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Arkansas Water Resources Center

WATER SAMPLING, ANALYSIS AND ANNUAL LOAD DETERMINATIONS FOR NUTRIENTS AND SEDIMENT AT THE ARKANSAS HIGHWAY 45 BRIDGE ON THE WHITE RIVER JUST ABOVE BEAVER LAKE

Submitted to the
Arkansas Soil and Water Conservation Commission

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NUTRIENTS AND SEDIMENT AT THE ARKANSAS HIGHWAY 45 BRIDGE ON THE WHITE
RIVER JUST ABOVE BEAVER LAKE**

2004 ANNUAL REPORT

Presented to the Arkansas Soil and Water Conservation Commission

By

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AWRC- Water Quality Lab

June 2005

INTRODUCTION

A water quality sampling station was installed at the Arkansas Highway 45 bridge on the White River just above Beaver Lake in 2002. This station is coordinated with a USGS gauging station at the same location. This station is instrumented to collect samples at sufficient intervals across the hydrograph to accurately estimate the flux of total suspended solids, nitrogen and phosphorus into the upper end of Beaver Lake from the White River. The West Fork of the White River is listed on Arkansas' 1998 303d list as impaired from sediment. The Upper White was designated as the states highest priority watershed in the 1999 Unified Watershed Assessment. Accurate determination of stream nutrients and sediment is critical for future determinations of TMDLs, effectiveness of best management practices and trends in water quality.

SCOPE

This report is for water quality sampling, water sample analysis and annual pollutant load calculations at the Arkansas Highway 45 Bridge on the White River for calendar year 2004.

METHODS

Initially the sampler was operated in a discrete mode taking samples at thirty-minute intervals for the first twenty-four samples and sixty-minute intervals for the next twenty-four samples of each storm event. The sampler was set to begin taking samples when the stage rose to ten percent over the prior base flow. Discrete samples were collected when all twenty-four bottles were filled or within forty-eight hours after the first sample. Grab samples were taken often enough to have a minimum of one sample between each storm event. The sampler was operated using this protocol until three storms were adequately sampled. The results from this initial sampling phase will be used to determine the sampling start (trigger) and frequency for flow-weighted composite sampling. In addition, the results will be used to develop rating curves to predict pollutant concentrations as a function of discharge in order to calculate loads for inadequately sampled storm events.

The trigger level for the storm sampling will be set after studying the results from the initial (intensive) sampling period. The trigger level will be chosen so that any chemograph peaks that may occur early in a storm are included in the storm sampling. The volume used in the flow-weighted composite sampling will be determined from the results of the intensive sampling.

After the initial phase, the sampler will be reconfigured to take flow-weighted composite samples. The sampler will begin sampling after the stage exceeds a set trigger level. It will take a discrete sample after a fixed volume of water has passed. The volume of water used for the flow-weighted composite samples, i.e. sampling frequency, will be determined from the results of the initial sampling phase. The discrete samples will be composited by combining equal volumes of each into a single sample for analysis. Discrete samples will be collected for compositing when all twenty-four bottles are filled or within forty-eight hours after the first sample. Storms will be sampled in this manner for the period when the river stage is above the trigger level. Grab samples will be taken approximately every two weeks, but a minimum of once between each storm event after the initial sampling phase. All samples were collected by AWRC Personnel and transported to the AWRC Water quality Laboratory for analysis. All samples were analyzed for nitrate-nitrogen, ammonia-nitrogen, total nitrogen, total phosphorus, dissolved reactive phosphorus, sulfate, chloride and total suspended solids.

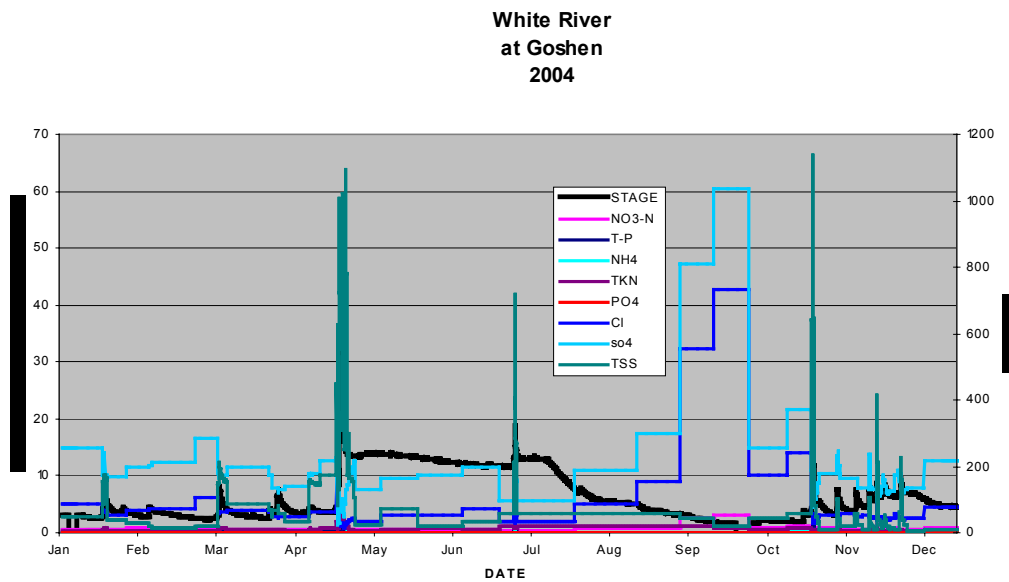
In addition to the above sampling for load determination, the AWRC in conjunction with the USGS conducted cross-section sampling to determine the relationship between autosampler concentrations and cross-section concentrations. The USGS collected evenly weighted integrated (EWI) cross section samples

at the same time AWRC collected discrete autosamples. All samples were transported and analyzed by the AWRC Water Quality Lab and the results used to determine correction factors for the auto sample concentrations. One storm flow sample was taken and compared during the year.

RESULTS

There were a total of 194 individual samples collected and analyzed for this project during the year. They include 26 grab samples, 156 discrete storm samples, 4 duplicate samples and 4 blank samples. A large storm on April 24 knocked the USGS gauging station out of business. It was inoperable until May 5. The USGS has estimated the daily discharge for this time period. The measured stage and concentrations are illustrated in figure 1.

Figure 1. 2003 Stage and measured concentrations



Quarterly duplicate samples taken on August 13 indicated that the intake line had become contaminated with sediment. It was estimated that the contamination began July 3. The intake was replaced on October 1. The concentrations used for the sediment related parameters TP, TN and TSS from July 3 to September 15 were estimated using concentrations prior to July 3. No storm events occurred during this period.

Parts of five small storm events were not sampled during the year. Concentrations for these time periods were estimated using discharge / concentration regression equations developed from discrete samples taken in 2004. Table 1 lists the regression equations and R² value for each parameter.

Table 1. Regression equations determined from discrete storm samples 2004

parameter	Regression equation	Regression coefficient
Sulfate	$y = -0.0059x + 10.392$	$R^2 = 0.1287$
Chloride	$y = -0.0026x + 3.8073$	$R^2 = 0.05$
Nitrate-N	$y = -0.0004x + 0.6507$	$R^2 = 0.0812$
Total Phosphorus	$y = 0.0011x + 0.2517$	$R^2 = 0.6308$
Ammonia-N	$y = -7E-05x + 0.0899$	$R^2 = 0.0438$
TKN	$y = 0.0015x + 0.6703$	$R^2 = 0.4325$
Phosphate-P	$y = 3E-06x + 0.026$	$R^2 = 0.0036$
TSS	$y = 0.5304x + 140.54$	$R^2 = 0.4435$

Total annual loads and flow-weighted mean concentrations were calculated for 2004 and listed in table 2. Flow-weighted mean concentrations were calculated by dividing the annual load by the annual discharge.

Figure 2. 2004 loads and mean concentrations

	Annual Loads (kg)	Mean concentrations (mg/l)
Discharge (M3)	726,401,938	
NO3-N	346,180	0.48
T-P	389,843	0.54
NH4	39,320	0.05
TKN	726,158	1.0
PO4	12,638	0.02
TSS	188,038,350	259

The loads can be segregated into storm and base-flow loads by defining storm flows as anything above 50 m³ /s at this site. The segregated loads and mean concentrations are listed in table 3.

Table 3. Storm flow loads, Base flow Loads and Mean Concentrations 2004.

	Storm Loads (kg)	Base Loads (kg)	Storm Concentrations (mg/l)	Base Concentrations (mg/l)
Discharge (M3)	389,319,217	337,082,721		
NO3-N	145,241	201,146	0.37	0.60
T-P	349,293	40,561	0.90	0.12
NH4	23,372	15,948	0.06	0.05
TKN	554,619	171,591	1.42	0.51
PO4	9,221	3,418	0.02	0.01
TSS	171,947,037	16,093,716	441	48

DISCUSSION

The White River @ 45 Bridge during 2004 can be compared to loads and concentrations developed in other watersheds in Northwest Arkansas for 2004. Six other watersheds in Northwest Arkansas have been monitored using the same monitoring and load calculation protocols. The only differences between the protocols are that trigger levels and storm composite sample volumes are different for each site. This

means that the distinction between storm and base flows (defined here as the trigger level) may be relatively different at each site.

The results for the six watersheds are summarized in Table 4 and Figure 2. The table and figure show TSS and phosphorus as total annual loads per watershed acre, as storm loads per watershed acre, as base-flow loads per watershed acre and as base-flow concentrations. Normalizing total and storm loads to a per acre basis allows comparison between watersheds of differing sizes. The total loads indicate the mass of TSS or P that are being transported to a receiving water body. Storm loads per acre may be used to represent relative impacts from non-point sources. The White River has high levels of total TSS compared to the others and most of the TSS is transported during storm events.

The P load for the White is also very high compared to the other watersheds with the primary transport occurring during storm events. Base Flow P concentrations are comparable to the other watersheds studied.

Figure 1 shows that there are significant levels of sulfate and chloride in the White River. These concentrations peak in late summer when the flow is at its lowest. This indicates a relatively constant source that is diluted at higher flows. The source of these constituents is unknown. However, chlorides and sulfate are often associated with wastewater from WWTPs or septic tanks. The peak values of 42 mg/l chlorides and 60 mg/l sulfates are comparable to the concentrations found in undiluted effluent.

Table 5 Comparison of seven northwest Arkansas watersheds

2004	Illinois River@59	Ballard Creek	Osage Creek@112	White River@45	West Fork	Kings River@143
Hectares	148,930	7,106	8,988	106,711	30,563	136,497
YEARS of data	1	1	1	1	1	1
tss load (kg/ha)	618	355	1,166	1,742	662	481
tss load storm (kg/ha)	605	330	1,114	1,605	631	467
tss load base (kg/ha)	14	25	52	137	30	14
tss conc. base (mg/l)	7	7	44	43	20	8
p load (kg/ha)	1.89	1.96	2.14	3.55	1.73	0.97
p storm load (kg/ha)	1.68	1.53	1.98	3.20	1.71	0.81
p load base (kg/ha)	0.21	0.43	0.16	0.36	0.02	0.16
p base conc. (mg/l)	0.11	0.11	0.14	0.11	0.01	0.09
DISCHARGE (m³)	565,760,474	43,096,381	60,308,416	726,401,938	182,387,037	535,880,146
DISCHARGE/AC (m³/ha)	3,799	6,065	6,710	6,807	5,968	3,926

Figure 3 Comparison of seven watersheds

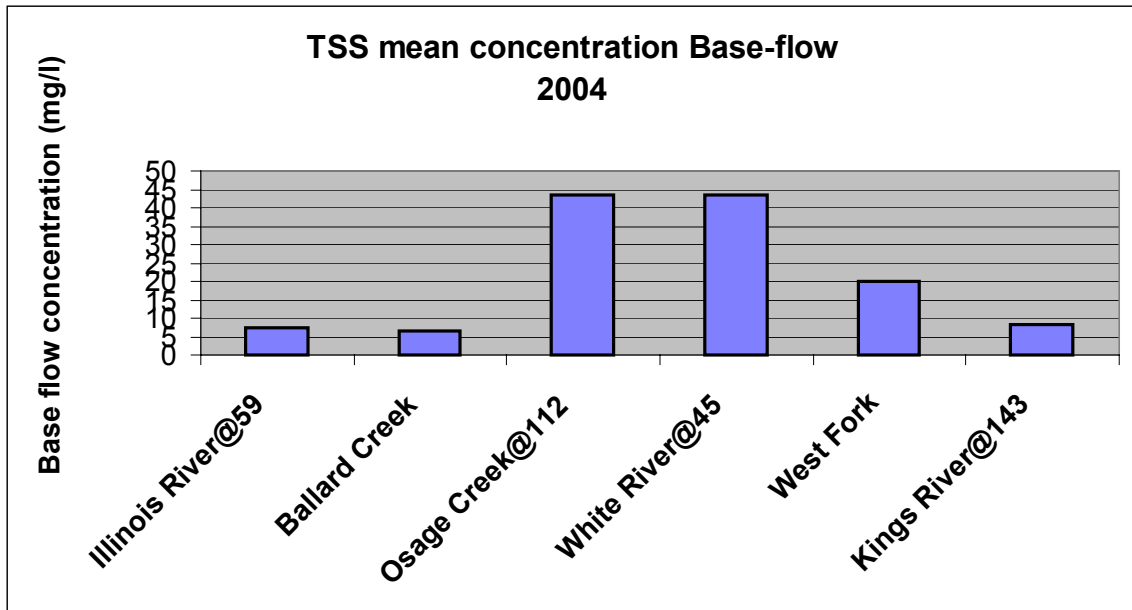
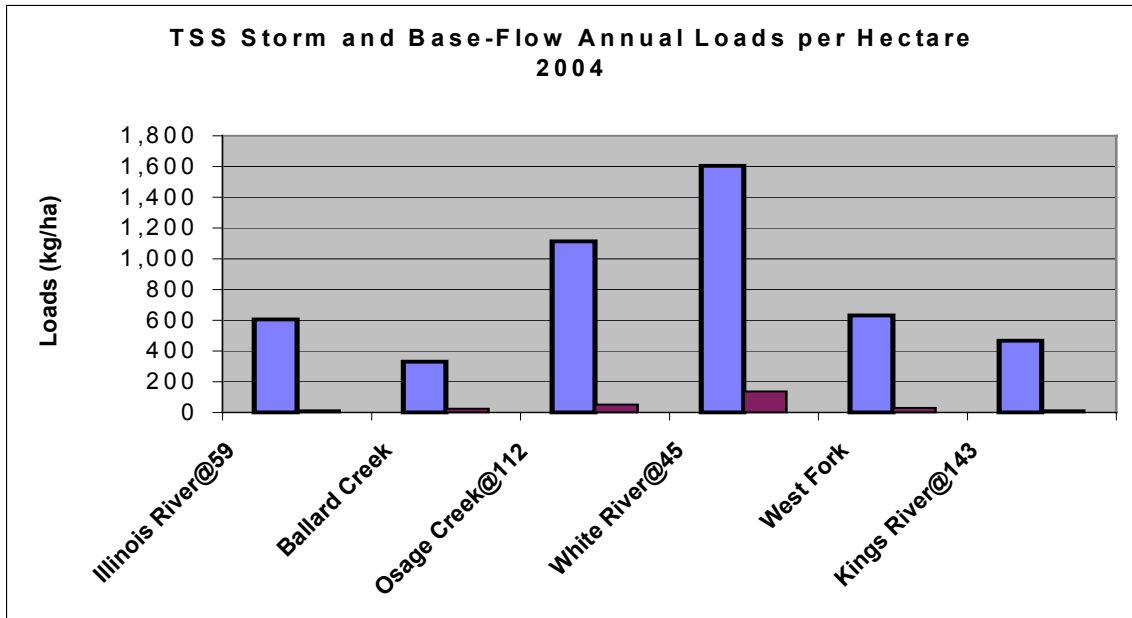
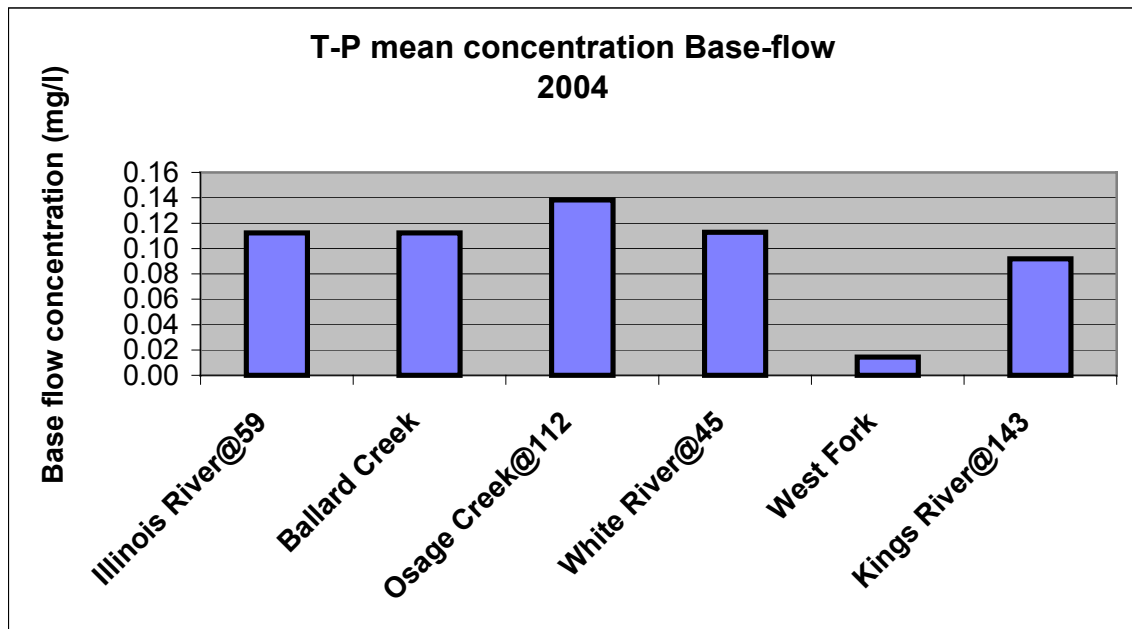
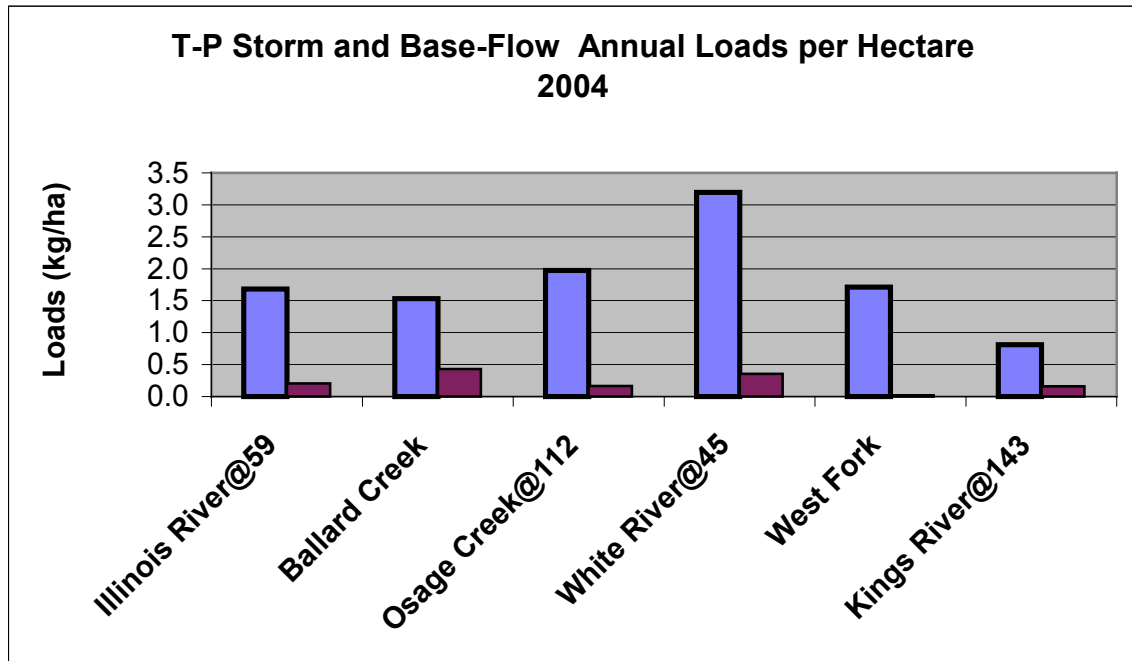


Figure 3 (continued).



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