PRIDE Water Quality Assessment Report: IV. Nutrient Assessment

By

The Kentucky Water Resources Research Institute
University of Kentucky

For

PRIDE

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ABSTRACT

The efficient utilization of federal funds in improving the water quality and aquatic habitat of the region requires a mechanism for assessing and evaluating the impacts of the proposed and ongoing projects as well as some mechanism for prioritizing the allocation of additional funds. In order to evaluate the effectiveness of these projects it is important to provide a formal monitoring and assessment program based on sound scientific principles. This report provides an initial 10 year baseline assessment of the existing water quality conditions in the 40 county PRIDE region for the purpose of evaluating the impacts of the PRIDE programs in the region and the extent to which such programs are satisfying their stated objectives of cleaning up the region's rivers and streams. A general assessment of the associated environmental problems and programs in the region can be found in the companion reports: *PRIDE Water Quality Assessment Report I: Problems and Programs* while recommendations for additional monitoring station locations is provided in *PRIDE Water Quality Assessment Report III: Existing and Proposed Monitoring Network.*

Because of the spatial and cumulative impacts of multiple projects within a region, it is best that project impacts be evaluated on a composite or watershed basis. In using such an approach, it is important that an appropriate assessment scale be selected that maintains a balance between the ability to quantify the impacts of local projects and the ability to effectively monitor a larger number of sites. In consideration of both issues, the various projects within the PRIDE counties were evaluated both on a county basis and on an 8-digit watershed basis. In order to evaluate the water quality conditions in the PRIDE region, some type of assessment parameters are required. In general, such assessment parameters may be subdivided into nutrient, chemical, biological, and habitat parameters. For this study, these parameters included measurements of ammonia, total phosphorus, pH, fecal coliform, macro-invertebrates, and general aquatic habitat. A summary of the later four parameters are provided in the report *PRIDE Water Quality Assessment Report II: Chemical, Biological, and Habitat Assessments.* A summary of the ammonia and phosphorus parameters are provided in this report.

In an attempt to provide a historical baseline of nutrient data in the region, a data query of the EPA STORET and USGS Water Quality databases were performed for those counties within the PRIDE region. These data were augmented by samples as collected by the Kentucky Watershed Watch Program.

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1.0 INTRODUCTION

The PRIDE (Personal Responsibility in a Desirable Environment) initiative was first announced by U.S. Congressman Harold "Hal" Rogers and Natural Resources and Environmental Protection Cabinet Secretary James Bickford in 1997. PRIDE is the first comprehensive, region-wide, local/state/federal cooperative effort designed to address the serious challenge of cleaning up the region's rivers and streams. The initiative is focusing on 40 separate counties located in the southeastern part of Kentucky that form the headwaters for the Big Sandy, Licking, Kentucky, Green and Cumberland river basins. Also included in the region are small segments of the Salt and Little Sandy river basins (see Figure 1.1). Since it’s formation in 1997, PRIDE has been responsible for the funding of numerous projects in the 40 PRIDE counties, many of which focus on the elimination of straight pipes and the upgrading of wastewater treatment plants. Since 1997, PRIDE and PRIDE-related projects have received almost $70,000,000 in federal funding and the PRIDE program itself has received $26,000,000 in funding through the U.S. Department of Commerce and the National Oceanic and Atmospheric Administration in support of the continuing aquatic resources environmental initiative. These funds have been used to support various initiatives including: 1) the PRIDE community grant program, 2) the PRIDE environmental education grant program, and 3) the PRIDE septic system loan program. In addition to the $26,000,000 in direct funds to PRIDE, additional PRIDE-related projects have been funding by the U.S. Army Corps of Engineers (COE) and the U.S. Environmental Protection Agency (EPA).

The efficient utilization of federal funds in improving the water quality and aquatic habitat of the region requires a mechanism for assessing and evaluating the impacts of the proposed and ongoing projects as well as some mechanism for prioritizing the allocation of additional funds. In order to evaluate the effectiveness of these projects it is important to provide a formal monitoring and assessment program based on sound scientific principles. This report provides an initial 10 year baseline assessment of the existing water quality conditions in the 40 county PRIDE region for the purpose of evaluating the impacts of the PRIDE programs in the region and the extent to which such programs are satisfying their stated objectives of cleaning up the region’s rivers and streams.

1.1 Physiographic Regions

The PRIDE region contains six major physiographic regions: the Eastern Coal Field, the Eastern Pennyroyal, the Inner Blue grass, the Knobs, the Outer Blue Grass, and the Western (see Figure 1.2). Each of these regions is topographically distinct and reflects the underlying geology (see Figure 1.3). The oldest exposed rocks are limestone of Ordovician age. They contain a few layers of shale and siltstone and form the surface of the Bluegrass Region. The Devonian and Silurian rocks are exposed in the Knobs surrounding the Bluegrass Region which provide a transition to the Mountain Region in the southeast and the Pennyroyal region to the south and southwest. Surface rocks in the Pennyroyal are of Mississippian age, mainly limestone but with some shales, siltstone, and sandstones. Pennsylvanian rocks are found at the surface in the Eastern Kentucky

Coal Field which roughly corresponds to the Mountain Region. Pennyslyvanian rocks, consist mainly of sandstones, conglomerates, shale, and coal.

Soils in the region are largely influenced by the underlying geology and the associated physiographic regions. Almost all soils in Kentucky, with the exception of stream deposits, have developed under forest cover and under essentially the same climate. The various combinations of parent material, topography, and time of exposure may be expressed by dividing the region into 6 separate major soil association areas that roughly correspond to the same physiographic regions discussed earlier (see Figure 1.2). As can be seen from the figure, the dominant areas are the Eastern Pennyroyal and the Eastern Coal Fields. The Pennyroyal area is made up of the Waynesboror-Baxter-Gramon-Bedford soils series while the soils in the Eastern Coal Fields are made up of the Shelocta-Jefferson-Rarden-Weikert soil series. In general, the soils which make up the Licking and Big Sandy River basins are severely limited for the land application of wastewater.

1.2 Geographical Assessment Units

Because of the spatial and cumulative impacts of multiple projects within a region, it is best that project impacts be evaluated on a county or watershed basis. In using such an approach, it is important that an appropriate assessment scale be selected to maintain a balance between the ability to quantify the impacts of local projects and the ability to effectively monitor a larger number of sites. In consideration of both issues, the various projects within the PRIDE counties have been evaluated both on a county basis and on a watershed basis. In evaluating the projects on a watershed basis, the 8-digit HUC watersheds will be used as identified using the U.S. Geological Survey Hydrologic Unit Code (HUC) system. The HUC code is a multi-digit integer that is used to identify a particular watershed. A map of the various watershed assessment units that encompass the PRIDE region along with the associated county boundaries is shown in Figure 1.4.

In future years, additional refined assessments will be performed at the 11-digit HUC level. A map of the 11-digit HUC watersheds that encompass the PRIDE region is shown in Figure 1.5. It should be emphasized that use of the 11-digit watershed assessment scale is consistent with the Kentucky Watershed Management Framework Initiative, and will provide a strong synergism between the two programs. Previous and ongoing monitoring results from the Watershed Management Framework may be used to help support an assessment of the PRIDE projects. Use of a 11-digit HUC scale will provide the basis for the development of detailed watershed models that can be used to evaluate proposed and ongoing PRIDE projects more accurately as well as be used in the formulation of detailed watershed management plans as envisioned as part of the overall Watershed Management Framework Initiative.

1.3 Assessment Strategy

In using monitoring; physical, chemical, and bacteriological parameters of a watershed may be measured in an attempt to assess the existing baseline conditions of a stream or to assess or predict the impacts of subsequent remediation efforts or projects. As a result of the topography and terrain of eastern Kentucky, stream water quantity and quality can change dramatically over short periods of time. These changes can be due to weather effects (such as rapid changes in precipitation) or to human activities like water removals, water inputs, or intermittent pollutant inputs. As a result, it is best to monitor water quality and flow continuously. Unfortunately, implementation of a continuous water quality and flow monitoring program for the over 200 11-digit HUC watersheds within the PRIDE region would be cost-prohibitive. However, by using a general region-wide monitoring effort coupled with a detailed watershed monitoring and modeling effort, calibrated models of selected watersheds may be developed which can then be extrapolated to the remaining basins on the basis of similarity of topography, land use, soils, and the density of straight pipes and other pollutant sources. Such models can then be used to predict the impacts of aggregate projects and guide in the targeting of more detailed sampling efforts.

The impacts of the PRIDE projects will be evaluated using both a geo-political basis (i.e. by counties) as well as a geo-hydrologic basis (i.e. by watersheds). The watershed assessment will involve a two-tier approach: 1) an annual region-wide assessment at the 8-digit HUC level, and 2) a more targeted river watershed assessment at the 11 digit HUC level rotated through each major river basin in the region over a five year rotating cycle (see Table 1.1). This approach is consistent with the National EPA watershed management approach and will directly support the goals and objectives of that program.

1.4 Kentucky Water Quality Standards

Water quality impacts within the PRIDE region will be evaluated on the basis of compliance with the Kentucky Water Quality Standards. KRS 224.10-100 requires the Kentucky Natural Resources and Environmental Protection Cabinet to develop and conduct a comprehensive program for the management of water resources and to provide for the prevention, abatement, and control of water pollution. This administrative regulation and 401 KAR 5:002, 5:026, 5:029, and 5:030 establish procedures to protect the surface waters of the Commonwealth, and thus protect water resources. This administrative regulation establishes water quality standards which consist of designated legitimate uses of the surface waters of the Commonwealth and the associated water quality criteria necessary to protect those uses. These water quality standards are minimum requirements that apply to all surface waters in the Commonwealth of Kentucky in order to maintain and protect them for designated uses.

1.5 Kentucky Water Quality Criteria

Kentucky's Water Quality Criteria are based on the designated use of the stream. Both general and separate criteria and limits for various physiochemical constituents or indicators have been developed for the following general categories: 1) Aquatic Life (both warm water and cold water habitats), 2) Water Based Recreation (both primary and secondary contact), 3 Domestic Water Supply, and 4) Outstanding State Resource Waters. In addition to water quality criteria based on these designated use categories, the Regulations also provide criteria for protection against constituent contamination from fish consumption.

1.6 Designated Uses

Kentucky lists water bodies (i.e. rivers, streams, lakes) according to specific uses in its water quality standards regulations. These uses include Warm Water Aquatic Habitat (WWAH), Cold Water Aquatic Habitat (CWAH), Domestic Water Supply (DWS), Primary Contact Recreation (PCR), Secondary Contact Recreation (SCR), and Outstanding Resource Waters (ORW). Those waters not specifically listed are classified (by default) for use as Warm water aquatic habitat, Primary and Secondary Contact Recreation, and Domestic Water Supply.

1.7 Kentucky 305(b) Report

Section 305(b) of the Federal Water Pollution Control Act of 1972 (P.L. 92-500), as subsequently amended and commonly known as the Clean Water Act, requires that states submit to the U.S. Environmental Protection Agency (EPA) on a biennial basis a report assessing current water quality conditions. The water quality assessment of rivers and streams is based on the support of designated uses in state waters depicted on U.S. Geological Survey (USGS) 1:100,000 scale topographic maps, excluding the Mississippi River.

In evaluating the extent to which the streams in the State are supporting their designated uses, Kentucky employs four assessment classes: 1) aquatic life (which focuses on warm water aquatic habitat), 2) fish consumption (which serves as a measure of compliance with the fish consumption criteria), 3) swimming (which represents the most restrictive of the primary and secondary contact recreation designated uses), and 4) drinking water. Different assessment methods are used to determine the use support for each class. In general, the assessment methods employ both physiochemical and biological data.

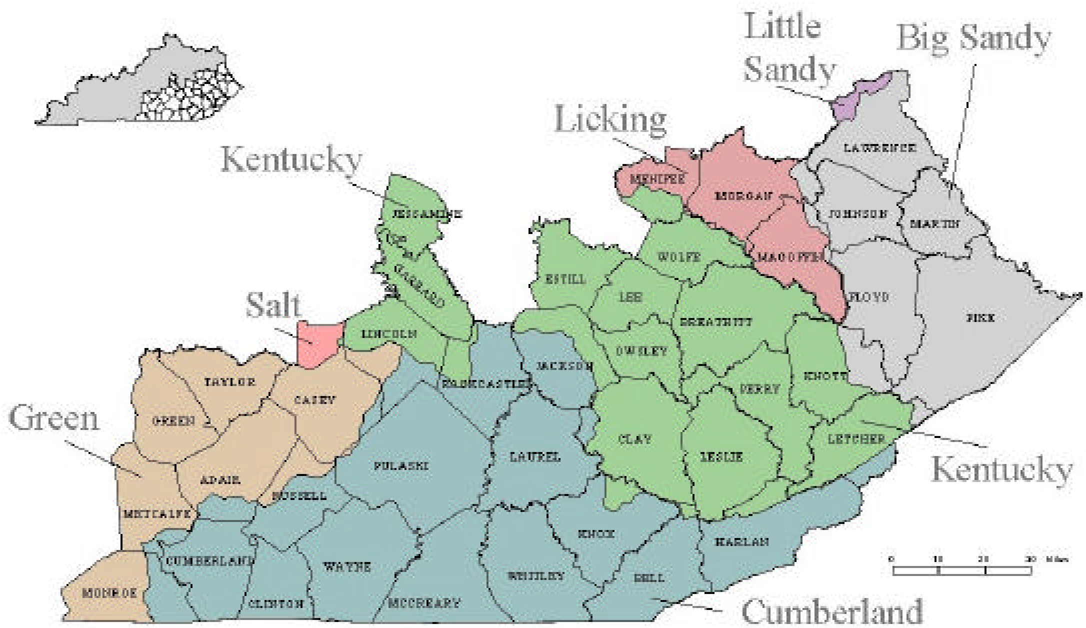

Figure 1.1 Counties and Major River Basins Located Within the PRIDE Region

Figure 1.1 Counties and Major River Basins Located Within the PRIDE Region

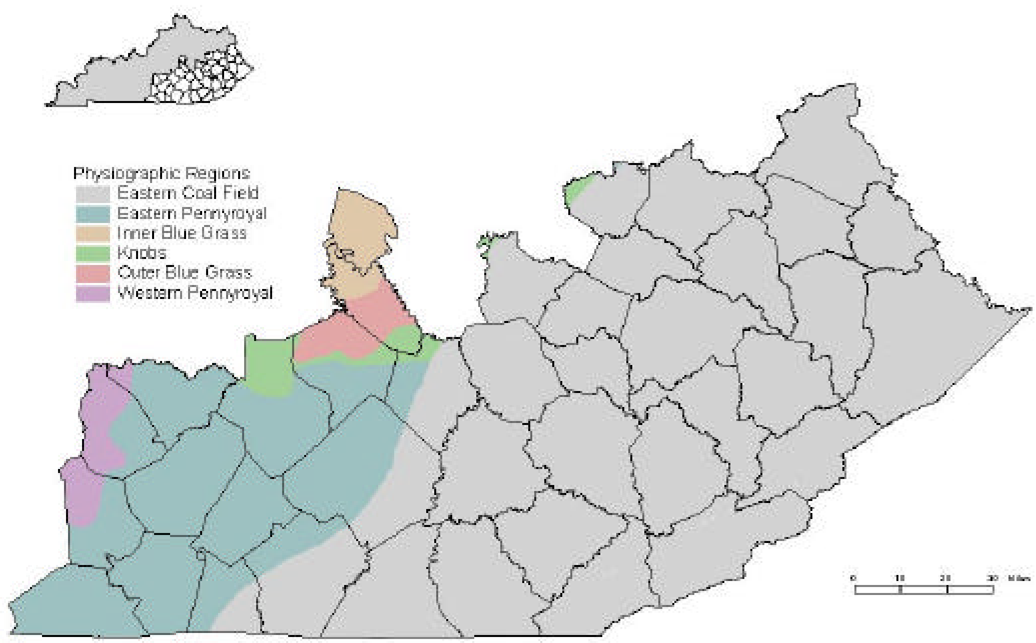

Figure 1.2 Physiographic Regions within the 40-County PRIDE area.

Figure 1.2 Physiographic Regions Within the PRIDE Region

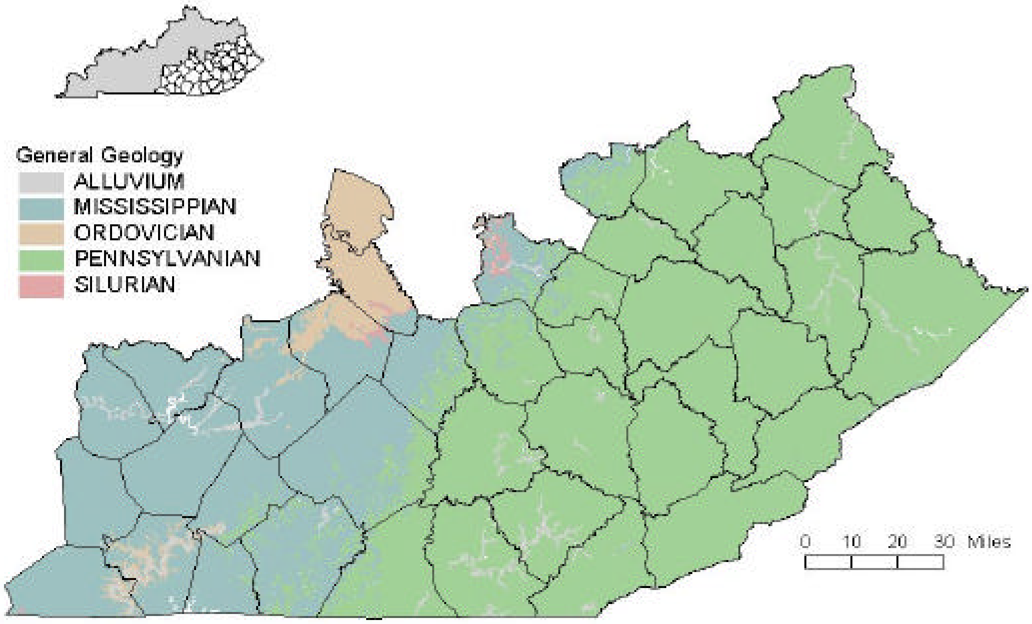

Figure 1.3 General Geologic Map of the PRIDE Region

Figure 1.3 Geologic Regions within the PRIDE Region

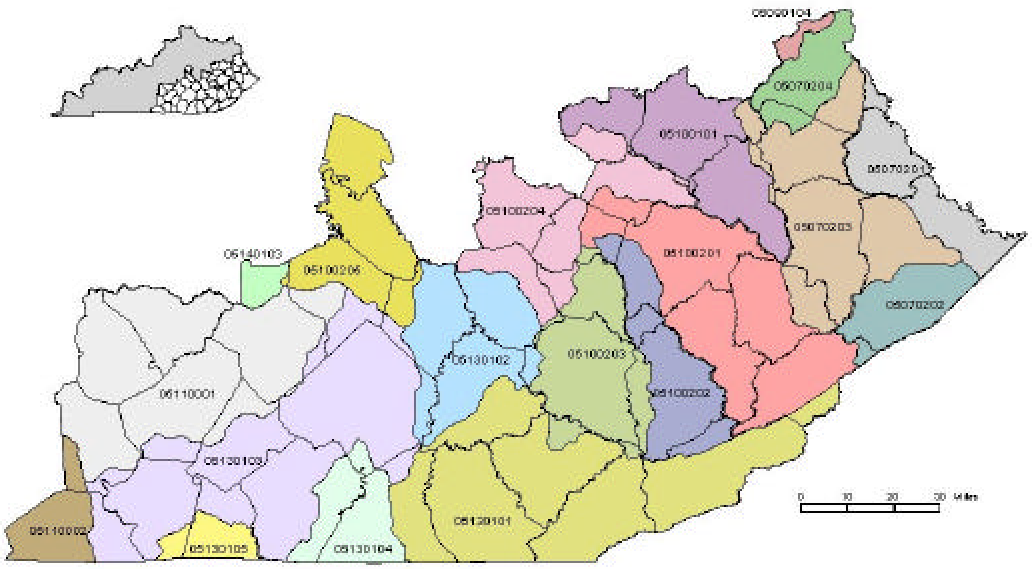

Figure 1.4 8-Digit Watersheds Located Within the PRIDE Region (with County Lines)

Figure 1.4 8-Digit Watersheds Within the PRIDE Region

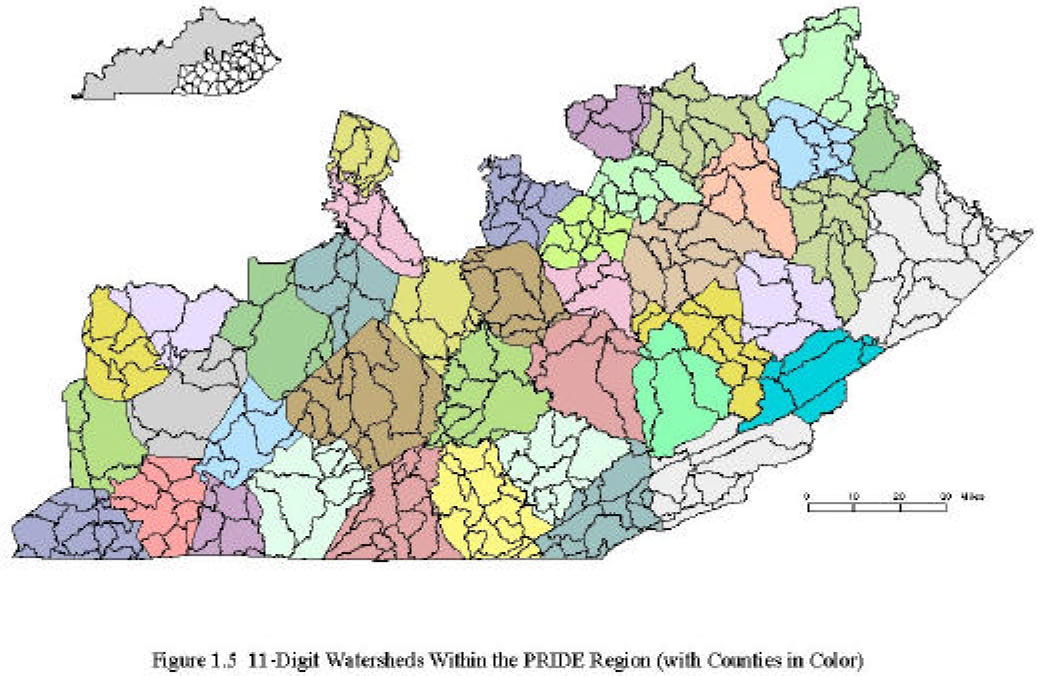

Figure 1.5 11-Digit Watersheds Within the PRIDE Region

Based on a stream's designated use, the stream may be classified as 1) fully supporting, 2) partially supporting, or 3) not supporting. Overall use support of a particular stream is determined by following EPA guidelines that define fully supporting as fully supporting all uses for which data are available. If a segment supports one use but not another, it is listed as not supporting. For instance, if a segment supports a warm water aquatic habitat use but not a primary contact recreation use, it is listed as not supporting. A segment is listed as partially supporting if any assessed use falls into that category even if another use was fully supported. Many waterbodies are assessed for only one use because data were not available to assess other uses. Those streams within the PRIDE area that did not meet the criteria for one or more of their assessment classes (generally their designated use) in 1998 are shown in Figure 1.6. A summary of each of the assessment classes are discussed in the following sections.

1.7.1 Aquatic Life Use Support

Aquatic Life use support is evaluated using both water quality and biological data. The utilized data are categorized as either "monitored" or "evaluated." Monitored data are derived from site specific ambient surveys, targeted watershed sites, and a probabilistic macro-invertebrate network. Evaluated data are from other sources such as questionnaires to regional field personnel or from ambient surveys that were conducted more than five years ago. The criteria for assessing these data to determine use support are explained below. In areas where both chemical and biological data were available, the biological data were generally the determinant factor for establishing WAH use support status.

Physical and chemical parameters and criteria used by the Kentucky Division of Water to determine use support status are shown in Table 1.2. A stream is designated as fully supporting the Aquatic Life use when criteria for dissolved oxygen, un-ionized ammonia, temperature, and pH were not met in 10 percent or less of the samples collected. Partial support is indicated if any one criterion for these parameters was not met 11-25 percent of the time. The segment is not supporting if any one of these criteria was not met more than 25 percent of the time. Data for mercury, cadmium, copper, lead, and zinc are analyzed for violations of acute criteria listed in state water quality standards using the 1998 monitoring data. The segment fully supports its use if all criteria are met at stations with quarterly or less frequent sampling or if only one violation occurs at stations with monthly sampling. Partial support is indicated if any one criterion is not met more than once but in less than 10 percent of the samples. A segment is not supporting if criteria are exceeded in greater than 10 percent of the samples. The assessment criteria are closely linked to the way state water quality criteria were developed. Aquatic life is considered to be protected if, on the average, the acute criteria are not exceeded more than once every three years.

1.7.2 Swimming Use Support

Fecal coliform and pH data are used to indicate the degree of support for Primary Contact Recreation (swimming) use. The swimming use is considered fully supported if the criterion in Table 1.2 is met in 90 percent or more of the measurements, partially supported if the criterion was met in 89-75 percent of the measurements, and not supported if the criterion was met less than 75 percent of the time. Streams with pH below 6.0 units were judged to not support swimming use.

1.7.3 Fish Consumption Use Support

Fish consumption is a category that, in conjunction with aquatic life use, assesses attainment of the fishable goal of the Clean Water Act. Assessment of the fishable goal was separated into these two categories in 1992 because a fish consumption advisory does not preclude attainment of the aquatic life use and vice versa. Separating fish consumption and aquatic life uses gives a clearer picture of actual water quality conditions. The following criteria are used to assess support for the fish consumption use:

** Fully Supporting: No fish advisories or bans in effect.*

** Partially Supporting: "Restricted consumption" fish advisory or ban in effect for general population or a sub-population that could be at potentially greater risk (e.g., pregnant women, children). Restricted consumption is defined as limits on the number of meals consumed per unit time for one or more fish species.*

** Not supporting: "No consumption" fish advisory or ban in effect for general population, or a sub-population that could potentially be at greater risk, for one or more fish species; commercial fishing ban in effect.*

1.7.4. Drinking Water Use Support

For purposes of assessing drinking water use, federal EPA Phase II/Phase V finished water results are compared to established maximum contaminant levels (MCLs). Although not a quantitative measurement of ambient water quality, it highlights water in which certain pollutants are high enough to exceed drinking water criteria even after conventional treatment by the drinking water plant. Lacking in-stream data, EPA's 1998 305(b) report guidance recommends using the finished water data for assessing drinking water use. Because of the importance of this data, each individual watershed assessment summary includes a separate table that provides the locations of each water sources and water withdrawl point.

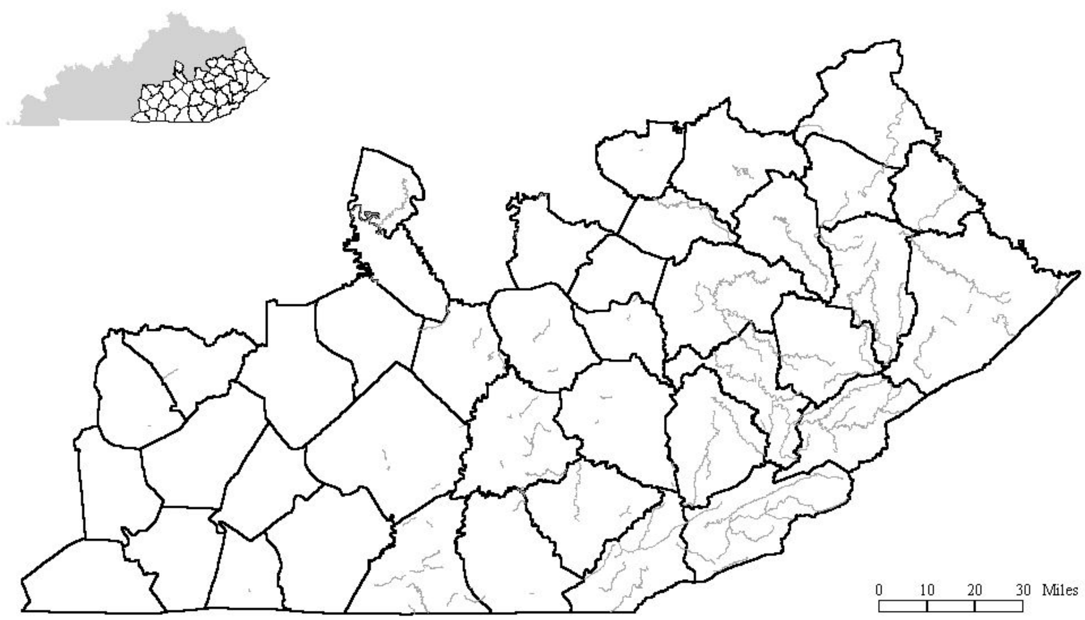

Figure 1.6 Assessed Streams in the PRIDE Region Not Fully Meeting Their Designated Uses.

Figure 1.6 Streams in PRIDE Region Not Meeting their Designated Use

Table 1.1 Watershed Assessment Cycle

Watersheds	***Assessment Year***
Kentucky	*2000-2001*
Licking/Salt	*2001-2002*
Upper Cumberland	*2002-2003*
Green	*2003-2004*
Big/Little Sandy	*2004-2005*

Table 1.2 Physical and Chemical Parameters and Criteria Used to Determine Use Support Status At Fixed Stations

Parameter	*Criterion* [a]
Dissolved Oxygen	*4.0 mg/l*
Temperature	*30^{o}C*
pH	*6 to 9 units*
Un-ionized Ammonia-N	*0.05 mg/1*
Mercury	*2.4 ug/1*
Cadmium	$e^{(1.28\ \ln x - 3.828)b}$
Copper	$e^{(.9422\ \ln x - 1.464)b}$
Lead	$e^{(1.273\ \ln x - 1.460)b}$
Zinc	$e^{(.8473\ \ln x + .8604)b}$
Fecal Coliform Bacteria	*400 colonies/100 ml (May 1 thru Oct 1)*

[a] *from Ky Water Quality Standards*
[b] *x = hardness in mg/1 as $CaCO_3$*

Table 1.3 Miles of Streams Not Meeting Their Designated Use

COUNTY	***MILES***
ADAIR	*0.00*
BELL	*68.06*
BREATHITT	*42.09*
CASEY	*0.00*
CLAY	*6.32*
CLINTON	*0.94*
CUMBERLAD	*0.00*

ESTILL	*4.33*
FLOYD	*101.88*
GARRARD	*30.56*
GREEN	*0.54*
HARLAN	*124.59*
JACKSON	*11.03*
JESSAMINE	*25.33*
JOHNSON	*26.79*
KNOTT	*54.37*
KNOX	*6.21*
LAUREL	*44.54*
LAWRENCE	*30.90*
LEE	*0.00*
LESLIE	*63.23*
LETCHER	*101.84*
LINCOLN	*3.96*
MAGOFFIN	*38.93*
MARTIN	*24.90*
MCCREARY	*57.31*
MENIFEE	*1.13*
METCALFEE	*0.00*
MONROE	*0.00*
MORGAN	*13.94*
OWSLEY	*2.02*
PERRY	*106.28*
PIKE	*93.05*
PULASKI	*7.93*
ROCKCASTE	*16.86*
RUSSELL	*0.00*
TAYLOR	*4.10*
WAYNE	*0.00*
WHITLEY	*10.69*
WOLFE	*34.55*

2.0 ENVIRONMENTAL ASSESSMENT

2.1 Assessment Parameters

In order to evaluate the water quality conditions in the PRIDE region, some type of assessment parameters are required. In general, such assessment parameters may be subdivided into chemical, biological, and habitat parameters. Previous assessments on pH, fecal coliform, and habitat parameters have been provided in the report entitled: *PRIDE Water Quality Assessment Report II: Chemical, Biological, and Habitat Assessments.* In this report, assessments are provided for both total phosphorus and ammonia.

Oxygen demanding materials and plant nutrients are the most common substances discharged to the environment by man's activities, through wastewater facilities and by agricultural, residential, and stormwater runoff. The most important plant nutrients, in terms of water quality, are phosphorus and nitrogen. In general, increasing nutrient concentrations are undesirable due to the potential for accelerated growth of aquatic plants, including algae. Nuisance plant growth can create imbalances in the aquatic community, as well as aesthetic and access issues. High densities of phytoplankton (algae) can cause wide fluctuations in pH and dissolved oxygen.

2.1.1. Phosphorus

Total phosphorus (TP) is commonly measured to determine phosphorus concentrations in surface waters. TP includes all of the various forms of phosphorus (organic, inorganic, dissolved, and particulate) present in a sample. Phosphorus is one of the key elements necessary for growth of plants and animals. Phosphates are made up of phosphorus and exist in three forms: orthophosphate, metaphosphate (or polyphosphate) and organically bound phosphate. Each compound contains phosphorous in a different chemical formula. Ortho forms are produced by natural processes and are found in sewage. Poly forms are used for treating boiler waters and in detergents. In water, they change into the ortho form. Organic phosphates are important in nature. Their occurrence may result from the breakdown of organic pesticides which contain phosphates. They may exist in solution, as particles, loose fragments or in the bodies of aquatic organisms.

Kentucky currently has no official numerical standards or criteria for total phosphorus. However, the USEPA has issued recommendations for phosphorus concentrations to prevent over-enrichment. In general, any concentration of phosphorus in excess of 0.1 mg/l has the potential to cause possible eutrophication problems in a stream. Currently, the Kentucky Division of Water is using 0.5 mg/l as a discharge guideline for new treatment plants.

2.1.2. Nitrogen

The forms of nitrogen routinely analyzed at most Kentucky ambient sampling sites are ammonia and ammonium (NH_3/NH_4), total Kjeldahl nitrogen (TKN), and nitrite and nitrate (NO_2/NO_3). Ammonia and ammonium are readily used by plants. TKN is a measure of organic nitrogen and ammonia in a sample. Nitrate is the product of aerobic transformation of ammonia, and is the most common form used by aquatic plants. Nitrite is usually not present in significant amounts.

Kentucky does have an in-stream standard in support of streams designated for aquatic life. This standard requires that the un-ionized form of ammonia shall not be greater than 0.05 mg/l at any time after in-stream mixing. Un-ionized ammonia shall be determined from values of total ammonia-N, in mg/l, pH and temperature, by means of the following equations:

$$Y = 1.2*(\text{Total Ammonia})/(1 + 10^{(pK_a - pH)})$$

Where: $pK_a = 0.0902 + (2730/(273.2 + T_c)$

T_c = temperature, degrees Celsius

Y = un-ionized ammonia (mg/l)

For the purposes of setting discharge limits for point sources, the Kentucky Division of Water assumes a summer temperature of 25 degrees celsius and a pH of 7.26. Use of these values translates into a total in-stream ammonia standard for the summer months of May thru October of 4 mg/l. For the non summer months of November thru April, the state uses an in-stream standard of 10 mg/l.

2.2 Assessment Data

Ten years of water quality data were collected from various sources for use in developing a baseline water quality assessment for the PRIDE Region. These data were obtained from the following sources: 1) EPA STORET database, 2) USGS water quality database, and 3) PRIDE supported Watershed Watch Data. A brief description of each of the data are provided in the following sections. A composite map of the nutrient monitoring stations is provided in Figure 2.1

2.2.1 EPA STORET Data

The State of Kentucky currently operates an ambient monitoring network that has been augmented through relationships with other state and federal agencies. These data are uploaded annually into the EPA STORET database. A map of the nutrient monitoring sites in the EPA STORET database is shown in Figure 2.2.

2.2.2 USGS Water Quality Data

The USGS also collects water quality data as part of various focused watershed studies. The locations of the USGS nutrient monitoring are region are shown in Figure 2.3.

2.2.3 PRIDE Watershed Watch Data

As part of the PRIDE educational grants program, PRIDE has awarded several educational grants to support volunteer sampling efforts across the PRIDE area. These grants have been awarded to five separate volunteer groups associated with the Kentucky Watershed Watch Program. The volunteer groups have been organized around 6-digit river basins and include: The Kentucky River Watershed Watch Group, The Licking River Watershed Watch Group, The Big Sandy Watershed Watch Group, The Upper Cumberland Watershed Watch Group, and the Upper Green Watershed Watch Group. A map of the five different sample regions is shown in Figure 2.4 along with the monitoring sites at which nutrient data is collected.

2.3 Assessment Analysis

Because of the spatial and cumulative impacts of multiple projects within a region, it is best that project impacts be evaluated on a composite or watershed basis. In using such an approach, it is important that an appropriate assessment scale be selected that maintains a balance between the ability to quantify the impacts of local projects and the ability to effectively monitor a larger number of sites. In consideration of both issues, the various projects within the PRIDE counties were evaluated both on a county basis and on an 8-digit watershed basis. Maps of the 19 8-digit watersheds along with their adjacent or included counties and the associated nutrient sampling locations are shown in Figures 2.5-2.23.

2.3.1 Ammonia Analysis

In an attempt to provide a historical baseline of ammonia concentrations in the region, statistical analyses of the ammonia data were performed on both a county basis and a 8-digit HUC basis. Median, maximum, and average annual spatially averaged values for each county and 8-digit HUC are provided in Tables 2.1-2.6. Individual tables and associated plots for each county and 8-digit HUC are also provided in Tables 2.7-2.XX and Figures 2.24-2.XX. An examination of the tables shows that the maximum ammonia concentration never exceeded the 4 mg/l threshold in any county or in any HUC. In addition, no consistent trends were observed in either the average or maximum series. Although the average and maximum measured ammonia values did not exceed the statutory limit of 4 mg/l, these values decrease as one moves away from the ammonia source and thus the location of the sampling is of particular importance.

Interestingly enough, however, is the fact that the three counties with consistently high ammonia levels were Floyd, Lawrence, and John Counties are all three located in the Big Sandy Basin. This is also true for the 05070203 and 05070204 basins. The topography in this region is not conducive to traditional septic systems and as a result, the region contains the largest number of package plants in the PRIDE region. Thus, the general trend of the higher values in the Big Sandy Basin may indicate higher levels of human sources of ammonia and thus provide an objective measure of future remediation efforts.

2.3.2 Phosphorus Analysis

In an attempt to provide a historical baseline of phosphorus concentrations in the region, statistical analyses of the phosphorus data were performed on both a county basis and a 8-digit HUC basis. Median, maximum, and average annual spatially averaged values for each county and 8-digit HUC are provided in Tables 2.XX-2.XX. Individual tables and associated plots for each county and 8-digit HUC are also provided in Tables 2.XX-2.XXX and Figures 2.XX-2.XXX. A general review of the average phosphorus data on the basis of both county and HUC spatial aggregation reveals that the majority of units had values less than the threshold value of 0.1 mg/l. The one noticeable exception was Jessamine County (and HUC 05100295) which had elevated values the last three years. This general observation is further enforced upon examination of the maximum values. It is possible that the elevated values may be due to impacts from wastewater treatment plants in Lexington or Nicholasville or due to high phosphate laden limestone in the area. Nonetheless, the elevated values are significantly different from the observed values in the rest of the region.

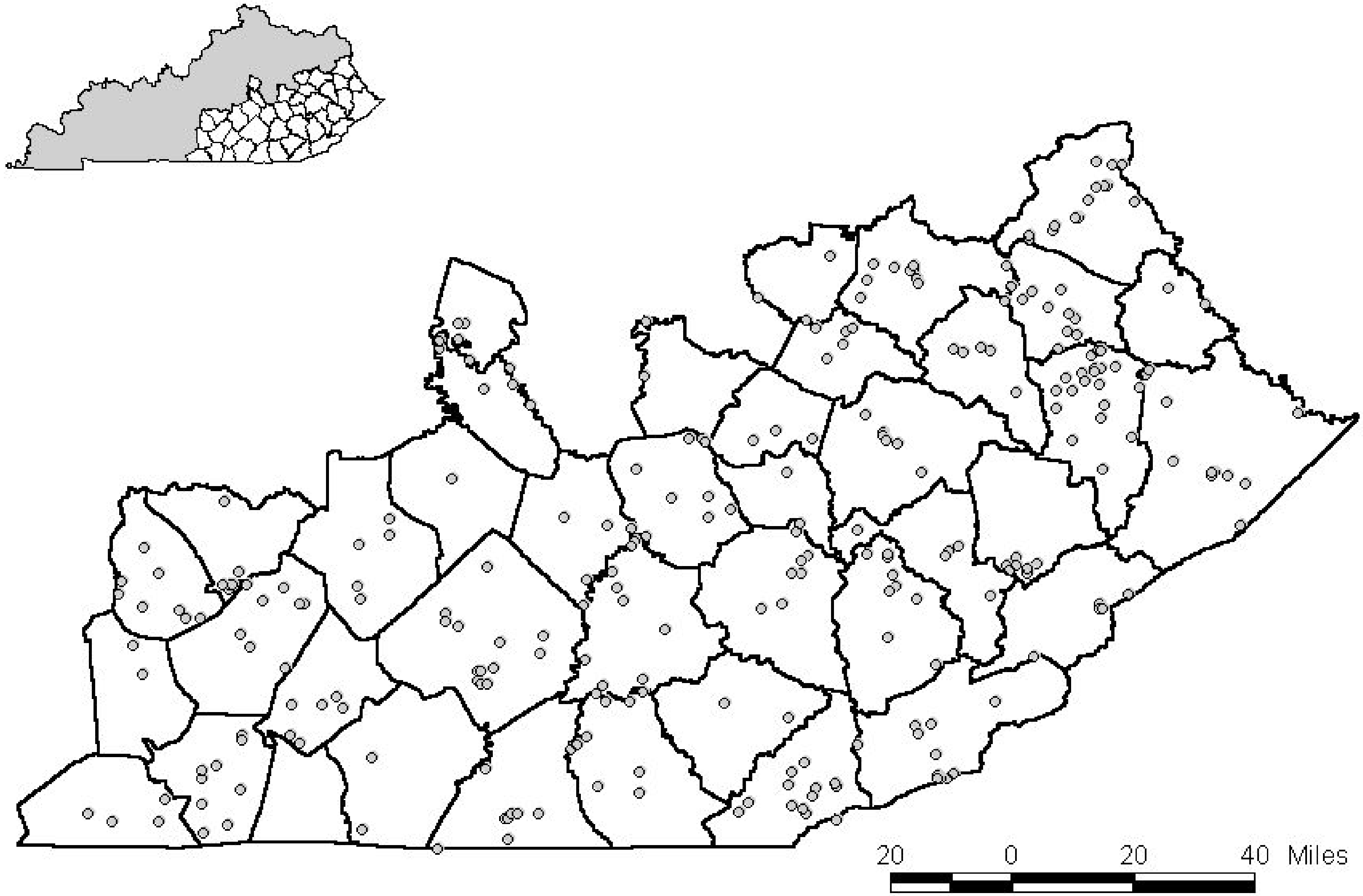

Figure 2.1 Map of the Nutrient Monitoring Sites

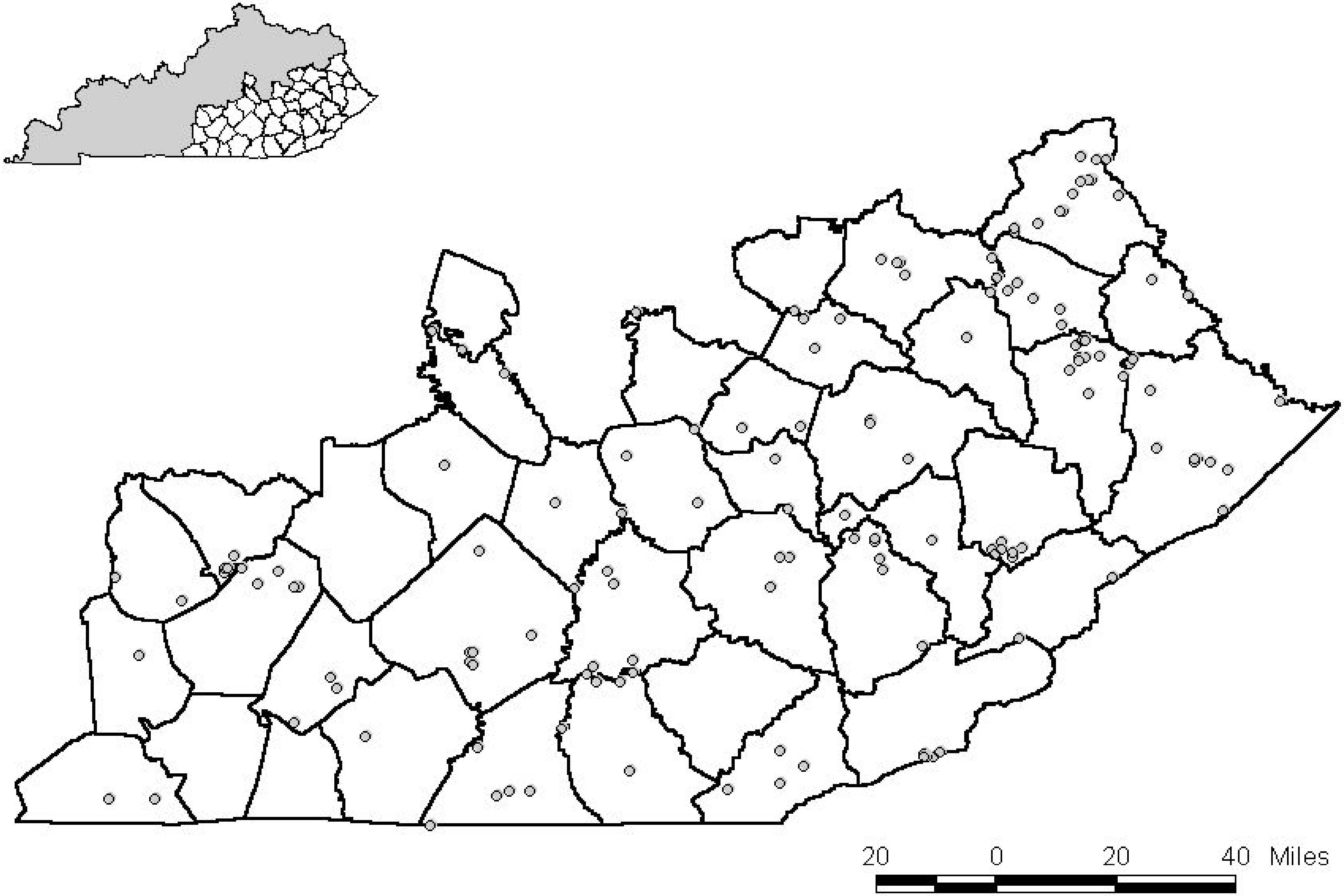

Figure 2.2 Map of EPA STORET Monitoring Sites

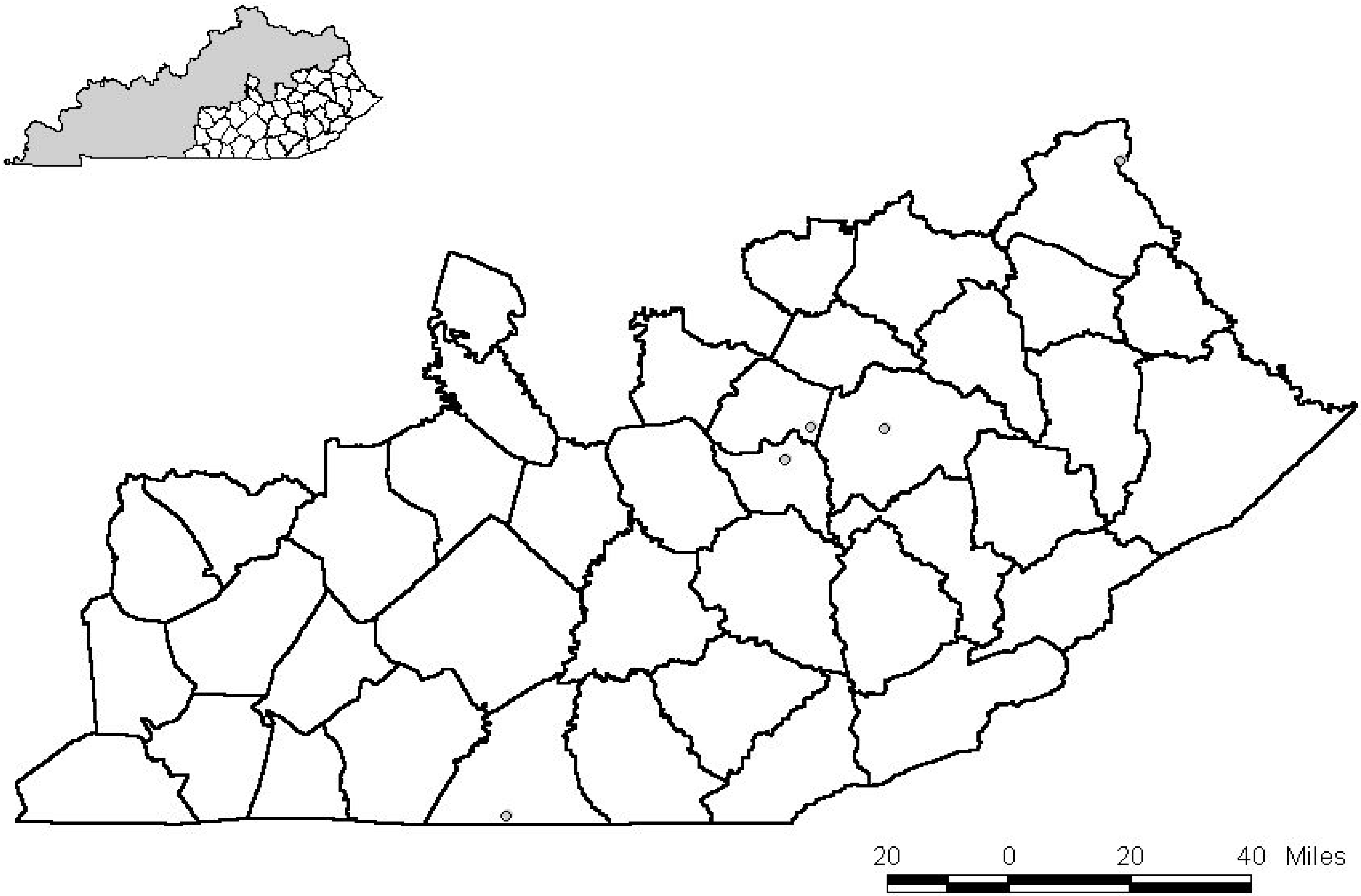

Figure 2.3 Map of USGS Monitoring Sites

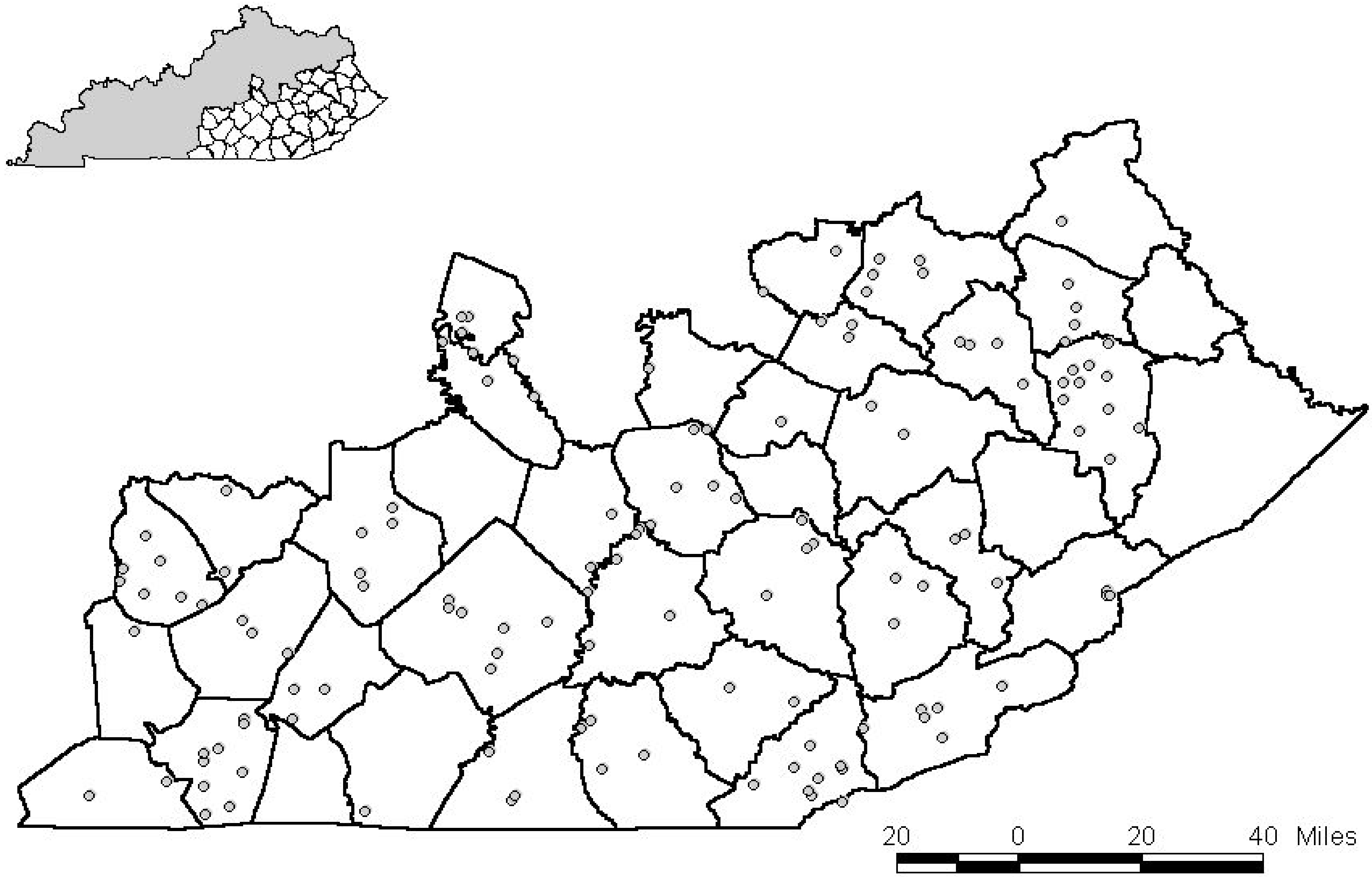

Figure 2.4 Map of PRIDE Watershed Watch Sample Regions and Sample Locations

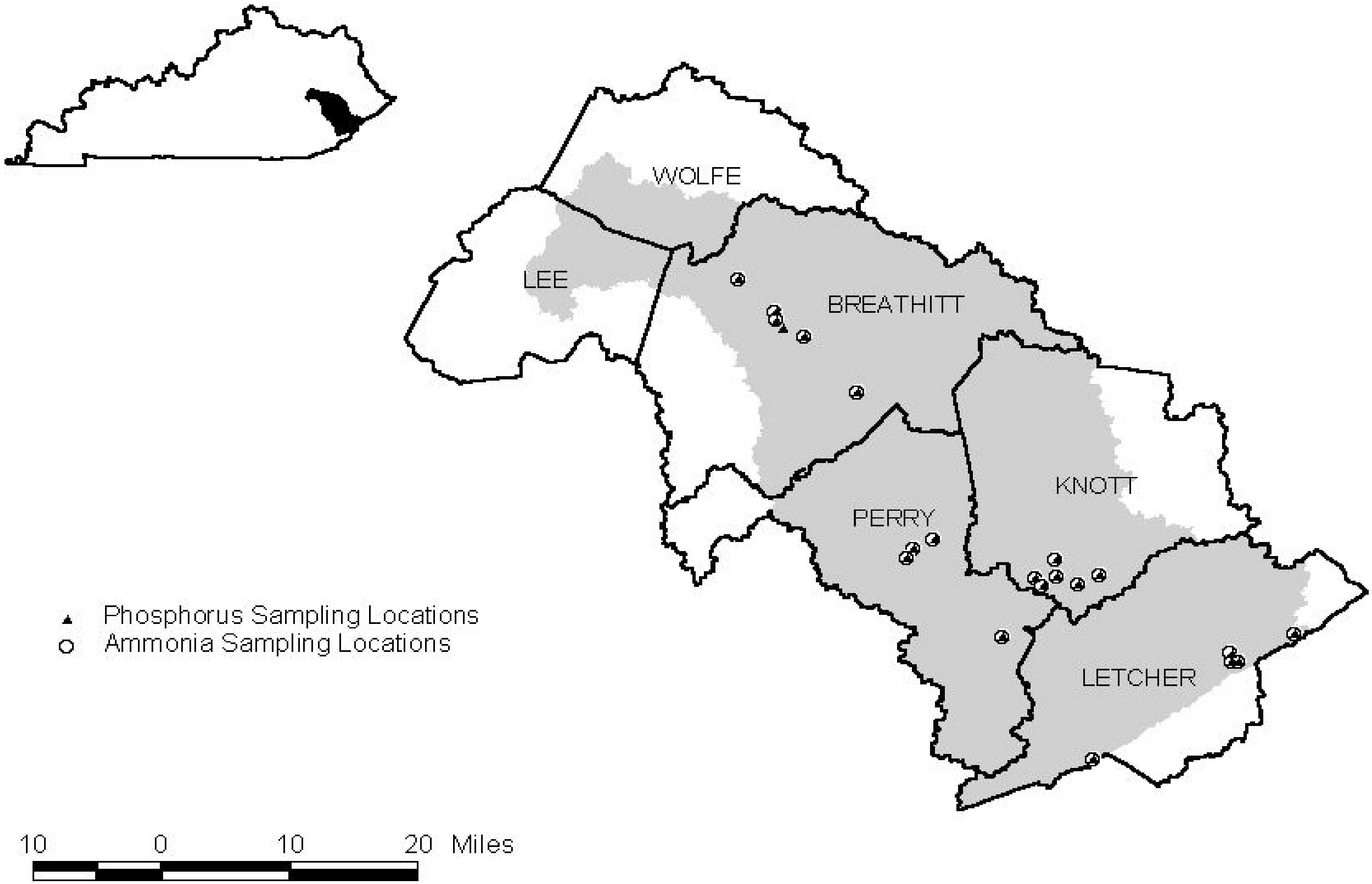

Figure 2.5 Kentucky River Basin 05100201 HUC Watershed

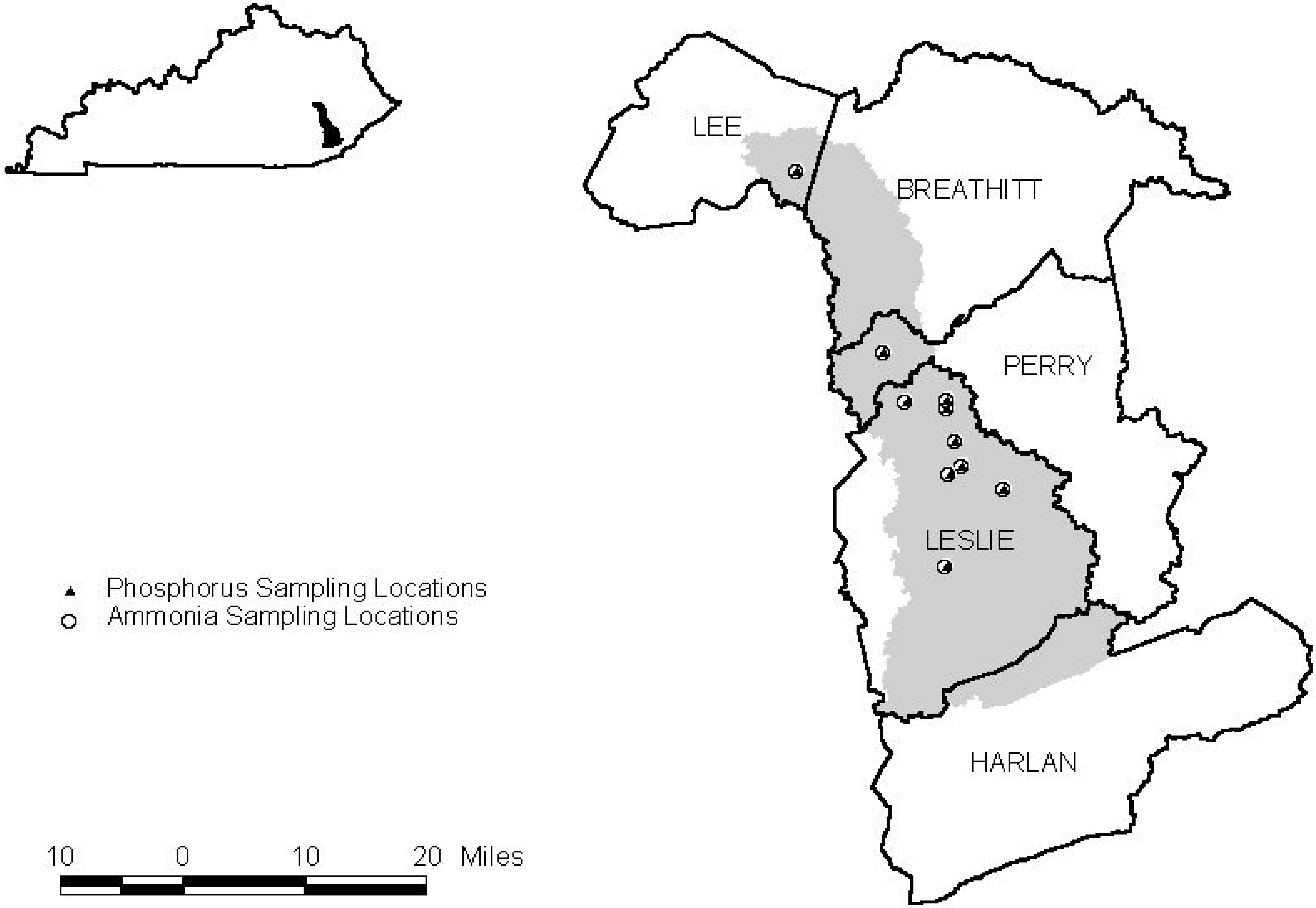

Figure 2.6 Kentucky River Basin 05100202 HUC Watershed

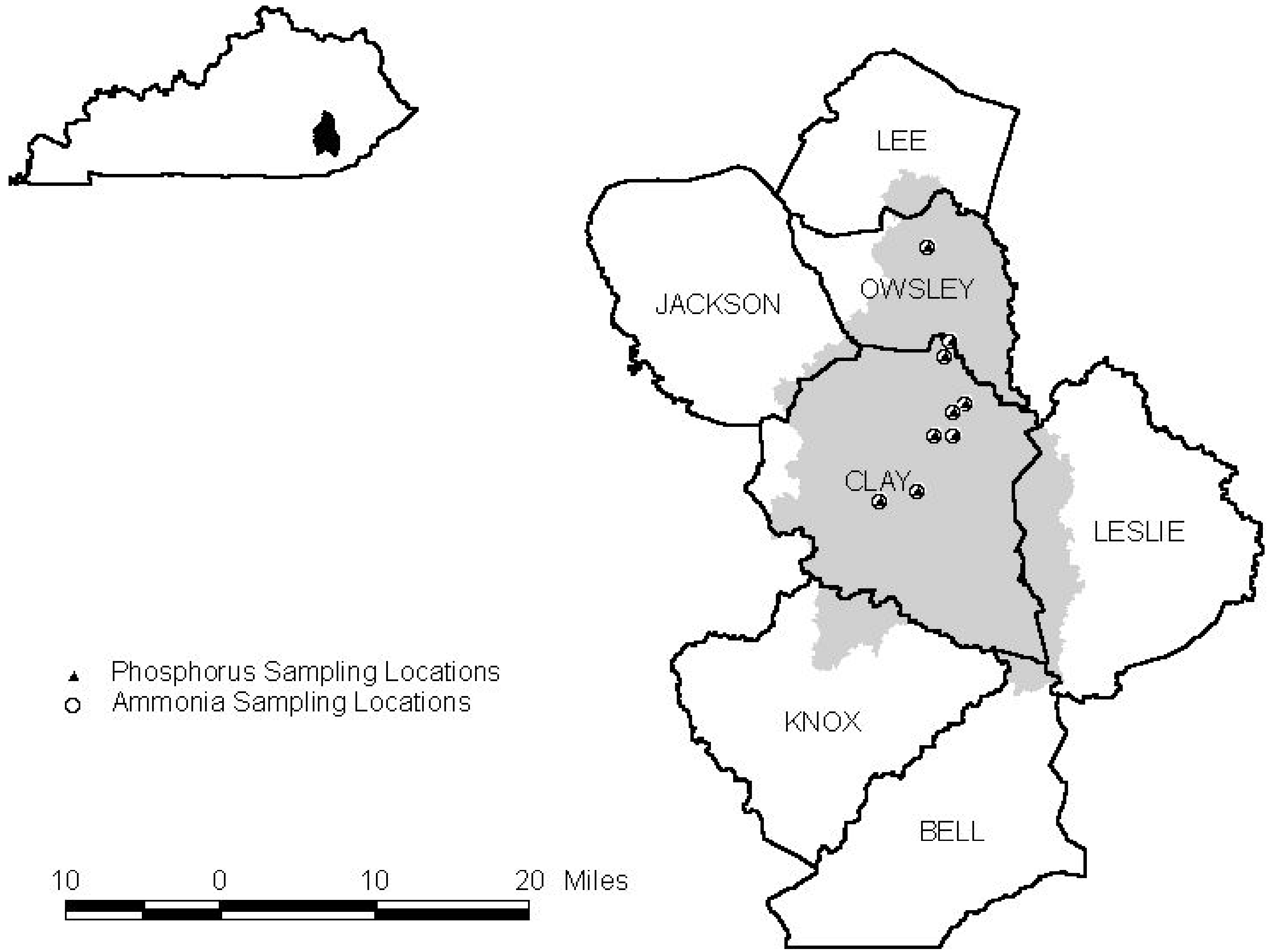

Figure 2.7 Kentucky River Basin 05100203 HUC Watershed

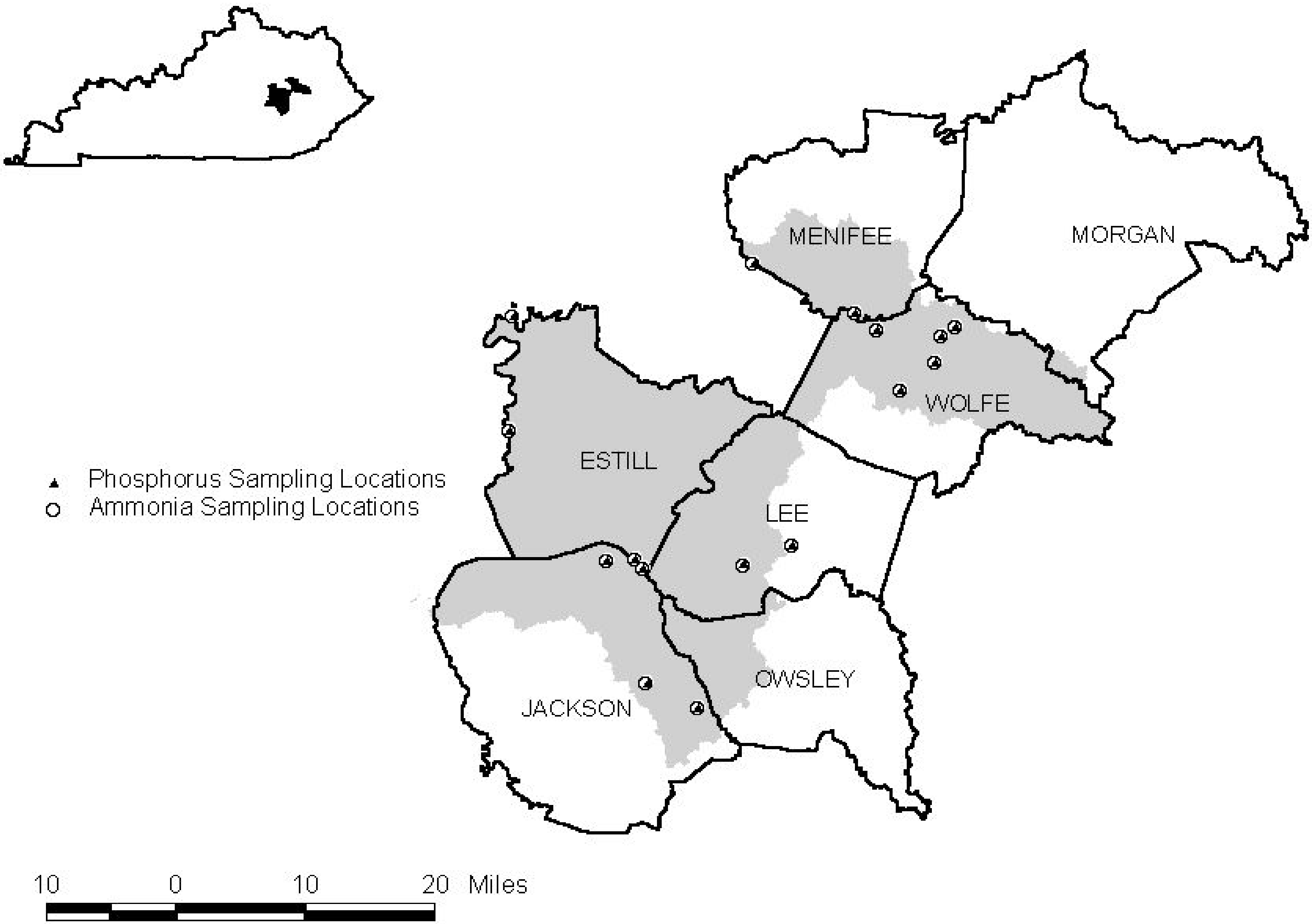

Figure 2.8 Kentucky River Basin 05100204 HUC Watershed

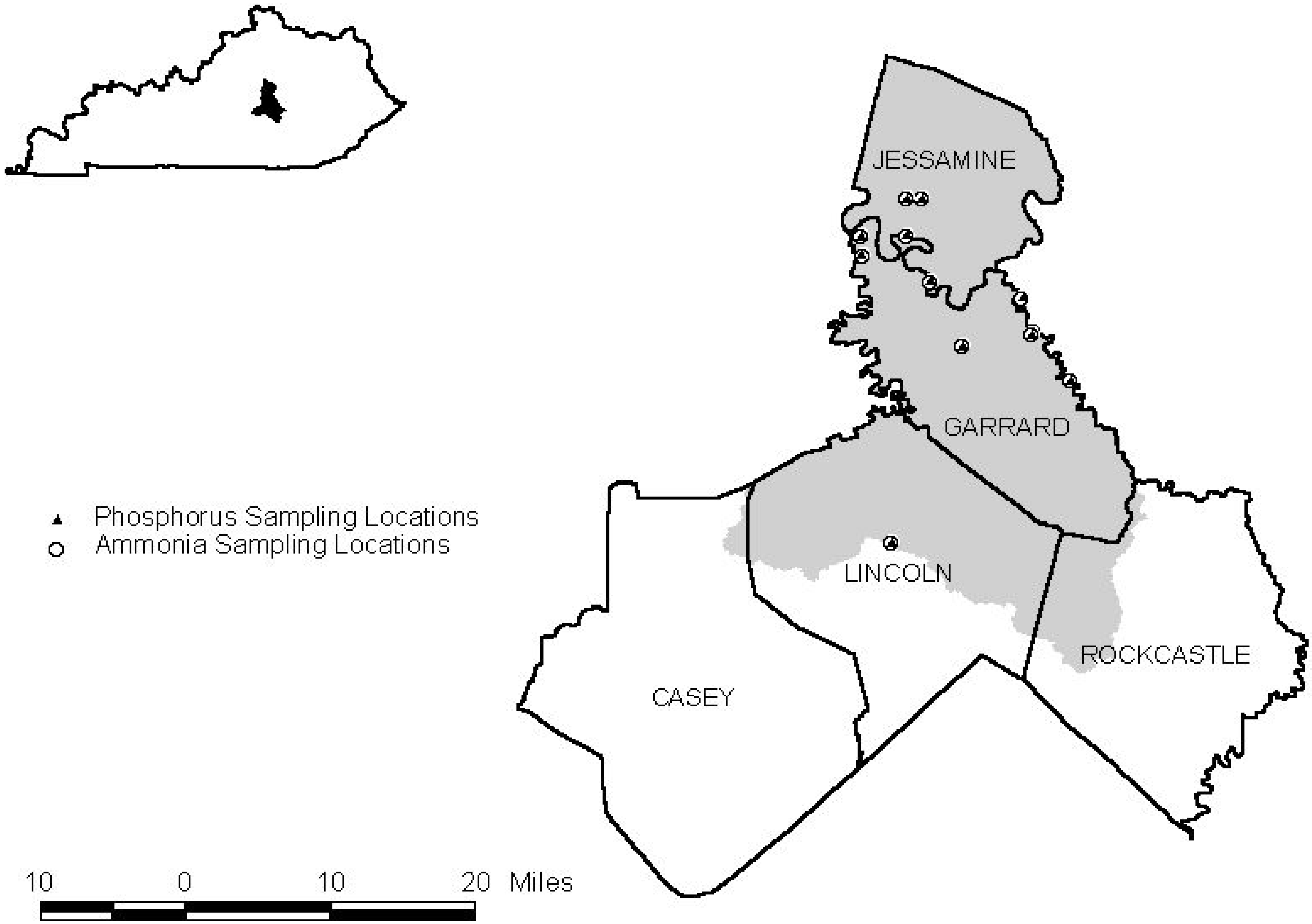

Figure 2.9 Kentucky River Basin 05100205 HUC Watershed

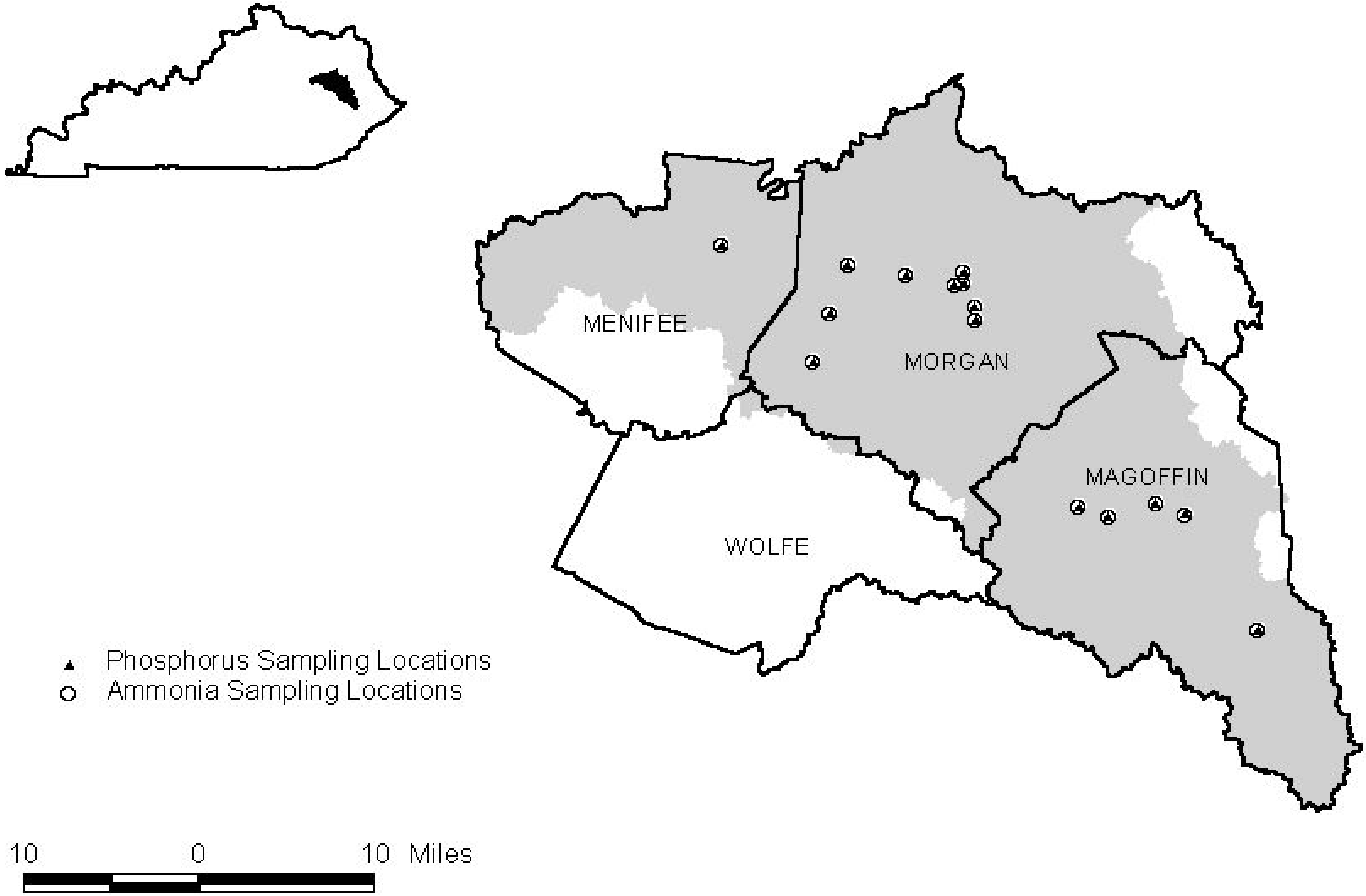

Figure 2.10 Licking River Basin 05100101 HUC Watershed

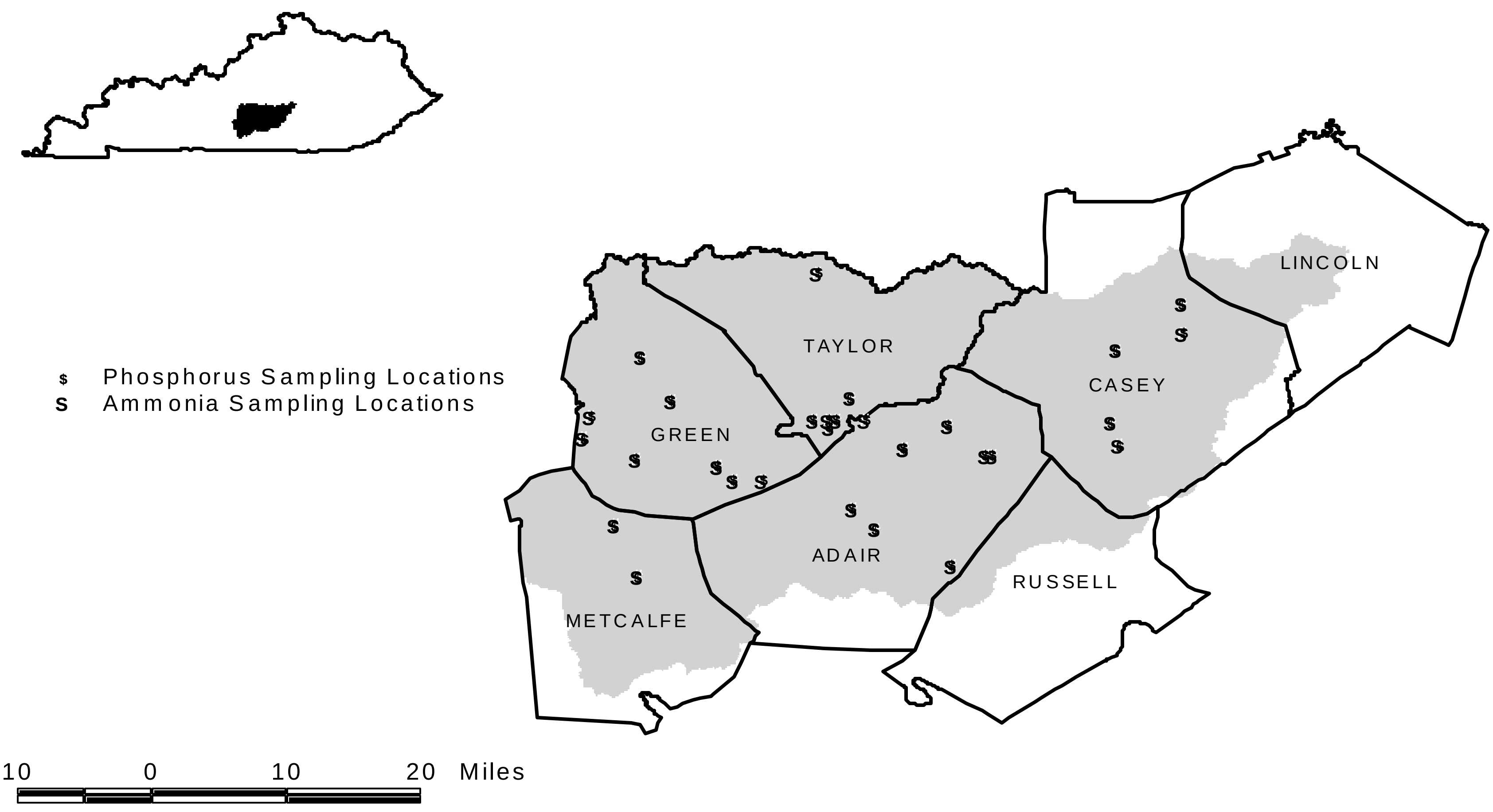

Figure 2.11 Green River Basin 05110001 HUC Watershed

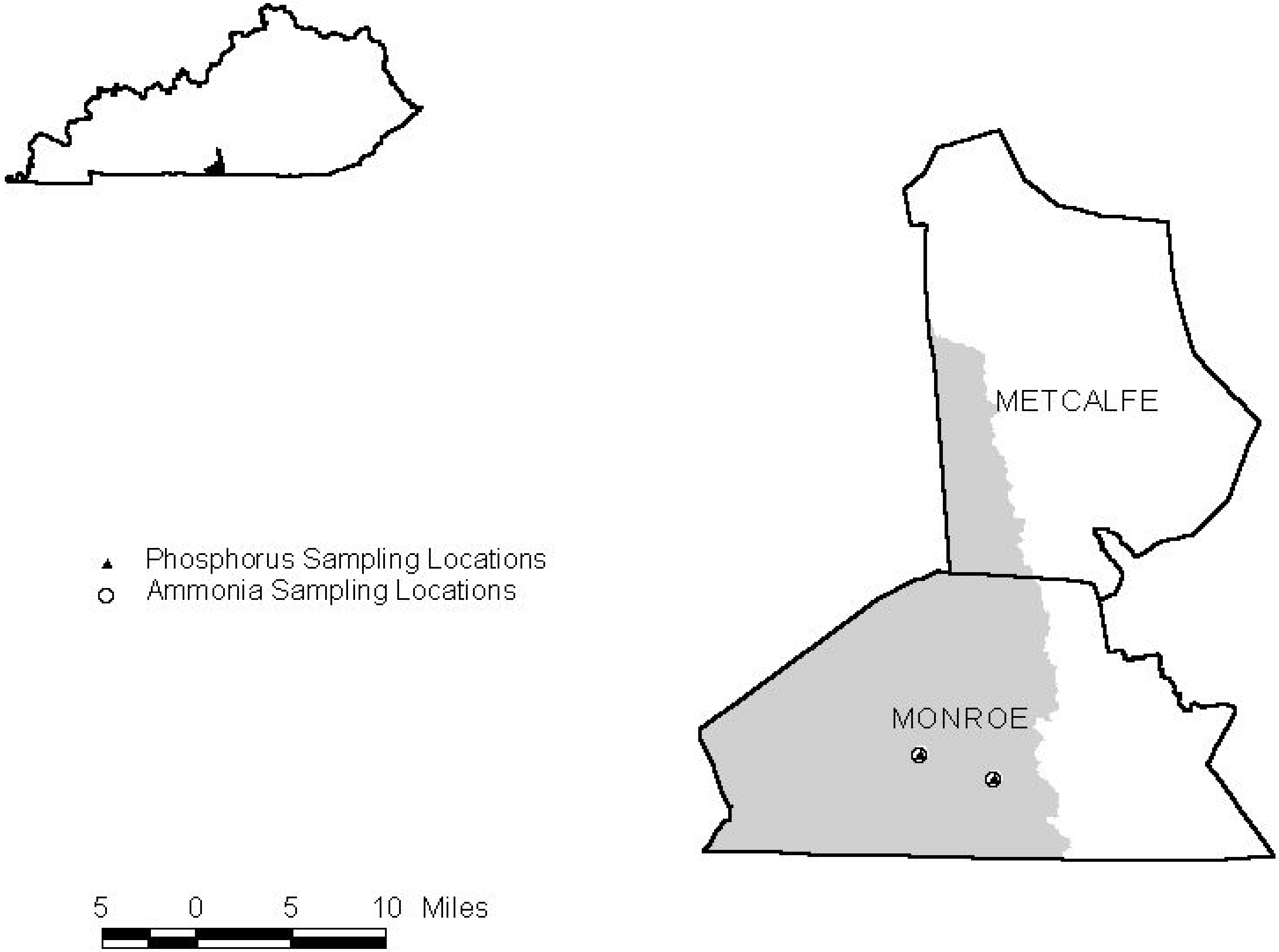

Figure 2.12 Green River Basin 05110002 HUC Watershed

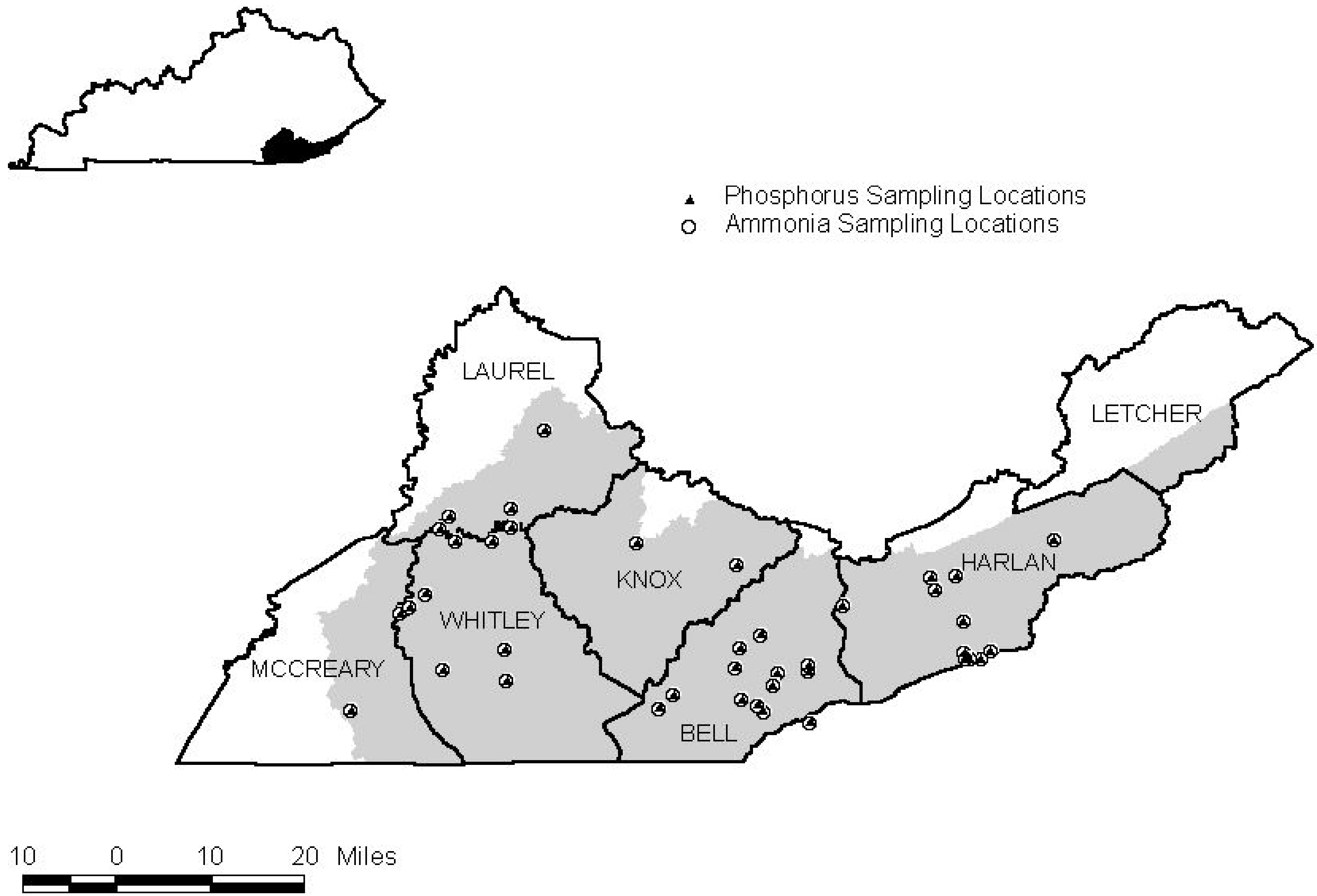

Figure 2.13 Upper Cumberland River Basin 05130101 HUC Watershed

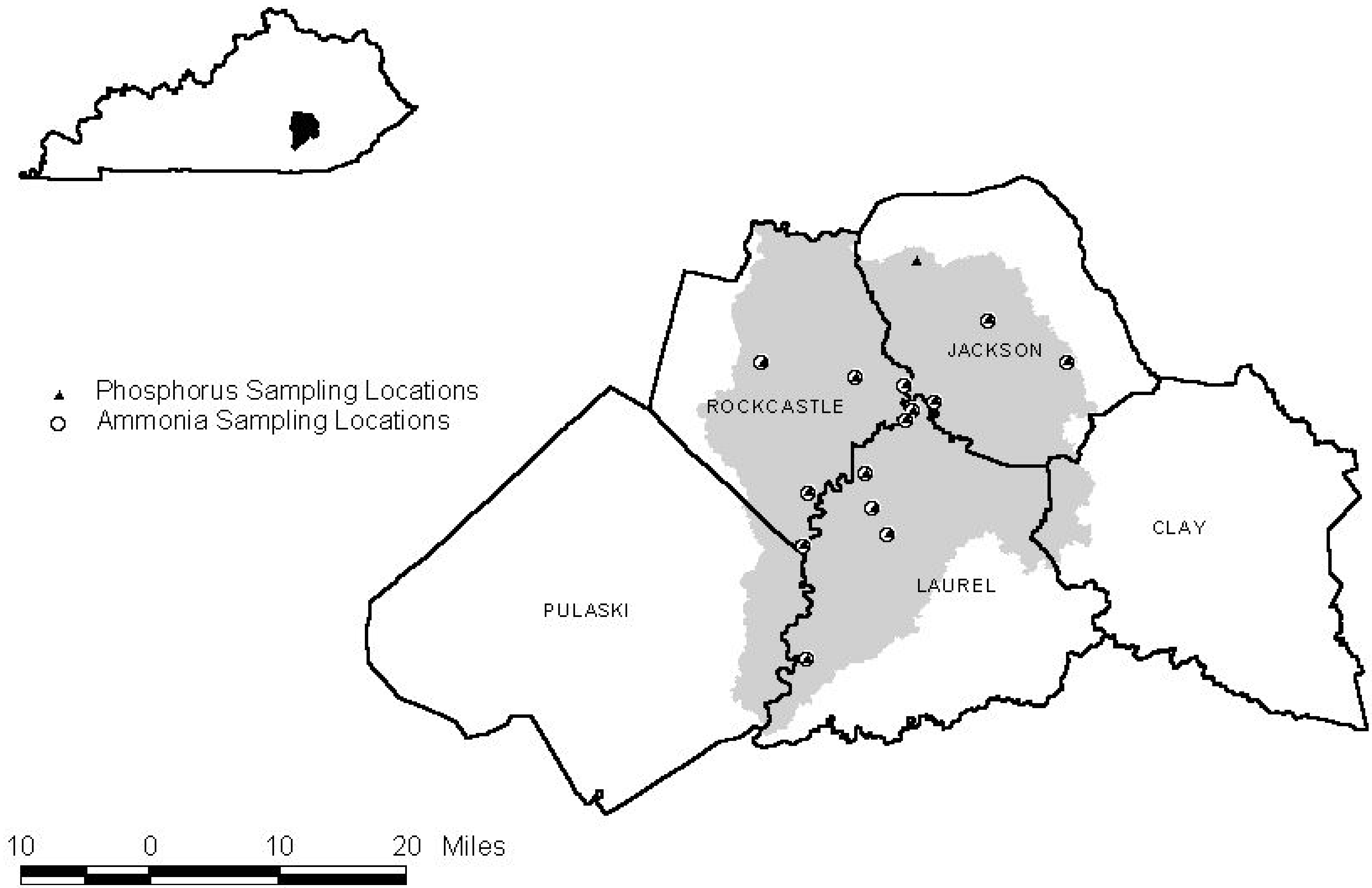

Figure 2.14 Upper Cumberland River Basin 05130102 HUC Watershed

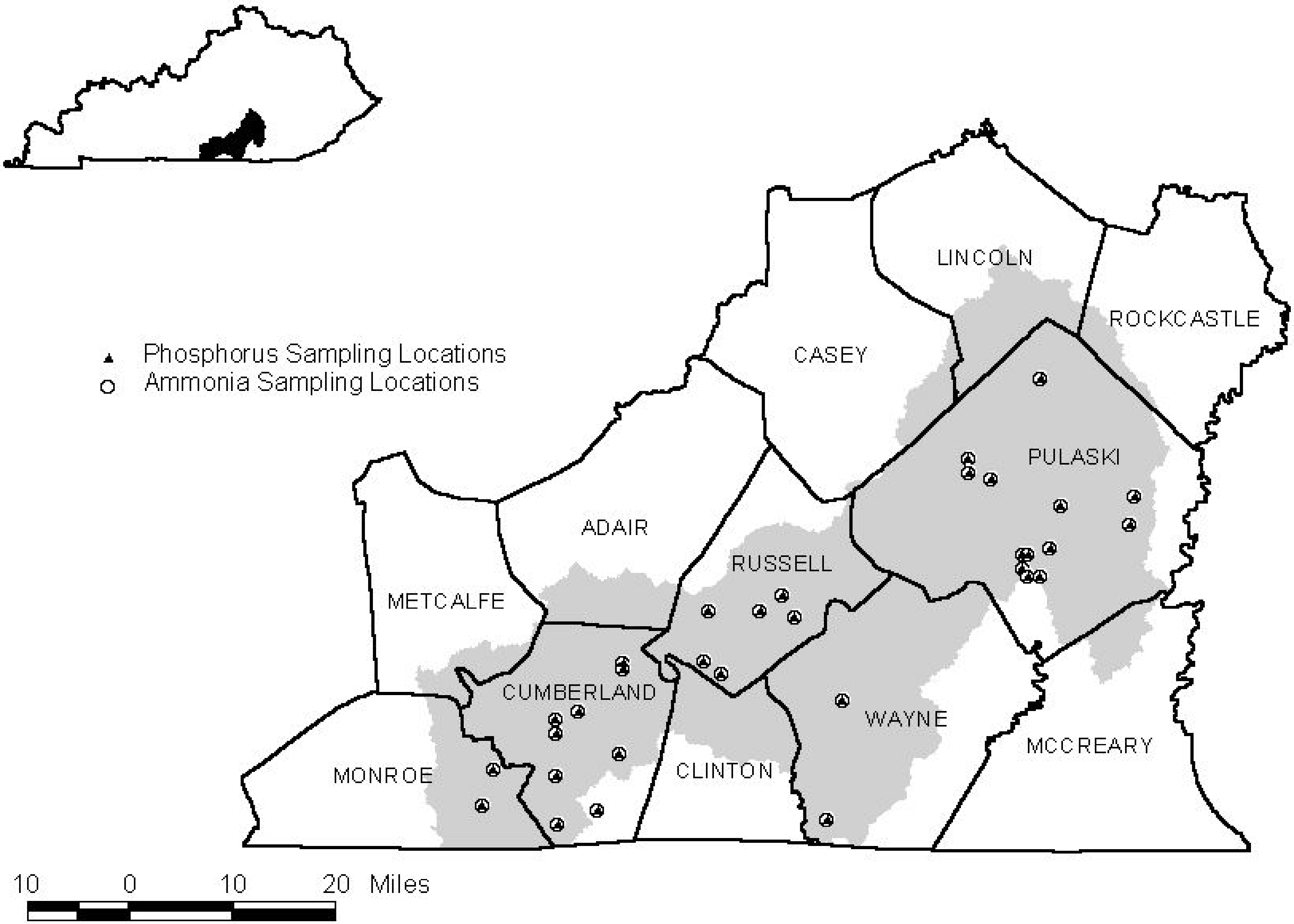

Figure 2.15 Upper Cumberland River Basin 05130103 HUC Watershed

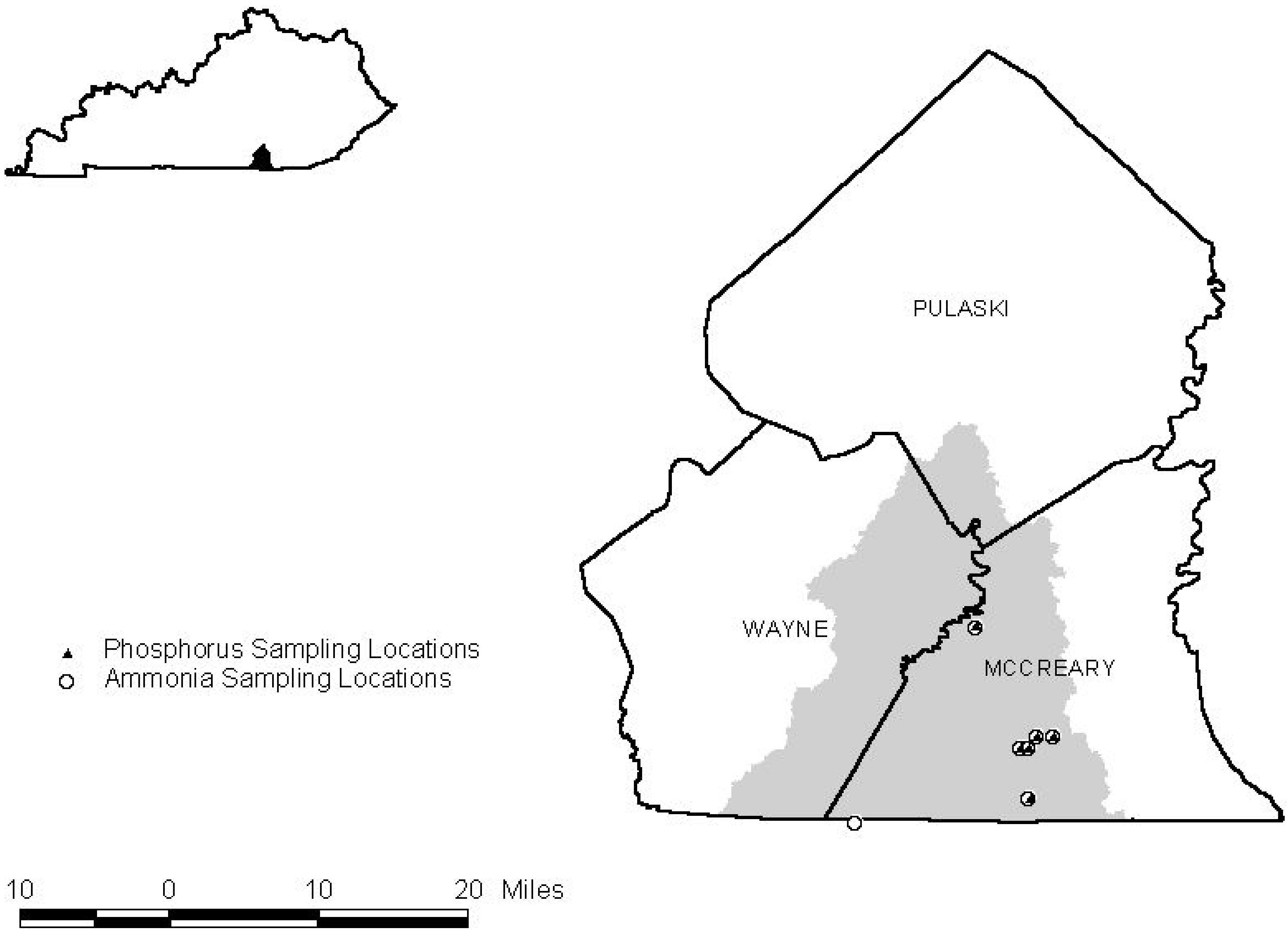

Figure 2.16 Upper Cumberland River Basin 05130105 HUC Watershed

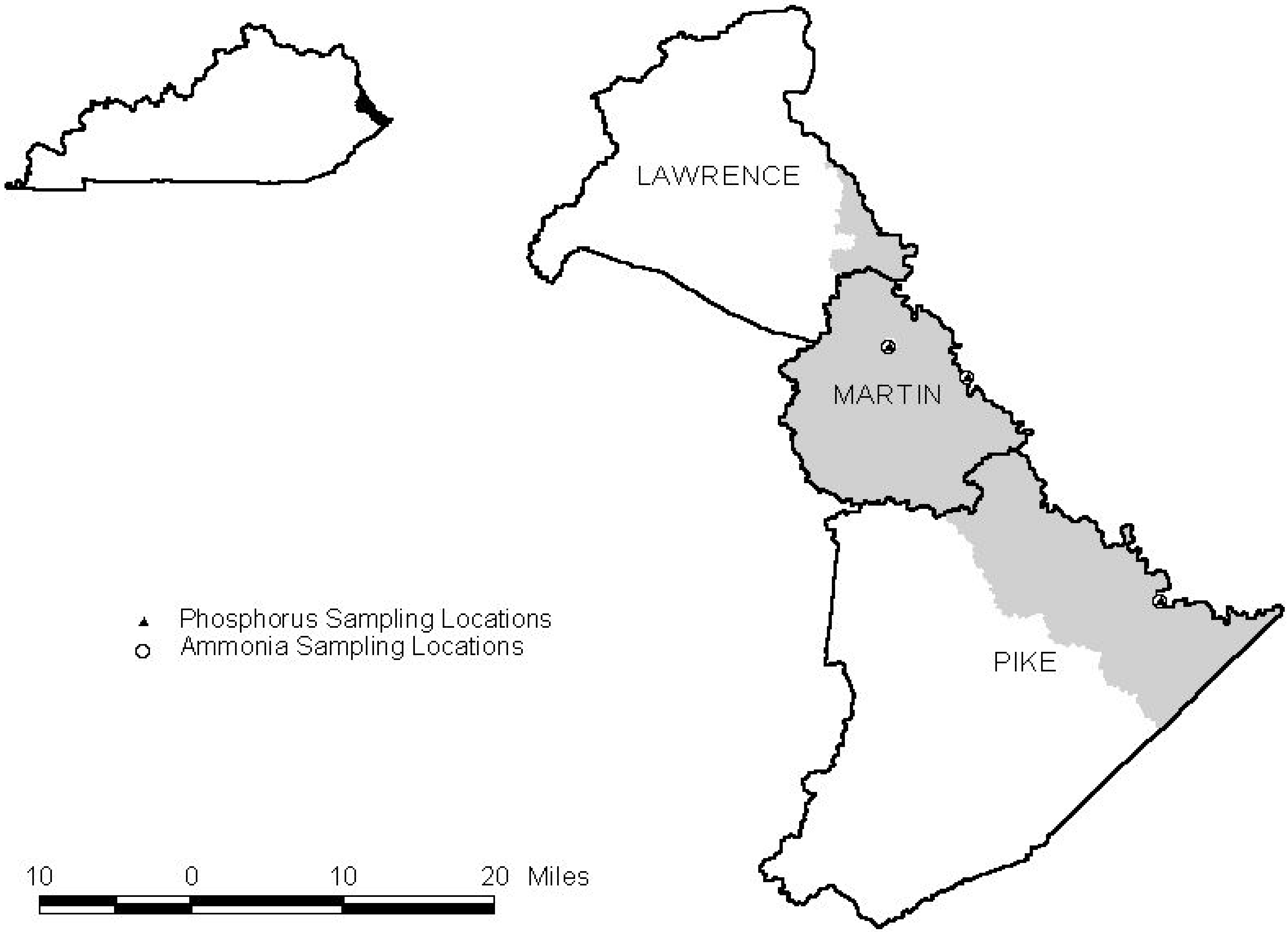

Figure 2.17 Big Sandy River Basin 05070201 HUC Watershed

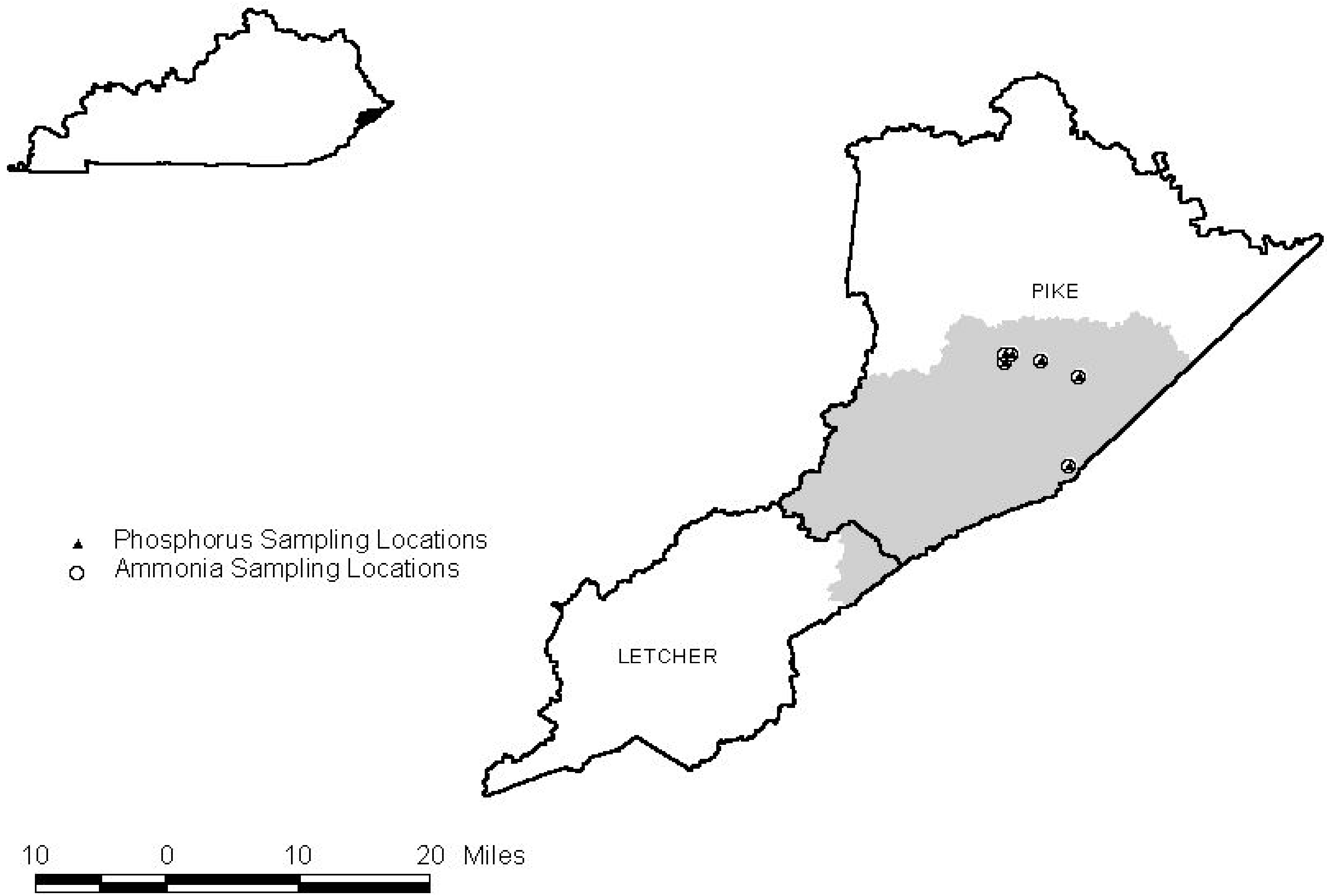

Figure 2.18 Big Sandy River Basin 05070202 HUC Watershed

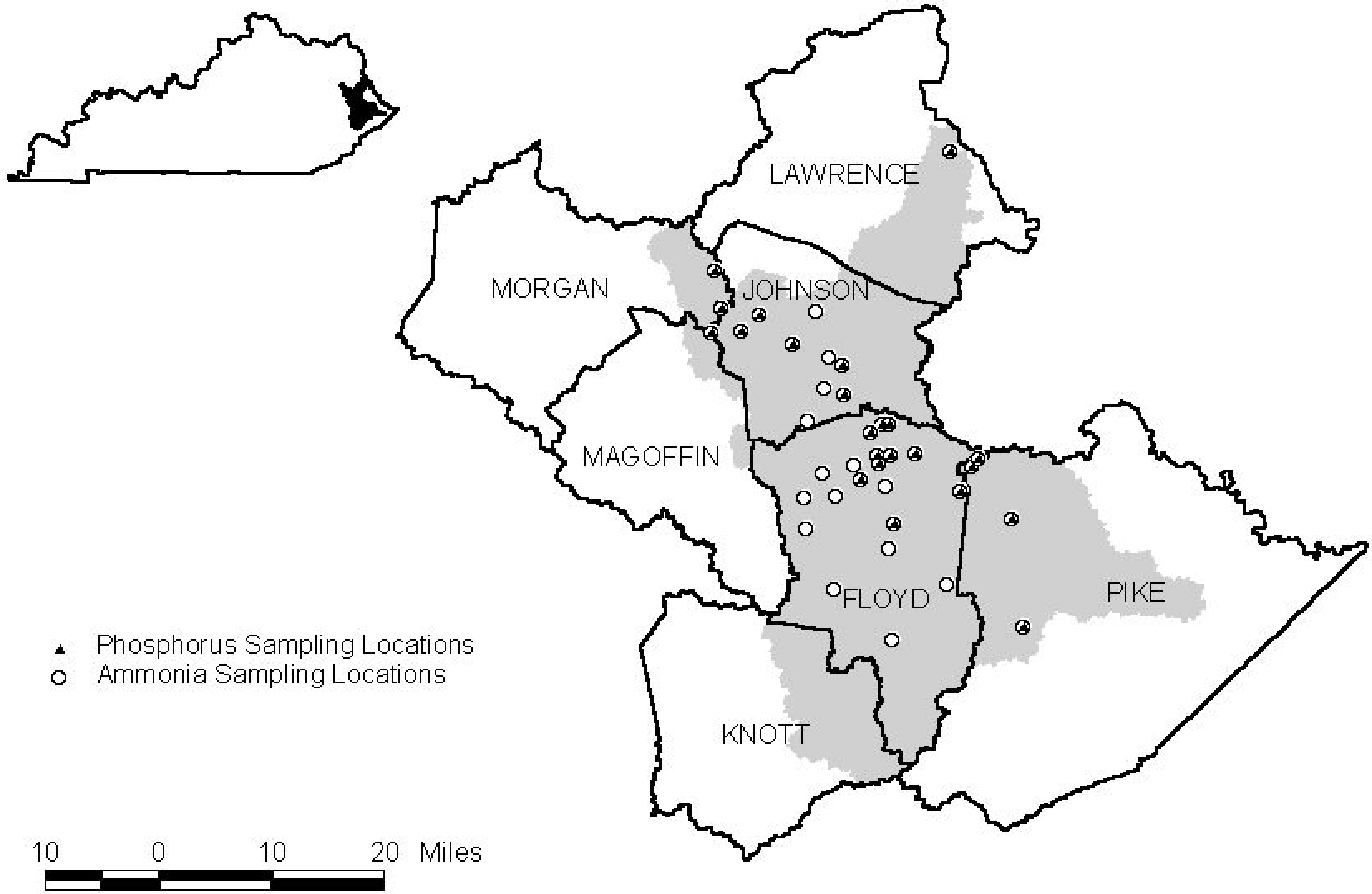

Figure 2.19 Big Sandy River Basin 05070203 HUC Watershed

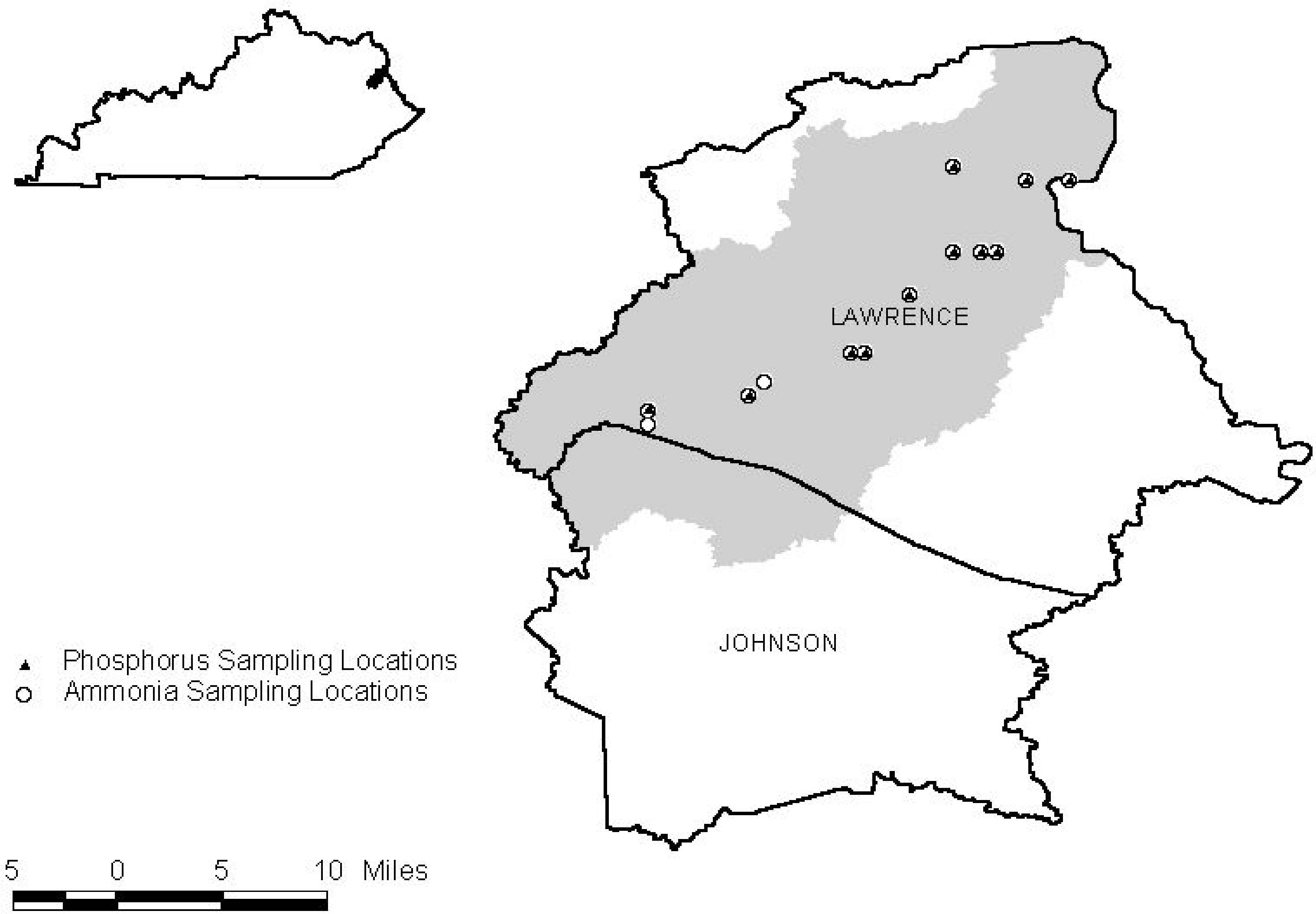

Figure 2.20 Big Sandy River Basin 05070204 HUC Watershed

Table 2.1 - Average Ammonia Statistics for Counties

County	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Adair	0.13	0.13	0.10	-	-	-	-	-	0.05	-
Bell	0.05	0.05	0.05	0.09	0.05	0.05	0.05	0.05	0.04	0.06
Breathitt	0.05	0.06	0.05	0.06	0.05	0.05	0.06	0.05	0.06	0.05
Clay	0.05	-	-	-	-	-	-	0.05	0.06	-
Cumberland	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.05	0.05
Estill	-	0.06	0.05	0.05	0.05	0.05	0.06	0.05	0.06	-
Floyd	-	0.09	0.10	0.29	-	0.58	0.21	0.02	0.09	1.00
Garrard	-	-	-	-	-	-	-	0.05	0.07	-
Green	-	-	-	-	-	-	-	-	0.05	-
Harlan	0.05	-	-	0.06	0.08	-	-	-	-	0.05
Jackson	0.05	0.05	0.05	0.05	0.05	0.13	0.05	0.05	0.05	0.05
Jessamine	0.05	0.05	0.06	0.05	0.09	0.05	0.05	0.05	0.10	-
Johnson	0.05	0.08	0.31	0.09	0.07	-	-	0.04	-	1.40
Knott	-	-	0.12	-	0.16	-	-	-	-	-
Knox	-	-	-	-	-	-	-	-	-	0.05
Laurel	0.07	0.05	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.28
Lawrence	0.06	0.12	0.15	0.16	0.13	0.52	0.10	0.09	0.05	1.00
Lee	0.05	0.08	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.10
Leslie	0.10	0.10	0.10	-	-	-	-	0.06	0.06	-
Letcher	0.05	-	-	-	-	-	-	-	0.06	-
Lincoln	-	-	-	-	-	-	-	-	0.05	-
Magoffin	0.09	-	-	-	-	-	-	-	0.05	0.06
Martin	0.05	0.06	0.09	0.05	0.06	0.05	0.05	0.05	0.06	-
McCreary	0.04	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Menifee	-	-	-	-	-	-	-	0.05	0.06	0.05
Metcalfe	0.17	-	-	-	0.22	0.30	-	-	-	-
Monroe	0.05	-	-	-	-	-	-	-	-	0.05
Morgan	-	0.07	0.26	0.07	0.07	0.05	0.05	0.04	0.05	0.10
Owsley	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	-
Perry	-	-	-	-	-	-	-	0.05	0.07	0.05
Pike	0.05	0.07	0.06	0.07	0.05	0.30	0.10	0.05	0.06	-
Pulaski	0.05	0.05	-	0.05	0.06	0.05	-	-	0.05	0.05
Rockcastle	0.10	-	-	-	-	-	-	-	-	0.05
Russell	0.06	0.09	0.05	0.05	0.06	0.05	-	-	-	0.05
Taylor	0.15	0.08	0.24	-	-	-	-	-	-	-
Wayne	0.05	-	-	-	-	-	-	-	-	0.05
Whitley	0.05	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Wolfe	0.05	0.11	0.05	0.04	0.05	0.05	-	0.05	0.07	-

Table 2.2 - Maximum Ammonia Statistics for Counties

County	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Adair	0.60	0.29	0.10	-	-	-	-	-	0.05	-
Bell	0.05	0.05	0.05	0.50	0.07	0.06	0.05	0.05	0.07	0.14
Breathitt	0.07	0.15	0.05	0.16	0.06	0.06	0.18	0.05	0.17	0.07
Clay	0.05	-	-	-	-	-	-	0.05	0.10	-
Cumberland	0.05	0.05	0.05	0.11	0.05	0.17	0.05	0.05	0.05	0.08
Estill	-	0.16	0.06	0.05	0.06	0.07	0.14	0.06	0.10	-
Floyd	-	0.30	0.10	1.22	-	0.82	0.59	0.03	0.16	1.00
Garrard	-	-	-	-	-	-	-	0.05	0.27	-
Green	-	-	-	-	-	-	-	-	0.05	-
Harlan	0.05	-	-	0.22	0.23	-	-	-	-	0.05
Jackson	0.09	0.05	0.05	0.05	0.06	0.50	0.05	0.05	0.10	0.05
Jessamine	0.07	0.06	0.18	0.05	0.51	0.06	0.05	0.05	0.10	-
Johnson	0.06	0.10	2.20	0.32	0.14	-	-	0.10	-	3.00
Knott	-	-	0.50	-	0.37	-	-	-	-	-
Knox	-	-	-	-	-	-	-	-	-	0.05
Laurel	0.31	0.05	0.07	0.16	0.07	0.07	0.05	0.05	0.05	0.28
Lawrence	0.22	1.20	0.75	1.42	2.40	3.00	1.91	1.54	0.07	1.00
Lee	0.06	0.30	0.08	0.05	0.05	0.09	0.05	0.06	0.05	0.10
Leslie	0.10	0.10	0.10	-	-	-	-	0.20	0.10	-
Letcher	0.05	-	-	-	-	-	-	-	0.10	-
Lincoln	-	-	-	-	-	-	-	-	0.05	-
Magoffin	0.19	-	-	-	-	-	-	-	0.05	0.09
Martin	0.05	0.16	0.50	0.09	0.14	0.07	0.05	0.05	0.10	-
McCreary	0.05	0.08	0.05	0.09	0.05	0.05	0.05	0.05	0.05	0.05
Menifee	-	-	-	-	-	-	-	0.05	0.10	0.05
Metcalfe	0.42	-	-	-	0.57	0.80	-	-	-	-
Monroe	0.05	-	-	-	-	-	-	-	-	0.05
Morgan	-	0.10	1.40	0.24	0.23	0.09	0.05	0.07	0.09	0.29
Owsley	0.06	0.07	0.06	0.05	0.05	0.07	0.05	0.07	0.05	-
Perry	-	-	-	-	-	-	-	0.05	0.10	0.05
Pike	0.07	0.12	0.10	0.26	0.14	1.15	0.43	0.05	0.11	-
Pulaski	0.05	0.05	-	0.05	0.08	0.05	-	-	0.05	0.05
Rockcastle	0.19	-	-	-	-	-	-	-	-	0.05
Russell	0.07	0.31	0.05	0.05	0.15	0.05	-	-	-	0.05
Taylor	0.90	0.35	0.90	-	-	-	-	-	-	-
Wayne	0.05	-	-	-	-	-	-	-	-	0.05
Whitley	0.05	0.07	0.11	0.05	0.05	0.07	0.05	0.05	0.07	0.05
Wolfe	0.06	0.57	0.08	0.05	0.05	0.05	-	0.05	0.10	-

Table 2.3 - Median Ammonia Statistics for Counties

County	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Adair	0.10	0.05	0.10	-	-	-	-	-	0.05	-
Bell	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Breathitt	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Casey	-	-	-	-	-	-	-	-	-	-
Clay	0.05	-	-	-	-	-	-	0.05	0.05	-
Clinton	-	-	-	-	-	-	-	-	-	-
Cumberland	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Estill	-	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	-
Floyd	-	0.10	0.10	0.10	-	0.57	0.13	0.02	0.08	1.00
Garrard	-	-	-	-	-	-	-	0.05	0.05	-
Green	-	-	-	-	-	-	-	-	0.05	-
Harlan	0.05	-	-	0.05	0.06	-	-	-	-	0.05
Jackson	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Jessamine	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.10	-
Johnson	0.05	0.10	0.19	0.10	0.05	-	-	0.02	-	1.00
Knott	-	-	0.10	-	0.15	-	-	-	-	-
Knox	-	-	-	-	-	-	-	-	-	0.05
Laurel	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.28
Lawrence	0.05	0.05	0.10	0.08	0.02	0.35	0.05	0.04	0.05	1.00
Lee	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.10
Leslie	0.10	0.10	0.10	-	-	-	-	0.05	0.05	-
Letcher	0.05	-	-	-	-	-	-	-	0.05	-
Lincoln	-	-	-	-	-	-	-	-	0.05	-
Magoffin	0.07	-	-	-	-	-	-	-	0.05	0.05
Martin	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	-
McCreary	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Menifee	-	-	-	-	-	-	-	0.05	0.05	0.05
Metcalfe	0.05	-	-	-	0.05	0.06	-	-	-	-
Monroe	0.05	-	-	-	-	-	-	-	-	0.05
Morgan	-	0.05	0.10	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Owsley	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	-
Perry	-	-	-	-	-	-	-	0.05	0.05	0.05
Pike	0.05	0.05	0.05	0.05	0.05	0.14	0.05	0.05	0.05	-
Pulaski	0.05	0.05	-	0.05	0.05	0.05	-	-	0.05	0.05
Rockcastle	0.05	-	-	-	-	-	-	-	-	0.05
Russell	0.05	0.05	0.05	0.05	0.05	0.05	-	-	-	0.05
Taylor	0.10	0.05	0.10	-	-	-	-	-	-	-
Wayne	0.05	-	-	-	-	-	-	-	-	0.05
Whitley	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Wolfe	0.05	0.05	0.05	0.05	0.05	0.05	-	0.05	0.05	-

Table 2.4 - Average Ammonia Statistics for HUCs

HUC8	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
05070201	0.05	0.06	0.09	0.05	0.06	0.05	0.05	0.05	0.06	-
05070202	-	0.10	0.06	0.07	0.03	0.38	-	-	-	-
05070203	0.05	0.07	0.29	0.09	0.06	0.33	0.11	0.04	0.06	1.13
05070204	0.06	0.13	0.17	0.18	0.14	0.59	0.11	0.09	0.04	1.00
05100101	0.09	0.07	0.10	0.05	0.08	0.05	0.05	0.05	0.05	0.08
05100201	0.05	0.06	0.10	0.06	0.11	0.05	0.06	0.05	0.06	0.05
05100202	0.06	0.09	0.08	0.05	0.05	0.05	0.05	0.06	0.06	-
05100203	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	-
05100204	0.05	0.09	0.05	0.05	0.05	0.05	0.06	0.05	0.06	0.10
05100205	0.05	0.05	0.06	0.05	0.09	0.05	0.05	0.05	0.08	-
05110001	0.15	0.10	0.20	-	0.22	0.30	-	-	0.05	-
05110002	0.05	-	-	-	-	-	-	-	-	-
05130101	0.06	0.05	0.05	0.07	0.06	0.05	0.05	0.05	0.05	0.06
05130102	0.06	0.05	0.06	0.05	0.05	0.09	0.05	0.05	0.05	0.05
05130103	0.05	0.06	0.05	0.05	0.06	0.06	0.05	0.05	0.05	0.05
05130104	0.04	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Table 2.5 - Maximum Ammonia Statistics for HUCs

HUC8	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
05070201	0.05	0.16	0.50	0.09	0.14	0.07	0.05	0.05	0.10	-
05070202	-	0.10	0.10	0.23	0.06	1.15	-	-	-	-
05070203	0.07	0.30	2.20	1.22	0.14	1.04	0.59	0.10	0.16	3.00
05070204	0.22	1.20	0.75	1.42	2.40	3.00	1.91	1.54	0.07	1.00
05100101	0.19	0.10	0.50	0.05	0.23	0.09	0.05	0.05	0.09	0.29
05100201	0.07	0.15	0.50	0.16	0.37	0.06	0.18	0.05	0.17	0.07
05100202	0.10	0.30	0.10	0.05	0.05	0.09	0.05	0.20	0.10	-
05100203	0.06	0.07	0.06	0.05	0.05	0.07	0.05	0.07	0.10	-
05100204	0.06	0.57	0.08	0.05	0.06	0.07	0.14	0.06	0.10	0.10
05100205	0.07	0.06	0.18	0.05	0.51	0.06	0.05	0.05	0.27	-
05110001	0.90	0.35	0.90	-	0.57	0.80	-	-	0.05	-
05110002	0.05	-	-	-	-	-	-	-	-	-
05130101	0.31	0.07	0.11	0.50	0.23	0.07	0.05	0.05	0.07	0.28
05130102	0.19	0.05	0.10	0.05	0.07	0.50	0.05	0.05	0.05	0.05
05130103	0.07	0.31	0.05	0.11	0.15	0.17	0.05	0.05	0.05	0.08
05130104	0.05	0.08	0.05	0.09	0.05	0.05	0.05	0.05	0.05	0.05

Table 2.7 Ammonia Statistics for Adair County

Year	Samples	Maximum	Median	Average
1990	13	0.60	0.10	0.13
1991	3	0.29	0.05	0.13
1992	6	0.10	0.10	0.10
1993				
1994				
1995				
1996				
1997				
1998	4	0.05	0.05	0.05
1999				

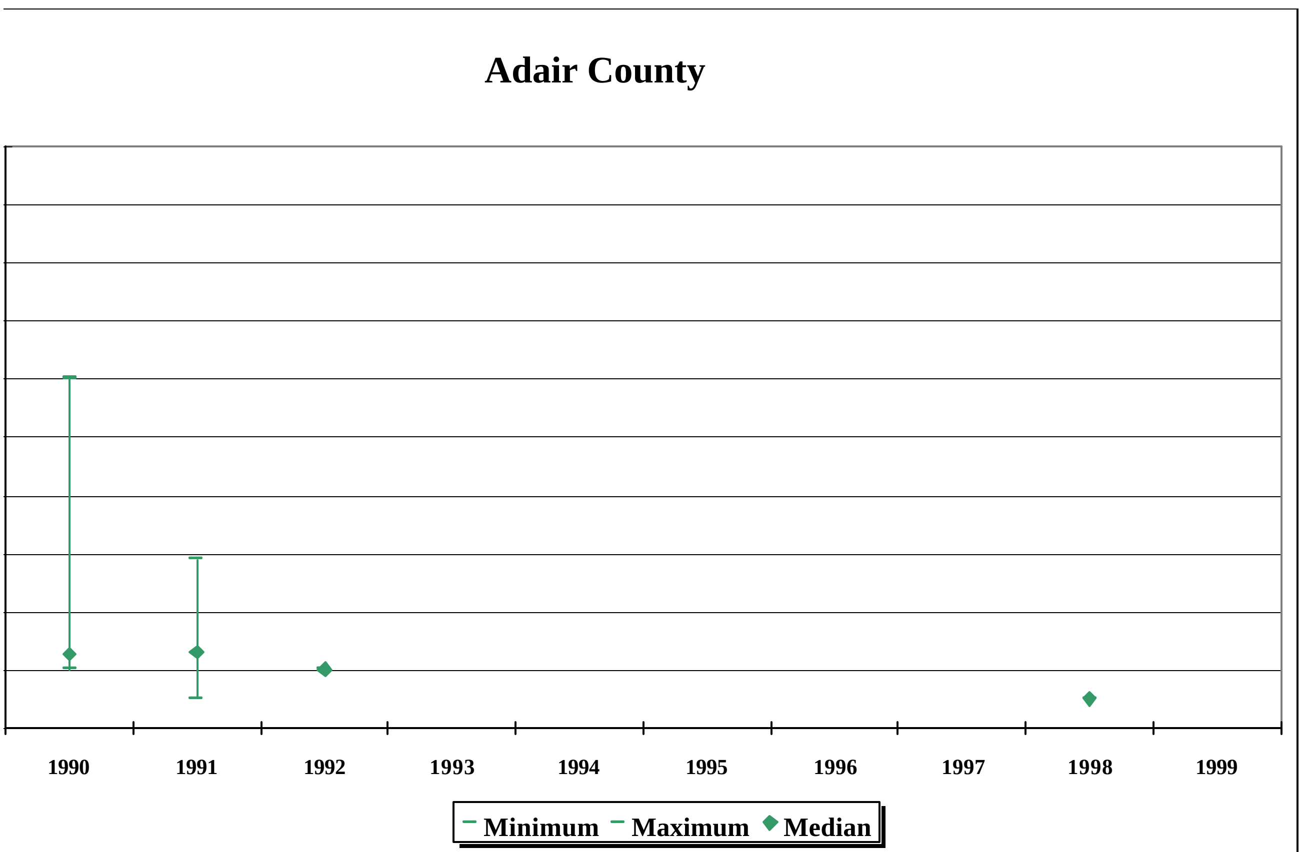

Figure 2.21 Ammonia Results for Adair County

Table 2.8 Ammonia Statistics for Bell County

Year	Samples	Maximum	Median	Average
1990	18	0.05	0.05	0.05
1991	11	0.05	0.05	0.05
1992	11	0.05	0.05	0.05
1993	12	0.50	0.05	0.09
1994	12	0.07	0.05	0.05
1995	12	0.06	0.05	0.05
1996	12	0.05	0.05	0.05
1997	11	0.05	0.05	0.05
1998	11	0.07	0.05	0.04
1999	11	0.14	0.10	0.06

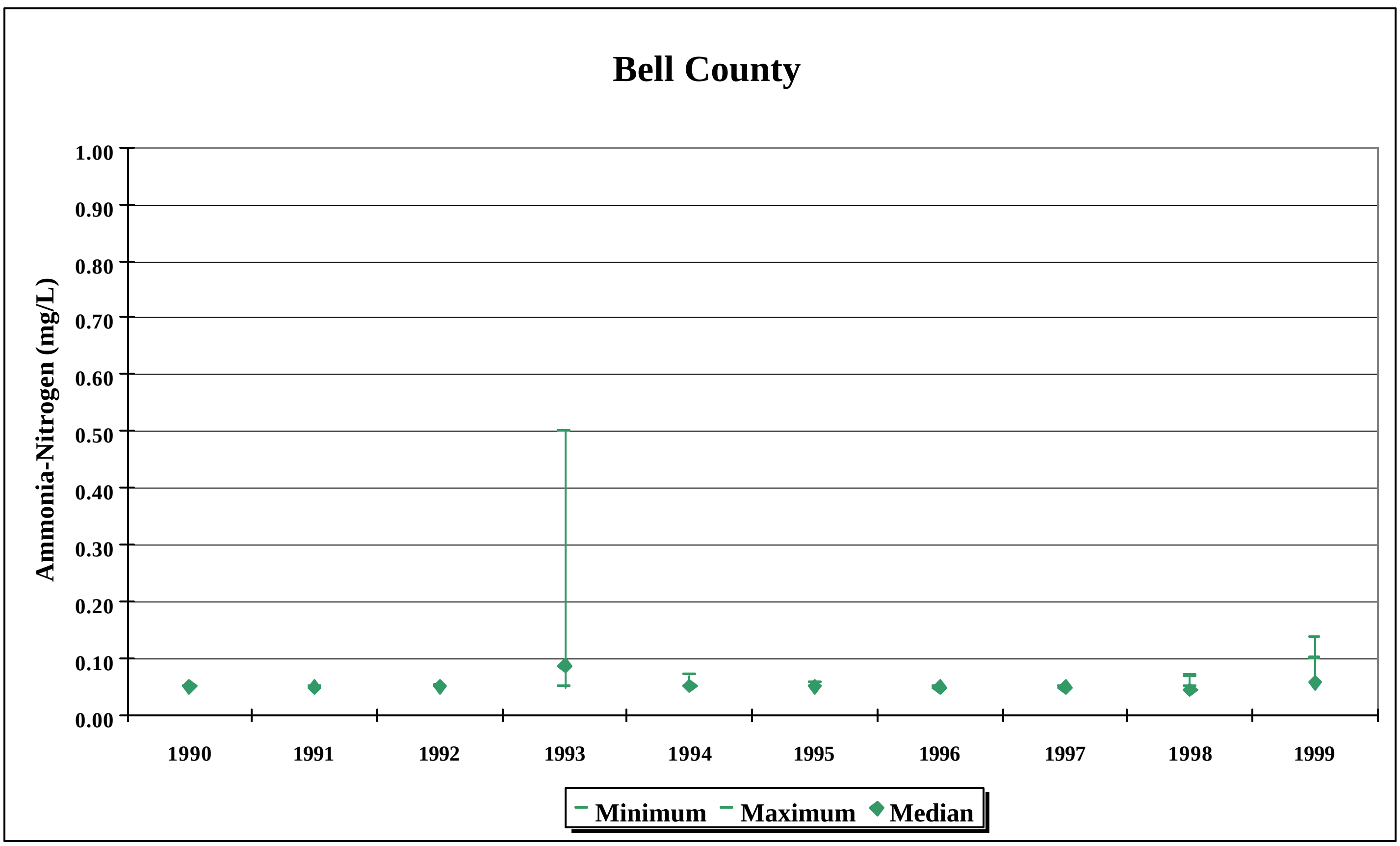

Figure 2.22 Ammonia Results for Bell County

Table 2.9 Ammonia Statistics for Breathitt County

Year	Samples	Maximum	Median	Average
1990	15	0.07	0.05	0.05
1991	11	0.15	0.05	0.06
1992	10	0.05	0.05	0.05
1993	12	0.16	0.05	0.06
1994	12	0.06	0.05	0.05
1995	12	0.06	0.05	0.05
1996	11	0.18	0.05	0.06
1997	15	0.05	0.05	0.05
1998	24	0.17	0.05	0.06
1999	2	0.07	0.05	0.05

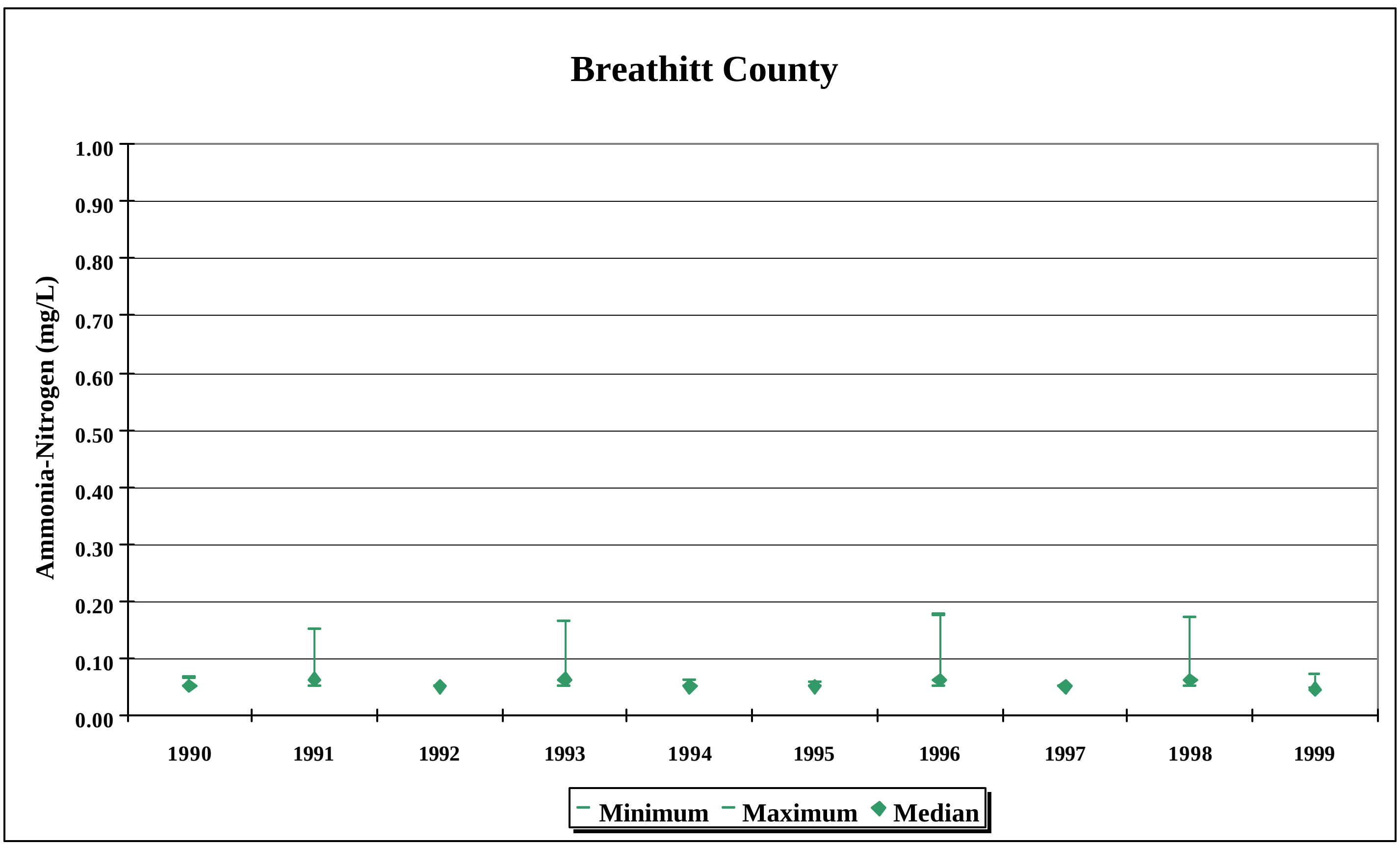

Figure 2.23 Ammonia Results for Breathitt County

Table 2.10 Ammonia Statistics for Clay County

Year	Samples	Maximum	Median	Average
1990	3	0.05	0.05	0.05
1991				
1992				
1993				
1994				
1995				
1996				
1997	4	0.05	0.05	0.05
1998	21	0.10	0.05	0.06
1999				

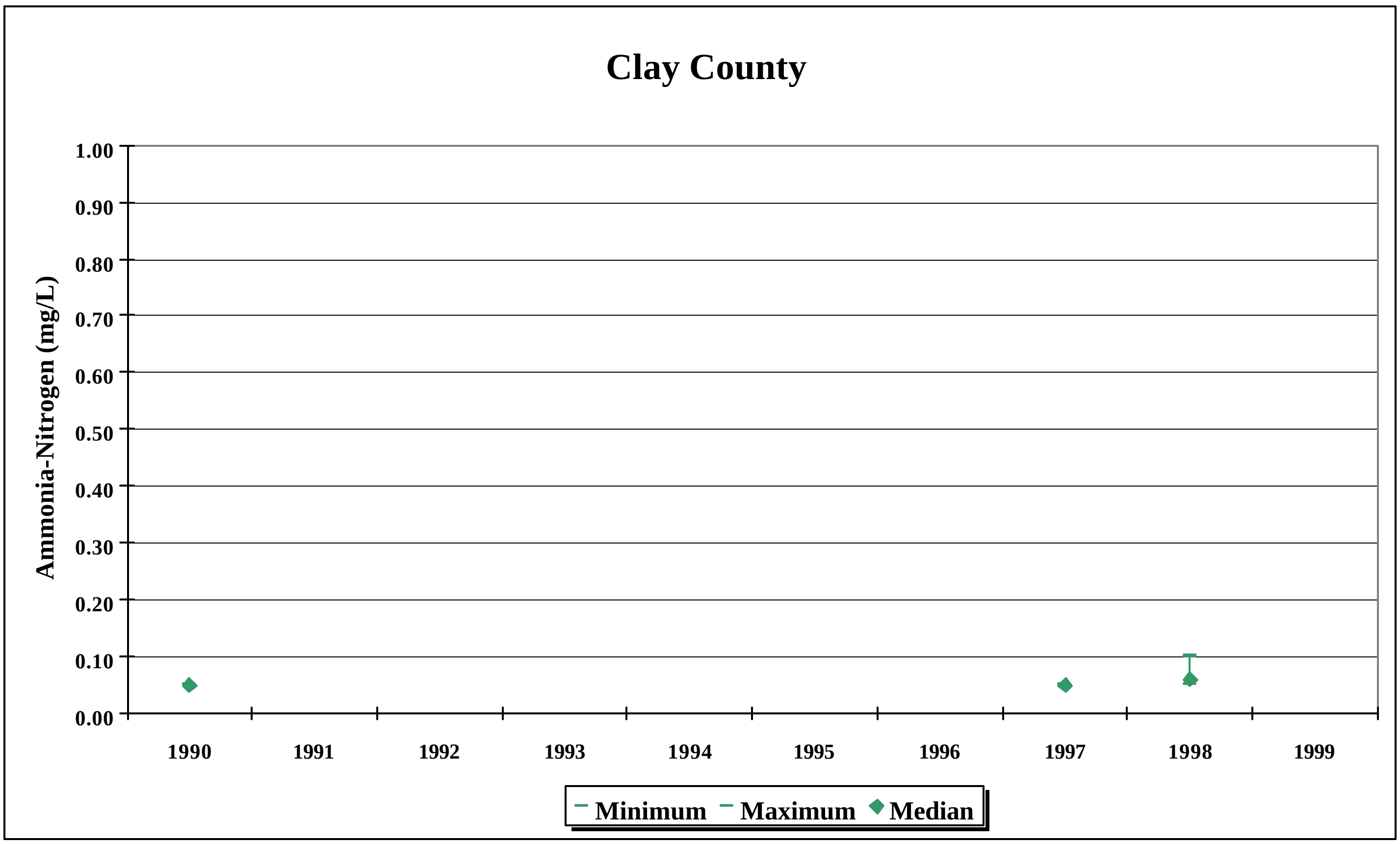

Figure 2.24 Ammonia Results for Clay County

Table 2.11 Ammonia Statistics for Cumberland County

Year	Samples	Maximum	Median	Average
1990	12	0.05	0.05	0.05
1991	12	0.05	0.05	0.05
1992	12	0.05	0.03	0.05
1993	12	0.11	0.05	0.05
1994	12	0.05	0.05	0.05
1995	12	0.17	0.05	0.06
1996	12	0.05	0.05	0.05
1997	11	0.05	0.05	0.05
1998	9	0.05	0.05	0.05
1999	8	0.08	0.05	0.05

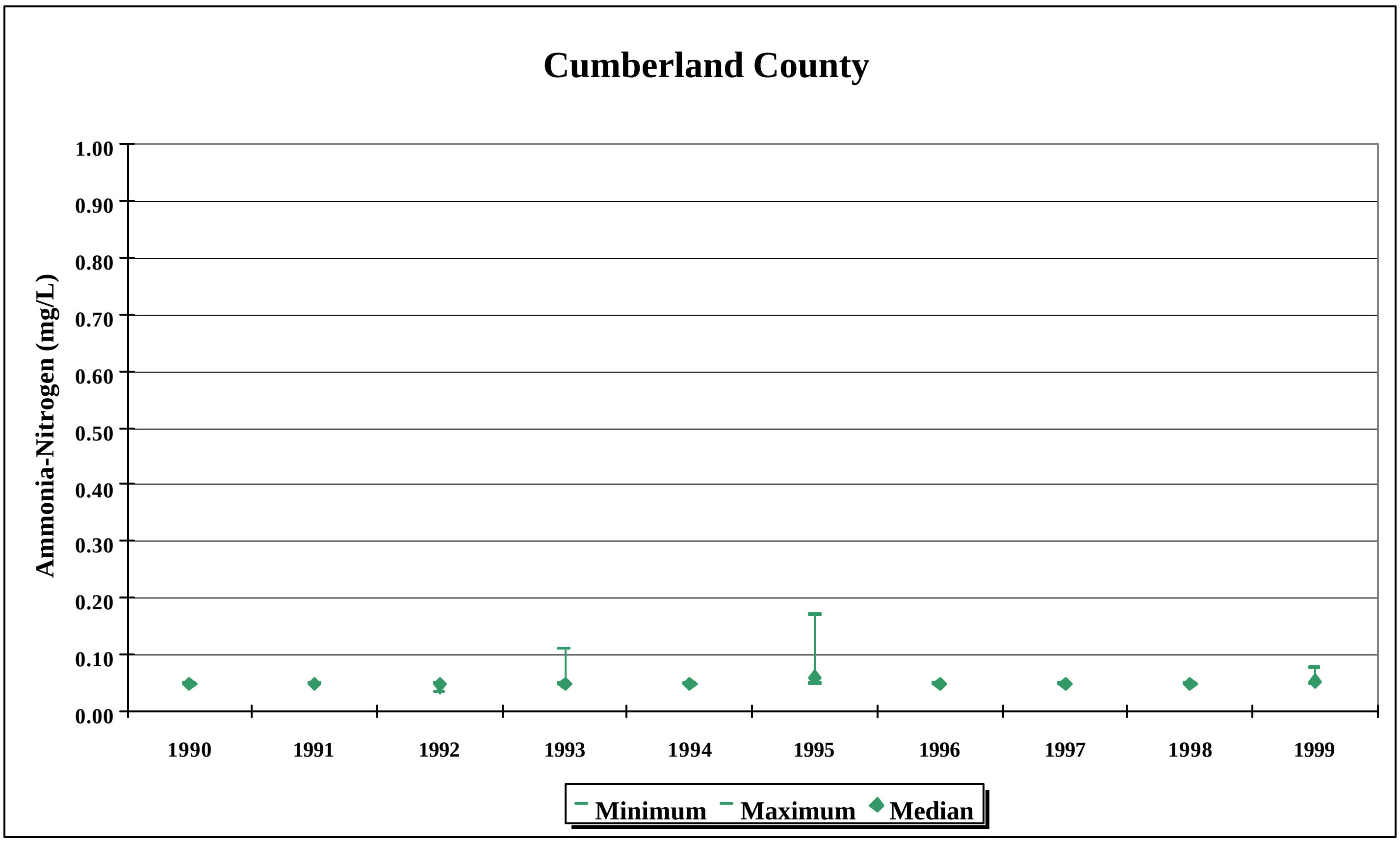

Figure 2.25 Ammonia Results for Cumberland County

Table 2.12 Ammonia Statistics for Estill County

Year	Samples	Maximum	Median	Average
1990				
1991	11	0.16	0.05	0.06
1992	10	0.06	0.05	0.05
1993	12	0.05	0.05	0.05
1994	12	0.06	0.05	0.05
1995	12	0.07	0.05	0.05
1996	11	0.14	0.05	0.06
1997	13	0.06	0.05	0.05
1998	11	0.10	0.05	0.06
1999				

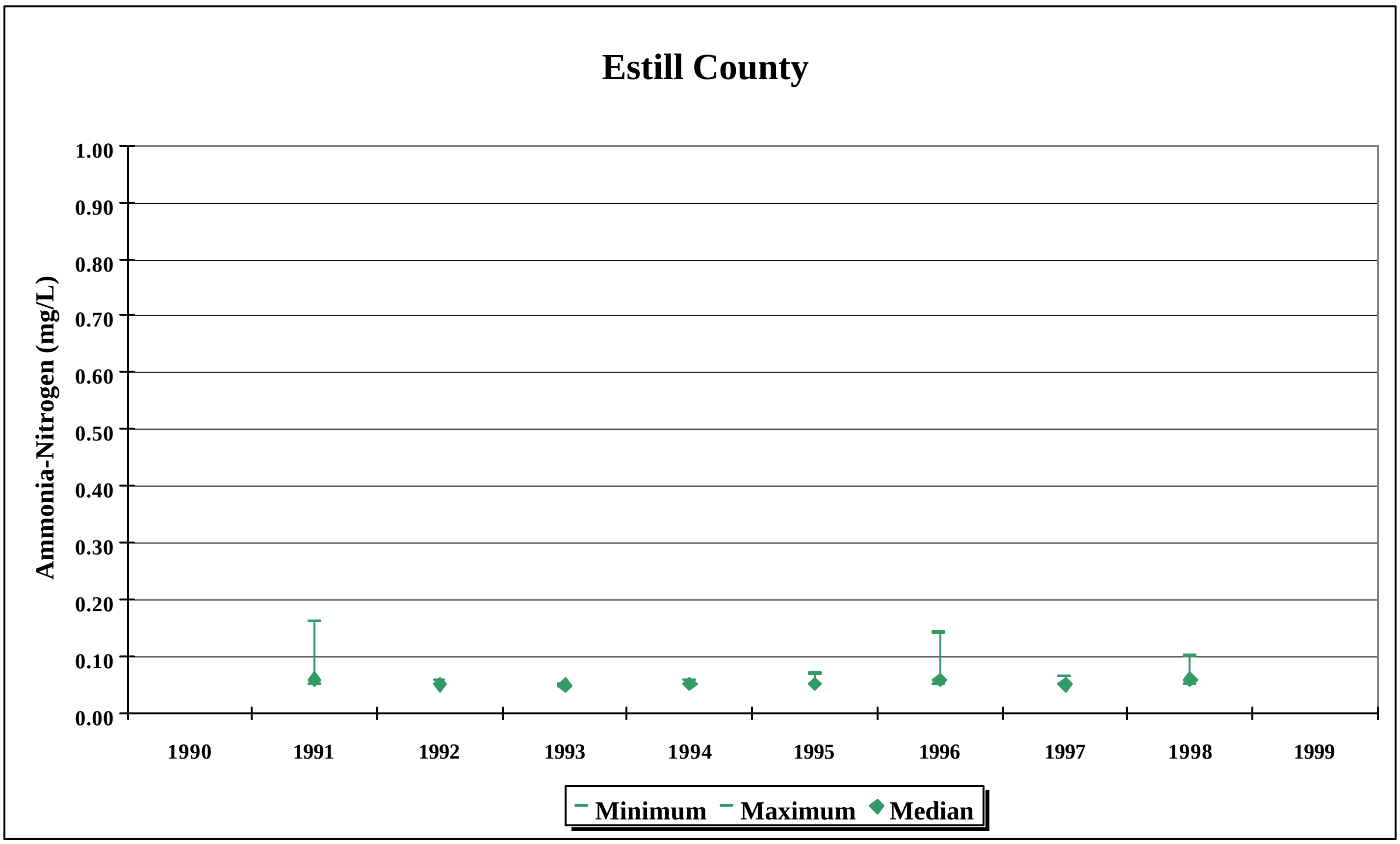

Figure 2.26 Ammonia Results for Estill County

Table 2.13 Ammonia Statistics for Floyd County

Year	Samples	Maximum	Median	Average
1990				
1991	13	0.30	0.10	0.09
1992	1	0.10	0.10	0.10
1993	6	1.22	0.10	0.29
1994				
1995	20	0.82	0.57	0.58
1996	10	0.59	0.13	0.21
1997	4	0.03	0.02	0.02
1998	6	0.16	0.08	0.09
1999	10	1.00	1.00	1.00

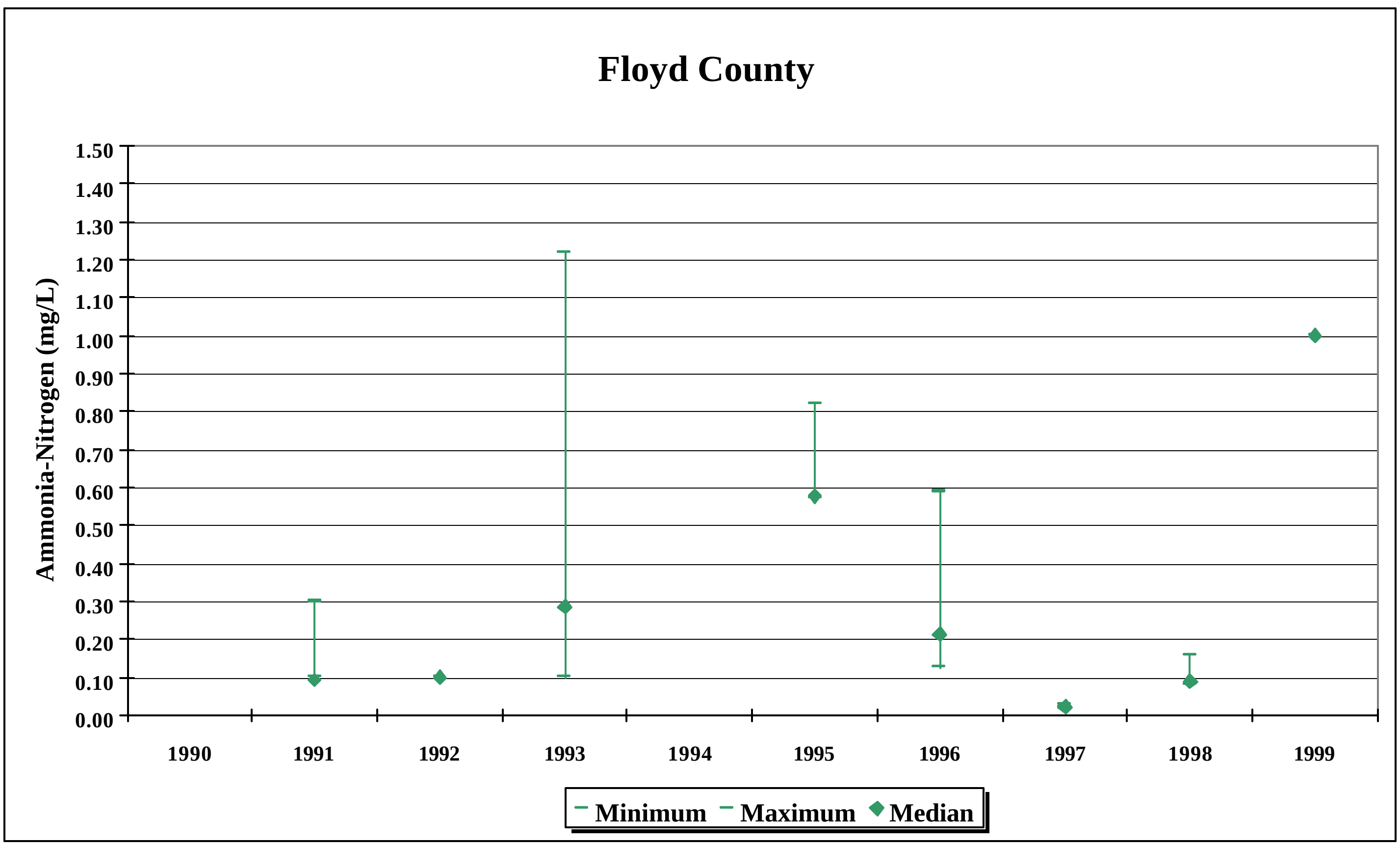

Figure 2.27 Ammonia Results for Floyd County

Table 2.14 Ammonia Statistics for Garrard County

Year	Samples	Maximum	Median	Average
1990				
1991				
1992				
1993				
1994				
1995				
1996				
1997	3	0.05	0.05	0.05
1998	15	0.27	0.05	0.07
1999				

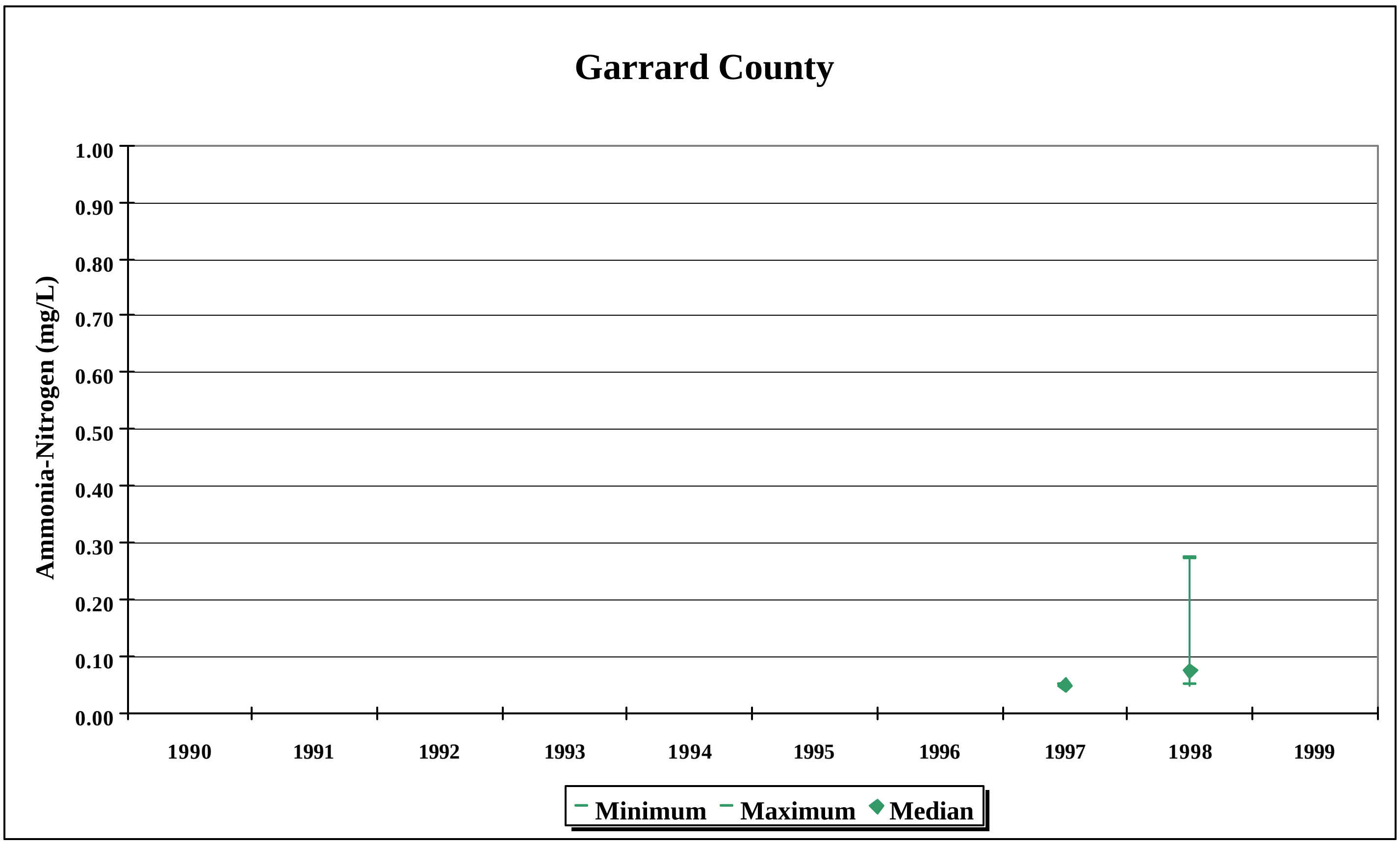

Figure 2.28 Ammonia Results for Garrrard County

Table 2.15 Ammonia Statistics for Green County

Year	Samples	Maximum	Median	Average
1990				
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998	8	0.05	0.05	0.05
1999				

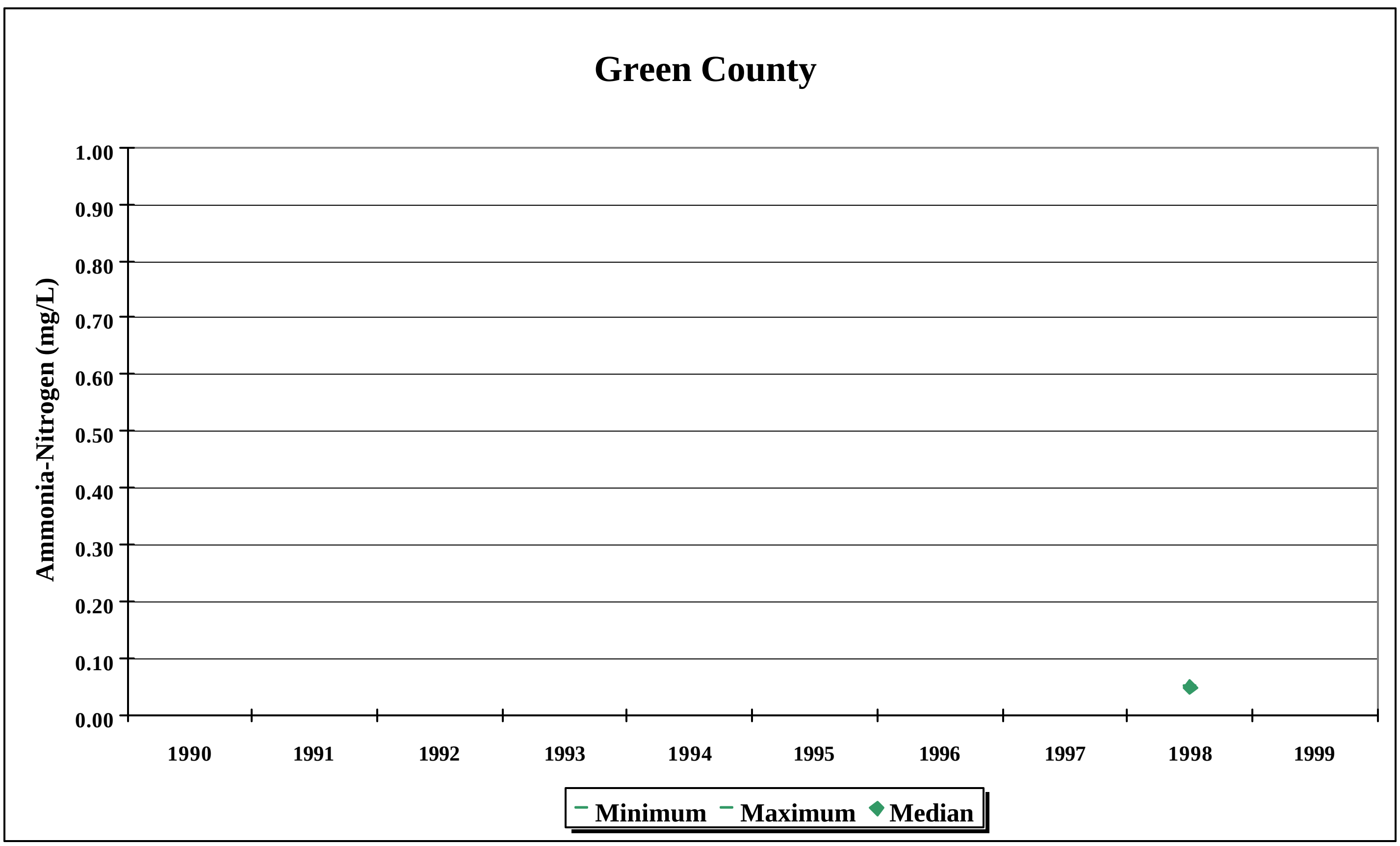

Figure 2.29 Ammonia Results for Green County

Table 2.16 Ammonia Statistics for Harlan County

Year	Samples	Maximum	Median	Average
1990	3	0.05	0.05	0.05
1991				
1992				
1993	15	0.22	0.05	0.06
1994	12	0.23	0.06	0.08
1995				
1996				
1997				
1998				
1999	6	0.05	0.05	0.05

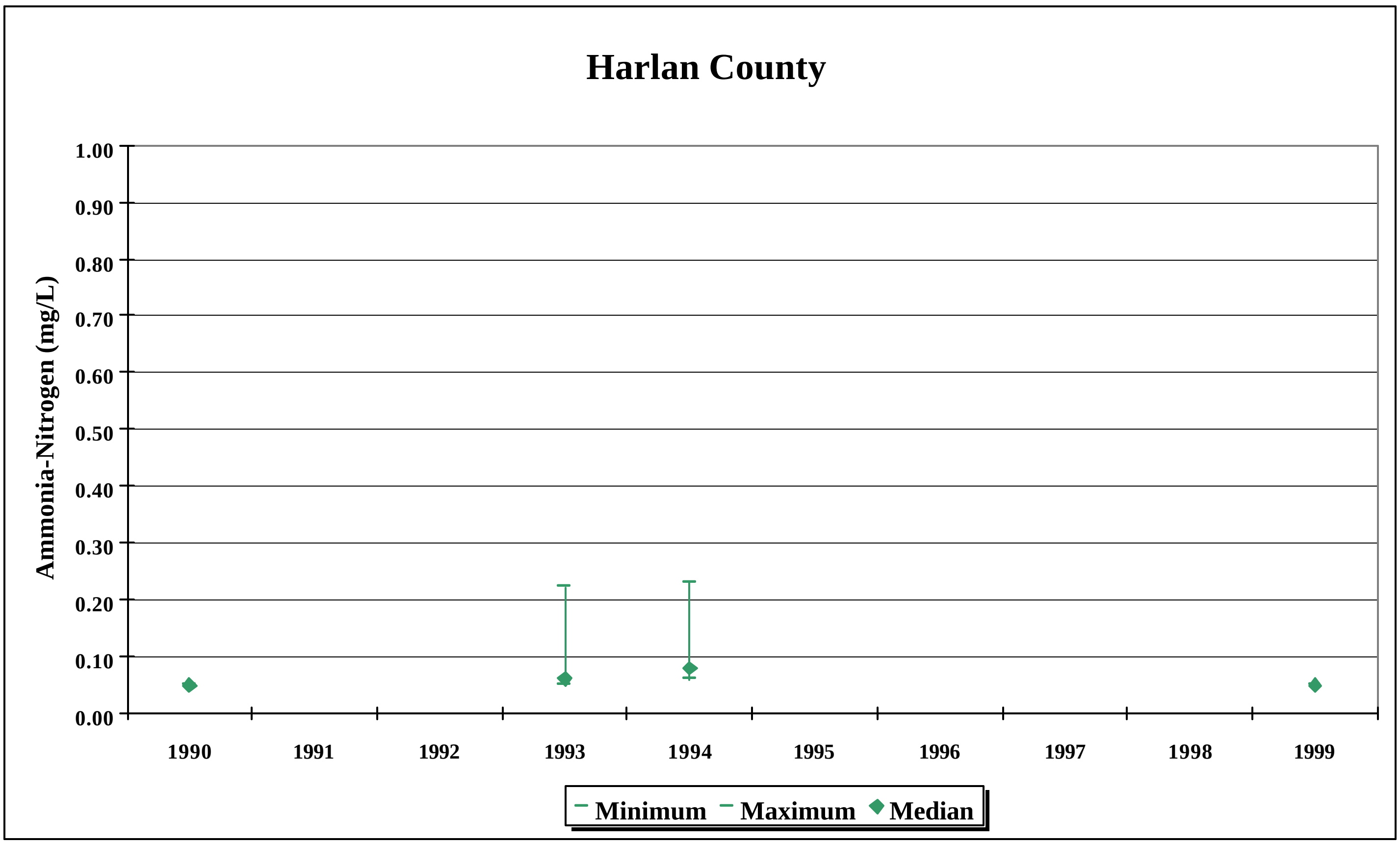

Figure 2.30 Ammonia Results for Harlan County

Table 2.17 Ammonia Statistics for Jackson County

Year	Samples	Maximum	Median	Average
1990	15	0.09	0.05	0.05
1991	11	0.05	0.05	0.05
1992	11	0.05	0.05	0.05
1993	11	0.05	0.05	0.05
1994	12	0.06	0.05	0.05
1995	12	0.50	0.05	0.13
1996	11	0.05	0.05	0.05
1997	12	0.05	0.05	0.05
1998	18	0.10	0.05	0.05
1999	3	0.05	0.05	0.05

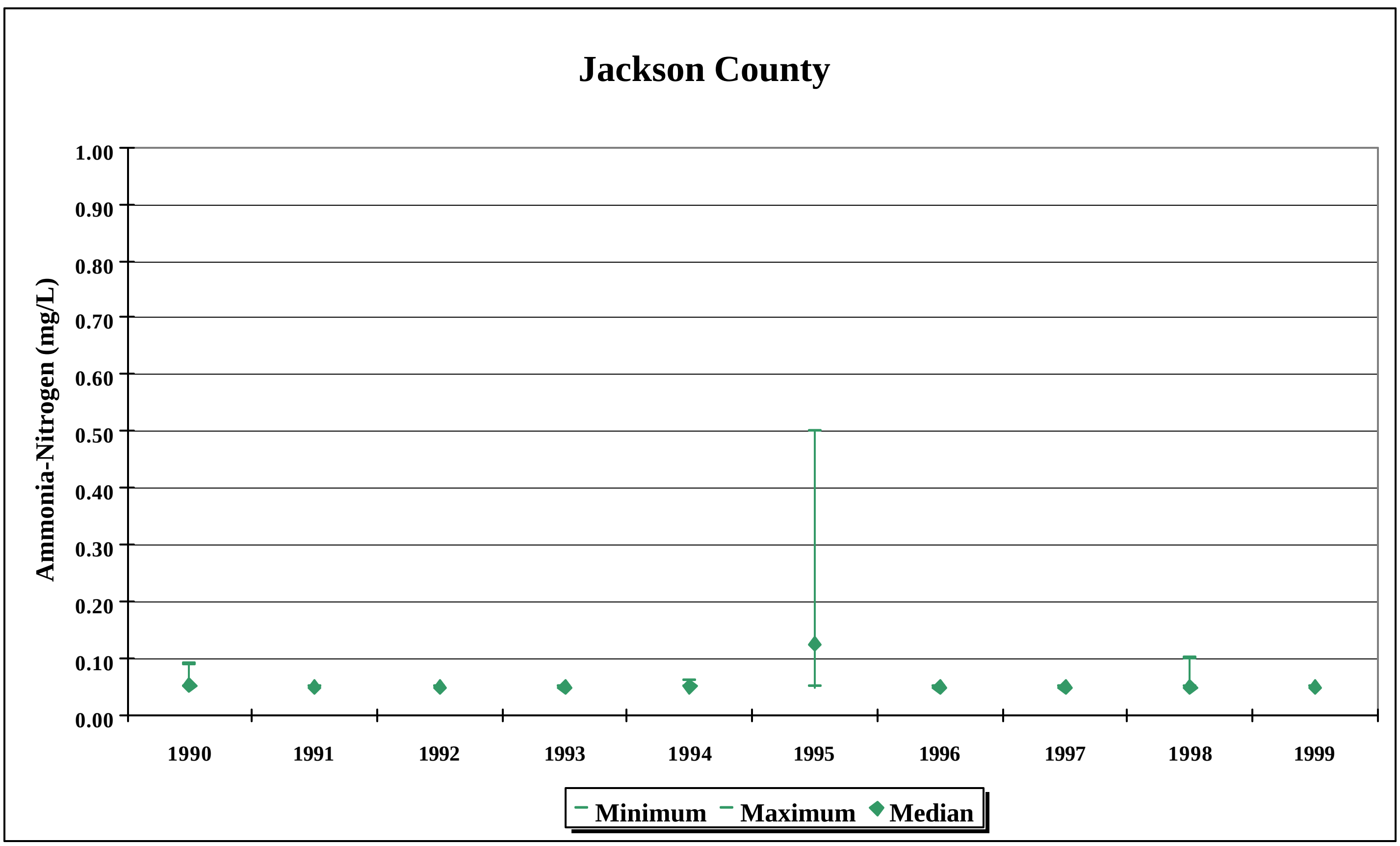

Figure 2.31 Ammonia Results for Jackson County

Table 2.18 Ammonia Statistics for Jessamine County

Year	Samples	Maximum	Median	Average
1990	12	0.07	0.05	0.05
1991	11	0.06	0.05	0.05
1992	11	0.18	0.05	0.06
1993	12	0.05	0.05	0.05
1994	13	0.51	0.05	0.09
1995	11	0.06	0.05	0.05
1996	9	0.05	0.05	0.05
1997	4	0.05	0.05	0.05
1998	4	0.10	0.10	0.10
1999				

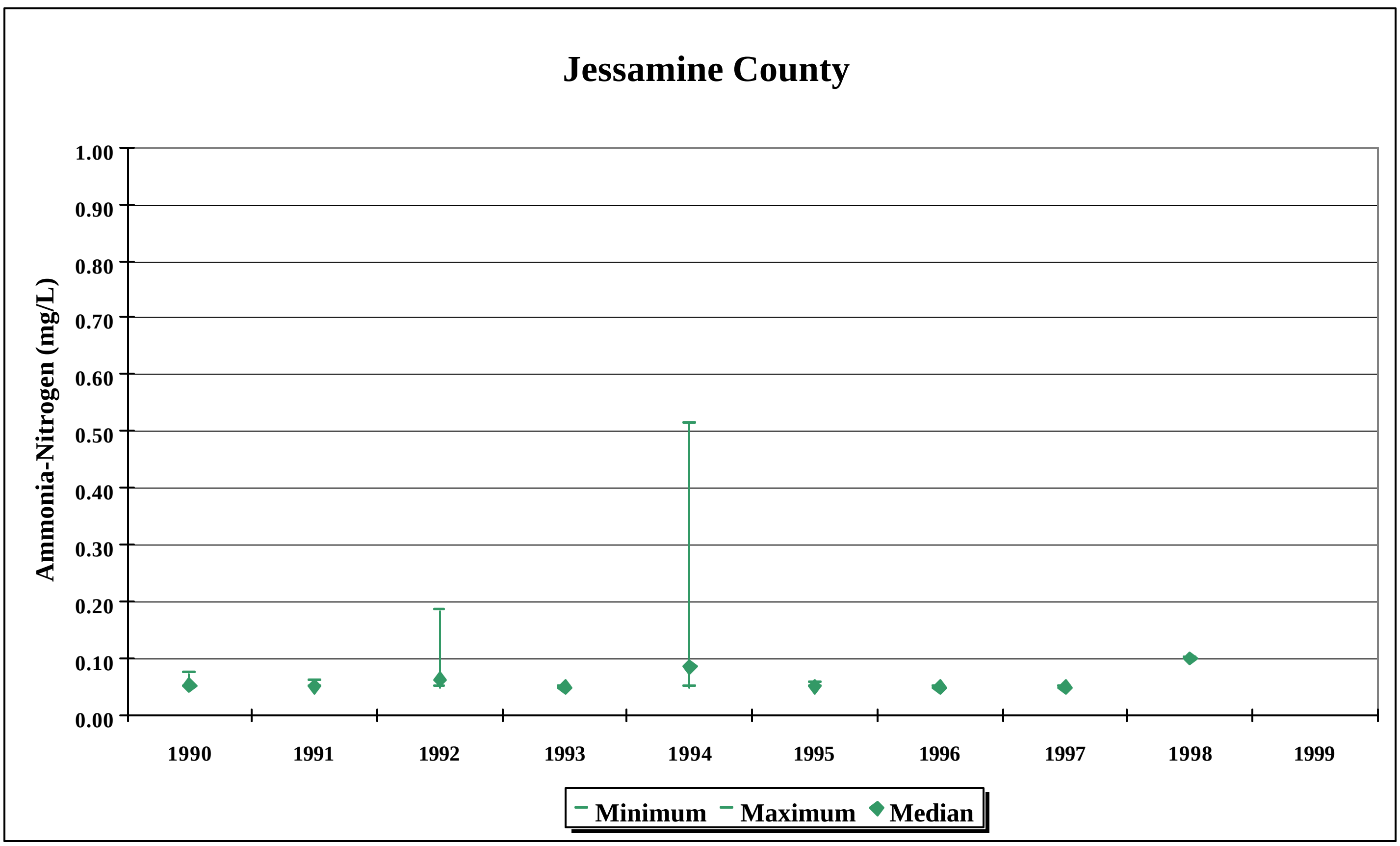

Figure 2.32 Ammonia Results for Jessamine County

Table 2.19 Ammonia Statistics for Johnson County

Year	Samples	Maximum	Median	Average
1990	12	0.06	0.05	0.05
1991	9	0.10	0.10	0.08
1992	204	2.20	0.19	0.31
1993	23	0.32	0.10	0.09
1994	4	0.14	0.05	0.07
1995				
1996				
1997	11	0.10	0.02	0.04
1998				
1999	5	3.00	1.00	1.40

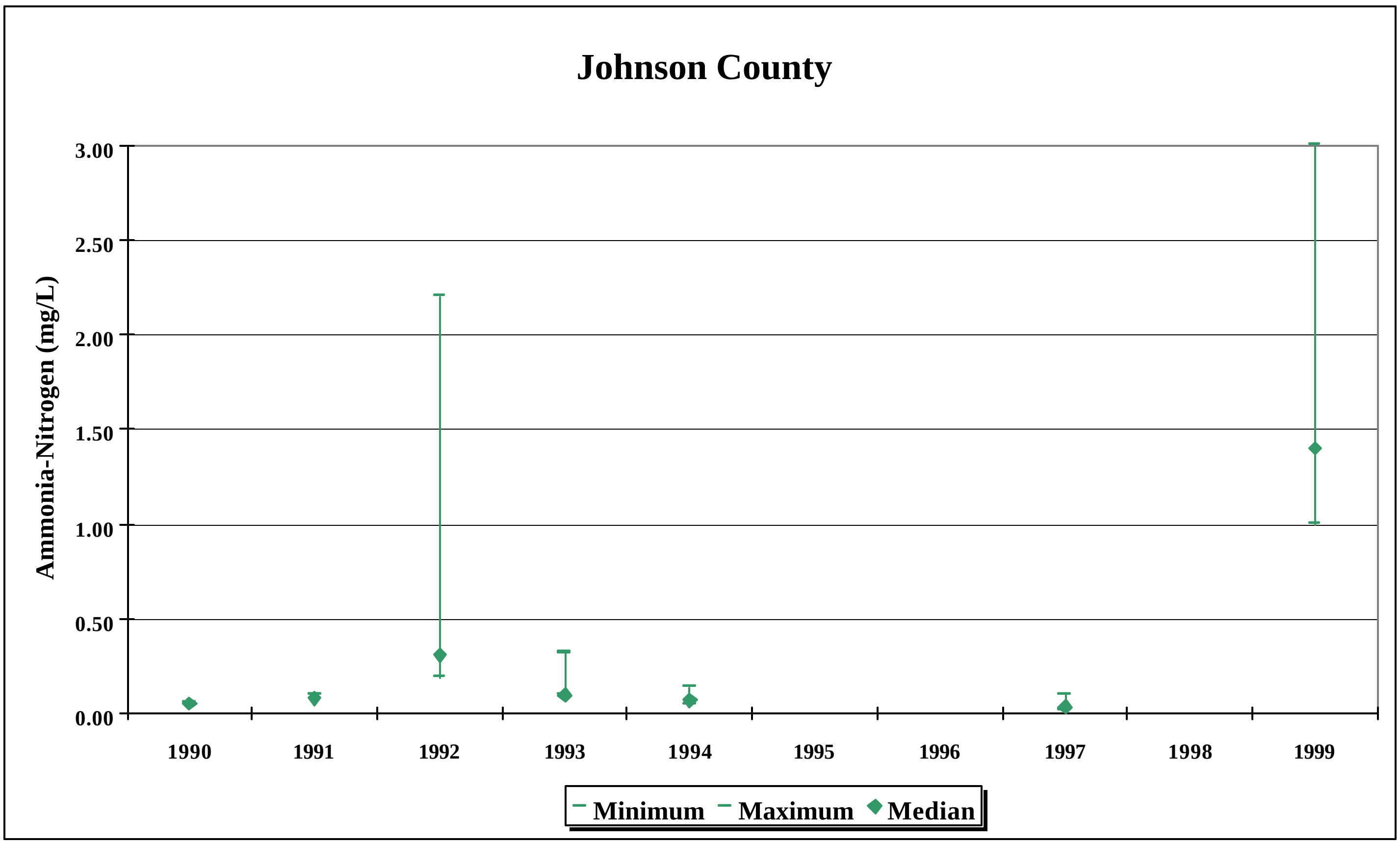

Figure 2.33 Ammonia Results for Johnson County

Table 2.20 Ammonia Statistics for Knott County

Year	Samples	Maximum	Median	Average
1990				
1991				
1992	26	0.50	0.10	0.12
1993				
1994	12	0.37	0.15	0.16
1995				
1996				
1997				
1998				
1999				

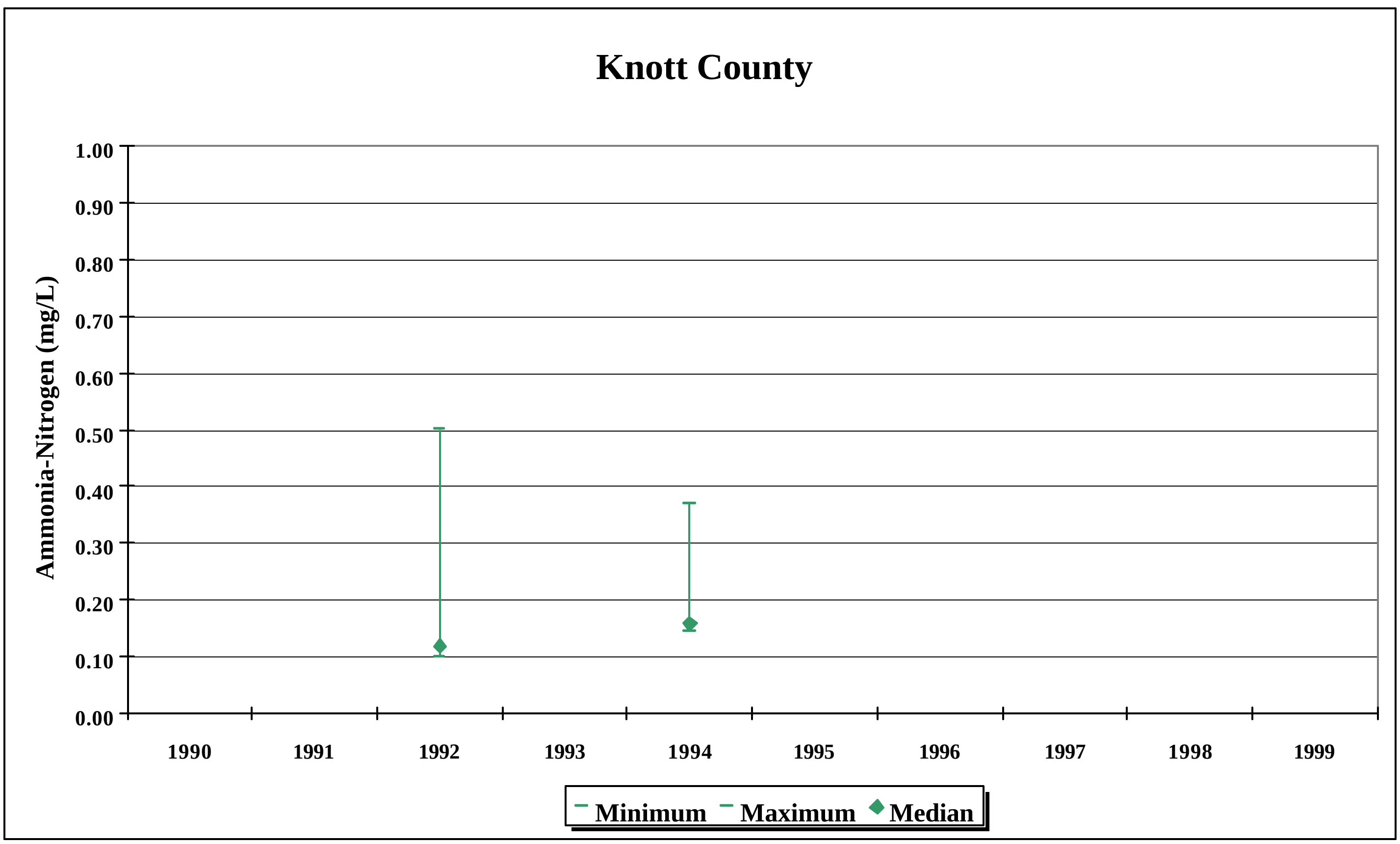

Figure 2.34 Ammonia Results for Knott County

Table 2.21 Ammonia Statistics for Knox County

Year	Samples	Maximum	Median	Average
1990				
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998				
1999	2	0.05	0.05	0.05

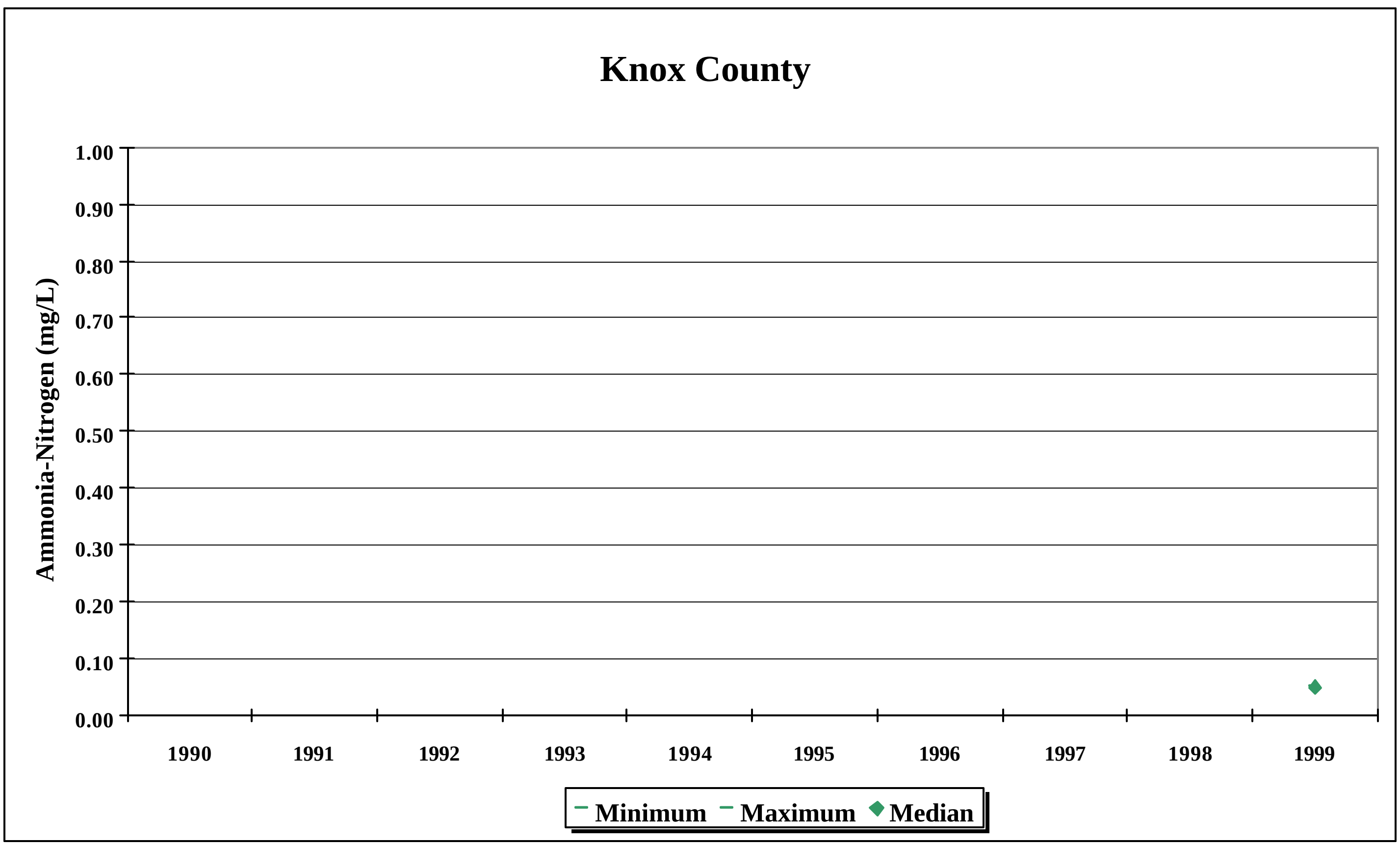

Figure 2.35 Ammonia Results for Knox County

Table 2.22 Ammonia Statistics for Laurel County

Year	Samples	Maximum	Median	Average
1990	18	0.31	0.05	0.07
1991	11	0.05	0.05	0.05
1992	27	0.07	0.05	0.05
1993	27	0.16	0.05	0.06
1994	12	0.07	0.05	0.05
1995	12	0.07	0.05	0.05
1996	18	0.05	0.05	0.05
1997	17	0.05	0.05	0.05
1998	8	0.05	0.05	0.05
1999	1	0.28	0.28	0.28

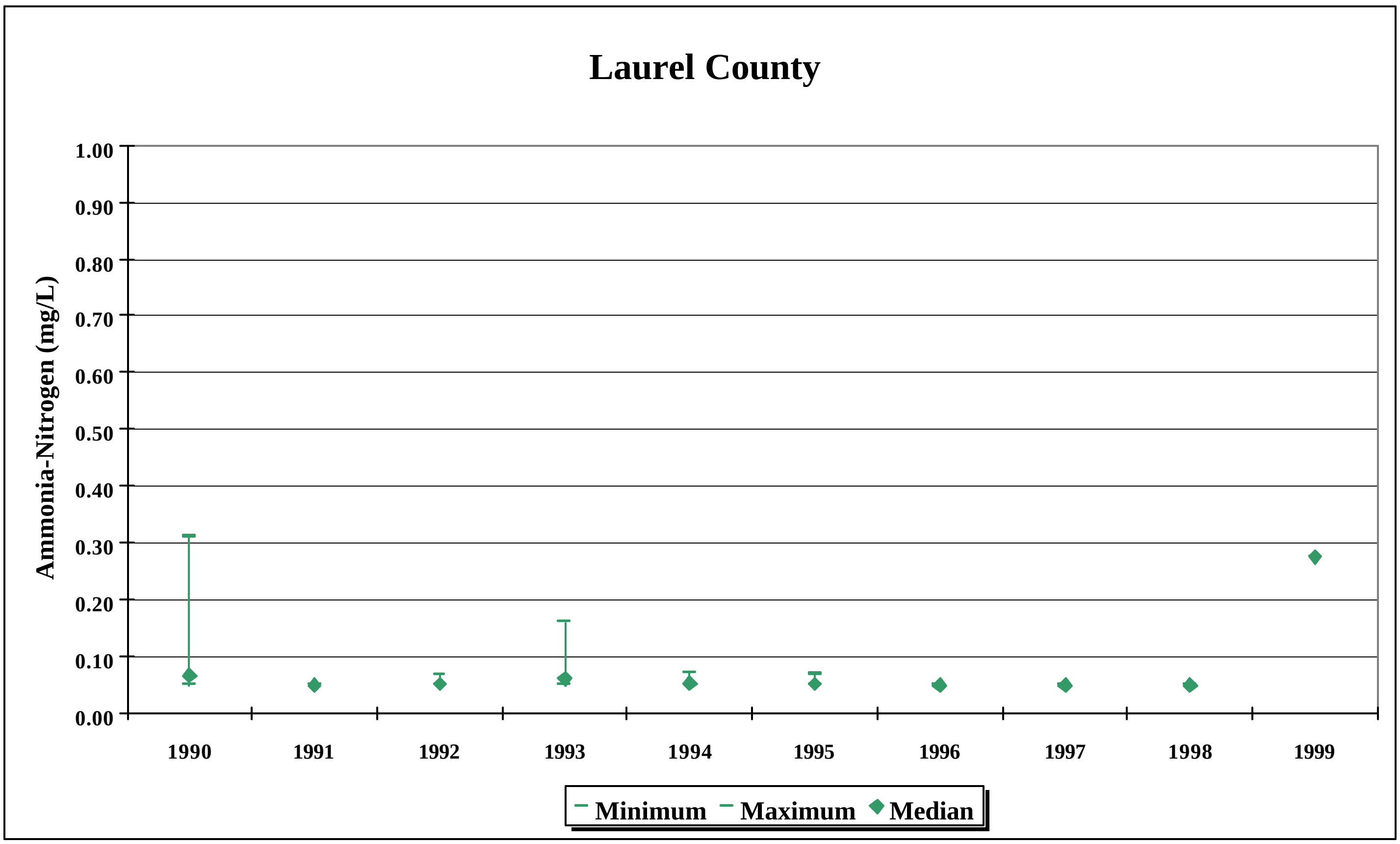

Figure 2.36 Ammonia Results for Laurel County

Table 2.23 Ammonia Statistics for Lawrence County

Year	Samples	Maximum	Median	Average
1990	24	0.22	0.05	0.06
1991	28	1.20	0.05	0.12
1992	60	0.75	0.10	0.15
1993	63	1.42	0.08	0.16
1994	123	2.40	0.02	0.13
1995	92	3.00	0.35	0.52
1996	101	1.91	0.05	0.10
1997	138	1.54	0.04	0.09
1998	14	0.07	0.05	0.05
1999	1	1.00	1.00	1.00

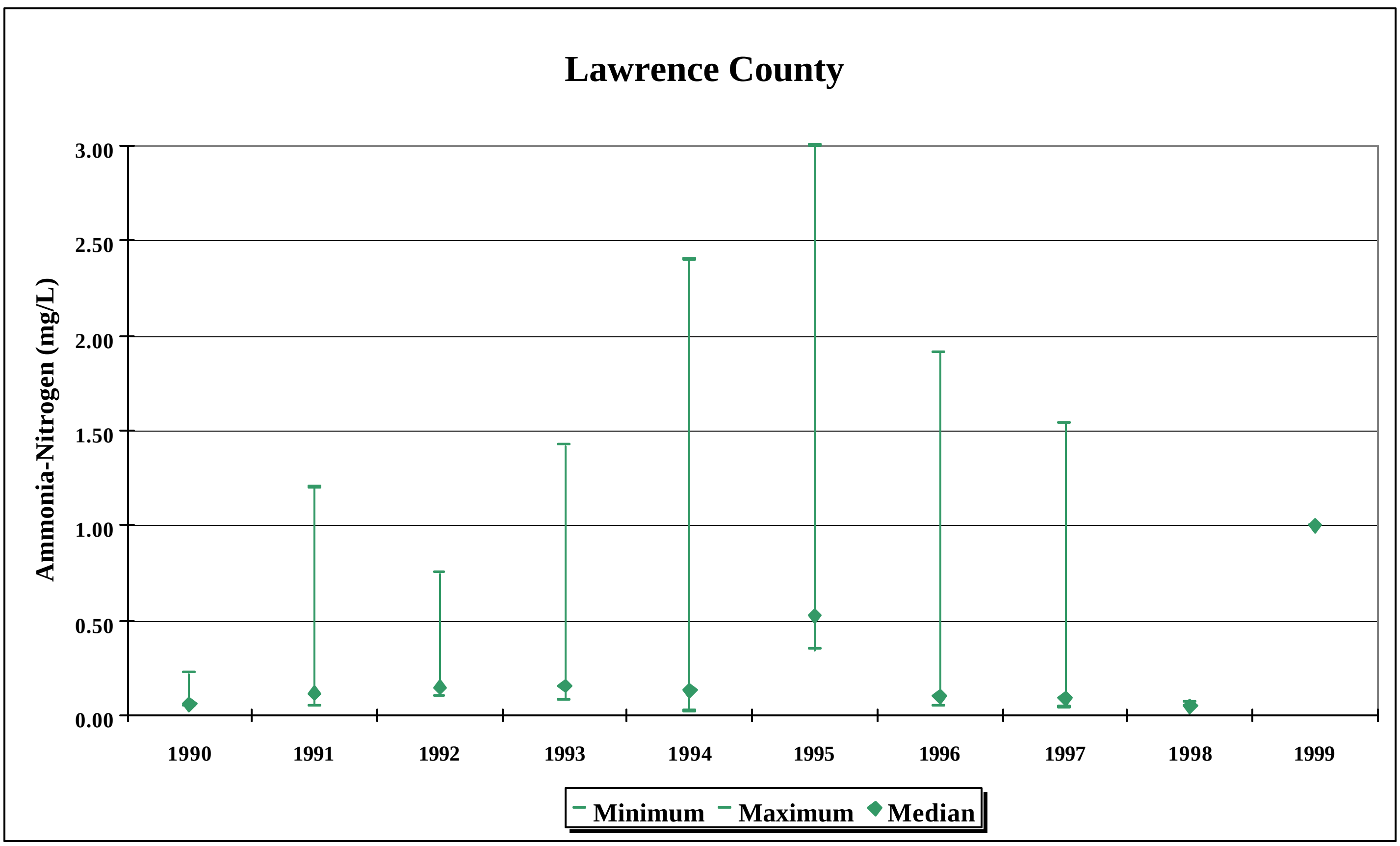

Figure 2.37 Ammonia Results for Lawrence County

Table 2.24 Ammonia Statistics for Lee County

Year	Samples	Maximum	Median	Average
1990	24	0.06	0.05	0.05
1991	11	0.30	0.05	0.08
1992	11	0.08	0.05	0.05
1993	12	0.05	0.05	0.05
1994	12	0.05	0.05	0.05
1995	12	0.09	0.05	0.05
1996	11	0.05	0.05	0.05
1997	11	0.06	0.05	0.05
1998	11	0.05	0.05	0.05
1999	1	0.10	0.10	0.10

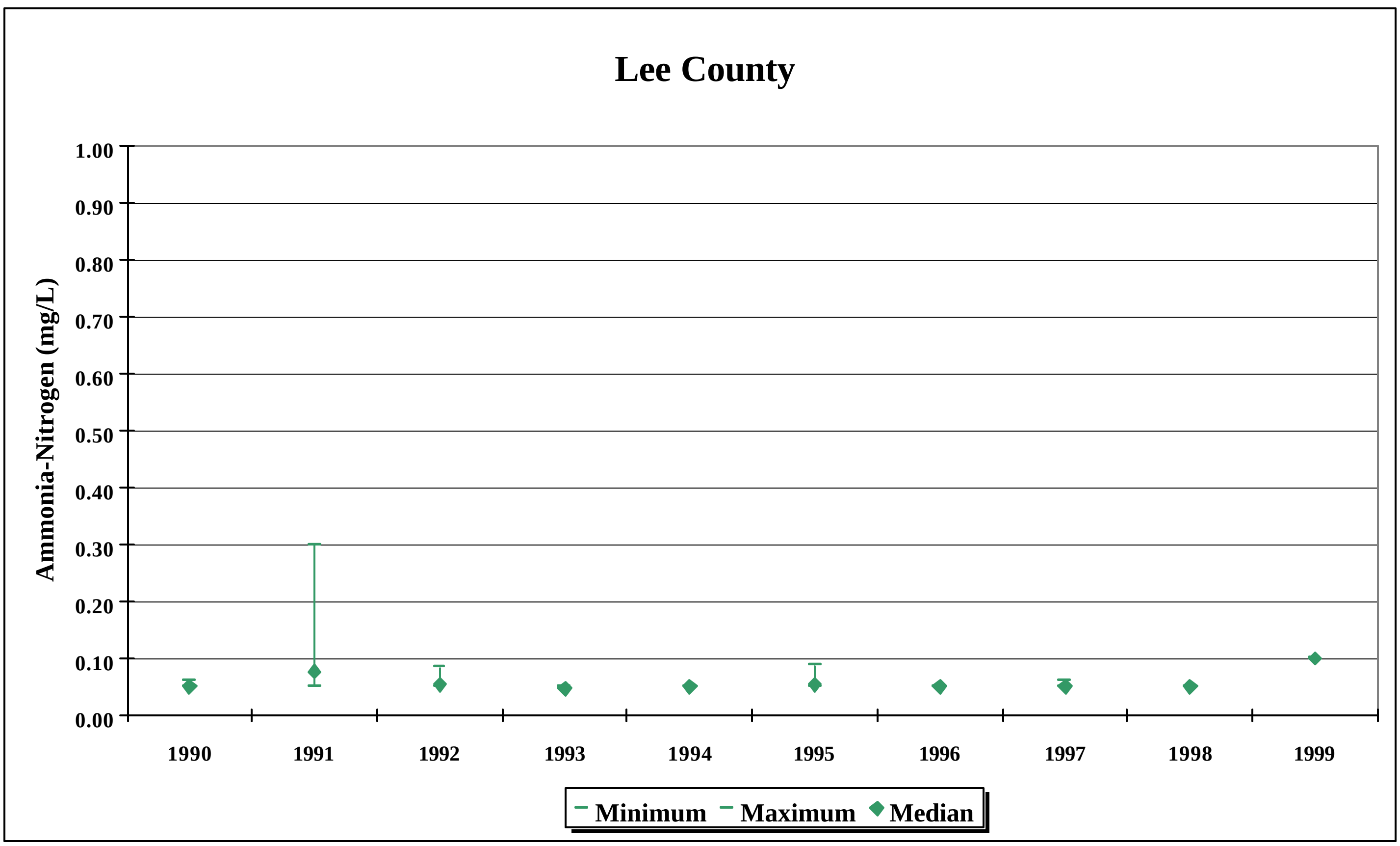

Figure 2.38 Ammonia Results for Lee County

Table 2.25 Ammonia Statistics for Leslie County

Year	Samples	Maximum	Median	Average
1990	4	0.10	0.10	0.10
1991	12	0.10	0.10	0.10
1992	12	0.10	0.10	0.10
1993				
1994				
1995				
1996				
1997	11	0.20	0.05	0.06
1998	17	0.10	0.05	0.06
1999				

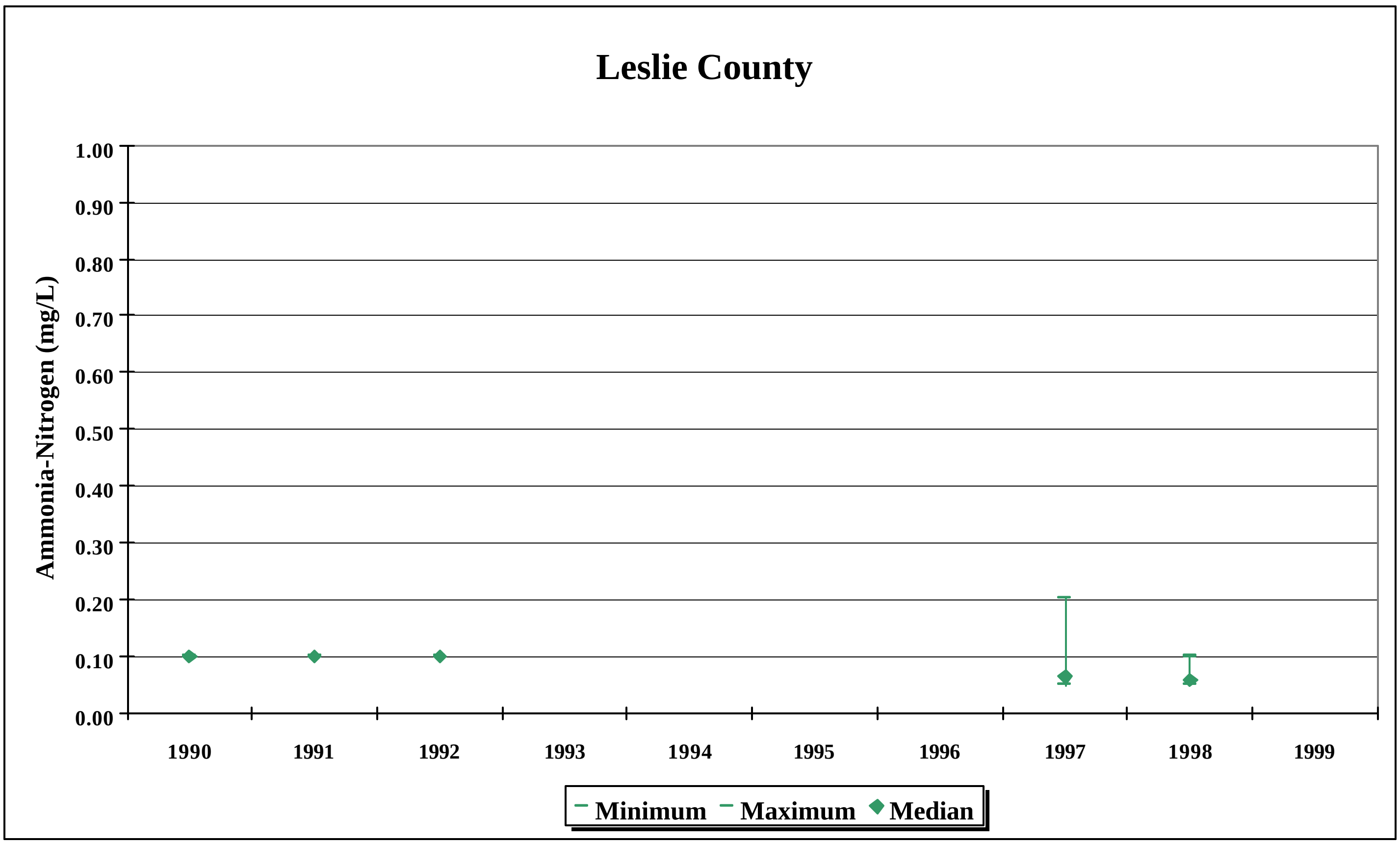

Figure 2.39 Ammonia Results for Leslie County

Table 2.26 Ammonia Statistics for Letcher County

Year	Samples	Maximum	Median	Average
1990	3	0.05	0.05	0.05
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998	12	0.10	0.05	0.06
1999				

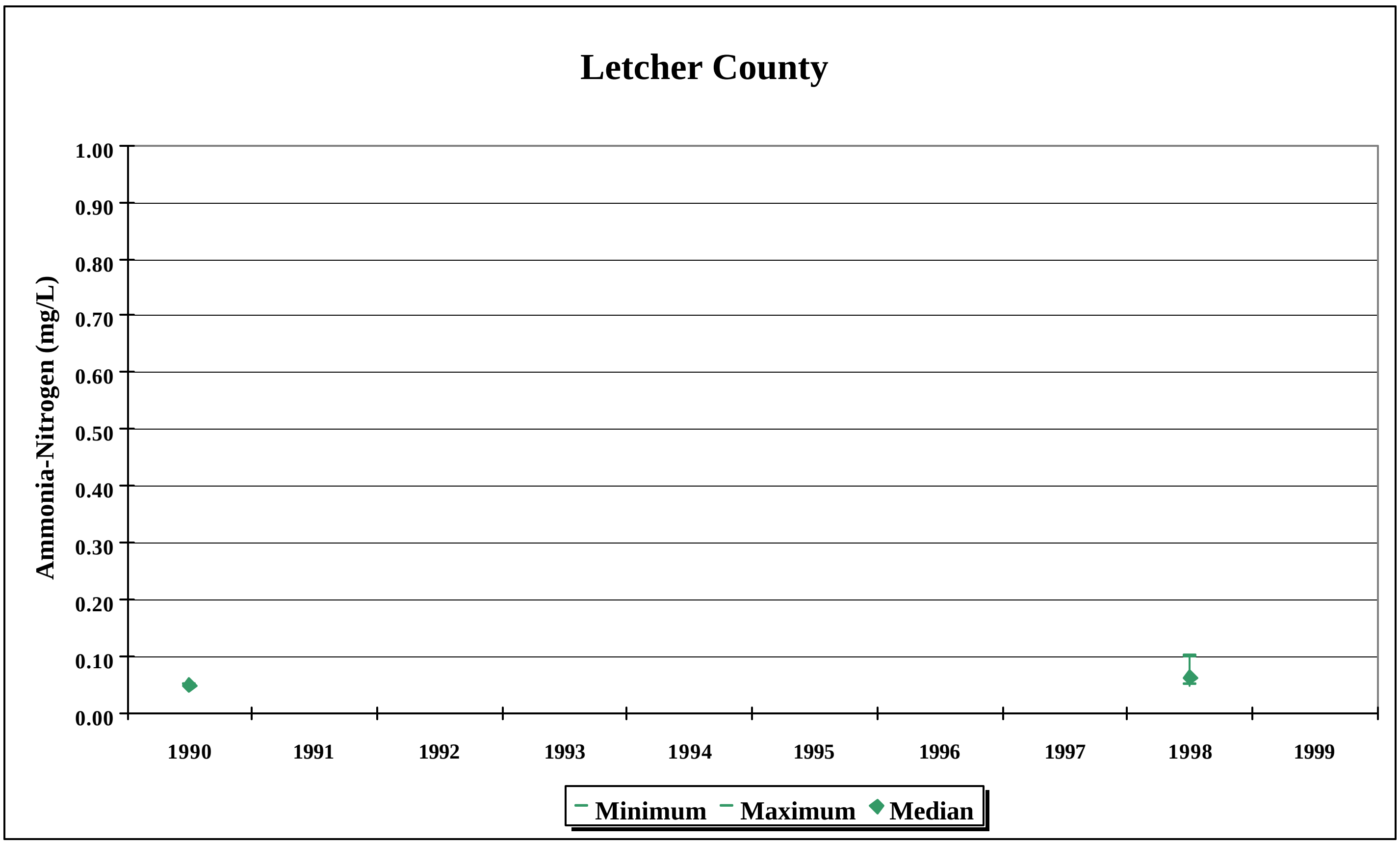

Figure 2.40 Ammonia Results for Letcher County

Table 2.27 Ammonia Statistics for Lincoln County

Year	Samples	Maximum	Median	Average
1990				
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998	3	0.05	0.05	0.05
1999				

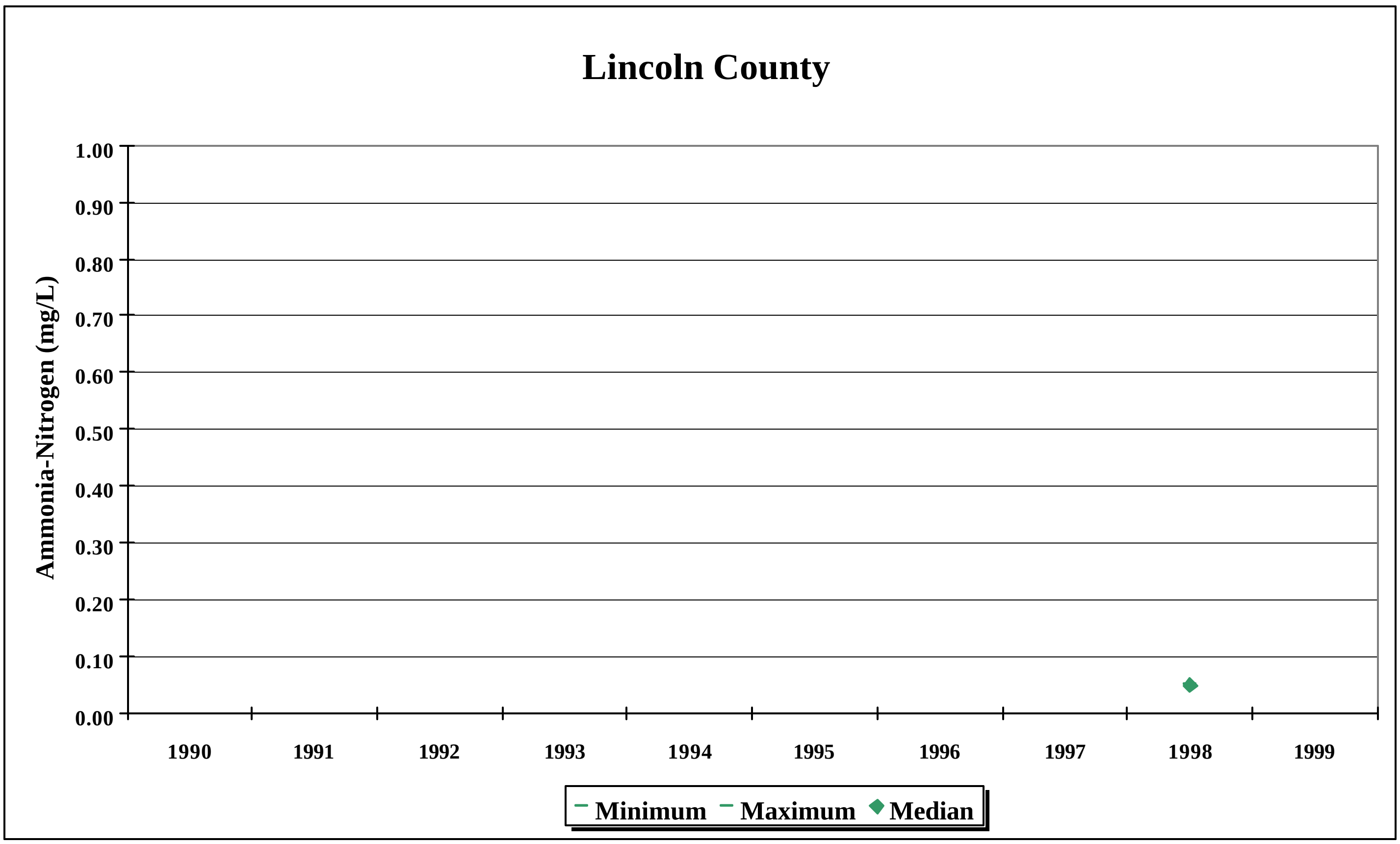

Figure 2.41 Ammonia Results for Lincoln County

Table 2.28 Ammonia Statistics for Magoffin County

Year	Samples	Maximum	Median	Average
1990	12	0.19	0.07	0.09
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998	4	0.05	0.05	0.05
1999	3	0.09	0.05	0.06

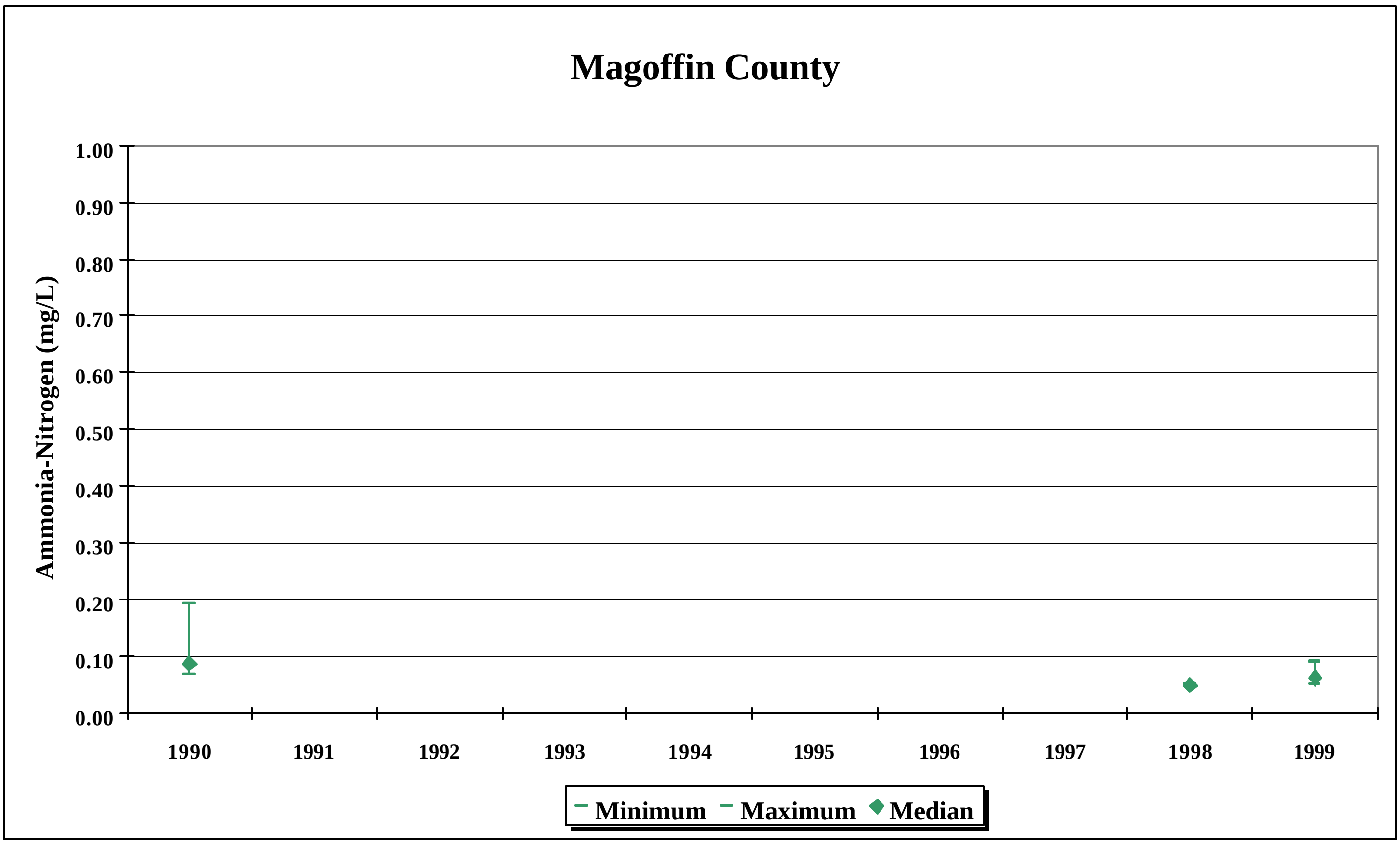

Figure 2.42 Ammonia Results for Magoffin County

Table 2.29 Ammonia Statistics for Martin County

Year	Samples	Maximum	Median	Average
1990	12	0.05	0.05	0.05
1991	10	0.16	0.05	0.06
1992	12	0.50	0.05	0.09
1993	12	0.09	0.05	0.05
1994	12	0.14	0.05	0.06
1995	12	0.07	0.05	0.05
1996	12	0.05	0.05	0.05
1997	12	0.05	0.05	0.05
1998	12	0.10	0.05	0.06
1999				

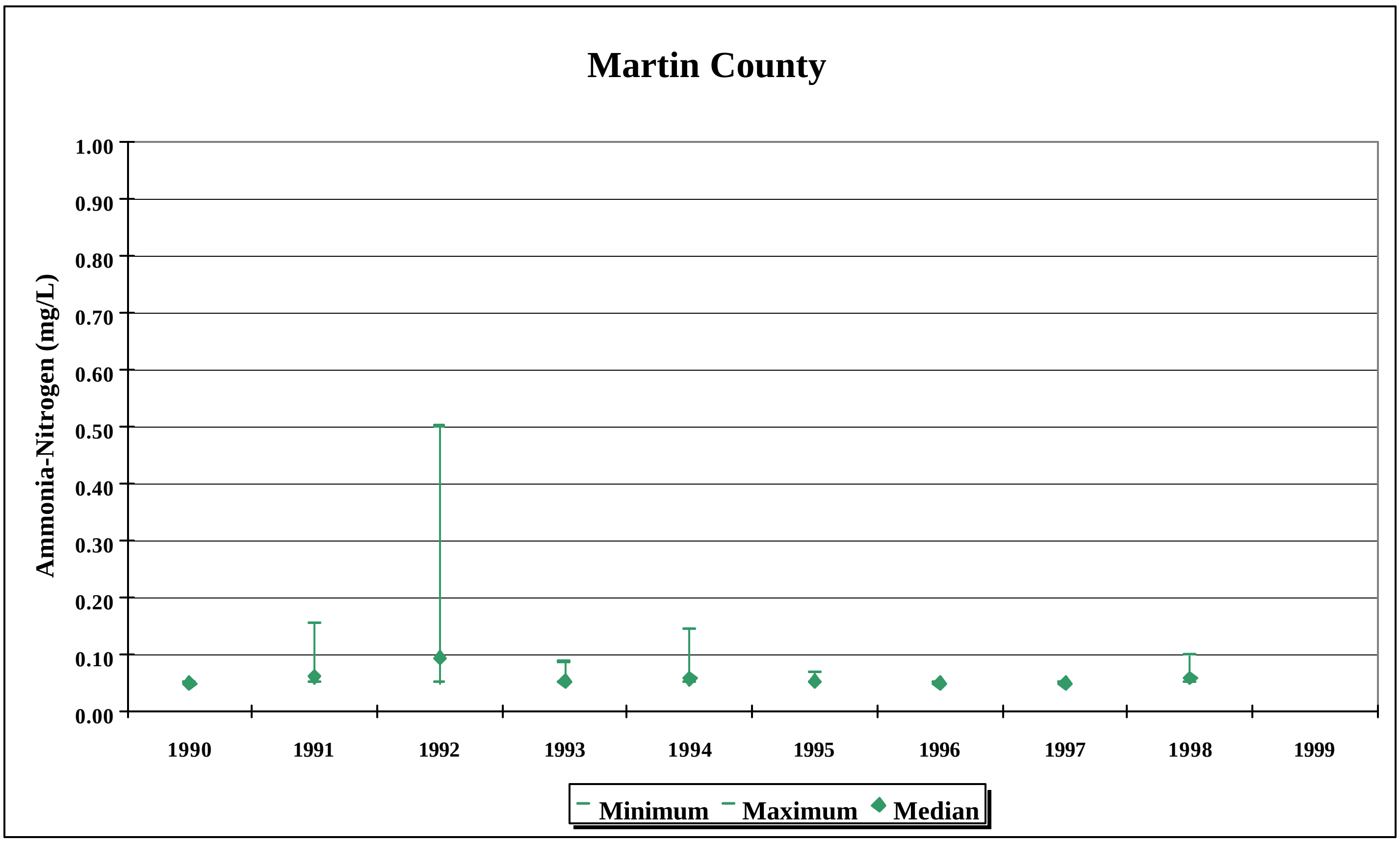

Figure 2.43 Ammonia Results for Martin County

Table 2.30 Ammonia Statistics for McCreary County

Year	Samples	Maximum	Median	Average
1990	24	0.05	0.05	0.04
1991	25	0.08	0.05	0.05
1992	25	0.05	0.05	0.04
1993	20	0.09	0.05	0.05
1994	20	0.05	0.05	0.05
1995	18	0.05	0.05	0.05
1996	12	0.05	0.05	0.05
1997	10	0.05	0.05	0.05
1998	11	0.05	0.05	0.05
1999	2	0.05	0.05	0.05

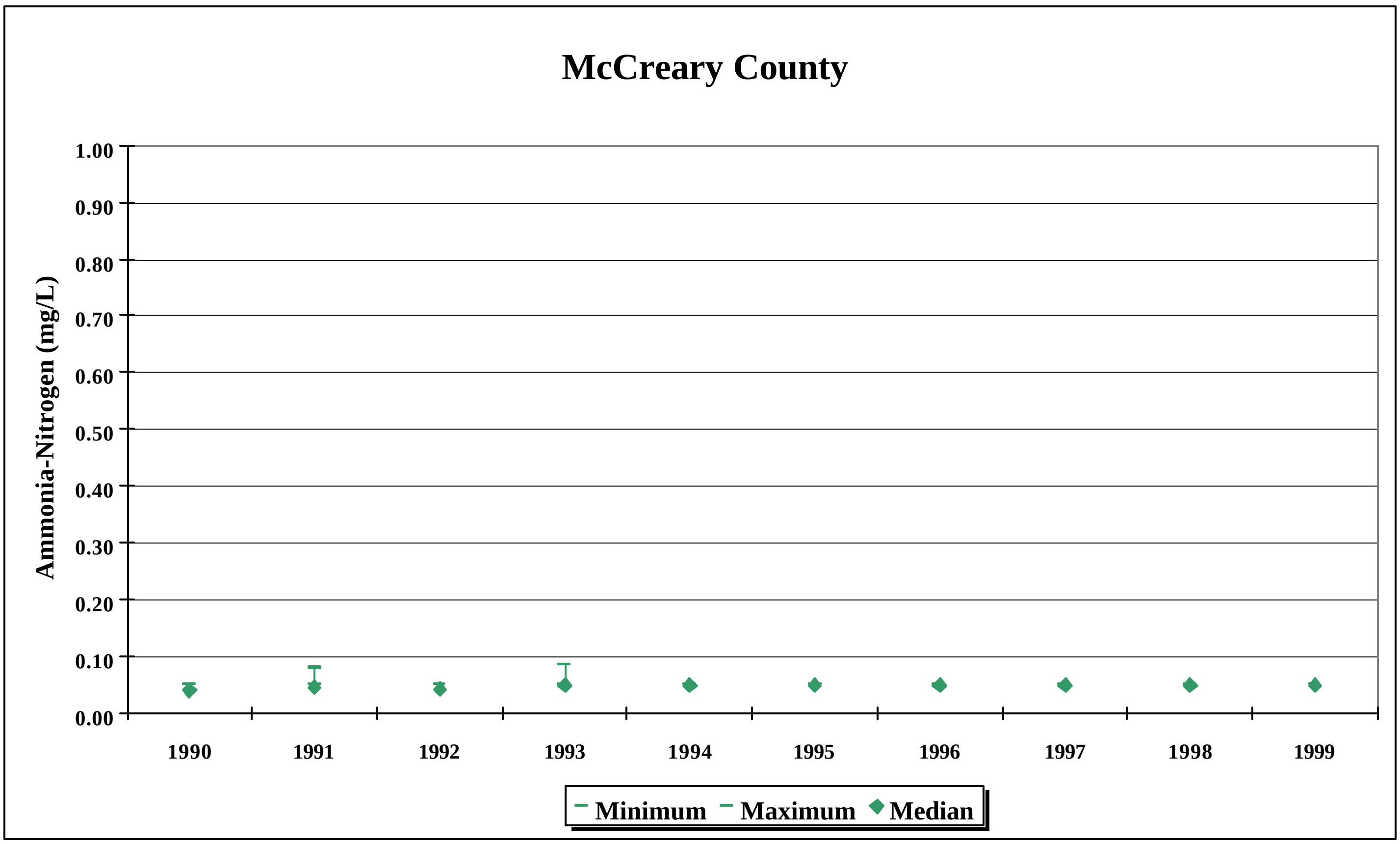

Figure 2.44 Ammonia Results for McCreary County

Table 2.31 Ammonia Statistics for Menifee County

Year	Samples	Maximum	Median	Average
1990				
1991				
1992				
1993				
1994				
1995				
1996				
1997	1	0.05	0.05	0.05
1998	7	0.10	0.05	0.06
1999	1	0.05	0.05	0.05

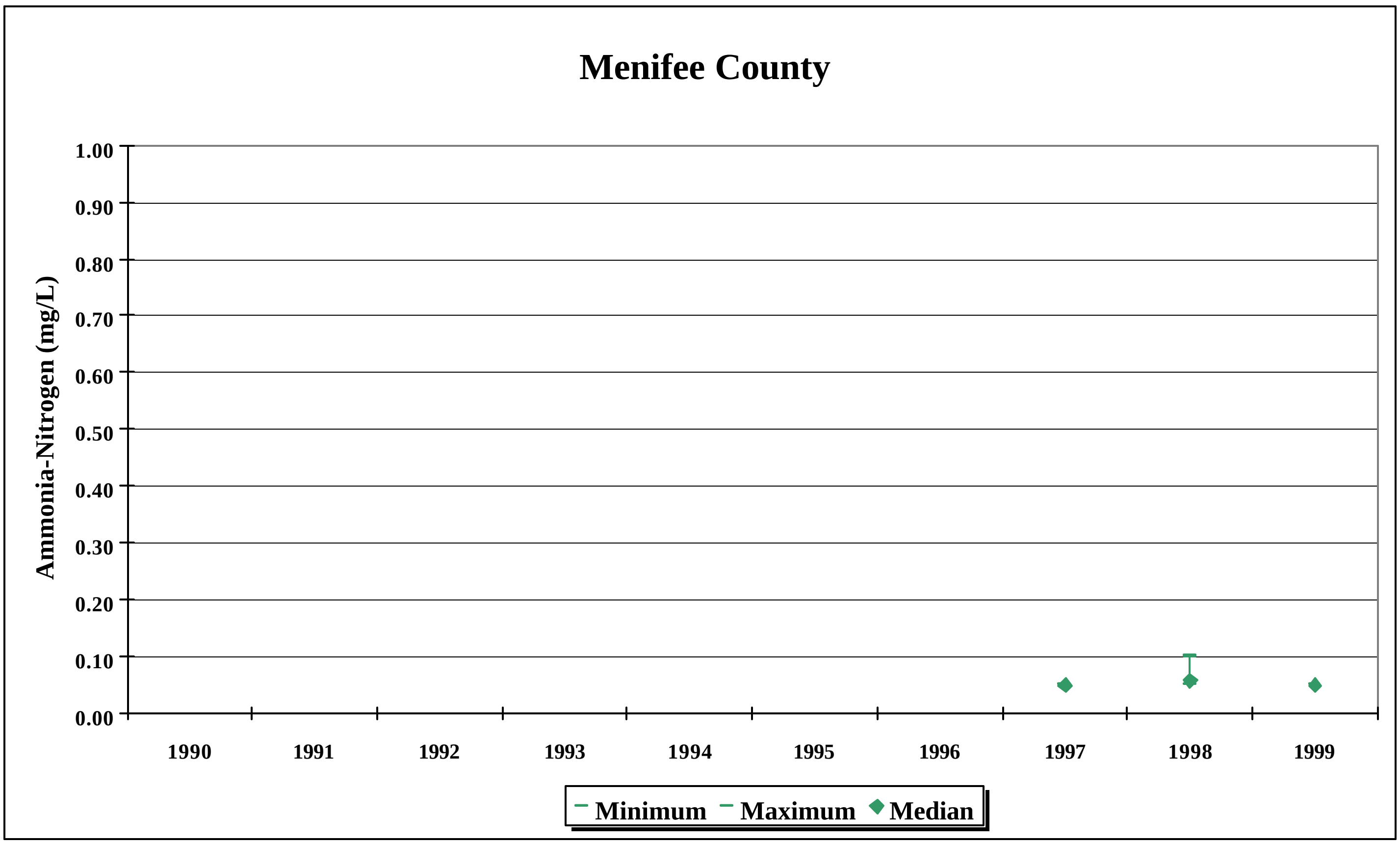

Figure 2.45 Ammonia Results for Menifee County

Table 2.32 Ammonia Statistics for Metcalfe County

Year	Samples	Maximum	Median	Average
1990	3	0.42	0.05	0.17
1991				
1992				
1993				
1994	3	0.57	0.05	0.22
1995	3	0.80	0.06	0.30
1996				
1997				
1998				
1999				

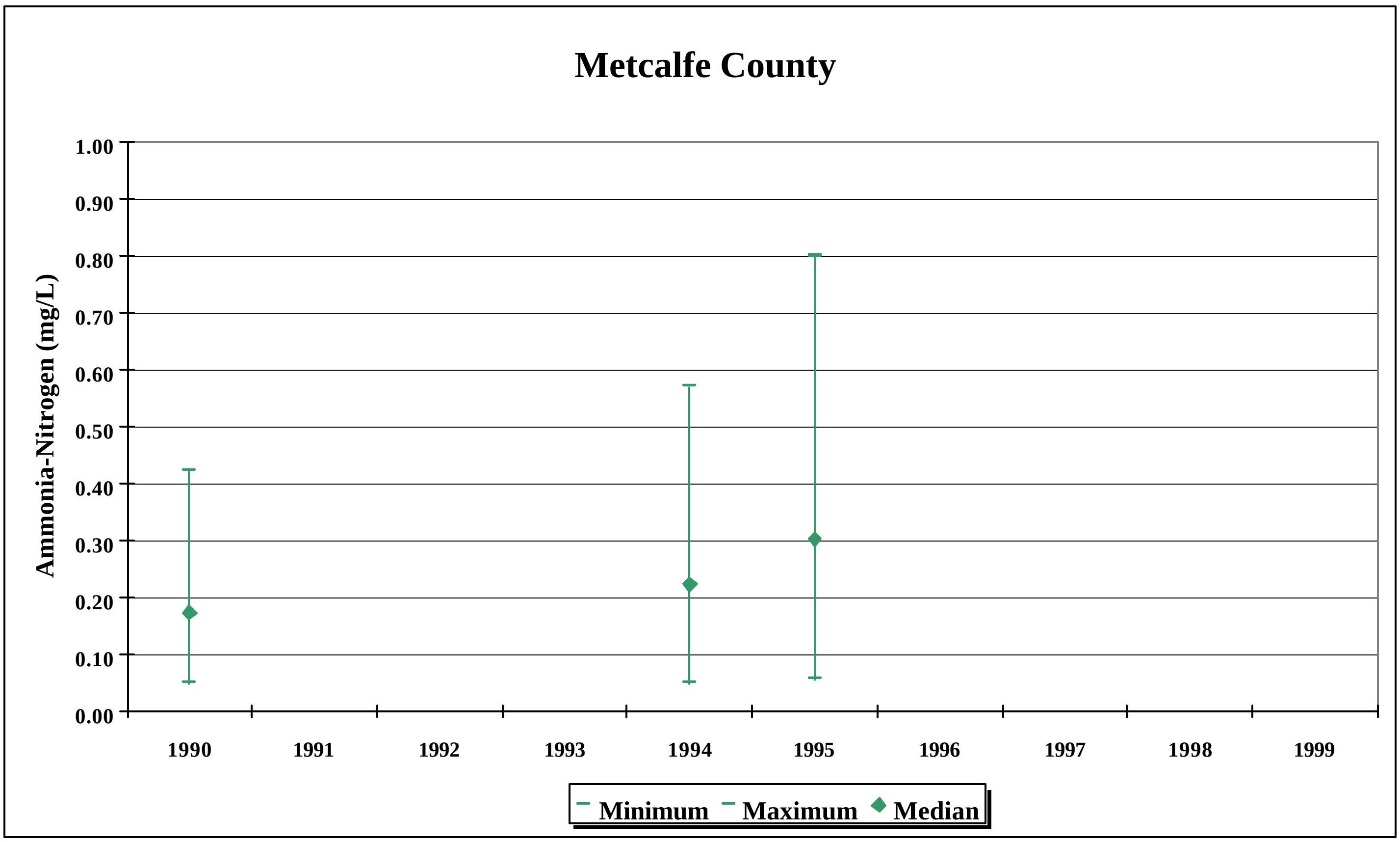

Figure 2.46 Ammonia Results for Metcalfe County

Table 2.33 Ammonia Statistics for Monroe County

Year	Samples	Maximum	Median	Average
1990	3	0.05	0.05	0.05
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998				
1999	2	0.05	0.05	0.05

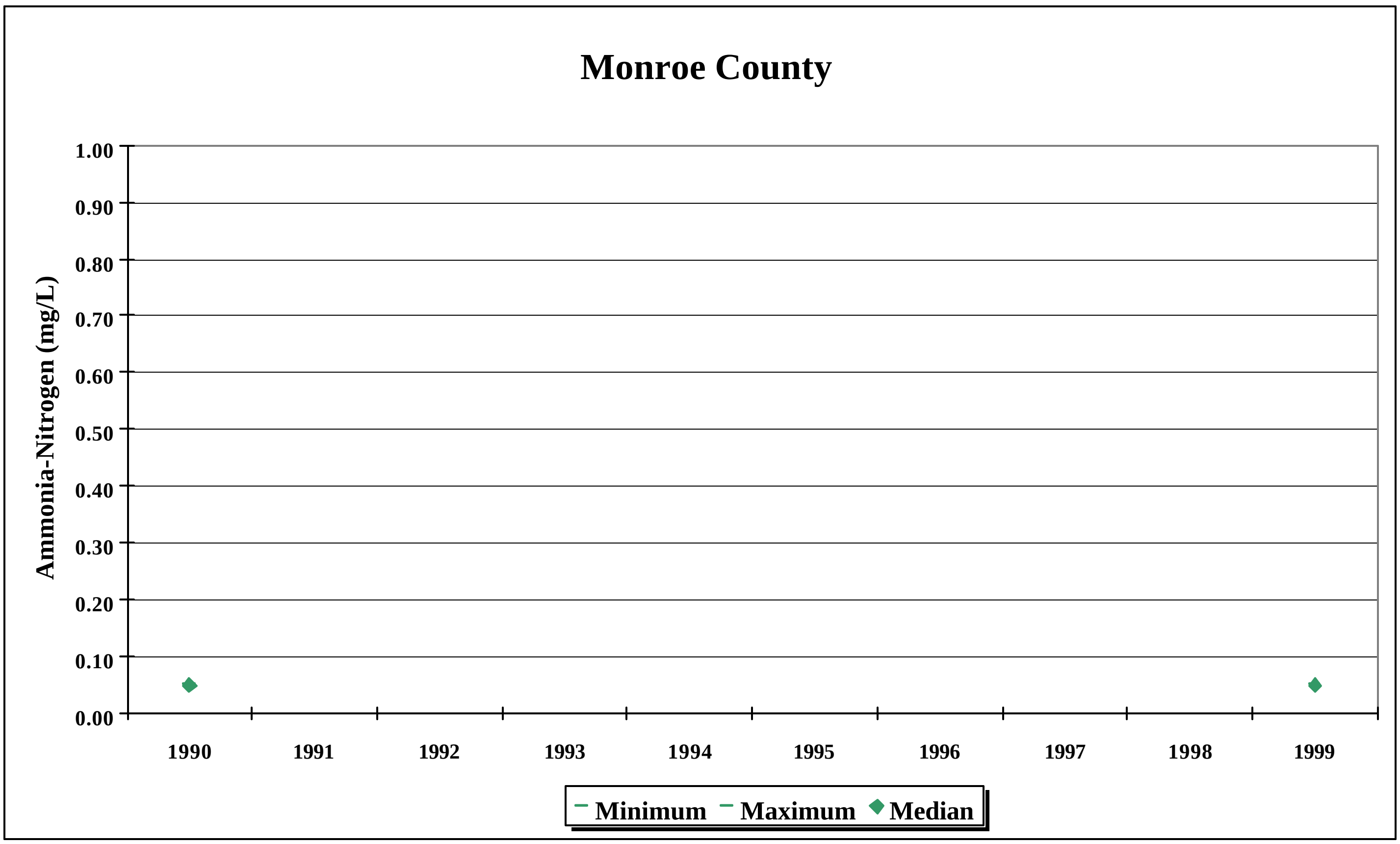

Figure 2.47 Ammonia Results for Monroe County

Table 2.34 Ammonia Statistics for Morgan County

Year	Samples	Maximum	Median	Average
1990				
1991	17	0.10	0.05	0.07
1992	87	1.40	0.10	0.26
1993	26	0.24	0.05	0.07
1994	26	0.23	0.05	0.07
1995	12	0.09	0.05	0.05
1996	12	0.05	0.05	0.05
1997	17	0.07	0.05	0.04
1998	12	0.09	0.05	0.05
1999	6	0.29	0.05	0.10

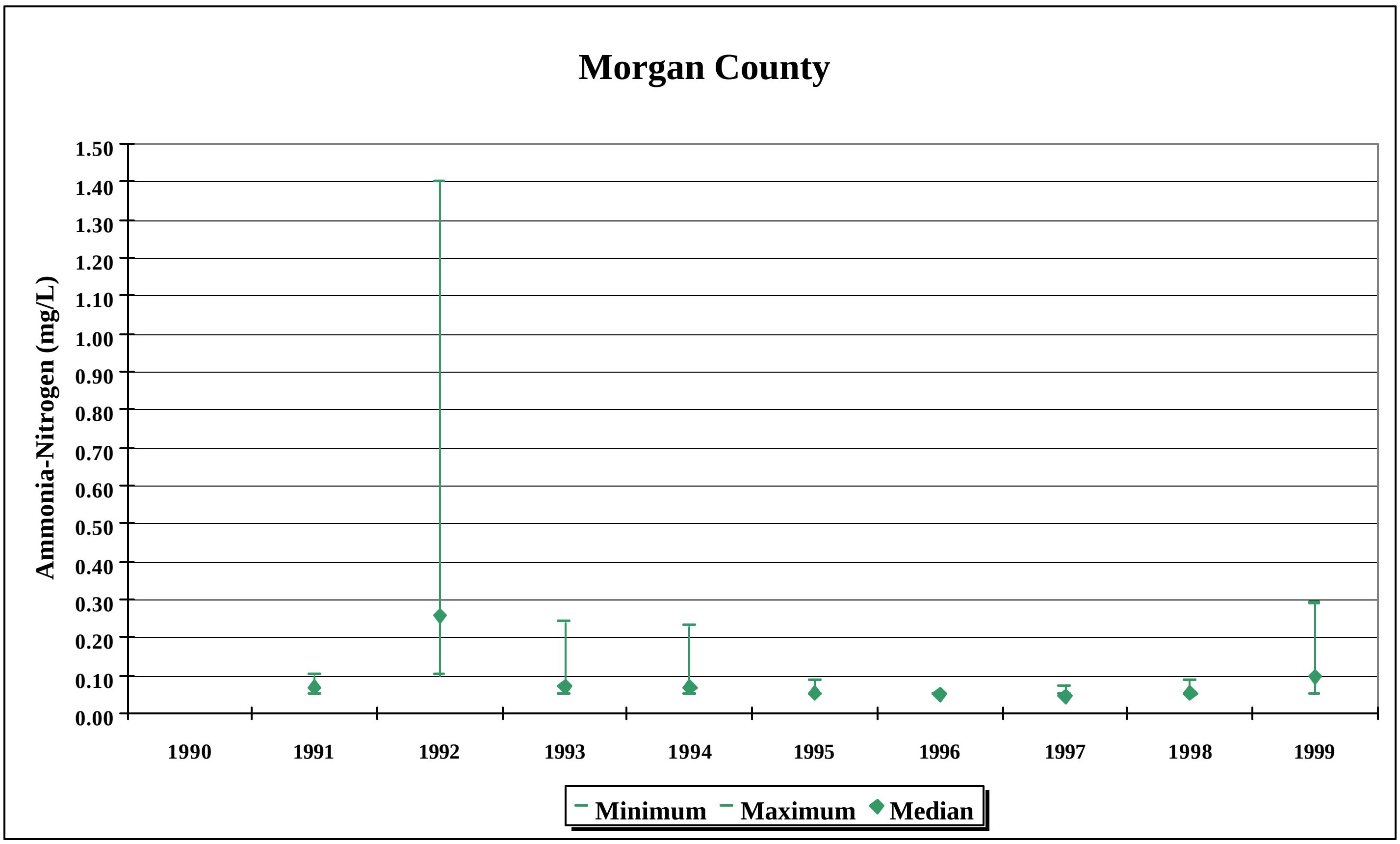

Figure 2.48 Ammonia Results for Morgan County

Table 2.35 Ammonia Statistics for Owsley County

Year	Samples	Maximum	Median	Average
1990	12	0.06	0.05	0.05
1991	11	0.07	0.05	0.05
1992	12	0.06	0.05	0.05
1993	12	0.05	0.05	0.05
1994	12	0.05	0.05	0.05
1995	12	0.07	0.05	0.05
1996	11	0.05	0.05	0.05
1997	11	0.07	0.05	0.05
1998	16	0.05	0.05	0.05
1999				

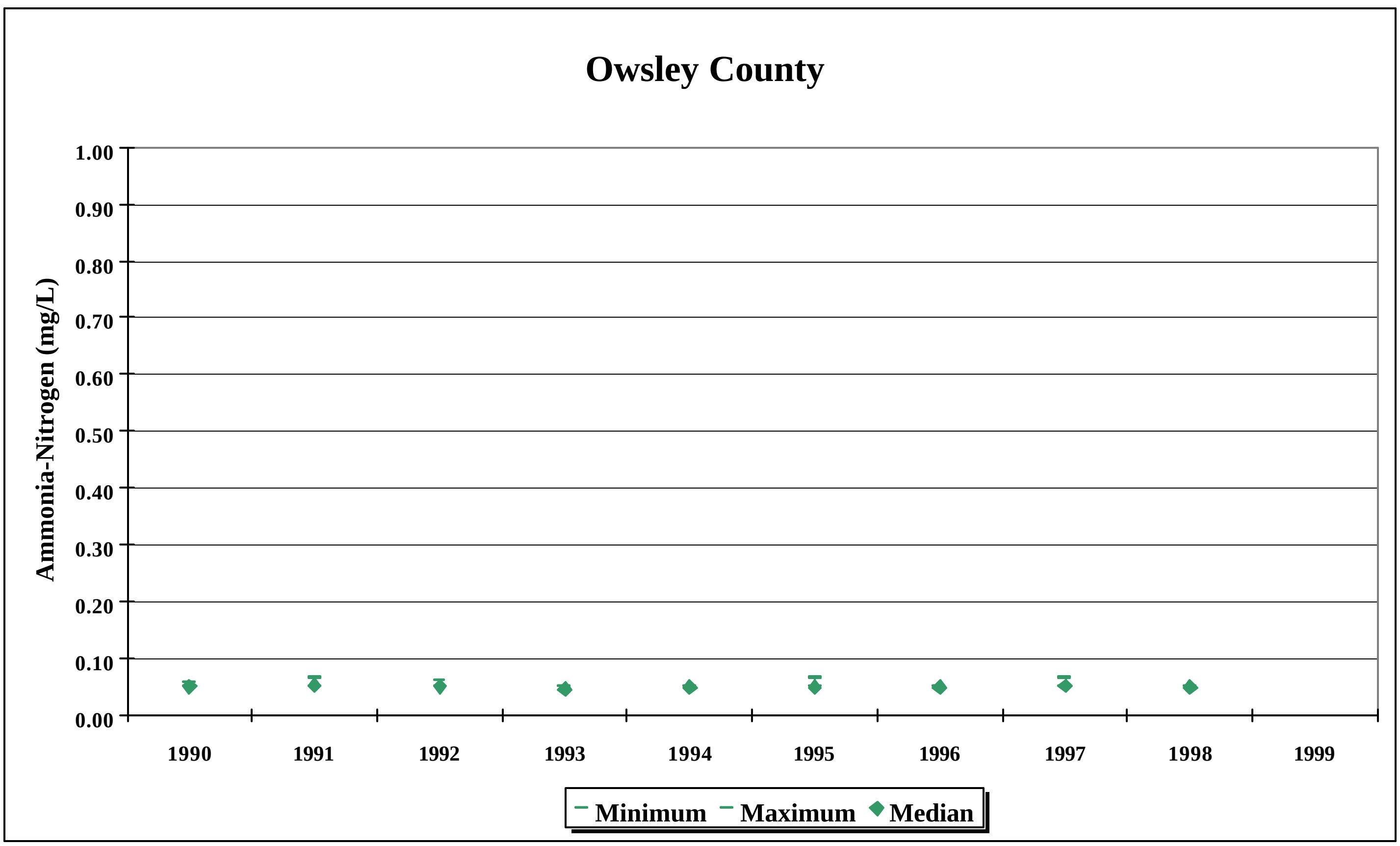

Figure 2.49 Ammonia Results for Owsley County

Table 2.36 Ammonia Statistics for Perry County

Year	Samples	Maximum	Median	Average
1990				
1991				
1992				
1993				
1994				
1995				
1996				
1997	3	0.05	0.05	0.05
1998	10	0.10	0.05	0.07
1999	1	0.05	0.05	0.05

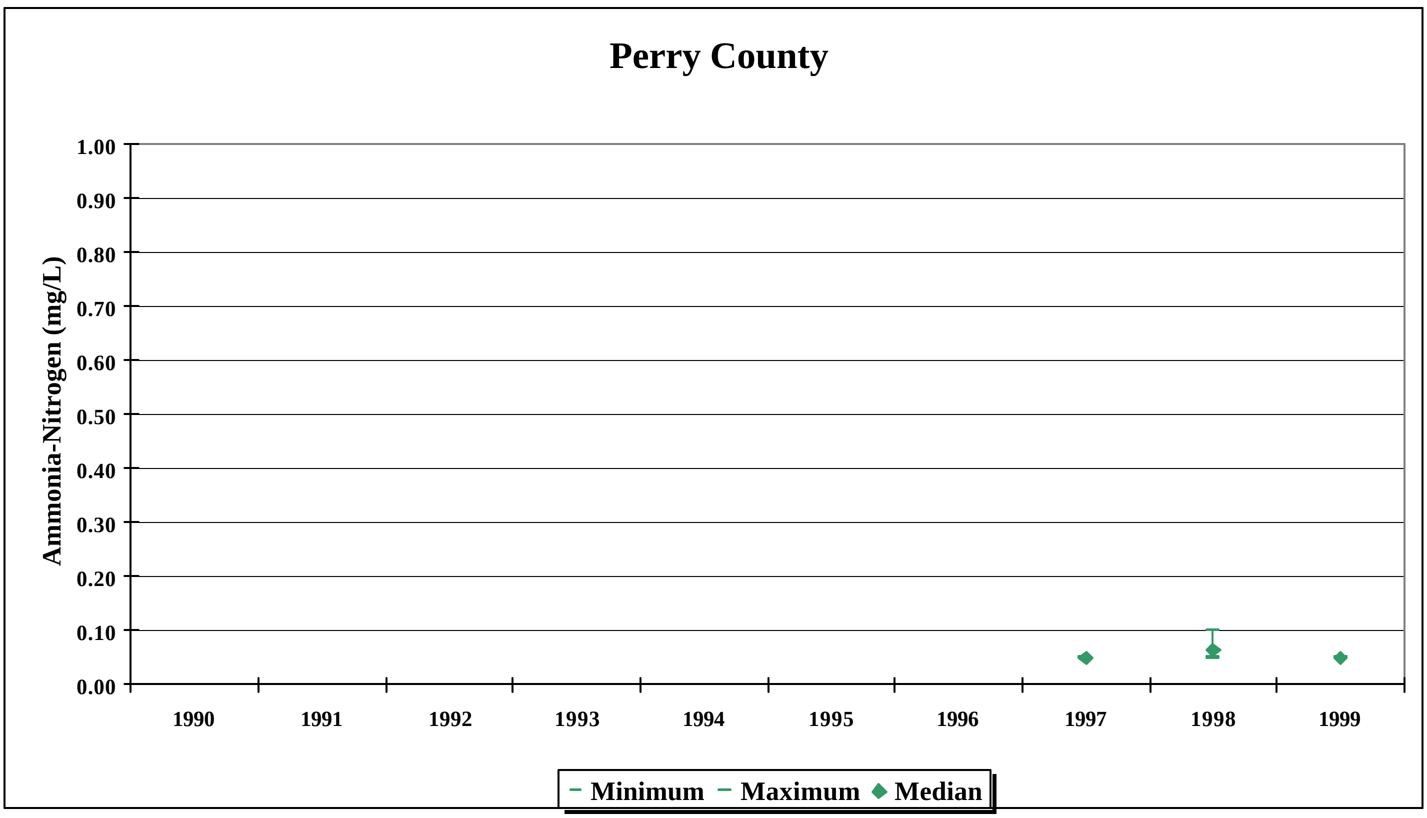

Figure 2.50 Ammonia Results for Perry County

Table 2.37 Ammonia Statistics for Pike County

Year	Samples	Maximum	Median	Average
1990	12	0.07	0.05	0.05
1991	14	0.12	0.05	0.07
1992	23	0.10	0.05	0.06
1993	137	0.26	0.05	0.07
1994	20	0.14	0.05	0.05
1995	35	1.15	0.14	0.30
1996	14	0.43	0.05	0.10
1997	12	0.05	0.05	0.05
1998	15	0.11	0.05	0.06
1999				

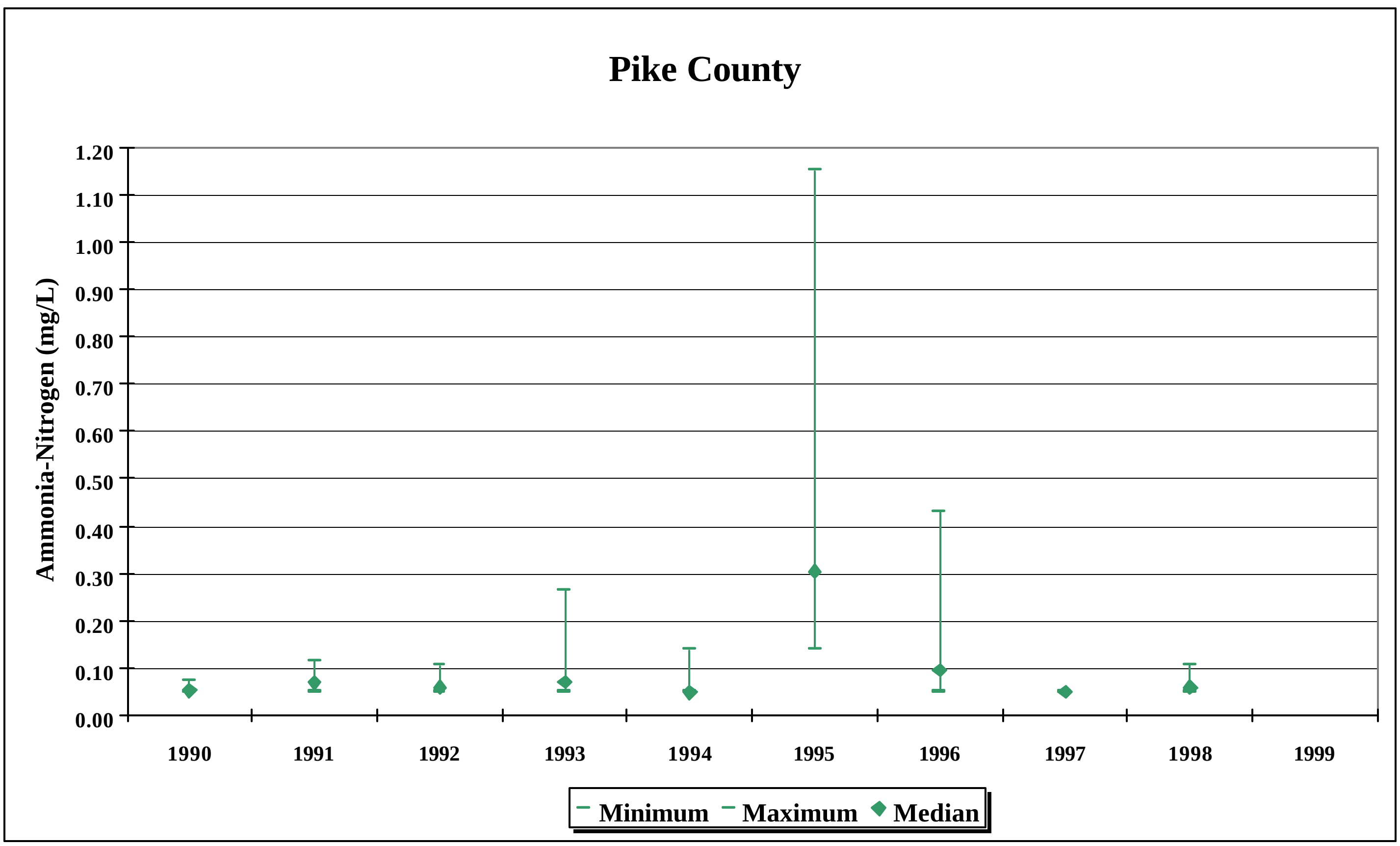

Figure 2.51 Ammonia Results for Pike County

Table 2.38 Ammonia Statistics for Pulaski County

Year	Samples	Maximum	Median	Average
1990	12	0.05	0.05	0.05
1991	1	0.05	0.05	0.05
1992				
1993	18	0.05	0.05	0.05
1994	15	0.08	0.05	0.06
1995	3	0.05	0.05	0.05
1996				
1997				
1998	3	0.05	0.05	0.05
1999	8	0.05	0.05	0.05

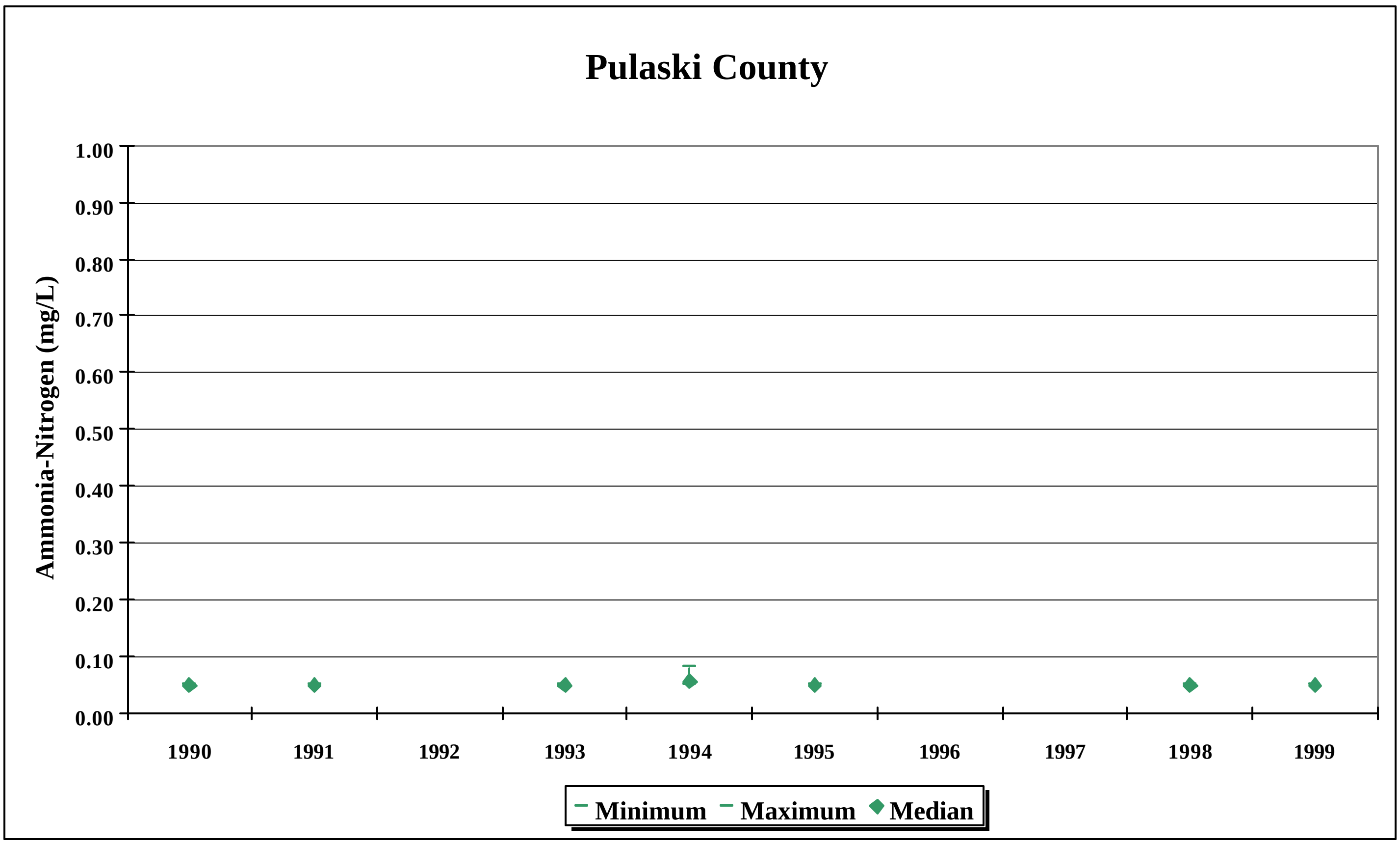

Figure 2.52 Ammonia Results for Pulaski County

Table 2.39 Ammonia Statistics for Rockcastle County

Year	Samples	Maximum	Median	Average
1990	3	0.19	0.05	0.10
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998				
1999	4	0.05	0.05	0.05

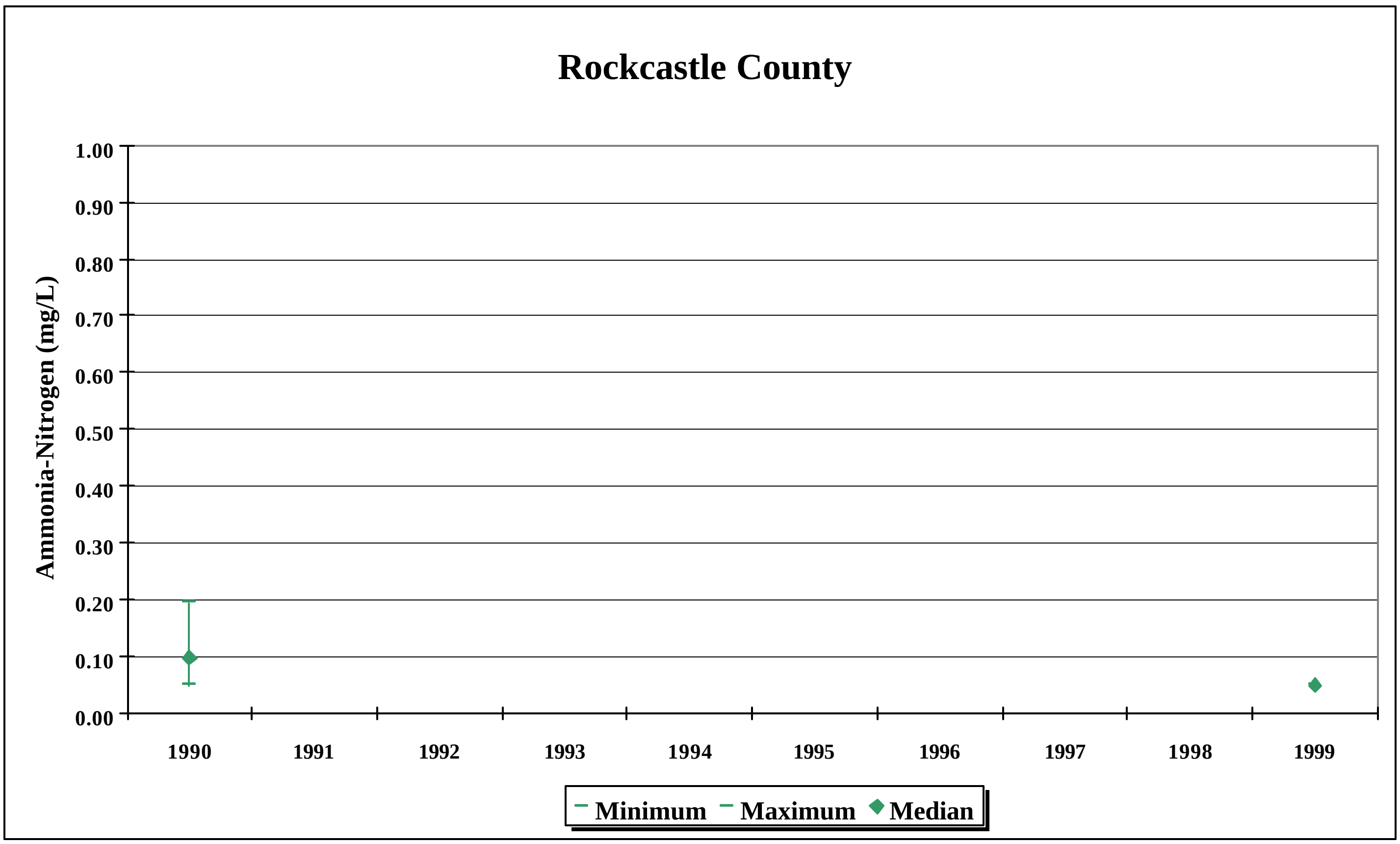

Figure 2.53 Ammonia Results for Rockcastle County

Table 2.40 Ammonia Statistics for Russell County

Year	Samples	Maximum	Median	Average
1990	3	0.07	0.05	0.06
1991	6	0.31	0.05	0.09
1992	6	0.05	0.05	0.05
1993	6	0.05	0.05	0.05
1994	9	0.15	0.05	0.06
1995	9	0.05	0.05	0.05
1996				
1997				
1998				
1999	4	0.05	0.05	0.05

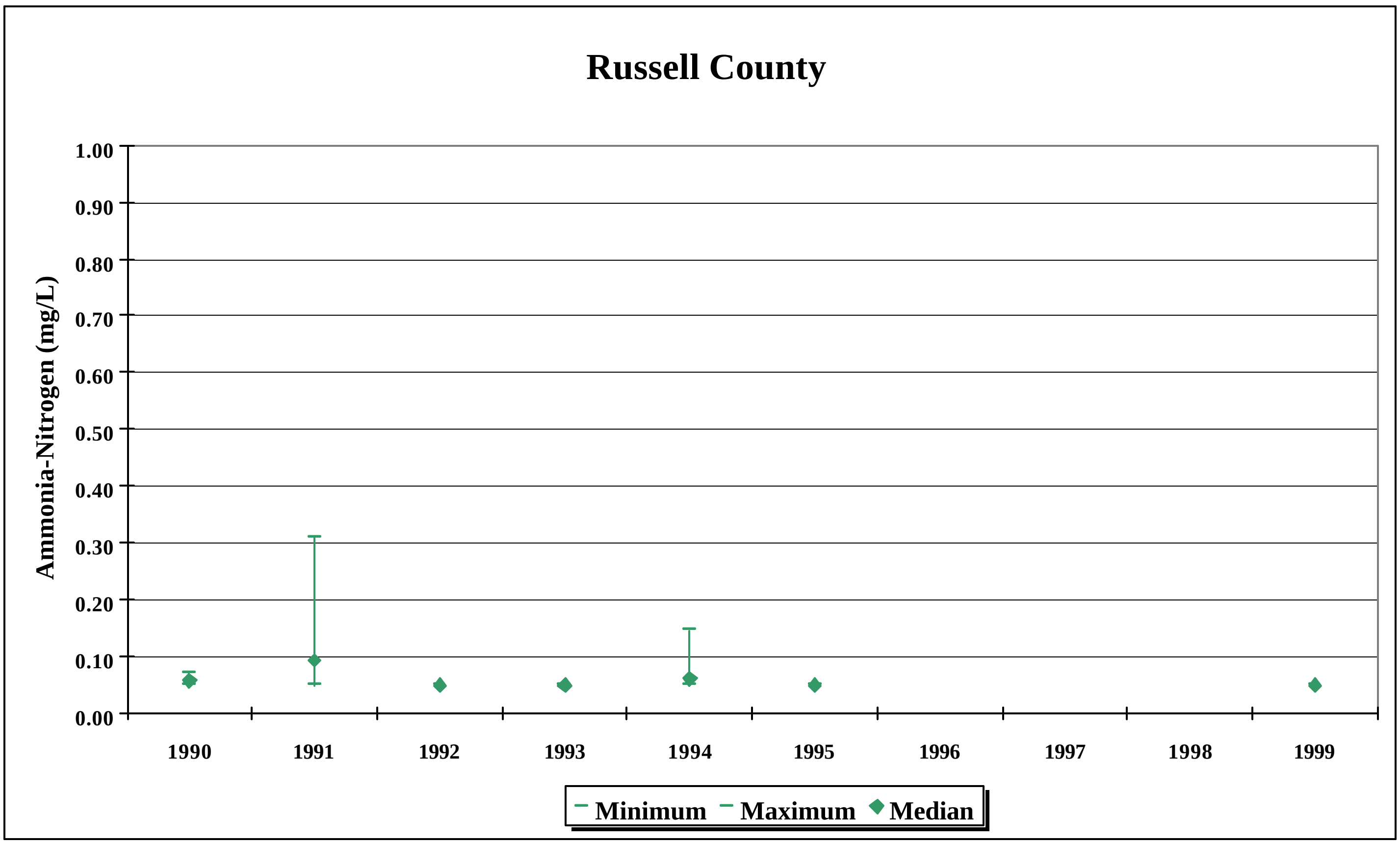

Figure 2.54 Ammonia Results for Russell County

Table 2.41 Ammonia Statistics for Taylor County

Year	Samples	Maximum	Median	Average
1990	20	0.90	0.10	0.15
1991	9	0.35	0.05	0.08
1992	16	0.90	0.10	0.24
1993				
1994				
1995				
1996				
1997				
1998				
1999				

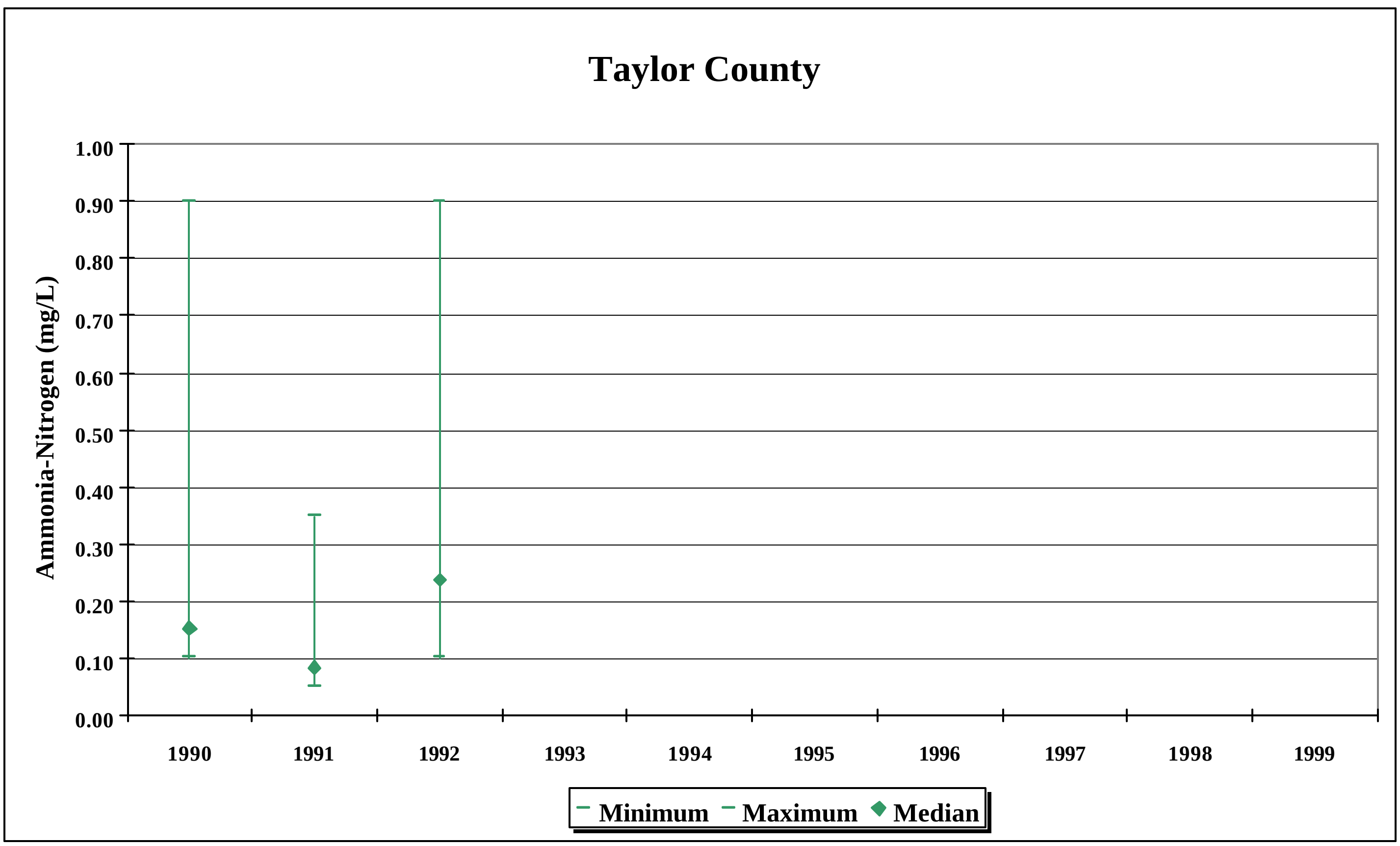

Figure 2.55 Ammonia Results for Taylor County

Table 2.42 Ammonia Statistics for Wayne County

Year	Samples	Maximum	Median	Average
1990	3	0.05	0.05	0.05
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998				
1999	2	0.05	0.05	0.05

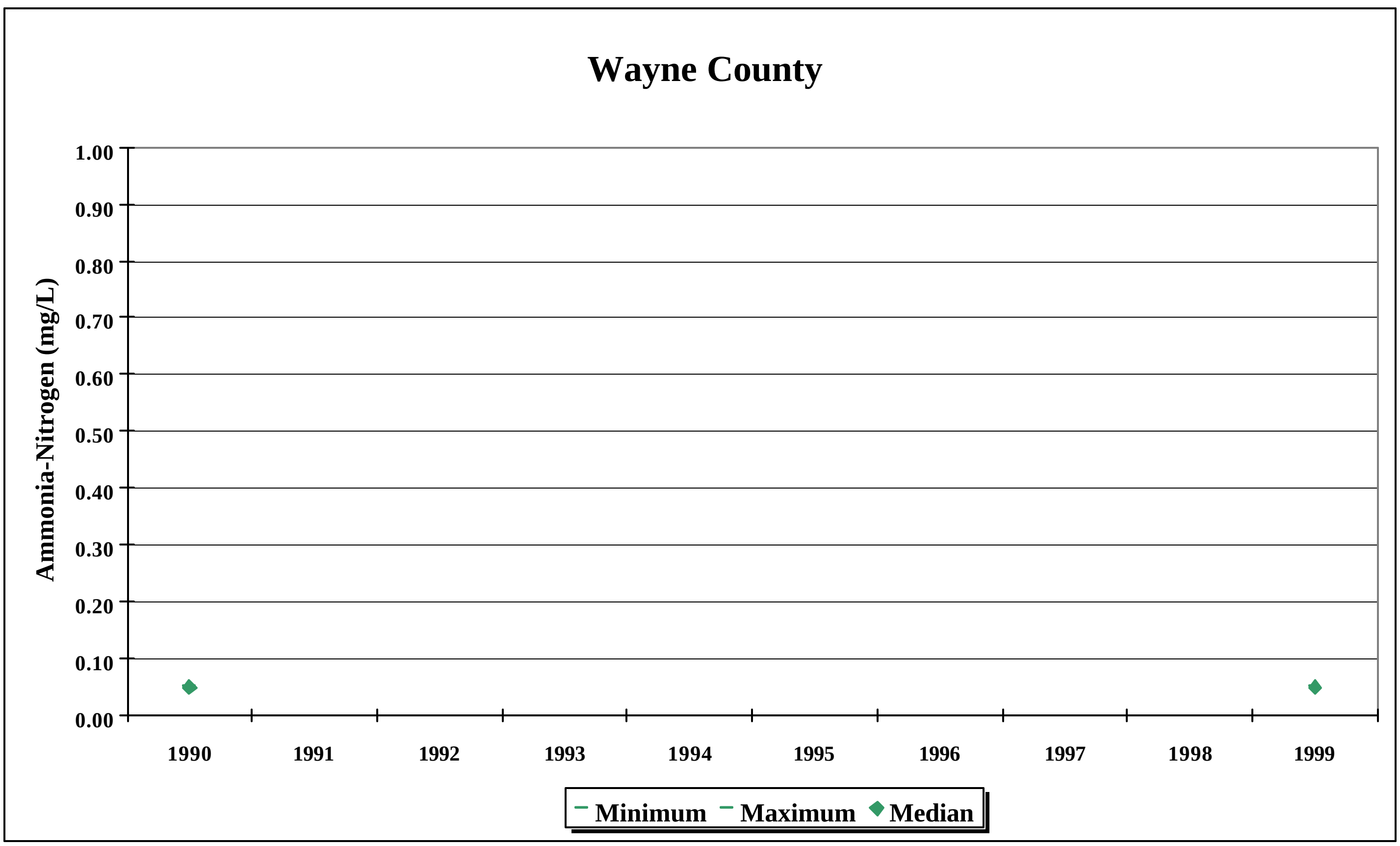

Figure 2.56 Ammonia Results for Wayne County

Table 2.43 Ammonia Statistics for Whitley County

Year	Samples	Maximum	Median	Average
1990	12	0.05	0.05	0.05
1991	11	0.07	0.05	0.05
1992	11	0.11	0.05	0.06
1993	12	0.05	0.05	0.05
1994	12	0.05	0.05	0.05
1995	12	0.07	0.05	0.05
1996	12	0.05	0.05	0.05
1997	12	0.05	0.05	0.05
1998	11	0.07	0.05	0.05
1999	5	0.05	0.05	0.05

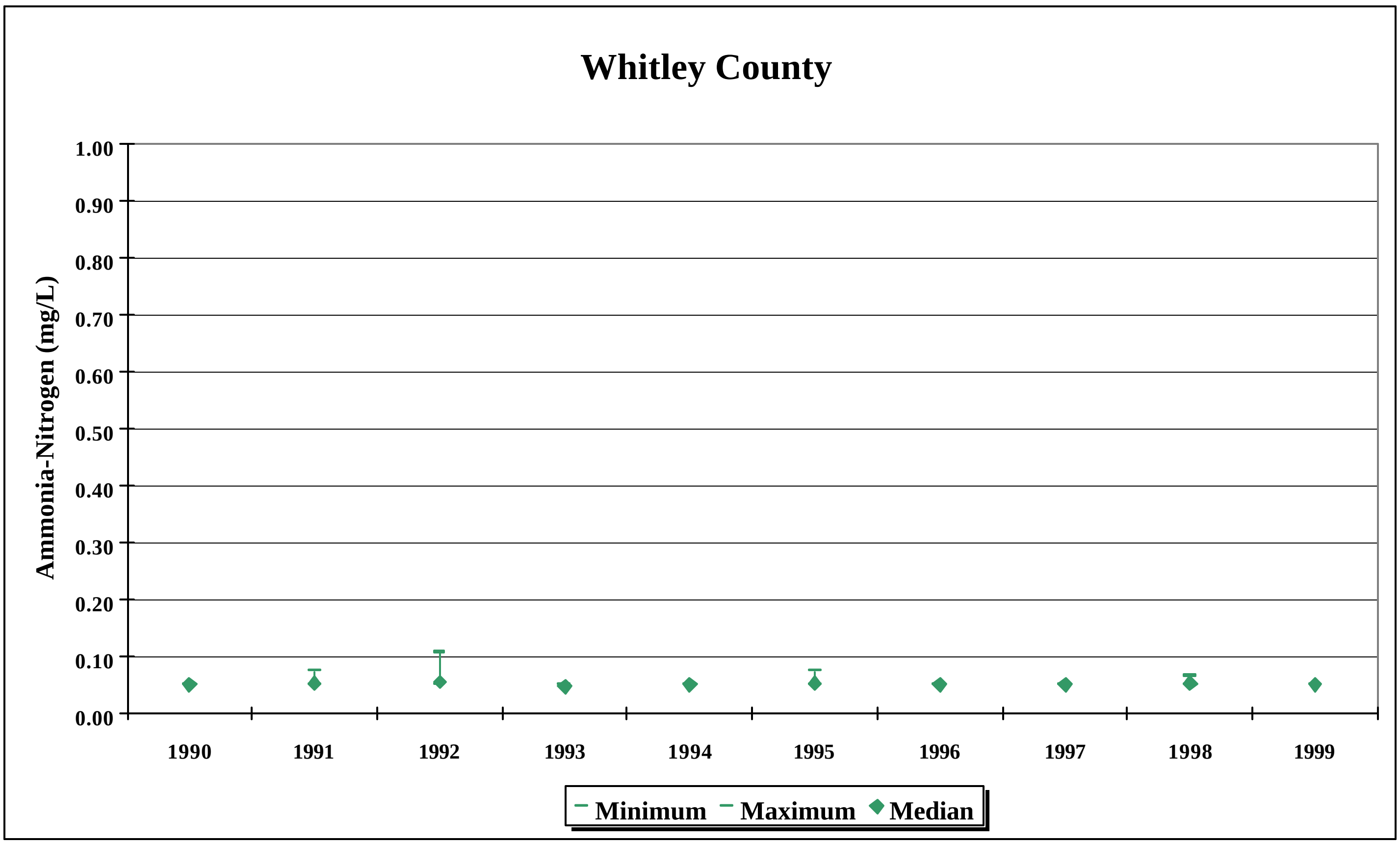

Figure 2.57 Ammonia Results for Whitley County

Table 2.44 Ammonia Statistics for Wolfe County

Year	Samples	Maximum	Median	Average
1990	16	0.06	0.05	0.05
1991	15	0.57	0.05	0.11
1992	9	0.08	0.05	0.05
1993	4	0.05	0.05	0.04
1994	4	0.05	0.05	0.05
1995	3	0.05	0.05	0.05
1996				
1997	2	0.05	0.05	0.05
1998	5	0.10	0.05	0.07
1999				

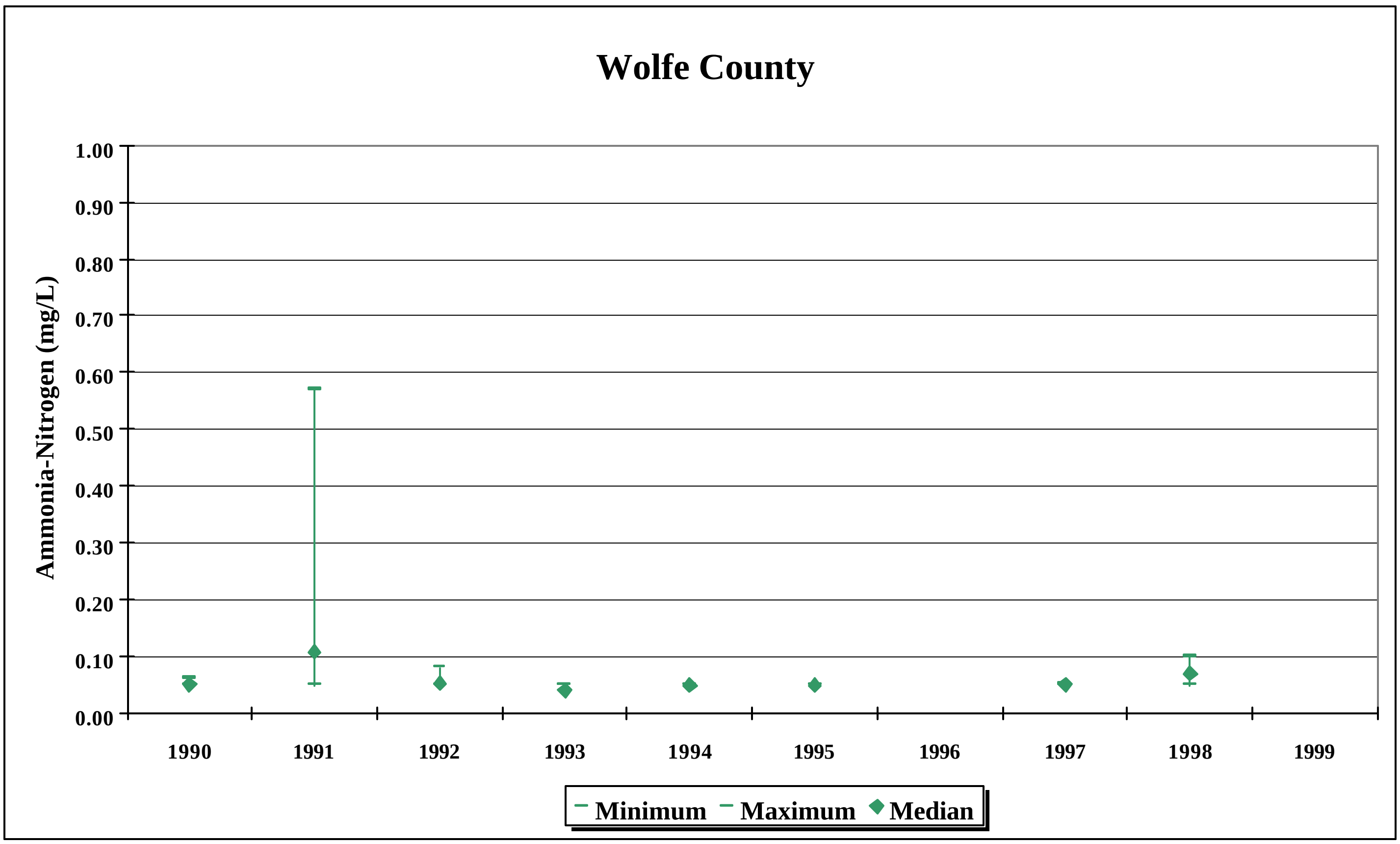

Figure 2.58 Ammonia Results for Wolfe County

Table 2.45 Ammonia Statistics for Big Sandy River Basin 05070201 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	12	0.05	0.05	0.05
1991	10	0.16	0.05	0.06
1992	12	0.50	0.05	0.09
1993	12	0.09	0.05	0.05
1994	12	0.14	0.05	0.06
1995	12	0.07	0.05	0.05
1996	12	0.05	0.05	0.05
1997	12	0.05	0.05	0.05
1998	15	0.10	0.05	0.06
1999				

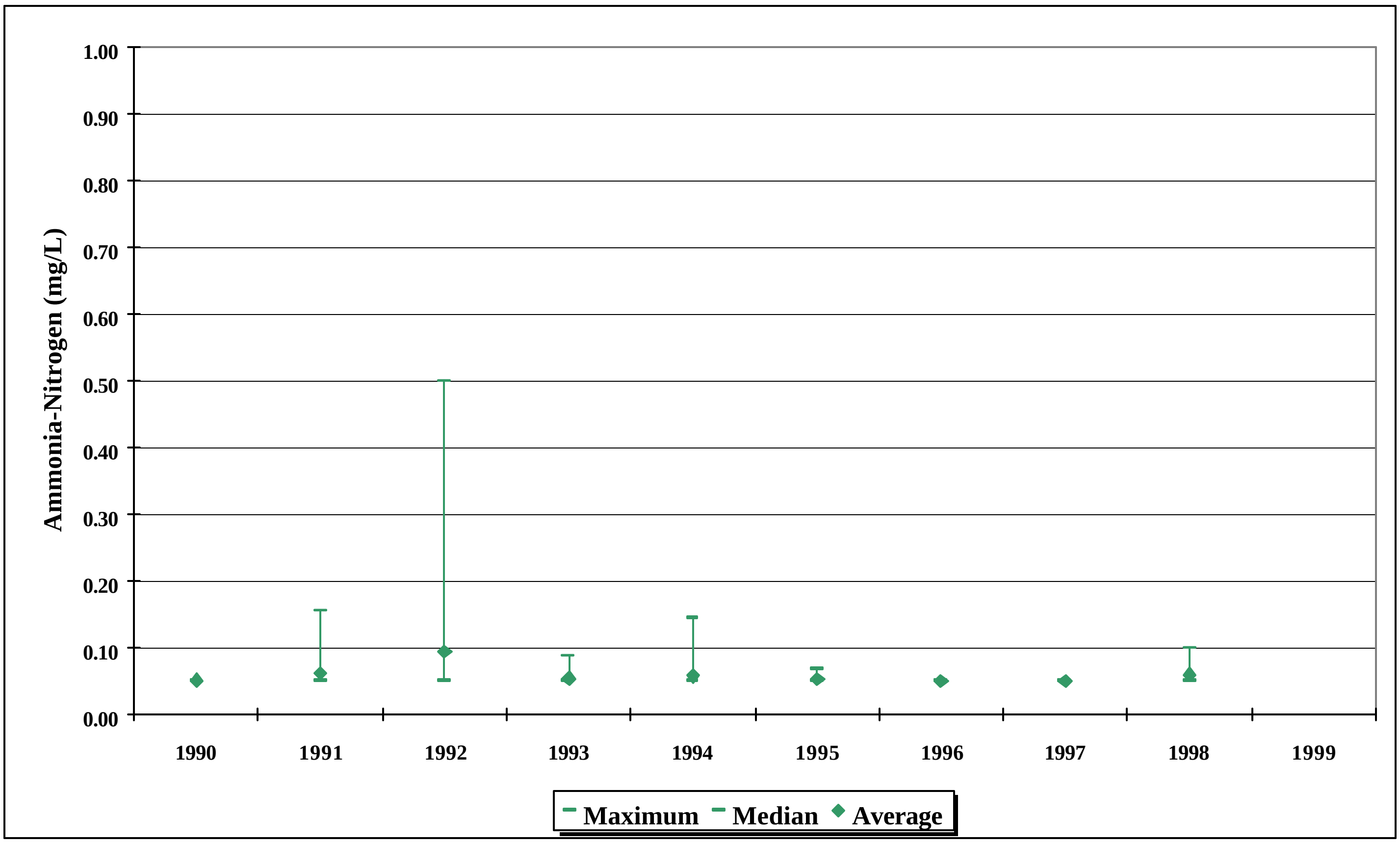

Figure 2.59 Ammonia Results for Big Sandy River Basin 05070201 HUC Watershed

**Table 2.46 Ammonia Statistics for Big Sandy River Basin
05070202 HUC Watershed**

Year	Samples	Maximum	Median	Average
1990				
1991	4	0.10	0.10	0.10
1992	10	0.10	0.05	0.06
1993	109	0.23	0.06	0.07
1994	6	0.06	0.02	0.03
1995	19	1.15	0.31	0.38
1996				
1997				
1998				
1999				

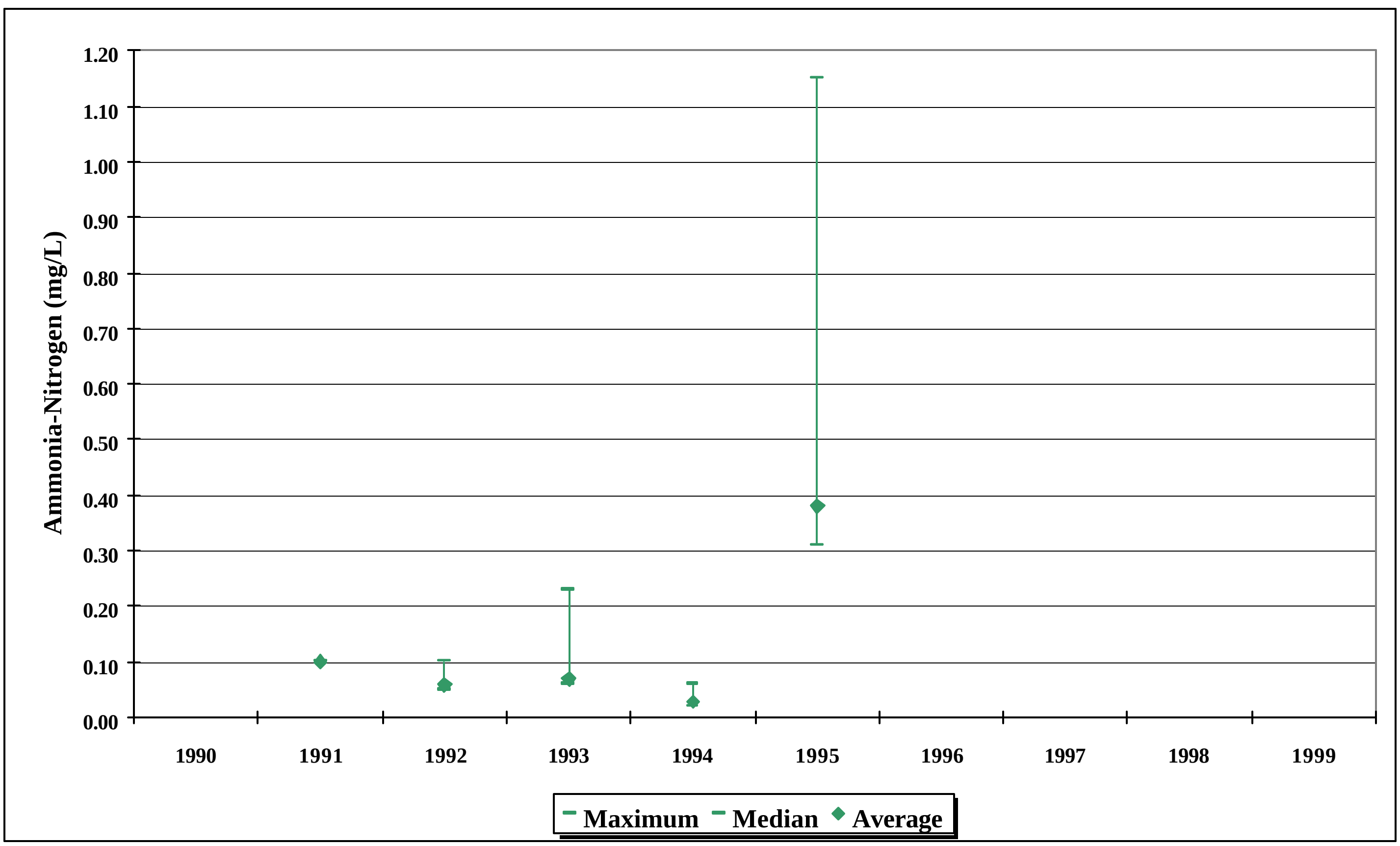

**Figure 2.60 Ammonia Results for Big Sandy River Basin
05070202 HUC Watershed**

Table 2.47 Ammonia Statistics for Big Sandy River Basin 05070203 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	24	0.07	0.05	0.05
1991	37	0.30	0.05	0.07
1992	297	2.20	0.14	0.29
1993	83	1.22	0.08	0.09
1994	42	0.14	0.05	0.06
1995	48	1.04	0.14	0.33
1996	36	0.59	0.05	0.11
1997	44	0.10	0.05	0.04
1998	26	0.16	0.05	0.06
1999	15	3.00	1.00	1.13

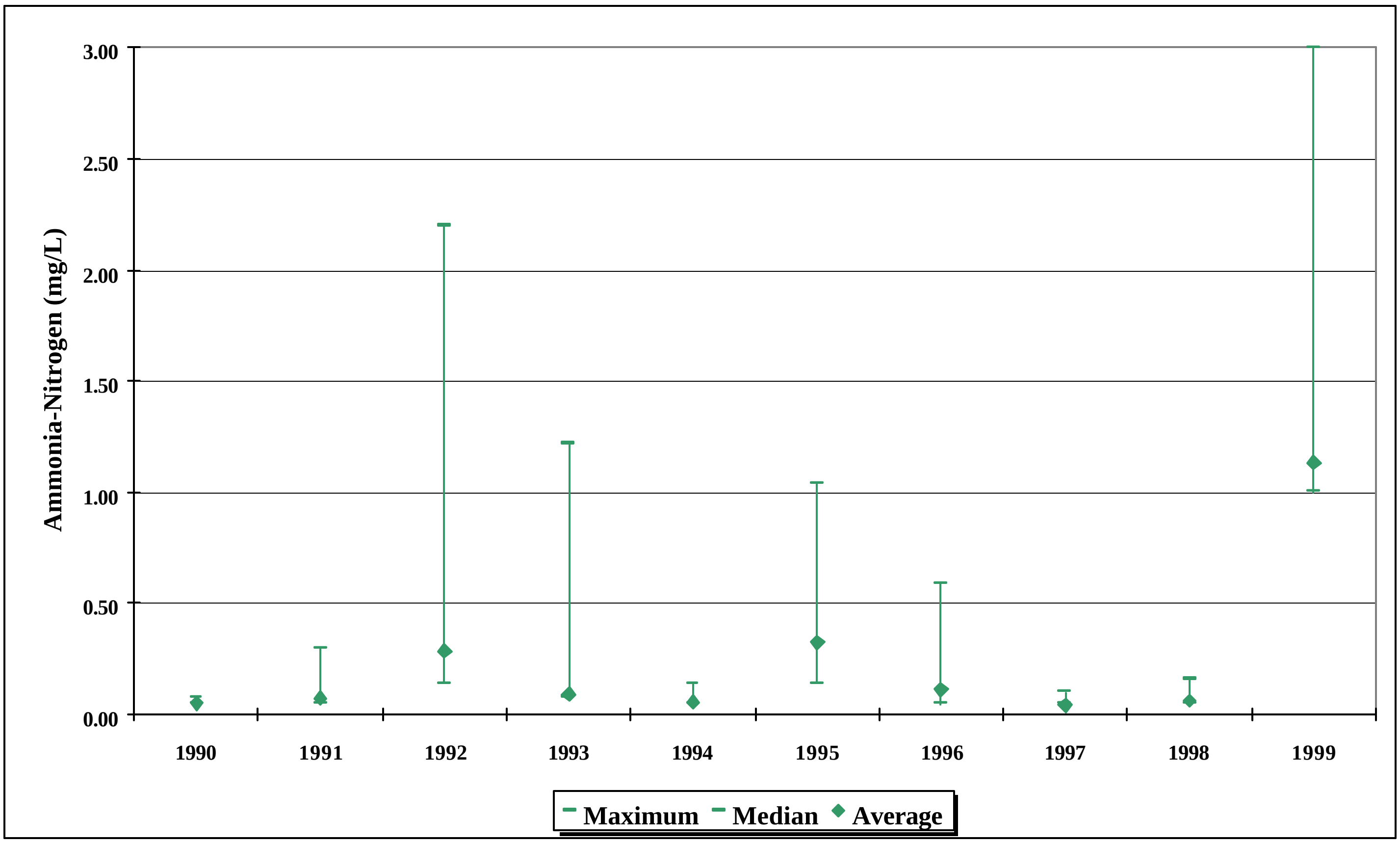

Figure 2.61 Ammonia Results for Big Sandy River Basin 05070203 HUC Watershed

Table 2.48 Ammonia Statistics for Big Sandy River Basin 05070204 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	24	0.22	0.05	0.06
1991	23	1.20	0.05	0.13
1992	48	0.75	0.10	0.17
1993	51	1.42	0.10	0.18
1994	111	2.40	0.02	0.14
1995	80	3.00	0.43	0.59
1996	89	1.91	0.06	0.11
1997	126	1.54	0.04	0.09
1998	6	0.07	0.03	0.04
1999	1	1.00	1.00	1.00

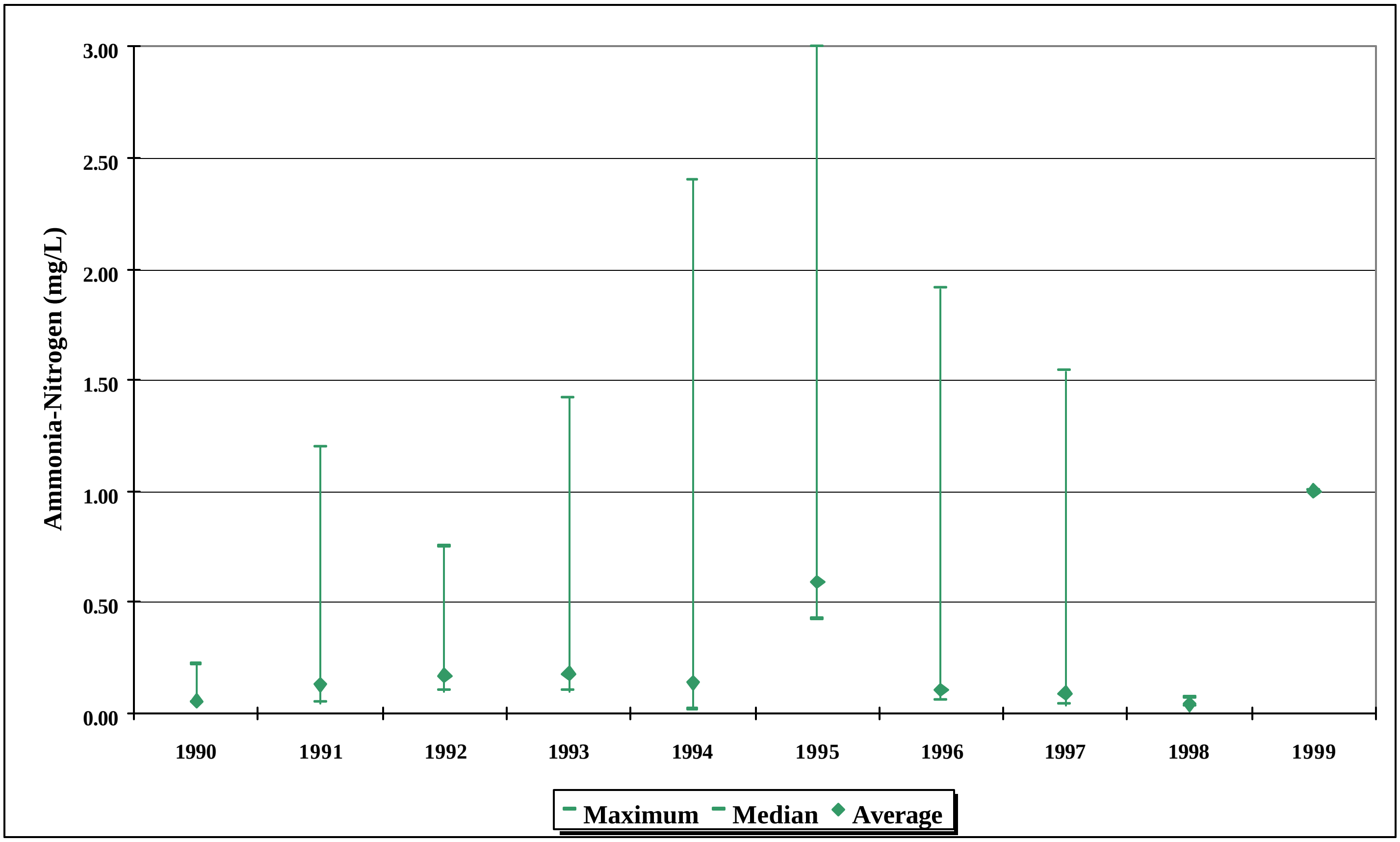

Figure 2.62 Ammonia Results for Big Sandy River Basin 05070204 HUC Watershed

Table 2.49 Ammonia Statistics for Licking River Basin 05100101 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	12	0.19	0.07	0.09
1991	17	0.10	0.05	0.07
1992	20	0.50	0.05	0.10
1993	12	0.05	0.05	0.05
1994	14	0.23	0.05	0.08
1995	12	0.09	0.05	0.05
1996	12	0.05	0.05	0.05
1997	12	0.05	0.05	0.05
1998	17	0.09	0.05	0.05
1999	10	0.29	0.05	0.08

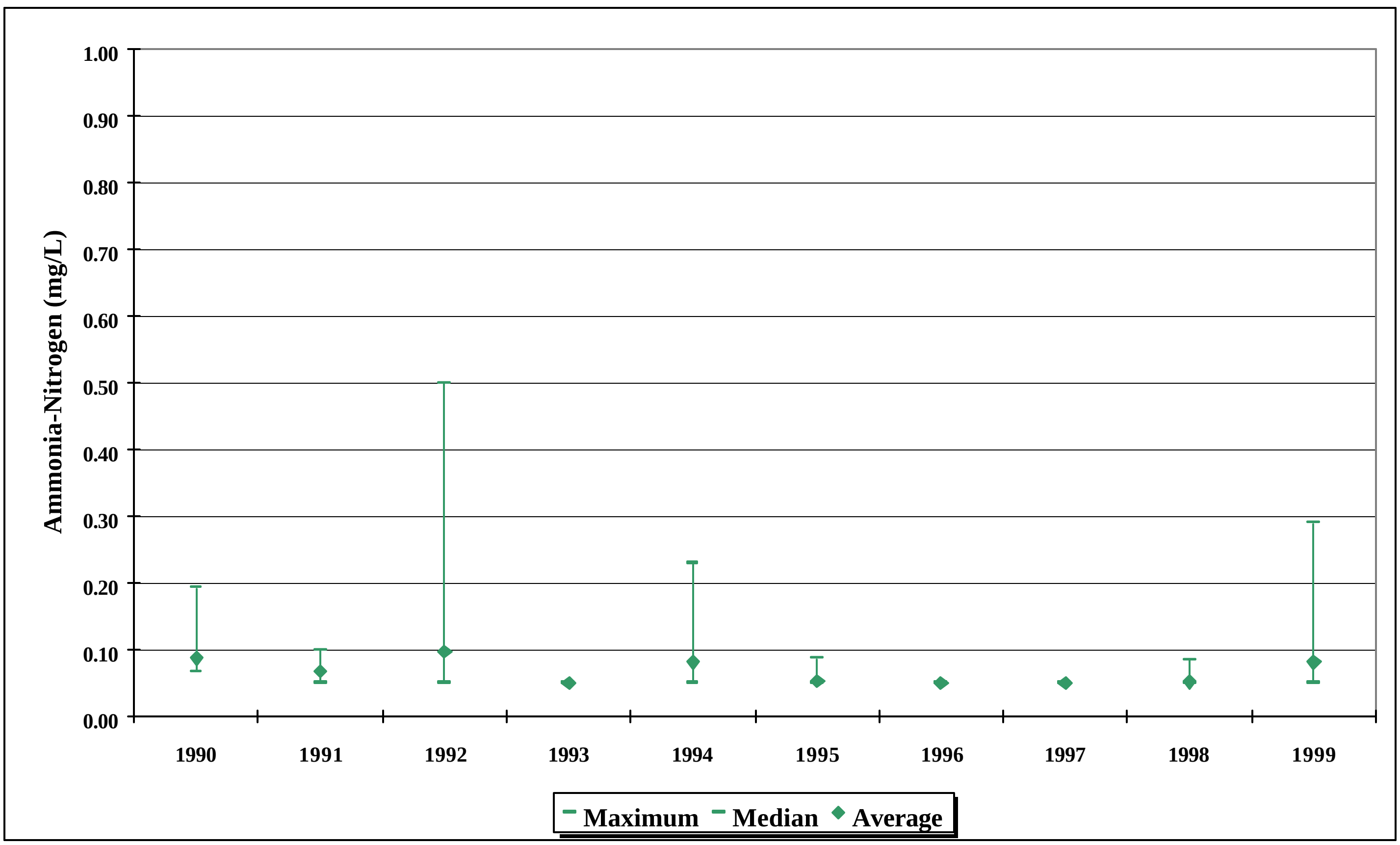

Figure 2.63 Ammonia Results for Licking River Basin 05100101 HUC Watershed

Table 2.50 Ammonia Statistics for Kentucky River Basin 05100201 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	18	0.07	0.05	0.05
1991	11	0.15	0.05	0.06
1992	33	0.50	0.10	0.10
1993	12	0.16	0.05	0.06
1994	24	0.37	0.05	0.11
1995	12	0.06	0.05	0.05
1996	11	0.18	0.05	0.06
1997	17	0.05	0.05	0.05
1998	45	0.17	0.05	0.06
1999	3	0.07	0.05	0.05

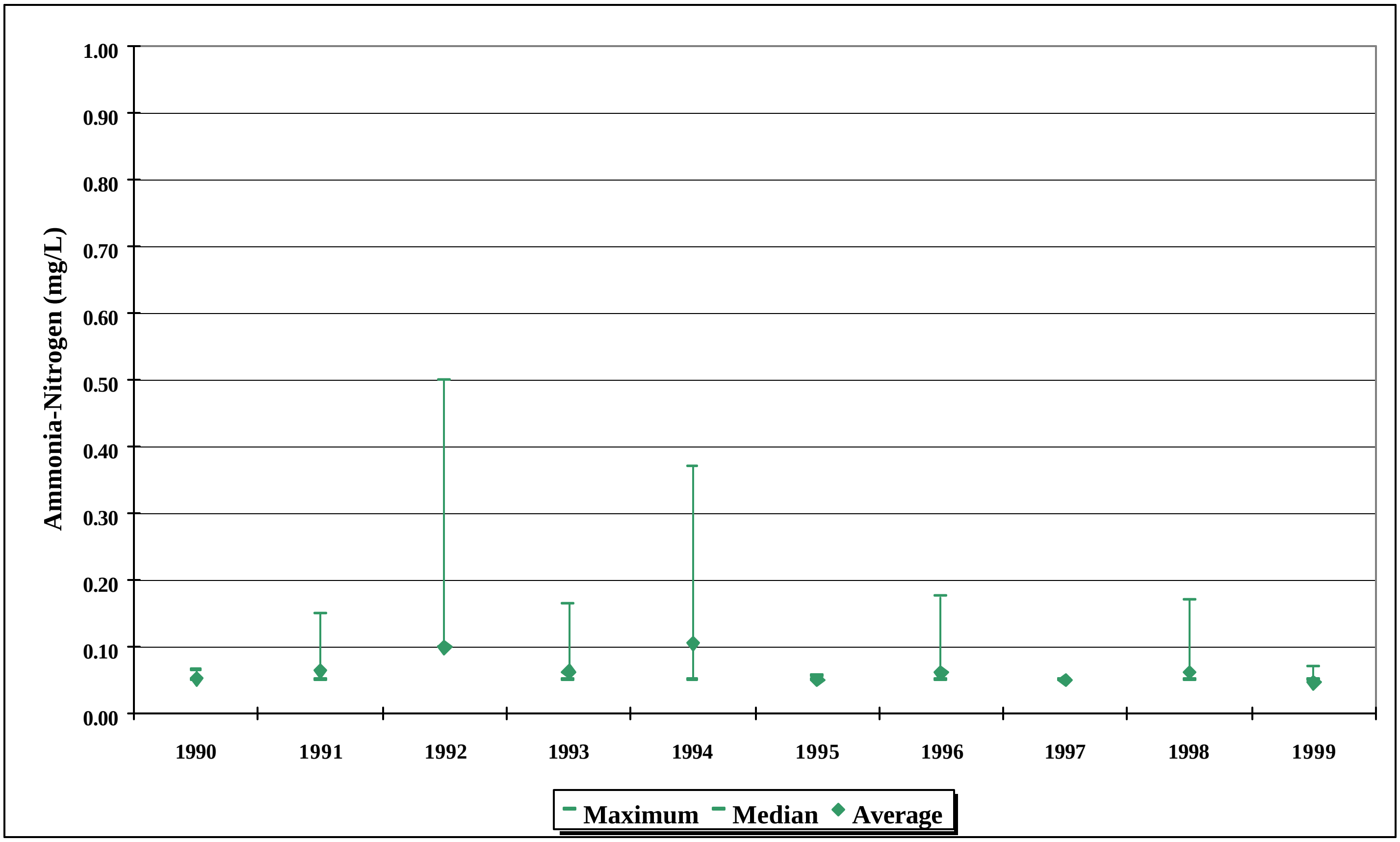

Figure 2.64 Ammonia Results for Kentucky River Basin 05100201 HUC Watershed

Table 2.51 Ammonia Statistics for Kentucky River Basin 05100202 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	16	0.10	0.05	0.06
1991	23	0.30	0.10	0.09
1992	23	0.10	0.10	0.08
1993	12	0.05	0.05	0.05
1994	12	0.05	0.05	0.05
1995	12	0.09	0.05	0.05
1996	11	0.05	0.05	0.05
1997	22	0.20	0.05	0.06
1998	28	0.10	0.05	0.06
1999				

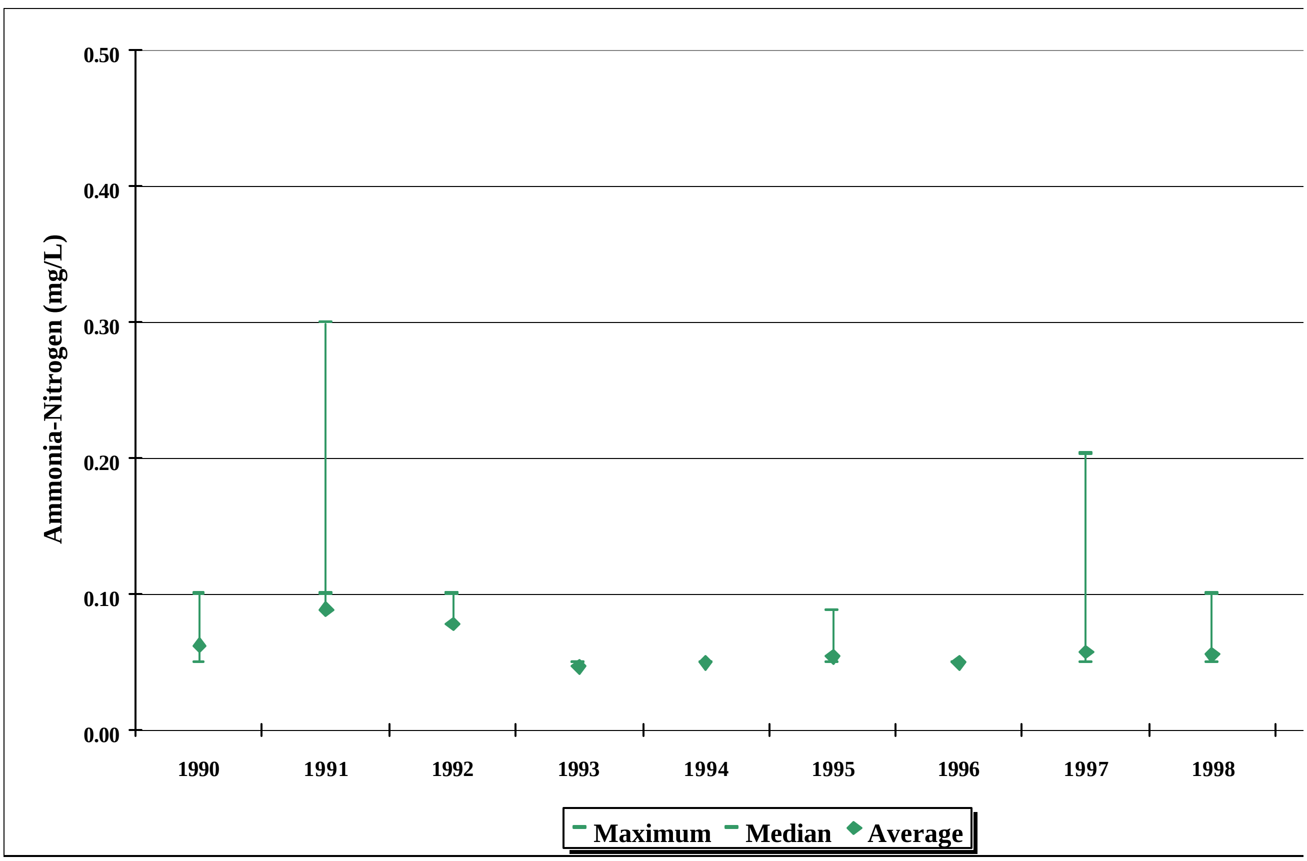

Figure 2.65 Ammonia Results for Kentucky River Basin 05100202 HUC Watershed

Table 2.52 Ammonia Statistics for Kentucky River Basin 05100203 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	15	0.06	0.05	0.05
1991	11	0.07	0.05	0.05
1992	12	0.06	0.05	0.05
1993	12	0.05	0.05	0.05
1994	12	0.05	0.05	0.05
1995	12	0.07	0.05	0.05
1996	11	0.05	0.05	0.05
1997	15	0.07	0.05	0.05
1998	37	0.10	0.05	0.06
1999				

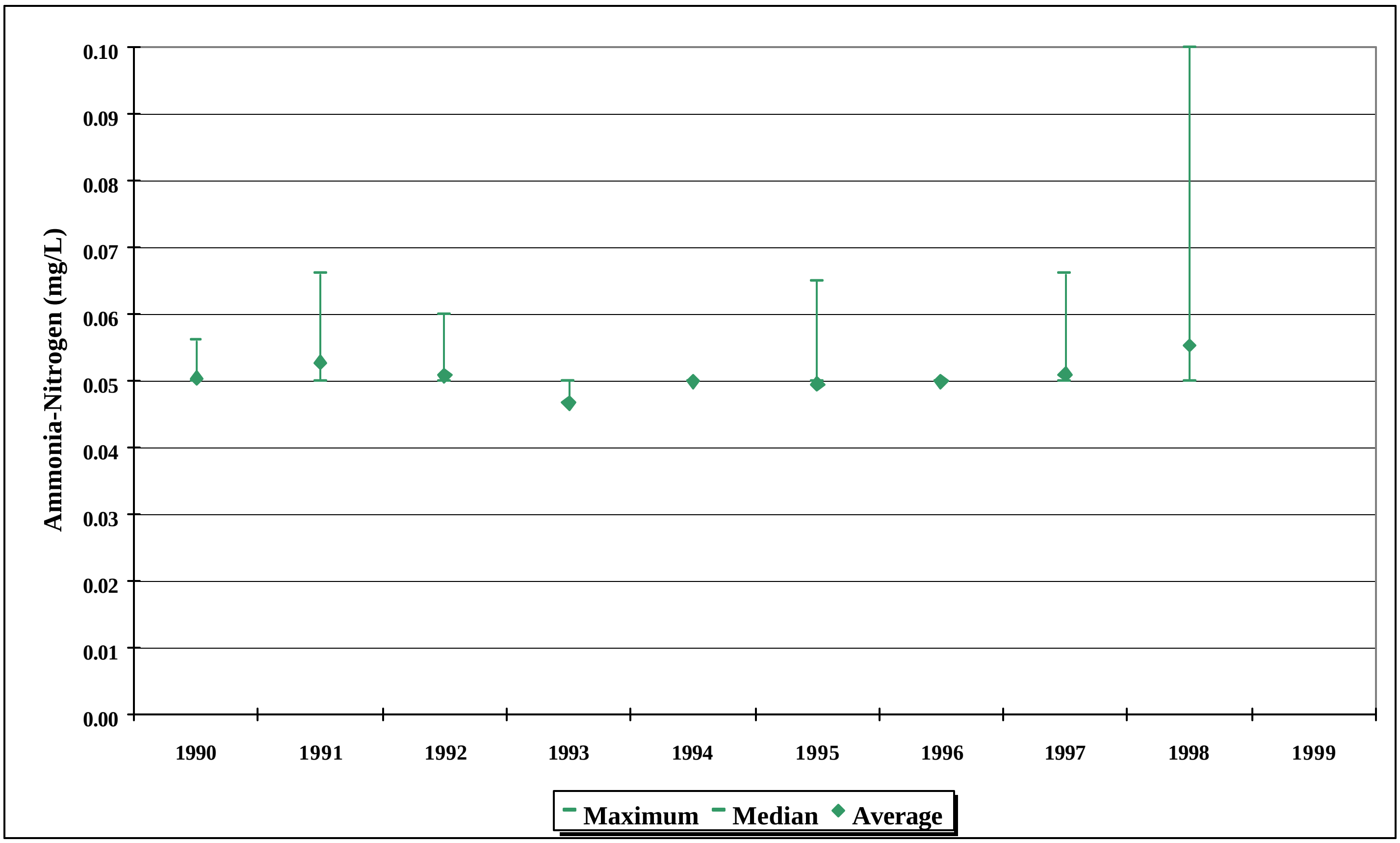

Figure 2.66 Ammonia Results for Kentucky River Basin 05100203 HUC Watershed

Table 2.53 Ammonia Statistics for Kentucky River Basin 05100204 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	28	0.06	0.05	0.05
1991	26	0.57	0.05	0.09
1992	19	0.08	0.05	0.05
1993	16	0.05	0.05	0.05
1994	16	0.06	0.05	0.05
1995	15	0.07	0.05	0.05
1996	11	0.14	0.05	0.06
1997	17	0.06	0.05	0.05
1998	30	0.10	0.05	0.06
1999	1	0.10	0.10	0.10

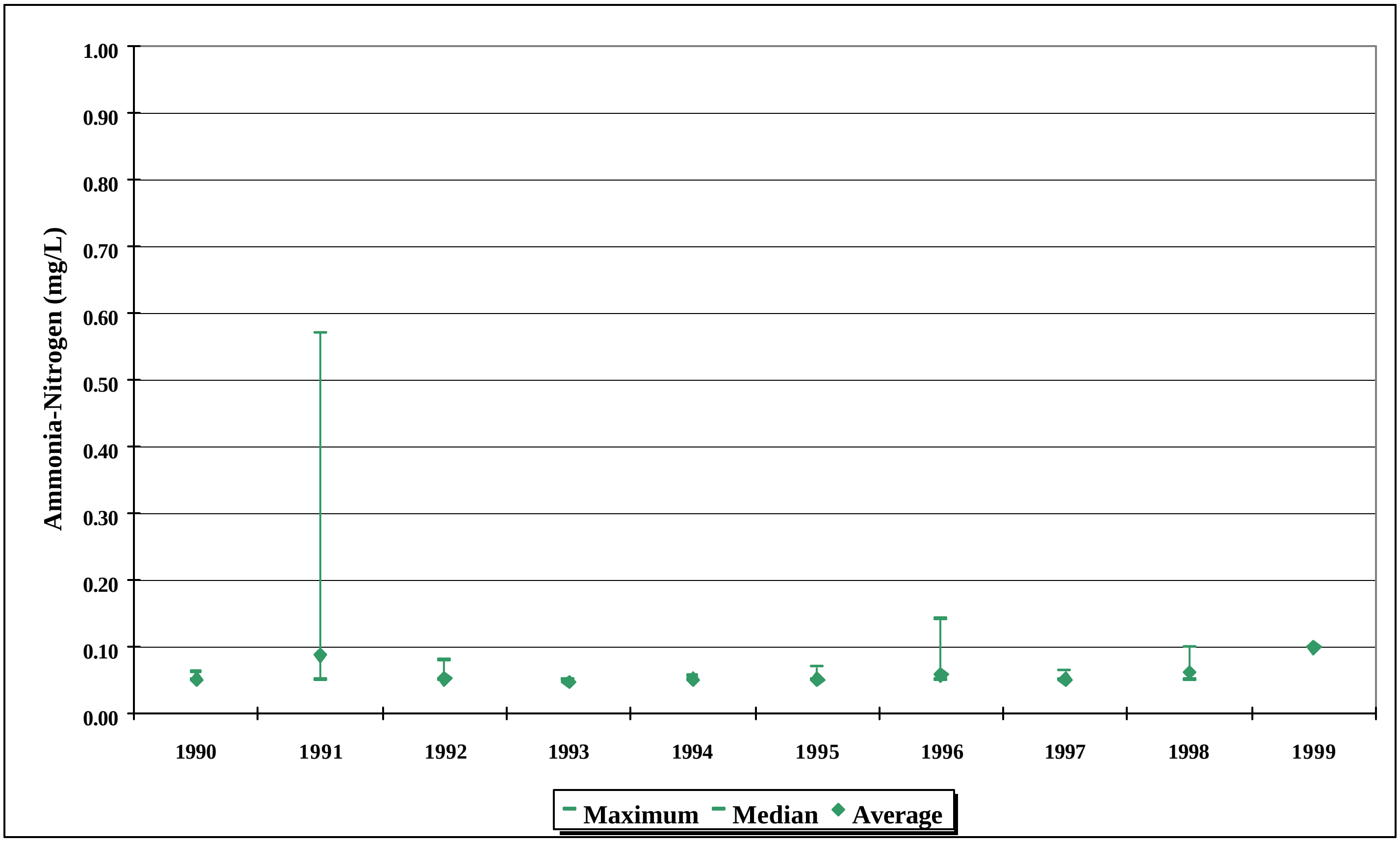

Figure 2.67 Ammonia Results for Kentucky River Basin 05100204 HUC Watershed

Table 2.54 Ammonia Statistics for Kentucky River Basin 05100205 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	12	0.07	0.05	0.05
1991	11	0.06	0.05	0.05
1992	11	0.18	0.05	0.06
1993	12	0.05	0.05	0.05
1994	13	0.51	0.05	0.09
1995	11	0.06	0.05	0.05
1996	9	0.05	0.05	0.05
1997	7	0.05	0.05	0.05
1998	22	0.27	0.05	0.08
1999				

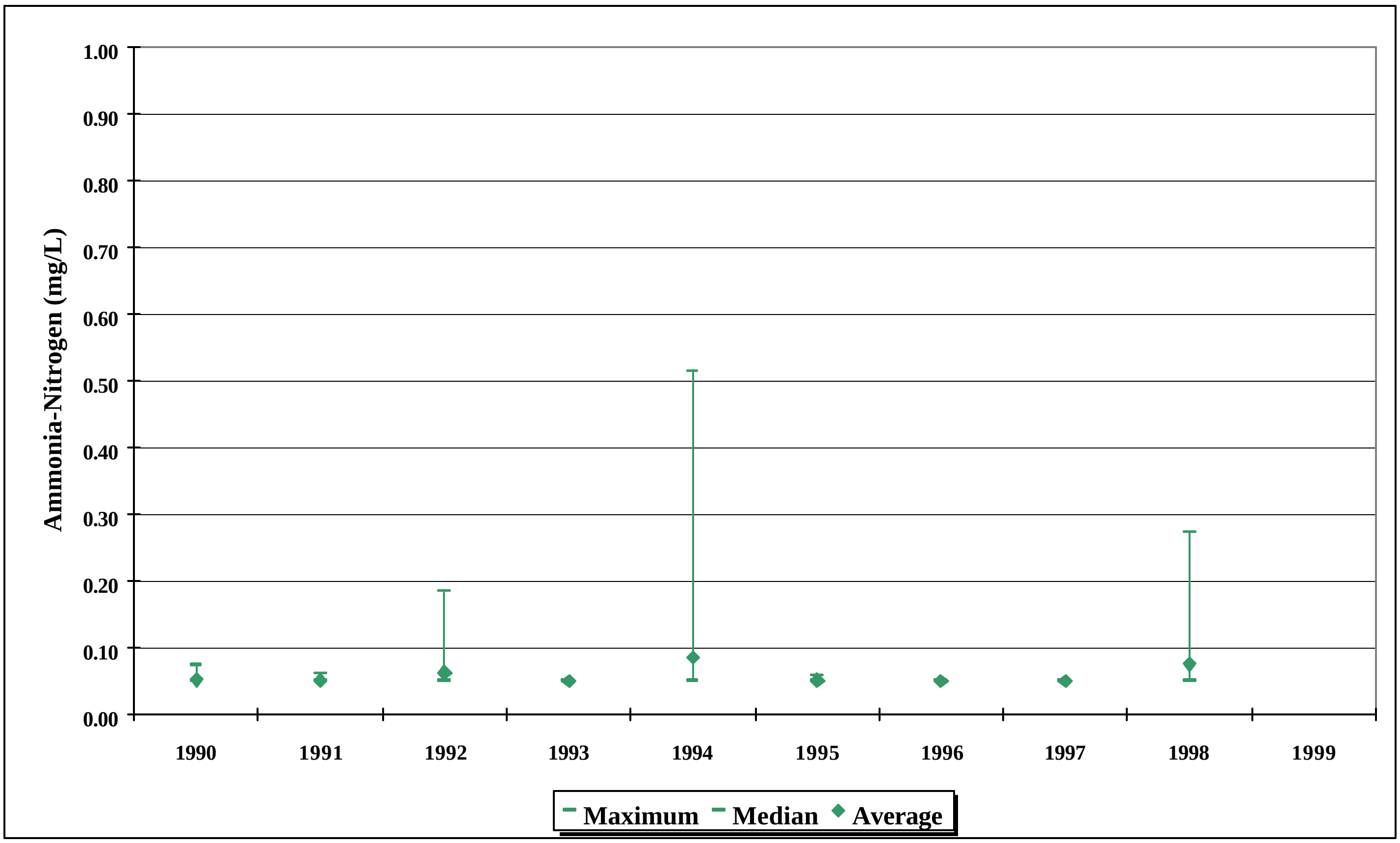

Figure 2.68 Ammonia Results for Kentucky River Basin 05100205 HUC Watershed

Table 2.55 Ammonia Statistics for Upper Green River Basin 05110001 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	36	0.90	0.10	0.15
1991	12	0.35	0.05	0.10
1992	22	0.90	0.10	0.20
1993				
1994	3	0.57	0.05	0.22
1995	3	0.80	0.06	0.30
1996				
1997				
1998	12	0.05	0.05	0.05
1999				

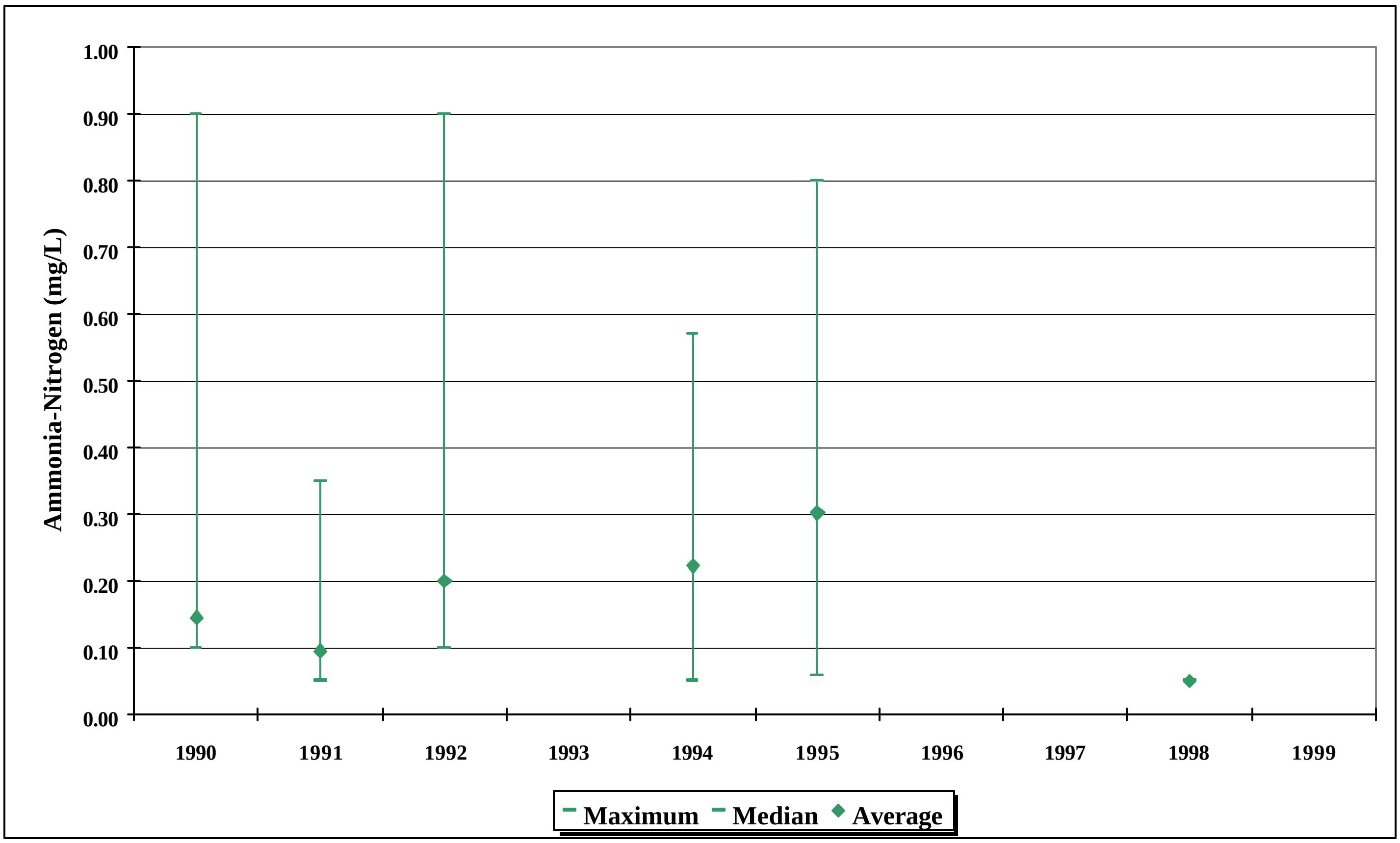

Figure 2.69 Ammonia Results for Upper Green River Basin 05110001 HUC Watershed

Table 2.56 Ammonia Statistics for Upper Green River Basin 05110002 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	3	0.05	0.05	0.05
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998				
1999				

Figure 2.70 Ammonia Results for Upper Green River Basin 05110002 HUC Watershed

Table 2.57 Ammonia Statistics for Upper Cumberland River Basin 05130101 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	42	0.31	0.05	0.06
1991	22	0.07	0.05	0.05
1992	37	0.11	0.05	0.05
1993	54	0.50	0.05	0.07
1994	36	0.23	0.05	0.06
1995	24	0.07	0.05	0.05
1996	24	0.05	0.05	0.05
1997	23	0.05	0.05	0.05
1998	22	0.07	0.05	0.05
1999	25	0.28	0.05	0.06

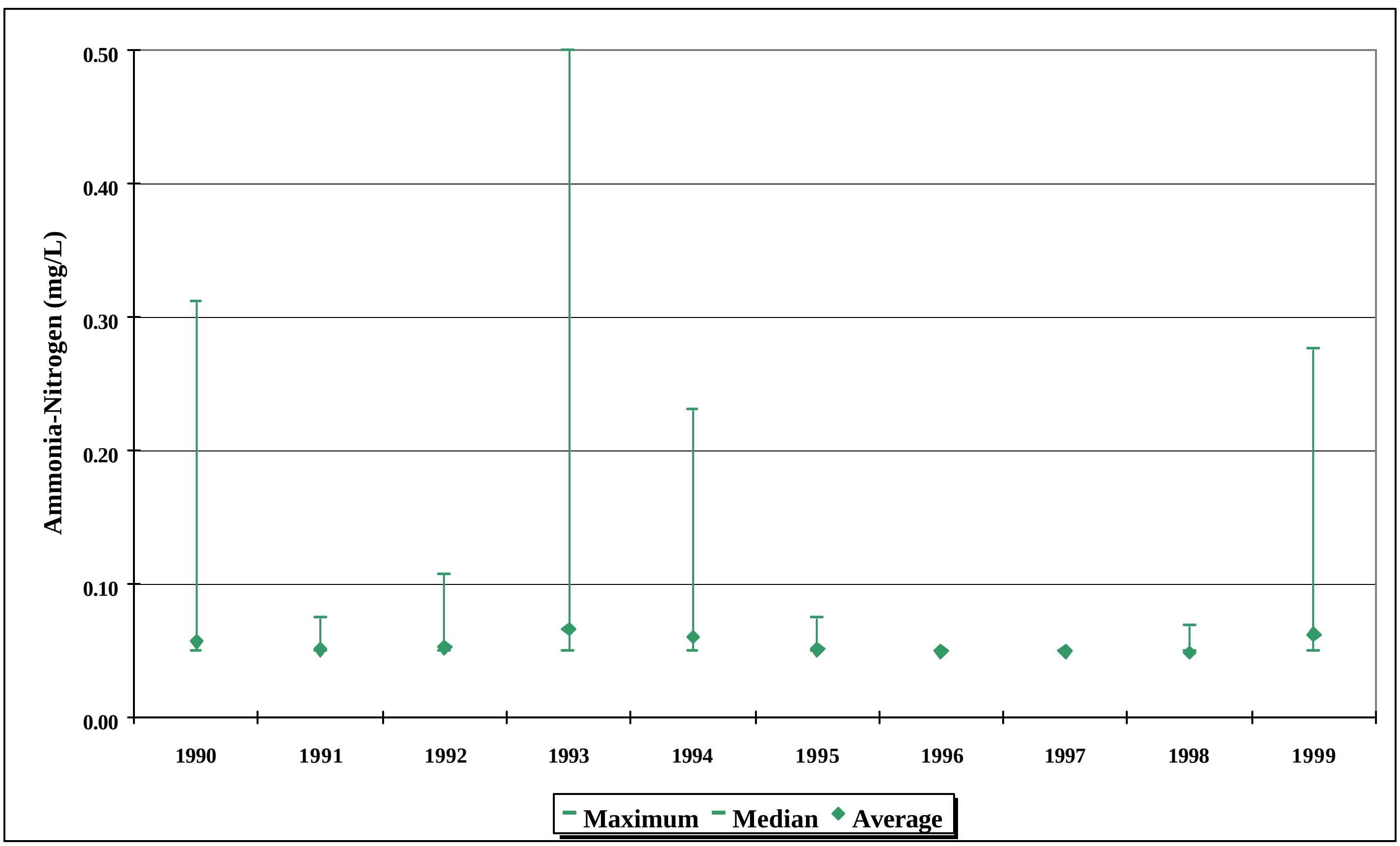

Figure 2.71 Ammonia Results for Upper Cumberland River Basin 05130101 HUC Watershed

Table 2.58 Ammonia Statistics for Upper Cumberland River Basin 05130102 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	30	0.19	0.05	0.06
1991	22	0.05	0.05	0.05
1992	26	0.10	0.05	0.06
1993	23	0.05	0.05	0.05
1994	24	0.07	0.05	0.05
1995	24	0.50	0.05	0.09
1996	29	0.05	0.05	0.05
1997	29	0.05	0.05	0.05
1998	19	0.05	0.05	0.05
1999	9	0.05	0.05	0.05

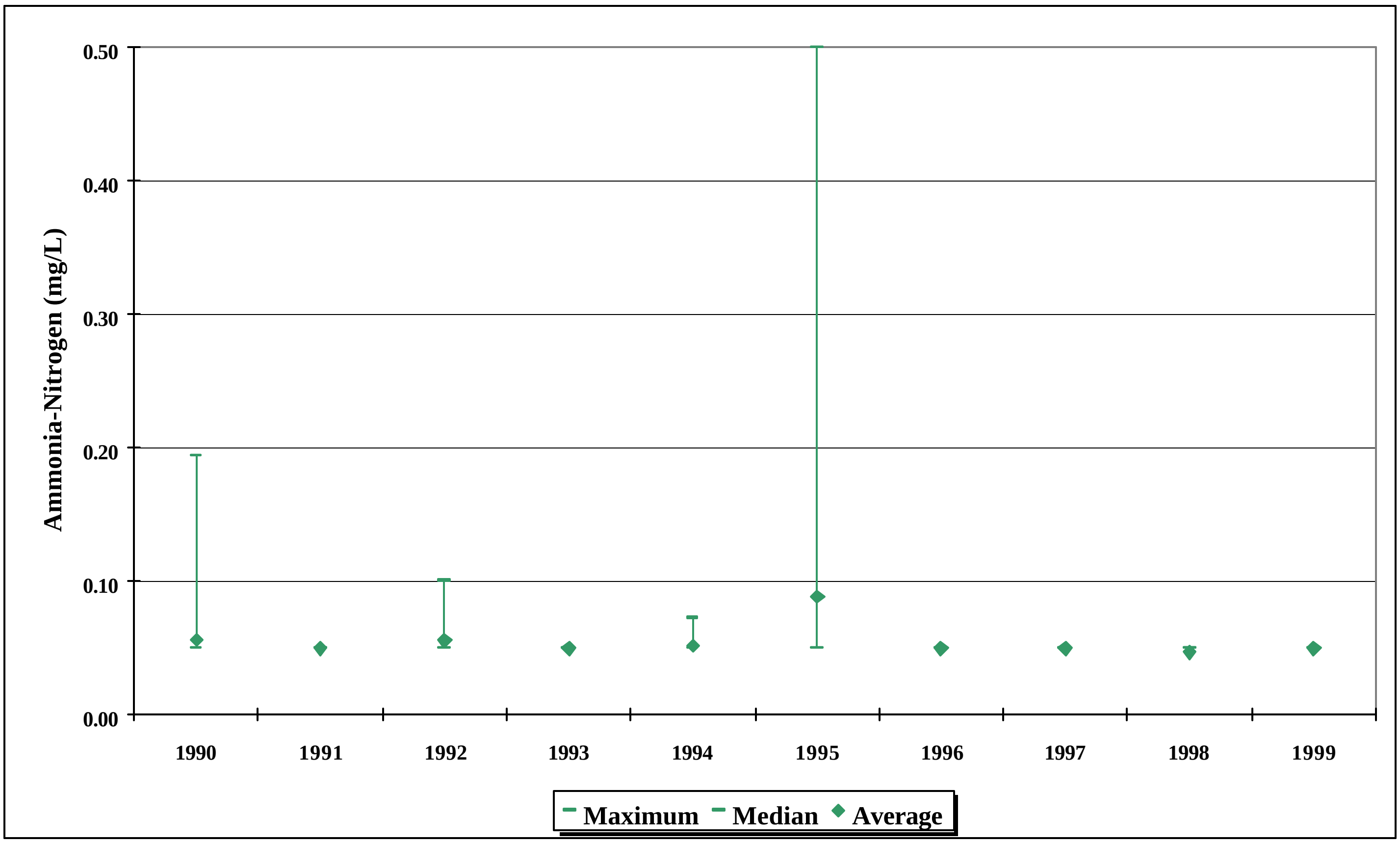

Figure 2.72 Ammonia Results for Upper Cumberland River Basin 05130102 HUC Watershed

Table 2.59 Ammonia Statistics for Upper Cumberland River Basin 05130103 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	30	0.07	0.05	0.05
1991	19	0.31	0.05	0.06
1992	18	0.05	0.05	0.05
1993	36	0.11	0.05	0.05
1994	36	0.15	0.05	0.06
1995	24	0.17	0.05	0.06
1996	12	0.05	0.05	0.05
1997	11	0.05	0.05	0.05
1998	12	0.05	0.05	0.05
1999	21	0.08	0.05	0.05

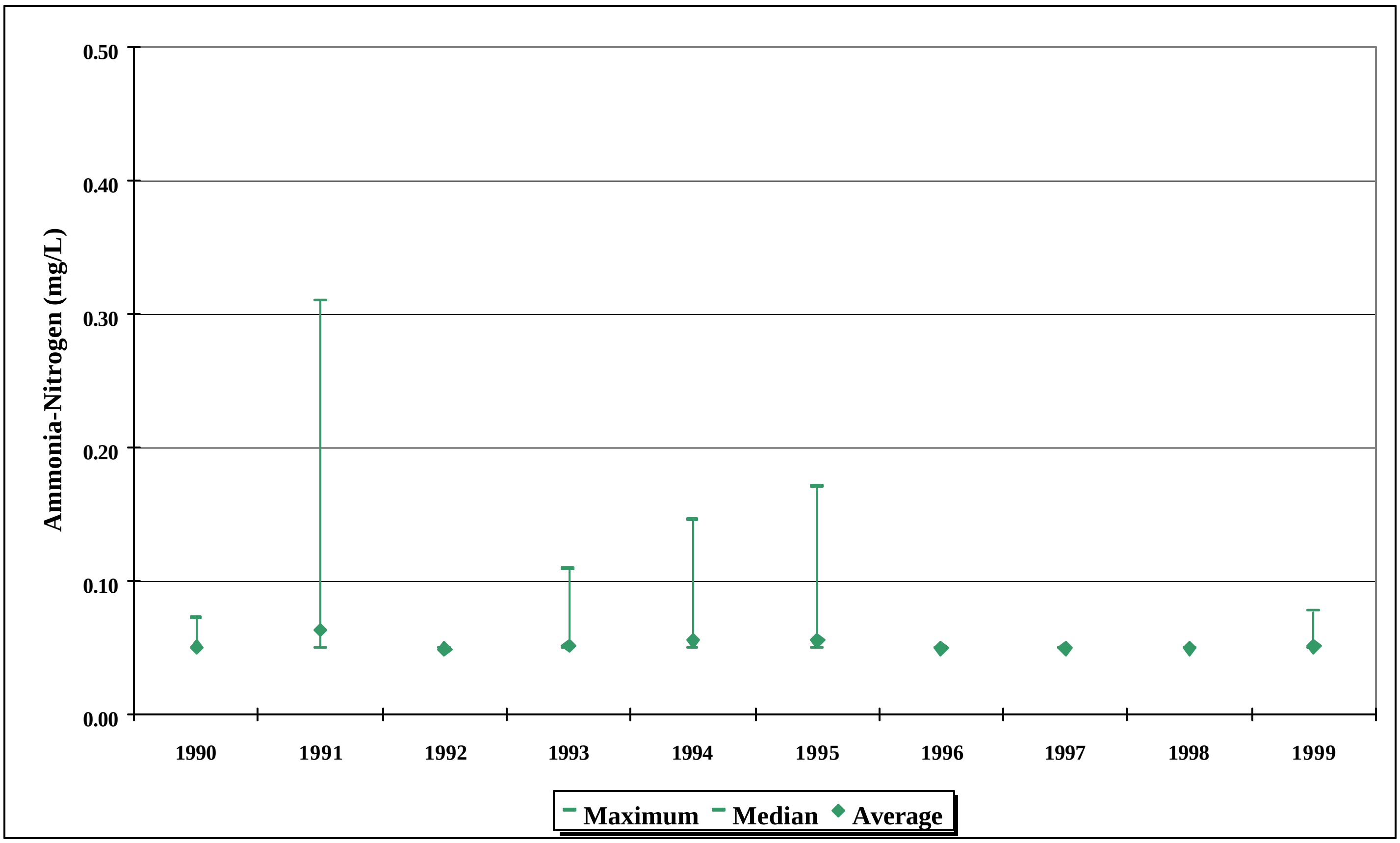

Figure 2.73 Ammonia Results for Upper Cumberland River Basin 05130103 HUC Watershed

Table 2.60 Ammonia Statistics for Upper Cumberland River Basin 05130104 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	21	0.05	0.05	0.04
1991	25	0.08	0.05	0.05
1992	25	0.05	0.05	0.04
1993	20	0.09	0.05	0.05
1994	20	0.05	0.05	0.05
1995	18	0.05	0.05	0.05
1996	12	0.05	0.05	0.05
1997	10	0.05	0.05	0.05
1998	11	0.05	0.05	0.05
1999	3	0.05	0.05	0.05

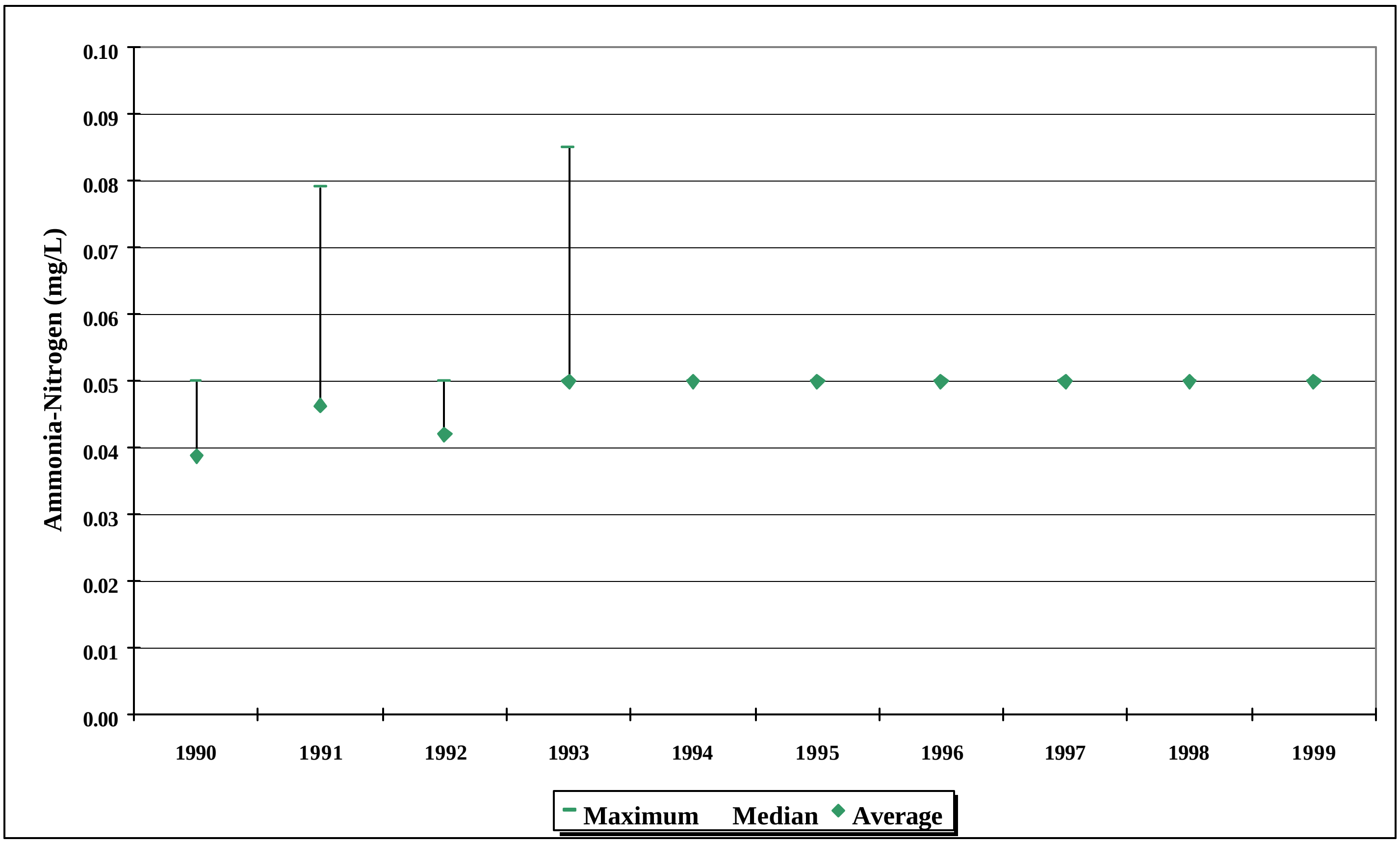

Figure 2.74 Ammonia Results for Upper Cumberland River Basin 05130104 HUC Watershed

Table 2.61 - Average Phosphorus Statistics for Counties

County	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Adair	0.03	0.01	0.13	-	-	-	-	-	0.01	-
Bell	0.01	0.04	0.02	0.02	0.03	0.02	0.01	0.01	0.02	0.02
Breathitt	0.05	0.02	0.04	0.03	0.03	0.05	0.02	0.03	0.02	-
Clay	0.01	-	-	-	-	-	-	0.19	0.01	0.08
Cumberland	0.02	0.01	0.01	0.09	0.02	0.02	0.01	0.01	0.01	0.09
Estill	-	0.01	0.02	0.03	0.05	0.03	0.02	0.03	0.01	0.07
Floyd	-	0.03	0.05	0.05	-	0.08	0.06	0.02	0.01	-
Garrard	-	-	-	-	-	-	-	0.15	0.06	0.10
Green	-	-	-	-	-	-	-	-	0.01	-
Harlan	0.01	-	-	0.01	0.03	-	-	-	-	0.02
Jackson	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.18
Jessamine	0.07	0.08	0.09	0.05	0.07	0.08	0.07	0.37	1.08	1.77
Johnson	0.02	0.02	0.05	0.05	0.10	-	-	0.03	-	-
Knott	-	-	0.05	-	0.03	-	-	-	-	-
Knox	-	-	-	-	-	-	-	-	-	0.02
Laurel	0.09	0.02	0.02	0.03	0.03	0.02	0.01	0.01	0.02	3.85
Lawrence	0.06	0.09	0.05	0.04	0.03	0.04	0.04	0.03	0.04	-
Lee	0.02	0.02	0.03	0.02	0.03	0.03	0.01	0.01	0.01	-
Leslie	0.11	0.05	0.12	-	-	-	-	0.10	0.01	0.07
Letcher	0.02	-	-	-	-	-	-	-	0.01	0.10
Lincoln	-	-	-	-	-	-	-	-	0.01	-
Magoffin	0.04	-	-	-	-	-	-	-	0.01	-
Martin	0.03	0.03	0.03	0.08	0.03	0.03	0.03	0.01	0.03	-
McCreary	0.01	0.02	0.01	0.05	0.01	0.01	0.01	0.01	0.02	0.01
Menifee	-	-	-	-	-	-	-	0.01	0.01	0.06
Metcalfe	0.04	-	-	-	0.05	0.09	-	-	-	-
Monroe	0.01	-	-	-	-	-	-	-	-	0.01
Morgan	-	0.02	0.04	0.03	0.05	0.02	0.02	0.02	0.03	-
Owsley	0.01	0.01	0.03	0.02	0.02	0.03	0.01	0.01	0.01	-
Perry	-	-	-	-	-	-	-	0.01	0.02	0.10
Pike	0.02	0.02	0.02	0.04	0.03	0.02	0.06	0.01	0.01	-
Pulaski	0.01	0.01	-	0.05	0.02	0.02	-	-	0.01	0.01
Rockcastle	0.01	-	-	-	-	-	-	-	-	0.02
Russell	0.24	0.09	0.05	0.03	0.02	0.02	-	-	-	0.02
Taylor	0.02	0.01	0.10	-	-	-	-	-	-	-
Wayne	0.02	-	-	-	-	-	-	-	-	0.01
Whitley	0.02	0.05	0.02	0.03	0.04	0.03	0.01	0.01	0.01	0.01
Wolfe	0.01	0.02	0.05	0.02	0.04	0.01	-	0.09	0.01	0.08

Table 2.62 - Maximum Phosphorus Statistics for Counties

County	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Adair	0.10	0.02	0.50	-	-	-	-	-	0.03	-
Bell	0.06	0.23	0.04	0.06	0.09	0.12	0.03	0.05	0.07	0.09
Breathitt	0.45	0.07	0.20	0.13	0.08	0.19	0.04	0.25	0.06	-
Clay	0.01	-	-	-	-	-	-	0.59	0.04	0.09
Cumberland	0.18	0.02	0.02	0.92	0.06	0.07	0.03	0.01	0.07	0.58
Estill	-	0.03	0.07	0.09	0.13	0.08	0.09	0.26	0.02	0.07
Floyd	-	0.25	0.05	0.05	-	0.75	0.16	0.02	0.01	-
Garrard	-	-	-	-	-	-	-	0.32	0.14	0.13
Green	-	-	-	-	-	-	-	-	0.04	-
Harlan	0.01	-	-	0.03	0.06	-	-	-	-	0.02
Jackson	0.24	0.02	0.03	0.04	0.04	0.03	0.02	0.02	0.06	0.60
Jessamine	0.14	0.30	0.24	0.09	0.16	0.23	0.30	1.15	2.30	1.88
Johnson	0.05	0.06	0.34	0.16	0.25	-	-	0.09	-	-
Knott	-	-	0.07	-	0.10	-	-	-	-	-
Knox	-	-	-	-	-	-	-	-	-	0.03
Laurel	0.91	0.07	0.07	0.12	0.12	0.04	0.03	0.07	0.07	3.85
Lawrence	0.15	0.65	0.20	0.14	0.21	0.29	0.24	0.17	0.10	-
Lee	0.12	0.10	0.22	0.07	0.11	0.16	0.03	0.02	0.05	-
Leslie	0.32	0.11	0.17	-	-	-	-	1.07	0.05	0.08
Letcher	0.05	-	-	-	-	-	-	-	0.03	0.12
Lincoln	-	-	-	-	-	-	-	-	0.01	-
Magoffin	0.16	-	-	-	-	-	-	-	0.01	-
Martin	0.18	0.08	0.08	0.47	0.05	0.05	0.12	0.03	0.18	-
McCreary	0.10	0.13	0.04	0.74	0.05	0.03	0.01	0.01	0.07	0.01
Menifee	-	-	-	-	-	-	-	0.01	0.02	0.06
Metcalfe	0.05	-	-	-	0.06	0.17	-	-	-	-
Monroe	0.02	-	-	-	-	-	-	-	-	0.01
Morgan	-	0.08	0.28	0.08	0.09	0.10	0.07	0.09	0.13	-
Owsley	0.03	0.01	0.22	0.04	0.08	0.07	0.02	0.05	0.05	-
Perry	-	-	-	-	-	-	-	0.03	0.03	0.16
Pike	0.07	0.05	0.07	0.91	0.10	0.05	0.65	0.03	0.09	-
Pulaski	0.04	0.01	-	0.22	0.04	0.04	-	-	0.03	0.01
Rockcastle	0.01	-	-	-	-	-	-	-	-	0.06
Russell	0.39	0.22	0.17	0.07	0.05	0.04	-	-	-	0.04
Taylor	0.11	0.01	0.50	-	-	-	-	-	-	-
Wayne	0.04	-	-	-	-	-	-	-	-	0.01
Whitley	0.06	0.28	0.04	0.09	0.15	0.13	0.06	0.02	0.07	0.02
Wolfe	0.01	0.07	0.39	0.03	0.10	0.01	-	0.18	0.03	0.08

Table 2.63 - Medain Phosphorus Statistics for Counties

County	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Adair	0.02	0.01	0.07	-	-	-	-	-	0.01	-
Bell	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
Breathitt	0.02	0.02	0.02	0.03	0.03	0.02	0.01	0.01	0.01	-
Casey	-	-	-	-	-	-	-	-	-	-
Clay	0.01	-	-	-	-	-	-	0.08	0.01	0.08
Clinton	-	-	-	-	-	-	-	-	-	-
Cumberland	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
Estill	-	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.07
Floyd	-	0.01	0.05	0.05	-	0.02	0.04	0.02	0.01	-
Garrard	-	-	-	-	-	-	-	0.10	0.04	0.11
Green	-	-	-	-	-	-	-	-	0.01	-
Harlan	0.01	-	-	0.01	0.04	-	-	-	-	0.02
Jackson	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.10
Jessamine	0.07	0.04	0.08	0.04	0.06	0.05	0.04	0.15	0.86	1.77
Johnson	0.02	0.02	0.05	0.05	0.06	-	-	0.02	-	-
Knott	-	-	0.05	-	0.03	-	-	-	-	-
Knox	-	-	-	-	-	-	-	-	-	0.02
Laurel	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	3.85
Lawrence	0.06	0.07	0.05	0.03	0.02	0.02	0.02	0.02	0.03	-
Lee	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	-
Leslie	0.05	0.05	0.11	-	-	-	-	0.01	0.01	0.07
Letcher	0.01	-	-	-	-	-	-	-	0.01	0.10
Lincoln	-	-	-	-	-	-	-	-	0.01	-
Magoffin	0.02	-	-	-	-	-	-	-	0.01	-
Martin	0.01	0.03	0.01	0.02	0.02	0.02	0.02	0.01	0.01	-
McCreary	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
Menifee	-	-	-	-	-	-	-	0.01	0.01	0.06
Metcalfe	0.03	-	-	-	0.05	0.07	-	-	-	-
Monroe	0.01	-	-	-	-	-	-	-	-	0.01
Morgan	-	0.02	0.05	0.05	0.04	0.02	0.01	0.01	0.01	-
Owsley	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	-
Perry	-	-	-	-	-	-	-	0.01	0.02	0.08
Pike	0.01	0.01	0.01	0.02	0.03	0.02	0.01	0.01	0.01	-
Pulaski	0.01	0.01	-	0.04	0.03	0.01	-	-	0.01	0.01
Rockcastle	0.01	-	-	-	-	-	-	-	-	0.01
Russell	0.23	0.04	0.02	0.03	0.01	0.01	-	-	-	0.03
Taylor	0.01	0.01	0.05	-	-	-	-	-	-	-
Wayne	0.01	-	-	-	-	-	-	-	-	0.01
Whitley	0.02	0.02	0.01	0.02	0.03	0.02	0.01	0.01	0.01	0.01
Wolfe	0.01	0.01	0.01	0.02	0.03	0.01	-	0.09	0.01	0.08

Table 2.64 - Average Phosphorus Statistics for HUCs

HUC8	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
05070201	0.03	0.03	0.03	0.08	0.03	0.03	0.03	0.01	0.02	-
05070202		0.02	0.02	0.04	0.04	0.02	-	-	-	-
05070203	0.02	0.03	0.04	0.04	0.05	0.05	0.05	0.02	0.01	-
05070204	0.06	0.10	0.06	0.04	0.03	0.04	0.04	0.03	0.07	-
05100101	0.04	0.02	0.02	0.03	0.04	0.02	0.02	0.01	0.02	-
05100201	0.04	0.02	0.04	0.03	0.03	0.05	0.02	0.02	0.02	0.10
05100202	0.03	0.04	0.06	0.02	0.03	0.03	0.01	0.06	0.01	0.07
05100203	0.01	0.01	0.03	0.02	0.02	0.03	0.01	0.06	0.01	0.08
05100204	0.01	0.02	0.03	0.03	0.04	0.02	0.02	0.05	0.01	0.09
05100205	0.07	0.08	0.09	0.05	0.07	0.08	0.07	0.27	0.24	0.76
05110001	0.03	0.01	0.11	-	0.05	0.09	-	-	0.01	-
05110002	0.01	-	-	-	-	-	-	-	-	-
05130101	0.05	0.05	0.02	0.02	0.04	0.02	0.01	0.01	0.01	0.17
05130102	0.02	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.08
05130103	0.04	0.04	0.02	0.06	0.02	0.02	0.01	0.01	0.01	0.04
05130104	0.01	0.02	0.01	0.05	0.01	0.01	0.01	0.01	0.02	0.01

Table 2.65 - Maximum Phosphorus Statistics for HUCs

HUC8	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
05070201	0.18	0.08	0.08	0.47	0.05	0.05	0.12	0.03	0.18	-
05070202	-	0.05	0.06	0.91	0.10	0.05	-	-	-	-
05070203	0.07	0.25	0.34	0.16	0.25	0.75	0.65	0.09	0.09	-
05070204	0.15	0.65	0.20	0.14	0.21	0.29	0.24	0.17	0.10	-
05100101	0.16	0.08	0.10	0.08	0.09	0.10	0.07	0.05	0.13	-
05100201	0.45	0.07	0.20	0.13	0.10	0.19	0.04	0.10	0.06	0.16
05100202	0.32	0.11	0.22	0.07	0.11	0.16	0.03	1.07	0.05	0.08
05100203	0.03	0.01	0.22	0.04	0.08	0.07	0.02	0.59	0.05	0.09
05100204	0.12	0.07	0.39	0.09	0.13	0.08	0.09	0.26	0.03	0.15
05100205	0.14	0.30	0.24	0.09	0.16	0.23	0.30	1.15	2.30	1.88
05110001	0.11	0.02	0.50	-	0.06	0.17	-	-	0.04	-
05110002	0.02	-	-	-	-	-	-	-	-	-
05130101	0.91	0.28	0.06	0.09	0.15	0.13	0.06	0.05	0.07	3.85
05130102	0.24	0.07	0.07	0.12	0.12	0.04	0.03	0.07	0.07	0.60
05130103	0.39	0.22	0.17	0.92	0.06	0.07	0.03	0.01	0.07	0.58
05130104	0.10	0.13	0.04	0.74	0.05	0.03	0.01	0.01	0.07	0.01

Table 2.67 Phosphorus Statistics for Adair County

Year	Samples	Maximum	Median	Average
1990	12	0.10	0.02	0.03
1991	3	0.02	0.01	0.01
1992	7	0.50	0.07	0.13
1993				
1994				
1995				
1996				
1997				
1998	4	0.03	0.01	0.01
1999				

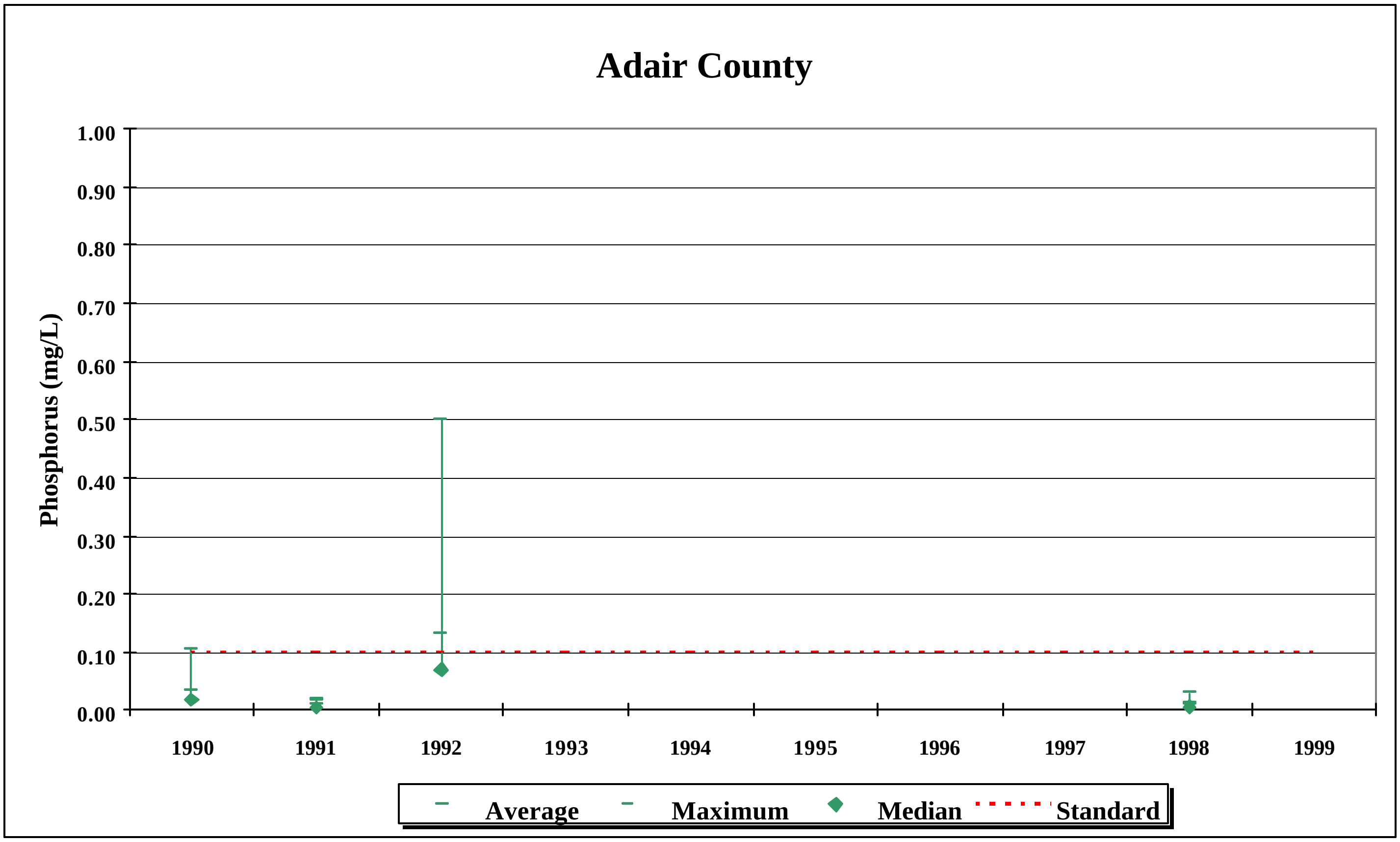

Figure 2.75 Phosphorus Results for Adair County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.68 Phosphorus Statistics for Bell County

Year	Samples	Maximum	Median	Average
1990	18	0.06	0.01	0.01
1991	12	0.23	0.02	0.04
1992	10	0.04	0.02	0.02
1993	12	0.06	0.02	0.02
1994	12	0.09	0.02	0.03
1995	12	0.12	0.01	0.02
1996	12	0.03	0.01	0.01
1997	11	0.05	0.01	0.01
1998	11	0.07	0.01	0.02
1999	11	0.09	0.01	0.02

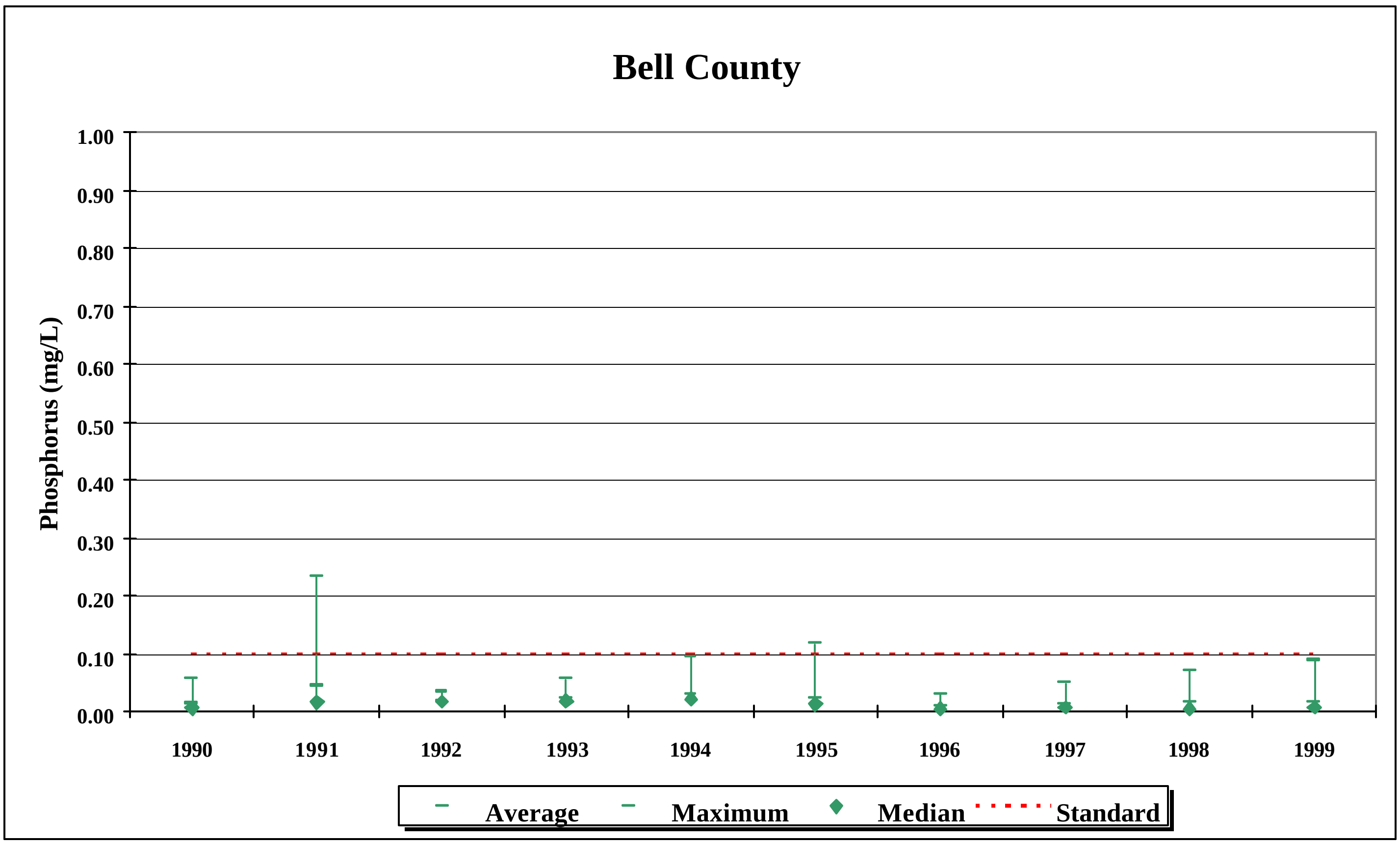

Table 2.76 Phosphorus Statistics for Bell County

Note: Phosphorus Standard is 0.1 mg/l

Table 2.69 Phosphorus Statistics for Breathitt County

Year	Samples	Maximum	Median	Average
1990	23	0.45	0.02	0.05
1991	15	0.07	0.02	0.02
1992	12	0.20	0.02	0.04
1993	12	0.13	0.03	0.03
1994	12	0.08	0.03	0.03
1995	12	0.19	0.02	0.05
1996	11	0.04	0.01	0.02
1997	15	0.25	0.01	0.03
1998	24	0.06	0.01	0.02
1999				

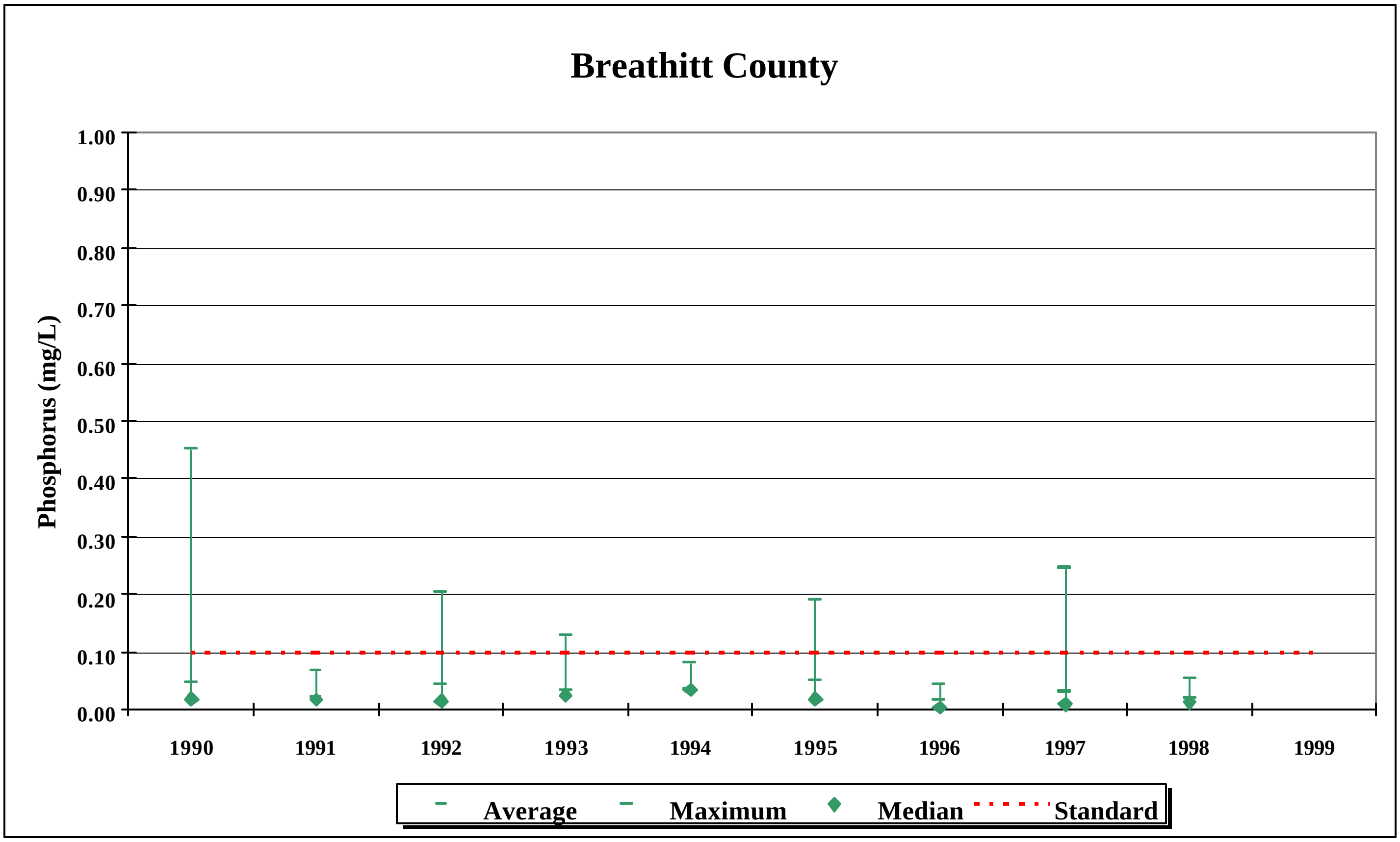

Table 2.77 Phosphorus Statistics for Breathitt County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.70 Phosphorus Statistics for Clay County

Year	Samples	Maximum	Median	Average
1990	3	0.01	0.01	0.01
1991				
1992				
1993				
1994				
1995				
1996				
1997	4	0.59	0.08	0.19
1998	21	0.04	0.01	0.01
1999	4	0.09	0.08	0.08

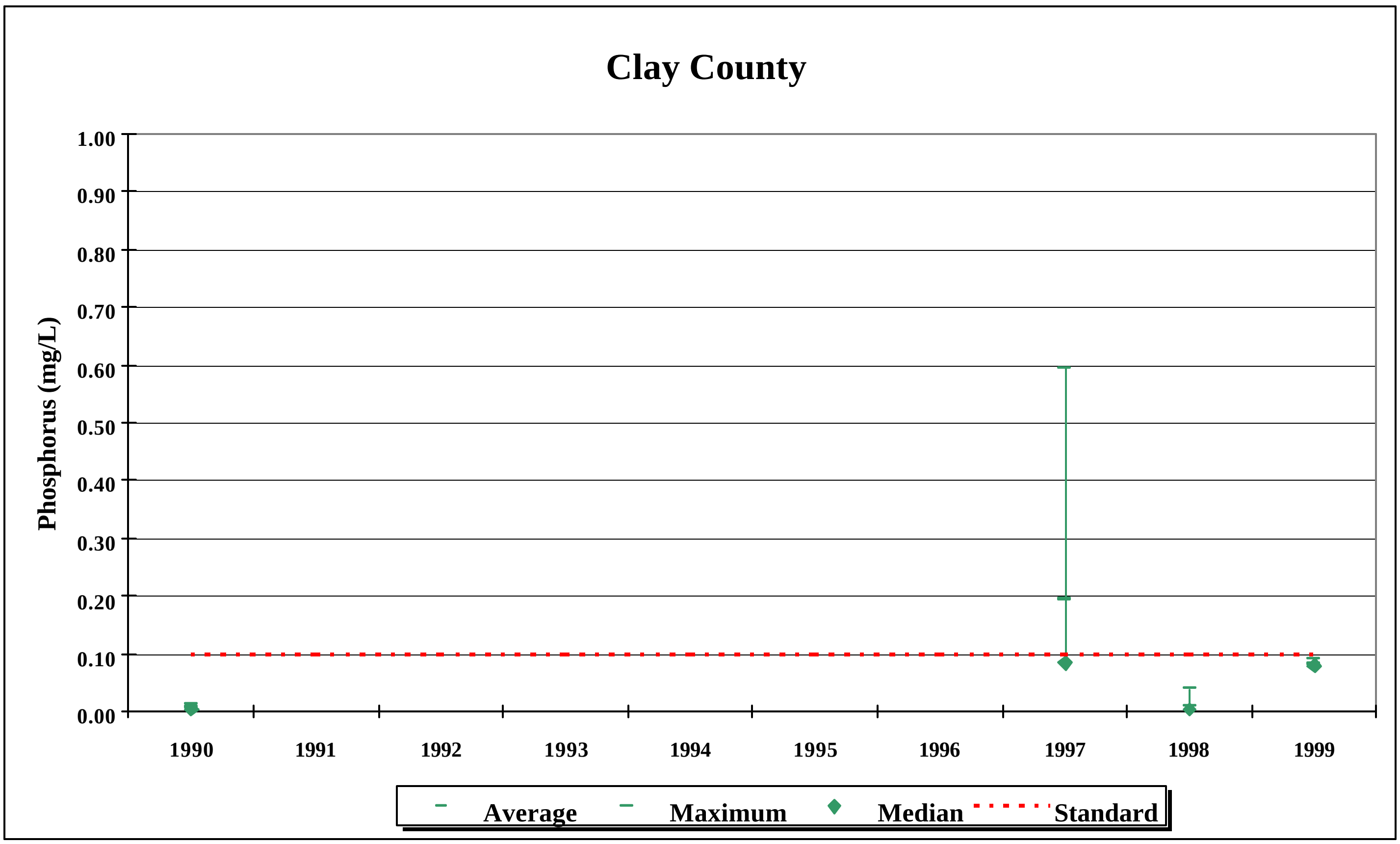

Table 2.78 Phosphorus Statistics for Clay County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.71 Phosphorus Statistics for Cumberland County

Year	Samples	Maximum	Median	Average
1990	12	0.18	0.01	0.02
1991	9	0.02	0.01	0.01
1992	11	0.02	0.01	0.01
1993	12	0.92	0.01	0.09
1994	12	0.06	0.01	0.02
1995	12	0.07	0.01	0.02
1996	12	0.03	0.01	0.01
1997	12	0.01	0.01	0.01
1998	9	0.07	0.01	0.01
1999	8	0.58	0.02	0.09

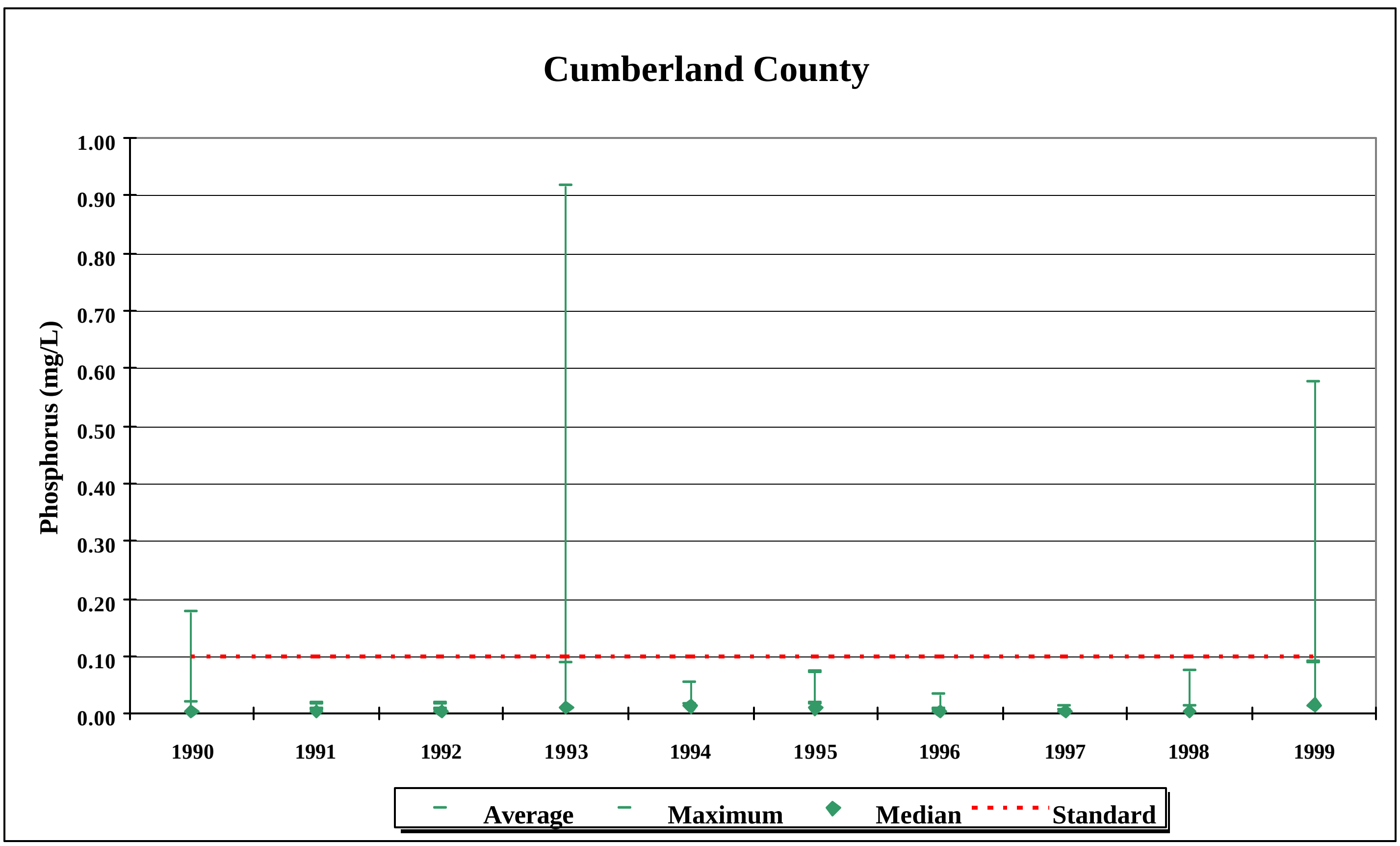

Table 2.79 Phosphorus Statistics for Cumberland County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.72 Phosphorus Statistics for Estill County

Year	Samples	Maximum	Median	Average
1990				
1991	10	0.03	0.01	0.01
1992	12	0.07	0.01	0.02
1993	12	0.09	0.01	0.03
1994	12	0.13	0.02	0.05
1995	12	0.08	0.02	0.03
1996	11	0.09	0.01	0.02
1997	13	0.26	0.01	0.03
1998	11	0.02	0.01	0.01
1999	1	0.07	0.07	0.07

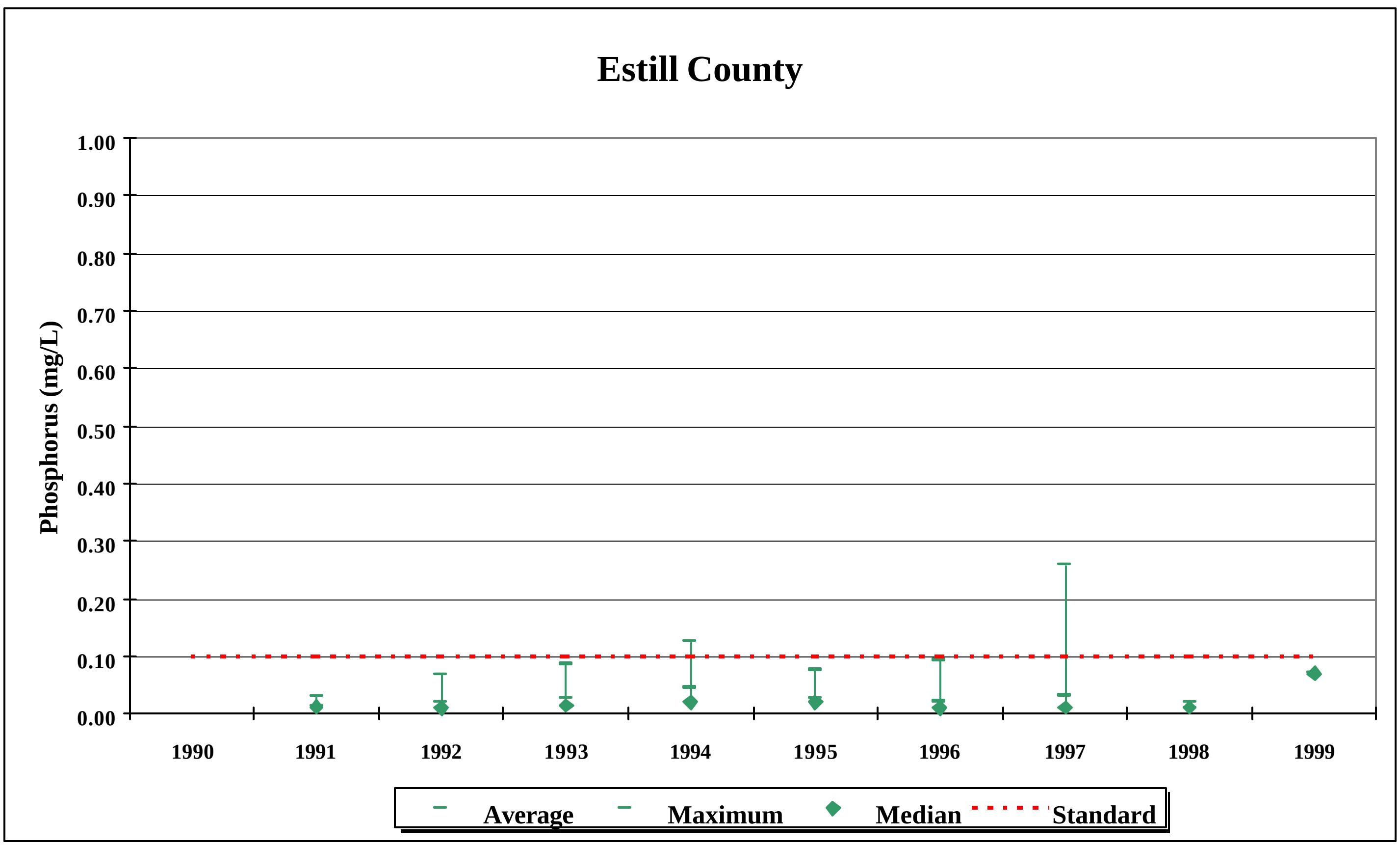

Table 2.80 Phosphorus Statistics for Estill County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.73 Phosphorus Statistics for Floyd County

Year	Samples	Maximum	Median	Average
1990				
1991	13	0.25	0.01	0.03
1992	1	0.05	0.05	0.05
1993	6	0.05	0.05	0.05
1994				
1995	20	0.75	0.02	0.08
1996	10	0.16	0.04	0.06
1997	2	0.02	0.02	0.02
1998	6	0.01	0.01	0.01
1999				

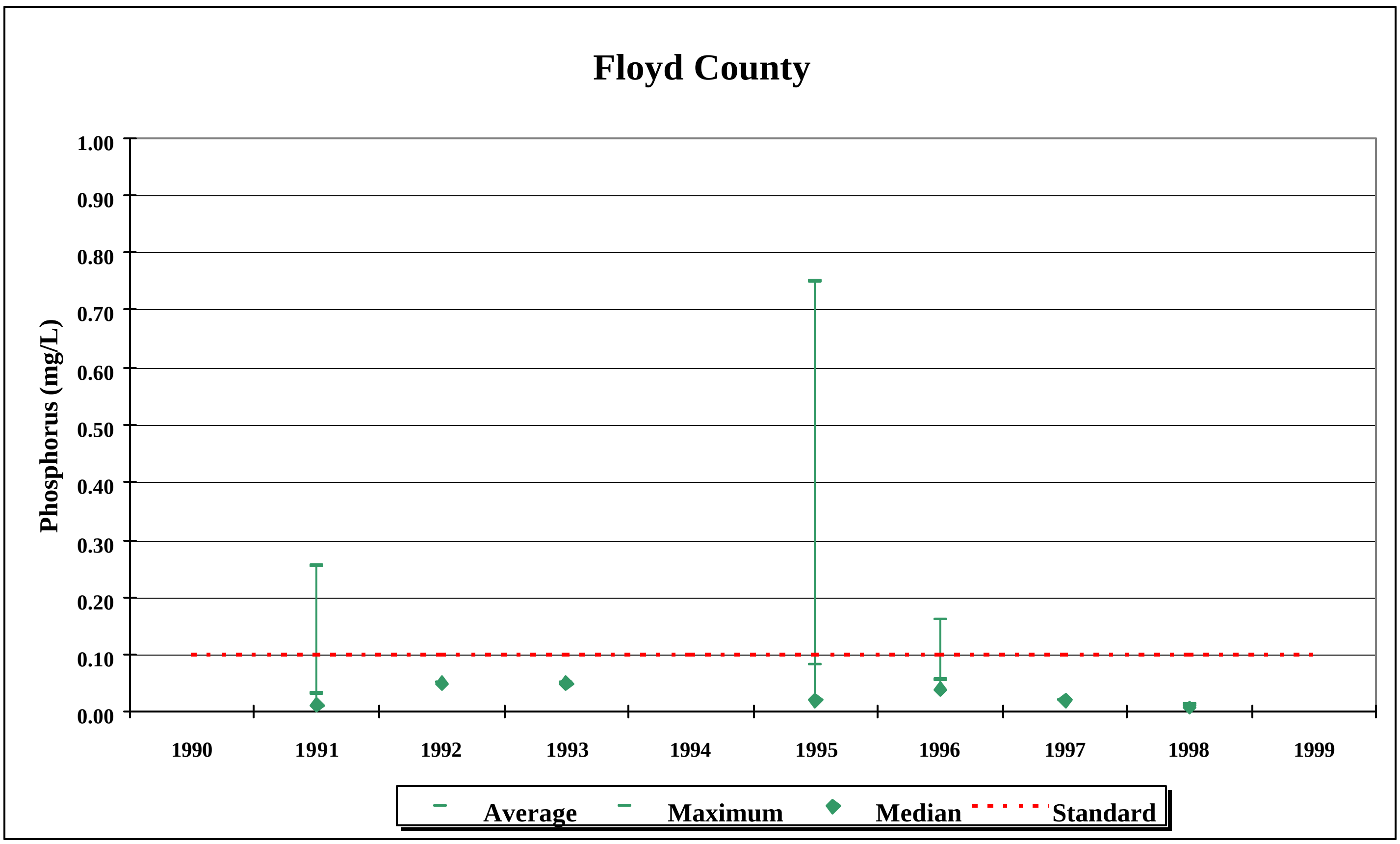

Table 2.81 Phosphorus Statistics for Floyd County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.74 Phosphorus Statistics for Garrard County

Year	Samples	Maximum	Median	Average
1990				
1991				
1992				
1993				
1994				
1995				
1996				
1997	3	0.32	0.10	0.15
1998	15	0.14	0.04	0.06
1999	3	0.13	0.11	0.10

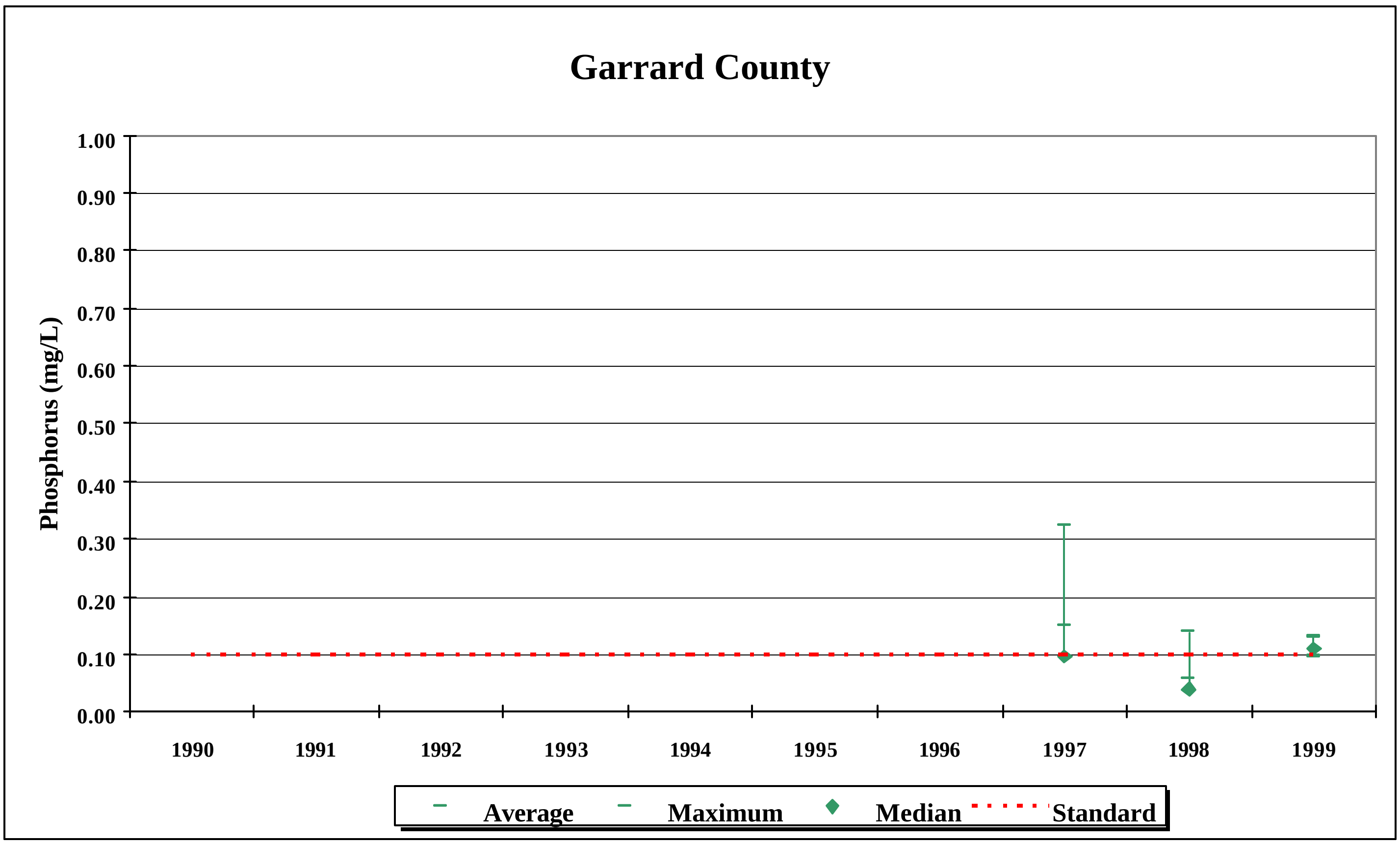

Table 2.82 Phosphorus Statistics for Garrard County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.75 Phosphorus Statistics for Green County

Year	Samples	Maximum	Median	Average
1990				
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998	8	0.04	0.01	0.01
1999				

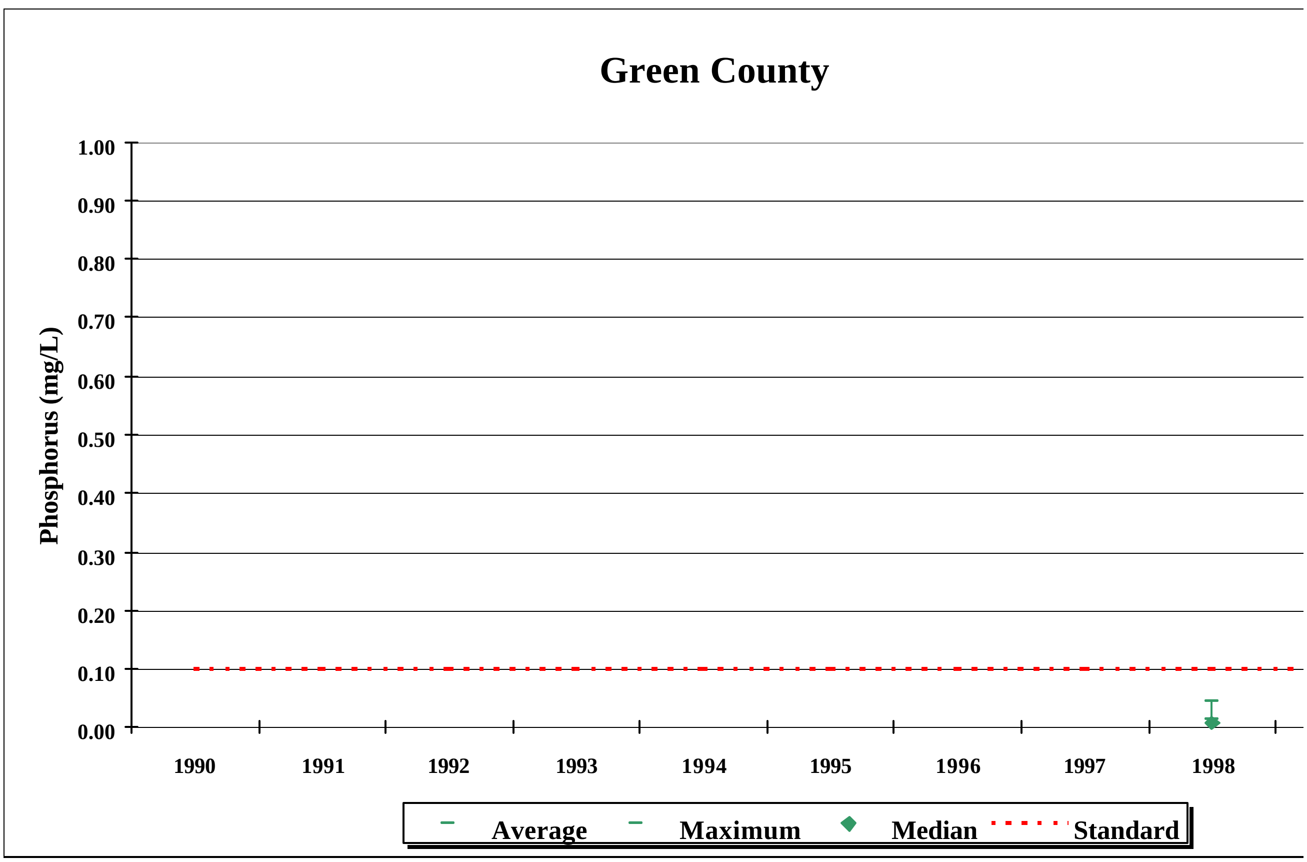

Table 2.83 Phosphorus Statistics for Green County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.76 Phosphorus Statistics for Harlan County

Year	Samples	Maximum	Median	Average
1990	3	0.01	0.01	0.01
1991				
1992				
1993	15	0.03	0.01	0.01
1994	12	0.06	0.04	0.03
1995				
1996				
1997				
1998				
1999	6	0.02	0.02	0.02

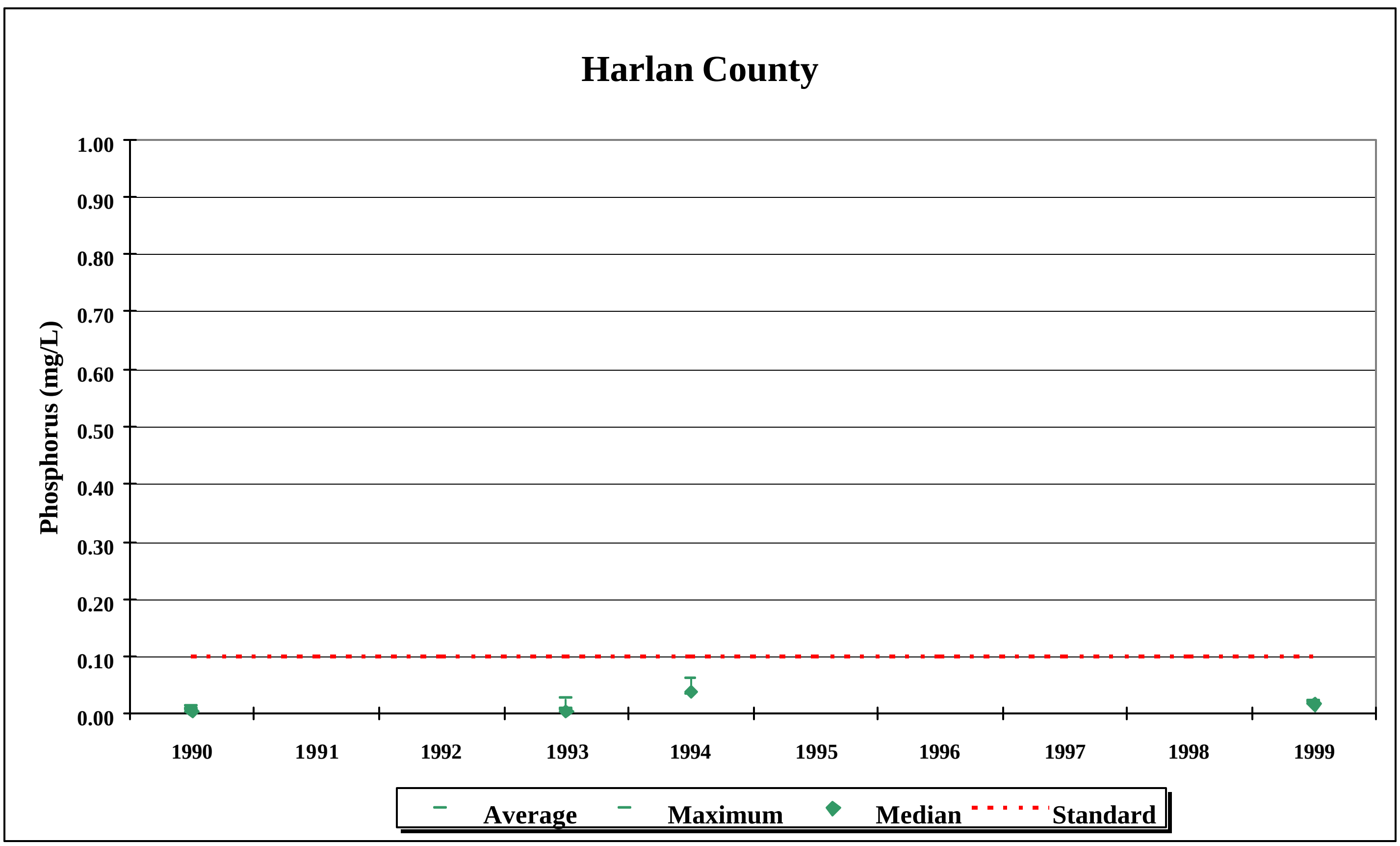

Table 2.84 Phosphorus Statistics for Harlan County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.77 Phosphorus Statistics for Jackson County

Year	Samples	Maximum	Median	Average
1990	16	0.24	0.01	0.02
1991	12	0.02	0.01	0.01
1992	10	0.03	0.01	0.01
1993	12	0.04	0.01	0.02
1994	12	0.04	0.02	0.02
1995	12	0.03	0.01	0.01
1996	12	0.02	0.01	0.01
1997	12	0.02	0.01	0.01
1998	18	0.06	0.01	0.01
1999	5	0.60	0.10	0.18

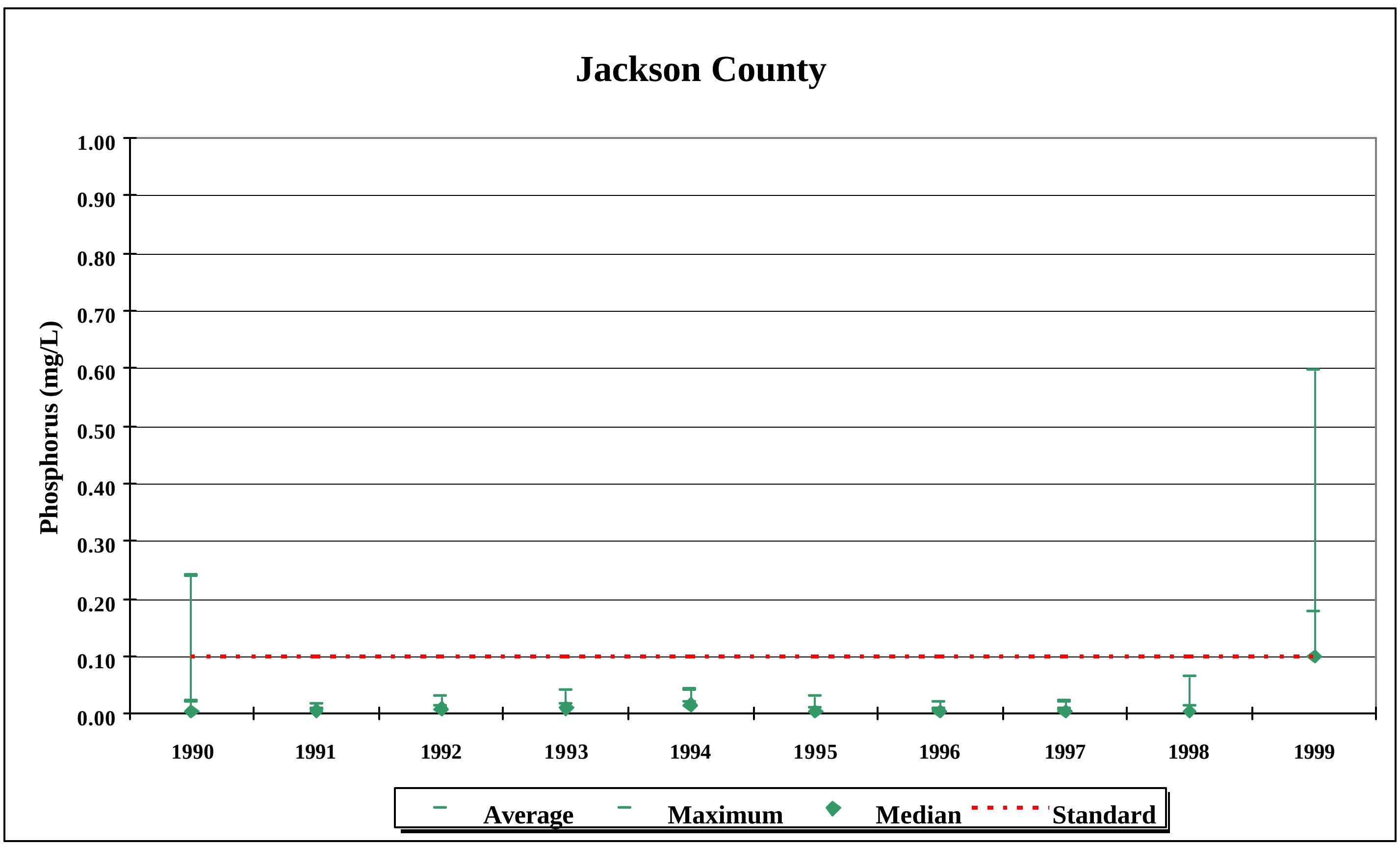

Table 2.85 Phosphorus Statistics for Jackson County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.78 Phosphorus Statistics for Jessamine County

Year	Samples	Maximum	Median	Average
1990	12	0.14	0.07	0.07
1991	11	0.30	0.04	0.08
1992	12	0.24	0.08	0.09
1993	12	0.09	0.04	0.05
1994	12	0.16	0.06	0.07
1995	12	0.23	0.05	0.08
1996	9	0.30	0.04	0.07
1997	4	1.15	0.15	0.37
1998	4	2.30	0.86	1.08
1999	2	1.88	1.77	1.77

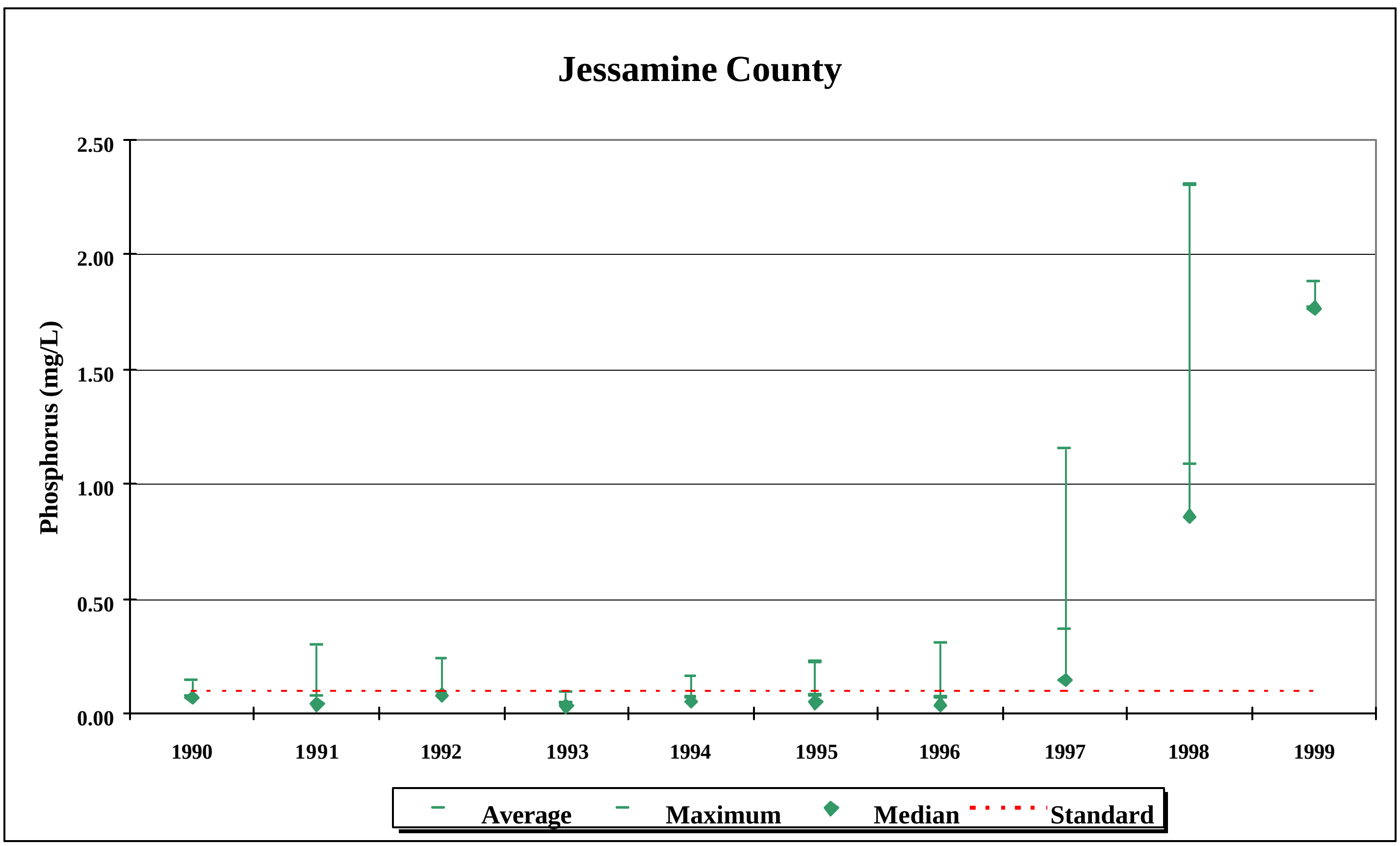

Table 2.86 Phosphorus Statistics for Jessamine County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.79 Phosphorus Statistics for Johnson County

Year	Samples	Maximum	Median	Average
1990	11	0.05	0.02	0.02
1991	9	0.06	0.02	0.02
1992	192	0.34	0.05	0.05
1993	23	0.16	0.05	0.05
1994	4	0.25	0.06	0.10
1995				
1996				
1997	11	0.09	0.02	0.03
1998				
1999				

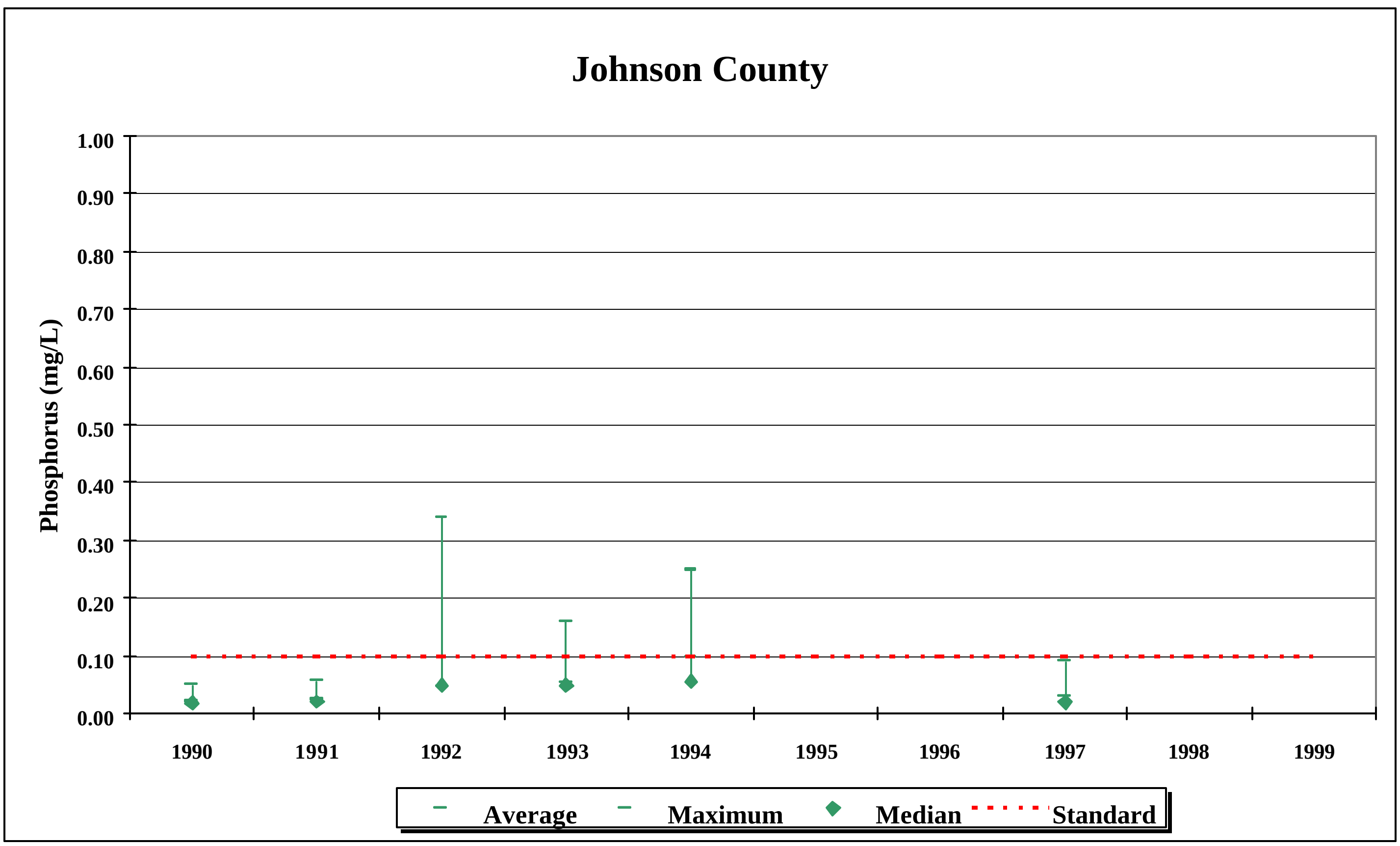

Table 2.87 Phosphorus Statistics for Johnson County

Note: Phosphorus Standard is 0.10 mg/l

Table 2.80 Phosphorus Statistics for Knott County

Year	Samples	Maximum	Median	Average
1990				
1991				
1992	18	0.07	0.05	0.05
1993				
1994	12	0.10	0.03	0.03
1995				
1996				
1997				
1998				
1999				

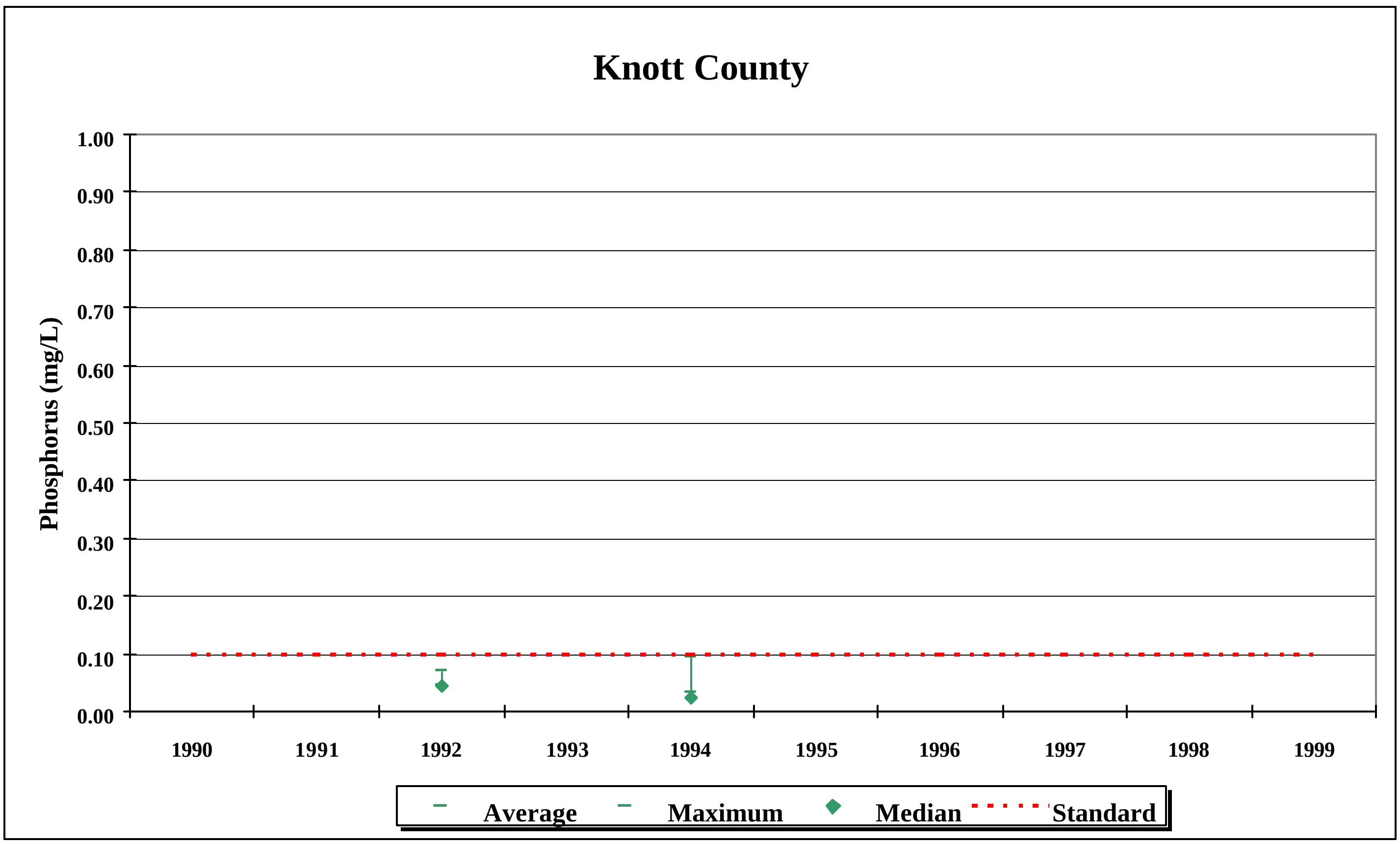

Table 2.88 Phosphorus Statistics for Knott County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.81 Phosphorus Statistics for Knox County

Year	Samples	Maximum	Median	Average
1990				
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998				
1999	2	0.03	0.02	0.02

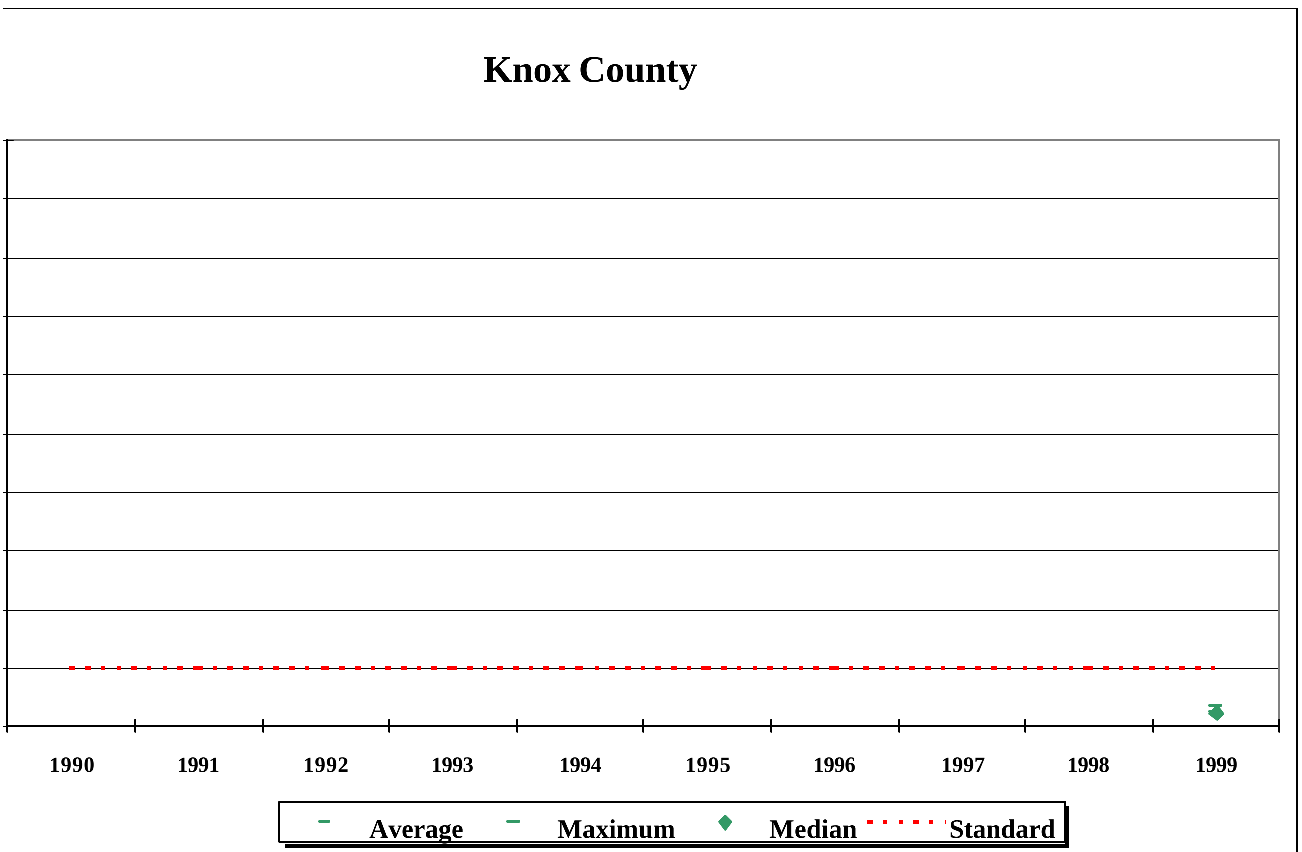

Table 2.89 Phosphorus Statistics for Knox County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.82 Phosphorus Statistics for Laurel County

Year	Samples	Maximum	Median	Average
1990	18	0.91	0.02	0.09
1991	11	0.07	0.01	0.02
1992	26	0.07	0.01	0.02
1993	27	0.12	0.02	0.03
1994	12	0.12	0.02	0.03
1995	12	0.04	0.01	0.02
1996	18	0.03	0.01	0.01
1997	17	0.07	0.01	0.01
1998	8	0.07	0.01	0.02
1999	1	3.85	3.85	3.85

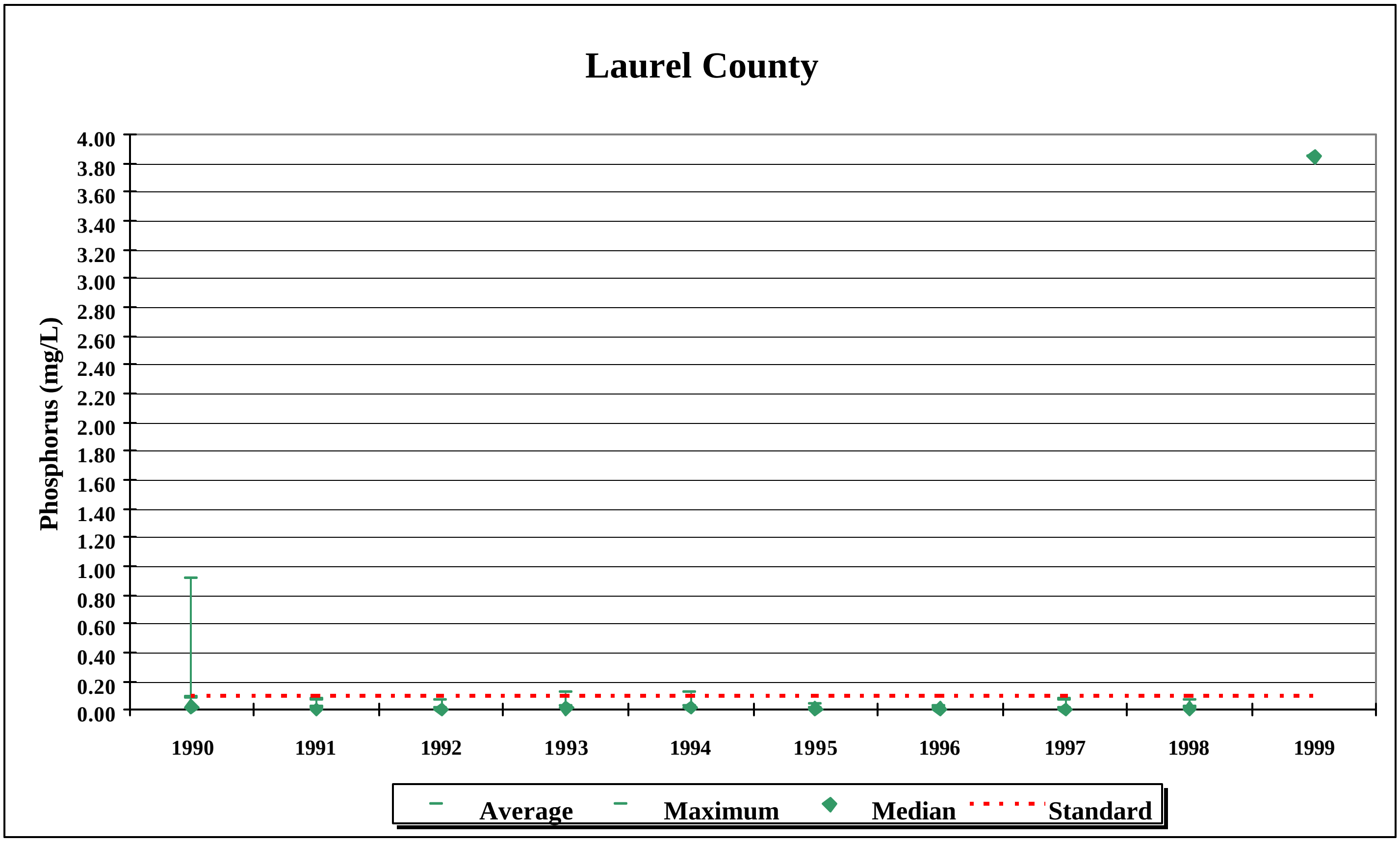

Table 2.90 Phosphorus Statistics for Laurel County

Note: Phosphorus Standard is 0.10 mg/l

Table 2.83 Phosphorus Statistics for Lawrence County

Year	Samples	Maximum	Median	Average
1990	21	0.15	0.06	0.06
1991	32	0.65	0.07	0.09
1992	60	0.20	0.05	0.05
1993	66	0.14	0.03	0.04
1994	123	0.21	0.02	0.03
1995	92	0.29	0.02	0.04
1996	101	0.24	0.02	0.04
1997	138	0.17	0.02	0.03
1998	14	0.10	0.03	0.04
1999				

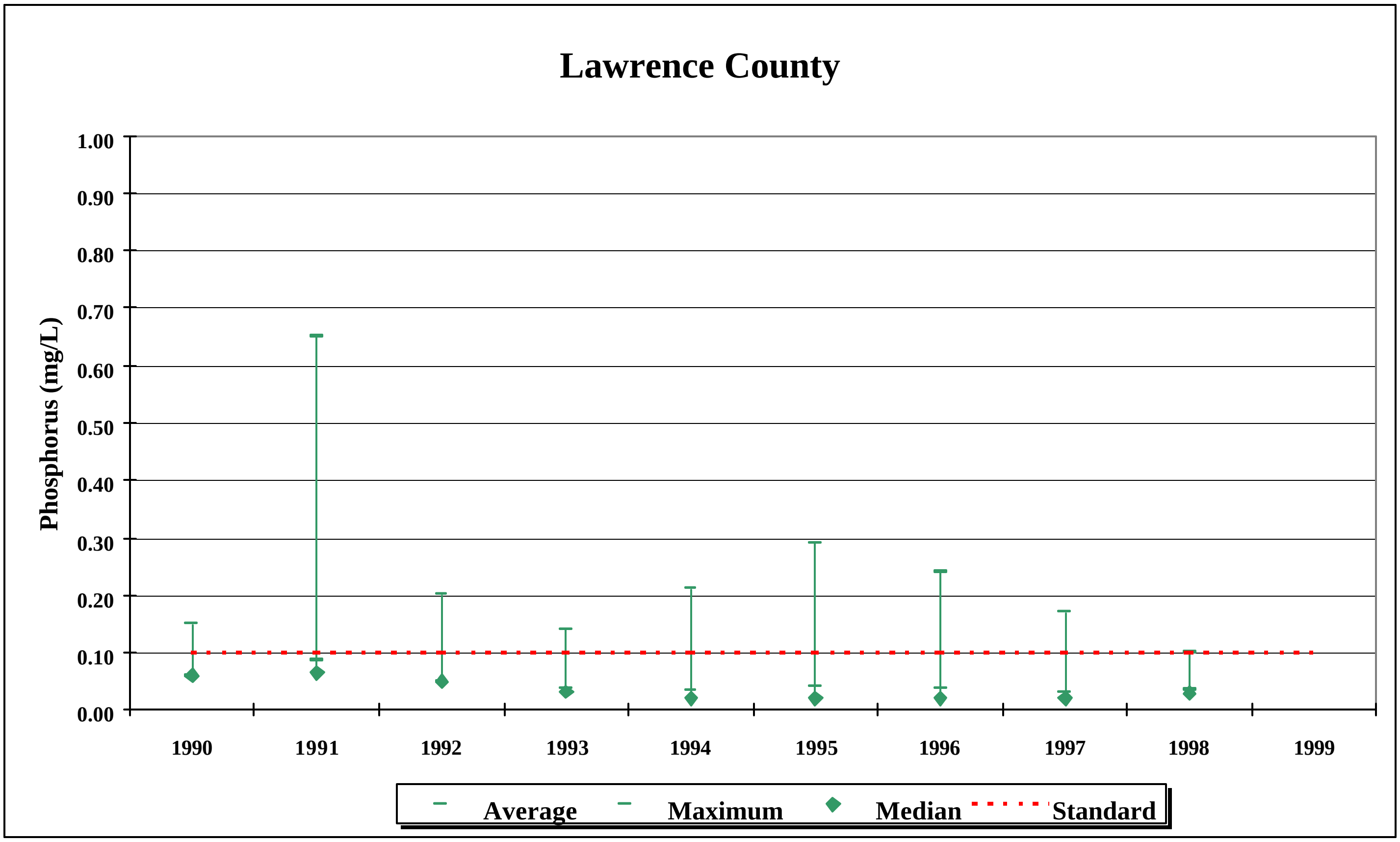

Table 2.91 Phosphorus Statistics for Lawrence County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.84 Phosphorus Statistics for Lee County

Year	Samples	Maximum	Median	Average
1990	27	0.12	0.01	0.02
1991	11	0.10	0.01	0.02
1992	12	0.22	0.01	0.03
1993	12	0.07	0.02	0.02
1994	12	0.11	0.02	0.03
1995	12	0.16	0.02	0.03
1996	11	0.03	0.01	0.01
1997	11	0.02	0.01	0.01
1998	11	0.05	0.01	0.01
1999				

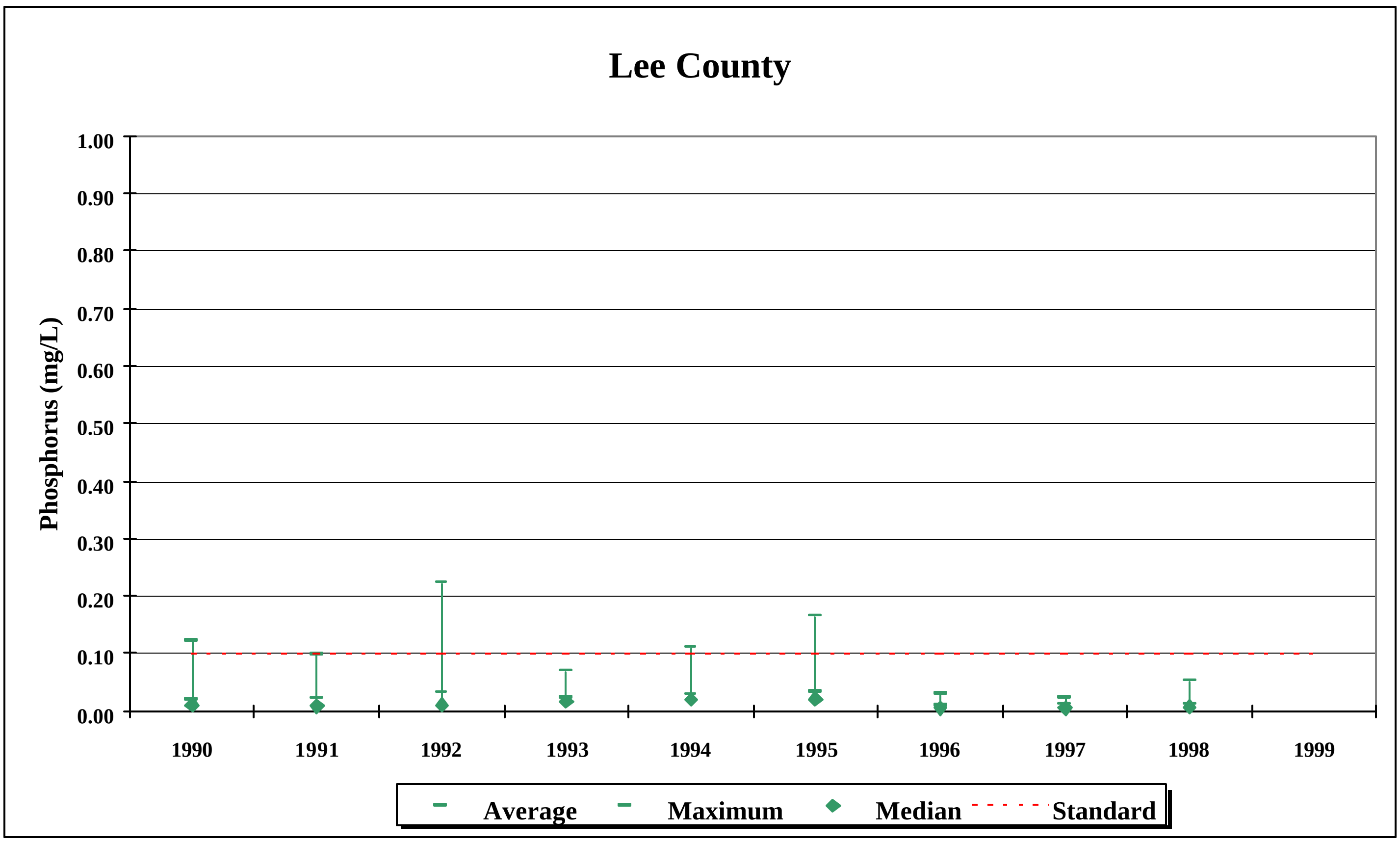

Table 2.92 Phosphorus Statistics for Lee County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.85 Phosphorus Statistics for Leslie County

Year	Samples	Maximum	Median	Average
1990	4	0.32	0.05	0.11
1991	12	0.11	0.05	0.05
1992	5	0.17	0.11	0.12
1993				
1994				
1995				
1996				
1997	11	1.07	0.01	0.10
1998	17	0.05	0.01	0.01
1999	3	0.08	0.07	0.07

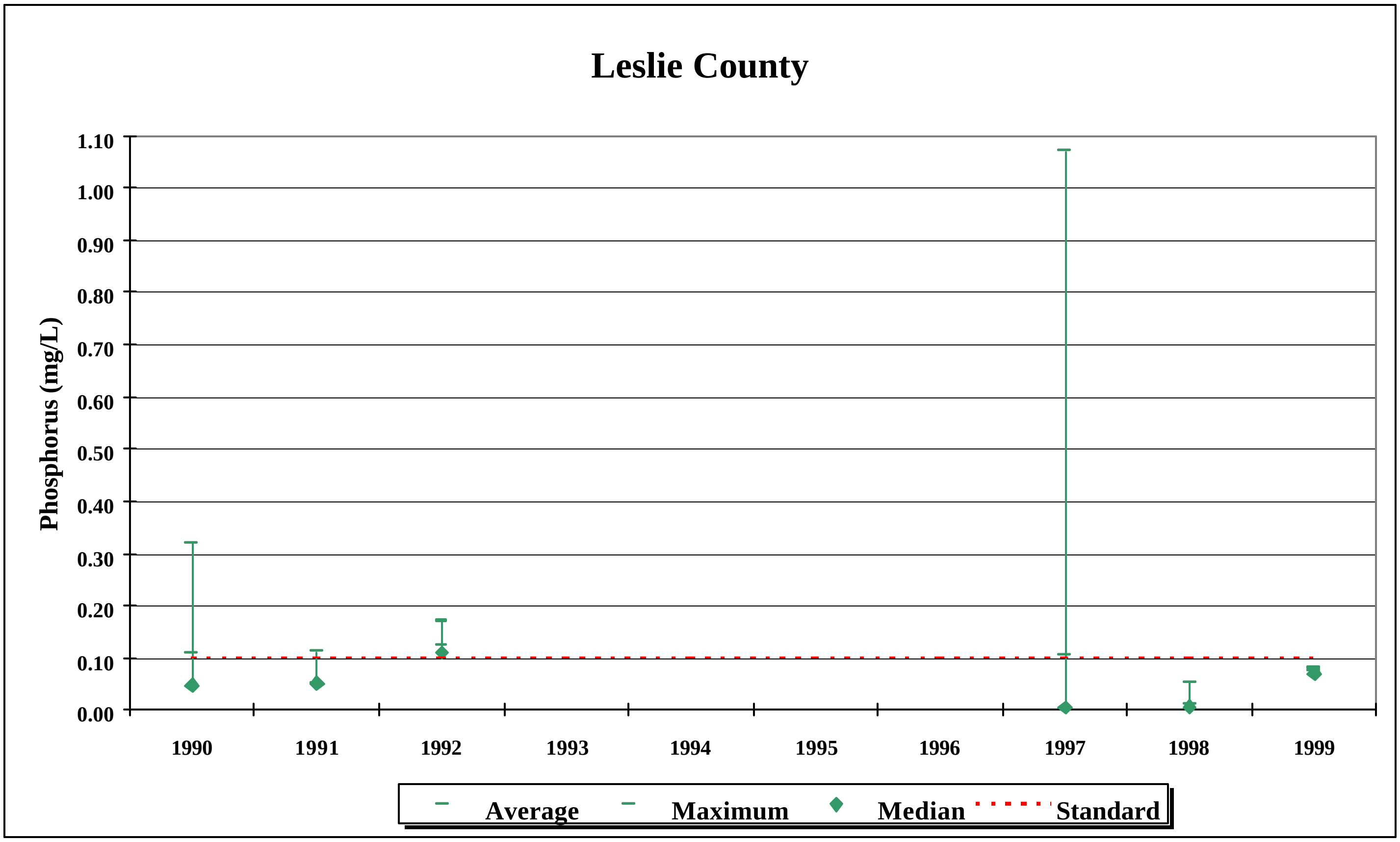

Table 2.93 Phosphorus Statistics for Leslie County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.86 Phosphorus Statistics for Letcher County

Year	Samples	Maximum	Median	Average
1990	3	0.05	0.01	0.02
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998	12	0.03	0.01	0.01
1999	2	0.12	0.10	0.10

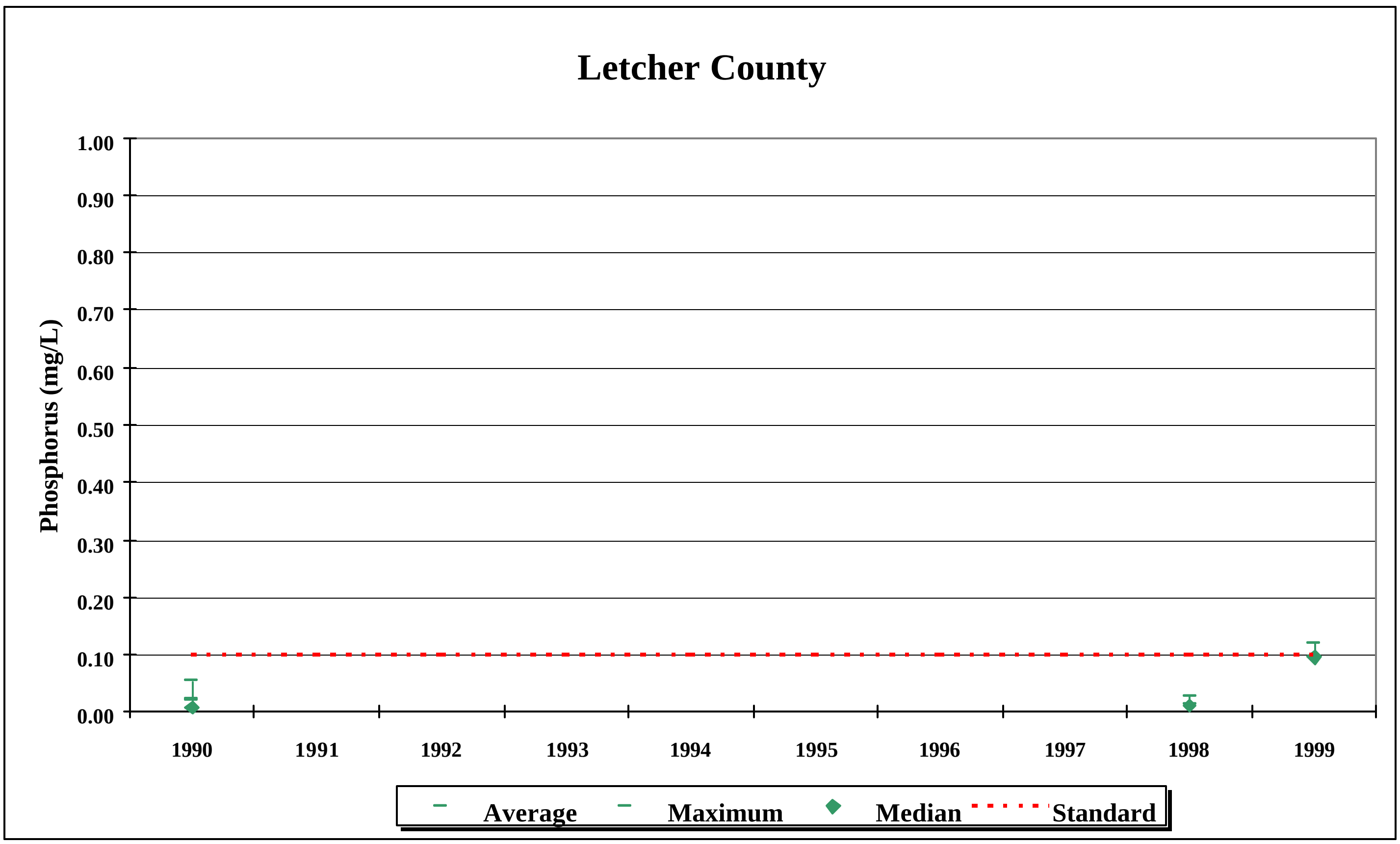

Table 2.94 Phosphorus Statistics for Letcher County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.87 Phosphorus Statistics for Lincoln County

Year	Samples	Maximum	Median	Average
1990				
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998	3	0.01	0.01	0.01
1999				

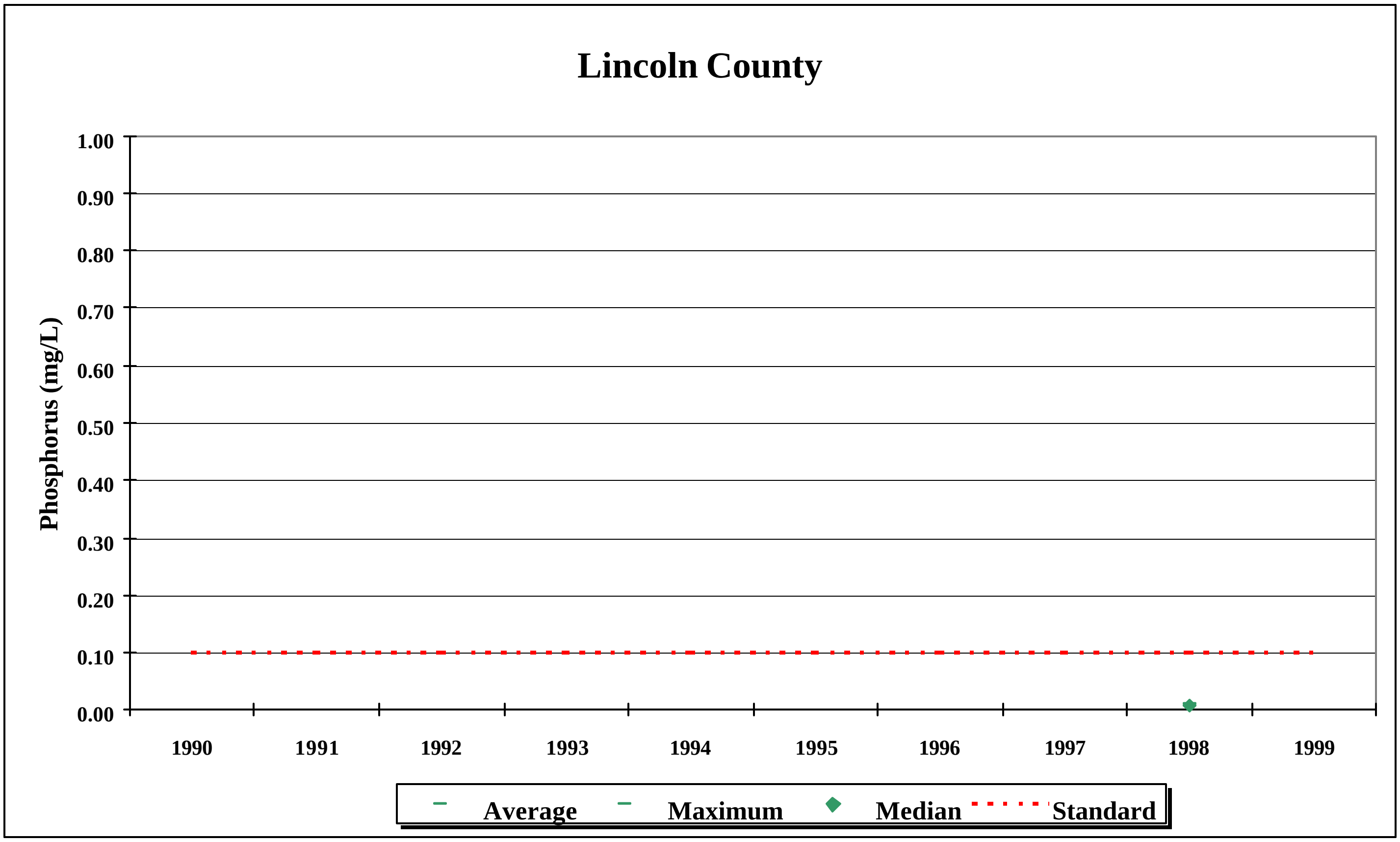

Table 2.95 Phosphorus Statistics for Lincoln County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.88 Phosphorus Statistics for Magoffin County

Year	Samples	Maximum	Median	Average
1990	11	0.16	0.02	0.04
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998	4	0.01	0.01	0.01
1999				

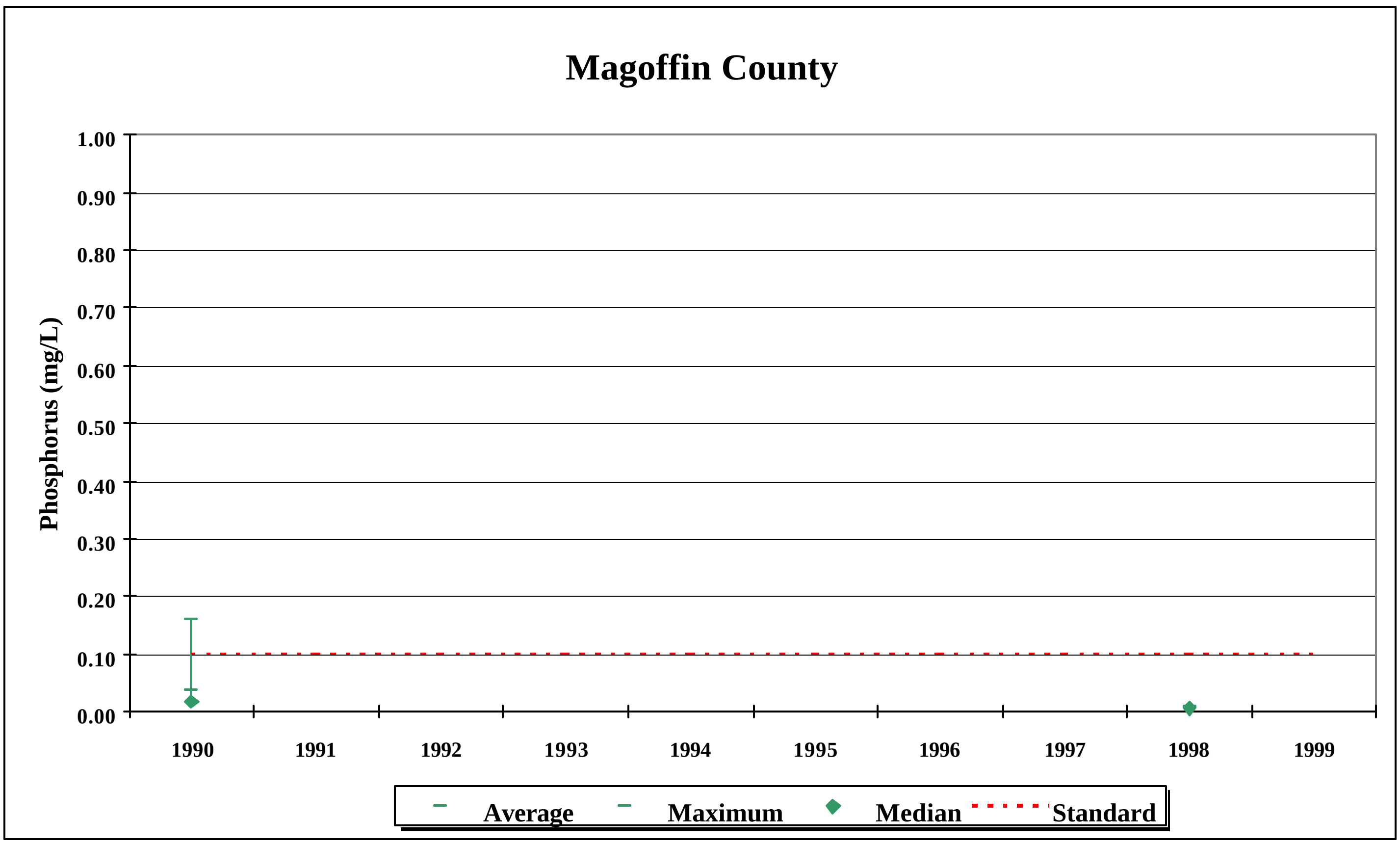

Table 2.96 Phosphorus Statistics for Magoffin County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.89 Phosphorus Statistics for Martin County

Year	Samples	Maximum	Median	Average
1990	11	0.18	0.01	0.03
1991	11	0.08	0.03	0.03
1992	12	0.08	0.01	0.03
1993	12	0.47	0.02	0.08
1994	12	0.05	0.02	0.03
1995	12	0.05	0.02	0.03
1996	12	0.12	0.02	0.03
1997	12	0.03	0.01	0.01
1998	12	0.18	0.01	0.03
1999				

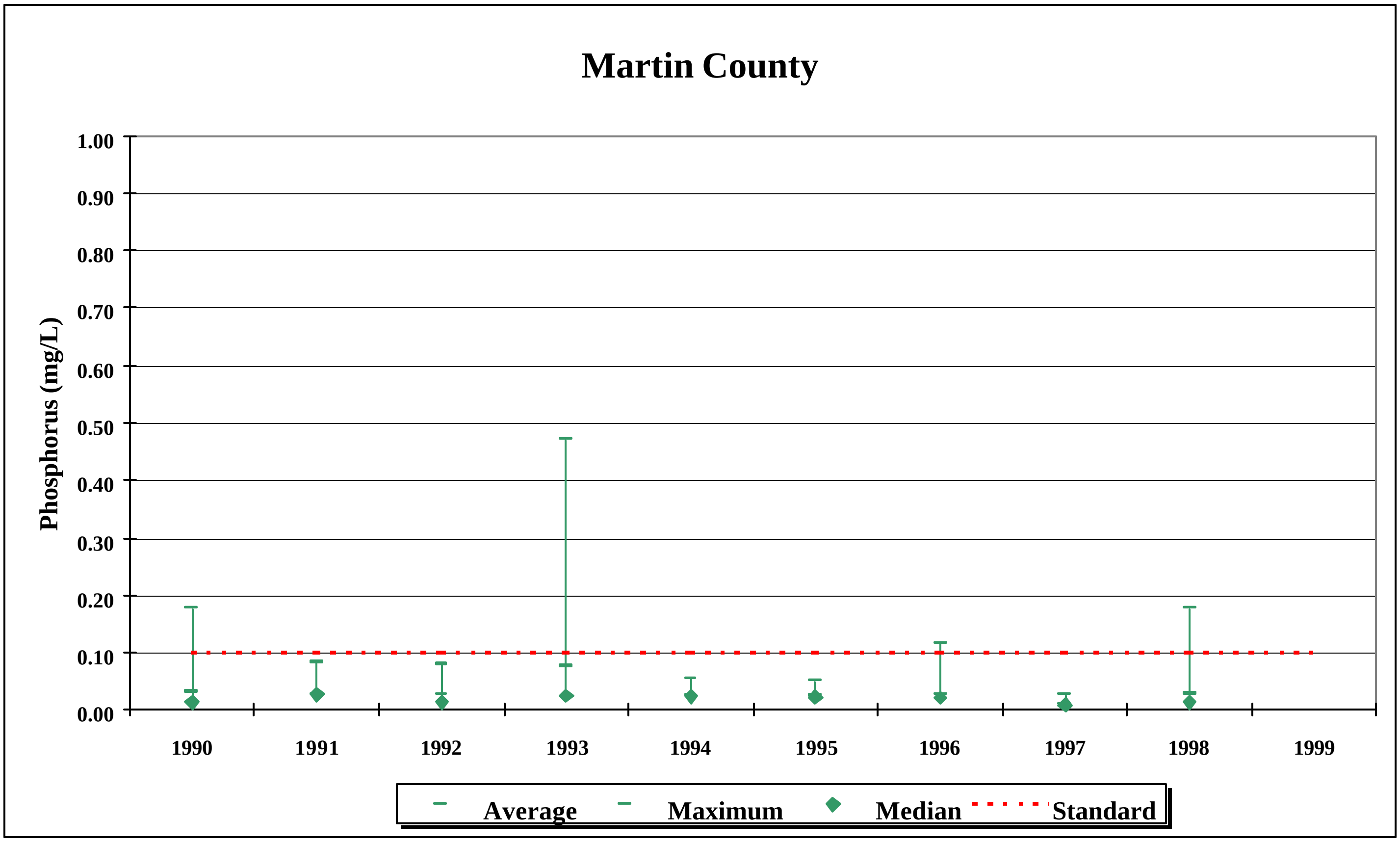

Table 2.97 Phosphorus Statistics for Martin County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.90 Phosphorus Statistics for McCreary County

Year	Samples	Maximum	Median	Average
1990	25	0.10	0.01	0.01
1991	21	0.13	0.01	0.02
1992	25	0.04	0.01	0.01
1993	26	0.74	0.02	0.05
1994	26	0.05	0.01	0.01
1995	19	0.03	0.01	0.01
1996	12	0.01	0.01	0.01
1997	10	0.01	0.01	0.01
1998	10	0.07	0.01	0.02
1999	2	0.01	0.01	0.01

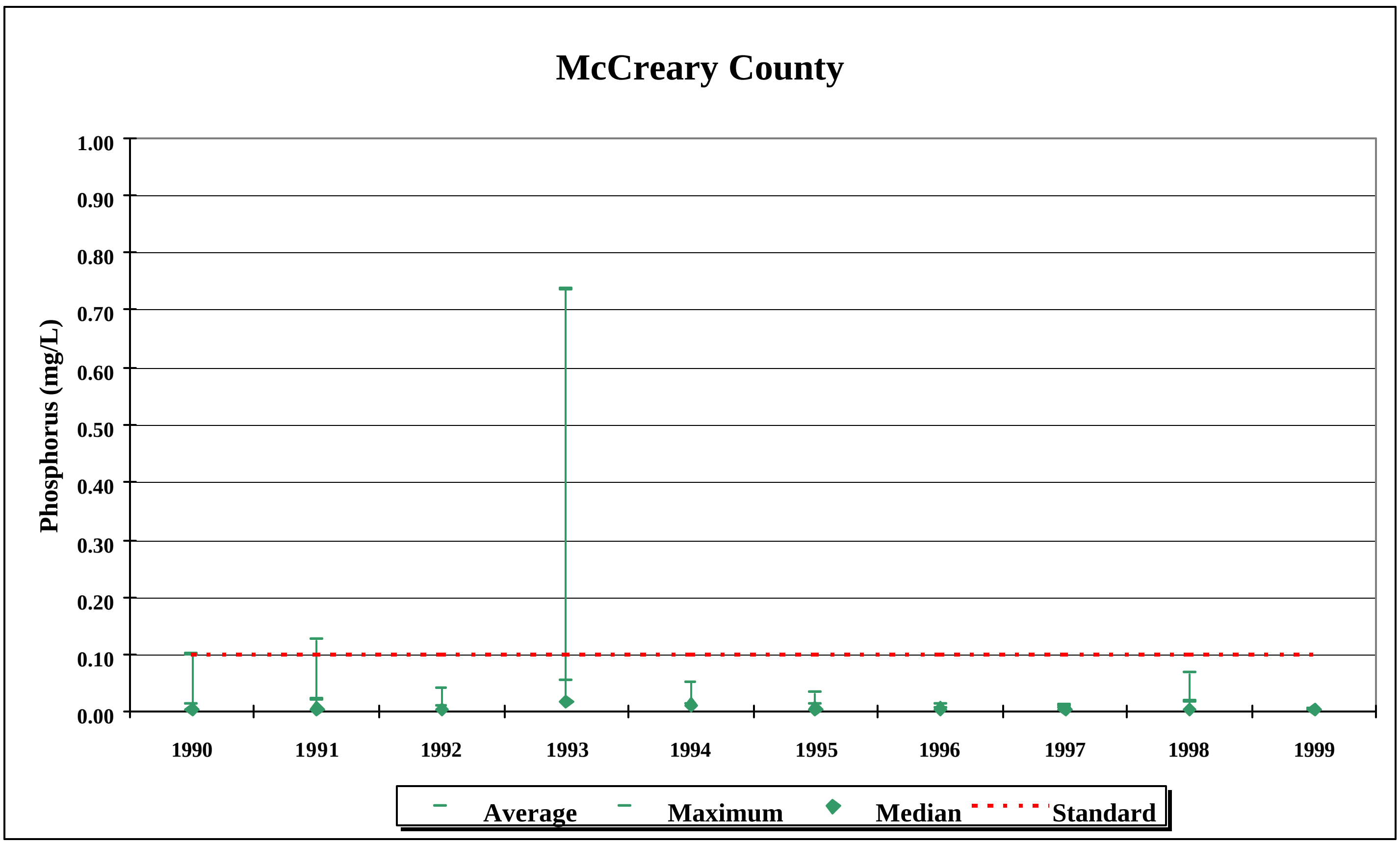

Table 2.98 Phosphorus Statistics for McCreary County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.91 Phosphorus Statistics for Menifee County

Year	Samples	Maximum	Median	Average
1990				
1991				
1992				
1993				
1994				
1995				
1996				
1997	1	0.01	0.01	0.01
1998	7	0.02	0.01	0.01
1999	1	0.06	0.06	0.06

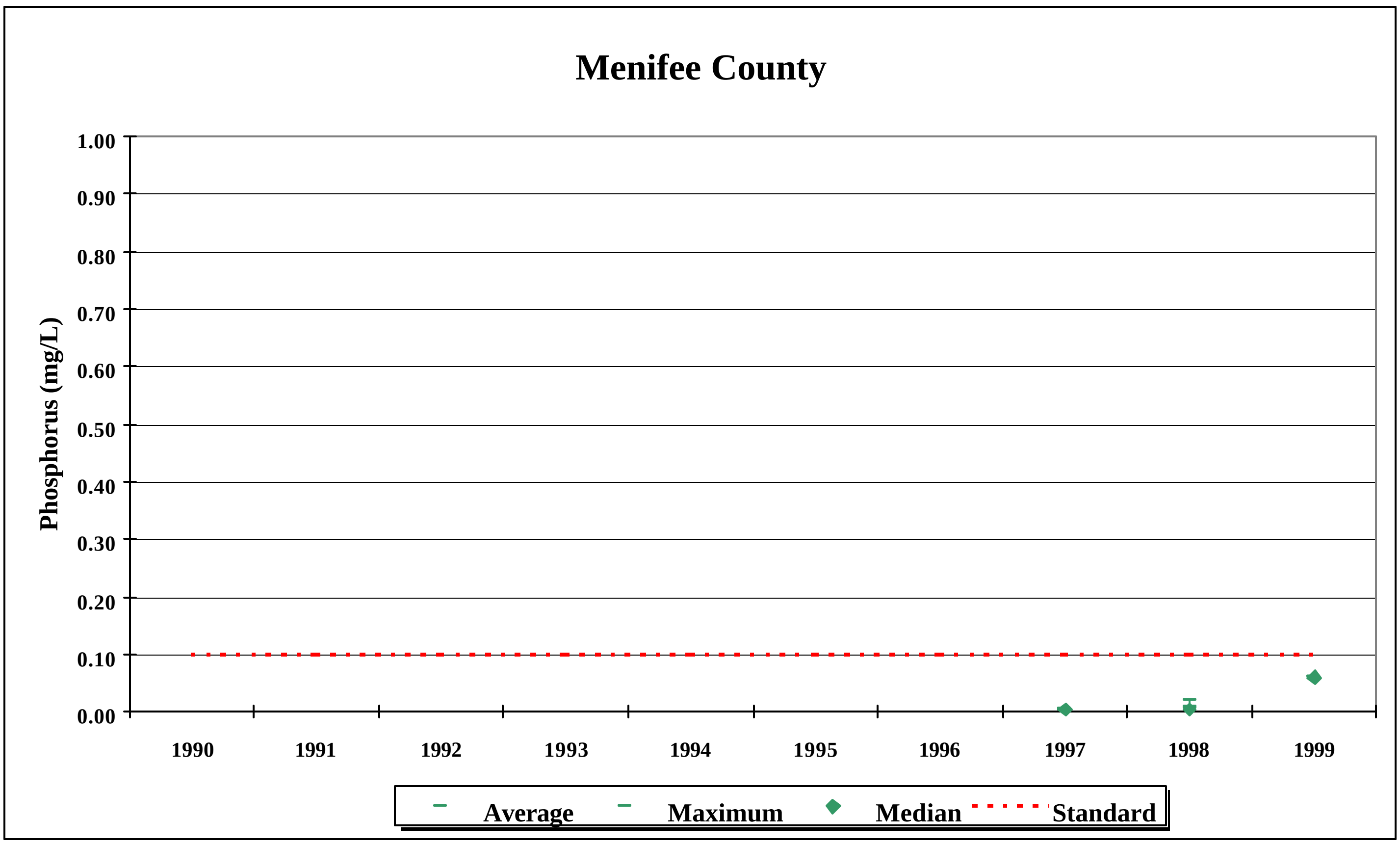

Table 2.99 Phosphorus Statistics for Menifee County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.92 Phosphorus Statistics for Metcalfe County

Year	Samples	Maximum	Median	Average
1990	3	0.05	0.03	0.04
1991				
1992				
1993				
1994	3	0.06	0.05	0.05
1995	3	0.17	0.07	0.09
1996				
1997				
1998				
1999				

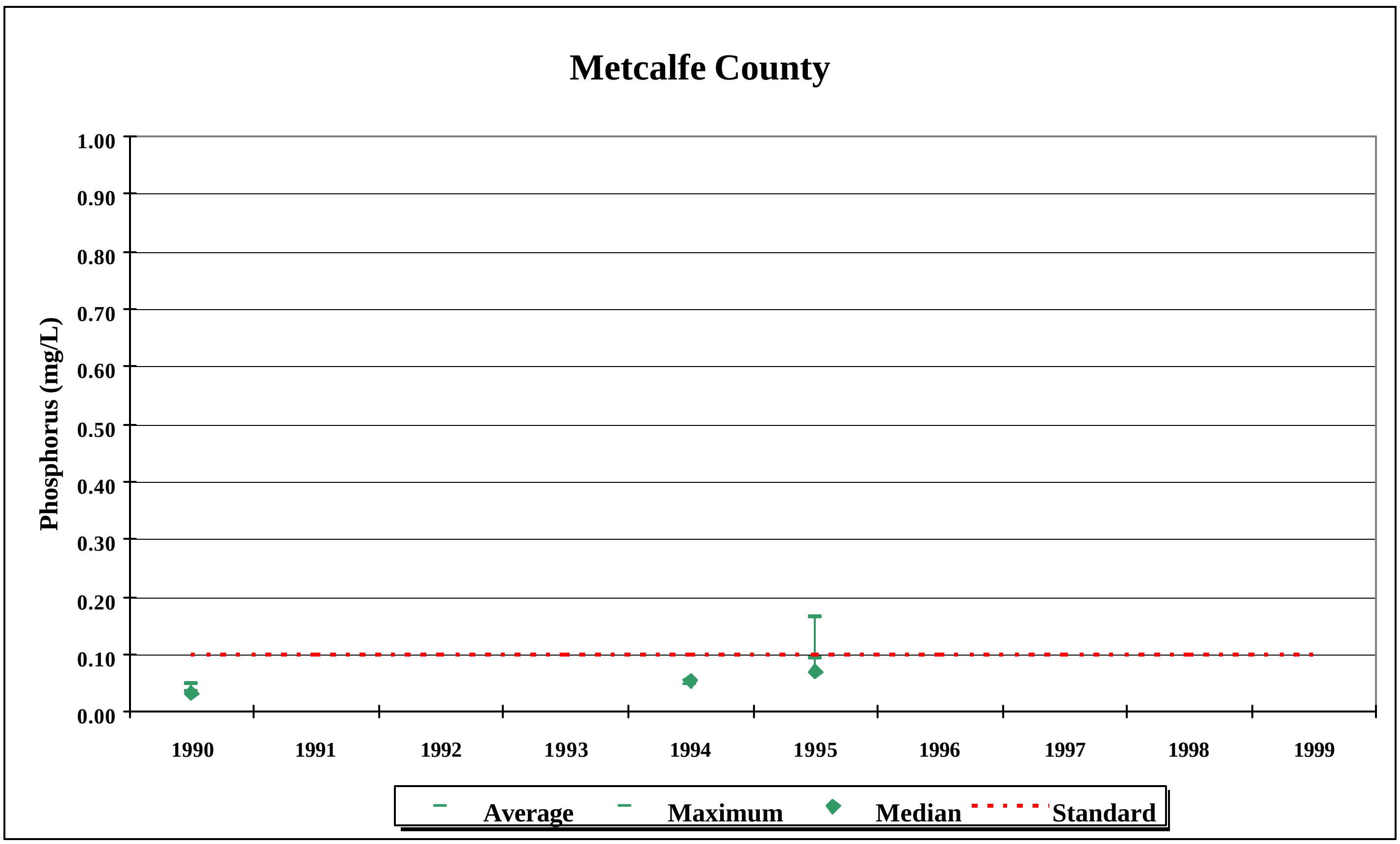

Table 2.100 Phosphorus Statistics for Metcalfe County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.93 Phosphorus Statistics for Monroe County

Year	Samples	Maximum	Median	Average
1990	3	0.02	0.01	0.01
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998				
1999	2	0.01	0.01	0.01

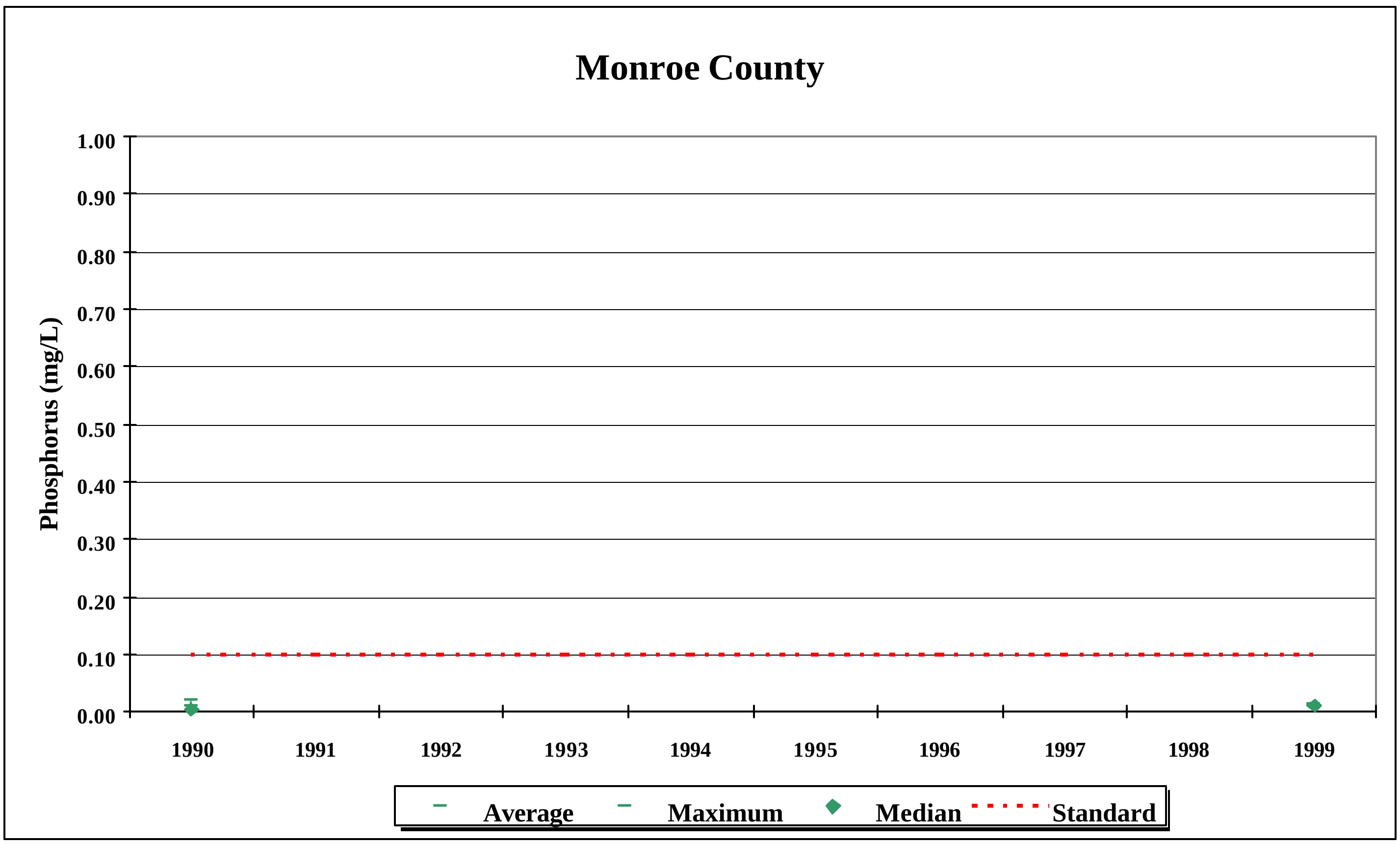

Table 2.101 Phosphorus Statistics for Monroe County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.94 Phosphorus Statistics for Morgan County

Year	Samples	Maximum	Median	Average
1990				
1991	17	0.08	0.02	0.02
1992	82	0.28	0.05	0.04
1993	26	0.08	0.05	0.03
1994	27	0.09	0.04	0.05
1995	12	0.10	0.02	0.02
1996	12	0.07	0.01	0.02
1997	17	0.09	0.01	0.02
1998	12	0.13	0.01	0.03
1999				

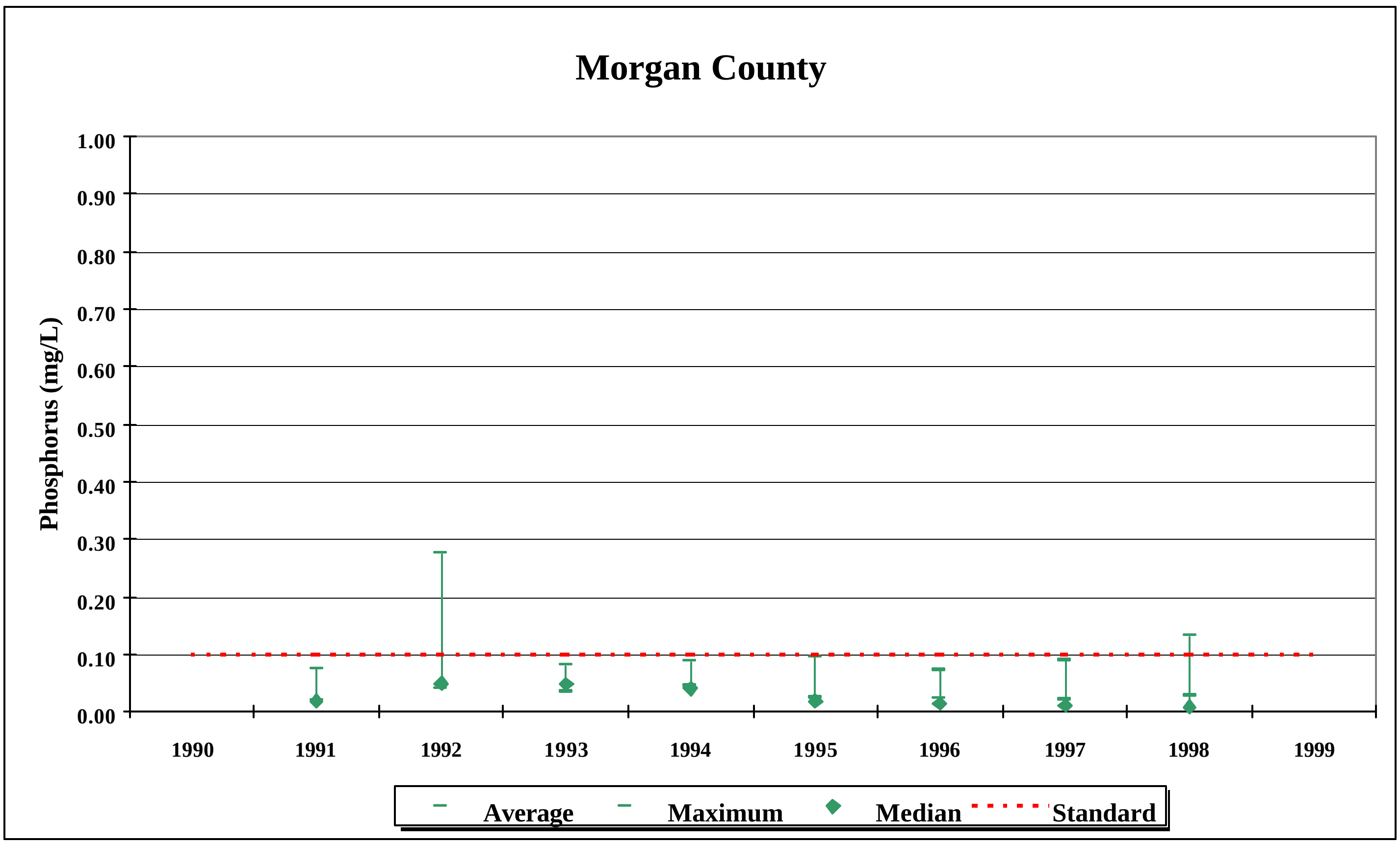

Table 2.102 Phosphorus Statistics for Morgan County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.95 Phosphorus Statistics for Owsley County

Year	Samples	Maximum	Median	Average
1990	15	0.03	0.01	0.01
1991	11	0.01	0.01	0.01
1992	12	0.22	0.01	0.03
1993	12	0.04	0.02	0.02
1994	12	0.08	0.02	0.02
1995	12	0.07	0.02	0.03
1996	11	0.02	0.01	0.01
1997	11	0.05	0.01	0.01
1998	16	0.05	0.01	0.01
1999				

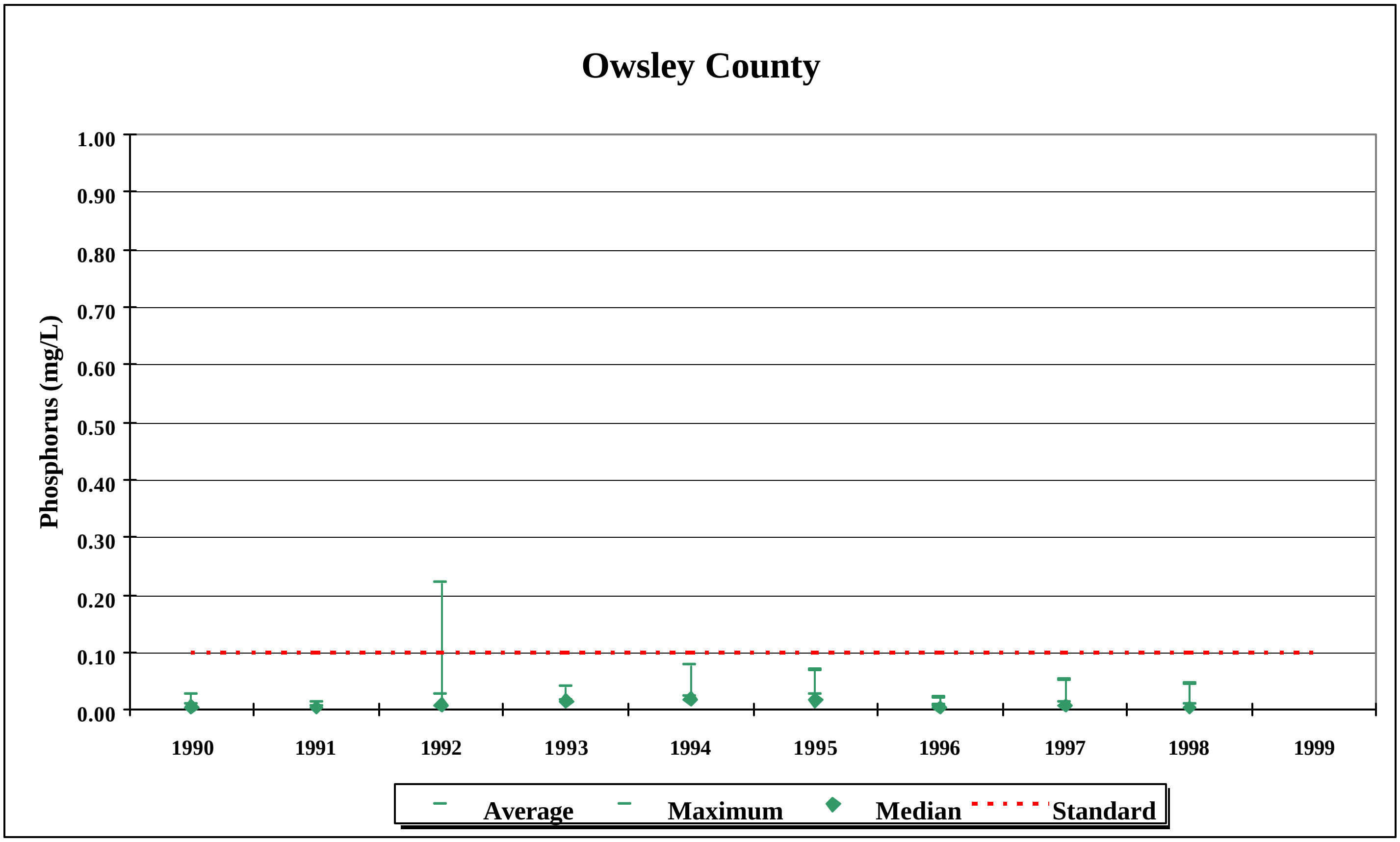

Table 2.103 Phosphorus Statistics for Owsley County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.96 Phosphorus Statistics for Perry County

Year	Samples	Maximum	Median	Average
1990				
1991				
1992				
1993				
1994				
1995				
1996				
1997	3	0.03	0.01	0.01
1998	10	0.03	0.02	0.02
1999	3	0.16	0.08	0.10

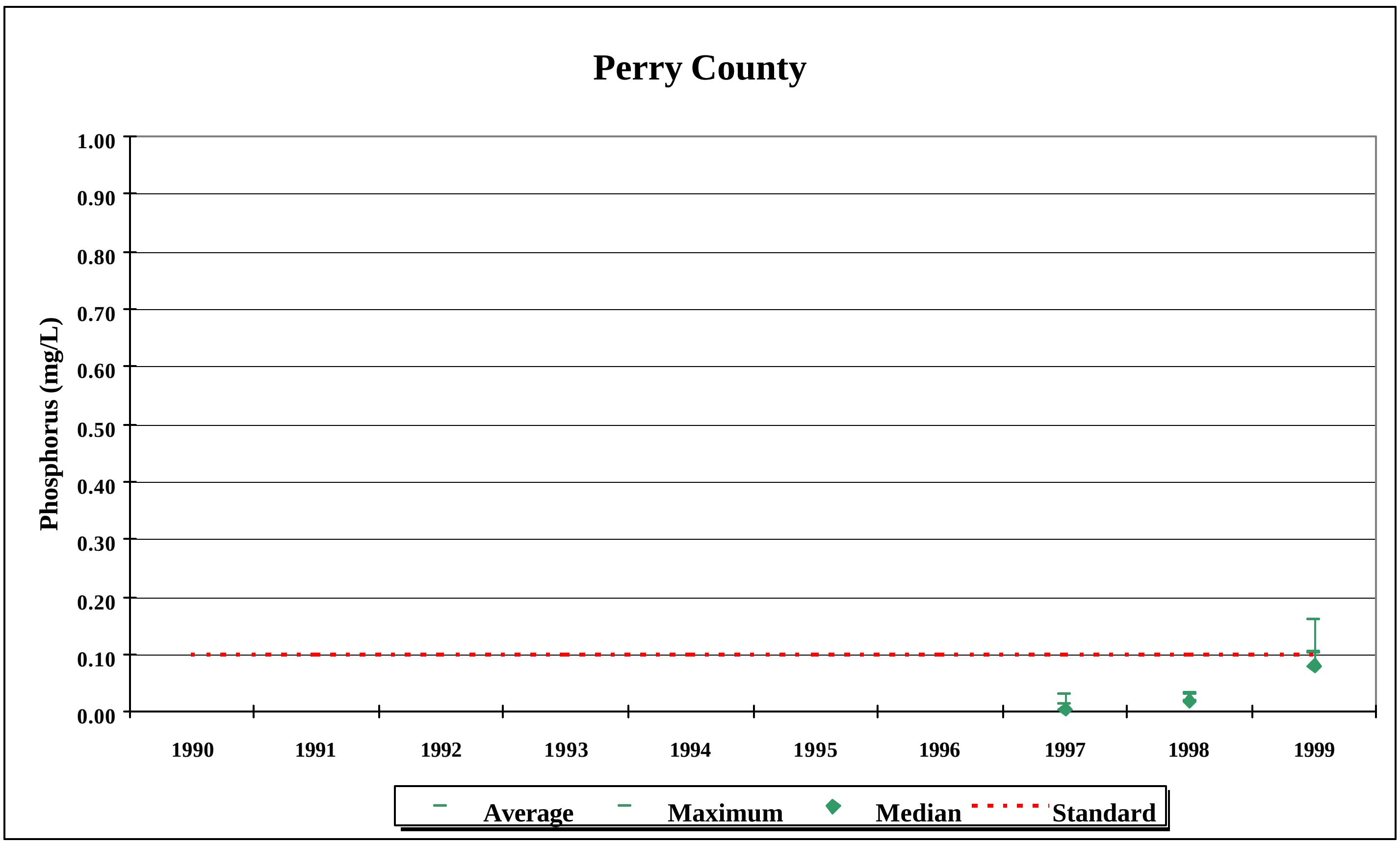

Table 2.104 Phosphorus Statistics for Perry County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.97 Phosphorus Statistics for Pike County

Year	Samples	Maximum	Median	Average
1990	11	0.07	0.01	0.02
1991	16	0.05	0.01	0.02
1992	24	0.07	0.01	0.02
1993	142	0.91	0.02	0.04
1994	22	0.10	0.03	0.03
1995	35	0.05	0.02	0.02
1996	14	0.65	0.01	0.06
1997	12	0.03	0.01	0.01
1998	15	0.09	0.01	0.01
1999				

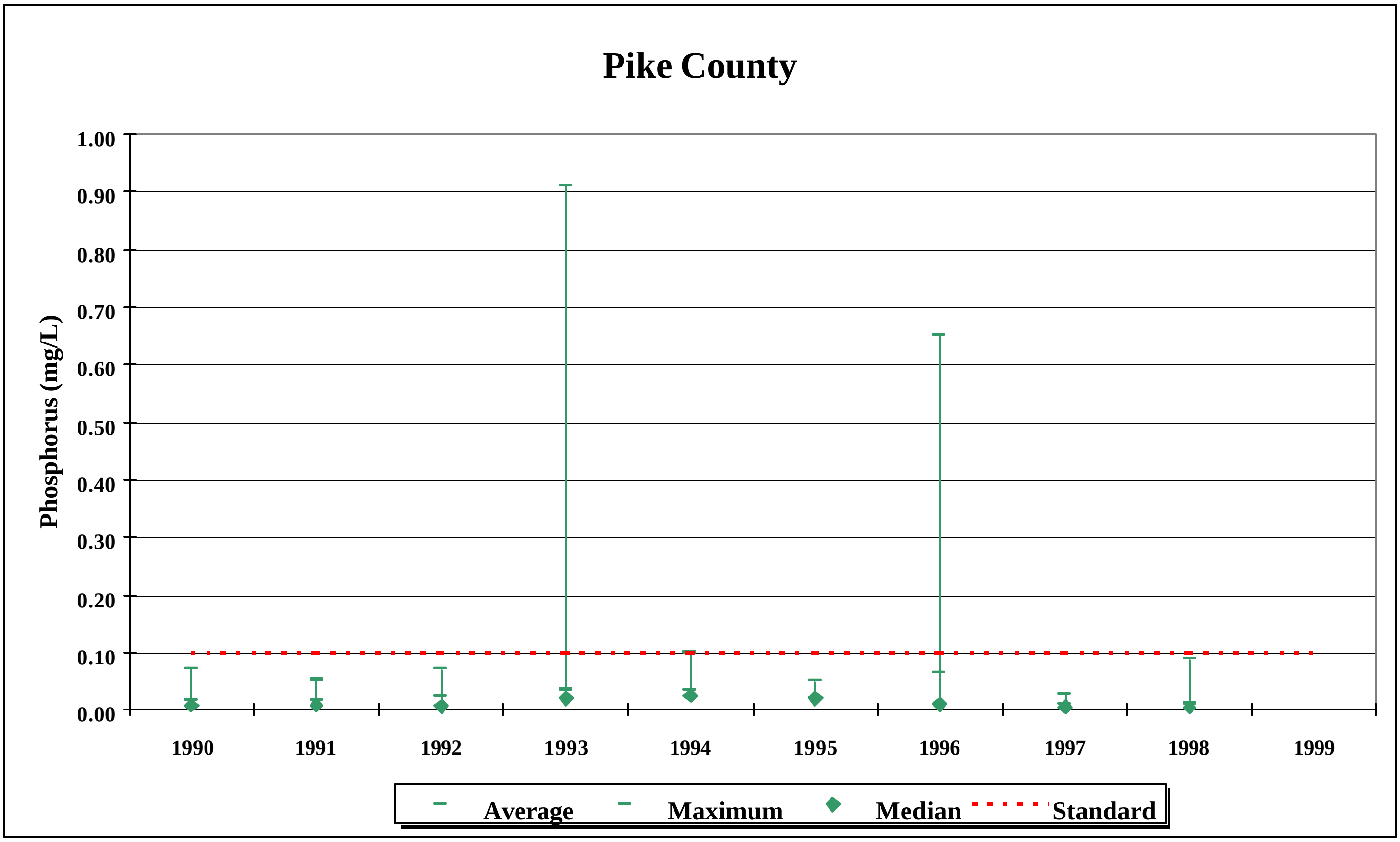

Table 2.105 Phosphorus Statistics for Pike County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.98 Phosphorus Statistics for Pulaski County

Year	Samples	Maximum	Median	Average
1990	12	0.04	0.01	0.01
1991	1	0.01	0.01	0.01
1992				
1993	18	0.22	0.04	0.05
1994	15	0.04	0.03	0.02
1995	3	0.04	0.01	0.02
1996				
1997				
1998	3	0.03	0.01	0.01
1999	8	0.01	0.01	0.01

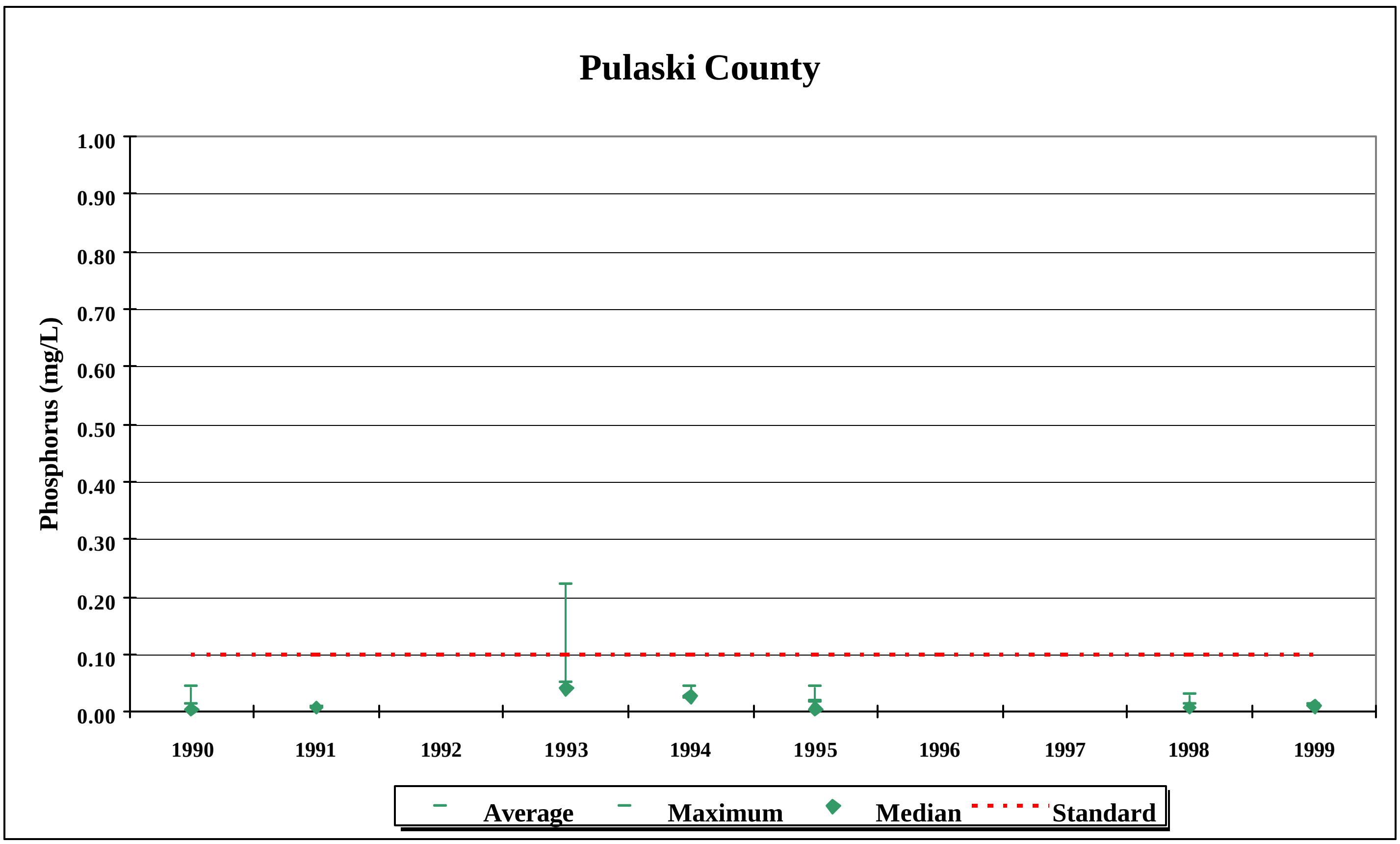

Table 2.106 Phosphorus Statistics for Pulaski County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.99 Phosphorus Statistics for Rockcastle County

Year	Samples	Maximum	Median	Average
1990	3	0.01	0.01	0.01
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998				
1999	4	0.06	0.01	0.02

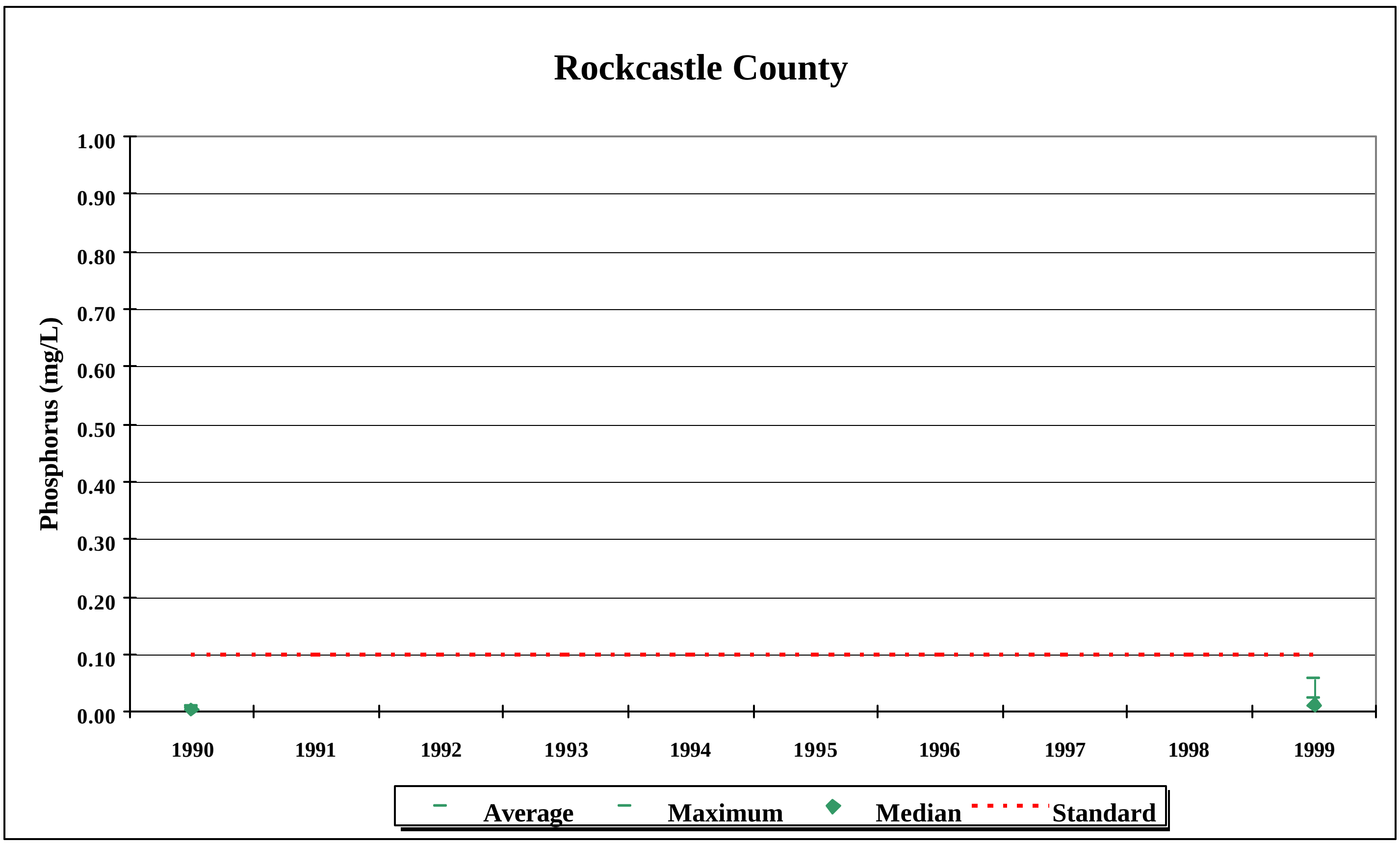

Table 2.107 Phosphorus Statistics for Rockcastle County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.100 Phosphorus Statistics for Russell County

Year	Samples	Maximum	Median	Average
1990	3	0.39	0.23	0.24
1991	6	0.22	0.04	0.09
1992	6	0.17	0.02	0.05
1993	6	0.07	0.03	0.03
1994	9	0.05	0.01	0.02
1995	9	0.04	0.01	0.02
1996				
1997				
1998				
1999	4	0.04	0.03	0.02

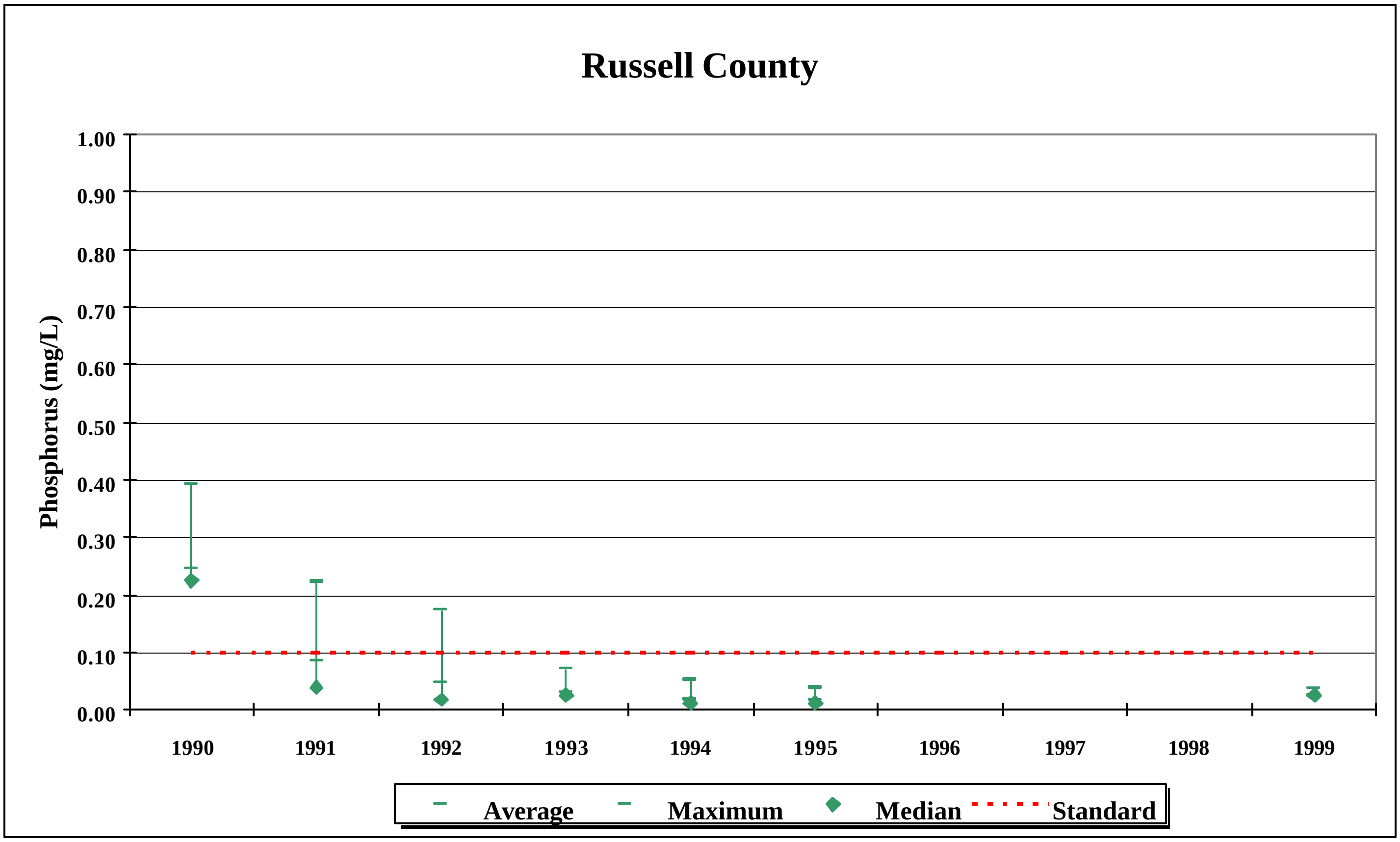

Table 2.108 Phosphorus Statistics for Russell County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.101 Phosphorus Statistics for Taylor County

Year	Samples	Maximum	Median	Average
1990	18	0.11	0.01	0.02
1991	9	0.01	0.01	0.01
1992	18	0.50	0.05	0.10
1993				
1994				
1995				
1996				
1997				
1998				
1999				

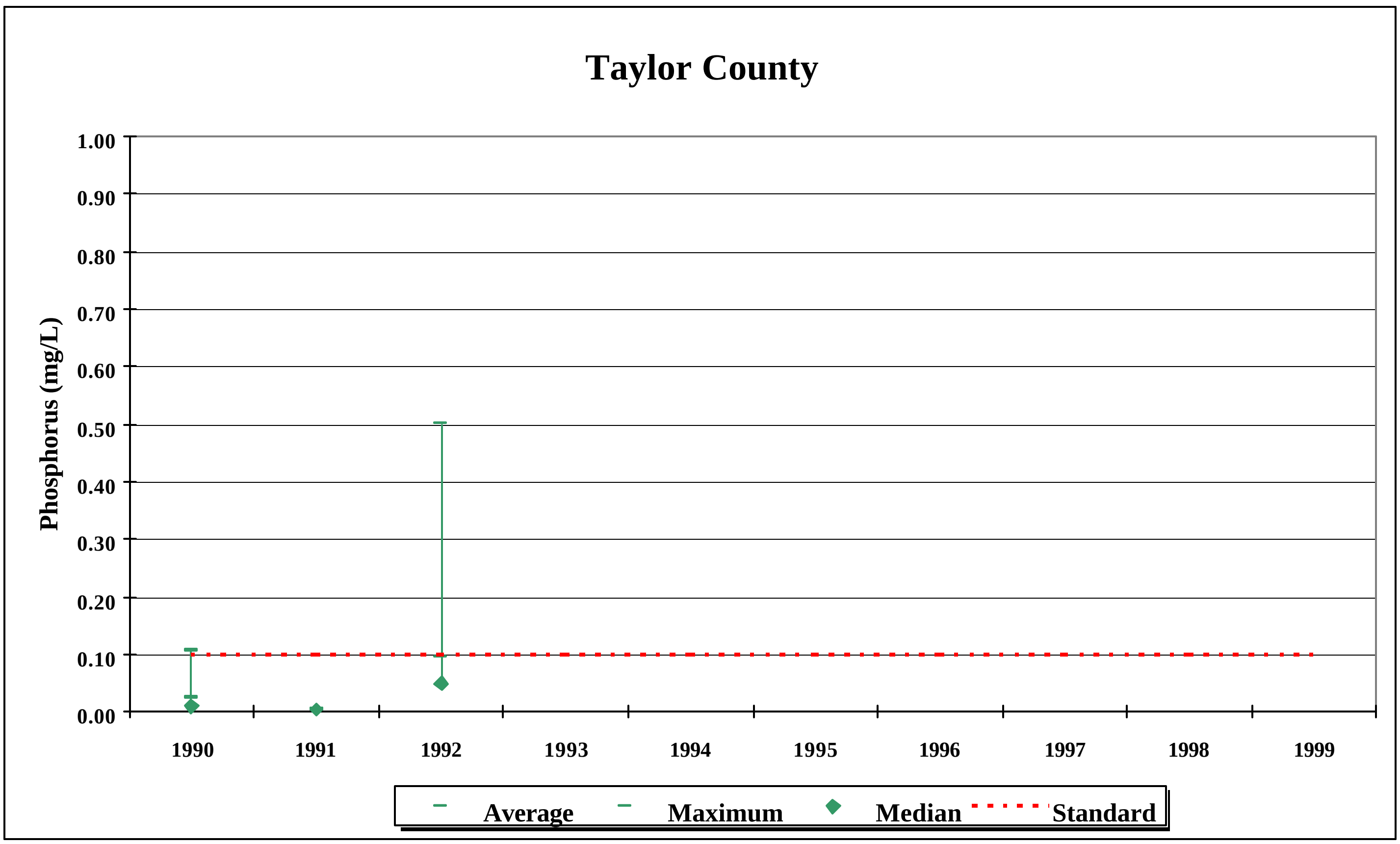

Table 2.109 Phosphorus Statistics for Taylor County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.102 Phosphorus Statistics for Wayne County

Year	Samples	Maximum	Median	Average
1990	3	0.04	0.01	0.02
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998				
1999	2	0.01	0.01	0.01

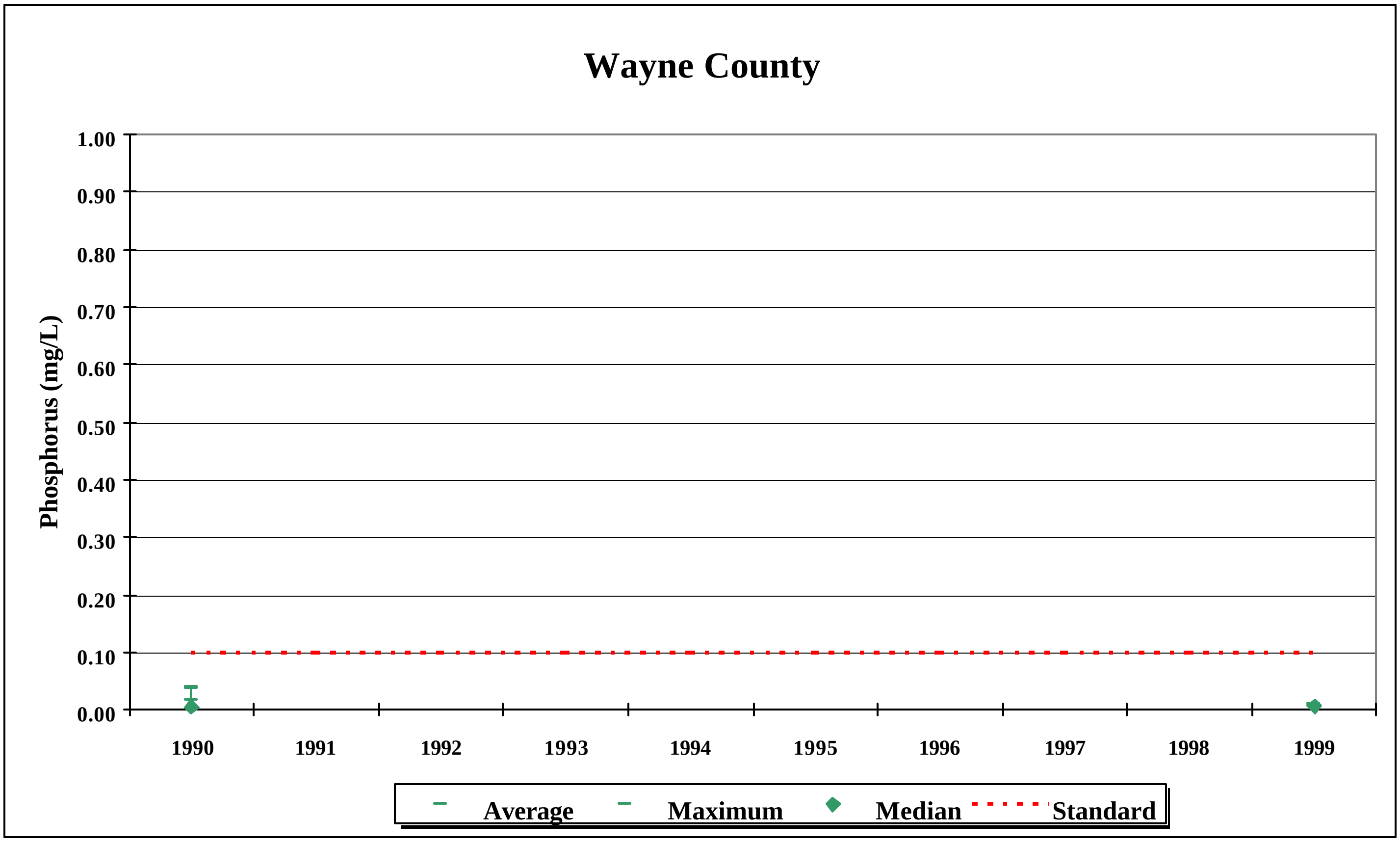

Table 2.110 Phosphorus Statistics for Wayne County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.103 Phosphorus Statistics for Whitley County

Year	Samples	Maximum	Median	Average
1990	12	0.06	0.02	0.02
1991	11	0.28	0.02	0.05
1992	10	0.04	0.01	0.02
1993	12	0.09	0.02	0.03
1994	12	0.15	0.03	0.04
1995	12	0.13	0.02	0.03
1996	12	0.06	0.01	0.01
1997	12	0.02	0.01	0.01
1998	11	0.07	0.01	0.01
1999	5	0.02	0.01	0.01

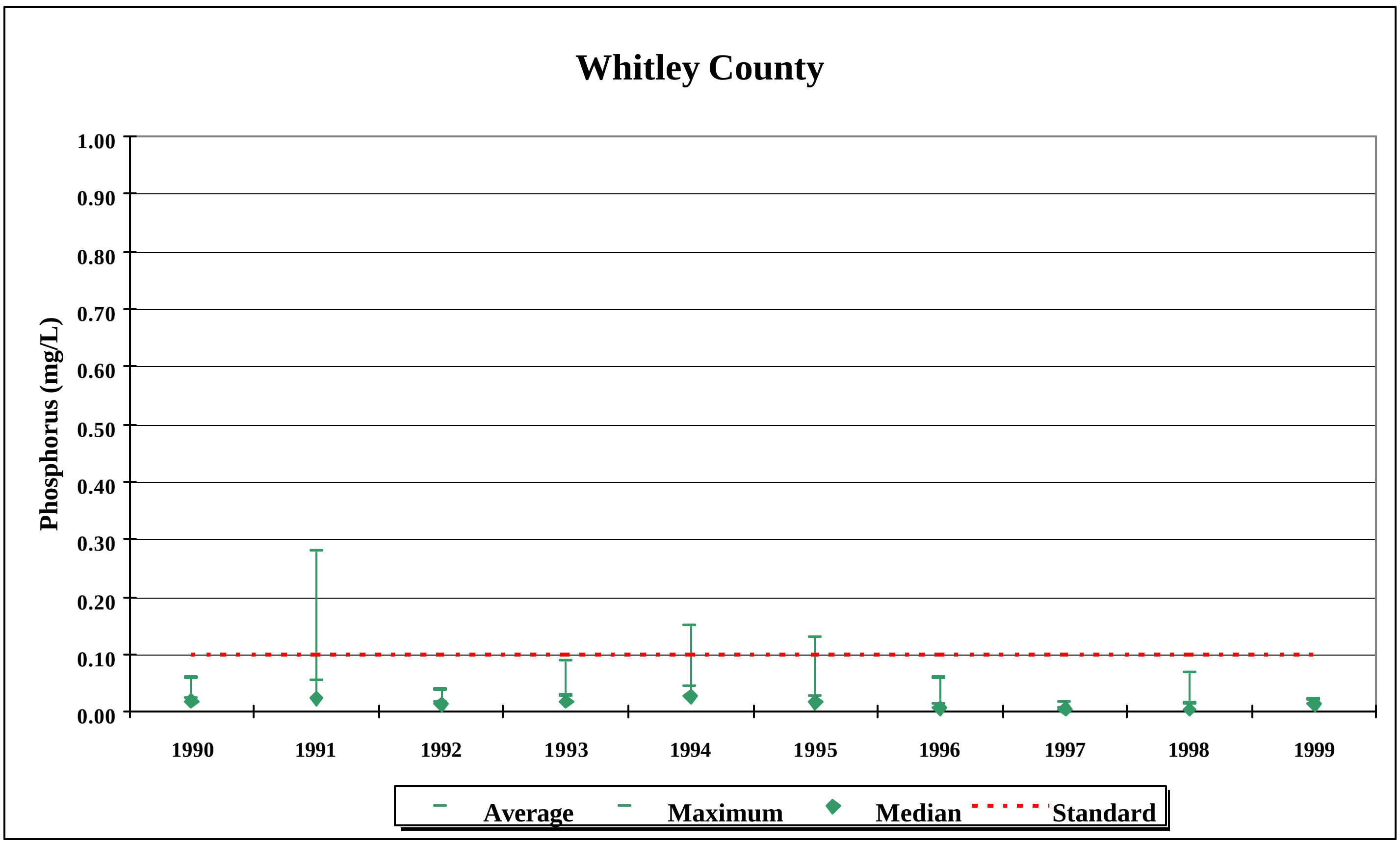

Table 2.111 Phosphorus Statistics for Whitley County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.104 Phosphorus Statistics for Wolfe County

Year	Samples	Maximum	Median	Average
1990		0.01	0.01	0.01
1991		0.07	0.01	0.02
1992		0.39	0.01	0.05
1993		0.03	0.02	0.02
1994		0.10	0.03	0.04
1995		0.01	0.01	0.01
1996				
1997		0.18	0.09	0.09
1998		0.03	0.01	0.01
1999		0.08	0.08	0.08

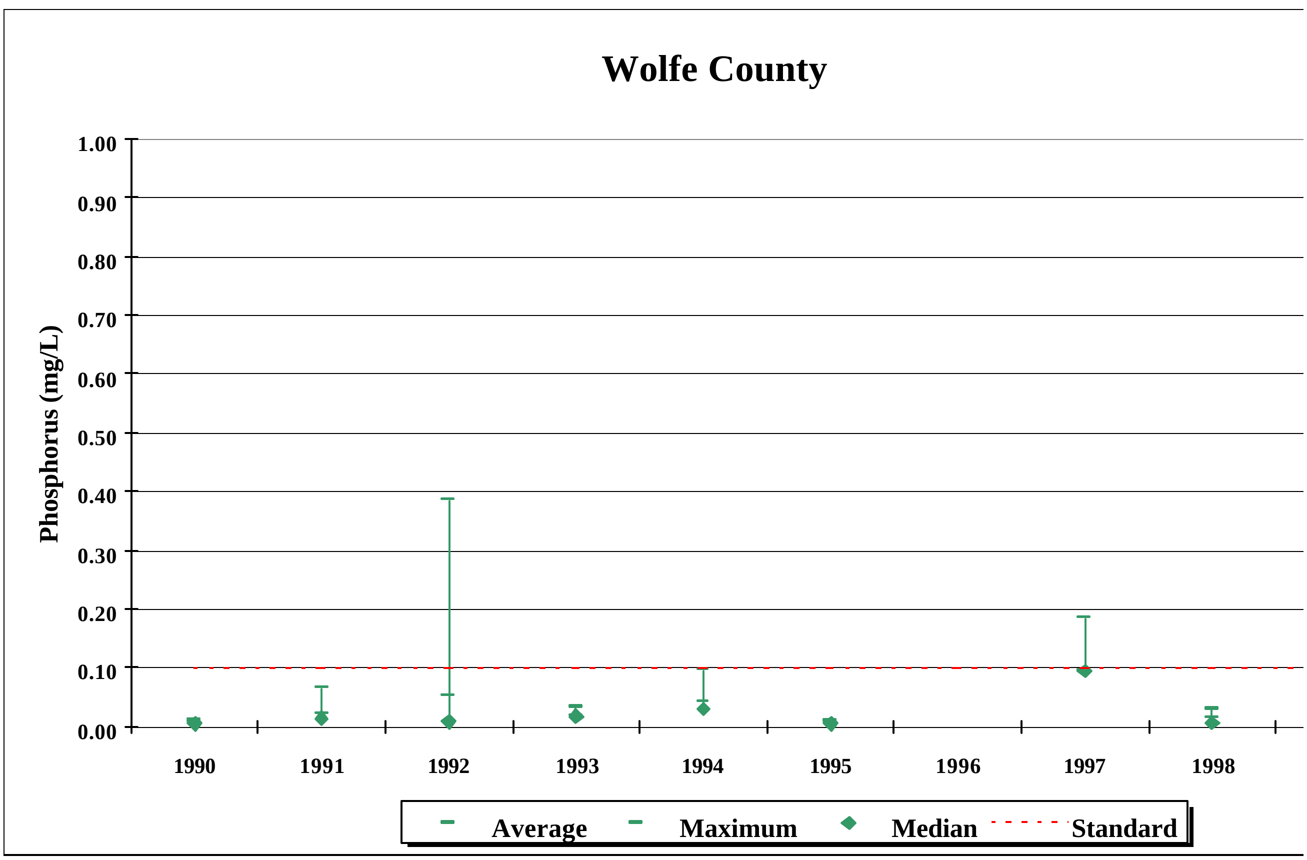

Table 2.112 Phosphorus Statistics for Wolfe County
Note: Phosphorus Standard is 0.10 mg/l

Table 2.105 Phosphorus Statistics for Big Sandy River Basin 05070201 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	11	0.18	0.01	0.03
1991	11	0.08	0.03	0.03
1992	12	0.08	0.01	0.03
1993	12	0.47	0.02	0.08
1994	12	0.05	0.02	0.03
1995	12	0.05	0.02	0.03
1996	12	0.12	0.02	0.03
1997	12	0.03	0.01	0.01
1998	15	0.18	0.01	0.02
1999				

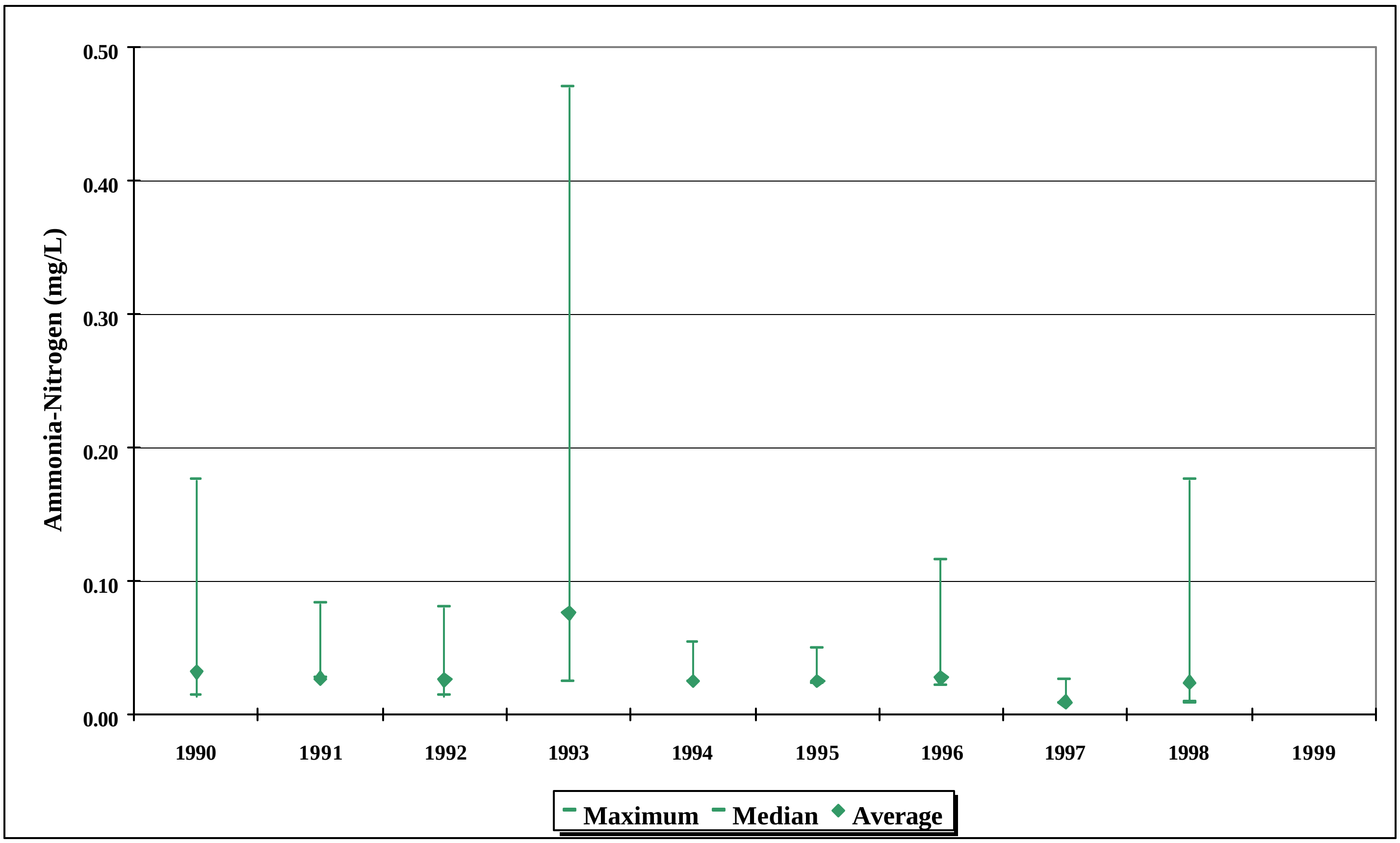

Figure 2.113 Phosphorus Results for Big Sandy River Basin 05070201 HUC Watershed
Note: Phosphorus Standard is 0.10 mg/l

Table 2.106 Phosphorus Statistics for Big Sandy River Basin 05070202 HUC Watershed

Year	Samples	Maximum	Median	Average
1990				
1991	4	0.05	0.02	0.02
1992	11	0.06	0.01	0.02
1993	114	0.91	0.02	0.04
1994	7	0.10	0.03	0.04
1995	19	0.05	0.02	0.02
1996				
1997				
1998				
1999				

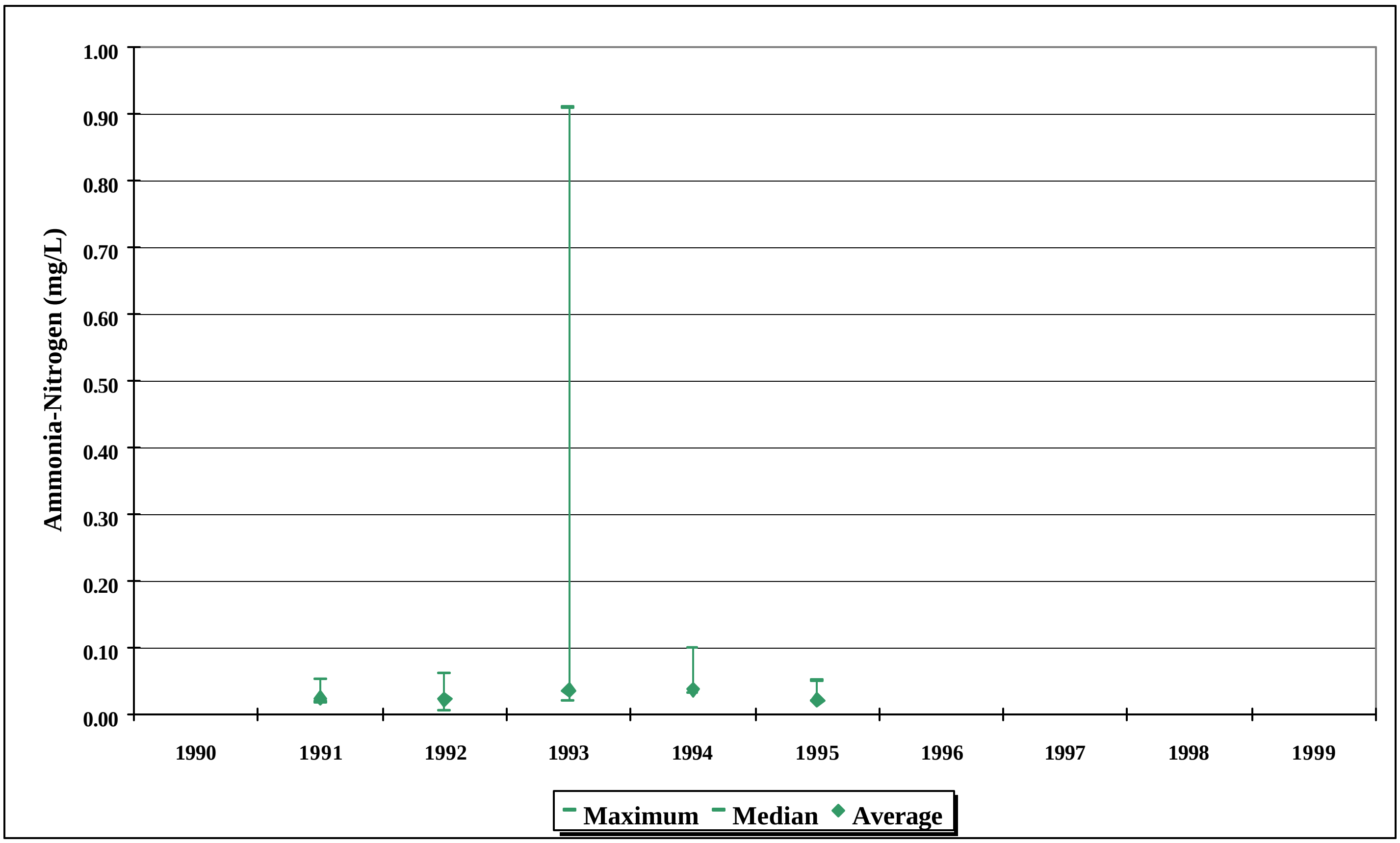

Figure 2.114 Phosphorus Results for Big Sandy River Basin 05070202 HUC Watershed
Note: Phosphorus Standard is 0.10 mg/l

Table 2.107 Phosphorus Statistics for Big Sandy River Basin 05070203 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	22	0.07	0.01	0.02
1991	42	0.25	0.02	0.03
1992	282	0.34	0.05	0.04
1993	83	0.16	0.05	0.04
1994	43	0.25	0.03	0.05
1995	48	0.75	0.02	0.05
1996	36	0.65	0.02	0.05
1997	42	0.09	0.02	0.02
1998	26	0.09	0.01	0.01
1999				

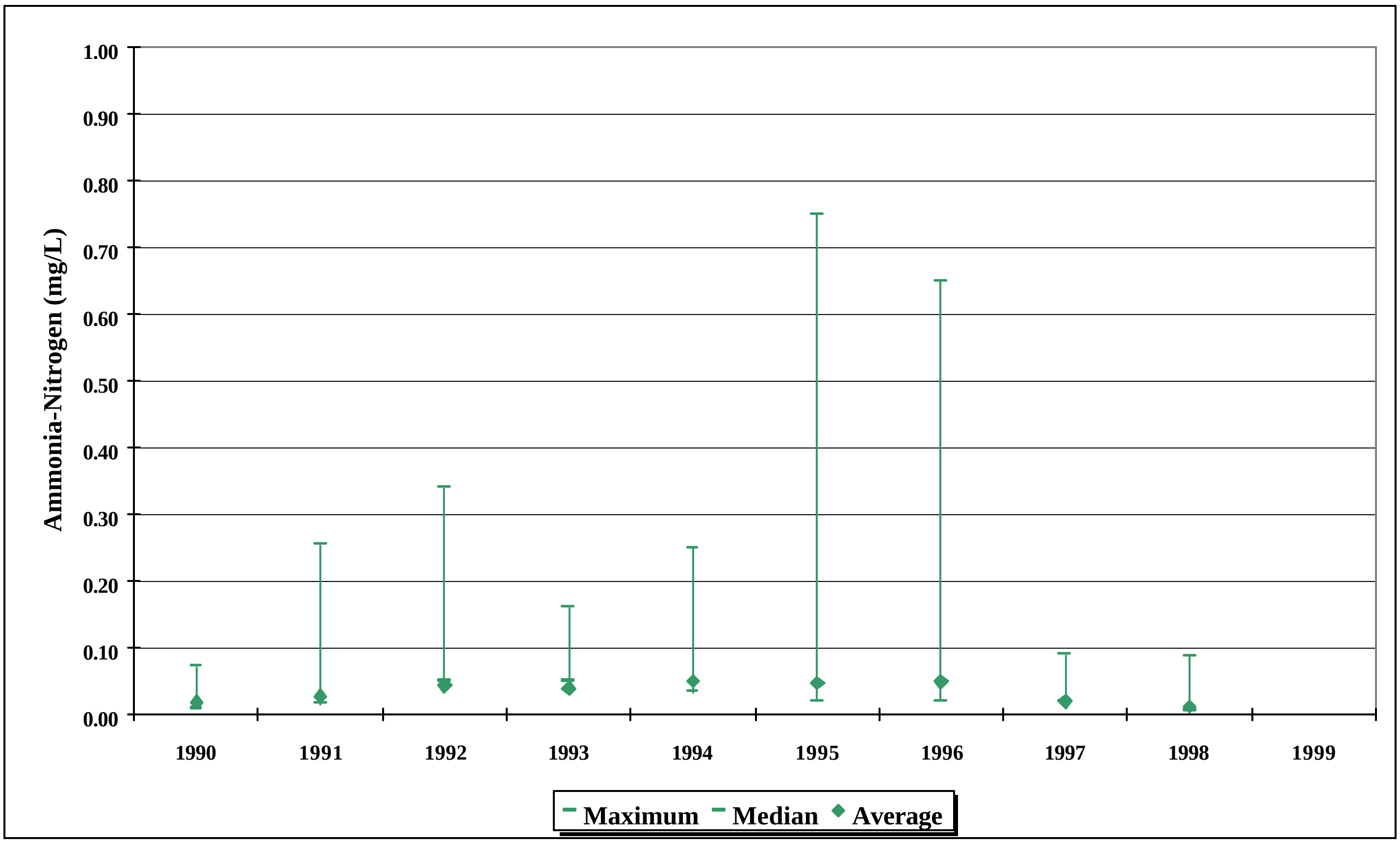

Figure 2.115 Phosphorus Results for Big Sandy River Basin 05070203 HUC Watershed
Note: Phosphorus Standard is 0.10 mg/l

Table 2.108 Phosphorus Statistics for Big Sandy River Basin 05070204 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	21	0.15	0.06	0.06
1991	24	0.65	0.09	0.10
1992	48	0.20	0.05	0.06
1993	54	0.14	0.03	0.04
1994	111	0.21	0.02	0.03
1995	80	0.29	0.02	0.04
1996	89	0.24	0.02	0.04
1997	126	0.17	0.02	0.03
1998	6	0.10	0.06	0.07
1999				

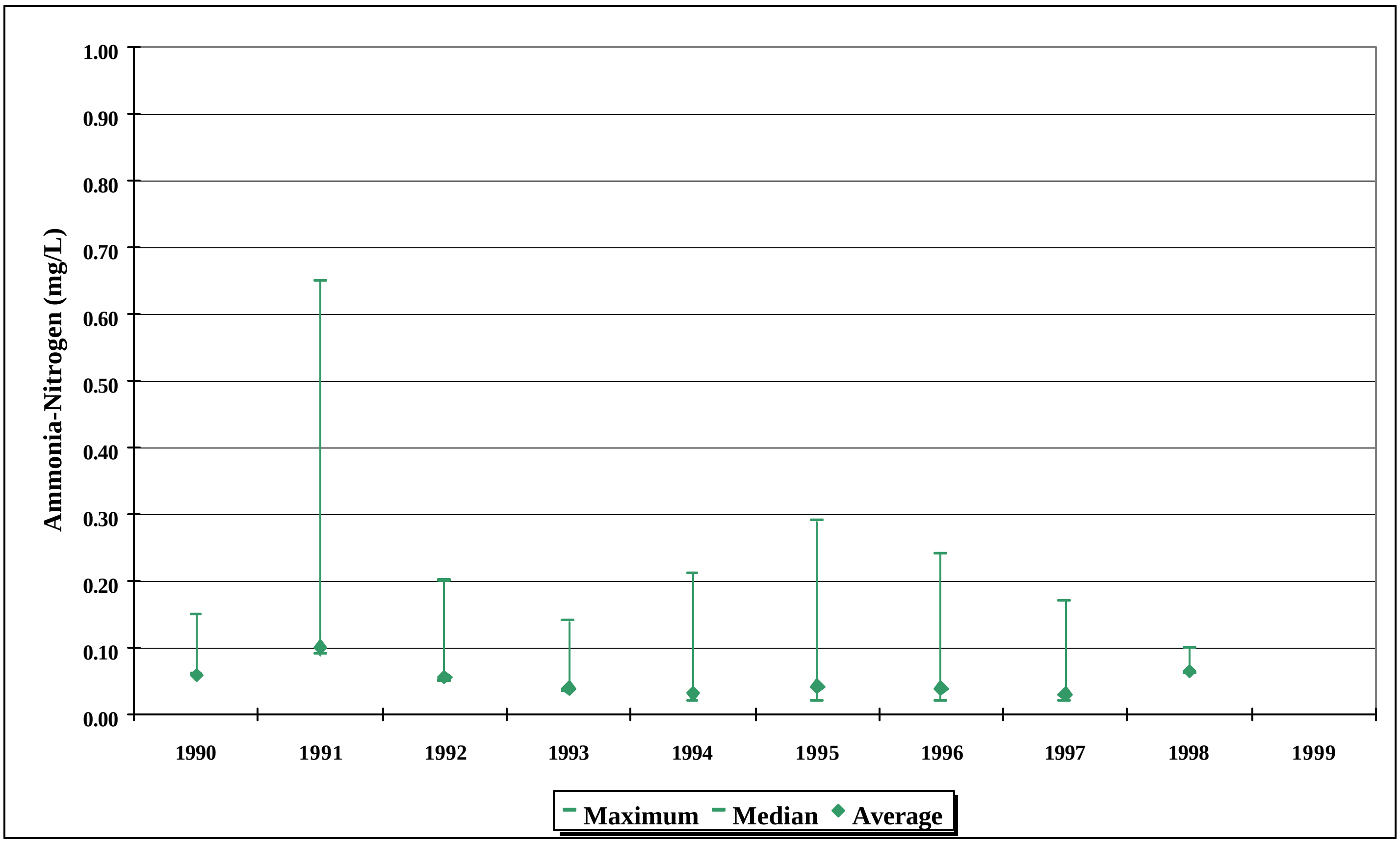

Figure 2.116 Phosphorus Results for Big Sandy River Basin 05070204 HUC Watershed
Note: Phosphorus Standard is 0.10 mg/l

Table 2.109 Phosphorus Statistics for Licking River Basin
05100101 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	11	0.16	0.02	0.04
1991	17	0.08	0.02	0.02
1992	18	0.10	0.01	0.02
1993	12	0.08	0.02	0.03
1994	15	0.09	0.04	0.04
1995	12	0.10	0.02	0.02
1996	12	0.07	0.01	0.02
1997	12	0.05	0.01	0.01
1998	17	0.13	0.01	0.02
1999				

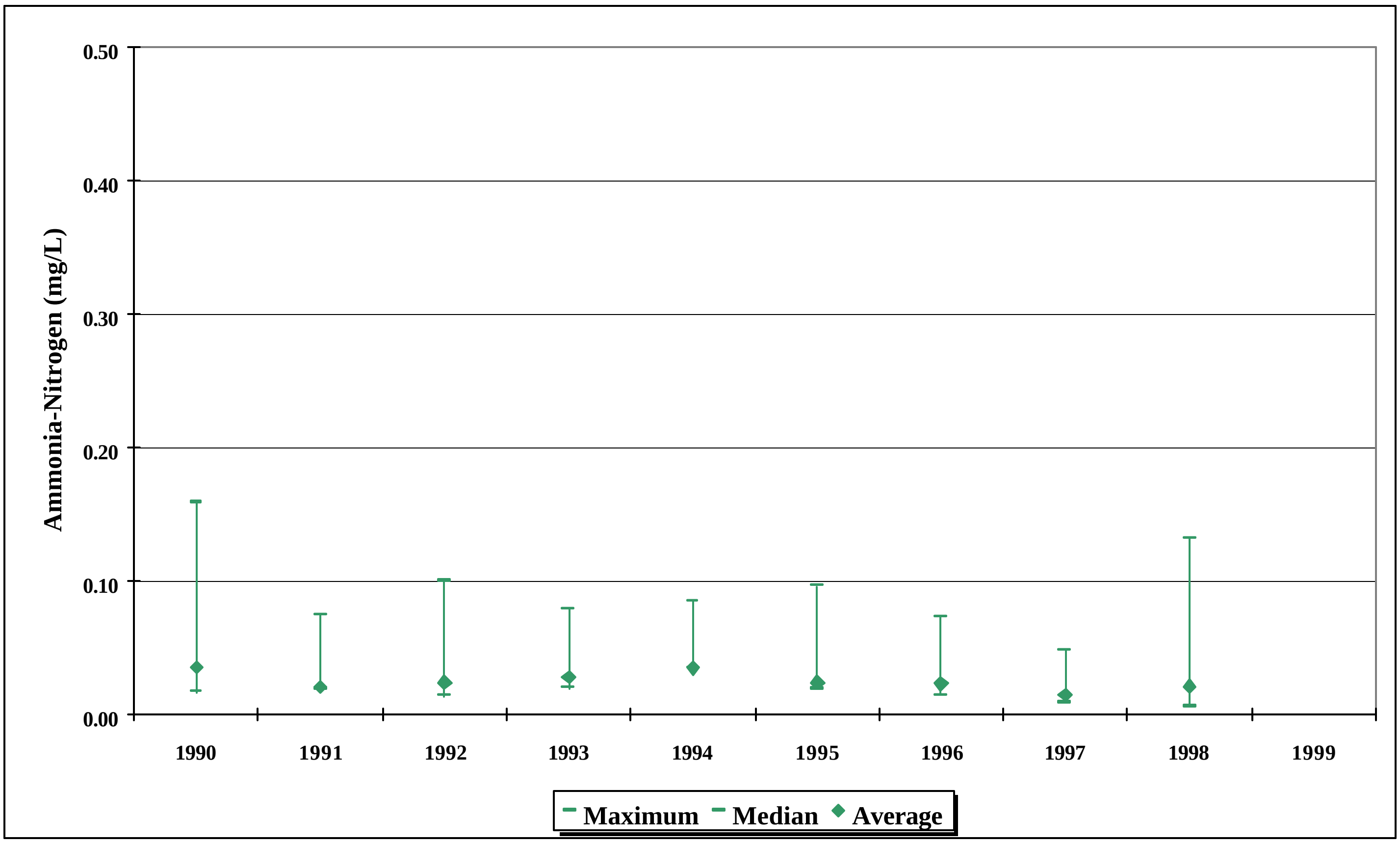

Figure 2.117 Phosphorus Results for Licking River Basin
05100101 HUC Watershed
Note: Phosphorus Standard is 0.10 mg/l

Table 2.110 Phosphorus Statistics for Kentucky River Basin 05100201 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	26	0.45	0.02	0.04
1991	15	0.07	0.02	0.02
1992	28	0.20	0.04	0.04
1993	12	0.13	0.03	0.03
1994	24	0.10	0.03	0.03
1995	12	0.19	0.02	0.05
1996	11	0.04	0.01	0.02
1997	17	0.10	0.01	0.02
1998	45	0.06	0.02	0.02
1999	5	0.16	0.08	0.10

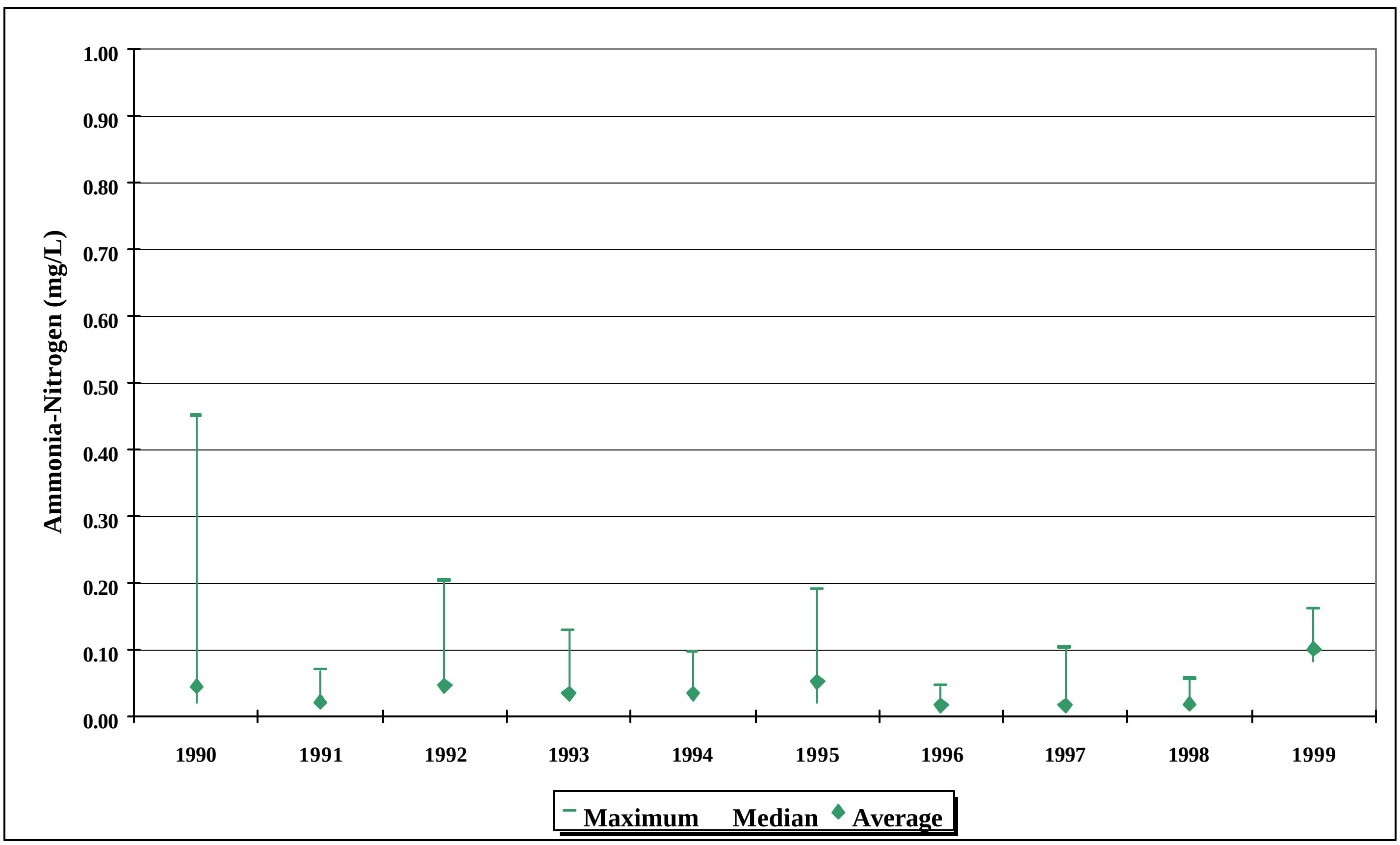

Figure 2.118 Phosphorus Results for Kentucky River Basin 05100201 HUC Watershed

Table 2.111 Phosphorus Statistics for Kentucky River Basin 05100202 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	19	0.32	0.01	0.03
1991	23	0.11	0.03	0.04
1992	17	0.22	0.02	0.06
1993	12	0.07	0.02	0.02
1994	12	0.11	0.02	0.03
1995	12	0.16	0.02	0.03
1996	11	0.03	0.01	0.01
1997	22	1.07	0.01	0.06
1998	28	0.05	0.01	0.01
1999	3	0.08	0.07	0.07

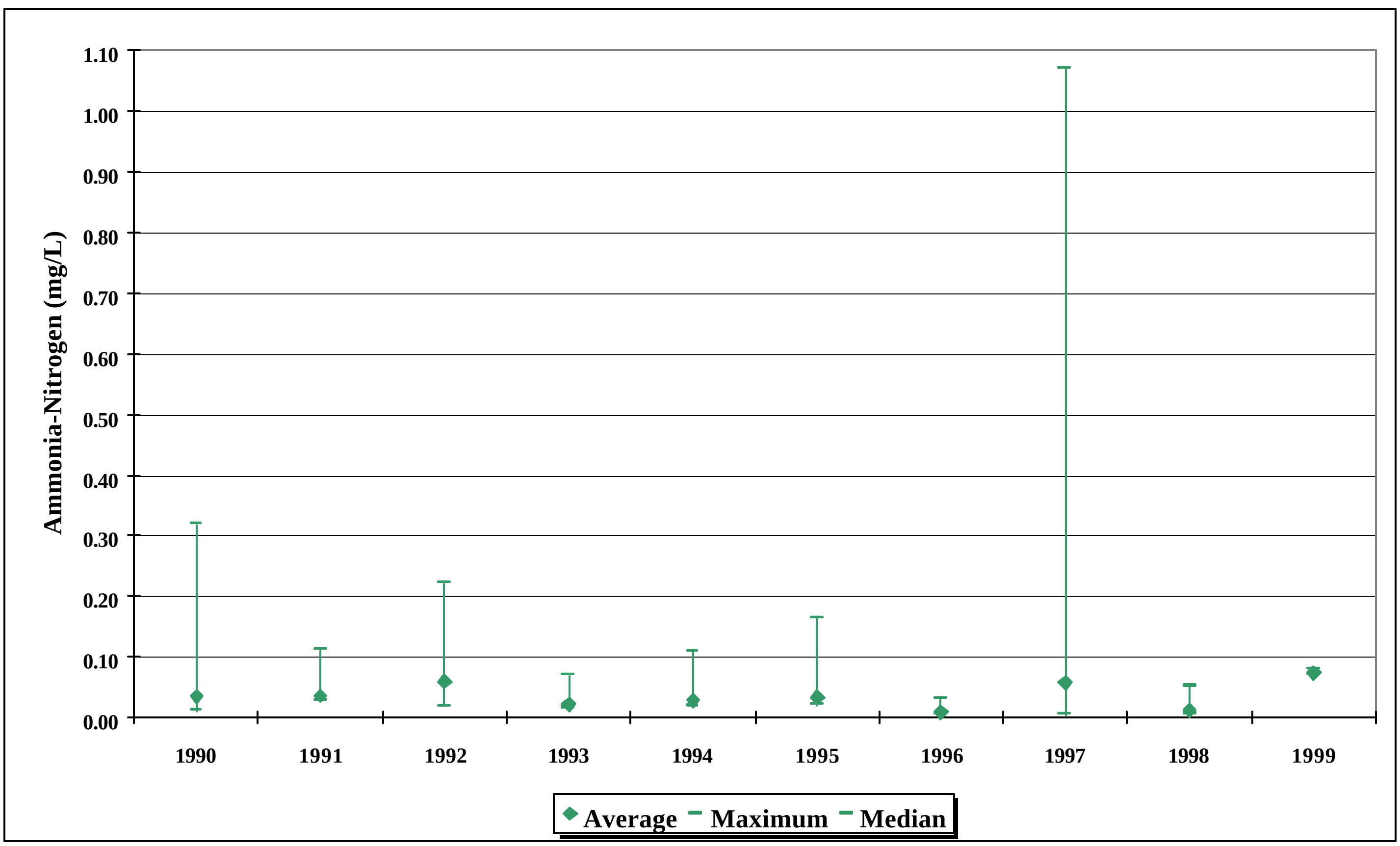

Figure 2.119 Phosphorus Results for Kentucky River Basin 05100202 HUC Watershed
Note: Phosphorus Standard is 0.10 mg/l

Table 2.112 Phosphorus Statistics for Kentucky River Basin 05100203 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	18	0.03	0.01	0.01
1991	11	0.01	0.01	0.01
1992	12	0.22	0.01	0.03
1993	12	0.04	0.02	0.02
1994	12	0.08	0.02	0.02
1995	12	0.07	0.02	0.03
1996	11	0.02	0.01	0.01
1997	15	0.59	0.01	0.06
1998	37	0.05	0.01	0.01
1999	4	0.09	0.08	0.08

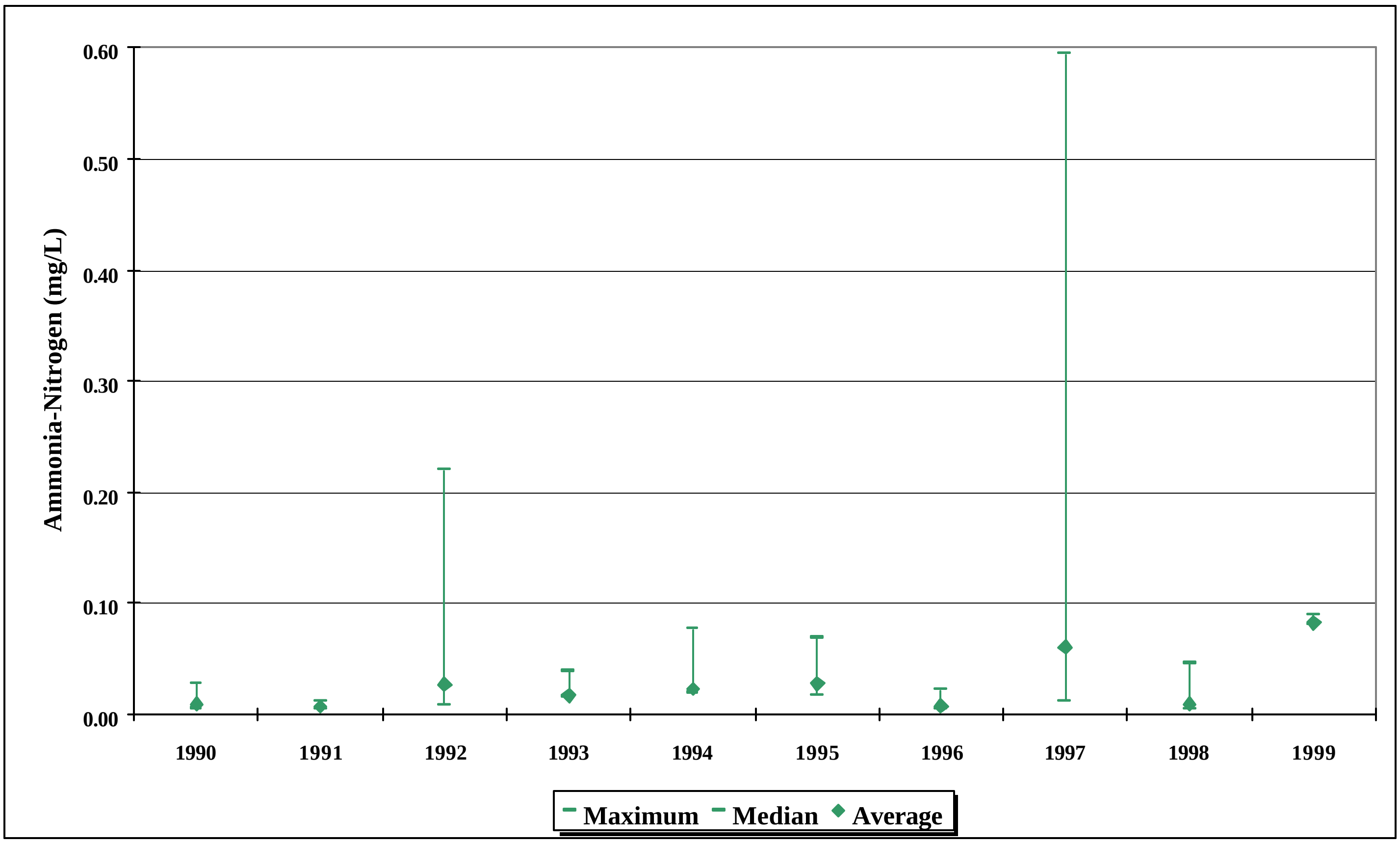

Figure 2.120 Phosphorus Results for Kentucky River Basin 05100203 HUC Watershed
Note: Phosphorus Standard is 0.10 mg/l

Table 2.113 Phosphorus Statistics for Kentucky River Basin 05100204 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	28	0.12	0.01	0.01
1991	25	0.07	0.01	0.02
1992	21	0.39	0.01	0.03
1993	16	0.09	0.01	0.03
1994	16	0.13	0.02	0.04
1995	15	0.08	0.02	0.02
1996	11	0.09	0.01	0.02
1997	17	0.26	0.01	0.05
1998	30	0.03	0.01	0.01
1999	6	0.15	0.08	0.09

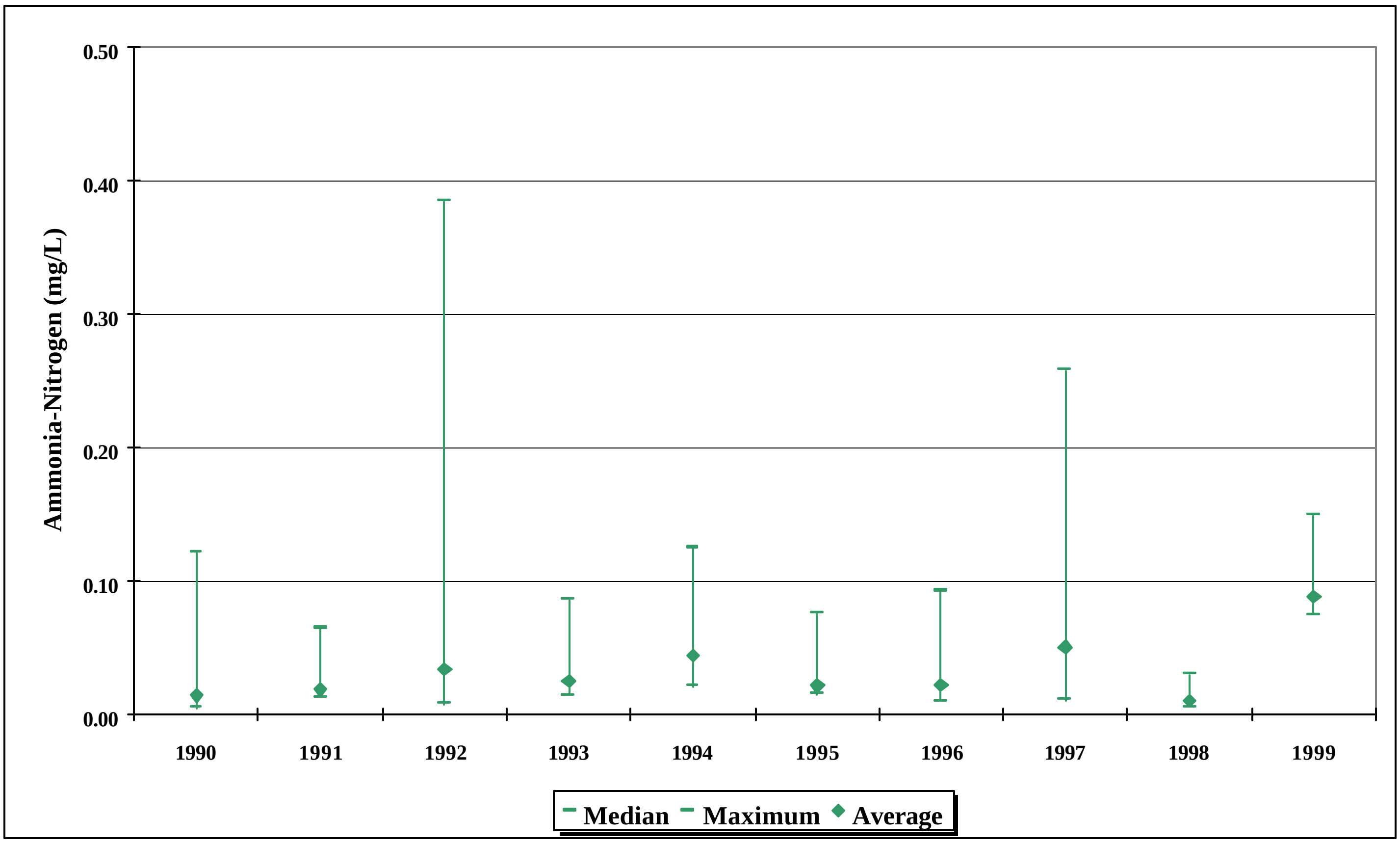

Figure 2.121 Phosphorus Results for Kentucky River Basin 05100204 HUC Watershed
Note: Phosphorus Standard is 0.10 mg/l

Table 2.114 Phosphorus Statistics for Kentucky River Basin 05100205 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	12	0.14	0.07	0.07
1991	11	0.30	0.04	0.08
1992	12	0.24	0.08	0.09
1993	12	0.09	0.04	0.05
1994	12	0.16	0.06	0.07
1995	12	0.23	0.05	0.08
1996	9	0.30	0.04	0.07
1997	7	1.15	0.10	0.27
1998	22	2.30	0.04	0.24
1999	5	1.88	0.13	0.76

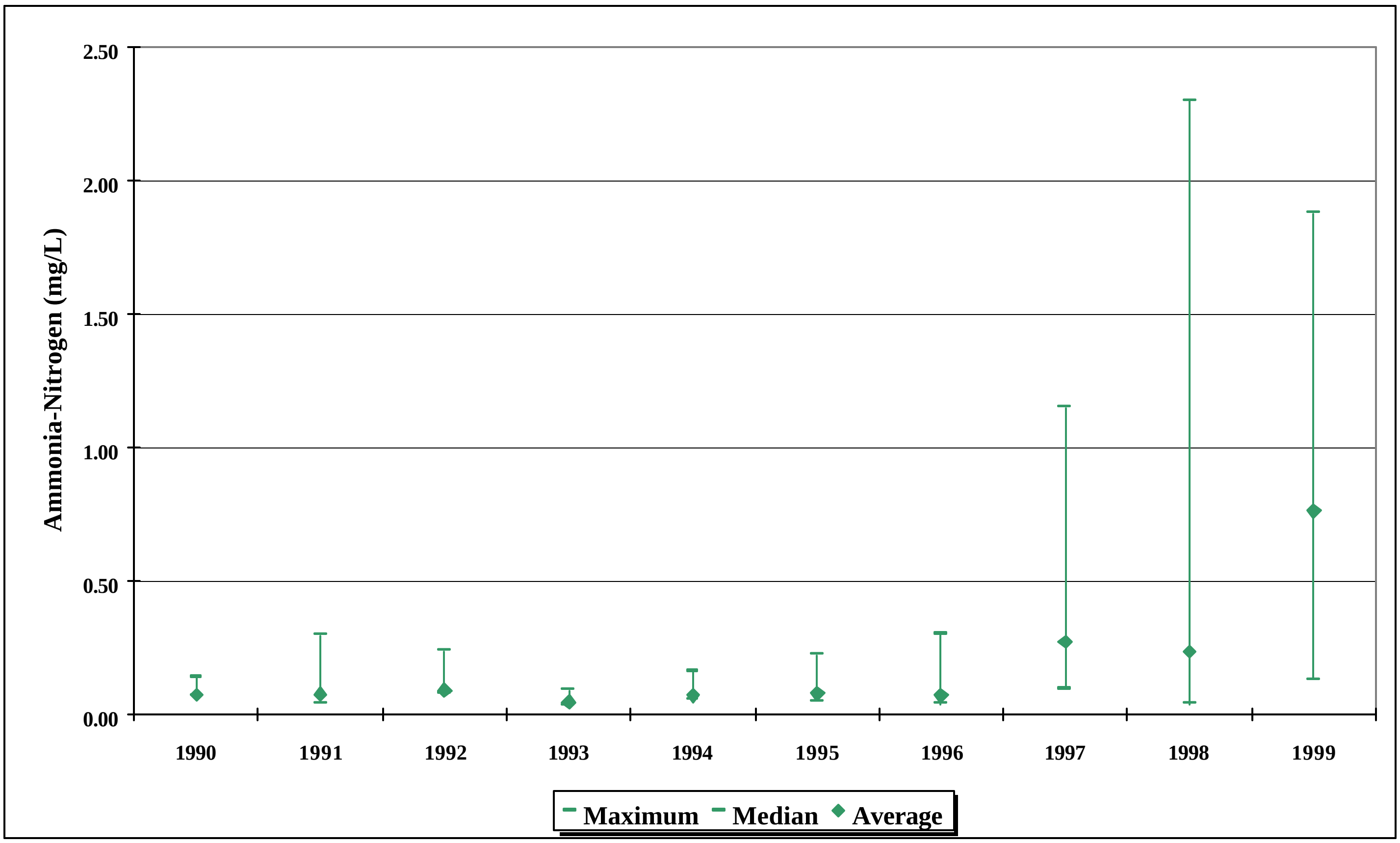

Figure 2.122 Phosphorus Results for Kentucky River Basin 05100205 HUC Watershed
Note: Phosphorus Standard is 0.10 mg/l

Table 2.115 Phosphorus Statistics for Upper Green River Basin 05110001 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	33	0.11	0.02	0.03
1991	12	0.02	0.01	0.01
1992	25	0.50	0.05	0.11
1993				
1994	3	0.06	0.05	0.05
1995	3	0.17	0.07	0.09
1996				
1997				
1998	12	0.04	0.01	0.01
1999				

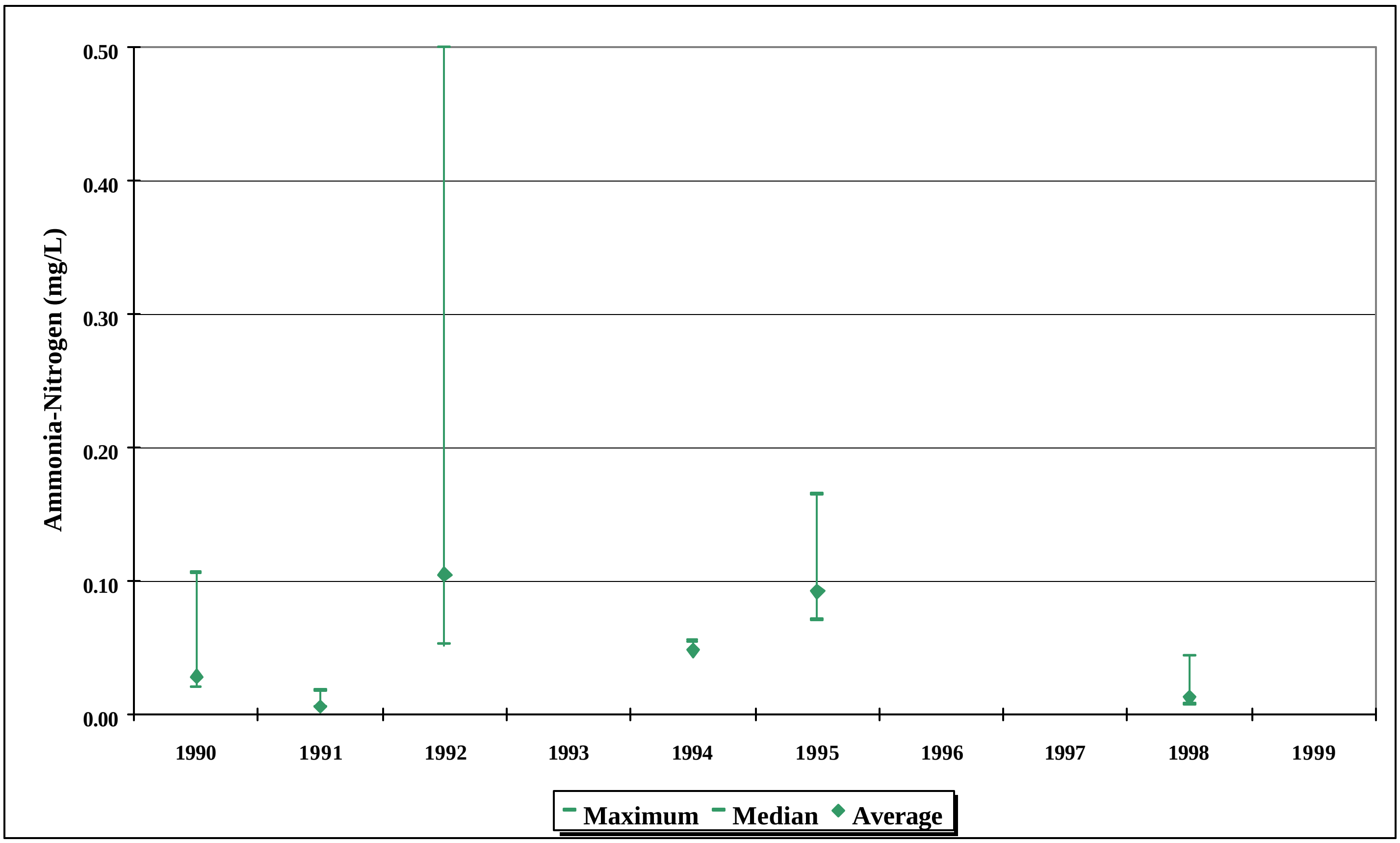

Figure 2.123 Phosphorus Results for Upper Green River Basin 05110001 HUC Watershed
Note: Phosphorus Standard is 0.10 mg/l

Table 2.116 Phosphorus Statistics for Upper Green River Basin 05110002 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	3	0.02	0.01	0.01
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998				
1999				

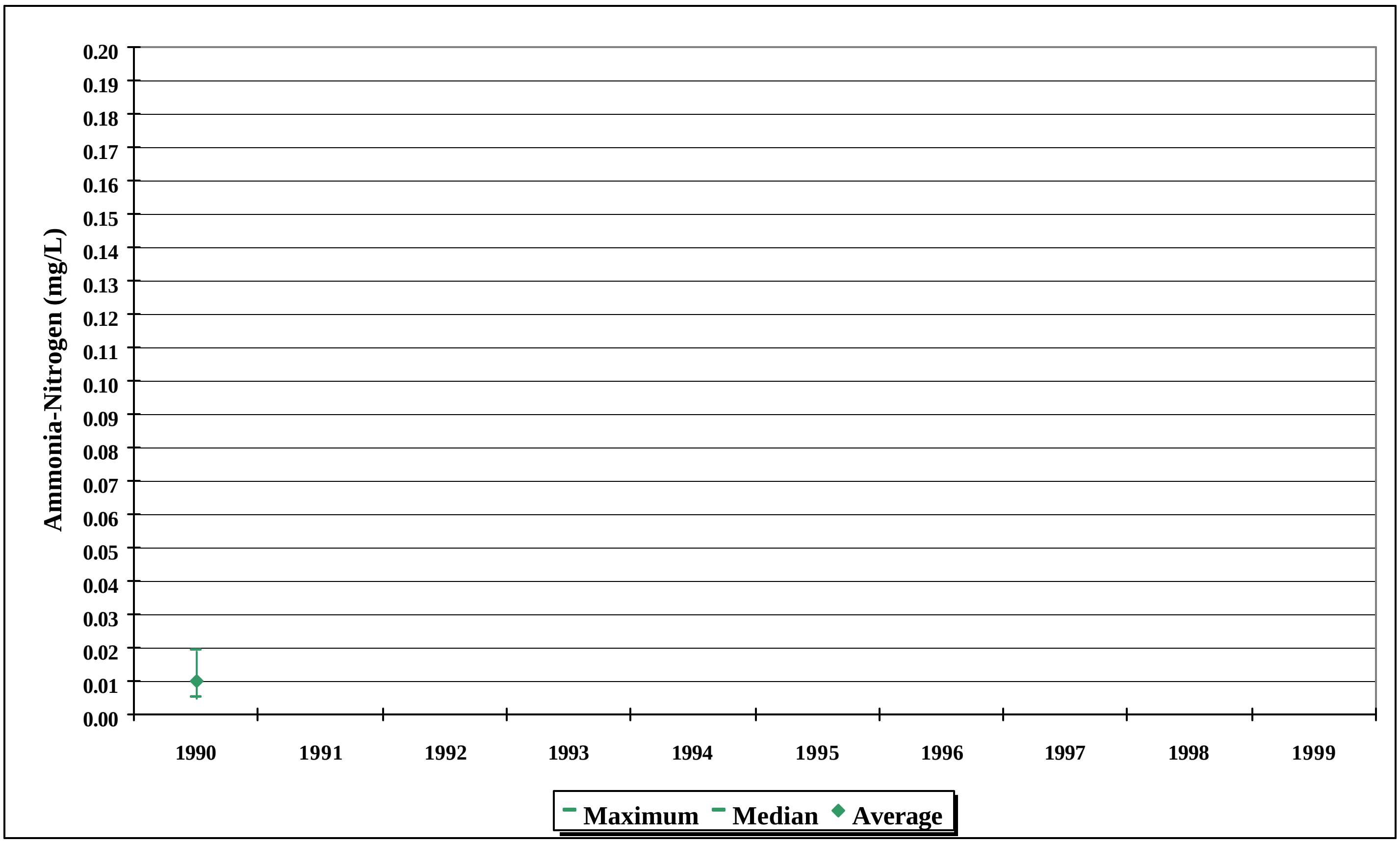

Figure 2.124 Phosphorus Results for Upper Green River Basin 05110002 HUC Watershed
Note: Phosphorus Standard is 0.10 mg/l

Table 2.117 Phosphorus Statistics for Upper Cumberland River Basin 05130101 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	42	0.91	0.01	0.05
1991	23	0.28	0.02	0.05
1992	35	0.06	0.02	0.02
1993	54	0.09	0.01	0.02
1994	36	0.15	0.03	0.04
1995	24	0.13	0.01	0.02
1996	24	0.06	0.01	0.01
1997	23	0.05	0.01	0.01
1998	22	0.07	0.01	0.01
1999	25	3.85	0.01	0.17

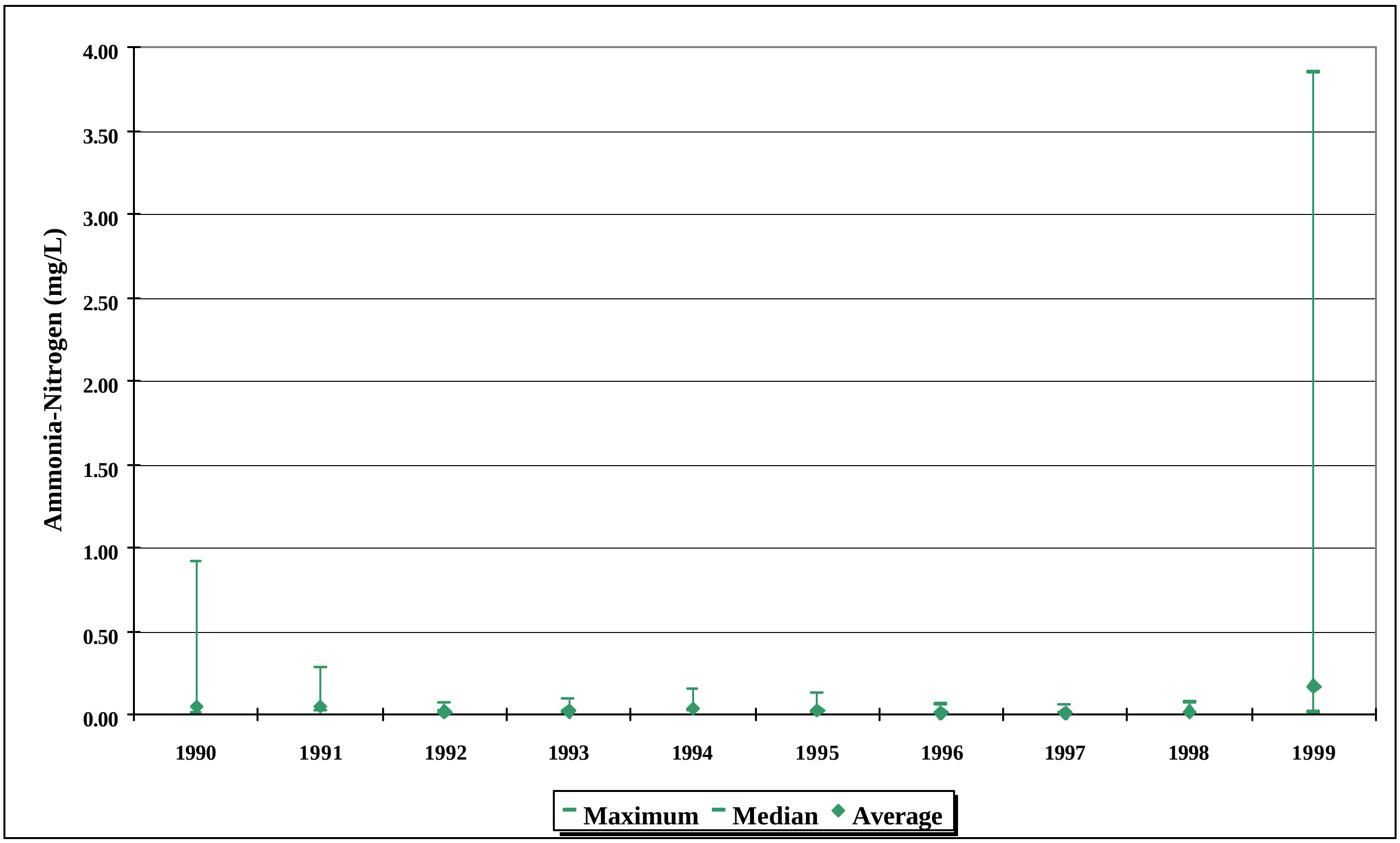

Figure 2.125 Phosphorus Results for Upper Cumberland River Basin 05130101 HUC Watershed
Note: Phosphorus Standard is 0.10 mg/l

Table 2.118 Phosphorus Statistics for Upper Cumberland River Basin 05130102 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	31	0.24	0.01	0.02
1991	23	0.07	0.01	0.01
1992	23	0.07	0.01	0.02
1993	24	0.12	0.01	0.02
1994	24	0.12	0.02	0.02
1995	24	0.04	0.01	0.01
1996	30	0.03	0.01	0.01
1997	29	0.07	0.01	0.01
1998	19	0.07	0.01	0.02
1999	9	0.60	0.01	0.08

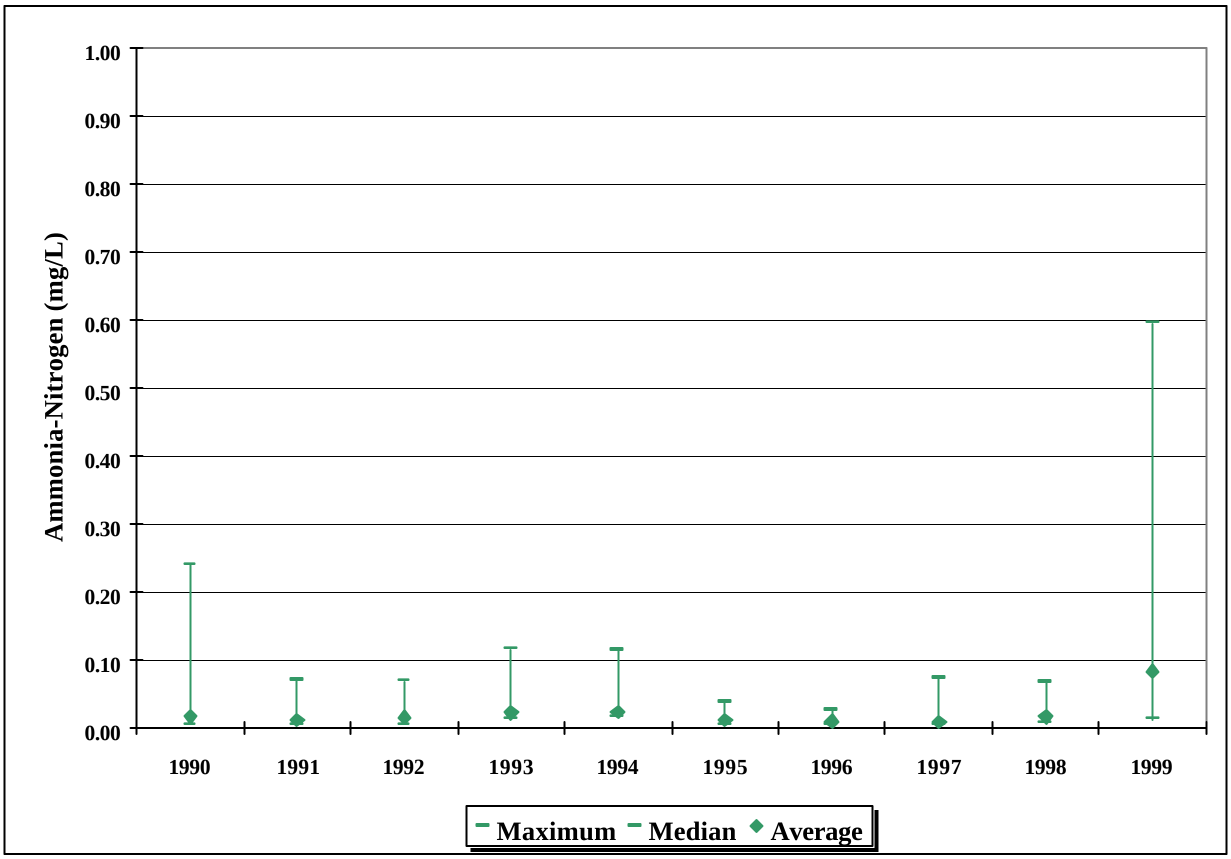

Figure 2.126 Phosphorus Results for Upper Cumberland River Basin 05130102 HUC Watershed
Note: Phosphorus Standard is 0.10 mg/l

Table 2.119 Phosphorus Statistics for Upper Cumberland River Basin 05130103 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	30	0.39	0.01	0.04
1991	16	0.22	0.01	0.04
1992	17	0.17	0.01	0.02
1993	36	0.92	0.03	0.06
1994	36	0.06	0.02	0.02
1995	24	0.07	0.01	0.02
1996	12	0.03	0.01	0.01
1997	12	0.01	0.01	0.01
1998	12	0.07	0.01	0.01
1999	21	0.58	0.01	0.04

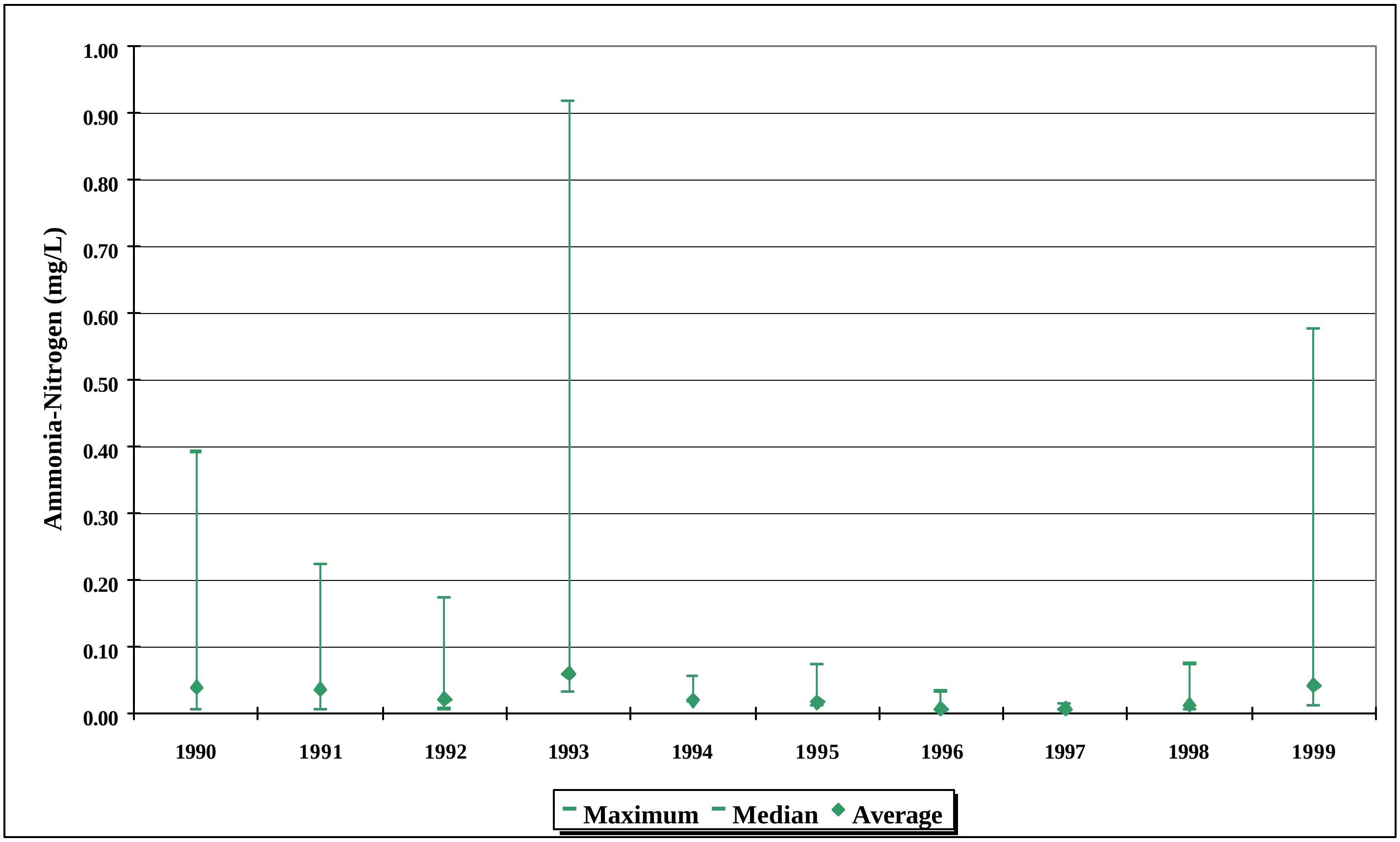

Figure 2.127 Phosphorus Results for Upper Cumberland River Basin 05130103 HUC Watershed
Note: Phosphorus Standard is 0.10 mg/l

Table 2.120 Phosphorus Statistics for Upper Cumberland River Basin 05130104 HUC Watershed

Year	Samples	Maximum	Median	Average
1990	22	0.10	0.01	0.01
1991	21	0.13	0.01	0.02
1992	25	0.04	0.01	0.01
1993	26	0.74	0.02	0.05
1994	26	0.05	0.01	0.01
1995	19	0.03	0.01	0.01
1996	12	0.01	0.01	0.01
1997	10	0.01	0.01	0.01
1998	10	0.07	0.01	0.02
1999	3	0.01	0.01	0.01

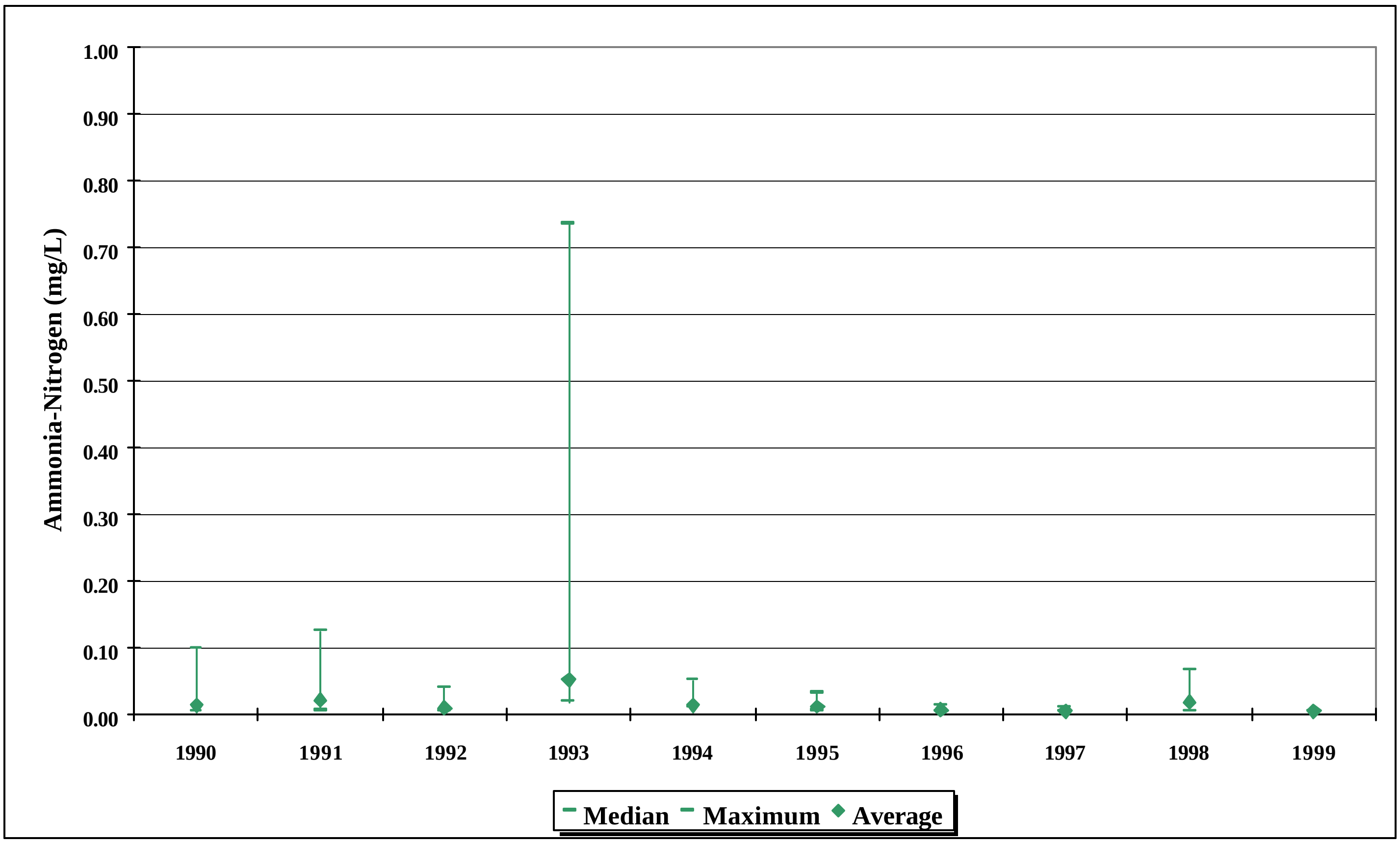

Figure 2.128 Phosphorus Results for Upper Cumberland River Basin 05130104 HUC Watershed
Note: Phosphorus Standard is 0.10 mg/l

Table 2.66 - Median Phosphorus Statistics for HUCs

HUC8	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
05070201	0.014	0.027	0.014	0.0245	0.024	0.0225	0.022	0.0085	0.009	-
05070202	-	0.018	0.005	0.02	0.03	0.02	-	-	-	-
05070203	0.009	0.016	0.05	0.05	0.034	0.02	0.02	0.02	0.006	-
05070204	0.06	0.09	0.05	0.0345	0.02	0.02	0.02	0.02	0.06	-
05100101	0.017	0.019	0.014	0.0195	0.035	0.019	0.0145	0.009	0.006	-
05100201	0.0185	0.018	0.04	0.026	0.0305	0.0195	0.005	0.008	0.016	0.08
05100202	0.011	0.028	0.019	0.016	0.0195	0.02	0.005	0.005	0.0065	0.07
05100203	0.0055	0.005	0.0085	0.016	0.0195	0.017	0.005	0.012	0.005	0.08
05100204	0.005	0.013	0.008	0.0145	0.021	0.015	0.01	0.011	0.0055	0.075
05100205	0.0715	0.042	0.0815	0.0355	0.055	0.0505	0.039	0.097	0.0405	0.13
05110001	0.02	0.005	0.052	-	0.054	0.071	-	-	0.0075	-
05110002	0.005	-	-	-	-	-	-	-	-	-
05130101	0.0115	0.021	0.015	0.0115	0.025	0.014	0.006	0.006	0.0055	0.013
05130102	0.005	0.005	0.005	0.0135	0.0165	0.005	0.0055	0.005	0.008	0.013
05130103	0.005	0.0055	0.006	0.0315	0.0165	0.011	0.005	0.005	0.005	0.011
05130104	0.005	0.006	0.005	0.0185	0.012	0.006	0.0055	0.005	0.005	0.005

3.0. SUMMARY AND RECOMMENDATIONS

The efficient utilization of federal funds in improving the water quality and aquatic habitat of the region requires a mechanism for assessing and evaluating the impacts of the proposed and ongoing projects as well as some mechanism for prioritizing the allocation of additional funds. In order to evaluate the effectiveness of these projects it is important to provide a formal monitoring and assessment program based on sound scientific principles. This report provides an initial 10 year baseline assessment of the existing water quality conditions in the 40 county PRIDE region for the purpose of evaluating the impacts of the PRIDE programs in the region and the extent to which such programs are satisfying their stated objectives of cleaning up the region's rivers and streams. For this study, assessment parameters included measurements of ammonia and total phosphorus. Assessments for pH, fecal coliform, macro-invertebrates, and habitat are included in the companion report: PRIDE Water Quality Assessment Report: II. Chemical, Biological, and Habitat Assessments.

In general elevated ammonia values are fairly localized to three counties: Lawrence, Johnson, and Floyd. In each case the maximum observed values are still below the statutory limit of 4 mg/l. It is hypothesized that the elevated values are due to diffused sources of human waste from inefficient septic systems or improperly operated package plants. Although more refined sampling is needed to support this hypothesis, this position is consistent with geologic and demographic data from the region. Although the diffused values may not exceed the statutory limit for ammonia, the ammonia data may still provide a quantitative means more documenting regional improvement in waste disposal.

In general, elevated phosphorus values are fairly localized in one county, Jessamine county. Over the last three years, both maximum and average measured values have exceeded the target value of 0.1 mg/l. It is hypothesized that the elevated values are due to a combination of impacts from discharges from wastewater treatment plants and runoff that is leaching out phosphorus from the soils and the underlying limestone.

Where available and with the noted exceptions, the historical data has revealed minimum ammonia and phosphorus impacts across the region. Although the ammonia values were all below the maximum threshold of 4 mg/l, it is still possible that the average and maximum values can be used as an implicit measure of future improvements to regional wastewater systems. The same may also be true of the phosphorus data although it is likely that this will be more significant when dealing with large point sources as opposed to diffused loads. As a result, it is expected that these data sets will provide the basis for a general assessment of the PRIDE program over the next several years. However, there remain several counties and even a few watersheds where no assessment data is available. Additionally, it is likely that more strategic locations of sampling sites will improve the overall assessment methodology. As a result, it is highly recommended that additional monitoring stations be placed in these areas to provide a more thorough basis for future project assessment. In addition, many monitoring stations are not located in specific watersheds where PRIDE projects are proposed or ongoing. As a result, it is also recommend that additional monitoring stations be placed in these watersheds as well. Such sites to address both of these concerns are proposed in the companion report: *PRIDE Water Quality Assessment Report III: Existing and Proposed Monitoring Network.*

4.0 REFERENCES

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