A REPORT FROM

The State Hygienic Laboratory

MEDICAL LABORATORIES BUILDING

THE UNIVERSITY OF IOWA
IOWA CITY, IOWA 52242

Winter Water Quality Survey
of the
Big Sioux River

#79-37

Prepared for the Iowa Department of Environmental Quality by the University of Iowa Hygienic Laboratory.

The publication of this report was financially aided through a contract between the Iowa Department of Environmental Quality and the University of Iowa Hygienic Laboratory utilizing funds made available to the Iowa Department of Environmental Quality by the United States Environmental Protection Agency.

ABSTRACT

A water quality study of the Iowa reach of the Big Sioux River was conducted during January, 1979. The major purpose of the survey was to assess winter water quality and evaluate changes that may have occurred since previous studies. A secondary purpose was to assess the impact of several point source waste dischargers on their receiving streams. Results of the survey show that very poor quality water entered Iowa and slowly improved as it proceeded along Iowa's border. The poor water quality resulted in violations of Iowa's ammonia nitrogen standard at four of eleven stations and violation of Iowa's dissolved oxygen standard at nine of eleven stations. A previous study conducted by the Environmental Protection Agency in 1973 demonstrated similar poor water quality and identified the waste dischargers in the Sioux Falls, South Dakota area as the major source of the problem. To date no improvement in water quality has been observed and is not expected to occur until abatement procedures are implemented. Effluent sampling conducted at the Hawarden and Akron, Iowa municipal wastewater treatment plants indicated Hawarden in compliance with their effluent limitations while Akron was in violation of their BOD limitation. Because of the poor water quality, it was impossible to assess any impact the Iowa wastewater dischargers may have had on the Big Sioux River. Until upstream water quality improves, the Iowa reach of the Big Sioux River is expected to remain poor.

INTRODUCTION

The Big Sioux River originates north of Watertown, South Dakota and flows generally southward for about 675 km (420 miles), joining with the Missouri River near Sioux City, Iowa. The Big Sioux River forms the State boundary between South Dakota and Iowa from near Sioux Falls, South Dakota to its confluence with the Missouri River at Sioux City. Approximately sixty-nine percent of the Big Sioux's drainage area (24,800 km^2 or 9,570 square miles) is located in South Dakota with 15 and 16 percent of the area located in Iowa and Minnesota, respectively (1). Major tributaries to the Big Sioux in the Iowa reach include the Rock River, with a drainage area of 4,372 km^2 (1,688 square miles), and Indian Creek, which has a drainage area of 160 km^2 (63 square miles). Although the linear distance between Sioux City and Sioux Falls is only about 120 kilometers (75 miles), by river the distance between these two points is about 200 kilometers (125 miles). The meandering nature of the river creates a diversity of aquatic habitats resulting in the Big Sioux having more potential for fisheries than any other northwest Iowa stream. A comment written in 1951 by the authors of the book Iowa Fish and Fishing states that the Big Sioux "is western Iowa's largest and most beautiful stream and except for heavy pollution might well be one of our best angling waters" (2). Most of the drainage basin in the Iowa reach is utilized for agriculture with row crops and livestock feeding operations the most common farm practices.

The entire Iowa reach of the Big Sioux River has been designated as a Class B warmwater stream by the Iowa Water Quality Standards and is to be protected for wildlife, fish, aquatic, and semi-aquatic life and secondary contact water uses (3).

Three stream water quality surveys (1, 4, and 5) were performed on the Big Sioux River during 1972 and 1973. Results of these surveys (two conducted by the University Hygienic Laboratory and one conducted by the U.S. Environmental Protection Agency-Office of Enforcement, Denver, Colorado) indicated water quality of the Big Sioux River was poor as a result of point source waste discharges. According to the U.S. Environmental Protection Agency (EPA) report, "the most severe pollution occurred downstream from the city of Sioux Falls, South Dakota. Major sources of pollution in this area included condenser waters from the John Morrell and Company, process wastes from Spencer Foods, Inc. (now Mielman Food Industries) and wastewater discharged from the Sioux Falls wastewater treatment plant" (1). The EPA study also stated that "although there are numerous waste sources in the Big Sioux River Basin, the city of Sioux Falls, South Dakota was demonstrated to be a substantially more significant one than any of the others in adversely affecting the quality of the Big Sioux River. Consequently, any further improvements of water quality in the Big Sioux will largely be determined by abatement measures required of the Sioux Falls municipality" (1).

The primary purpose of this survey was to assess the Iowa reach of the Big Sioux River during conditions similar to the previous studies for comparative purposes in evaluating changes, if any, in water quality since 1973. Another purpose of the study was to assess the impact of several of Iowa's point source waste dischargers on Big Sioux water quality. Table 1 lists all of the wastewater dischargers located in the basin and information regarding each facility.

Water samples were collected during the second week of January from twelve stream stations, including one from the Rock River. Approximate stream sampling locations are shown in Figure 1 and listed in Table 2. At the time of collection, the Big Sioux River was predominately ice and snow covered. In addition to the stream sampling, twenty-four hour composite effluent samples were collected from the municipalities of Akron and Hawarden.

TABLE 1

Big Sioux River Basin Wastewater Dischargers

Discharger	1970 Population[1]	Wastewater Plant Type[1]	Average Flow (mgd)[1]	Design Capacity (mgd)[1]	Status in Construction Grants Program[2]	Stream Receiving Discharge[1]
Larchwood	611	2-Cell Lagoon	0.0611	0.067	Step I; reserve funding	Blood Run Creek
Inwood	644	2-Cell Lagoon	0.0644	--	Step I; reserve funding	Unnamed Tributary to Big Sioux River
Hawarden	2,789	Activated Sludge with Polishing Lagoon	0.168	0.501	Not in Program	Dry Creek
Chatsworth	90	Septic Tanks	--	--	Not in Program	Six Mile Creek
Ireton	582	Trickling Filter	0.040	0.065	Not in Program	Indian Creek
Akron	1,324	Activated Sludge	0.134	0.150	Step I; reserve funding	Big Sioux River
Westfield	148	2-Cell Lagoon	0.028	0.018	Not in Program	Big Sioux River

[1] Information from Western Iowa Basin Plan

[2] Information from Iowa Department of Environmental Quality

mgd - millions of gallons per day

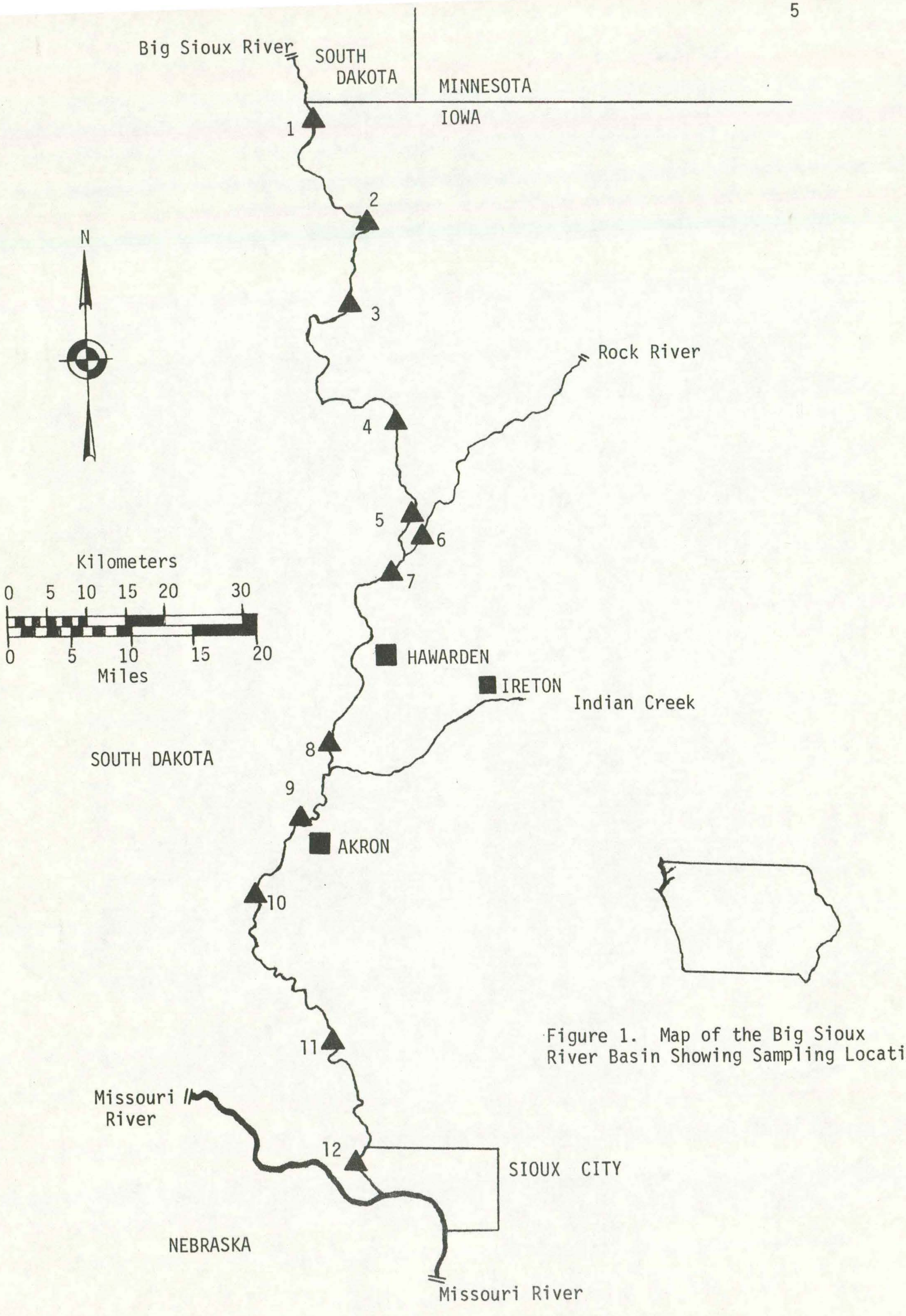

Figure 1. Map of the Big Sioux River Basin Showing Sampling Locations

TABLE 2

Big Sioux River Basin Sampling Locations
January 8, 9, and 10, 1979

Stream Station		Location
1	Big Sioux River	Lyon County Road K10 bridge, T100N, R49W, Section 13
2	Big Sioux River	Lyon County Road A26 bridge, T99N, R48W, Section 21
3	Big Sioux River	Lyon County Hwy 18 bridge, T98N, R48W, Section 16
4	Big Sioux River	Sioux County Road bridge, T97N, R48W, Section 24/25
5	Big Sioux River	Sioux County Road bridge, T96N, R48W, Section 30
6	Rock River	Sioux County Road bridge, T95N, R48W, Section 6
7	Big Sioux River	Sioux County Hwy 10 bridge, T95N, R48W, Section 15
8	Big Sioux River	Sioux County Road bridge, T94N, R48W, Section 32
9	Big Sioux River	Plymouth County Hwy 48 bridge, T93N, R48W, Section 31
10	Big Sioux River	Plymouth County Hwy 3 bridge, T92N, R49W, Section 28
11	Big Sioux River	Plymouth County Road bridge, T90N, R48W, Section 9
12	Big Sioux River	Woodbury County Interstate 29 bridge, T89N, R48W, Sioux City, Iowa

Wastewater Dischargers	
Hawarden Municipal WWTP	Final effluent - 24 hour composite
Akron Municipal WWTP	Final effluent - 24 hour composite
Ireton Municipal WWTP	Indian Creek - Grab

WWTP - Wastewater Treatment Plant

Provisional flow data provided by the U.S. Geological Survey gave a flow value of 90 cubic feet per second (cfs) at Akron on January 10, 1979. This value is subject to correction for ice cover and in the final analysis may vary substantially. In comparison, the seven day, ten year low flow for the Big Sioux River at Akron is 20.4 cfs. Stream flow values for the previous studies at Akron were: 1972 University Hygienic Laboratory (UHL) report, 13 cfs; 1973 UHL report, 400 cfs; 1973 EPA report, 580 cfs.

SAMPLING AND ANALYTICAL METHODOLOGY

Procedures used in sample collection, preservation, and analysis are described in Standard Methods (6) and Manual of Methods for Chemical Analysis of Water and Wastes (7). Grab samples were collected using a high density polyethylene sampling bucket and a weighted stainless steel dissolved oxygen sampler. Composite samples were collected by ISCO (Instrumentation Specialties Company)[1] automated samplers. Provisional stream flow data were obtained from the U.S. Geological Survey.

RESULTS AND DISCUSSION

Selected data for the Big Sioux River and tributary stations are presented in Table 3. All data obtained from the study are included in the Appendix.

Station 1, located at the very northwest corner of Iowa, was indicative of water quality as it enters Iowa's boundary area. Several parameters had values much higher than expected normal background values; i.e., specific conductance 1,900 micromhos, soluble phosphate 4.2 mg/l, chloride 230 mg/l and ammonia nitrogen 9.4 mg/l. The Iowa Water Quality Standard for ammonia nitrogen is 5 mg/l from November 1 to March 31 for class B warmwater streams (3). These elevated parameters are usually characteristic of a waste discharge and, based

[1] Disclaimer: Mention of trade names or commercial products does not constitite endorsement or recommendation for use by the University Hygienic Laboratory.

TABLE 3

Selected Chemical Data from the Big Sioux River

January 10, 1979

(All values in mg/l unless indicated otherwise)

Station	Specific Conductance[1]	Nitrogen Organic	Nitrogen Ammonia	Nitrate	Phosphate Soluble	Phosphate Total	Dissolved Oxygen	TOC	Chloride	Turbidity[2]
1	1900	1.5	9.4	2.4	4.2	4.3	7.2	23	230	5.0
2	2100	0.9	10	2.3	4.7	4.7	3.0	16	290	5.4
3	2100	1.2	9.2	2.5	4.6	4.7	3.0	13	260	17
4	1900	0.4	6.0	2.9	2.5	2.5	2.7	8	150	5.4
5	1800	0.81	4.7	3.0	2.5	2.6	2.4	12	160	4.3
6 (Rock R.)	1200	0.36	0.79	3.7	0.20	0.23	5.4	4	32	2.5
7	1600	1.1	3.3	3.1	1.8	2.0	2.8	7	130	4.1
8	1500	0.68	2.6	3.6	1.7	1.8	3.1	6	130	3.8
9	1500	0.54	2.3	3.4	1.4	1.5	2.6	6	120	3.2
10	1400	0.60	2.0	3.4	1.7	1.7	3.2	6	90	3.1
11	1400	0.45	2.0	2.8	2.0	2.1	3.6	6	70	15
12	1300	0.51	1.9	2.3	0.75	0.80	5.2	6	70	15

[1] micromhos per cm at 25^{o}C

[2] Jackson Turbidity Units

on previous studies (1,4, and 5), it appears that the majority of the problem originates in Sioux Falls, South Dakota. One apparent inconsistency compared to the organic waste level was the 7.2 mg/l dissolved oxygen value at station 1. A similar occurrence was observed in the EPA study and attributed to aeration from open water and flow over falls in the Sioux Falls, South Dakota area (1). This relatively high dissolved oxygen value, however, was not maintained downstream.

The next stream station, station 2, was similar to station 1 with a specific conductance of 2,100 micromhos, ammonia nitrogen of 10 mg/l, soluble phosphate of 4.7 mg/l, chloride of 290 mg/l, and a dissolved oxygen of 3.0 mg/l. The minimum allowable Iowa Water Quality Standard for dissolved oxygen is 4.0 mg/l (3).

Water quality at station 3 was also very poor with only a slight change in ammonia nitrogen from 10 mg/l at station 2 to 9.2 mg/l at station 3. Assimilation and dilution between stations 3 and 4 possibly accounted for the ammonia nitrogen declining to 6.0 mg/l, soluble phosphate to 2.5 mg/l, and chloride to 150 mg/l at station 4. Dissolved oxygen was also low (2.7 mg/l) at station 4. Station 5 had water quality similar to station 4 (conductance 1800 micromhos, total phosphate 2.6 mg/l, chloride 160 mg/l, dissolved oxygen 2.4 mg/l) with the only notable changes being a decrease in ammonia nitrogen from 6.0 to 4.7 mg/l and an increase in organic nitrogen from 0.40 to 0.81 mg/l.

Station 6, located on the Rock River, exhibited more typical winter water quality as compared to the Big Sioux River, with a specific conductance of 1200 micromhos, ammonia nitrogen of 0.79 mg/l, soluble phosphate of 0.20 mg/l, chloride of 32 mg/l, and a dissolved oxygen of 5.4 mg/l.

As a result of the Rock River discharge, water quality in the Big Sioux River improved slightly at station 7, located downstream of their juncture. Ammonia nitrogen decreased to 3.3 mg/l, soluble phosphate to 1.8 mg/l, chloride to 130 mg/l and dissolved oxygen increased to 2.8 mg/l.

Hawarden, Iowa, located upstream from station 8, represents the first major continuous point source discharger to the Big Sioux located on the Iowa reach. Pollution indicator values at station 8 were still declining as compared to upstream values making it impossible to assess Hawarden's discharge impact on river quality. A more detailed discussion of the Hawarden discharge will follow in the wastewater treatment plant sampling section.

Indian Creek was sampled immediately downstream from Ireton's wastewater treatment plant and in reality, the sample reflects more a wastewater treatment plant sample than a stream sample. Although water quality of this sample was exceedingly poor, no adverse effects were observed in the water quality of the Big Sioux River as a result of its confluence with Indian Creek.

Stations 9,10,11 and 12 demonstrated a gradual decline in specific conductance, ammonia nitrogen, phosphate, and chloride from Akron to the Big Sioux's junction with the Missouri River at Sioux City. Dissolved oxygen increased from 2.6 mg/l at station 9 to 5.2 mg/l at station 12. Stations 1 and 12 were the only stations not in violation of Iowa's dissolved oxygen standard.

Selected winter data from the 1972, 1973 and 1979 University Hygienic Lab reports are shown graphically in Figures 2, 3, and 4. All three ammonia nitrogen curves (Figure 2) demonstrate a similar pattern of high values at station 1 and a decline in a downstream direction. During 1972 when stream flow was low (13 cfs), ammonia nitrogen values were quite high (8.1 - 25 mg/l). At the higher stream flows encountered during 1973 and 1979, lower ammonia nitrogen values were obtained although they were still in excess of Iowa's standard for over 80 km (50 river miles). A recent revision of Iowa's ammonia nitrogen standard from a maximum of 2 mg/l to 5 mg/l from November 1 to March 31 for Class B warmwater streams resulted in the 1979 report having fewer violations than previous studies.

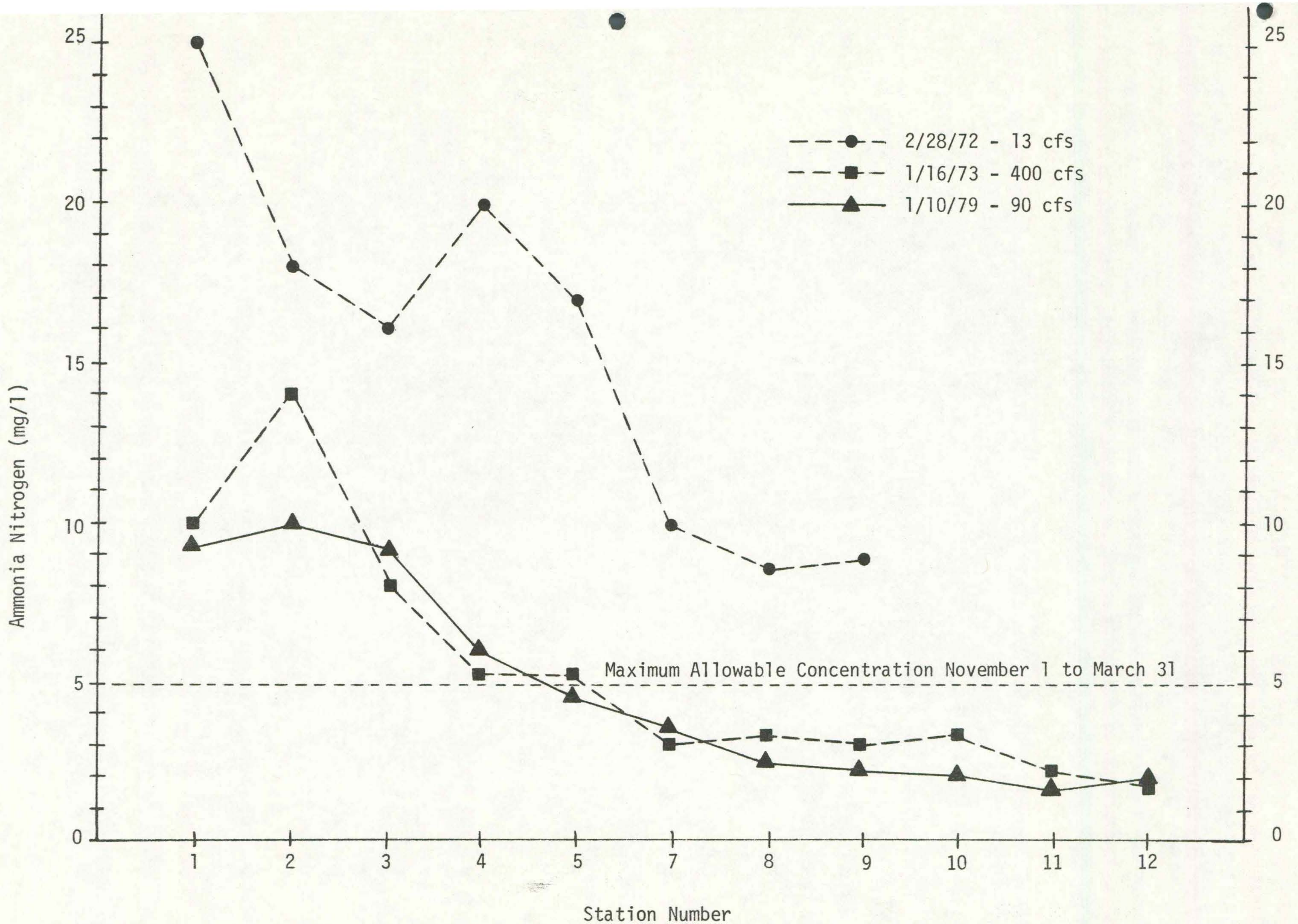

Figure 2. Ammonia Nitrogen Values for the Big Sioux River, February 1972, January 1973 and January 1979.

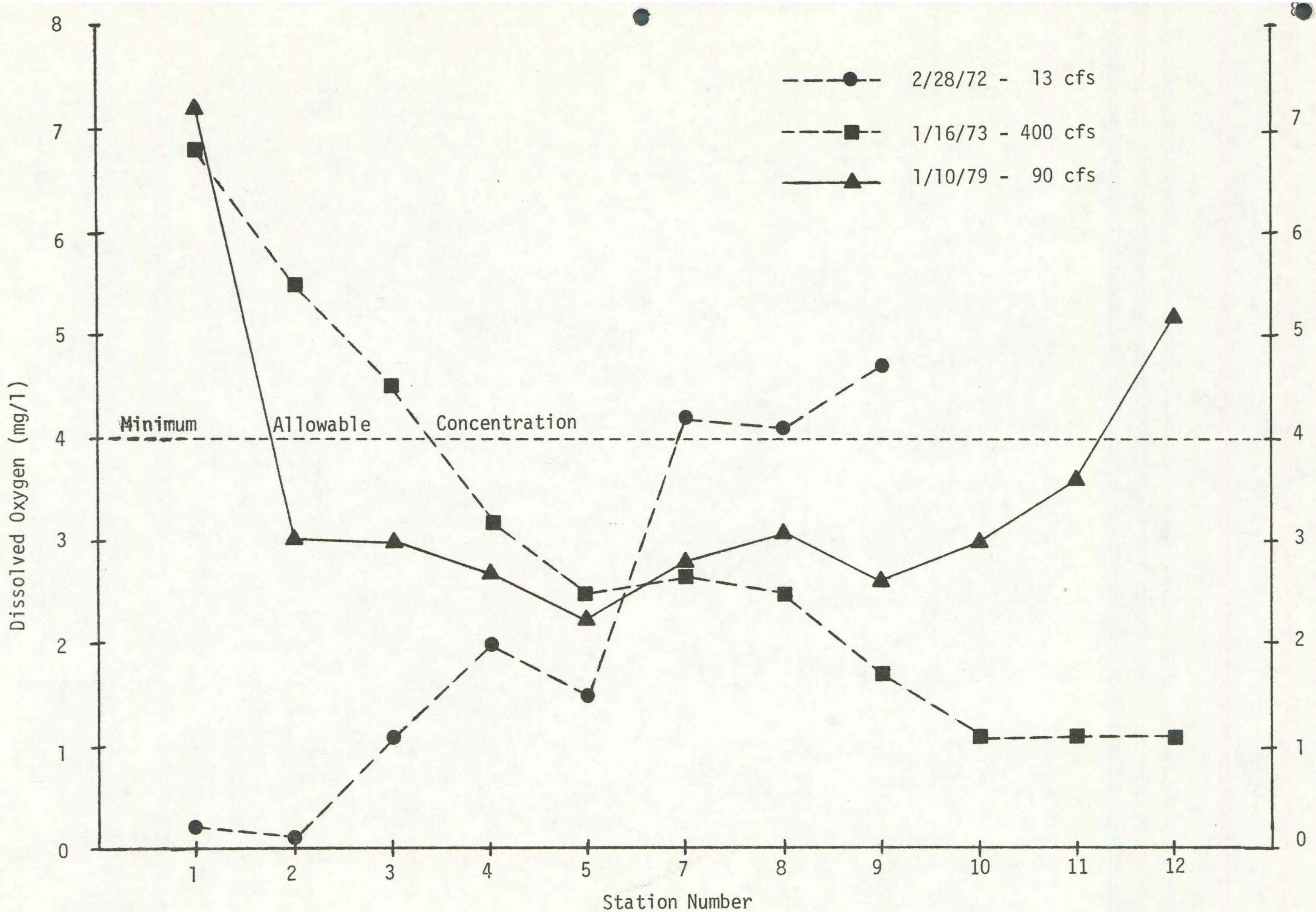

Figure 3. Dissolved Oxygen Values for the Big Sioux River, February 1972, January 1973, and January 1979

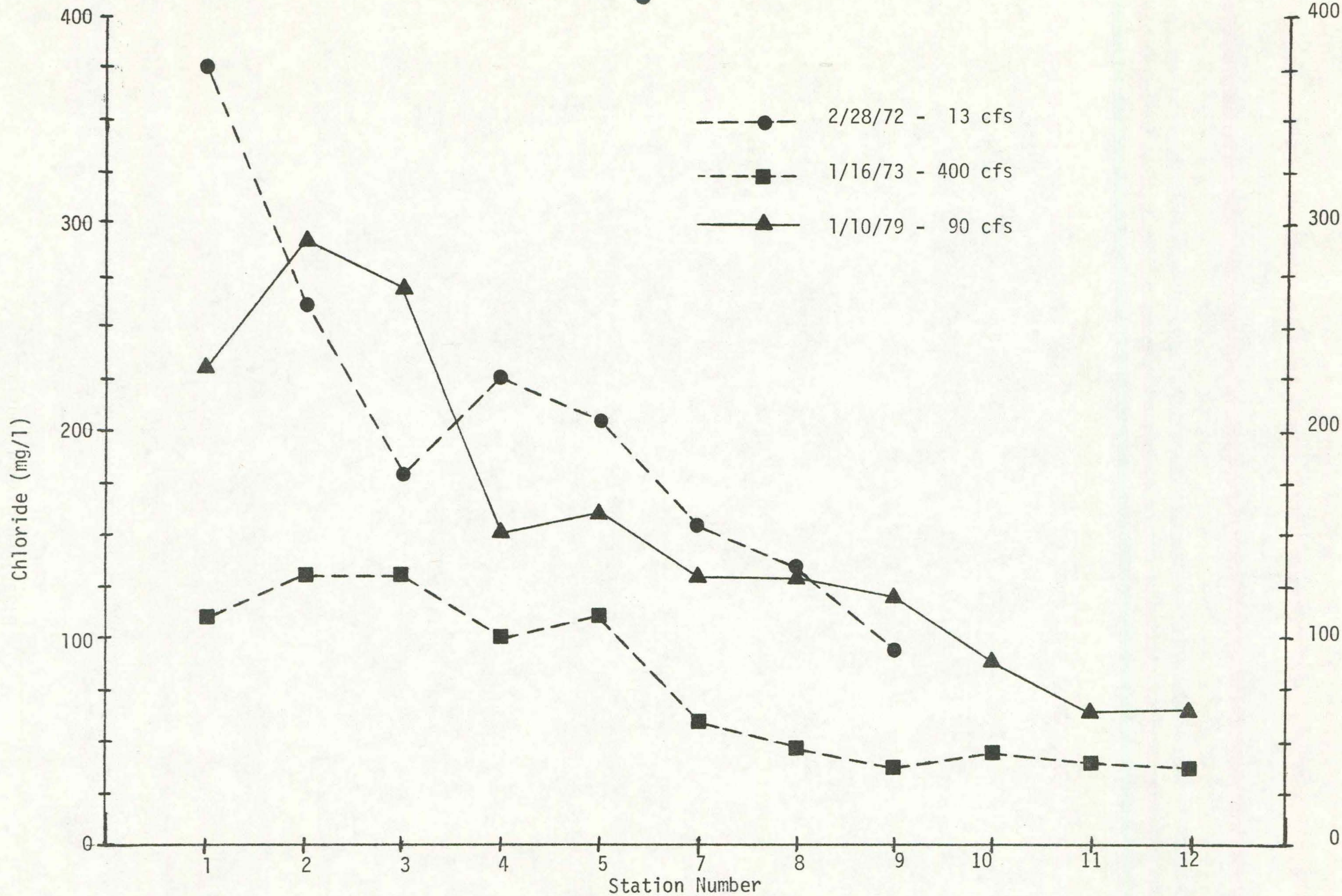

Figure 4. Chloride Values for the Big Sioux River, February 1972, January 1973, and January 1979.

The dissolved oxygen curves (Figure 3) were quite variable, but all indicated low dissolved oxygen. Although no definite pattern was established with dissolved oxygen, some recovery was observed at station 12 during the 1979 study. Of the eleven dissolved oxygen samples collected, nine (82%) violated the Iowa water quality standard.

According to the standards, the dissolved oxygen shall not be less than 5.0 mg/l during at least sixteen hours of any twenty-four hour period and not less than 4.0 mg/l at any time during the 24 hour period (3). This was to allow for natural variation in the diurnal fluctuation of dissolved oxygen where, for short periods of time, the dissolved oxygen concentration may fall below 5.0 mg/l.

In a study designed to determine the daily variation in dissolved oxygen during winter ice and snow covered conditions, dissolved oxygen samples were collected during different time periods of the day from three Big Sioux River stations (7, 8, and 9). The values for those samples are listed below:

	Midday (1 pm)	Midnight (1 am)	Early Morning (6 am)	Average
Station 7	3.1	2.8	2.8	2.9
Station 8	2.7	3.5	3.0	3.0
Station 9	3.0	3.2	3.2	3.1

Dissolved oxygen values at the three stations varied only slightly during a twenty-four hour period indicating that in winter, during ice and snow cover, dissolved oxygen values fluctuate very little. As a result, once the oxygen level is depressed, it may remain so until stream conditions change. In this study, therefore, any dissolved oxygen between 4.0 and 5.0 mg/l would have been in violation of the standard.

Chloride values for the three surveys are depicted in Figure 4. The three curves are very similar to the ammonia curves, being elevated at station 1 and declining in a downstream direction. Because of usually very low levels of natural chloride, elevated levels indicate waste contamination. Typical chloride levels for northwest Iowa range from 15 to 30 mg/l. Chloride values found in the Big Sioux River represent some of the highest values found in Iowa streams.

Water quality data from an ambient monitoring station located on the Big Sioux River at Akron since 1972 indicate that values for ammonia nitrogen, dissolved oxygen, and chloride observed during this study are typical wintertime values. This is not meant to infer the levels reflect natural conditions, but rather to demonstrate the chronic pollution of the Big Sioux River.

In addition to the previously discussed analyses, four samples for trace metals analysis were collected at stations 1, 5, 9, and 12. Low background levels of barium (0.1 mg/l) and zinc (0.02 mg/l) were the only values found during the survey. (See Appendix for complete data sheets.)

As mentioned in the introduction, Table 1 lists the actual and potential wastewater dischargers located in the Iowa reach of the Big Sioux River basin. During the study all wastewater discharge facilities were visited and grab samples collected if they were discharging. Twenty-four hour composite effluent samples were also collected from the municipalities of Hawarden and Akron, Iowa. Data from those municipal samples have been compared to their discharge permit limitations and may be found in Table 4. A review of Table 4 indicates the Hawarden wastewater treatment plant was well below its discharge permit limitations while the Akron wastewater treatment plant exceeded its BOD limitations.

TABLE 4

Discharge Permit Limitations and Sample Values for
Municipal Wastewater Treatment Plant Facilities Discharging into the Big Sioux River

	Permit Limitations BOD		Sample Values BOD		Permit Limitations Suspended Solids		Sample Values Suspended Solids	
	Average	Maximum	24 hr. comp.	Grab	Average	Maximum	24 hr. comp.	Grab
Hawarden	30	45	7	5	30	45	12	10
Akron	30	45	45	70	30	45	24	36
Ireton*	40	60	NC	21	40	60	NC	30

*The Ireton sample was collected just downstream from the Wastewater Treatment Plant discharge and may not be a total representation of the final effluent.

NC - Not Collected

comp. - composite

For most wastewater treatment plant processes, plant operation and biological efficiency is more difficult to achieve during the winter months. In many instances, effluent sampling in the winter may represent worst case situations. The good quality of the Hawarden municipal plant discharge is due to a combination of several factors; i.e., knowledgable, well trained operators, a relatively new plant (7 - 8 years old), and it is operating at only approximately one third of its design capacity even though it treats local packing house wastes (telephone conversation with Fred Thies, IDEQ Regional Office).

In contrast, the Akron wastewater treatment plant, which was in violation of its BOD effluent limitations, is a "package plant" close to its design capacity and physical limitations (telephone conversation with Fred Thies, IDEQ Regional Office).

Evaluation of the Ireton wastewater treatment plant discharge compared to its effluent limitations is not possible due to the sample collection location.

Any impact the waste dischargers might have had on water quality in the Big Sioux was masked by the poor river quality upstream from the dischargers. In fact, water quality generally improved downstream from the dischargers.

SUMMARY AND CONCLUSIONS

Results of a winter water quality survey of the Big Sioux River indicate very poor quality water entering Iowa and improving as it proceeds along Iowa's border. The Iowa water quality standards for ammonia nitrogen and dissolved oxygen were violated for over 80 river km (50 miles) and 160 river km (100 miles) respectively. In addition to these violations, high levels of soluble phosphate, chloride and specific conductance were observed decreasing in a downstream direction. As indicated by ambient monitoring data collected since 1972, the water in the Big Sioux River has been of poor quality every winter. A 1973 EPA report indicated the major source of the problem was the Sioux Falls, South Dakota area with its municipal and industrial waste discharges. No improvement in water quality has been observed since the problem was identified in the 1973 EPA report. Because of the poor water quality upstream, it was impossible to assess any impact the Iowa wastewater dischargers may have had on the receiving stream. Effluent sampling conducted at the Hawarden and Akron municipal systems indicated Hawarden in compliance with their discharge limitations while Akron was in violation of their BOD limitation. Until improvement in the quality of the Sioux Falls discharges occurs, water quality of the Iowa reach of the Big Sioux River is expected to remain unsatisfactory.

Jack O Kennedy

Jack O Kennedy
Limnologist

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APPENDIX

WATER QUALITY REPORT

STATE HYGIENIC LABORATORY, Des Moines Branch
H.A. WALLACE BUILDING
DES MOINES, IOWA 50309

Town Source Specific Location	Big Sioux River Gitchie Manitou Park T100N, R49W, Sec. 12	Klondike Big Sioux River Co. Rd. T99N, R48W Sec. 21	Big Sioux River Hwy 18 Bridge T98N, R48W, Sec. 16
Date Collected	1/10/79	1/10/79	1/10/79
Date Received	1/11/79	1/11/79	1/11/79
Lab Number	4016	4017	4018
		FIELD DATA	
Collection Time	1045	1115	1300
pH			
Temperature	0^oC	0^oC	1^oC
Dissolved Oxygen			
		BACTERIOLOGICAL EXAMINATION	
Fecal Coliform/100 ml	60	<10	<10
		CHEMICAL ANALYSIS (as mg/l unless designated otherwise)	
Conductance (micromhos)	1900	2100	2100
MBAS (as LAS)			
pH (units)	7.7	7.6	7.5
Alkalinity: P	none	none	none
T	338	341	358
NITROGEN: Organic N	1.5	0.90	1.2
Ammonia N	9.4	10	9.2
Nitrite N			
Nitrate N	2.4	2.3	2.5
Nitrate as NO_3			
RESIDUE: Total			
Fixed			
Volatile			
Filtrable Residue T			
F			
V			
Nonfiltrable Residue T	22	12	90
F			
V			
Settleable Matter (ml/l)			
PHOSPHATE: Filtrable P	4.2	4.7	4.6
Total P	4.3	4.7	4.7
Dissolved Oxygen	7.2	3.0	3.0
BOD	3	4	14
COD	43	46	56
Grease or Oil			
Turbidity (JTU)	5.0	5.4	17
Total Hardness (as $CaCO_3$)			
Calcium (Ca^{++})			
Magnesium (Mg^{++})			
Chloride (Cl^-)	230	290	270
Sulfate (SO_4^{--})			
l organic carbon	23	16	13

REMARKS:

COLLECTOR
REPORT TO

Limnology Division
Hygienic Laboratory
Des Moines, Ia.

W.J. HAUSLER, JR., Ph.D.
DIRECTOR

1133

WATER QUALITY REPORT

STATE HYGIENIC LABORATORY, Des Moines Branch
H.A. WALLACE BUILDING
DES MOINES, IOWA 50309

Town			Hawarden
Source	Big Sioux River	Big Sioux River	Big Sioux River
Specific Location	Co. Rd. Bridge T97N, R48W, Sec. 24/25	Co. Rd. Br., T96N, R48W, Sec. 30	Hwy 10 Bridge, T95N, R48W, Sec. 15
Date Collected	1/10/79	1/10/79	1/10/79
Date Received	1/11/79	1/11/79	1/11/79
Lab Number	4019	4020	4021
FIELD DATA			
Collection Time	1345	1400	1450
pH			
Temperature	0^oC	0^oC	0^oC
Dissolved Oxygen			
BACTERIOLOGICAL EXAMINATION			
Fecal Coliform/100 ml	<10	<10	110
CHEMICAL ANALYSIS (as mg/l unless designated otherwise)			
Conductance (micromhos)	1900	1800	1600
MBAS (as LAS)			
pH (units)	7.5	7.6	7.55
Alkalinity: P	none	none	none
T	397	402	377
NITROGEN: Organic N	0.40	0.81	1.1
Ammonia N	6.0	4.7	3.3
Nitrite N			
Nitrate N	2.9	3.0	3.1
Nitrate as NO_3			
RESIDUE: Total			
Fixed			
Volatile			
Filtrable Residue T			
F			
V			
Nonfiltrable Residue T	15	8	9
F			
V			
Settleable Matter (ml/l)			
PHOSPHATE: Filtrable P	2.5	2.5	1.8
Total P	2.5	2.6	2.0
Dissolved Oxygen	2.7	2.4	2.8
BOD	2	2	1
COD	54	47	27
Grease or Oil			
Turbidity (JTU)	5.4	4.3	4.1
Total Hardness (as $CaCO_3$)			
Calcium (Ca^{++})			
Magnesium (Mg^{++})			
Chloride (Cl^-)	150	160	130
Sulfate (SO_4^{--})			
al organic carbon	8	12	7

REMARKS:

COLLECTOR
REPORT TO

Limnology Division
Hygienic Laboratory
Des Moines, Iowa

W.J. HAUSLER, JR., Ph.D.
DIRECTOR

1133

WATER QUALITY REPORT

STATE HYGIENIC LABORATORY, Des Moines Branch
H.A. WALLACE BUILDING
DES MOINES, IOWA 50309

Town	Chatsworth	Ireton	Akron
Source	Big Sioux River	Indian Creek	Big Sioux River
Specific Location	Co. Rd. T94N, R48W, Sec. 32	Sioux County Road T94N R46W, Sec. 7 downstream from the Ireton WWTP	Hwy 48 Bridge
Date Collected	1/10/79	1/10/78	1/10/79
Date Received	1/11/79	1/11/78	1/11/79
Lab Number	4022	4023	4024
FIELD DATA			
Collection Time	1645	1600	1530
pH			
Temperature	$0^{o}C$	$0^{o}C$	$0^{o}C$
Dissolved Oxygen			
BACTERIOLOGICAL EXAMINATION			
Fecal Coliform/100 ml	240	48,000	90
CHEMICAL ANALYSIS (as mg/l unless designated otherwise)			
Conductance (micromhos)	1500	8800	1500
MBAS (as LAS)			
pH (units)	7.7	7.7	7.6
Alkalinity: P	none	none	none
T	365	879	367
NITROGEN: Organic N	0.68	4.0	0.54
Ammonia N	2.6	43	2.3
Nitrite N			
Nitrate N	3.6	18	3.4
Nitrate as NO_3			
RESIDUE: Total			
Fixed			
Volatile			
Filtrable Residue T			
F			
V			
Nonfiltrable Residue T	9	30	9
F			
V			
Settleable Matter (ml/l)			
PHOSPHATE: Filtrable P	1.7	19	1.4
Total P	1.8	20	1.5
Dissolved Oxygen	3.1		2.6
BOD	2	21	2
COD	18		54
Grease or Oil			
Turbidity (JTU)	3.8	27	3.2
Total Hardness (as $CaCO_3$)			
Calcium (Ca^{++})			
Magnesium (Mg^{++})			
Chloride (Cl^-)	130	1800	120
Sulfate (SO_4^{--})			
otal organic carbon	6	39	6

REMARKS:

COLLECTOR
REPORT TO Limnology Division
Hygienic Laboratory
Des Moines, Iowa

W.J. HAUSLER, JR., Ph.D.
DIRECTOR

1133

WATER QUALITY REPORT

STATE HYGIENIC LABORATORY, Des Moines Branch
H.A. WALLACE BUILDING
DES MOINES, IOWA 50309

'own			Sioux City
ource	Big Sioux River	Big Sioux River	Big Sioux River
pecific Location	Hwy 3 Bridge west of Westfield Ia.	Co. Rd. Br., T90N, R48W, Sec. 9	Woodbury Co. Interstate 29 at Riverside Park
Date Collected	1/10/79	1/10/79	1/10/79
Date Received	1/11/79	1/11/79	1/11/79
ab Number	4025	4026	4027
FIELD DATA			
Collection Time	1615	1700	1745
H			
Temperature	$0^{o}C$	$0^{o}C$	$0^{o}C$
Dissolved Oxygen			
BACTERIOLOGICAL EXAMINATION			
ecal Coliform/100 ml	600	1100	30
CHEMICAL ANALYSIS (as mg/l unless designated otherwise)			
Conductance (micromhos)	1400	1400	1300
IBAS (as LAS)			
H (units)	7.6	7.55	7.6
lkalinity: P	none	none	none
T	362	365	377
ITROGEN: Organic N	0.60	0.45	0.51
Ammonia N	2.0	2.0	1.9
Nitrite N			
Nitrate N	3.4	2.8	2.3
Nitrate as NO_3			
ESIDUE: Total			
Fixed			
Volatile			
iltrable Residue T			
F			
V			
Nonfiltrable Residue T	9	13	16
F			
V			
ettleable Matter (ml/l)			
HOSPHATE: Filtrable P	1.7	2.0	0.75
Total P	1.7	2.1	0.80
issolved Oxygen	3.0	3.6	5.2
OD	1	1	1
OD	55	46	23
rease or Oil			
urbidity (JTU)	3.1	6.1	15
otal Hardness (as $CaCO_3$)			
alcium (Ca^{++})			
agnesium (Mg^{++})			
hloride (Cl^-)	90	70	70
ulfate (SO_4^{--})			
tal organic carbon	6	5	6

EMARKS:

OLLECTOR
EPORT TO

Limnology Division
Hygienic Laboratory
Des Moines, Ia.

W.J. HAUSLER, JR., Ph.D.
DIRECTOR

WATER QUALITY REPORT

STATE HYGIENIC LABORATORY, Des Moines Branch
H.A. WALLACE BUILDING
DES MOINES, IOWA 50309

own ource pecific Location	Akron Akron WWTP effluent grab	Akron Akron WWTP 24 hr comp.	Hawarden Hawarden WWTP effluent grab
ate Collected ate Received ab Number	1/9/79 1/10/79 3987	1/8-9/79 1/10/79 3986	1/9/79 1/10/79 3984
		FIELD DATA	
ollection Time	1500	1230-1230	1600
H			
emperature		$10^{o}C$	$23^{o}C$
issolved Oxygen			
		BACTERIOLOGICAL EXAMINATION	
ecal Coliform/100 ml	1,300,000		10,000
		CHEMICAL ANALYSIS (as mg/l unless designated otherwise)	
onductance (micromhos)			2000
IBAS (as LAS)			
H (units)	7.7	7.8	7.4
lkalinity: P			none
T			212
ITROGEN: Organic N			
Ammonia N	18	15	0.03
Nitrite N			
Nitrate N			32
Nitrate as NO_3			
ESIDUE: Total			
Fixed			
Volatile			
iltrable Residue T			
F			
V			
Nonfiltrable Residue T	36	24	10
F			
V			
ettleable Matter (ml/l)			
HOSPHATE: Filtrable P			
Total P			
issolved Oxygen	5.5		6.7
OD	70	45	5
OD			63
rease or Oil			
urbidity (JTU)			2.8
otal Hardness (as $CaCO_3$)			
alcium (Ca^{++})			
agnesium (Mg^{++})			
hloride (Cl^-)			230
ulfate (SO_4^{--})			
l organic carbon	34	25	12

EMARKS: 24 hr. flow 120,000 gallons per day

OLLECTOR
EPORT TO Limnology Division
Hygienic Laboratory
Des Moines, Iowa

W.J. HAUSLER, JR., Ph.D.
DIRECTOR

133

WATER QUALITY REPORT

STATE HYGIENIC LABORATORY, Des Moines Branch
H.A. WALLACE BUILDING
DES MOINES, IOWA 50309

own ource pecific Location	Hawarden Hawarden WWTP effluent 24 hr comp.	Rock River Co. Rd. B-40 bridge	
ate Collected	1/8-9/79	1/09/79	
ate Received	1/10/79	1/10/79	
ab Number	3985	3983	
FIELD DATA			
ollection Time	1330-1330	0940	
H			
emperature	$23^{o}C$	$0^{o}C$	
issolved Oxygen			
BACTERIOLOGICAL EXAMINATION			
ecal Coliform/100 ml		1200	
CHEMICAL ANALYSIS (as mg/l unless designated otherwise)			
onductance (micromhos)		1200	
BAS (as LAS)			
H (units)	7.6	7.5	
lkalinity: P		none	
T		340	
ITROGEN: Organic N		0.36	
Ammonia N	0.06	0.79	
Nitrite N			
Nitrate N		3.7	
Nitrate as NO_3			
ESIDUE: Total			
Fixed			
Volatile			
iltrable Residue T			
F			
V			
Nonfiltrable Residue T	12	6	
F			
V			
ettleable Matter (ml/l)			
HOSPHATE: Filtrable P		0.22	
Total P		0.23	
issolved Oxygen		5.4	
OD	7	1	
OD		21	
rease or Oil			
urbidity (JTU)		2.5	
otal Hardness (as $CaCO_3$)			
alcium (Ca^{++})			
agnesium (Mg^{++})			
hloride (Cl^-)		32	
ulfate (SO_4^{--})			
l organic carbon	12	4	

EMARKS: 24 hr flow 207,000 gallons per day

OLLECTOR
EPORT TO

Limnology Division
Hygienic Laboratory
Des Moines, Iowa

W.J. HAUSLER, JR., Ph.D.
DIRECTOR

WATER QUALITY REPORT
METALS

STATE HYGIENIC LABORATORY, Des Moines Branch
The University of Iowa
515:281-5371

Town / Source / Specific Location	Big Sioux River Gitchie Manitou Park T100N, R49W, Sec. 12	Big Sioux River Co. Rd. Bridge, T96N R48W, Sec. 30	Akron Big Sioux River Hwy 48 Bridge
Date Collected	1/10/79	1/10/79	1/10/79
Date Received	1/11/79	1/11/79	1/11/79
Lab Number	4016	4020	4024
METALS ANALYSIS (as mg/l unless designated otherwise)			
Arsenic	<0.01	<0.01	<0.01
Barium	0.1	0.1	0.1
Cadmium	<0.01	<0.01	<0.01
Chromium, Total	<0.01	<0.01	<0.01
Chromium, Hexavalent			
Copper	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	<0.01
Mercury	<0.001	<0.001	<0.001
Nickel	<0.1	<0.1	<0.1
Selenium	<0.01	<0.01	<0.01
Silver	<0.01	<0.01	<0.01
Zinc	0.01	0.02	<0.01

REMARKS:

COLLECTOR
REPORT TO Limnology Division
Hygienic Laboratory
Des Moines, Iowa

Date Reported FEB 1 1979

W.J. Hausler Jr., Ph.D.
Director

WATER QUALITY REPORT
METALS

STATE HYGIENIC LABORATORY, Des Moines Branch
The University of Iowa
515:281-5371

wn	Sioux City		
irce	Big Sioux River		
ecific Location	Woodbury Co. Interstate 29 at Riverside Park		
e Collected	1/10/79		
e Received	1/11/79		
Number	4027		

METALS ANALYSIS (as mg/l unless designated otherwise)

enic	<0.01		
ium	0.1		
dmium	<0.01		
omium, Total	<0.01		
omium, Hexavalent			
pper	<0.01		
d	<0.01		
rcury	<0.001		
kel	<0.1		
enium	<0.01		
er	<0.01		
c	<0.01		

MARKS:

LLECTOR
PORT TO

Date Reported FEB 1 1979

W.J. Hausler Jr., Ph.D.
Director