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ILLINOIS RIVER 1997 POLLUTANT LOADS AT ARKANSAS HIGHWAY 59 BRIDGE

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Arkansas Water Resources Center
112 Ozark Hall
University of Arkansas
Fayetteville, Arkansas 72701

ILLINOIS RIVER
1997 POLLUTANT LOADS
At Arkansas Highway 59 Bridge

Submitted to the
Arkansas – Oklahoma Illinois River Compact Commission

By

Marc A. Nelson Ph.D., P.E.
Arkansas Water Resource Center

Thomas S. Soerens Ph.D., P.E.
Department of Civil Engineering

University of Arkansas
Fayetteville, Arkansas

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INTRODUCTION

Automatic water samplers and a USGS gauging station were established in 1995 on the main stem of the Illinois River at the Arkansas Highway 59 Bridge. Since that time, continuous stage and discharge measurements and water quality sampling have been used to determine pollutant concentrations and loads in the Arkansas portion of the Illinois River. This report represents the results from the measurement and sampling for January 1, 1997 to December 31, 1997.

BACKGROUND

A gauge was installed at the Highway 59 bridge in the fall of 1995 by the USGS. A stage–discharge relationship was developed and used to calculate discharge. This relationship was used during 1995 and part of 1996. In the fall of 1996, the USGS performed further measurements and revised the stage–discharge relationship. This relationship was used to calculate discharges beginning in 1997. The two stage- discharge relationships are shown in figure 1.

In September 1995, sampling was begun on the Illinois River. Grab samples were taken every week and storms were sampled using an automatic sampler set to take samples every 4 hours. During the period from September 13, 1995 to September 15, 1996 a total of one hundred thirty seven grab and discrete storm samples were collected and analyzed. Table 1. summarizes the results from that study (Parker et al, 1997). The relationship used to calculate total discharge and total loads was the initial stage-discharge relationship.

Table 1. Results from previous study period (Parker et al, 1997)

Nutrients	Total Discharge (ft3/yr)	Total Load (kg/yr)	Average Discharge (cfs)	Average Flow Weighted Concentrations (mg/l)
N03-N	2,675,263	550,000	299.68	2.0
NH3-N	(9.460.800,000)	8,530		0.031
TKN	View comment	201,000		0.74
TP		89,900		0.33
TSS		27,500,000		101
TOC		1,130,000		4.2

Sampling was discontinued on September 15, 1996 and no water quality samples were taken between September 15, 1996 and November 1, 1996. Stage and discharge was still recorded for this time period, however, no loads were calculated. Water quality sampling was reinitiated on November 1, 1996. The sampling protocol was modified to collecting grab samples every two weeks and collecting flow-weighted storm composite samples. Between November 1, 1996 and December 31, 1996 a total of four grab samples and one storm composite sample were collected and analyzed. Stage and discharge were recorded.

METHODS

Starting January 1, 1997, the sampling protocol consisted of collecting grab samples every two weeks and flow-weighted composite samples during storms. Storms were defined as all flows above a five foot trigger level, except during the Summer and early Fall, when the base flows were consistently below four feet, the trigger level was set to four feet. Once stage had risen above the trigger, a USGS Sutron programmable data logger began totalizing the volume of water discharged. Once a determined amount of water had been discharged, the data logger sent a signal to a Sigma automatic water sampler that filled one of twenty four one-liter bottles. The totalizer was then reset to zero and discharge was again summed for the next sample. In this fashion up to twenty four samples, each representing an equal volume of storm water was collected. The volume of water represented by each individual sample was two million cubic feet. These samples were retrieved before all twenty four bottles were filled, or within 48 hours after being taken. The individual samples were composited into a flow-weighted composite storm sample by combining equal volumes of each. Samples were taken as long as the stage remained above the trigger level. All samples were analyzed for Nitrate nitrogen (NO3-N), Total Kjeldahl Nitrogen (TKN), Total Phosphorus (TP) and Total Suspended Solids (TSS). AWRC Field Services personnel collected all samples and all samples were analyzed by the AWRC Water Quality Lab using standard field and laboratory QA/QC procedures. This sampling protocol was used from January 1, 1997 to October 15, 1997.

Beginning October 15, 1997, the Illinois River sampling was supplemented by sampling from another research project. That project, titled "Investigation of Optimum Sample Interval for Determining Storm Water Pollutant Loads" by Marc A. Nelson, Thomas S. Soerens and Jean Spooner, was sponsored by the USGS Water Resource Institute Program. The sampling protocol for that project consisted of taking grab samples every two days and discrete storm water samples at thirty minute intervals on the rising limb and sixty minutes on the falling limb of storm water hydrographs. Storm water sampling was begun at a variable trigger level set to the current stage plus ten percent and adjusted every two days. After the first thirty six hours of each storm, sample times were increased to from four to twenty four hours until the stage fell below the initial trigger. All samples were collected within twenty four hours. All samples were analyzed for Nitrate Nitrogen (NO3-N), Ammonia Nitrogen (NH4-N), Total Kjeldahl Nitrogen (TKN), Total Phosphorus (TP), Ortho Phosphate (O-P) and Total Suspended Solids (TSS). AWRC Field Services personnel collected all samples and all samples were analyzed by the AWRC Water Quality Lab using standard field and laboratory QA/QC procedures. This sampling protocol was used from October 15, 1997 to December 31, 1997.

Calendar year pollutant loads and mean concentrations were calculated from the collected data. USGS stage and discharge data in sixty minute intervals was used to calculate sixty minute total volumes. Each volume was assigned a pollutant concentration. The pollutant concentrations were assigned by applying the results of grab samples between storm trigger levels and the results of storm water samples above trigger levels. All concentration data was applied from half way to the previous sample to half way to the subsequent sample except the first and last of a storm or base flow period which were applied to the start or end of the period. Sixty minute loads were calculated by multiplying sixty minute volumes by their assigned concentrations. The yearly loads were calculated by summing the sixty minute loads during the calendar year. Yearly mean concentrations were calculated by dividing the yearly load by the yearly volume.

RESULTS

During the time period from January 1, 1997 to October 15, 1997 there were twenty six grab samples and twenty five storm composite samples collected and analyzed. During the period from October 15, 1997 to December 31, 1997 there were twenty four grab samples and one hundred and forty storm discrete samples collected and analyzed. These results are summarized in Table 2. and Figure 2.

Table 2. Results for Illinois River at AR59 for Calendar Year 1997.

Pollutant	Total Discharge (ft3/yr)	Total Load (kg/yr)	Average Discharge (cfs)	Mean Concentrations (mg/l)
N03-N	16,200,000,000	1,020,000	512	2.24
TKN		301,000		0.68
TP		127,000		0.28
TSS		18,400,000		40.2

DISCUSSION

Comparison between the discharges during 1997 and 1996 indicate a significant difference. This difference can be attributed in part to the use of different rating curves. The storm flows were defined as beginning at a five foot trigger level and were measured up to twenty feet of stage. In this range the old curve varies from seventy eight percent to sixty eight percent of the new curve. This difference is also evident in total load values. The discharge and loads for 1996 would need to be recalculated with the current rating curve to allow direct comparison or trend analysis with 1997 and subsequent years.

During the later part of the year, when discrete storm samples were being taken, the first sample of storm sample series were observed to have much higher TSS, T-P and TKN concentrations that samples immediately following. A series of grab samples, at fifteen-minute intervals, taken with the sampler, with a bucket from the surface above the sampler intake and from the bank, was taken to determine the source of possible error. The results showed that the first sample taken with the sampler was much higher in TSS, T-P and TKN than the samples taken at other locations and later in time. These results are shown in Figure 3. It was concluded that the first sample from the sampler was contaminated. As a result the concentrations determined from the first sample of storms was not used to calculate storm loads during the discrete sampling portion of the project. The first sample was included in storm water composites samples. However, since most composites consisted of around twenty four samples, each individual sample represents only about four percent of the total composite sample.

During the low flow period of the summer of 1998, the sample intake was investigated. The sampler intake consists of a two inch PVC pipe that extends from the sampler to eighteen inches above the riverbed. This two inch pipe is perforated for about the last four feet. Inside the two inch pipe is a 3/8 in sampler intake line with a 1 1/2-inch diameter strainer on the end. This strainer rests on a bolt through the end of the pipe. During the investigation, it was found that the inside of the two-inch pipe about two to three feet above the intake strainer was filled with gravel and silt. This material had entered into the pipe through the perforations and was suspended above the strainer. It was concluded that the first sample from the sampler was removing sediment that had been caught in the gravel above the intake. The intake line was replaced, the pipe cleaned and a smaller intake strainer was installed to reduce the possibility of future contamination.

The observation that gravel and silt filled the perforated portion of the pipe about four to five feet above the riverbed may point to a possible source of error in the determination of loads, especially for particulate forms of pollutants. The sample intake may be located so that during storms, samples are being taken from within a portion of the flow that contains elevated solids, particulate and organic matter. Since this stratification probably is greatest at the highest flows, the effect on load calculations may be significant. Research is needed to determine how the concentrations of samples collected with the autosampler relate to the concentrations of the entire river at different flows.

Figure 1. Initial and New stage-discharge relationships for the Illinois River at AR 59.

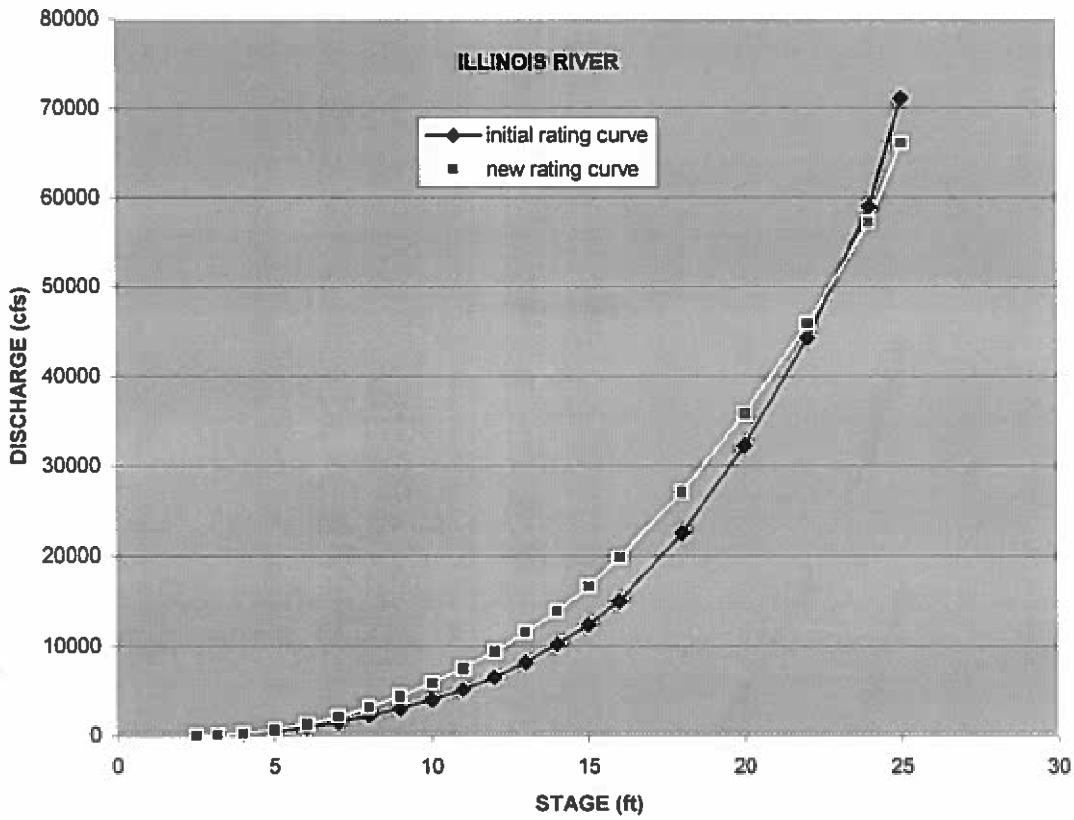
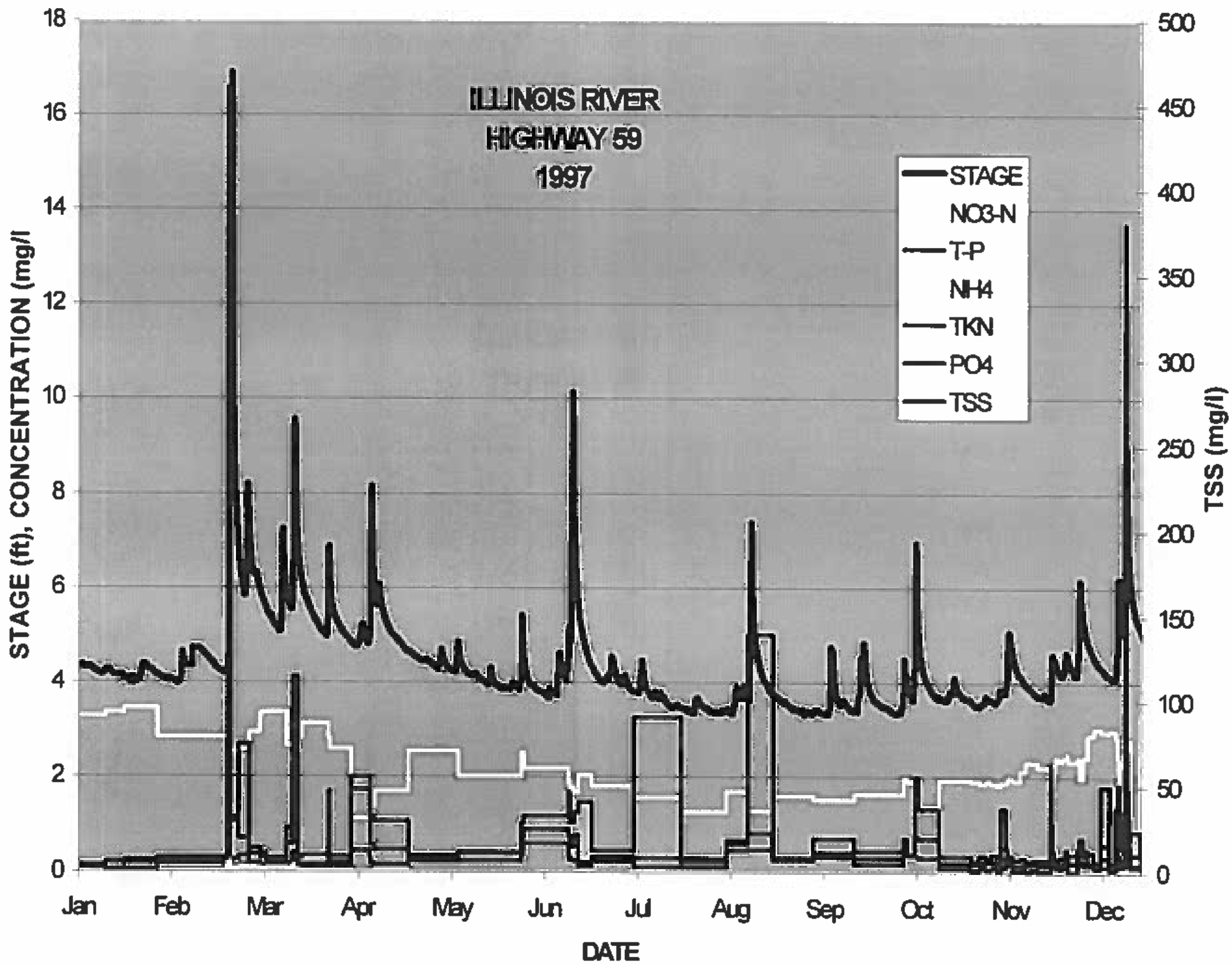


Figure 2. Summary of Stage and Measured Pollutant concentrations for 1997.



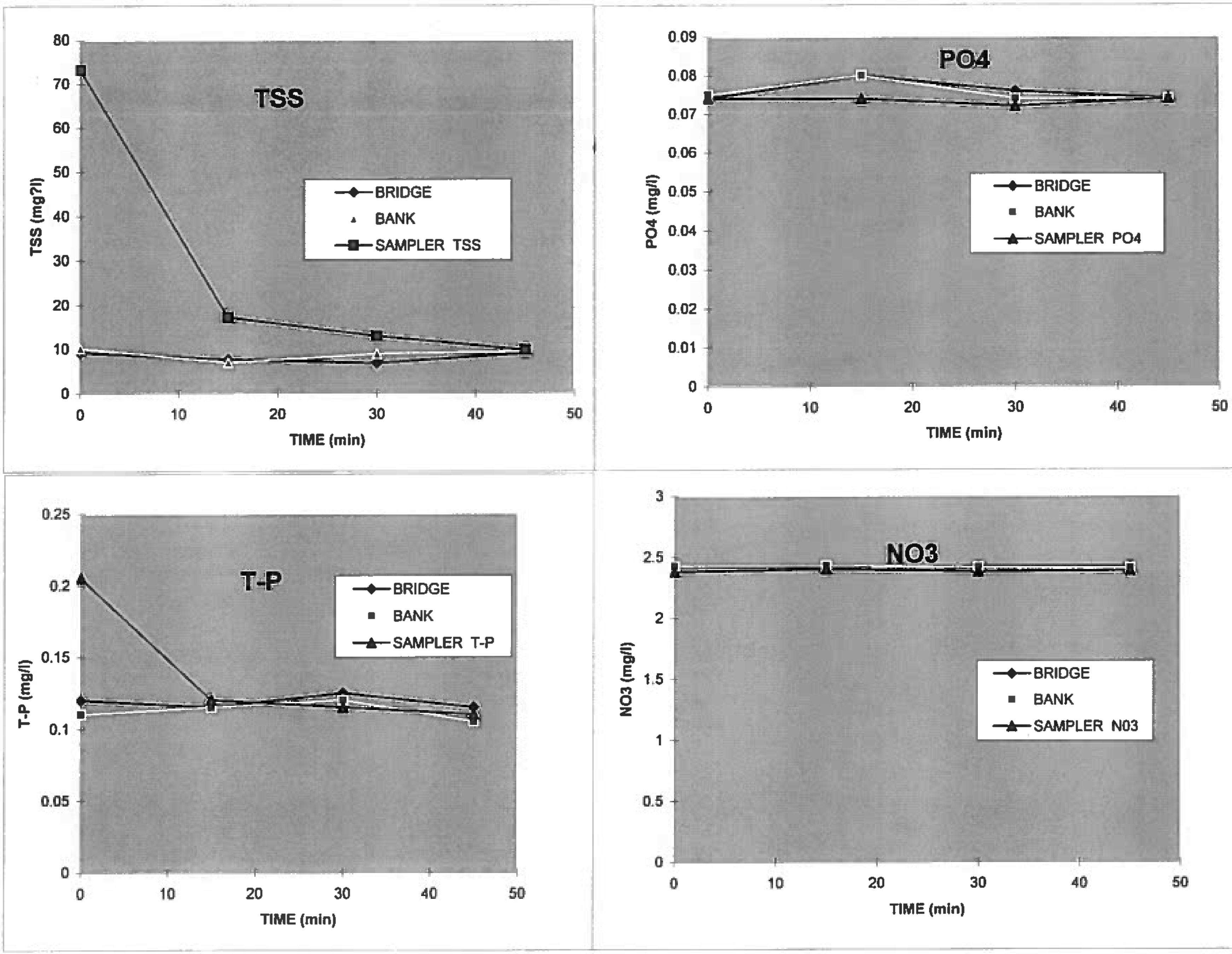


Figure 3. Comparison of grab sample locations and times