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ILLINOIS RIVER
WATER QUALITY, MACROINVERTEBRATE,
and
FISH COMMUNITY SURVEY

Introduction

The Illinois River has its origin in Northwest Arkansas. It arises on the Springfield Plateau in Washington County and flows northward to its confluence with the south flowing Osage Creek. It then flows westward into Oklahoma just south of Siloam Springs, Arkansas. Major tributaries entering the Illinois River include Osage Creek, Clear Creek, and the Muddy Fork of the Illinois River. This interstate basin has a long history of water quality concerns expressed by the States of Arkansas and Oklahoma. These concerns are the result of substantial development in the upper basin. This includes significant urban expansion and rural land use changes from forested areas to agriculture pasture lands for confined animal production and dairy and beef cattle production.

The State of Oklahoma has actively pursued a restriction on nutrient loading from point source discharges. As a result, Oklahoma has objected to the discharge permits issued to municipal dischargers in the Illinois River Basin in Arkansas. In December 1994, Consent Administrative Orders were entered into by the State of Oklahoma, Oklahoma Scenic Rivers Commission, the Arkansas Department of Pollution Control and Ecology and the cities of Prairie Grove, Fayetteville and Rogers, Arkansas. The Orders required The Arkansas Department of Pollution Control and Ecology (Department) and the cities to conduct an in-stream water quality study to determine the impacts of the cities' discharges on the receiving streams and on the Illinois River at the state line.

The objective of the study was to quantify and determine the impacts of the Prairie Grove, Rogers, Springdale and Fayetteville wastewater treatment facilities on the Illinois River water quality and aquatic life communities and to generally characterize the seasonal water quality in the drainage basin as it is affected by both point and nonpoint sources.

This survey was comprised of five different water quality sampling activities. These include: 1) chemical water quality analyses; 2) diel dissolved oxygen fluctuation; 3) in-stream periphyton production; 4) macroinvertebrate community analyses; and 5) determination of fish community structure. Water quality grab sampling stations were located above and below the point source discharges; in the effluents of the major point sources; along the main stem of the discharge receiving streams; and along the main stem of the Illinois River. Diel dissolved oxygen sample locations were below point source discharges, near the mouth of tributaries receiving discharges and in the Illinois River near the state line. Periphyton samples were collected above and below the point source discharges, along the main stems of the receiving streams and in the Illinois River, and macroinvertebrate samples were collected at the same locations. Fish community samples were collected above and below the point source dischargers and at the furthest downstream site on the main stem of the Illinois River.

WATER QUALITY

Historical Data

The upper Illinois River Basin in Arkansas is rich in water quality data. One of the more significant data sets in the basin includes monthly grab samples at two sites on the Illinois River and one site on Osage Creek. Two of these sites have been sampled for almost 20 years; the other for 14 years. Instantaneous flows, the basic water quality parameters and nutrient concentrations have been collected throughout the period of record. In recent years, metals and numerous inorganic ions have been added to the parameter list. All data is available through the U. S. Environmental Protection Agency (EPA) STORET data base.

Long-term, trend graphics from this data set for total phosphorus load, nitrate-nitrogen load and total suspended solids (residue) load can be found in Appendix A. At the upper Illinois River station near Savoy (ARK 40), the total phosphorus load shows a very slight upward trend which seems to be influenced by several high values in the mid-to-late 1980's. Peak values seem to occur most often during the fall and winter periods and probably correlate to increased run-off from the watershed. Nitrate-nitrogen loads show a rather sharp increase beginning in 1984. Peak values also seem to be in response to increases in run-off. Total suspended solids show an upward trend, although the trend is somewhat skewed by a few very high values. The station on Osage Creek near Elm Springs shows a decline in total phosphorus load as a result of consistently lower values in the late 1980's and early 1990's. Nitrate-nitrogen, however, indicates a slight increase and the large variation in values directly relates to flows. Total suspended solids loads show a slight decline over the period of record, although this trend may be influenced by almost six years of missing data and several exceptionally large peaks in 1978 and 1987-88. The lowest station on the Illinois River (ARK 06A) includes only 13 years of load data (1995-96 flow data has not been entered into STORET at this time). In the attached graphics, total phosphorus loads appear to have declined slightly over the period of record, but the major phosphorus peaks were reduced significantly since 1987. Additionally, based on combined data from water quality stations near the stateline and flow data from USGS station neat Watts, Oklahoma, there has veen a 35% reduction in concentration and a 17% reduction in phosphorus loads from 1990-1994 compared to the 1980-1993 time period (Maner 1996). Nitrate-nitrogen loads, in contrast, show a slight increase. Total suspended solids also indicate an upward trend and the frequency of the peak loads seems to have increased.

Another significant water quality data source in the Illinois River Basin is the "Water-Quality Assessment of the Illinois River Basin, Arkansas" (USGS 1984). This study provides multiple synoptic data collection events during 1978, 1979 and 1981 in the Illinois River and in the tributaries of Muddy Fork, Osage Creek and Spring Creek. This study also established wasteload allocations of CBOD and ammonia-N for discharges from the Cities of Fayetteville, Springdale, Rogers and Prairie Grove.

An extensive data compilation report from the Illinois River Basin was completed in 1991 as a cooperative effort of the University of Arkansas and Oklahoma State University. This report indicates that excessive phosphorus loading was occurring in Lake Tenkiller, Oklahoma, and, at that time, the major point source loading of phosphorus to the lake was from the City of Tahlequah, Oklahoma, located approximately six miles upstream. Substantial increases in nitrogen loads over the period of record were noted in Osage Creek and at the Illinois River near Siloam Springs, Arkansas. Parameters relative to water clarity did not indicate a general trend of decreasing clarity of the Illinois River; however, the areas below Lake Frances, along Highway 10 in Oklahoma and below the City of Tahlequah, Oklahoma did show substantial decreases in water clarity (Burks, et al, 1991).

A Phase I "Clean-Lakes" Diagnostic and Feasibility Study on Tenkiller Lake, Oklahoma was completed in 1996. This study estimated nutrient loading to the lake, identified phosphorus, nitrogen and chlorophyll *a* levels which indicate eutrophic conditions in the lake, and the study recommended a short term goal of 30-40% reduction in nutrient input to the lake (Jobe, et al 1996).

Current Study

Materials and Methods

The Illinois River drainage basin was subdivided into four units which include three sub-basins and the main stem of the Illinois River. The sub-basins include the Osage/ Spring Creek basin, Clear/Mud Creek basin and the Muddy Fork of the Illinois River basin. Thirty-one water quality sampling sites were established within these four units. Three of the sites were at the same location as stations in Arkansas' Water Quality Monitoring Network. Below is a list of these sub-basins and the number of sample sites located in each.

Sub-basins	Sample Sites
Osage Creek	12
Clear Creek	6
Muddy Fork Illinois River	6
Main Stem Illinois River	7

The sampling sites were located above and below the major point source discharges and in the effluent of the discharges. Stations were also located near the mouth of each sub-basin and at strategic points along the receiving streams. Stations on the main stem of the Illinois River were located above and below the confluence of each sub-basin with the Illinois river. One station was located in the Illinois River just upstream of the Arkansas/Oklahoma state line. A list of these water quality sample sites, their locations and the type of samples collected at each station can be found in Appendix B. It should be noted that in some instances, station names have been shortened in order to appear on graphics (Example: MFI01A = MFI1A). Figure 1 is a map of the study area depicting the sample sites.

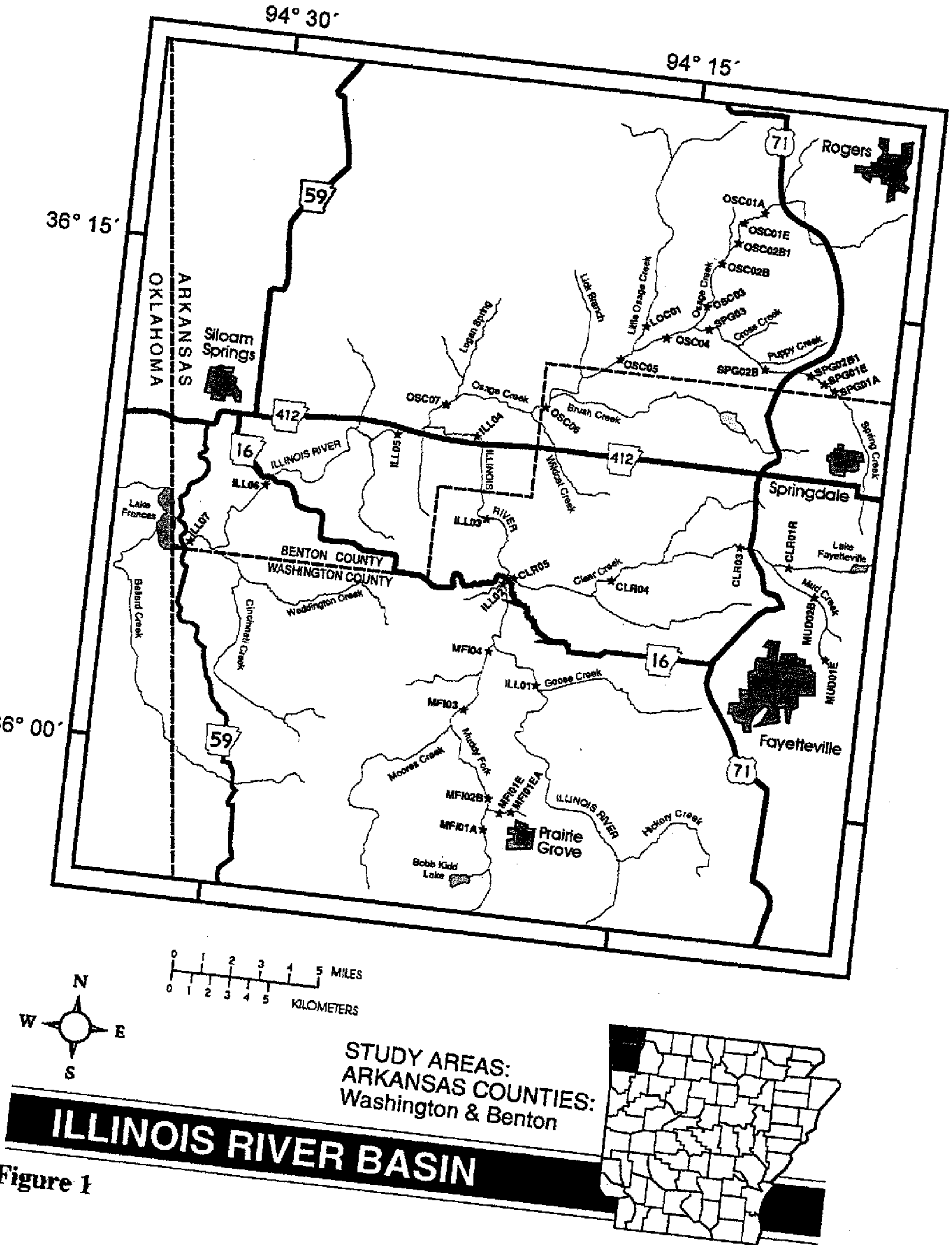

94° 30′
94° 15′
36° 15′
36° 00′
ARKANSAS
OKLAHOMA
Siloam Springs
Rogers
Springdale
Fayetteville
Prairie Grove
59
71
412
16
BENTON COUNTY
WASHINGTON COUNTY
ILLINOIS RIVER
Osage Creek
Brush Creek
Clear Creek
Mud Creek
Goose Creek
Moores Creek
Muddy Fork
Hickory Creek
Ballard Creek
Cincinnati Creek
Weddington Creek
Little Osage Creek
Lick Branch
Logan Spring
Spring Creek
Puppy Creek
Cross Creek
Wildcat Creek
Lake Frances
Lake Fayetteville
Bobb Kidd Lake
OSC01A
OSC01E
OSC02B1
OSC02B
OSC03
SPG03
OSC04
LOC01
OSC05
SPG02B
SPG02B1
SPG01E
SPG01A
OSC07
OSC06
ILL04
ILL05
ILL06
ILL07
ILL03
ILL02
ILL01
CLR05
CLR04
CLR03
CLR01R
MUD02B
MUD01E
MFI04
MFI03
MFI02B
MFI01E
MFI01EA
MFI01A
0 1 2 3 4 5 MILES
0 1 2 3 4 5 KILOMETERS
N
S
E
W
STUDY AREAS:
ARKANSAS COUNTIES:
Washington & Benton
ILLINOIS RIVER BASIN

Figure 1

Water quality samples were collected seven times from May 1995 to June 1996 during different flow events. Stream samples were collected, preserved, and analyzed according to the 18th Edition of Standard Methods for Examination of Water and Wastewater and the Department's existing Quality Assurance Project Plan For Ambient Water Quality And Compliance Monitoring, 1995 (QAPP). In-stream dissolved oxygen and temperature measurements were taken with Orion Model 840 dissolved oxygen meters. An Orion Model 230A pH meter was used to take in-situ pH measurements. Stream flow velocities were taken with Marsh-McBirney Model 2000 Flow-Mates. Continuous dissolved oxygen and temperature measurements were taken with four Hydrolab Recorders. All meter calibration and maintenance procedures, and the stream-flow measuring procedure were performed as outlined in the Department QAPP. U.S. Geological Survey flow gaging stations located at three sites on the Illinois River and one site on lower Osage Creek were used to determine flow when stream flows were to high for manual flow measurements.

Results and Discussion

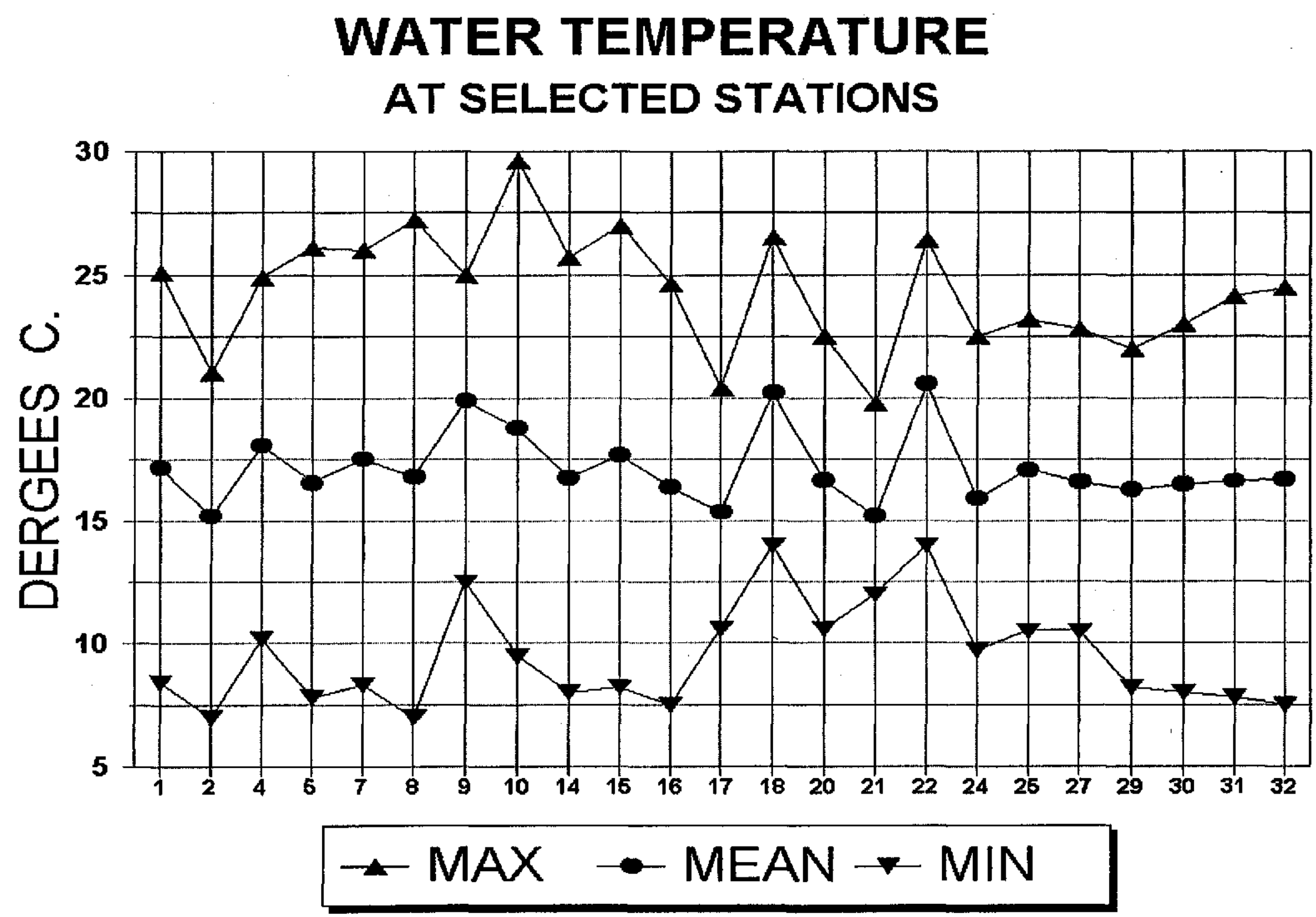
Although the primary emphasis of the current study was on nitrogen and phosphorus input into the basin, a large number of additional parameters were collected to evaluate the overall status of the water quality in the Illinois River Basin in Arkansas. The results will be discussed in three segments including: 1) the conventional water quality parameters such as D.O., pH, temperature, nutrients, total suspended solids, total dissolved solids, turbidity, BOD, TOC and others; 2) dissolved metals; 3) diel dissolved oxygen and temperature monitoring; and 4) major point source discharge data.

Conventional Parameters

Tabulation of all data for conventional parameters, including flow, can be found in Appendix C. Spatial differences in these parameters were most apparent in flows, water temperatures, minerals (chlorides, sulfates and TDS) and nutrients (NO_3-N, O-Phos, T-Phos). Turbidity and total suspended solids variations were related to stream flow values.

Water temperature variations were obviously variable over time; however, other notable differences are shown in Figure WQ-1. Much lower maximum temperatures were found in the tributary streams above the wastewater treatment plant (WWTP) discharges. The Muddy Fork Illinois River (#2), Osage Creek (#17) and Spring Creek (#21) had noticeably lower maximum temperatures and lower mean temperatures than all other stations. In contrast, generally higher temperatures were found in the effluent discharges of Prairie Grove (#4), Fayetteville (#9), Rogers (#18) and Springdale (#22). Station #10 is predominantly Fayetteville discharge after flowing several miles through an urban area with little or no canopy. The differences in the stream temperatures above and below the WWTP's discharges was a significant influence on the biological communities in these areas.

Figure WQ-1



X-axis numbers refer to stations listed in Appendix C.

The influence of **minerals** discharges from WWTP's is demonstrated in Figure WQ-2 by the average chloride values at selected stations. The point source discharges from Prairie Grove (MFIE), Fayetteville (MUDE), Rogers (OSCE) and Springdale (SPGE) had significantly elevated chloride values, but near the mouth of the receiving streams the values declined to near background levels.

The average **flows** measured during the survey at selected stations are shown in Figure WQ-3. These data reflect the increasing watershed sizes in a downstream direction. However, the average flow values at ILL4, ILL5, ILL6 and ILL7 were skewed toward lower values due to the sampling procedure during a major storm event on June 1 and June 2, 1996. Most of the samples were taken on June 1 which was near the peak storm flow, however due to time constraints, stations ILL4, ILL5, ILL6 and ILL7 were sampled on June 2 during declining flows. This factor was reflected in other data, particularly in load calculations. .

As might be expected, **total suspended solids** (TSS) were strongly influenced by storm event runoff. This resulted in large differences in the TSS values over the duration of the study. One major storm event was sampled which established the maximum TSS values and influenced the average TSS shown in Figure WQ-4. However, due to the sampling schedule used during the June 1996 storm event (discussed above), the TSS values at stations ILL4, ILL5, ILL6 and ILL7 are likely much lower than the values that occurred during the peak runoff of this storm. Generally the larger watersheds produced the higher TSS concentrations. However, the Muddy Fork Illinois watershed (MFI4) produced slightly higher TSS values than the upper Illinois River watershed (ILL1) which is slightly larger in area. Maximum and average suspended solids values from point source discharges were less than 12 mg/L and less than 5 mg/L respectively.

Total phosphorus loads from selected stations in the Illinois River watershed (Figure WQ-5) indicate a substantially higher loading from the Springdale WWTP (SPG1E) compared to the other point source discharges. Although in-stream assimilation and dilution is occurring at low flows, stations downstream from this discharge maintain elevated phosphorus loads. However, during the high flow event on June 1, 1996, nonpoint source loads dominate in the Spring and Osage Creek watersheds (Figure WQ-6). The ILL5 value does not represent the maximum storm event value on this date for reasons discussed above.

The fate of the Fayetteville WWTP discharge of total phosphorus to Mud Creek, Clear Creek and the Illinois River is shown in Figure WQ-7. There appears to be little noticeable influence from this discharge on the phosphorus loads in these streams. Of the measured phosphorus loads in the Illinois River below the Clear Creek confluence (ILL3), approximately 30% was from Clear Creek. Similarly, 31% of the watershed of the Illinois River at ILL3 is from Clear Creek drainage. It should be noted, however, that during the major storm event on June 1, 1996, Clear Creek contributed almost 50% of the phosphorus load in the Illinois River at ILL3. This loading was predominately from nonpoint sources.

Figure WQ-2

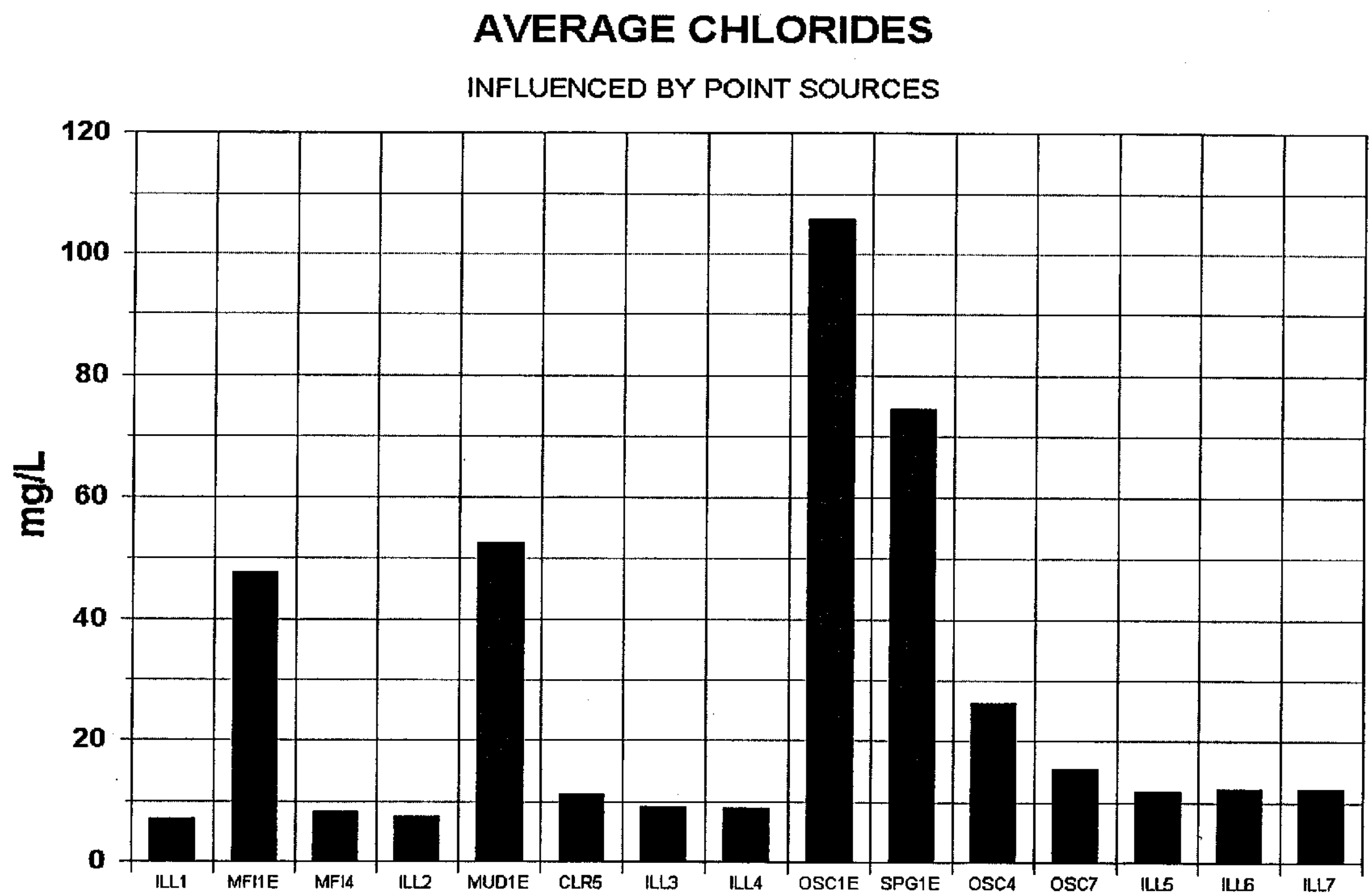

AVERAGE CHLORIDES
INFLUENCED BY POINT SOURCES
mg/L
120
100
80
60
40
20
0
ILL1
MFI1E
MFI4
ILL2
MUD1E
CLR5
ILL3
ILL4
OSC1E
SPG1E
OSC4
OSC7
ILL5
ILL6
ILL7

Figure WQ-3

AVERAGE FLOWS

Illinois River Basin

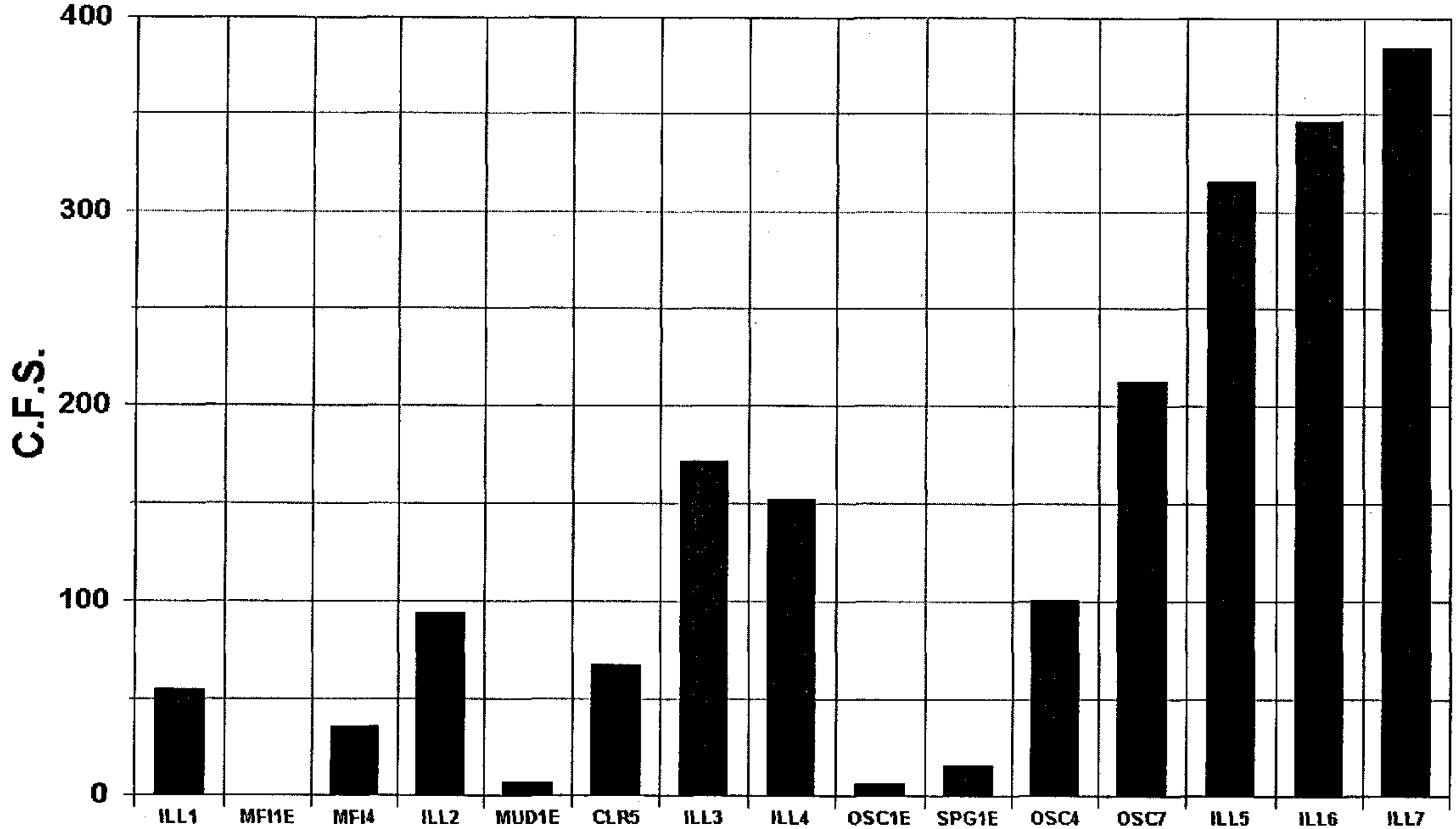


Figure WQ-4

TOTAL SUSPENDED SOLIDS

from selected sources

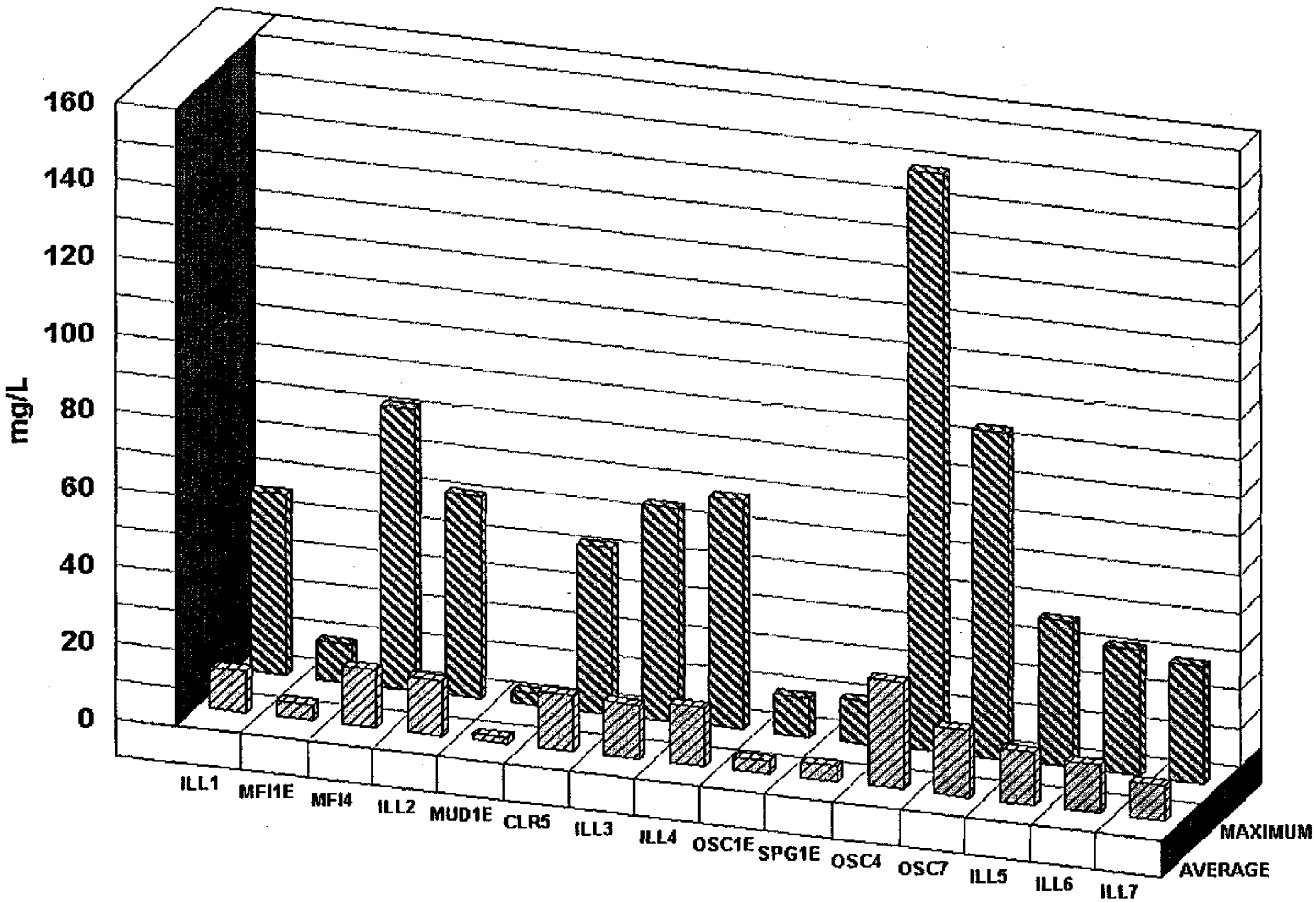


Figure WQ-5

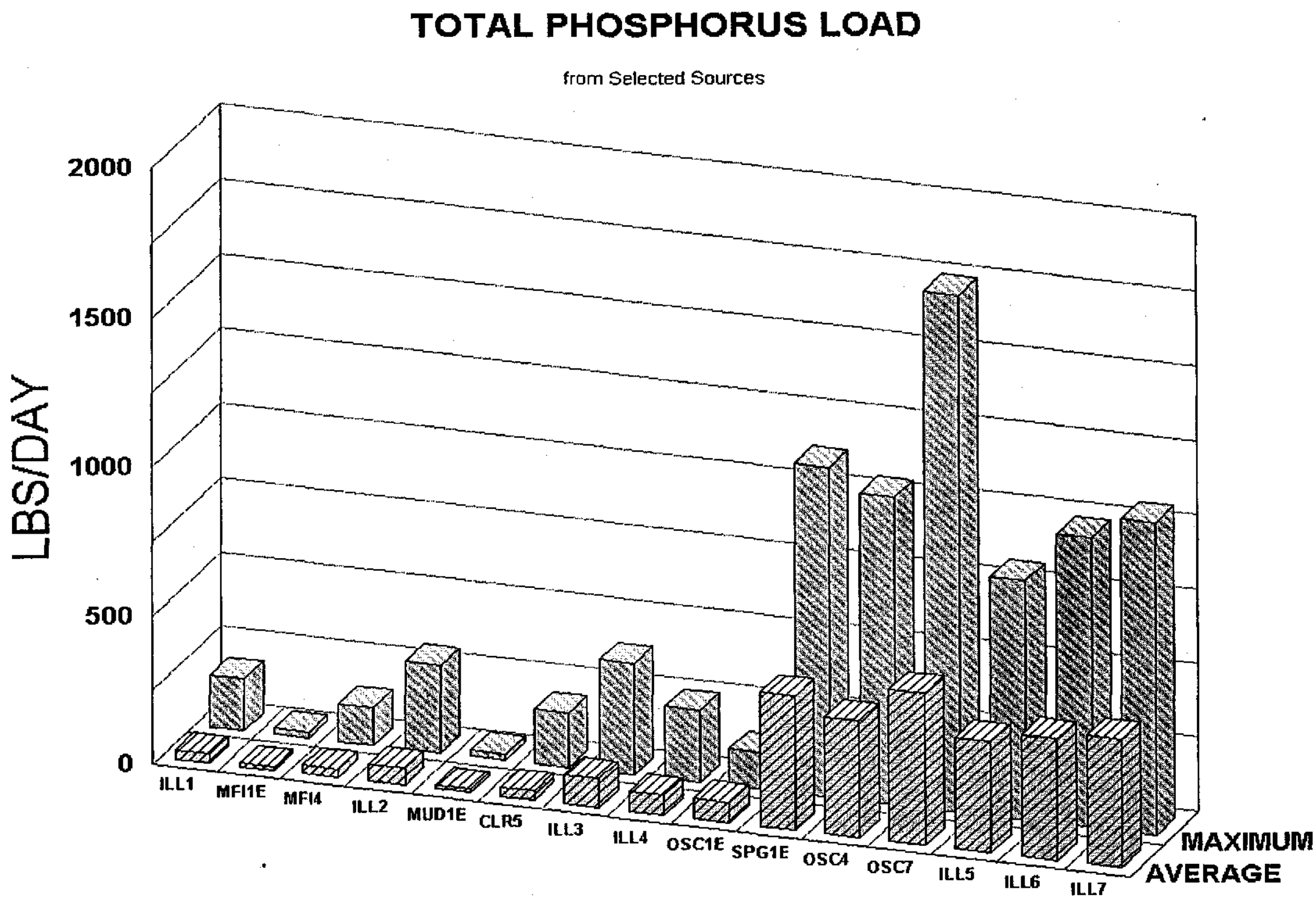

TOTAL PHOSPHORUS LOAD
from Selected Sources
LBS/DAY
2000
1500
1000
500
0
ILL1
MFI1E
MFI4
ILL2
MUD1E
CLR5
ILL3
ILL4
OSC1E
SPG1E
OSC4
OSC7
ILL5
ILL6
ILL7
MAXIMUM
AVERAGE

Figure WQ-6

TOTAL PHOSPHORUS LOAD

from Osage and Spring Creeks

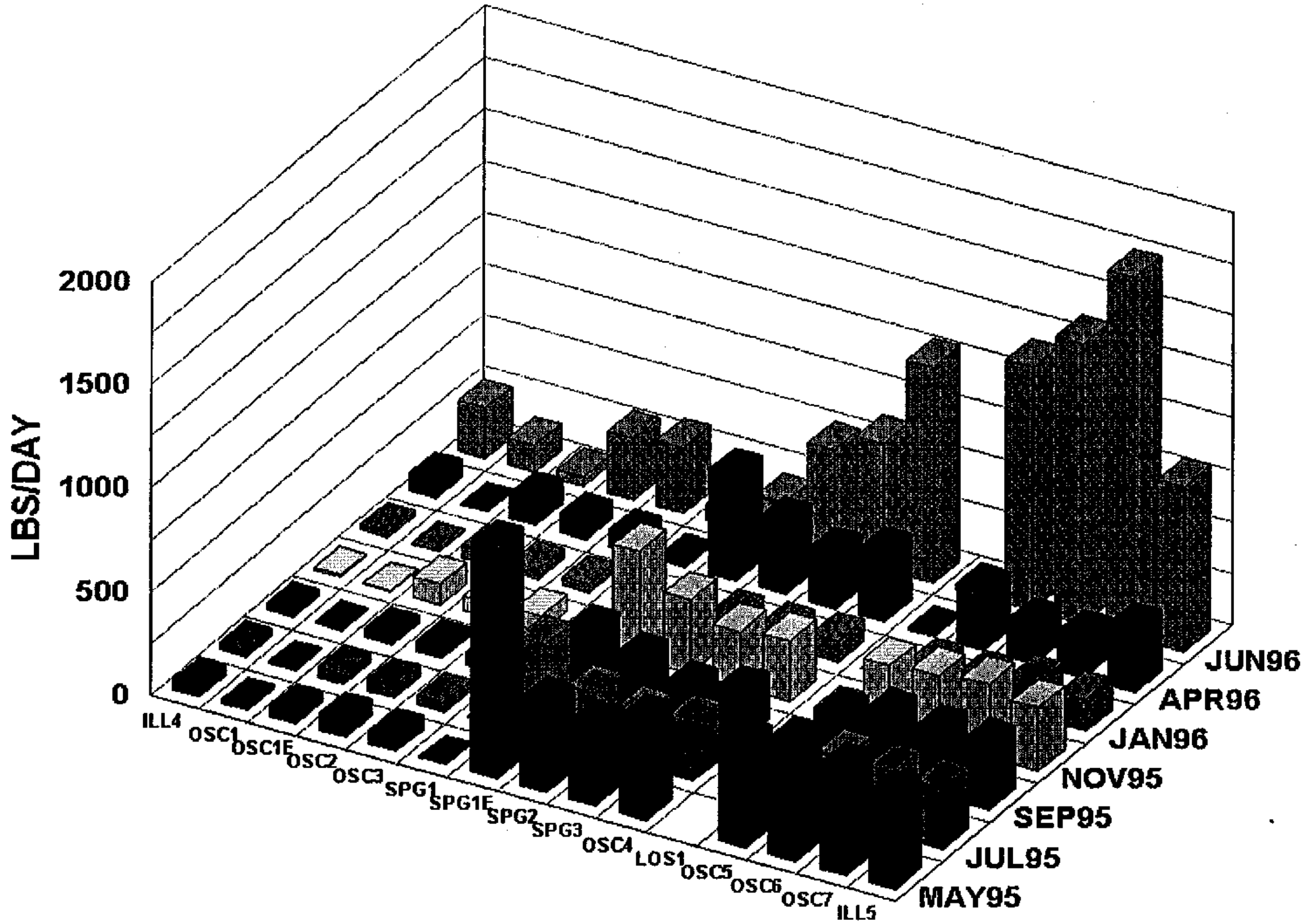


Figure WQ-7

TOTAL PHOSPHORUS LOAD

from Clear Creek

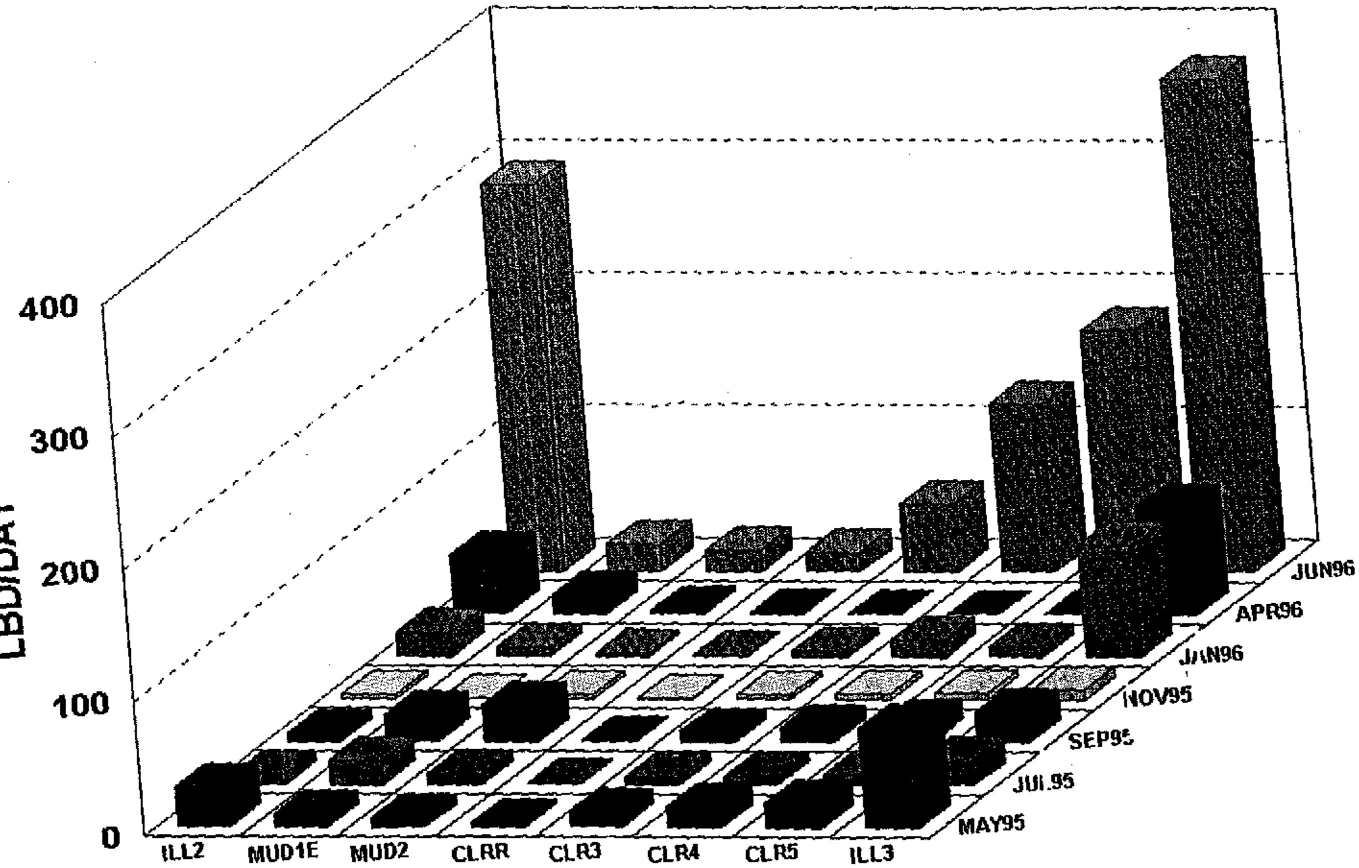


Figure WQ-8 indicates very little influence from the Prairie Grove WWTP discharge (MFIE) on the total phosphorus load in the Muddy Fork of Illinois River. An isolated storm event on April 15, 1996 and a major event on June 1, 1996 show substantial increases in phosphorus loading from the watershed of the Muddy Fork Illinois River. During the local storm event (Apr96) which occurred predominantly in the Muddy Fork drainage, approximately 63% of the phosphorus load in the Illinois River at ILL2 was from the Muddy Fork Illinois River (MFI4). In contrast, during a basin-wide, major storm event, about 43% of the phosphorus load at ILL2 was from the Muddy Fork which also makes up 44% of the watershed.

Figure WQ-9 shows the measured phosphorus loads at all stations on the main stem of the Illinois River. It is apparent that phosphorus loads increased substantially below the confluence of Osage Creek (ILL5) during low flow periods. It should also be noted that the total phosphorus concentrations also increased notably below the Osage Creek confluence. During the major storm event(Jun96), there was more of a progressive increase in phosphorus loads in the Illinois River in a downstream direction. As discussed earlier, the loads at ILL4, ILL5, ILL6 and ILL7 were measured on the declining phase of that storm event and their values were likely much higher on the previous day when all other stations were sampled.

Nitrate nitrogen load at selected stations is shown in Figure WQ-10. These loads were generally four to five times greater than the total phosphorus loads for these stations. In addition, point source loads comprised a smaller portion of the receiving stream load of nitrate-N than for total phosphorus. This was most apparent from the Springdale WWTP discharge (SPG1E). The general trend of progressive increases in nitrate-N load in a downstream direction indicates this parameter is strongly influenced by runoff from the watershed. Although point source discharges add insignificant volumes to the total basin flow, they often dominate the tributary receiving stream flow and pollutant load. During low flow periods, about 50% to 80% of the measured flow at the next downstream station from the Springdale discharge (SPG2B) was composed of WWTP flow, and the measured nitrate-N load from the WWTP ranged from 60% to 90% of the load at this station.

Figure WQ-11 indicates that the nitrate-N load in Osage Creek above the Rogers WWTP(OSC1) was greater than the load from the WWTP. In contrast, the nitrate-N loads from the Springdale WWTP were generally substantially greater than background loads (SPG1), except during major storm events. The measured nitrate-N load near the mouth of Spring Creek (SPG3) was about 50% of the load measured at the next downstream station on Osage Creek (OSC4). Similarly, the Spring Creek watershed area and the measured flows were about 50% of that at OSC4.

The influence of the Fayetteville WWTP discharge (MUD1E) on the Mud/Clear Creek nitrate-N load is shown in Figure WQ-12. Station CLRR was on Clear Creek above the confluence of Mud Creek which carries the Fayetteville WWTP discharge; therefore it serves as a background or reference site since there is normally no flow in Mud Creek above the WWTP outfall. At station MUD2, which is the next station below the Fayetteville WWTP, there appears to be a consistent reduction in the nitrate-N load from dilution or assimilation. On the Nov. 13, 1995 sampling event, there was no discharge from the Fayetteville facility; however, at station MUD2

Figure WQ-8

TOTAL PHOSPHORUS LOAD

from Muddy Fork Illinois River

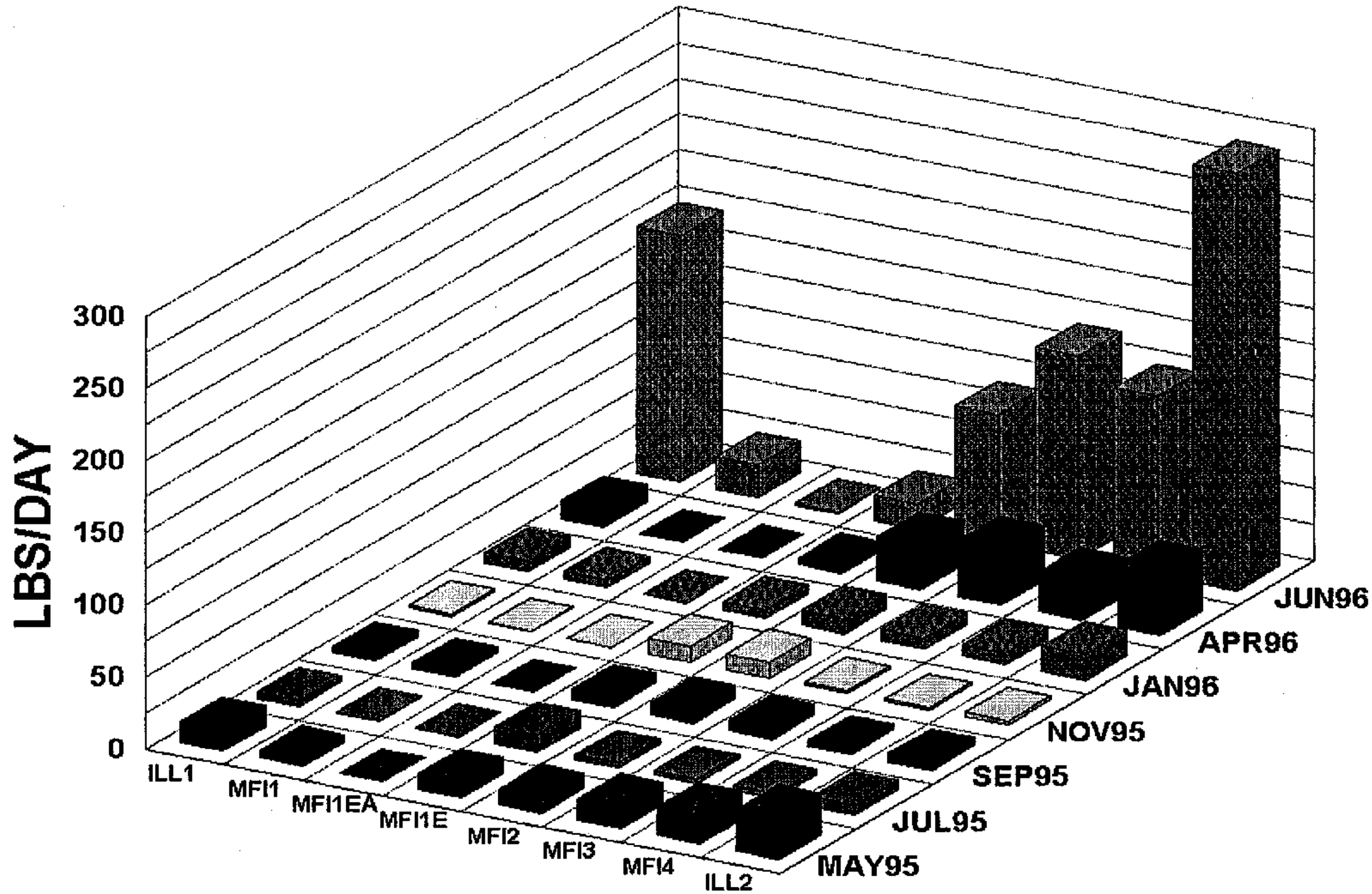


Figure WQ-9

TOTAL PHOSPHORUS LOAD

ILLINOIS RIVER STATIONS

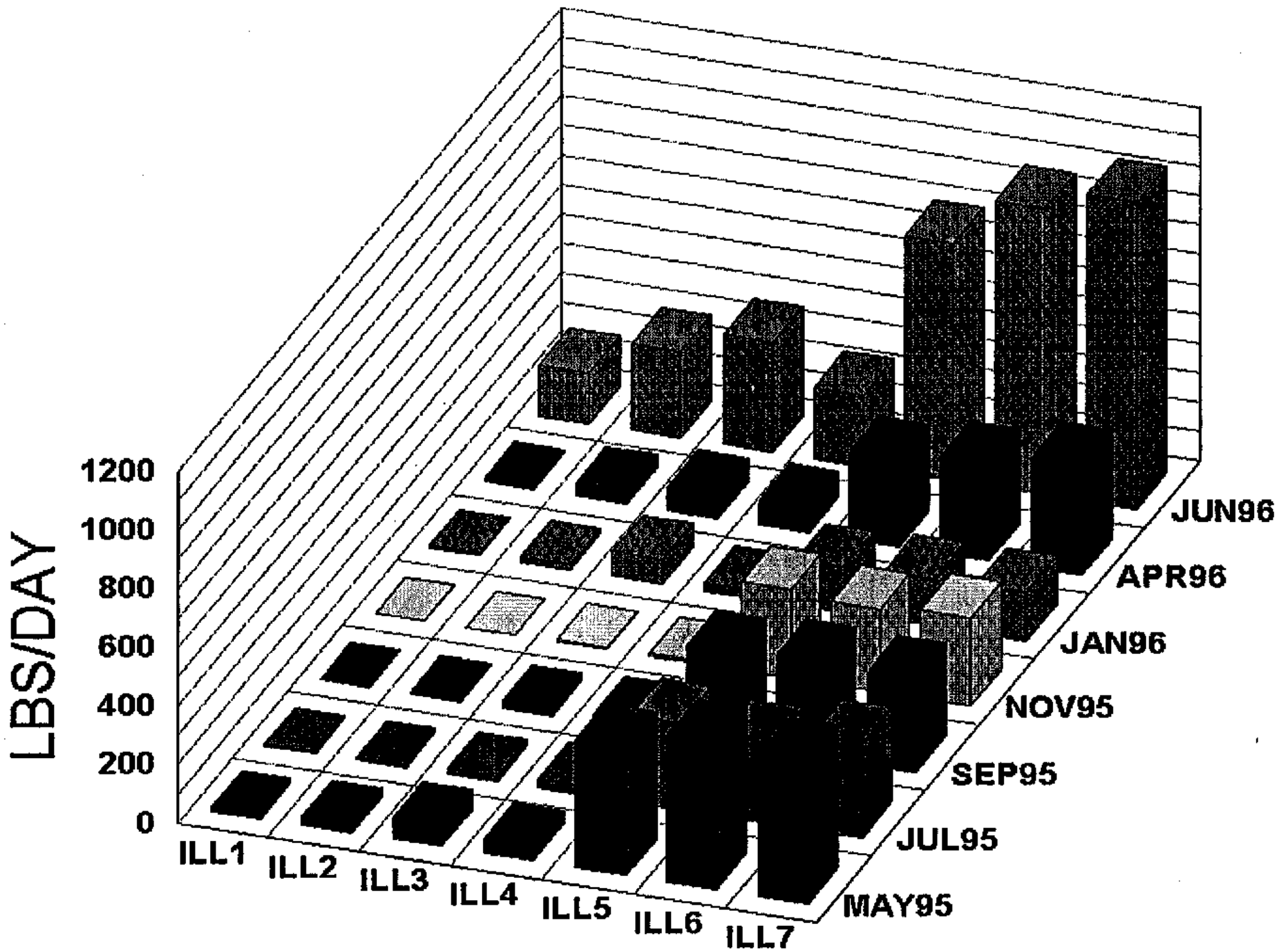


Figure WQ-10

NITRATE - N- LOAD

FROM SELECTED STATIONS

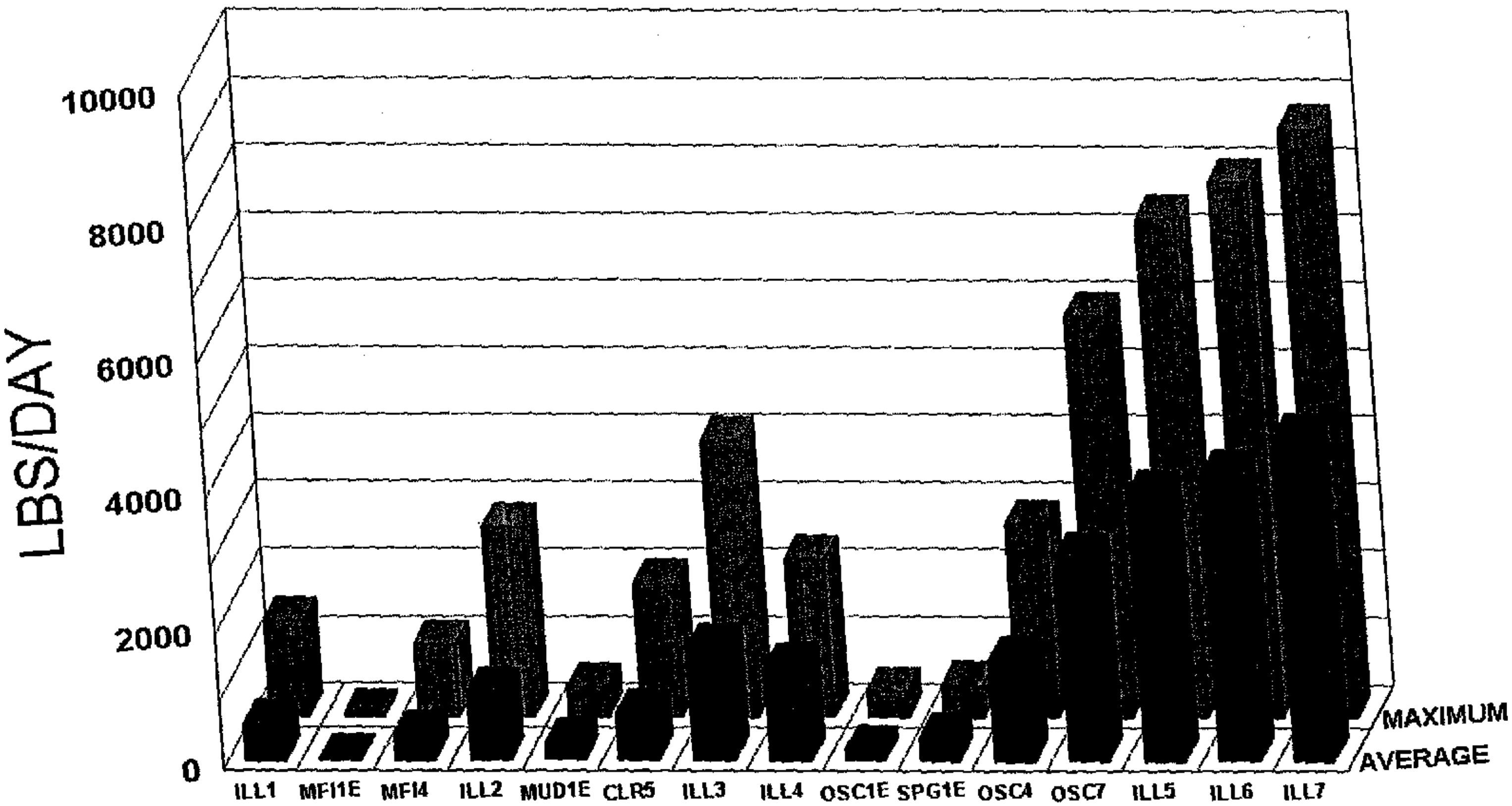


Figure WQ-11

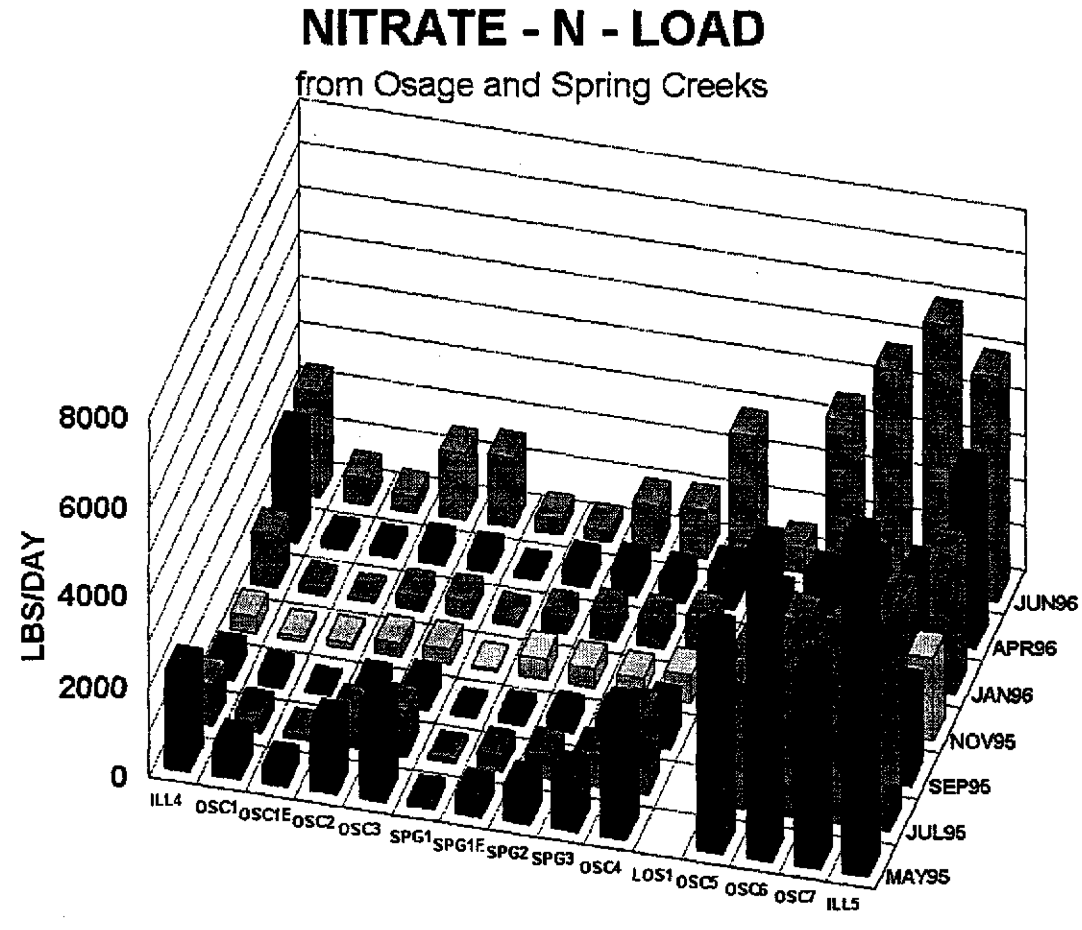
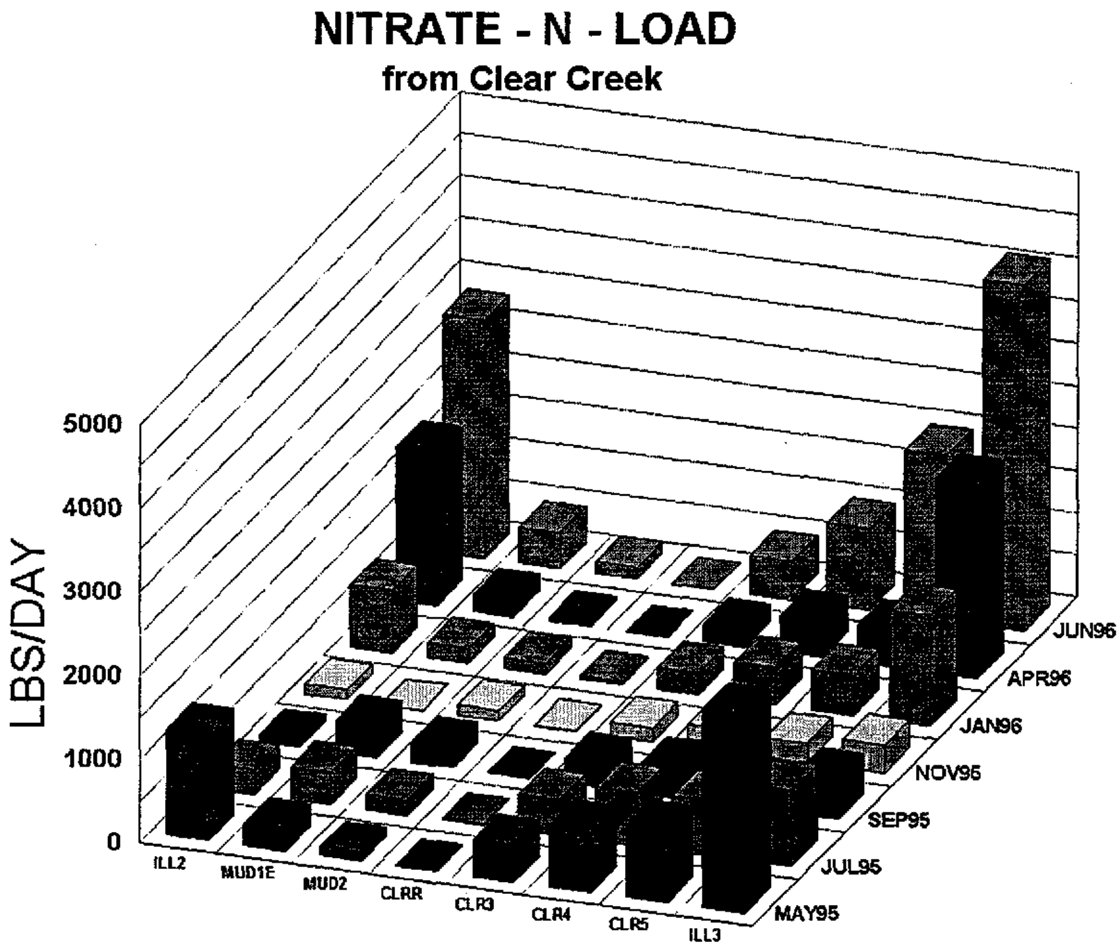

NITRATE - N - LOAD
from Osage and Spring Creeks
LBS/DAY
8000
6000
4000
2000
0
ILL4
OSC1
OSC1E
OSC2
OSC3
SPG1
SPG1E
SPG2
SPG3
OSC4
LOS1
OSC5
OSC6
OSC7
ILL5
JUN96
APR96
JAN96
NOV95
SEP95
JUL95
MAY95

Figure WQ-12


NITRATE - N - LOAD
from Clear Creek
LBS/DAY
5000
4000
3000
2000
1000
0
ILL2
MUD1E
MUD2
CLRR
CLR3
CLR4
CLR5
ILL3
JUN96
APR96
JAN96
NOV95
SEP95
JUL95
MAY95

some flow existed and nitrate-N loads were measured. The measured nitrate-N loads near the mouth of Clear Creek (CLR5) averaged about 50% of the load in the Illinois River below their confluence. There was no correlation with these values and the flows recorded in Clear Creek; however, there was a strong correlation between the ratio of nitrate-N loads at CLR5 and ILL3 and the ratio of measured flows at these stations. Therefore, the influence of Clear Creek on the Illinois River nitrate-N load is a function of the flow relationship between the two streams rather than a constant loading.

The nitrate-N loads in the Muddy Fork Illinois River is demonstrated in Figure WQ-13. At the station below the Prairie Grove WWTP discharge (MFI2), the nitrate-N loads seem to be influenced more by background values above the discharge (MFI1) than from the WWTP. In addition, substantial increases in the loads are noted at MFI3, particularly during increased watershed runoff. This station is below the confluence of Moore's Creek which doubles the watershed area present at the next upstream station.

Nitrate-N loading measured at stations along the Illinois River are shown in Figure WQ-14. In general, there is a gradual increase in loading in a downstream direction. There appears to be a pattern of a noticeable increase between ILL4 and ILL5. Osage Creek enters the Illinois River between these stations and its drainage basin increases the size of the watershed by over 80%. Concentrations of nitrate-N also show a slight increase below the Osage Creek confluence. These increases in loading and concentration are not believed to be measurably influenced by the point source discharges in the Osage Creek Basin since the loading is more directly correlated to size of watershed and amount of runoff. This basin also contains significantly greater amounts of ground water in its base flow, and Osage Creek is often the dominant flow in the Illinois River below the Osage Creek confluence during low flow conditions. Almost all ground water sources in this area have elevated nitrate-N concentrations.

Dissolved Metals

The dissolved portion of 18 metals was sampled during six of the seven sampling events of the study. Results are tabulated in Appendix D. Calculations of the mean and minimum values in this table recognized "less than" values as a zero. Therefore, those calculated values should be used with caution.

The greatest source of these metals was point source discharges, although storm events normally produced elevated iron and aluminum values. None of the metals, including those from the four point sources, exceeded toxic criteria established in the National Toxics Rule (EPA 1995). However, nickel values were noticeably elevated in the Fayetteville WWTP discharge and cobalt was elevated in the Rogers discharge. There were also some interesting relationships among several of the metals related to the WWTP discharges.

Figure WQ-15 shows the average values of selected dissolved metals from stations above, below and at the Prairie Grove WWTP discharge. Average sodium values were significantly elevated in the WWTP outfall (MFI1E) and potassium levels were also elevated. In contrast,

Figure WQ-13

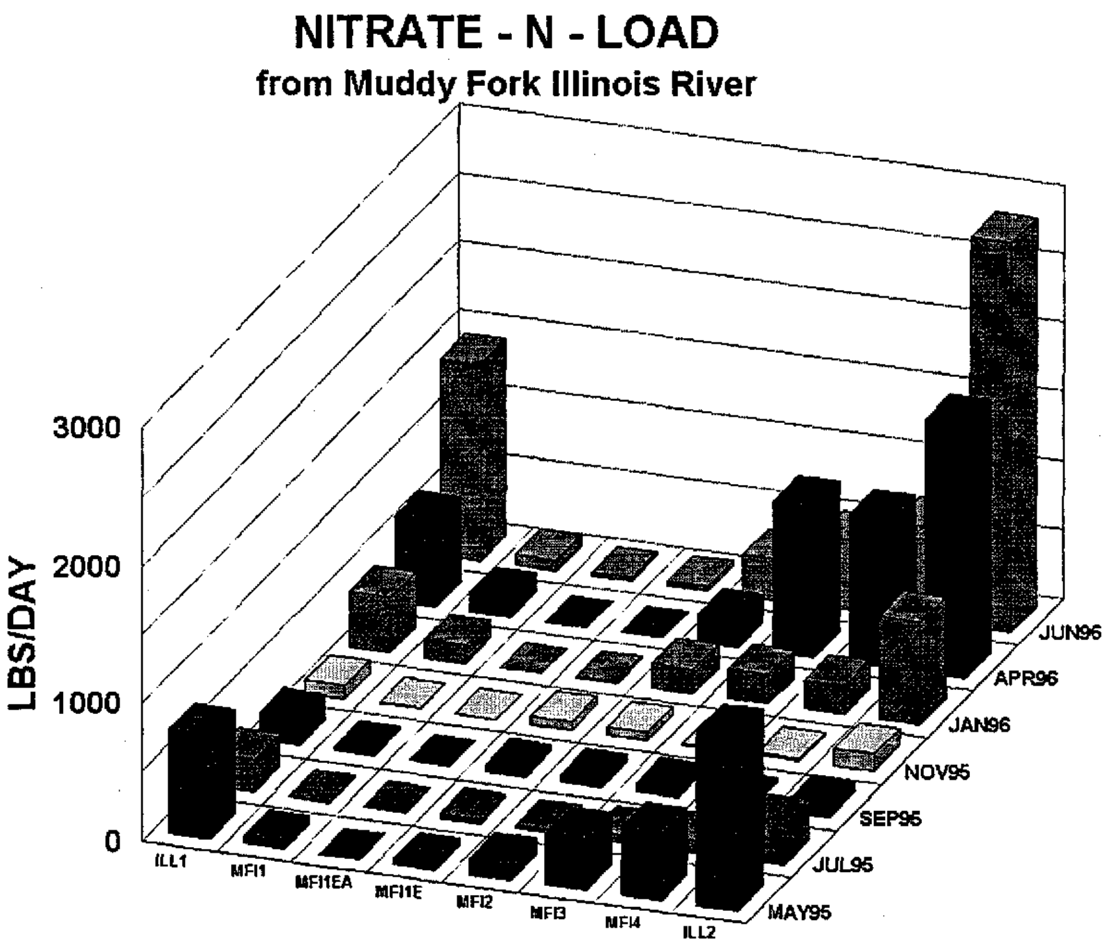

NITRATE - N - LOAD
from Muddy Fork Illinois River
3000
2000
1000
0
LBS/DAY
ILL1
MFI1
MFI1EA
MFI1E
MFI2
MFI3
MFI4
ILL2
JUN96
APR96
JAN96
NOV95
SEP95
JUL95
MAY95

Figure WQ-14

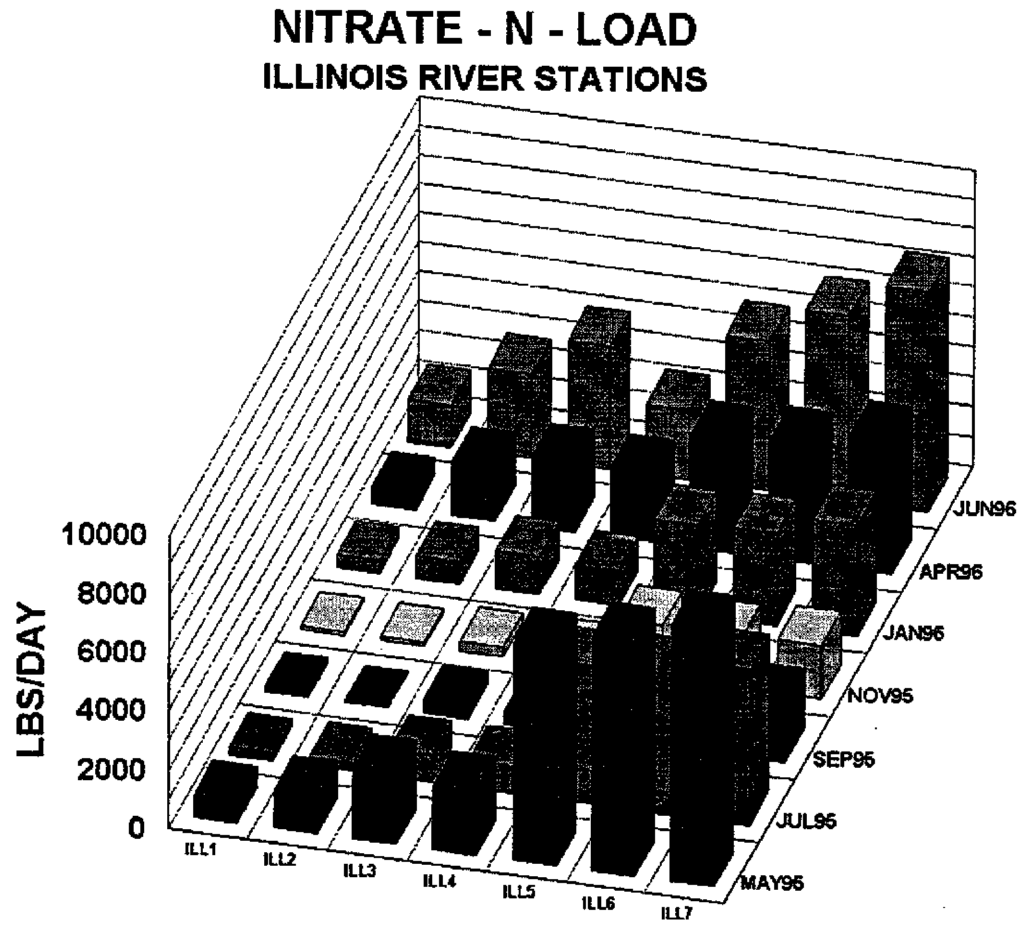
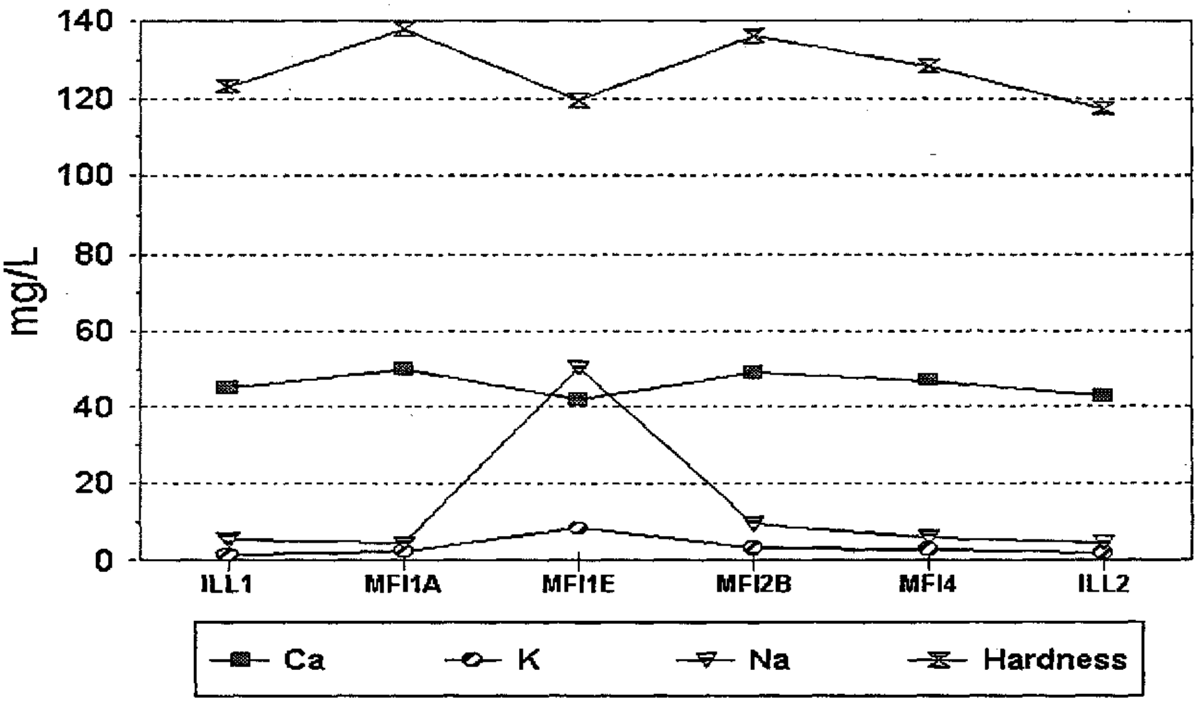
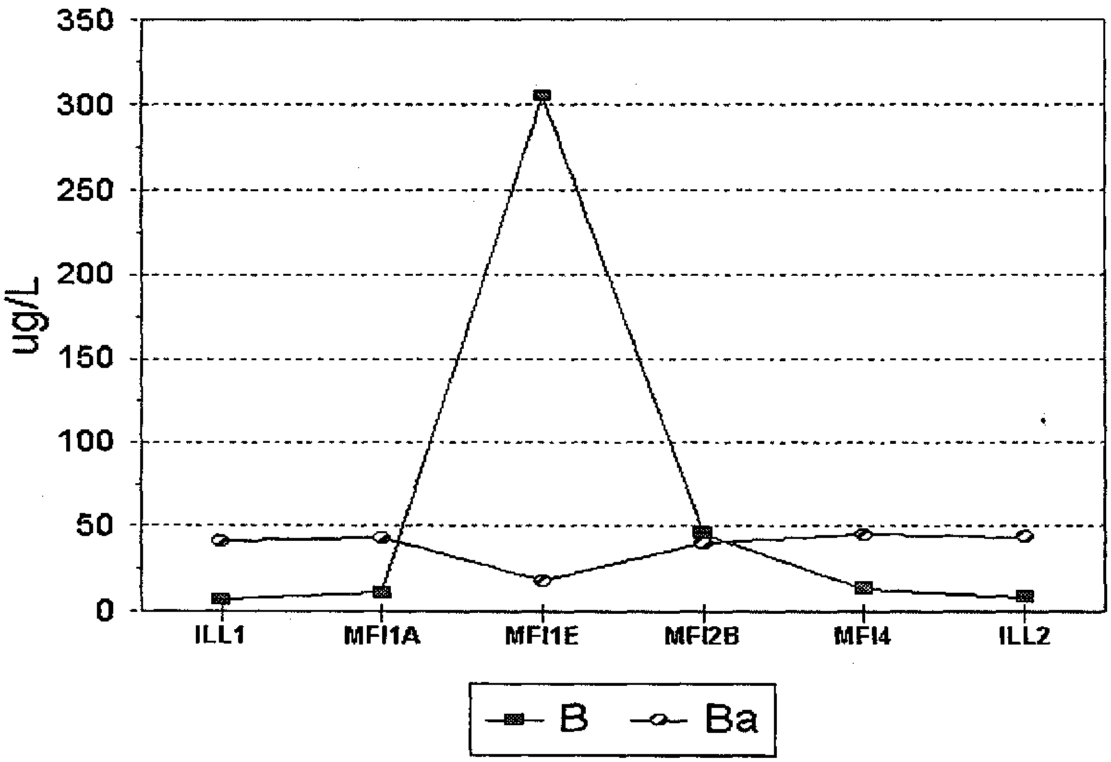

NITRATE - N - LOAD
ILLINOIS RIVER STATIONS
LBS/DAY
10000
8000
6000
4000
2000
0
ILL1
ILL2
ILL3
ILL4
ILL5
ILL6
ILL7
JUN96
APR96
JAN96
NOV95
SEP95
JUL95
MAY95

Figure WQ-15

MEANS OF SELECTED DISSOLVED METALS
from MUDDY FORK ILLINOIS RIVER





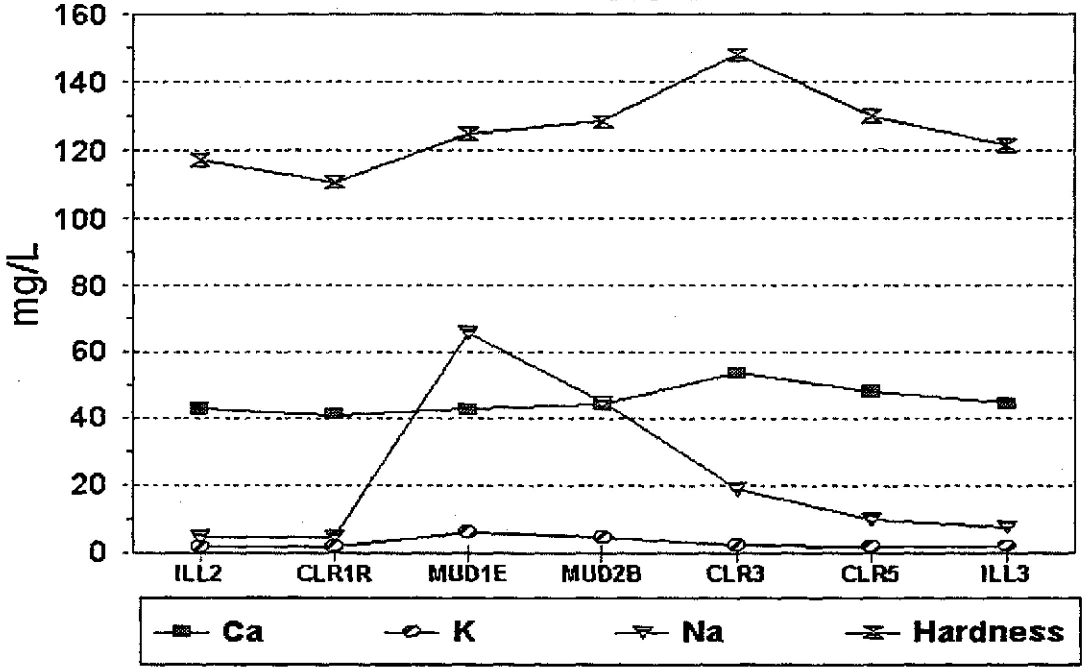
calcium and total hardness values were somewhat lower in the effluent. Boron was substantially higher in the effluent while barium was lower. There was very little difference in these parameters in the Illinois River above (ILL1) and below (ILL2) the confluence of Muddy Fork with the Illinois River.

Dissolved metals from stations in the Mud Creek/Clear Creek drainages are shown in Figure WQ-16. They demonstrate a very similar pattern from the Fayetteville WWTP (MUD1E) as discussed for the Prairie Grove discharge. Sodium and boron levels were much higher in the WWTP discharge. Potassium was elevated and barium was lowest in the effluent. The calcium and hardness values did not decline sharply in this effluent as noted in the other WWTP discharges but they increased downstream in Clear Creek (CLR3) from greater inflows of spring water.

The pattern of dissolved metals at the Osage and Spring Creek stations was the same as discussed above, but it was more pronounced. Influences of the WWTP discharges from Rogers (OSC1E) and Springdale (SPG1E) are evident in Figure WQ-17. Sodium and potassium were noticeably higher in the WWTP discharges and calcium and total hardness were distinctly lower. The inverse relationship between barium and boron was also very evident at these sites. All values quickly moderated downstream to near their "above-effluent" values. The influences of these discharges on the Illinois River were negligible as shown by comparing values at ILL4 and ILL5.

Figure WQ-16

MEANS OF SELECTED DISSOLVED METALS
from MUD/CLEAR CREEKS



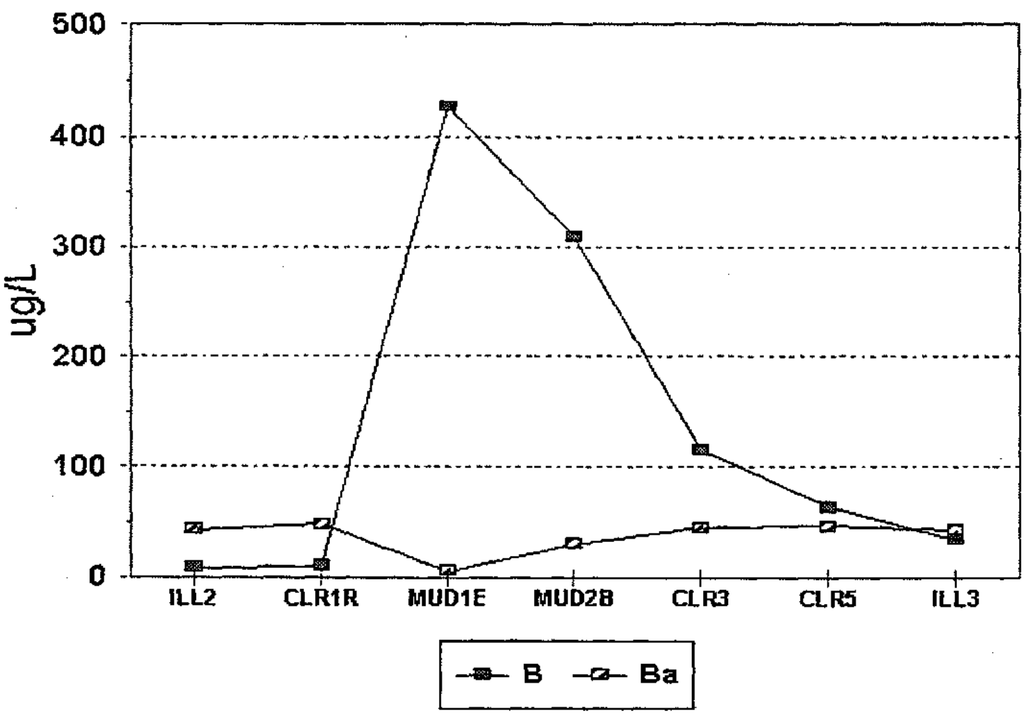
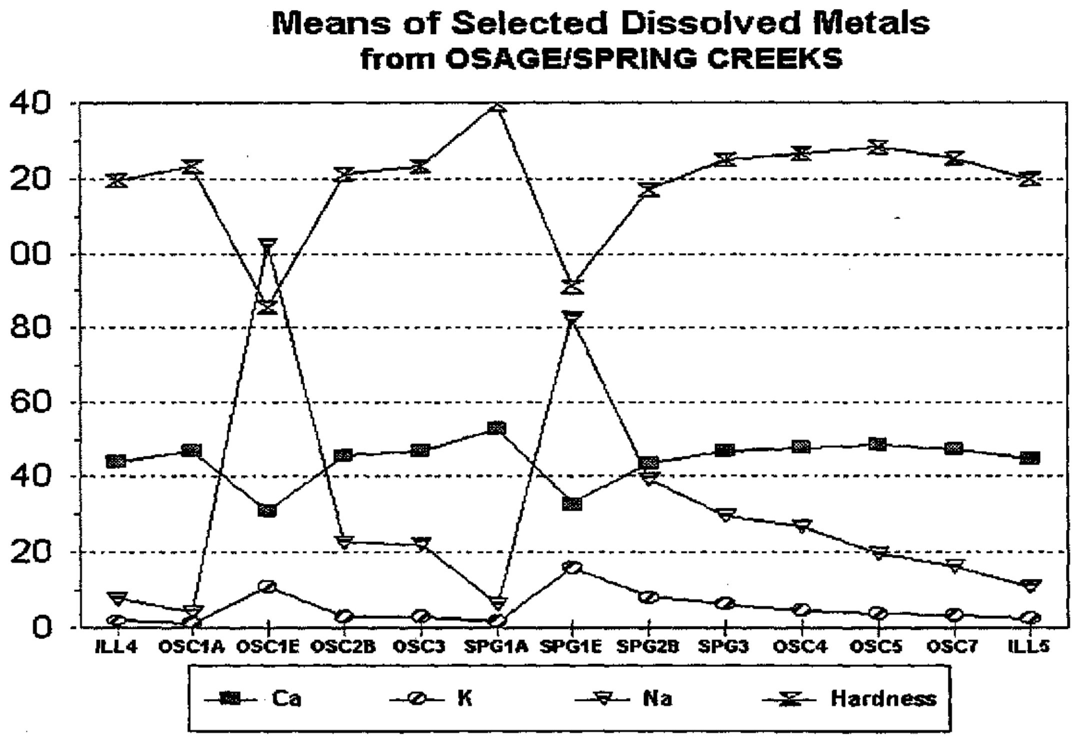
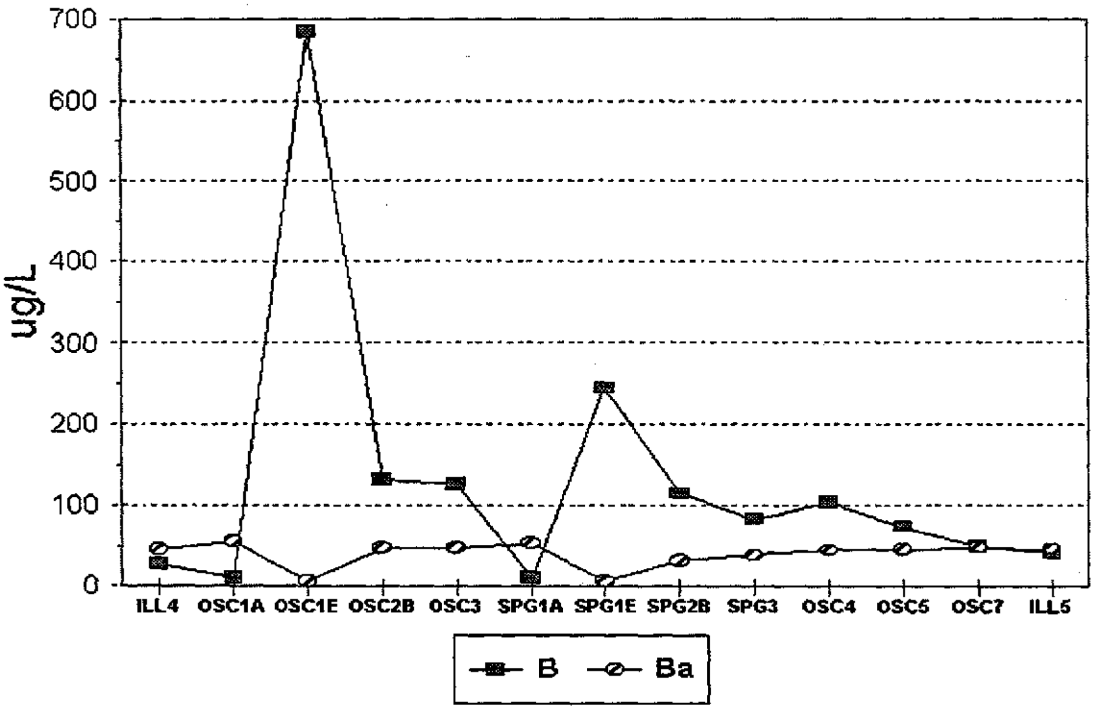


Figure WQ-17


Means of Selected Dissolved Metals
from OSAGE/SPRING CREEKS
40
20
00
80
60
40
20
0
ILL4 OSC1A OSC1E OSC2B OSC3 SPG1A SPG1E SPG2B SPG3 OSC4 OSC5 OSC7 ILL5
Ca
K
Na
Hardness


700
600
500
400
300
200
100
0
ug/L
ILL4 OSC1A OSC1E OSC2B OSC3 SPG1A SPG1E SPG2B SPG3 OSC4 OSC5 OSC7 ILL5
B
Ba

Diel Dissolved Oxygen and Temperature

Hydrolab Recorder multi-parameter water quality sampling meters were used to measure the diel fluctuation of both D.O. and temperature. On August 15, 1995 three meters were placed at the mouth of subbasins of the Illinois River that contained major point source discharges. Meters were placed at Osage Creek above Highway 68 (near OSC07), at CLR05, and at MFI04. In addition, a meter was placed near the Arkansas-Oklahoma state line at ILL07 on this date to record conditions in the farthest downstream sampling station. On August 21, 1995 meters were placed below municipal waste water treatment plants at MFI02B, at MUD02B, at SPG02B and on Osage Creek approximately one-half mile below the City of Rogers waste treatment plant discharge (above OSG02B). In order to reevaluate the data collected below the Prairie Grove WWTP (MFI02B) in 1995, meters were placed at MFI01A and MFI02B on August 12, 1996. On all three occasions the meters were deployed for 48 hours, collecting data in 10 or 15 minute intervals. Table WQ-1 is a summary of the temperature and D.O. data.

Table WQ-1 - Diel D.O. and Temperature Summary

Station ID	Sample Date	D.O.			Temperature		
		Max	Min	M.D.F.*	Max	Min	M.D.F.
OSG at 68	8/15-8/17/95	8.8	6.4	2.4	27.0	24.0	3.0
CLR05	8/15-8/17/95	8.0	6.5	1.4	27.8	25.4	2.3
MFI04	8/15-8/17/95	8.0	4.8	3.2	29.2	24.5	4.7
ILL07	8/15-8/17/95	8.7	5.5	3.1	28.9	25.8	3.1
OSG blw WTP	8/21-8/23/95	10.6	6.9	3.7	24.0	19.6	4.4
SPG02B	8/21-8/23/95	10.2	6.8	3.4	26.8	22.2	4.6
MUD02B	8/21-8/23/95	8.1	4.5	3.6	29.3	24.7	4.5
MFI02B	8/21-8/23/95	3.1	1.4	1.7	26.4	23.7	2.7
MFI01A	8/12-8/14/96	6.3	3.8	2.4	20.1	17.5	2.5
MFI02B	8/12-8/14/96	6.5	4.6	1.9	23.7	21.1	2.6

*Maximum Daily Fluctuation

Dissolved oxygen concentrations in Osage Creek above the Highway 68 bridge ranged from 6.4 mg/L to 8.8 mg/L with D.O. saturation values between 77% and 110%. Temperatures at this site ranged from 24.0 °C to 27.0 °C. At CLR05 (near mouth of Clear Creek) D.O. saturation values ranged from 81% to 102%, and temperature measurements ranged from 25.4 °C to 27.8 °C. The D.O. concentrations at MFI04 (near mouth of Muddy Fork) ranged from 4.8 mg/L to 8.0 mg/L, and saturation values were 59% to 106%. Temperatures at this site ranged from 24.5 °C to 29.2 °C. The maximum daily D.O. fluctuations for the three sites ranged from 1.4 mg/L at CLR05 to 3.2 mg/L at MFI04. Figures WQ-18, WQ-19, and WQ-20 represent the D.O. and temperature data from Osage Creek, CLR05, and MFI04 respectively.

At the Illinois River site (ILL07), dissolved oxygen concentrations ranged from 5.5 mg/L to 8.7 mg/L, and D.O. saturation values ranged from 69% to 113%. Temperatures at the site ranged from 25.4 °C to 27.8 °C. The data collected at ILL07 is presented in Figure WQ-21.

Figure WQ-18

OSAGE CR. at HWY. 68
D.O./TEMP AUG 15-17, 1995

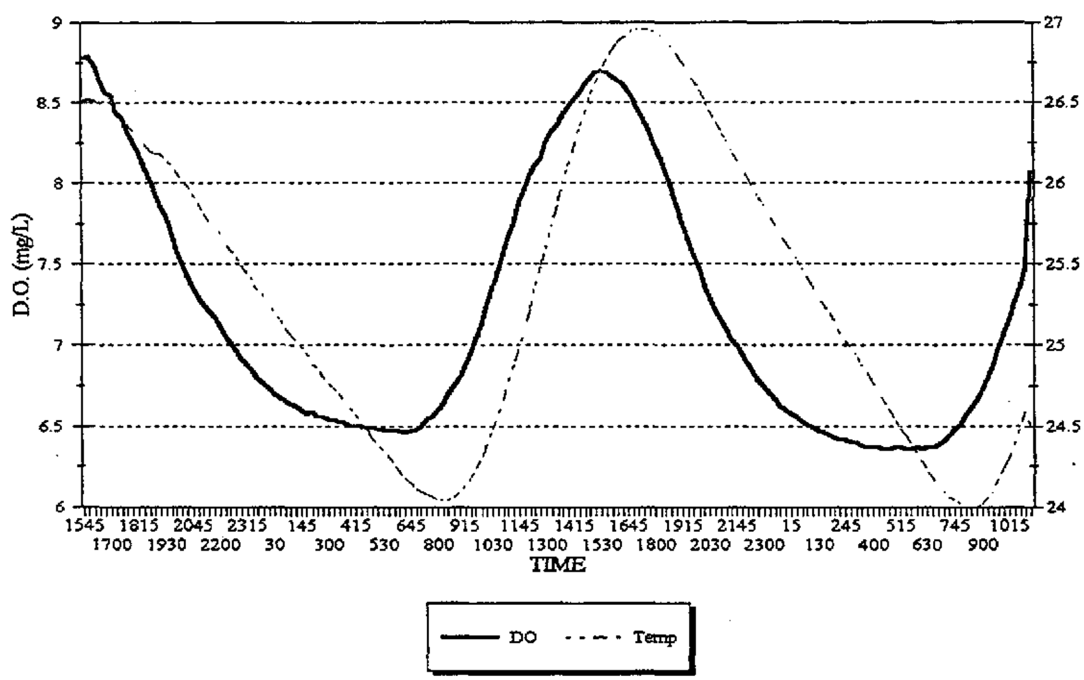


Figure WQ-19

CLR05

D.O./TEMP AUG 15-17, 1995

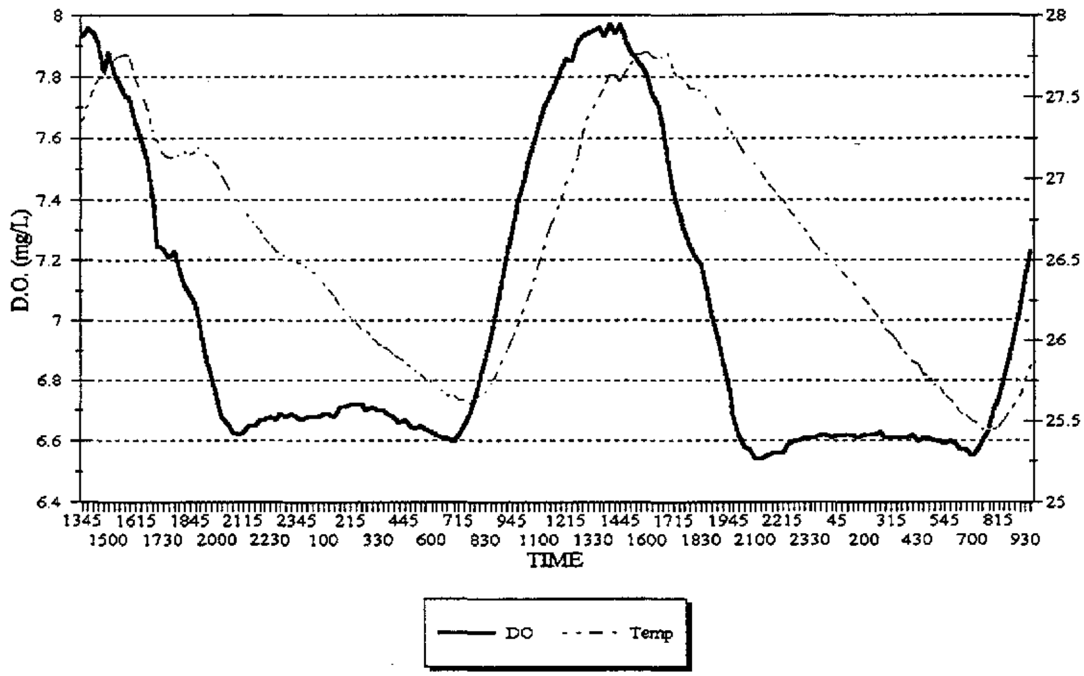


Figure WQ-20

MFI04

D.O./TEMP AUG 15-17, 1995

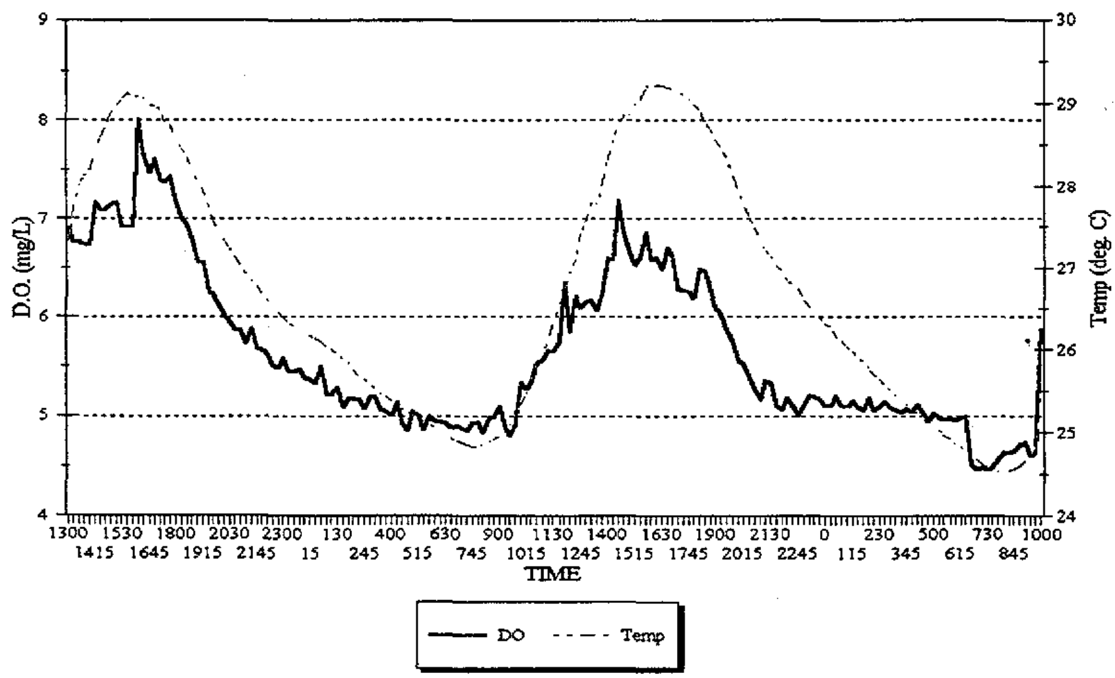
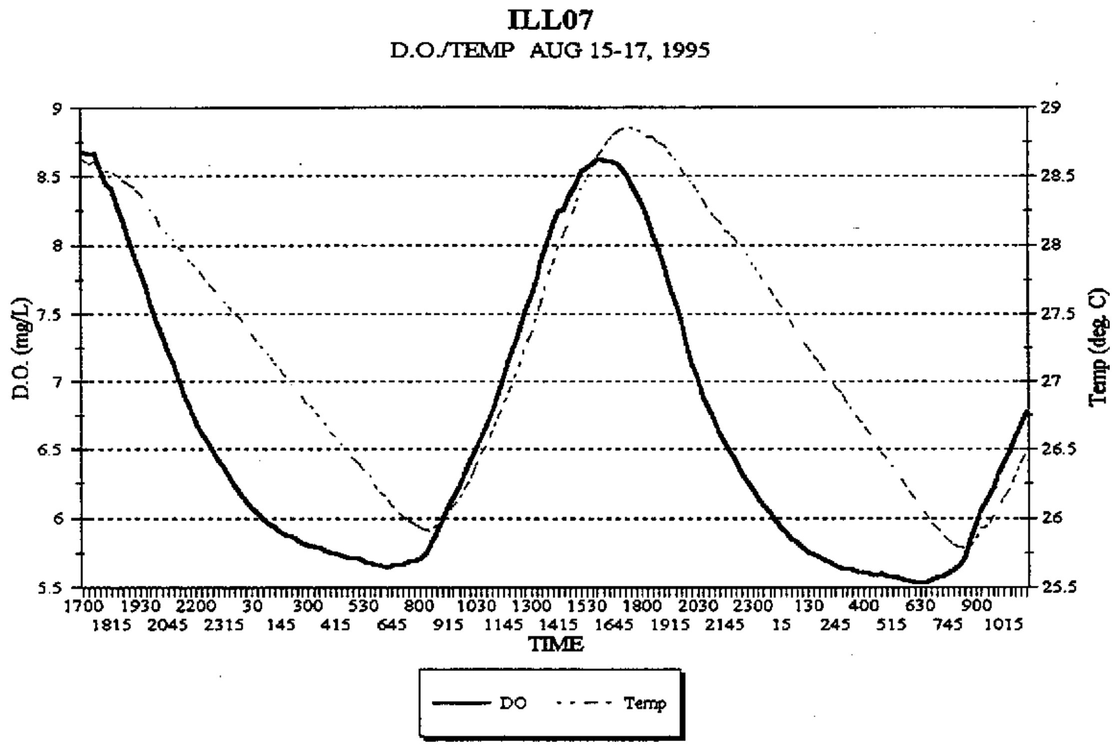


Figure WQ-21



In Osage Creek below the City of Rogers WWTP, D.O. concentrations ranged from 6.9 mg/L to 10.6 mg/L, and D.O. saturation values ranged from 78% to 126%. The D.O. and temperature data for this station is presented in Figure WQ-22. The D.O. concentrations below the Springdale WWTP (SPG02B) ranged from 6.8 mg/L to 10.2 mg/L, and produced saturation values of 84% to 128%. The D.O. and temperature data for SPG02B is graphically represented in Figure WQ-23. Diel D.O. and temperature was measured below the Fayetteville WWTP at MUD02B. At this station, D.O. saturations ranged from 55% to 107% and D.O. ranged from 4.5 mg/L to 8.1 mg/L. The data from MUD02B is presented in Figure WQ-24.

Concentrations of D.O. at MFI02B (below the Prairie Grove WWTP) for the 1995 sampling event is presented in Figure WQ-25. The minimum and maximum D.O. values at this site were significantly lower than all other sites. The reason for this is unknown since D.O. values were substantially higher during all synoptic sampling events both above and below the Prairie Grove discharge. The minimum D.O. value occurred about 5:00 p.m. on August 22, 1995, declining sharply from the maximum value of 3.1 mg/L at about 2:00 p.m. Possible explanations for these low values and the atypical daily pattern include: 1) meter malfunction, 2) an inadequately treated or bypass discharge from the WWTP, or 3) excessive disturbance by cattle of high oxygen demanding sediment in the stream. Cattle were observed in the pool just above the meter installation and there was considerable evidence of frequent use of the area by cattle.

Figure WQ-22

OSAGE CR. BLW ROGERS WTP

D.O./TEMP AUG. 21-23, 1995

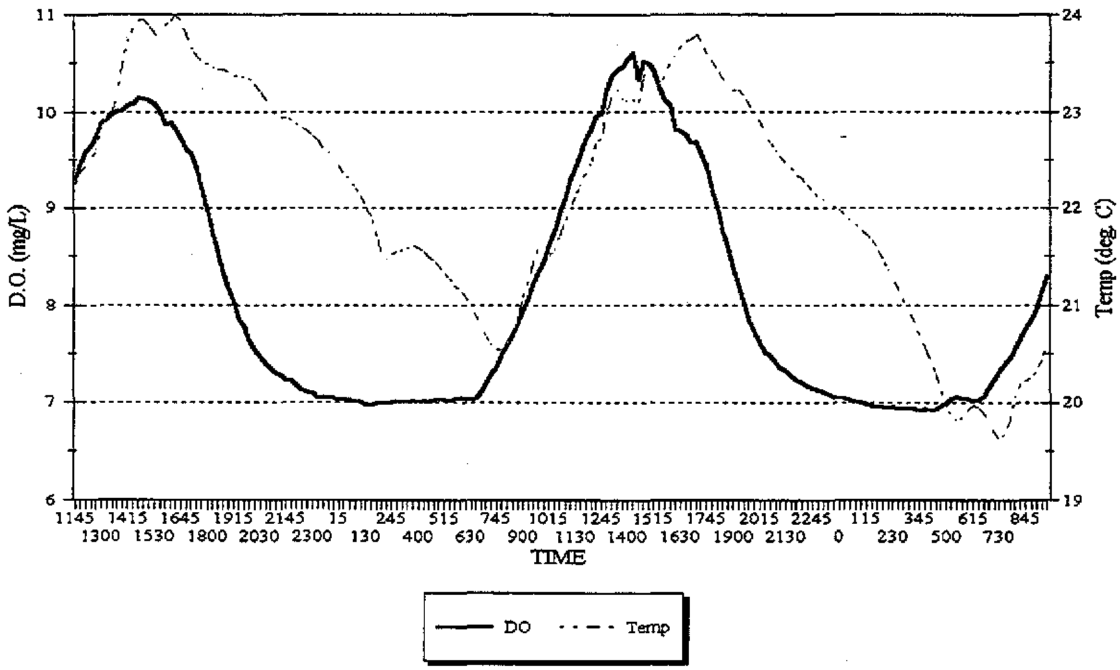


Figure WQ-23

SPG02B

D.O./TEMP AUG 21-23, 1995

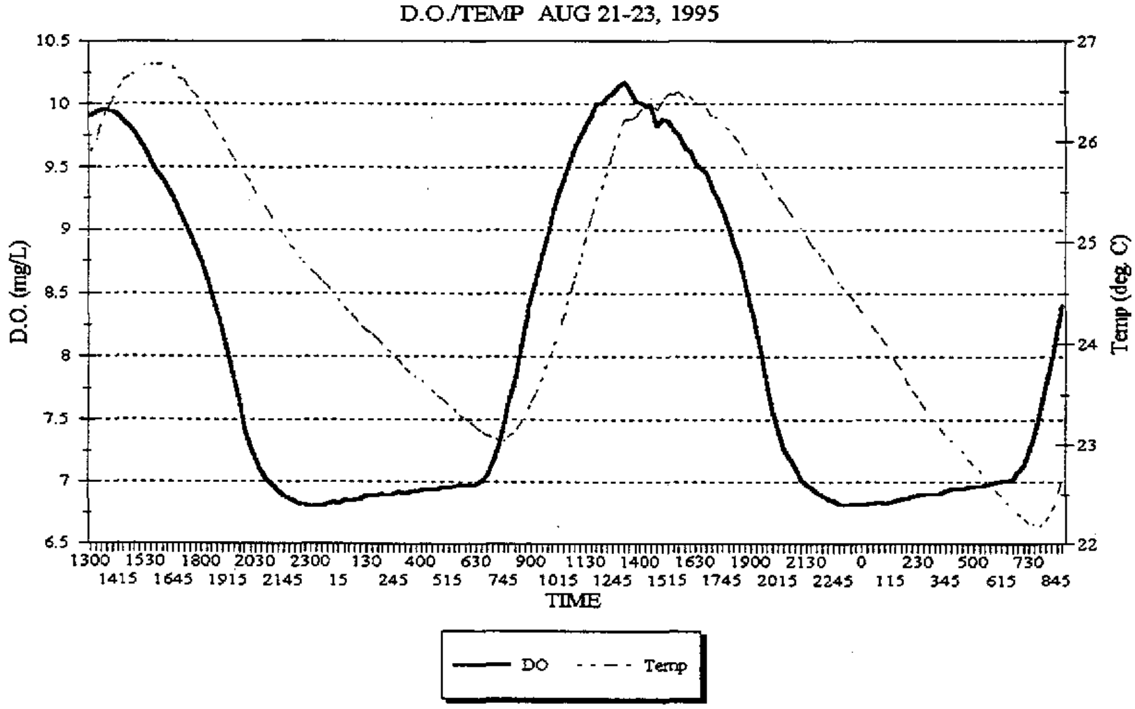


Figure WQ-24

MUD02B

D.O./TEMP AUG 21-23, 1995

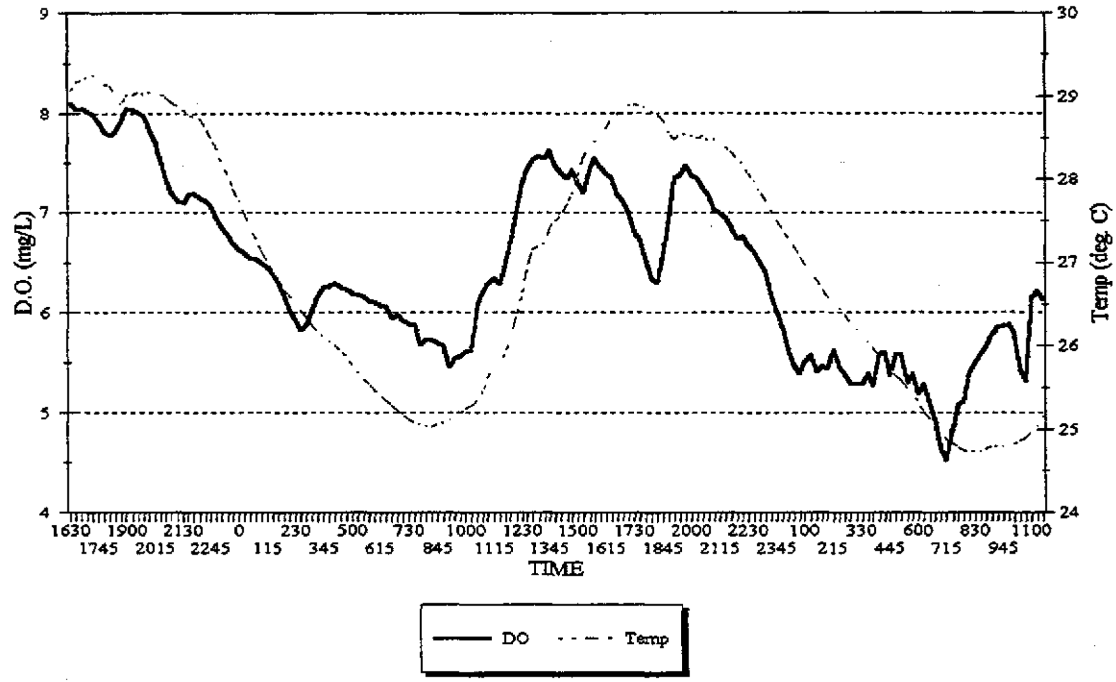
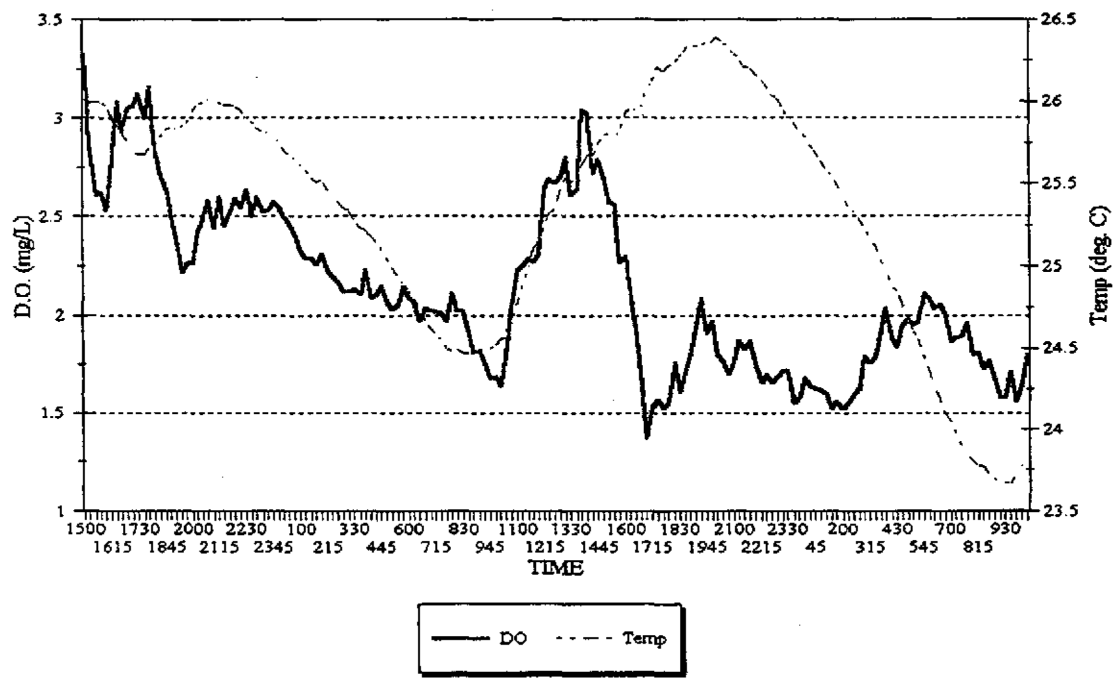


Figure WQ-25

MFI02B

D.O./TEMP AUG 21-23, 1995



Although the maximum daily fluctuation at MFI02B was only 1.7 mg/L due to the very low maximum and minimum D.O. values, generally, the D.O. maximum daily fluctuation was greater below the WWTP's than at the other sites. These values were normally 3.4 to 3.7 mg/L. To recheck the atypical results at station MFI02B from August 1995, meters were replaced in Muddy Fork above and below the Prairie Grove waste treatment plant discharge tributary at MFI01A and MFI02B on August 12, 1996. The D.O. concentrations at MFI01A ranged from 3.8 mg/L to 6.3 mg/L, and at MFI02B, D.O.'s were from 4.6 mg/L to 6.5 mg/L. Data for these stations is presented in Figures WQ-26 and WQ-27. As can be seen, the minimum and maximum D.O. values at MFI02B were noticeably higher in 1996 than in 1995. The maximum daily fluctuations were very similar and water temperatures were lower in 1996. This sampling event also produced an unexplained anomaly at the upstream station (MFI01A). This plot showed maximum D.O. and temperature values occurring during the hours of darkness (approx. 11p.m. - 3 a.m.) And minimum values in late afternoon. This appears to be an improper orientation of the "Time" scale or an improper functioning time clock. Neither could be verified as the cause.

Figure WQ-26

MFI01A

D.O./TEMP AUG. 12-14, 1996

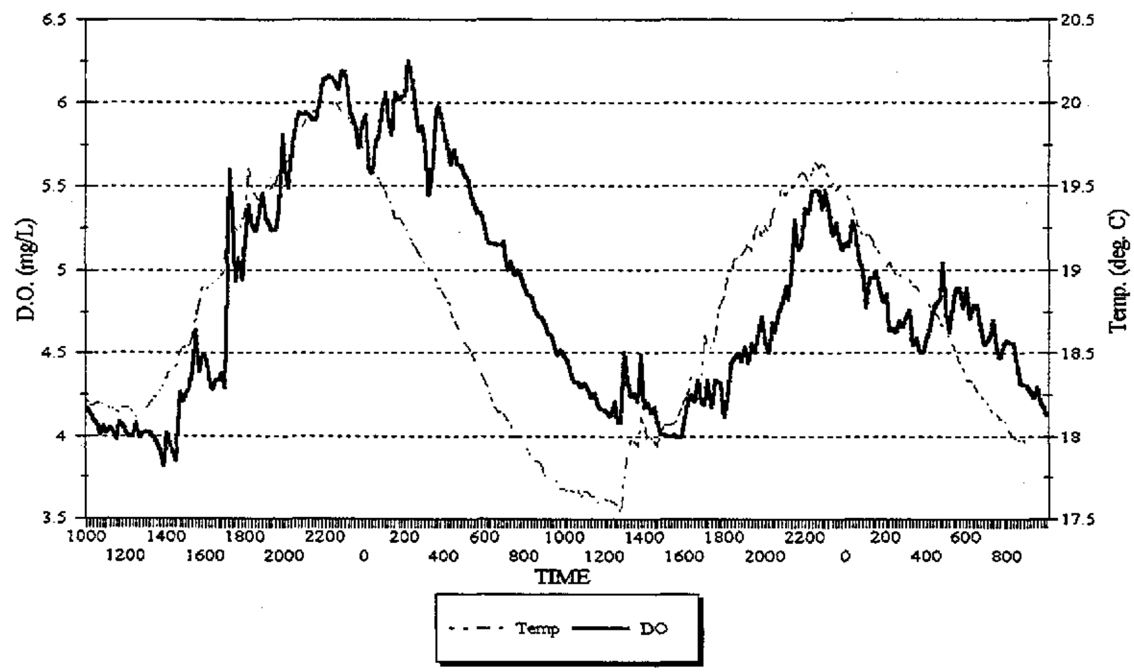
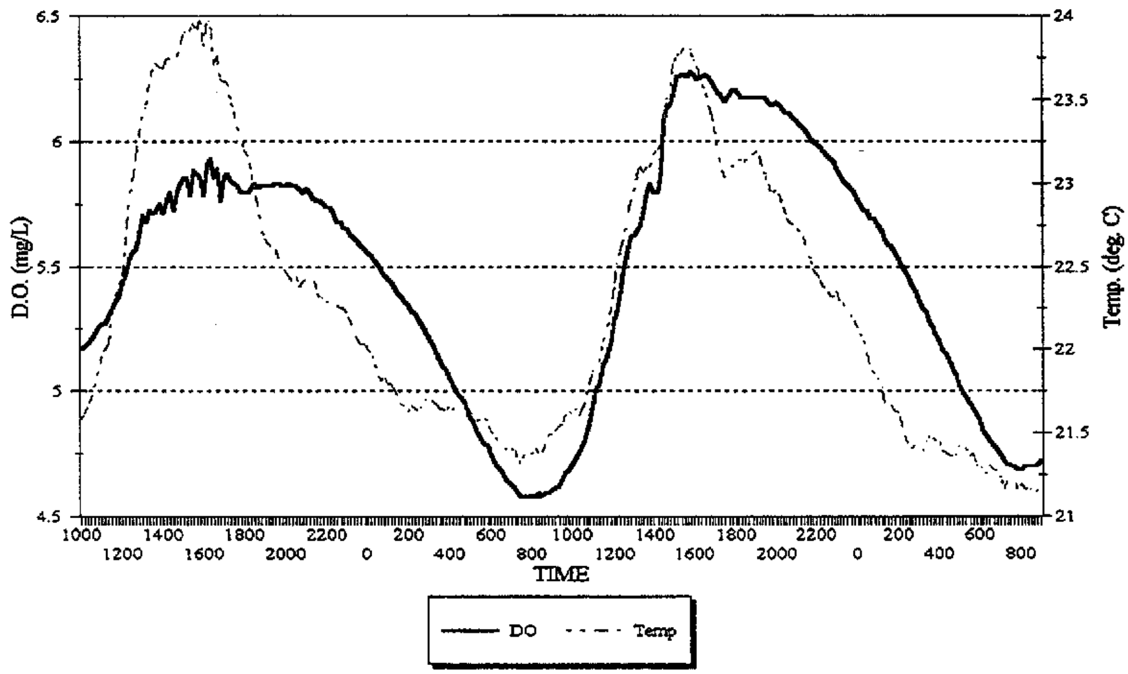


Figure WQ-27

MFI02B

D.O./TEMP AUG 12-14,1996



Nutrient Loads from Major Dischargers

The four WWTP's in the headwater tributaries of the Illinois River are located approximately 30 to 45 stream miles from the Oklahoma boundary. Three of these facilities are multi-million dollar tertiary level treatment plants.

Daily discharge reports, in addition to those required for NPDES permits, were supplied by these facilities between May 1995 and April 1996. Fayetteville and Springdale WWTP's recorded daily discharge flow and daily values for 5-day carbonaceous biochemical oxygen demand ($CBOD_5$), total phosphorus, and ammonia nitrogen (NH_3-N). Orthophosphate phosphorus and nitrate+nitrite-nitrogen (NO_3+NO_2-N) values were recorded three times monthly. Rogers WWTP reported daily discharge flow, $CBOD_5$, and NH_3-N. Total and orthophosphate phosphorus and NO_3+NO_2-N were reported three times monthly. Prairie

Grove WWTP reported daily discharge flow while $CBOD_5$ and NH_3-N were reported three times monthly. Water samples for total phosphorus and NO_2+NO_3-N values were collected monthly and analyzed by the Department. Fayetteville, Springdale and Rogers have water quality laboratory facilities certified by the Department.

Mean phosphorus and nitrate-nitrogen concentrations were determined each month for each discharge. Nutrient loads were calculated using the product of the mean concentrations for the month x the average discharge flow for the month(MGD) x 8.34 to express as lbs/day.

Annual nutrient loads (lbs/year) are shown in Figure WQ-28. Phosphorus loads were highest at the Springdale WWTP and lowest at the Prairie Grove WWTP. The annual phosphorus load from Springdale was approximately four times greater than Rogers and about 40 times greater than Fayetteville or Prairie Grove. Also, discharge flows from Springdale were more than twice as large as Rogers or Fayetteville discharges and over 20 times that of Prairie Grove. Annual nitrogen loads were lowest at the Prairie Grove WWTP and highest at the Fayetteville WWTP, although Rogers, Springdale and Fayetteville contributed almost equal loads. The nutrient loads for Prairie Grove were calculated by extrapolation of the data for the months of December and January through April for phosphorus and for the month of December for nitrogen loads.

Figure WQ-29 presents the monthly averages of the daily loads from the Springdale WWTP. The average for phosphorus was 369.8 lbs/day for the 12 month period. The maximum monthly loading of phosphorus occurred in August 1995 at 568.5 lbs/day. The highest daily load of phosphorus during the study period was 891.7 lbs/day. Mean nitrogen loads peaked in January 1996 at 376.0 lbs/day with an annual mean of the monthly values of 173.0 lbs/day. Mean effluent discharge flow from this WWTP was 9.3 MGD.

Rogers WWTP released an average of 162.3 lbs/day of phosphorus in October 1995 with an annual mean of the monthly averages of 88.5 lbs/day (Figure WQ-30). Nitrogen loads peaked in May 1995 with an average of 522.3 lbs/day, and a yearly mean of the 12 months of 165.1 lbs/day. A similar annual pattern existed for nitrogen as for phosphorus at this discharge.

The highest monthly phosphorus loads from the Fayetteville WWTP was in May 1995 at 19.6 lbs/day and the annual mean was 10.1 lbs/day. Throughout the year, the phosphorus loading was very consistent (Figure WQ-31). Mean nitrogen loads were highest from Fayetteville during August 1995 at 351.7 lbs/day which was the greatest nitrogen contribution to the system per month for the year.

Prairie Grove WWTP contributed the smallest load of nutrients to the Illinois River of the four facilities. Phosphorus and nitrogen loads peaked in May 1995 at 11.9 and 52.0 lbs/day, respectively. Annual mean phosphorus loads were 8.6 lbs/day and mean nitrogen loads were 36.9 lbs/day (Figure WQ-32). Phosphorus loading from this facility was generally uniform while nitrogen loads were somewhat more variable.

Because of the extensive data from the Springdale facility, daily total phosphorus loads were plotted for this facility in Figure WQ-33. This plot shows a substantial fluctuation in the phosphorus loads from the Springdale discharge. Daily flows and concentrations of total phosphorus from this facility are plotted in Figure WQ-34. By comparing this figure with Figure WQ-33, it is apparent how the weekly cyclic flows, i.e., higher flows during weekdays and lower flows on weekends, influences the daily loads. A similar weekly cycle can be seen in the phosphorus concentrations. However, there was also a seasonal variation, with generally higher concentrations in August through November and lower values in December through February.

Figure WQ-28. Nutrient loads discharged by WWTP's in the Illinois River Watershed.

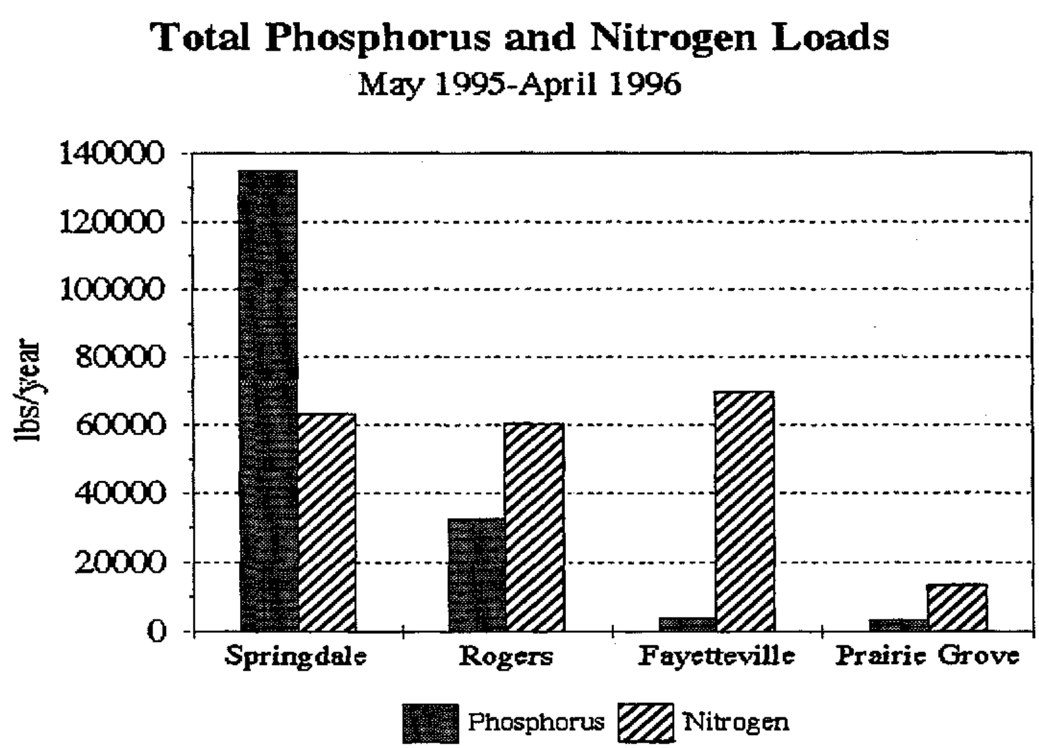


Figure WQ-29. Monthly nutrient loads from Springdale's WWTP.

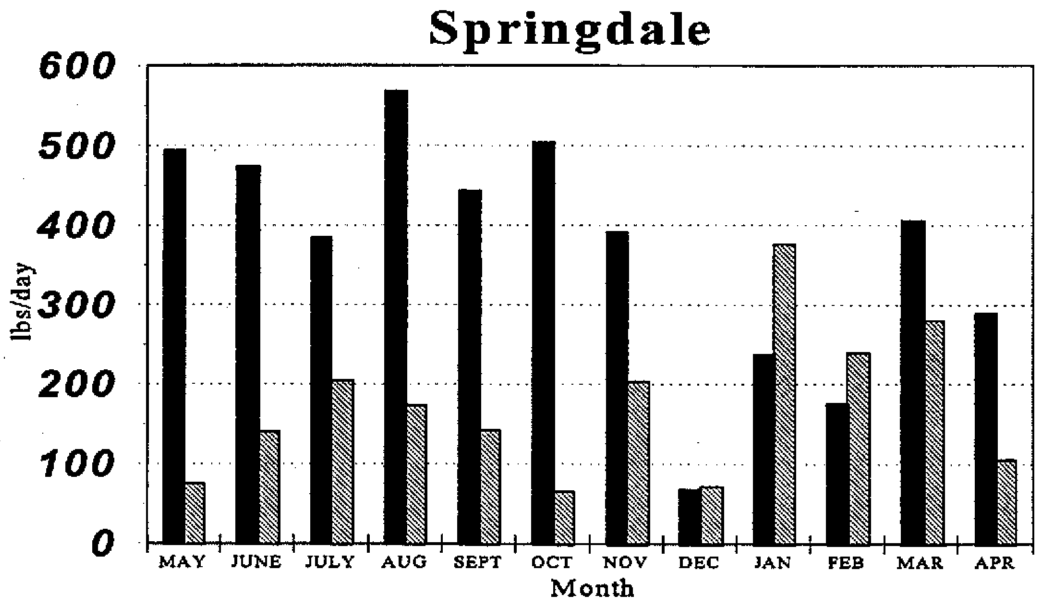


Figure WQ-30. Average daily load by month from Rogers' WWTP.

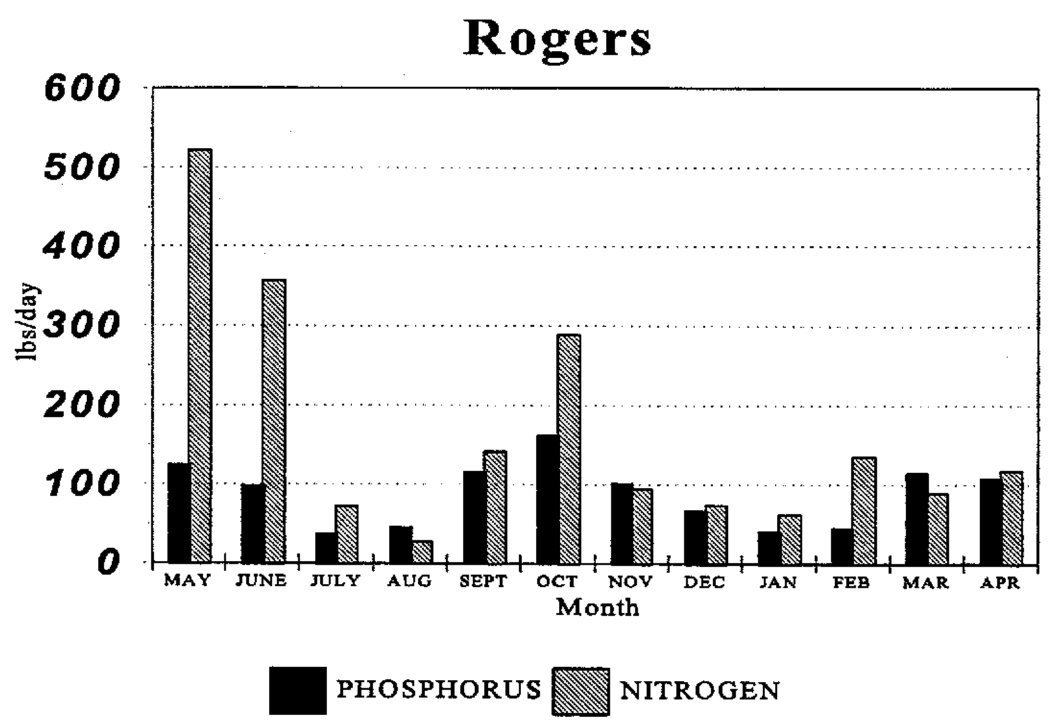


Figure WQ-31. Average daily load by month from Fayetteville's WWTP.

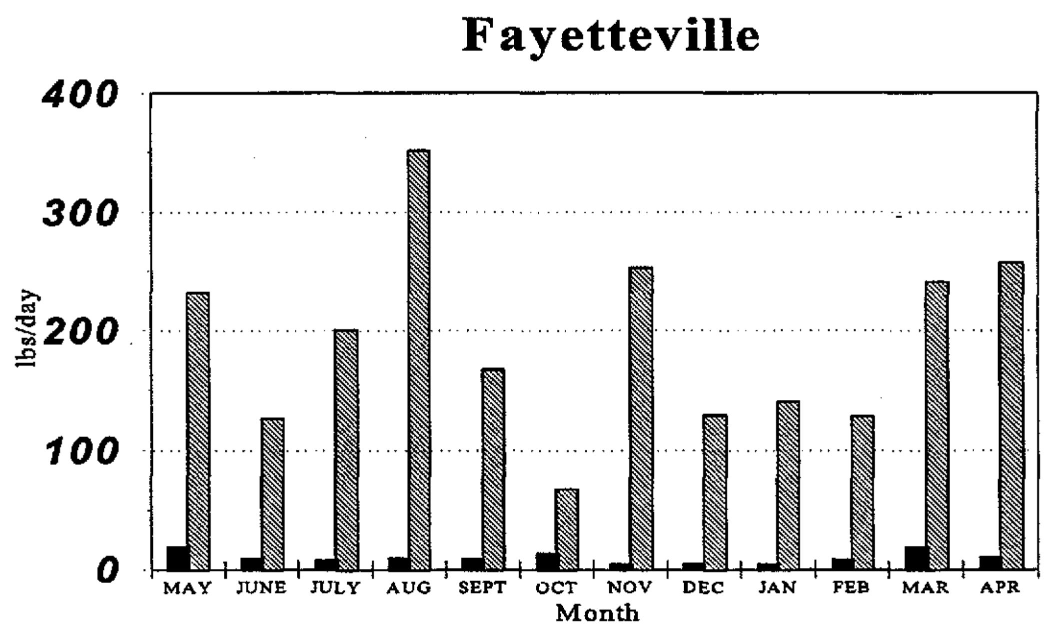


Figure WQ-32. Average daily load by month from Prairie Grove's WWTP.

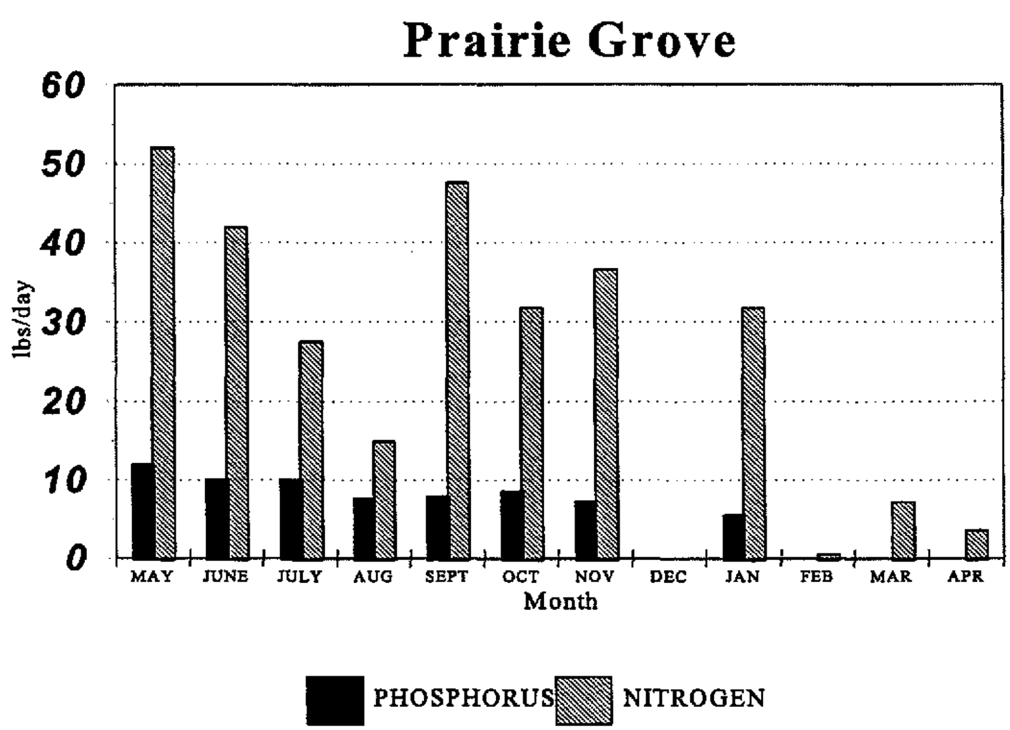


Figure WQ-33

Daily Phosphorus Load

Springdale WWTP

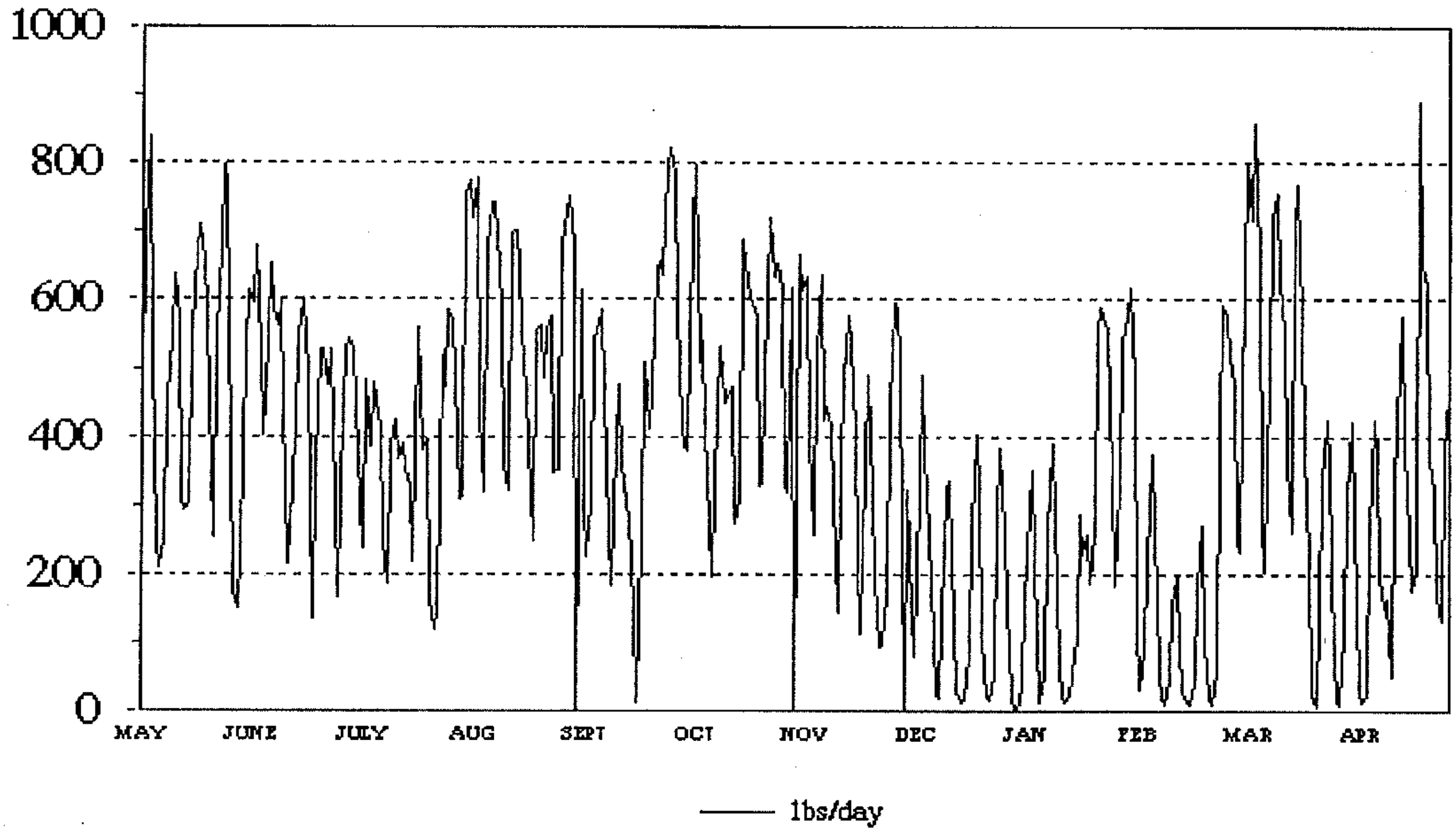
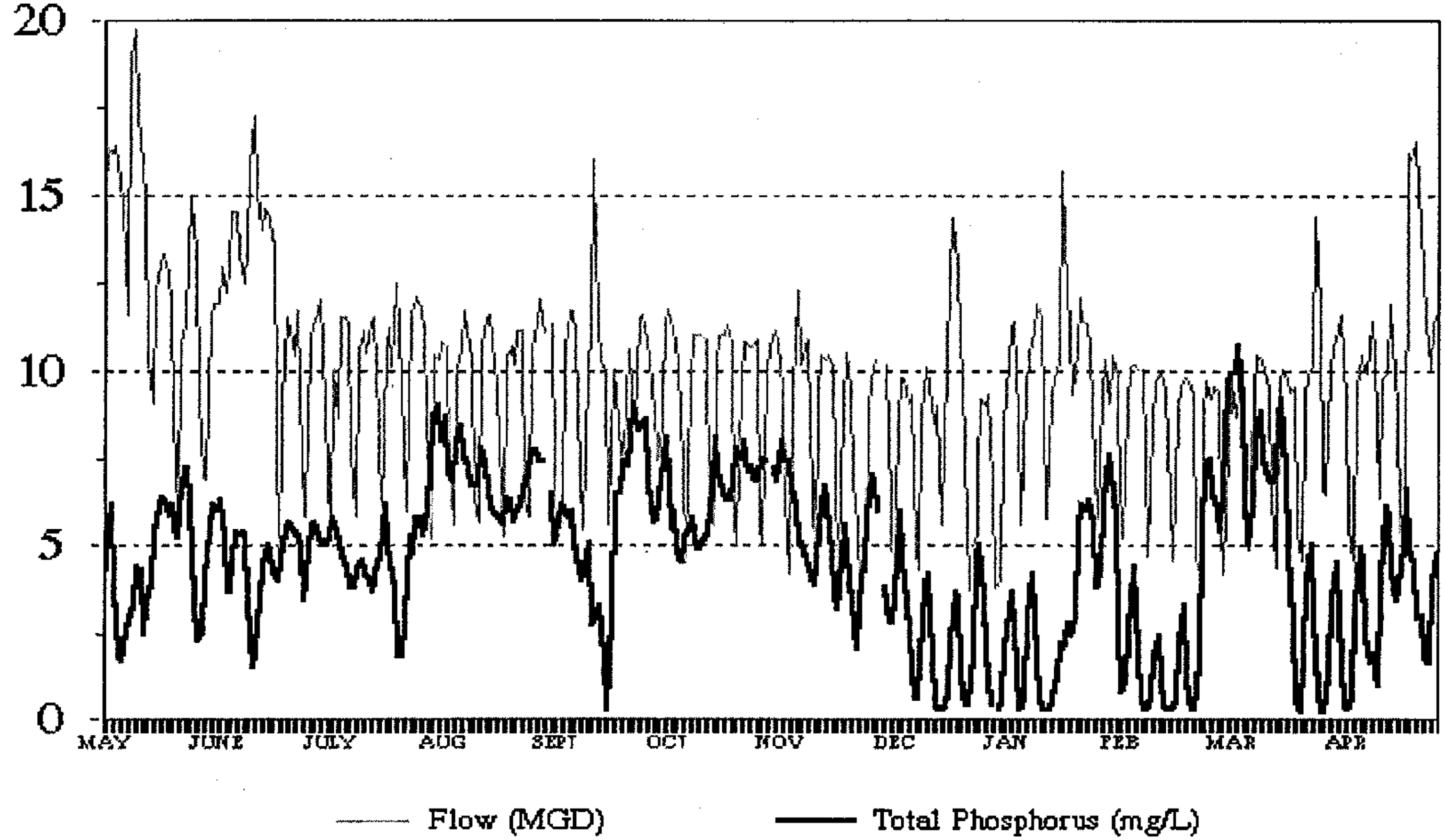


Figure WQ-34

Daily Phosphorus and Volume Discharge

Springdale WWTP



BIOLOGICAL DATA

Periphyton Production

An attempt was made to measure the productivity of the Illinois River watershed based on the growth of periphyton. Periphytometers were placed in the Illinois River and its tributaries for a period of approximately seven days. Analyses were performed to document levels of Chlorophyll-*a*, dry weight of biomass and ash free dry weight.

Materials and Methods

Floating periphytometers were constructed by attaching four 2-inch long 1-inch diameter acrylic rods with a known surface area to a 12 inch wooden dowel. This unit was supported by two pieces of buoyant foam and tethered to a weighted bag on the stream floor. This design was chosen due to its ability to rise and fall with the water level of the stream, thus keeping all acrylic rods at all sites at the same depth.

Periphyton sampling stations were located upstream and downstream of the four major point source discharges in the watershed. They were also located in the Illinois River upstream and downstream of its confluence with Osage Creek, Muddy Fork Illinois River, Clear Creek and in the Illinois River near the state line. Additionally, samplers were placed at intervals along the main stem of the Illinois River and Osage Creek in an effort to document the productivity of these waters.

Since a comparison would be made of the data obtained at each station, the exact position of all periphytometers in each stream was carefully chosen. In-situ measurements of pH, D.O., water temperature, depth, and stream velocity were recorded during deployment and retrieval. Percent canopy cover was recorded at deployment only. In stream sampler placement followed the Standard Operating Procedure provided by the Oklahoma Conservation Commission with the exception of the requirement that the stream velocity be <0.1 ft/sec. At some stations this criteria could not be met; however, an attempt was made to position samplers in the lowest velocity possible and to position the sampler at the comparison station in an area of similar velocity.

The decision was made to analyze the periphytic growth at each station for Chlorophyll-*a*, dry weight of biomass and ash free dry weight. Therefore, two samplers were placed at each of 18 sites in 1995 and 1996. At each station the four rods from one sampler were used for the Chlorophyll-*a* analysis and the other four rods for dry weight and ash free dry weight.

The following eighteen stations were chosen for periphyton sampling:

MFI01A	MFI02B
ILL01	ILL02
ILL03	ILL04
ILL05	ILL07
CLR01R	CLR05
MUD02B	OSC01A
OSC02B	OSC03
OSC04	OSC07
SPG01A	SPG02B

(see Figure 1)

Periphytometers were deployed on August 14,15,16, 1995 and were recovered August 21,22,23, 1995. The recovery was made in the same order as the deployment, therefore, all samplers deployed in 1995 were in the field for seven days +/- two hours. Sampling was repeated in 1996 by deploying the samplers on August 12 and retrieving on August 19 and 20. Due to the time required to retrieve the samplers, two days were required for completion. To ensure comparability of samples from similar areas, all stations were recovered on August 19 with the exception of those stations on Osage Creek which were recovered on August 20.

After the designated period, the samplers were carefully removed from the stream and disassembled. Those acrylic rods that were to be used for the dry weight and ash free dry weight analyses were placed in ventilated polypropylene wide-mouth bottles and returned to the lab for analysis. Those rods to be analyzed for Chlorophyll-*a* were scraped in the field, and the attached material was collected using a millipore vacuum funnel and 0.45 micron glass fiber filters. The collected material and filter were transferred by forceps to small petri plates, wrapped in aluminum foil and frozen on dry ice for the return trip to the lab.

In 1995, several samplers were either not found during retrieval or not included in the data base due to vandalism. The sample stations affected were CLR05, ILL07, OSC07 and one of two samplers at OSC03. In 1996, the samplers that were not recovered were from stations MUD02B, ILL04, ILL05 and OSC04. Also in 1996, the samples to be analyzed for dry weight and ash free weight at station OSC01A and OSC01AD (duplicate) were voided in the laboratory.

Results and Discussion

A tabulation of all periphyton data at all stations can be found in Appendix E. The data displayed considerable variability and some inconsistencies. For example, the ILL07 site in 1996 had the next to highest mean chlorophyll-*a* value recorded during the entire survey, but the ILL05(1995) site, which is about 10 miles upstream from the ILL07 site and below all of the major point source discharges, had the lowest value (Figure P-1). Somewhat more expected was that the Spring Creek site below the Springdale WWTP had the highest mean chlorophyll-*a* of all stations. This occurred in 1996. In 1995, this station had the second highest value of all stations for that year. However, the highest value for 1995 occurred above the Springdale WWTP. During both years the chlorophyll-*a* values at all stations on Osage Creek were very similar.

In 1996, a slight increase in productivity was noted below the Prairie Grove WWTP (Figure P-2). Chlorophyll-*a* values at MFI01A (above the discharge) was 17.24 mg/m^2 (c.v.24%). Below the discharge the chlorophyll-*a* was 29.46 mg/m^2 (c.v.16%). This trend of higher chlorophyll-*a* downstream was not apparent in the Illinois River. The chlorophyll-*a* value at ILL01 was 17.89 mg/m^2 (c.v.19%). In the Illinois River below Muddy Fork (ILL02)the Chlorophyll-*a* value was 10.40 mg/m^2 (c.v.21%).

The samplers deployed in 1996 below the Fayetteville WWTP were not recovered, and in 1995, the samplers from the reference stream were not recovered. Therefore the only comparison that could be made from the Mud and Clear Creek basin was from the 1996 data at the upstream reference site (CLR01R) and the station near the mouth of Clear Creek (CLR05). These stations had chlorophyll-*a* values of 4.29 mg/m^2 (c.v.61%) and 26.22 mg/m^2 (c.v.3%) respectively (Figure P-2). The difference in these chlorophyll-*a* values was probably a result of the much larger watershed and sections of intense urban development and intensely grazed pasture land above station CLR05.

Below the Rogers WWTP (OSC02B) in both 1995 and 1996, the chlorophyll-*a* values were very similar to those found above. Values were also similar at the other two Osage Creek stations. Chlorophyll-*a* values in Osage Creek ranged from 11.07 mg/m^2(c.v.37%) to 18.08 mg/m^2 (c.v.26%) (Figure P-1).

Conflicting data were obtained from the samplers deployed in Spring Creek in 1995 and 1996. In 1995, a higher chlorophyll-*a* value was found above the Springdale discharge (SPG01A) than below (SPG02B). Those values were 36.65 mg/m^2 (c.v.26%) and 28.23 mg/m^2 (c.v.25%) respectively (Figure P-3). In 1996, chlorophyll-*a* values were nearly 400% higher downstream at SPG02B than upstream at SPG01A. However, it should be noted that the coefficient of variation at SPG02B in 1996 was very high (Figure P-2).

In the Illinois River in 1995, the periphytometers were lost at ILL07. In 1996, ILL04 and ILL05 samplers were lost. Therefore, no comparison could be made between the station upstream of Osage Creek and the downstream-most station (ILL07). However, the ILL04 and ILL05 samplers were recovered in 1995. These chlorophyll-*a* values reflect a lower chlorophyll-*a* concentration below the confluence of Osage Creek than in the Illinois River above Osage Creek. Those values were 10.25 mg/m^2 (c.v.25%) above and 2.32 mg/m^2 (c.v.84%) below (Figure P-3). The highest chlorophyll-*a* value found in the Illinois River was at station ILL07 in 1996. This could have been influenced by the total lack of canopy cover at this site.

Figure P-1

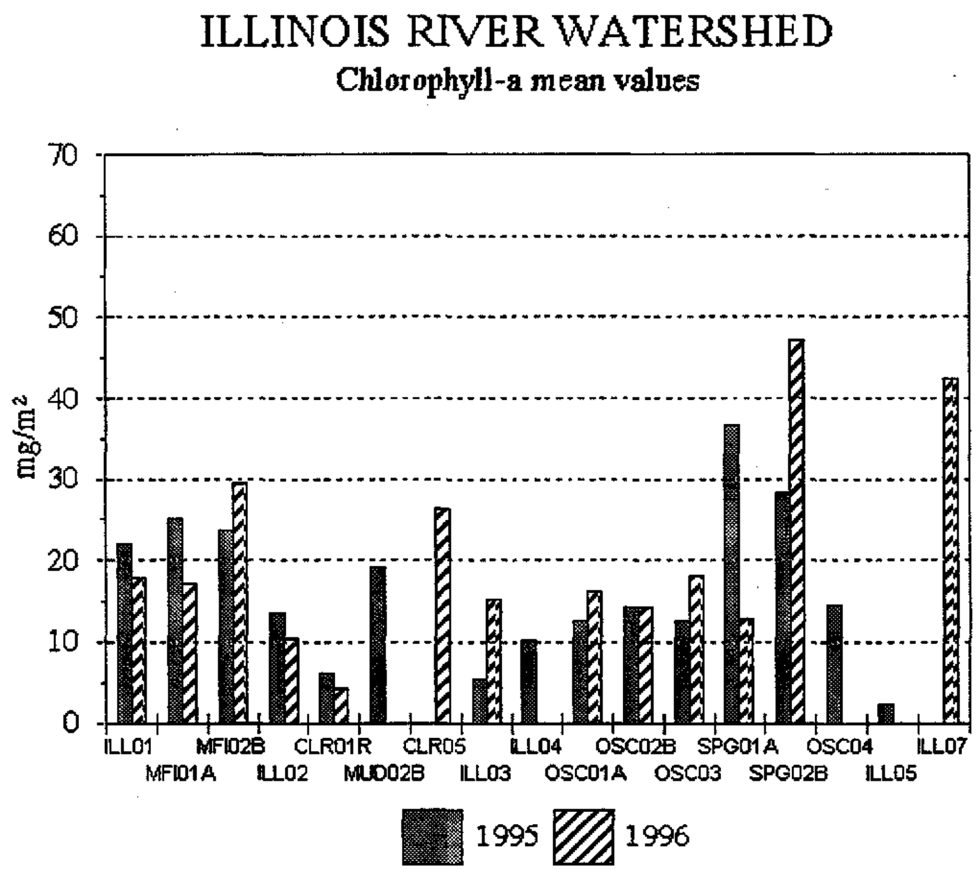

ILLINOIS RIVER WATERSHED
Chlorophyll-a mean values
70
60
50
40
30
20
10
0
mg/m²
ILL01
MFI01A
MFI02B
ILL02
CLR01R
MUD02B
CLR05
ILL03
ILL04
OSC01A
OSC02B
OSC03
SPG01A
SPG02B
OSC04
ILL05
ILL07
1995
1996

Figure P-2

ILLINOIS RIVER WATERSHED 1996

Chlorophyll-a

mean +/- one standard deviation

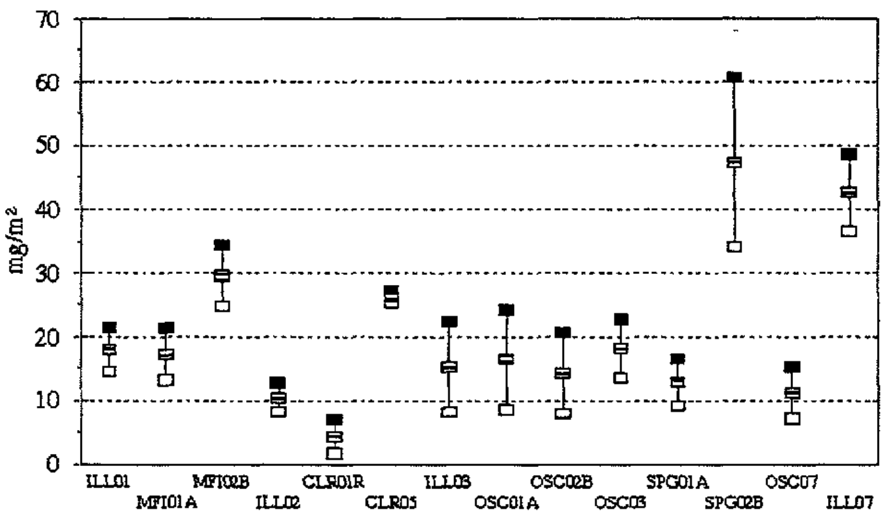
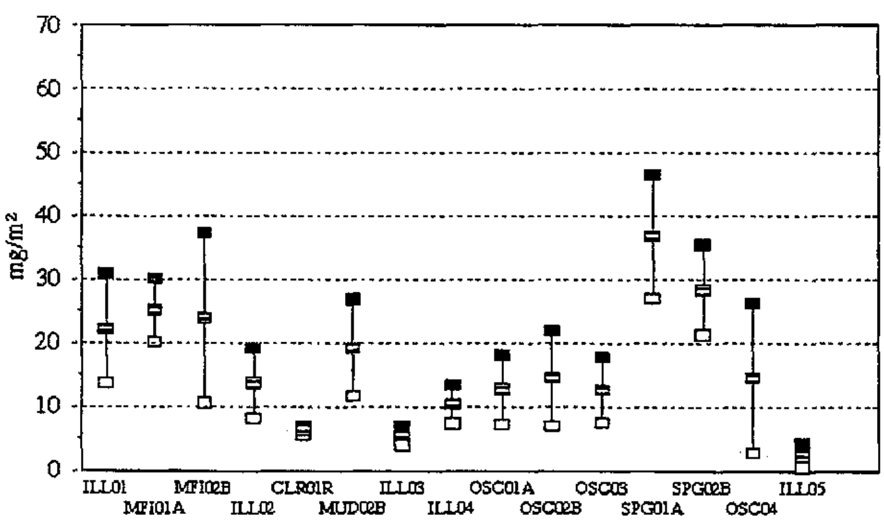


Figure P-3

ILLINOIS RIVER WATERSHED 1995

Chlorophyll-a

mean +/- one standard deviation



Macroinvertebrate Communities

Rapid bioassessment (RBA) techniques were used to collect and analyze macroinvertebrate populations throughout the Illinois River study area. The techniques are similar to those listed in the EPA document, Rapid Bioassessment Protocols for Use in Streams and Rivers (Plafkin et al, 1989). The protocol used most closely follows Protocol Three in that document. Some modifications have been made to fulfill the objective of this study, which was to evaluate the water quality of selected sites through macroinvertebrate community analyses. The seven metrics used in the final community analyses were those used by Oklahoma in a similar study of Sager Creek (ADPCE & OWRB, 1995). One metric used by Oklahoma was omitted as will be discussed in a later section. Macroinvertebrate samples were collected at the same sites that were sampled for periphyton production.

Materials and Methods

Ninteen macroinvertebrate samples were collected during the study. One macroinvertebrate sample was collected at each station except ILL03 where two samples were collected due to differences in riffle habitats. All macroinvertebrate samples were collected using a 1 M kicknet, as described by Plafkin et al. (1989). The kicknet was placed at random in a riffle. Approximately one square meter of the substrate upstream of the net was agitated by kicking. Dislodged organisms collected on the net. The net was removed and visually examined to decide if sufficient organisms were available for a sample. If sufficient organisms were not observed, the net was repositioned in the riffle and kicking continued. When it was determined that sufficient organisms were available for a subsample, the net was washed into a large bucket. The bucket contents were then sieved through a U.S. Standard No. 30 sieve. Sieved organisms and extraneous material were placed in a labeled jar for laboratory picking and identification. Samples were preserved with a 70% solution of ethyl alcohol (ethanol).

In the laboratory, the samples were rinsed in a small pore sieve and placed in a 305-mm X 460-mm aluminum pan for picking. The pan was swirled to achieve even distribution of material throughout. Subsamples of organisms were taken by randomly tossing a 105-mm ring into the pan. All organisms inside the ring were picked. The ring subsampling continued until a minimum of 95 organisms had been collected. All organisms in the ring were picked after each toss. Subsamples were preserved with fresh 70% ethanol until identification.

Taxonomic determinations were done by one individual to reduce variation between the samples. Organisms were identified to the lowest feasible taxonomic level, usually genus. Various keys were used to identify the organisms including, but not limited to, Merritt and Cummins (1984) and Pennak (1978). Identifications were checked against the ADPC&E macroinvertebrate list, regional distribution lists or other lists to decide validity. All questionable identifications were corroborated by an in-house taxonomist. Taxa and raw tallies were recorded on bench sheets.

Table M-1. Metrics and raw data used in RBA analyses.

Metric	Station										
	CLR01R	CLR05	ILL01	ILL02	ILL03	ILL03(g)	ILL04	ILL05	ILL07	MFI01A	MFI02B
Taxa Richness	13	11	13	13	9	16	9	14	10	7	10
Hilsenhoff Biotic Index	2.5	2.9	2.9	2.6	3.0	2.9	2.9	2.8	2.6	3.1	3.1
Contribution of Dominant Taxa (%)	28	30	28	27	47	41	45	37	38	43	32
EPT Index	5	6	5	7	4	10	5	7	5	3	5
EPT Abundance / (Chironomidae+EPT Abundances)	0.88	0.87	0.75	0.91	0.96	0.96	1.00	0.96	0.99	0.71	0.66
Scraper Abundance / (Scraper+Filter Feeder Abundances)	1.0	1.0	0.95	1.0	0.94	0.95	0.98	1.0	1.0	1.0	1.0
Community Loss Index based	REF	0.5	0.4	0.4	0.6	0.4	0.9	0.4	0.5	1.0	0.6

Metric	Station							
	MUD02B	OSG01A	OSG02B	OSG03	OSG04	OSG07	SPG01A	SPG02B
Taxa Richness	10	9	13	14	11	13	9	13
Hilsenhoff Biotic Index	2.9	3.0	2.7	2.7	2.7	2.8	3.0	3.0
Contribution of Dominant Taxa (%)	55	39	38	30	28	33	63	66
EPT Index	3	4	4	7	4	4	4	6
EPT Abundance / (Chironomidae+EPT Abundances)	0.81	0.89	0.92	0.86	0.88	0.99	0.97	0.93
Scraper Abundance / (Scraper+Filter Feeder Abundances)	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Community Loss Index	0.7	0.9	0.5	0.4	0.5	0.5	0.9	0.5

Organisms and raw counts were entered into a computer spreadsheet for data analysis. Data analyses were accomplished using spreadsheet calculations from Charlie Howell of EPA Region 6, with modifications to use genus-level identifications. Rapid bioassessment scores were calculated in the spreadsheet and were printed for review.

Community comparisons were made using the seven metrics listed in Tables M-1 and M-2. RBA community comparison scores were determined by comparing scores with a reference site. The metrics were those used by Oklahoma Water Respurces Board to characterize water quality in Sager Creek. The metric omitted in this study is the Functional Group Percent Similarity. Coarse particulate organic matter (CPOM) samples are required to evaluate this metric fully. CPOM sampling was not done during this study. Therefore, that metric is omitted from the analysis.

All analyses are based, primarily, on genus-level identifications. The spreadsheet program scores each metric from zero to six based on actual data or a comparison of the study site to the reference site, as indicated in Table M-2. The scores for each site are totaled as shown in Table M-2. The total at the study site is compared with the total of the reference site and is expressed as a percentage. The percentage is compared with the chart in Table M-3 to find the level of impairment. The biologist has some room to make professional judgements on samples that fall in the areas between impairment levels.

Table M-2. RBA metrics and scores based on scoring criteria.

Metric	Station										
	CLR01R	CLR05	ILL01	ILL02	ILL03	ILL03(g)	ILL04	ILL05	ILL07	MFI01A	MFI02B
Taxa Richness[1]	6	6	6	6	4	6	4	6	4	2	4
Hilsenhoff Biotic Index[1]	6	6	6	6	4	6	6	6	6	4	4
Contribution of Dominant Taxa	4	2	4	4	0	0	0	2	2	0	2
EPT Index[1]	6	6	6	6	2	6	6	6	6	0	6
EPT Abundance / (Chironomidae+EPT Abundances)	6	6	4	6	6	6	6	6	6	4	4
Scraper Abundance / (Scraper+Filter Feeder Abundances)[1]	6	6	6	6	6	6	6	6	6	6	6
Community Loss Index	6	4	6	6	4	6	4	6	4	4	4
Sum of Metrics	40	36	38	40	26	36	32	38	34	20	30

Metric	Station							
	MUD02B	OSG01A	OSG02B	OSG03	OSG04	OSG07	SPG01A	SPG02B
Taxa Richness[1]	4	4	6	6	6	4	4	6
Hilsenhoff Biotic Index[1]	6	4	6	6	6	6	4	4
Contribution of Dominant Taxa	0	2	2	2	4	2	0	0
EPT Index[1]	0	2	2	6	2	2	2	6
EPT Abundance / (Chironomidae+EPT Abundances)	6	6	6	6	6	6	6	6
Scraper Abundance / (Scraper+Filter Feeder Abundances)[1]	6	6	6	6	6	6	6	6
Community Loss Index	4	4	4	6	4	4	4	4
Sum of Metrics	26	28	32	38	34	30	26	32

[1]-score is based on a comparison with the reference site (CLR01R in this table)

Table M-3. RBA scoring categories and community characteristics (Plafkin et al., 1989)

Percent Comparison to Reference	Biological Condition Category	Community Characteristics
>83%	Not Significantly Impaired	• comparable to ideal situation for region • good community structure and function for stream size and habitat quality
54 - 79%	Slightly Impaired	• taxa richess decreased due to loss of sensitive taxa • tolerant forms increase in relative abundance • trophic structure beginning to show imbalance
21-50%	Moderately Impaired	• continued decrease in sensitive taxa • EPT taxa richness declines • shift in anticipated trophic structure
<17%	Severely Impaired	• severe reduction in taxa richness • organisms density may markedly decreased or increased • if increased densities are observed taxa list is dominated by one or two tolerant forms

Habitat assessments and limited water quality analyses were done when the macroinvertebrate samples were collected. Habitat assessments are a part of the rapid bioassessment process. They are not intended to be exhaustive descriptions of the site. The primary use of the habitat assessment is to insure that stations being compared in the RBA could support similar communities. Habitat measurements were taken after macroinvertebrate sampling to avoid physical disturbance of the organisms. Riffle lengths and widths were measured using a fiberglass tape. Average water velocity was determined using a flow meter at random points across the riffle. Water depth and substrate composition were recorded at 10 equidistant points along a transect set perpendicular to the riffle being studied. Inorganic substrate components were categorized as bedrock, large boulder, small boulder, cobble, gravel, sand, and silt (fines). Organic components were also observed and recorded. These components included both large and small woody debris; emergent and submergent vegetation; thin layer periphyton and filamentous algae; leaf litter; and fine detritus.

Habitat assessments included a categorical description of the surrounding land usage, riparian area and any channel alteration. Canopy cover was determined using a canopy densiometer. Water depth, current velocity, substrate composition, and canopy cover were determined in the immediate area the macroinvertebrate sample was collected. The land usage, riparian area, and channel alteration observations encompassed a visually observable area both upstream and downstream of the macroinvertebrate sample site. Stream flows taken during the summer water quality sampling events were used in the habitat analysis.

Habitat parameters are scored by category. The scores are summed, similar to RBA scores. Individual site scores are compared to the reference site to determine a percentage. If the habitat comparison is greater than or equal to 90% then the study site is considered

comparable to the reference. The community at a site in this category should have similar structure and function as the reference site. If the evaluation site is 75%-88% of the reference, then the community is considered **supporting**. While the community at a site in this category may not exactly resemble the reference site, it should be similar in diversity and function. Habitat comparisons in the 60-73% range fall in the **partially supporting** category. Communities at sites in this category may differ from the reference site because of habitat quality. Site comparisons that fall in this category must be made with discretion. Habitat comparisons using sites with less than 59% comparison are considered **non-supporting**. Community comparisons in the non-supporting range are not valid.

Water quality measurements were taken before and just upstream of the macroinvertebrate samples. Parameters included D.O., pH, and temperature. Data collected during this phase of the study was not critical since massive water quality sampling efforts were the focus of another part of the study. All parameters were recorded using meters calibrated at the beginning of the day and checked against known standards throughout the day.

Results

Taxa lists were generated for each station. Raw macroinvertebrate data are shown in Appendix F. In an RBA analysis, raw data are usually only considered important as a consideration in the final analysis. It is also acknowledged that a RBA is a community-based comparison of several metrics and any one metric is not as important as the sum of the comparisons. However, in deciding that the comparison of reference to study sites is valid it is important that one examine the individual metrics. Sometimes, the fauna at a reference site may not be as good as that of the study site. For these cases, only by looking at the raw data and individual metrics can one make this determination. Therefore, each metric was reviewed individually, in addition to its use in composite scoring.

The total number of individuals or numeric abundance in a subsample can be deceptive. It is not evaluated as a metric in the RBA analysis. The number primarily depends on the subsampling process, but it can suggest the relative abundance of organisms in a sample. The number of "ring tosses" required to collect the subsample is important. Four tosses were made to collect the subsamples in the CLR01R, ILL05, and OSG07 samples. Two tosses were required to collect the subsample from the ILL01 site. The remainder of the sites required only one toss to achieve the required number of organisms for the subsample.

Total numeric abundance in this study ranged from a low of 93 at OSG07, because some organisms were determined to be terrestrial, to a high of 227 at MFI01A (Figure M-1). SPG01A ranked second in numeric abundance with 190 organisms. An interesting note is that the sites with the highest number of individuals required only one toss of the subsampling ring to get the required number of organisms. Some might argue that a greater relative abundance indicates a healthier population. If the greater abundance was accompanied by increased taxa richness this statement might be true. However, as will be discussed, taxa richness did not normally increase with increases in abundance. A greater abundance at stations, such as MFI01A, probably suggests that the food base is being artificially enhanced by nutrient input or another stress factor is playing a role in the aquatic environment.

Taxa richness is a gauge of diversity. Usually, higher taxa richness values are associated with better water quality. Thirty-eight (38) taxa were collected in the study, but taxa richness varied at each station. It ranged from 7 taxa at station MFI01A to 16 taxa at ILL03(g) (Figure M-2). The most common taxon encountered was *Baetis*, a mayfly nymph. *Baetis* was collected at all stations. *Baetis* was the most abundant taxon in the study which produced 858 organisms in the 19 samples. It was also the most abundant taxon in the individual samples. It occurred in the Spring Creek sites, SPG01A and SPG02B, at 119 and 109 individuals, respectively. *Stenonema*, another mayfly nymph, and Chironomidae (often called bloodworms) were the second most commonly encountered taxa. Each taxon occurred in 18 of the samples. *Cheumatopsyche*, a caddisfly larva, was the second most abundant taxon with 297 individuals collected in the study. It was collected in 15 of the 19 samples.

The Hilsenhoff Biotic Index (HBI) gives an indication of the pollution tolerance of the macroinvertebrate community. It ranges from zero to five with communities having lower values being considered less pollution tolerant than communities with higher values. The HBI values in this study ranged from 2.5 at CLR01R to 3.1 MFI01A and MFI02B. All HBI values were in the good to fair water quality range. The HBI values are illustrated in Figure M-3. HBI tolerance values for each taxon were taken from the publications by the Klemm et al. (1990) and Bode et al. (1991). The scoring ranges shown in Figure M-3 are from the Klemm et al. (1990).

The Percent Contribution of the Dominant Taxa (%DT) was highest at the Spring Creek sites with 63%DT at SPG01A and 66%DT at SPG02B. The lowest %DT was 27% recorded at ILL02. Three sites had values with 28%DT. Percent DT is plotted in Figure M-4. As with taxa richness, the %DT is an indication of diversity. Usually, better water quality is associated with streams that have lower %DT values.

The EPT Index is simply a taxa richness of the Ephemeroptera, Plecoptera and Trichoptera orders of insects. These orders are usually considered less tolerant of pollution. EPT Index values for this study ranged from a low of three at MFI01A and MUD02B to a high of ten at ILL03(g) (Figure M-5). The EPT to EPT and chironomid relative abundance ratio is another community balance metric. A community associated with good water quality should have a moderately balanced representation of all four groups. Ratios that are heavily weighted to the chironomid side may reflect a stressed community (Klemm et al., 1990). The EPT/EPT +Chironomidae abundance ratios in this study ranged from 0.71:1 at MFI01A to 1:1 at ILL04 (Figure M-6).

Scrapers to scrapers plus filter feeders ratios are shown in Figure M-7. It varied little throughout the study with the value being one at all but five of the study sites. The lowest

Figure M-1. Number of organisms collected at each Illinois River study site.

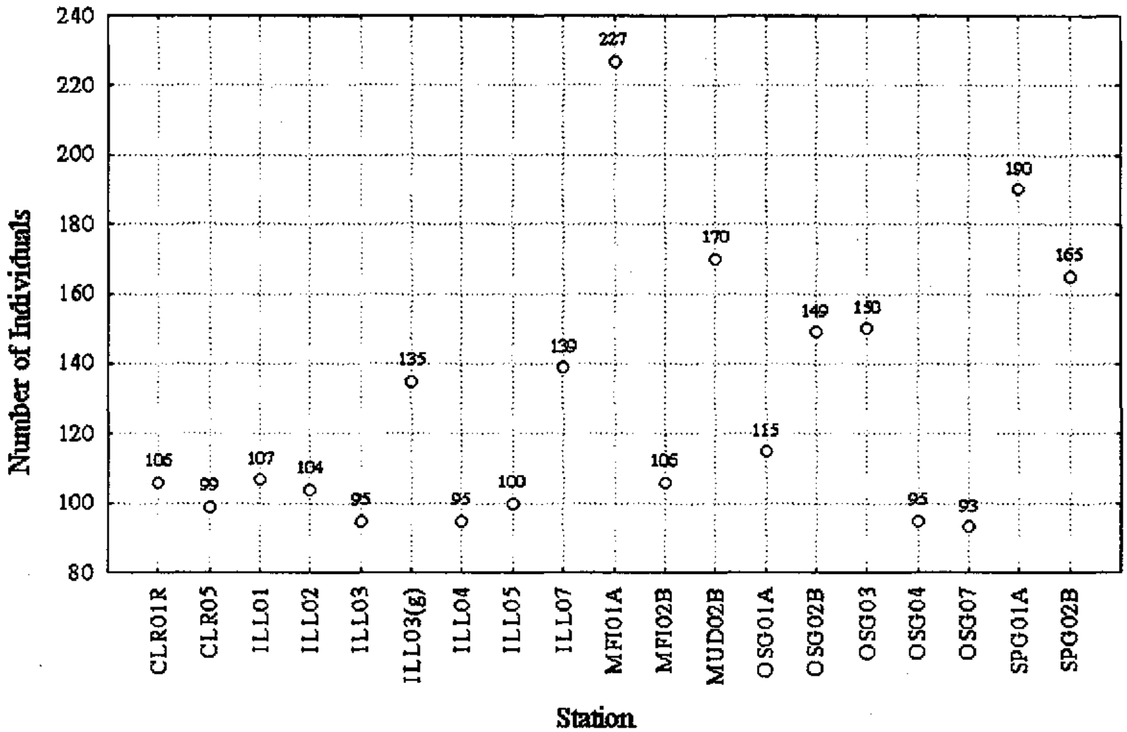


Figure M-2 Taxa richness at Illinois River study sites.

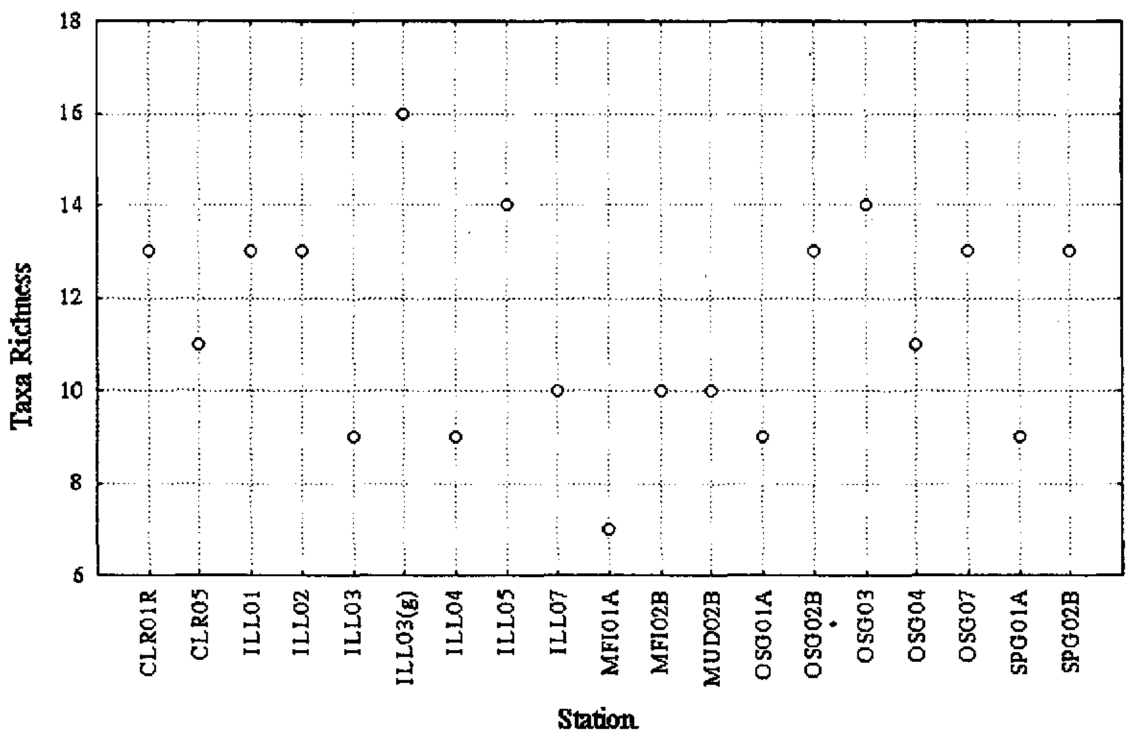


Figure M-3. Hilsenhoff Biotic Index values for Illinois River study sites.

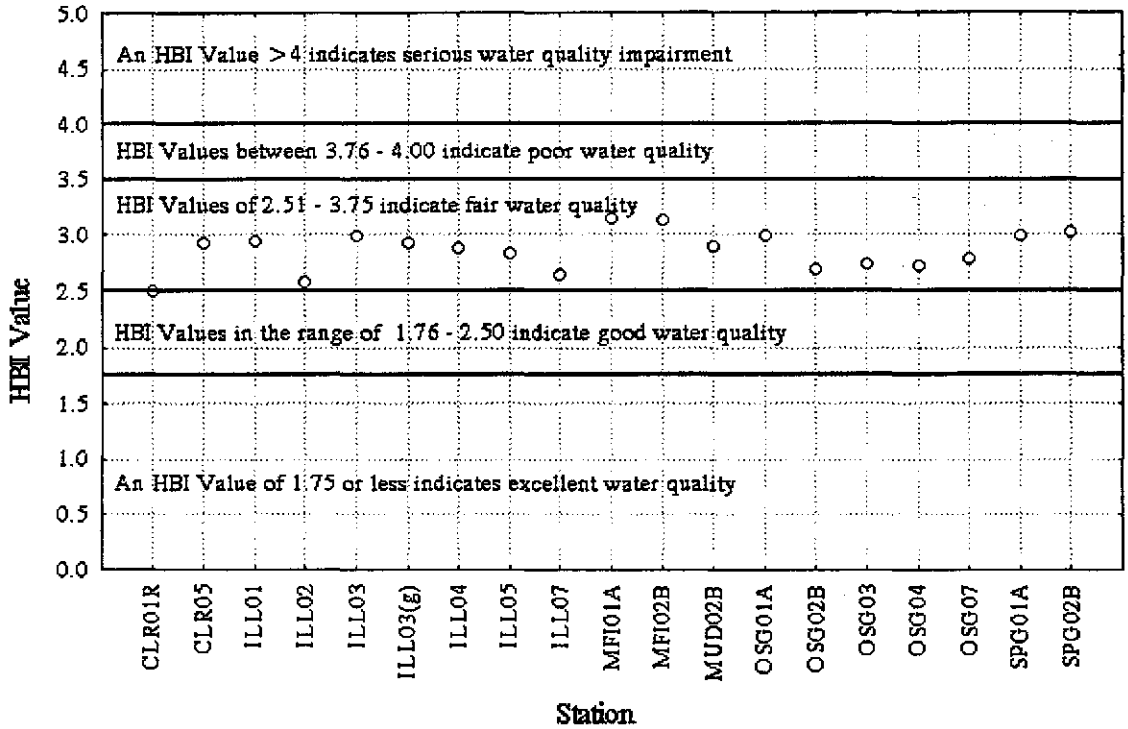


Figure M-4 Plot showing % contribution of dominant taxa at Illinois River study sites.

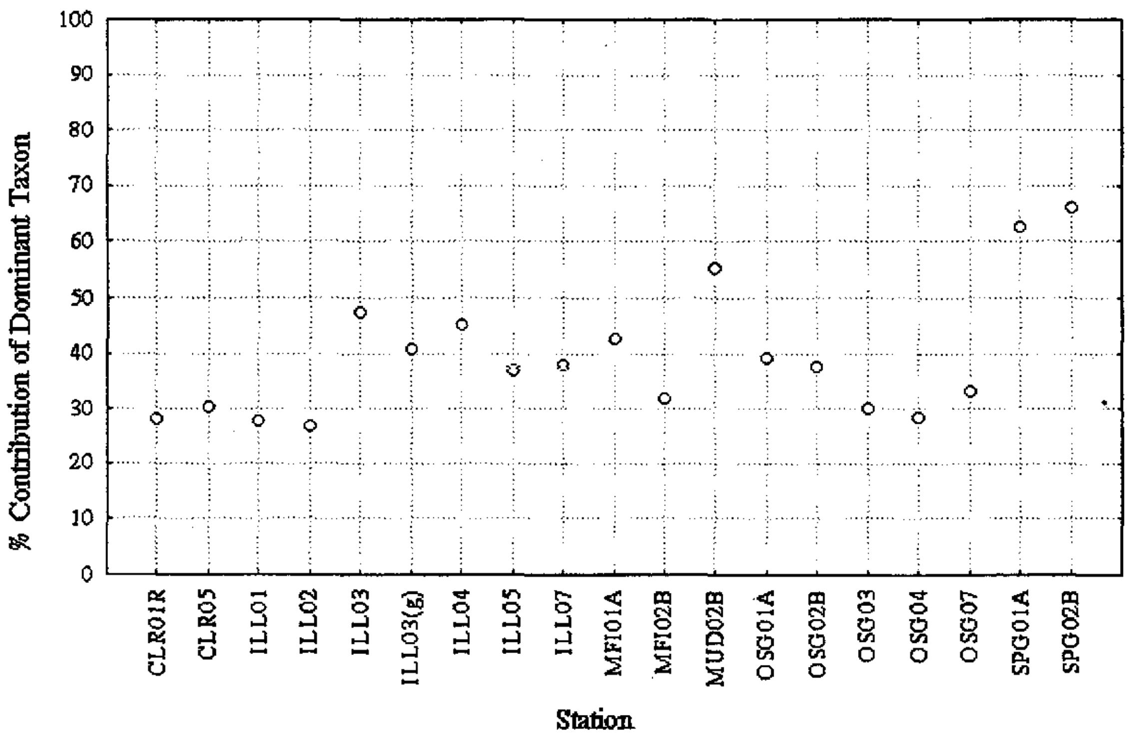


Figure M-5. EPT Index plot for Illinois River study sites.

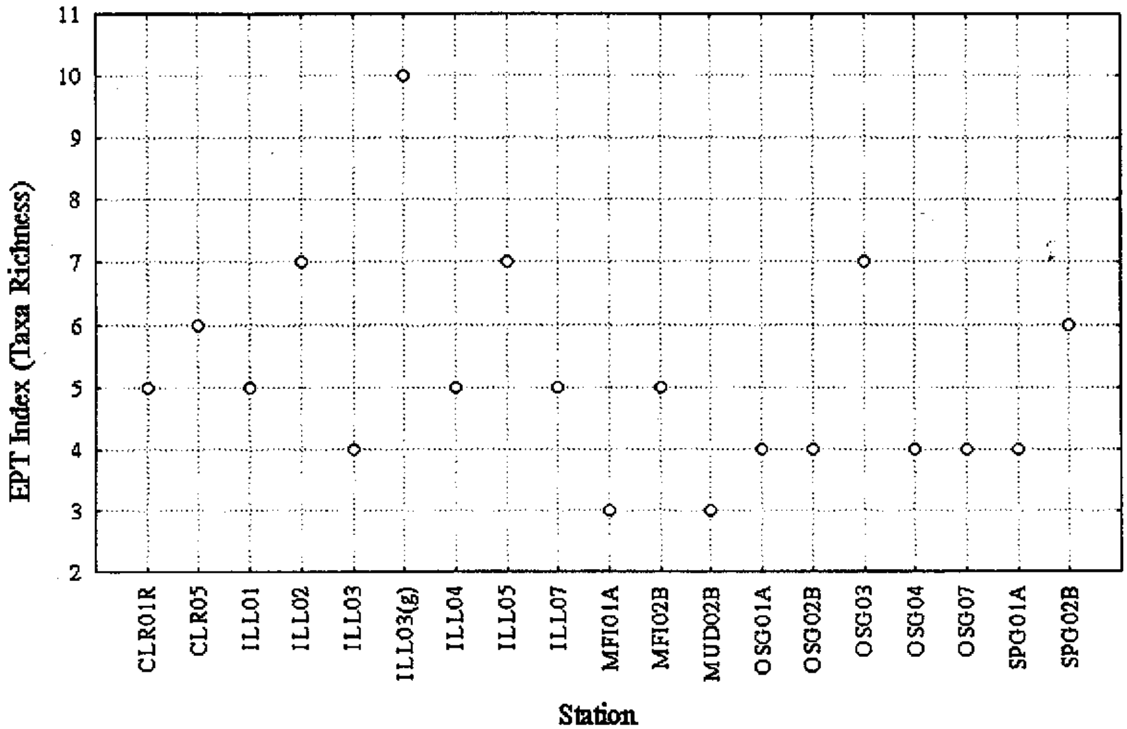


Figure M-6. EPT/(Chironomidae+EPT abundances) for Illinois River study sites.

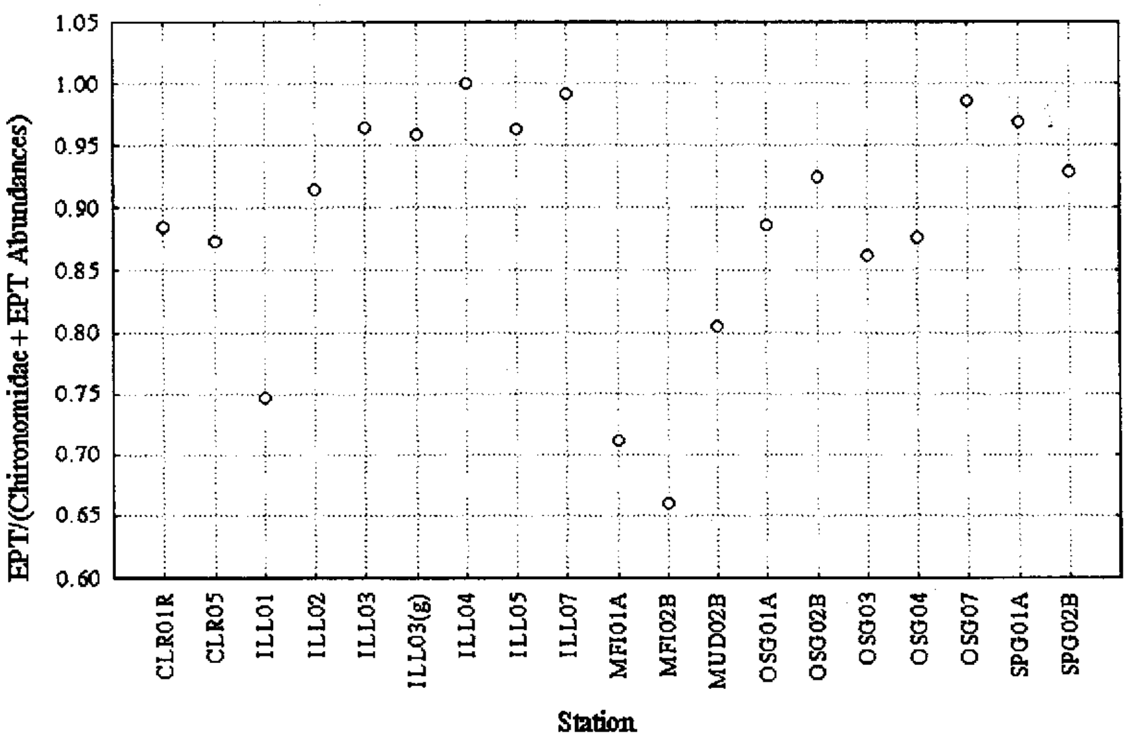


Figure M-7. Ratio of scraper to filter feeders+scrapers in the study sites.

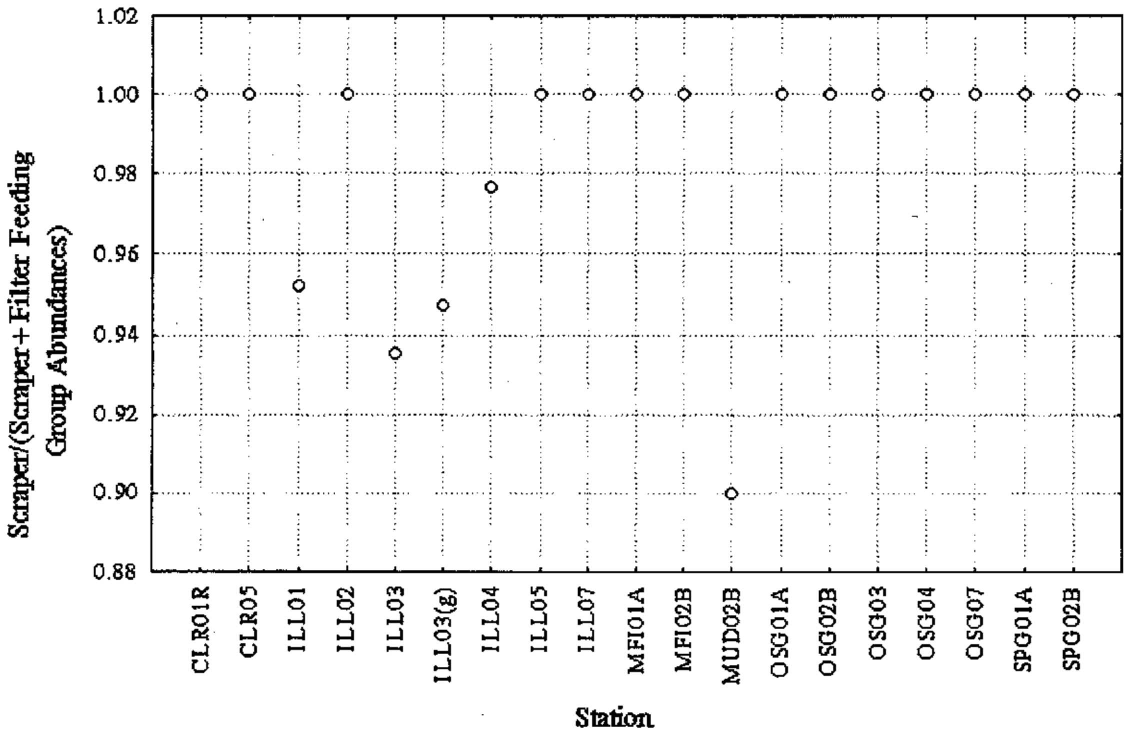
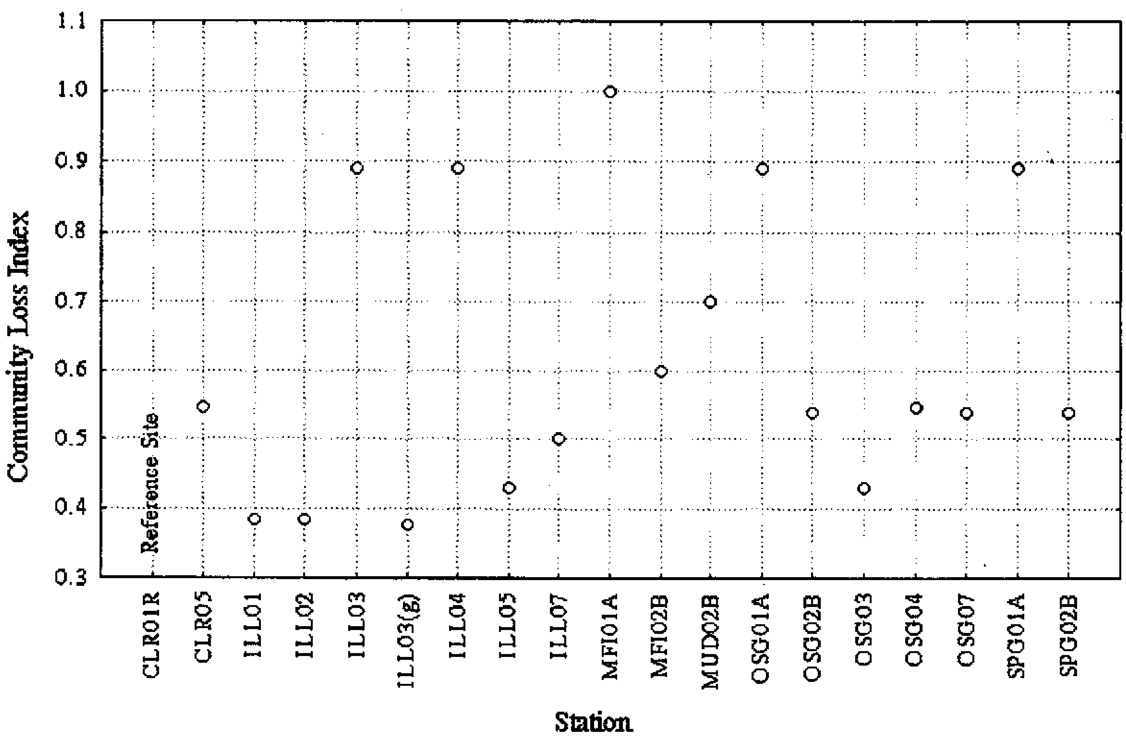


Figure M-8. Community Loss Index using CLR01R as the reference site.



ratio was 0.9, recorded at MUD02B. The ratio of the two feeding groups is integral. An overabundance of any one functional feeding group would reflect an unstable community. The unbalanced community could be a response to an excess of a particular food supply. Increases in the filter feeding group are usually associated with an increase in filamentous algae that is the result of organic enrichment (Klemm et al., 1990).

The community loss index (CLI) is a measurement of the loss of macroinvertebrate taxa between the reference site and the comparison station. Usually, high CLI values (~1.0) suggest significant differences in the communities because of some impairment. The CLI requires a reference site. Since most of the discussion will focus on CLR01R as the reference site for this study, the CLI was reviewed on that basis. Figure M-8 shows the CLI ranged from less than 0.4 at three sites to 1.0 at MFI01A.

Site characteristics are reported in Tables M-4 and M-5. Again, the main emphasis of the habitat assessment is to insure that stations in the comparison analysis could support similar macroinvertebrate communities. The value of the water quality data taken with the macroinvertebrate part of the study is diminished by the massive water sampling efforts undertaken and analyzed in a previous section. Therefore, it is not included in the tables and will not be evaluated.

Average depth of the sample area varied with the stream, stream width and to some extent watershed size. The deepest site sampled was in Osage Creek, OSG07, which had an average depth of 0.26 M. OSG07 is also the most downstream point sampled on Osage Creek. Site ILL02 was the deepest site in the Illinois River at 0.15 M. The most downstream point on the Illinois River, ILL07, was the shallowest riffle sampled. At this site, the stream is a wide, shallow area with deep pools both above and below the riffle. While flow is greater, it is spread out over the expansive gravel riffle. Therefore, the average depth of the sample area was reduced. Other sites had average depths between the two extremes discussed above (Table M-4).

Substrate composition (Table M-5) was primarily inorganic components (cobble, gravel, and sand) versus the organic components like vegetation, woody debris and detritus. The predominant substrate type was gravel (2-75 mm particle size). It was the major substrate component at all sites with values ranging from 50% to 100%. Cobble substrates (76-305 mm particle size) were recorded at 12 of the 18 sites. Cobbles ranged from 5-40% at sites where it was observed. Sand and silt or fines made up the remainder of the substrate in the sample sites. Sand occurred at MFI01A and MFI02B and made up 6.7% and 30% of the substrate at each site, respectively. Silt was recorded at MFI01A and MUD02B making up between 20 and 25 percent of the substrate at each site. Although other substrate materials like bedrock, large boulders, and small boulders were observed at several sites, they did not occur directly in the sampled area.

Table M-4. Stream measurements, bank features and riparian area description of the Illinois River study sites.

Station	Stream Measurements					Bank Features			Riparian Area Description									
	Water width (M)	Mean depth (M)	Mean velocity (M/s)	Flow (cfs)	Man-made Channel Alteration	Bank Stability[1]		Bank Material	Land Use[2]	Vegetation[3]								
										Trees		Shrubs		Grasses		Bare	
						L	R			L	R	L	R	L	R	L	R
CLR01R	4.3	0.05	0.4	3.4	Moderate	MS	MS	Soil-Gravel	U	M	M	M	M	M	M	S	A
CLR05	5.9	0.12	0.6	50	Some	MU	MS	Soil	A	D	M	S	S	S	M	S	S
ILL01	10.4	0.04	0.3	19	Moderate	MU	MU	Soil-Gravel	A	M	M	M	S	M	M	S	A
ILL02	16.8		0.3	31	Some	MU	MS	Soil	A	S	D	M	S	M	S	S	S
ILL03	12.8	0.03	0.4	81	Moderate	MS	MS	Soil-Gravel	AC	D	D	M	D	M	M	A	A
ILL03(g)	12.8	0.13	0.4	81	Moderate	MS	MS	Soil-Gravel	AC	D	D	M	D	M	M	A	A
ILL04	5.18	0.09	0.8	93	Moderate	MS	MU	Soil-Gravel	A	D	M	D	M	M	D	S	S
ILL05	8.5	0.14	0.40	301	Moderate	MU	U	Soil-Gravel	A	D	D	M	M	D	D	S	S
ILL07	5.5	0.03	0.43	338	Moderate	MU	MU	Soil	A	S	S	M	S	M	M	S	S
MFI01A	5.0	0.02	0.44	1.14	None	S	MS	Soil-Gravel	A	S	M	S	S	M	S	M	M
MFI02B	3.0	0.05	0.27	1.9	Some	MU	MU	Soil-Gravel	A	M	M	S	S	M	M	S	S
MUD02B	7.3	0.07	0.23	4.8	None	S	S	Soil-Gravel	U	A	S	D	D	D	D	A	A
OSG01A	6.7	0.05		18.7	Some	MU	MU	Soil-Gravel	U	M	M	S	M	M	S	S	S
OSG02B	6.1	0.12	0.5	40	Some	S	S	Gravel	A	M	S	S	S	S	D	S	S
OSG03	14.6	0.08	0.5	44	Moderate	MU	MU	Soil-Gravel	U	S	D	S	S	D	D	A	A
OSG04	22.9	0.06	0.5	84	Some	MS	MU	Soil-Gravel	A	M	S	S	S	M	M	S	S
OSG07	15.2	0.26	0.55	208	Some	MS	MU	Soil-Gravel	A	D	S	S	M	S	M	A	S
SPG01A	7.6	0.05	0.34	7.5	Some	MU	MU	Soil-Gravel	U	S	M	S	M	S	M	S	M
SPG02B	7.0	0.09	0.6	27	Some	U	U	Soil-Gravel	A	S	S	A	A	D	D	S	S

[1]S-Stable, MS-Mod. Stable, MU-Mod. Unstable, U-Unstable

[2]A-Animal Prod., AC-Agriculture, U-Urban

[3]D-Dense, M-Moderate, S-Sparse and A-Absent

Table M-5. Substrate composition of the Illinois River sample sites.

Bedrock, large boulders, instream vegetation and large woody debris have been omitted. Although, these components may have been present at the site, they were not recorded in the sample transects.

Station	Inorganic Components (% Coverage)					Organic Components (% encounterd)			Algae		Substrate embeddedness (%)	Canopy cover (%)
	Small boulder (330-610 mm)	Cobble (76-329 mm)	Gravel (2-75 mm)	Sand <2 mm gritty	Silt (fines)	Sm. woody debris	Leaf litter	Fine Detritus	Periphyton	Filamentous		
CLR01R	0	5	95	0	0	30	20	0	0	0	0	100
CLR05	0	0	100	0	0	0	0	0	60	0	0	100
ILL01	0	30	60	0	0	0	30	0	70	0	30	0
ILL02	0	0	100	0	0	0	0	0	100	0	0	52
ILL03	0	0	100	0	0	0	10	0	90	0	0	24
ILL04	0	100	0	0	20	0	0	0	70	0	20	12
ILL05	0	10	90	0	0	0	0	0	0	0	0	12
ILL07	0	0	100	0	0	0	0	0	100	0	0	0
MFI01A	0	10	61.6	6.7	21.7	0	40	0	20	10	58	0
MFI02B	0	20	50	30	0	0	0	0	10	30	70	100
MUD02B	0	18.3	58.3	0	23.4	0	0	0	90	30	70	0
OSG01A	0	30	70	0	0	0	20	0	40	0	86	0
OSG02B	0	15	85	0	0	0	10	0	40	0	25	90
OSG03	0	35	65	0	0	0	0	0	100	10	0	10
OSG04	0	0	100	0	0	0	0	0	100	0	0	0
OSG07	0	10	90	0	0	0	0	0	30	0	0	13
SPG01A	0	30	65	0	10	0	100	0	50	0	40	100
SPG02B	30	40	60	0	0	0	0	0	10	10	35	18

Substrates were heavily embedded (>50%) at three sites. MFI01A, MFI02B and MUD02B had embeddedness values of 58%, 70%, and 70%, respectively. SPG01A substrates were about 40% embedded and 35% embeddedness was recorded at SPG02B. The remainder of the stations had embeddness values ≤30% (Table M-5). Embeddedness has an impact on the fauna. If the interstitial spaces that macroinvertebrates occupy are taken up by silt and fines (embedded) then there is a reduction in either the numeric abundance or the taxa richness or both. Embeddedness can be caused by manmade channel alterations such as bridge construction, road construction and in stream gravel mining. It can also occur where large amounts of particulates are washed into the stream. These particulates may be the result of erosion. They may also be the result of runoff from pastures, areas where dry chicken litter is applied, or from confined feeding areas that are not operating using best management practices.

Organic substrate components were not detected in most of the riffles sampled. Emergent vegetation was recorded at one site, SPG02B. Submerged vegetation and large woody debris was not recorded at any site in the study. Small woody debris was limited to one site, CLR01R, where it was encountered at three points on the transect. Leaf litter was observed at seven of the sites in the study (Table M-5). The heaviest concentrations were found at the uppermost sites of the watersheds as one might expect (Vannote et al, 1980).

Periphyton, was prevalent on the rocks at most sites (Table M-5). Only two sites exhibited no periphyton growth, CLR01R and ILL05. Canopy cover was 100 percent at CLR01R and contributed to the lack of periphyton growth. Canopy cover was not a limiting factor at ILL05 as it only covered 12% of the sample area. The sample at ILL05 was taken in a glide type environment more than a riffle. The glide may not have been as conducive to periphyton growth. Filamentous algae were detected at six sites. It was most abundant at stations MFI02B and MUD02B. Filamentous algae were observed at three points along the transect at each of these sites. It also was recorded at one point on the transect at each of the following sites: CLR05, MFI01A, OSG03, and SPG02B.

Stream bank material was either soil, gravel, or a mixture of soil and gravel at all stations. Fully stable stream banks were observed at only two sites, MUD02B and OSG02B. The remainder of the sites exhibited some erosion potential with moderately stable banks to moderately unstable banks. SPG02B exhibited unstable banks on both sides of the stream. Bank stability has been affected throughout the study area by man's manipulation of the channel. At all but three sites, anthropogenic channel alteration was detected. The alteration ranged from minor manipulation for roads and bridges to extreme widening due to gravel removal or another cause. Only ILL03, MFI01A, and MUD02B showed no channel alteration from direct anthropogenic activity.

RBA evaluations were done by comparing a reference station to the station to be evaluated. Habitat comparisons were done to learn if the stations can support a similar fauna. Station comparisons were made using an overall reference site (CLR01R) and a same-stream reference site. Other comparisons based on habitat cluster analysis and stream flows were also evaluated to detect if impairments were due to varying conditions. All comparisons yielded similar results as will be revealed in the discussion.

RBA metrics and scores are displayed in Table M-2. Macroinvertebrate community analysis showed that eight sites were not significantly impaired when compared with CLR01R (Figure M-9). Four sites had RBA scores that fell in the range between the not significantly impaired and slightly impaired. Five samples had macroinvertebrate faunas that showed slight impairment when compared with the community at CLR01R. Only station MFI01A was moderately impaired in the CLR01R comparison. MFI01A showed a 50% decrease in the quality of the fauna compared with the reference site (Table M-6 and Figure M-9).

RBA scores based on same-stream reference sites were similar to the CLR01R comparisons (Table M-6 and Figure M-10). CLR05 was compared with CLR01R again, giving the same results. ILL02 served as the reference site for the Illinois River stations. The fauna at ILL02, while not as good as the ILL03(g) site, was more representative. Based on the ILL02 comparison, the ILL01 station dropped from an RBA comparison of 95 to 80. ILL03 comparison came up from 65 to 70, while ILL03(g) remained constant at 95. RBA scores at ILL04 and ILL07 also decreased in the same-stream comparison. ILL04 decreased 5 points to 75, and ILL07 dropped from 85 to 75. The MFI stations were difficult to compare as both appear to be influenced by some source of pollution. Using MFI01A as the reference, MFI02B had an RBA score of 104 suggesting the macroinvertebrate community is actually better at MFI02B. OSG03 was used for the Osage Creek comparisons. The same-stream comparisons for each Osage Creek station showed a 4-point increase over the CLR01R comparisons except OSG04 declined from 85 to 79. The SPG02B RBA score, when compared with SPG01A, was 100 suggesting no significant difference in the communities.

Clustering analysis was also done on the raw habitat data to develop another set of comparisons. Habitat data was grouped into four clusters of stations. A reference community was selected from each cluster. Only one cluster had a questionable reference community. In that cluster, ILL05 was used for comparison. The results of the RBA comparisons based on the habitat cluster analysis are shown in Table M-6 and Figure M-11. Comparisons were not much different from the previously described values. ILL04 went from borderline not significantly impaired and slightly impaired to the slightly impaired group. It was the only RBA score that went down based on the comparison. The RBA habitat cluster comparison at MFI01A went up from moderately impaired to slightly impaired in the habitat cluster comparisons, probably a result of comparing to a lesser quality reference site.

In a previous ADPC&E study (ADPC&E, 1996), it was observed that macroinvertebrate communities differentiated based on flow. According to the results of that study and the RBA protocols of EPA (Plafkin et al., 1989), five cubic feet per second (cfs) is the break over point where flows have an impact on the community. Based on that information, macroinvertebrate communities in streams with flows less than 5 cfs were compared with a reference site within

Table M-6. Biological condition of Illinois River sites expressed as a percent of reference.

RBA site scores as compared to		Station									
		CLR01R	CLR05	ILL01	ILL02	ILL03	ILL03(g)	ILL04	ILL05	ILL07	MFI01A
Overall Reference Site	CLR01R	REF[1]	90	95	100	65	90	80	95	85	50
Instream Reference Site	Varied	REF	90	80	REF	70	90	75	95	75	REF
Reference Sites Based on Habitat Cluster Analysis	ILL02				REF	65	90	70		80	
	CLR01R	REF	90								
	ILL05								REF		
	ILL01			REF							58
Flow based reference <5 cfs	CLR01R	REF									50
Flow based reference >5 cfs	ILL02		90	85	REF	65	90	70	95	80	

RBA site scores as compared to		Station								
		MFI02B	MUD02B	OSG01A	OSG02B	OSG03	OSG04	OSG07	SPG01A	SPG02B
Overall Reference Site	CLR01R	75	65	70	80	95	85	80	65	80
Instream Reference Site	Varied	104	65*	74	84	REF	79	84	REF	100
Reference Sites Based on Habitat Cluster Analysis	ILL02					95	80			
	CLR01R	75		70	80				65	
	ILL05							84		89
	ILL01		68							
Flow based reference <5 cfs	CLR01R	75	65							
Flow based reference > 5cfs	ILL02			70	80	95	80	80	65	85

[1] - Site used for reference
* - CLR01R used for reference

that group. Likewise, streams with greater than 5 cfs were compared with a reference community. CLR01R continued to serve as the reference community in the less than 5 cfs sites. ILL02 was used in the comparisons of the above 5 cfs group. Again, there was little deviation in the numbers from these comparisons and the other comparisons (Table M-6 and Figure M-12).

The flow-based habitat assessment showed that all but one site in the study should support a fauna similar to CLR01R. Only MFI02B fell into the partially supporting range when compared with CLR01R (Figure M-9). All same-stream reference site habitat comparisons showed that the study site should at least support a community similar to the reference site. Most of the comparisons were greater than 90%, considered fully comparable in the RBA analysis (Figure M-10). The cluster analysis habitat comparisons were similar to the previous comparisons (Figure M-11). MFI02B remained in the partially supporting category since the reference site was CLR01R. Habitat comparisons based on flows less than 5 cfs were shown to be fully supportive, except the Muddy Fork sites (Figure M-12). MFI01A and MFI02B continued to fall into supporting and partially supporting categories, respectively. In streams with 5 cfs or greater flows, all habitat analyses were considered comparable except SPG02B. The habitat assessment at SPG02B was in the supporting category (Figure M-12).

Discussion

Since CLR01R is not directly influenced by any discharges or has any major nonpoint sources of pollution, this part of the discussion will focus on that site as the reference site. The habitat analysis shows that all communities sampled in the study should at least support a community similar to CLR01R (Figure M-9). As previously mentioned, MFI02B had the lowest habitat comparability score at 75% of the reference. The remainder of the habitat scores showed that all sites should support communities similar to the reference.

One macroinvertebrate community, MFI01A, showed moderate impairment in comparison to CLR01R. A review of the metrics suggests this is probably an accurate assessment of the MFI01A macroinvertebrate community. It scored the worst or next to worst in five of the seven metrics analyzed. It also had the greatest relative abundance. These indicators show that the community at MFI01A is impaired. The most likely source of the impairment is nonpoint source pollution since this station was not associated with a specific National Pollutant Discharge Elimination System (NPDES) permitted discharge.

Five sites showed slight impairment in comparison to the CLR01R reference site. The Mud Creek (MUD02B) community was only about 65% of the CLR01R community. Again, this site scored poorly in the metrics analyzed. With this limited data, it would be premature to determine if the impact is due to the discharge from City of Fayetteville to this stream, but something is clearly having an impact on the community at this site.

The ILL03 site fell into the slightly impaired category, also. It is interesting since the ILL03(g) site, nearly the same site, scored consistently better in all metrics. The ILL03 sample was collected in a very shallow portion of the riffle. It is possible that this area was influenced by warmer temperatures, and this area may be totally dry at times and the community may reflect that. The ILL03(g) site was done in a deeper part of the riffle with greater velocity. It was less likely to go dry during periods of reduced rainfall. In any case, the apparent community impairment at ILL03 is probably not directly related to pollution sources.

The uppermost Spring Creek and Osage Creek sites (SPG01A and OSG01A) showed slight impairment. These sites are possibly impaired by channel alteration or the community changes might be due to manmade influences such as nonpoint source pollution. What is probably occurring here is that the communities reflect the coldwater influence of the springs that feed them. Coldwater communities are usually dominated by taxa that have adapted to the colder conditions. The coldwater organisms also fall into the category of greater tolerance to pollution or other stressors. Therefore, these communities usually score lower in an RBA analysis.

MFI02B also fell into the slightly impaired category. Since this site is below an NPDES discharge it would be very easy to assume that the impairment is a direct result of the discharge. This would probably be an incorrect assumption. The habitat score at this site showed that this site indicates only partial support for a community similar to CLR01R (Figure M-9). The same-stream reference comparisons showed that the community at this site was much better when compared with MFI01A, the upstream site. With these facts in mind, it is probably safe to say that the water quality at this site is not detrimentally altered by the discharge from Prairie Grove.

The OSG02B and SPG02B sites fell into the category between slightly impaired and not significantly impaired. The limited data set makes an assessment of these communities which are between categories somewhat difficult. It could be argued that OSG02B and SPG02B are reflecting the discharge from the cities of Rogers and Springdale. In the flow-based and cluster-based comparisons, OSG02B fell into the area between impairment categories while SPG02B showed no significant impairment. These sites should probably be categorized just the way they are, borderline between not significantly impaired to slightly impaired. Placement in this category would emphasize that any additional stress from the NPDES discharges would probably have a detrimental impact on these communities.

Macroinvertebrate communities at OSG07 and ILL04 were also in the gray area between slightly impaired and not significantly impaired. These sites are not associated with specific discharges. If the sites are impaired, it would be due to the cumulative effects of both nonpoint and point-source pollution. Here, the other reference-based determinations were reviewed to see how OSG07 and ILL04 were categorized. Based on the same-stream reference and the cluster-based comparisons, OSG07 showed no significant impairment. Flow-based comparisons continued to show that OSG07 was in the gray area of impairment between slight and not significant. In the author's judgement, this station should probably be classified as not significantly impaired. It does, again, point out the fragility of this stream system. Any additional influence from pollutant sources could result in decreased quality of the macroinvertebrate community in these streams. On the other hand, ILL04 scored consistently in the slightly impaired category of each of the other comparisons. Therefore, the decreased quality of the macroinvertebrate community at this site is probably the result of pollution-related influences.

In the same-stream reference site comparisons, MUD02B, ILL03, and OSG01A continued to score in the slightly impaired category. The influences on these communities have been discussed previously. ILL04, ILL07, and OSG04 also showed slight impairment based on the same-stream reference comparison. In the cluster-based comparisons and flow-based comparisons, ILL07 and OSG04 fell in the area between the slightly impaired and not significantly impaired categories. Therefore, these sites are probably borderline not significantly impaired. This suggests the need for pollution control to avoid potential impacts to the biotic integrity at these sites.

Eight of the nineteen communities analyzed showed no significant impairment in the CLR01R comparisons (Figure M-9). Communities falling into this category include the Clear Creek site below the Mud Creek confluence (CLR05); communities of the Illinois River including ILL01, ILL02, ILL03(g), ILL05, and ILL07; and OSG03 and OSG04 on Osage Creek. These categorizations indicate that the deterioration of the macroinvertebrate communities of the other sites is localized at this time.

Finally, as a sideline of the study, some regression analyses with 95% confidence limits was done on the comparisons. In the previously cited ADPC&E study (1996), the metrics showed normal distribution, a result of the study sites being randomly selected. In this study, one might not expect to see normal distribution since the stream sites were selected to bracket discharges and confluences with other streams. If we assume that random site selection would give us normal distribution, we could use the linear regression analysis and the resulting confidence limits to make some determinations.

In Plafkin et al. (1989) , three possible curves are described on page 8-2 and reproduced here in Figure M-13. The mid-line shows those stations where the biotic community actually reflects the habitat quality with no deleterious effects from water quality. The bottom curve reflects a biological community that is reacting to a stressor such as severely degraded water quality or a toxic substance. Another curve (curve I in the Figure M-13) reflects a biotic community that exceeds the habitat quality. This could be the result of an artificial enhancement of the community by excess nutrient input, but not to the point of causing stress to the community.

In all figures illustrating the comparisons, the linear regression line with 95% confidence limits has been drawn. Examining the graphs we find that MUD02B and ILL03 are consistently below the 95% confidence limit line for all comparisons (Figures M-9 to M-12). MFI01A and SPG01A are below the confidence limits in three of the four comparisons, further validating our previous assumptions that these communities were impaired. MFI01A and MUD02B were impaired by pollutant related sources and SPG01A by coldwater influence. When CLR01R was used as a reference, OSG02B, OSG04, and OSG07 all fell between the 95% confidence intervals. These results may show that the biotic community is reflecting the carrying capacity of the habitat at these sites.

Of more interest are the sites that occur above the 95% confidence intervals. No community occurred above the 95% confidence limits in all comparisons, but ILL03(g), ILL05, OSG03, and SPG02B were above the line in three of the four comparisons. If our assumptions are

Figure M-9. Reference-based (CLR01R) RBA analysis.

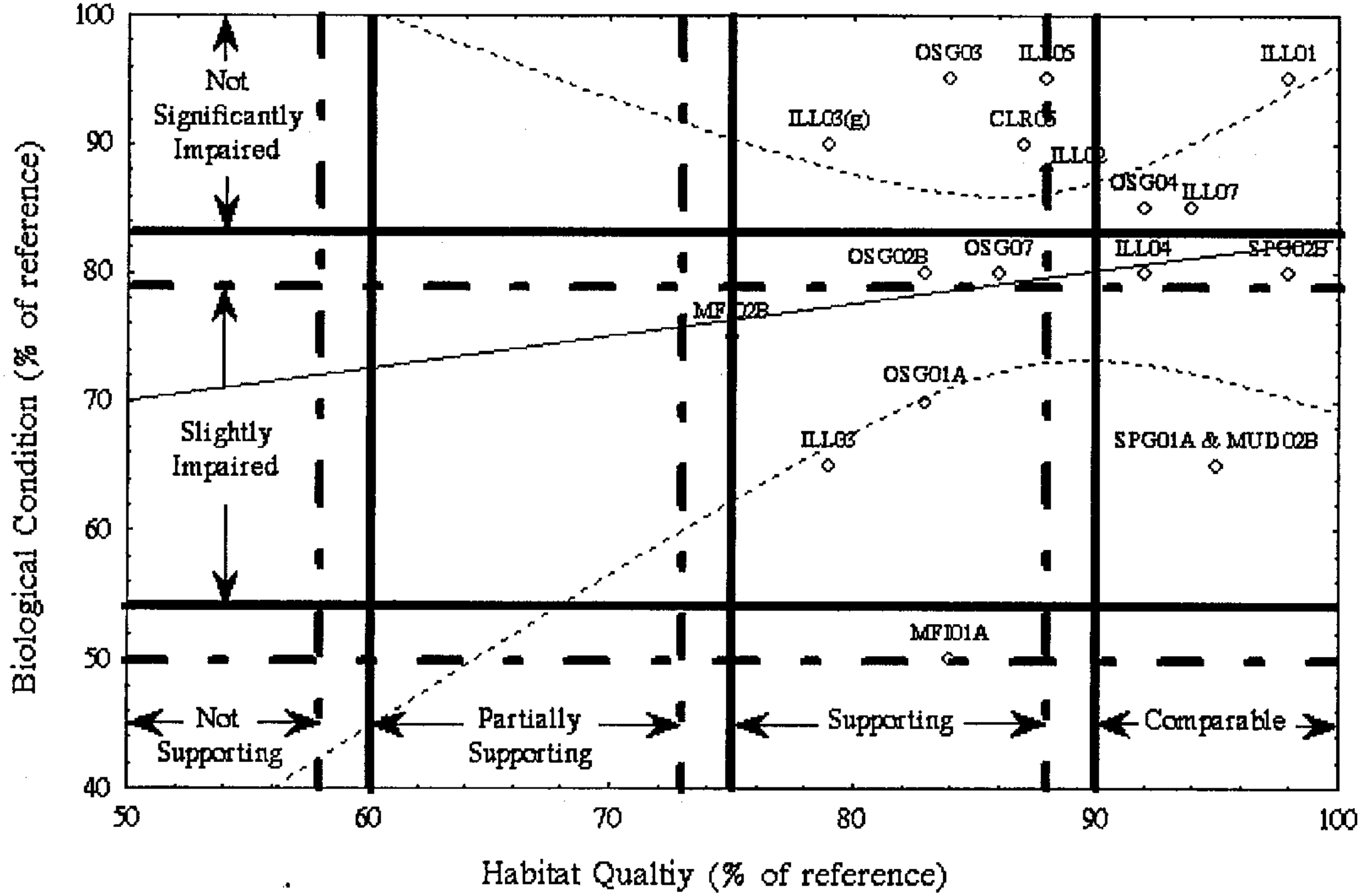


Figure M-10. Same-stream reference-based RBA analysis.

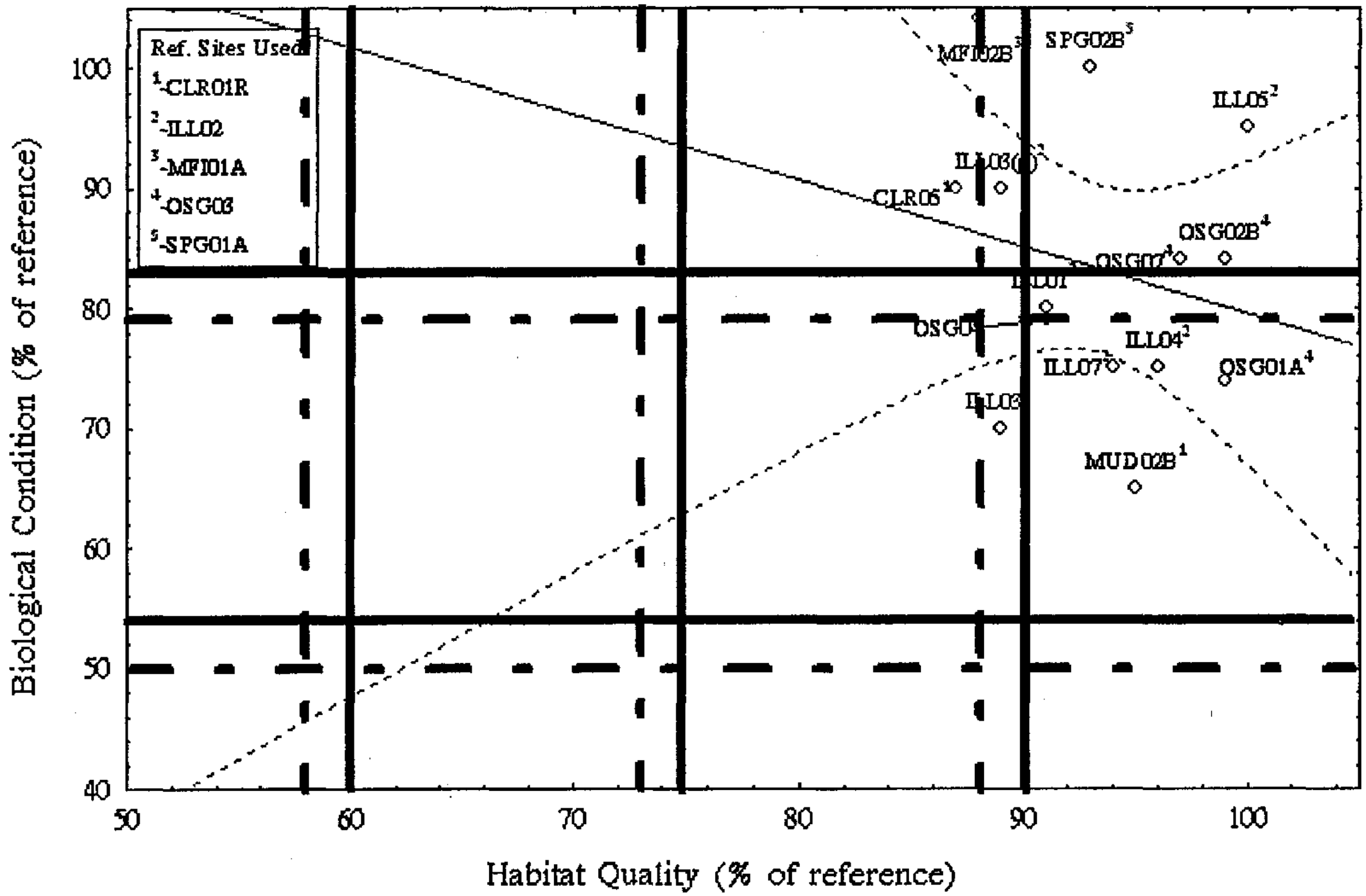


Figure M-11. Cluster-based RBA analysis.

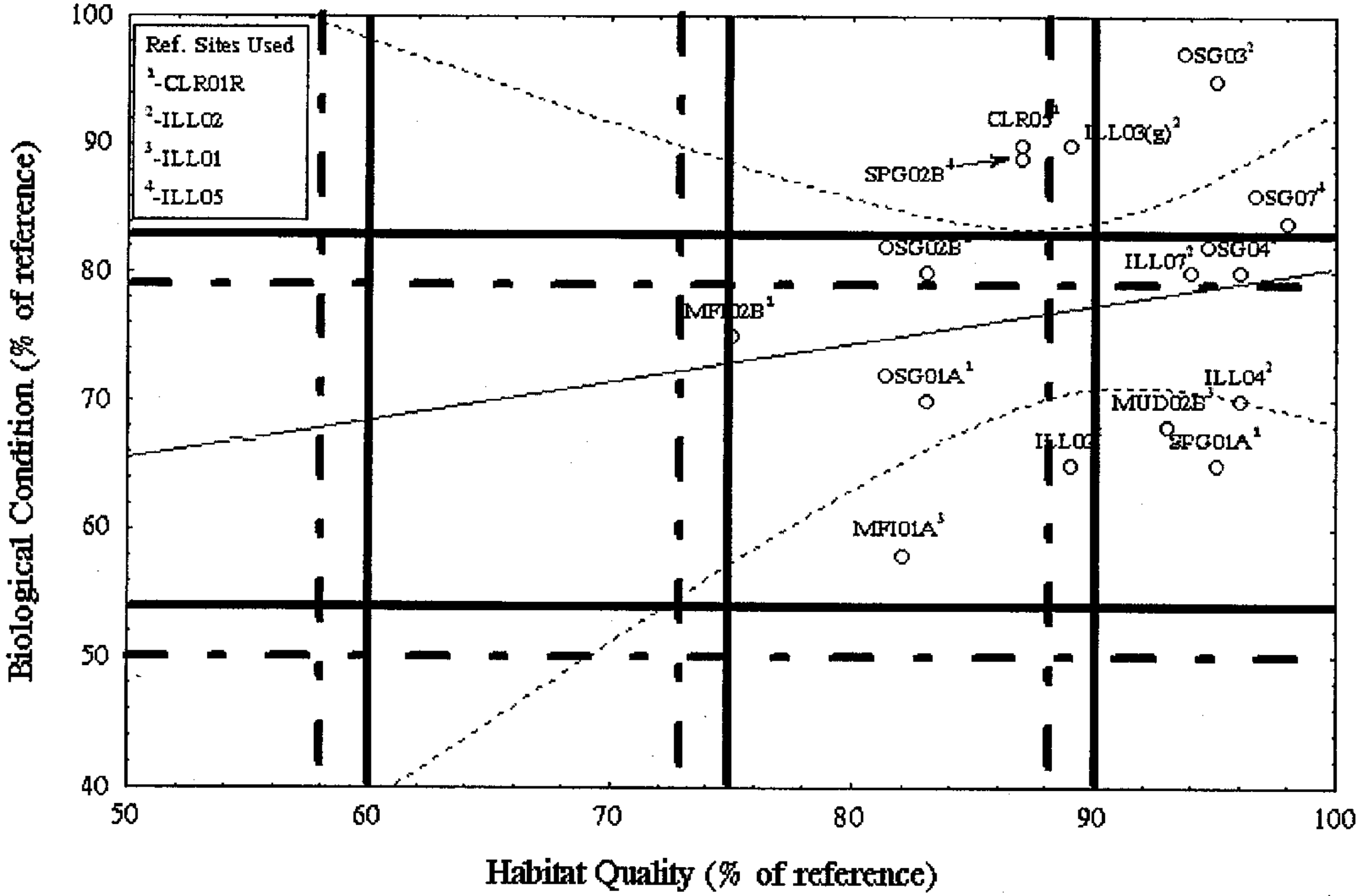
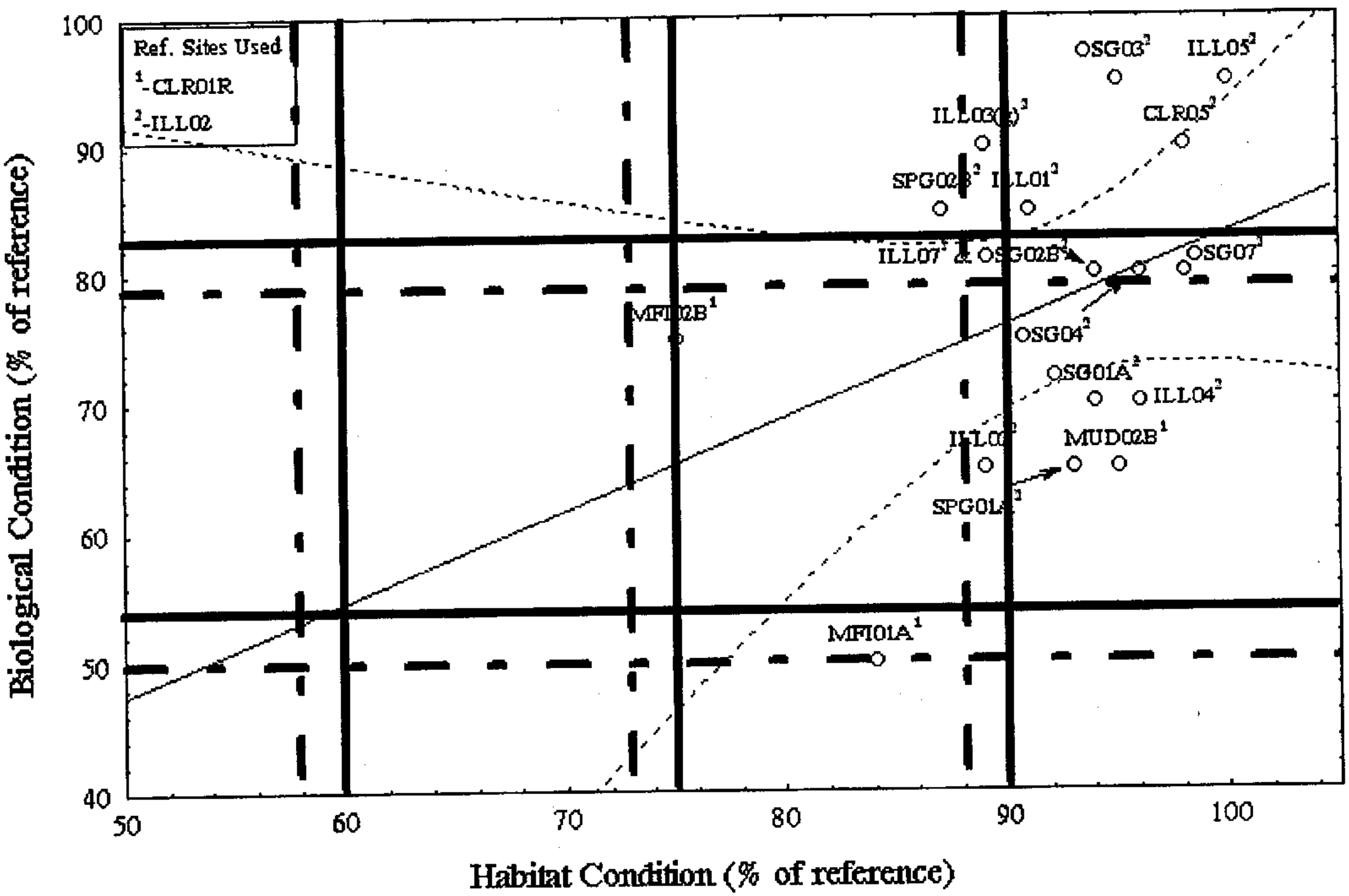


Figure M-12. Flow-based RBA analysis.



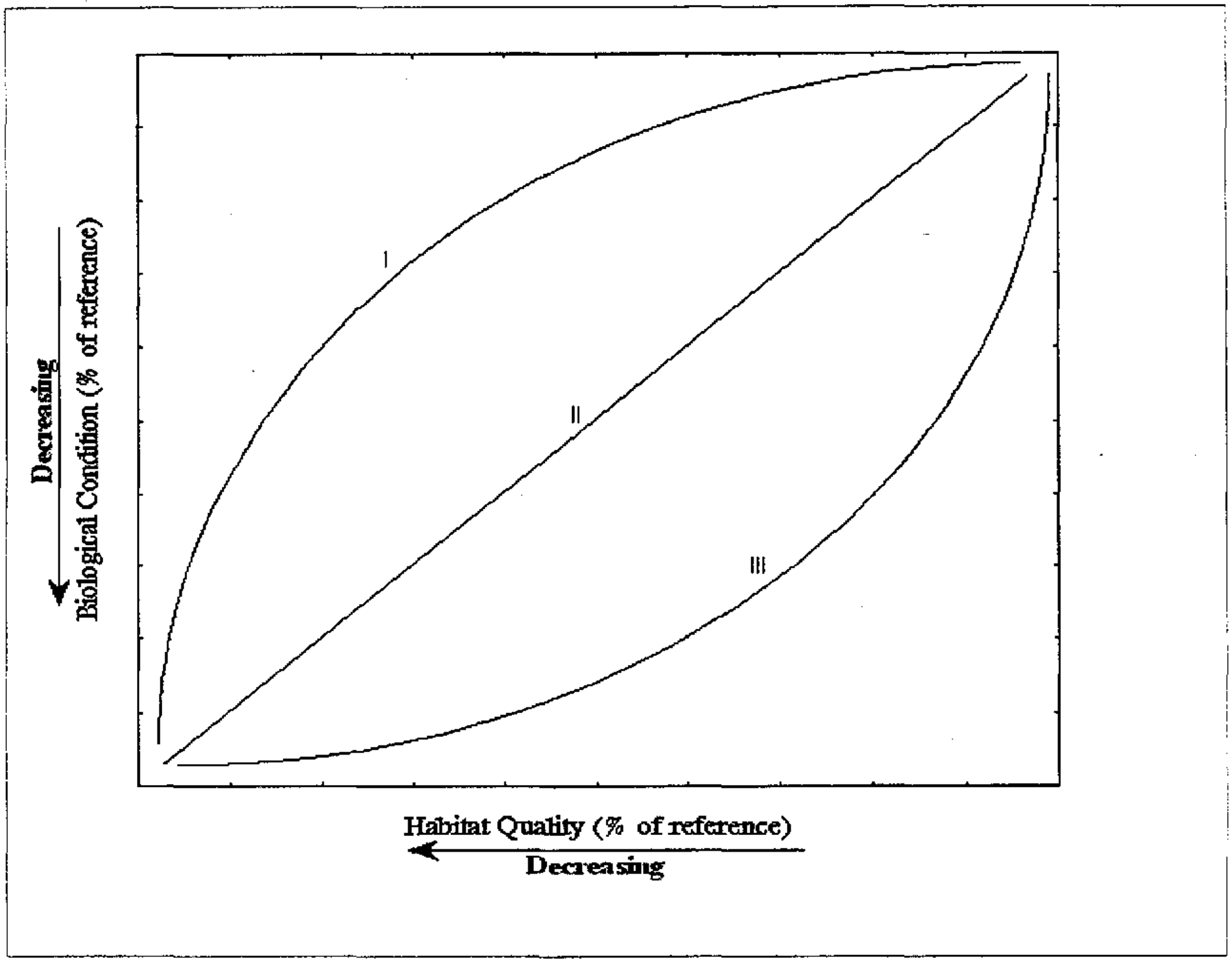


Figure M-13. Habitat quality vs. biological condition with inferences to water quality (from Plafkin et al., 1989).

correct, these communities may be exhibiting the artificial enhancement of excess nutrient input as described by Plafkin et al. (1989). If nutrient input were to increase, it is possible that these communities could be subject to excessive oxygen demand, increased filamentous algal growth, and other stressors that might cause the communities to shift into a worse impairment category.

Fish Communities

Material and Methods

In June and September 1995, and August 1996, fish community surveys were conducted at the stations listed below. All tributary stations were sampled in June 1995 and the Illinois River site was sampled in September 1995. The two Spring Creek sites were resampled in September 1995. Due to limited habitat at the lower Spring Creek site, an additional site below the Springdale discharge was sampled in August 1996. All major habitat types in 700 feet to 1500 feet of stream were intensively sampled at each site listed below:

OSC01A	Osage Creek above the City of Rogers WWTP
OSC02B1	Osage Creek below the City of Rogers WWTP
SPG01A	Spring Creek above the City of Springdale WWTP
SPG02B1	Spring Creek approx. ½ mile below the City of Springdale WWTP
SPG02B	Spring Creek approx. 1.8 miles below the City of Springdale WWTP
MUD02B	Mud Creek below the City of Fayetteville WWTP
CLR01R	Clear Creek above the confluence of Mud Creek
MFI01A	Muddy Fork Illinois River above Prairie Grove WWTP
MFI02B	Muddy Fork Illinois River below Prairie Grove WWTP
ILL07	Illinois River near the Arkansas-Oklahoma state line

A Smith-Root model 15-B backpack electrofishing device with pulsed DC current was used to collect fish from these sites. The device was used in the shallow pools and along the pool edges while wading upstream and dipping the stunned fishes from the water with dip nets. The riffles were collected by posting a twenty foot seine near the toe of the riffle and while working the electrofisher in a downstream direction through the riffle, the bottom substrate was overturned and the fish were herded into the seine or washed in by the current. In addition, a barge was used at the ILL07 site due to the size and depth of the river. This device, a Bass-Tracker two man pontoon boat was modified to transport the electric generator and D.C. pulsator. A cathode curtain was attached to the front of the barge and sampling personnel worked two anode wands. The barge was pushed upstream through and around the deeper pools as personnel dipped the stunned fishes from the edges of the deeper pools, around log-jams and from deep, swift riffles and runs. The backpack unit was also used in the shallow pools and riffles at this site.

Fish species were collected from all available habitat within the sample area until a fully representative sample of the species and their abundance was obtained. Larger specimens were field identified and released. The smaller specimens and those unidentifiable in the field were preserved in ten percent (10%) formalin solution and returned to the lab for identification.

Habitat Evaluation

Habitat evaluations were performed at all sites except the Illinois River site. The evaluations consisted of five parameters each having three to seven variables. These parameters included: 1) habitat type; 2) habitat quantity; 3) quality of substrate type based on fish use; 4) quantity of instream cover; and 5) sediment on substrate. Field sheets outlining the instream and riparian evaluation can be found in Appendix G.

Each parameter for substrate type and instream cover was given a score depending on its abundance. The scores given to the substrate parameters were multiplied by a weighting factor based on how they relate to fish habitat quality. Length, depth and width measurements were estimated for each habitat type and recorded in feet. The sedimentation parameter was scored according to the amount of sediment accumulated on the substrate.

A total score for each habitat type was calculated by summing the scores for the substrate type, instream cover and sediment on substrate. The scores from like habitat types were averaged for each sampling station. The lengths of each habitat type were also summed giving a total length of habitat type sampled per station. The total habitat type lengths were then divided by 100 and multiplied by the average habitat type score. This score is the Ichthyofauna Habitat Index (IHI). Table F- 1 summarizes the fish habitat evaluations and includes the IHI for all tributary stations sampled.

Results and Discussion

Fish communities were evaluated by comparing various metrics of communities above and below the major point sources. The fish habitat available at each site was also given consideration in the evaluation. Since there was no upstream community above the Fayetteville discharge, Clear Creek (CLR01R) was used as the reference for the Mud Creek site below the Fayetteville WWTP. No reference site was established for the Illinois River station at the state line.

Fish communities in Osage Creek above and below the Rogers WWTP discharge are compared in Table F-2. The station below the discharge (OSC02B1) was approximately one-half mile below the discharge and approximately one and one-half mile above the water quality site OSC02B. The species proportion similarity index of these communities was 68.5 which indicates generally similar communities but in the lower range of similarity. The major difference between the communities was the higher percentage of primary feeding fishes (planktonic and periphytic feeders) in the station below the WWTP (OSC02B1). This metric is strongly influenced by the large population of Stonerollers, *Campostoma anomalum*, at this site. The noticeably higher percentage of Cyprinidae (minnows) at the lower station was also primarily influenced by the large stoneroller population. In addition, an atypically large carp, *Cyprinus carpio*, community was sampled at this location. In contrast, the Percidae (darter) community was substantially lower below the discharge. The Banded sculpin, *Cottus carolinae*, population was much greater above the discharge, but this was likely due to the cooler, spring-flow dominated habitat above the WWTP. A comparison of the habitat index scores (Figure F-1) indicates better riffle habitat downstream, better run habitat upstream and similar pool habitat at both sites. This difference in habitat would not have influenced the stoneroller dominance in the downstream community. In addition the Percidae community was not habitat limited below the discharge since the riffle habitat (preferred Percidae habitat) was best downstream. Elevated nutrients at the downstream site was likely the cause of these fish community differences.

Table F-1

Fish Habitat Evaluation at Fish Sample Sites

SITE	Riffle				Run				Pool			
	Number Sampled	Total Length	Average Habitat Score	IHI*	Number Sampled	Total Length	Average Habitat Score	IHI	Number Sampled	Total Length	Average Habitat Score	IHI
OSC01A	3	205	34.1	70	3	955	48.8	466	2	530	45.6	242
OSC02B1	3	240	50.9	122	2	490	58.2	285	2	400	52.7	211
SPG01A	2	80	47.3	38	2	240	60.2	144	5	530	50.6	268
SPG02B	4	230	32.8	75	3	600	44.1	265	1	300	55.0	165
SPG02B1	8	370	48.8	181	3	670	51.9	348	2	100	48.4	48
MUD02B	4	105	31.8	33	1	185	29.5	55	4	530	37.4	198
CLR01R	3	86	44.0	38	3	886	45.3	401	0	0	0	0
MFI01A	2	150	52.6	79	2	400	37.1	148	1	300	59.9	180
MFI02B	4	140	29.6	41	1	190	29.0	55	4	650	43.5	283

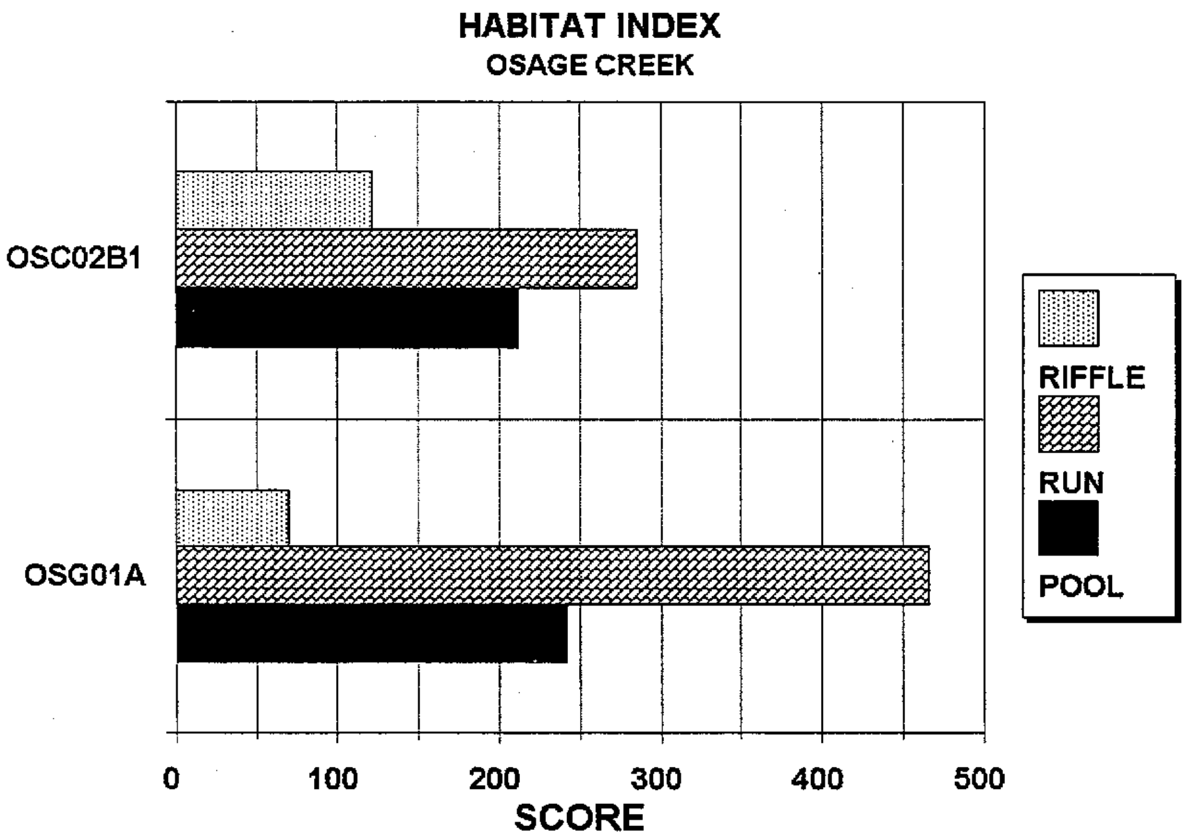
*Ichthyofauna Habitat Index - Total Length of habitat in hundredths multiplied by the Average Habitat Score.

In Spring Creek, the receiving stream for the Springdale WWTP, fish communities were sampled above the discharge and at two sites below the discharge. Site SPG01A was above the discharge. Site SPG02B1 was nearest the discharge and downstream of it, while SPG02B was the farthest downstream station. The similarity index comparing the upstream (reference) site to the nearest downstream site was 67.6, a low percentage of similarity. The similarity index between the upstream site and the farthest downstream site was 76.2, a higher degree of similarity. Major differences among the sites were: 1) a lower number of species upstream; 2) a substantial increase in Stonerollers at the nearest downstream station, but a declining proportion at the farthest downstream station; 3) an atypically large population of Yellow bullhead, *Ictalurus natalis*, at the first station below the discharge; and 4) an atypically low population of Percidae at all stations (Table F-3). The catch rate at station SPG02B1 was very high and could be attributed to the large number of Stonerollers. This species also greatly influenced the percentage

Table F-2. Osage Creek Fish Communities

SPECIES		OSC01A No.	OSC01A %	OSCO2B1 No.	OSCO2B1 %
Lepisosteus osseus	Longnose gar			1	0.2
Dorosoma cepedianum	Gizzard shad			1	0.2
Campostoma anomalum	Stoneroller	110	19.9	235	47.7
Ctenopharyngoden idella	Grass carp			2	0.4
Cyprinus carpio	Carp	2	0.4	12	2.4
Luxilus cardinalis	Cardinal shiner	56	10.1	85	17.2
Notropis rubellus	Rosyface shiner	1	0.2		
Phoxinus erythrogaster	Southern redbelly dace	29	5.2	2	0.4
Semotilus atromaculatus	Creek chub	48	8.7	8	1.6
Catostomus commersoni	White sucker	1	0.2	7	1.4
Hypentelium nigricans	Northern hogsucker	16	2.9	14	2.8
Moxostoma duquesnei	Black redhorse			1	0.2
Moxostoma erythrurum	Golden redhorse	4	0.7	24	4.9
Ameiurus natalis	Yellow bullhead	1	0.2		
Lepomis cyanellus	Green sunfish	27	4.9	9	1.8
Lepomis macrochirus	Bluegill	24	4.3	20	4.1
Lepomis megalotis	Longear	3	0.5		
Micropterus dolomieu	Smallmouth bass			3	0.6
Micropterus salmoides	Largemouth bass	5	0.9	6	1.2
Pomoxis nigromaculatus	Black crappie			1	0.2
Etheostoma blennioides	Greenside darter			1	0.2
Etheostoma punctulatum	Stippled darter	4	0.7		
Etheostoma spectabile	Orangethroat darter	96	17.4	16	3.2
Etheostoma zonale	Banded darter			2	0.4
Percina caprodes	Logperch	1	0.2		
Cottus carolinae	Banded sculpin	125	22.6	43	8.7
	TOTAL SPECIES	18		21	
	TOTAL NUMBERS	553		493	
	EFFORT(seconds)	3650		3316	
	CATCH RATE(NO./MIN.)	9.1		8.9	
	NO. SENSITIVE SPECIES	7		9	
	NO.SENSITIVE INDIVIDUALS	232		158	
	% SENSITIVE INDIVIDUALS	42.0		32.0	
	% CYPRINIDAE	44.5		69.8	
	% CATOSTOMIDAE	3.8		9.3	
	% ICTALURIDAE	0.2		0.0	
	% CENTRARCHIDAE	10.7		7.9	
	% PERCIDAE	18.3		3.9	
	NO. PRIMARY TFL	141		252	
	% PRIMARY TFL	25.5		51.1	
	NO. KEY INDIVIDUALS	168		118	
	% KEY INDIVIDUALS	30.4		23.9	
	SIMILARITY INDEX			68.5	

Figure F-1


HABITAT INDEX
OSAGE CREEK
OSC02B1
OSG01A
RIFFLE
RUN
POOL
0
100
200
300
400
500
SCORE

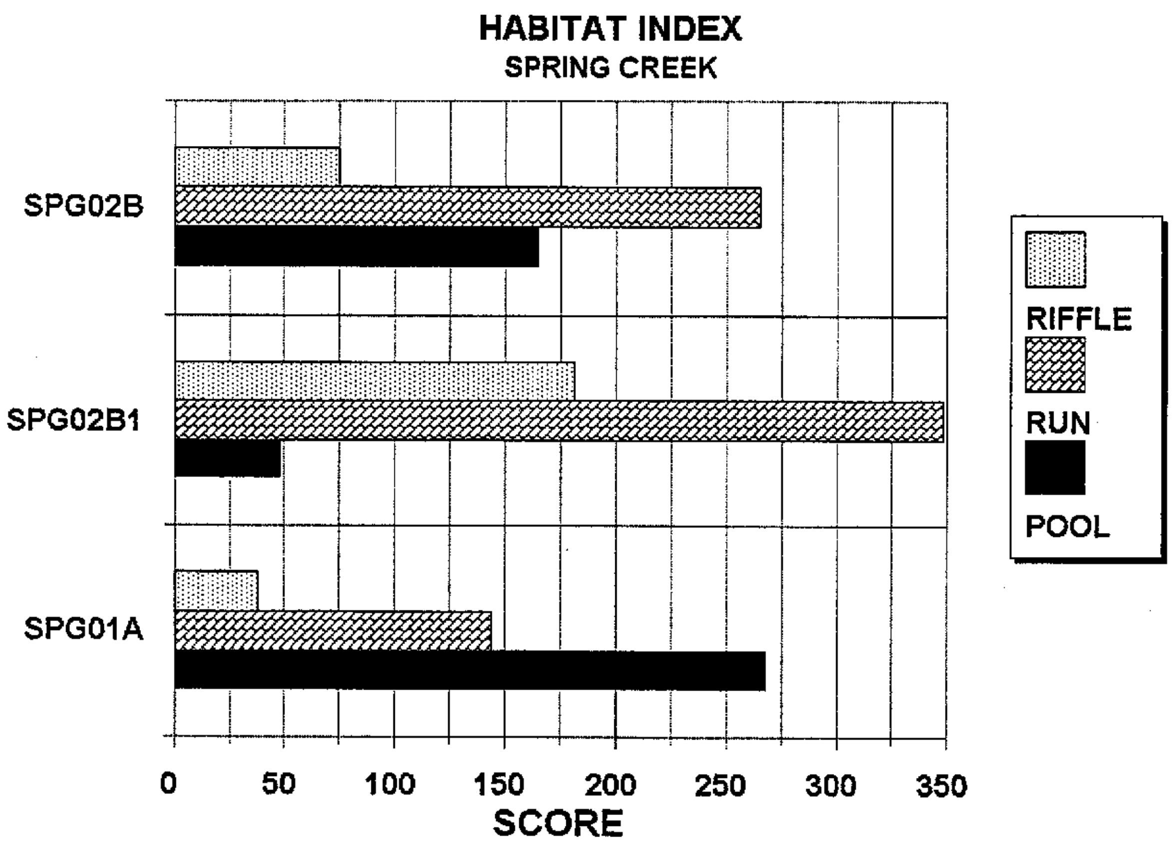
of primary feeders at this station. Although the percent primary feeders was highest at the station above the effluent, this was a result of a combination of stonerollers and a large community of Southern redbelly dace, *Phoxinus erythrogaster*, which is a common species of small, springfed streams such as Spring Creek. It is also a primary feeding fish. The proportion of Stonerollers significantly declined at the farthest downstream station compared to the station immediately below the discharge (SPG02B). The percentage of sensitive individuals dropped sharply just below the effluent but recovered to near the above-effluent levels at the farthest downstream station. At the SPG02B1 site, an atypically large number of Yellow bullhead was collected. This species is an indication of nutrient enrichment and reduced water quality. The Percidae communities were lower than typical Ozark Highland streams at all stations, although they were highest immediately below the discharge. The upstream station was spring-flow dominated with very cool water which likely reduced the Percidae community; however, discharges from the Springdale WWTP noticeably increased the water temperature, therefore the reduced darter communities downstream are probably due to nutrient enrichment, sedimentation on substrate and/or competition from other species. Habitat index scores at the upstream reference site were lowest for riffle and run habitats but highest for pools (Figure F-2). The run/riffle dominated habitat below the discharge is a direct result of the discharge dominated flow in this small tributary stream. However, the fish community differences resulted from nutrient enrichment of the stream rather than habitat differences.

The impact of the Fayetteville WWTP discharge on the fish community in Mud Creek was evaluated by comparing the fish communities at MUD02B with that in Clear Creek just above its confluence with Mud Creek (Table F-4). The fish community similarity index between these stations was 64.9. It is generally believed that a similarity of less than 65 indicates dissimilar communities. Although there were a number of species common to both communities, there were some significant differences in the proportions of several species. As has been evident in most other communities below a WWTP discharge, the stoneroller population increased significantly. This substantially influenced the proportions of Cyprinidae and primary feeders in the Mud Creek community. Bluntnose minnow, *Pimephales notatus*, also a primary feeder, showed a noticeable increase below the WWTP. In contrast the Slender madtom, *Noturus exilis*, was significantly more abundant in the reference stream (CLR01R). Although it has been typical to find a substantially reduced or an absent madtom community below a WWTP, the difference in these communities may have been partially due to habitat differences. The Clear Creek site contained optimum madtom habitat. There was also a substantial difference in the proportion of sensitive individuals between these communities. Although this metric was influenced by the differences in the madtom communities, several sensitive cyprinids and the Percidae communities were much more abundant and diverse in the reference stream. There was little difference in the proportion of Centrarchidae (sunfishes) between these sites; however, below the WWTP, Bluegill, *Lepomis macrochirus*, and Green sunfish, *Lepomis cyanellus*, were the dominant centrarchids. In the reference stream, Longear, *Lepomis megalotis*, was the dominant sunfish; this is more typical of Ozark Highlands stream communities. There was a notable difference in the fish habitat of the two sites (Figure F-3). The reference stream (CLR01R) was run habitat dominated but had no pool habitat in the sample area. Both streams had similar, but low quantity and quality, riffle habitat. Mud Creek had a better balance of habitat types, but they

Table F-3. Spring Creek Fish Communities

SPECIES		SPG01A No.	SPG01A %	SPG02B1 No.	SPG02B1 %	SPG02B No.	SPG02B %
Campostoma anomalum	Stoneroller	220	50.7	1412	71.2	325	48.7
Cyprinus carpio	Carp			4	0.2	6	0.9
Luxilus cardinalis	Cardinal shiner			289	14.6	33	4.9
Phoxinus erythrogaster	Southern redbelly dace	158	36.4	38	1.9	87	13.0
Semotilus atromaculatus	Creek chub	13	3.0	20	1.0	8	1.2
Catostomus commersoni	White sucker	5	1.2			3	0.4
Hypentelium nigricans	Northern hogsucker			17	0.9	13	1.9
Ameiurus melas	Black bullhead					1	0.1
Ameiurus natalis	Yellow bullhead			99	5.0	5	0.7
Noturus exilis	Slender madtom					1	0.1
Lepomis cyanellus	Green sunfish	11	2.5	19	1.0	7	1.0
Lepomis macrochirus	Bluegill					5	0.7
Lepomis megalotis	Longear			1	0.1		
Micropterus dolomieu	Smallmouth bass			2	0.1		
Micropterus punctulatus	Spotted bass			1	0.1		
Micropterus salmoides	Largemouth bass			1	0.1		
Etheostoma punctulatum	Stippled darter			10	0.5		
Etheostoma spectabile	Orangethroat darter	8	1.8	49	2.5	10	1.5
Etheostoma zonale	Banded darter					3	0.4
Cottus carolinae	Banded sculpin	19	4.4	20	1.0	160	24.0
	TOTAL SPECIES	7		15		15	
	TOTAL NUMBERS	434		1982		667	
	EFFORT(seconds)	2813		3736		1865	
	CATCH RATE(NO./MIN.)	9.3		31.8		21.5	
	NO. SENSITIVE SPECIES	4.0		6.0		8.0	
	NO.SENSITIVE INDIVIDUALS	195		376		308	
	% SENSITIVE INDIVIDUALS	44.9		19.0		46.2	
	% CYPRINIDAE	90.1		89.0		68.8	
	% CATOSTOMIDAE	1.2		0.9		2.4	
	% ICTALURIDAE	0.0		5.0		1.0	
	% CENTRARCHIDAE	2.5		1.2		1.8	
	% PERCIDAE	1.8		3.0		1.9	
	NO. PRIMARY TFL	378		1454		418	
	% PRIMARY TFL	87.1		73.4		62.7	
	NO. KEY INDIVIDUALS	8.0		357.0		57.0	
	% KEY INDIVIDUALS	1.8		18.0		8.5	
	SIMILARITY INDEX			67.6		76.2	

Figure F-2



HABITAT INDEX
SPRING CREEK
SPG02B
SPG02B1
SPG01A
0
50
100
150
200
250
300
350
SCORE
RIFFLE
RUN
POOL

Table F-4. Clear Creek and Mud Creek Fish Communities

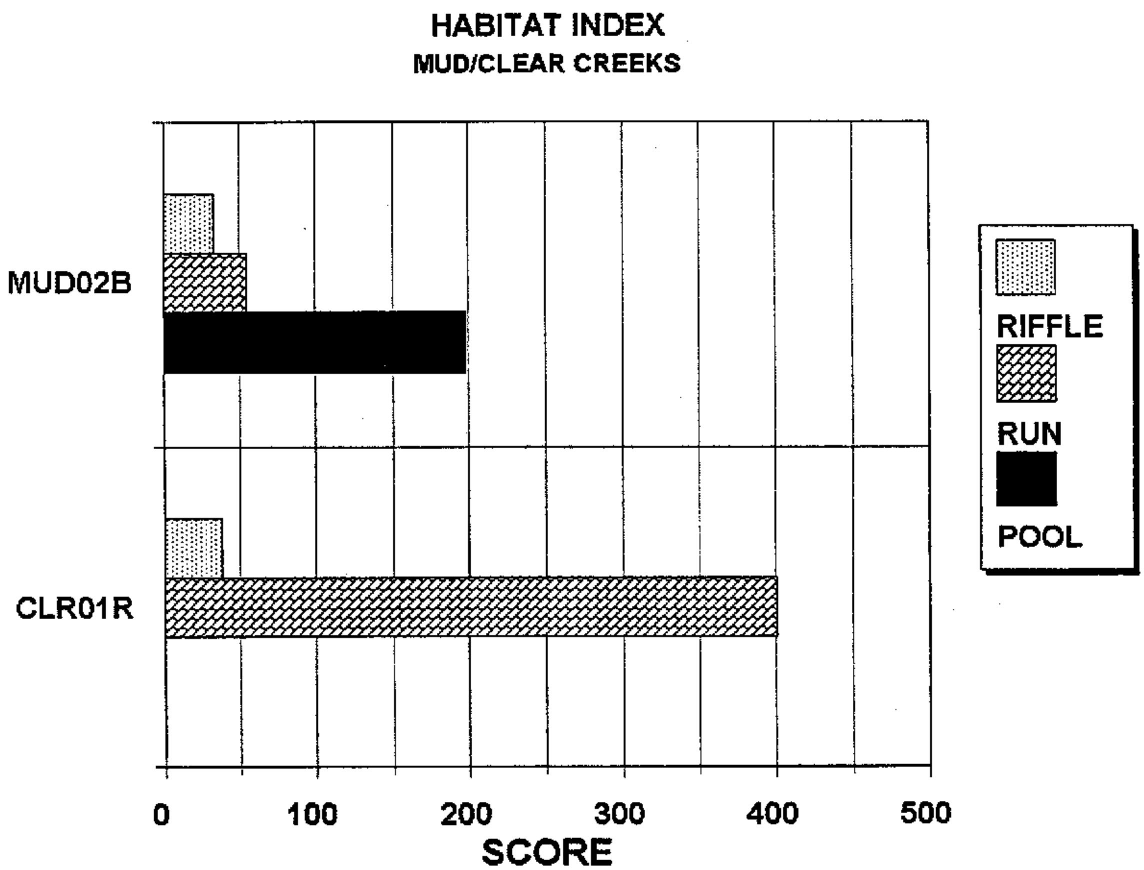
SPECIES		CLR01R No.	CLR01R %	MUD02B No.	MUD02B %
Campostoma anomalum	Stoneroller	271	29.2	728	65.1
Nocomis asper	Redspot chub	4	0.4		
Luxilus cardinalis	Cardinal shiner	10	1.1	4	0.4
Notropis boops	Bigeye shiner	15	1.6	2	0.2
Notropis nubilus	Ozark minnow	3	0.3		
Pimephales notatus	Bluntnose minnow	19	2.0	71	6.3
Semotilus atromaculatus	Creek chub	3	0.3	10	0.9
Hypentelium nigricans	Northern hogsucker	2	0.2		
Ameiurus natalis	Yellow bullhead	3	0.3	15	1.3
Noturus exilis	Slender madtom	239	25.7	6	0.5
Fundulus olivaceus	Blackspotted topminnow	6	0.6	2	0.2
Gambusia affinis	Mosquitofish	1	0.1	6	0.5
Lepomis cyanellus	Green sunfish	28	3.0	87	7.8
Lepomis macrochirus	Bluegill	26	2.8	87	7.8
Lepomis megalotis	Longear	71	7.6	31	2.8
Micropterus salmoides	Largemouth bass	15	1.6	15	1.3
Etheostoma blennioides	Greenside darter	1	0.1		
Etheostoma flabellare	Fantail darter	67	7.2		
Etheostoma spectabile	Orangethroat darter	145	15.6	55	4.9
	TOTAL SPECIES	19		14	
	TOTAL NUMBERS	929		1119	
	EFFORT(seconds)	2639		2361	
	CATCH RATE(NO./MIN.)	21.1		28.4	
	NO. SENSITIVE SPECIES	7		3	
	NO.SENSITIVE INDIVIDUALS	338		12	
	% SENSITIVE INDIVIDUALS	36.4		1.1	
	% CYPRINIDAE	35.0		72.8	
	% CATOSTOMIDAE	0.2		0.0	
	% ICTALURIDAE	26.0		1.9	
	% CENTRARCHIDAE	15.1		19.7	
	% PERCIDAE	22.9		4.9	
	NO. PRIMARY TFL	293		799	
	% PRIMARY TFL	31.5		71.4	
	NO. KEY INDIVIDUALS	396		65	
	% KEY INDIVIDUALS	42.6		5.8	
	SIMILARITY INDEX			64.9	

were of low quality due to a lack of riparian cover and excessive sedimentation. Much of this habitat disruption was from urban clearing activities. It is believed that many of the differences in the fish communities at these two sites was a result of habitat differences.

Table F-5 compares the fish communities in Muddy Fork Illinois River above (MFI01A) and below (MFI02B) the discharge of the Prairie Grove WWTP. The similarity index of these two communities was 70.8, indicating some degree of similarity. This index was suppressed somewhat by the relatively large number of uncommon species. Ten species were found below the discharge which were not found above, and three species were found above but not below. However, many of these species were represented by only one individual. Contrary to the other community comparisons above and below WWTP discharges, the Stoneroller populations were very similar above and below the Prairie Grove discharge. There was a significant Carp population below the discharge and the Bluntnose minnow population was noticeably larger at the downstream site. Both species prefer nutrient enriched waters and both are primary feeders. The percent of sensitive individuals was higher above the discharge and the Percidae community was slightly greater upstream. The habitat index scores (Figure F-4) indicate a better balance of habitat above the discharge, but the fish community was more diverse and had a greater number of species below the discharge.

The fish community found at station ILL07 (Illinois River near the Arkansas-Oklahoma state line) is shown in Table F-6. A total of 35 species were collected at this site and the Shannon-Wiener dominance diversity index was 3.01 (log base 2). The stoneroller population made up 47.5% of the total community. This was higher than the typical least-disturbed community from Ozark Highland streams. The large Stoneroller population produced a slightly higher than typical Cyprindae population and a higher proportion of primary feeding fishes than typical streams in this ecoregion. The buffalo, *Ictiobus sp*, and Carp populations also seemed to be larger than typical. However, the collection gear and sample technique were very effective for these species. Also at this station the population of sensitive species was lower than the ecoregion norm, but the population of ecoregion key species was greater than normal. The remaining community metrics evaluated were very similar to the typical Ozark Highland Ecoregion stream values. Although the habitat evaluation index was not determined for this site, the habitat was generally composed of a braided channel with small, deep pools usually around fallen tree tops. Riffles were wide and relatively shallow but with a few constricted swift riffles. Immediately above the sample site was a large, deep and steep-side pool; however, the typical pools above the site were long, wide and atypically shallow from gravel and silt deposits. Heavy sediment deposits were common except on the very swift riffle and run habitats.

Figure F-3



HABITAT INDEX
MUD/CLEAR CREEKS
MUD02B
CLR01R
RIFFLE
RUN
POOL
0
100
200
300
400
500
SCORE

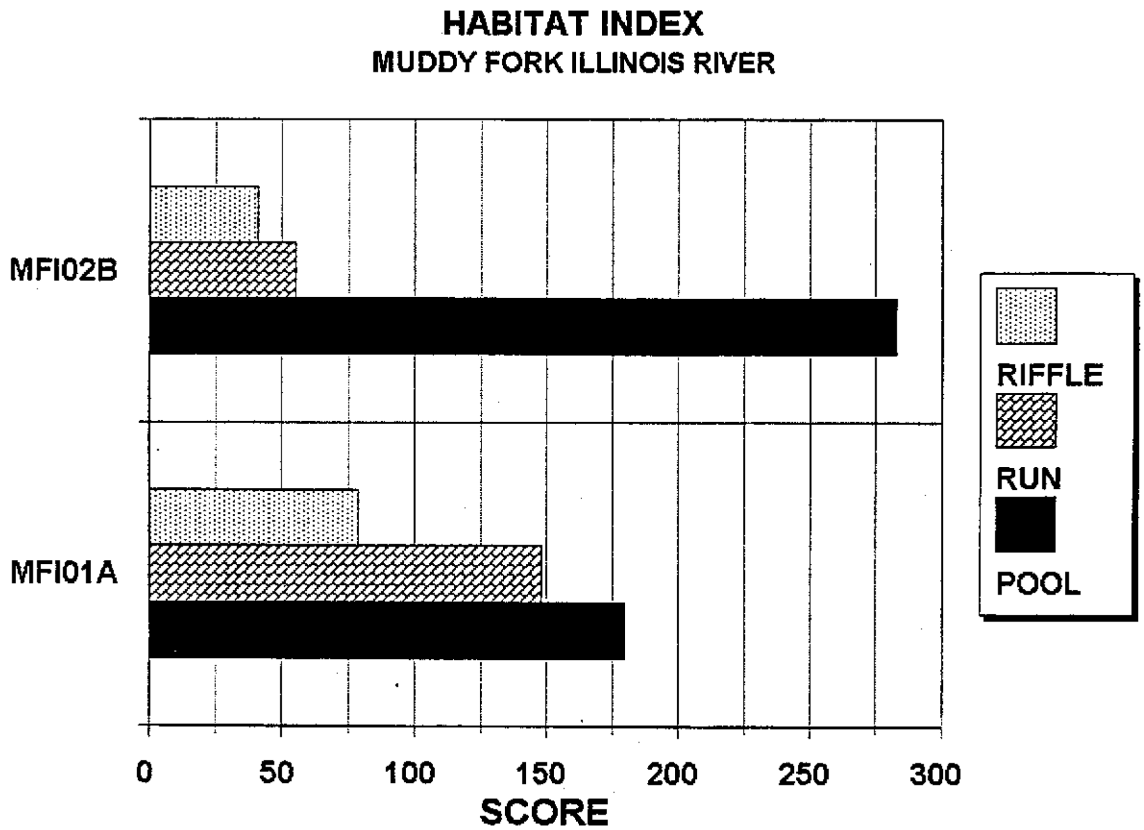
Table F-5. Muddy Fork Illinois River Fish Communities

SPECIES		MFI01A No.	MFI01A %	MFI02B No.	MFI02B %
Dorosoma cepedianum	Gizzard shad			2	0.2
Campostoma anomalum	Stoneroller	203	16.8	165	17.4
Cyprinus carpio	Carp			14	1.5
Luxilus cardinalis	Cardinal shiner	55	4.5	32	3.4
Luxilus chrysocephalus	Striped shiner	1	0.1		
Lythrurus umbratilis	Redfin shiner	16	1.3	11	1.2
Notropis boops	Bigeye shiner	62	5.1	108	11.4
Notropis nubilus	Ozark minnow			1	0.1
Phoxinus erythrogaster	Southern redbelly dace	18	1.5		
Pimephales notatus	Bluntnose minnow	18	1.5	123	13.0
Semotilus atromaculatus	Creek chub	3	0.2	1	0.1
Hypentelium nigricans	Northern hogsucker	14	1.2	8	0.8
Minytrema melanops	Spotted sucker			2	0.2
Moxostoma duquesnei	Black redhorse	1	0.1	3	0.3
Moxostoma erythrurum	Golden redhorse	9	0.7	19	2.0
Moxostoma macrolepidotum	Shorthead redhorse			1	0.1
Ameiurus natalis	Yellow bullhead			1	0.1
Noturus exilis	Slender madtom	2	0.2	4	0.4
Gambusia affinis	Mosquitofish	4	0.3	57	6.0
Labidesthes sicculus	Brook silversides	2	0.2	4	0.4
Ambloplites ariommus	Shadow bass			1	0.1
Lepomis cyanellus	Green sunfish	36	3.0	38	4.0
Lepomis macrochirus	Bluegill	40	3.3	33	3.5
Lepomis megalotis	Longear	26	2.2	91	9.6
Micropterus punctulatus	Spotted bass			17	1.8
Micropterus salmoides	Largemouth bass	3	0.2	1	0.1
Pomoxis nigromaculatus	Black crappie			1	0.1
Etheostoma blennioides	Greenside darter	5	0.4	8	0.8
Etheostoma punctulatum	Stippled darter	5	0.4		
Etheostoma spectabile	Orangethroat darter	144	11.9	75	7.9
Etheostoma zonale	Banded darter			5	0.5
Percina caprodes	Logperch	6	0.5	3	0.3
Cottus carolinae	Banded sculpin	536	44.3	119	12.6

Table F-5 continued

TOTAL SPECIES	23	30
TOTAL NUMBERS	1209	948
EFFORT(seconds)	3260	4219
CATCH RATE(NO./MIN.)	22.3	13.5
NO. SENSITIVE SPECIES	9	9
NO.SENSITIVE INDIVIDUALS	698	288
% SENSITIVE INDIVIDUALS	57.7	30.4
% CYPRINIDAE	31.1	48.0
% CATOSTOMIDAE	2.0	3.5
% ICTALURIDAE	0.2	0.5
% CENTRARCHIDAE	8.7	19.2
% PERCIDAE	13.2	9.6
NO. PRIMARY TFL	239	305
% PRIMARY TFL	19.8	32.2
NO. KEY INDIVIDUALS	215	120
% KEY INDIVIDUALS	17.8	12.7
SIMILARITY INDEX		70.8
DIVERSITY INDEX	2.79	3.70

Figure F-4



HABITAT INDEX
MUDDY FORK ILLINOIS RIVER
MFI02B
MFI01A
0
50
100
150
200
250
300
SCORE
RIFFLE
RUN
POOL

Table F-6. Illinois River Fish Community at State Line

SPECIES		ILL07 No.	%
Dorosoma cepedianum	Gizzard shad	1	0.0
Campostoma anomalum	Stoneroller	1239	47.5
Cyprinus carpio	Carp	10	0.4
Erimystax x-punctata	Gravel Chub	35	1.3
Luxilus cardinalis	Cardinal shiner	380	14.6
Notropis boops	Bigeye shiner	2	0.1
Notropis nubilus	Ozark minnow	61	2.3
Notropis rubellus	Rosyface shiner	8	0.3
Pimephales notatus	Bluntnose minnow	46	1.8
Hypentelium nigricans	Northern hogsucker	50	1.9
Ictiobus bubalus	Smallmouth buffalo	15	0.6
Ictiobus niger	Black buffalo	4	0.2
Moxostoma duquesnei	Black redhorse	9	0.3
Moxostoma erythrurum	Golden redhorse	42	1.6
Moxostoma macrolepidotum	Shorthead redhorse	9	0.3
Ictalurus punctatus	Channel catfish	18	0.7
Noturus exilis	Slender madtom	108	4.1
Pylodictis olivaris	Flathead catfish	4	0.2
Fundulus olivaceus	Blackspotted topminnow	7	0.3
Gambusia affinis	Mosquitofish	2	0.1
Labidesthes sicculus	Brook silversides	3	0.1
Ambloplites ariommus	Shadow bass	3	0.1
Lepomis cyanellus	Green sunfish	2	0.1
Lepomis gulosus	Warmouth	2	0.1
Lepomis macrochirus	Bluegill	39	1.5
Lepomis megalotis	Longear	95	3.6
Lepomis microlophus	Redear	4	0.2
Micropterus dolomieu	Smallmouth bass	25	1.0
Micropterus punctulatus	Spotted bass	18	0.7
Micropterus salmoides	Largemouth bass	10	0.4
Etheostoma blennioides	Greenside darter	18	0.7
Etheostoma spectabile	Orangethroat darter	156	6.0
Etheostoma zonale	Banded darter	56	2.1
Percina caprodes	Logperch	10	0.4
Cottus carolinae	Banded sculpin	119	4.6

Table F-6 continued.

TOTAL SPECIES	35
TOTAL NUMBERS	2610
NO. SENSITIVE SPECIES	12
NO.SENSITIVE INDIVIDUALS	813
% SENSITIVE INDIVIDUALS	31.1
% CYPRINIDAE	68.2
% CATOSTOMIDAE	4.9
% ICTALURIDAE	5.0
% CENTRARCHIDAE	7.6
% PERCIDAE	9.2
NO. PRIMARY TFL	1376
% PRIMARY TFL	52.7
NO. KEY INDIVIDUALS	722
% KEY INDIVIDUALS	27.7
DIVERSITY INDEX	3.01

SUMMARY

- This study project was initiated through a Consent Administrative Order between the State of Oklahoma, Oklahoma Scenic Rivers Commission, the Arkansas Department of Pollution Control and Ecology and the cities of Prairie Grove, Fayetteville and Rogers in response to objections by the State of Oklahoma to NPDES discharge permits issued by ADPC&E to these cities.

- Areas of investigation in the study include 1) chemical water quality analyses, 2)diel dissolved oxygen fluctuations, 3) in-stream periphyton production, 4) macroinvertebrate community analyses, and 5) determination of fish community structure. Over 30 stations were sampled during the survey and water quality analyses included 33 parameters plus flow during seven different events.

- Long-term, historical water quality data from the Illinois River basin indicates a slight increase in phosphorus loads in the upper segment and notably decreased loads from the Osage Creek subbasin and in the lower Illinois River. Nitrate loads increased sharply in the upper basin and slightly increased in the Osage Creek and in the lower Illinois River. TSS data shows increases from all segments, with the Osage Creek subbasin exhibiting the smallest increase.

- Water temperatures were significantly cooler upstream from the WWTP discharges in the small tributary streams receiving effluent from the cities of Prairie Grove, Springdale, and Rogers. There was normally no flow upstream of the Fayetteville discharge. These discharge flows dominated the stream flow and were much warmer than the upstream temperatures. This factor influenced the biological community comparisons above and below the discharges. Minerals (Cl, SO_4, and TDS) were substantially elevated in the WWTP discharges, but they normally returned to background levels near the mouth of the receiving streams. Total suspended solids were strongly influenced by storm event runoff, and WWTP discharges of TSS averaged less than 5 mg/L.

- Total phosphorus loads were noticeably higher from the Springdale WWTP than from any of the other major point source discharges. During low-flow periods Spring Creek provided the dominant phosphorus load to Osage Creek and Osage Creek dominated the phosphorus load in the Illinois River below their confluence. During major storm events, phosphorus loading to the Illinois River was directly related to watershed size and runoff volumes.

- Although nitrate-nitrogen loads were normally much higher than phosphorus loads, the point source discharges made up a much smaller proportion of the nitrogen load than for total phosphorus loads in the tributary receiving streams. Nitrogen loading during both low flow and high flow events were most influenced by the size of the watershed and the amount of runoff, including ground water contributions.

- Several dissolved metals were noticeably elevated below the WWTP discharges; however, none of the samples had toxic levels of any of the metals measured. Generally, all WWTP discharges produced noticeably elevated levels of sodium, boron and potassium. In contrast, hardness, calcium and barium values were lower in the effluent than upstream values.

- Diel dissolved oxygen data showed no violations of water quality standards, except for the unusual data obtained in the Muddy Fork of Illinois River in August 1995, which was possibly due to instream disturbances caused by cattle watering and wading in the pools near the meters. Maximum daily fluctuations of D.O. was greatest at stations below WWTP discharges where supersaturation of oxygen occurred during daylight periods. However, night time values of D.O. did not fall below water quality standards at these stations.

- Effluent discharge data provided by the major point source dischargers showed that Springdale's total phosphorus load for the 12-month study period was approximately four times greater than from Rogers and about 40 times greater than Fayetteville or Prairie Grove. The total annual load of phosphorus calculated from these four dischargers was just under 90 tons. Annual nitrate-nitrogen loads from these facilities showed approximately equal loading from Springdale, Rogers and Fayetteville with a Prairie Grove loading of less than one-third of the others. The total annual load from all facilities equaled over 100 tons of nitrogen from nitrates.

- Periphyton production was measured primarily through the analysis of chlorophyll-*a* from periphyton growth on artificial substrate samplers suspended in the streams. Data was collected for a 7-day period on two different years at the same 18 stations. The data displayed considerable variability and some inconsistencies. The highest values were found in Spring Creek both above and below the Springdale WWTP and at the ILL07 site near the Arkansas-Oklahoma stateline. All Osage Creek stations had similar values and were in the lower data range. This may have been influenced by the lower water temperatures.

- Macroinvertebrate communities were analyzed at 18 sites throughout the study area. Four comparisons were made based on: 1) an overall reference site, 2) same-stream reference sites, 3) habitat cluster analysis and, 4) stream flow. All comparisons produced similar results. The macroinvertebrate community most affected was at the uppermost site in the Muddy Fork of Illinois River. Slightly impaired benthic communities were detected in the Mud Creek area below Fayetteville, mid-Illinois River, Osage Creek, and Spring Creek above the Rogers and Springdale WWTP, respectively. The Osage Creek and Spring Creek sites are influenced by the cold water of the springs in their watersheds. The mid-Illinois site may appear impacted because of the habitat. An additional sample at the same site revealed a high quality fauna. Only impacts at the Mud Creek site were attributable to pollution-related causes. Slight impairment was noted at the Muddy Fork site below Prairie Grove. Habitat quality at this station was questionable, therefore, the impairment is probably not as critical as it appeared. No significant impairment was detected at the remainder of the stations. Some stations were borderline between slight and no significant impairment suggesting the fragile nature of the Illinois River system. Two stations on the Illlinois River, the Spring Creek station below Springdale WWTP, and one station on Osage Creek indicated fauna quality was exceeding the habitat quality. It is possible that any additional nutrient enrichment could cause a significant reduction in the quality of the macroinvertebrate community and associated aquatic life in this stream system.

- Fish community structures were affected below the point source dischargers. A species proportion similarity index comparing communities above and below discharges indicated a very low degree of similarity. In general, the community difference measured include: 1)larger populations of primary feeding fishes (planktonic and periphytonic feeders) below the discharges (particularly Stonerollers), 2) a reduction in sensitive species, and 3) normally a reduction in Percidae (darters). Habitat measurements indicate that the difference found was not significantly habitat influenced, except for the station below the Fayetteville discharge and its reference stream. No reference station was used to compare the fish community at ILL07 (near state line). The fish community at this site included a diverse and well distributed species abundance which was typical of most Ozark Highland fish communities. However the Stoneroller population was greater and the sensitive species community was lower than the typical, least-disturbed communities of this ecoregion.

- The receiving streams of the major point source dischargers reflect the impact from these dischargers by their elevated water temperatures, minerals, nutrients and some dissolved metals. Impacts on the aquatic life uses included some areas of periphyton production increases; borderline, slightly impaired macroinvertebrate communities; and fish communities with substantial increases in primary feeders and reductions in sensitive species. In the Illinois River at the state line, such conditions were not apparent, except for the elevated nutrient values, and all designated uses were being met.

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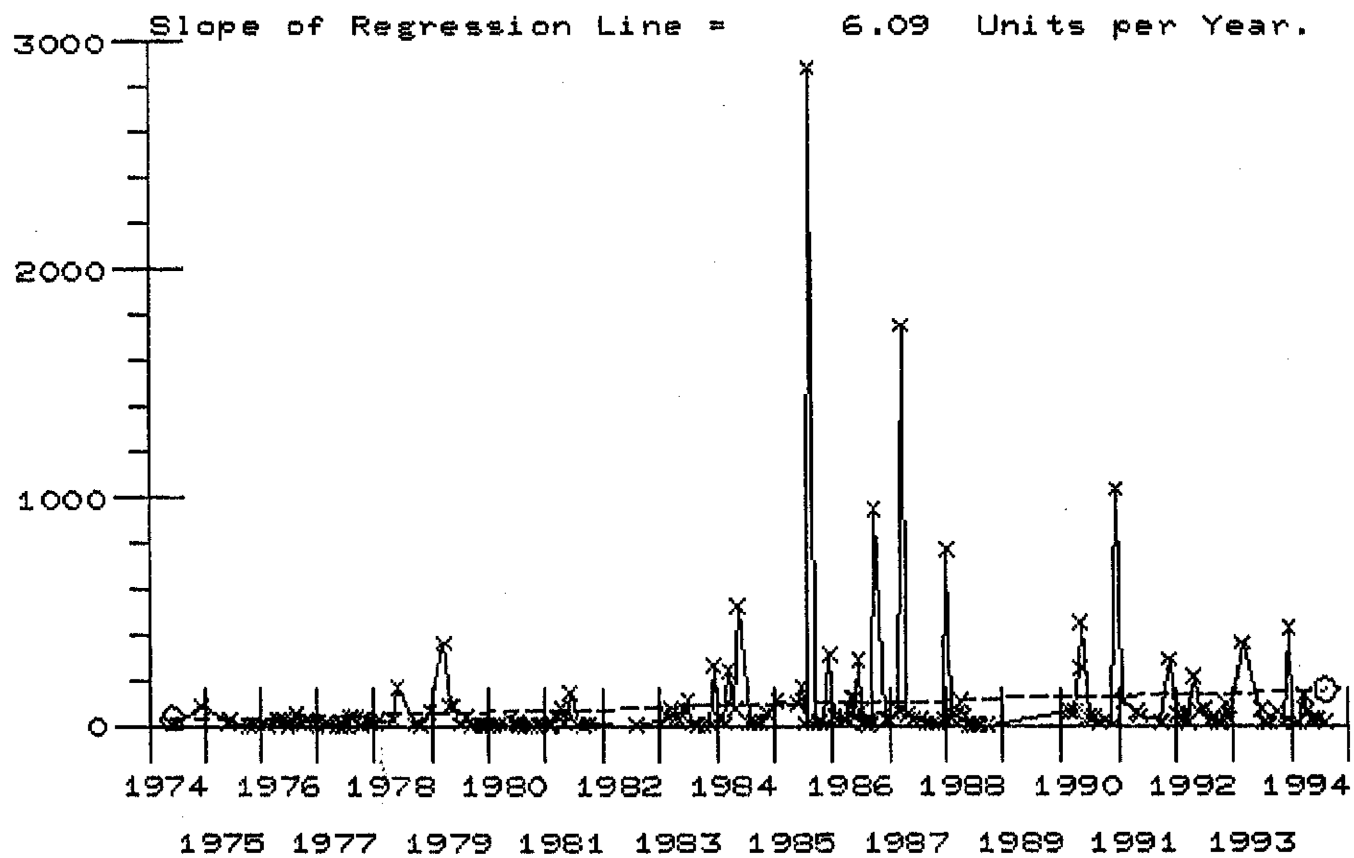
Appendix A

Historical Trend Data

from Illinois River Basin

1116APCC 050134 ARK40 USGS071948 36 06 11.0 094 20 39.0
ILLINOIS RIVER NR SAVOY, AR 05143 ARKANSAS
W
ARK. RIV. TULSA TO VAN BUREN SW LOWER MISSISSIPPI

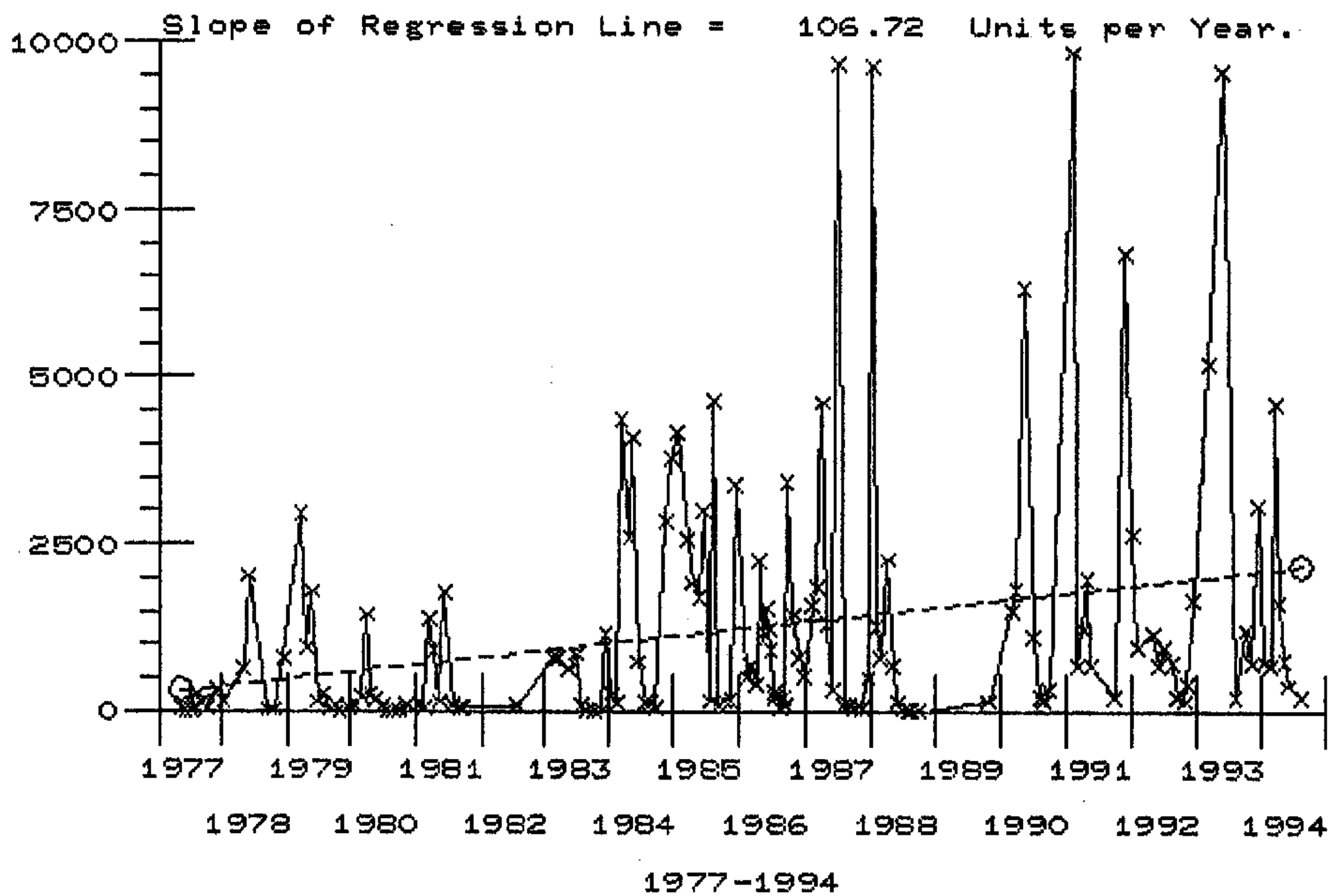
665 PHOS-TOT LB/DAY



1974-1994

1116APCC 050134 ARK40 USGS071948 36 06 11.0 094 20 39.0
ILLINOIS RIVER NR SAVOY, AR 05143 ARKANSAS
W
ARK. RIV. TULSA TO VAN BUREN SW LOWER MISSISSIPPI

630 NO2&NO3 N-TOTAL LB/DAY



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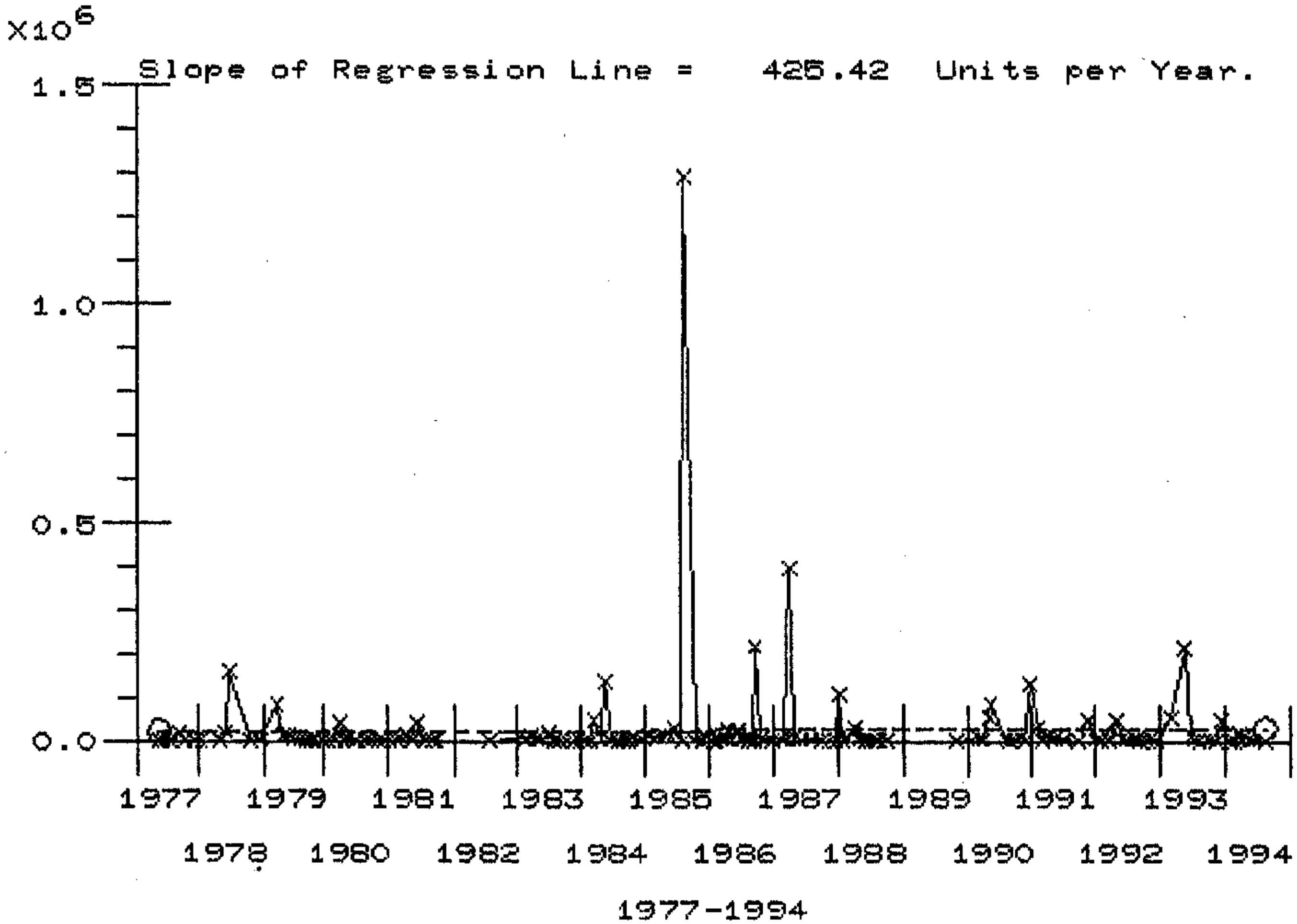
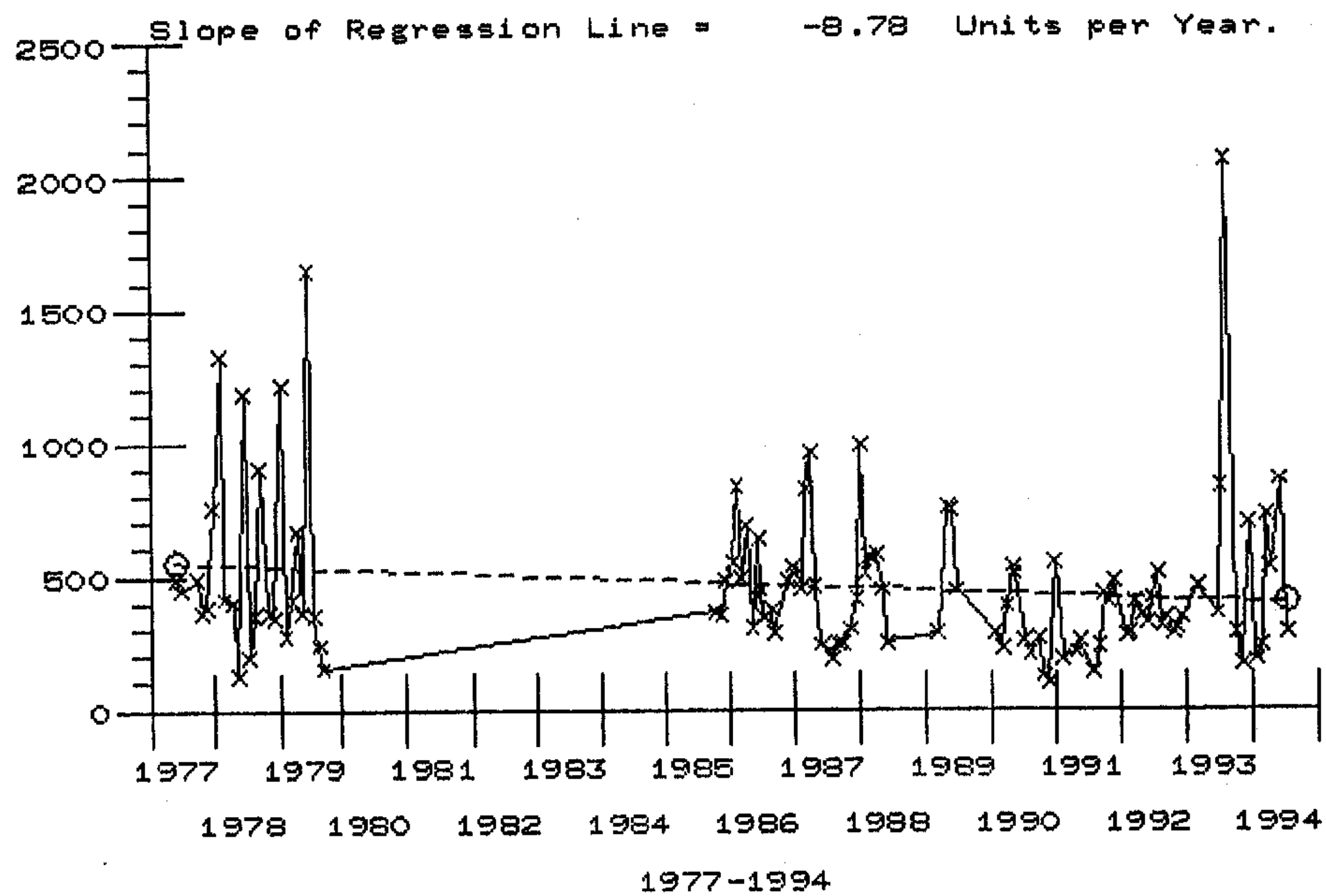
ILLINOIS RIVER NR SAVOY, AR 05143 ARKANSAS
W
ARK. RIV. TULSA TO VAN BUREN SW LOWER MISSISSIPPI

530 RESIDUE TOT NFLT LB/DAY



1116APCC 050135 ARK41 USGS071950 36 13 19.0 094 17 18.0
OSAGE CREEK NR ELM SPRINGS ARK 05007 ARKANSAS
B
ARK. RIV. TULSA TO VAN BUREN SW LOWER MISSISSIPPI

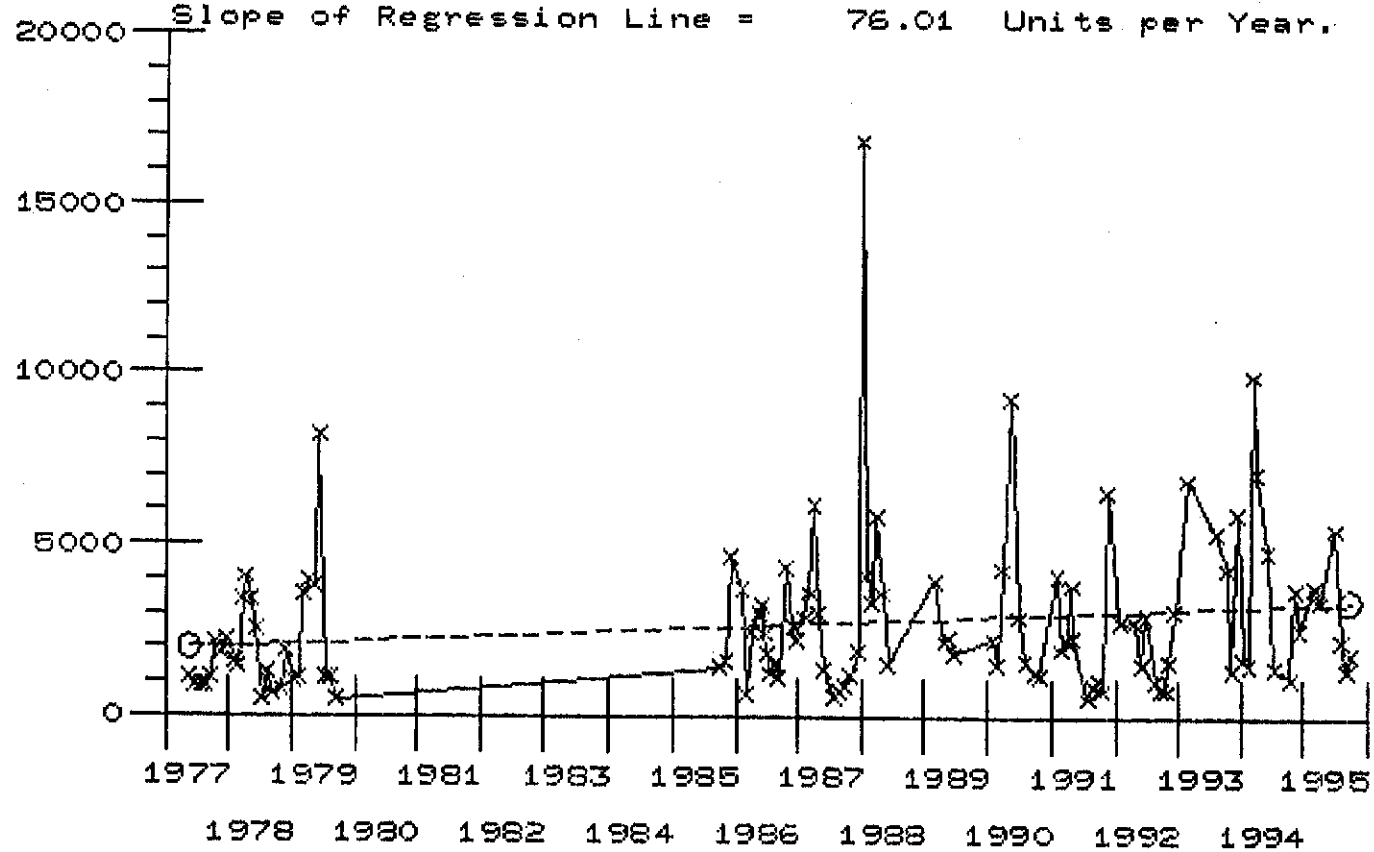
665 PHOS-TOT LB/DAY



1116APCC 050135 ARK41 USGS071950 36 13 19.0 094 17 18.0
OSAGE CREEK NR ELM SPRINGS ARK 05007 ARKANSAS
B
ARK. RIV. TULSA TO VAN BUREN SW LOWER MISSISSIPPI

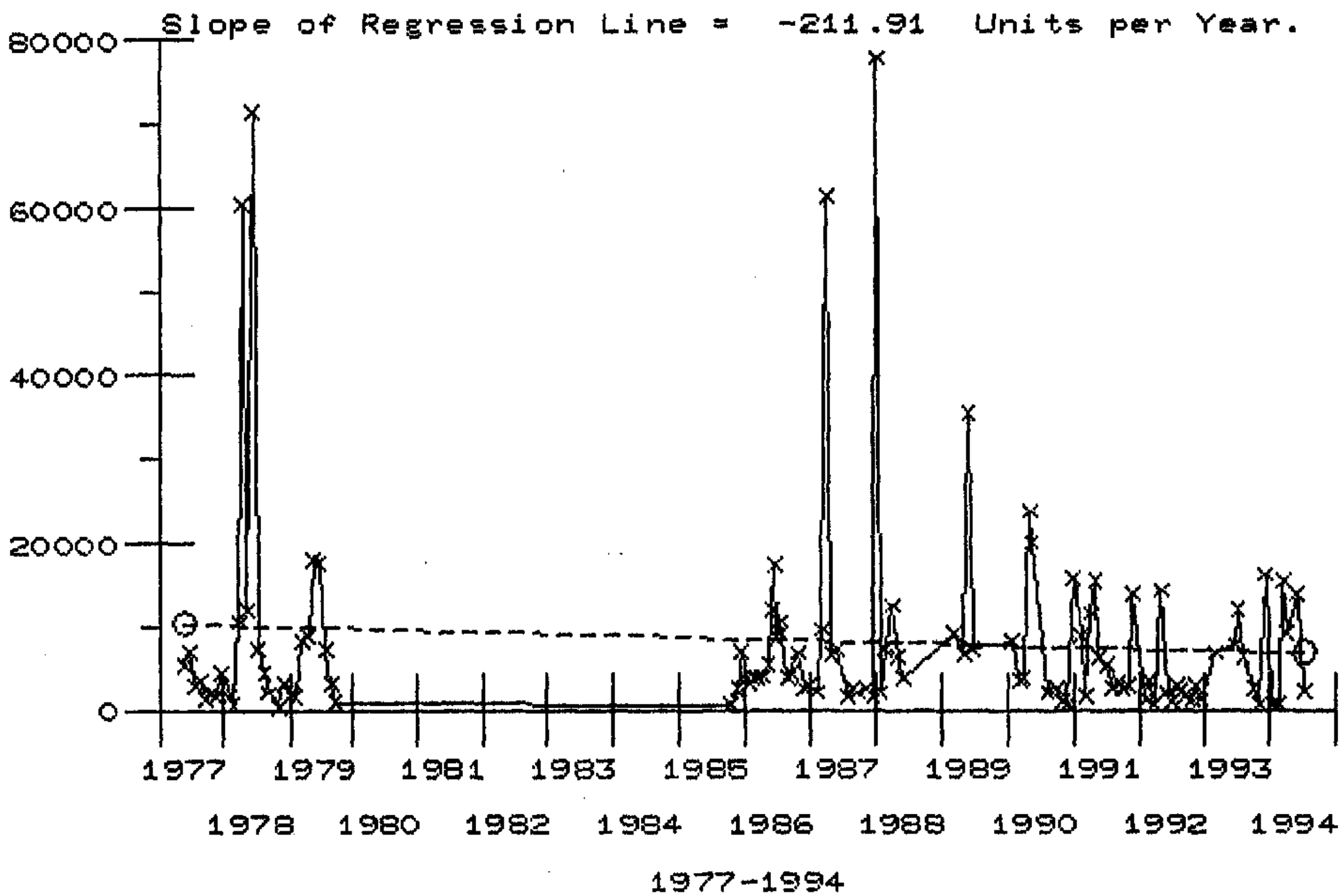
630 NO2&NO3 N-TOTAL LB/DAY

Slope of Regression Line = 76.01 Units per Year.



1116APCC 050135 ARK41 USGS071950 36 13 19.0 094 17 18.0
OSAGE CREEK NR ELM SPRINGS ARK 05007 ARKANSAS
B
ARK. RIV. TULSA TO VAN BUREN SW LOWER MISSISSIPPI

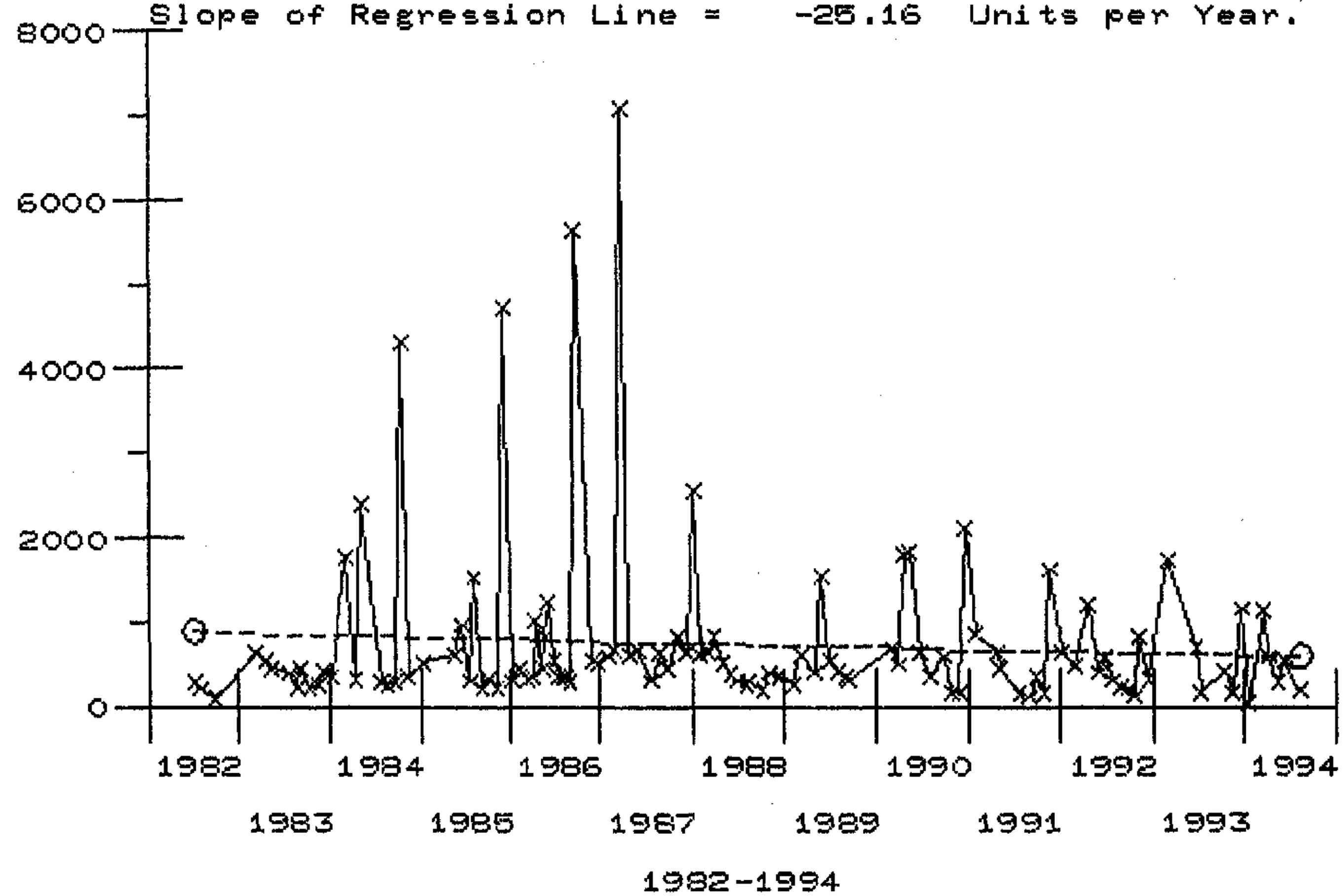
530 RESIDUE TOT NFLT LB/DAY



1116APCC 050010 ARK06A USGS071954 36 08 41.0 094 29 41.0
ILLINOIS RIVER NR SILOAM SPRINGS ARK 05007 ARKANSAS
B
ARKANSAS TULSA TO VAN BUREN SW LOWER MISSISSIPPI

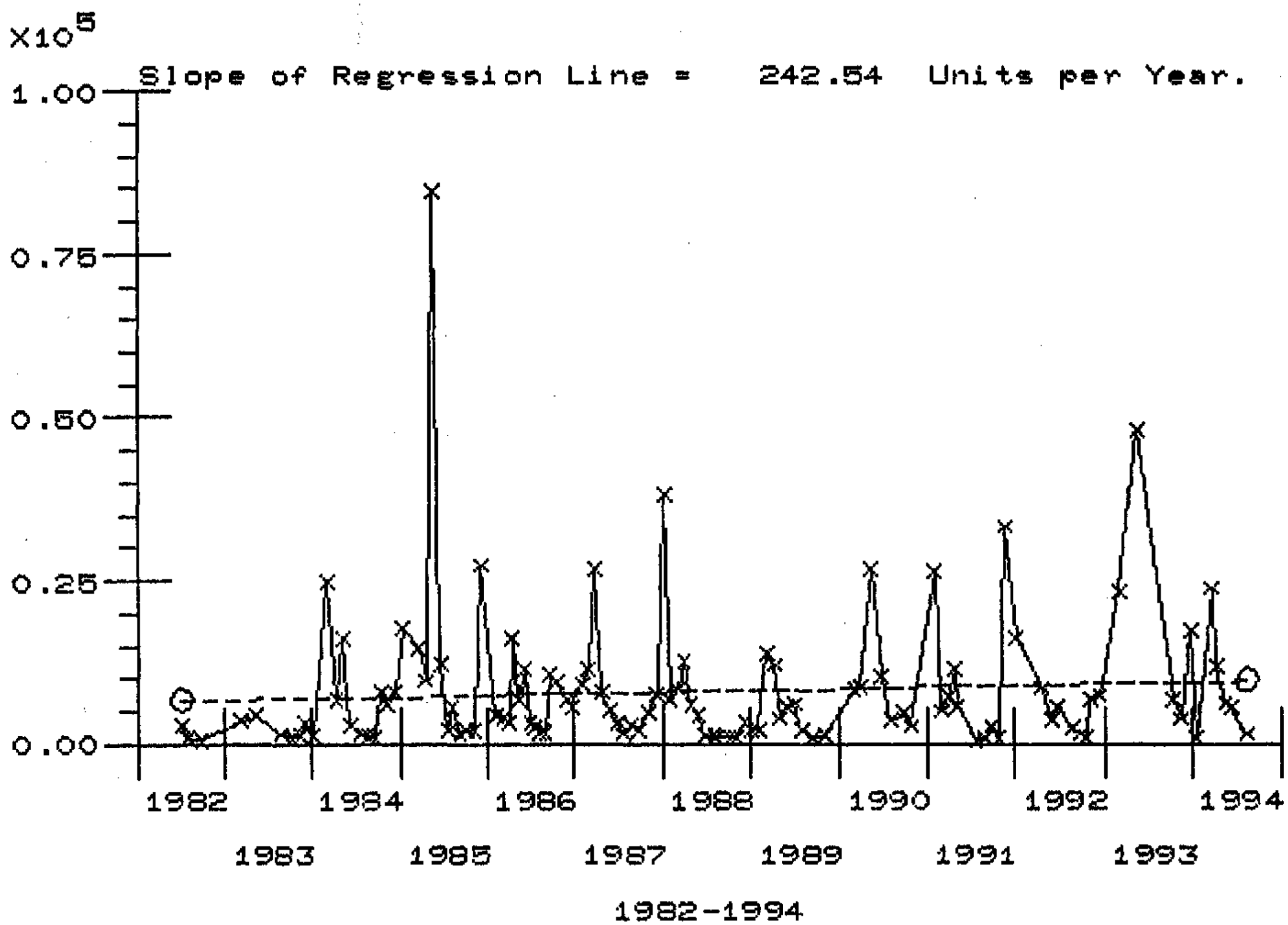
665 PHOS-TOT LB/DAY

Slope of Regression Line = -25.16 Units per Year.



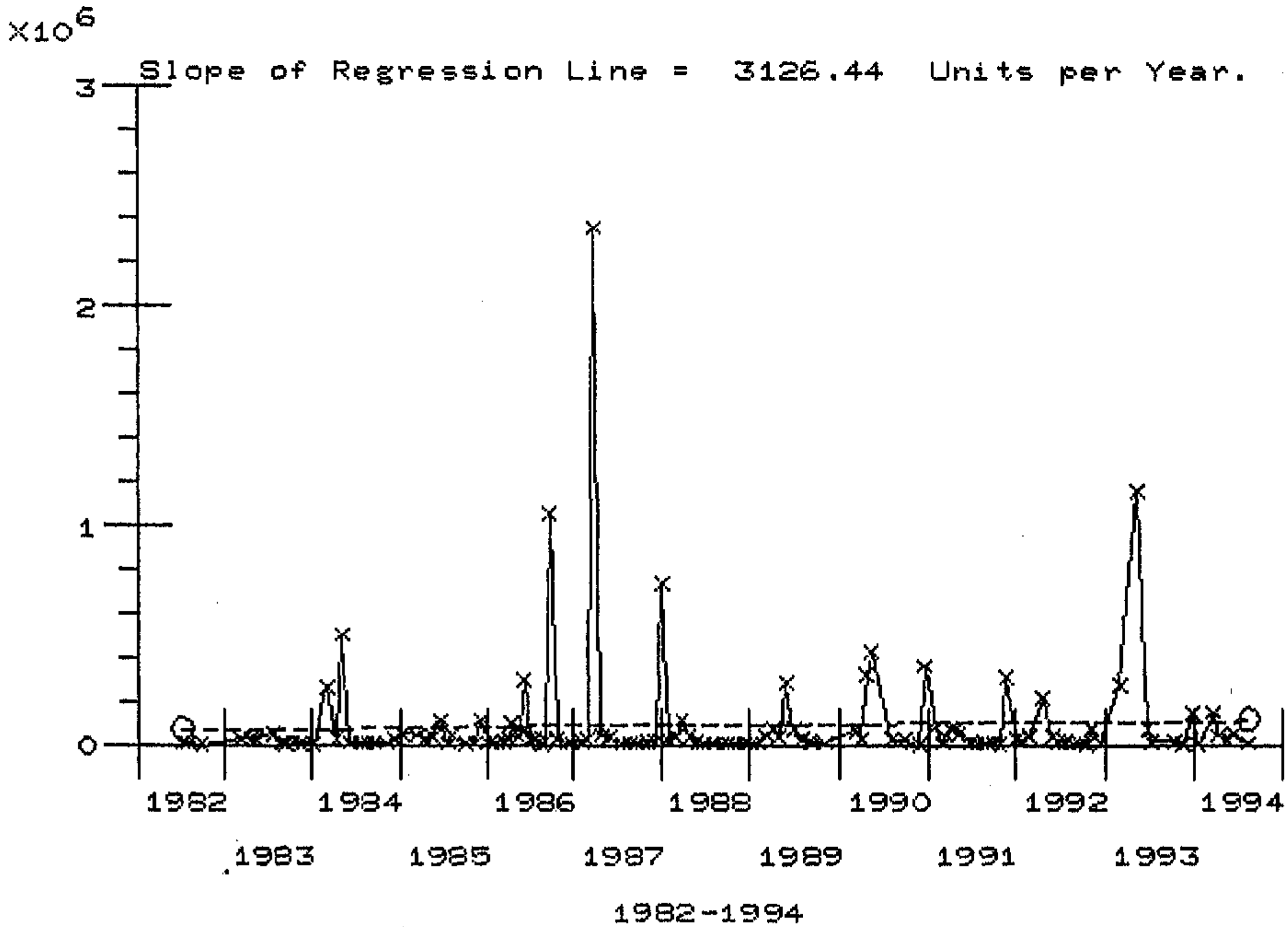
1116APCC 050010 ARK06A USGS071954 36 08 41.0 094 29 41.0
ILLINOIS RIVER NR SILOAM SPRINGS ARK 05007 ARKANSAS
B
ARKANSAS TULSA TO VAN BUREN SW LOWER MISSISSIPPI

630 NO2&NO3 N-TOTAL LB/DAY



1116APCC 050010 ARK06A USGS071954 36 08 41.0 094 29 41.0
ILLINOIS RIVER NR SILOAM SPRINGS ARK 05007 ARKANSAS
B
ARKANSAS TULSA TO VAN BUREN SW LOWER MISSISSIPPI

530 RESIDUE TOT NFLT LB/DAY



Appendix B

Monitoring Site Descriptions

SURVEY SITES

OSAGE CREEK

OSG01A (ARK25B) Osage Creek above Rogers WWTP outfall (Sec 19, T19N, R30W); drainage basin 33.0 mi^2; 4.4 stream miles from headwaters; samples - WPMF.

OSG01E City of Rogers WWTP outfall (Sec 19, T19N, R30W); 31.7 stream miles to State line; 5.5 stream miles from headwaters; samples - W.

OSG02B (ARK25C) Osage Creek @ Ar Hwy 112 (Sec 36, T19N, R31W); drainage basin 40 mi^2; 1.6 stream miles below WWTP; samples - WPMF.

OSG03B Osage Creek off Ar Hwy 112 above Spring Creek confluence (Sec 12, T18N, R31W); drainage basin 42.5 mi^2; 3.5 stream miles below WWTP; samples - WPM.

OSG04B (ARK68B) Osage Creek at county rd bridge below Spring Creek confluence (Sec 14, T18N, R31W); drainage basin 80.0 mi^2; 4.7 stream miles below WWTP; samples - WPM.

OSG05 (ARK41) Osage Creek @ Co Rd 0.5 mi below Little Osage Creek (Sec 21, T18N, R31W); drainage basin 129 mi^2; 8.3 stream miles below WWTP; samples - W.

OSG06 Osage Creek below confluence of Brush Creek near Washington County line (NE ¼ Sec 36, T18N, R32W); drainage basin 170.5 mi^2; 12.9 stream miles below WWTP; samples - W.

OSG07 (ARK82) Osage Creek @ Co Rd (Logan Cave Rd.) 1.5 mi above Illinois River S of Logan (Sec 34, T18N, R32W); drainage basin 205.0 mi^2; 16.6 stream miles below WWTP; 1.6 stream miles to confluence with Illinois River; samples - WPM.

LOS01 Little Osage Creek @ Hwy 264 bridge, approx. 2.5 mi. W. of Cave Springs (Sec 10, T18N, R31W); drainage basin 42.5 mi^2; samples - W as of November, 1995.

SPRING CREEK

SPG01A	(ARK26A) Spring Creek above the City of Springdale WWTP discharge (Sec 22, T18N, R30W); drainage basin 8.0 mi^2; 2.8 stream miles from headwaters; samples - WPMF.
SPG01E	City of Springdale WWTP discharge (Sec 22, T18N, R30W); 3.0 stream miles from headwaters; 33.5 stream miles to State line; samples - W.
SPG02B	(ARK26B) Spring Creek on Co Rd above Puppy Creek Confluence (NW ¼ Sec 21, T18N, R30W); drainage basin 12.2 mi^2; 1.8 stream miles below WWTP; samples - WPMF.
SPG03	(ARK68C) Spring Creek @ Ar Hwy 112 (Sec 12, T18N, R31W); drainage basin 36.8 mi^2; 5.6 stream miles below WWTP; 0.5 stream miles to Osage Creek confluence; samples - W.

MUD/CLEAR CREEK

MUD01E	Fayetteville WWTP discharge (Sec 1, T16N, R30W); 1.0 mile from headwaters; 44.2 stream miles to State line; samples - W.
MUD02B	Mud Creek E. of US Hwy 71B (Sec 26, T17N, R30W); drainage basin 8.0 mi^2; 3.5 stream miles below WWTP; 1.8 stream miles to Clear Creek confluence; samples - WPMF.
CLR01R	Clear Creek just above confluence of Mud Creek (reference site) (Sec 22, T17N, R30W); drainage basin 10.8 mi^2; 5.3 stream miles below WWTP; samples - WPMF.
CLR03	Clear Creek below confluence of Mud Creek @ US Hwy 71 (Sec 21, T17N, R30W); drainage basin 31 mi^2; 6.3 stream miles below WWTP; samples - W.
CLR04	Clear Creek on Co. Rd N. of Wheeler (Sec 26, T17N, R31W); drainage basin 50.8 mi^2; 13.3 stream miles below WWTP; samples - W.
CLR05	Clear Creek on Co. Rd. just above confluence with Illinois River SW of Savoy (Sec 31, T17N, R31W); drainage basin 76.9 mi^2; 18.9 stream miles below WWTP; 0.2 stream miles to confluence with Illinois River; samples - WPM.

MUDDY FORK ILLINOIS RIVER

MFI01A	Muddy Fork below confluence of Budd Kidd Creek, above Prairie Grove WWTP discharge (Sec 12, T15N, R32W); drainage basin 27.5 mi^2; 9.1 stream miles from headwaters; samples - WPMF.

MFI01E	Prairie Grove WWTP discharge (Sec 12, T15N, R32W); 37 stream mile to State line; samples - W.

MFI02B	Muddy Fork below Prairie Grove WWTP discharge W of Viney Grove (Sec 2, T15N, R32W); drainage basin 32 mi^2; 1.8 stream miles below WWTP; samples - WPMF.

MFI03	Muddy Fork N of Viney Grove (Sec 26, T16N, R32W); drainage basin 64.5 mi^2; 5.8 stream miles below WWTP; samples - W.

MFI04	Muddy Fork above confluence with Illinois River (Sec 14, T16N, R32W); drainage basin 73.2 mi^2; 7.9 stream miles below WWTP; 0.4 stream miles to confluence with Illinois River; samples - W.

ILLINOIS RIVER

ILL01	Illinois River above confluence of Muddy Fork of the Illinois River (Sec 19, T16N, R31W); drainage basin 80.2 mi^2; 22.5 stream miles from headwaters; 30.5 stream miles from State line; samples - WPM.

ILL02	(ARK40) Illinois River at AR Hwy 16 above confluence of Clear Creek SW of Savoy, below confluence of Muddy Fork of the Illinois River (Sec 36, T17N, R32W); drainage basin 167 mi^2; 25.5 stream miles from State line; samples - WPM.

ILL03	Illinois River below confluence of Clear Creek (Sec 23, T17N, R32W); drainage basin 249 mi^2; 22 stream miles from State line; samples - WPM.

ILL04	Illinois River N of Hwy 412, above Osage Creek confluence (Sec 4, T17N, R32W); drainage basin 263 mi^2; 14.4 stream miles from State line; samples - WPM.

ILL05 Illinois River S of Hwy 412 below confluence of Osage Creek (Sec 7, T17N, R32W); drainage basin 477 mi^2; 11.2 stream miles from State line; 2.2 stream miles below confluence of Osage Creek; samples - WPM.

ILL06 ARK06A - Illinois River at Hwy 16 bridge S of Siloam Springs (Sec 22, T17N, R33W); drainage basin 520 mi^2; 5.0 stream miles from State line; samples - W.

ILL07 Illinois River @ Ar Hwy 59 bridge (Sec 31, T17N, R33W); drainage basin 568 mi^2; 1.4 stream miles from state line; samples - WPMF.

Legend to Abbreviations

A	Station located above a discharge	W	Water Station
B	Station located below a discharge	P	Periphyton Station
E	Station is WWTP effluent	M	Macroinvertebrate Station
R	Reference stream site	F	Fish Community Station

Appendix C

Water Quality Data

Conventional Parameters

Appendix C - Water Quality Data Conventional Parameters

	Station	DATE	DO	pH	Temp.	NH3-N	CL	NO3-N	O-PHOS	T-PHOS		SO4	TOC	BOD	Turb.	TSS	TDS	Flow	
			mg/l	S.U.	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l		mg/l	mg/l	mg/l	ntu	mg/l	mg/l	cfs	
1	ILL01	950622	10.8	8.4	20.6	<0.05	6	3.01	0.03	0.06		13	1.5	0.8	3	4	161	46.5	
1	ILL01	950710	8.0	7.7	25.1	<0.05	6	2.29	0.06	0.04		6	3.5	1.0	6	7	159	19.0	
1	ILL01	950918	6.9	7.8	22.5	<0.05	9	2.30	<0.03	0.05		6	2.3	0.1	6	6	192	16.4	
1	ILL01	951113	8.2	7.7	9.8	<0.05	10	1.68	0.08	0.03		10	3.9	1.1	4	4	207	10.8	
1	ILL01	960115	12.3	8.0	8.4	<0.05	6	1.73	<0.03	<0.03		19	3.4	1.0	9	1	119	43.6	
1	ILL01	960415	10.4	7.7	14.0	<0.05	5	1.47	<0.03	0.03	*	15	3.6	0.7	24	9	126	77.8	
1	ILL01	960601	7.6	7.8	19.5	<0.05	6	1.56	0.10	0.19		17	5.1	1.8	48	47	155	168.2	**
1	ILL1	MAX.	12.3	8.4	25.1	0.05	10	3.01	0.10	0.19		19	5.1	1.8	48	47	207	168.2	
		MEAN	9.2	7.9	17.2	0.05	7	2.01	0.05	0.06		12	3.3	0.9	14	11	160	54.5	
		MIN	6.9	7.7	8.4	0.05	5	1.47	0.03	0.03		6	1.5	0.1	3	1	119	10.8	
2	MFI01A	950622	10.7	7.3	19.0	<0.05	5	1.29	0.06	0.11		17	3.0	1.2	5	7	144	8.8	
2	MFI01A	950710	5.9	7.4	21.0	<0.05	7	2.14	0.04	0.06		11	3.9	2.4	3	3	223	1.1	
2	MFI01A	950918	6.4	7.6	19.2	0.12	14	1.20	0.08	0.19		18	7.6	1.5	30	22	264	3.9	
2	MFI01A	951113	6.6	7.4	10.4	<0.05	8	0.67	0.03	0.06		25	6.0	1.3	4	<1	233	1.4	
2	MFI01A	960115	13.5	7.9	7.0	<0.05	5	1.22	0.03	0.04		18	4.5	1.0	4	2	118	20.7	
2	MFI01A	960415	10.3	7.9	11.7	<0.05	5	0.70	0.03	NR		18	4.5	1.3	7	8	109	37.2	
2	MFI01A	960601	7.1	7.8	18.2	0.08	6	0.69	0.12	0.20		22	7.7	1.9	50	44	152	21.1	
2	MFI1A	MAX	13.5	7.9	21.0	0.12	14	2.14	0.12	0.20		25	7.7	2.4	50	44	264	37.2	
		MEAN	8.5	7.6	15.2	0.06	7	1.13	0.05	0.11		19	5.3	1.5	15	12	176	13.5	
		MIN	5.4	7.3	7.0	0.05	5	0.67	0.03	0.04		11	3.0	1.0	3	1	109	1.1	
3	MFI01EA	950622			NOT SAMPLED														
3	MFI01EA	950710	3.2	7.7	22.6	1.40	24	1.14	0.10	0.25		10	8.9	8.1	60	109	344	<0.1	
3	MFI01EA	950918	3.5	7.6	20.4	<0.05	6	1.64	0.05	0.09		10	4.0	0.3	5	2	209		
3	MFI01EA	951113	6.2	7.3	8.6	0.28	15	1.32	0.05	0.12		89	5.2	2.0	30	21	452	<0.1	
3	MFI01EA	960115	16.3	7.7	7.6	0.05	16	2.74	0.04	0.11		109	4.7	1.0	6	7	441	<0.1	
3	MFI01EA	960415	12.8	7.8	10.0	0.07	14	4.98	0.04	0.12	*	69	3.6	1.2	15	23	364	0.2	
3	MFI01EA	960601	6.2	7.5	18.7	0.36	13	2.93	0.76	0.10		39	16.3	4.9	70	111	290	1.5	
3	MFI1EA	MAX	16.3	7.8	22.6	1.40	24	4.98	0.76	0.25		109	16.3	8.1	70	111	452	1.5	
		MEAN	7.9	7.6	14.7	0.37	15	2.46	0.17	0.13		54	7.1	2.9	29	45	348	0.4	
		MIN	3.2	7.3	7.6	0.05	6	1.14	0.04	0.09		10	3.6	0.3	5	2	209	0.1	

	Station	DATE	DO mg/l	pH S.U.	Temp. mg/l	NH3-N mg/l	CL mg/l	NO3-N mg/l	O-PHOS mg/l	T-PHOS mg/l		SO4 mg/l	TOC mg/l	BOD mg/l	Turb. ntu	TSS mg/l	TDS mg/l	Flow cfs
4	MFI01E	950522	9.5	7.6	20.1	0.31	47	16.50	3.48	3.79		39	7.1	3.0	5	10	335	0.5
4	MFI01E	950710	7.6	7.6	24.9	0.07	52	15.20	4.98	5.56		39	8.6	3.9	4	10	341	0.4
4	MFI01E	950918	8.0	7.5	23.7	<0.05	47	27.60	4.54	4.48		36	7.0	0.2	2	<1	351	0.3
4	MFI01E	951113	8.0	7.1	13.0	0.14	47	21.40	3.72	4.27		38	7.0	2.0	2	3	346	0.3
4	MFI01E	960115	9.2	7.5	10.2	<0.05	55	7.68	3.09	3.40		51	7.8	2.7	1	1	339	0.3
4	MFI01E	960415	11.2	7.7	14.0	0.39	42	1.36	1.83	2.26	*	52	7.3	2.1	2	2	284	0.4
4	MFI01E	960601	8.2	7.5	20.5	0.60	42	7.83	2.79	3.76		43	7.6	2.6	3	3	287	0.9
4	MFI1E	MAX	11.2	7.7	24.9	0.60	55	27.60	4.98	5.56		52	8.6	3.9	5	10	351	0.9
		MEAN	8.8	7.5	18.1	0.23	47	13.94	3.49	3.93		43	7.5	2.4	3	4	326	0.4
		MIN	7.6	7.1	10.2	0.05	42	1.36	1.83	2.26		36	7.0	0.2	1	1	284	0.3
5	MFI02B	950522	9.6	8.0	20.4	<0.05	7	1.93	0.04	0.18		16	3.0	1.9	6	10	163	11.2
5	MFI02B	950710	6.4	7.8	26.1	<0.05	10	2.17	0.28	0.32		12	4.5	1.5	4	11	216	1.9
5	MFI02B	950918	6.5	7.9	23.1	<0.05	21	6.13	0.86	1.10		23	6.0	0.6	7	10	249	1.5
5	MFI02B	951113	8.5	7.7	8.5	<0.05	17	4.42	0.81	0.94		25	5.9	1.1	2	2	271	2.2
5	MFI02B	960115	12.1	8.3	7.8	<0.05	6	1.25	0.04	0.07		19	5.1	1.8	4	4	124	26.8
5	MFI02B	960415	11.4	8.0	12.0	<0.05	6	0.82	<0.03	0.12	*	23	4.9	1.2	9	12	131	46.7
5	MFI02B	960601	7.2	7.6	18.0	0.21	9	2.04	0.53	0.62		19	10.0	3.8	95	117	181	27.1
5	MFI2B	MAX	12.1	8.3	26.1	0.21	21	6.13	0.86	1.10		25	10.0	3.8	95	117	271	46.7
		MEAN	8.8	7.9	16.6	0.07	11	2.68	0.37	0.48		20	5.5	1.7	18	24	191	16.8
		MIN	6.4	7.6	7.8	0.05	6	0.82	0.03	0.07		12	3.0	0.6	2	2	124	1.5
6	MFI03	950522	9.5	7.8	20.4	<0.05	7	2.77	0.04	0.11		14	3.0	0.8	4	6	172	25.3
6	MFI03	950710	5.4	7.6	25.2	<0.05	7	1.92	0.10	0.12		8	5.3	1.6	4	6	201	4.8 **
6	MFI03	950918	4.4	7.8	21.0	<0.05	12	0.88	0.03	0.11		10	5.5	0.5	4	2	196	12.7
6	MFI03	951113	7.0	7.6	8.8	<0.05	13	0.59	0.19	0.19		15	6.9	1.3	2	1	222	2.4
6	MFI03	960115	12.4	8.1	10.9	<0.05	6	1.54	0.07	0.06		22	4.6	1.3	5	4	132	25.1
6	MFI03	960415	10.2	7.6	12.0	<0.05	6	2.01	0.03	0.07	*	14	5.7	1.4	26	15	129	101.3
6	MFI03	960601	6.7	7.7	18.6	0.11	8	1.71	0.33	0.48		16	7.9	3.2	71	78	181	54.8
6	MFI3	MAX	12.4	8.1	25.2	0.11	13	2.77	0.33	0.48		22	7.9	3.2	71	78	222	101.3
		MEAN	7.9	7.8	16.7	0.06	9	1.63	0.11	0.16		14	5.5	1.4	17	16	176	32.3
		MIN	4.4	7.6	8.8	0.05	6	0.59	0.03	0.06		8	3.0	0.5	2	1	129	2.4

	Station	DATE	DO mg/l	pH S.U.	Temp. mg/l	NH3-N mg/l	CL mg/l	NO3-N mg/l	O-PHOS mg/l	T-PHOS mg/l		SO4 mg/l	TOC mg/l	BOD mg/l	Turb. ntu	TSS mg/l	TDS mg/l	Flow cfs
7	MFI04	950622	11.4	8.4	20.6	<0.05	6	2.41	0.07	0.10		14	2.0	0.3	3	3	149	37.4
7	MFI04	950710	7.9	7.8	26.0	<0.05	8	1.89	0.07	0.08		5	4.6	1.3	4	6	162	8.6
7	MFI04	950918	7.2	8.0	24.1	<0.05	12	0.85	0.07	0.11		8	4.5	0.4	4	4	165	6.8
7	MFI04	951113	9.7	7.8	10.3	<0.05	12	0.78	0.08	0.06		11	5.2	1.1	2	<1	201	4.4
7	MFI04	960116	12.6	8.2	8.3	<0.05	6	1.46	0.05	0.06		20	4.5	1.5	5	2	135	26.4
7	MFI04	960415	9.3	7.7	14.0	<0.05	6	1.96	0.03	0.06	*	14	5.8	1.5	16	18	123	101.6
7	MFI04	960601	7.6	7.9	19.4	0.06	8	2.09	0.26	0.38		14	6.7	2.4	58	73	183	60.7
7	MFI4	MAX	12.6	8.4	26.0	0.06	12	2.41	0.26	0.38		20	6.7	2.4	58	73	201	101.6
		MEAN	9.4	8.0	17.5	0.05	8	1.63	0.09	0.12		12	4.8	1.2	13	15	165	35.1
		MIN	7.2	7.7	8.3	0.05	6	0.78	0.03	0.06		5	2.0	0.3	2	1	123	4.4
8	ILL02	950522	11.1	8.4	20.0	<0.05	6	2.55	<0.03	0.06		9	2.8	0.2	4	4	152	92.3
8	ILL02	950919	6.4	8.0	20.9	<0.05	10	1.17	<0.03	0.08		7	3.5	0.8	void	20	176	13.3
8	ILL02	951113	11.7	8.2	10.1	<0.05	10	1.26	<0.03	<0.03		8	3.5	1.0	2	<1	192	17.8
8	ILL02	951113	8.5	7.9	27.2	<0.05	6	1.67	0.03	0.04		6	3.8	1.0	7	10	155	31.7
8	ILL02	960115	13.3	8.5	7.0	<0.05	8	1.89	<0.03	0.04		19	4.1	0.8	7	<1	133	82.1
8	ILL02	960415	9.1	7.9	13.0	<0.05	6	1.69	0.04	0.04	*	14	4.4	1.1	16	13	126	201.1
8	ILL02	960601	7.3	7.9	19.3	0.07	8	2.42	0.18	0.25		14	6.1	1.7	47	53	170	216.0
8	ILL2	MAX	13.3	8.5	27.2	0.07	10	2.55	0.18	0.25		19	6.1	1.7	47	53	192	216.0
		MEAN	9.6	8.1	16.8	0.05	7	1.78	0.05	0.08		11	4.0	0.9	14	15	158	93.5
		MIN	6.4	7.9	7.0	0.05	6	1.17	0.03	0.03		6	2.6	0.2	2	1	126	13.3
9	MUD01E	950622	8.2	7.3	20.0	0.09	37	7.88	0.20	0.29		94	12.1	6.0	1	2	338	6.2
9	MUD01E	950710	8.0	7.0	24.6	0.11	72	12.40	0.43	0.56		84	7.8	1.3	0	<1	418	5.7
9	MUD01E	950919	7.8	7.5	26.0	0.08	72	6.15	0.19	0.33		87	12.5	5.5	void	3	396	11.0
9	MUD01E	951113			NO DISCHARGE													ND
9	MUD01E	960116	9.4	7.6	12.5	1.00	52	6.58	0.13	0.27		72	8.8	6.1	4	3	366	4.8
9	MUD01E	960415	7.9	7.4	16.0	1.55	35	7.67	0.42	0.54	*	67	8.0	2.9	3	3	309	4.8
9	MUD01E	960601	7.7	7.4	22.2	0.46	48	4.39	0.08	0.20		71	7.8	1.8	1	<1	318	18.3
9	MUD1E	MAX	9.4	7.6	25.0	1.55	72	12.40	0.43	0.56		97	12.5	6.0	4	3	418	18.3
		MEAN	8.3	7.4	19.9	0.55	53	7.60	0.24	0.37		81	9.5	3.7	2	2	357	8.5
		MIN	7.7	7.0	12.5	0.08	35	4.39	0.08	0.20		67	7.8	1.3	0	1	309	4.8

	Station	DATE	DO mg/l	pH S.U.	Temp. mg/l	NH3-N mg/l	CL mg/l	NO3-N mg/l	O-PHOS mg/l	T-PHOS mg/l	SO4 mg/l	TOC mg/l	BOD mg/l	Turb. ntu	TSS mg/l	TDS mg/l	Flow cfs
10	MUD02B	950522	11.8	8.7	24.4	<0.05	22	2.53	0.12	0.16	44	5.6	0.5	3	3	223	8.1
10	MUD02B	950710	11.6	8.5	29.6	<0.05	65	6.64	0.25	0.27	77	6.3	1.2	4	10	390	4.9
10	MUD02B	950919	6.4	8.0	22.0	0.36	63	4.11	0.37	0.48	89	9.1	1.1	void	16	397	10.8
10	MUD02B	951113	12.2	8.1	11.5	0.07	40	5.93	0.12	0.15	61	6.5	1.2	6	8	324	3.8
10	MUD02B	960116	14.4	8.6	9.5	<0.05	33	3.16	0.04	0.05	53	5.4	1.1	3	3	268	7.4
10	MUD02B	960416	13.8	9.0	13.0	<0.05	19	1.82	0.06	0.10	* 48	4.3	1.3	6	3	216	5.2
10	MUD02B	960601	8.1	8.0	21.4	0.06	16	1.59	0.08	0.17	30	7.7	1.9	28	20	189	16.2
10	MUD2B	MAX	14.4	9.0	29.6	0.36	65	6.64	0.37	0.48	89	9.1	1.9	28	20	397	16.2
		MEAN	11.2	8.4	18.8	0.10	37	3.68	0.16	0.20	57	6.4	1.2	8	9	287	8.0
		MIN	6.4	8.0	9.5	0.05	16	1.59	0.04	0.06	30	4.3	0.5	3	3	189	3.8
11	CLR01R	950522	8.3	8.2	24.4	<0.05	5	0.45	0.03	0.08	7	6.0	0.8	3	3	121	7.7
11	CLR01R	950710	8.4	7.8	26.3	<0.05	5	0.60	0.06	0.06	9	6.4	0.8	3	2	137	3.4
11	CLR01R	950919	7.1	8.0	21.0	<0.05	6	0.69	0.04	0.10	9	6.1	0.2	void	24	137	2.2
11	CLR01R	951113	11.6	8.3	11.0	<0.05	6	0.60	0.04	<0.03	8	4.8	0.9	3	4	142	2.3
11	CLR01R	960116	13.6	8.5	7.0	<0.05	7	0.77	<0.03	<0.03	8	6.0	1.0	3	<1	146	6.1
11	CLR01R	960416	13.0	8.7	13.0	<0.05	7	0.31	<0.03	0.06	* 7	3.6	0.6	1	<1	139	3.3
11	CLR01R	960601	8.1	7.9	23.4	<0.05	6	0.03	<0.03	0.11	7	7.8	3.2	16	24	116	22.2
11	CLR1R	MAX	13.6	8.7	26.3	0.05	7	0.77	0.06	0.11	9	7.8	3.2	16	24	146	22.2
		MEAN	10.0	8.2	18.0	0.05	6	0.49	0.04	0.06	8	6.2	1.1	5	8	134	6.7
		MIN	7.1	7.8	7.0	0.05	5	0.03	0.03	0.03	7	3.6	0.2	1	1	116	2.2
12	CLR03	950522	9.8	8.2	21.0	<0.05	9	2.26	0.04	0.06	15	3.1	0.4	2	2	176	35.8
12	CLR03	950710	11.1	8.1	23.4	<0.05	20	3.30	0.05	0.04	22	3.7	0.7	3	5	239	23.9
12	CLR03	950919	8.6	8.1	20.0	<0.05	24	2.82	0.03	0.07	32	4.2	0.2	void	5	245	20.0
12	CLR03	951113	11.8	8.2	11.3	<0.05	15	1.61	0.07	0.03	31	4.3	1.0	3	<1	227	19.0
12	CLR03	960116	15.1	8.7	9.0	<0.05	23	2.19	<0.03	<0.03	37	4.4	0.9	3	<1	236	21.6
12	CLR03	960416	12.9	8.7	13.0	<0.05	13	1.82	<0.03	NR	28	3.5	1.5	3	2	205	21.2
12	CLR03	960601	8.2	7.8	20.2	<0.05	8	1.26	0.08	0.14	15	7.1	2.5	33	30	145	67.0
12	CLR3	MAX	15.1	8.7	23.4	0.05	24	3.30	0.08	0.14	37	7.1	2.5	33	30	245	67.0
		MEAN	11.1	8.2	16.8	0.05	16	2.18	0.05	0.06	26	4.3	1.0	8	6	210	29.8
		MIN	8.2	7.8	9.0	0.05	8	1.26	0.03	0.03	15	3.1	0.2	2	1	145	19.0

	Station	DATE	DO mg/l	pH S.U.	Temp. mg/l	NH3-N mg/l	CL mg/l	NO3-N mg/l	O-PHOS mg/l	T-PHOS mg/l	SO4 mg/l	TOC mg/l	BOD mg/l	Turb. ntu	TSS mg/l	TDS mg/l	Flow cfs
13	CLR04	950522	12.0	8.3	21.9	<0.05	8	2.33	<0.03	0.05	12	2.7	0.5	3	3	153	68.4
13	CLR04	950710	11.4	7.8	24.9	<0.05	14	2.96	<0.03	<0.03	15	3.3	0.6	4	7	197	39.9
13	CLR04	950919	7.6	7.6	20.0	<0.05	14	2.17	<0.03	0.06	20	3.1	0.2	void	7	199	32.0
13	CLR04	951113	12.4	7.7	12.1	<0.05	12	2.17	0.03	<0.03	18	3.2	0.9	2	<1	199	22.7
13	CLR04	960115	15.2	8.5	9.5	<0.05	17	2.62	<0.03	0.07	29	3.8	0.8	5	1	208	32.5
13	CLR04	960415	10.9	8.0	13.0	<0.05	11	2.32	<0.03	NR	19	2.8	0.7	4	2	175	34.5
13	CLR04	960601	7.5	7.6	19.8	<0.05	9	1.46	0.18	0.19	17	6.2	2.1	69	68	149	122.5
13	CLR4	MAX	15.2	8.5	24.9	0.05	17	2.96	0.18	0.19	29	6.2	2.1	69	68	208	122.5
		MEAN	11.0	8.0	17.3	0.05	12	2.28	0.06	0.07	19	3.6	0.8	14	13	183	48.9
		MIN	7.5	7.6	9.5	0.05	8	1.46	0.03	0.03	12	2.7	0.2	2	1	149	22.7
14	CLR05	950522	9.2	8.2	20.4	<0.05	7	2.19	<0.03	0.05	10	2.5	0.5	4	5	156	73.0
14	CLR05	950710	10.0	8.0	25.7	<0.05	11	2.42	<0.03	<0.03	10	3.8	0.7	5	7	183	60.1
14	CLR05	950919	7.5	8.0	21.0	<0.05	11	1.64	<0.03	0.08	16	4.0	0.6	void	38	178	32.8
14	CLR05	951113	11.6	8.2	10.0	<0.05	12	1.56	<0.03	<0.03	16	2.9	0.7	3	1	185	26.7
14	CLR05	960115	11.9	8.2	8.0	<0.05	16	1.98	<0.03	<0.03	26	3.5	0.7	5	4	198	43.5
14	CLR05	960415	9.2	8.5	13.0	<0.05	9	1.78	<0.03	NR	14	3.1	0.7	7	6	157	46.2
14	CLR05	960601	7.8	7.9	19.2	<0.05	12	1.84	0.15	0.17	21	6.0	1.6	60	43	173	198.4
14	CLR5	MAX	11.9	8.5	25.7	0.05	16	2.42	0.15	0.17	26	6.0	1.6	60	43	198	198.4
		MEAN	9.6	8.1	16.8	0.05	11	1.91	0.05	0.06	16	3.7	0.8	14	15	176	67.2
		MIN	7.5	7.9	8.0	0.05	7	1.56	0.03	0.03	10	2.5	0.5	3	1	156	26.7
15	ILL03	950523	8.9	8.4	20.1	<0.05	7	2.15	0.04	0.07	14	2.4	0.6	4	7	161	204.7
15	ILL03	950710	7.5	7.1	27.0	<0.05	8	1.93	0.04	0.04	8	3.8	0.7	6	9	169	87.1
15	ILL03	950918	7.3	8.0	23.3	<0.05	12	1.29	0.04	0.06	14	2.8	0.1	8	8	172	69.0
15	ILL03	951113	10.2	8.0	9.9	<0.05	12	1.32	0.04	<0.03	13	3.1	0.7	2	<1	184	46.0
15	ILL03	960115	11.7	8.2	8.2	<0.05	9	1.71	<0.03	0.11	21	3.5	1.1	6	2	162	141.4
15	ILL03	960415	9.3	7.9	15.0	<0.05	6	1.72	<0.03	0.06	14	4.3		15	18	136	247.3
15	ILL03	960601	7.9	7.9	20.1	<0.05	9	1.87	0.10	0.17	17	4.5	1.5	33	56	170	405.4
15	ILL3	MAX	11.7	8.4	27.0	0.05	12	2.15	0.10	0.17	21	4.5	1.5	33	56	184	405.4
		MEAN	9.0	7.9	17.7	0.05	9	1.71	0.05	0.08	14	3.5	0.8	11	14	162	171.6
		MIN	7.3	7.1	8.2	0.05	6	1.29	0.03	0.03	8	2.4	0.1	2	1	136	46.0

	Station	DATE	DO mg/l	pH S.U.	Temp. mg/l	NH3-N mg/l	CL mg/l	NO3-N mg/l	O-PHOS mg/l	T-PHOS mg/l		SO4 mg/l	TOC mg/l	BOD mg/l	Turb. ntu	TSS mg/l	TDS mg/l	Flow cfs
16	ILL04	960523	9.0	8.3	19.6	<0.05	7	2.07	<0.03	0.05		15	2.0	0.6	4	6	146	195.4
16	ILL04	960711	6.8	7.7	24.6	<0.05	8	1.82	0.08	0.06		6	3.5	0.6	5	8	166	94.1
16	ILL04	960919	6.6	7.6	21.2	<0.05	11	1.18	0.05	0.08		15	2.7	0.1	6	6	170	67.6
16	ILL04	961114	10.4	7.8	8.3	<0.05	12	1.20	0.06	<0.03		14	2.8	0.8	2	<1	186	57.6
16	ILL04	960116	11.1	7.8	7.5	<0.05	9	1.72	0.03	0.04		23	3.5	0.9	5	3	152	126.1
16	ILL04	960416	9.7	7.9	15.0	<0.05	6	1.65	0.04	0.06	*	14	4.3	1.4	23	60	136	261.2
16	ILL04	960602	7.7	7.7	18.5	<0.05	7	1.65	0.14	0.17		19	5.2	1.4	34	25	162	263.2
16	ILL4	MAX	11.1	8.3	24.6	0.05	12	2.07	0.14	0.17		23	5.2	1.4	34	60	186	263.2
		MEAN	8.6	7.8	16.4	0.05	9	1.61	0.06	0.07		15	3.4	0.8	11	15	159	152.1
		MIN	6.6	7.6	7.5	0.05	6	1.18	0.03	0.03		6	2.0	0.1	2	1	136	57.6
17	OSC01A	960523	9.1	7.6	16.0	<0.05	6	3.81	<0.03	0.10		7	1.7	0.3	2	3	153	35.4
17	OSC01A	960711	10.6	7.6	18.6	<0.05	6	3.76	0.12	0.05		4	2.3	0.6	2	1	168	18.8
17	OSC01A	960918	8.8	7.2	17.8	<0.05	6	2.73	0.19	0.09		8	2.3	0.2	4	2	156	13.7
17	OSC01A	961114	9.6	8.1	10.6	<0.05	5	2.64	0.08	0.05		5	1.9	1.0	2	<1	166	8.3
17	OSC01A	960116	9.6	7.6	12.0	<0.05	9	2.92	<0.03	0.04		8	2.1	0.7	2	1	170	8.5
17	OSC01A	960416	8.8	6.9	12.0	<0.05	10	3.16	0.12	0.12	*	7	2.6	0.5	120	166	216	10.1
17	OSC01A	960601	7.9	7.8	20.4	0.05	4	0.88	0.16	0.19		7	8.2	2.6	67	81	104	124.1
17	OSC1A	MAX	10.6	8.1	20.4	0.05	10	3.81	0.19	0.19		8	8.2	2.6	120	166	216	124.1
		MEAN	9.2	7.5	15.3	0.05	7	2.84	0.11	0.09		7	3.0	0.8	28	39	162	31.0
		MIN	7.9	6.9	10.6	0.05	4	0.88	0.03	0.04		4	1.7	0.2	2	1	104	8.3
18	OSC01E	960523	8.3	7.6	21.0	0.06	92	11.40	1.66	1.63		41	7.2	1.5	1	2	376	6.2
18	OSC01E	960711	8.9	7.7	26.5	<0.05	82	4.06	1.81	1.78		41	7.2	1.0	1	<1	371	4.8
18	OSC01E	960918	10.7	7.7	25.6	<0.05	82	0.66	1.00	1.07		41	6.4	0.2	1	<1	324	6.8
18	OSC01E	961114	9.3	7.8	17.1	<0.05	104	4.56	3.61	3.53		45	6.9	1.8	3	4	406	5.2
18	OSC01E	960116	10.0	7.6	14.0	<0.05	122	1.70	2.00	2.12		46	8.0	3.5	2	3	450	5.1
18	OSC01E	960416	8.9	7.4	15.0	<0.05	152	5.63	5.03	5.10	*	52	7.5	2.8	4	10	476	4.6
18	OSC01E	960601	8.8	7.3	22.2	<0.05	106	6.42	0.63	0.77		44	8.6	1.9	3	6	391	10.2
18	OSC1E	MAX	10.7	7.8	26.5	0.06	152	11.40	5.03	5.10		52	8.6	3.5	4	10	476	10.2
		MEAN	9.3	7.6	20.2	0.05	106	4.92	2.22	2.29		44	7.4	1.8	2	4	399	6.1
		MIN	8.3	7.3	14.0	0.05	82	0.66	0.63	0.77		41	6.4	0.2	1	1	324	4.6

	Station	DATE	DO mg/l	pH S.U.	Temp. mg/l	NH3-N mg/l	CL mg/l	NO3-N mg/l	O-PHOS mg/l	T-PHOS mg/l		SO4 mg/l	TOC mg/l	BOD mg/l	Turb. ntu	TSS mg/l	TDS mg/l	Flow cfs
19	OSC02B	950523	9.7	7.8	17.3	<0.05	13	4.67	0.20	0.25		9	2.8	0.4	3	6	182	59.7
19	OSC02B	950711	10.8	7.8	19.2	<0.05	14	3.93	0.25	0.26		9	3.1	0.6	2	3	192	37.0
19	OSC02B	950918	10.6	7.9	19.7	<0.05	24	2.42	0.29	0.35		17	3.3	0.2	5	6	201	24.9
19	OSC02B	951114	10.1	8.3	10.2	<0.05	31	3.04	0.65	0.72		17	3.0	1.3	2	<1	231	18.6
19	OSC02B	960116	10.6	8.1	11.6	<0.05	35	2.91	0.36	0.42		18	3.5	1.2	3	3	235	20.6
19	OSC02B	960416	10.5	8.3	11.0	<0.05	40	3.30	0.86	0.92	*	17	3.1	0.7	6	8	246	18.3
19	OSC02B	960601	7.9	7.6	18.4	0.07	16	1.63	0.22	0.32		9	7.6	2.5	81	133	143	169.3
19	OSC2B	MAX	10.8	8.3	19.7	0.07	40	4.67	0.86	0.92		17	7.6	2.5	81	133	246	169.3
		MEAN	10.0	8.0	15.3	0.05	25	3.13	0.40	0.46		13	3.7	1.0	14	23	204	49.8
		MIN	7.9	7.6	10.2	0.05	13	1.63	0.20	0.25		9	2.8	0.2	2	1	143	18.3
20	OSC03	950523	11.3	8.2	19.4	<0.05	10	4.79	0.15	0.16		9	2.6	0.7	2	4	179	80.4
20	OSC03	950711	11.3	8.0	20.7	<0.05	13	4.13	0.22	0.19		6	2.8	0.8	1	5	199	45.0
20	OSC03	950918	12.5	8.3	22.5	<0.05	22	2.54	0.27	0.33		13	3.4	0.1	7	19	200	35.6
20	OSC03	951114	13.1	8.4	10.6	<0.05	32	2.98	0.63	0.68		16	3.1	1.1	2	1	234	20.8
20	OSC03	960116	12.9	8.6	11.0	<0.05	34	3.08	0.32	0.33		17	3.8	1.1	3	3	247	23.4
20	OSC03	960416	11.4	8.4	13.0	<0.05	41	2.97	0.71	0.74	*	29	2.7	0.5	4	7	245	19.7
20	OSC03	960601	6.9	7.6	19.3	0.09	17	1.71	0.26	0.35		10	6.0	1.9	99	180	149	169.5
20	OSC3	MAX	13.1	8.6	22.5	0.09	41	4.79	0.71	0.74		29	6.0	1.9	99	180	247	169.5
		MEAN	11.3	8.2	16.6	0.06	24	3.17	0.37	0.40		14	3.5	0.9	17	31	208	56.3
		MIN	6.9	7.6	10.6	0.05	10	1.71	0.15	0.16		6	2.6	0.1	1	1	149	19.7
21	SPG01A	950523	8.4	7.5	15.8	<0.05	7	2.64	0.06	0.07		11	1.6	0.3	1	1	170	11.5
21	SPG01A	950711	11.1	7.3	17.4	<0.05	8	2.72	0.10	<0.03		5	2.1	0.4	1	<1	195	7.6
21	SPG01A	950918	10.4	7.5	19.8	<0.05	7	2.14	0.07	0.06		12	2.3	0.2	2	5	187	6.2
21	SPG01A	951114	8.4	7.8	12.1	<0.05	8	1.89	0.08	0.06		15	2.4	0.8	1	<1	196	4.8
21	SPG01A	960116	9.2	7.6	12.0	<0.05	11	2.58	0.09	0.07		17	2.6	0.6	1	<1	203	8.7
21	SPG01A	960416	7.6	7.6	12.0	<0.05	9	2.49	0.05	0.06	*	13	1.7	0.4	2	1	165	7.4
21	SPG01A	960601	7.9	7.5	17.6	0.07	5	0.98	0.25	0.22		10	7.7	2.4	91	87	125	66.5
21	SPG1A	MAX	11.1	7.8	19.8	0.07	11	2.72	0.25	0.22		17	7.7	2.4	91	87	203	66.5
		MEAN	9.0	7.5	16.2	0.05	8	2.21	0.10	0.08		12	2.9	0.7	14	14	180	16.1
		MIN	7.6	7.3	12.0	0.05	5	0.98	0.05	0.03		5	1.5	0.2	1	1	125	4.8

	Station	DATE	DO mg/l	pH S.U.	Temp. mg/l	NH3-N mg/l	CL mg/l	NO3-N mg/l	O-PHOS mg/l	T-PHOS mg/l		SO4 mg/l	TOC mg/l	BOD mg/l	Turb. ntu	TSS mg/l	TDS mg/l	Flow cfs
22	SPG01E	950523	9.1	7.3	21.8	0.06	81	5.03	7.18	11.80		79	7.0	2.4	2	3	383	17.5
22	SPG01E	950711	9.5	7.3	26.2	<0.05	74	3.70	4.88	4.94		69	7.0	1.3	1	<1	367	17.2
22	SPG01E	950918	11.3	7.6	26.4	0.06	66	2.00	3.59	3.86		63	7.0	1.4	4	11	330	16.6
22	SPG01E	951114	10.4	8.0	16.6	0.07	80	5.19	5.47	6.04		83	8.7	2.3	3	5	420	16.1
22	SPG01E	960116	9.6	7.4	14.0	<0.05	77	4.47	0.48	0.47		78	8.7	4.4	2	4	393	15.0
22	SPG01E	960416	10.0	7.3	16.0	<0.05	64	5.29	4.96	6.10	*	71	7.1	2.6	2	4	359	16.3
22	SPG01E	960601	8.9	7.3	22.9	<0.05	80	3.57	2.26	2.67		86	9.4	1.4	3	1	416	13.2
22	SPG1E	MAX	11.3	8.0	26.4	0.07	81	5.29	7.18	11.80		86	9.4	4.4	4	11	420	17.5
		MEAN	9.8	7.5	20.6	0.06	75	4.18	4.12	5.13		76	7.8	2.3	2	4	381	15.7
		MIN	8.9	7.3	14.0	0.05	64	2.00	0.48	0.47		63	7.0	1.3	1	1	330	13.2
23	SPG02B	950523	10.3	7.7	18.0	<0.05	29	4.11	1.98	2.12		32	3.3	1.0	1	4	241	36.9
23	SPG02B	950711	8.3	7.5	20.8	<0.05	36	3.40	1.81	1.94		36	3.9	0.9	1	3	268	27.4
23	SPG02B	950918	10.7	7.8	24.4	<0.05	43	2.12	1.53	1.70		48	4.5	0.2	4	12	273	28.2
23	SPG02B	951114	10.0	8.1	12.8	<0.05	49	3.94	2.92	3.41		54	5.4	0.9	1	1	322	19.4
23	SPG02B	960116	10.5	7.9	12.5	<0.05	44	3.99	0.49	0.57		49	5.1	1.3	2	2	302	26.6
23	SPG02B	960416	9.5	7.8	13.0	<0.05	36	4.06	2.27	2.47	*	46	4.2	0.7	2	3	272	26.3
23	SPG02B	960601	8.3	7.4	18.8	0.06	18	1.82	0.78	0.92		26	6.9	2.2	57	64	178	102.0
23	SPG2B	MAX	10.7	8.1	24.4	0.06	49	4.11	2.92	3.41		54	6.9	2.2	57	64	322	102.0
		MEAN	9.7	7.7	17.2	0.05	37	3.35	1.68	1.88		42	4.8	1.0	10	12	265	37.8
		MIN	8.3	7.4	12.5	0.05	18	1.82	0.49	0.57		26	3.3	0.2	1	1	178	19.4
24	SPG03	950523	11.0	8.2	17.8	<0.05	21	4.30	1.24	1.36		23	2.7	0.4	1	2	218	51.5
24	SPG03	950711	8.4	7.8	20.8	<0.05	28	3.34	1.10	1.21		25	3.3	0.5	1	3	246	38.3
24	SPG03	950918	12.2	8.3	22.5	<0.05	28	2.37	0.89	1.01		33	3.2	0.2	2	4	239	33.7
24	SPG03	951114	10.8	8.5	9.7	<0.05	39	2.93	2.01	2.21		43	4.6	0.9	1	<1	288	22.5
24	SPG03	960116	11.9	8.3	11.0	<0.05	37	3.64	0.44	0.50		40	4.2	0.9	1	<1	285	30.2
24	SPG03	960416	10.0	8.1	11.0	<0.05	29	3.29	1.50	1.62	*	37	3.4	0.8	2	2	256	29.5
24	SPG03	960601	7.5	7.6	18.6	<0.05	13	1.60	0.77	0.91		19	7.3	1.9	43	69	149	123.3
24	SPG3	MAX	12.2	8.5	22.5	0.05	39	4.30	2.01	2.21		43	7.3	1.9	43	69	288	123.3
		MEAN	10.3	8.1	15.9	0.05	28	3.07	1.14	1.26		32	4.1	0.8	7	12	240	47.0
		MIN	7.5	7.6	9.7	0.05	13	1.60	0.44	0.50		19	2.7	0.2	1	1	149	22.5

	Station	DATE	DO mg/l	pH S.U.	Temp. mg/l	NH3-N mg/l	CL mg/l	NO3-N mg/l	O-PHOS mg/l	T-PHOS mg/l		SO4 mg/l	TOC mg/l	BOD mg/l	Turb. ntu	TSS mg/l	TDS mg/l	Flow cfs
25	OSC04	950523	12.6	8.6	21.5	<0.05	16	4.28	0.64	0.73		16	2.5	0.3	2	10	196	119.9
25	OSC04	950711	9.9	7.8	20.9	<0.05	20	3.73	0.58	0.60		13	3.2	0.6	2	10	218	85.7
25	OSC04	950918	11.2	8.2	23.2	<0.05	25	2.42	0.56	0.65		20	3.0	0.2	6	15	219	64.6
25	OSC04	951114	12.0	8.2	10.5	<0.05	35	2.84	1.34	1.38		28	3.8	1.1	1	2	259	39.3
25	OSC04	960116	13.3	8.7	11.0	<0.05	37	3.11	0.37	0.39		30	3.7	1.0	2	3	262	48.3
25	OSC04	960416	11.9	8.3	13.0	<0.05	34	3.09	1.15	1.20	*	27	3.1	0.8	2	6	247	50.2
25	OSC04	960601	7.1	7.7	19.4	0.07	17	1.82	0.49	0.66		15	5.9	2.1	97	160	160	292.8
25	OSC4	MAX	13.3	8.7	23.2	0.07	37	4.28	1.34	1.38		30	5.9	2.1	97	160	262	292.8
		MEAN	11.1	8.2	17.1	0.05	26	3.04	0.73	0.80		21	3.6	0.9	16	28	223	100.1
		MIN	7.1	7.7	10.5	0.05	16	1.82	0.37	0.39		13	2.5	0.2	1	2	160	39.3
26	LOS01	951114	10.5	8.3	14.4	<0.05	5	3.12	0.08	0.03		20	1.8	1.1	1	2	166	18.4
26	LOS01	960116	12.6	8.5	12.0	<0.05	6	3.62	0.03	0.03		5	2.4	0.8	2	2	172	18.1
26	LOS01	960416	11.5	8.8	15.0	<0.05	7	3.52	0.06	0.06	*	2	1.4	0.5	3	5	174	16.8
26	LOS01	960601	10.5	8.1	18.2	<0.05	7	3.11	0.08	0.14		4	5.1	1.1	10	17	177	31.2
26	LOS1	MAX	12.6	8.8	18.2	0.05	26	3.82	0.73	0.80		21	5.1	1.1	16	28	223	100.1
		MEAN	10.6	8.3	14.5	0.05	11	3.07	0.23	0.24		11	2.8	0.8	5	9	178	37.6
		MIN	7.1	7.7	10.5	0.05	5	1.82	0.03	0.03		2	1.4	0.2	1	2	160	18.1
27	OSC05	950523	11.0	8.5	21.0	<0.05	11	4.35	0.39	0.45		12	2.0	0.3	2	7	176	202.9
27	OSC05	950711	9.0	7.7	20.0	<0.05	15	3.86	0.40	0.41		10	3.2	0.6	2	12	199	134.1
27	OSC05	950918	12.0	8.2	22.8	<0.05	19	2.60	0.43	0.61		17	3.0	0.2	4	5	196	92.2
27	OSC05	951114	12.4	8.2	10.6	<0.05	24	2.76	0.91	0.95		22	3.3	1.3	1	<1	229	59.5
27	OSC05	960116	12.0	8.4	10.5	<0.05	27	3.02	0.27	0.30		23	3.4	0.8	1	<1	236	67.8
27	OSC05	960416	11.5	8.5	12.0	<0.05	25	2.90	0.73	0.77	*	20	2.8	0.6	3	3	222	66.9
27	OSC05	960601	7.1	7.7	19.2	0.07	16	2.05	0.64	0.68		14	5.6	2.2	110	180	164	321.0
27	OSC5	MAX	12.4	8.5	22.8	0.07	27	4.35	0.91	0.95		23	5.6	2.2	110	180	236	321.0
		MEAN	10.7	8.2	16.6	0.05	20	3.06	0.62	0.58		17	3.3	0.9	17	30	203	134.9
		MIN	7.1	7.7	10.5	0.05	11	2.05	0.27	0.30		10	2.0	0.2	1	1	164	59.5

	Station	DATE	DO mg/l	pH S.U.	Temp. mg/l	NH3-N mg/l	CL mg/l	NO3-N mg/l	O-PHOS mg/l	T-PHOS mg/l		SO4 mg/l	TOC mg/l	BOD mg/l	Turb. ntu	TSS mg/l	TDS mg/l	Flow cfs	
28	OSC06	950523	7.7	8.1	17.7	<0.05	11	4.40	0.28	0.36		14	2.2	0.4	3	12	170	290.7	
28	OSC06	950711	6.8	7.5	21.3	<0.05	13	3.71	0.32	0.31		8	2.9	0.7	3	6	188	182.9	
28	OSC06	950919	7.6	7.8	20.9	<0.05	17	2.57	0.40	0.48		18	2.4	0.2		8	192	124.7	
28	OSC06	951114	10.2	7.7	9.0	<0.05	20	2.69	0.64	0.66		20	2.6	0.7	1	<1	211	91.2	
28	OSC06	960115	10.8	8.1	9.6	<0.05	21	3.29	0.26	0.30		17	2.7	0.8	2	5	212	72.7	
28	OSC06	960415	11.0	8.2	15.0	<0.05	17	2.85	0.32	0.36	*	15	2.6	1.1	4	7	200	94.0	**
28	OSC06	960601	7.0	7.8	19.4	<0.05	15	1.99	0.48	0.58		15	6.0	1.6	60	113	169	449.4	**
28	OSC6	MAX	11.0	8.2	21.3	0.05	21	4.40	0.64	0.66		20	6.0	1.6	60	113	212	449.4	
		MEAN	8.7	7.9	16.1	0.05	16	3.07	0.38	0.43		16	2.9	0.8	12	22	192	186.5	
		MIN	6.8	7.5	9.0	0.05	11	1.99	0.26	0.30		8	2.2	0.2	1	1	169	72.7	
29	OSC07	950523	7.7	7.8	18.4	<0.05	6	2.56	0.04	0.30		13	1.7	0.3	4	15	152	317.5	
29	OSC07	950711	6.3	7.7	22.0	<0.05	11	3.59	0.26	0.27		6	3.6	0.7	3	6	180	208.4	
29	OSC07	950919	7.6	7.9	20.8	<0.05	17	2.48	0.37	0.41		13	2.2	0.1	5	8	187	140.6	
29	OSC07	951114	10.3	7.6	9.4	<0.05	19	2.66	0.53	0.57		15	2.5	0.6	1	<1	204	113.8	
29	OSC07	960116	9.6	7.9	8.2	<0.05	21	3.12	0.24	0.26		18	2.7	0.8	2	3	208	114.9	
29	OSC07	960415	10.9	8.3	16.0	<0.05	18	2.73	0.32	0.35	*	14	2.4	0.8	3	5	192	102.0	
29	OSC07	960601	7.2	7.8	19.2	<0.05	17	2.26	0.60	0.66		16	4.5	1.4	39	86	182	490.8	
29	OSC7	MAX	10.9	8.3	22.0	0.05	21	3.59	0.53	0.66		18	4.5	1.4	39	86	208	490.8	
		MEAN	8.6	7.9	16.3	0.05	16	2.77	0.32	0.40		14	2.8	0.7	8	18	186	212.6	
		MIN	6.3	7.6	8.2	0.05	6	2.26	0.04	0.26		6	1.7	0.1	1	1	152	102.0	
30	ILL05	950523	8.0	8.3	19.4	<0.05	8	3.01	0.14	0.18		14	1.6	0.4	3	9	167	457.7	**
30	ILL05	950711	6.2	7.7	23.0	<0.05	10	2.84	0.18	0.18		6	3.0	0.8	4	9	176	305.7	
30	ILL05	950919	7.2	7.9	21.3	<0.05	14	2.00	0.24	0.30		14	2.8	0.2	12	20	179	187.0	
30	ILL05	951114	9.1	7.9	9.6	<0.05	16	2.06	0.30	0.35		14	2.5	0.7	1	<1	193	162.3	
30	ILL05	960116	11.5	8.1	8.0	<0.05	15	2.41	0.12	0.12		19	3.2	0.9	4	4	169	237.3	
30	ILL05	960416	9.1	7.9	16.0	<0.05	9	1.94	0.11	0.16	*	14	4.2	1.0	12	16	149	363.2	
30	ILL05	960602	7.1	7.7	18.2	<0.05	11	1.88	0.23	0.30		16	4.4	1.2	27	38	166	494.1	
30	ILL5	MAX	11.5	8.3	23.0	0.05	16	3.01	0.30	0.35		19	4.4	1.2	27	38	193	494.1	
		MEAN	8.3	7.8	16.5	0.05	12	2.31	0.19	0.23		14	3.1	0.7	9	14	170	315.3	
		MIN	6.2	7.7	8.0	0.05	8	1.88	0.11	0.12		6	1.6	0.2	1	1	149	162.3	

	Station	DATE	DO mg/l	pH S.U.	Temp. mg/l	NH3-N mg/l	CL mg/l	NO3-N mg/l	O-PHOS mg/l	T-PHOS mg/l		SO4 mg/l	TOC mg/l	BOD mg/l	Turb. ntu	TSS mg/l	TDS mg/l	Flow cfs	
31	ILL06	950523	9.1	8.3	20.7	<0.05	8	2.84	0.12	0.18		13	1.6	0.5	4	20	153	520.0	
31	ILL06	950711	7.0	7.8	24.1	<0.05	10	2.62	0.15	0.15		6	3.0	0.8	3	7	168	338.6	**
31	ILL06	950919	7.7	7.9	21.4	<0.05	14	1.81	0.21	0.28		14	2.5	0.1	8	11	174	212.3	**
31	ILL06	951114	10.3	8.2	10.4	<0.05	16	1.90	0.28	0.32		13	2.6	0.7	1	<1	192	166.4	
31	ILL06	960116	10.7	8.0	7.8	<0.05	15	2.32	0.11	0.12		19	3.0	0.9	4	4	173	252.5	
31	ILL06	960416	9.3	7.8	13.0	<0.05	10	1.97	0.12	0.16	*	16	3.5	1.0	13	13	152	374.0	
31	ILL06	960602	7.3	7.7	19.0	<0.05	12	2.05	0.23	0.32		16	3.7	1.2	31	33	170	561.0	
31	ILL6	MAX	10.7	8.3	24.1	0.05	16	2.84	0.28	0.32		19	3.7	1.2	31	33	192	561.0	
		MEAN	8.8	7.9	16.6	0.05	12	2.22	0.17	0.22		14	2.8	0.7	9	12	169	346.4	
		MIN	7.0	7.7	7.8	0.05	8	1.81	0.11	0.12		6	1.6	0.1	1	1	152	166.4	
32	ILL07	950523	9.7	9.2	21.0	<0.05	8	2.83	0.11	0.16		13	1.8	0.5	3	7	155	574.0	
32	ILL07	950711	6.8	7.8	24.5	<0.05	9	2.63	0.17	0.16		6	4.0	0.6	4	7	169	375.0	
32	ILL07	950919	7.8	7.9	21.4	<0.05	15	1.73	0.23	0.27		14	2.5	0.1	6	7	177	215.0	
32	ILL07	951114	10.6	8.1	10.0	<0.05	16	1.81	0.28	0.30		14	2.5	0.6	1	<1	189	190.0	
32	ILL07	960116	10.6	8.1	7.5	<0.05	15	2.31	0.11	0.10		19	3.1	0.9	4	3	174	305.0	
32	ILL07	960416	8.8	7.5	13.0	<0.05	10	1.95	0.12	0.16	*	14	3.4	0.8	9	11	153	430.0	**
32	ILL07	960602	7.1	7.8	19.5	<0.05	12	2.27	0.24	0.32		16	3.6	1.1	19	31	177	603.0	
32	ILL7	MAX	10.6	9.2	24.5	0.05	16	2.83	0.28	0.32		19	4.0	1.1	19	31	189	603.0	
		MEAN	8.8	8.1	16.7	0.05	12	2.22	0.18	0.21		13	3.0	0.7	7	9	171	384.6	
		MIN	6.8	7.5	7.5	0.05	8	1.73	0.11	0.10		6	1.8	0.1	1	1	153	190.0	

NOTES:

NR=Not Run. These samples were not run due to inoperative lab equipment (autoclave).
** = flow data calculated by watershed ratio or addition of upstream flows
* = value calculated from previous T-PHOS/O-PHOS relation
< = value of zero used in calculations

Appendix D

Water Quality Data

Dissolved Metals

Appendix D - Dissolved Metals

Station	Date	Cd	Cr	Pb	Al	Cu	Ca	Fe	K	Mg	Mn	Na	Zn	Hardness	Ni	B	Be	Ba	Co	V
		ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	mg/L	mg/L	ug/L	mg/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
ILL1	950710	<0.5	<1	<2	18	2.5	45.4	16	1.8	2.4	22	7.1	2.4	123	<5	14.6	<2	45.8	<3	<5
ILL1	950918	<0.5	<1	<2	<16	<2	56.7	18	1.8	2.1	35	10.2	2.2	150	<5	4.8	<2	53.2	<3	<5
ILL1	951113	<0.5	<1	<2	<16	<2	64.8	32	2.1	3	23	3.8	<2.0	174	<5	<3	<2	52.8	3.2	<5
ILL1	960115	<0.5	<1	<2	<16	<2	29.8	16	1	2.8	8	5	3.3	86	<5	<3	<2	27.9	4.9	<5
ILL1	960415	<0.5	<1	<2	58.5	<2	30.8	88.9	1	2.6	26.1	2.6	<2	88	<5	9.9	<2	26.5	<3	<5
ILL1	960601	<0.5	<1	<2	<16	<2	42.3	38.9	1.8	2.8	12.9	4.1	<2	117	<5	14.6	<2	39.2	<3	<5
	MAX	0	0	0	58.5	2.5	64.8	88.9	2.1	3	35	10.2	3.3	174	0	14.6	2	53.2	4.9	0
ILL1	MEAN	0	0	0	23.4	0.417	44.97	34.97	1.583	2.617	21.17	5.467	2.317	123	0	8.317	2	40.9	3.35	0
	MIN	0	0	0	0	0	29.8	16	1	2.1	8	2.6	0	86	0	3	2	26.5	3	0
MFI1A	950710	<0.5	<1	<2	<16	3.4	68.6	11	2.4	3	68	6.9	7.8	184	<5	18	<2	56	<3	<5
MFI1A	950918	<0.5	<1	<2	<16	<2	68	39	2.3	2.3	126	8.9	3.7	179	<5	7.6	<2	53.7	<3	<5
MFI1A	951113	<0.5	1.8	<2	<16	<2	68.3	33	3.8	4.4	41	2.9	2.7	189	<5	<3	<2	55.8	3.1	<5
MFI1A	960115	<0.5	<1	<2	21	<2	31.4	23	2	2.9	13	3	2.4	90	<5	7	<2	31.8	4.1	<5
MFI1A	960415	<0.5	<1	<2	40.1	<2	25.9	33	1.4	2.9	24.9	1.4	<2	77	<5	11.9	<2	25	<3	<5
MFI1A	960601	<0.5	<1	<2	<16	<2	37.5	52.2	2.2	3.2	19.7	3.6	3	107	<5	21.1	<2	36.4	<3	<5
	MAX	0	1.8	0	40.1	3.4	68.6	52.2	3.8	4.4	126	8.9	7.8	189	0	21.1	0	56	4.1	0
MFI1A	MEAN	0	1.133	0	20.9	2.233	49.95	31.87	2.35	3.117	48.77	4.45	3.6	138	0	11.43	0	43.12	3.2	0
	MIN	0	0	0	0	0	25.9	11	1.4	2.3	13	1.4	0	77	0	3	0	25	0	0
MFI1EA	950710	<0.5	<1	<2	38	7.5	92.1	108	11.8	4.8	511	10.8	6.4	250	<5	26	<2	131.6	3.5	<5
MFI1EA	950918	<0.5	<1	<2	<16	<2	72	21	4.9	3.8	275	10.7	2.4	195	<5	6.6	<2	90.3	<3	<5
MFI1EA	951113	<0.5	1	<2	<16	<2	110	10	4.2	16.3	65	17.1	2.1	342	5.3	68.4	<2	132.7	3.2	<5
MFI1EA	960115	<0.5	<1	<2	<16	<2	91.8	6.3	1.8	9.3	111	10.9	<2	268	<5	37.8	<2	82.7	<3	<5
MFI1EA	960415	<0.5	<1	<2	<16	4.2	62.4	91.7	6.4	5.3	140	7.9	3.4	178	<5	30.2	<2	81.8	<3	<5
	MAX	0	1	0	'38	7.5	110	108	11.8	16.3	511	17.1	6.4	342	5.3	68.4	0	132.7	3.5	0
MFI1EA	MEAN	0	1	0	20.4	3.54	85.66	47.4	5.82	7.9	220.4	11.48	3.26	247	5.06	33.8	0	103.8	3.14	0
	MIN	0	0	0	0	0	62.4	6.3	1.8	3.8	65	7.9	0	178	0	6.6	0	81.8	3	0

Station	Date	Cd	Cr	Pb	Al	Cu	Ca	Fe	K	Mg	Mn	Na	Zn	Hardness	Ni	B	Be	Ba	Co	V
		ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	mg/L	mg/L	ug/L	mg/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MFI1E	950710	<0.5	<1	<2	17	5.9	40.4	57	12	3.5	10	55.1	61.2	115	5	337.7	<2	4	<3	<5
MFI1E	950918	<0.5	<1	<2	<16	2.8	40.2	28	10.2	3.3	3	51.4	24.5	114	<5	355.4	<2	5.3	<3	<5
MFI1E	951113	<0.5	2	<2	<16	<2	38.6	36	8.3	3.3	44	52	29.5	110	<5	264.2	<2	90.3	<3	<5
MFI1E	960115	<0.5	2	<2	17.8	3.3	46.6	39	7	3.8	137	62	26.9	132	<5	365.8	<2	4.7	3.6	<5
MFI1E	960415	<0.5	<1	<2	22.1	<2	42.1	79.6	5.7	3.4	84.6	41.2	11	119	<5	340.3	<2	<2	<3	<5
MFI1E	960601	<0.5	<1	<2	<16	<2	44.9	28.2	6.6	3.3	29.1	39.3	25.6	126	<5	169.3	<2	4.9	<3	<5
	MAX	0	2	0	22.1	5.9	46.6	79.6	12	3.8	137	62	61.2	132	5	365.8	0	90.3	3.6	0
MFI1E	MEAN	0	1.333	0	17.5	3	42.13	44.63	8.3	3.433	51.28	50.17	29.78	119	5	305.5	0	18.5	3.1	0
	MIN	0	0	0	0	0	38.6	28	5.7	3.3	3	39.3	11	110	0	169.3	0	0	0	0
MFI2B	950710	<0.5	<1	<2	<16	2.9	60.5	16	3.1	3.3	70	10.1	3.1	164	<5	42.5	<2	53.6	3.1	<5
MFI2B	950918	<0.5	<1	<2	<16	<2	58.7	23	5	2.8	45	21.6	5	158	<5	113.4	<2	40.3	<3	<5
MFI2B	951113	<0.5	1.6	<2	<16	<2	68	30	4.4	4.3	18	15.7	5.9	188	<5	71.4	<2	42.5	<3	<5
MFI2B	960115	<0.5	<1	<2	33.3	<2	33.3	29	2	3	16	4	<2	96	<5	11	<2	31.1	<3	<5
MFI2B	960415	<0.5	<1	<2	39.5	<2	30.4	41.9	1.7	3.5	43.8	<0.04	<2	90	<5	14.6	<2	29.2	<3	<5
MFI2B	960601	<0.5	<1	<2	23.7	<2	43.3	61.9	3.5	2.6	39.7	5.3	3.8	119	<5	22.1	<2	42.8	<3	<5
	MAX	0	1.6	0	39.5	2.9	68	61.9	5	4.3	70	21.6	5.9	188	0	113.4	0	53.6	3.1	0
MFI2B	MEAN	0	1.1	0	24.1	2.15	49.03	33.63	3.283	3.25	38.75	9.457	3.633	136	0	45.83	0	39.92	3.02	0
	MIN	0	0	0	0	0	30.4	16	1.7	2.6	16	0	0	90	0	11	0	29.2	0	0
MFI3	950710	<0.5	<1	<2	<16	3.2	57.1	34	3.4	3.1	73	7.2	6	155	<5	23.7	<2	58.2	<3	<5
MFI3	950918	<0.5	<1	<2	<16	<2	50.8	65	5.2	2.7	82	12.2	<2.0	138	<5	43.8	<2	56.4	<3	<5
MFI3	951113	<0.5	<1	<2	<16	<2	60.6	80	4.9	3.7	26	8.2	2	166	<5	31.7	<2	46.9	<3	<5
MFI3	960115	<0.5	<1	<2	16.8	<2	35.4	22	2	3.1	16	5	3.1	101	<5	10.4	<2	33.4	4.3	<5
MFI3	960415	<0.5	1.9	<2	59.2	<2	27.8	85.5	1.9	2.8	41.3	<0.04	<2	81	<5	12.2	<2	34.5	<3	<5
MFI3	960601	<0.5	1.9	<2	22.8	<2	48.1	53.1	3	2.6	37.7	4.9	<2	131	<5	19.9	<2	47.5	<3	<5
	MAX	0	1.9	0	59.2	3.2	60.6	85.5	5.2	3.7	82	12.2	6	166	0	43.8	0	58.2	4.3	0
MFI3	MEAN	0	1.3	0	24.5	2.2	46.63	56.6	3.4	3	46	6.257	2.85	129	0	23.62	0	46.15	3.22	0
	MIN	0	0	0	0	0	27.8	22	1.9	2.6	16	0	0	81	0	10.4	0	33.4	0	0

Station	Date	Cd	Cr	Pb	Al	Cu	Ca	Fe	K	Mg	Mn	Na	Zn	Hardness	Ni	B	Be	Ba	Co	V
		ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	mg/L	mg/L	ug/L	mg/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MFI4	950710	<0.5	<1	<2	<16	<2	54.2	13	2.5	2.6	39	7.3	2.8	146	<5	17.4	<2	52.6	<3	<5
MFI4	950918	<0.5	<1	<2	<16	<2	51.1	31	3.8	2.3	54	10.8	<2.0	137	<5	25.1	<2	53.8	<3	<5
MFI4	951113	<0.5	<1	<2	<16	<2	58.8	73	3.6	3	27	7.6	<2.0	159	<5	<3	<2	46.1	3	<5
MFI4	960115	<0.5	<1	<2	17.7	<2	37.6	21	2	2.9	18	4	<2.0	106	<5	7.6	<2	33.4	4	<5
MFI4	960415	<0.5	<1	<2	46.8	<2	28.5	78.5	1.8	2.8	35.2	0.9	<2	82	<5	11.9	<2	33.4	<3	<5
MFI4	960601	<0.5	<1	<2	<16	<2	51.2	36.7	2.8	2.7	29.2	5.7	2	139	<5	19.1	<2	50.3	<3	<5
	MAX	0	0	0	46.8	0	58.8	78.5	3.8	3	54	10.8	2.8	159	0	25.1	0	53.8	4	0
MFI4	MEAN	0	0	0	21.4	0	46.9	42.2	2.75	2.717	33.73	6.05	2.133	128	0	14.02	0	44.93	3.17	0
	MIN	0	0	0	0	0	28.5	13	1.8	2.3	18	0.9	0	82	0	0	0	33.4	0	0
ILL2	950710	<0.5	<1	<2	25	7.3	43.4	21	2	2.4	43	6.7	<2.0	118	<5	17.3	<2	47.1	<3	<5
ILL2	950919	<0.5	<1	<2	<16	2	51.7	19	2.5	2.4	49	10.6	5.5	139	<5	10.2	<2	52.8	<3	<5
ILL2	951113	<0.5	<1	<2	<16	<2	42.1	30	1.8	2.1	23	1.4	<2.0	114	<5	<3	<2	49.5	<3	<5
ILL2	960115	<0.5	<1	<2	16.1	<2	34.5	31	1	2.8	16	5	2.9	98	<5	4.6	<2	32.1	5	<5
ILL2	960415	<0.5	<1	<2	30.7	<2	27.7	59.8	1.5	2.4	31.4	<0.04	<2	79	<5	11.5	<2	32.7	<3	<5
ILL2	960601	<0.5	<1	<2	25.5	<2	58.2	31.4	2.6	2.6	28.3	4.4	3.2	156	<5	8.4	<2	48.6	<3	<5
	MAX	0	0	0	30.7	7.3	58.2	59.8	2.6	2.8	49	10.6	5.5	156	0	17.3	0	52.8	5	0
ILL2	MEAN	0	0	0	21.6	2.883	42.93	32.03	1.9	2.45	31.78	4.69	2.933	117	0	9.167	0	43.8	3.33	0
	MIN	0	0	0	0	0	27.7	19	1	2.1	16	0	0	79	0	0	0	32.1	0	0
MUD1E	950710	<0.5	<1	<2	<16	2.4	40.7	68	7.3	4.7	11	84.1	7.8	121	8.3	542.5	<2	8.9	<3	<5
MUD1E	950919	<0.5	<1	<2	<16	<2	38.4	62	9.7	3.3	6	83.1	10.3	110	49.3	536.5	<2	7.6	<3	<5
MUD1E	951113	ND																		
MUD1E	960115	<0.5	<1	<2	19.1	5.8	48.8	31	6	4.9	95	67	26.4	142	157.6	322.2	<2	8	3.2	<5
MUD1E	960415	<0.5	<1	<2	<16	<2	45.7	30.2	3.6	5.4	131	37.7	12.6	136	15	371.8	<2	<4	<3	<5
MUD1E	960601	<0.5	<1	<2	<16	<2	39.6	34.1	4.8	4	15.2	57.2	8	115	9.1	363.6	<2	4.3	<3	<5
	MAX	0	0	0	19.1	5.8	48.8	68	9.7	5.4	131	84.1	26.4	142	157.6	542.5	0	8.9	3.2	0
MUD1E	MEAN	0	0	0	16.6	2.84	42.64	45.06	6.28	4.46	51.64	65.82	13.02	125	47.8	427.3	0	6.56	3.04	0
	MIN	0	0	0	0	0	38.4	30.2	3.6	3.3	6	37.7	7.8	110	8.3	322.2	0	0	0	0

Station	Date	Cd	Cr	Pb	Al	Cu	Ca	Fe	K	Mg	Mn	Na	Zn	Hardness	Ni	B	Be	Ba	Co	V
		ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	mg/L	mg/L	ug/L	mg/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MUD2B	950710	<0.5	<1	<2	32	3.3	46.8	25	7.1	4.5	21	74.4	4.6	135	8.2	652.5	<2	35.6	<3	<5
MUD2B	950913	<0.5	<1	<2	<16	<2	43.3	39	8.5	3.8	48	79.8	7.7	124	20.4	489	<2	32.6	<3	<5
MUD2B	951113	<0.5	<1	<2	<16	<2	49.7	25	5.1	4.7	38	45.4	6.4	143	49.8	271.8	<2	32.1	<3	<5
MUD2B	960115	<0.5	<1	<2	<16	2	48.5	16	3	5.1	47	35	10.7	142	39.5	166	<2	29.4	4.3	<5
MUD2B	960415	<0.5	<1	<2	<16	<2	43.2	30.7	2	4.7	50.9	19.5	2.7	127	<5	111.5	<2	24.1	<3	<5
MUD2B	960601	<0.5	1.1	<2	21	<2	34.4	75.9	2.5	3.3	28	16.2	4.1	100	<5	167.7	<2	29.4	<3	<5
	MAX	0	0	0	32	3.3	49.7	75.9	8.5	5.1	50.9	79.8	10.7	143	49.8	652.5	0	35.6	4.3	0
MUD2B	MEAN	0	0	0	19.5	2.217	44.317	35.27	4.7	4.35	38.82	45.05	6.033	128.5	47.8	309.8	0	30.53	3.217	0
	MIN	0	0	0	0	0	34.4	16	2	3.3	21	16.2	2.7	100	5	111.5	0	0	0	0
CLR1R	950710	<0.5	<1	<2	19	2.7	38.9	68	2.5	2	52	5.9	3.4	105	<5	24.3	<2	50.8	<3	<5
CLR1R	950919	<0.5	<1	<2	<16	<2	39.3	47	2.2	1.9	24	9.3	<2.0	106	<5	11.8	<2	52.1	<3	<5
CLR1R	951113	<0.5	<1	<2	<16	<2	42.5	30	1.8	2.1	23	2	<2.0	115	<5	3.7	<2	50	<3	<5
CLR1R	960115	<0.5	<1	<2	<16	<2	44.5	23	2	2	23	4	7.4	119	<5	5.4	<2	53.5	3.6	<5
CLR1R	960415	<0.5	<1	<2	<16	<2	41.63	22.8	1.3	1.9	28	3.8	2.5	112	<5	9.7	<2	44	<3	<5
CLR1R	960601	<0.5	<1	<2	30.4	<2	39.9	31.6	1.8	1.8	25.1	4.4	2.6	107	<5	6	<2	41.8	<3	<5
	MAX	0	0	0	30.4	2.7	44.5	68	2.5	2.1	52	9.3	7.4	119	0	24.3	0	53.5	3.6	0
CLR1R	MEAN	0	0	0	18.9	2.117	41.12	37.07	1.933	1.95	29.18	4.9	3.317	111	0	10.15	0	48.7	3.1	0
	MIN	0	0	0	0	0	38.9	22.8	1.3	1.8	23	2	0	105	0	3.7	0	41.8	0	0
CLR3	950710	<0.5	<1	<2	16	3.9	52.5	18	2.9	3	10	24.4	3.6	143	<5	214.9	<2	50	<3	<5
CLR3	950918	<0.5	<1	<2	<16	<2	53.4	17	3.1	2.7	13	26.3	4	144	<5	140.4	<2	47.4	<3	<5
CLR3	951113	<0.5	<1	<2	<16	<2	55.2	26	2.5	3.6	15	14.6	2.8	152	8.6	82.6	<2	45.2	<3	<5
CLR3	960115	<0.5	<1	<2	<16	<2	56.2	13	2	4.2	20	21	5.8	158	20.6	91.8	<2	44.1	<3	<5
CLR3	960415	<0.5	<1	<2	<16	<2	51.1	11.2	1.6	3.7	19.1	8.7	3.9	143	<5	52	<2	42	<3	<5
CLR3	960601	<0.5	<1	<2	LOST															
	MAX	0	0	0	16	3.9	56.2	26	3.1	4.2	20	26.3	5.8	158	20.6	214.9	0	50	0	0
CLR3	MEAN	0	0	0	16	2.38	53.68	17.04	2.42	3.44	15.42	19	4.02	148	8.84	116.3	0	45.74	0	0
	MIN	0	0	0	0	0	51.1	11.2	1.6	2.7	10	8.7	2.8	143	0	52	0	42	0	0

Station	Date	Cd	Cr	Pb	Al	Cu	Ca	Fe	K	Mg	Mn	Na	Zn	Hardness	Ni	B	Be	Ba	Co	V
		ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	mg/L	mg/L	ug/L	mg/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
CLR4	950710	<0.5	<1	<2	26	3.4	49.7	9	2.3	2.6	13	15.8	2	135	<5	100.9	<2	54.6	<3	<5
CLR4	950919	<0.5	<1	<2	<16	<2	50.1	12	2.6	2.5	15	16.3	5.4	135	<5	73.7	<2	51.1	<3	<5
CLR4	951113	<0.5	<1	<2	<16	<2	52.7	3	1.9	2.6	7	8.2	2.3	142	<5	47.8	<2	44.8	<3	<5
CLR4	960115	<0.5	<1	<2	<16	<2	54.4	8	2	3.4	8	15	4.2	150	5.8	59.6	<2	45.4	3.1	<5
CLR4	960415	<0.5	<1	<2	<16	<2	45.9	10.4	1.2	2.9	16.1	13.6	2.4	126	<5	39.2	<2	42.1	<3	<5
CLR4	960601	<0.5	<1	<2	35.4	<2	39.9	27.8	1.8	2	11.8	7.5	3.3	108	<5	63.9	<2	34.3	<3	<5
	MAX	0	0	0	35.4	3.4	54.4	27.8	2.6	3.4	16.1	16.3	5.4	150	5.8	100.9	0	54.6	3.1	0
CLR4	MEAN	0	0	0	20.9	2.233	48.78	11.7	1.967	2.667	11.82	12.73	3.267	133	5.13	64.18	0	45.38	3.02	0
	MIN	0	0	0	0	0	39.9	3	1.2	2	7	7.5	2	108	0	39.2	0	34.3	0	0
CLR5	950710	<0.5	<1	<2	28	3.1	46.8	12	2.2	2.3	20	11.9	2.2	126	<5	82.4	<2	54.1	<3	<5
CLR5	950919	<0.5	<1	<2	<16	3.8	47.2	15	2.4	2.2	34	14.3	4.9	127	<5	47	<2	52.5	<3	<5
CLR5	951113	<0.5	<1	<2	<16	<2	49.2	6	2	2.4	12	7.5	<2	133	<5	41	<2	43.9	<3	<5
CLR5	960115	<0.5	<1	<2	<16	<2	53.9	5	2	3.1	23	12	2.8	148	<5	44.3	<2	47.5	4	<5
CLR5	960415	<0.5	<1	<2	<16	<2	41	12.4	1.2	2.3	21.8	4	2.1	112	<5	25.7	<2	40.2	<3	<5
CLR5	960601	<0.5	<1	<2	28.2	<2	50.5	23.2	1.9	2.3	20.3	10.2	4.4	135	<5	146.6	<2	45.1	<3	<5
	MAX	0	0	0	28.2	3.8	53.9	23.2	2.4	3.1	34	14.3	4.9	148	0	146.6	0	54.1	4	0
CLR5	MEAN	0	0	0	20	2.483	48.1	12.27	1.95	2.433	21.85	9.983	3.067	130	0	64.5	0	47.22	3.17	0
	MIN	0	0	0	0	0	41	5	1.2	2.2	12	4	0	112	0	25.7	0	40.2	0	0
ILL3	950710	<0.5	<1	<2	<16	2.5	44.8	6	2.1	2.4	24	9.3	<2.0	122	<5	48.3	<2	49.1	<3	<5
ILL3	950918	<0.5	<1	<2	<16	<2	44.9	16	2.7	2.1	23	13.2	<2.0	121	<5	44.6	<2	49	<3	<5
ILL3	951113	<0.5	<1	<2	<16	<2	53.4	18	2.1	2.6	15	6.9	<2.0	144	<5	<3	<2	46.6	3.2	<5
ILL3	960115	<0.5	<1	<2	<16	<2	42.1	13	2	2.8	13	7	<2.0	117	<5	17.9	<2	36.9	4.2	<5
ILL3	960415	<0.5	<1	<2	34.5	<2	33.9	62.9	1.5	2.4	24.6	3.3	<2	94	<5	11.5	<2	32	<3	<5
ILL3	960601	<0.5	<1	<2	<16	<2	48.7	21	2	2.4	20.5	6.7	<2	131	<5	84.7	<2	46.8	<3	<5
	MAX	0	0	0	34.5	2.5	53.4	62.9	2.7	2.8	24.6	13.2	0	144	0	84.7	0	49.1	4.2	0
ILL3	MEAN	0	0	0	19.1	2.083	44.63	22.82	2.066	2.45	20.02	7.733	0	122	0	35	0	43.4	3.23	0
	MIN	0	0	0	0	0	33.9	6	1.5	2.1	13	3.3	0	94	0	0	0	32	0	0

Station	Date	Cd	Cr	Pb	Al	Cu	Ca	Fe	K	Mg	Mn	Na	Zn	Hardness	Ni	B	Be	Ba	Co	V
		ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	mg/L	mg/L	ug/L	mg/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
ILL4	950711	<0.5	<1	<2	19	2.6	45.1	15	2.1	2.3	14	9.4	2.3	122	<5	46.1	<2	50	<3	<5
ILL4	950919	<0.5	<1	<2	<16	<2	46	21	2.5	2.2	26	13.9	<2.0	124	<5	45.9	<2	52.6	<3	<5
ILL4	951114	52	<1	<2	<16	2	54	12	2	2.6	12	6.5	<2	145	<5	<3	<2	47.7	<3	<5
ILL4	960116	<0.5	<1	<2	<16	<2	44.2	12	1	2.8	6	8	<2	122	<5	18.6	<2	40.6	6.7	<5
ILL4	960415	<0.5	<1	<2	22.8	<2	33.6	50.8	1.5	2.4	12.7	3.1	<2	94	<5	12.9	<2	31.6	<3	<5
ILL4	960601	<0.5	<1	<2	16.1	3.5	40.6	39.5	2	2.3	7.7	5.3	2	111	<5	43.2	<2	44.9	<3	<5
	MAX	52	0	0	22.8	3.5	54	50.8	2.5	2.8	26	13.9	2.3	145	0	46.1	0	52.6	6.7	0
ILL4	MEAN	9.083	0	0	17.7	2.35	43.92	25.05	1.85	2.433	13.07	7.7	2.05	120	0	28.28	0	44.57	3.62	0
	MIN	0	0	0	0	0	33.6	12	1	2.2	6	3.1	0	94	0	0	0	31.6	0	0
OSC1A	950711	<0.5	<1	<2	<16	2.5	49.5	4	1.1	1.7	9	6.2	2.7	131	<5	9.6	<2	58.4	<3	<5
OSC1A	950918	<0.5	<1	<2	<16	<2	46.9	5	1.3	1.5	9	8	5	123	<5	8.6	<2	57.5	<3	<5
OSC1A	951114	<0.5	<1	<2	<16	<2	49.9	<1.8	0.9	1.5	12	<0.04	2.5	131	<5	<3	<2	50.9	<3	<5
OSC1A	960616	<0.5	<1	<2	<16	<2	55.7	<1.8	1	1.6	12	5	<2	146	<5	6.1	<2	56	3.2	<5
OSC1A	960416	<0.5	<1	<2	<16	<2	54.3	7.5	0.9	1.7	39.3	4.7	2.5	143	<5	19.1	<2	65.8	<3	<5
OSC1A	960601	<0.5	<1	<2	78	<2	25.4	80.1	1.5	0.9	21	1.6	13.1	67	<5	18.9	<2	41	<3	<5
	MAX	0	0	0	78	2.5	55.7	80.1	1.5	1.7	39.3	8	13.1	146	0	19.1	0	65.8	3.2	0
OSC1A	MEAN	0	0	0	26.3	2.083	46.95	16.7	1.116	1.483	17.05	4.257	4.633	124	0	10.88	0	54.93	3.03	0
	MIN	0	0	0	0	0	25.4	0	0.9	0.9	9	0	0	67	0	3	0	41	0	0
OSC1E	950711	<0.5	<1	<2	27	3	27	19	11.5	1.4	24	96.8	59.3	73	<5	792.8	<2	5.2	12.1	<5
OSC1E	950918	<0.5	<1	<2	17.1	<2	32.5	24	9.4	1.9	21	76.9	29	89	<5	496	<2	7.3	10.3	<5
OSC1E	951114	<0.5	<1	<2	<16	<2	32.6	29	10.4	2.2	16	91.6	33.2	90	<5	761.4	<2	5	25.4	<5
OSC1E	960116	<0.5	<1	<2	22.3	<2	37.3	54	12	2.2	29	124	59.4	102	<5	627.7	<2	7.3	17	<5
OSC1E	960416	<0.5	<1	<2	19.5	<2	29.2	30.1	10.6	3	22.4	126.9	59.5	85	<5	767.8	<2	4.9	20.6	<5
OSC1E	960601	<0.5	<1	<2	<16	<2	27.2	34.4	10.6	1.6	24.9	99	39	75	<5	654.5	<2	8.3	7.5	<5
	MAX	0	0	0	27	3	37.3	54	12	3	29	126.9	59.5	102	0	792.8	0	8.3	25.4	0
OSC1E	MEAN	0	0	0	19.7	2.167	30.97	31.75	10.75	2.05	22.88	102.5	46.57	85.7	0	683.4	0	6.333	15.48	0
	MIN	0	0	0	0	0	27	19	9.4	1.4	16	76.9	29	73	0	496	0	4.9	7.5	0

Station	Date	Cd	Cr	Pb	Al	Cu	Ca	Fe	K	Mg	Mn	Na	Zn	Hardness	Ni	B	Be	Ba	Co	V
		ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	mg/L	mg/L	ug/L	mg/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
OSC2B	950711	<0.5	<1	<2	23	3.6	50.5	9	2.3	1.8	7	15.9	11.2	133	<5	99	<2	54.1	3.3	<5
OSC2B	950918	<0.5	<1	<2	<16	<2	45	12	3.4	1.7	8	24.9	7.4	119	<5	123.9	<2	52.4	3.4	<5
OSC2B	951114	<0.5	<1	<2	<16	2	47.5	3	3.2	1.8	6	21.8	8	126	<5	161.7	<2	44.4	6	<5
OSC2B	951114	<0.5	<1	<2	<16	<2	53.1	10	3	1.9	8	30	12.4	140	<5	138.2	<2	47.6	5.2	<5
OSC2B	960416	<0.5	<1	<2	<16	<2	49.1	6.2	2.6	1.9	24.8	30.1	11.9	131	<5	174.2	<2	48.5	5.6	<5
OSC2B	960601	<0.5	<1	<2	59.5	<2	29.4	72.6	2.4	1.1	19.8	13.2	8.8	78	<5	92.8	<2	39.5	<3	<5
	MAX	0	0	0	59.5	3.6	53.1	72.6	3.4	1.9	24.8	30.1	12.4	140	0	174.2	0	54.1	6	0
OSC2B	MEAN	0	0	0	24.4	2.267	45.77	18.8	2.816	1.7	12.27	22.65	9.95	121	0	131.6	0	47.75	4.42	0
	MIN	0	0	0	0	0	29.4	3	2.3	1.1	6	13.2	7.4	78	0	92.8	0	39.5	0	0
OSC3	950711	<0.5	<1	<2	<16	3.5	50.2	7	2.1	1.7	5	14.6	7.3	132	<5	84.9	<2	53.3	<3	<5
OSC3	950918	<0.5	<1	<2	<16	<2	46.6	5	3	1.7	5	22.4	5.7	123	<5	105.3	<2	52.4	3.4	<5
OSC3	951114	<0.5	<1	<2	<16	2	48.5	4	3.2	1.8	3	21.2	7.9	128	<5	151.3	<2	43.5	5.9	<5
OSC3	960116	<0.5	<1	<2	<16	<2	54	12	3	1.8	4	34	13.8	142	<5	153.5	<2	47.2	4	<5
OSC3	960416	<0.5	<1	<2	<16	<2	48.8	10.1	2.7	1.9	11.6	29.7	10.6	130	<5	174.1	<2	48.2	4.4	<5
OSC3	960601	<0.5	<1	<2	53.8	<2	32.6	55.6	2.4	1	16	12	15.1	86	<5	88.6	<2	38.3	<3	<5
	MAX	0	0	0	53.8	3.5	54	55.6	3.2	1.9	16	34	15.1	142	0	174.1	0	53.3	5.9	0
OSC3	MEAN	0	0	0	22.3	2.25	46.78	15.62	2.733	1.65	7.433	22.32	10.07	124	0	126.3	0	47.15	3.95	0
	MIN	0	0	0	0	0	32.6	4	2.1	1	3	12	5.7	86	0	84.9	0	38.3	0	0
SPG1A	950711	<0.5	<1	<2	<16	2.5	57.6	9	1.2	2	8	8.4	4.3	152	<5	13.8	<2	59.7	<3	<5
SPG1A	950918	<0.5	<1	<2	<16	<2	54.7	9	1.7	1.9	8	9.8	6.3	144	<5	9.9	<2	58.9	<3	<5
SPG1A	951114	<0.5	<1	<2	<16	<2	60.12	4	1.4	2.1	6	3.1	3.8	159	<5	<3	<2	55.6	<3	<5
SPG1A	960616	<0.5	<1	<2	<16	<2	61.7	3	1	2.2	6	8	4.2	163	<5	8	<2	58.2	4.1	<5
SPG1A	960416	<0.5	<1	<2	<16	<2	55.4	7	1.1	2.1	11.4	5.1	3.2	147	<5	12.4	<2	55	<3	<5
SPG1A	960601	<0.5	<1	<2	60.9	<2	28.1	48.6	2	1.1	9.8	2.2	8.2	74	<5	13.7	<2	35.9	<3	<5
	MAX	0	0	0	60.9	2.5	61.7	48.6	2	2.2	11.4	9.8	8.2	163	0	13.8	0	59.7	4.1	0
SPG1A	MEAN	0	0	0	23.5	2.083	52.94	13.43	1.4	1.9	8.2	6.1	5	140	0	10.13	0	53.88	3.18	0
	MIN	0	0	0	0	0	28.1	3	1	1.1	6	2.2	3.2	74	0	0	0	35.9	0	0

Station	Date	Cd	Cr	Pb	Al	Cu	Ca	Fe	K	Mg	Mn	Na	Zn	Hardness	Ni	B	Be	Ba	Co	V
		ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	mg/L	mg/L	ug/L	mg/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
SPG1E	950711	<0.5	<1	<2	17	<2	30.2	68	18.6	2.5	29	81.8	63.9	86	11.3	282.6	<2	6	<3	<5
SPG1E	950918	<0.5	<1	<2	<16	<2	31.1	74	15.5	2.2	20	72	50.8	87	6.8	229.4	<2	5.3	<3	<5
SPG1E	951114	<0.5	<1	<2	<16	2.4	33.9	41	15.3	3.3	16	83.2	58.2	98	9.7	239.2	<2	4.7	<3	<5
SPG1E	960116	<0.5	<1	<2	23.5	3.4	38.7	66	15	2.2	35	89	89	105	11.2	224.9	<2	10.1	4	<5
SPG1E	960416	<0.5	<1	2.5	<16	<2	31.7	34.7	12.4	2.8	21.9	70.4	77.4	90	11.1	211.8	<2	6.2	<3	<5
SPG1E	960601	<0.5	<1	2.5	29.9	<2	31.7	81.4	17.8	1.6	41.5	99.7	50.8	81	9.9	280.8	<2	4	<3	<5
	MAX	0	0	2.5	29.9	3.4	38.7	81.4	18.6	3.3	41.5	99.7	89	105	11.3	282.6	0	10.1	4	0
SPG1E	MEAN	0	0	2.167	19.7	2.3	32.88	60.85	15.76	2.433	27.23	82.68	65.02	91.2	10	244.8	0	6.05	3.17	0
	MIN	0	0	0	0	0	30.2	34.7	12.4	1.6	16	70.4	50.8	81	6.8	211.8	0	4	0	0
SPG2B	950711	<0.5	<1	<2	<16	3.3	47.4	21	7.7	2.2	3	38.7	27.6	127	<5	118.2	<2	42.3	<3	<5
SPG2B	950918	<0.5	<1	<2	<16	<2	41.9	19	9.9	1.9	14	46.9	26.6	112	<5	139.7	<2	31.8	<3	<5
SPG2B	951114	<0.5	<1	<2	<16	2.1	44.8	16	10	2.7	5	43.2	32.8	123	<5	133.8	<2	27.3	<3	<5
SPG2B	960116	<0.5	<1	<2	<16	2	50.9	30	9	2.3	13	50	47.4	137	<5	122.8	<2	33.4	3.3	<5
SPG2B	960416	<0.5	<1	<2	<16	<2	44.5	18.8	6.9	2.3	19	35.8	39.6	121	<5	109.5	<2	29.6	<3	<5
SPG2B	960601	<0.5	<1	<2	27.3	<2	31	35.2	5.1	1.2	11	21	15.1	82	<5	66.4	<2	28.8	<3	<5
	MAX	0	0	0	27.3	3.3	50.9	35.2	10	2.7	19	50	47.4	137	0	139.7	0	42.3	3.3	0
SPG2B	MEAN	0	0	0	17.9	2.233	43.42	23.33	8.1	2.1	10.83	39.27	31.52	117	0	115.1	0	32.2	3.05	0
	MIN	0	0	0	0	0	31	16	5.1	1.2	3	21	15.1	82	0	66.4	0	27.3	0	0
SPG3	950711	<0.5	<1	<2	<16	2	51.9	9	5.5	2.1	3	30.2	17.2	138	<5	79.9	<2	53	<3	<5
SPG3	950918	<0.5	<1	<2	<16	<2	47.5	9	6.7	1.9	3	31.1	11.2	126	<5	82.8	<2	41.1	<3	<5
SPG3	951114	<0.5	<1	<2	<16	3.5	48.2	16	8.1	2.5	2	32.4	24.7	131	<5	104.3	<2	34.7	<3	<5
SPG3	960616	<0.5	<1	<2	<16	<2	54.9	19	7	2.3	3	40	37.8	147	<5	95.3	<2	40.6	3.4	<5
SPG3	960416	<0.5	<1	<2	<16	<2	46.8	14.5	5.7	2.2	10.7	30.4	31.8	126	5.2	90.1	<2	35.8	<3	<5
SPG3	960601	<0.5	<1	<2	22	<2	31.2	26.9	3.7	1.2	10.2	14.8	10	83	<5	47.2	<2	26.7	<3	<5
	MAX	0	0	0	22	3.5	54.9	26.9	8.1	2.5	10.7	40	37.8	147	0	104.3	0	53	3.4	0
SPG3	MEAN	0	0	0	17	2.25	46.75	15.73	6.116	2.033	5.317	29.82	22.117	125	0	83.27	0	38.65	3.07	0
	MIN	0	0	0	0	0	31.2	9	3.7	1.2	2	14.8	10	83	0	47.2	0	26.7	0	0

Station	Date	Cd	Cr	Pb	Al	Cu	Ca	Fe	K	Mg	Mn	Na	Zn	Hardness	Ni	B	Be	Ba	Co	V
		ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	mg/L	mg/L	ug/L	mg/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
OSC4	950711	<0.5	<1	<2	20	3.7	52.3	6	3.7	2	7	22.6	11.4	139	<5	90.7	<2	56.2	<3	<5
OSC4	950918	<0.5	<1	<2	<16	<2	46.9	7	4.9	1.7	7	26.5	7.1	124	<5	97.8	<2	48	<3	<5
OSC4	951114	<0.5	<1	<2	<16	2.3	49.9	4	5.5	2.2	2	31.1	16.1	134	<5	118.6	<2	40.3	3.6	<5
OSC4	960116	<0.5	1.2	<2	<16	<2	54.3	11	5	2.1	5	36	28.1	144	<5	117.1	<2	44.1	5.3	<5
OSC4	960416	<0.5	<1	<2	<16	<2	47.9	9.1	4.3	2.1	12.6	29.8	22.4	128	<5	122.5	<2	41	<3	<5
OSC4	960601	<0.5	<1	<2	46	<2	35	34.8	3.1	1.1	12.9	14.9	7.8	92	<5	80.8	<2	35.6	<3	<5
	MAX	0	1.2	0	46	3.7	54.3	34.8	5.5	2.2	12.9	36	28.1	144	0	122.5	0	56.2	5.3	0
OSC4	MEAN	0	1.033	0	21.7	2.333	47.72	11.98	4.416	1.867	7.75	26.82	15.48	127	0	104.6	0	44.2	3.48	0
	MIN	0	0	0	0	0	35	4	3.1	1.1	2	14.9	7.1	92	0	80.8	0	35.6	0	0
LOS1	951114	<0.5	<1	<2	<16	<2	50.3	4	0.5	1.2	4	<0.04	<2.0	130	<5	<3	<2	32.1	<3	<5
LOS1	960116	<0.5	<1	<2	<16	<2	54.8	4	1	1.5	5	5	<2.0	143	<5	<3	<2	43.1	3.1	<5
LOS1	960416	<0.5	<1	<2	<16	<2	50.2	7.6	0.7	1.5	10.8	0.1	<2	131	<5	5.8	<2	41.9	<3	<5
LOS1	960601	<0.5	<1	<2	17.7	<2	58.8	20.9	1.4	1.6	21.5	3.7	3.5	154	<5	<3	<2	51.1	<3	<5
	MAX	0	0	0	17.7	0	58.8	20.9	1.4	1.6	21.5	5	3.5	154	0	5.8	0	51.1	3.1	0
LOS1	MEAN	0	0	0	16.4	0	53.53	9.125	0.9	1.45	10.33	2.21	2.375	140	0	3.7	0	42.05	3.03	0
	MIN	0	0	0	0	0	50.2	4	0.5	1.2	4	0	0	130	0	0	0	32.1	0	0
OSC5	950116	<0.5	<1	<2	<16	<2	54.7	7	4	2	4	27	18.2	145	<5	82.7	<2	46.3	5.4	<5
OSC5	950711	<0.5	<1	<2	<16	<2	50.5	4	2.8	1.9	6	16.6	7.4	134	<5	58.9	<2	58	<3	<5
OSC5	950918	<0.5	<1	<2	<16	<2	47	9	3.8	1.7	6	20	6	124	<5	67.4	<2	48.6	<3	<5
OSC5	951114	<0.5	<1	<2	<16	3.8	50.1	2	4	2.2	3	20.9	11.9	134	<5	74.7	<2	42.5	4.5	<5
OSC5	960416	<0.5	<1	<2	<16	<2	48.8	9.5	3.5	1.9	10.5	20	14.8	130	<5	88.6	<2	43.1	<3	<5
OSC5	960601	<0.5	<1	<2	39.3	<2	39.5	30.3	2.9	1.2	16	14	7	103	<5	69.6	<2	36.1	<3	<5
	MAX	0	0	0	39.3	3.8	54.7	30.3	4	2.2	16	27	18.2	145	0	88.6	0	58	5.4	0
OSC5	MEAN	0	0	0	19.9	2.3	48.43	10.3	3.5	1.817	7.583	19.75	10.88	128	0	73.65	0	45.77	3.65	0
	MIN	0	0	0	0	0	39.5	2	2.8	1.2	3	14	6	103	0	58.9	0	36.1	0	0

Station	Date	Cd	Cr	Pb	Al	Cu	Ca	Fe	K	Mg	Mn	Na	Zn	Hardness	Ni	B	Be	Ba	Co	V
		ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	mg/L	mg/L	ug/L	mg/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
OSC6	950711	<0.5	<1	<2	19	2.5	48.9	15	2.6	1.9	9	14.1	5.9	130	<5	46.2	<2	58.1	<3	<5
OSC6	950919	<0.5	<1	<2	22.1	<2	46.5	20	3.6	1.7	7	19.1	4	123	<5	58.2	<2	51.5	<3	<5
OSC6	951114	<0.5	<1	<2	<16	2.2	50.5	6	3.7	2.1	3	16.3	7.1	1354	<5	25.4	<2	46.2	3.8	<5
OSC6	960115	<0.5	<1	<2	<16	<2	54.1	4	3	2	3	20	9.3	143	<5	60.9	<2	46.3	4.4	<5
OSC6	960415	<0.5	<1	<2	<16	<2	48.8	8.9	3	1.9	10.3	14.9	6.9	130	<5	64.1	<2	42	3.1	<5
OSC6	960601	<0.5	<1	<2	27	<2	38.6	31.1	2.9	1.3	12.7	14.3	5.7	102	<5	70.3	<2	38.5	<3	<5
	MAX	0	0	0	27	2.5	54.1	31.1	3.7	2.1	12.7	20	9.3	1354	0	70.3	0	58.1	4.4	0
OSC6	MEAN	0	0	0	19.4	2.117	47.9	14.17	3.133	1.817	7.5	16.45	6.483	330	0	54.18	0	47.1	3.38	0
	MIN	0	0	0	0	0	38.6	4	2.6	1.3	3	14.1	4	102	0	25.4	0	38.5	0	0
OSC7	950711	<0.5	<1	<2	20	3.6	47.5	9	2.6	1.9	8	12	4	126	<5	37	<2	56	<3	<5
OSC7	950919	<0.5	<1	<2	<16	<2	46	10	3.6	1.7	7	17.8	2.8	122	<5	53.5	<2	52	<3	<5
OSC7	951114	<0.5	<1	<2	<16	2.2	50.1	2	3.3	2.1	3	15.1	5.2	134	<5	12.6	<2	46.6	3.7	<5
OSC7	960116	<0.5	<1	<2	<16	<2	53.4	4	3	2	3	21	9.4	141	<5	58.3	<2	48.9	5.9	<5
OSC7	960415	<0.5	<1	<2	<16	<2	48.3	10	2.9	1.8	11.1	15	6	128	<5	61	<2	41.5	3.3	<5
OSC7	960601	<0.5	<1	<2	<16	<2	38.2	21.5	3.3	1.5	14	15.7	6.2	102	<5	73.5	<2	43.9	<3	<5
	MAX	0	0	0	20	3.6	53.4	21.5	3.6	2.1	14	21	9.4	141	0	73.5	0	56	5.9	0
OSC7	MEAN	0	0	0	16.7	2.3	47.25	9.417	3.116	1.833	7.683	16.1	5.6	126	0	49.32	0	48.15	3.65	0
	MIN	0	0	0	0	0	38.2	2	2.6	1.5	3	12	2.8	102	0	12.6	0	41.5	0	0
ILL5	950711	<0.5	<1	<2	26	2.8	46.9	12	2.3	2	17	11.4	2.7	125	<5	39.8	<2	55.1	<3	<5
ILL5	950919	<0.5	<1	<2	20.3	<2	44.8	19	3.2	1.8	21	15.7	2	119	<5	48	<2	51.2	<3	<5
ILL5	951114	<0.5	<1	<2	<16	<2	51.3	8	2.8	2.2	14	12.5	2.7	137	<5	50.5	<2	46.2	<3	<5
ILL5	960116	<0.5	<1	<2	<16	<2	48.2	9	2	2.4	7	13	5.1	130	<5	35.2	<2	44.3	6.5	<5
ILL5	960415	<0.5	<1	<2	21.2	<2	37.3	39.6	1.9	2.2	14.1	5.4	<2	102	<5	24.8	<2	34.4	<3	<5
ILL5	960601	<0.5	<1	<2	<16	<2	40.2	27.4	2.6	1.9	12.2	8.1	3.1	108	<5	52.4	<2	45.4	<3	<5
	MAX	0	0	0	26	2.8	51.3	39.6	3.2	2.4	21	15.7	5.1	137	0	52.4	0	55.1	6.5	0
ILL5	MEAN	0	0	0	19.3	2.133	44.78	19.17	2.466	2.083	14.22	11.02	2.933	120	0	41.78	0	46.1	3.58	0
	MIN	0	0	0	0	0	37.3	8	1.9	1.8	7	5.4	0	102	0	24.8	0	34.4	0	0

Station	Date	Cd	Cr	Pb	Al	Cu	Ca	Fe	K	Mg	Mn	Na	Zn	Hardness	Ni	B	Be	Ba	Co	V
		ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	mg/L	mg/L	ug/L	mg/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
ILL6	950711	<0.5	<1	<2	<16	2.6	46.2	5	2.3	2	9	10.5	<2.0	124	<5	35.3	<2	53.4	<3	<5
ILL6	950919	<0.5	<1	<2	39.2	<2	44.1	29	3.2	1.8	12	15.6	2.8	117	<5	47.4	<2	50.6	<3	<5
ILL6	951114	<0.5	<1	<2	<16	<2	48.9	10	2.7	2.1	6	13.7	2.1	131	<5	50.5	<2	42.8	<3	<5
ILL6	960116	<0.5	<1	<2	<16	<2	48.2	11	2	2.4	5	12	10.2	130	<5	34.2	<2	43.3	5.8	<5
ILL6	960416	<0.5	<1	<2	<16	<2	36	27.5	1.8	2.1	11.1	5.2	<2	99	<5	30.5	<2	38.7	<3	<5
ILL6	960601	<0.5	<1	<2	<16	<2	41.3	17.7	2.6	1.9	11.2	8.6	3.4	111	<5	62.7	<2	45.2	<3	<5
	MAX	0	0	0	39.2	2.6	48.9	29	3.2	2.4	12	15.6	10.2	131	0	62.7	0	53.4	5.8	0
ILL6	MEAN	0	0	0	19.9	2.1	44.12	16.7	2.433	2.05	9.05	10.93	3.75	119	0	43.43	0	45.67	3.47	0
	MIN	0	0	0	0	0	36	5	1.8	1.8	5	5.2	0	99	0	30.5	0	38.7	0	0
ILL7	950711	<0.5	<1	<2	24	2.4	46.3	10	2.4	2	14	10.5	5.5	124	<5	32.1	<2	53.7	<3	<5
ILL7	950919	<0.5	<1	<2	17.5	<2	43.9	18	3.2	1.8	10	16.5	3	117	<5	50.5	<2	50.2	<3	<5
ILL7	951114	<0.5	<1	<2	<16	<2	48.4	10	2.7	2.1	6	13	2.2	129	<5	45.1	<2	42.6	<3	<5
ILL7	960116	<0.5	<1	<2	<16	2.4	48.1	14	2	2.3	4	13	5.4	130	<5	31.9	<2	44	7.7	<5
ILL7	960416	<0.5	<1	<2	<16	<2	36.2	24.1	1.8	2.1	10.3	6.3	<2	99	<5	27.4	<2	38.4	<3	<5
ILL7	960601	<0.5	<1	<2	<16	<2	43.8	16.1	2.5	2	11.7	11	3.2	118	<5	62.5	<2	47.6	<3	<5
	MAX	0	0	0	24	2.4	48.4	24.1	3.2	2.3	14	16.5	5.5	130	0	62.5	0	53.7	7.7	0
ILL7	MEAN	0	0	0	17.6	2.133	44.45	15.37	2.433	2.05	9.333	11.72	3.55	120	0	41.58	0	46.08	3.78	0
	MIN	0		0	0	0	36.2	10	1.8	1.8	4	6.3	0	99	0	27.4	0	38.4	0	0

Appendix E

Periphyton Data

APPENDIX E
Periphyton 1995

Chlorophyll-a (mg/m²)	ILL1	MFI1A	MFI2B	ILL2	CLR1R	MUD2B	ILL3	ILL3D	ILL4	OSC1A	OSC1AD	OSC2B	OSC3	SPG1A	SPG2B	OSC4	ILL4	ILL5
Chlorophyll-a Rod 1	22.03	30.53	4.94	15.22	7.11	14.13	2.87	7.01	6.13	21.34	1.78	9.39	16.60	28.16	36.36	34.28	6.13	0.89
Chlorophyll-a Rod 2	25.98	28.55	42.58	7.81	5.14	32.31	5.43	4.45	14.52	12.75	5.14	5.73	8.40	47.92	33.99	6.32	14.52	0.69
Chlorophyll-a Rod 3	31.81	17.49	22.53	21.93	6.52	14.03	7.21	4.35	9.98	8.20	0.00	24.70	6.62	25.98	22.92	12.15	9.98	2.17
Chlorophyll-a Rod 4	8.40	23.71	24.90	9.48	5.63	15.91	5.93	3.36	10.37	8.00	13.63	17.59	18.57	44.56	19.66	5.24	10.37	5.53
sum	88.23	100.28	94.95	54.44	24.40	76.37	21.44	19.17	41.00	50.29	20.55	57.40	50.19	146.62	112.93	58.00	41.00	9.29
mean	22.06	25.07	23.74	13.61	6.10	19.09	5.36	4.79	10.25	12.57	5.14	14.35	12.55	36.65	28.23	14.50	10.25	2.32
stdev.	8.62	5.03	13.34	5.54	0.77	7.67	1.58	1.35	2.97	5.41	5.24	7.36	5.13	9.69	7.09	11.72	2.97	1.94
c.v.[(stdX100)/mean]	39%	20%	56%	41%	13%	40%	29%	28%	29%	43%	102%	51%	41%	26%	25%	81%	29%	84%
Dry Weight (g/m²)																		
Dry Weight Rod 1	16.05	13.78	6.44	20.29	2.64	12.10	13.16	7.58	34.86	6.24	5.85	10.01	Void	5.14	8.34	10.85	34.86	25.77
Dry Weight Rod 2	8.50	11.30	6.85	20.20	3.08	17.12	9.46	7.34	44.32	8.45	5.87	14.64		6.88	9.25	12.67	44.32	20.93
Dry Weight Rod 3	17.63	14.52	6.34	22.52	3.43	16.92	24.94	11.14	30.76	7.77	3.20	18.10		6.50	9.05	11.98	30.76	17.03
Dry Weight Rod 4	15.90	11.11	5.55	28.70	3.18	15.44	4.93	6.97	38.52	7.45	5.10	16.16		5.87	9.94	11.25	38.52	13.72
sum	58.08	50.71	25.17	91.72	12.33	61.59	52.50	33.04	148.46	29.92	20.02	58.90		24.40	36.58	46.74	148.46	77.44
mean	14.52	12.68	6.29	22.93	3.08	15.40	13.12	8.26	37.11	7.48	5.01	14.73		6.10	9.15	11.69	37.11	19.36
stdev.	3.54	1.50	0.47	3.46	0.29	2.01	7.42	1.68	4.98	0.80	1.09	2.99		0.66	0.57	0.70	4.98	4.49
c.v.[(stdX100)/mean]	24%	12%	7%	15%	9%	13%	57%	20%	13%	11%	22%	20%		11%	6%	6%	13%	23%
Ash FreeWt. (g/m²)																		
Ash Free Wt. Rod 1	13.58	10.34	4.24	17.70	1.87	8.38	6.40	11.55	31.08	4.63	4.39	7.96	Void	3.74	4.34	9.44	31.08	23.28
Ash Free Wt. Rod 2	6.93	8.46	4.39	17.53	2.22	12.05	5.99	8.23	39.84	6.32	4.42	11.69		4.81	5.58	11.04	39.84	19.18
Ash Free Wt. Rod 3	14.83	11.11	4.37	19.25	2.57	12.56	9.76	22.57	27.37	5.95	2.44	14.58		4.79	4.53	10.32	27.37	15.22
Ash Free Wt. Rod 4	13.35	7.89	3.73	24.97	2.00	11.06	5.74	3.84	34.35	5.50	3.71	13.23		4.14	5.37	9.73	34.35	12.48
sum	48.68	37.81	16.73	79.45	8.66	44.05	27.89	46.18	132.65	22.39	14.96	47.46		17.48	19.81	40.53	132.65	70.16
mean	12.17	9.45	4.18	19.86	2.16	11.01	6.97	11.55	33.16	5.60	3.74	11.87		4.37	4.95	10.13	33.16	17.54
stdev.	3.08	1.32	0.27	3.02	0.26	1.61	1.63	6.93	4.58	0.63	0.80	2.48		0.45	0.53	0.61	4.58	4.08
c.v.[(stdX100)/mean]	25%	14%	6%	15%	12%	15%	23%	60%	14%	11%	21%	21%		10%	11%	6%	14%	23%

ILL1D, CLR5, ILL7 and OSC7 were voided.

APPENDIX E
Periphyton 1996

Chlorophyll-a (mg/m²)	ILL1	ILL1D	MFI1A	MFI2B	ILL2	CLR1R	CLR5	ILL3	OSC1A	OSC1AD	OSC2B	OSC3	SPG1A	SPG2B	OSC7	ILL7
Chlorophyll-a Rod 1	21.27	24.68	13.78	26.34	11.73	2.24	26.10	18.77	5.26	21.49	8.78	10.85	15.72	28.52	14.39	45.25
Chlorophyll-a Rod 2	12.64	38.51	23.51	29.77	7.37	6.91	25.28	22.90	14.44	44.22	17.13	21.50	16.01	46.33	11.23	32.10
Chlorophyll-a Rod 3	20.81	29.12	18.37	36.99	9.31	1.13	27.66	15.34	18.66	27.25	7.68	22.61	12.68	48.14	14.24	46.77
Chlorophyll-a Rod 4	16.85	24.96	13.28	24.76	13.18	6.90	25.83	3.88	26.93	16.86	23.27	17.35	6.87	65.99	4.41	45.74
sum	71.56	117.27	68.94	117.86	41.58	17.17	104.88	60.90	65.30	109.82	56.86	72.30	51.27	188.97	44.26	169.87
mean	17.89	29.32	17.24	29.46	10.40	4.29	26.22	15.23	16.32	27.45	14.21	18.08	12.82	47.24	11.07	42.47
stdev.	3.49	5.59	4.13	4.71	2.23	2.64	0.88	7.07	7.81	10.36	6.38	4.61	3.67	13.26	4.05	6.01
c.v.[(stdevX100)/mean]	19%	19%	24%	16%	21%	61%	3%	46%	48%	38%	45%	26%	29%	28%	37%	14%
Dry Weight (g/m²)																
Dry Weight Rod 1	16.40	18.92	23.76	10.48	20.66	4.18	34.29	15.37	Void	Void	9.47	4.55	3.71	15.70	15.01	34.29
Dry Weight Rod 2	16.48	14.73	24.26	13.35	15.89	3.91	27.59	36.50			14.05	4.05	3.85	12.19	7.09	27.59
Dry Weight Rod 3	14.01	16.61	15.18	14.69	17.74	6.40	45.07	23.30			15.34	14.94	4.23	15.70	19.08	45.07
Dry Weight Rod 4	14.42	15.63	15.68	15.33	14.86	4.17	26.75	16.77			13.37	23.28	4.13	10.93	14.88	26.75
sum	61.31	65.89	78.88	53.85	69.15	18.66	133.71	91.94			52.24	46.81	15.92	54.52	56.06	133.71
mean	15.33	16.47	19.72	13.46	17.29	4.67	33.43	22.99			13.06	11.70	3.98	13.63	14.02	33.43
stdev.	1.12	1.56	4.30	1.86	2.20	1.01	7.33	8.36			2.19	7.97	0.21	2.12	4.34	7.33
c.v.[(stdevX100)/mean]	7%	9%	22%	14%	13%	22%	22%	36%			17%	68%	5%	16%	31%	22%
Ash Free Wt. (g/m²)																
Ash Free Wt. Rod 1	14.01	15.89	20.66	8.71	18.27	3.59	19.86	13.52	Void	Void	7.22	2.82	3.02	12.58	13.54	30.65
Ash Free Wt. Rod 2	13.89	12.15	20.98	11.11	13.89	3.29	23.87	33.18			11.18	2.69	3.03	9.57	6.09	24.42
Ash Free Wt. Rod 3	11.83	13.81	13.15	12.29	15.48	5.45	19.82	20.80			12.41	11.89	3.38	12.37	17.81	40.68
Ash Free Wt. Rod 4	12.14	13.20	13.47	12.77	12.74	3.58	19.32	14.81			10.37	19.54	3.27	8.49	13.36	23.55
sum	51.87	55.05	68.26	44.87	60.38	15.91	82.86	82.31			41.17	36.94	12.70	43.01	50.81	119.30
mean	12.97	13.76	17.06	11.22	15.09	3.98	20.72	20.58			10.29	9.24	3.18	10.75	12.70	29.82
stdev.	0.99	1.36	3.76	1.57	2.07	0.86	1.83	7.78			1.92	7.02	0.15	1.77	4.21	6.84
c.v.[(stdevX100)/mean]	8%	10%	22%	14%	14%	22%	9%	38%			19%	76%	5%	16%	33%	23%

MUD2B, ILL3D, OSC4, ILL4 and ILL5 were voided.

Appendix F

Macroinvertebrate Data Sheet

Appendix F. Raw data used in macroinvertebrate analysis of the Illinois River and its tributaries.

TAXA	CLR01R	CLR05	ILL01	ILL02	ILL03	ILL03(g)	ILL04	ILL05	ILL07	MFI01A	MFI02B	MUD02B	OSG01A	OSG02B	OSG03	OSG04	OSG07	SPG01A	SPG02B	Station Count	Total Collected
Antocha																			1	1	1
Argia	2											1								2	3
Asellus	2									1									2	3	5
Atherix																	1			1	1
Baetis	11	21	30	17	45	55	43	25	53	97	28	94	45	10	2	23	31	119	109	19	858
Caenis	30	7	11	28		2	1	5	20		1				33	27	1			12	166
Cambarinae	3		1													1		1		4	6
Ceratopsyche															4					1	4
Chimarra						1					1		1		2				2	5	7
Chironomidae	9	10	18	7	3	4		3	1	63	34	31	10	6	16	10	1	4	11	18	241
Choroterpes	9															1		1		3	11
Cheumatopsyche	6	7	9	3	9	19		1	1	57	34		25	56	45			2	23	15	297
Corbicula		1																		1	1
Corydalus cornutus		15	14	4	2	10	2	11	3		3			1	1		4		2	13	72
Cura formanii								1												1	1
Ectopria												1								1	1
Ephoron				2		1														2	3
Gastropoda			1			1		1						2	1	6	1			7	13
Hemerodromia													1		1	2				3	4
Hexatoma			1	1																2	2
Hyalella azteca																		1		1	1
Isonychia		3	2		3	2	4	4						2	2		9		1	10	32
Leptophlebia		1		5			2													3	8
Lirceus											1			1		1		43	1	5	47
Lumbriculidae								4				2		1			1		2	5	10
Mollusca-Bivalve			1		2	2	1					1								5	7
Nigronia						1														1	1
Optioservus larvae													5	48	11		8			4	72
Phasganophora						1		5												2	6
Psephenus larvae	11	1		1			4	1	7		1	2					2			9	30
Pseudocloeon																		1		1	1
Rhagovelia	1																			1	1
Simulium					2					2			14	5			2	18		6	43
Stenelmis adult	1		2	7		1	1		1				7	11	1				1	10	33
Stenelmis larvae	8	3	16	9	5	24		1	8	6	1	4		1	19	3	1			15	109
Stenonema	13	30	1	13	24	10	37	37	22	1	2	2	7	5	12	20	31		9	18	276
Stylogomphus albistylus																1				1	1
Tricorythodes				7		1		1	23			32							1	6	65
Total Number of Taxa	13	11	13	13	9	16	9	14	10	7	10	10	9	13	14	11	13	9	13		
Total Number in Sample	106	99	107	104	95	135	95	100	139	227	106	170	115	149	150	95	93	190	165		

Appendix G

Fish Habitat Evaluation Sheet

INSTREAM & RIPARIAN HABITAT

STATION NO.:____________________ DATE:__________________

Sample Location:____

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1st Habitat ______Pool ______Riffle ______Run

Measurements (feet)	Substrate Type		Instream Cover
Length__________	Bedrock______	X 0.1______	Woody Debris______
Channel Width______	Lg Boulder______	X 1.0______	Undercut Banks______
Stream Width______	Boulder______	X 1.0______	Aquatic Veg______
Avg. Depth______	Rubble______	X 1.0______	Hanging Veg______
Max. Depth______	Gravel______	X 0.5______	Root Wads______
	Sand______	X 0.1______	Leafy Debris______
	Mud/Silt______	X 0.1______	
		TOTAL______	TOTAL______

Score: Abundant 11-15 Common 6-10 Sparce 1-5 Absent 0

Sedimentation on Substrate:____________________

Score: None 11-15 Light 6-10 Noticeable 1-5 Excessive 0

TOTAL SCORE:______________

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2nd Habitat ______Pool ______Riffle ______Run

Measurements (feet)	Substrate Type	(Score)	Instream Cover
Length__________	Bedrock______	X 0.1______	Woody Debris______
Channel Width______	Lg Boulder______	X 1.0______	Undercut Banks______
Stream Width______	Boulder______	X 1.0______	Aquatic Veg______
Avg. Depth______	Rubble______	X 1.0______	Hanging Veg______
Max. Depth______	Gravel______	X 0.5______	Root Wads______
	Sand______	X 0.1______	Leafy Debris______
	Mud/Silt______	X 0.1______	
		TOTAL______	TOTAL______

Score: Abundant 11-15 Common 6-10 Sparce 1-5 Absent 0

Sedimentation on Substrate:____________________

Score: None 11-15 Light 6-10 Noticeable 1-5 Excessive 0

TOTAL SCORE:______________