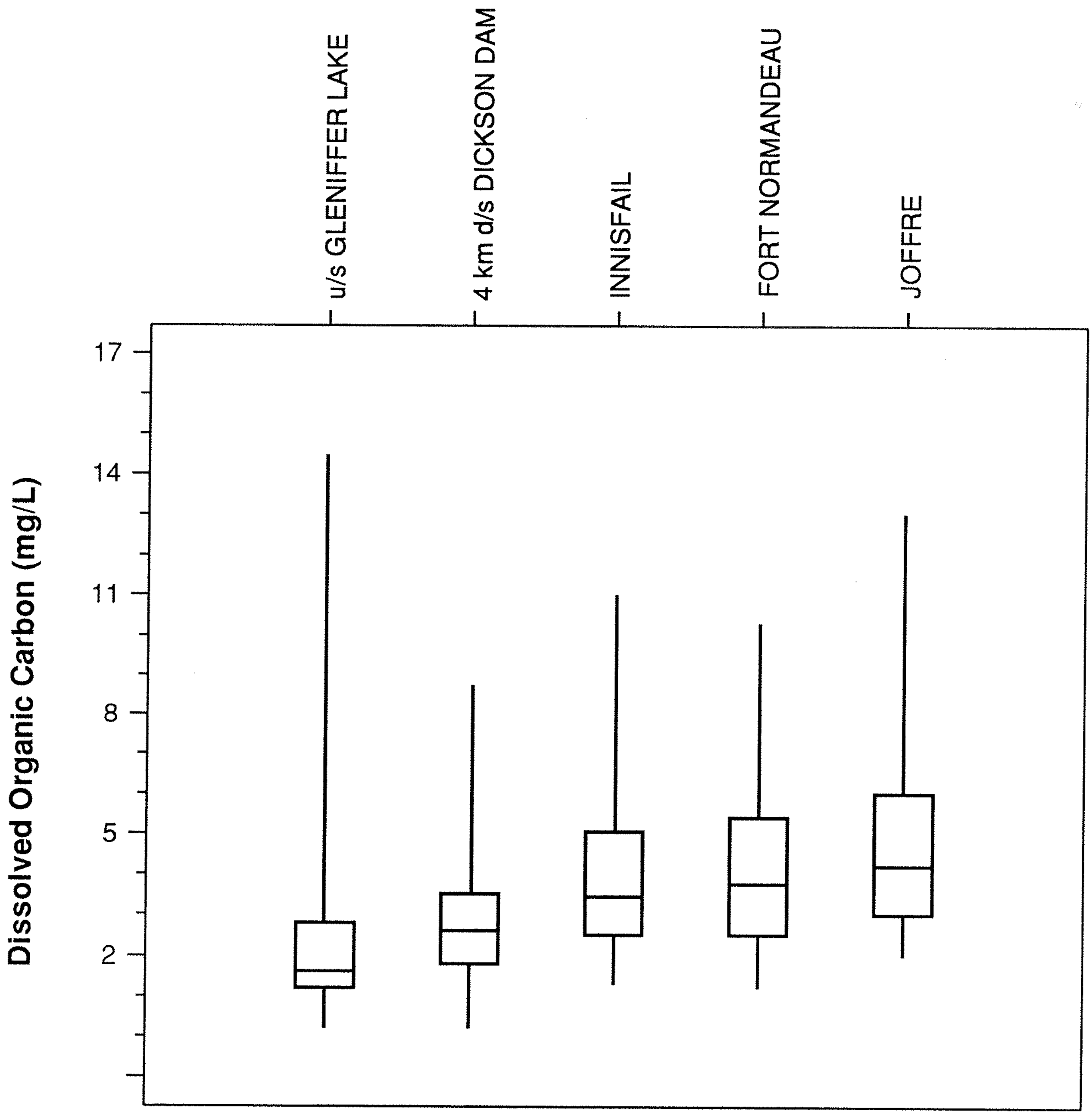


Figure 27. DOC concentrations in the Red Deer River, 1983-88 synoptic surveys.

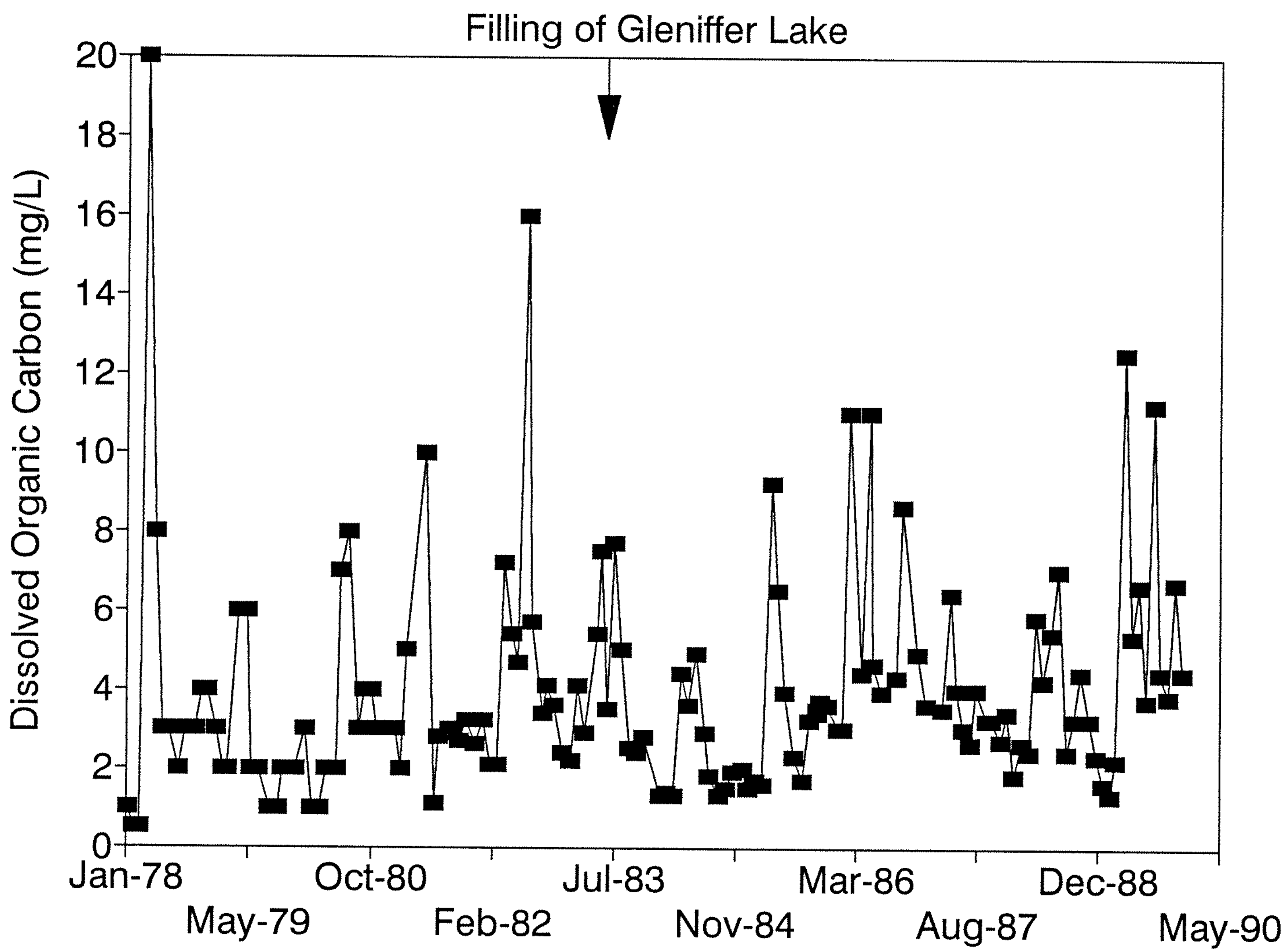


Fig. 28. DOC levels at the Red Deer long-term monitoring site, 1978-89.

4.3.7 *Bacteria*

Reservoirs may improve river water quality because the water retention time allows the number of bacteria to decrease (Purcell 1939). Decreases in numbers of both total and fecal coliform bacteria were noticeable at the site 4 km downstream of Gleniffer Lake (Figure 29). The lower bacterial levels did not extend far downstream, however, and peak bacterial counts at Innisfail were higher than upstream of the reservoir (Figure 29).At the Red Deer long-term monitoring site, post-impoundment median levels of total coliforms were significantly lower than pre-impoundment levels (Table 3). Immediately after Gleniffer Lake was filled, total coliform counts decreased substantially, but have since increased by 5.5/100 mL per year (Table 3; Figure 30). The change in total coliform numbers was, however, restricted to the Red Deer site (Tables 4, 5). There were no significant differences in fecal coliform numbers between pre- and post-impoundment periods river at any of the long-term monitoring sites.

4.3.8 *Algae*

Increased populations of phytoplankton and attached algae are found downstream of some reservoirs (Baxter and Glaude 1980). Below Gleniffer Lake levels of both planktonic and epilithic chlorophyll *a* are higher downstream of the dam than upstream of the reservoir (Figure 31). It is not known whether the increase in algal populations at the site 4 km below the dam is related to increases in nitrogen and phosphorus because water flowing out of the reservoir was not monitored. Other factors that may have produced elevated levels of algae below the dam include increased water clarity and a more stable temperature and flow regime. Higher concentrations of phytoplanktonic chlorophyll *a* may be a result of washout from the reservoir or scouring of the epilithon.

Epilithic algal biomass was particularly high at the Joffre site (Figure 31). Increased algal growth at Joffre was probably a response to high nutrient loads from the city of Red Deer's wastewater treatment plant.

There are no chlorophyll *a* data from the long-term monitoring sites on the Red Deer River.

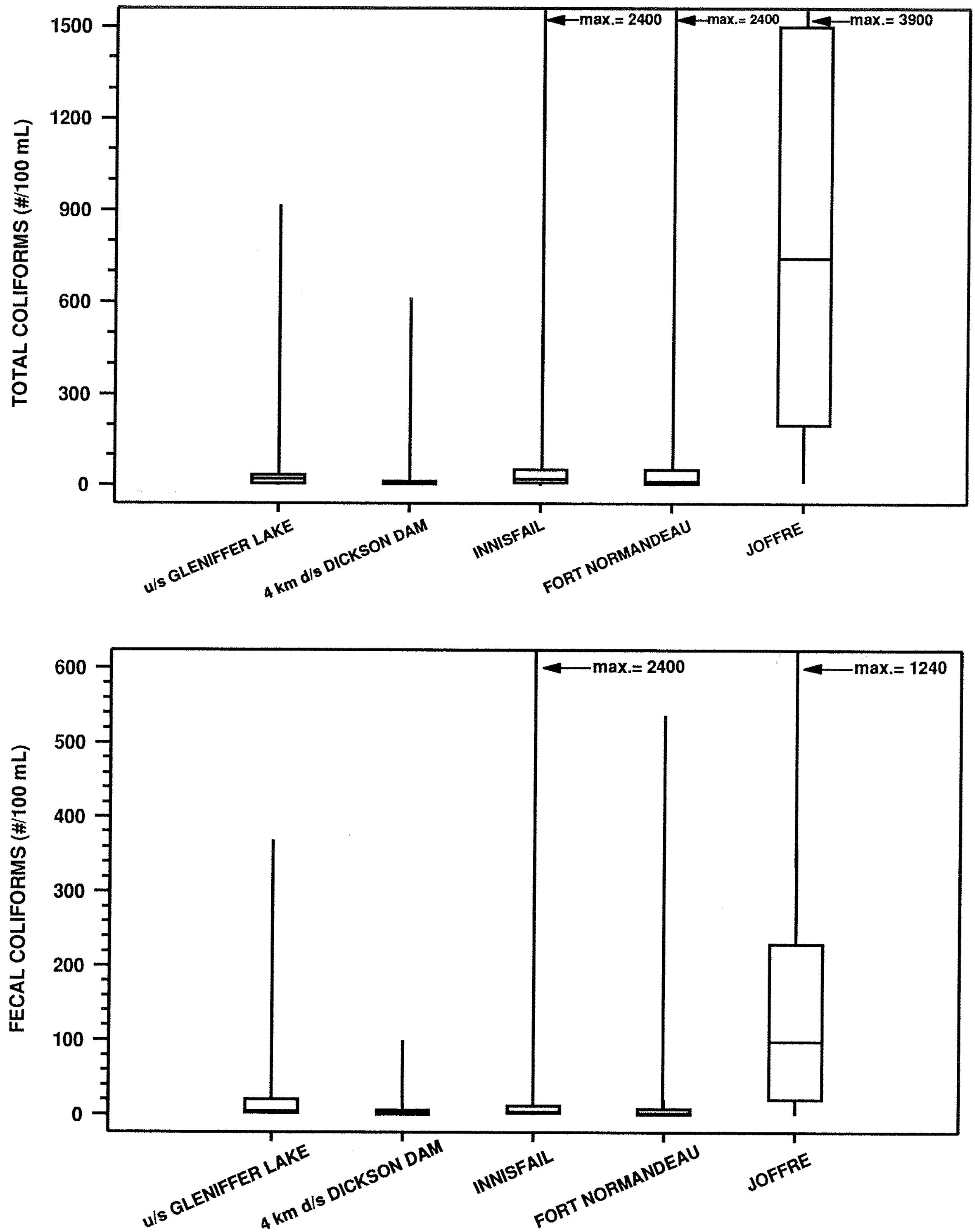


Figure 29. Coliform levels in the Red Deer River, 1983-88 synoptic surveys.

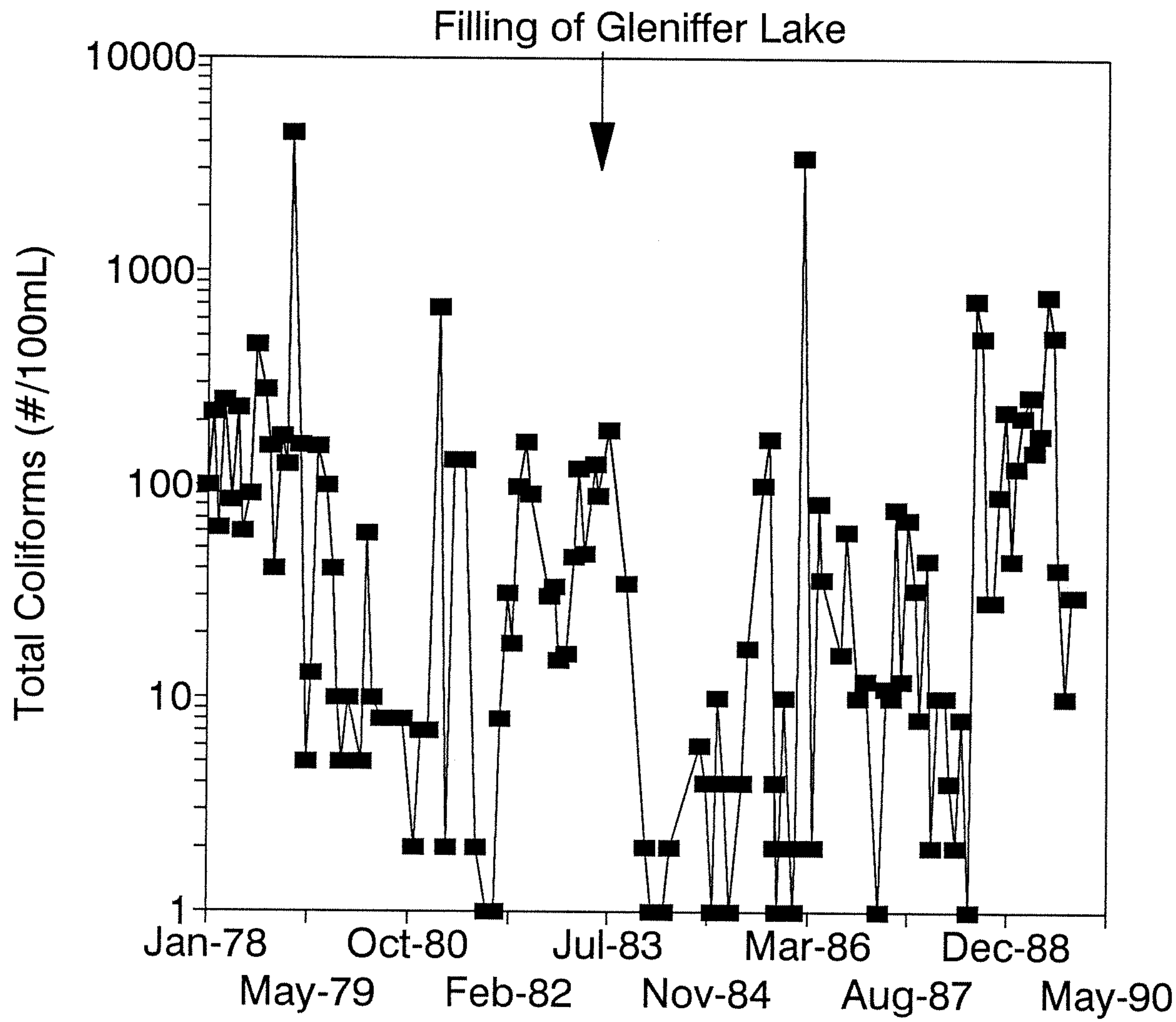


Fig. 30. Total coliforms at the Red Deer long-term monitoring site, 1978-89.

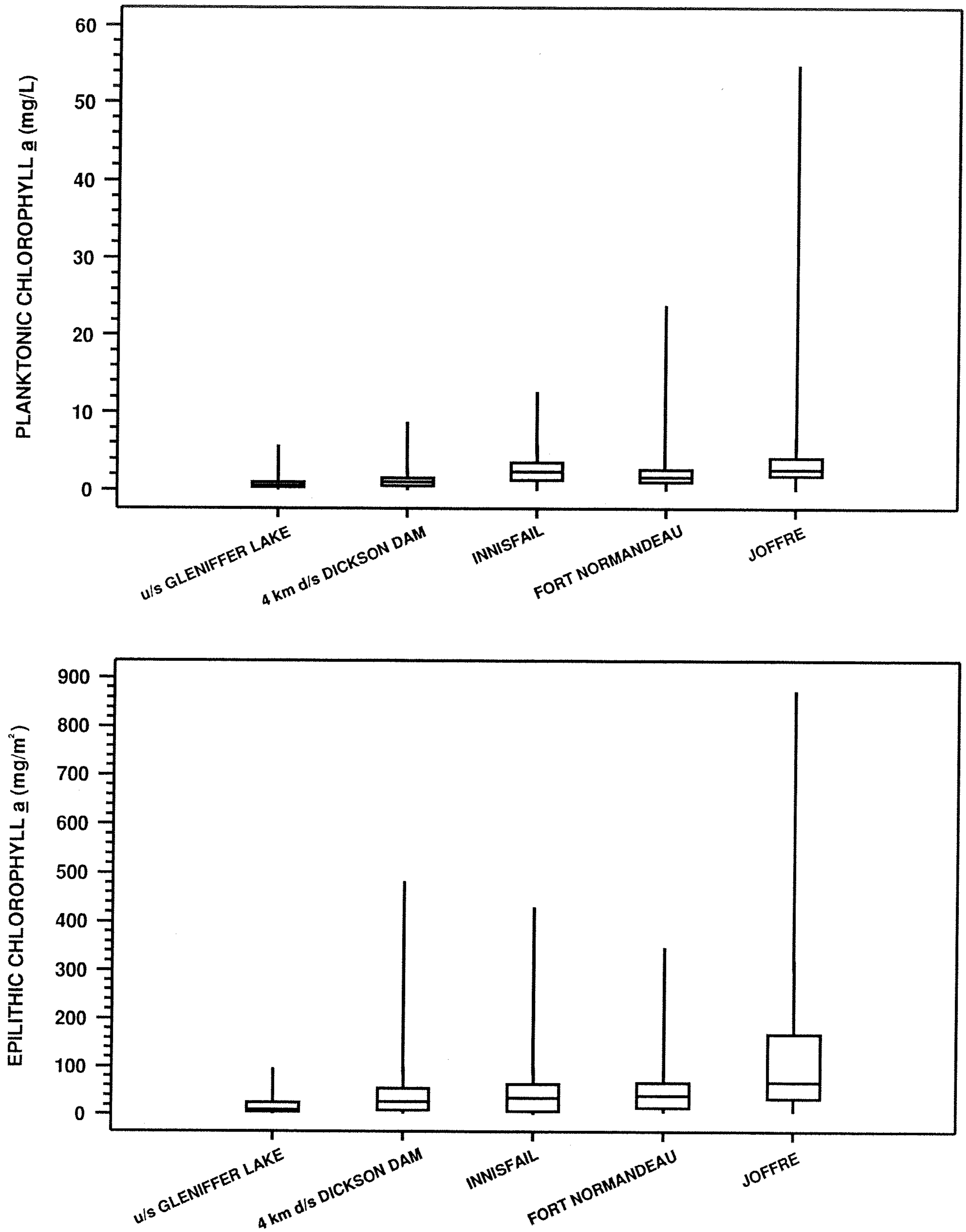


Figure 31. Algal biomass in the Red Deer River, 1983-88 synoptic surveys.

4.4 RED DEER RIVER ZOOBENTHOS

4.4.1 Total Numbers of Invertebrates and Taxa Per Site

Invertebrate data collected during the 1970s showed consistently that the Joffre site below Red Deer had the highest numbers of benthic invertebrates (Figure 32). Invertebrate numbers upstream of Joffre were generally very low, whereas numbers downstream of Joffre tapered off gradually. High benthic invertebrate numbers at Joffre were a response to enrichment of the river by municipal wastewater discharges from the City of Red Deer. A similar trend was observed in data collected in the spring of 1983, prior to completion of the Dickson Dam (Figure 33). Changes were apparent, however, as early as the fall of 1983, a few months after completion of the dam. Invertebrate numbers increased dramatically downstream of the dam, often overshadowing the high numbers typically encountered at Joffre.

An increase in benthic invertebrate abundance downstream of reservoirs is typical where flow constancy is enhanced (i.e. increased winter flows, decreased summer and spring flows). Other impounded rivers in Alberta where this phenomenon occurs are the Bow River below Ghost Lake and the North Saskatchewan River below the Bighorn Dam (Shaw et al. 1990). In the Red Deer River, the increase in total invertebrate numbers below the dam is greater than the increase in invertebrate numbers that occurs below the city of Red Deer as a response to the enrichment effect of the city's municipal discharge. In all three rivers, the increase in zoobenthic numbers is attributable to a few taxa (i.e. Chironomidae, Oligochaeta, Hydrozoa, and small crustaceans).

In the Red Deer River, the number of different taxonomic groups encountered in each survey was often lower at the site immediately downstream of the Dickson Dam than at any other site, particularly in spring (Table 8). The highest numbers of taxa recorded per seasonal survey, however, were often from Innisfail and Fort Normandeau, the second and third sites below the dam. Decreased diversity of organisms is probably related to habitat alteration, food base alteration, and changes in the physical and chemical characteristics of the river because of flow regulation.

4.4.2 Taxonomic Composition

Oligochaeta (aquatic earthworms), Chironomidae (midges), Ephemeroptera (mayflies), Trichoptera (caddisflies), and Plecoptera (stoneflies) are usually the numerically

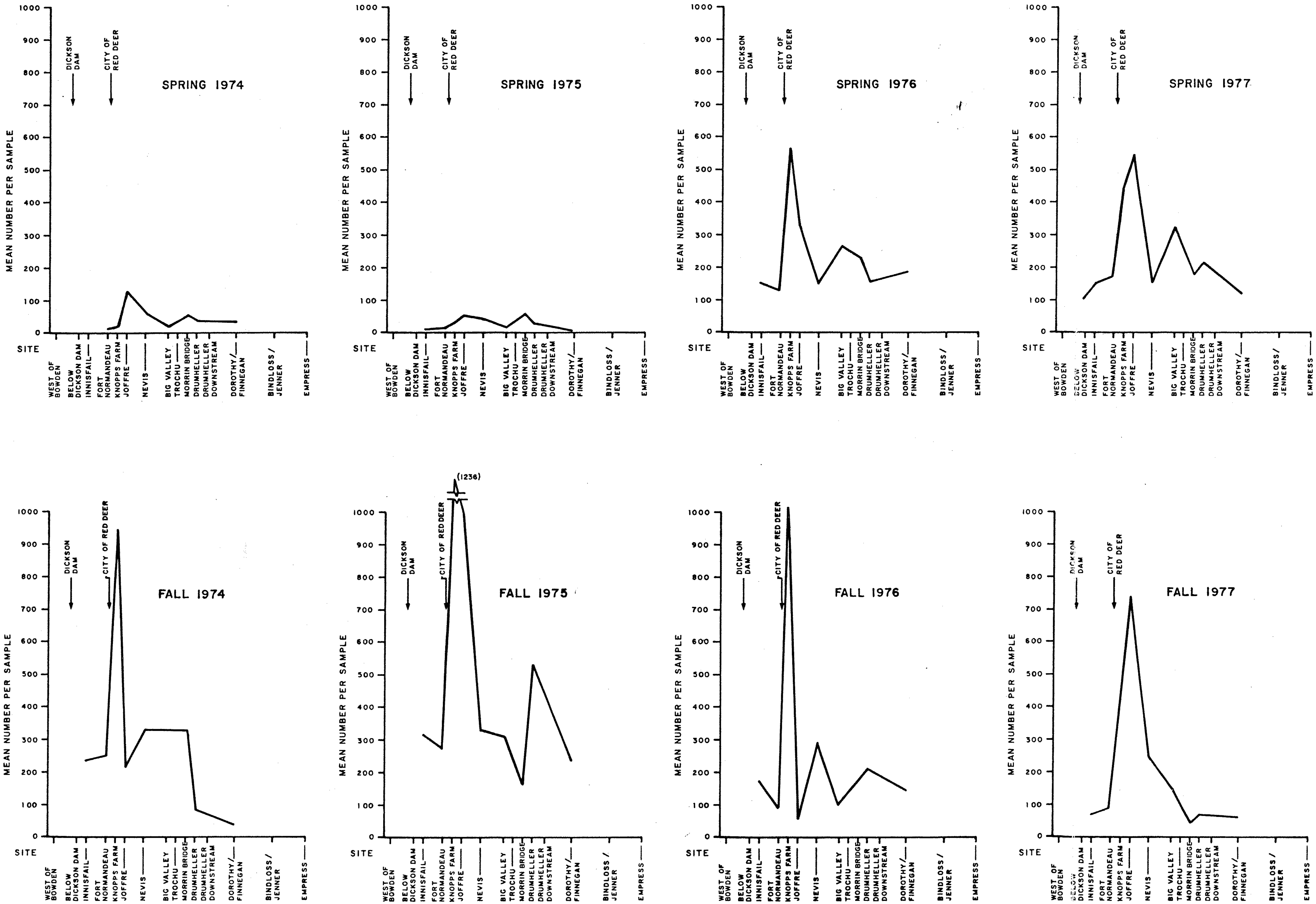


Figure 32. A comparison of spring and fall data for benthic invertebrates collected from the Red Deer River between 1974 and 1977 - total numbers.

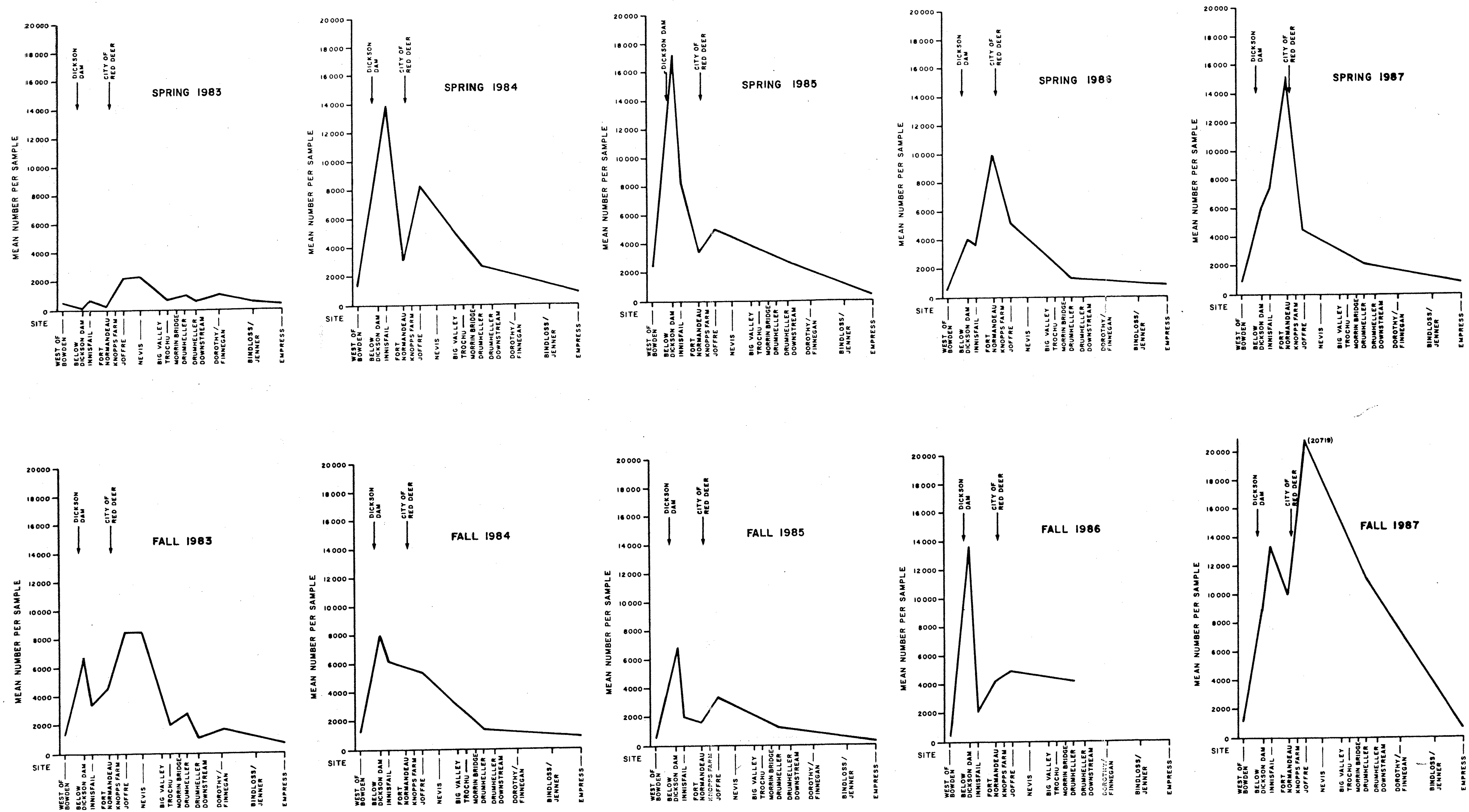


Figure 33. A comparison of spring and fall data for benthic invertebrates collected from the Red Deer River between 1983 and 1987 - total numbers.

Table 8. Mean number of invertebrate taxa (± standard error) recorded per site in the Red Deer River

	1983	1984	1985	1986	1987
<u>Spring</u>					
West of Bowden	23.4 ± 0.7	29.6 ± 1.3	36.8 ± 1.6	36.2 ± 2.0	29.2 ± 1.7
Below Dickson Dam	17.6 ± 1.0	23.6 ± 1.2	24.2 ± 1.2	18.2 ± 1.0	12.8 ± 0.4
Innisfail	21.8 ± 0.9	30.0 ± 1.0	32.0 ± 2.7	33.8 ± 1.7	31.8 ± 1.4
Fort Normandeau	23.6 ± 0.4	28.6 ± 0.9	29.0 ± 1.4	37.8 ± 0.9	32.4 ± 2.3
Joffre	22.6 ± 1.0	29.6 ± 0.7	32.0 ± 1.2	30.0 ± 1.1	35.0 ± 1.2
Nevis	16.0 ± 0.9	-	-	-	-
Trochu	15.6 ± 1.0	-	-	-	-
Drumheller	19.0 ± 1.1	30.8 ± 1.1	26.0 ± 0.9	25.0 ± 1.8	36.2 ± 0.4
East Coulee	17.6 ± 0.5	-	-	-	-
Finnegan	21.6 ± 0.9	-	-	-	-
Jenner	17.0 ± 0.6	-	-	-	-
Empress	16.0 ± 0.8	27.6 ± 1.2	18.4 ± 0.9	23.6 ± 1.3	23.6 ± 0.5
<u>Fall</u>					
West of Bowden	22.8 ± 1.2	38.0 ± 0.8	40.4 ± 1.5	29.8 ± 1.1	33.2 ± 1.4
Below Dickson Dam	25.0 ± 1.5	33.8 ± 0.6	21.0 ± 1.3	29.4 ± 1.6	32.4 ± 0.9
Innisfail	21.0 ± 1.2	34.8 ± 1.0	36.6 ± 0.7	37.4 ± 1.2	40.0 ± 0.9
Fort Normandeau	27.8 ± 1.4	36.2 ± 1.0	24.2 ± 5.1	33.4 ± 1.0	46.6 ± 1.5
Joffre	26.6 ± 1.1	32.6 ± 0.7	29.0 ± 3.5	32.6 ± 0.9	34.0 ± 0.8
Nevis	20.2 ± 0.6	-	-	-	-
Trochu	21.2 ± 1.0	-	-	-	-
Drumheller	25.4 ± 0.7	35.4 ± 1.6	30.4 ± 1.4	34.6 ± 1.9	31.0 ± 1.0
East Coulee	21.8 ± 1.5	-	-	-	-
Finnegan	24.0 ± 0.7	-	-	-	-
Empress	25.2 ± 0.6	30.0 ± 1.4	17.2 ± 2.0	-	25.6 ± 1.5

dominant invertebrates in Alberta rivers. The latter three groups are often associated with clean water and unstressed conditions, whereas the midges and aquatic earthworms can tolerate a wider range of environmental stress.

In spring 1983, before the impoundment of the Red Deer River, oligochaetes were an important component of the zoobenthos only at Joffre and at sites further downstream (Figure 34). After the dam was built, they also became numerically important at all sites between the dam and Joffre (Figure 35); Naididae has become the dominant oligochaete family below the dam and Tubificidae, another family, has become important further downstream.

Chironomids were always very abundant in the Red Deer River, even before the river was impounded. Even so, numbers have increased considerably since completion of the Dickson Dam. Orthocladiinae has become the most important chironomid sub-family above Joffre, but Tanypodinae, Chironomini, and Tanytarsini have also become important below Red Deer.

Mayflies, stoneflies, and caddisflies have undergone the most notable changes in their distribution patterns. Prior to completion of the dam, they were important numerical contributors to the zoobenthos at all sites except Joffre, where their contribution to the total benthic invertebrate density was considerably less (Figure 34). Since the impoundment of the Red Deer River, a decline in the relative and absolute numbers of mayflies, stoneflies, and caddisflies occurred at the Dickson Dam site, where one of the three groups was often absent (Figure 35). Mayfly and caddisfly numbers increased again from Innisfail downstream, but stonefly populations, which were the most affected by the dam, did not recover.

Thirty to 60% of the invertebrates in the samples from the Dickson Dam site are hydrozoans (sac animals). Zooplankters (cyclopoids, calanoids, and daphnids) spilled from the reservoir are often very abundant at this site. These taxa are rare or absent at most other sites in the Red Deer River.

4.4.3 Longitudinal Distribution

Among the taxa for which identification was carried to the genus level, mayflies exhibited the best-defined longitudinal distribution patterns. Their distribution appears to have been most affected by impoundment of the river. For example, *Rhithrogena* was

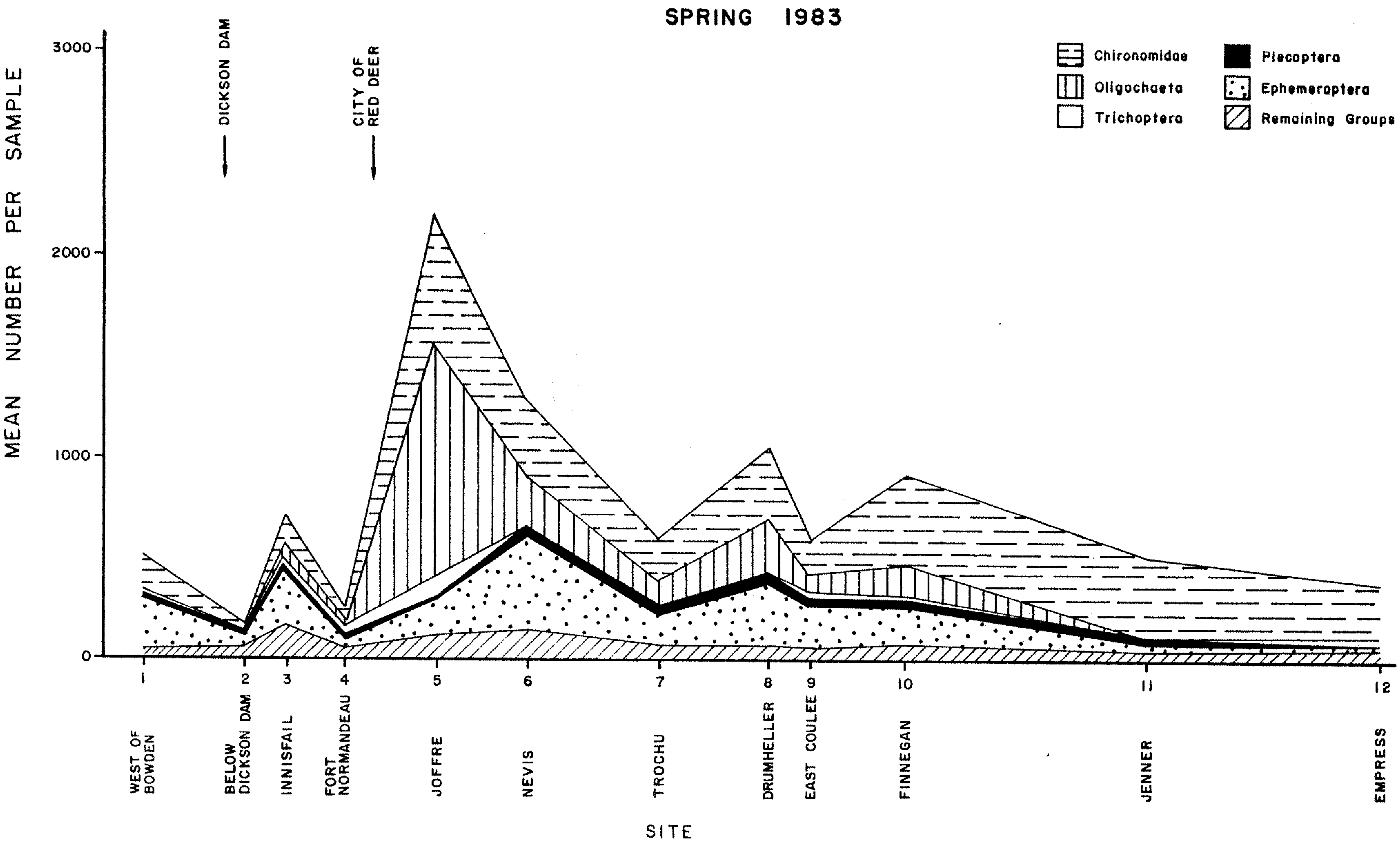


Figure 34. Mean numbers of benthic invertebrates collected from the Red Deer River in spring, 1983.

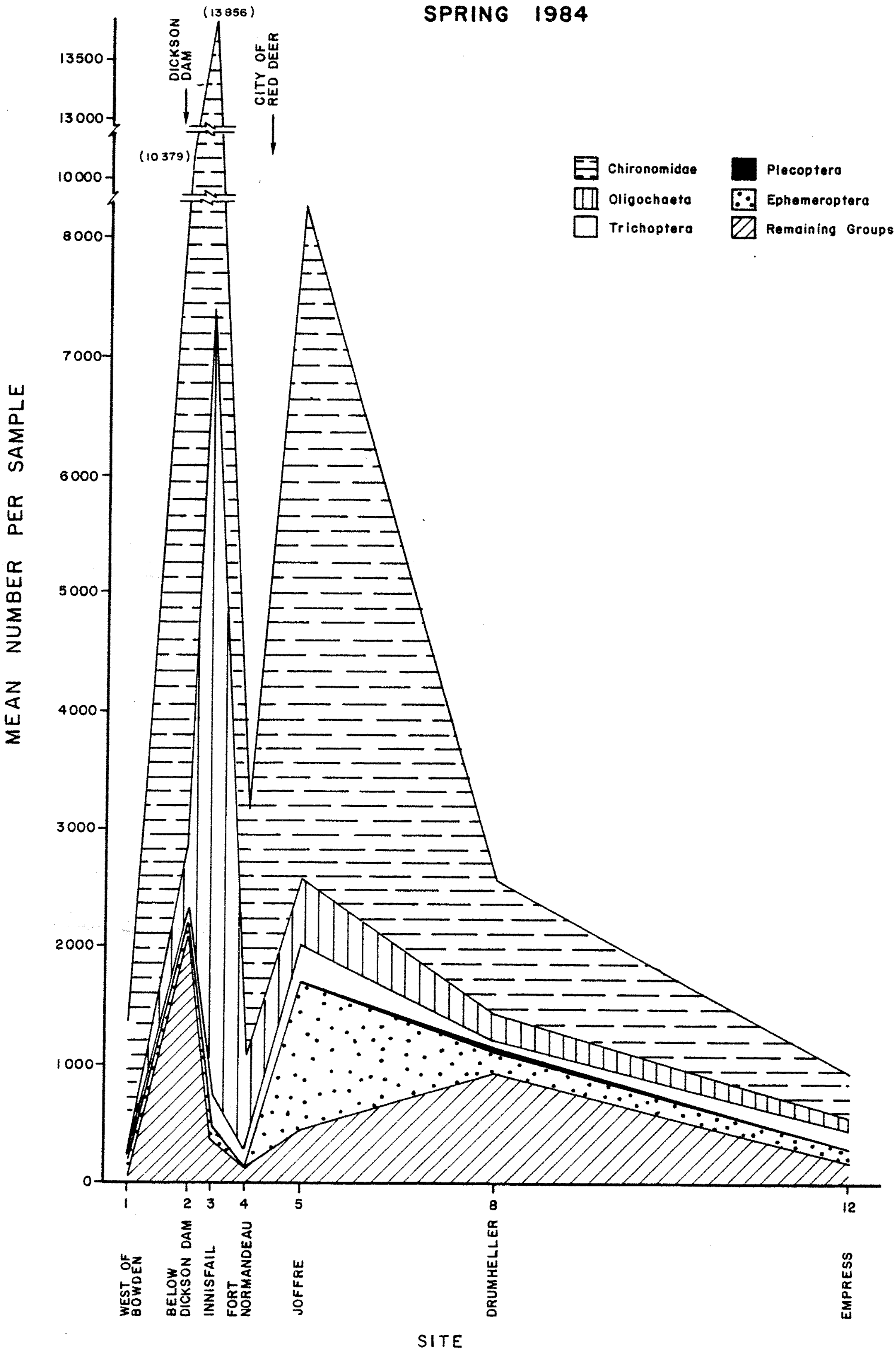


Figure 35. Mean numbers of benthic invertebrates collected from the Red Deer River in spring, 1984.

common in the Red Deer River zoobenthos as far downstream as Joffre during the 1970s and in spring 1983 (Figure 36). Since the river was impounded, *Rhithrogena* has been found only occasionally below the dam, although it is still common upstream of the reservoir (Figure 37). Other mayflies, such as *Ephemerella (Drunella), Ameletus, Cinygmula,* and *Epeorus*, are now found only upstream of the reservoir. Mayflies that tend to be distributed along most of the upper and central reaches of the Red Deer River exhibit a pronounced decrease in numbers at the Dickson Dam site, but recover further downstream (e.g. *Tricorythodes*, *Ephemerella (Ephemerella)*, and *Heptagenia*).

Some stonefly genera, such as *Skwala* and *Zapada*, are now confined to the site west of Bowden, but pre-impoundment information is insufficient to comment on the effects of the dam on the distribution of these taxa. Most stonefly taxa are absent from the Dickson Dam site, and genera encountered further downstream occur in low numbers.

The Dickson Dam also marks an interruption in the longitudinal distribution of most genera of caddisflies, although no genera were confined to the site west of Bowden, as with the stoneflies. Hydropsychidae (i.e. *Hydropsyche* and *Cheumatopsyche*) were very common at most sites in the Red Deer River, especially at Fort Normandeau and Joffre. Other common caddisflies in this area are *Hydroptila*, *Oecetis*, and *Psychomyia*.

Habitat alteration is a common result of increased flow constancy resulting from flow regulation. When scouring caused by high flows (e.g. spring peak) is reduced or eliminated, interstices between stones become clogged with fine particulate matter. Additionally, algae and macrophytes commonly increase in standing stock below reservoirs in response to: 1) greater water clarity (the reservoir acts as a sediment trap), 2) the release of hypolimnetic water rich in nutrients, and 3) the reduction in scouring. Invertebrates that require clean rocky substrates or that dwell in interstices may not find suitable habitat below dams, whereas burrowing invertebrates or those that prowl among vegetation will find their habitat considerably expanded. In the Red Deer River, the algal standing stock below the dam is considerably greater than above the reservoir (Section 4.3.8). Habitat alteration below the reservoir may, therefore, be responsible for the elimination of mayflies common in the upstream reaches (e.g. *Rhithrogena, Ephemerella (Drunella), Ameletus, Cinygmula,* and *Epeorus*) and for the increase in taxa such as Orthocladiinae, Naididae, Hydrozoa, and the mayflies *Tricorythodes* and *Ephemerella (Ephemerella)*, which dwell among algae, are attached to algae, or burrow in the sediment.

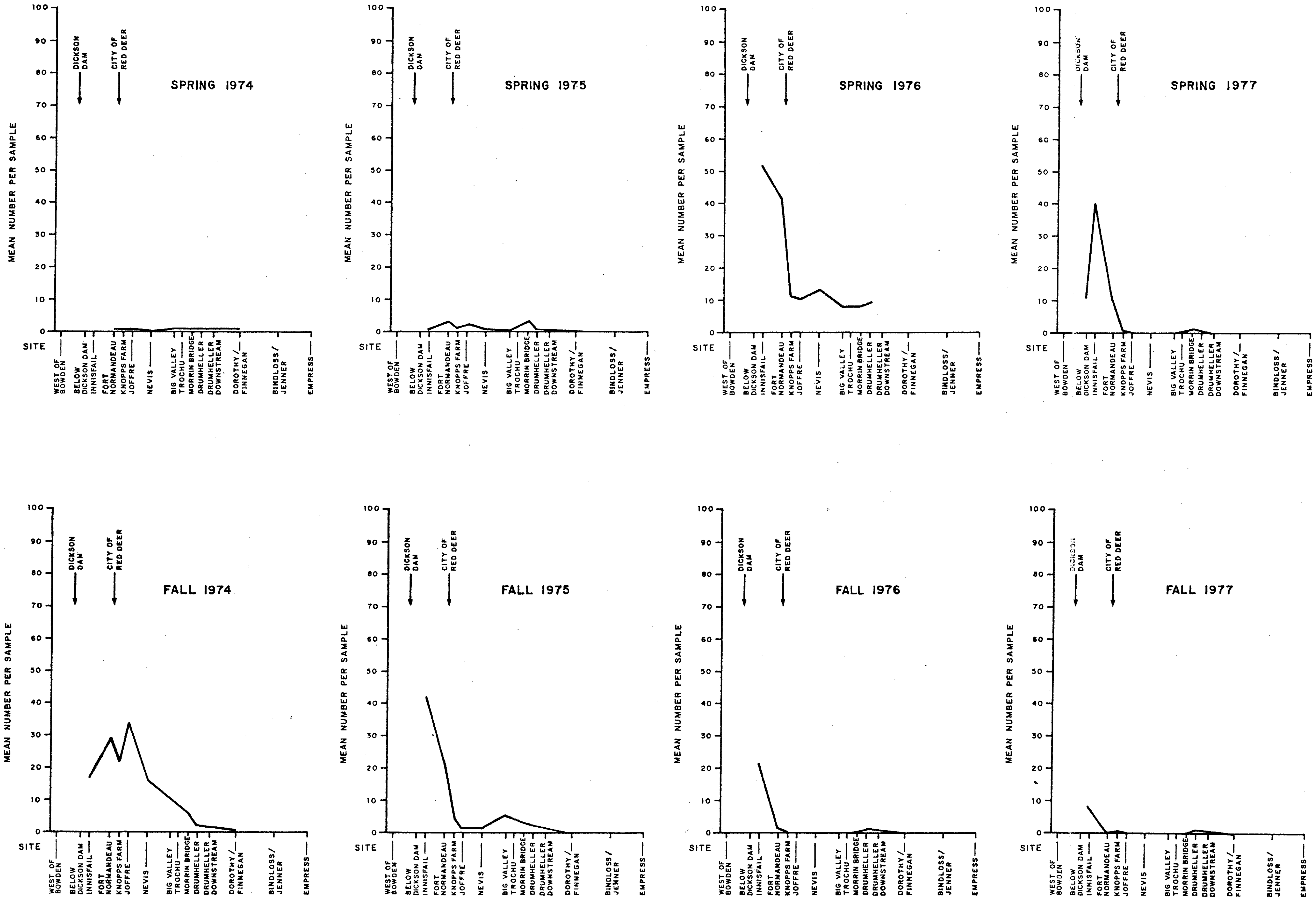


Figure 36. A comparison of spring and fall data for benthic invertebrates collected from the Red Deer River between 1974 and 1977 - *Rhithrogena*.

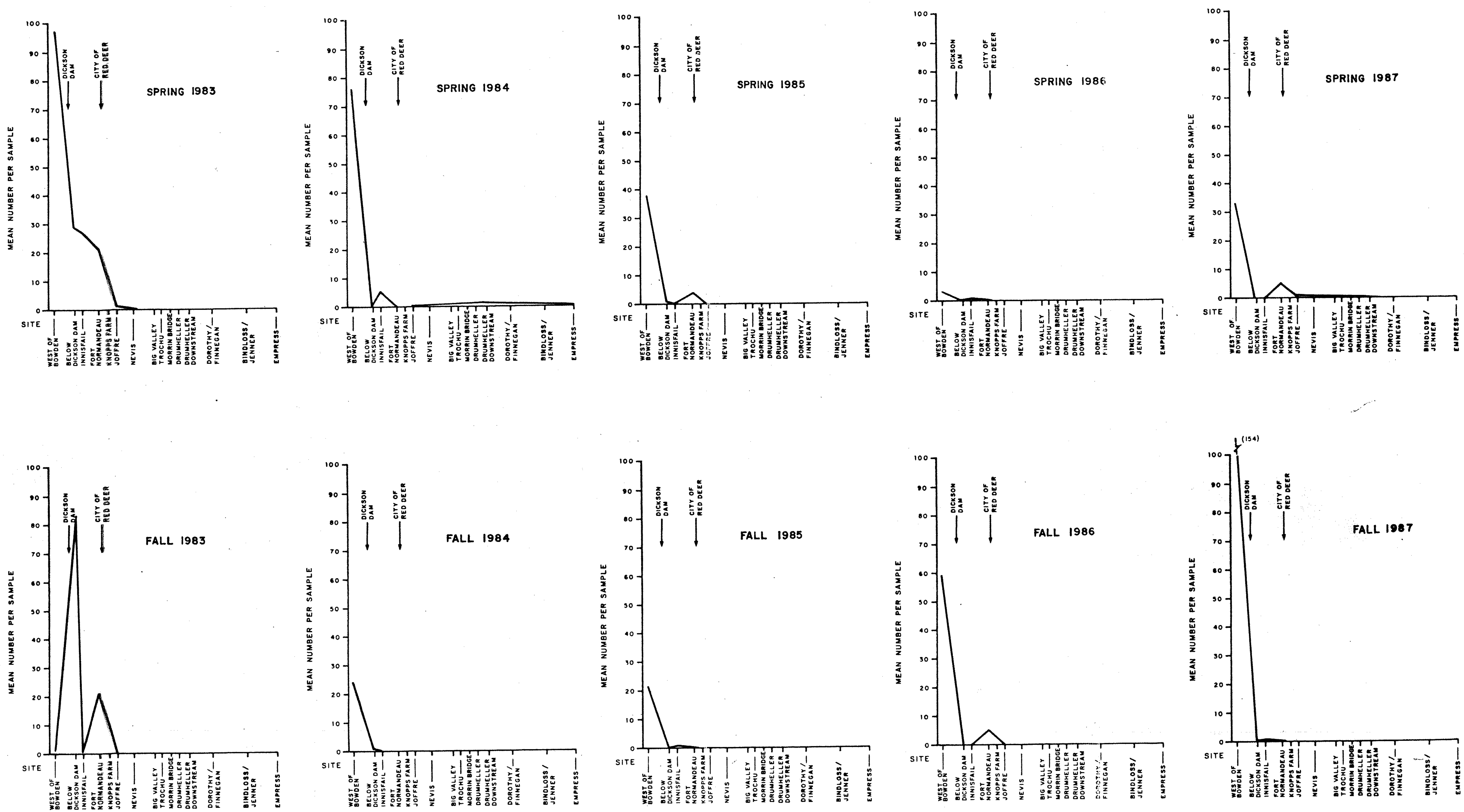


Figure 37. A comparison of spring and fall data for benthic invertebrates collected from the Red Deer River between 1983 and 1987 - *Rhithrogena*.

Coarse particulate organic matter (CPOM) derived from leaf litter is an important food source for invertebrates in headwaters (Cummins and Klug 1979). CPOM typical of upstream reaches is effectively trapped by reservoirs and becomes unavailable to downstream communities. Reservoirs with alternate epi- and hypolimnetic water release supply an autochthonous source of particulate matter to downstream communities in the form of seston and plankton. The change in food type below the dam can certainly contribute to the truncation of the distribution pattern of certain taxa at the Dickson Dam. Seston and plankton favour the development of populations of suspended particle feeders (e.g. Hydrozoa), deposit feeders (e.g. Chironomidae and Oligochaeta), or even filter feeders (e.g. net-spinning caddisflies such as Hydropsychidae), all of which have become abundant at the site immediately downstream of the dam or further downstream.

The increased algal standing stocks below the Dickson Dam could contribute to the increase in numbers of most taxa ordinarily typical of the mid-reaches of the Red Deer River, in particular *Ephemerella (Ephemerella)*, *Heptagenia*, *Tricorythodes*, Chloroperlidae, Perlodidae, most Chironomidae, Naididae, and Tubificidae.

Temperature changes in impounded rivers can be of particular importance to aquatic invertebrates of cold temperature regions, especially when most reservoir release is from the hypolimnion, as in the case of the Dickson Dam (Armitage 1984, Ward and Stanford 1987). Although all insects with aerial stages in their life cycles can be affected by changes in temperature regime (Armitage 1984), stoneflies are probably the most vulnerable (Saltveit et al. 1987). Most North American authors cited in Saltveit et al. (1987) conclude that temperature alteration is the main cause of stonefly scarcity below dams. Considering that the population density of stoneflies below the Dickson Dam is reduced more than that of any other group, it is likely that temperature changes in the impounded Red Deer River have disrupted stonefly distribution.

5.0 SUMMARY

Impoundments can have both positive and negative effects on water quality. They can improve water quality by facilitating the processing of certain materials, reducing the number of bacteria, and allowing suspended solids (and the nutrients, metal ions, and trace elements adsorbed to particulate matter) to settle out (Purcell 1939). Furthermore, flow augmentation results in higher minimum flows, thereby increasing the assimilative capacity of the river downstream. On the other hand, impoundments can adversely affect water quality. Plant nutrients and other inorganic solutes (including toxic substances such as mercury) may be leached from the flooded soils and decaying vegetation; these adverse effects are usually temporary and diminish as the reservoir matures (Baxter and Glaude 1980). There are, however, also persistent changes associated with impoundments. Decreases in turbidity (as a result of suspended solids settling out) and more stable temperature and flow regimes can lead to excessive growth of algae and macrophytes downstream of dams.

In the Red Deer River, changes in water quality caused by the Dickson Dam are primarily restricted to the reach from the dam to the city of Red Deer (Table 9). As with most impoundments, the Dickson Dam has had both positive and negative effects on river water quality, and changes will probably continue to take place for some time. The most important positive change has been an increase in levels of dissolved oxygen. Minimum dissolved oxygen concentrations during winter have increased along the entire length of the river, although concentrations below 5 mg/L are still occasionally recorded. The negative effects associated with the dam are predominantly related to the proliferation of algal populations immediately downstream. With the possible exception of dissolved organic carbon, there is little evidence of leaching of material from soils or decaying vegetation within Gleniffer Lake. A reassessment of downstream water quality in the future may reveal significant differences when compared to pre-impoundment conditions, not presently discernible because of the slow changes that are occurring.

Since completion of the Dickson Dam, a substantial change has occurred in the structure of the benthic invertebrate community. In the spring of 1983, prior to completion of the dam, longitudinal patterns of benthic invertebrate distribution in the Red Deer River reflected the passage of the river through areas with a different geology or through different ecoregions. The enrichment effect of the City of Red Deer's municipal effluent was also reflected in local changes in zoobenthic patterns.

Following completion of the dam, invertebrate distribution patterns changed dramatically downstream of the Dickson Dam, particularly at the site 4 km below the dam. The increase in total numbers, the tendency towards a lower taxonomic diversity, and the shift in taxonomic composition below the Dickson Dam are all zoobenthic responses to flow regulation that have been observed in many other impounded rivers in the world (Armitage 1984, Ward and Stanford 1987).

Table 9. Summary of water quality changes up to 1988 in the Red Deer River downstream of the Dickson Dam.

VARIABLE	POST-IMPOUNDMENT EFFECT
Temperature	reduced seasonal and diurnal variability immediately below dam
	little effect downstream of Red Deer
Dissolved oxygen	increased median levels as far downstream as Drumheller
	increased minimum concentrations in winter along entire length of river
Suspended solids	some reduction immediately below dam
	little effect downstream of Red Deer
Nutrients	reduced peak values in summer associated with high concentrations of suspended solids
	little effect on median levels of phosphorus and nitrogen
	silica concentrations reduced at Red Deer
TDS, major ions, and associated variables	reduced median levels and seasonal variability along entire length of river
Metals and trace elements	reduced peak values associated with high concentrations of suspended solids as far downstream as Red Deer
	some increases in iron and manganese
Coliform bacteria	reduced levels only at site immediately below dam
Algae	increased planktonic and epilithic algal growth below dam
Benthic invertebrates	increase in invertebrate numbers, decrease in taxonomic diversity and change in taxonomic composition
	effects of impoundment became indistinguishable from those of municipal discharges downstream of Red Deer

Flow regulation alone can seriously alter the distribution pattern of certain aquatic invertebrates. Impoundment, however, usually results in changes in physical and chemical characteristics of the river below the reservoir. It is often difficult to separate cause and effect when trying to pinpoint factors that trigger changes in zoobenthic community composition. In general, changes in the zoobenthos of the Red Deer River can be attributed to alterations in habitat, food base, and temperature regime.

In addition, it is probable that chemical and physical changes in the river water as a result of flow regulation have also contributed to changes in the zoobenthos of the Red Deer River.

All data concerning the mercury content of fish in Gleniffer Lake and the Red Deer River are published elsewhere (Alberta Environmental Centre 1984 and 1989).

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7.0 APPENDICES

Appendix I. NAQUADAT codes, locations and distances for synoptic water quality sampling sites on the Red Deer River.

NAQUADAT CODE	NAME AND LOCATION	DISTANCE (km) FROM	
		RIVER MOUTH	DAM
00AL05CB0600	West of Bowden, upstream of dam	634	-
00AL05CC1000	4 km downstream of dam	577	4
00AL05CC1700	Hwy. 54 Bridge, near Innisfail	561	20
00AL05CC1800	Ft. Normandeau, u/s Red Deer	533	48
00AL05CD1000	Joffre Bridge, d/s Red Deer	488	93

Appendix II. Analytical methods for water chemistry, 1983-88 synoptic surveys.

Variable	Container	Preservation	Analytical Code	Analytical Method or Instrument
Field Analysis				
Temperature			02061F	Field meter
pH			10301F	Field meter
Conductance			02041F	Field meter
Dissolved Oxygen			08102F	Field meter
Lab Analysis				
Conductance	P	Cool to 4°C	02041L	Meter
Turbidity	P	Cool to 4°C	02074L	Nephelometric method with turbidimeter
Suspended Solids	P	Cool to 4°C	10401L	Gravimetric method
pH	P	Cool to 4°C	10301L	Meter
Alkalinity, total	P	Cool to 4°C	10101L	Potentiometric titration
Total dissolved solids			00205	Calculated
Hardness, total	P	Cool to 4°C	10605L	Titration with EDTA
Ca	P	Cool to 4°C	20103L	Automated atomic absorption
Mg	P	Cool to 4°C	12102L	Atomic absorption, direct aspiration
Na	P	Cool to 4°C	11103L	Flame photometry
K	P	Cool to 4°C	19103L	Flame photometry, internal standard
HCO_3			06202L	Calculated
CO_3			06302L	Calculated
Cl	P	Cool to 4°C	17203L	Colourimetry on autoanalyzer
SO_4	P	Cool to 4°C	16306L	Colourimetry, $BaCl_2$ and methylthymol blue
F, dissolved	P	Cool to 4°C	09107L	Automated potentiometric method
Biochemical oxygen demand	G	Cool to 4°C	08201L	5 day, 20°C
Al, extractable	P	1:1 HNO_3	13306L	Atomic absorption, solvent extraction
As, total	P	1:1 HNO_3	33005L	Goulden and Brooksbank's method
Be, total	P	1:1 HNO_3	04103L	ICAP
Cd, total	P	1:1 HNO_3	48009L	ICAP
Co, total	P	1:1 HNO_3	27009L	ICAP
Cr, total	P	1:1 HNO_3	24004L	Atomic absorption, graphite furnace
Cu, total	P	1:1 HNO_3	29009L	ICAP
Fe, extractable	P	Cool to 4°C	26304L	Atomic absorption, direct aspiration
Pb, total	P	1:1 HNO_3	82302L	Atomic absorption, solvent extraction
Mn, total	P	1:1 HNO_3	25001L	ICAP
Hg, total	P	HNO_3-$K_2Cr_2O_7$	80015L	Flameless atomic absorption
Mo, total	P	1:1 HNO_3	42009L	ICAP
Ni, total	P	1:1 HNO_3	28009L	ICAP
Se, total	P	1:1 HNO_3	34003L	ICAP
V, total	P	1:1 HNO_3	23001L	Atomic absorption, direct aspiration
Zn, total	P	1:1 HNO_3	30009L	ICAP
NH_3-N	P	2ml 5% H_2SO_4	07505L	Colourimetric analysis
NH_3-N	P	2ml 5% H_2SO_4	07561L	Colourimetric on autoanalyzer
NO_2^--N	P	Cool to 4°C	07205L	Colourimetry on autoanalyzer
$(NO_2^- + NO_3^-)$-N	P	Cool to 4°C	07111L	Colourimetry
Total Kjeldahl Nitrogen	P	2ml 5% H_2SO_4	07021L	Colourimetry on autoanalyzer
Particulate Nitrogen	P	Cool to 4°C	07906L	Thermal conductivity method
Total Nitrogen	P		07602L	Calculated

P - polyethylene; G- Glass

Appendix II. Continued...

Variable	Container	Preservation	Analytical Code	Analytical Method or Instrument
Total Dissolved Phosphorus	P	2ml 5% H_2SO_4	15105L	Colourimetry on autoanalyzer
Particulate Phosphorus			15901L	Calculated
Total Phosphorus	P	2ml 5% H_2SO_4	15421L	Colourimetry on autoanalyzer
Silica, reactive	P	Cool to 4°C	14105L	Heteropoly blue colourimetry
Dissolved Organic Carbon	P	Cool to 4°C	06107L	Colourimetry
Total Organic Carbon	P	Cool to 4°C	06001L	Colourimetry
Phenols	G	1:1 H_2SO_4	06536L	Automated 4-aminoantipyrine colourimetry
Tannin and Lignin	G	Cool to 4°C	06551L	Filtered if turbid: acid colourimetry
Oil and Grease	G	Cool to 4°C	06521L	Petroleum ether extraction
Biological				
Total coliforms	G	Cool to 4°C	36001L	Tube dilution
Fecal coliforms	G	Cool to 4°C	36900L	Agar Plate Count
Standard Plate Count	G	Cool to 4°C	36011L	Tube dilution
Chlorophyll-*a*, planktonic	P	Cool to 4°C	06715L	Fluorometry of acetone extractant
Chlorophyll-*a*, epilithic	P	Cool to 4°C	06722L	Fluorometry of acetone extractant

P - polyethylene; G- Glass

Appendix III. NAQUADAT summary reports from the long-term monitoring sites on the Red Deer River, January 1978 to April 1983.

NAQUADAT SUMMARY REPORT JAN 08, 1991
SURFACE WATER DATA

STATION 00AL05CC0004 LAT. 52D 16M 3S LONG. 113D 51M 48S PR 4 UTM 12 304600E 5794400N FOR JAN 16, 1978 TO APR 26, 1983
RED DEER RIVER AT HWY 2 ABOVE RED DEER, ALBERTA

	SUBM ID	00201L TOTAL DISSOLVED SOLIDS (CALCD.) MG/L	00205L TOTAL DISSOLVED SOLIDS MG/L	02011L COLOUR APPARENT REL. UNITS	02021L COLOUR TRUE REL. UNITS	02041F SPECIFIC CONDUCT. US/CM	02041L SPECIFIC CONDUCT. US/CM	02061F TEMPERATURE OF WATER DEG.C	02073F TURBIDITY JTU
SAMPLES(FLAGS)	0479	60(0)	12(0)	39(7)	25(1)	57(0)	63(0)	63(0)	49(1)
LOW		154.	168.	L5.	L5.0	244.	280.	.0	.1
HIGH		330.	330.	120.	60.	660.	570.	21.5	G200.
AVERAGE		231.	243.	17.*	17.4*	422.4	427.9	6.9	14.2*
STD.DEV.		43.	48.	21.*	14.0*	93.6	81.7	6.8	33.8*
PERCNT:10TH		177.	185.	L5.	5.0	319.	327.	.0	1.1
25TH		196.	208.	5.	10.	363.0	356.	.5	2.0
MEDIAN 50TH		224.	240.	10.	10.	410.	429.	5.0	4.4
75TH		275.	283.	20.	20.	477.	486.	13.0	10.0
90TH		286.	287.	35.	40.	570.	544.	16.5	25.
SECONDARY CODE						41S		61S	73S

	SUBM ID	02071L TURBIDITY JTU	06001L CARBON TOTAL ORGANIC C MG/L	06051L CARBON TOTAL INORGANIC C MG/L	06101L CARBON DISSOLVED ORGANIC C MG/L	06151L CARBON DISSOLVED INORGANIC C MG/L	06901L CARBON ORGANIC PARTICUL. C MG/L	06904L CARBON PARTICULATE ORGANIC C MG/L	06201L BICARBONT. (CALCD.) HCO3 MG/L
SAMPLES(FLAGS)	0479	64(0)	13(2)	4(0)	63(2)	27(0)	58(1)	7(6)	60(2)
LOW		.3	L0.	30.	L0.	29.	L.0	.00	119.5
HIGH		180.	22.	53.	20.	58.	9.0	L2.00	313.3
AVERAGE		12.1	4.8*	46.5	3.77*	40.48	.9*	1.71*	216.0*
STD.DEV.		28.1	5.6*	11.0	3.24*	8.35	1.7*	.76*	46.3*
PERCNT:10TH		1.1	L0.		1.	30.	.1		162.1
25TH		1.6	2.0	40.5	2.	34.0	.2	L2.00	174.3
MEDIAN 50TH		3.0	3.0	51.5	3.	38.	.3	L2.00	209.7
75TH		10.0	5.0	52.5	4.1	49.	.8	L2.00	260.3
90TH		22.	8.0		7.0	53.	1.8		273.1
SECONDARY CODE		73L	05L		04L 04F	52L	02L		

	SUBM ID	06301L CARBONATE (CALCD.) CO3 MG/L	06401L FREE CO2 (CALCD.) CO2 MG/L	06535L PHENOLIC MATERIAL PHENOL MG/L	06717L CHLORO-PHYLL A MG/L	07110L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07506P NITROGEN TOTAL AMMONIA N MG/L	07651L NITROGEN DISSOLVED N MG/L	07651F NITROGEN DISSOLVED N MG/L
SAMPLES(FLAGS)	0479	60(2)	60(0)	13(6)	37(9)	64(19)	63(61)	61(0)	37(0)
LOW		.0	.7	L.001	L.001	L.01	L.1	.06	.07
HIGH		24.0	13.4	.004	.020	.95	.2	1.9	.80
AVERAGE		.7*	4.1	.002*	.003*	.094*	.102*	.243	.241
STD.DEV.		3.2*	3.8	.001*	.003*	.139*	.013*	.249	.145
PERCNT:10TH		.0	1.2	L.001	L.001	L.01	L.1	.09	.11
25TH		.0	1.5	L.001	.001	L.010	L.1	.13	.14
MEDIAN 50TH		.0	2.1	.001	.001	.035	L.10	.21	.22
75TH		.0	6.9	.002	.003	.160	L.1	.25	.270
90TH		1.7	10.6	.003	.006	.20	L.1	.37	.39
SECONDARY CODE				35F	17P	10F			

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

NAQUADAT SUMMARY REPORT JAN 08, 1991
SURFACE WATER DATA

STATION 00AL05CC0004 LAT. 52D 16M 3S LONG. 113D 51M 48S PR 4 UTM 12 304600E 5794400N FOR JAN 16, 1978 TO APR 26, 1983
RED DEER RIVER AT HWY 2 ABOVE RED DEER, ALBERTA

	SUBM ID	07901L NITROGEN PARTICUL. N MG/L	08101F OXYGEN DISSOLVED DO O2 MG/L	09105L FLUORIDE DISSOLVED F MG/L	10101L ALKALINITY TOTAL CACO3 MG/L	10151L ALKALINITY PHENOL PHTHALEIN CACO3 MG/L	10301F PH PH UNITS	10301L PH PH UNITS	10401L RESIDUE NONFILTR. MG/L
SAMPLES(FLAGS)	0479	61(13)	60(0)	60(0)	61(0)	60(2)	63(0)	63(0)	62(6)
LOW		L.01	7.0	.1	109.	0.	7.4	7.5	L1.
HIGH		.590	13.4	.2	257.0	20.	8.6	8.5	242.
AVERAGE		.085*	10.00	.1	178.3	.6*			19.*
STD.DEV.		.111*	1.41	.0	36.3	2.7*			45.*
PERCNT:10TH		L.01	8.60	.1	135.0	.0	7.7	7.6	1.
25TH		.02	9.05	.1	145.0	.0	7.9	7.7	2.
MEDIAN 50TH		.050	9.75	.1	170.0	.0	8.2	8.1	4.
75TH		.11	10.90	.2	213.0	.0	8.4	8.3	12.
90TH		.16	12.20	.2	224.	1.4*	8.5	8.4	31.
SECONDARY CODE		02L	01P		06L		01S		

	SUBM ID	10602L HARDNESS TOTAL (CALCD.) CACO3 MG/L	11101L SODIUM DISSOLVED NA MG/L	12102L MAGNESIUM DISSOLVED MG MG/L	14101L SILICA REACTIVE SIO2 MG/L	15103L PHOSPHORUS DISSOLVED P MG/L	15255L PHOSPHORUS DISSOLVED ORTHO PO4 P MG/L	15406L PHOSPHORUS TOTAL P MG/L	15901L PHOSPHORUS PARTICULATE (CALCD.) P MG/L
SAMPLES(FLAGS)	0479	63(0)	64(0)	64(0)	63(0)	59(22)	18(16)	62(5)	58(22)
LOW		134.2	3.6	10.7	3.2	L.003	L.003	L.003	Q.000
HIGH		302.6	13.	38.2	8.8	.10	.17	.36	.205
AVERAGE		209.4	7.3	18.3	5.8	.009*	.012*	.038*	.025*
STD.DEV.		38.1	2.0	4.5	1.4	.016*	.039*	.063*	.042*
PERCNT:10TH		163.4	4.7	13.2	4.1	L.003	L.003	.003	Q.000
25TH		182.8	5.7	15.1	4.8	L.003	L.003	.007	Q.004
MEDIAN 50TH		206.7	7.3	17.5	5.7	.004	L.003	.015	.011
75TH		242.1	8.7	21.7	7.0	.007	L.003	.028	.019
90TH		257.4	9.5	22.4	7.4	.019	.004	.091	.083
SECONDARY CODE			03L		02L 05L	03F	56L		

	SUBM ID	16301L SULPHATE DISSOLVED SO4 MG/L	17206L CHLORIDE DISSOLVED CL MG/L	19101L POTASSIUM DISSOLVED K MG/L	20103L CALCIUM DISSOLVED CA MG/L	03301L LITHIUM EXTRBLE. LI MG/L	04301L BERYLLIUM EXTRBLE. BE MG/L	05105L BORON DISSOLVED B MG/L	13303L ALUMINUM EXTRBLE. AL MG/L
SAMPLES(FLAGS)	0479	64(0)	64(0)	63(0)	63(0)	9(4)		46(1)	9(0)
LOW		16.	.5	.7	35.1	L.005		L.02	.020
HIGH		54.	4.5	9.9	80.3	.006		.140	1.4
AVERAGE		37.2	1.44	1.50	53.7	.005*		.052*	.2150
STD.DEV.		10.0	.73	1.30	9.2	.001*		.023*	.4459
PERCNT:10TH		24.	.8	.9	43.3			.03	
25TH		30.0	1.00	1.0	48.0	L.005		.04	.028
MEDIAN 50TH		37.0	1.30	1.2	50.8	.005		.050	.087
75TH		46.0	1.70	1.4	60.1	.006		.06	.10
90TH		51.	2.0	2.3	66.8			.070	
SECONDARY CODE		06L		03L		01P		05F	05P

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

NAQUADAT SUMMARY REPORT JAN 08, 1991
SURFACE WATER DATA

STATION 00AL05CC0004 LAT. 52D 16M 3S LONG. 113D 51M 48S PR 4 UTM 12 304600E 5794400N FOR JAN 16, 1978 TO APR 26, 1983
RED DEER RIVER AT HWY 2 ABOVE RED DEER, ALBERTA

	SUBM ID	23020L VANADIUM TOTAL RECOVERABLE VA MG/L	23301L VANADIUM EXTRBLE. V MG/L	24302L CHROMIUM EXTRBLE. CR MG/L	25101L MANGANESE DISSOLVED MN MG/L	25303L MANGANESE EXTRBLE. MN MG/L	26104L IRON DISSOLVED FE MG/L	26304L IRON EXTRBLE. FE MG/L	27020L COBALT TOTAL RECOVERABLE CO MG/L
SAMPLES(FLAGS)	0479	12(9)	9(8)	9(9)	36(24)	9(2)	37(20)	9(0)	12(9)
LOW		L.001	L.001	L.015	L.01	L.010	L.04	.05	L.002
HIGH		.020	.004	L.015	.040	.32	.150	3.0	.013
AVERAGE		.003*	.001*		.012*	.053*	.053*	.531	.003*
STD.DEV.		.005*	.001*		.006*	.101*	.025*	.948	.003*
PERCNT:10TH		L.001			L.01		L.04		L.002
25TH		L.001	L.001	L.015	L.010	.012	L.04	.07	L.002
MEDIAN 50TH		L.001	L.001	L.015	L.010	.017	L.040	.12	L.002
75TH		.001*	L.001	L.015	.010	.029	.050	.53	.002*
90TH		.002			.02		.090		.004
SECONDARY CODE		20P 20F	02P	02P	04L	04P		04P	20P

	SUBM ID	27301L COBALT EXTRBLE. CO MG/L	28020L NICKEL TOTAL RECOVERABLE NI MG/L	28301L NICKEL EXTRBLE. NI MG/L	29020L COPPER TOTAL RECOVERABLE CU MG/L	29305L COPPER EXTRBLE. CU MG/L	30020L ZINC TOTAL RECOVERABLE ZN MG/L	30305L ZINC EXTRBLE. ZN MG/L	33104L ARSENIC DISSOLVED AS MG/L
SAMPLES(FLAGS)	0479	9(8)	9(1)	9(6)	11(3)	9(3)	11(1)	9(2)	46(40)
LOW		L.002	L.002	L.002	L.001	L.001	L.001	L.001	L.0005
HIGH		.006	.009	.010	.010	.004	.010	.007	.0008
AVERAGE		.002*	.004*	.003*	.002*	.002*	.004*	.003*	.0005*
STD.DEV.		.001*	.002*	.003*	.003*	.001*	.003*	.002*	.0001*
PERCNT:10TH					L.001		.001		L.0005
25TH		L.002	.002	L.002	L.001	L.001	.001	.003	L.0005
MEDIAN 50TH		L.002	.003	L.002	.001	.002	.004	.003	L.0005
75TH		L.002	.005	.003	.002	.003	.007	.004	L.0005
90TH					.004		.008		.0005
SECONDARY CODE		02P	20P	02P	20P	05P	20P	05P	04F

	SUBM ID	34102L SELENIUM DISSOLVED SE MG/L	38301L STRONTIUM EXTRBLE. SR MG/L	42301L MOLYBDENUM EXTRBLE. MO MG/L	47301L SILVER EXTRBLE. AG MG/L	48020L CADMIUM TOTAL RECOVERABLE CD MG/L	48301L CADMIUM EXTRBLE. CD MG/L	56020L BARIUM TOTAL RECOVERABLE BA MG/L	56301L BARIUM EXTRBLE. BA MG/L
SAMPLES(FLAGS)	0479	27(21)	8(0)	9(9)	19(18)	12(12)	9(9)	12(0)	9(1)
LOW		L.0005	.29	L.10	L.004	L.001	L.001	.060	L.05
HIGH		.0006	.79	L.10	.01	L.001	L.001	.150	.18
AVERAGE		.0005*	.415		.004*			.108	.104*
STD.DEV.		.0000*	.162		.001*			.032	.044*
PERCNT:10TH		L.0005			L.004	L.001		.070	
25TH		L.0005	.315	L.10	L.004	L.001	L.001	.080	.07
MEDIAN 50TH		L.0005	.370	L.10	L.004	L.001	L.001	.110	.09
75TH		L.0005	.435	L.10	L.004	L.001	L.001	.135	.13
90TH		.0005			L.004	L.001		.15	
SECONDARY CODE			01P	01P	01P	20P	02P	20P	01P

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NAQUADAT SUMMARY REPORT JAN 08, 1991
SURFACE WATER DATA

STATION 00AL05CC0004 LAT. 52D 16M 3S LONG. 113D 51M 48S PR 4 UTM 12 304600E 5794400N FOR JAN 16, 1978 TO APR 26, 1983
RED DEER RIVER AT HWY 2 ABOVE RED DEER, ALBERTA

	SUBM ID	80011L MERCURY TOTAL HG UG/L	80311L MERCURY EXTRBLE. HG UG/L	82020L LEAD TOTAL RECOVERABLE PB MG/L	82301L LEAD EXTRBLE. PB MG/L	36001L COLIFORMS TOTAL MPN NO/100ML	36011L COLIFORMS FECAL MPN NO/100ML	36101L STREP. FECAL	36103L FECAL STREP. MF NO/DL
SAMPLES(FLAGS)	0479	49(47)	12(10)	12(11)	9(9)	53(1)	62(12)	40(8)	38(7)
LOW		L.02	L.02	L.004	L.004	1.	L1.	1.	1.
HIGH		.05	.13	.004	L.004	4400.	306.	540.	900.
AVERAGE		.021*	.029*	.004*		171.*	22.*	44.*	91.*
STD.DEV.		.004*	.032*	.000*		604.*	43.*	104.*	190.*
PERCNT:10TH		L.02	L.02	L.004		5.	L2.	L2.	L2.
25TH		L.02	L.020	L.004	L.004	10.	2.	2.*	2.
MEDIAN 50TH		L.02	L.020	L.004	L.004	47.	8.	8.	15.
75TH		L.020	L.020	L.004	L.004	130.	21.	47.	70.
90TH		L.020	.02	L.004		230.	55.	73.	420.
SECONDARY CODE		11P	13P	20P	02P	02L 02F	12L 12F	02L 02F	03F

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NAQUADAT SUMMARY REPORT JAN 08, 1991
SURFACE WATER DATA

STATION 00AL05CE0001 LAT. 51D 28M 9S LONG. 112D 42M 30S PR 4 UTM 12 381300E 5703100N FOR JAN 16, 1978 TO APR 18, 1983
RED DEER RIVER AT DRUMHELLER, ALBERTA

	SUBM ID	00201L TOTAL DISSOLVED SOLIDS (CALCD.)	00205L TOTAL DISSOLVED SOLIDS	02011L COLOUR APPARENT	02021L COLOUR TRUE	02041F SPECIFIC CONDUCT.	02041L SPECIFIC CONDUCT.	02061F TEMPERATURE OF WATER	02073F TURBIDITY
		MG/L	MG/L	REL. UNITS	REL. UNITS	US/CM	US/CM	DEG.C	JTU
SAMPLES(FLAGS)	0479	60(0)	12(0)	39(3)	25(0)	60(0)	64(0)	65(0)	55(0)
LOW		155.	173.	L5.	5.0	265.	292.	.0	.3
HIGH		440.	440.	500.	100.	7125.	5523.	21.0	600.0
AVERAGE		249.	259.	65.*	29.0	558.1	530.0	7.0	60.0
STD.DEV.		70.	81.	109.*	24.2	870.1	646.1	7.1	135.3
PERCNT:10TH		176.	180.	5.	10.	320.0	319.	.0	.7
25TH		194.	201.	5.	10.	366.5	349.5	.5	1.1
MEDIAN 50TH		235.	229.	30.	20.	424.5	438.0	3.5	5.7
75TH		310.	313.	55.	30.	535.0	547.5	13.0	42.
90TH		353.	351.	200.	70.0	615.0	602.	18.5	230.0
SECONDARY CODE						41S		61S	73S

	SUBM ID	02071L TURBIDITY	06001L CARBON TOTAL ORGANIC C	06051L CARBON TOTAL INORGANIC C	06101L CARBON DISSOLVED ORGANIC C	06151L CARBON DISSOLVED INORGANIC C	06901L CARBON ORGANIC PARTICUL. C	06904L CARBON PARTICULATE ORGANIC C	06201L BICARBONT. (CALCD.) HCO3
		JTU	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
SAMPLES(FLAGS)	0479	63(0)	12(0)	3(0)	63(0)	27(0)	59(0)	6(6)	57(1)
LOW		.4	2.	23.	1.0	19.	.1	L2.00	121.9
HIGH		550.0	49.	60.	49.	65.	13.6	L2.00	420.6
AVERAGE		43.0	10.1	45.7	6.07	40.15	1.9		223.9*
STD.DEV.		82.9	12.9	19.9	6.54	13.00	2.7		67.7*
PERCNT:10TH		1.0	3.0		2.	22.	.1		154.3
25TH		1.6	3.5		3.0	31.	.2	L2.00	168.7
MEDIAN 50TH		8.2	6.0	54.	4.8	42.	.9	L2.00	201.1
75TH		45.	9.5		7.0	50.	2.8	L2.00	280.4
90TH		130.0	16.0		12.0	58.	6.3		323.0
SECONDARY CODE		73L	05L		04L 04F	52L	02L		

	SUBM ID	06301L CARBONATE (CALCD.) CO3	06401L FREE CO2 (CALCD.) CO2	06535L PHENOLIC MATERIAL PHENOL	06717L CHLORO- PHYLL A	07110L NITROGEN DISSOLVED NO3 & NO2 N	07506P NITROGEN TOTAL AMMONIA N	07651L NITROGEN DISSOLVED N	07651F NITROGEN DISSOLVED N
		MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
SAMPLES(FLAGS)	0479	57(1)	61(0)	14(4)	34(3)	63(18)	65(51)	60(0)	36(0)
LOW		.0	.4	L.001	L.001	L.01	L.1	.09	.14
HIGH		25.2	26.6	.007	.040	4.100	.8	5.00	5.00
AVERAGE		1.7*	5.2	.002*	.007*	.340*	.173*	.631	.665
STD.DEV.		4.1*	6.8	.002*	.008*	.734*	.169*	.793	.913
PERCNT:10TH		.0	.8	L.001	.001	L.010	L.1	.145	.16
25TH		.0	1.1	L.001	.001	L.010	L.1	.195	.195
MEDIAN 50TH		.0	1.7	.002	.004	.04	L.1	.330	.335
75TH		1.8	4.6	.002	.010	.360	L.1	.785	.785
90TH		5.5	16.2	.005	.018	.850	.5	1.400	1.20
SECONDARY CODE					17P	10F			

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NAQUADAT SUMMARY REPORT JAN 08, 1991
SURFACE WATER DATA

STATION 00AL05CE0001 LAT. 51D 28M 9S LONG. 112D 42M 30S PR 4 UTM 12 381300E 5703100N FOR JAN 16, 1978 TO APR 18, 1983
RED DEER RIVER AT DRUMHELLER, ALBERTA

	SUBM ID	07901L NITROGEN PARTICUL. N MG/L	08101F OXYGEN DISSOLVED DO O2 MG/L	09105L FLUORIDE DISSOLVED F MG/L	10101L ALKALINITY TOTAL CACO3 MG/L	10151L ALKALINITY PHENOL PHTHALEIN CACO3 MG/L	10301F PH PH UNITS	10301L PH PH UNITS	10401L RESIDUE NONFILTR. MG/L
SAMPLES(FLAGS)	0479	61(8)	60(0)	61(3)	61(0)	57(1)	64(0)	64(0)	63(7)
LOW		L.01	.4	L.0	103.	0.	7.3	7.3	L1.
HIGH		4.400	13.3	.3	345.0	21.	8.9	8.7	3750.
AVERAGE		.326*	8.88	.1*	182.8	1.4*			140.*
STD.DEV.		.626*	3.36	.0*	54.4	3.5*			482.*
PERCNT:10TH		L.01	2.60	.1	125.	0.	7.5	7.5	L1.
25TH		.03	7.85	.1	143.	.0	8.00	7.75	2.
MEDIAN 50TH		.13	9.55	.1	168.	.0	8.30	8.20	15.
75TH		.28	11.30	.2	226.0	1.5	8.45	8.40	116.
90TH		.88	12.60	.2	265.	4.6	8.6	8.6	308.
SECONDARY CODE		02L	01P		06L		01S		

	SUBM ID	10602L HARDNESS TOTAL (CALCD.) CACO3 MG/L	11101L SODIUM DISSOLVED NA MG/L	12102L MAGNESIUM DISSOLVED MG MG/L	14101L SILICA REACTIVE SIO2 MG/L	15103L PHOSPHORUS DISSOLVED P MG/L	15255L PHOSPHORUS DISSOLVED ORTHO PO4 P MG/L	15406L PHOSPHORUS TOTAL P MG/L	15901L PHOSPHORUS PARTICULATE (CALCD.) P MG/L
SAMPLES(FLAGS)	0479	64(0)	64(0)	64(0)	61(0)	61(9)	18(6)	63(1)	60(9)
LOW		60.3	5.0	4.7	.2	L.003	L.003	L.003	Q.000
HIGH		357.8	1020.	30.2	11.0	.360	.25	2.200	2.144
AVERAGE		204.0	32.5	18.0	4.6	.049*	.032*	.167*	.118*
STD.DEV.		60.8	125.7	5.2	3.1	.079*	.059*	.324*	.304*
PERCNT:10TH		138.3	8.8	12.2	.8	L.003	L.003	.010	.004
25TH		162.2	11.0	14.0	1.5	.004	L.003	.027	.007
MEDIAN 50TH		184.4	15.5	16.8	5.0	.016	.006	.065	.028
75TH		261.8	19.5	22.6	6.8	.059	.055	.20	.126
90TH		287.8	27.	25.3	8.4	.150	.062	.35	.253
SECONDARY CODE			03L		02L 05L	03F	56L		

	SUBM ID	16301L SULPHATE DISSOLVED SO4 MG/L	17206L CHLORIDE DISSOLVED CL MG/L	19101L POTASSIUM DISSOLVED K MG/L	20103L CALCIUM DISSOLVED CA MG/L	03301L LITHIUM EXTRBLE. LI MG/L	04301L BERYLLIUM EXTRBLE. BE MG/L	05105L BORON DISSOLVED B MG/L	13303L ALUMINUM EXTRBLE. AL MG/L
SAMPLES(FLAGS)	0479	64(0)	64(0)	63(0)	64(0)	9(0)		46(2)	8(0)
LOW		3.2	.9	.9	16.4	.005		L.02	.019
HIGH		110.0	1690.	12.	93.5	.009		.270	2.3
AVERAGE		43.0	30.57	2.73	52.1	.007		.069*	.3688
STD.DEV.		16.6	210.89	2.53	16.5	.001		.047*	.7872
PERCNT:10TH		26.	1.3	1.1	35.6			.02	
25TH		32.5	1.75	1.4	40.3	.006		.04	.0260
MEDIAN 50TH		40.0	3.00	1.8	47.2	.007		.060	.0595
75TH		53.0	4.40	2.3	65.5	.008		.09	.2300
90TH		60.	6.5	6.0	74.8			.14	
SECONDARY CODE		06L		03L		01P		05F	05P

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NAQUADAT SUMMARY REPORT JAN 08, 1991
SURFACE WATER DATA

STATION 00AL05CE0001 LAT. 51D 28M 9S LONG. 112D 42M 30S PR 4 UTM 12 381300E 5703100N FOR JAN 16, 1978 TO APR 18, 1983
RED DEER RIVER AT DRUMHELLER, ALBERTA

	SUBM ID	23020L VANADIUM TOTAL RECOVERABLE VA MG/L	23301L VANADIUM EXTRBLE. V MG/L	24302L CHROMIUM EXTRBLE. CR MG/L	25101L MANGANESE DISSOLVED MN MG/L	25303L MANGANESE EXTRBLE. MN MG/L	26104L IRON DISSOLVED FE MG/L	26304L IRON EXTRBLE. FE MG/L	27020L COBALT TOTAL RECOVERABLE CO MG/L
SAMPLES(FLAGS)	0479	12(8)	9(6)	8(8)	35(21)	9(1)	37(21)	9(1)	12(11)
LOW		L.001	L.001	L.015	L.01	L.010	L.04	L.04	L.002
HIGH		.004	.004	L.015	.46	.17	.320	2.7	.008
AVERAGE		.002*	.002*		.029*	.046*	.071*	.712*	.002*
STD.DEV.		.001*	.001*		.076*	.053*	.066*	1.084*	.002*
PERCNT:10TH		L.001			L.01		L.04		L.002
25TH		L.001	L.001	L.0150	L.01	.015	L.04	.06	L.002
MEDIAN 50TH		L.001	L.001	L.0150	L.010	.030	L.040	.09	L.002
75TH		.002	.001	L.0150	.02	.04	.06	.49	L.002
90TH		.004			.030		.16		L.002
SECONDARY CODE		20P	02P	02P	04L	04P	04F	04P	20P

	SUBM ID	27301L COBALT EXTRBLE. CO MG/L	28020L NICKEL TOTAL RECOVERABLE NI MG/L	28301L NICKEL EXTRBLE. NI MG/L	29020L COPPER TOTAL RECOVERABLE CU MG/L	29305L COPPER EXTRBLE. CU MG/L	30020L ZINC TOTAL RECOVERABLE ZN MG/L	30305L ZINC EXTRBLE. ZN MG/L	33104L ARSENIC DISSOLVED AS MG/L
SAMPLES(FLAGS)	0479	9(8)	10(5)	9(6)	11(4)	9(2)	10(2)	9(3)	46(26)
LOW		L.002	L.002	L.002	L.001	L.001	L.001	L.001	L.0005
HIGH		.004	.012	.006	.004	.004	.012	.010	.0014
AVERAGE		.002*	.003*	.003*	.002*	.002*	.005*	.003*	.0006*
STD.DEV.		.001*	.003*	.002*	.001*	.001*	.004*	.004*	.0002*
PERCNT:10TH			L.002		L.001		L.001		L.0005
25TH		L.002	L.002	L.002	L.001	.001	.002	L.001	L.0005
MEDIAN 50TH		L.002	.002*	L.002	.001	.002	.004	.001	L.0005
75TH		L.002	.002	.006	.002	.003	.007	.004	.0007
90TH			.009		.003		.011		.0009
SECONDARY CODE		02P	20P	02P	20P	05P	20P	05P	04F

	SUBM ID	34102L SELENIUM DISSOLVED SE MG/L	38301L STRONTIUM EXTRBLE. SR MG/L	42301L MOLYBDENUM EXTRBLE. MO MG/L	47301L SILVER EXTRBLE. AG MG/L	48020L CADMIUM TOTAL RECOVERABLE CD MG/L	48301L CADMIUM EXTRBLE. CD MG/L	56020L BARIUM TOTAL RECOVERABLE BA MG/L	56301L BARIUM EXTRBLE. BA MG/L
SAMPLES(FLAGS)	0479	25(24)	8(0)	8(8)	19(19)	12(11)	9(8)	12(1)	9(0)
LOW		L.0005	.30	L.10	L.004	L.001	L.001	L.050	.05
HIGH		.0005	.80	L.10	L.004	.001	.002	.210	.17
AVERAGE		.0005*	.433			.001*	.001*	.108*	.106
STD.DEV.		.0000*	.168			.000*	.000*	.042*	.040
PERCNT:10TH		L.0005			L.004	L.001		.070	
25TH		L.0005	.325	L.100	L.004	L.001	L.001	.070	.09
MEDIAN 50TH		L.0005	.365	L.100	L.004	L.001	L.001	.110	.10
75TH		L.0005	.490	L.100	L.004	L.001	L.001	.120	.14
90TH		L.0005			L.004	L.001		.140	
SECONDARY CODE			01P	01P	01P	20P	02P	20P	01P

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NAQUADAT SUMMARY REPORT JAN 08, 1991
SURFACE WATER DATA

STATION 00AL05CE0001 LAT. 51D 28M 9S LONG. 112D 42M 30S PR 4 UTM 12 381300E 5703100N FOR JAN 16, 1978 TO APR 18, 1983
RED DEER RIVER AT DRUMHELLER, ALBERTA

	SUBM ID	80011L MERCURY TOTAL HG UG/L	80311L MERCURY EXTRBLE. HG UG/L	82020L LEAD TOTAL RECOVERABLE PB MG/L	82301L LEAD EXTRBLE. PB MG/L	36001L COLIFORMS TOTAL MPN NO/100ML	36011L COLIFORMS FECAL MPN NO/100ML	36101L STREP. FECAL	36103L FECAL STREP. MF NO/DL
SAMPLES(FLAGS)	0479	49(38)	12(11)	12(11)	9(9)	58(3)	61(13)	42(3)	38(6)
LOW		L.02	L.02	L.004	L.004	1.	1.	L2.	L1.
HIGH		.14	.04	.005	L.004	2400.	660.	5500.	27000.
AVERAGE		.028*	.022*	.004*		227.*	71.*	470.*	1360.*
STD.DEV.		.023*	.006*	.000*		419.*	146.*	1305.*	4535.*
PERCNT:10TH		L.02	L.02	L.004		2.	L2.	2.	L2.
25TH		L.02	L.020	L.004	L.004	14.	2.	4.	6.
MEDIAN 50TH		L.020	L.020	L.004	L.004	46.	13.	20.	28.
75TH		L.020	L.020	L.004	L.004	200.	52.	107.	300.
90TH		.050	L.02	L.004		810.	250.	1000.	4700.
SECONDARY CODE		11P	13P	20P	02P	02L 02F	12L 12F	02L 02F	03F

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

NAQUADAT SUMMARY REPORT JAN 08, 1991
SURFACE WATER DATA

STATION 00AL05CK0001 LAT. 50D 54M 9S LONG. 110D 17M 51S PR 4 UTM 12 549400E 5639000N FOR JAN 10, 1978 TO APR 19, 1983
RED DEER RIVER AT BINDLOSS, ALBERTA

	SUBM ID	00201L TOTAL DISSOLVED SOLIDS (CALCD.) MG/L	00205L TOTAL DISSOLVED SOLIDS MG/L	02011L COLOUR APPARENT REL. UNITS	02021L COLOUR TRUE REL. UNITS	02041F SPECIFIC CONDUCT. US/CM	02041L SPECIFIC CONDUCT. US/CM	02061F TEMPERATURE OF WATER DEG.C	02073F TURBIDITY JTU
SAMPLES(FLAGS)	0462	64(1)	29(0)	39(0)	25(0)	62(0)	64(0)	64(0)	42(3)
LOW		168.	182.	5.	5.	320.	323.	.0	.1
HIGH		589.	589.	500.	100.0	959.	916.	25.0	G1000.
AVERAGE		302.*	299.	63.	28.6	502.6	522.1	7.7	197.4*
STD.DEV.		95.*	102.	101.	23.0	152.9	154.1	8.4	337.8*
PERCNT:10TH		203.	200.	5.	10.	345.0	371.	.0	1.4
25TH		227.	227.	10.	10.	393.	392.5	.0	4.6
MEDIAN 50TH		272.	271.	30.	20.	445.0	482.0	3.5	27.5
75TH		379.	356.	80.	40.	592.0	634.0	15.5	94.0
90TH		434.	465.	200.	60.	730.	757.	20.5	900.0
SECONDARY CODE						41S		61S	

	SUBM ID	02071L TURBIDITY JTU	06001L CARBON TOTAL ORGANIC C MG/L	06051L CARBON TOTAL INORGANIC C MG/L	06101L CARBON DISSOLVED ORGANIC C MG/L	06151L CARBON DISSOLVED INORGANIC C MG/L	06901L CARBON ORGANIC PARTICUL. C MG/L	06904L CARBON PARTICULATE ORGANIC C MG/L	06201L BICARBONT. (CALCD.) HCO3 MG/L
SAMPLES(FLAGS)	0462	61(0)	12(1)	3(0)	61(0)	24(0)	62(0)	7(5)	62(0)
LOW		.5	L0.	32.	2.0	16.	.1	.00	143.8
HIGH		1200.	12.0	76.	16.	81.	33.6	5.00	508.3
AVERAGE		94.2	6.7*	57.7	5.42	45.96	4.1	2.14*	243.2
STD.DEV.		203.0	3.5*	22.9	2.59	19.57	6.4	1.46*	89.0
PERCNT:10TH		1.8	4.		3.	28.	.2		154.8
25TH		3.1	4.0		4.	29.50	.3	L2.00	174.3
MEDIAN 50TH		21.	6.0	65.	4.9	37.00	1.4	L2.00	206.6
75TH		95.0	10.0		6.0	63.00	5.4	L2.00	303.5
90TH		250.0	12.		9.	75.	8.4		384.0
SECONDARY CODE		73L	05L		04L 04F	52L	02L		

	SUBM ID	06301L CARBONATE (CALCD.) CO3 MG/L	06401L FREE CO2 (CALCD.) CO2 MG/L	06535L PHENOLIC MATERIAL PHENOL MG/L	06717L CHLORO-PHYLL A MG/L	07110L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07506P NITROGEN TOTAL AMMONIA N MG/L	07651L NITROGEN DISSOLVED N MG/L	07651F NITROGEN DISSOLVED N MG/L
SAMPLES(FLAGS)	0462	62(0)	63(0)	18(4)	36(2)	64(18)	25(22)	64(0)	35(0)
LOW		.0	1.2	L.001	L.001	L.01	L.10	.13	.15
HIGH		5.2	23.2	.008	.160	2.200	.2	3.00	2.90
AVERAGE		.1	4.1	.002*	.019*	.271*	.104*	.576	.530
STD.DEV.		.7	4.2	.002*	.029*	.393*	.020*	.497	.509
PERCNT:10TH		.0	1.3	L.001	.001	L.010	L.1	.17	.17
25TH		.0	1.6	.001	.006	L.010	L.1	.230	.22
MEDIAN 50TH		.0	2.2	.001	.009	.105	L.100	.435	.32
75TH		.0	4.5	.002	.021	.420	L.100	.720	.68
90TH		.0	10.3	.006	.050	.62	.1	1.1	1.000
SECONDARY CODE						10F			

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

NAQUADAT SUMMARY REPORT JAN 08, 1991
SURFACE WATER DATA

STATION 00AL05CK0001 LAT. 50D 54M 9S LONG. 110D 17M 51S PR 4 UTM 12 549400E 5639000N FOR JAN 10, 1978 TO APR 19, 1983
RED DEER RIVER AT BINDLOSS, ALBERTA

	SUBM ID	07901L NITROGEN PARTICUL. N MG/L	08101F OXYGEN DISSOLVED DO O2 MG/L	09105L FLUORIDE DISSOLVED F MG/L	10101L ALKALINITY TOTAL CACO3 MG/L	10151L ALKALINITY PHENOL PHTHALEIN CACO3 MG/L	10301F PH PH UNITS	10301L PH PH UNITS	10401L RESIDUE NONFILTR. MG/L
SAMPLES(FLAGS)	0462	63(1)	61(0)	64(1)	64(0)	62(0)	63(0)	63(0)	63(1)
LOW		L.01	.9	L.0	118.	.0	2.8	7.5	L1.
HIGH		3.3	14.2	.3	417.0	4.3	8.6	8.4	3860.
AVERAGE		.452*	8.84	.1*	199.0	.1			242.*
STD.DEV.		.610*	3.38	.0*	72.5	.6			567.*
PERCNT:10TH		.040	3.3	.1	127.0	0.	7.50	7.70	3.
25TH		.07	7.50	.1	142.5	.0	7.8	7.9	9.
MEDIAN 50TH		.19	9.2	.2	169.5	.0	8.0	8.2	46.
75TH		.57	11.5	.2	248.0	.0	8.3	8.3	232.
90TH		1.200	12.9	.2	315.	.0	8.4	8.4	528.
SECONDARY CODE		02L	01P		06L		01S		

	SUBM ID	10602L HARDNESS TOTAL (CALCD.) CACO3 MG/L	11101L SODIUM DISSOLVED NA MG/L	12102L MAGNESIUM DISSOLVED MG MG/L	14101L SILICA REACTIVE SIO2 MG/L	15103L PHOSPHORUS DISSOLVED P MG/L	15255L PHOSPHORUS DISSOLVED ORTHO PO4 P MG/L	15406L PHOSPHORUS TOTAL P MG/L	15901L PHOSPHORUS PARTICULATE (CALCD.) P MG/L
SAMPLES(FLAGS)	0462	64(1)	64(0)	64(1)	64(0)	64(4)	24(14)	64(0)	64(4)
LOW		112.7	1.5	10.2	1.2	L.003	L.003	.007	.000
HIGH		425.2	55.0	40.8	9.5	.18	.043	11.	10.995
AVERAGE		217.3*	28.1	20.5*	5.0	.017*	.007*	.350	.333*
STD.DEV.		78.3*	10.9	8.2*	2.3	.025*	.011*	1.382	1.383*
PERCNT:10TH		139.1	14.	12.5	1.9	.003	L.003	.010	.005
25TH		152.5	21.0	14.0	2.9	.005	L.003	.023	.010
MEDIAN 50TH		187.6	27.5	17.0	5.1	.008	L.003	.069	.055
75TH		291.3	34.5	27.3	6.7	.018	.005	.250	.210
90TH		333.0	42.0	34.9	8.2	.037	.012	.580	.571
SECONDARY CODE			03L		02L 05L	03F	56L		

	SUBM ID	16301L SULPHATE DISSOLVED SO4 MG/L	17206L CHLORIDE DISSOLVED CL MG/L	19101L POTASSIUM DISSOLVED K MG/L	20103L CALCIUM DISSOLVED CA MG/L	03301L LITHIUM EXTRBLE. LI MG/L	04301L BERYLLIUM EXTRBLE. BE MG/L	05105L BORON DISSOLVED B MG/L	13303L ALUMINUM EXTRBLE. AL MG/L
SAMPLES(FLAGS)	0462	64(0)	64(0)	64(0)	64(1)			62(0)	15(0)
LOW		24.	1.6	1.6	28.3			.02	.012
HIGH		125.	15.0	8.6	103.0			.22	.33
AVERAGE		67.1	5.30	3.04	53.2*			.074	.0643
STD.DEV.		23.2	2.99	1.47	18.3*			.043	.0813
PERCNT:10TH		43.	2.1	1.8	35.1			.03	.012
25TH		48.0	2.95	2.05	38.1			.040	.018
MEDIAN 50TH		65.0	4.85	2.65	47.0			.060	.040
75TH		85.0	6.60	3.40	66.3			.090	.065
90TH		97.	9.4	5.4	82.0			.130	.14
SECONDARY CODE		06L		03L					05P

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NAQUADAT SUMMARY REPORT JAN 08, 1991
SURFACE WATER DATA

STATION 00AL05CK0001 LAT. 50D 54M 9S LONG. 110D 17M 51S PR 4 UTM 12 549400E 5639000N FOR JAN 10, 1978 TO APR 19, 1983
RED DEER RIVER AT BINDLOSS, ALBERTA

	SUBM ID	23020L VANADIUM TOTAL RECOVERABLE VA MG/L	23301L VANADIUM EXTRBLE. V MG/L	24302L CHROMIUM EXTRBLE. CR MG/L	25101L MANGANESE DISSOLVED MN MG/L	25303L MANGANESE EXTRBLE. MN MG/L	26104L IRON DISSOLVED FE MG/L	26304L IRON EXTRBLE. FE MG/L	27020L COBALT TOTAL RECOVERABLE CO MG/L
SAMPLES(FLAGS)	0462	37(12)	25(10)	38(38)	36(27)	27(2)	36(28)	27(1)	36(18)
LOW		L.001	L.001	L.015	L.01	L.010	L.04	L.04	L.002
HIGH		.056	.036	L.0150	.090	1.1	.150	11.0	.040
AVERAGE		.007*	.004*		.014*	.125*	.050*	1.483*	.004*
STD.DEV.		.012*	.007*		.014*	.225*	.023*	2.353*	.007*
PERCNT:10TH		L.001	L.001	L.015	L.01	.01	L.04	.05	L.002
25TH		L.001	L.001	L.015	L.010	.017	L.040	.08	L.002
MEDIAN 50TH		.003	.001	L.0150	L.010	.044	L.040	.39	.002*
75TH		.006	.005	L.0150	.010*	.16	L.040	2.3	.004
90TH		.027	.008	L.0150	.03	.254	.080	3.5	.009
SECONDARY CODE		20P	01P 02P	02P	04L	04P		04P	20P

	SUBM ID	27301L COBALT EXTRBLE. CO MG/L	28020L NICKEL TOTAL RECOVERABLE NI MG/L	28301L NICKEL EXTRBLE. NI MG/L	29020L COPPER TOTAL RECOVERABLE CU MG/L	29305L COPPER EXTRBLE. CU MG/L	30020L ZINC TOTAL RECOVERABLE ZN MG/L	30305L ZINC EXTRBLE. ZN MG/L	33104L ARSENIC DISSOLVED AS MG/L
SAMPLES(FLAGS)	0462	24(10)	35(6)	8(4)	36(3)	26(4)	32(2)	26(3)	64(40)
LOW		L.002	L.002	L.002	L.001	L.001	L.001	L.001	L.0005
HIGH		.024	.100	.035	.070	.046	.710	.040	L.005
AVERAGE		.004*	.013*	.007*	.010*	.007*	.046*	.010*	.0006*
STD.DEV.		.005*	.020*	.011*	.015*	.010*	.128*	.012*	.0006*
PERCNT:10TH		L.002	L.002		.001	L.001	.003	L.001	L.0005
25TH		L.002	.002	L.002	.002	.001	.006	.002	L.0005
MEDIAN 50TH		.002	.005	.002*	.004	.003	.009	.004	L.0005
75TH		.004	.009	.006	.008	.009	.025	.012	.0005
90TH		.007	.032		.029	.019	.070	.029	.0008
SECONDARY CODE		02P	20P	02P	20P	05P	20P	05P	04F

	SUBM ID	34102L SELENIUM DISSOLVED SE MG/L	38301L STRONTIUM EXTRBLE. SR MG/L	42301L MOLYBDENUM EXTRBLE. MO MG/L	47301L SILVER EXTRBLE. AG MG/L	48020L CADMIUM TOTAL RECOVERABLE CD MG/L	48301L CADMIUM EXTRBLE. CD MG/L	56020L BARIUM TOTAL RECOVERABLE BA MG/L	56301L BARIUM EXTRBLE. BA MG/L
SAMPLES(FLAGS)	0462	56(51)			6(6)	37(34)	25(22)	37(2)	25(3)
LOW		L.0005			L.004	L.001	L.001	L.05	L.05
HIGH		.0008			L.004	.002	.001	1.100	.39
AVERAGE		.0005*				.001*	.001*	.189*	.123*
STD.DEV.		.0000*				.000*	.000*	.187*	.071*
PERCNT:10TH		L.0005				L.001	L.001	.070	L.05
25TH		L.0005			L.004	L.001	L.001	.100	.06
MEDIAN 50TH		L.0005			L.004	L.001	L.001	.14	.12
75TH		L.0005			L.004	L.001	L.001	.170	.15
90TH		L.0005				L.001	.001	.380	.18
SECONDARY CODE					01P	20P	02P	20P	01P

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NAQUADAT SUMMARY REPORT JAN 08, 1991
SURFACE WATER DATA

STATION 00AL05CK0001 LAT. 50D 54M 9S LONG. 110D 17M 51S PR 4 UTM 12 549400E 5639000N FOR JAN 10, 1978 TO APR 19, 1983
RED DEER RIVER AT BINDLOSS, ALBERTA

	SUBM ID	80011L MERCURY TOTAL HG UG/L	80311L MERCURY EXTRBLE. HG UG/L	82020L LEAD TOTAL RECOVERABLE PB MG/L	82301L LEAD EXTRBLE. PB MG/L	36001L COLIFORMS TOTAL MPN NO/100ML	36011L COLIFORMS FECAL MPN NO/100ML	36101L STREP. FECAL	36103L FECAL STREP. MF NO/DL
SAMPLES(FLAGS)	0462	49(37)	15(13)	37(29)	26(17)	61(15)	63(26)		
LOW		L.02	L.02	L.004	L.004	L2.	L1.		
HIGH		.14	.02	.050	.026	1000.	1900.		
AVERAGE		.030*	.020*	.007*	.0058*	83.*	72.*		
STD.DEV.		.025*	.000*	.008*	.0046*	178.*	263.*		
PERCNT:10TH		L.02	L.02	L.004	L.004	L2.	L2.		
25TH		L.02	L.02	L.004	L.004	2.	L2.		
MEDIAN 50TH		L.02	L.02	L.004	L.0040	20.	5.		
75TH		L.020	L.02	L.004	.006	60.	30.		
90TH		.06	.02	.013	.010	200.	120.		
SECONDARY CODE		11P	13P	20P	02P	02L 02F	12L 12F		

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Appendix IV. NAQUADAT summary reports from the long-term monitoring sites on the Red Deer River, January 1984 to December 1989.

NAQUADAT SUMMARY REPORT JAN 09, 1991
SURFACE WATER DATA

STATION 00AL05CC0004 LAT. 52D 16M 3S LONG. 113D 51M 48S PR 4 UTM 12 304600E 5794400N FOR JAN 09, 1984 TO DEC 06, 1989
RED DEER RIVER AT HWY 2 ABOVE RED DEER, ALBERTA

	SUBM ID	00201L TOTAL DISSOLVED SOLIDS (CALCD.) MG/L	00205L TOTAL DISSOLVED SOLIDS MG/L	02011L COLOUR APPARENT REL. UNITS	02021L COLOUR TRUE REL. UNITS	02041F SPECIFIC CONDUCT. US/CM	02041L SPECIFIC CONDUCT. US/CM	02061F TEMPERATURE OF WATER DEG.C	02073F TURBIDITY JTU
SAMPLES(FLAGS)	0479	48(0)	23(0)	9(0)	59(5)	68(0)	69(0)	67(0)	33(0)
LOW		160.	153.	5.	L5.0	244.	242.	.0	1.0
HIGH		255.	257.	20.	80.0	445.0	560.0	19.4	44.0
AVERAGE		214.	202.	13.	15.6*	365.9	380.7	7.6	7.3
STD.DEV.		25.	28.	6.	15.7*	42.4	49.3	6.6	10.9
PERCNT:10TH		185.	170.		5.0	307.0	324.0	.1	1.5
25TH		192.	185.	10.	5.0	341.5	344.0	.5	2.0
MEDIAN 50TH		214.	203.	10.	10.0	368.0	377.0	8.0	2.7
75TH		235.	220.	20.	20.0	392.0	416.0	14.	4.5
90TH		251.	237.		40.0	425.	443.0	16.5	24.0
SECONDARY CODE					24L				

	SUBM ID	02071L TURBIDITY JTU	06001L CARBON TOTAL ORGANIC C MG/L	06051L CARBON TOTAL INORGANIC C MG/L	06101L CARBON DISSOLVED ORGANIC C MG/L	06151L CARBON DISSOLVED INORGANIC C MG/L	06901L CARBON ORGANIC PARTICUL. C MG/L	06904L CARBON PARTICULATE ORGANIC C MG/L	06201L BICARBONT. (CALCD.) HCO3 MG/L
SAMPLES(FLAGS)	0479	35(0)	31(0)	1(0)	72(0)	17(0)	37(0)	28(7)	63(26)
LOW	0446	.5	1.3	45.0	1.30	30.00	.1	.10	143.8
HIGH		36.0	12.5	45.0	12.50	47.50	2.5	1.30	268.2
AVERAGE		4.7	4.2		4.00	38.11	.5	.31*	204.4*
STD.DEV.		8.0	2.1		2.47	5.14	.6	.28*	27.4*
PERCNT:10TH		.8	2.5		1.60	30.4	.2	.10	168.2
25TH		1.0	2.8		2.35	34.2	.2	L.20	Q185.0
MEDIAN 50TH		1.7	3.7		3.50	38.00	.3	.20	207.7
75TH		2.5	4.5		4.40	42.00	.4	.40	224.3
90TH		19.0	6.5		6.70	45.00	1.5	.60	Q238.7
SECONDARY CODE		73L	05L	52L	04L 07L	52L 54L	02L		

	SUBM ID	06301L CARBONATE (CALCD.) CO3 MG/L	06401L FREE CO2 (CALCD.) CO2 MG/L	06535L PHENOLIC MATERIAL PHENOL MG/L	06717L CHLORO-PHYLL A MG/L	07110L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07506P NITROGEN TOTAL AMMONIA N MG/L	07651L NITROGEN DISSOLVED N MG/L	07651F NITROGEN DISSOLVED N MG/L
SAMPLES(FLAGS)	0479	63(26)	48(0)	47(17)	38(17)	72(32)	69(48)	38(0)	12(0)
LOW	0446	.0	.9	L.001	L.001	.001	L.010	.070	.060
HIGH		8.2	9.4	.023	.004	1.400	.370	1.200	.260
AVERAGE		.7*	2.7	.003*	.001*	.059*	.051*	.191	.131
STD.DEV.		1.8*	1.7	.004*	.001*	.170*	.057*	.187	.056
PERCNT:10TH		.0	1.1	L.001	L.001	L.003	L.010	.080	.060
25TH		.0	1.5	L.001	L.001	.007*	.010	.130	.085
MEDIAN 50TH		Q.1	2.1	.001	.001	.010*	L.050	.140	.140
75TH		Q.1	3.5	.002	.002	.075	.060	.180	.150
90TH		2.9	4.9	.008	.003	.100	L.1	.280	.170
SECONDARY CODE				37L		11L	05L		

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NAQUADAT SUMMARY REPORT JAN 09, 1991
SURFACE WATER DATA

STATION 00AL05CC0004 LAT. 52D 16M 3S LONG. 113D 51M 48S PR 4 UTM 12 304600E 5794400N FOR JAN 09, 1984 TO DEC 06, 1989
RED DEER RIVER AT HWY 2 ABOVE RED DEER, ALBERTA

	SUBM ID	07901L NITROGEN PARTICUL. N MG/L	08101F OXYGEN DISSOLVED DO O2 MG/L	09105L FLUORIDE DISSOLVED F MG/L	10101L ALKALINITY TOTAL CACO3 MG/L	10151L ALKALINITY PHENOL PHTHALEIN CACO3 MG/L	10301F PH PH UNITS	10301L PH PH UNITS	10401L RESIDUE NONFILTR. MG/L
SAMPLES(FLAGS)	0479	65(3)	69(0)	68(0)	68(0)	64(26)	69(0)	69(0)	72(6)
LOW	0446	L.010	8.20	.1	118.0	.0	7.0	7.63	L0.
HIGH		.560	14.2	.2	220.0	6.8	8.50	8.60	176.
AVERAGE		.071*	11.06	.1	167.0	.5*			8.*
STD.DEV.		.097*	1.42	.0	22.5	1.5*			23.*
PERCNT:10TH		.020	9.10	.1	138.0	.0	7.4	7.80	L1.
25TH		.020	9.8	.1	151.0	.0	7.80	8.00	2.
MEDIAN 50TH		.040	11.1	.1	169.5	L.1	8.00	8.20	3.
75TH		.060	12.0	.2	182.5	L.1	8.1	8.31	5.
90TH		.210	12.8	.2	197.0	2.4	8.30	8.40	18.
SECONDARY CODE		02L 04L	01L 02F	08L 06L 07L	06L 11L				07L

	SUBM ID	10602L HARDNESS TOTAL (CALCD.) CACO3 MG/L	11101L SODIUM DISSOLVED NA MG/L	12102L MAGNESIUM DISSOLVED MG MG/L	14101L SILICA REACTIVE SIO2 MG/L	15103L PHOSPHORUS DISSOLVED P MG/L	15255L PHOSPHORUS DISSOLVED ORTHO PO4 P MG/L	15406L PHOSPHORUS TOTAL P MG/L	15901L PHOSPHORUS PARTICULATE (CALCD.) P MG/L
SAMPLES(FLAGS)	0479	69(0)	69(0)	69(0)	66(0)	71(17)		72(2)	71(17)
LOW	0446	132.7	3.2	10.5	2.0	L.003		L.003	.000
HIGH		236.1	13.7	18.5	9.5	.160		.280	.148
AVERAGE		183.5	6.8	15.1	4.7	.010*		.025*	.015*
STD.DEV.		24.1	2.0	2.0	1.3	.024*		.049*	.028*
PERCNT:10TH		153.0	4.6	12.5	2.8	L.003		.004	.000
25TH		167.0	5.6	13.8	4.0	.003		.006	.002
MEDIAN 50TH		181.7	6.5	15.0	4.6	.004		.010	.005
75TH		203.6	7.9	17.1	5.5	.008		.024	.013
90TH		220.6	9.7	17.7	6.3	.015		.052	Q.049
SECONDARY CODE			03L	05L	02L 05L	05L		21L	

	SUBM ID	16301L SULPHATE DISSOLVED SO4 MG/L	17206L CHLORIDE DISSOLVED CL MG/L	19101L POTASSIUM DISSOLVED K MG/L	20103L CALCIUM DISSOLVED CA MG/L	03301L LITHIUM EXTRBLE. LI MG/L	04301L BERYLLIUM EXTRBLE. BE MG/L	05105L BORON DISSOLVED B MG/L	13303L ALUMINUM EXTRBLE. AL MG/L
SAMPLES(FLAGS)	0479	68(0)	38(0)	69(0)	66(0)			65(13)	22(2)
LOW	0446	20.7	.70	.57	30.4			L.01	L.0100
HIGH		45.8	5.30	7.92	64.2			.130	.0800
AVERAGE		33.7	1.57	1.52	48.9			.040*	.0300*
STD.DEV.		6.4	1.05	1.22	7.1			.028*	.0193*
PERCNT:10TH		25.2	.70	.90	40.8			L.01	.0100
25TH		28.9	.90	1.00	44.1			.01	L.02
MEDIAN 50TH		34.0	1.10	1.11	47.9			.040	.0250
75TH		38.1	2.00	1.57	55.0			.060	.0400
90TH		43.0	3.20	2.27	59.5			.070	.0600
SECONDARY CODE		06L		03L				07L	

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

NAQUADAT SUMMARY REPORT JAN 09, 1991
SURFACE WATER DATA

STATION 00AL05CC0004 LAT. 52D 16M 3S LONG. 113D 51M 48S PR 4 UTM 12 304600E 5794400N FOR JAN 09, 1984 TO DEC 06, 1989
RED DEER RIVER AT HWY 2 ABOVE RED DEER, ALBERTA

	SUBM ID	23020L VANADIUM TOTAL RECOVERABLE VA MG/L	23301L VANADIUM EXTRBLE. V MG/L	24302L CHROMIUM EXTRBLE. CR MG/L	25101L MANGANESE DISSOLVED MN MG/L	25303L MANGANESE EXTRBLE. MN MG/L	26104L IRON DISSOLVED FE MG/L	26304L IRON EXTRBLE. FE MG/L	27020L COBALT TOTAL RECOVERABLE CO MG/L
SAMPLES(FLAGS)	0479		11(5)	4(4)	68(43)	5(0)	68(29)	10(1)	
LOW	0446		L.001	L.0010	L.004	.014	L.010	L.01	
HIGH			.010	L.0010	.070	.047	.190	.16	
AVERAGE			.002*		.014*	.032	.042*	.071*	
STD.DEV.			.003*		.010*	.014	.040*	.053*	
PERCNT:10TH			L.001		L.004		L.010	.010*	
25TH			L.001	L.0010	.004	.026	.013	.020	
MEDIAN 50TH			.001	L.0010	.012	.030	L.040	.075	
75TH			.002	L.0010	L.020	.045	.040	.080	
90TH			.002		L.020		.071	.155	
SECONDARY CODE			02L		04L 04P	04L	04P		

	SUBM ID	27301L COBALT EXTRBLE. CO MG/L	28020L NICKEL TOTAL RECOVERABLE NI MG/L	28301L NICKEL EXTRBLE. NI MG/L	29020L COPPER TOTAL RECOVERABLE CU MG/L	29305L COPPER EXTRBLE. CU MG/L	30020L ZINC TOTAL RECOVERABLE ZN MG/L	30305L ZINC EXTRBLE. ZN MG/L	33104L ARSENIC DISSOLVED AS MG/L
SAMPLES(FLAGS)		10(7)		11(6)		11(7)		11(8)	29(2)
LOW		L.001		L.001		L.001		L.001	L.0002
HIGH		.003		.004		.002		.019	.0056
AVERAGE		.001*		.001*		.001*		.003*	.0006*
STD.DEV.		.001*		.001*		.000*		.005*	.0010*
PERCNT:10TH		L.001		L.001		L.001		L.001	.0002
25TH		L.001		L.001		L.001		L.001	.0003
MEDIAN 50TH		L.001		L.001		L.001		L.001	.0004
75TH		.002		.002		.001		.002	.0005
90TH		.003		.003		.001		.005	.0009
SECONDARY CODE		02L		02L					

	SUBM ID	34102L SELENIUM DISSOLVED SE MG/L	38301L STRONTIUM EXTRBLE. SR MG/L	42301L MOLYBDENUM EXTRBLE. MO MG/L	47301L SILVER EXTRBLE. AG MG/L	48020L CADMIUM TOTAL RECOVERABLE CD MG/L	48301L CADMIUM EXTRBLE. CD MG/L	56020L BARIUM TOTAL RECOVERABLE BA MG/L	56301L BARIUM EXTRBLE. BA MG/L
SAMPLES(FLAGS)	0479	72(20)			22(22)		11(11)		8(0)
LOW	0446	L.0001			L.001		L.001		.08
HIGH		.0007			L.005		L.001		.160
AVERAGE		.0003*							.114
STD.DEV.		.0001*							.024
PERCNT:10TH		L.0002			L.001		L.001		
25TH		L.0002			L.001		L.001		.100
MEDIAN 50TH		.0003			L.004		L.001		.110
75TH		.0004			L.004		L.001		.125
90TH		.0004			L.004		L.001		
SECONDARY CODE		08L			01P 02L		02L		

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NAQUADAT SUMMARY REPORT JAN 09, 1991
SURFACE WATER DATA

STATION 00AL05CC0004 LAT. 52D 16M 3S LONG. 113D 51M 48S PR 4 UTM 12 304600E 5794400N FOR JAN 09, 1984 TO DEC 06, 1989
RED DEER RIVER AT HWY 2 ABOVE RED DEER, ALBERTA

	SUBM ID	80011L MERCURY TOTAL HG UG/L	80311L MERCURY EXTRBLE. HG UG/L	82020L LEAD TOTAL RECOVERABLE PB MG/L	82301L LEAD EXTRBLE. PB MG/L	36001L COLIFORMS TOTAL MPN NO/100ML	36011L COLIFORMS FECAL MPN NO/100ML	36101L STREP. FECAL	36103L FECAL STREP. MF NO/DL
SAMPLES(FLAGS)	0479	64(63)			12(10)	64(8)	71(25)	44(15)	35(2)
LOW	0446	L.020			L.0020	0.	1.	0.	L2.
HIGH		L.050			.003	3400.	353.	88.	12000.
AVERAGE		.032*			.0022*	128.*	23.*	16.*	450.*
STD.DEV.		.015*			.0004*	444.*	50.*	22.*	2018.*
PERCNT:10TH		L.020			L.0020	L2.	L2.	L2.	2.
25TH		L.020			L.0020	4.	2.	L4.	10.
MEDIAN 50TH		L.020			L.0020	11.	8.	8.	56.
75TH		L.050			L.0020	72.	14.	12.	130.
90TH		L.050			.0030	224.	56.	56.	300.
SECONDARY CODE		11P			02L	02L 02F	12L 12F	02F	03F

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

NAQUADAT SUMMARY REPORT JAN 09, 1991
SURFACE WATER DATA

STATION 00AL05CE0001 LAT. 51D 28M 9S LONG. 112D 42M 30S PR 4 UTM 12 381300E 5703100N FOR JAN 18, 1984 TO JAN 07, 1987
RED DEER RIVER AT DRUMHELLER, ALBERTA

	SUBM ID	00201L TOTAL DISSOLVED SOLIDS (CALCD.) MG/L	00205L TOTAL DISSOLVED SOLIDS MG/L	02011L COLOUR APPARENT REL. UNITS	02021L COLOUR TRUE REL. UNITS	02041F SPECIFIC CONDUCT. US/CM	02041L SPECIFIC CONDUCT. US/CM	02061F TEMPERATURE OF WATER DEG.C	02073F TURBIDITY JTU
SAMPLES(FLAGS)	0479	15(0)	21(0)		37(2)	37(0)	37(0)	37(0)	35(2)
LOW		159.	114.		L5.0	244.0	236.0	.0	1.1
HIGH		262.	294.		120.0	489.0	514.0	23.0	310.0
AVERAGE		213.	212.		25.4*	381.3	386.2	7.2	49.7*
STD.DEV.		34.	46.		29.1*	60.3	66.6	7.6	76.8*
PERCNT:10TH		169.	166.		5.0	311.0	312.0	.0	2.0
25TH		187.	183.		10.0	344.0	344.0	.5	3.0
MEDIAN 50TH		207.	208.		10.0	368.0	381.0	4.0	15.0
75TH		245.	242.		30.0	424.0	427.0	13.5	51.0
90TH		259.	274.		80.0	458.0	477.0	18.5	L200.0
SECONDARY CODE									

	SUBM ID	02071L TURBIDITY JTU	06001L CARBON TOTAL ORGANIC C MG/L	06051L CARBON TOTAL INORGANIC C MG/L	06101L CARBON DISSOLVED ORGANIC C MG/L	06151L CARBON DISSOLVED INORGANIC C MG/L	06901L CARBON ORGANIC PARTICUL. C MG/L	06904L CARBON PARTICULATE ORGANIC C MG/L	06201L BICARBONT. (CALCD.) HCO3 MG/L
SAMPLES(FLAGS)	0479	37(0)			40(0)		40(0)		31(1)
LOW	0446	.7			.40		.1		100.1
HIGH		275.0			16.00		8.3		293.8
AVERAGE		43.6			4.52		1.7		195.9*
STD.DEV.		72.6			3.05		2.3		44.5*
PERCNT:10TH		1.0			1.65		.2		140.2
25TH		2.4			2.50		.2		165.8
MEDIAN 50TH		13.0			3.55		.7		194.6
75TH		36.0			5.40		1.8		230.9
90TH		185.0			9.25		5.2		238.9
SECONDARY CODE		73L			04L		02L		

	SUBM ID	06301L CARBONATE (CALCD.) CO3 MG/L	06401L FREE CO2 (CALCD.) CO2 MG/L	06535L PHENOLIC MATERIAL PHENOL MG/L	06717L CHLORO-PHYLL A MG/L	07110L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07506P NITROGEN TOTAL AMMONIA N MG/L	07651L NITROGEN DISSOLVED N MG/L	07651F NITROGEN DISSOLVED N MG/L
SAMPLES(FLAGS)	0479	31(1)	15(0)	14(8)	40(13)	40(12)	40(31)	40(0)	11(0)
LOW	0446	.0	.5	L.001	L.001	L.010	L.050	.080	.100
HIGH		6.6	12.0	.006	.020	.900	.540	1.800	.730
AVERAGE		1.0*	3.7	.002*	.003*	.166*	.100*	.373	.315
STD.DEV.		2.0*	3.5	.002*	.004*	.203*	.097*	.343	.179
PERCNT:10TH		.0	.7	L.001	L.001	L.010	L.050	.150	.140
25TH		.0	1.5	L.001	L.001	L.010	L.050	.200	.160
MEDIAN 50TH		.0	2.4	L.001	.002	.105	.050*	.280	.280
75TH		Q.6	4.2	.002	.005	.230	L.100	.385	.390
90TH		5.2	9.4	.004	.009	.385	.215	.715	.470
SECONDARY CODE									

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NAQUADAT SUMMARY REPORT JAN 09, 1991
SURFACE WATER DATA

STATION 00AL05CE0001 LAT. 51D 28M 9S LONG. 112D 42M 30S PR 4 UTM 12 381300E 5703100N FOR JAN 18, 1984 TO JAN 07, 1987
RED DEER RIVER AT DRUMHELLER, ALBERTA

	SUBM ID	07901L NITROGEN PARTICUL. N MG/L	08101F OXYGEN DISSOLVED DO O2 MG/L	09105L FLUORIDE DISSOLVED F MG/L	10101L ALKALINITY TOTAL CACO3 MG/L	10151L ALKALINITY PHENOL PHTHALEIN CACO3 MG/L	10301F PH PH UNITS	10301L PH PH UNITS	10401L RESIDUE NONFILTR. MG/L
SAMPLES(FLAGS)	0479	40(0)	37(0)	35(0)	36(0)	31(1)	37(0)	37(0)	40(1)
LOW	0446	.010	5.10	.1	86.1	.0	7.70	7.50	L1.
HIGH		1.300	14.20	.2	241.0	5.5	8.90	9.00	620.
AVERAGE		.217	9.81	.2	160.1	.9*			96.*
STD.DEV.		.299	2.38	.0	35.5	1.7*			163.*
PERCNT:10TH		.020	6.10	.1	114.0	.0	7.80	7.70	2.
25TH		.030	8.40	.1	134.5	.0	8.00	8.00	4.
MEDIAN 50TH		.110	9.60	.2	159.0	.0	8.30	8.20	15.
75TH		.215	11.70	.2	187.5	L.5	8.50	8.40	107.
90TH		.620	13.00	.2	198.0	4.3	8.70	8.60	351.
SECONDARY CODE		02L	01L	08L 06L	06L 11L				

	SUBM ID	10602L HARDNESS TOTAL (CALCD.) CACO3 MG/L	11101L SODIUM DISSOLVED NA MG/L	12102L MAGNESIUM DISSOLVED MG MG/L	14101L SILICA REACTIVE SIO2 MG/L	15103L PHOSPHORUS DISSOLVED P MG/L	15255L PHOSPHORUS DISSOLVED ORTHO PO4 P MG/L	15406L PHOSPHORUS TOTAL P MG/L	15901L PHOSPHORUS PARTICULATE (CALCD.) P MG/L
SAMPLES(FLAGS)	0479	36(0)	36(0)	36(0)	36(0)	40(2)		40(0)	40(2)
LOW	0446	96.9	6.0	7.4	.2	L.003		.006	.001
HIGH		241.4	27.7	19.3	8.5	.270		.750	.480
AVERAGE		169.0	13.4	14.8	3.3	.033*		.100	.067*
STD.DEV.		36.3	4.4	2.6	2.1	.059*		.149	.105*
PERCNT:10TH		129.1	9.1	12.1	.6	.003		.010	.003
25TH		149.6	10.3	13.1	1.5	.005		.016	.006
MEDIAN 50TH		165.5	12.6	14.3	2.9	.012		.049	.018
75TH		193.2	15.2	17.1	5.0	.030		.090	.073
90TH		221.9	19.6	17.9	5.9	.069		.285	.225
SECONDARY CODE			03L		02L				

	SUBM ID	16301L SULPHATE DISSOLVED SO4 MG/L	17206L CHLORIDE DISSOLVED CL MG/L	19101L POTASSIUM DISSOLVED K MG/L	20103L CALCIUM DISSOLVED CA MG/L	03301L LITHIUM EXTRBLE. LI MG/L	04301L BERYLLIUM EXTRBLE. BE MG/L	05105L BORON DISSOLVED B MG/L	13303L ALUMINUM EXTRBLE. AL MG/L
SAMPLES(FLAGS)	0479	36(0)	36(0)	36(0)	36(0)			40(1)	
LOW	0446	20.8	.90	.95	19.1			L.020	
HIGH		51.8	8.30	9.60	65.2			.150	
AVERAGE		38.9	2.54	2.11	43.3			.060*	
STD.DEV.		7.3	1.26	1.68	11.3			.030*	
PERCNT:10TH		29.7	1.50	1.18	29.2			.030	
25TH		34.0	1.80	1.32	36.3			.040	
MEDIAN 50TH		39.6	2.40	1.64	41.9			.050	
75TH		44.3	2.80	2.05	50.6			.070	
90TH		48.0	3.80	2.70	59.5			.110	
SECONDARY CODE		06L		03L					

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NAQUADAT SUMMARY REPORT JAN 09, 1991
SURFACE WATER DATA

STATION 00AL05CE0001 LAT. 51D 28M 9S LONG. 112D 42M 30S PR 4 UTM 12 381300E 5703100N FOR JAN 18, 1984 TO JAN 07, 1987
RED DEER RIVER AT DRUMHELLER, ALBERTA

	SUBM ID	23020L VANADIUM TOTAL RECOVERABLE VA MG/L	23301L VANADIUM EXTRBLE. V MG/L	24302L CHROMIUM EXTRBLE. CR MG/L	25101L MANGANESE DISSOLVED MN MG/L	25303L MANGANESE EXTRBLE. MN MG/L	26104L IRON DISSOLVED FE MG/L	26304L IRON EXTRBLE. FE MG/L	27020L COBALT TOTAL RECOVERABLE CO MG/L
SAMPLES(FLAGS)	0479				39(28)		39(27)		
LOW	0446				.002		L.007		
HIGH					.040		.180		
AVERAGE					.018*		.046*		
STD.DEV.					.007*		.032*		
PERCNT:10TH					.005		L.020		
25TH					.017		L.040		
<u>MEDIAN</u> <u>50TH</u>					<u>L.020</u>		<u>L.040</u>		
75TH					L.020		L.040		
90TH					L.020		.071		
SECONDARY CODE					04L 04P		04P		

	SUBM ID	34102L SELENIUM DISSOLVED SE MG/L	38301L STRONTIUM EXTRBLE. SR MG/L	42301L MOLYBDENUM EXTRBLE. MO MG/L	47301L SILVER EXTRBLE. AG MG/L	48020L CADMIUM TOTAL RECOVERABLE CD MG/L	48301L CADMIUM EXTRBLE. CD MG/L	56020L BARIUM TOTAL RECOVERABLE BA MG/L	56301L BARIUM EXTRBLE. BA MG/L
SAMPLES(FLAGS)	0479	39(0)			13(13)				
LOW	0446	.0001			L.004				
HIGH		.0005			L.005				
AVERAGE		.0003							
STD.DEV.		.0001							
PERCNT:10TH		.0002			L.004				
25TH		.0002			L.004				
<u>MEDIAN</u> <u>50TH</u>		<u>.0003</u>			<u>L.004</u>				
75TH		.0004			L.004				
90TH		.0004			L.004				
SECONDARY CODE		08L			01P				

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NAQUADAT SUMMARY REPORT JAN 09, 1991
SURFACE WATER DATA

STATION 00AL05CE0001 LAT. 51D 28M 9S LONG. 112D 42M 30S PR 4 UTM 12 381300E 5703100N FOR JAN 18, 1984 TO JAN 07, 1987
RED DEER RIVER AT DRUMHELLER, ALBERTA

	SUBM ID	80011L MERCURY TOTAL HG UG/L	80311L MERCURY EXTRBLE. HG UG/L	82020L LEAD TOTAL RECOVERABLE PB MG/L	82301L LEAD EXTRBLE. PB MG/L	36001L COLIFORMS TOTAL MPN NO/100ML	36011L COLIFORMS FECAL MPN NO/100ML	36101L STREP. FECAL	36103L FECAL STREP. MF NO/DL
SAMPLES(FLAGS)	0479	39(38)				33(0)	39(2)	11(1)	37(2)
LOW	0446	L.020				5.	L2.	L2.	L2.
HIGH		.040				500.	300.	460.	14100.
AVERAGE		.021*				131.	51.*	106.*	522.*
STD.DEV.		.003*				153.	79.*	145.*	2311.*
PERCNT:10TH		L.020				10.	2.	2.	3.
25TH		L.020				34.	5.	5.	18.
MEDIAN 50TH		L.020				50.	12.	24.	62.
75TH		L.020				245.	70.	195.	160.
90TH		L.020				390.	180.	230.	460.
SECONDARY CODE		11P				02L 02F	12L 12F	02F	03F

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NAQUADAT SUMMARY REPORT JAN 09, 1991
SURFACE WATER DATA

STATION 00AL05CE0002 LAT. 51D 39M 10S LONG. 112D 54M 15S PR 3 UTM 12 368300E 5723900N FOR MAR 25, 1987 TO DEC 06, 1989
RED DEER RIVER AT MORRIN BRIDGE
CENTER AUGUST 1987

SUBM ID	00201L TOTAL DISSOLVED SOLIDS (CALCD.)	00205L TOTAL DISSOLVED SOLIDS	02011L COLOUR APPARENT	02021L COLOUR TRUE	02041F SPECIFIC CONDUCT.	02041L SPECIFIC CONDUCT.	02061F TEMPERATURE OF WATER	02073F TURBIDITY
	MG/L	MG/L	REL. UNITS	REL. UNITS	US/CM	US/CM	DEG.C	JTU
SAMPLES(FLAGS)	34(3)	3(0)	10(0)	24(2)	32(0)	34(0)	34(0)	
LOW	Q155.	167.	10.	L5.0	223.	286.0	.0	
HIGH	315.	177.	100.	50.0	518.	524.0	20.7	
AVERAGE	225.*	172.	28.	17.1*	373.8	393.2	9.1	
STD.DEV.	44.*	5.	29.	12.4*	81.5	71.3	8.4	
PERCNT:10TH	171.		10.	5.0	270.	305.	.0	
25TH	Q189.		10.	10.0	323.5	336.0	.2	
MEDIAN 50TH	211.	173.	15.	10.5	357.0	380.0	9.5	
75TH	264.		30.	20.0	444.5	460.0	18.5	
90TH	275.		75.	40.	464.	485.0	20.0	
SECONDARY CODE				24L				

SUBM ID	02071L TURBIDITY	06001L CARBON TOTAL ORGANIC C	06051L CARBON TOTAL INORGANIC C	06101L CARBON DISSOLVED ORGANIC C	06151L CARBON DISSOLVED INORGANIC C	06901L CARBON ORGANIC PARTICUL. C	06904L CARBON PARTICULATE ORGANIC C	06201L BICARBONT. (CALCD.) HCO3
	JTU	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
SAMPLES(FLAGS)		31(0)	2(0)	34(0)	11(0)		28(5)	31(23)
LOW		2.1	40.5	.01	29.7		.02	Q136.3
HIGH		10.0	46.0	10.3	47.00		4.70	Q270.4
AVERAGE		5.0	43.3	4.85	36.37		.52*	205.2*
STD.DEV.		2.0	3.9	2.37	6.68		.90*	38.7*
PERCNT:10TH		3.0		2.80	30.00		.10	169.2
25TH		3.4		3.20	31.00		L.20	177.0
MEDIAN 50TH		4.4	43.3	4.30	32.6		.20	193.8
75TH		5.5		5.80	44.00		.45	Q243.6
90TH		8.5		8.40	46.0		L1.00	Q252.1
SECONDARY CODE		05L	52L	04L 07L	52L 54L			

SUBM ID	06301L CARBONATE (CALCD.) CO3	06401L FREE CO2 (CALCD.) CO2	06535L PHENOLIC MATERIAL PHENOL	06717L CHLORO-PHYLL A	07110L NITROGEN DISSOLVED NO3 & NO2 N	07506P NITROGEN TOTAL AMMONIA N	07651L NITROGEN DISSOLVED N	07651F NITROGEN DISSOLVED N
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
SAMPLES(FLAGS)	31(23)	34(0)	34(16)		34(15)	31(7)		
LOW	Q.1	.5	L.001		L.001	L.010		
HIGH	11.4	14.1	.007		1.400	.260		
AVERAGE	1.7*	2.7	.002*		.132*	.044*		
STD.DEV.	3.0*	2.7	.002*		.268*	.068*		
PERCNT:10TH	Q.1	.8	L.001		L.003	L.010		
25TH	Q.1	1.0	L.001		L.003	.010		
MEDIAN 50TH	Q.1	1.7	.001		.005	.010		
75TH	3.8	3.7	.002		.140	.050		
90TH	6.5	4.0	.003		.390	.140		
SECONDARY CODE			37L		11L	05L		

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

NAQUADAT SUMMARY REPORT JAN 09, 1991
SURFACE WATER DATA

STATION 00AL05CE0002 LAT. 51D 39M 10S LONG. 112D 54M 15S PR 3 UTM 12 368300E 5723900N FOR MAR 25, 1987 TO DEC 06, 1989
RED DEER RIVER AT MORRIN BRIDGE
CENTER AUGUST 1987

SUBM ID	07901L NITROGEN PARTICUL. N MG/L	08101F OXYGEN DISSOLVED DO O2 MG/L	09105L FLUORIDE DISSOLVED F MG/L	10101L ALKALINITY TOTAL CACO3 MG/L	10151L ALKALINITY PHENOL PHTHALEIN CACO3 MG/L	10301F PH PH UNITS	10301L PH PH UNITS	10401L RESIDUE NONFILTR. MG/L
SAMPLES(FLAGS)	28(0)	34(0)	34(0)	34(0)	31(23)	31(0)	34(0)	34(0)
LOW	.020	3.9	.1	112.0	L.1	6.8	7.45	1.
HIGH	.500	17.6	.2	222.0	9.5	8.6	8.70	791.
AVERAGE	.136	10.04	.2	168.1	1.4*			54.
STD.DEV.	.142	2.68	.0	31.2	2.5*			142.
PERCNT:10TH	.020	7.0	.1	133.	L.1	7.1	7.81	2.
25TH	.020	8.8	.1	147.0	L.1	7.6	8.04	3.
MEDIAN 50TH	.070	10.05	.2	159.0	L.1	8.0	8.23	6.
75TH	.190	11.0	.2	200.0	3.2	8.2	8.43	54.
90TH	.400	13.5	.2	207.0	5.4	8.4	8.52	115.
SECONDARY CODE	04L	02F	07L					07L

SUBM ID	10602L HARDNESS TOTAL (CALCD.) CACO3 MG/L	11101L SODIUM DISSOLVED NA MG/L	12102L MAGNESIUM DISSOLVED MG MG/L	14101L SILICA REACTIVE SIO2 MG/L	15103L PHOSPHORUS DISSOLVED P MG/L	15255L PHOSPHORUS DISSOLVED ORTHO PO4 P MG/L	15406L PHOSPHORUS TOTAL P MG/L	15901L PHOSPHORUS PARTICULATE (CALCD.) P MG/L
SAMPLES(FLAGS)	34(0)	34(0)	34(0)	31(3)	33(0)		34(0)	33(0)
LOW	115.1	7.0	10.8	L.0	.003		.006	.003
HIGH	265.8	25.2	22.1	8.6	.138		.420	.292
AVERAGE	184.2	13.2	16.2	3.3*	.023		.065	.043
STD.DEV.	38.4	4.5	2.6	2.7*	.029		.091	.077
PERCNT:10TH	144.3	8.5	12.5	.2	.004		.009	.004
25TH	155.0	10.0	14.8	.8	.005		.014	.006
MEDIAN 50TH	169.9	12.0	15.6	2.7	.010		.031	.010
75TH	215.9	15.5	18.2	5.2	.032		.070	.040
90TH	235.5	19.0	19.3	7.3	.066		.144	.114
SECONDARY CODE		03L	05L	05L 02L	05L		21L	

SUBM ID	16301L SULPHATE DISSOLVED SO4 MG/L	17206L CHLORIDE DISSOLVED CL MG/L	19101L POTASSIUM DISSOLVED K MG/L	20103L CALCIUM DISSOLVED CA MG/L	03301L LITHIUM EXTRBLE. LI MG/L	04301L BERYLLIUM EXTRBLE. BE MG/L	05105L BORON DISSOLVED B MG/L	13303L ALUMINUM EXTRBLE. AL MG/L
SAMPLES(FLAGS)	34(0)	3(0)	34(0)	31(0)			28(8)	19(0)
LOW	21.	1.8	1.11	28.2			L.01	.0100
HIGH	63.5	3.1	6.60	71.9			.049	.8600
AVERAGE	38.7	2.30	1.83	48.1			.017*	.1653
STD.DEV.	9.5	.70	1.01	11.6			.009*	.2210
PERCNT:10TH	29.		1.20	34.2			L.01	.0200
25TH	32.5		1.25	40.2			L.010	.0300
MEDIAN 50TH	36.1	2.0	1.58	45.4			.010	.0800
75TH	45.0		2.00	57.0			.020	.1600
90TH	52.4		2.22	62.5			.03	.5500
SECONDARY CODE	06L		03L				07L	

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NAQUADAT SUMMARY REPORT JAN 09, 1991
SURFACE WATER DATA

STATION 00AL05CE0002 LAT. 51D 39M 10S LONG. 112D 54M 15S PR 3 UTM 12 368300E 5723900N FOR MAR 25, 1987 TO DEC 06, 1989
RED DEER RIVER AT MORRIN BRIDGE
CENTER AUGUST 1987

SUBM ID	23020L VANADIUM TOTAL RECOVERABLE VA MG/L	23301L VANADIUM EXTRBLE. V MG/L	24302L CHROMIUM EXTRBLE. CR MG/L	25101L MANGANESE DISSOLVED MN MG/L	25303L MANGANESE EXTRBLE. MN MG/L	26104L IRON DISSOLVED FE MG/L	26304L IRON EXTRBLE. FE MG/L	27020L COBALT TOTAL RECOVERABLE CO MG/L
SAMPLES(FLAGS)		10(6)	1(1)	31(7)	3(0)	31(9)	3(0)	
LOW		L.001	L.0010	L.004	.026	L.01	.07	
HIGH		.010	L.0010	.220	.050	4.950	1.61	
AVERAGE		.002*		.017*	.040	.207*	.847	
STD.DEV.		.003*		.039*	.013	.897*	.770	
PERCNT:10TH		L.001		L.004		L.010		
25TH		L.001		.004		L.010		
MEDIAN 50TH		L.001		.006	.045	.010	.86	
75TH		.002		.011		.030		
90TH		.008		.025		.040		
SECONDARY CODE		02L		04L	04L			

SUBM ID	27301L COBALT EXTRBLE. CO MG/L	28020L NICKEL TOTAL RECOVERABLE NI MG/L	28301L NICKEL EXTRBLE. NI MG/L	29020L COPPER TOTAL RECOVERABLE CU MG/L	29305L COPPER EXTRBLE. CU MG/L	30020L ZINC TOTAL RECOVERABLE ZN MG/L	30305L ZINC EXTRBLE. ZN MG/L	33104L ARSENIC DISSOLVED AS MG/L
SAMPLES(FLAGS)	10(4)		10(2)		10(5)		10(5)	31(2)
LOW	L.001		L.001		L.001		L.001	L.0002
HIGH	.006		.018		.015		.038	.0017
AVERAGE	.002*		.005*		.004*		.011*	.0006*
STD.DEV.	.001*		.006*		.006*		.015*	.0003*
PERCNT:10TH	L.001		L.001		L.001		L.001	.0003
25TH	L.001		.001		L.001		L.001	.0004
MEDIAN 50TH	.002		.003		.001*		.001*	.0005
75TH	.002		.005		.002		.020	.0006
90TH	.004		.017		.015		.037	.0008
SECONDARY CODE	02L		02L					

SUBM ID	34102L SELENIUM DISSOLVED SE MG/L	38301L STRONTIUM EXTRBLE. SR MG/L	42301L MOLYBDENUM EXTRBLE. MO MG/L	47301L SILVER EXTRBLE. AG MG/L	48020L CADMIUM TOTAL RECOVERABLE CD MG/L	48301L CADMIUM EXTRBLE. CD MG/L	56020L BARIUM TOTAL RECOVERABLE BA MG/L	56301L BARIUM EXTRBLE. BA MG/L
SAMPLES(FLAGS)	31(18)			9(9)		10(10)		7(0)
LOW	L.0001			L.001		L.001		.100
HIGH	.0005			L.001		L.001		.23
AVERAGE	.0002*							.129
STD.DEV.	.0001*							.047
PERCNT:10TH	L.0002					L.001		
25TH	L.0002			L.001		L.001		.100
MEDIAN 50TH	L.0002			L.001		L.001		.110
75TH	.0003			L.001		L.001		.140
90TH	.0003					L.001		
SECONDARY CODE				02L		02L		

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NAQUADAT SUMMARY REPORT JAN 09, 1991
SURFACE WATER DATA

STATION 00AL05CE0002 LAT. 51D 39M 10S LONG. 112D 54M 15S PR 3 UTM 12 368300E 5723900N FOR MAR 25, 1987 TO DEC 06, 1989
RED DEER RIVER AT MORRIN BRIDGE
CENTER AUGUST 1987

	SUBM ID	80011L MERCURY TOTAL HG UG/L	80311L MERCURY EXTRBLE. HG UG/L	82020L LEAD TOTAL RECOVERABLE PB MG/L	82301L LEAD EXTRBLE. PB MG/L	36001L COLIFORMS TOTAL MPN NO/100ML	36011L COLIFORMS FECAL MPN NO/100ML	36101L STREP. FECAL	36103L FECAL STREP. MF NO/DL
SAMPLES(FLAGS)		26(26)			11(7)	34(6)	34(13)	34(14)	
LOW		L.05			L.0020	L1.	0.	0.	
HIGH		L.050			.010	5400.	1500.	1000.	
AVERAGE					.0034*	423.*	88.*	71.*	
STD.DEV.					.0026*	1138.*	267.*	202.*	
PERCNT:10TH		L.05			L.0020	L10.	4.	L4.	
25TH		L.050			L.0020	10.	L10.	L10.	
MEDIAN 50TH		L.050			L.002	30.	10.*	L10.	
75TH		L.050			.005	200.	40.	20.	
90TH		L.050			.0060	700.	180.	80.	
SECONDARY CODE					02L				

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NAQUADAT SUMMARY REPORT JAN 09, 1991
SURFACE WATER DATA

STATION 00AL05CK0001 LAT. 50D 54M 9S LONG. 110D 17M 51S PR 4 UTM 12 549400E 5639000N FOR JAN 24, 1984 TO DEC 05, 1988
RED DEER RIVER AT BINDLOSS, ALBERTA

	SUBM ID	00201L TOTAL DISSOLVED SOLIDS (CALCD.) MG/L	00205L TOTAL DISSOLVED SOLIDS MG/L	02011L COLOUR APPARENT REL. UNITS	02021L COLOUR TRUE REL. UNITS	02041F SPECIFIC CONDUCT. US/CM	02041L SPECIFIC CONDUCT. US/CM	02061F TEMPERATURE OF WATER DEG.C	02073F TURBIDITY JTU
SAMPLES(FLAGS)	0462	14(1)	38(0)		58(6)	54(0)	58(0)	55(0)	53(12)
LOW	0003	211.	165.		L5.0	290.0	289.0	.0	2.6
HIGH	0446	326.	427.		L100.0	692.0	705.0	24.5	G200.0
AVERAGE	0315	270.*	283.		21.3*	470.5	486.3	8.6	52.7*
STD.DEV.		36.*	66.		18.7*	83.7	103.1	8.5	52.8*
PERCNT:10TH		229.	211.		5.0	358.0	367.0	.0	4.6
25TH		233.	232.		10.0	404.0	400.0	.4	9.0
MEDIAN 50TH		271.	267.		20.0	481.0	461.5	7.3	34.0
75TH		293.	333.		20.0	531.0	545.0	17.0	94.0
90TH		314.	410.		40.0	565.0	669.0	20.0	L100.0
SECONDARY CODE									

	SUBM ID	02071L TURBIDITY JTU	06001L CARBON TOTAL ORGANIC C MG/L	06051L CARBON TOTAL INORGANIC C MG/L	06101L CARBON DISSOLVED ORGANIC C MG/L	06151L CARBON DISSOLVED INORGANIC C MG/L	06901L CARBON ORGANIC PARTICUL. C MG/L	06904L CARBON PARTICULATE ORGANIC C MG/L	06201L BICARBONT. (CALCD.) HCO3 MG/L
SAMPLES(FLAGS)	0462	34(0)			58(0)		58(0)		54(1)
LOW	0003	1.3			1.70		.2		149.9
HIGH	0446	430.0			11.00		17.0		382.8
AVERAGE	0315	51.6			4.74		2.2		236.9*
STD.DEV.		81.5			1.98		3.0		64.8*
PERCNT:10TH		1.8			2.40		.2		168.2
25TH		3.1			3.40		.3		185.3
MEDIAN 50TH		23.5			4.25		1.2		224.3
75TH		62.0			6.10		2.6		280.4
90TH		100.0			7.60		6.6		347.4
SECONDARY CODE		73L			04L		02L		

	SUBM ID	06301L CARBONATE (CALCD.) CO3 MG/L	06401L FREE CO2 (CALCD.) CO2 MG/L	06535L PHENOLIC MATERIAL PHENOL MG/L	06717L CHLORO-PHYLL A MG/L	07110L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07506P NITROGEN TOTAL AMMONIA N MG/L	07651L NITROGEN DISSOLVED N MG/L	07651F NITROGEN DISSOLVED N MG/L
SAMPLES(FLAGS)	0462	54(1)	14(0)	16(6)	55(7)	58(25)	45(39)	58(0)	12(0)
LOW	0003	.0	1.3	L.001	L.001	L.010	L.050	.100	.140
HIGH	0446	1.4	13.3	.007	.130	.800	.800	1.400	.550
AVERAGE	0315	.0*	4.8	.003*	.010*	.113*	.092*	.317	.298
STD.DEV.		.2*	4.0	.002*	.020*	.173*	.122*	.211	.130
PERCNT:10TH		.0	1.4	L.001	L.001	L.010	L.050	.160	.170
25TH		.0	1.7	L.001	.001	L.010	L.050	.190	.190
MEDIAN 50TH		.0	2.5	.001	.004	.015	L.050	.240	.265
75TH		.0	7.4	.005	.009	.110	L.100	.370	.380
90TH		.0	11.2	.006	.020	.380	.100	.570	.480
SECONDARY CODE					17P				

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NAQUADAT SUMMARY REPORT JAN 09, 1991
SURFACE WATER DATA

STATION 00AL05CK0001 LAT. 50D 54M 9S LONG. 110D 17M 51S PR 4 UTM 12 549400E 5639000N FOR JAN 24, 1984 TO DEC 05, 1988
RED DEER RIVER AT BINDLOSS, ALBERTA

	SUBM ID	07901L NITROGEN PARTICUL. N MG/L	08101F OXYGEN DISSOLVED DO O2 MG/L	09105L FLUORIDE DISSOLVED F MG/L	10101L ALKALINITY TOTAL CACO3 MG/L	10151L ALKALINITY PHENOL PHTHALEIN CACO3 MG/L	10301F PH PH UNITS	10301L PH PH UNITS	10401L RESIDUE NONFILTR. MG/L
SAMPLES(FLAGS)	0462	58(1)	52(0)	54(0)	56(0)	54(1)	55(0)	58(0)	58(0)
LOW	0003	L.010	2.60	.1	123.0	.0	7.20	7.50	2.
HIGH	0446	1.700	14.30	.2	314.0	1.2	9.10	8.50	1618.
AVERAGE	0315	.274*	9.47	.2	192.8	.0*			142.
STD.DEV.		.336*	2.55	.0	53.0	.2*			290.
PERCNT:10TH		.030	7.10	.1	136.0	.0	7.50	7.78	2.
25TH		.040	8.05	.2	151.5	.0	7.80	8.00	8.
MEDIAN 50TH		.155	9.00	.2	179.5	.0	8.10	8.15	38.
75TH		.340	11.20	.2	224.0	.0	8.30	8.27	129.
90TH		.860	13.00	.2	285.0	.0	8.40	8.30	460.
SECONDARY CODE		02L	01L	08L 06L	06L 11L				

	SUBM ID	10602L HARDNESS TOTAL (CALCD.) CACO3 MG/L	11101L SODIUM DISSOLVED NA MG/L	12102L MAGNESIUM DISSOLVED MG MG/L	14101L SILICA REACTIVE SIO2 MG/L	15103L PHOSPHORUS DISSOLVED P MG/L	15255L PHOSPHORUS DISSOLVED ORTHO PO4 P MG/L	15406L PHOSPHORUS TOTAL P MG/L	15901L PHOSPHORUS PARTICULATE (CALCD.) P MG/L
SAMPLES(FLAGS)	0462	56(0)	56(0)	56(0)	56(0)	58(3)	58(43)	58(0)	58(3)
LOW	0003	116.9	12.0	10.1	1.0	L.003	L.003	.008	.002
HIGH	0446	322.1	45.3	27.4	7.4	.084	.050	.700	.616
AVERAGE	0315	201.4	24.5	17.9	3.4	.013*	.005*	.096	.083*
STD.DEV.		54.6	7.2	4.5	1.6	.016*	.007*	.129	.119*
PERCNT:10TH		146.0	14.9	13.0	1.4	.003	L.003	.011	Q.006
25TH		158.3	18.7	14.1	2.2	.004	L.003	.020	.010
MEDIAN 50TH		193.8	24.5	17.2	3.4	.006	L.003	.054	.048
75TH		239.2	29.8	20.6	4.5	.015	.003	.110	.094
90TH		281.9	32.8	25.1	5.7	.028	.005	.260	.255
SECONDARY CODE			03L		02L		56L		

	SUBM ID	16301L SULPHATE DISSOLVED SO4 MG/L	17206L CHLORIDE DISSOLVED CL MG/L	19101L POTASSIUM DISSOLVED K MG/L	20103L CALCIUM DISSOLVED CA MG/L	03301L LITHIUM EXTRBLE. LI MG/L	04301L BERYLLIUM EXTRBLE. BE MG/L	05105L BORON DISSOLVED B MG/L	13303L ALUMINUM EXTRBLE. AL MG/L
SAMPLES(FLAGS)	0462	56(0)	56(1)	56(0)	56(0)			58(0)	
LOW	0003	24.4	L.10	1.29	28.5			.020	
HIGH	0446	102.0	8.90	5.60	83.8			.140	
AVERAGE	0315	60.7	4.54*	2.57	51.1			.066	
STD.DEV.		14.2	1.79*	.94	14.7			.024	
PERCNT:10TH		44.3	2.50	1.70	35.7			.040	
25TH		50.7	3.30	1.92	39.5			.050	
MEDIAN 50TH		58.9	4.30	2.20	48.8			.060	
75TH		69.3	5.60	2.90	61.5			.079	
90TH		73.9	7.10	3.80	73.3			.100	
SECONDARY CODE		06L		03L					

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NAQUADAT SUMMARY REPORT JAN 09, 1991
SURFACE WATER DATA

STATION 00AL05CK0001 LAT. 50D 54M 9S LONG. 110D 17M 51S PR 4 UTM 12 549400E 5639000N FOR JAN 24, 1984 TO DEC 05, 1988
RED DEER RIVER AT BINDLOSS, ALBERTA

	SUBM ID	23020L VANADIUM TOTAL RECOVERABLE VA MG/L	23301L VANADIUM EXTRBLE. V MG/L	24302L CHROMIUM EXTRBLE. CR MG/L	25101L MANGANESE DISSOLVED MN MG/L	25303L MANGANESE EXTRBLE. MN MG/L	26104L IRON DISSOLVED FE MG/L	26304L IRON EXTRBLE. FE MG/L	27020L COBALT TOTAL RECOVERABLE CO MG/L
SAMPLES(FLAGS)	0462			2(2)	57(38)		57(34)		
LOW	0003			L.0010	L.002		L.007		
HIGH	0446			L.0010	.030		.120		
AVERAGE	0315				.012*		.032*		
STD.DEV.					.008*		.023*		
PERCNT:10TH					L.002		L.007		
25TH					.004		.011		
MEDIAN 50TH				L.0010	.012		L.040		
75TH					L.020		L.040		
90TH					L.020		.040		
SECONDARY CODE					04L				

	SUBM ID	34102L SELENIUM DISSOLVED SE MG/L	38301L STRONTIUM EXTRBLE. SR MG/L	42301L MOLYBDENUM EXTRBLE. MO MG/L	47301L SILVER EXTRBLE. AG MG/L	48020L CADMIUM TOTAL RECOVERABLE CD MG/L	48301L CADMIUM EXTRBLE. CD MG/L	56020L BARIUM TOTAL RECOVERABLE BA MG/L	56301L BARIUM EXTRBLE. BA MG/L
SAMPLES(FLAGS)	0462	57(3)							4(0)
LOW	0003	L.0001							.110
HIGH	0446	.0030							.230
AVERAGE	0315	.0003*							.170
STD.DEV.		.0004*							.049
PERCNT:10TH		.0002							
25TH		.0002							.140
MEDIAN 50TH		.0003							.170
75TH		.0004							.200
90TH		.0004							
SECONDARY CODE		08L							

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NAQUADAT SUMMARY REPORT JAN 09, 1991
SURFACE WATER DATA

STATION 00AL05CK0001 LAT. 50D 54M 9S LONG. 110D 17M 51S PR 4 UTM 12 549400E 5639000N FOR JAN 24, 1984 TO DEC 05, 1988
RED DEER RIVER AT BINDLOSS, ALBERTA

	SUBM ID	80011L MERCURY TOTAL HG UG/L	80311L MERCURY EXTRBLE. HG UG/L	82020L LEAD TOTAL RECOVERABLE PB MG/L	82301L LEAD EXTRBLE. PB MG/L	36001L COLIFORMS TOTAL MPN NO/100ML	36011L COLIFORMS FECAL MPN NO/100ML	36101L STREP. FECAL	36103L FECAL STREP. MF NO/DL
SAMPLES(FLAGS)	0462	56(42)				44(16)	52(26)		
LOW	0003	L.010				0.	L2.		
HIGH	0446	.090				130.	900.		
AVERAGE	0315	.023*				23.*	37.*		
STD.DEV.		.015*				36.*	129.*		
PERCNT:10TH		.010				L2.	L2.		
25TH		L.020				L2.	L2.		
MEDIAN 50TH		L.020				9.*	4.*		
75TH		L.020				20.	21.		
90TH		.030				100.	56.		
SECONDARY CODE		11P				02L 02F	12L 12F		

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Appendix V. NAQUADAT summary reports from the Red Deer River synoptic surveys, 1983-88.

NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CB0600 LAT. 51D 56M 35S LONG. 114D 29M 55S PR 5 UTM 11 672000E 5757400N FOR APR 11, 1983 TO MAR 14, 1988
RED DEER RIVER WEST OF BOWDEN UPSTREAM DICKSON
DAM IMPACT STUDY - SITE 1

SUBM ID	00203L TOTAL DISSOLVED SOLIDS (CALCULATED) MG/L	00205L TOTAL DISSOLVED SOLIDS MG/L	02041L SPECIFIC CONDUCT. US/CM	02041F SPECIFIC CONDUCT. US/CM	02061F TEMPERATURE OF WATER DEG.C	02071L TURBIDITY JTU	02074L TURBIDITY NTU	06001L CARBON TOTAL ORGANIC C MG/L
SAMPLES(FLAGS)	64(18)	19(0)	65(0)	47(0)	63(0)	12(1)	51(0)	24(0)
LOW	119.	119.	240.	244.	-1.0	L.1	.5	1.3
HIGH	300.	264.	511.0	507.	17.9	200.0	420.0	14.8
AVERAGE	210.*	200.	376.9	373.5	7.0	36.6*	18.3	3.2
STD.DEV.	36.*	36.	64.8	58.2	6.0	76.3*	61.9	2.9
PERCNT:10TH	172.	161.	306.0	308.	.0	1.0	1.0	1.4
25TH	182.	176.	330.0	328.0	.1	2.5	1.8	1.8
MEDIAN 50TH	211.	195.	370.0	369.0	6.5	4.5	3.8	2.2
75TH	240.	226.	442.0	428.	12.1	8.0	9.0	3.4
90TH	258.	255.	460.0	449.	16.0	200.0	18.0	6.4
SECONDARY CODE						73L		05L

SUBM ID	06101L CARBON DISSOLVED ORGANIC C MG/L	06201L BICARBONT. (CALCD.) HCO3 MG/L	06202L BICARBONT. (CALCD.) HCO3 MG/L	06301L CARBONATE (CALCD.) CO3 MG/L	06536L PHENOLIC MATERIAL PHENOL MG/L	06551L TANNIN AND LIGNIN LIG.SULPH. MG/L	06715L CHLORO - PHYLL A MG/M3	06720L CHLOROPHYLL -A- PHYTOPLANKTO N MG/M3
SAMPLES(FLAGS)	65(2)	65(44)	65(0)	65(44)	64(32)		21(0)	51(3)
LOW	.2	Q122.9	123.1	.0	L.001		.1	.0
HIGH	14.5	Q255.7	256.0	10.8	1.400		1.4	5.950
AVERAGE	2.5*	191.3*	191.6	1.0*	.027*		.51	.894*
STD.DEV.	2.4*	30.1*	30.0	2.4*	.176*		.29	1.211*
PERCNT:10TH	.9	Q153.4	156.0	.0	L.001		.2	.0
25TH	1.2	169.4	169.	Q.1	.001*		.3	.3
MEDIAN 50TH	1.6	Q186.3	187.0	Q.1	L.002		.48	.5
75TH	2.8	Q213.1	213.3	Q.1	.002		.7	1.013
90TH	5.2	Q230.1	230.4	Q5.0	.004		.8	1.680
SECONDARY CODE	07L 04L				37L			

SUBM ID	06721L CHLOROPHYLL -A- EPILITHON MG/M2	06722L CHLOROPHYLL A EPILITHIC SUBSAMPLE (TEMPLATE) MG/M2	07015L NITROGEN TOTAL KJELDAHL N MG/L	07105L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07111L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07205L NITROGEN DISSOLVED NITRITE N MG/L	07501L NITROGEN TOTAL AMMONIA N MG/L	07561L NITROGEN DISSOLVED AMMONIA N MG/L
SAMPLES(FLAGS)	11(0)	32(0)	65(0)	47(0)	19(0)	19(17)	45(24)	19(6)
LOW	1.6	.0	.060	.006	.025	L.001	L.01	L.002
HIGH	50.4	103.0	5.000	.44	.190	.007	.070	.055
AVERAGE	18.355	25.007	.411	.087	.076	.001*	.014*	.015*
STD.DEV.	13.555	23.543	.691	.080	.054	.001*	.012*	.018*
PERCNT:10TH	3.7	2.420	.100	.023	.032	L.001	L.01	L.002
25TH	9.4	7.297	.120	.030	.040	L.001	L.010	L.002
MEDIAN 50TH	17.0	19.585	.220	.056	.052	L.001	L.010	.009
75TH	23.7	33.618	.320	.132	.104	L.001	.010	.020
90TH	30.0	43.9	.950	.183	.180	.003	.020	.054
SECONDARY CODE			21L	07L 10L		06L	05L	62L

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CB0600 LAT. 51D 56M 35S LONG. 114D 29M 55S PR 5 UTM 11 672000E 5757400N FOR APR 11, 1983 TO MAR 14, 1988
RED DEER RIVER WEST OF BOWDEN UPSTREAM DICKSON
DAM IMPACT STUDY - SITE 1

SUBM ID	07602L NITROGEN TOTAL (CALCD.) N MG/L	07906L NITROGEN PARTICULATE TOTAL N MG/L	08101F OXYGEN DISSOLVED DO O2 MG/L	08201L OXYGEN BIOCHEM. DEMAND-BOD O2 MG/L	08301L OXYGEN TOTAL COD O2 MG/L	09101L FLUORIDE DISSOLVED F MG/L	10101L ALKALINITY TOTAL CACO3 MG/L	10301F PH PH UNITS
SAMPLES(FLAGS)	65(0)	19(6)	64(0)	50(8)	65(19)	20(0)	65(0)	40(0)
LOW	.103	L.01	7.5	L.1	L0.	.11	101.0	6.6
HIGH	2.057	7.20	14.2	5.4	122.2	.17	210.0	8.6
AVERAGE	.406	.524*	10.88	.9*	13.4*	.15	158.6	
STD.DEV.	.342	1.632*	1.61	.9*	17.4*	.02	24.1	
PERCNT:10TH	.125	L.01	8.9	.1	L5.0	.13	132.0	7.00
25TH	.223	L.010	9.45	.4	L5.0	.14	139.	7.40
MEDIAN 50TH	.322	.06	10.75	.8	9.1	.14	158.	7.70
75TH	.417	.25	12.05	1.1	15.3	.16	176.	8.00
90TH	.880	.94	13.0	1.6	21.0	.17	189.	8.30
SECONDARY CODE			02F	02L	04L	07L 05L		

SUBM ID	10301L PH PH UNITS	10401L RESIDUE NONFILTR. MG/L	10602L HARDNESS TOTAL (CALCD.) CACO3 MG/L	10603L HARDNESS TOTAL CACO3 MG/L	11101L SODIUM DISSOLVED NA MG/L	12101L MAGNESIUM DISSOLVED (CALCD.) MG MG/L	12102L MAGNESIUM DISSOLVED MG MG/L	14101L SILICA REACTIVE SIO2 MG/L
SAMPLES(FLAGS)	65(0)	65(2)	64(0)	52(0)	65(0)	45(0)	65(0)	65(0)
LOW	7.16	L.4	93.7	113.2	2.20	10.02	7.	3.65
HIGH	8.57	1517.	278.2	278.4	6.20	22.74	22.70	6.86
AVERAGE		61.3*	189.7	194.9	4.46	15.74	15.16	4.84
STD.DEV.		236.4*	33.6	31.8	.98	2.86	2.96	.70
PERCNT:10TH	7.60	1.0	154.3	159.4	3.00	12.43	12.	4.00
25TH	8.03	2.6	165.2	167.5	4.	13.43	13.	4.40
MEDIAN 50TH	8.2	6.6	194.9	198.2	4.70	15.73	15.00	4.70
75TH	8.31	14.4	214.9	219.3	5.10	18.14	17.50	5.26
90TH	8.40	38.5	232.2	232.8	5.60	19.14	19.	5.84
SECONDARY CODE		07L		05L	03L			02L 05L

SUBM ID	15101L PHOSPHORUS TOTAL DISSOLVED P MG/L	15114L PHOSPHORUS TOTAL DISSOLVED P MG/L	15255L PHOSPHORUS DISSOLVED ORTHO PO4 P MG/L	15406L PHOSPHORUS TOTAL P MG/L	15421L PHOSPHORUS TOTAL P MG/L	15422L PHOSPHORUS TOTAL P MG/L	15901L PHOSPHORUS PARTICULATE (CALCD.) P MG/L	15902L PHOSPHORUS PARTICULATE P MG/L
SAMPLES(FLAGS)	52(11)	10(0)	14(2)	46(0)	18(4)	10(0)	52(13)	12(4)
LOW	L.003	.0011	L.002	.003	L.006	.0030	.000	L.002
HIGH	.042	.0043	.270	.460	1.400	.0113	1.360	1.360
AVERAGE	.008*	.0022	.029*	.026	.1062*	.0058	.049*	.140*
STD.DEV.	.010*	.0009	.070*	.068	.3299*	.0027	.197*	.391*
PERCNT:10TH	L.003	.0013	L.003	.005	L.006	.0030	.001	L.002
25TH	.003	.0017	.004	.007	.0070	.0042	.003	L.002
MEDIAN 50TH	.004	.0020	.007	.011	.0130	.0052	.007	.005
75TH	.008	.0027	.020	.018	.022	.0071	.014	.017
90TH	.014	.0037	.028	.036	.300	.0102	.032	.258
SECONDARY CODE	05L 03L		56L					

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CB0600 LAT. 51D 56M 35S LONG. 114D 29M 55S PR 5 UTM 11 672000E 5757400N FOR APR 11, 1983 TO MAR 14, 1988
RED DEER RIVER WEST OF BOWDEN UPSTREAM DICKSON
DAM IMPACT STUDY - SITE 1

	16301L SULPHATE DISSOLVED	17201L CHLORIDE DISSOLVED	19101L POTASSIUM DISSOLVED	20101L CALCIUM DISSOLVED	20105L CALCIUM DISSOLVED (CALCD.)	36001L COLIFORMS TOTAL	36011L COLIFORMS FECAL	04301L BERYLLIUM EXTRBLE.
SUBM ID	SO4 MG/L	CL MG/L	K MG/L	CA MG/L	CA MG/L	MPN NO/100ML	MPN NO/100ML	BE MG/L
SAMPLES(FLAGS)	65(0)	65(18)	65(0)	64(0)	52(0)	50(5)	50(7)	19(19)
LOW	10.	.30	.6	26.	28.77	.0	.0	L.001
HIGH	70.0	2.60	2.2	74.00	73.94	920.	370.0	L.001
AVERAGE	42.3	.96*	.88	50.93	52.08	66.8*	26.8*	
STD.DEV.	12.0	.45*	.29	8.78	8.45	170.5*	64.6*	
PERCNT:10TH	28.3	.40	.7	42.	42.77	2.0*	.0	L.001
25TH	36.0	.60	.72	44.10	44.94	4.	2.0	L.001
MEDIAN 50TH	41.8	L0.	.80	52.00	52.84	20.0	5.0	L.001
75TH	48.6	1.00	.9	56.40	57.94	32.	20.	L.001
90TH	59.5	1.50	1.18	62.60	63.45	98.0	39.0	L.001
SECONDARY CODE	06L	03L	03L	10L 03L 02L				04L

	13301L ALUMINUM EXTRBLE.	13305L ALUMINUM EXTRBLE.	23001L VANADIUM TOTAL	23301L VANADIUM EXTRBLE.	24004L CHROMIUM TOTAL	24302L CHROMIUM EXTRBLE.	25001L MANGANESE TOTAL	25301L MANGANESE EXTRBLE
SUBM ID	AL MG/L	AL MG/L	V MG/L	V MG/L	CR MG/L	CR MG/L	MN MG/L	MN MG/L
SAMPLES(FLAGS)	18(3)	19(4)	22(9)	13(10)	19(7)	18(12)	19(11)	18(6)
LOW	L.01	L.020	L.001	L.001	L.001	L.001	L.008	L.004
HIGH	.740	9.910	.059	.010	.039	.008	.667	.280
AVERAGE	.111*	.643*	.006*	.002*	.006*	.002*	.066*	.026*
STD.DEV.	.187*	2.260*	.013*	.003*	.009*	.002*	.172*	.064*
PERCNT:10TH	L.010	L.020	.001	L.001	L.001	L.001	L.008	L.004
25TH	.02	.021	L.002	L.001	L.001	L.001	L.008	.005
MEDIAN 50TH	.045	.050	.003	L.001	.004	L.001	L.008	L.010
75TH	.080	.128	.004	L.001	.006	.001	.013	.017
90TH	.440	1.210	.006	.004	.017	.004	.413	.043
SECONDARY CODE	02L 03L	06L	09L 02L	02L	09L		03L	04L

	26301L IRON EXTRBLE.	27001L COBALT TOTAL	28001L NICKEL TOTAL	28301L NICKEL EXTRBLE.	29005L COPPER TOTAL	30005L ZINC TOTAL	30301L ZINC EXTRBL.	33001L ARSENIC TOTAL
SUBM ID	FE MG/L	CO MG/L	NI MG/L	NI MG/L	CU MG/L	ZN MG/L	ZN MG/L	AS MG/L
SAMPLES(FLAGS)	65(6)	19(16)	19(1)	18(11)	19(9)	19(6)	18(4)	32(4)
LOW	L.010	L.001	L.001	L.001	L.001	L.001	L.001	L.0002
HIGH	8.68	.018	.049	.010	.044	.135	.043	.0190
AVERAGE	.425*	.002*	.009*	.002*	.007*	.018*	.006*	.0012*
STD.DEV.	1.459*	.004*	.011*	.002*	.013*	.036*	.010*	.0034*
PERCNT:10TH	.010	L.001	.003	L.001	L.001	L.001	L.001	L.0002
25TH	.030	L.001	.004	L.001	L.001	L.001	.001	.0003
MEDIAN 50TH	.070	L.001	.006	L.001	.002	.006	.002	.0004
75TH	.18	L.001	.008	.002	.003	.016	.008	.0006
90TH	.39	.009	.028	.003	.043	.103	.010	.0016
SECONDARY CODE	04L 02L	09L	09L	02L	09L	09L	05L	05L

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CB0600 LAT. 51D 56M 35S LONG. 114D 29M 55S PR 5 UTM 11 672000E 5757400N FOR APR 11, 1983 TO MAR 14, 1988
RED DEER RIVER WEST OF BOWDEN UPSTREAM DICKSON
DAM IMPACT STUDY - SITE 1

	SUBM ID	33101L ARSENIC DISSOLVED AS MG/L	34003L SELENIUM TOTAL SE MG/L	34102L SELENIUM DISSOLVED SE MG/L	42001L MOLYBDENUM TOTAL MO MG/L	48301L CADMIUM EXTRBLE. CD MG/L	80002L MERCURY TOTAL HG MG/L	80011L MERCURY TOTAL HG UG/L	82301L LEAD EXTRBLE. PB MG/L
SAMPLES(FLAGS)		5(0)	20(20)	6(4)	19(17)	18(17)	53(50)	10(10)	35(24)
LOW		.0002	L.0002	L.0002	L.001	L.001	L.0001	L.05	.001
HIGH		.008	L.0002	.0003	.024	.001	.0002	L.05	.012
AVERAGE		.0019		.0002*	.003*	.001*	.0001*		.003*
STD.DEV.		.0034		.0000*	.006*	.000*	.0000*		.002*
PERCNT:10TH			L.0002		L.001	L.001	L.0001	L.05	L.002
25TH		.0003	L.0002	L.0002	L.001	L.001	L.0001	L.05	L.002
MEDIAN 50TH		.0003	L.0002	L.0002	L.001	L.001	L.0001	L.05	L.003
75TH		.0005	L.0002	.0002	L.001	L.001	L.0001	L.05	.003
90TH			L.0002		.010	L.001	L.0001	L.05	.005
SECONDARY CODE		04L	05L		09L	02L	15L		02L

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CC1000 LAT. 52D 4M 0S LONG. 114D 13M 0S PR 3 UTM 11 690800E 5771900N FOR JAN 25, 1983 TO MAR 14, 1988
RED DEER RIVER 4KM. BELOW DICKSON DAM
DAM IMPACT STUDY - SITE 3

SUBM ID	00203L TOTAL DISSOLVED SOLIDS (CALCULATED) MG/L	00205L TOTAL DISSOLVED SOLIDS MG/L	02041L SPECIFIC CONDUCT. US/CM	02041F SPECIFIC CONDUCT. US/CM	02061F TEMPERATURE OF WATER DEG.C	02071L TURBIDITY JTU	02074L TURBIDITY NTU	06001L CARBON TOTAL ORGANIC C MG/L
SAMPLES(FLAGS)	66(19)	19(0)	67(0)	46(0)	64(0)	12(2)	53(2)	26(0)
LOW	161.	168.	292.0	228.	1.0	L.1	L.1	1.3
HIGH	265.	242.	484.0	447.	16.0	40.0	42.0	6.8
AVERAGE	207.*	200.	373.4	364.7	8.3	9.1*	4.2*	3.3
STD.DEV.	24.*	22.	43.6	49.3	5.1	11.5*	7.4*	1.4
PERCNT:10TH	181.	173.	321.	300.	1.7	L.1	.6	1.7
25TH	190.	182.	342.0	342.0	2.5	1.3	1.3	2.2
MEDIAN 50TH	202.	196.	361.	365.0	8.3	5.3	1.8	3.2
75TH	Q226.	222.	420.0	396.	13.3	11.8	4.0	3.8
90TH	241.	236.	438.0	424.	15.0	20.0	7.0	5.9
SECONDARY CODE						73L		05L

SUBM ID	06101L CARBON DISSOLVED ORGANIC C MG/L	06201L BICARBONT. (CALCD.) HCO3 MG/L	06202L BICARBONT. (CALCD.) HCO3 MG/L	06301L CARBONATE (CALCD.) CO3 MG/L	06536L PHENOLIC MATERIAL PHENOL MG/L	06551L TANNIN AND LIGNIN LIG.SULPH. MG/L	06715L CHLORO - PHYLL A MG/M3	06720L CHLOROPHYLL -A- PHYTOPLANKTO N MG/M3
SAMPLES(FLAGS)	66(1)	66(46)	65(0)	66(46)	67(33)	2(1)	20(0)	48(2)
LOW	L.4	Q150.9	151.2	.0	L.001	L.1	.4	.0
HIGH	8.7	Q247.2	247.5	10.1	.051	.3	2.2	8.9
AVERAGE	2.8*	196.8*	195.5	1.0*	.003*	.20*	1.10	1.462*
STD.DEV.	1.4*	24.7*	23.5	2.1*	.007*	.14*	.48	1.734*
PERCNT:10TH	1.4	169.7	170.	.0	L.001		.55	.0
25TH	1.7	178.7	179.	Q.1	L.001		.80	.525
MEDIAN 50TH	2.6	193.1	193.	.1	L.002	.20*	1.00	1.000
75TH	3.4	213.6	209.7	Q.1	.002		1.40	1.705
90TH	4.8	234.0	230.	Q5.0	.004		1.82	3.169
SECONDARY CODE	04L 07L				37L			

SUBM ID	06721L CHLOROPHYLL -A- EPILITHON MG/M2	06722L CHLOROPHYLL A EPILITHIC SUBSAMPLE (TEMPLATE) MG/M2	07015L NITROGEN TOTAL KJELDAHL N MG/L	07105L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07111L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07205L NITROGEN DISSOLVED NITRITE N MG/L	07501L NITROGEN TOTAL AMMONIA N MG/L	07561L NITROGEN DISSOLVED AMMONIA N MG/L
SAMPLES(FLAGS)	13(0)	37(0)	66(0)	49(1)	19(0)	21(12)	47(7)	19(0)
LOW	9.8	1.00	.120	L.003	.010	L.001	L.002	.003
HIGH	127.9	760.44	1.12	.187	.100	L.05	.060	.047
AVERAGE	43.085	171.693	.317	.065*	.049	.005*	.017*	.020
STD.DEV.	34.783	177.208	.216	.038*	.024	.011*	.011*	.014
PERCNT:10TH	15.2	7.089	.16	.023	.010	L.001	L.010	.004
25TH	23.6	31.553	.180	.034	.030	L.001	.010	.009
MEDIAN 50TH	27.8	120.53	.260	.07	.052	L.001	.010	.017
75TH	45.4	251.33	.360	.080	.069	.003	.020	.028
90TH	99.0	433.1	.500	.109	.075	.006	.03	.042
SECONDARY CODE			21L	10L		06L	05L	62L

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NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CC1000 LAT. 52D 4M 0S LONG. 114D 13M 0S PR 3 UTM 11 690800E 5771900N FOR JAN 25, 1983 TO MAR 14, 1988
RED DEER RIVER 4KM. BELOW DICKSON DAM
DAM IMPACT STUDY - SITE 3

	SUBM ID	07602L NITROGEN TOTAL (CALCD.) N MG/L	07906L NITROGEN PARTICULATE TOTAL N MG/L	08101F OXYGEN DISSOLVED DO O2 MG/L	08201L OXYGEN BIOCHEM. DEMAND-BOD O2 MG/L	08301L OXYGEN TOTAL COD O2 MG/L	09101L FLUORIDE DISSOLVED F MG/L	10101L ALKALINITY TOTAL CACO3 MG/L	10301F PH PH UNITS
SAMPLES(FLAGS)		66(1)	19(10)	66(1)	59(11)	67(16)	23(0)	67(0)	43(0)
LOW		.130	.003	8.6	L.1	L0.	.11	124.0	6.9
HIGH		1.149	.230	13.7	3.9	40.0	.19	203.0	8.4
AVERAGE		.367*	.049*	11.45*	1.0*	11.3*	.14	162.9	
STD.DEV.		.221*	.069*	1.31*	.6*	8.2*	.02	19.6	
PERCNT:10TH		.178	L.01	9.6	.3	L5.0	.12	142.0	7.1
25TH		.239	L.01	10.4	.5	5.0	.13	147.0	7.4
MEDIAN 50TH		.323	L.01	11.55	L1.0	8.0	.14	161.0	7.6
75TH		.409	.07	12.6	1.2	15.1	.15	178.1	7.9
90TH		.581	.200	13.1	1.6	24.0	.16	192.	8.1
SECONDARY CODE				02F	02L	04L	05L 07L		

	SUBM ID	10301L PH PH UNITS	10401L RESIDUE NONFILTR. MG/L	10602L HARDNESS TOTAL (CALCD.) CACO3 MG/L	10603L HARDNESS TOTAL CACO3 MG/L	11101L SODIUM DISSOLVED NA MG/L	12101L MAGNESIUM DISSOLVED (CALCD.) MG MG/L	12102L MAGNESIUM DISSOLVED MG MG/L	14101L SILICA REACTIVE SIO2 MG/L
SAMPLES(FLAGS)		67(0)	67(4)	66(0)	51(0)	67(0)	44(0)	67(0)	67(0)
LOW		6.97	L.4	136.1	145.1	3.	12.05	10.	3.0
HIGH		8.57	140.	245.1	224.4	6.	18.64	20.10	6.54
AVERAGE			7.7*	187.5	190.6	4.48	15.20	14.85	5.03
STD.DEV.			17.6*	22.0	20.6	.69	1.72	2.03	.78
PERCNT:10TH		7.73	.6	160.9	166.0	3.50	13.13	12.10	4.10
25TH		7.92	1.3	172.5	177.0	4.	13.68	13.30	4.30
MEDIAN 50TH		8.18	4.	184.8	187.4	4.70	15.06	14.80	5.02
75TH		8.32	7.2	202.4	214.9	5.00	16.69	16.50	5.56
90TH		8.40	14.	217.7	218.0	5.10	17.24	17.20	6.16
SECONDARY CODE			07L		05L	03L			02L 05L

	SUBM ID	15101L PHOSPHORUS TOTAL DISSOLVED P MG/L	15114L PHOSPHORUS TOTAL DISSOLVED P MG/L	15255L PHOSPHORUS DISSOLVED ORTHO PO4 P MG/L	15406L PHOSPHORUS TOTAL P MG/L	15421L PHOSPHORUS TOTAL P MG/L	15422L PHOSPHORUS TOTAL P MG/L	15901L PHOSPHORUS PARTICULATE (CALCD.) P MG/L	15902L PHOSPHORUS PARTICULATE P MG/L
SAMPLES(FLAGS)		54(7)	10(0)	15(0)	48(1)	18(1)	10(0)	54(7)	
LOW		L.003	.0020	.003	L.003	L.0060	.0058	.000	
HIGH		.032	.0060	.030	.055	.134	.0135	.124	
AVERAGE		.007*	.0037	.011	.013*	.0251*	.0092	.010*	
STD.DEV.		.005*	.0014	.008	.011*	.0288*	.0026	.018*	
PERCNT:10TH		L.003	.0023	.003	.005	.008	.0063	Q.001	
25TH		.004	.0027	.005	.007	.010	.0074	.002	
MEDIAN 50TH		.006	.0030	.008	.009	.0180	.0091	.004	
75TH		.008	.0053	.013	.015	.030	.0103	.010	
90TH		.012	.0057	.022	.028	.034	.0133	.020	
SECONDARY CODE		03L 05L		56L					

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CC1000 LAT. 52D 4M 0S LONG. 114D 13M 0S PR 3 UTM 11 690800E 5771900N FOR JAN 25, 1983 TO MAR 14, 1988
RED DEER RIVER
DAM IMPACT STUDY - SITE 3
4KM. BELOW DICKSON DAM

	16301L SULPHATE DISSOLVED	17201L CHLORIDE DISSOLVED	19101L POTASSIUM DISSOLVED	20101L CALCIUM DISSOLVED	20105L CALCIUM DISSOLVED (CALCD.)	36001L COLIFORMS TOTAL	36011L COLIFORMS FECAL	04301L BERYLLIUM EXTRBLE.
SUBM ID	SO4 MG/L	CL MG/L	K MG/L	CA MG/L	CA MG/L	MPN NO/100ML	MPN NO/100ML	BE MG/L
SAMPLES(FLAGS)	67(0)	67(19)	67(0)	66(0)	51(0)	50(3)	50(5)	18(18)
LOW	20.7	.40	.5	38.	39.57	.0	.0	L.001
HIGH	56.0	2.70	2.3	65.00	60.55	620.	100.	L.001
AVERAGE	37.1	1.02*	1.06	50.53	51.24	35.6*	9.0*	
STD.DEV.	7.4	.45*	.27	5.82	5.65	120.2*	20.8*	
PERCNT:10TH	27.0	.60	.85	43.	44.46	.0	.0	L.001
25TH	32.0	.70	.9	46.20	47.76	2.	0.	L.001
MEDIAN 50TH	37.	L0.	1.0	50.00	50.70	5.0	2.0	L.001
75TH	42.0	1.00	1.20	55.00	57.95	12.0	6.0	L.001
90TH	45.0	1.50	1.5	58.80	58.76	46.0	18.0	L.001
SECONDARY CODE	06L	03L	03L	03L 10L 02L				04L

	13301L ALUMINUM EXTRBLE.	13305L ALUMINUM EXTRBLE.	23001L VANADIUM TOTAL	23301L VANADIUM EXTRBLE.	24004L CHROMIUM TOTAL	24302L CHROMIUM EXTRBLE.	25001L MANGANESE TOTAL	25301L MANGANESE EXTRBLE
SUBM ID	AL MG/L	AL MG/L	V MG/L	V MG/L	CR MG/L	CR MG/L	MN MG/L	MN MG/L
SAMPLES(FLAGS)	18(1)	19(4)	20(10)	12(9)	18(7)	19(14)	18(2)	19(5)
LOW	L.010	L.020	L.001	L.001	L.001	L.001	L.008	L.004
HIGH	.160	.250	.007	.003	.010	.003	.064	.036
AVERAGE	.034*	.081*	.003*	.001*	.003*	.001*	.023*	.012*
STD.DEV.	.035*	.072*	.001*	.001*	.002*	.001*	.017*	.009*
PERCNT:10TH	.01	L.020	L.001	L.001	L.001	L.001	L.008	L.004
25TH	.01	.030	L.002	L.001	L.001	L.001	.011	.005
MEDIAN 50TH	.025	.050	.002*	L.001	.003	L.001	.018	L.01
75TH	.040	.145	.004	.001*	.004	.001	.031	.020
90TH	.07	.22	.005	.002	.005	.002	.059	.022
SECONDARY CODE	02L 03L	06L	09L 02L	02L	09L		03L	04L

	26301L IRON EXTRBLE.	27001L COBALT TOTAL	28001L NICKEL TOTAL	28301L NICKEL EXTRBLE.	29005L COPPER TOTAL	30005L ZINC TOTAL	30301L ZINC EXTRBL.	33001L ARSENIC TOTAL
SUBM ID	FE MG/L	CO MG/L	NI MG/L	NI MG/L	CU MG/L	ZN MG/L	ZN MG/L	AS MG/L
SAMPLES(FLAGS)	67(10)	18(18)	18(3)	19(11)	18(8)	18(5)	19(6)	31(0)
LOW	L.01	L.001	L.001	L.001	L.001	L.001	L.001	.0002
HIGH	.860	L.001	.010	.004	.008	.024	.020	.0020
AVERAGE	.099*		.005*	.002*	.002*	.005*	.004*	.0006
STD.DEV.	.143*		.003*	.001*	.002*	.006*	.005*	.0003
PERCNT:10TH	L.010	L.001	L.001	L.001	L.001	L.001	L.001	.0003
25TH	.020	L.001	.003	L.001	L.001	L.001	L.001	.0003
MEDIAN 50TH	.06	L.001	.005	L.001	.002	.003	.001	.0005
75TH	.11	L.001	.006	.002	.002	.004	.005	.0007
90TH	.25	L.001	.009	.003	.004	.012	.009	.0008
SECONDARY CODE	02L 04L	09L	09L	02L	09L	09L	05L	05L

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NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CC1000 LAT. 52D 4M 0S LONG. 114D 13M 0S PR 3 UTM 11 690800E 5771900N FOR JAN 25, 1983 TO MAR 14, 1988
RED DEER RIVER
4KM. BELOW DICKSON DAM
DAM IMPACT STUDY - SITE 3

SUBM ID	33101L ARSENIC DISSOLVED AS MG/L	34003L SELENIUM TOTAL SE MG/L	34102L SELENIUM DISSOLVED SE MG/L	42001L MOLYBDENUM TOTAL MO MG/L	48301L CADMIUM EXTRBLE. CD MG/L	80002L MERCURY TOTAL HG MG/L	80011L MERCURY TOTAL HG UG/L	82301L LEAD EXTRBLE. PB MG/L
SAMPLES(FLAGS)	6(0)	19(19)	7(5)	18(18)	19(18)	54(51)	11(11)	35(24)
LOW	.0002	L.0002	L.0002	L.001	L.001	L.0001	L.00	.001
HIGH	.0009	L.0002	.0003	L.001	.001	.0002	L.05	.005
AVERAGE	.0005		.0002*		.001*	.0001*		.003*
STD.DEV.	.0002		.0000*		.000*	.0000*		.001*
PERCNT:10TH		L.0002		L.001	L.001	L.0001	L.05	L.002
25TH	.0003	L.0002	L.0002	L.001	L.001	L.0001	L.05	L.002
<u>MEDIAN</u> <u>50TH</u>	<u>.0005</u>	<u>L.0002</u>	<u>L.0002</u>	<u>L.001</u>	<u>L.001</u>	<u>L.0001</u>	<u>L.05</u>	<u>L.003</u>
75TH	.0005	L.0002	.0002	L.001	L.001	L.0001	L.05	L.003
90TH		L.0002		L.001	L.001	L.0001	L.05	.004
SECONDARY CODE	04L	05L		09L	02L	15L		02L

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NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CC1700 LAT. 52D 4M 15S LONG. 113D 59M 9S PR 4 UTM 12 295300E 5772900N FOR JAN 25, 1983 TO MAR 14, 1988
RED DEER RIVER AT INNISFAIL HWY. 54 BRIDGE
DAM IMPACT STUDY SITE - 4

SUBM ID	00203L TOTAL DISSOLVED SOLIDS (CALCULATED) MG/L	00205L TOTAL DISSOLVED SOLIDS MG/L	02041L SPECIFIC CONDUCT. US/CM	02041F SPECIFIC CONDUCT. US/CM	02061F TEMPERATURE OF WATER DEG.C	02071L TURBIDITY JTU	02074L TURBIDITY NTU	06001L CARBON TOTAL ORGANIC C MG/L
SAMPLES(FLAGS)	65(13)	19(0)	66(0)	46(0)	63(0)	13(4)	52(0)	25(0)
LOW	156.	177.	297.0	243.	-1.0	L.1	.3	1.7
HIGH	Q348.	284.	507.	459.	18.3	150.0	148.0	10.6
AVERAGE	214.*	206.	381.1	365.6	8.7	14.6*	7.3	4.1
STD.DEV.	33.*	29.	45.3	48.3	5.9	40.8*	21.1	2.1
PERCNT:10TH	Q184.	181.	329.0	294.	.1	L.1	1.0	2.0
25TH	191.	184.	348.0	342.	2.3	L.1	1.5	2.8
MEDIAN 50TH	Q206.	196.	372.0	363.0	9.3	4.0	2.4	3.6
75TH	232.	225.	402.0	390.	14.1	6.5	4.5	4.3
90TH	256.	249.	448.0	442.	16.5	9.0	10.0	7.0
SECONDARY CODE						73L		05L

SUBM ID	06101L CARBON DISSOLVED ORGANIC C MG/L	06201L BICARBONT. (CALCD.) HCO3 MG/L	06202L BICARBONT. (CALCD.) HCO3 MG/L	06301L CARBONATE (CALCD.) CO3 MG/L	06536L PHENOLIC MATERIAL PHENOL MG/L	06551L TANNIN AND LIGNIN LIG.SULPH. MG/L	06715L CHLORO - PHYLL A MG/M3	06720L CHLOROPHYLL -A- PHYTOPLANKTON MG/M3
SAMPLES(FLAGS)	66(0)	66(47)	64(0)	66(47)	66(26)	2(1)	21(0)	48(0)
LOW	1.3	Q148.5	148.7	.0	L.001	L.1	.7	0.
HIGH	11.0	Q270.4	265.7	16.0	.012	.3	5.38	12.480
AVERAGE	4.0	203.4*	202.4	1.9*	.002*	.20*	2.64	3.117
STD.DEV.	2.3	28.7*	26.7	3.4*	.002*	.14*	1.18	2.843
PERCNT:10TH	1.8	Q172.9	176.	.0	L.001		1.1	.8
25TH	2.4	Q182.6	183.1	Q.1	.001		1.8	1.457
MEDIAN 50TH	3.2	196.1	195.8	.1	L.002	.20*	2.6	2.430
75TH	5.0	Q224.1	215.8	1.0	.003		3.3	3.628
90TH	7.2	Q252.1	241.4	7.2	.005		3.9	7.613
SECONDARY CODE	04L 07L				37L			

SUBM ID	06721L CHLOROPHYLL -A- EPILITHON MG/M2	06722L CHLOROPHYLL A EPILITHIC SUBSAMPLE (TEMPLATE) MG/M2	07015L NITROGEN TOTAL KJELDAHL N MG/L	07105L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07111L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07205L NITROGEN DISSOLVED NITRITE N MG/L	07501L NITROGEN TOTAL AMMONIA N MG/L	07561L NITROGEN DISSOLVED AMMONIA N MG/L
SAMPLES(FLAGS)	13(0)	39(0)	66(0)	48(2)	19(0)	21(11)	46(9)	19(3)
LOW	2.4	.42	.12	L.003	.003	L.001	L.002	L.002
HIGH	78.4	433.1	1.560	.242	.370	L.05	.140	.120
AVERAGE	39.092	90.469	.410	.058*	.044	.005*	.021*	.017*
STD.DEV.	24.463	84.612	.306	.052*	.085	.011*	.023*	.027*
PERCNT:10TH	5.1	9.636	.160	.006	.004	L.001	L.010	L.002
25TH	15.5	36.38	.200	.015	.005	L.001	.010	.004
MEDIAN 50TH	44.5	67.10	.320	.053	.018	.002	.010	.010
75TH	53.1	120.73	.480	.080	.029	.004	.020	.018
90TH	69.1	202.1	.90	.144	.120	.008	.05	.040
SECONDARY CODE			21L	10L		06L	05L	62L

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NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CC1700 LAT. 52D 4M 15S LONG. 113D 59M 9S PR 4 UTM 12 295300E 5772900N FOR JAN 25, 1983 TO MAR 14, 1988
RED DEER RIVER AT INNISFAIL HWY. 54 BRIDGE
DAM IMPACT STUDY SITE - 4

	SUBM ID	07602L NITROGEN TOTAL (CALCD.) N MG/L	07906L NITROGEN PARTICULATE TOTAL N MG/L	08101F OXYGEN DISSOLVED DO O2 MG/L	08201L OXYGEN BIOCHEM. DEMAND-BOD O2 MG/L	08301L OXYGEN TOTAL COD O2 MG/L	09101L FLUORIDE DISSOLVED F MG/L	10101L ALKALINITY TOTAL CACO3 MG/L	10301F PH PH UNITS
SAMPLES(FLAGS)		66(2)	19(9)	65(0)	50(4)	66(10)	21(0)	66(0)	41(0)
LOW		.145	L.01	8.0	L.1	L0.	.11	122.0	6.2
HIGH		1.495	5.50	14.0	5.1	57.4	.24	222.0	8.6
AVERAGE		.444*	.359*	11.16	1.2*	15.6*	.14	170.0	
STD.DEV.		.292*	1.250*	1.48	.9*	10.3*	.03	22.9	
PERCNT:10TH		.209	L.01	9.1	.4	L5.0	.13	145.0	7.2
25TH		.264	L.01	10.2	.6	7.0	.13	152.0	7.4
MEDIAN 50TH		.345	.040	11.0	1.0	14.9	.14	167.0	7.8
75TH		.520	.16	12.4	1.6	20.0	.15	185.2	8.1
90TH		.911	.43	12.9	2.2	29.0	.16	207.0	8.3
SECONDARY CODE				02F	02L	04L	05L 07L		

	SUBM ID	10301L PH PH UNITS	10401L RESIDUE NONFILTR. MG/L	10602L HARDNESS TOTAL (CALCD.) CACO3 MG/L	10603L HARDNESS TOTAL CACO3 MG/L	11101L SODIUM DISSOLVED NA MG/L	12101L MAGNESIUM DISSOLVED (CALCD.) MG MG/L	12102L MAGNESIUM DISSOLVED MG MG/L	14101L SILICA REACTIVE SIO2 MG/L
SAMPLES(FLAGS)		66(0)	65(2)	65(0)	51(0)	66(0)	44(0)	66(0)	66(0)
LOW		7.09	L.4	147.4	147.5	3.50	11.43	11.40	2.50
HIGH		8.71	674.	252.9	242.0	158.	18.94	21.40	7.70
AVERAGE			21.9*	186.5	189.3	9.57	15.18	15.04	4.83
STD.DEV.			89.2*	26.0	25.1	18.82	2.09	2.27	1.13
PERCNT:10TH		7.59	1.3	158.9	159.0	4.40	12.73	12.70	3.40
25TH		8.04	3.0	167.5	171.6	5.50	13.73	13.50	4.10
MEDIAN 50TH		8.26	5.6	180.0	183.5	7.00	14.88	14.10	4.67
75TH		8.4	9.0	206.9	214.1	8.20	17.09	16.80	5.75
90TH		8.50	18.0	228.1	228.3	10.00	18.04	18.10	6.50
SECONDARY CODE			07L		05L	03L			02L 05L

	SUBM ID	15101L PHOSPHORUS TOTAL DISSOLVED P MG/L	15114L PHOSPHORUS TOTAL DISSOLVED P MG/L	15255L PHOSPHORUS DISSOLVED ORTHO PO4 P MG/L	15406L PHOSPHORUS TOTAL P MG/L	15421L PHOSPHORUS TOTAL P MG/L	15422L PHOSPHORUS TOTAL P MG/L	15901L PHOSPHORUS PARTICULATE (CALCD.) P MG/L	15902L PHOSPHORUS PARTICULATE P MG/L
SAMPLES(FLAGS)		53(3)	10(0)	16(2)	47(0)	18(0)	10(0)	53(3)	12(3)
LOW		L.003	.0026	L.002	.005	.008	.0088	.002	L.002
HIGH		.081	.0121	.067	.350	.640	.0252	.620	.620
AVERAGE		.012*	.0060	.015*	.029	.0588	.0147	.028*	.062*
STD.DEV.		.014*	.0030	.019*	.052	.1472	.0050	.093*	.176*
PERCNT:10TH		.004	.0027	L.002	.008	.008	.0094	.003	L.002
25TH		.005	.0043	.004	.011	.010	.0101	.004	.003*
MEDIAN 50TH		.008	.0054	.007	.014	.0160	.0148	.008	.011
75TH		.012	.0087	.018	.022	.0260	.0166	.014	.017
90TH		.024	.0104	.055	.059	.112	.0221	.037	.040
SECONDARY CODE		03L 05L		56L					

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NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CC1700 LAT. 52D 4M 15S LONG. 113D 59M 9S PR 4 UTM 12 295300E 5772900N FOR JAN 25, 1983 TO MAR 14, 1988
RED DEER RIVER AT INNISFAIL HWY. 54 BRIDGE
DAM IMPACT STUDY SITE - 4

	SUBM ID	16301L SULPHATE DISSOLVED SO4 MG/L	17201L CHLORIDE DISSOLVED CL MG/L	19101L POTASSIUM DISSOLVED K MG/L	20101L CALCIUM DISSOLVED CA MG/L	20105L CALCIUM DISSOLVED (CALCD.) CA MG/L	36001L COLIFORMS TOTAL MPN NO/100ML	36011L COLIFORMS FECAL MPN NO/100ML	04301L BERYLLIUM EXTRBLE. BE MG/L
SAMPLES(FLAGS)		66(0)	66(13)	66(0)	65(0)	51(0)	49(1)	49(5)	
LOW		18.6	.50	.85	36.10	36.06	0.	.0	
HIGH		54.4	11.00	20.70	66.40	66.36	G2400.	G2400.	
AVERAGE		34.0	1.71*	1.70	49.83	50.62	130.7*	84.9*	
STD.DEV.		8.1	1.55*	2.47	7.12	6.91	383.3*	360.7*	
PERCNT:10TH		25.	.90	.97	42.70	42.97	4.0	0.	
25TH		27.6	L0.	1.00	44.00	46.06	8.0	2.	
MEDIAN 50TH		34.4	1.10	1.19	48.50	48.96	20.0	4.	
75TH		39.4	2.00	1.50	54.00	55.96	50.0	12.	
90TH		44.5	3.20	2.11	61.40	61.35	300.	40.0	
SECONDARY CODE		06L	03L	03L	03L 10L				

	SUBM ID	13301L ALUMINUM EXTRBLE. AL MG/L	13305L ALUMINUM EXTRBLE. AL MG/L	23001L VANADIUM TOTAL V MG/L	23301L VANADIUM EXTRBLE. V MG/L	24004L CHROMIUM TOTAL CR MG/L	24302L CHROMIUM EXTRBLE. CR MG/L	25001L MANGANESE TOTAL MN MG/L	25301L MANGANESE EXTRBLE MN MG/L
SAMPLES(FLAGS)		3(0)			2(1)		3(1)		3(0)
LOW		.01			L.001		L.001		.007
HIGH		.030			.001		.008		.036
AVERAGE		.020			.001*		.003*		.024
STD.DEV.		.010			.000*		.004*		.015
PERCNT:10TH									
25TH									
MEDIAN 50TH		.020			.001*		.001		.03
75TH									
90TH									
SECONDARY CODE		02L 03L			02L				04L

	SUBM ID	26301L IRON EXTRBLE. FE MG/L	27001L COBALT TOTAL CO MG/L	28001L NICKEL TOTAL NI MG/L	28301L NICKEL EXTRBLE. NI MG/L	29005L COPPER TOTAL CU MG/L	30005L ZINC TOTAL ZN MG/L	30301L ZINC EXTRBL. ZN MG/L	33001L ARSENIC TOTAL AS MG/L
SAMPLES(FLAGS)		64(10)			3(2)			3(1)	3(0)
LOW		L.01			L.001			L.001	.0003
HIGH		3.30			.002			.006	.0007
AVERAGE		.167*			.001*			.004*	.0005
STD.DEV.		.432*			.001*			.003*	.0002
PERCNT:10TH		L.010							
25TH		.025							
MEDIAN 50TH		.060			L.001			.005	.0005
75TH		.120							
90TH		.33							
SECONDARY CODE		02L 04L			02L			05L	05L

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NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CC1700 LAT. 52D 4M 15S LONG. 113D 59M 9S PR 4 UTM 12 295300E 5772900N FOR JAN 25, 1983 TO JAN 11, 1988
RED DEER RIVER AT INNISFAIL HWY. 54 BRIDGE
DAM IMPACT STUDY SITE - 4

	SUBM ID	33101L ARSENIC DISSOLVED AS MG/L	34003L SELENIUM TOTAL SE MG/L	34102L SELENIUM DISSOLVED SE MG/L	42001L MOLYBDENUM TOTAL MO MG/L	48301L CADMIUM EXTRBLE. CD MG/L	80002L MERCURY TOTAL HG MG/L	80011L MERCURY TOTAL HG UG/L	82301L LEAD EXTRBLE. PB MG/L
SAMPLES(FLAGS)			1(0)	1(1)		3(3)	6(6)	1(1)	3(2)
LOW			.0004	L.0002		L.001	L.0001	L.05	L.002
HIGH			.0004	L.0002		L.001	L.0001	L.05	.004
AVERAGE									.003*
STD.DEV.									.001*
PERCNT:10TH									
25TH							L.0001		
MEDIAN 50TH						L.001	L.0001		L.002
75TH							L.0001		
90TH									
SECONDARY CODE			05L			02L	15L		02L

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NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CC1800 LAT. 52D 15M 39S LONG. 113D 52M 41S PR 3 UTM 12 303600E 5793750N FOR JAN 25, 1983 TO FEB 24, 1987
RED DEER RIVER ABOVE RED DEER FT. NORMANDEAU
DAM IMPACT STUDY - SITE 5

	SUBM ID	00203L TOTAL DISSOLVED SOLIDS (CALCULATED) MG/L	00205L TOTAL DISSOLVED SOLIDS MG/L	02041L SPECIFIC CONDUCT. US/CM	02041F SPECIFIC CONDUCT. US/CM	02061F TEMPERATURE OF WATER DEG.C	02071L TURBIDITY JTU	02074L TURBIDITY NTU	06001L CARBON TOTAL ORGANIC C MG/L
SAMPLES(FLAGS)		52(15)	18(0)	54(0)	34(0)	52(0)	12(2)	41(0)	15(0)
LOW		159.	179.	304.0	234.	-1.0	L.1	.5	1.8
HIGH		285.	248.	471.0	458.	26.3	85.0	144.0	10.6
AVERAGE		210.*	204.	377.3	352.0	9.9	10.5*	7.9	4.9
STD.DEV.		27.*	22.	45.3	51.3	7.1	23.8*	23.2	2.5
PERCNT:10TH		Q183.	181.	324.0	280.	.0	L.1	.8	1.8
25TH		190.	185.	339.	335.0	2.3	1.0	1.4	3.6
MEDIAN 50TH		204.	202.	370.5	355.5	11.3	2.8	2.0	4.4
75TH		230.	217.	407.0	382.	15.4	6.3	2.8	6.7
90TH		Q248.	245.	444.0	393.	18.0	15.0	16.0	9.0
SECONDARY CODE							73L		05L

	SUBM ID	06101L CARBON DISSOLVED ORGANIC C MG/L	06201L BICARBONT. (CALCD.) HCO3 MG/L	06202L BICARBONT. (CALCD.) HCO3 MG/L	06301L CARBONATE (CALCD.) CO3 MG/L	06536L PHENOLIC MATERIAL PHENOL MG/L	06551L TANNIN AND LIGNIN LIG.SULPH. MG/L	06715L CHLORO - PHYLL A MG/M3	06720L CHLOROPHYLL -A- PHYTOPLANKTON MG/M3
SAMPLES(FLAGS)		52(0)	54(34)	52(0)	54(34)	54(17)	2(1)	2(0)	50(0)
LOW		1.2	135.8	135.8	.0	L.001	L.1	4.39	.0
HIGH		10.3	Q270.4	265.7	15.4	.032	.3	4.4	24.067
AVERAGE		4.2	200.2*	198.0	2.7*	.003*	.20*	4.40	2.280
STD.DEV.		2.3	30.4*	28.3	3.8*	.005*	.14*	.01	3.398
PERCNT:10TH		1.6	166.5	166.	Q.1	L.001			.250
25TH		2.5	Q177.7	177.5	Q.1	.001			1.0
MEDIAN 50TH		3.7	195.2	195.0	.1	.002	.20*	4.40	1.621
75TH		5.3	Q220.4	215.0	6.0	.003			2.625
90TH		6.9	Q238.7	234.	8.0	.005			4.400
SECONDARY CODE		04L 07L				37L			

	SUBM ID	06721L CHLOROPHYLL -A- EPILITHON MG/M2	06722L CHLOROPHYLL A EPILITHIC SUBSAMPLE (TEMPLATE) MG/M2	07015L NITROGEN TOTAL KJELDAHL N MG/L	07105L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07111L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07205L NITROGEN DISSOLVED NITRITE N MG/L	07501L NITROGEN TOTAL AMMONIA N MG/L	07561L NITROGEN DISSOLVED AMMONIA N MG/L
SAMPLES(FLAGS)		13(0)	18(0)	54(0)	39(12)	18(2)	20(13)	35(13)	18(3)
LOW		8.5	18.35	.100	L.003	L.001	L.001	L.002	L.002
HIGH		355.9	350.9	2.00	.305	.360	L.05	.160	.110
AVERAGE		63.500	136.141	.446	.059*	.041*	.007*	.023*	.017*
STD.DEV.		90.441	96.308	.349	.073*	.089*	.015*	.027*	.025*
PERCNT:10TH		13.9	24.21	.18	L.003	L.001	L.001	L.01	L.002
25TH		29.6	46.79	.240	L.003	.002	L.001	L.010	.006
MEDIAN 50TH		43.1	106.645	.320	.035	.005	L.001	.010	.009
75TH		51.4	213.33	.52	.088	.047	.004	.03	.017
90TH		86.0	252.12	.980	.163	.160	.031*	.05	.034
SECONDARY CODE				21L	10L 07L		06L	05L	62L

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CC1800 LAT. 52D 15M 39S LONG. 113D 52M 41S PR 3 UTM 12 303600E 5793750N FOR JAN 25, 1983 TO FEB 24, 1987
RED DEER RIVER ABOVE RED DEER FT. NORMANDEAU
DAM IMPACT STUDY - SITE 5

SUBM ID	07602L NITROGEN TOTAL (CALCD.) N MG/L	07906L NITROGEN PARTICULATE TOTAL N MG/L	08101F OXYGEN DISSOLVED DO O2 MG/L	08201L OXYGEN BIOCHEM. DEMAND-BOD O2 MG/L	08301L OXYGEN TOTAL COD O2 MG/L	09101L FLUORIDE DISSOLVED F MG/L	10101L ALKALINITY TOTAL CACO3 MG/L	10301F PH PH UNITS
SAMPLES(FLAGS)	54(14)	18(8)	54(1)	45(3)	54(9)	20(0)	54(0)	27(0)
LOW	Q.103	L.01	8.3	.3	L0.	.13	126.0	6.6
HIGH	2.188	26.90	14.3	4.1	55.0	.19	222.0	8.7
AVERAGE	.493*	1.673*	11.05*	1.2*	15.8*	.14	168.8	
STD.DEV.	.388*	6.303*	1.49*	.8*	10.8*	.01	22.9	
PERCNT:10TH	.217	L.01	9.0	.5	L5.0	.13	144.0	7.3
25TH	.275	L.01	9.8	.8	6.3	.14	150.	7.4
MEDIAN 50TH	.347	.050	11.30	L1.0	14.1	.14	164.0	8.0
75TH	.583	.39	12.2	1.5	20.	.15	184.0	8.2
90TH	1.026	1.20	12.9	2.0	30.0	.16	201.9	8.5
SECONDARY CODE			02F	02L	04L	05L 07L		

SUBM ID	10301L PH PH UNITS	10401L RESIDUE NONFILTR. MG/L	10602L HARDNESS TOTAL (CALCD.) CACO3 MG/L	10603L HARDNESS TOTAL CACO3 MG/L	11101L SODIUM DISSOLVED NA MG/L	12101L MAGNESIUM DISSOLVED (CALCD.) MG MG/L	12102L MAGNESIUM DISSOLVED MG MG/L	14101L SILICA REACTIVE SIO2 MG/L
SAMPLES(FLAGS)	54(0)	53(4)	53(0)	39(0)	54(0)	33(0)	54(0)	54(0)
LOW	7.21	L.4	149.3	152.9	3.50	11.43	11.40	1.60
HIGH	8.67	338.0	260.8	236.2	14.	18.74	21.50	7.50
AVERAGE		18.8*	185.1	188.2	7.08	14.92	14.86	4.44
STD.DEV.		63.6*	26.0	23.7	2.34	2.15	2.25	1.35
PERCNT:10TH	7.55	.6	155.9	159.5	4.20	12.63	12.60	2.70
25TH	7.86	1.6	165.9	169.8	5.40	13.22	13.00	3.7
MEDIAN 50TH	8.28	4.	179.1	184.0	6.85	14.43	14.05	4.28
75TH	8.5	9.6	192.7	212.3	8.00	16.43	16.00	5.30
90TH	8.6	20.0	222.7	222.9	9.80	18.14	18.10	6.40
SECONDARY CODE		07L		05L	03L			02L 05L

SUBM ID	15101L PHOSPHORUS TOTAL DISSOLVED P MG/L	15114L PHOSPHORUS TOTAL DISSOLVED P MG/L	15255L PHOSPHORUS DISSOLVED ORTHO PO4 P MG/L	15406L PHOSPHORUS TOTAL P MG/L	15421L PHOSPHORUS TOTAL P MG/L	15422L PHOSPHORUS TOTAL P MG/L	15901L PHOSPHORUS PARTICULATE (CALCD.) P MG/L	15902L PHOSPHORUS PARTICULATE P MG/L
SAMPLES(FLAGS)	42(4)	3(0)	15(3)	36(0)	17(1)	3(0)	42(5)	11(2)
LOW	L.003	.0045	L.002	.005	L.006	.0169	Q-.038	L.002
HIGH	.090	.0086	.082	.360	.300	.0245	.309	.280
AVERAGE	.014*	.0071	.013*	.030	.0385*	.0197	.024*	.034*
STD.DEV.	.017*	.0023	.020*	.061	.0709*	.0042	.062*	.082*
PERCNT:10TH	.003		L.002	.006	.0070		Q.002	L.002
25TH	.005		.003	.008	.010		.004	.003
MEDIAN 50TH	.009	.0083	.006	.015	.0180	.0177	.008	.010
75TH	.012		.013	.020	.0270		.012	.018
90TH	.026		.027	.060	.098		.032	.030
SECONDARY CODE	03L 05L		56L					

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CC1800 LAT. 52D 15M 39S LONG. 113D 52M 41S PR 3 UTM 12 303600E 5793750N FOR JAN 25, 1983 TO FEB 24, 1987
RED DEER RIVER ABOVE RED DEER FT. NORMANDEAU
DAM IMPACT STUDY - SITE 5

SUBM ID	16301L SULPHATE DISSOLVED SO4 MG/L	17201L CHLORIDE DISSOLVED CL MG/L	19101L POTASSIUM DISSOLVED K MG/L	20101L CALCIUM DISSOLVED CA MG/L	20105L CALCIUM DISSOLVED (CALCD.) CA MG/L	36001L COLIFORMS TOTAL MPN NO/100ML	36011L COLIFORMS FECAL MPN NO/100ML	04301L BERYLLIUM EXTRBLE. BE MG/L
SAMPLES(FLAGS)	54(0)	53(14)	54(1)	53(0)	39(0)	42(1)	42(1)	18(18)
LOW	18.9	.50	L.20	40.	41.21	.0	.0	L.001
HIGH	49.5	5.10	5.1	69.00	63.65	G2400.	540.	L.001
AVERAGE	33.5	1.50*	1.48*	49.54	50.47	111.0*	24.2*	
STD.DEV.	7.4	.97*	.89*	7.01	6.36	375.5*	85.9*	
PERCNT:10TH	24.7	.80	.97	41.50	43.06	.0	0.	L.001
25TH	27.6	L0.	1.00	44.40	45.67	4.0	.0	L.001
MEDIAN 50TH	33.6	1.00	1.20	48.	48.87	13.0	2.0	L.001
75TH	39.1	2.	1.60	55.70	56.02	50.0	8.0	L.001
90TH	43.0	2.60	2.20	60.00	60.95	180.0	38.	L.001
SECONDARY CODE	06L	03L	03L	03L 10L 02L				04L

SUBM ID	13301L ALUMINUM EXTRBLE. AL MG/L	13305L ALUMINUM EXTRBLE. AL MG/L	23001L VANADIUM TOTAL V MG/L	23301L VANADIUM EXTRBLE. V MG/L	24004L CHROMIUM TOTAL CR MG/L	24302L CHROMIUM EXTRBLE. CR MG/L	25001L MANGANESE TOTAL MN MG/L	25301L MANGANESE EXTRBLE MN MG/L
SAMPLES(FLAGS)	17(2)	18(5)	18(7)	8(5)	18(6)	16(11)	18(4)	17(2)
LOW	L.01	L.020	L.002	L.001	L.001	L.001	L.008	L.004
HIGH	.780	.700	.015	.005	.010	L.01	.226	.250
AVERAGE	.085*	.107*	.004*	.002*	.003*	.002*	.029*	.032*
STD.DEV.	.185*	.172*	.003*	.002*	.003*	.003*	.051*	.057*
PERCNT:10TH	L.010	L.020	L.002		L.001	L.001	L.008	L.004
25TH	.01	L.020	L.002	L.001	L.001	L.001	.009	.01
MEDIAN 50TH	.03	.043	.003	L.001	.003	L.001	.013	.020
75TH	.040	.070	.004	.003	.004	.001	.021	.03
90TH	.150	.385	.005		.009	.006	.055	.04
SECONDARY CODE	02L 03L	06L	09L	02L	09L		03L	04L

SUBM ID	26301L IRON EXTRBLE. FE MG/L	27001L COBALT TOTAL CO MG/L	28001L NICKEL TOTAL NI MG/L	28301L NICKEL EXTRBLE. NI MG/L	29005L COPPER TOTAL CU MG/L	30005L ZINC TOTAL ZN MG/L	30301L ZINC EXTRBL. ZN MG/L	33001L ARSENIC TOTAL AS MG/L
SAMPLES(FLAGS)	54(3)	18(16)	18(4)	17(9)	18(6)	18(5)	17(3)	26(0)
LOW	L.010	L.001	L.001	L.001	L.001	L.001	L.001	.0002
HIGH	3.920	.004	.153	.012	.008	.027	.055	.0046
AVERAGE	.247*	.001*	.014*	.003*	.002*	.006*	.011*	.0009
STD.DEV.	.613*	.001*	.035*	.003*	.002*	.008*	.017*	.0010
PERCNT:10TH	.010	L.001	L.001	L.001	L.001	L.001	L.001	.0004
25TH	.040	L.001	.003	L.001	L.001	L.001	.001	.0005
MEDIAN 50TH	.080	L.001	.006	L.001	.002	.003	.003	.0006
75TH	.16	L.001	.007	.003	.002	.007	.010	.0009
90TH	.490	.002	.013	.009	.004	.024	.048	.0021
SECONDARY CODE	02L 04L	09L	09L	02L	09L	09L	05L	05L

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NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CC1800 LAT. 52D 15M 39S LONG. 113D 52M 41S PR 3 UTM 12 303600E 5793750N FOR JAN 25, 1983 TO FEB 24, 1987
RED DEER RIVER ABOVE RED DEER FT. NORMANDEAU
DAM IMPACT STUDY - SITE 5

	SUBM ID	33101L ARSENIC DISSOLVED AS MG/L	34003L SELENIUM TOTAL SE MG/L	34102L SELENIUM DISSOLVED SE MG/L	42001L MOLYBDENUM TOTAL MO MG/L	48301L CADMIUM EXTRBLE. CD MG/L	80002L MERCURY TOTAL HG MG/L	80011L MERCURY TOTAL HG UG/L	82301L LEAD EXTRBLE. PB MG/L
SAMPLES(FLAGS)		8(0)	16(16)	9(6)	18(16)	17(16)	53(50)		33(21)
LOW		.0003	L.0002	L.0002	L.001	L.001	L.0001		L.002
HIGH		.0029	L.0002	.0006	.005	.003	.0002		.014
AVERAGE		.0008		.0003*	.001*	.001*	.0001*		.004*
STD.DEV.		.0009		.0002*	.001*	.000*	.0000*		.003*
PERCNT:10TH			L.0002		L.001	L.001	L.0001		L.002
25TH		.0004	L.0002	L.0002	L.001	L.001	L.0001		L.002
MEDIAN 50TH		.0005	L.0002	L.0002	L.001	L.001	L.0001		L.003
75TH		.0007	L.0002	.0004	L.001	L.001	L.0001		.003
90TH			L.0002		.004	L.001	L.0001		.005
SECONDARY CODE		04L	05L		09L	02L	15L		02L

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NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CD1000 LAT. 52D 16M 0S LONG. 113D 35M 5S PR 3 UTM 12 323600E 5793600N FOR JAN 25, 1983 TO MAR 14, 1988
RED DEER RIVER BELOW RED DEER JOFRE BRIDGE
DAM IMPACT STUDY - SITE 6

	SUBM ID	00203L TOTAL DISSOLVED SOLIDS (CALCULATED) MG/L	00205L TOTAL DISSOLVED SOLIDS MG/L	02041L SPECIFIC CONDUCT. US/CM	02041F SPECIFIC CONDUCT. US/CM	02061F TEMPERATURE OF WATER DEG.C	02071L TURBIDITY JTU	02074L TURBIDITY NTU	06001L CARBON TOTAL ORGANIC C MG/L
SAMPLES(FLAGS)		64(6)	18(0)	65(0)	47(0)	64(0)	13(2)	52(0)	26(0)
LOW		160.	169.	288.0	238.	-1.0	L.1	.2	2.2
HIGH		300.	260.	515.0	474.	26.4	30.0	320.0	13.2
AVERAGE		216.*	208.	388.6	366.1	9.7	6.0*	10.4	4.6
STD.DEV.		32.*	28.	57.9	57.2	7.5	8.4*	44.5	2.4
PERCNT:10TH		175.	171.	318.	291.	.0	L.1	.7	2.4
25TH		190.	182.	339.	328.0	.1	1.0	1.2	3.2
MEDIAN 50TH		213.	208.	383.0	362.	11.4	2.5	2.0	4.1
75TH		242.	229.	428.0	408.	16.2	7.5	3.0	5.0
90TH		260.	256.	474.0	448.	19.0	15.0	8.0	7.6
SECONDARY CODE							73L		05L

	SUBM ID	06101L CARBON DISSOLVED ORGANIC C MG/L	06201L BICARBONT. (CALCD.) HCO3 MG/L	06202L BICARBONT. (CALCD.) HCO3 MG/L	06301L CARBONATE (CALCD.) CO3 MG/L	06536L PHENOLIC MATERIAL PHENOL MG/L	06551L TANNIN AND LIGNIN LIG.SULPH. MG/L	06715L CHLORO - PHYLL A MG/M3	06720L CHLOROPHYLL -A- PHYTOPLANKTO N MG/M3
SAMPLES(FLAGS)		64(0)	64(42)	63(0)	64(42)	65(20)	2(1)	19(0)	51(0)
LOW		2.0	63.9	63.9	.0	L.001	L.1	1.5	.0
HIGH		13.0	Q285.0	271.8	41.8	.014	.5	7.9	54.783
AVERAGE		4.7	202.4*	199.9	3.1*	.003*	.30*	3.27	4.290
STD.DEV.		2.5	39.4*	37.6	6.4*	.003*	.28*	1.92	7.621
PERCNT:10TH		2.1	Q154.6	154.8	Q.1	L.001		1.7	1.010
25TH		3.0	178.6	174.3	.1	.001		1.8	1.75
MEDIAN 50TH		4.1	199.8	198.7	.1	.002	.30*	2.6	2.9
75TH		6.0	232.2	229.	5.0	.003		4.3	4.463
90TH		8.2	253.3	244.	10.0	.005		6.73	6.1
SECONDARY CODE	04L 07L					37L			

	SUBM ID	06721L CHLOROPHYLL -A- EPILITHON MG/M2	06722L CHLOROPHYLL A EPILITHIC SUBSAMPLE (TEMPLATE) MG/M2	07015L NITROGEN TOTAL KJELDAHL N MG/L	07105L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07111L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07205L NITROGEN DISSOLVED NITRITE N MG/L	07501L NITROGEN TOTAL AMMONIA N MG/L	07561L NITROGEN DISSOLVED AMMONIA N MG/L
SAMPLES(FLAGS)		13(0)	33(0)	65(0)	49(10)	18(3)	20(9)	46(11)	18(1)
LOW		5.5	16.41	.200	L.003	L.001	L.001	L.01	L.002
HIGH		442.8	899.0	1.800	.615	.460	L.05	1.000	.300
AVERAGE		104.485	281.458	.518	.141*	.061*	.010*	.086*	.054*
STD.DEV.		129.322	213.467	.315	.171*	.120*	.015*	.161*	.095*
PERCNT:10TH		8.5	76.9	.260	L.003	L.001	L.001	L.010	.003
25TH		12.7	164.34	.320	.006	.002	L.001	.010	.006
MEDIAN 50TH		44.8	224.93	.44	L.05	.005	.004	.035	.013
75TH		168.3	359.58	.580	.258	.054	.009	.080	.029
90TH		254.0	556.4	.840	.390	.220	.040*	.280	.280
SECONDARY CODE				21L	10L		06L	05L	62L

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NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CD1000 LAT. 52D 16M 0S LONG. 113D 35M 5S PR 3 UTM 12 323600E 5793600N FOR JAN 25, 1983 TO MAR 14, 1988
RED DEER RIVER BELOW RED DEER JOFRE BRIDGE
DAM IMPACT STUDY - SITE 6

SUBM ID	07602L NITROGEN TOTAL (CALCD.) N MG/L	07906L NITROGEN PARTICULATE TOTAL N MG/L	08101F OXYGEN DISSOLVED DO O2 MG/L	08201L OXYGEN BIOCHEM. DEMAND-BOD O2 MG/L	08301L OXYGEN TOTAL COD O2 MG/L	09101L FLUORIDE DISSOLVED F MG/L	10101L ALKALINITY TOTAL CACO3 MG/L	10301F PH PH UNITS
SAMPLES(FLAGS)	65(13)	18(5)	65(1)	62(5)	65(5)	20(0)	65(0)	40(0)
LOW	Q.201	L.01	7.0	L.1	L0.	.13	122.0	6.5
HIGH	2.040	6.10	16.5	10.0	94.0	.23	234.0	9.0
AVERAGE	.623*	.452*	11.40*	1.6*	16.7*	.15	170.9	
STD.DEV.	.384*	1.418*	2.08*	1.3*	13.4*	.02	27.1	
PERCNT:10TH	Q.243	L.01	8.6	.7	5.0	.13	137.0	7.00
25TH	Q.363	L.01	9.80	1.1	10.	.14	149.	7.40
MEDIAN 50TH	.501	.070	11.5	1.4	14.0	.15	165.0	7.90
75TH	.820	.24	12.8	1.9	21.3	.16	192.0	8.35
90TH	1.115	.62	14.0	2.5	28.	.16	207.8	8.55
SECONDARY CODE			02F	02L	04L	05L 07L		

SUBM ID	10301L PH PH UNITS	10401L RESIDUE NONFILTR. MG/L	10602L HARDNESS TOTAL (CALCD.) CACO3 MG/L	10603L HARDNESS TOTAL CACO3 MG/L	11101L SODIUM DISSOLVED NA MG/L	12101L MAGNESIUM DISSOLVED (CALCD.) MG MG/L	12102L MAGNESIUM DISSOLVED MG MG/L	14101L SILICA REACTIVE SIO2 MG/L
SAMPLES(FLAGS)	65(0)	64(3)	64(0)	50(0)	65(0)	44(0)	65(0)	65(0)
LOW	7.12	L.4	134.3	137.2	4.30	10.47	10.40	.45
HIGH	9.23	524.0	264.5	235.3	17.20	19.04	21.80	7.40
AVERAGE		18.7*	184.9	187.5	9.64	15.41	15.26	3.54
STD.DEV.		67.9*	29.6	27.8	2.93	2.27	2.35	2.02
PERCNT:10TH	7.47	1.2	150.9	154.7	6.	12.72	12.70	1.10
25TH	8.00	1.8	163.5	165.0	7.70	13.63	13.60	1.70
MEDIAN 50TH	8.25	4.0	176.8	183.0	9.70	15.05	15.	3.40
75TH	8.5	9.5	207.9	212.0	11.20	17.59	17.00	5.2
90TH	8.7	28.	230.8	229.6	13.80	18.34	18.40	6.35
SECONDARY CODE		07L		05L	03L			02L 05L

SUBM ID	15101L PHOSPHORUS TOTAL DISSOLVED P MG/L	15114L PHOSPHORUS TOTAL DISSOLVED P MG/L	15255L PHOSPHORUS DISSOLVED ORTHO PO4 P MG/L	15406L PHOSPHORUS TOTAL P MG/L	15421L PHOSPHORUS TOTAL P MG/L	15422L PHOSPHORUS TOTAL P MG/L	15901L PHOSPHORUS PARTICULATE (CALCD.) P MG/L	15902L PHOSPHORUS PARTICULATE P MG/L
SAMPLES(FLAGS)	54(0)	9(0)	15(1)	47(0)	17(0)	9(0)	54(0)	11(0)
LOW	.006	.0211	L.002	.012	.012	.0382	.000	.004
HIGH	.150	.0568	.150	.510	.191	.0768	.459	.143
AVERAGE	.041	.0412	.049*	.070	.0631	.0550	.027	.035
STD.DEV.	.032	.0131	.049*	.073	.0537	.0133	.064	.046
PERCNT:10TH	.010		.008	.024	.014		.004	.004
25TH	.016	.0332	.010	.036	.028	.0439	.007	.006
MEDIAN 50TH	.030	.0419	.028	.055	.040	.0576	.010	.012
75TH	.062	.0516	.090	.084	.0720	.0590	.020	.058
90TH	.084		.130	.101	.1560		.057	.100
SECONDARY CODE	03L 05L		56L					

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CD1000 LAT. 52D 16M 0S LONG. 113D 35M 5S PR 3 UTM 12 323600E 5793600N FOR JAN 25, 1983 TO MAR 14, 1988
RED DEER RIVER BELOW RED DEER JOFRE BRIDGE
DAM IMPACT STUDY - SITE 6

	SUBM ID	16301L SULPHATE DISSOLVED S04 MG/L	17201L CHLORIDE DISSOLVED CL MG/L	19101L POTASSIUM DISSOLVED K MG/L	20101L CALCIUM DISSOLVED CA MG/L	20105L CALCIUM DISSOLVED (CALCD.) CA MG/L	36001L COLIFORMS TOTAL MPN NO/100ML	36011L COLIFORMS FECAL MPN NO/100ML	04301L BERYLLIUM EXTRBLE. BE MG/L
SAMPLES(FLAGS)		65(0)	65(6)	65(0)	64(0)	50(0)	54(1)	54(0)	
LOW		21.0	L0.	.94	33.30	33.27	10.0	0.	
HIGH		50.0	9.50	6.25	70.00	62.95	3900.	1240.0	
AVERAGE		35.0	2.65*	1.72	48.83	49.57	1026.0*	178.3	
STD.DEV.		7.3	1.51*	1.02	8.23	7.80	1005.2*	255.0	
PERCNT:10TH		25.0	1.10	1.1	39.	41.02	90.0	8.0	
25TH		29.8	1.60	1.20	43.40	43.57	200.	20.	
MEDIAN 50TH		34.0	2.20	1.42	47.15	48.04	743.0	98.0	
75TH		40.2	3.10	1.70	54.80	55.95	1500.	230.0	
90TH		45.0	4.70	2.40	61.00	61.00	2700.0	550.	
SECONDARY CODE		06L	03L	03L	03L 10L				

	SUBM ID	13301L ALUMINUM EXTRBLE. AL MG/L	13305L ALUMINUM EXTRBLE. AL MG/L	23001L VANADIUM TOTAL V MG/L	23301L VANADIUM EXTRBLE. V MG/L	24004L CHROMIUM TOTAL CR MG/L	24302L CHROMIUM EXTRBLE. CR MG/L	25001L MANGANESE TOTAL MN MG/L	25301L MANGANESE EXTRBLE MN MG/L
SAMPLES(FLAGS)		4(0)			2(0)		3(3)		4(0)
LOW		.02			.001		L.001		.005
HIGH		.08			.001		L.01		.057
AVERAGE		.040			.001				.023
STD.DEV.		.028			.000				.024
PERCNT:10TH									
25TH		.020							.008
MEDIAN 50TH		.030			.001		L.001		.015
75TH		.060							.039
90TH									
SECONDARY CODE	02L	03L			02L				04L

	SUBM ID	26301L IRON EXTRBLE. FE MG/L	27001L COBALT TOTAL CO MG/L	28001L NICKEL TOTAL NI MG/L	28301L NICKEL EXTRBLE. NI MG/L	29005L COPPER TOTAL CU MG/L	30005L ZINC TOTAL ZN MG/L	30301L ZINC EXTRBL. ZN MG/L	33001L ARSENIC TOTAL AS MG/L
SAMPLES(FLAGS)		63(11)			4(3)			4(1)	2(0)
LOW		L.001			L.001			L.001	.0004
HIGH		1.07			.002			.012	.0008
AVERAGE		.109*			.001*			.007*	.0006
STD.DEV.		.192*			.001*			.005*	.0003
PERCNT:10TH		L.010							
25TH		.010			L.001			.003*	
MEDIAN 50TH		.040			L.001			.008	.0006
75TH		.09			.001*			.012	
90TH		.32							
SECONDARY CODE	02L	04L			02L			05L	05L

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

NAQUADAT SUMMARY REPORT JAN 07, 1991
RED DEER RIVER DATA

STATION 00AL05CD1000 LAT. 52D 16M 0S LONG. 113D 35M 5S PR 3 UTM 12 323600E 5793600N FOR JAN 25, 1983 TO JAN 11, 1988
RED DEER RIVER BELOW RED DEER JOFRE BRIDGE
DAM IMPACT STUDY - SITE 6

	SUBM ID	33101L ARSENIC DISSOLVED AS MG/L	34003L SELENIUM TOTAL SE MG/L	34102L SELENIUM DISSOLVED SE MG/L	42001L MOLYBDENUM TOTAL MO MG/L	48301L CADMIUM EXTRBLE. CD MG/L	80002L MERCURY TOTAL HG MG/L	80011L MERCURY TOTAL HG UG/L	82301L LEAD EXTRBLE. PB MG/L
SAMPLES(FLAGS)		2(0)	1(0)	2(1)		4(4)	6(6)	1(1)	4(2)
LOW		.0005	.0004	L.0002		L.001	L.0001	L.05	L.002
HIGH		.0055	.0004	.0020		L.001	L.0001	L.05	.013
AVERAGE		.0030		.0011*					.005*
STD.DEV.		.0035		.0013*					.005*
PERCNT:10TH									
25TH						L.001	L.0001		L.002
MEDIAN 50TH		.0030		.0011*		L.001	L.0001		.002*
75TH						L.001	L.0001		.008
90TH									
SECONDARY CODE		04L	05L			02L	15L		02L

* THESE STATISTICS INCLUDE VALUES FLAGGED WITH L,G OR Q

Appendix VI. Summary of zoobenthic data, 1983-87.

TABLE 1 Summary of benthic invertebrate data, Red Deer River, 1983
(Means of five replicate samples at each site, indicating standard error).

SITE NO.*	NEMATODA x̄	± SE	OLIGOCHAETA x̄	± SE	CRUSTACEA x̄	± SE	EPHEMEROPTERA x̄	± SE	TRICHOPTERA x̄	± SE	PLECOPTERA x̄	± SE
SPRING 1983												
1	0.6	0.6	0.8	0.4	4.2	0.9	245.6	40.2	5.4	2.0	52.8	9.9
2	2.8	1.8	8.0	4.6	13.2	1.5	83.6	15.4	2.2	1.0	15.8	3.7
3	39.6	9.0	75.6	9.9	22.8	3.8	270.0	15.2	14.4	2.2	34.2	6.4
4	6.4	1.5	35.6	6.0	25.6	4.2	46.0	5.3	13.4	2.2	25.8	3.2
5	68.4	18.3	1146.6	160.4	4.2	1.2	182.0	48.5	100.2	20.8	24.4	4.4
6	140.8	39.2	245.8	110.9	4.6	0.9	465.0	64.3	3.2	1.1	36.8	14.7
7	35.8	20.7	100.8	29.7	14.8	3.9	137.0	31.7	0.4	0.2	54.8	15.3
8	11.4	3.2	240.8	53.3	3.4	2.0	293.6	78.4	9.4	1.7	72.0	12.6
9	8.8	2.7	76.0	14.5	1.0	0.8	227.8	46.8	13.4	5.9	41.0	13.5
10	15.2	2.4	142.0	24.3	2.4	0.4	198.4	27.2	17.2	5.0	36.0	7.1
11	1.6	0.9	9.2	3.3	26.6	6.4	34.8	4.1	6.8	2.6	30.6	10.0
12	6.4	1.2	8.0	2.0	45.0	8.4	14.0	3.4	21.0	6.2	4.0	1.3
FALL 1983												
1	30.0	10.9	160.8	78.0	9.0	6.1	75.0	10.0	9.8	2.0	29.0	4.8
2	12.8	12.8	177.6	56.1	126.4	17.6	779.4	173.3	704.6	116.5	282.2	45.4
3	157.8	37.3	621.8	148.8	145.6	16.2	12.0	2.3	11.4	2.8	4.2	2.7
4	58.0	10.4	60.2	13.6	1.6	1.0	623.0	201.0	1097.6	312.6	214.8	53.6
5	119.2	41.8	2173.0	1158.2	31.2	13.0	397.0	78.1	704.2	188.5	22.6	12.9
6	147.2	34.6	421.6	90.3	244.8	66.1	95.6	26.0	6.4	2.8	0.8	0.8
7	16.0	3.3	71.0	33.9	199.4	65.1	23.2	5.8	4.4	1.3	0.4	0.4
8	13.6	10.7	162.8	15.8	3.2	3.2	630.6	46.5	186.0	77.9	38.2	10.8
9	12.8	3.0	74.0	11.5	95.2	51.4	46.2	17.8	10.8	6.3	8.6	4.1
10	19.2	5.1	56.0	23.1	98.4	51.8	80.4	15.6	44.2	18.8	6.2	1.7
11°												
12	13.6	4.5	48.4	7.4	203.8	61.1	82.6	22.0	36.2	12.0	5.2	1.5

SITE NO.*	CHIRONOMIDAE x̄	± SE	MISC.DIPTERA x̄	± SE	MISC.INSECTA x̄	± SE	MOLLUSCA x̄	± SE	OTHERS x̄	± SE	TOTAL x̄	± SE	NUMBER OF TAXA x̄	± SE
SPRING 1983														
1	146.8	42.9	39.0	6.2	9.2	2.1	0.0		7.0	1.3	511.4	72.8	23.4	0.7
2	24.8	7.1	22.8	5.9	2.4	0.6	0.0		0.0		175.6	33.8	17.6	1.0
3	139.8	12.3	110.8	4.7	0.6	0.2	0.2	0.2	4.4	1.1	712.4	30.5	21.8	0.9
4	82.0	10.0	9.6	0.7	2.2	0.4	0.8	0.6	4.2	1.4	251.6	17.0	23.6	0.4
5	629.4	95.1	26.0	4.7	2.2	1.1	0.0		0.8	0.5	2184.2	277.0	22.6	1.0
6	388.8	28.1	0.6	0.6	1.6	0.9	0.2	0.2	1.4	0.7	1288.8	133.6	16.0	0.9
7	230.8	41.9	0.4	0.2	6.0	1.7	0.0		1.6	0.7	582.4	76.1	15.6	1.0
8	356.4	64.8	23.6	8.6	1.8	0.6	2.2	1.1	6.0	2.7	1020.6	100.4	19.0	1.1
9	190.6	15.5	16.4	4.3	1.2	0.6	0.0		6.4	2.4	582.6	74.6	17.6	0.5
10	451.8	75.5	6.4	2.2	3.6	1.2	0.2	0.2	36.0	16.2	909.2	98.6	21.6	0.9
11	387.4	26.9	5.0	0.9	1.0	0.3	0.0		2.8	1.4	505.8	29.9	17.0	0.6
12	279.0	29.6	9.2	1.2	1.4	0.7	0.0		3.4	1.1	391.4	47.9	16.0	0.8
FALL 1983														
1	995.0	153.2	19.0	4.7	16.4	5.2	0.4	0.2	9.4	1.4	1353.8	198.0	22.8	1.2
2	3588.8	545.3	93.8	53.6	0.0		0.0		977.6	230.1	6743.2	900.2	25.0	1.5
3	2383.6	454.8	7.2	3.6	6.4	1.8	1.8	1.0	67.0	5.5	3418.8	555.6	21.0	1.2
4	2092.0	380.6	6.6	2.7	25.4	10.1	0.0		394.8	39.9	4574.0	936.9	27.8	1.4
5	4721.4	1450.1	133.6	39.2	27.8	10.4	4.2	1.4	85.2	17.8	8420.2	2920.9	26.6	1.1
6	7464.4	1670.1	10.6	5.5	8.2	4.5	7.0	4.5	31.8	15.1	8438.4	1766.4	20.2	0.6
7	1577.2	138.6	2.8	0.9	46.4	12.6	1.0	0.3	30.0	10.5	1971.8	144.6	21.2	1.0
8	1129.6	161.4	10.4	4.0	43.0	10.9	36.8	6.1	432.8	86.6	2687.0	215.3	25.4	0.7
9	739.8	293.5	5.6	2.6	5.2	2.6	1.0	0.8	40.8	16.7	1040.0	320.4	21.8	1.5
10	1264.6	167.7	9.4	4.8	5.2	0.9	0.0		68.8	10.9	1652.4	211.0	24.0	0.7
11°														
12	172.4	14.3	73.6	10.5	12.0	3.6	0.2	0.2	10.0	3.2	658.0	83.0	25.2	0.6

* refer to Figure 1 for site names
° not sampled

C217z

TABLE 2 Summary of benthic invertebrate data, Red Deer River, 1984
(Means of five replicate samples at each site, indicating standard error).

SITE NO.*	NEMATODA $\bar{x}$	± SE	OLIGOCHAETA $\bar{x}$	± SE	CRUSTACEA $\bar{x}$	± SE	EPHEMEROPTERA $\bar{x}$	± SE	TRICHOPTERA $\bar{x}$	± SE	PLECOPTERA $\bar{x}$	± SE	CHIRONOMIDAE $\bar{x}$	± SE	MISC.DIPTERA $\bar{x}$	± SE	MISC.INSECTA $\bar{x}$	± SE	MOLLUSCA $\bar{x}$	± SE	OTHERS $\bar{x}$	± SE	TOTAL $\bar{x}$	± SE	NUMBER OF TAXA $\bar{x}$	± SE
SPRING 1984																										
1	7.6	2.7	16.0	6.7	6.2	1.7	154.4	31.9	17.0	6.6	46.8	12.2	1076.2	328.3	38.2	14.0	0.4	0.2	0.2	0.2	10.6	1.0	1373.6	327.1	29.6	1.3
2	8.8	5.1	529.2	73.3	2086.2	274.4	102.4	13.2	70.6	8.9	17.6	4.5	7522.2	1611.7	7.8	2.6	1.2	0.8	0.0		33.6	12.8	10379.6	1825.1	23.6	1.2
3	91.8	44.5	6686.6	2163.7	33.2	27.7	141.8	39.3	221.4	85.8	16.4	5.3	6426.0	2323.9	165.8	74.0	16.6	5.0	0.8	0.6	56.2	0.2	13856.6	4689.0	30.0	1.0
4	88.0	13.1	797.8	155.6	22.8	7.9	31.4	1.4	101.0	11.7	9.0	2.3	2070.6	333.4	4.2	0.6	1.2	0.4	2.2	1.0	12.4	0.2	3140.6	462.8	28.6	0.9
5	350.4	157.2	561.8	121.0	25.0	9.0	1262.6	415.0	301.6	86.4	7.2	1.8	5710.8	794.0	33.0	11.8	3.2	1.4	1.6	0.5	26.8	0.4	8284.0	659.6	29.6	0.7
8	102.6	9.6	219.2	51.6	20.2	8.9	164.4	42.2	74.8	20.0	26.8	6.2	1102.6	215.2	23.4	2.3	41.6	9.0	4.8	1.9	751.8		2532.2	578.6	300.8	1.1
12	11.0	2.9	102.0	40.8	81.2	22.9	137.6	16.9	149.8	21.3	6.8	1.8	397.2	33.2	27.6	6.9	3.4	0.9	0.2	0.2	35.4	0.6	952.2	76.1	27.6	1.2
FALL 1984																										
1	17.4	2.1	419.2	85.6	2.2	1.0	147.8	18.8	91.2	12.6	126.4	8.0	429.2	61.1	41.2	5.1	2.2	0.2	0.0		72.0	11.0	1348.8	97.2	38.0	0.8
2	100.0	29.9	590.2	126.7	280.4	51.9	63.4	17.2	113.8	32.9	7.4	2.3	5045.6	502.5	11.2	3.4	0.2	0.2	5.2	4.0	1848.0	348.4	8065.4	520.2	33.8	0.6
3	65.0	17.6	1731.4	296.7	44.4	7.9	79.4	17.5	188.0	53.8	16.6	6.0	3937.8	375.5	56.4	10.5	8.6	3.3	5.8	2.6	43.2	3.1	6176.6	361.9	34.8	1.0
4	62.8	8.1	902.6	410.2	36.2	20.8	372.4	101.3	317.6	97.4	27.6	15.2	3876.4	462.0	22.6	10.1	3.2	1.4	63.0	51.9	73.0	14.6	5757.4	663.1	36.2	1.0
5	77.2	13.9	1236.4	227.2	2.0	1.0	1325.0	259.1	265.8	124.0	0.4	0.2	2332.2	272.4	124.8	35.5	4.0	1.4	33.0	8.0	37.4	11.4	5438.2	595.4	32.6	0.7
8	35.2	11.1	161.4	32.4	7.8	0.5	430.8	86.3	120.4	55.1	10.0	2.7	460.8	96.2	43.2	11.7	10.8	2.6	37.0	9.3	96.6	35.6	1414.0	167.5	35.4	1.6
12	10.0	0.9	97.8	19.8	11.6	1.5	227.2	39.2	108.4	31.5	16.8	4.7	433.6	44.8	7.4	2.2	2.8	1.6	0.0		6.8	1.9	922.4	42.7	30.0	1.4

* refer to Figure 1 for site names

TABLE 3 Summary of benthic invertebrate data, Red Deer River, 1985
(Means of five replicate samples at each site, indicating standard error).

SITE NO.*	NEMATODA $\bar{x}$	± SE	OLIGOCHAETA $\bar{x}$	± SE	CRUSTACEA $\bar{x}$	± SE	EPHEMEROPTERA $\bar{x}$	± SE	TRICHOPTERA $\bar{x}$	± SE	PLECOPTERA $\bar{x}$	± SE	CHIRONOMIDAE $\bar{x}$	± SE
SPRING 1985														
1	21.0	3.5	169.8	33.2	10.4	2.9	143.8	12.6	45.6	6.4	78.8	3.6	1875.2	317.3
2	157.2	73.3	3650.6	392.6	765.2	102.5	17.4	2.6	78.0	16.7	3.8	2.6	12865.6	852.8
3	394.6	133.6	3521.2	357.5	16.4	3.3	23.2	7.0	30.0	8.4	3.6	1.5	4222.0	499.7
4	65.4	14.9	64.2	9.5	4.4	2.1	87.8	21.1	178.6	36.3	106.6	34.4	2806.4	183.9
5	273.0	49.3	1780.6	676.5	30.8	15.5	507.8	60.6	114.8	6.9	2.4	1.1	1863.2	167.4
8	10.4	3.4	64.8	18.0	0.8	0.4	174.8	22.8	57.6	12.2	6.8	2.1	1849.2	546.7
12	21.6	11.4	1.0	1.0	58.0	28.6	24.8	5.1	4.0	0.9	38.0	14.5	167.0	27.9
FALL 1985														
1	7.0	1.5	122.4	15.6	5.0	1.3	123.2	15.0	108.0	26.0	101.0	15.5	92.2	14.0
2	7.8	1.4	271.2	73.2	360.0	70.3	1.2	0.5	3.0	1.4	0.0		1473.6	24.2
3	60.6	16.4	1142.2	253.7	5.8	1.6	48.0	4.3	50.6	7.2	38.6	4.5	611.6	77.6
4	7.8	2.1	429.2	71.3	7.6	2.7	50.4	7.3	24.2	5.1	12.4	2.4	1087.4	237.1
5	35.0	9.1	2519.8	713.6	39.0	20.9	62.8	21.3	42.6	14.9	0.2	0.2	746.0	225.6
8	6.6	3.2	402.6	73.0	12.2	3.8	257.8	41.7	42.6	8.9	3.2	1.4	442.0	26.8
12	2.4	1.6	158.6	96.3	0.0		35.8	4.7	17.4	4.6	27.6	8.3	13.8	5.2

SITE NO.*	MISC.DIPTERA $\bar{x}$	± SE	MISC.INSECTA $\bar{x}$	± SE	MOLLUSCA $\bar{x}$	± SE	OTHERS $\bar{x}$	± SE	TOTAL $\bar{x}$	± SE	NUMBER OF TAXA $\bar{x}$	± SE
SPRING 1985												
1	33.4	2.5	1.4	1.0	0.2	0.2	49.4	9.0	2429.0	351.4	36.8	1.6
2	3.8	1.2	0.0		0.0		41.0	8.6	17582.6	1157.1	24.2	1.2
3	31.4	8.4	7.4	0.6	3.6	1.1	23.8	7.1	8277.2	947.2	32.0	2.7
4	6.0	1.1	10.2	2.9	2.2	0.9	43.6	8.7	3375.4	256.3	29.0	1.4
5	28.8	4.6	31.8	20.1	14.0	7.9	246.6	40.9	4893.8	652.7	32.0	1.2
8	56.0	16.6	2.4	0.8	7.4	1.9	700.4	181.9	2930.6	697.9	26.0	0.9
12	82.2	42.2	0.2	0.2	0.0		5.8	2.9	402.6	85.5	18.4	0.9
FALL 1985												
1	39.8	6.0	0.8	0.2	1.8	0.8	47.0	8.5	648.2	55.5	40.4	1.5
2	0.6	0.4	2.8	0.7	10.6	1.6	4678.4	390.8	6809.2	35.85	21.0	1.3
3	33.4	7.2	13.4	3.8	7.8	1.9	65.0	13.9	2077.0	284.6	36.6	0.7
4	9.0	2.4	13.0	5.0	6.8	2.3	14.4	2.7	50.4	7.3	24.2	5.1
5	12.8	7.7	6.4	3.9	2.6	0.9	17.0	7.1	3484.2	684.2	29.0	3.5
8	23.4	3.2	6.8	1.2	5.4	1.7	38.8	16.9	1241.4	124.3	30.4	1.4
12	5.2	3.8	1.8	0.7	0.0		1.2	0.5	263.8	117.5	17.2	2.0

* refer to Figure 1 for site names

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TABLE 4 Summary of benthic invertebrate data, Red Deer River, 1986
(Means of five replicate samples at each site, indicating standard error).

SITE NO.*	NEMATODA $\bar{x}$	± SE	OLIGOCHAETA $\bar{x}$	± SE	CRUSTACEA $\bar{x}$	± SE	EPHEMEROPTERA $\bar{x}$	± SE	TRICHOPTERA $\bar{x}$	± SE	PLECOPTERA $\bar{x}$	± SE
SPRING 1986												
1	19.0	3.7	7.2	1.9	24.8	4.7	42.0	13.6	11.8	5.6	37.2	14.4
2	16.8	3.3	170.6	84.8	468.2	177.0	.6	.2	2.2	0.9	0.0	0.0
3	590.6	190.1	910.0	351.0	39.8	10.7	61.0	14.5	37.2	5.4	18.2	4.9
4	1252.4	184.6	32.6	10.2	21.2	4.8	833.2	68.1	946.8	139.4	36.4	4.9
5	975.4	106.4	946.4	295.6	4.0	1.2	481.8	152.8	160.6	108.7	2.0	.6
8	140.0	66.5	97.2	20.7	14.8	8.6	74.8	29.8	24.2	9.5	3.2	2.0
12	19.2	7.7	49.4	10.5	5.2	2.2	89.2	38.6	166.6	69.7	2.6	1.4
FALL 1986												
1	2.6	.8	12.8	6.0	15.8	1.7	127.4	19.3	3.4	.5	145.8	30.8
2	491.4	56.8	5410.8	1482.7	3216.2	592.0	10.4	1.4	15.8	4.1	1.0	0.4
3	136.0	39.2	652.0	119.8	58.0	7.0	156.6	32.8	91.4	31.9	30.6	6.6
4	301.6	49.9	2000.2	330.4	22.4	4.4	319.4	132.7	310.2	139.7	86.0	30.5
5	149.8	31.5	2498.0	216.6	11.2	2.8	1549.6	114.5	70.8	14.3	13.4	3.7
8	70.8	21.5	1391.8	218.7	4.2	1.5	960.6	164.7	382.8	47.9	31.2	5.9

SITE NO.*	CHIRONOMIDAE $\bar{x}$	± SE	MISC.DIPTERA $\bar{x}$	± SE	MISC.INSECTA $\bar{x}$	± SE	MOLLUSCA $\bar{x}$	± SE	OTHERS $\bar{x}$	± SE	NUMBER OF TAXA $\bar{x}$	± SE	TOTAL NUMBERS $\bar{x}$	± SE
SPRING 1986														
1	510.4	109.7	38.6	16.5	2.4	0.4	0.2	0.2	2.8	0.7	36.2	2.0	671.6	139.2
2	2380.8	90.4	25.4		0.2	0.2	0.0	0.0	1217.2	183.7	18.2	1.0	4282.0	341.2
3	1939.2	386.3	55.4	13.3	28.0	3.0	2.0	1.1	109.2	45.7	33.8	1.7	3750.8	721.2
4	5736.0	372.3	22.8	8.9	40.6	10.9	6.0	2.5	1160.6	110.7	37.8	0.9	10067.4	451.3
5	2628.4	429.8	4.6	0.7	5.0	1.0	0.8	0.4	36.4	7.5	30.0	1.1	5241.4	757.7
8	928.0	272.5	36.4	7.9	4.0	1.4	6.2	2.9	68.6	33.7	25.0	1.8	1382.6	305.5
12	561.2	168.3	51.2	11.4	4.2	1.8	0.0	0.0	22.8	9.1	23.6	1.3	966.4	238.8
FALL 1986														
1	112.0	12.7	6.0	1.6	0.4	0.2	0.0	0.0	3.0	0.9	29.8	1.1	429.2	59.4
2	3140.2	185.8	2.6	0.4	0.2	0.2	10.6	3.6	1401.2	224.8	29.4	1.6	13700.4	1419.6
3	930.2	112.9	31.6	4.1	2.2	0.8	0.2	0.2	21.2	3.4	37.4	1.2	2110.0	325.4
4	1152.6	129.5	9.2	1.8	14.0	8.3	4.8	2.5	34.6	16.5	39.4	1.0	4255.0	680.4
5	4621.6	258.7	3.2	1.4	0.0	0.0	1.2	1.0	6.6	1.2	32.6	0.9	8925.4	503.9
8	1241.0	189.9	9.4	2.2	6.4	2.1	12.0	8.4	177.4	64.5	34.6	1.9	4287.6	454.9

* refer to Figure 1 for site names

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TABLE 5 Summary of benthic invertebrate data, Red Deer River, 1987
(Means of five replicate samples at each site, indicating standard error).

SITE NO.*	NEMATODA		OLIGOCHAETA		CRUSTACEA		EPHEMEROPTERA		TRICHOPTERA		PLECOPTERA		CHIRONOMIDAE	
	x̄	± SE	x̄	± SE	x̄	± SE	x̄	± SE	x̄	± SE	x̄	± SE	x̄	± SE
SPRING 1987														
1	11.4	2.7	6.0	1.6	34.8	3.6	183.4	17.6	0.6	0.6	68.6	5.9	501.0	62.3
2	19.2	3.1	68.6	22.1	5950.8	328.5	0.0	0.0	0.0	0.0	0.0	0.0	36.6	6.8
3	173.6	30.4	2116.8	212.0	1911.0	159.3	51.0	9.4	2.2	1.2	26.6	8.1	1187.2	148.5
4	884.0	166.9	9048.8	1763.8	916.0	124.4	340.0	30.8	58.2	13.5	26.8	0.8	2436.0	202.4
5	228.0	48.0	984.6	148.4	35.2	15.0	486.0	130.1	235.0	34.0	17.8	1.6	2427.6	218.6
8	217.0	58.7	346.0	122.7	36.4	13.7	160.4	28.3	34.2	4.6	72.6	12.4	689.0	127.7
12	10.4	2.1	2.2	0.7	4.0	1.3	291.6	11.6	58.2	13.6	56.4	11.7	354.2	33.0
FALL 1987														
1	10.2	2.5	21.0	7.7	14.0	0.7	332.0	24.4	35.0	6.9	157.8	17.2	565.2	92.9
2	254.0	47.5	2133.2	92.8	981.6	54.1	19.8	4.7	33.4	4.7	0.0	0.8	3613.6	186.0
3	213.6	41.6	6125.8	732.6	27.6	4.1	519.6	46.5	563.8	90.0	172.6	14.5	4810.4	272.2
4	584.0	176.0	2221.2	125.5	127.0	27.3	88.0	17.5	959.6	88.1	80.0	9.9	4285.6	669.8
5	436.0	134.4	1310.8	294.9	31.2	19.1	284.8	27.9	1099.8	103.4	4.0	1.0	17191.2	1057.4
8	690.0	128.0	1253.0	254.2	4.4	2.4	525.2	55.7	436.0	79.1	6.0	1.3	7104.0	645.9
12	13.2	3.2	12.2	2.2	1.0	0.8	57.2	6.9	254.4	22.9	145.4	6.2	163.8	9.6

SITE NO.*	MISC.DIPTERA		MISC.INSECTA		MOLLUSCA		OTHERS		NUMBER OF TAXA		TOTAL NUMBERS	
	x̄	± SE	x̄	± SE	x̄	± SE	x̄	± SE	x̄	± SE	x̄	± SE
SPRING 1987												
1	5.0	1.7	1.8	0.2	0.0	0.0	2.6	0.9	29.2	1.7	821.0	65.6
2	0.4	0.2	0.0	0.0	0.6	0.2	6.0	1.0	12.8	0.4	6084.6	318.1
3	21.2	2.0	8.4	2.4	0.0	0.0	1883.0	231.8	31.2	1.4	7381.8	386.6
4	9.8	0.8	7.0	0.9	4.4	2.4	1447.4	205.8	32.4	2.3	15182.4	2192.6
5	8.0	3.2	6.4	1.4	3.6	1.6	105.4	31.6	35.0	1.2	4551.8	337.1
8	14.0	7.9	4.4	2.6	0.6	0.4	636.4	131.4	36.2	0.4	2265.6	448.7
12	2.6	1.7	0.4	0.2	0.0	0.0	53.4	15.3	23.6	0.5	872.2	49.1
FALL 1987												
1	31.6	4.5	0.6	0.4	0.0	0.0	76.2	16.6	38.2	1.4	1243.0	116.2
2	100.2	19.5	0.4	0.2	33.6	2.1	1919.8	285.1	32.4	0.9	9089.6	440.7
3	416.6	33.7	43.4	7.0	0.0	0.0	511.4	46.8	40.0	0.9	13404.8	842.9
4	20.2	4.9	89.8	9.9	116.2	17.9	1339.4	113.3	46.6	1.5	9911.0	1064.9
5	46.4	18.1	12.0	2.9	9.8	3.6	292.8	102.5	34.0	0.8	20718.8	1467.5
8	102.0	8.9	9.2	1.1	5.0	1.5	989.6	240.5	31.0	1.0	11124.4	1001.3
12	4.8	1.5	2.4	1.2	0.0	0.0	52.6	9.0	25.6	1.5	707.0	32.8

* refer to Figure 1 for site names