6-1-2006

Water Quality Sampling, Analysis and Annual Load Determinations for TSS, Nitrogen and Phosphorus in the Bayou Bartholomew at Garrett Bridge, Arkansas and Near Portland, Arkansas

Marc Nelson

Wade Cash

Keith Trost

Jennifer Purtle

Ralph Davis

See next page for additional authors

Authors
Marc Nelson, Wade Cash, Keith Trost, Jennifer Purtle, Ralph Davis, and K. Steele

Arkansas Water Resources Center

WATER QUALITY SAMPLING, ANALYSIS AND ANNUAL LOAD DETERMINATIONS FOR TSS, NITROGEN AND PHOSPHORUS IN THE BAYOU BARTHOLOMEW AT GARRETT BRIDGE, ARKANSAS AND NEAR PORTLAND, AR

Submitted to the
Arkansas Natural Resources Commission

Prepared by:

Marc Nelson, Wade Cash, Keith Trost and Jennifer Purtle
Arkansas Water Resources Center
Water Quality Lab
R. Davis, K. Steele
Geosciences Department
University of Arkansas
Fayetteville, Arkansas 72701

MSC-330

June 2006

ARKANSAS WATER RESOURCES CENTER
UNIVERSITY OF ARKANSAS
112 OZARK HALL
FAYETTEVILLE, ARKANSAS 72701

WATER QUALITY SAMPLING, ANALYSIS AND ANNUAL LOAD DETERMINATIONS FOR TSS, NITROGEN AND PHOSPHORUS IN THE BAYOU BARTHOLOMEW AT GARRETTT BRIDGE, AR AND NEAR PORTLAND, AR

2005 Annual Report

Presented to:
Arkansas Natural Resources Commission

By:

Marc Nelson, Wade Cash, Keith Trost and Jennifer Purtle
Arkansas Water Resources Center
AWRC Water Quality Lab
R. Davis, K. Steele
Geosciences Department
University of Arkansas
Fayetteville, Arkansas 72701

MSC-330

June 2006

SUMMARY

Calculated load and mean concentrations for Garrett Bridge 2005

	Loads (kg)	Flow-weighted Mean Concentrations (mg/l)
Discharge (m3)	297,639,036	
No3+No2-N	93,639	0.31
T-P	95,041	0.32
NH4-N	58,005	0.19
TN	246,880	0.83
PO4	29,409	0.10
TSS	14,678,709	49.32

Calculated loads and mean concentrations for Portland 2005.

	Load (kg)	Flow-weighted mean Concentration (mg/l)
Discharge (m3)	789,867,748	
No3&No2-N	128,103	0.16
T-P	212,469	0.27
NH4	64,540	0.08
TN	531,347	0.67
PO4	84,427	0.11
TSS	11,713,152	14.83

INTRODUCTION

Water quality sampling stations were installed at the Bayou Bartholomew at Garrett Bridge, AR and near Portland, AR. These stations are coordinated with USGS gauging stations at the same locations. These stations are instrumented to collect samples at sufficient intervals across the hydrograph to accurately estimate the flux of total suspended solids, nitrogen and phosphorus in the River. Bayou Bartholomew watershed is about 437,000 hectares and is located in the south east corner of the state. The land use in the watershed is mostly in forest and cropland agriculture with some urban area. High turbidity levels and excessive silt loads in the streams are problems in this watershed. The reason for high turbidity levels and silt loads are thought to be row crop agriculture. 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 continued water quality sampling, water sample analysis and annual pollutant load calculations at the Bayou Bartholomew at Garrett Bridge, AR and near Portland, AR. The Garrett Bridge site drains about 98,000 hectares and the Portland site drains an unknown area about 2 to 3 times larger than the Garrett Bridge site. The Garrett Bridge site is a full storm-water sampling station with auto-sampler and data sonde. The Portland site has a data sonde only. These stations were installed in August 2004 and began operation in January 2005. The parameters measured from collected samples are nitrate-nitrogen, ammonia-nitrogen, total nitrogen, total phosphorus, dissolved reactive phosphorus and total suspended solids. In addition turbidity, conductivity and pH will be measured in-situ and recorded in sixty-minute intervals. AWRC and ADEQ will collect samples and analyze the data from the water quality sampling stations, compute the annual loads for all parameters and report annually to the ASWCC. This report is for calendar year 2005.

Figure 1. Garret Bridge site.

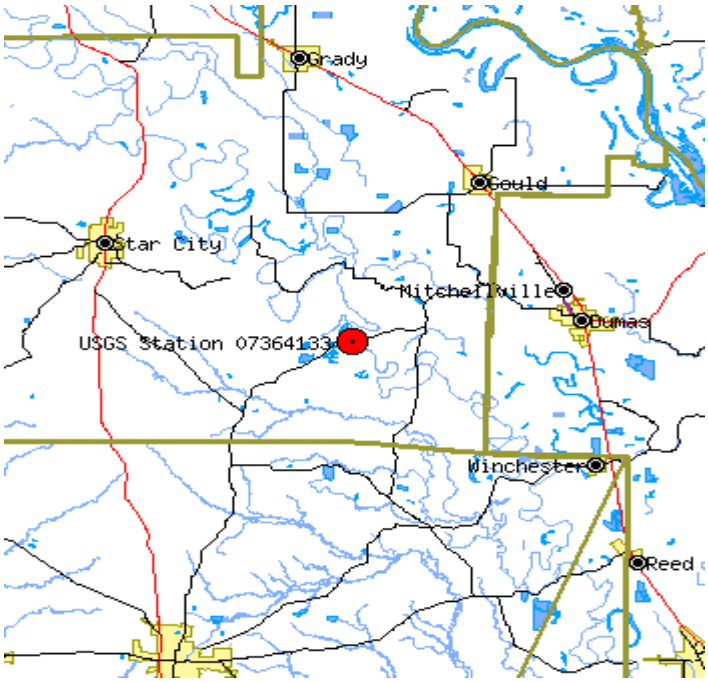
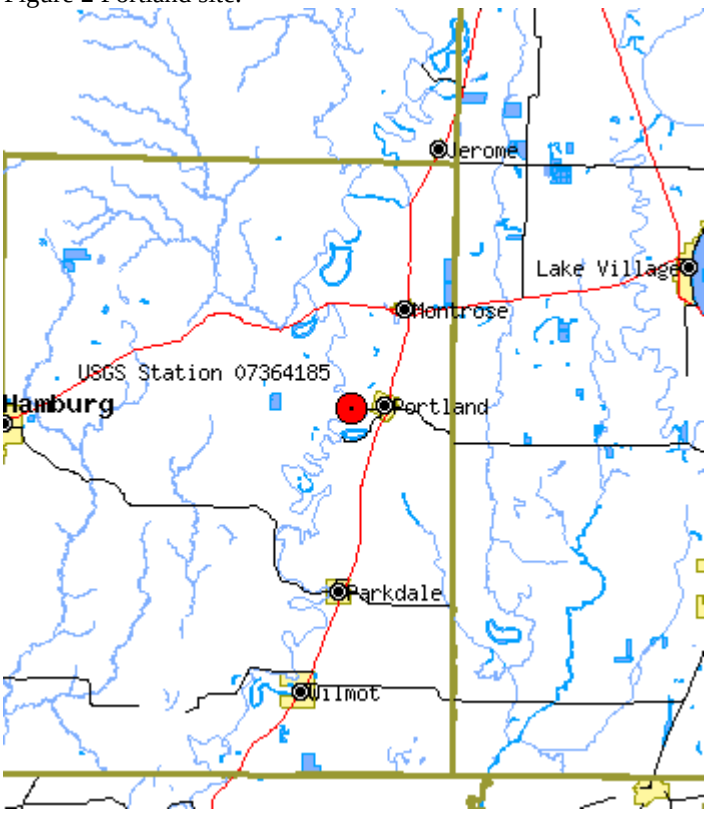


Figure 2 Portland site.



METHODS

The Garrett Bridge site is a full storm-water sampling station. It uses an automatic sampler to collect storm water samples as well as a data sonde to collect continuous turbidity and conductivity information. The Portland site is instrumented with a data sonde measuring turbidity and conductivity. There were grab samples collected every two weeks at both sites.

Initially, the sampler was operated in a discrete mode, taking timed discrete samples during two storm events. 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 two storms were adequately sampled. The results from this initial sampling phase were used to determine the sampling start (trigger) and frequency for flow-weighted composite sampling. In addition, the results were 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 was not set to a fixed value. It was determined that there was no consistent base-flow, just rising and falling stages. Therefore, a variable storm trigger was used and the value was set at each grab sample to just above the stage. Composite samples were not collected due to problems with the USGS DCP, which did not allow us to collect samples based on discharge volume. Discrete storm samples were collected. All samples were collected by ADEQ personnel and transported to the AWRC Water quality Laboratory for analysis. All samples were analyzed for nitrate/ nitrite-nitrogen, ammonia-nitrogen, total nitrogen, total phosphorus, dissolved reactive phosphorus, turbidity, conductivity and total suspended solids.

RESULTS

There were 171 samples collected and analyzed at Garrett Bridge. There were 26 grab samples, 2 duplicates, 1 match, 2 blanks and 140 storm discrete samples. Figure 3 and table 1 summarize the data collected and the resulting loads for Garrett Bridge.

Figure 3 Sampling results for Garrett Bridge 2005

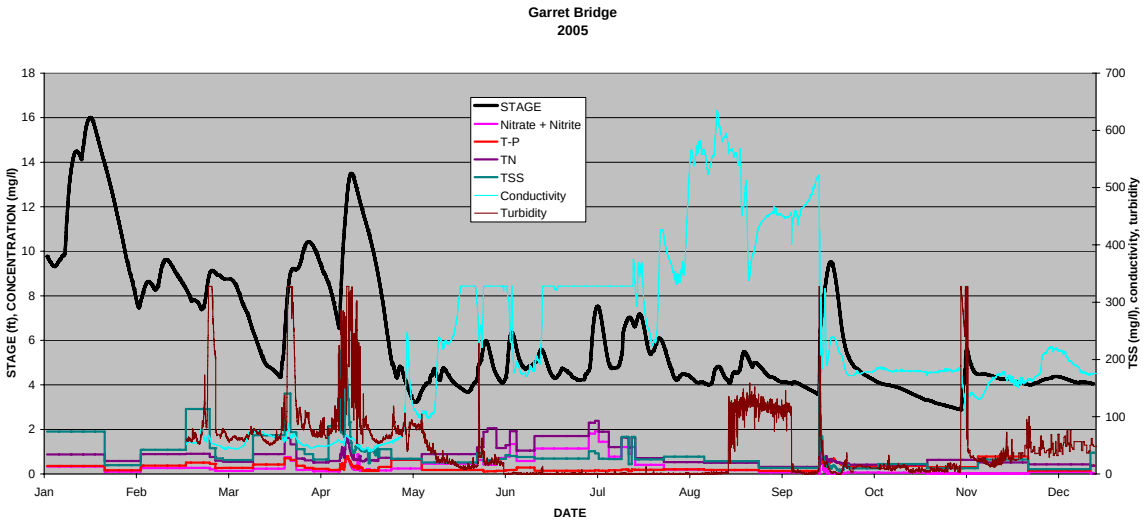


Table 1 Calculated load and mean concentrations for Garrett Bridge 2005

	Loads (kg)	Flow-weighted Mean Concentrations (mg/l)
Discharge (m3)	297,639,036	
No3+No2-N	93,639	0.31
T-P	95,041	0.32
NH4-N	58,005	0.19
TN	246,880	0.83
PO4	29,409	0.10
TSS	14,678,709	49.32

Discrete samples during two storm events were used to calculate regression equations relating stage to concentrations. These equations can be used to estimate concentrations for inadequately sampled storm events. The resulting equations and regression coefficients are shown in table 4. The equations are a very poor fit to the data for all parameters as evidenced by the low coefficients. As a result, flow-weighted mean concentrations measured during the storm event on April 11 were used instead of the regression equations to estimate the concentrations during a storm event that began on January 7 and ended on January 20.

Table 2 Regression equations for Garrett Bridge

	regression equation	Regression coefficient
No3+No2-N	y=0.0275x + 0.0122	0.0766
ammonia-N	y=0.0275x + 0.0122	0.105
total N	y=0.0285x+0.5438	0.0332
total P	y=).0364x - 0.0635	0.1444
Po4-P	y= 0.002x + 0.0633	0.0461

TSS	y= -6.9914x +155.35	0.0671

Turbidity and conductivity were measured in-situ using a YSI data sonde and in the lab from collected samples. Figures 4 and 5 show the results from these analyses. The maximum values for turbidity and for conductivity before July were truncated to 320 by the USGS where the data was collected and stored.

Figure 4 Turbidity measured in-situ and in the lab Garrett Bridge 2005

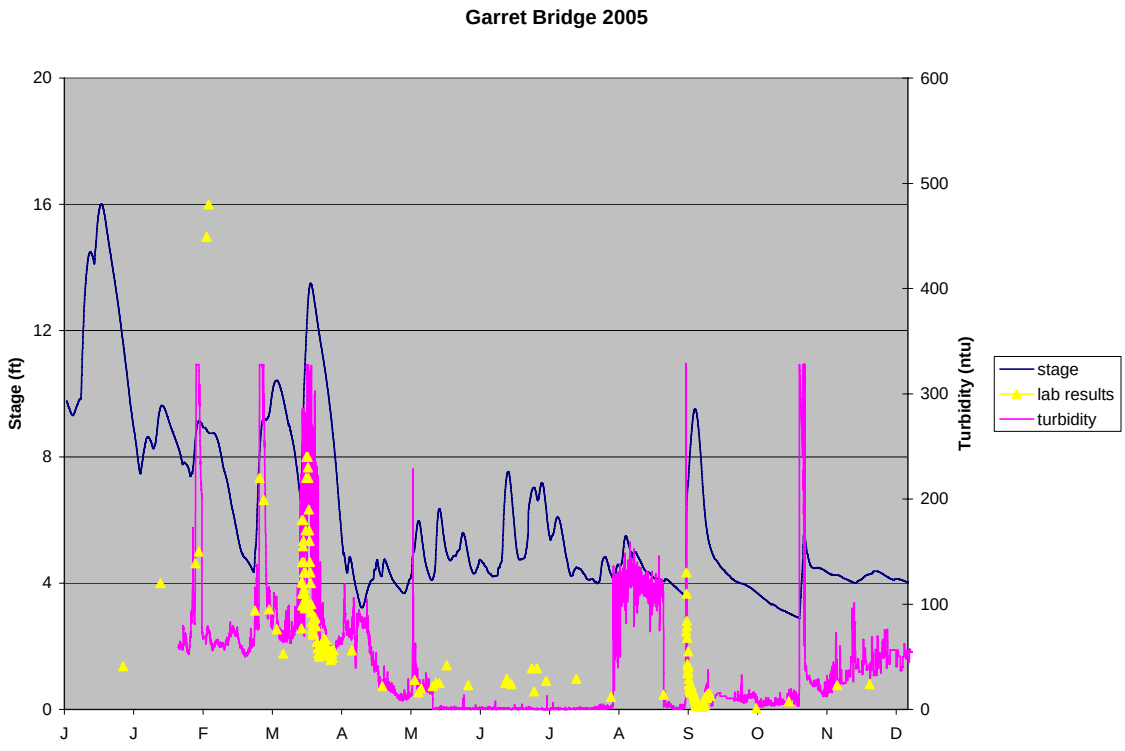
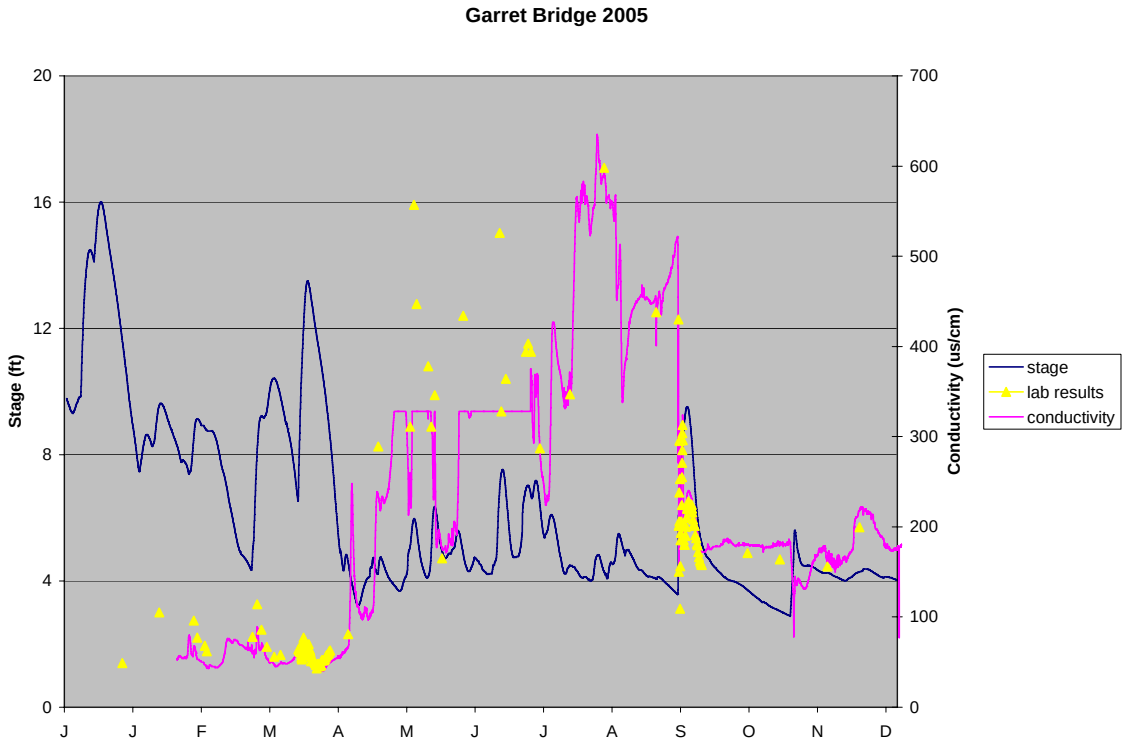


Figure 5 Conductivity measured in-situ and in the lab Garrett Bridge 2005



There were 28 samples collected at the Portland site. There were 26 grab samples and 2 duplicate samples collected. Figure 6 and table 3 summarize the results for the Portland site.

Figure 6 Sampling results for Portland 2005

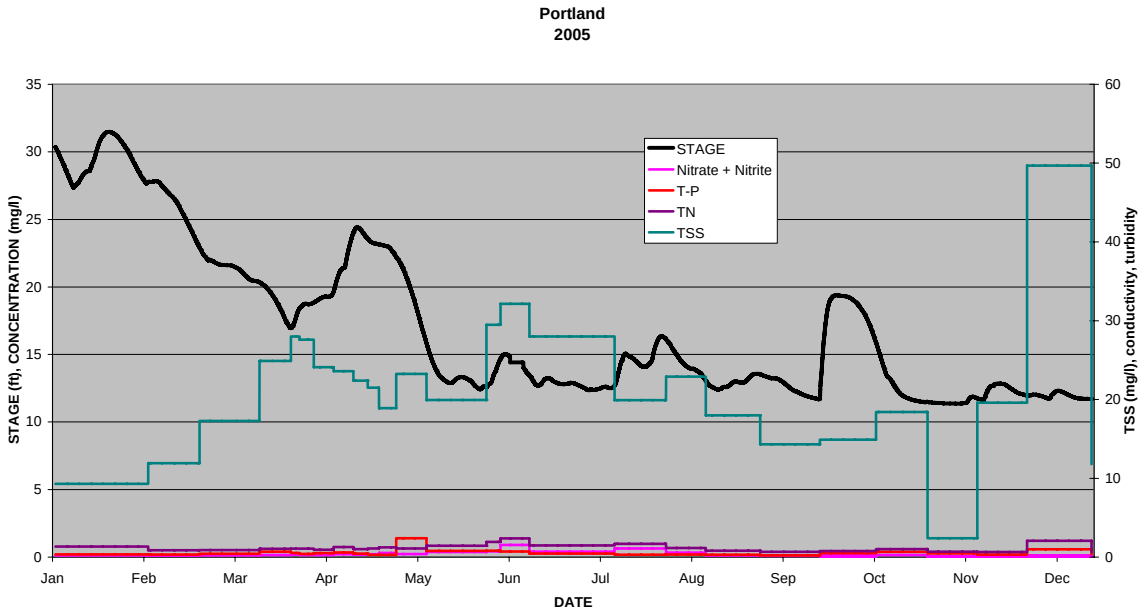


Table 4. Loads and mean concentrations for Portland 2005.

	Load (kg)	Flow-weighted mean Concentration (mg/l)
Discharge (m3)	789,867,748	
No3&No2-N	128,103	0.16
T-P	212,469	0.27
NH4	64,540	0.08
TN	531,347	0.67
PO4	84,427	0.11
TSS	11,713,152	14.83

Turbidity and conductivity were measured in-situ using a YSI sonde and in the lab from collected samples. These results are shown on figures 7 and 8. Values were truncated at 320 by the USGS data system. Both probes were out of the water at times during the year.

Figure 7 Turbidity measured in-situ and in the Lab-Portland 2005

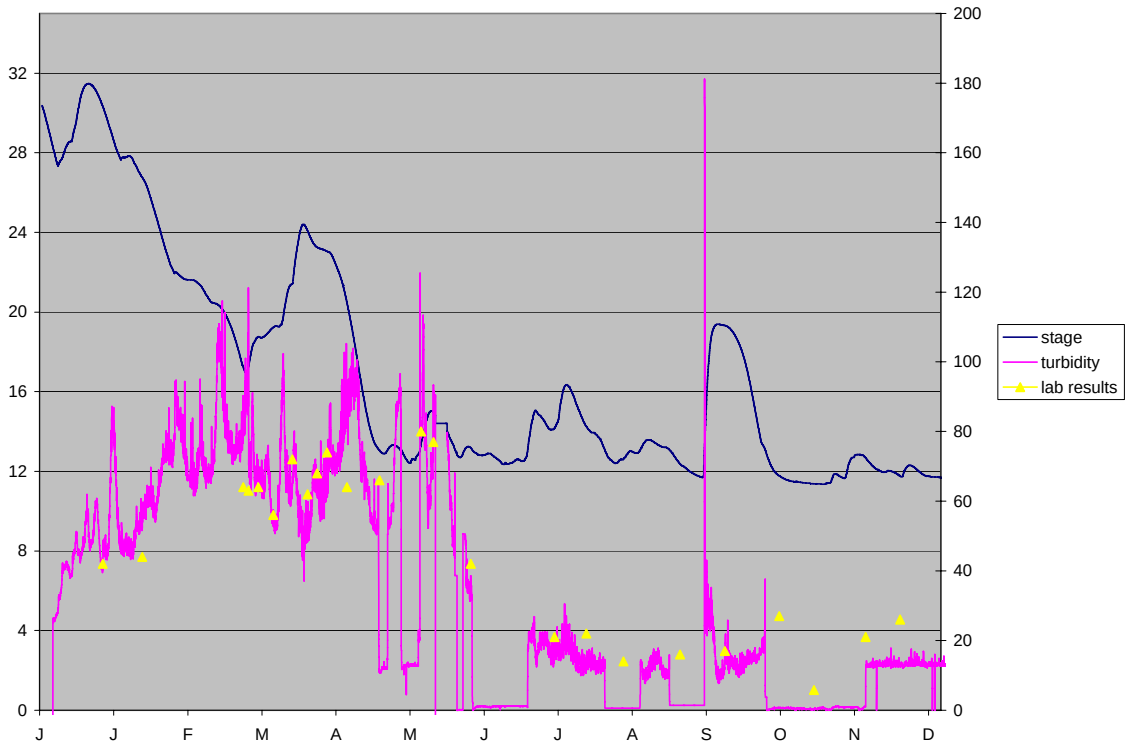
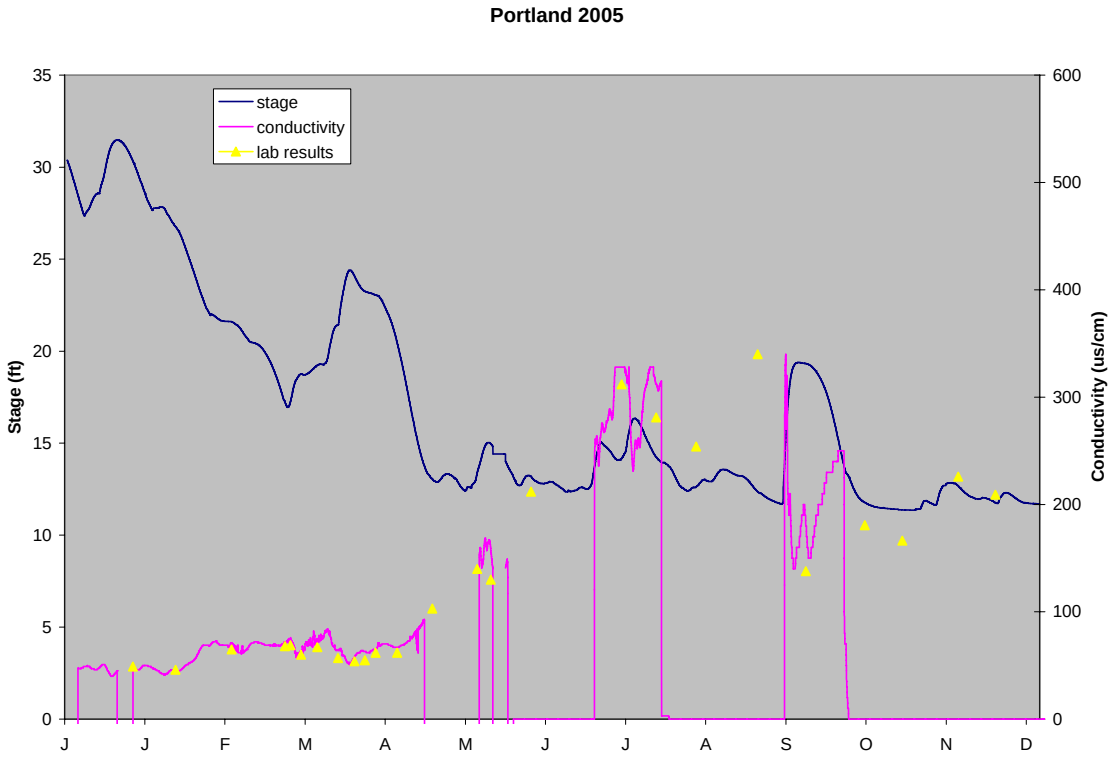


Figure 8 Conductivity measured in-situ and in the lab - Portland 2005



The Garrett Bridge results can be compared to monitoring results from 7 Northwest Arkansas (NWA) watersheds. The watersheds in NWA are not directly comparable to the Bayou Bartholomew because of numerous differences such as ecoregion, land use, morphology and watershed size. However, if all are results are normalized by dividing by watershed area; the results can be compared with caution. The comparison values are listed in table 5.

Table 5 Comparison between average values for Garrett Bridge and 7 Northwest Arkansas Watersheds.

	Average of 7 NWA watersheds	Garrett Bridge
Hectares	67,925	98,000
years of data	4	1
tss load (kg/ha)	587	150
p load (kg/ha)	1.62	0.97
total nitrogen load (kg/ha)	9.48	2.5
discharge/area (m^3/ha)	4,092	3,037

REFERENCES

Nelson, M.A., L.W. Cash "Water Quality Sampling, Analysis And Annual Load Determinations For TSS, Nitrogen And Phosphorus on the L'Anguille River near Palestine, AR., 2004 Annual Report" Arkansas Water Resources Center Publication, 2005.

Nelson, M.A., L.W. Cash "Water Quality Sampling, Analysis And Annual Load Determinations For TSS, Nitrogen And Phosphorus At The 143 Bridge On The Kings River, 2005 Annual Report" Arkansas Water Resources Center Publication, 2006.

Nelson, M.A., L.W. Cash "Water Quality Sampling, Analysis And Annual Load Determinations For TSS, Nitrogen And Phosphorus on Ballard Creek, 2005 Annual Report" Arkansas Water Resources Center Publication, 2006.

Nelson, M.A., L.W. Cash "Water Quality Sampling, Analysis And Annual Load Determinations For TSS, Nitrogen And Phosphorus on the West Fork, 2005 Annual Report" Arkansas Water Resources Center Publication, 2006.

Nelson, M.A., L.W. Cash "Water Quality Sampling, Analysis And Annual Load Determinations For TSS, Nitrogen And Phosphorus on the White River at the 45 Bridge, 2005 Annual Report" Arkansas Water Resources Center Publication, 2006.