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SOURCES AND QUANTITIES OF NUTRIENTS ENTERING THE GULF OF MEXICO FROM SURFACE WATERS OF THE UNITED STATES

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PREFACE

This report was prepared for the Nutrient Enrichment Subcommittee of the U.S. Environmental Protection Agency's Gulf of Mexico Program. Because nearly 60% of the continental United States drains into the Gulf of Mexico, a large and diverse amount of data are available that could potentially be used to assess the sources and quantities of nutrients entering the Gulf. Unfortunately, data from these studies often are not comparable in their timeframes, methods employed, or the water quality parameters reported. In addition, data on nutrient concentrations in rivers often are not accompanied by data on water flow, therefore pollutant loadings cannot be ascertained. As this report indicates, there is no shortage of appropriate data of documented quality upon which to base decisions about protection of the water of the Gulf of Mexico.

This report is not intended to be a complete examination of the sources of nutrients in the Gulf of Mexico. Rather, it represents an effort to examine the data for one specific year—1989. Funding was inadequate to include analysis of additional years. While care was used in selecting this year, 1989 may not represent a typical year for nutrient inflow into the Gulf. The examination of only one specific year also means that no trend analysis over a multiyear timeframe was performed. It is hoped that future reports will address these and other questions concerning the relationship between nutrient enrichment and the ecological integrity of the Gulf of Mexico.

After reviewing this document, the members of the Nutrient Enrichment Subcommittee caution readers to bear these aforementioned limitations of the report in mind.

Executive Summary: Sources and Quantities of Nutrients Entering the Gulf of Mexico from Surface Waters of the United States

The Gulf of Mexico is one of our nation's premier natural resources. A vital habitat for both aquatic and terrestrial species, it is a major supplier of seafood production and recreational opportunities. However, this marine ecosystem is now threatened by a variety of contaminants resulting from man's activities. This degradation of the Gulf is caused by activities in the coastal areas as well as from freshwaters flowing into the Gulf from the entire drainage area. One specific area of concern is the potential overenrichment of Gulf waters by excessive nutrients, particularly nitrogen and phosphorus.

At the beginning of the Gulf of Mexico project, some felt that we needed to concentrate on the activities in the Gulf Coast states but others felt that we needed to include the entire drainage basin in any analysis or particularly in management plans. We quickly arrived at the point where we were uncertain from where these excessive nutrients were originating. On farms in Louisiana or Texas or ranches in Montana? From industries in Florida or municipalities in Indiana or Minnesota?

We knew that nationally nonpoint sources of nitrogen and phosphorus accounted for about 80% of total loadings into U.S. rivers and streams. But there was a great deal of variance across regions of the country. For nitrogen, in the Northeast, less than 50% came from nonpoint sources, while in the Northern Plains over 96% came from nonpoint sources.[1] For phosphorus, in the Southeast only 45% came from nonpoint sources while nonpoint sources accounted for 90% or more in the northern Great Plains, Pacific and Mountain states.[2] In order to answer these questions, we decided to initiate a study to examine the sources and quantities of nutrients entering the Gulf of Mexico.

The drainage area into the Gulf is quite extensive, it covers roughly from the Appalachians to the Rockies plus the Florida Gulf Coast. The Gulf's drainage basin extends up into New York state in the east to nearly all of Montana on the west or nearly 60% of the land area of the continental United States. Nearly half of the population of the United States lives in the drainage area.[3] Three-fourths of our land in farms and ranches is in the drainage basin and almost 80% of our cropland. The basin produces nearly 90% of the corn and soybeans in the United States and 70% or more of our wheat and hay.[4]

This is obviously a vast, agriculturally productive area with major population centers and extensive industry including much of what we have called the rust belt. So, we have extensive agriculture with high levels of nutrient application; we have hundreds of cities discharging nutrients; and thousands of industries discharging pollutants. All of these are putting nutrients into water that eventually flows into the Gulf of Mexico.

With such diversity of sources in the geographic dispersion, the issue became how to simplify in order to begin the analysis and to discover the data that was available. We found data that was comparable and *covered the entire* drainage area in both the Purdue University Water Quality Model and in EPA's STORET data base. Both of these are described in detail in the final report. Here we will point out some difficulties and general results of that investigation.

Attempting the study of the sources and quantities of pollutants in all of the major waterways comprising an area as large as the Gulf of Mexico drainage basin severely limits the data sources which one can utilize effectively. We believed it necessary to collect or estimate data from one recent time span, with a strong preference for a very recent and fairly typical year. While there is a plethora of studies on various segments of waterways in river systems flowing into the Gulf, most are of value to this particular study only for general background information rather than as actual data sources.

For example, research on the Galveston Bay Entrance Channel, the Mississippi River near St. Cloud MN, Lake Austin in Texas and the Tampa Harbor is all within the geographic scope of this project. However, these and other studies are not comparable in their time frames or in the methods employed and chemical elements reported. Data collected from 1973 to 1979 may differ from that collected in 1981 or 1987 for many reasons, none of which may be relevant to our current study. Some individual states in the Gulf drainage area publish comprehensive data on water quality every few years; some others publish, for example, data on concentrations but no data on water flow or pollutant loadings. And the sum total of all of these reports for the relevant area was far from complete geographically.

With such a large geographic dispersion, the issue became one of simplifying in order to begin the analysis from the large databases available. We considered using the National Stream Quality Accounting Network (NASQAN) data, established in 1972. Its data includes streamflow, concentrations of major inorganic and trace constituents, presence or absence of bacterial indicators, and pesticide concentrations. However, NASQAN only has approximately 500 stations in the entire United States, all located at the mouths of major river systems and therefore not obtaining measurements from upstream reaches of many waterways. Furthermore, federal budget constraints have led to bimonthly and quarterly sampling, leading to a very low number of measurements even from fairly large geographic areas in a particular season or even over the course of a year. For these reasons we decided to use primarily the two data sources mentioned below.

We found data that was comparable and which covered the entire Gulf of Mexico drainage area in both the Purdue University Water Quality Model and in the U.S. Environmental Protection Agency's STORET database. The Purdue Model, described in detail on pages 5-7 of this report, has more than 1300 nodal points around the nation both at the mouths of rivers and upstream on major tributaries, with an average distance of 66 miles between nodal points. For this report we updated the original 1982 database with estimates for 1990.

The Environmental Protection Agency's STORET system is the only national database which we located that provides data comparable to that in Purdue's Water Quality Model for the Gulf of Mexico drainage basin. STORET contains water quality data for more than 700,000 sampling sites throughout the United States and Canada, including several measures of phosphorus and nitrogen, though some are reported in only one or a few surface water subsystems. A package of analytical programs allows access and some analysis of water quality data, with the ability to restrict the analysis to data which were collected and stored using certain quality control standards.

We made several decisions regarding which data to select, to maintain as high a degree of quality control as possible. Only "active" data, for which an individual currently with the agency that entered the data is willing to be responsible for the accuracy and collection methods used, was retrieved; "retired" data was not. We used only actual grab samples from surface waters, excluding such categories as underground aquifers, wells or springs. Several "remark" codes may cast doubt on the accuracy of a particular sample; we excluded all such samples except those consisting of the mean of samples collected on the same date, calculations from actual samples, field measurements and those after any amount of recent rainfall, to retrieve a cross section of all accurate data.

As noted in the report, we occasionally ended up with less data than desired for a specific subregion and season. We did not attempt to pad these gaps with nearby or less accurate data, as this could reduce the credibility of comparisons among subregions or seasons. We also attempted to run a "lowest station" analysis using the most-downstream data collection stations' data to confirm the "lowest subregions" analysis for Gulf-adjacent subregions and the Mississippi River system. After a lengthy attempt, the decision was made that sufficient data was not available for several subregions, negating the ability to confirm the data in others.

The lack of data for 1990 also led to our decision to analyze 1989 data, as it is the most recent year for which consistently sufficient data was generally available at the time of the analysis. With all of these restrictions we believe we have reduced any quality control variability which was formerly sometimes associated with the STORET system.

We began by examining the 1989 seasonal concentrations in each of the USGS regions and subregions which form the Gulf of Mexico drainage basin. This includes the Upper and Lower Mississippi regions, the Ohio, Tennessee, Missouri, Arkansas and Texas Gulf regions as well as part of the South Atlantic-Gulf or "Southeast" region.

One of the more surprising observations about nutrient concentrations was the lack of any consistent seasonal trend in any of the regions or subregions. Nonpoint sources of nutrients such as cropland runoff, urban lawn runoff and large construction projects would be expected to be somewhat seasonal.

A second finding is that concentrations of nutrients do not generally increase as a river system flows downstream. While in some stream reaches in some seasons, we found a trend, it was not consistent across regions or across seasons. This may be the result of nutrient degradation or plant uptake of nutrients, lags from sediment attached nutrients or simply that volumes of water increase more quickly than volumes of nutrients.

For instance, if we begin in the Upper Mississippi region we find average concentrations of phosphorus and nitrogen at .4 mg/L and 1.6 mg/L. As we go south toward the Gulf, the Missouri comes in with higher average concentrations in its system of 1 mg/L of phosphorus and 2.4 mg/L of nitrogen, the Ohio system inflow has average concentrations of .2 and .6 and the Tennessee, which flows into the lower Ohio shortly before it reaches the Mississippi, has concentrations of .1 and .4. By the time all this water reaches the Lower Mississippi, the average daily concentrations including lower Mississippi tributaries are .2 mg/L of phosphorus and .8 mg/L of nitrogen. Therefore, the concentrations in the lower Mississippi are lower than most of the major regions of its drainage basin. However, since the amount of water being contributed to the Mississippi from its tributaries is so vastly different, the next step was to examine loadings of nutrients.

The mean concentrations throughout each of the USGS regions discussed above, and the average daily flows, are used to calculate nutrient loadings. Regional mean loadings are useful primarily as a basis for comparisons between regions, as they represent a cross section of data from the largest rivers to the smaller tributaries. Our estimates of mean daily loadings of phosphorus are highest in the Ohio River region over the entire year, with the Lower Mississippi region's mean loadings second highest. The lowest average daily phosphorus loadings are found in the Rio Grande region. Average daily Kjeldahl nitrogen loadings were highest in the Lower Mississippi region in 1989; the Ohio system is a fairly distant second for nitrogen. Several other regions report fairly low average daily Kjeldahl nitrogen loadings, with the Rio Grande region again the lowest throughout the entire year.

Based on analysis later in the report of only the "lowest subregion" data, which studies only those subregions closest to the Gulf of Mexico, much higher daily loadings of nutrients actually flowing into the Gulf are likely. From this analysis we estimate that more than 379,000 pounds of phosphorus and over 1,872,600 pounds of Kjeldahl nitrogen are discharged into the Gulf on an average day. Approximately 94% of the phosphorus and 91% of the Kjeldahl nitrogen from these gulfside subregions comes from the Mississippi River system.

Because of the high proportion of nutrients clearly coming from the Mississippi system using either method, we should examine it more closely. When we looked at concentrations, remember that the waters from the Missouri system and the Upper Mississippi were the most heavily nutrient laden. However, we know that the Ohio discharges considerably more water into the Mississippi than the Missouri. If we look at the data available for average daily loadings into the Mississippi system, specifically those systems above the lower Mississippi region, we find for example that the relatively "nutrient rich" Missouri accounts for only approximately 10% of average daily loadings of phosphorus and Kjeldahl nitrogen near the mouth of the Mississippi. The largest amounts of water flowing into the Lower Mississippi come from the Upper Mississippi and the Ohio regions, both of which also have many large population centers and large amounts of agricultural activity. The Upper Mississippi then contributes roughly one-third of the phosphorus and Kjeldahl nitrogen discharged into the Gulf from the Mississippi system, and the Ohio River system (including relatively small loadings from the Tennessee region) which contributes more than half of the phosphorus and more than a quarter of the Kjeldahl nitrogen.

We must remember that these are averages across the entire year; there is considerable seasonal variation within the huge Mississippi drainage basin. For instance, the Ohio River System contributes over 60% of the phosphorus in the spring but well under 20% in the summer. The Upper Mississippi and its tributaries contribute only roughly 10% of the phosphorus in the spring but well over four-fifths in the summer.

Overenrichment of the Gulf of Mexico, then, is caused by not only activities along the Coast but also by the behaviors of Iowa farmers, Pennsylvania steel magnates and urban residents in cities like Indianapolis, Louisville, St. Louis, Minneapolis and Rising Sun, Indiana. If we are to develop plans to protect the Gulf, we must examine methods for influencing those behaviors. In addition, we need to identify which nutrient is the most important to control or which is the most troublesome for the Gulf ecosystem. The contributions of regions vary by nutrient and by season. In addition, the proportion of various nutrients from point sources and nonpoint sources varies across regions and nutrients. Attempting to protect and preserve the Gulf of Mexico ecosystem will require consideration of the activities throughout the entire drainage basin as well as along the Gulf coast.

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1 See Table 2 of report.

2 See Table 1 of report.

3 United States Department of Commerce, Bureau of the Census, Statistical Abstract of the United States: 1990, 110th Edition, Washington, D.C., 1990.

4 United States Department of Commerce, Bureau of the Census, 1987 Census of Agriculture, Volume 1: Geographic Area Series, Part 51: United States Summary and State Data, 1989.

Sources and Quantities of Nutrients Entering the Gulf of Mexico from Surface Waters of the United States

Introduction

The Gulf of Mexico is one of our nation's premier natural resources. A vital habitat for both aquatic and terrestrial species, it is a major supplier of seafood production and recreational opportunities. However, this marine ecosystem is now threatened by a variety of contaminants resulting from man's activities. This degradation of the Gulf is caused by activities in the coastal areas as well as from freshwaters flowing into the Gulf from the entire drainage area. One specific area of concern is the potential overenrichment of Gulf waters by excessive nutrients, particularly nitrogen and phosphorus. Before a strategy to manage and protect the resources of the Gulf can be established, the sources and quantities of these nutrients entering it from major United States river systems must be identified.

This paper reports on efforts to gather the available information and data to accomplish such identification. The report utilizes primarily a combination of data from the U.S. Environmental Protection Agency's STORET database and analysis from Purdue University's Water Quality Model. The geographic area studied covers the entire U.S. drainage area into the Gulf, roughly from the Appalachians to the Rockies plus the Florida Gulf Coast.

Many people do not realize the extent of this drainage area; it extends even to a small portion of New York state and nearly all of Montana, covering nearly 60% of the continental United States' area. A little less than half of the U.S. population lives in this area,[1] but it includes approximately three-quarters of all U.S. land in farms and nearly 80% of our cropland. Approximately 90% of the soybeans produced in this country (a source of nitrogen in soils) comes from this area, and nearly 90% of our corn, one of the more heavily fertilized crops. More than 70% of our wheat is produced in the region, and approximately 70% of U.S. acres in hay production (about 65% of dry tons produced) are located in this vast drainage area.[2]

This vast area, then, includes extensive agricultural regions with high levels of nutrient application, major population centers discharging nutrients and other pollutants, and many varied industries also discharging a multitude of pollutants. Eventually many of these pollutants must flow into the Gulf of Mexico.

This report contains first, a description of Purdue's Water Quality Model and the analysis of results obtained through its use for the river systems in the Gulf of Mexico drainage area. Next, the Environmental Protection Agency's STORET database is described and the general results of studying 1989 data from it are presented. Comparisons of data from USGS regions on nutrient concentrations and loadings follow, again using the STORET database. Loadings entering the Gulf from its coastal (USGS) subregions, and some further analysis of the vast Mississippi River system, complete the main body of the report, along with the summary and conclusions.

Five important appendices follow the main report. Appendices A and B analyze STORET's USGS subregional data on concentrations of phosphorus and nitrogen within regions; the data in Appendix A include some non-ambient observations, while Appendix B includes strictly ambient data. Appendix C contains nutrient loadings for USGS subregions within each region, from STORET. These three appendices provide the means of locating more specific geographic problem areas regarding sources of nutrients and Appendix D provides a cross-reference between USGS subregion or region numbers and the Purdue Water Quality Model river system numbers and Appendix E provides a concentration of pollutants for each river mode in the Purdue Water Quality Model.

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1 United States Department of Commerce, Bureau of the Census Statistical Abstract of the United States: 1990, 110th Edition, Washington, D.C., 1990.

2 United States Department of Commerce, Bureau of the Census, 1987 Census of Agriculture, Volume 1: Geographic Area Series, Part 51: United States Summary and State Data, 1989.

The Purdue University Water Quality Model

Description

In recent years, the issue of water quality has achieved a much more important focus. The general public, as well as their representatives in Washington, are increasingly suggesting that the country needs clean water as well as food and fiber production. It should be the goal of the government as well as both agricultural and environmental groups to provide these desired commodities and amenities. The Environmental Protection Agency has concentrated their water quality efforts on assisting municipalities in construction and operation of sewage treatment plants and in regulating and assisting industries in reducing the discharge of pollutants into our nation's surface waters. However, recent investigation suggests that reducing point sources of pollution will be inadequate for achieving society's water quality goals. The role of agriculture in nonpoint source water pollution has been well documented.

The U.S. Department of Agriculture has also been responding to the social forces which are suggesting that agricultural practices should be less environmentally degrading. Their work on the National Program for Soil and Water Conservation for 1988 through 1997 illustrates the department's concern over water quality and, in general, the offsite impacts of agricultural production practices. While their first priority remains reducing the damage caused by excessive soil erosion, the damages mentioned include offsite damages as well as onsite damages. In addition, their number two priority for their ten year program is to "protect the quality of surface and groundwater against harmful contamination from nonpoint sources."[3]

All of this interest in the water quality impacts of agricultural production practices suggests that as a sector, agriculture will be increasingly called upon to estimate the water quality impacts of alternative agricultural program's and policies. However, unlike estimating changes in gross soil erosion resulting from agricultural policies, the tools for estimating the water quality impacts of agricultural policies are not

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[3] United States Department of Agriculture. 1988. *"National Conservation Program."* In Journal of Soil and Water Conservation, 43(3):243.

as refined. In the 1970's and early 1980's, a group of researchers at Resources for the Future in Washington, D.C., began construction of a model to estimate the water quality impact of various point and nonpoint sources. This model has been used in several procedures, such as the RCA process, to provide some baseline information on the impact of cropland production practices upon nutrient loadings into the nation's surface waters. This type of national model for estimating the water quality impacts associated with alternative policies is absolutely essential. While Americans desire cleaner water, they also want the most efficient and effective policies for achieving their water quality goals.

This concern about water quality impacts of agricultural practices led the Soil Conservation Service and the U.S. EPA, in cooperation with Purdue University, to revive and renew the development of the Water Quality Model which was originally constructed by Leonard Gianessi and Henry Peskin at Resources for the Future. This Water Quality Model (WQM) is utilized to provide directional estimates of water quality impacts to decision makers for use in policy deliberations.

While there are many water quality models oriented toward small watersheds (ANSWERS, AGNPS, CREAMS, etc.), there has been much less work done on regional or national water quality models. In considering the degradation of surface water quality by agricultural production at the national level, it is useful to take one or two steps back from the water quality problem and examine the endowment of the United States in terms of surface water. The United States has thousands of rivers, lakes, reservoirs, creeks, etc., into which flow billions of gallons of water per day. Obviously, some method for representing these hundreds of thousands of water bodies is essential for wise use of the resources. The Water Quality Model, as originally developed by Resources for the Future and now adapted by Purdue University, attempts to represent an aggregate picture of the nation's water resource by concentrating on the major rivers, streams and lakes in the nation. In order to do this, the Water Quality Model establishes nodal points at the mouths of rivers, the entrances to reservoirs, forks of major tributaries, major population centers and the beginning of estuaries. This method yields 1,300 nodal points around the nation which are used in 44 distinct subnetworks and then aggregated for national estimates. For instance, the Mississippi River subnetwork (the largest) has a total of 124 different rivers as well as 78 lakes and reservoirs. Nationwide, the average distance between nodal points is 66 miles.

A first question in the analysis of water quality is determining the sources of various pollutants. Data developed by Leonard Gianessi at Resources for the Future suggests that sediment, phosphorus and nitrogen are generated in large quantities by rural land uses including cropland. Nearly all suspended sediments come from rural land uses, and over 80% of total phosphorus and nitrogen comes from rural land uses. This suggests that when these are the pollutants of concern, the loadings emanating from rural lands must be considered in any policies or proposals to reduce the amount of degradation of our water resources.

The Water Quality Model is unique in its ability to examine the issues surrounding the sources of pollutants into our surface waters. The Water Quality Model is very data intensive in the sense that substantial information on point source pollution, rural land uses, urban nonpoint source pollution and technical coefficients are necessary. The Water Quality Model is illustrated in Figure 1. Figure 1 shows that the point sources of pollution consist of industrial discharges as well as municipal treatment plants. The nonpoint sources can be divided into the rural and urban. The rural pollutants can best be described by separating out sediment originating from various rural land uses, nutrient from animal agricultural practices and nutrient runoff from cropland. These various sources are described in more detail in figures 2 through 4. Figure 5 consists of a map showing the USDA Crop Reporting Regions for the continental U.S. Note that some part or all of every region except the Pacific Region is included in the Gulf of Mexico drainage area.

Model Results

Data from the original 1982 base of the Model is shown in Table 1 for Total Phosphorus and in Table 2 for Total Kjeldahl Nitrogen, for nonurban nonpoint, urban nonpoint and point sources, and the total from all sources. The Pacific Region is included for comparison only.

Note the very wide differences between regions in both phosphorus and nitrogen loadings. In the Northeast (little of which is in the Gulf of Mexico drainage area, see Figure 6 on page 23) and the

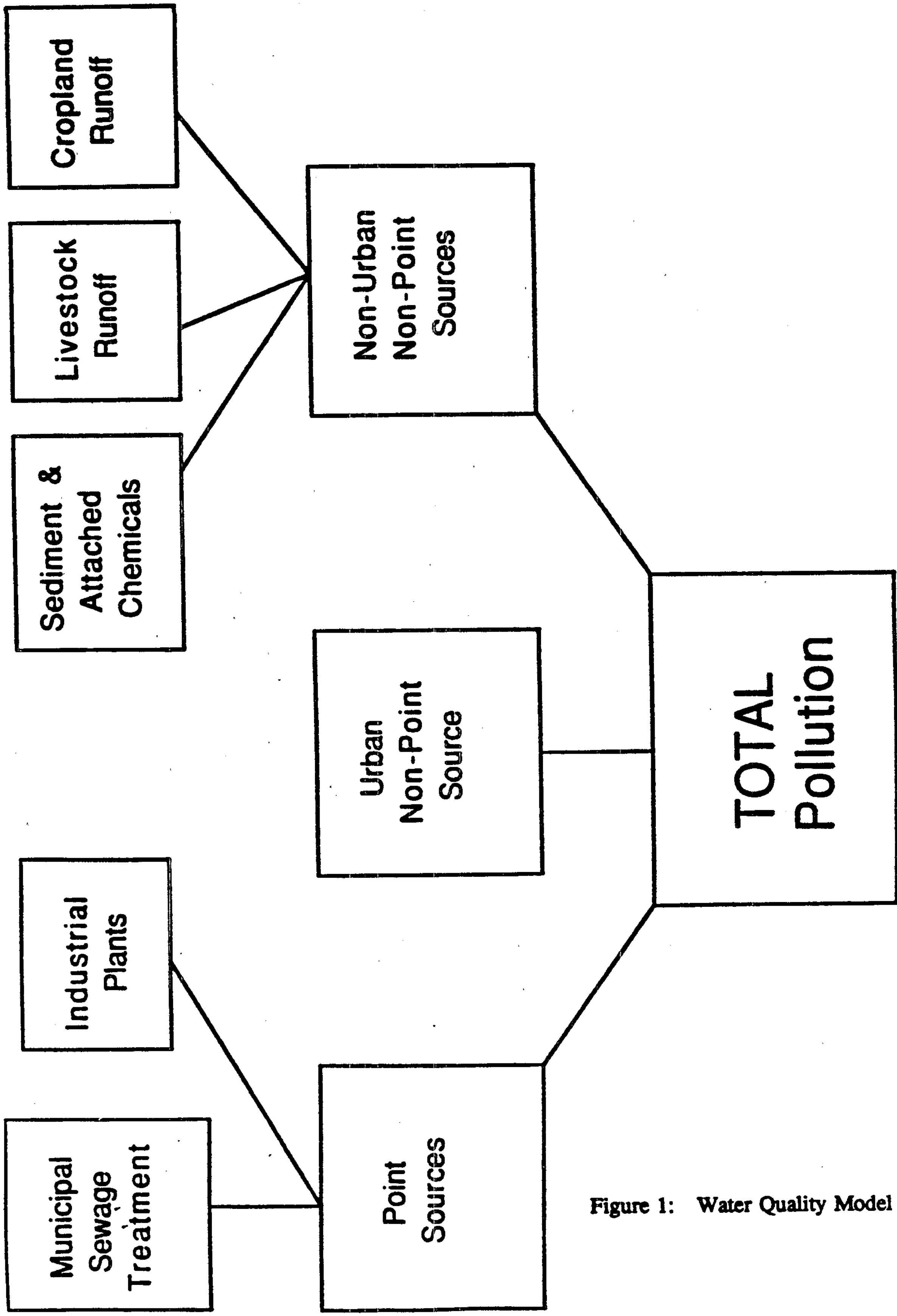

Figure 1: Water Quality Model Description

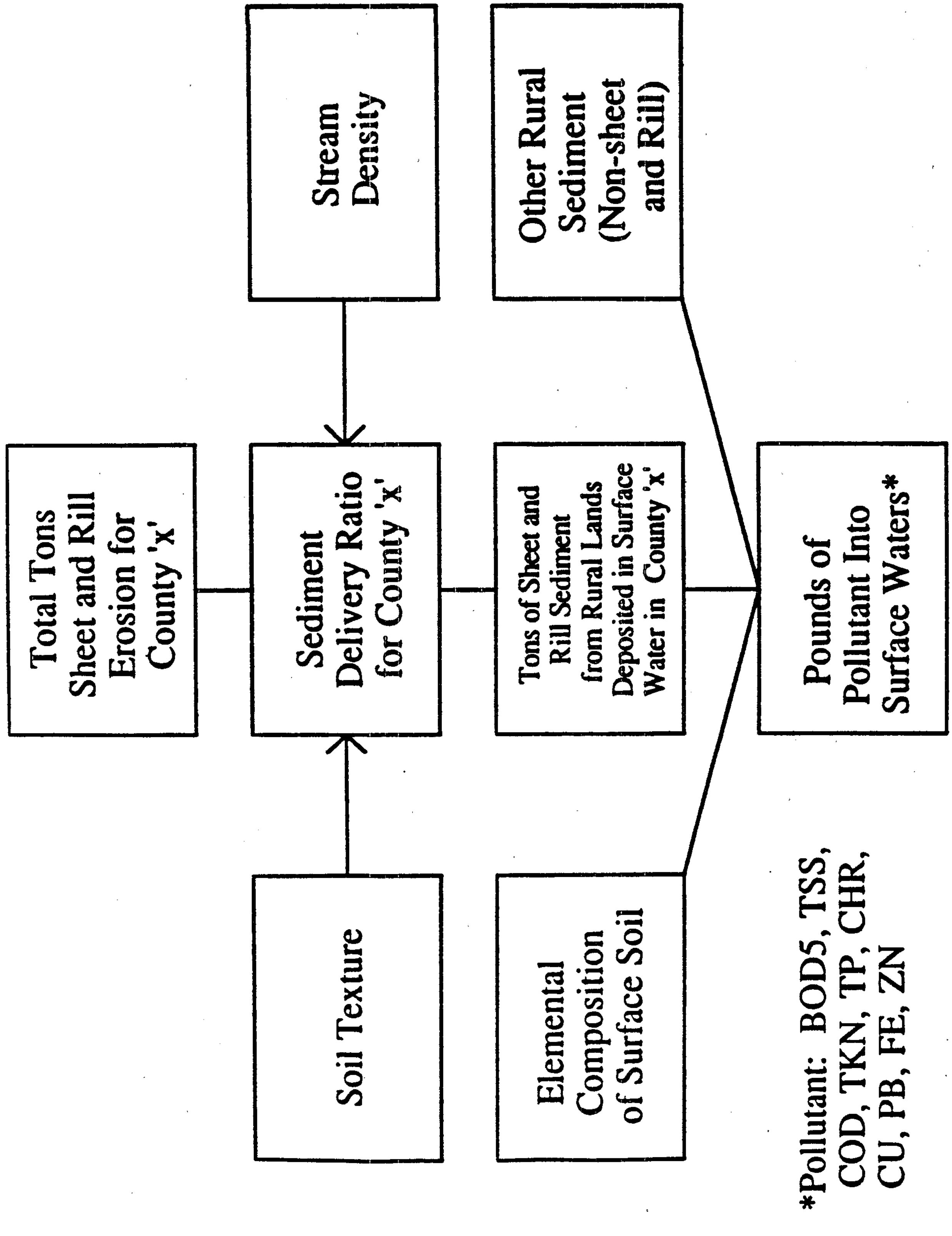

Figure 2: Sediment and Related Pollutants Models for Water Quality Model

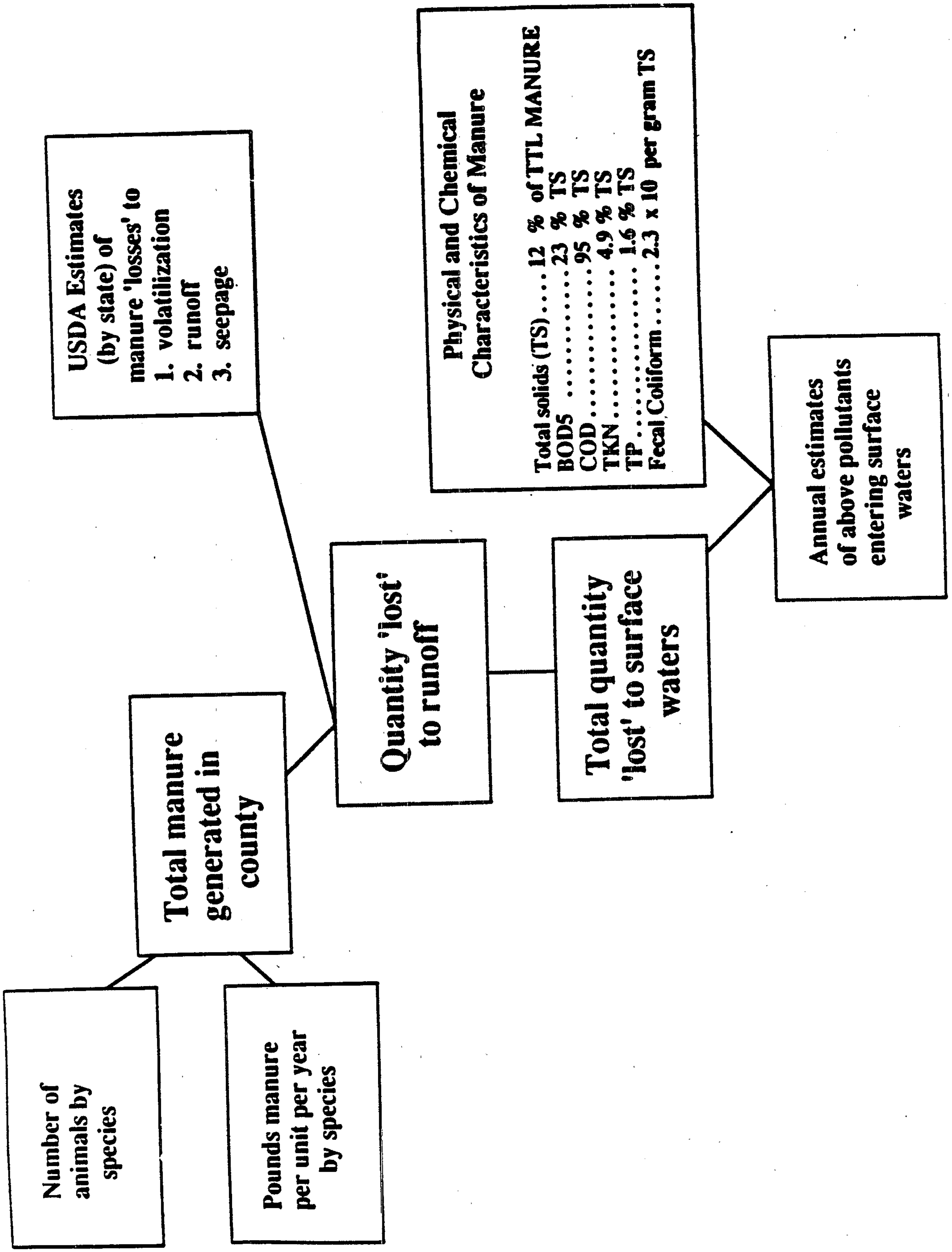

Figure 3: Livestock Runoff Models for Water Quality Model

(Cornell Nutrient Simulation Model)

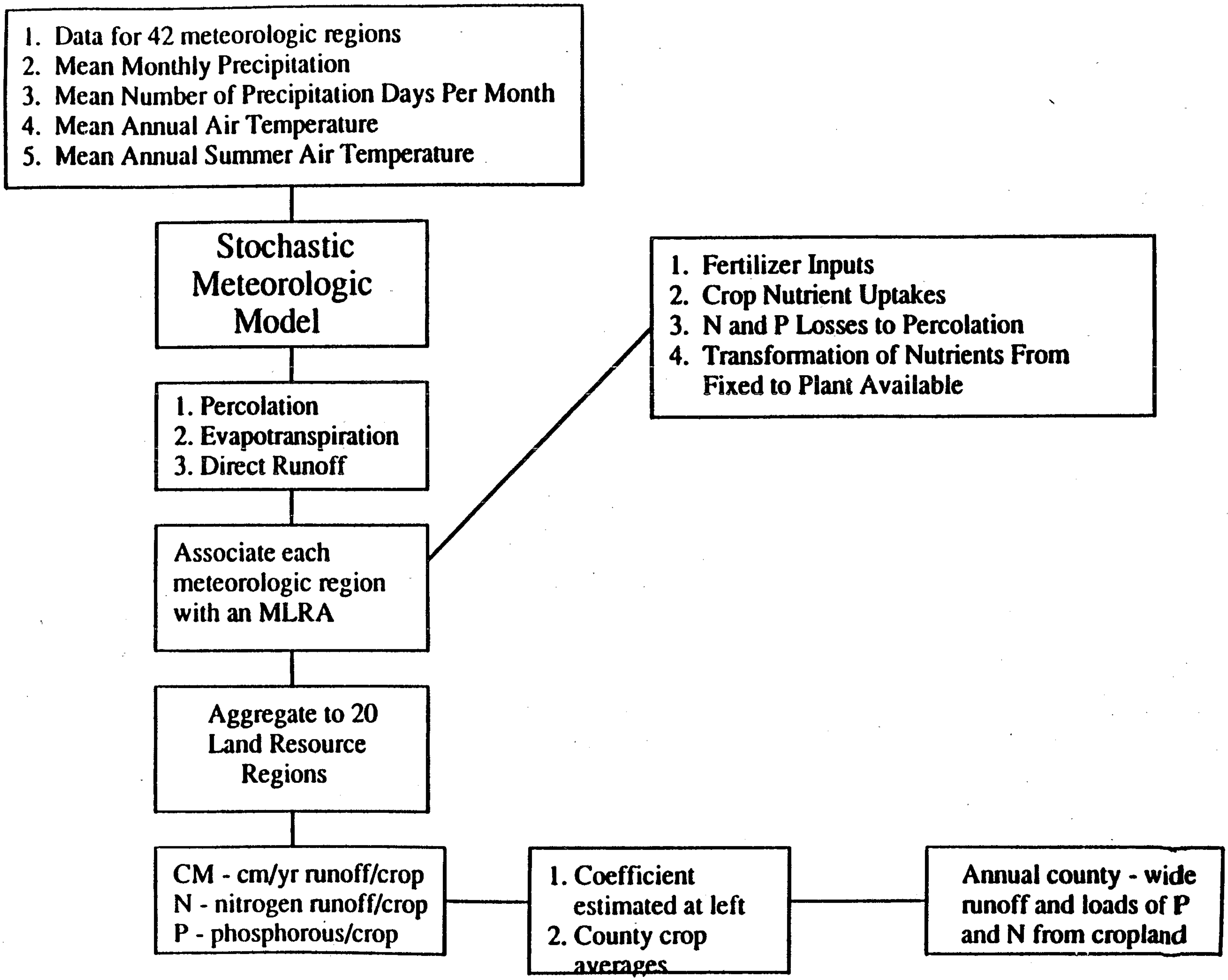

Figure 4: Cropland Nutrient Runoff Models for Water Quality Model

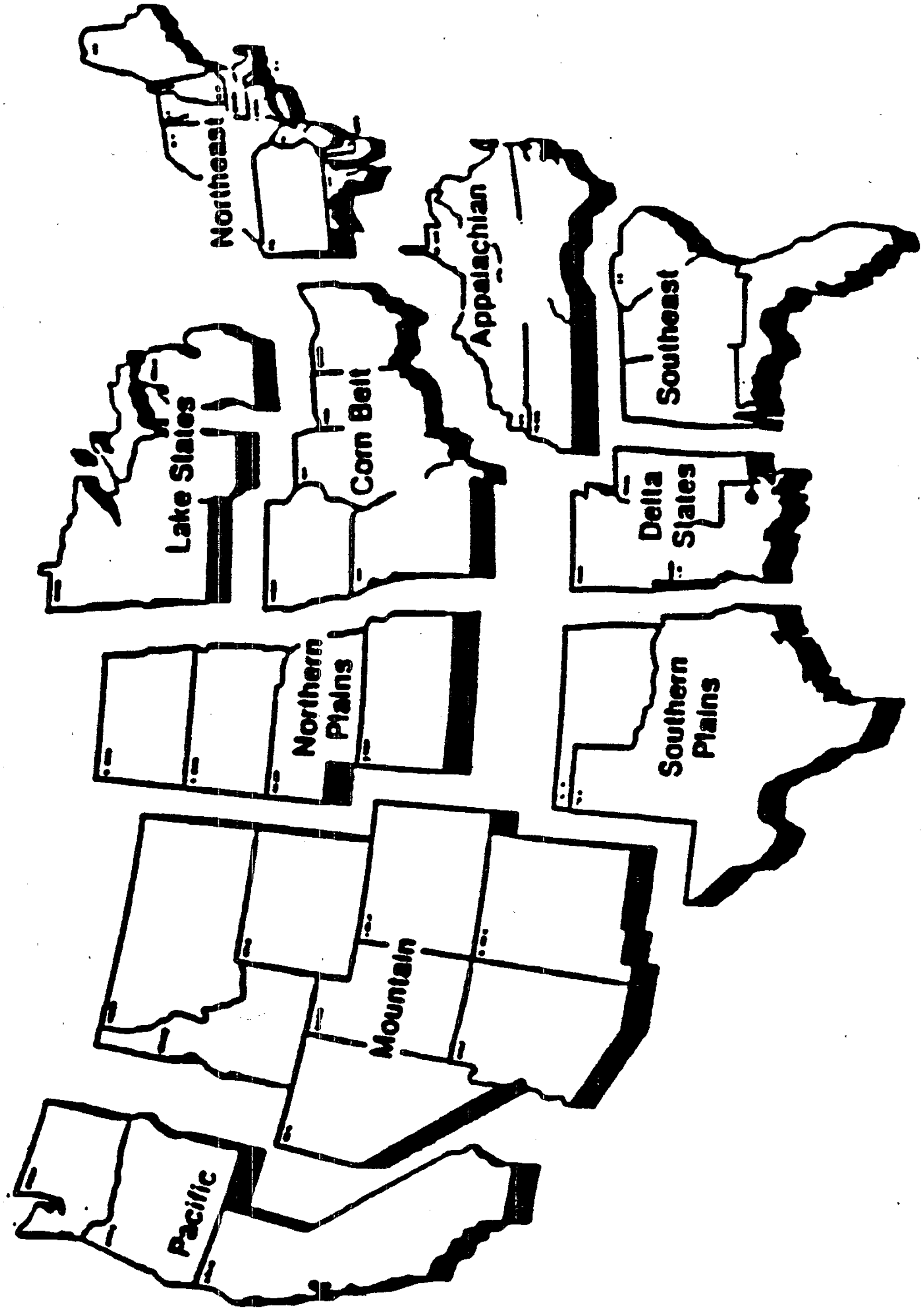

Figure 5: USDA Crop Reporting Regions

TABLE 1: 1982 Model Base: Nonurban Nonpoint, Urban Nonpoint, Point and Total Loadings: Total Phosphorus (TP)

All data: 1000 tons/year

Region	Nonurban Nonpoint TP	Urban Nonpoint TP	Point Source TP	Total: All Sources Phosphorus
Northeast	64.4	5.8	68.0	138.2
Appalachian	119.8	0.7	31.3	151.8
Southeast	22.3	0.9	23.9	47.2
Delta States	40.5	0.2	20.2	61.0
Cornbelt	306.0	2.1	39.8	348.0
Lake States	33.1	1.5	18.6	53.2
Northern Plains	183.7	0.1	6.6	190.4
Southern Plains	53.2	0.4	23.5	77.1
Mountain States	247.1	0.1	11.8	259.0
Pacific	356.8	0.7	39.6	397.2
Continental U.S.	1427.0	12.6	283.5	1723.0

TABLE 2: 1982 Model Base: Nonurban Nonpoint, Urban Nonpoint, Point and Total Loadings: Total Kjeldahl Nitrogen (TKN)

All data: 1000 tons/year

Region	Nonurban Nonpoint TKN	Urban Nonpoint TKN	Point Source TKN	Total: All Sources TKN
Northeast	256.5	21.5	339.0	617.0
Appalachian	563.2	4.3	118.5	686.0
Southeast	182.6	6.4	90.0	279.0
Delta States	202.0	2.1	80.6	284.7
Cornbelt	1848.7	8.3	216.5	2073.5
Lake States	334.1	5.1	123.8	463.0
Northern Plains	827.1	0.8	29.1	857.0
Southern Plains	353.8	3.9	104.0	461.6
Mountain States	844.4	0.6	40.0	885.1
Pacific	569.5	4.3	146.0	719.8
Continental U.S.	5981.8	57.2	1287.4	7326.5

Southeast (approximately half of whose waters flow to the Gulf) about half of all phosphorus is from point sources such as industries and municipal sewage plants. In the Northeast more than half of the Total Kjeldahl Nitrogen is from point sources. These data are in sharp contrast with many other regions, which receive most of their nutrients from nonpoint sources, primarily from agriculture. For example in the Northern Plains, nearly all draining to the Gulf, over 96% of both nitrogen and phosphorus comes from nonpoint sources. Agriculture is clearly a primary source of nutrients which eventually enter the Gulf of Mexico.

With the assistance of the Center for Agricultural and Rural Development at Iowa State University in providing us with estimates of changes in land use and changes in erosion, we were able to estimate the impacts of specific policies or programs upon water quality parameters (e.g. loadings of total phosphorus and TKN). The 1982 NRI was utilized as the baseline with the changes in cropping and erosion estimated for government policies by CARD. These results are then used to estimate an updated "base" for 1990, and the model is run for this 1990 base (Table 1, Appendix E).

One part of the solution to erosion and water quality problems which has already been implemented, is the Conservation Reserve Program (CRP) of the Food Security Act of 1985. Farmers are encouraged to set aside highly erodible cropland and to plant permanent vegetative cover on such land through a ten year contract, with USDA making annual "rental payments" on the land. Assuming that 40 million acres of agricultural land are enrolled in the Conservation Reserve Program in 1990 (34 million acres were enrolled by 1989), there has been a dramatic reduction in pollution in most regions of the United States since 1982.[4]

Over the past several years we have seen tremendous changes in the Conservation Reserve Program including dramatic changes in eligibility requirements. These changes have resulted in changes in the definition of highly erodible land as well as broadening of eligibility criteria to include filter strips,

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4 Lovejoy, S.B., J.J. Jones, B.B. Dunkelberg, J.J. Fletcher and P.J. Kuch. 1990. *"Water Quality and the Conservation Title."* In Implementing the Conservation Title of the Food Security Act of 1985, Ted L. Napier (editor): Soil and Water Conservation Society, Ankeny, Iowa, pp. 122-132.

cropped wetlands and other acres that are not highly erodible but are deemed worthy of protection for some other environmental amenity. We have accounted for these changes in the 1990 base.

Tables 3 and 4 show the percentage changes from the 1982 base in phosphorus and nitrogen loadings for the "90 base," along with the estimated loadings for all sources. Note that only changes from agricultural programs such as the Conservation Reserve Program are accounted for; changes for urban nonpoint sources and point sources are not estimated at this time. Again, the regional variations are noteworthy.

The Northeast (hardly relevant to Gulf studies) and the Southern Plains (all flowing to the Gulf) are estimated to have higher water pollution from nutrients in 1990 than in 1982, as more land is put into production and cropping patterns may change to require more fertilization. The Cornbelt (nearly all eventually draining into the Gulf) and Lake States (slightly over half draining to the Gulf) show very large decreases in nutrient pollution from croplands, which in turn lead to decreases of more than 30% in these pollutants from all sources in the Cornbelt, and more than 20% in the Lake States.

Policies which result in a reduction in nutrient pollution from agriculture, then, may have a large impact on some regions but lead to little or no reduction of nutrients in water systems in other areas. The discussion which follows summarizes the 1990 estimated concentrations for the major river systems flowing into the Gulf, from the Purdue Water Quality Model data.

Table 1, Appendix E: Purdue University Water Quality Model Summary For Gulf of Mexico Drainage Area

As a very general rule, the concentrations of nitrogen and phosphorus estimated in the Model's summary are slightly lower than the subregion summaries reported later from the STORET database. One possible explanation is that STORET data includes samples which were taken by an agency specifically because a problem was known to exist at or near a particular station; some of the STORET means, then, may overstate the degree of nitrogen or phosphorus pollution over an entire region or subregion. It should be noted again that the Water Quality Model's 1990 "base" is updated from 1982 only for agricultural changes in cropland and its erosion; no changes in point sources of pollution since 1982 are included.

TABLE 3:

Changes in Nonurban, Nonpoint & Total Phosphorus Loadings: 90 Base (40 Million Acre CRP)

	% Change From 1982 NRI Base			
Region	Cropland TP	Nonurban Nonpoint TP	All Sources: Change	Total Phosphorus Estimated Loadings[1]
Northeast	+28%	+15%	+7%	147.7
Appalachian	-23	-8	-6	142.8
Southeast	-31	-17	-8	43.4
Delta States	-19	-12	-8	56.0
Cornbelt	-45	-36	-32	236.5
Lake States	-43	-36	-22	41.4
Northern Plains	-13	-6	-6	178.5
Southern Plains	+15	+5	+3	79.6
Mountain States	-17	-3	-3	252.1
Pacific	-26	-3	-2	387.5
National Total	-29%	-12%	-10%	1558.1

[1] 1000 tons/year

TABLE 4: Changes in Cropland, Nonurban Nonpoint & Total Nitrogen (TKN) Loadings: 90 Base (40 Million Acre CRP)

Region	% Change From 1982 NRI Base			Total Nitrogen Estimated Loadings[1]
	Cropland TKN	Nonurban Nonpoint TKN	All Sources: Change	
Northeast	+28%	+14%	+6%	652.7
Appalachian	-23	-10	-8	632.5
Southeast	-31	-15	-10	251.1
Delta States	-19	-13	-9	257.7
Cornbelt	-45	-35	-32	1417.4
Lake States	-43	-33	-24	351.8
Northern Plains	-13	-7	-7	799.0
Southern Plains	+15	+5	+4	478.1
Mountain States	-17	-3	-3	860.6
Pacific	-26	-3	-3	700.5
National Total	-29%	-15%	-12%	6438.4

[1] 1000 tons/year

"River System 12" is comprised of the Kissimmee-Okeechobee-Caloosahatchie subsystem and the Peace (FL)-Tampa Bay subsystem. (See Appendix D for a list of the USGS subregions comprising each of the Model's River Systems.) Using an arbitrary standard of 0.2 mg/L for total phosphorus in surface waters (used throughout the remainder of this section), all of the river miles in the Gulf river systems of South Florida and the Peace River-Tampa Bay area of Florida, Subregions 0309 and 0310 respectively, are estimated to be above the limit in phosphorus pollution. Note that phosphate production does take place in some of these areas. See the summary for River System 12, Table 1, Appendix E. Using an arbitrary standard of 1.5 mg/L for TKN (also used for the remainder of this section), the percent of river system miles in these subregions with TKN above this standard decreases steadily through the seasons from 100% in winter to 42% in the fall.

River System 13 encompasses USGS Subregions 0311, 0312 and 0313: the Suwanee, Ochlockonee and Apalachicola systems. Using the 0.2 mg/L standard for phosphorus, the percent of river miles not meeting the standard increase steadily through the year from 12% in winter to 57% in the fall. A 1.5 mg/L standard for TKN appears easier to meet in these subregions: 7% of river miles are estimated to be above the limit in winter, increasing seasonally to 24% in the fall in these subregions. See summary for River System 13.

The Choctawhatchee-Escambia, Coosa-Alabama, Tombigbee-Mobile Bay, Pascagoula and Pearl River systems (USGS Subregions 0314-0318) comprise the Water Quality Model's River System 14. A large seasonal change in meeting the phosphorus standard is found, with 2% and 4% of river miles exceeding the standard in winter and spring, respectively, but 42% and 44% in the summer and fall, respectively. The TKN standard is estimated to be met by all miles of these rivers in the winter, but 13% of river miles in Subregions 0314-0318 do not meet the TKN standard by the fall season. See summary for River System 14. Note that diversion of some water from the Tennessee River system to the Tombigbee after 1982 is not accounted for in the Model.

The Model's "River System 18" includes most of Appendix E, Table 1's data: The entire Mississippi River system. All of USGS Regions 05, 06, 07, 08, 10, and 11 (the Ohio, Tennessee, Upper

Mississippi, Lower Mississippi, Missouri and Arkansas-White-Red Regions) are part of the Mississippi system. For the whole Mississippi system stretching from western New York State and Pennsylvania to western Montana to Louisiana, the 0.2 mg/L total phosphorus standard is not met in 32% of all river miles in winter, 19% in spring, 24% in summer and 27% in fall. The 1.5 mg/L TKN standard is by our estimation not met for 23% of all river miles in winter, 13% in spring, 16% in summer and 18% in the fall season. See summary for River System 18.

A further perusal of the 1990 estimated concentrations for the nodes in the Mississippi system ("River System 18" in Appendix E) indicates tendencies similar to the 1989 data from STORET. The Upper Mississippi generally shows slightly higher concentrations of phosphorus (TP) and TKN than the Lower Mississippi. Some of the largest groups of nodes with very high estimated concentrations are in the Missouri and Arkansas-White-Red systems, especially in a wide range of their middle reaches. Compared to average concentrations for the entire Gulf drainage area, the Ohio system shows generally lower concentrations, especially for TP; and the Tennessee system's estimated concentrations are generally lower than average for both TP and TKN. These results are generally consistent with data from the EPA STORET data base, discussed later in this paper.

Four of the eastern subregions of the USGS Texas Gulf Region comprise the Water Quality Model's "River System 19". These are the Sabine, Neches, Trinity and Galveston Bay-San Jacinto Subregions (1201-1204). In this combination of rivers it is estimated that 39% of the river miles do not meet the 0.2 mg/L standard for phosphorus in winter, but in summer 100% of the river miles are above that limit. In summer many of these miles may be nearly dry, increasing the concentrations of phosphorus from previous runoff or from point sources. The percent of river miles failing to meet a 1.5 mg/L standard for TKN is 17% in winter rising to 74% in summer, possibly for the same reason. See "Summary for River System 19."

The Model's "River System 20" consists of the seven western subregions of USGS Region 12. Included are all three Brazos River Subregions, both Colorado River of Texas Subregions including the San Bernard Coastal area, the Central Texas Coastal and Nueces-Southwestern Texas Coastal Subregions

(1205-1211). The Guadalupe and San Antonio Rivers and Corpus Christi Bay are also part of this system. There is less seasonal variation in mid- to western Texas: 24% of river miles are estimated to exceed the 0.2 mg/L standard for phosphorus in winter, rising to 41% in the fall. 20% of river miles in this area are estimated to fail a 1.5 mg/L standard for TKN in spring (21% in winter) with the highest percent of river miles exceeding the standard at only 29% in the fall season. See "Summary for River System 20."

The Rio Grande system, USGS Region 13, is the Model's River System 21. While some high individual concentrations are estimated, notably in the Pecos River and at a few Rio Grande nodes, only 13% of river miles are estimated to exceed the 0.2 mg/L phosphorus standard in the summer. In this system the winter months are estimated to have the most phosphorus, with 46% of river miles failing to meet the standard. (This does not appear to be consistent with 1989 STORET data, but means are not necessarily consistent with miles meeting a particular standard, and 1989 data during a drought in that region may not be consistent with a 1990 estimation based on "average" years.) The TKN proposed standard of 1.5 mg/L is exceeded by only 4% of river miles in the summer, rising to 42% in winter. See "Summary for River System 21."

Summary of Water Quality Model Estimates

The Water Quality Model's estimations of total phosphorus (TP) concentrations for 1990 show that nearly every major river system or group of smaller rivers would have at least one season of the year in which at least 40% of its river miles exceed a 0.2 mg/L standard. The exception is the huge Mississippi system, whose estimates of percent of river miles exceeding this standard range from 19% in the spring to 32% in the winter season. The rivers and lakes of the western Florida peninsula (River System 12) show the highest percentages, with 100% of their river miles exceeding the 0.2 mg/L standard in all seasons.

With regard to Total Kjeldahl Nitrogen (TKN), all river systems have lower estimates of the percent of river miles exceeding a 1.5 mg/L standard for TKN in most seasons. The Florida peninsula again is estimated to have a large percentage of river miles exceeding the standard, ranging from 24% of river miles in summer to 100% in winter. The Gulf of Mexico rivers in Mississippi and Alabama (River System 14), on the other hand, are estimated to have few miles above the 1.5 mg/L standard, ranging from 0% in winter to only a 13% maximum in fall. The other river systems (except the eastern Texas Gulf rivers which have higher percentages), have much lower percentages of river miles exceeding the TKN standard, less than 50% in their highest-percentage season. The Mississippi system's percent of river miles not meeting the standard ranges from 13% in spring to 23% in winter.

STORET Data: Quantities of Nitrogen and Phosphorus at Monitoring Stations

The Environmental Protection Agency's STORET database and computerized management information system provides thorough and timely water quality data for the U.S. It includes data which is comparable to that in the Water Quality Model. With nearly 200 million parametric observations from more than 700,000 monitoring sites, sampled primarily over the last twenty years, it includes data from the U.S. Geological Society, EPA, state public health and environmental agencies, U.S. Forest Service, TVA, Army Corps of Engineers, and other interstate agencies. STORET includes data on many metals and nutrients, including several different measures of phosphorus and nitrogen, some of which are measured in only one or a few small surface water systems. We used only that data which is from an actual sample, and is not "retired," i.e. a specific person at the reporting agency will vouch for its accuracy at the time of the sample.

The most recent time period for which there is currently and consistently sufficient data to analyze in STORET is the year 1989, which is analyzed by calendar quarters, closely equivalent to our seasons. The terms "quarterly" and "seasonal" are used interchangeably in this report. Table 5 on pages 26-27, Table 6 on pages 30-31, Table 7 on pages 36-37 and Tables A1-A10, B1-B10 and C1-C10 in Appendices A, B and C represent summaries of the 1989 quarterly data for nitrogen and phosphorus by region and subregion for USGS Water Resource Regions 05, 06, 07, 08, 10, 11, 12, 13, and part of 03, whose waters eventually flow into the Gulf of Mexico. See Figure 6, which consists of a continental U.S. map of USGS Water Resource Regions.

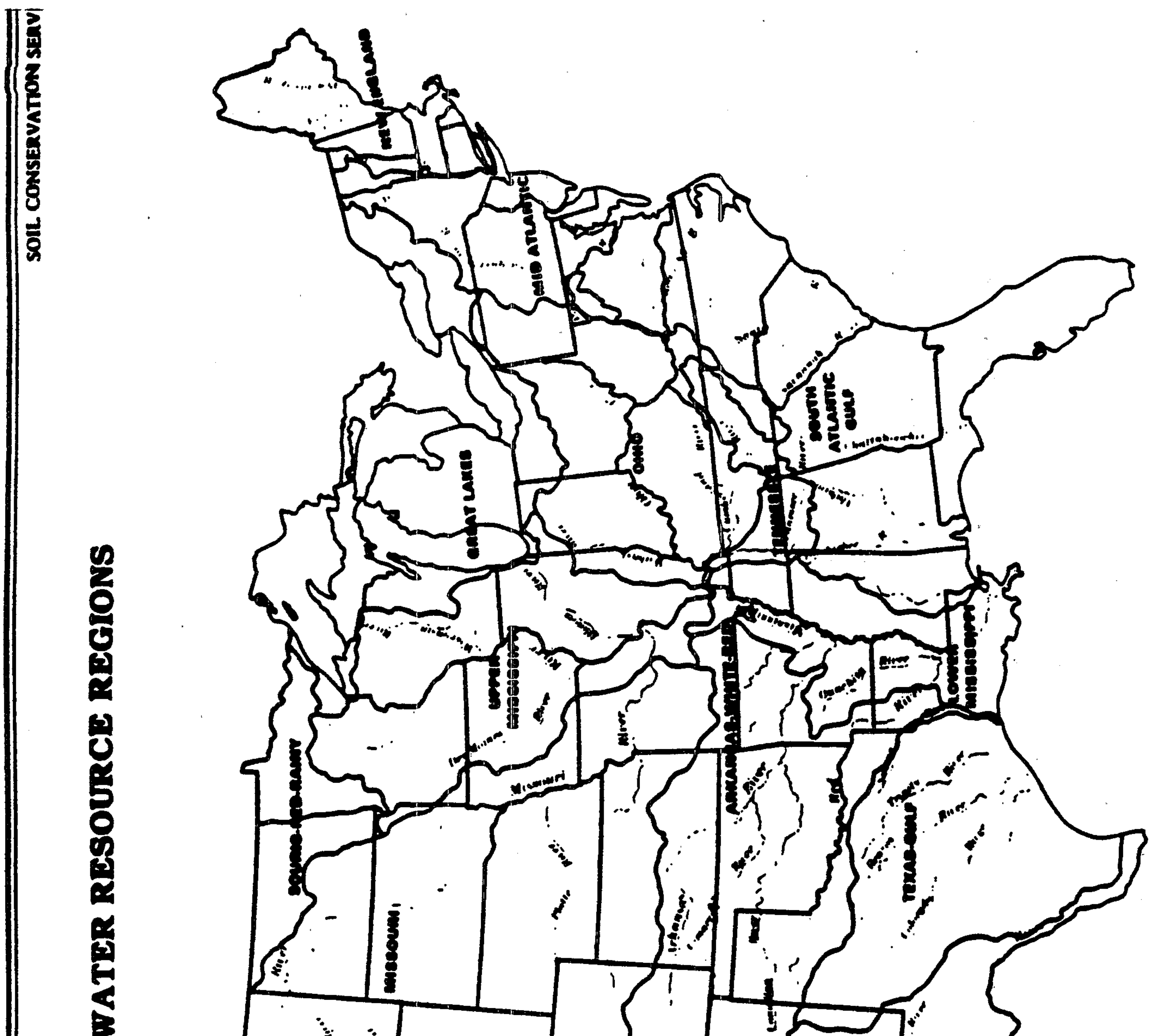

Figure 6: Continental U.S. Map of USGS Water Resource Regions.

1989 STORET Data for Gulf of Mexico Drainage Area

Concentration

One of the more surprising observations about the 1989 STORET data on nitrogen and phosphorus concentrations is the lack of any consistent seasonal trend, either among the Water Resource Regions or in the subregions of most regions. Nonpoint sources of nutrients such as agricultural cropland runoff and even urban runoff from streets and large construction projects would be expected to be seasonal, with more fertilizer applied in the spring as an example. It is possible that point sources of pollution from industrial and municipal plants still have the most influence on overall nitrogen and particularly phosphorus pollution, at least in many smaller areas and even groups of subregions. Further analysis of seasonal trends (or lack thereof) is recommended.

A second finding is that samples in surface waters do not show increasing concentrations as the river system flows downstream in several regions, and in most seasons. In some regions such as the Missouri River system (Region 10) and the Lower Mississippi River (Region 08) there is a slight increase in phosphorus or nitrogen when traveling downstream along some reaches, but it is not consistent throughout the system. In no region does the most downstream subregion report the highest concentrations of nitrogen and phosphorus in the region in even two seasons.

The Lower Mississippi Region (08) reports lower nutrient concentrations than most of its constituent parts. It shows generally consistently lower nutrient pollution than the Upper Mississippi (Region 07), the Missouri (Region 10) and the Arkansas-White-Red Rivers (Region 11). The degradation of both nitrogen and phosphorus as they are transported downstream could provide an explanation of this. At least in some seasons, sediment-attached phosphorus, and nitrogen to a lesser degree, may have settled to the riverbed as it flows downstream. And, the large water volume with input from cleaner tributaries, and wide surface of the lower Mississippi River itself with higher plant growth, may be factors in decreasing nutrient concentrations.

An interesting regional comparison is found among the Ohio River system (Region 05), the

Tennessee system (Region 06), and the Lower Mississippi (Region 08). The Lower Mississippi has slightly higher concentrations of Total Kjeldahl Nitrogen (TKN) than the Ohio Region in all four seasons; compared to the Tennessee Region which flows into the Ohio just before they reach the Mississippi, the Lower Mississippi shows approximately double the concentrations of TKN in all seasons, with even more difference in the fall. For phosphorus, however, the situation is generally reversed: the Lower Mississippi has lower concentrations than the Ohio in winter, summer and fall and is lower in phosphorus than the Tennessee in winter and fall. The higher concentration downstream only in the spring (or spring and summer, for the Tennessee tributary system) appears reasonable: phosphorus attached to sediment may be deposited soon after entering upstream waters in the summer, fall and winter in the Ohio, then picked up and taken downstream to the Lower Mississippi during spring storms. For the Tennessee, the timing of storms and transport time may extend the time for nutrients to reach the Lower Mississippi.

The Southeast and Texas Gulf Regions (03 and 12, respectively) are more difficult to analyze in terms of upstream-downstream trends. Neither of these regions, nor the Rio Grande system (Region 13) reports a consistent seasonal or downstream trend, though many subregions in Regions 03 and 12 consist of one smaller river system. The lack of trends may be the most important finding of this part of the study.

Brief Interpretation of Table 5 - The Gulf of Mexico Drainage Area: Regional Comparison of Ambient and Some Nonambient Concentrations*

The geographic area covered by the Gulf of Mexico drainage area extends approximately from the Appalachians to the Rockies. South of the Appalachians, many rivers from Florida and Georgia also flow west or southwest into the Gulf. In the northern states, the Great Lakes system (USGS Region 04) and the Souris-Red-Rainy area of northern Minnesota and North Dakota (Region 05) eventually flow north to Canada and are not part of the Gulf systems. The data is presented quarterly for the year 1989, the most recent time period with complete data. Means are weighted by the number of observations in each

* Nonambient samples are drawn directly downstream from a pollution source while ambient samples should not be influenced by a particular source.

Table 5

USGS Region Summaries: Mean Nitrogen and Phosphorus Concentrations by Region

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
03	TP[2]	.336 (756)	.306 (713)	.222 (607)	.176 (420)
Southeast (Gulf	TKN	1.111 (625)	1.301 (699)	1.138 (641)	.745 (366)
of Mexico River	OrgN	.808 (214)	.888 (197)	.982 (177)	.780 (112)
Systems Only)	TOTN	1.062 (98)	1.311 (46)	*	*
05	TP	.290 (847)	.135 (1395)	.255 (2074)	.331 (896)
Ohio River	TKN	.674 (582)	.618 (1259)	.682 (1847)	.706 (645)
System	OrgN	*	*	*	*
06	TP	.451 (130)	.130 (385)	.081 (572)	.250 (54)
Tennessee	TKN	.450 (72)	.471 (146)	.421 (136)	.282 (94)
	OrgN	1.690 (44)	.325 (302)	.239 (490)	1.268 (5)
07	TP	.414 (1168)	.347 (2575)	.484 (3089)	.444 (1022)
Upper Miss	TKN	1.771 (551)	1.429 (1347)	1.623 (1421)	1.105 (588)
	OrgN	1.033 (53)	1.576 (194)	1.413 (235)	.638 (46)
08	TP	.196 (1016)	.187 (1014)	.188 (988)	.182 (626)
Lower Miss	TKN	.856 (681)	.901 (699)	.850 (637)	.763 (531)
	OrgN	*	*	*	*
10	TP	1.665 (955)	.358 (1359)	1.697 (1600)	.407 (587)
Missouri River	TKN	1.929 (434)	1.398 (642)	5.328 (881)	1.526 (201)
System	OrgN	.889 (9)	*	*	*
11	TP	.728 (911)	.631 (1064)	.535 (1205)	1.305 (520)
Arkansas -	TKN	3.256 (553)	2.391 (589)	1.889 (654)	3.505 (343)
Red - White	OrgN	5.335 (134)	2.817 (197)	3.118 (120)	4.235 (120)
River System	TOTN	8.244 (242)	6.261 (223)	3.345 (203)	8.815 (144)
12	TP	.730 (572)	.279 (453)	.436 (391)	.755 (148)
Texas Gulf	TKN	1.003 (403)	.747 (358)	.911 (438)	.809 (148)
	OrgN	*	*	*	*

Table 5 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
13	TP[2]	.158 (88)	.288 (188)	.557 (101)	.337 (29)
Rio Grande	TKN	.678 (61)	1.231 (183)	1.185 (99)	.672 (29)
System	OrgN	.240 (21)	.630 (150)	.418 (57)	.328 (6)
	TOTN	1.656 (17)	1.695 (140)	2.022 (57)	.513 (6)
Entire U.S.	TP	.609 (6443)	.315 (9146)	.562 (10627)	.463 (4302)
Gulf of Mexico	TKN	1.454 (3962)	1.201 (5922)	1.679 (6754)	1.174 (2945)
Drainage	OrgN	2.169 (475)	1.181 (1040)	.946 (1079)	2.191 (289)

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring: April 1 - June 30
Summer: July 1 - September 30
Fall: October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen
TOTN = Total Nitrogen

quarter, for each region or subregion. As expected, nutrient concentrations are highly variable among the regions; however, no consistent seasonal trends appear.

Total Kjeldahl Nitrogen is measured by the Kjeldahl method, one most commonly used for converting combined forms of nitrogen to ammonia. The majority of nitrogen compounds are amenable to the Kjeldahl method, except such ring structures as pyrazolones, diazines and triazoles (H.D. Drew, "Determination of Total Nitrogen"). Organic nitrogen is generally those compounds which are degraded from nitrogen-containing living organisms including urea, uric acid, amino acids and others; it may include some ammonia, but excludes such compounds as nitrites and nitrates.

The <u>mean</u> for total phosphorus varied from a low of .081 milligrams per liter (mg/L) in the summer, in the Tennessee River Region, to a high of 1.697 mg/L in summer in the Missouri River system. Total Kjeldahl Nitrogen (TKN) regional means ranged from .282 mg/L in the fall season in the Tennessee system, to 5.328 in the summer in the Missouri Region. Organic nitrogen means were found as low as .24 mg/L in both the Tennessee Region in the summer and the Rio Grande Region in the winter. The high mean for organic nitrogen was 5.335 mg/L in winter in the Arkansas-White-Red tributary system of the Mississippi River*.

It should be noted that not all regions measure organic nitrogen, and in many regions both TKN and organic nitrogen are not measured in all subregions. Attention should also be called to the fact that some regional and subregional means may be influenced by one or a few extremely high readings from individual samples, as will be noted in the descriptions of each region's data.

<u>Brief Interpretation of Table 6 - The Gulf of Mexico Drainage Area</u>: Regional Comparison of Ambient Concentrations Only

When data samples are strictly limited to ambient data only, mean seasonal concentrations change very little in many USGS regions. A few regions, however, show large decreases in nutrient concentrations or some individual quarterly means which are much lower than the corresponding means

* Measurements of total nitrogen are made in too few regions to provide a basis for comparison, though the means are shown in the tables for those regions in which some subregions reported it.

in Table 5. Region 03 (partial Southeast Region) means are generally very slightly lower for total phosphorus and Total Kjeldahl Nitrogen, while organic nitrogen means, where data are available, are identical. In regions 05, 07, 08 and 10 the seasonal means generally show small decreases when compared with Table 5, with some nitrogen means showing no change. Ambient data excludes any data collected at waterway points such as those near industrial or municipal outlet pipes.

In the Tennessee River system (Region 06), the winter means for phosphorus and organic nitrogen and the fall mean for organic nitrogen, are much lower than those which included some non-ambient sampling. All seasonal TKN means in the Tennessee area are identical to those in Table 5, and all other means are slightly lower than those which included some nonambient data. All Region 11 (Arkansas-Red-White) seasonal means are much lower when all nonambient data are excluded; this region's waters still have somewhat higher concentrations of nutrients than those of several other regions, but these differences are much smaller. In Region 12, the Texas Gulf Region, all quarterly means are identical to those in the previous table; in other words, no nonambient samples were included before. The Rio Grande system's data show large decreases from those in Table 5 in all spring and summer means, with fall means showing no change and winter means slightly lower for phosphorus and TKN and much lower for organic nitrogen.

Across the Gulf of Mexico drainage area, ambient mean concentrations for total phosphorus ranged from .070 mg/L in the Tennessee River system in the summer, to 1.641 mg/L in the Missouri River system, again in the summer. Regional TKN means varied from a low of .282 mg/L in the fall in the Tennessee Region, to 4.853 mg/L in the Missouri Region in summer. The lowest organic nitrogen mean was .155 in winter in the Rio Grande Region; the highest was 1.576 mg/L in the Upper Mississippi system in the spring. Again, we must point out that organic nitrogen measurements were not reported in some entire regions.

It is interesting to compare annual average ambient concentrations of the two most widely reported nutrients, computed as an arithmetic average of the four seasonal means. (These averages are not shown in the table.) The Tennessee Region still appears to have the lowest concentrations, with annual average phosphorus of .128 mg/L and TKN of .406 mg/L. The Lower Mississippi Region is not far behind in

Table 6

USGS Region Summaries: Mean Ambient Nitrogen and Phosphorus Concentrations by Region

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
03	TP[2]	.337 (766)	.305 (713)	.219 (615)	.180 (427)
Southeast (Gulf	TKN	1.106 (630)	1.298 (704)	1.131 (641)	.739 (371)
of Mexico River	OrgN	.808 (214)	.888 (197)	.982 (177)	.780 (112)
Systems Only)	TOTN	1.062 (98)	1.311 (46)	*	*
05	TP	.268 (845)	.130 (1404)	.206 (2068)	.309 (916)
Ohio River	TKN	.599 (585)	.549 (1278)	.649 (1843)	.697 (670)
System	OrgN	*	*	*	*
06	TP	.187 (113)	.084 (381)	.070 (569)	.172 (85)
Tennessee	TKN	.450 (72)	.471 (146)	.421 (136)	.282 (94)
	OrgN	.385 (33)	.260 (298)	.228 (488)	.380 (12)
07	TP	.396 (1160)	.286 (2566)	.350 (3074)	.394 (1012)
Upper Miss	TKN	1.758 (549)	1.419 (1344)	1.587 (1408)	1.104 (591)
	OrgN	1.033 (53)	1.576 (194)	1.418 (234)	.638 (46)
08	TP	.196 (1016)	.187 (1014)	.186 (1021)	.179 (714)
Lower Miss	TKN	.856 (681)	.901 (699)	.828 (669)	.711 (606)
	OrgN	*	*	*	*
10	TP	1.630 (953)	.335 (1346)	1.641 (1569)	.418 (562)
Missouri River	TKN	1.929 (434)	1.341 (635)	4.853 (856)	1.526 (201)
System	OrgN	.543 (7)	*	*	*
11	TP	.301 (794)	.274 (964)	.429 (1153)	.526 (423)
Arkansas -	TKN	1.129 (435)	1.007 (499)	1.296 (619)	1.433 (248)
Red - White	OrgN	.486 (20)	.464 (112)	1.342 (89)	.496 (32)
River System	TOTN	2.016 (124)	1.031 (132)	1.434 (176)	1.597 (49)
12	TP	.730 (572)	.279 (453)	.436 (391)	.755 (148)
Texas Gulf	TKN	1.003 (403)	.747 (358)	.911 (438)	.809 (148)
	OrgN	*	*	*	*

Table 6 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
13	TP[2]	.154 (86)	.126 (180)	.259 (92)	.337 (29)
Rio Grande	TKN	.580 (59)	.553 (175)	.783 (90)	.672 (29)
System	OrgN	.155 (19)	.294 (142)	.305 (48)	.328 (6)
	TOTN	.637 (15)	.687 (132)	.644 (48)	.513 (6)

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen
TOTN = Total Nitrogen

phosphorus with an annual average of .187 mg/L, and most regions' annual average phosphorus is below .5 mg/L. The highest annual average phosphorus mean is clearly in the Missouri Region, at 1.006 mg/L; the second highest is far lower, at .550 in the Texas Gulf Region. For Total Kjeldahl Nitrogen the next lowest annual average concentrations are .624 mg/L in the Ohio Region and .647 mg/L in the Rio Grande Region. The highest annual average TKN concentrations are 2.412 mg/L, again in the Missouri system, and 1.556 mg/L in the Upper Mississippi system. As expected, annual averages have somewhat less variation than seasonal means though concentrations measured in the Missouri system are still at least six times as high as those in the Tennessee Region.

We have seen the areas of the Gulf of Mexico drainage basin which have higher or lower concentrations of nutrients in their waterways. This information is important for determining regions or smaller subregions (see Appendices A and B), perhaps far upstream of the Gulf itself, which merit closer scrutiny. The specific causes of high concentrations will eventually need to be located; these are the places most likely to be able to be "cleaned up" to reduce nutrient pollution in waterways flowing into the Gulf. Those areas with very low concentrations may be close to "background levels" or naturally occurring levels of nitrogen and phosphorus, where further reductions in nutrients will be difficult to achieve.

While concentrations of a pollutant indicate the water quality in a specific region relative to other regions, they do not account for different quantities of water and pollutants which are transported to downstream regions and ultimately to the Gulf of Mexico. To discover how <u>much</u> nitrogen or phosphorus actually flows into the Gulf of Mexico from the many waterways feeding into it, we now turn to the data from Table 7 on nutrient loadings, which account for not only the nutrient concentrations but the amount of water flowing downstream.

<u>**Loadings**</u>

These loadings were calculated from STORET data showing the average record concentration and average record flow rates for each hydrolized unit. However, the flow and concentration parameters often came from different samples. There were relatively few STORET data points containing both flow and concentration values. While this would certainly raise questions about the loading estimates, the purpose of this analysis is not to furnish point estimates, but rather to compare regions relative to each other.

Table 7 - The Gulf of Mexico Drainage Area: Regional Comparison of Ambient Nutrient Loadings

When we analyze data on loadings of specific nutrients we see a somewhat different picture from that which appeared in the analysis of concentrations. There is still considerable variation between regions and in some cases, among the subregions of a given region (see Appendix C). However, those regions and subregions which had the higher concentrations in the previous discussions do not necessarily contribute the largest loadings or actual amounts of nutrients to the waterways flowing into the Gulf of Mexico.

Among all of the USGS regions whose waters eventually flow into the Gulf, the highest mean loadings of total phosphorus in 1989 are found in the Ohio River system (Region 05): mean phosphorus loadings of 84856 pounds per day (lbs/day) in the winter season. The next highest seasonal means are 50621 lbs/day in spring, again in the Ohio Region, and 41987 lbs/day in the fall in the Lower Mississippi Region. The lowest quarterly mean phosphorus loadings come from the Rio Grande system (Region 13): 176 lbs/day in the fall season. The next lowest phosphorus means are 229 lbs/day in spring, again in the Rio Grande, and 237 lbs/day in the spring in the Tennessee River system, Region 06.

We must note that the Missouri River system (Region 10) and the Arkansas-Red-White system (Region 11), which generally had some of the highest <u>concentrations</u> of phosphorus, have relatively low <u>loadings</u> of the same nutrient once the flow of water is taken into account. An annual arithmetic average of the seasonal phosphorus means in the Missouri system is only 1436 lbs/day, and that for the Arkansas-Red-White system is 4007 lbs/day. Their contribution to loadings in the Lower Mississippi and the Gulf is quite small; see the later discussion of the Mississippi system. The Tennessee system (Region 06) still does average very small amounts of loadings in most seasons (note the very small number of samples in the fall season throughout the entire region). And even the Upper Mississippi and its tributaries (Region 07) average relatively small actual amounts of phosphorus heading to the lower Mississippi River and the

Gulf of Mexico. The Southeast (Region 03) waterways flowing into the Gulf, and the Texas Gulf river systems (Region 12), also have relatively small mean daily loadings of phosphorus.

Regarding Total Kjeldahl Nitrogen (TKN), the mean seasonal loadings for entire regions in 1989 ranged from a low of 627 lbs/day in the fall in the Rio Grande (Region 13) to a high of 904,023 lbs/day in the winter in the Lower Mississippi (Region 08). Other very low seasonal means are 756 lbs/day in the summer in the Tennessee River system (Region 06) and 902 lbs/day in the fall in the Texas Gulf Region. Additional very high mean loadings of TKN are 329,792 lbs/day in the spring, again in theLower Mississippi region, and 153,703 lbs/day and 152,129 lbs/day in winter and spring, respectively, both in the Ohio River system (Region 05).

Organic nitrogen loadings are measured in relatively few regions and seasons, particularly when one considers the low number of samples, (shown in parentheses in Table 7), included in many of the means. The highest seasonal "mean" of 67,798 lbs/day is based on only one measurement, in the fall in the Tennessee River system (Region 06). The lowest seasonal mean of .5 lbs/day is for only four measurements, in the fall in the Southeast (Region 03) rivers flowing to the Gulf of Mexico.

The loading measurements detailed above in Table 7 are means for entire USGS regions, useful for determining the broad areas producing higher amounts of nutrient pollution. Appendix C details the variations among subregions within these regions, from which one can point to more specific areas of concern. To see how much phosphorus and nitrogen are actually entering the Gulf of Mexico, however, we must turn to the "Lowest Subregions" analysis in Table 8 and Table 9. These are the subregions which actually border on the Gulf, and whose nutrients are presumably being input into the Gulf during the same season of record or very soon thereafter. The "Lowest Subregions" were chosen because, as much as one would be interested in further study of the most downstream Accounting Unit or Catalog Unit, there simply is not a consistent amount of data available for these smaller units across four seasons. Subregions are the smallest units for which data for all seasons in nearly every subregion exists. Total phosphorus and Total Kjeldahl Nitrogen loadings data are analyzed. The apparent difference between Table 7 and Table 8 result from Table 7 utilizing all samples within a hydrologic region whereas Table 8 reports data only from the lowest sampling point. There are also differences in the number of samples. Some points in Table 8 have very few samples.

Table 7

USGS Region Summaries: Mean Ambient Phosphorus and Nitrogen Loadings by Region

1989: All data in lbs/day

Region	Nutrient	Winter	Spring	Summer	Fall[1]
03 Southeast (Gulf of Mexico River Systems Only)	TP[2]	4315 (180)	2295 (170)	1364 (169)	1538 (111)
	TKN	13197 (90)	11345 (100)	3983 (92)	5829 (28)
	OrgN	*	8 (14)	6 (22)	.5 (4)
05 Ohio River System	TP	84856 (281)	50621 (311)	9806 (333)	10742 (128)
	TKN	153703 (249)	152129 (270)	37560 (312)	48096 (118)
	OrgN	*	*	*	*
06 Tennessee	TP	2816 (8)	237 (37)	777 (22)	14070 (4)
	TKN	9502 (4)	1169 (33)	756 (20)	5717 (1)
	OrgN	14025 (2)	107 (3)	20581 (5)	67798 (1)
07 Upper Mississippi	TP	5670 (276)	5017 (440)	7451 (293)	1450 (133)
	TKN	40311 (199)	61588 (218)	44435 (195)	8823 (109)
	OrgN	250 (1)	6161 (10)	40 (9)	86 (3)
08 Lower Mississippi	TP	5158 (192)	19097 (246)	15455 (185)	41987 (16)
	TKN	904023 (26)	329792 (37)	144973 (25)	133620 (15)
	OrgN	*	*	*	*
10 Missouri River System	TP	2148 (426)	1006 (541)	2209 (339)	379 (146)
	TKN	5606 (311)	5288 (401)	10671 (216)	1760 (103)
	OrgN	111 (3)	*	*	*
11 Arkansas - Red - White River System	TP	5775 (196)	5488 (187)	3687 (118)	1078 (30)
	TKN	26267 (117)	32327 (124)	14924 (128)	3963 (54)
	OrgN	*	*	*	*
12 Texas Gulf	TP	1845 (199)	2409 (183)	1689 (168)	696 (90)
	TKN	3598 (171)	12000 (160)	6736 (171)	902 (74)
	OrgN	*	*	*	*

Table 7 (continued)

Region	Nutrient	Winter	Spring	Summer	Fall[1]
13	TP[2]	345 (37)	229 (30)	829 (38)	176 (26)
Rio Grande	TKN	1243 (31)	1231 (30)	2554 (38)	627 (24)
System	OrgN	*	*	*	*

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Tables 8-9: Lowest Subregions' Mean Loadings of Phosphorus and Nitrogen

There is a huge variation in nutrient loadings for those subregions adjacent to the Gulf of Mexico, as we found across regions and across subregions even within the same USGS region. As one would expect, by far the highest loadings of both phosphorus and nitrogen are found in the waters of the Lower Mississippi and the Atchafalaya. Each of these subregions has higher nutrient loadings than the sum of all others.

The highest mean seasonal phosphorus loadings are found in the Lower Mississippi River in winter and spring at 308,804 lbs/day and 301,958 lbs/day respectively. The Atchafalaya's loadings are not far behind in some seasons. Subregions which apparently send very little phosphorus into the Gulf from their river systems, at least in most seasons, include the river systems of South Florida (Partial Subregion 0309) which flow into the Gulf, with a maximum of 102 lbs/day in summer (though it should be noted that no data was collected in the fall); Subregion 1211 in the Nueces area of Southwestern Texas, with a maximum seasonal mean of 83 lbs/day in the fall; and the Lower Rio Grande with a maximum quarterly mean of 271 lbs/day in winter. Many other river systems consistently send far less than 1,000 lbs/day of phosphorus to the Gulf. The highest seasonal phosphorus loadings into the Gulf from outside the Mississippi system are found in the wintertime in the Tombigbee-Mobile Bay area at 30,551 lbs/day.

For Total Kjeldahl Nitrogen the highest seasonal means are also in the Lower Mississippi River in the winter and the spring, with loadings of 1,715,000 lbs/day and 1,632,000 lbs/day respectively. Again the Atchafalaya River, with some flow from the Mississippi diverted to it above these two subregions, also has TKN loadings far exceeding the sum of the loadings from all Gulf-adjacent subregions east and west of Region 08. Subregions which sent very low amounts of TKN into the Gulf from their river systems in 1989 include the Peace River-Tampa Bay area (subregion 0310) with maximum mean loadings of 557 lbs/day in the winter; subregion 1210 on the Central Texas Coast with a maximum seasonal mean of 1,205 lbs/day, also in winter; and once again the Nueces River area of Southwestern Texas with maximum seasonal mean loadings of 1,421 lbs/day in the fall. The highest mean seasonal TKN loadings outside of the Mississippi-Atchafalaya region were 82,949 lbs/day in the Sabine River outlet in Eastern Texas

Table 8

"Lowest Subregions": Mean Ambient Phosphorus and Nitrogen Loadings for USGS Subregions Adjacent to the Gulf of Mexico

1989: All data in lbs/day

East-to-West USGS Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
0309 (Partial)	TP[2]	51 (3)	57 (4)	102 (4)	*
South Florida	TKN	1854 (3)	1355 (4)	747 (4)	*
0310	TP	297 (38)	136 (26)	353 (17)	5 (2)
Peace - Tampa Bay	TKN	557 (39)	143 (24)	399 (16)	122 (2)
0311	TP	343 (23)	444 (22)	477 (22)	387 (19)
Suwanee	TKN	1796 (6)	3401 (5)	4979 (4)	5018 (3)
0312	TP	350 (11)	1040 (11)	881 (11)	396 (9)
Ochlockonee	TKN	1417 (3)	6220 (2)	379 (2)	670 (2)
0313	TP	2283 (35)	3944 (35)	2659 (37)	3536 (36)
Apalachicola	TKN	13038 (8)	28226 (9)	8416 (7)	19830 (6)
0314	TP	973 (4)	1 (6)	373 (4)	690 (4)
Choctawhatchee - Escambia	TKN	11261 (4)	50 (13)	1433 (10)	8344 (3)
0315[3]	TP	3792 (47)[3]	3192 (46)[3]	1620 (56)[3]	846 (35)[3]
Coosa-Alabama	TKN	23896 (14)	19459 (27)	6621 (31)	265 (9)
0316	TP	30551 (16)	5360 (14)	770 (16)	11 (6)
Tombigbee - Mobile Bay	TKN	71003 (9)	25965 (10)	3377 (15)	64 (3)
0317	TP	1209 (2)	1047 (4)	822 (1)	*
Pascagoula	TKN	6881 (3)	11387 (4)	2941 (2)	*

Table 8 (continued)

Subregion	NNutrient	Winter	Spring	Summer	Fall[1]
0318 Pearl	TP[2]	250 (1)	548 (2)	231 (1)	*
	TKN	1877 (1)	5483 (2)	1384 (1)	*
Total: Region 03 Gulf River Systems	TP	36307	12577	6668	[5025][4]
	TKN	109684	82230	24055	[34048]
0809: Lower Mississippi R.	TP	308804 (2)	301958 (3)	114467 (2)	191674 (3)
	TKN	1715000 (2)	1632000 (3)	572763 (2)	774006 (2)
0808: Louisiana Coastal incl. Atchafalaya	TP	200640 (10)	130900 (12)	76923 (10)	95470 (1)
	TKN	1031000 (5)	570777 (6)	204154 (5)	445525 (1)
Total: Region 08 Flow to Gulf	TP	509444	432858	191390	287144
	TKN	2746000	2202777	776917	1219531
1201 Sabine	TP	1418 (5)	2786 (4)	4705 (4)	282 (3)
	TKN	13560 (5)	22156 (4)	82949 (4)	1586 (3)
1202 Neches	TP	3724 (10)	1526 (7)	2918 (5)	3908 (4)
	TKN	16282 (8)	59510 (7)	50844 (5)	5426 (3)
1204 Galveston Bay - San Jacinto	TP	1309 (51)	2465 (11)	368 (50)	496 (4)
	TKN	3710 (34)	6595 (9)	520 (50)	664 (4)
1207 Lower Brazos	TP	148 (8)	442 (9)	845 (9)	666 (4)
	TKN	214 (7)	3892 (10)	3853 (8)	1157 (3)
1209: Lower Colorado - San Bernard Coastal	TP	861 (31)	517 (43)	293 (12)	536 (19)
	TKN	2921 (32)	3339 (42)	1006 (19)	1318 (19)
1210 Central Texas Coastal	TP	1793 (28)	1221 (39)	751 (33)	870 (24)
	TKN	1205 (28)	1014 (30)	260 (34)	258 (19)

Table 8 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
1211: Nueces - Southwestern Texas Coastal	TP[2]	11 (3)	52 (11)	56 (3)	83 (4)
	TKN	55 (7)	1170 (5)	301 (5)	1421 (2)
Total: Region 12 Flow to Gulf	TP	9264	9009	9936	6841
	TKN	37947	97676	139733	11830
1309 Lower Rio Grande	TP	271 (2)	47 (3)	53 (1)	171 (2)
	TKN	5630 (2)	592 (3)	740 (1)	1248 (2)

* No samples taken
( ) = Number of samples

1 Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

2 TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen

3 Subregion 0315 does not flow directly into the Gulf of Mexico; it flows into the Tombigbee system (subregion 16) a short distance north of Mobile Bay. This data is not included in the total for Region 03. It is included in Table 8 only because it obviously contributes the major proportion of the nutrient pollution to subregion 0316 in most seasons.

4 The total for the fall is incomplete, as some subregions had no measurements in the fall. It is included and should be interpreted as a minimum amount.

Table 9

Regional Summary of Nutrient Loadings for "Lowest Subregions": Subregions Adjacent to the Gulf of Mexico

1989: All data in lbs/day; % of total loadings

Region/Primary States or Rivers	Nutrient	Winter	Spring	Summer	Fall[1]
03/FL/AL/ MS Coast	TP[2]	36307: 7%	12577: 3%	6668: 3%	[5025: 2%]
	TKN	109684: 4%	82230: 3%	24055: 3%	[34048: 3%]
08/LA: Mississippi R./ Atchafalaya	TP	509444: 92%	432858: 95%	191390: 92%	287144: [96%]
	TKN	2746000: 95%	2202777: 92%	776917: 83%	1219531: [96%]
12/TX Coast	TP	9264: 2%	9009: 2%	9936: 5%	6841: [2%]
	TKN	37947: 1%	97676: 4%	139733: 15%	11830: [1%]
13/Rio Grande	TP	271: 0%	47: 0%	53: 0%	171: 0%
	TKN	5630: 0%	592: 0%	740: 0%	1248: 0%
Total: All USGS subregions adjacent to Gulf of Mexico	TP	555286: 100%*	454491: 100%	208047: 100%	[299181: 100%][3]
	TKN	2899261: 100%	2383275: 100%	941445: 100%	[1266657: 100%]

1 Winter runoff: January 1 - March 31
Spring: April 1 - June 30
Summer: July 1 - September 30
Fall: October 1 - December 31

2 TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen

3 The total for Region 03 in the fall season is incomplete, as no data was collected for a few subregions.

* Columns may not add to exactly 100% due to rounding.

(subregion 1201) in the summer and 71,003 lbs/day in the winter in the Tombigbee-Mobile Bay area. The Neches River area (subregion 1202) also had some high TKN loadings.

Table 9 presents the summary of loadings from Gulf-adjacent subregions by region, and their estimated percentage contributions to the total loadings of phosphorus and nitrogen into the Gulf of Mexico. Even with this degree of summation it is apparent that while there are wide seasonal variations, these seasonal variations are not consistent across regions.

As was previously indicated, the Mississippi River-Atchafalaya system accounts for the vast majority of nutrients entering the Gulf. More than ninety percent of total phosphorus loadings are attributable to it in each season of 1989. (As noted in footnote 3 of Table 9, the fall season totals for Region 03 should be interpreted as minimum amounts; the percentages for other regions in the fall season should therefore be interpreted as maxima. However, it is extremely unlikely that the addition of data from these few subregions of Region 03, all of which had very small phosphorus loadings in the other three seasons, would lower the Mississippi-Atchafalaya contribution to loadings into the Gulf to 90% or less.)

The seasonal loadings from the Florida/Alabama/state of Mississippi coast contribute seven percent or less of the phosphorus entering the Gulf of Mexico, the maximum being in the winter. The annual average is less than 4%. The Texas coast subregions contribute no more than five percent of phosphorus loadings to the Gulf in any one season; its annual average is less than 3%. The Rio Grande's seasonal mean phosphorus loadings never approached one-half of one percent in 1989. Unless authorities along the Rio Grande were to decide to lower water levels in its reservoirs all at the same time, these reservoirs appearing to trap somewhat higher nutrient levels from upper reaches, the Rio Grande does not at this time present a nutrient threat to the Gulf.

Total Kjeldahl Nitrogen loadings into the Gulf of Mexico also enter largely from the Mississippi and Atchafalaya rivers. Approximately five-sixths of the TKN entered from these subregions in the summer of 1989, and more than ninety percent in all other seasons. (The comment regarding Region 03's missing data in a few subregions for the fall season applies to TKN as well as to phosphorus.) Outside of Region

08, only the summer TKN loadings from part of the Texas coast would appear to warrant further study, as will be discussed below.

TKN loadings from the Gulf coastline of the states of Florida, Alabama, and Mississippi contributed a maximum of four percent of the total Gulf loadings in any season of 1989, the maximum being during the winter season. The annual average was only three percent. Seasonal TKN loadings from the Texas coast varied greatly, from 11,830 lbs/day or one percent of the total loadings in the fall to 139,733 lbs/day in the summer, or fifteen percent of total Gulf loadings during this season. Nearly all of the Texas coast loadings of TKN in summer came from only the two easternmost subregions in Texas: the Sabine and Neches valleys. Each of these two means, it should be noted, is based on few measurements. The annual average TKN loadings from the Texas coast still contribute only five percent of all Gulf loadings, as they are quite a small percentage in all other seasons. The Rio Grande's TKN loadings into the Gulf are again insignificant relative to those from other areas.

Total loadings of phosphorus into the Gulf of Mexico from all subregions adjacent to the coast ranged from a seasonal low of 208,047 lbs/day in the summer to 555,286 lbs/day in the winter, for an average of more than 379,000 lbs/day in 1989. Total seasonal mean TKN loadings into the Gulf varied from 941,445 lbs/day in the summer to a high of 2,899,261 lbs/day in the winter in 1989; the annual average was more than 1,872,600 lbs/day. These annual averages can be translated to 190 tons per day of phosphorus and 1,450 tons per day of Kjeldahl Nitrogen entering the Gulf of Mexico from the surface waters of the United States.

We have now looked at the total loadings into the Gulf of Mexico, and their immediate sources along its coast. Since such a high proportion of nutrients comes from the Mississippi system, its components obviously deserve some further analysis. Unfortunately, complete data for all of the most downstream subregions of each tributary river system comprising this vast system is available for only the spring and summer seasons.

Table 10: Relative Contributions of Mississippi River System Tributary Systems or Regions

Table 10 summarizes the relative contributions to the Lower Mississippi-Atchafalaya Rivers' loadings of total phosphorus and TKN, for the various systems comprising the entire Mississippi system. It should be noted first that the proportional contributions do not add to 100%, for a variety of reasons. The Upper Mississippi loadings include those from the Missouri system, and the Ohio system's loadings include the Tennessee's contribution, small though it may be. Some of the phosphorus or TKN dissipates as it flows downstream, at potentially widely varying rate due to temperatures, turbulence and flow rates. There are time lags from sediment attached nutrients, and plant uptake of nutrients varies seasonally. And additional nutrients enter the surface waters in the Lower Mississippi region itself; this factor was especially apparent for the spring season in 1989. Many operations involving various chemicals are located along or near the lower Mississippi River.

Nevertheless, seasonal differences in the relative contributions of Mississippi "tributary" systems are of interest. The greatest flows of water into the Lower Mississippi come from the Upper Mississippi and the Ohio regions, each of which has large amounts of agricultural activity as well as many large population centers. In the spring the Upper Mississippi contributes only approximately 10% of the phosphorus and 21% of the TKN found near the mouths of the Mississippi-Atchafalaya outlets, but in the summer season this rises to approximately 88% and 76% respectively. Conversely, the Ohio system has larger contributions in the spring: approximately 62% of the phosphorus and 28% of the TKN falling to about 17% for phosphorus and 14% for TKN in the summer. The Tennessee subsystem of the Ohio, and the Arkansas-Red-White river systems, contribute very low proportions of nutrients to the Lower Mississippi in any season. The Missouri system contributes very little of either nutrient in the spring, but about a quarter of the phosphorus and of the TKN in the summer.

Table 10

Relative Contributions of Mississippi River System Components to Nutrient Loadings Entering the Gulf of Mexico from the Lower Mississippi River and the Atchafalaya River

All Proportions Calculated from 1989 Data

		Spring		Summer[1]	
River System	Most-Downstream Subregion #	TP	TKN	TP	TKN[2]
Missouri	1030	.03	.04	.26	.24
Tennessee	0604[3]	.003	.001	*	*
Ohio	0514	.62	.28	.17	.14
Upper Mississippi[4]	0714	.10	.21	.88	.76
Arkansas-Red-White	1114	.02	.01	.03	.005

* Less than .0005

1 Spring runoff: April 1 - June 30
Summer runoff: July 1 - September 30

2 TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen

3 Subregion 0604 flows into the Ohio River in the downstream reaches of subregion 0514.

4 Includes flow from Missouri River system.

Summary and Discussion

Data from both the Purdue Water Quality Model and the U.S. Environmental Protection Agency's STORET database confirm the lack of any consistent seasonal trend in nutrient concentrations or loadings, among the overall regional means and among the subregions within a given region. A priori theories would suggest that nutrient sources such as cropland runoff, construction runoff and urban gardening runoff would be seasonal, but at least in 1989 these sources are apparently negated by opposite seasonal trends in other sources in many regions and subregions. There are wide variations in nutrient concentrations and loadings within most subregions, but these variations are quite inconsistent across subregions.

Secondly, nutrient concentrations do not generally increase as a river system flows downstream. Some slight trends appear for a few subregions within one region, but the trend then disappears farther downstream. Several possible explanations of this observation are noted in the report. Nutrient loadings do increase somewhat as they move downstream, in some river systems. Once again, however, the trend is not consistent across all relevant regions, nor does it appear all of the way from upstream to downstream in any given region.

From our analysis we estimate that on an average day in 1989 more than 379,000 pounds (190 tons) of phosphorus and more than 1,872,600 pounds (1450 tons) of Kjeldahl nitrogen were discharged into the Gulf of Mexico from the surface waters of the United States. More than 90% of each nutrient comes from the Mississippi River system alone, but most of this originates far from the Gulf itself.

It is clear that the regions which are the major sources of both Kjeldahl nitrogen and phosphorus during much of the year are the Ohio River basin and the Upper Mississippi River basin. In both of these regions, nonurban nonpoint sources provide by far the largest sources of nutrient pollution in waterways. It would seem, then, that continuation and expansion of policies directed toward decreasing nutrient runoff from nonurban lands in these upstream regions could have the biggest impact on programs to reduce nutrient pollution in the Gulf.

Several questions arise which will, of course, need further study. One is that of possible spatial variations within the Gulf of Mexico. For example: is a pound of phosphorus or nitrogen from southern Florida or the Rio Grande equivalent, in terms of ecosystem damage, to a pound of phosphorus or nitrogen from the Mississippi-Atchafalaya Gulf Coast which is much farther north? Does a pound of a nutrient discharged into the Gulf in winter have the same impact on the ecosystem as in the summer? Many such questions will be answered by other groups in the Gulf of Mexico Project, and the answers will help to determine which potential policies will have the greatest favorable impact.

Nutrient overenrichment in the Gulf of Mexico is caused by the practices of rural and urban residents far from the Gulf Coast as well as those living near the coast. Plans to protect the Gulf must examine ways of influencing these practices. The particular nutrient which is the limiting factor in the Gulf ecosystem must also be determined. The contributions of the various regions whose waterways flow to the Gulf vary widely, both by season and by nutrient, though there is not much consistency in these variations. The proportion of nutrients coming from point sources and nonpoint sources also varies, though nonpoint sources appear to be the larger factor in those regions which provide the majority of the nutrients in most seasons. Protecting the Gulf ecosystem requires that we consider the full range of activities throughout the entire drainage area of river systems flowing into the Gulf of Mexico.

Data Discussion

This analysis clearly illustrates a major problem in environmental programs and policies, insufficient data of reasonable quality. The measurements of actual concentrations of pollutants and flows were nonexistent, both temporally and spatially. In addition, this project found that there is relatively little known about the transport of pollutants through a large river basin. While laboratory or small watershed models have been developed and calibrated, refocusing these micro-level models on meso- or micro-scale basins is a major research need.

If we expect better discussions regarding protection of Gulf of Mexico waters, or other environmental resources, we need better data that is consistent, spatially and temporally, which can be utilized to structure research efforts.

One major finding of this study is the poor quality of the data upon which to base decisions about protection of the water of the Gulf of Mexico.

APPENDIX A

Subregional Analysis of Ambient and Nonambient Concentrations

Appendix A: Brief Interpretation of Tables A2-A10:

(Table A1 is included for easy reference only. It is identical to Table 5.)

Table A2 - Region 03 (Partial): The Gulf Coast River Systems of the Southeast Region

Region 03 is the only region whose flow is divided, between the Atlantic Ocean and the Gulf of Mexico (though there is no definitive line dividing these two bodies of water). Subregions 01 through 08 and part of 09 flow directly into the Atlantic, while part of 09 and all of 10 through 18 flow into the Gulf. The half (approximately) of Region 03 flowing into the Gulf of Mexico covers the geographic area from southwestern Florida through a small part of eastern Louisiana.

The quarterly means presented by subregions show a wide range of nutrient concentrations (all data is in milligrams per liter), as is true of most regions. Mean total phosphorus ranged from .05 mg/L in the spring in subregion 17, the Pascagoula River system, to .89 mg/L in the winter in subregion 12, the Ochlockonee system, though a few very high readings may dominate the latter, as is the case in several regions. The highest individual sample readings include 6.6 mg/L in the summer in the Peace River system in Florida (Subregion 10), 5.6 mg/L in both the Peace River system (FL) in winter and the Ochlockonee system (Subregion 12), also in winter, and 5.42 mg/L in the Kissimmee-Okeechobee (Subregion 09) in winter.

Mean TKN ranged from .416 mg/L in the fall in Subregion 13, the Apalachicola River system, to 2.927 mg/L in Subregion 14, the Choctawhatchee-Peace (Alabama) system in spring. Maximum individual samples were an extremely high 98.8 mg/L in the summer in Subregion 15, the Coosa River system (the mean was still 1.47 mg/L), 18.8 mg/L in summer in the Choctawhatchee-Peace (Alabama) system and 18.4 mg/L in spring in Subregion 16, the Tombigbee system. Many subregions had single samples of TKN of 11 mg/L or higher in the Gulf rivers of Region 03.

Organic Nitrogen is not reported in every subregion. Mean Organic N ranged from .083 mg/L in spring in the Suwanee River system (Subregion 11) to 2.962 mg/L in spring in the Tombigbee system, the latter strongly influenced by the highest individual sampling in the region in 1989 of 13.6 mg/L. The second highest concentration reported was 6.50 mg/L in spring in the Peace River system in Florida.

For Region 03's gulf coast river systems overall, quarterly means of total phosphorus ranged from .176 mg/L for the fall season to .336 mg/L in winter. TKN varied from a low of .745 mg/L in fall to 1.301 mg/L during the spring. Organic nitrogen means (with many subregions not reporting) were lowest in fall (.780 mg/L) and highest in summer (.982 mg/L). Many of the nitrogen means in some Gulf of Mexico river systems of the Southeast Region are above generally accepted safe upper limits.

Table A-1

USGS Region Summaries: Mean Nitrogen and Phosphorus Concentrations by Region

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
03 Southeast (Gulf of Mexico River Systems Only)	TP[2]	.336 (756)	.306 (713)	.222 (607)	.176 (420)
	TKN	1.111 (625)	1.301 (699)	1.138 (641)	.745 (366)
	OrgN	.808 (214)	.888 (197)	.982 (177)	.780 (112)
	TOTN	1.062 (98)	1.311 (46)	*	*
05 Ohio River System	TP	.290 (847)	.135 (1395)	.255 (2074)	.331 (896)
	TKN	.674 (582)	.618 (1259)	.682 (1847)	.706 (645)
	OrgN	*	*	*	*
06 Tennessee	TP	.451 (130)	.130 (385)	.081 (572)	.250 (54)
	TKN	.450 (72)	.471 (146)	.421 (136)	.282 (94)
	OrgN	1.690 (44)	.325 (302)	.239 (490)	1.268 (5)
07 Upper Miss	TP	.414 (1168)	.347 (2575)	.484 (3089)	.444 (1022)
	TKN	1.771 (551)	1.429 (1347)	1.623 (1421)	1.105 (588)
	OrgN	1.033 (53)	1.576 (194)	1.413 (235)	.638 (46)
08 Lower Miss	TP	.196 (1016)	.187 (1014)	.188 (988)	.182 (626)
	TKN	.856 (681)	.901 (699)	.850 (637)	.763 (531)
	OrgN	*	*	*	*
10 Missouri River System	TP	1.665 (955)	.358 (1359)	1.697 (1600)	.407 (587)
	TKN	1.929 (434)	1.398 (642)	5.328 (881)	1.526 (201)
	OrgN	.889 (9)	*	*	*
11 Arkansas - Red - White River System	TP	.728 (911)	.631 (1064)	.535 (1205)	1.305 (520)
	TKN	3.256 (553)	2.391 (589)	1.889 (654)	3.505 (343)
	OrgN	5.335 (134)	2.817 (197)	3.118 (120)	4.235 (120)
	TOTN	8.244 (242)	6.261 (223)	3.345 (203)	8.815 (144)
12 Texas Gulf	TP	.730 (572)	.279 (453)	.436 (391)	.755 (148)
	TKN	1.003 (403)	.747 (358)	.911 (438)	.809 (148)
	OrgN	*	*	*	*

Table A-1 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
13	TP[2]	.158 (88)	.288 (188)	.557 (101)	.337 (29)
Rio Grande	TKN	.678 (61)	1.231 (183)	1.185 (99)	.672 (29)
System	OrgN	.240 (21)	.630 (150)	.418 (57)	.328 (6)
	TOTN	1.656 (17)	1.695 (140)	2.022 (57)	.513 (6)
Entire U.S.	TP	.609 (6443)	.315 (9146)	.562 (10627)	.463 (4302)
Gulf of Mexico	TKN	1.454 (3962)	1.201 (5922)	1.679 (6754)	1.174 (2945)
Drainage	OrgN	2.169 (475)	1.181 (1040)	.946 (1079)	2.191 (289)

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen
TOTN = Total Nitrogen

Table A-2

Partial USGS Region 03: Southeast Gulf Coast River Systems
Mean Nitrogen and Phosphorus Concentrations
by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Partial Caloosahatchee L. Okeechobee	TP[2]	.227 (90)	.298 (105)	.251 (96)	.086 (67)
	TKN	1.171 (96)	1.230 (106)	1.530 (93)	1.153 (66)
	OrgN	.946 (64)	1.102 (60)	1.153 (61)	1.006 (57)
10 Peace (FL) - Tampa Bay	TP	.371 (158)	.549 (118)	.664 (43)	.306 (34)
	TKN	1.070 (159)	1.118 (115)	1.388 (42)	.955 (34)
	OrgN	.842 (103)	.944 (50)	2.474 (7)	2.864 (5)
	TOTN	1.062 (98)	1.311 (46)	*	*
11 Suwanee	TP	.667 (61)	.364 (58)	.488 (34)	.603 (29)
	TKN	.555 (26)	.791 (35)	.779 (22)	.783 (9)
	OrgN	.446 (7)	.083 (7)	.431 (7)	.255 (4)
12 Ochlockonee	TP	.897 (27)	.599 (17)	.439 (17)	.438 (12)
	TKN	2.877 (7)	1.886 (5)	.661 (8)	.607 (3)
	OrgN	.651 (19)	.782 (19)	.572 (16)	.338 (20)
13 Apalachicola	TP	.275 (185)	.191 (190)	.150 (195)	.142 (117)
	TKN	.816 (29)	.700 (47)	.602 (48)	.416 (23)
	OrgN	.193 (11)	.440 (11)	.356 (10)	.145 (11)
14 Choctawhatchee - Escambia	TP	.505 (68)	.542 (73)	.252 (42)	.060 (52)
	TKN	1.454 (98)	2.927 (110)	1.015 (70)	.583 (60)
	OrgN	.812 (10)	.650 (13)	.693 (20)	.544 (11)
15 Coosa - Alabama	TP	.178 (96)	.106 (93)	.107 (89)	.087 (51)
	TKN	1.104 (49)	.746 (80)	1.468 (118)	.422 (52)
	OrgN	*	.317 (29)	.295 (37)	.087 (4)
16 Tombigbee - Mobile Bay	TP	.133 (26)	.098 (22)	.074 (25)	.085 (22)
	TKN	.786 (106)	1.056 (159)	1.034 (170)	.550 (79)
	OrgN	*	2.962 (8)	2.401 (19)	*

Table A-2 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
17	TP[2]	.065 (16)	.054 (10)	.107 (35)	.739 (8)
Pascagoula	TKN	1.713 (24)	.613 (15)	.768 (39)	2.060 (12)
	OrgN	*	*	*	*
18	TP	.111 (29)	.096 (27)	.099 (31)	.113 (28)
Pearl	TKN	1.044 (31)	.814 (27)	.892 (31)	.730 (28)
	OrgN	*	*	*	*
Region 03	TP	.336 (756)	.306 (713)	.222 (607)	.176 (420)
(Partial)	TKN	1.111 (625)	1.301 (699)	1.138 (641)	.745 (366)
	OrgN	.808 (214)	.888 (197)	.982 (177)	.780 (112)
	TOTN	1.062 (98)	1.311 (46)	*	*

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen
TOTN = Total Nitrogen

Table A3 - Region 05: The Ohio River System*

The Ohio River and its tributaries comprise one of the larger tributary systems of the Mississippi River system, particularly in terms of the amount of water flowing into the Mississippi. Consequently the Tennessee River system, which joins the Ohio shortly before it flows into the Mississippi, has been given its own separate region (06) by the USGS. Geographically, Region 05 extends from a small part of southwestern New York State through West Virginia to western Kentucky and eastern Illinois.

For the rest of the Ohio system, Region 05, quarterly mean concentrations of total phosphorus in the subregions varied from a low of .032 mg/L in the fall in the Kentucky-Licking rivers area (several other subregions also had seasonal means below .1 mg/L) to 1.578 mg/L, also in the fall, in the Middle Ohio Subregion (09). The maximum individual samples were 35.7 mg/L in the fall in the Middle Ohio area, 16.0 mg/L in the fall in Subregion 06, the Scioto River area, and 15.36 mg/L in winter in the Wabash River Subregion (12).

Mean TKN in Region 05 ranged on a seasonal basis from a low of .160 mg/L in the springtime in the Monongahela area (Subregion 02), to 1.448 mg/L in the fall in Subregion 12 (Wabash). Maximum single readings of TKN were 44.4 mg/L in spring, 37.0 mg/L in spring and 34.0 mg/L in the fall in Subregions 09 (Kentucky-Licking), 05 (Kanawha River) and 12 (Wabash), respectively.

Organic nitrogen was not measured in Region 05 in 1989.

For the region as a whole, mean total phosphorus in the Ohio Region varied from a low of .135 mg/L in spring to .331 mg/L in the fall. TKN was steady overall, though not in all subregions: it ranged from .618 mg/L in the spring to a high of .706 mg/L in the fall.

* Excluding the Tennessee tributary system (Region 06).

Table A-3

USGS Region 05: Ohio River System
Mean Nitrogen and Phosphorus Concentrations
by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01 Allegheny	TP[2]	.045 (73)	.066 (74)	.060 (79)	.052 (79)
	TKN	.217 (3)	.242 (4)	.330 (3)	.330 (3)
	OrgN	*	*	*	*
02 Monongahela	TP	.075 (64)	.093 (61)	.076 (69)	.113 (60)
	TKN	.240 (26)	.160 (24)	.371 (27)	.301 (18)
	OrgN	*	*	*	*
03 Upper Ohio	TP	.185 (98)	.133 (96)	.128 (120)	.136 (110)
	TKN	.786 (50)	.461 (60)	.491 (78)	.453 (64)
	OrgN	*	*	*	*
04 Muskingum	TP	.476 (39)	.088 (129)	.428 (383)	.169 (60)
	TKN	1.167 (51)	.397 (164)	.754 (391)	.429 (68)
	OrgN	*	*	*	*
05 Kanawha	TP	.098 (67)	.099 (97)	.109 (134)	.091 (93)
	TKN	.363 (70)	.604 (135)	.367 (147)	.470 (100)
	OrgN	*	*	*	*
06 Scioto	TP	.205 (45)	.148 (85)	.500 (111)	1.083 (59)
	TKN	1.030 (36)	.759 (75)	.596 (124)	.851 (70)
	OrgN	*	*	*	*
07 Big Sandy - Guyandotte	TP	.082 (51)	.055 (74)	.059 (105)	.042 (33)
	TKN	.258 (75)	.207 (111)	.255 (124)	.217 (58)
	OrgN	*	*	*	*
08 Great Miami	TP	.297 (23)	.220 (66)	.312 (224)	.323 (19)
	TKN	.910 (31)	.845 (106)	.667 (238)	.561 (18)
	OrgN	*	*	*	*

Table A-3 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Middle Ohio	TP[2]	.162 (23)	.160 (92)	.345 (124)	1.578 (43)
	TKN	.468 (36)	1.024 (108)	.800 (162)	.560 (49)
	OrgN	*	*	*	*
10 Kentucky - Licking	TP	.193 (43)	.121 (73)	.154 (66)	.032 (13)
	TKN	.495 (44)	.407 (87)	.424 (78)	.582 (15)
	OrgN	*	*	*	*
11 Green	TP	.064 (25)	.085 (34)	.042 (46)	*
	TKN	.436 (26)	.451 (53)	.379 (51)	*
	OrgN	*	*	*	*
12 Wabash	TP	.682 (197)	.189 (298)	.232 (400)	.305 (259)
	TKN	1.550 (52)	1.032 (144)	1.098 (239)	1.448 (118)
	OrgN	*	*	*	
13 Cumberland	TP	.059 (23)	.132 (37)	.071 (39)	.078 (2)
	TKN	.228 (19)	.584 (30)	.353 (33)	.441 (5)
	OrgN	*	*	*	*
14 Lower Ohio	TP	.324 (76)	.144 (179)	.224 (169)	.264 (44)
	TKN	.664 (63)	.593 (158)	.932 (144)	.820 (29)
	OrgN	*	*	*	*
Region 05	TP	.290 (847)	.135 (1395)	.255 (2074)	.331 (896)
	TKN	.674 (582)	.618 (1259)	.682 (1847)	.706 (645)
	OrgN	*	*	*	*

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table A4 - Region 06: **Tennessee River System**

Flowing into the Ohio and thence to the Mississippi, the Tennessee River and its tributaries comprise one of the smaller USGS hydrologic Regions. It extends geographically from western Virginia and North Carolina to the Ohio River at Kentucky and Illinois. Small or not, the Tennessee Valley was one of the less polluted areas in 1989, in terms of both nitrogen and phosphorus.

Mean total phosphorus presented quarterly for the four subregions ranged from .07 mg/L in the spring and summer in the Middle Tennessee-Hiwassee Subregion, with several seasonal means below 1.0 mg/L, to 1.5 mg/L in the fall in the Middle Tennessee-Elk Subregion. The highest individual 1989 measurement of TP (total phosphorus) was 9.0 mg/L in the Middle Tennessee-Elk area, in the spring season.

Quarterly TKN means varied from a low of .16 mg/L in the spring in the Middle Tennessee-Hiwassee Subregion, to 1.76 mg/L in the Middle Tennessee-Elk Region, also in the spring. The maximum sample readings were 4.0 mg/L and 3.9 mg/L in spring and winter, respectively, in the Middle Tennessee-Elk area.

Seasonal mean organic nitrogen, reported in most subregions and seasons, ranged from .19 mg/L in the Middle Tennessee-Hiwassee area in summer (for data with sufficient observations), to 4.97 mg/L in winter in the Middle Tennessee-Elk subsystem.

In the entire Tennessee Valley, total phosphorus varied from a low of .08 mg/L in summer to a high of .45 mg/L in winter; TKN from .28 mg/L in fall to .47 mg/L in spring; and Organic Nitrogen from .24 mg/L in summer to 1.69 mg/L in winter.

Table A-4

USGS Region 06: Tennessee River System
Mean Nitrogen and Phosphorus Concentrations
by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01 Upper Tennessee	TP[2]	.353 (79)	.082 (82)	.086 (97)	.115 (35)
	TKN	.322 (57)	.347 (106)	.315 (110)	.278 (85)
	OrgN	.814 (28)	*	.292 (15)	*
02 Middle Tennessee - Hiwassee	TP	.314 (29)	.072 (209)	.066 (223)	.274 (11)
	TKN	.465 (6)	.164 (20)	.500 (1)	*
	OrgN	.310 (4)	.198 (196)	.190 (209)	*
03 Middle Tennessee - Elk	TP	1.281 (14)	.321 (77)	.079 (235)	1.522 (4)
	TKN	1.717 (6)	1.762 (14)	1.007 (19)	.320 (6)
	OrgN	4.971 (10)	.560 (106)	.274 (264)	1.535 (4)
04 Lower Tennessee	TP	.468 (8)	.219 (17)	.292 (17)	.100 (3)
	TKN	.320 (3)	.668 (6)	.486 (6)	.343 (3)
	OrgN	.310 (2)	*	.180 (2)	*
Region 06	TP	.451 (130)	.130 (385)	.081 (572)	.250 (54)
	TKN	.450 (72)	.471 (146)	.421 (136)	.282 (94)
	OrgN	1.690 (44)	.325 (302)	.239 (490)	1.268 (5)

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring: April 1 - June 30
Summer: July 1 - September 30
Fall: October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table A5 - Region 07: Upper Mississippi River System

The Upper Mississippi system includes the upper reaches of the mighty river which eventually drains nearly two-thirds of the surface water in the 48 contiguous states, and all of its tributaries in Minnesota, Wisconsin, Iowa, northern Missouri and Illinois which join it upstream of the Missouri River (Region 10) on the western bank and the Ohio River (Region 05) on the eastern bank.

Nutrient concentrations are highly variable in the Upper Mississippi Region, again without a consistent trend either seasonally or from upstream to downstream. Mean total phosphorus in each subregion ranged in 1989 from .05 mg/L in winter in the St. Croix River Subregion (03) to a high of 2.74 mg/L in the summer in the Wisconsin River area (Subregion 07). The highest individual phosphorus samples were a rather extreme measurement of 170.0 mg/L in the Wisconsin River Subregion in summer and 29.8 mg/L in the Minnesota River system, also in summer.

Mean TKN among the subregions ranged from .57 mg/L in the fall season in the Upper Mississippi-Black-Root system (Subregion 04) to 3.69 mg/L in winter in the Iowa-Skunk-Wapsipinicon area (Subregion 08). There was a slight trend of increasing concentrations from upstream to downstream in some seasons. Maximum concentrations were found at 48.0 mg/L in the summer in the Wisconsin River area, and several 25 to 28 mg/L readings in various seasons and subregions.

The means for organic nitrogen, reported in fewer than half of the subregions, varied from a low of .4 mg/L in the St. Croix River area in winter to 3.77 mg/L in the Des Moines River subsystem, Subregion 10, in spring. The highest individual concentrations were 27.3 mg/L in summer in the Minnesota River area and 26.5 mg/L in the spring in Subregion 04, the Upper Mississippi-Black-Root.

For Region 07 the mean total phosphorus was fairly steady, ranging from .35 mg/L in spring to .48 mg/L in summer. Mean TKN varied only from 1.1 mg/L in the fall to 1.77 mg/L in winter. Seasonal means for organic nitrogen (for those subregions reporting) ranged from a low of .64 mg/L in the fall to 1.58 mg/L in the spring.

Table A-5

USGS Region 07: Upper Mississippi River System
Mean Nitrogen and Phosphorus Concentrations
by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01 Mississippi Headwaters	TP[2]	.318 (103)	.210 (343)	.347 (422)	.215 (49)
	TKN	2.196 (74)	.929 (132)	1.248 (182)	1.168 (19)
	OrgN	.946 (15)	.964 (50)	.947 (49)	.615 (13)
02 Minnesota R.	TP	.299 (70)	.185 (155)	.524 (176)	.813 (23)
	TKN	2.316 (26)	1.819 (74)	2.617 (100)	1.352 (13)
	OrgN	1.396 (20)	1.244 (51)	2.078 (51)	.852 (13)
03 St. Croix R.	TP	.051 (73)	.152 (169)	.306 (151)	.645 (38)
	TKN	.895 (11)	1.526 (104)	2.116 (69)	1.011 (26)
	OrgN	.397 (3)	.888 (12)	.745 (11)	.483 (3)
04 Upper Miss.-Black-Root	TP	.367 (34)	.714 (146)	.321 (131)	.180 (56)
	TKN	1.191 (34)	2.611 (146)	1.381 (129)	.570 (54)
	OrgN	.653 (12)	2.195 (43)	.823 (44)	.512 (13)
05 Chippewa	TP	.950 (85)	.632 (197)	.858 (213)	.347 (73)
	TKN	.778 (46)	.791 (131)	1.083 (105)	.679 (32)
	OrgN	*	*	*	*
06 Upper Mississippi -Maquaketa-Plum -Escambia	TP	.410 (21)	.222 (30)	.703 (36)	.184 (24)
	TKN	1.860 (15)	.844 (16)	2.583 (30)	.733 (18)
	OrgN	*	*	*	*
07 Wisconsin R.	TP	.528 (68)	1.468 (124)	2.741 (160)	.329 (46)
	TKN	1.588 (34)	1.240 (60)	2.480 (45)	.770 (46)
	OrgN	*	*	*	*
08 Upper Miss.-Iowa Skunk-Wapsipinicon	TP	.785 (55)	.366 (94)	.491 (158)	.623 (57)
	TKN	3.692 (26)	1.896 (34)	1.508 (51)	1.189 (28)
	OrgN	1.193 (3)	1.602 (25)	1.384 (62)	.550 (4)

Table A-5 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Rock R.	TP[2]	.349 (162)	.134 (227)	.223 (427)	.280 (90)
	TKN	3.053 (32)	1.213 (62)	2.481 (21)	1.433 (21)
	OrgN	*	*	*	*
10 DesMoines R.	TP	.725 (13)	.599 (36)	.538 (51)	.898 (12)
	TKN	1.750 (14)	1.454 (13)	1.848 (14)	1.500 (12)
	OrgN	*	3.769 (13)	2.744 (18)	*
11 Upper Miss. - Salt	TP	.129 (14)	.451 (25)	.177 (18)	136 (9)
	TKN	1.180 (5)	1.088 (8)	.925 (8)	.900 (1)
	OrgN	*	*	*	*
12 Upper Illinois	TP	.419 (198)	.298 (383)	.238 (493)	.576 (183)
	TKN	1.939 (128)	1.545 (231)	1.464 (276)	1.397 (143)
	OrgN	*	*	*	*
13 Lower Illinois	TP	.419 (136)	.230 (322)	.324 (294)	.542 (182)
	TKN	1.200 (35)	1.318 (128)	1.561 (140)	1.436 (61)
	OrgN	*	*	*	*
14 Upper Miss.- Kaskaskia- Meramec	TP	.280 (136)	.195 (324)	.292 (359)	.380 (180)
	TKN	.996 (71)	1.171 (208)	1.614 (251)	.990 (114)
	OrgN	*	*	*	*
Region 07	TP	.414 (1168)	.347 (2575)	.484 (3089)	.444 (1022)
	TKN	1.771 (551)	1.429 (1347)	1.623 (1421)	1.105 (588)
	OrgN	1.033 (53)	1.576 (194)	1.413 (235)	.638 (46)

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table A6 - Region 08: Lower Mississippi River System Excluding the Arkansas-White-Red System

The Mississippi and its tributaries below the Missouri and Ohio systems (minus the Arkansas-White-Red Region) comprise this region which extends from southern Missouri and Kentucky through the Mississippi delta in southern Louisiana. Region 08 has few individual samples with high phosphorus or nitrogen, and the means are perhaps lower than some might expect from the river draining our nation's entire heartland.

Seasonal means for the nine subregions for total phosphorus ranged from .07 mg/L in the spring season in the Lower Mississippi-Big Black-Escambia Subregion (06) to a high of only .47 mg/L in the fall in the Lower Mississippi-Yazoo area (Subregion 03). The highest individual sample had a 4.6 mg/L concentration of phosphorus, in the summer in the Lower Mississippi-St. Francis Subregion (02).

TKN subregion means in 1989 varied from a low of .44 mg/L in the summer in Subregion 06 to a high of 2.346 mg/L in Subregion 03 in the fall, for subregions and seasons with at least three observations. The maximum single samples had concentrations of 11.26 mg/L TKN in the Louisiana Coastal area (Subregion 08) in the summer, and 10.8 mg/L in the fall in the Lower Red-Ouachita Subregion (04).

For Region 08 as a whole, mean total phosphorus was seasonally steady, varying only from a low of .182 in the fall to .196 in the winter. TKN ranged only from .763 in the fall to .9 in the spring. These and the subregion means are generally lower than those for the measurements taken upstream, particularly from the Missouri River system (Region 10) and the Arkansas-White-Red rivers system (Region 11), and even somewhat lower in general than those for the Upper Mississippi Region. This suggests several possible interpretations including either: (1) There is considerable degradation of nutrient pollutants as they travel downstream in surface waters, applicable to both phosphorus and nitrogen; (2) there is considerable settling out of sediment-attached chemicals and nutrients, particularly applicable to phosphorus; or (3) the increased volume of water in the Lower Mississippi has additional input from smaller, cleaner tributaries leading to dilution of nutrients; and (4) its large surface expanse and therefore increased plant growth which utilizes nitrogen and phosphorus, contribute to a lowering of concentrations. A combination of these processes and possibly others is most likely.

Table A-6

USGS Region 08: Lower Mississippi River System Excluding Arkansas-White-Red (Region 11)
Mean Nitrogen and Phosphorus Concentrations by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01 Lower Mississippi R. - Hatchie	TP[2]	.161 (23)	.114 (43)	.147 (32)	.170 (1)
	TKN	1.100 (1)	.684 (13)	.892 (18)	.500 (1)
	OrgN	*	*	*	*
02 Lower Miss.- St. Francis	TP	.188 (87)	.259 (60)	.398 (100)	.446 (43)
	TKN	.815 (13)	.797 (21)	.872 (17)	.713 (11)
	OrgN	*	*	*	*
03 Lower Miss.- Yazoo	TP	.262 (243)	.190 (292)	.191 (177)	.470 (7)
	TKN	.483 (138)	.507 (125)	.459 (75)	2.346 (7)
	OrgN	*	*	*	*
04 Lower Red - Ouachita	TP	.089 (294)	.097 (279)	.132 (325)	.131 (229)
	TKN	.526 (199)	.621 (226)	.726 (204)	.569 (197)
	OrgN	*	*	*	*
05 Boeuf - Tensas	TP	.286 (94)	.330 (86)	.205 (91)	.159 (92)
	TKN	1.373 (91)	1.320 (85)	1.131 (91)	1.014 (91)
	OrgN	*	*	*	*
06 Lower Miss.- Big Black - Escambia	TP	.193 (7)	.073 (6)	.110 (4)	*
	TKN	1.257 (7)	.517 (6)	.443 (3)	6.340 (1)
	OrgN	*	*	*	*
07 Lower Miss.- Lake Maurepas	TP	.198 (66)	.218 (56)	.184 (65)	.176 (64)
	TKN	1.005 (58)	1.127 (49)	.945 (57)	.640 (52)
	OrgN	*	*	*	*
08 Louisiana Coastal	TP	.274 (103)	.277 (103)	.178 (97)	.174 (101)
	TKN	1.303 (89)	1.460 (91)	1.009 (89)	.721 (90)
	OrgN	*	*	*	*

Table A-6 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09	TP[2]	.199 (99)	.193 (89)	.174 (97)	.198 (89)
Lower	TKN	1.081 (85)	1.172 (83)	.963 (83)	.883 (81)
Mississippi R.	OrgN	*	*	*	*
Region 8	TP	.196 (1016)	.187 (1014)	.188 (988)	.182 (626)
	TKN	.856 (681)	.901 (699)	.850 (637)	.763 (531)
	OrgN	*	*	*	*

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table A7 - Region 10: The Missouri River System

The Missouri River system is the largest geographic USGS Region, covering an area from western Montana through eastern Colorado and southwestern Minnesota to most of Missouri. Its thirty subregions have the highest individual sample concentrations in the study, and some of the higher subregion means. Its upper reaches are frozen and therefore not sampled in the winter and fall seasons.

The lowest subregion mean concentration for total phosphorus in 1989 was .024 mg/L in Subregion 06, the Missouri-Poplar area, in the fall, for subregions and seasons with sufficient observations. The highest means were 18.12 mg/L and 11.15 mg/L in the summer and winter, respectively, in the Cheyenne River subsystem (Subregion 12). Both of these high means were dominated by extremely high individual samples with 830.0 mg/L summer and 1102.0 mg/L winter concentrations, the maximum observations for the region. The next highest single sample was 30.9 mg/L in summer in the Missouri-White Subregion (14).

Seasonal means for TKN in Region 10 ranged from a low of .20 mg/L in the fall in the Gasconade-Osage Subregion (29) to 153.76 mg/L in the Cheyenne Subregion in summer, the latter again dominated by a single sample measurement, of 1300.0 mg/L, the maximum for the region. The second highest individual sample concentration was 28.0, in the summer in the Nebraska Subregion (15).

Organic nitrogen was measured in only one subregion of the thirty, and in only one season.

For the entire Missouri Region as a whole, the seasonal mean total phosphorus varied from .36 mg/L in the spring to a high of 1.70 mg/L in summer; TKN seasonal means ranged from 1.40 mg/L in the spring to 5.33 mg/L in the summer.

Table A-7

USGS Region 10: Missouri River System
Mean Nitrogen and Phosphorus Concentrations by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01 Saskatchewan	TP[2]	*	.020 (1)	.020 (1)	*
	TKN	*	.300 (1)	.200 (1)	*
	OrgN	*	*	*	*
02 Missouri Headwaters	TP	*	.097 (4)	.135 (2)	*
	TKN	*	*	*	*
	OrgN	*	*	*	*
03 Missouri - Marias	TP	.030 (3)	.036 (12)	.052 (8)	.030 (3)
	TKN	.367 (3)	.420 (10)	.367 (6)	.300 (2)
	OrgN	*	*	*	*
04 Missouri - Musselshell	TP	.040 (5)	.046 (9)	.037 (10)	.040 (4)
	TKN	.520 (5)	.432 (8)	.472 (9)	.360 (5)
	OrgN	*	*	*	*
05 Milk	TP	.698 (5)	.075 (4)	.053 (3)	.033 (6)
	TKN	2.640 (5)	.700 (4)	.833 (3)	.600 (4)
	OrgN	*	*	*	*
06 Missouri - Poplar - Escambia	TP	.079 (8)	.057 (11)	.051 (12)	.024 (8)
	TKN	1.225 (8)	.736 (11)	.873 (15)	.700 (8)
	OrgN	*	*	*	*
07 Upper Yellowstone	TP	.035 (2)	.063 (6)	.028 (5)	.030 (2)
	TKN	.400 (2)	.550 (2)	.450 (2)	1.900 (1)
	OrgN	*	*	*	*
08 Big Horn	TP	.112 (22)	.097 (48)	.057 (39)	.075 (15)
	TKN	.589 (19)	2.413 (23)	.695 (22)	.350 (6)
	OrgN	*	*	*	*

Table A-7 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09	TP[2]	.084 (28)	.179 (69)	.654 (31)	.859 (19)
Powder -	TKN	.500 (11)	.557 (23)	.514 (7)	.860 (10)
Tongue	OrgN	*	*	*	*
10	TP	.893 (3)	.038 (4)	.046 (5)	.037 (3)
Lower	TKN	1.533 (3)	1.050 (2)	.720 (5)	.425 (4)
Yellowstone	OrgN	*	*	*	*
11	TP	.510 (1)	.454 (6)	.079 (7)	.038 (5)
Missouri -	TKN	2.600 (1)	1.318 (5)	.850 (2)	.600 (3)
Little Missouri	OrgN	*	*	*	*
12	TP	11.150 (102)	.195 (138)	18.120 (100)	.238 (81)
Cheyenne	TKN	1.155 (11)	.647 (42)	153.760 (17)	.555 (5)
	OrgN	*	*	*	*
13	TP	.254 (62)	.243 (87)	.169 (109)	.090 (24)
Missouri - Oahe	TKN	1.993 (26)	1.624 (30)	2.097 (23)	.725 (8)
	OrgN	*	*	*	*
14	TP	.458 (20)	.945 (30)	3.201 (25)	.316 (14)
Missouri -	TKN	.625 (4)	.899 (7)	1.484 (8)	.540 (2)
White	OrgN	*	*	*	*
15	TP	.168 (34)	.145 (47)	1.269 (142)	.138 (22)
Niobrara	TKN	1.167 (3)	1.237 (18)	5.399 (113)	2.286 (12)
	OrgN	*	*	*	*
16	TP	.543 (41)	.369 (75)	.820 (155)	.724 (17)
James	TKN	2.798 (30)	1.798 (44)	2.878 (136)	1.750 (3)
	OrgN	*	*	*	*
17	TP	.798 (41)	.380 (48)	.584 (51)	.923 (38)
Missouri -	TKN	1.133 (3)	.718 (9)	1.149 (8)	.815 (4)
Big Sioux	OrgN	*	*	*	*
18	TP	.160 (37)	.122 (72)	.235 (70)	.167 (22)
North Platte	TKN	1.066 (15)	1.484 (37)	1.269 (45)	2.779 (15)
	OrgN	*	*	*	*

Table A-7 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
19 South Platte	TP[2]	1.133 (87)	.785 (130)	.293 (181)	.620 (111)
	TKN	5.162 (55)	1.982 (79)	1.734 (127)	2.162 (67)
	OrgN	*	*	*	*
20 Platte	TP	.692 (25)	.723 (33)	.618 (24)	.427 (11)
	TKN	2.216 (19)	2.035 (32)	1.987 (22)	1.799 (11)
	OrgN	*	*	*	*
21 Loup	TP	.240 (41)	.256 (43)	.395 (44)	.182 (4)
	TKN	1.056 (8)	.895 (11)	2.032 (13)	.397 (3)
	OrgN	*	*	*	*
22 Elkhorn	TP	.426 (17)	.353 (18)	.744 (19)	.197 (3)
	TKN	1.334 (14)	1.269 (18)	2.621 (18)	1.303 (3)
	OrgN	*	*	*	*
23 Missouri - Little Sioux	TP	1.784 (28)	.540 (24)	1.487 (26)	.688 (8)
	TKN	1.354 (19)	1.574 (24)	2.036 (26)	1.600 (7)
	OrgN	.889 (9)	*	*	*
24 Missouri - Nishnabotna	TP	.215 (30)	.310 (43)	.277 (72)	.186 (16)
	TKN	1.220 (11)	2.096 (13)	1.340 (9)	.300 (4)
	OrgN	*	*	*	*
25 Republican	TP	.159 (26)	.298 (35)	.684 (51)	.211 (11)
	TKN	.853 (3)	1.110 (9)	1.261 (25)	1.040 (1)
	OrgN	*	*	*	*
26 Smoky Hill	TP	.373 (39)	.360 (61)	1.119 (80)	.231 (24)
	TKN	.625 (4)	1.167 (6)	1.270 (15)	*
	OrgN	*	*	*	*
27 Kansas	TP	.536 (197)	.408 (190)	.539 (181)	.446 (51)
	TKN	1.523 (133)	1.383 (125)	1.505 (88)	.867 (9)
	OrgN	*	*	*	*
28 Chariton - Grand	TP	.144 (7)	.177 (24)	.393 (35)	.100 (3)
	TKN	.829 (7)	1.241 (19)	1.039 (36)	.600 (3)
	OrgN	*	*	*	*

Table A-7 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
29 Gasconade - Osage	TP[2]	.091 (27)	.099 (58)	.149 (94)	.166 (37)
	TKN	.489 (9)	.674 (16)	3.758 (74)	.200 (1)
	OrgN	*	*	*	*
30 Lower Missouri	TP	1.814 (17)	1.245 (29)	.976 (18)	1.387 (14)
	TKN	.567 (3)	.874 (14)	.663 (6)	*
	OrgN	*	*	*	*
Region 10	TP	1.165 (955)	.358 (1359)	1.697 (1600)	.407 (587)
	TKN	1.929 (434)	1.398 (642)	5.328 (881)	1.526 (201)
	OrgN	.889 (9)	*	*	*

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring: April 1 - June 30
Summer: July 1 - September 30
Fall: October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table A8 - Region 11: The Arkansas-White-Red System

The Arkansas-White-Red River Region is the last (and farthest downstream) of the great tributary systems flowing into the Mississippi. Geographically, it stretches from eastern Colorado to Arkansas and Louisiana. It also appears to be one of the regions with higher nutrient concentrations, with several individual samples measuring very high, especially in nitrogen.

Total phosphorus seasonal means for Region 11's subregions ranged from a low of .03 mg/L in the Upper Cimarron Subregion (04) in the winter, to a high of 5.01 mg/L in the Red-Washita Rivers area, Subregion 13, in the fall. The highest individual measurement of TP in 1989 was 18.6 mg/L in the summertime in Subregion 07, the Neosho-Verdigris area; several subregions also had one or more measurements over 12 mg/L.

Seasonal means of TKN varied from a low of .50 mg/L in the Upper Cimarron Subregion in the spring, to reports of 10.95 mg/L in winter in Subregion 09, the Lower Canadian, 9.86 mg/L in winter in the Arkansas-Keystone Subregion (06), and 9.53 mg/L in the fall in the Red-Washita Subregion. The maximum single observations of TKN in 1989 were 82.0 mg/L in winter in the Lower Canadian area, 80.7 mg/L in spring in the Neosho-Verdigris Subregion, and 70.6 mg/L in winter in the Red-Washita area. There were many other individual measurements higher than 40 mg/L in Region 11, making some of its waters higher in nitrogen concentrations than any others flowing to the Gulf of Mexico (with the Missouri River system a close second in some of its subregions).

Organic nitrogen is measured in ten subregions and most seasons for Region 11. The lowest mean subregion organic N was .46 mg/L in spring for the Upper Canadian Subregion (08), for subregions and seasons with sufficient observations; this is unusually low for most subregions in this region. The highest subregion means were 21.68 mg/L in Subregion 14 (Red-Sulphur), 10.83 mg/L in Subregion 06 (Arkansas-Keystone) and 9.78 mg/L in Subregion 13 (Red-Washita). Many subregions and seasons appear to be high in organic nitrogen as well as TKN; maximum individual organic N readings were 58.14 mg/L in winter in the Red-Washita area and 48.28 mg/L in winter in the North Canadian Subregion (10).

Total nitrogen was also measured in a majority of subregions and seasons in Region 11. Subregion means varied from lows of .9 mg/L in summer in the North Canadian area (10) and the Arkansas-Keystone area (06), to highs of 17.9 mg/L in winter in the Lower Canadian, 16.0 mg/L in fall in the Red-Sulphur, 15.8 mg/L in spring in the Neosho-Verdigris and 15.1 mg/L in winter in the Red-Washita. Many subregions had seasonal mean total nitrogen readings over 10 mg/L; data mentioned are from those with a sufficient number of observations.

For the entire Region 11, mean total phosphorus ranged from a low of .535 in summer to 1.305 in the fall; TKN varied from 1.889 in summer to 3.505 in the fall; organic nitrogen ranged from a low of 2.817 in spring to 5.335 in winter; and total nitrogen ranged from 3.345 in summer to 8.815 in the fall season.

Table A-8

USGS Region 11: Arkansas-White-Red System
Mean Nitrogen and Phosphorus Concentrations
by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01	TP[2]	.117 (154)	.153 (181)	.296 (135)	.773 (43)
Upper White	TKN	1.057 (60)	.714 (72)	.742 (65)	.941 (31)
	OrgN	*	*	*	*
02	TP	1.081 (14)	.429 (27)	.342 (28)	.082 (5)
Upper	TKN	3.974 (35)	1.676 (41)	1.868 (73)	4.155 (33)
Arkansas	OrgN	*	*	*	*
03	TP	.624 (60)	.675 (72)	.327 (113)	.409 (41)
Middle	TKN	1.500 (1)	.900 (1)	2.600 (1)	*
Arkansas	OrgN	*	*	*	*
04	TP	.026 (5)	.058 (10)	.146 (20)	.070 (2)
Upper	TKN	.533 (6)	.500 (6)	.500 (2)	.400 (2)
Cimarron	OrgN	*	*	*	*
05	TP	2.894 (16)	.187 (3)	.700 (5)	8.070 (1)
Lower	TKN	5.246 (17)	.867 (3)	.560 (7)	1.546 (1)
Cimarron	OrgN	4.257 (9)	*	*	.870 (1)
	TOTN	9.971 (14)	*	.902 (5)	3.550 (1)
06	TP	2.512 (9)	1.934 (6)	.347 (7)	*
Arkansas -	TKN	9.865 (9)	4.712 (6)	.787 (4)	*
Keystone	OrgN	10.832 (4)	3.940 (4)	*	*
	TOTN	13.141 (7)	12.367 (4)	.920 (3)	*
07	TP	.635 (108)	1.269 (160)	.961 (169)	1.508 (79)
Neosho -	TKN	1.874 (43)	8.488 (44)	6.681 (37)	5.409 (24)
Verdigris	OrgN	3.087 (10)	5.536 (34)	4.645 (19)	2.789 (19)
	TOTN	4.276 (19)	15.804 (32)	11.545 (25)	11.674 (17)
08	TP	.015 (2)	.225 (92)	.408 (42)	.010 (1)
Upper	TKN	.300 (2)	.743 (79)	1.789 (42)	.400 (1)
Canadian	OrgN	*	.465 (93)	1.755 (38)	*
	TOTN	*	1.031 (93)	2.022 (38)	*

Table A-8 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09	TP[2]	2.338 (21)	3.146 (17)	2.057 (55)	2.796 (33)
Lower	TKN	10.955 (19)	5.127 (18)	4.214 (53)	7.847 (34)
Canadian	OrgN	9.060 (8)	3.060 (15)	2.817 (41)	5.539 (32)
	TOTN	17.943 (13)	9.073 (15)	2.001 (13)	10.306 (32)
10	TP	2.632 (35)	.657 (42)	.198 (40)	4.872 (15)
North	TKN	6.617 (33)	2.230 (33)	1.048 (24)	5.880 (15)
Canadian	OrgN	6.083 (21)	5.310 (5)	*	5.019 (14)
	TOTN	11.910 (28)	10.014 (5)	.929 (7)	10.943 (14)
11	TP	.729 (283)	.834 (255)	.570 (322)	1.105 (168)
Lower	TKN	2.704 (203)	2.831 (157)	1.172 (185)	2.329 (113)
Arkansas	OrgN	3.894 (62)	4.685 (40)	1.111 (15)	2.528 (33)
	TOTN	5.802 (131)	6.847 (68)	1.588 (95)	4.617 (59)
12	TP	.133 (8)	1.723 (7)	.192 (6)	.476 (2)
Red	TKN	.635 (6)	4.436 (7)	.826 (8)	3.904 (2)
Headwaters	OrgN	*	6.480 (2)	*	7.080 (1)
	TOTN	3.010 (1)	16.825 (2)	.700 (1)	9.010 (1)
13	TP	2.237 (33)	2.176 (7)	.505 (15)	5.011 (17)
Red-Washita	TKN	8.636 (28)	7.966 (7)	2.586 (15)	9.532 (16)
	OrgN	9.781 (14)	8.247 (4)	10.185 (2)	5.977 (13)
	TOTN	15.110 (19)	14.920 (4)	4.872 (8)	14.824 (14)
14	TP	.198 (163)	.139 (185)	.197 (246)	.566 (113)
Red-Sulphur	TKN	1.245 (91)	1.081 (115)	1.474 (136)	1.758 (71)
	OrgN	3.970 (6)	*	21.677 (3)	6.423 (6)
	TOTN	6.520 (10)	*	10.410 (8)	15.978 (6)
Region 11	TP	.728 (911)	.631 (1064)	.535 (1205)	1.305 (520)
	TKN	3.256 (553)	2.391 (589)	1.889 (654)	3.505 (343)
	OrgN	5.335 (134)	2.817 (197)	3.118 (120)	4.235 (120)
	TOTN	8.244 (242)	6.261 (223)	3.345 (203)	8.815 (144)

* No samples taken

( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen
TOTN = Total Nitrogen

Table A9 - Region 12: The Texas Gulf Region

The Texas Gulf Region consists of several individual river systems flowing into the Gulf of Mexico, from the Sabine River on the Texas-Louisiana state line westward to the Nueces near the southern tip of Texas.

Subregion seasonal mean concentrations for total phosphorus ranged from .02 mg/L in summer in Subregion 11, the Nueces-Southwestern Texas Coastal area, to the highest mean of 1.5 mg/L in the summer in the Central Texas Coastal Subregion (10). Several quarterly means were below .1 mg/L in this region. Maximum individual measurements in 1989 were 8.2 mg/L in the Central Texas Coastal area in winter, 7.7 mg/L in the Galveston Bay-San Jacinto Subregion (04) in spring and 7.6 mg/L in winter in the same subregion.

Quarterly TKN means varied from a low of .37 mg/L in summer in the Nueces-Southwestern Texas Coastal Subregion to 1.63 mg/L in Subregion 05, the Brazos Headwaters, for subregions and seasons with sufficient data. The highest individual samples had TKN concentrations of 17.0 mg/L in winter in the Galveston Bay-San Jacinto Subregion, 16.0 mg/L in winter in Subregion 09, the Lower Colorado-San Bernard Coastal Subregion, and 14.0 mg/L in summer in the Middle Brazos Subregion (06).

Organic total and total inorganic nitrogen were not reported in Region 12. For the entire Texas Gulf Region seasonal means of total phosphorus varied from a low of .28 in spring to .76 in the fall; TKN means ranged from .75 in the spring to 1.0 in the winter.

Table A-9

USGS Region 12: Texas Gulf Region
Mean Nitrogen and Phosphorus Concentrations
by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01 Sabine	TP[2]	.109 (18)	.125 (17)	.066 (11)	.110 (11)
	TKN	.905 (14)	.851 (14)	.849 (13)	.736 (11)
	OrgN	*	*	*	*
02 Neches	TP	.492 (12)	.252 (10)	.068 (5)	.055 (4)
	TKN	.640 (10)	1.557 (7)	.760 (5)	.500 (4)
	OrgN	*	*	*	*
03 Trinity	TP	.772 (95)	.301 (62)	.255 (72)	2.231 (17)
	TKN	1.019 (76)	.910 (59)	.826 (74)	1.118 (17)
	OrgN	*	*	*	*
04 Galveston Bay - San Jacinto	TP	1.325 (149)	.670 (70)	.527 (139)	.689 (49)
	TKN	1.241 (81)	1.126 (43)	1.088 (139)	.829 (49)
	OrgN	*	*	*	*
05 Brazos Headwaters	TP	.045 (5)	.063 (5)	.037 (3)	.010 (1)
	TKN	.675 (4)	.500 (2)	1.633 (3)	.400 (1)
	OrgN	*	*	*	*
06 Middle Brazos	TP	.440 (63)	.183 (56)	.434 (53)	1.334 (8)
	TKN	.865 (57)	.663 (49)	1.112 (65)	1.150 (8)
	OrgN	*	*	*	*
07 Lower Brazos	TP	.127 (59)	.082 (50)	.064 (48)	1.030 (3)
	TKN	.691 (54)	.580 (56)	.735 (60)	.700 (3)
	OrgN	*	*	*	*
08 Upper Colorado	TP	.060 (2)	.080 (1)	.145 (2)	.060 (1)
	TKN	1.000 (2)	.600 (1)	2.150 (2)	.500 (1)
	OrgN	*	*	*	*

Table A-9 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Lower Colorado - San Bernard Coastal	TP[2]	.426 (68)	.105 (99)	.099 (22)	.290 (25)
	TKN	1.264 (66)	.509 (87)	.557 (35)	.711 (28)
	OrgN	*	*	*	*
10 Central Texas Coastal	TP	.811 (73)	.464 (56)	1.491 (33)	.646 (27)
	TKN	.919 (32)	.809 (33)	.682 (36)	.687 (24)
	OrgN	*	*	*	*
11 Nueces - Southwestern Texas Coastal	TP	.547 (28)	.188 (27)	.020 (3)	.075 (2)
	TKN	.414 (7)	.714 (7)	.367 (6)	.750 (2)
	OrgN	*	*	*	*
Region 12	TP	.730 (572)	.279 (453)	.436 (391)	.755 (148)
	TKN	1.003 (403)	.747 (358)	.911 (438)	.809 (148)
	OrgN	*	*	*	*

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table A10 - Region 13: The Rio Grande System

Geographically, the Rio Grande system extends from its headwaters in southern Colorado through the heart of New Mexico and southwestern Texas. The Rio Grande Region has a few subregions (especially the Rio Grande-Elephant Butte and Mimbres areas near its headwaters) with a large number of samples in some seasons of 1989, while some other subregions have very few observations for some nutrients as noted in Table 9. The quarterly means for subregions do not have as much variability in nutrient concentrations as some other regions.

Mean total phosphorus ranged from a low of .026 mg/L in the lower Rio Grande valley in the winter to .752 mg/L in summer in the intensively sampled Rio Grande-Elephant Butte Subregion, for those subregions with several observations per season. The maximum individual sample in 1989 was 6.54 mg/L in the spring in the Elephant Butte area (Subregion 02).

Mean TKN by subregion varied from .300 mg/L in the Rio Grande Headwaters Subregion in wintertime to 1.825 mg/L in summer in Subregion 04, the Rio Grande-Armistad area, again for those subregions and seasons with sufficient sampling. The highest single sample was again in the spring in the Rio Grande-Elephant Butte Subregion: 28.0 mg/L.

Organic nitrogen is measured in only a few subregions. The lowest mean for a subregion and season with sufficient sampling was .244 mg/L in winter in the Elephant Butte area; the highest such mean was .670 in spring in the same subregion. A 13.99 mg/L reading was the maximum single measurement, in the same Elephant Butte Subregion in spring.

Total nitrogen is reported in the Rio Grande Region, but sparsely. A fairly high mean of 2.022 mg/L in summer was found in the Elephant Butte area. The highest reading was 28.95 mg/L in spring for total N in the Elephant Butte Subregion.

For the entire Rio Grande system, 1989 total phosphorus means ranged from a low of .158 mg/L in winter to a high of .557 mg/L in summer. TKN means were .672 mg/L in fall and .678 mg/L in winter, with a seasonal high of 1.231 in spring. Organic nitrogen, for all of the subregions reporting, ranged from .240 in winter to .630 in the spring.

Table A-10

USGS Region 13: Rio Grande System
Mean Nitrogen and Phosphorus Concentrations
by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01	TP[2]	.084 (11)	.082 (8)	.075 (10)	.107 (3)
Rio Grande	TKN	.300 (1)	.550 (2)	.600 (1)	.600 (2)
Headwaters	OrgN	*	*	*	*
02	TP	.210 (27)	.409 (114)	.752 (69)	.514 (14)
Rio Grande -	TKN	.705 (25)	1.555 (121)	1.242 (77)	.756 (13)
Elephant Butte	OrgN	.244 (19)	.670 (115)	.418 (57)	.352 (4)
	TOTN	1.656 (17)	1.993 (105)	2.022 (57)	.560 (4)
03	TP	.489 (9)	.091 (36)	.155 (2)	.310 (1)
Rio Grande -	TKN	1.317 (6)	.614 (35)	1.000 (2)	.400 (1)
Mimbres	OrgN	*	.507 (34)	*	*
	TOTN	*	.812 (34)	*	*
04	TP	.147 (12)	.305 (2)	.590 (3)	.720 (2)
Rio Grande -	TKN	.667 (12)	.600 (3)	1.825 (4)	.933 (3)
Armistad	OrgN	*	*	*	*
05	TP	.025 (2)	*	.030 (2)	.040 (1)
Rio Grande	TKN	.400 (2)	.400 (1)	.400 (2)	.200 (1)
Closed Basins	OrgN	*	*	*	*
06	TP	.050 (9)	.069 (11)	.120 (12)	.042 (6)
Upper	TKN	.381 (8)	.526 (13)	.800 (10)	.527 (6)
Pecos	OrgN	.205 (2)	.240 (1)	*	.280 (2)
	TOTN	*	.460 (1)	*	.420 (2)
07	TP	.025 (2)	.010 (1)	.010 (2)	*
Lower Pecos	TKN	.500 (2)	.400 (1)	1.150 (2)	.200 (1)
	OrgN	*	*	*	*
08	TP	.050 (8)	.147 (7)	*	*
Rio Grande -	TKN	.350 (2)	.825 (4)	*	*
Falcon	OrgN	*	*	*	*

Table A-10 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Lower Rio Grande	TP[2]	.026 (7)	.132 (9)	.050 (1)	.110 (2)
	TKN	.750 (2)	.567 (3)	.700 (1)	.850 (2)
	OrgN	*	*	*	*
Region 13	TP	.158 (88)	.288 (188)	.557 (101)	.337 (29)
	TKN	.678 (61)	1.231 (183)	1.185 (99)	.672 (29)
	OrgN	.240 (21)	.630 (150)	.418 (57)	.328 (6)
	TOTN	1.656 (17)	1.695 (140)	2.022 (57)	.513 (6)

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring: April 1 - June 30
Summer: July 1 - September 30
Fall: October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen
TOTN = Total Nitrogen

APPENDIX B

Subregional Analysis of Ambient Concentrations

Appendix B: Brief Interpretation of Tables B2-B10: Ambient Concentrations

(Table B1 is included for easy reference only. It is identical to Table 6.)

Table B2 - Region 03 (Partial): The Gulf Coast River Systems of the Southeast Region

Region 03, we must remember, is the only region whose data is for approximately half of its subregions only. Subregions 01 through 08 and part of 09 flow directly into the Atlantic, while part of 09 and all of 10 through 18 flow into the Gulf. The half of Region 03 flowing into the Gulf of Mexico covers the geographic area from southwestern Florida through a small part of eastern Louisiana.

The quarterly ambient means presented by subregion again show a wide range of nutrient concentrations (all data is in milligrams per liter). Mean total phosphorus ranged from .05 mg/L in the spring in Subregion 17, the Pascagoula River system, to .89 mg/L in the winter in Subregion 12, the Ochlockonee system, though a few very high readings may dominate the latter, as is the case in several regions. The means generally show a very slight decrease from Table A2; organic and total nitrogen means, where data exist, are identical. The highest individual sample readings in 1989 include 6.6 mg/L in the summer in the Peace River system in Florida (Subregion 10), 5.6 mg/L in both the Peace River system (FL) in winter and the Ochlockonee system (Subregion 12), also in winter, and 5.42 mg/L in the Kissimmee-Okeechobee (Subregion 09) in winter.

Mean ambient TKN ranged from .416 mg/L in the fall in Subregion 13, the Apalachicola River system, to 2.927 mg/L in Subregion 14, the Choctawhatchee-Escambia-Peace (Alabama) system in spring. Maximum individual samples were an extremely high 98.8 mg/L in the summer in Subregion 15, the Coosa-Alabama River system (the mean was still 1.45 mg/L) and 3.04 mg/L in spring in the Choctawhatchee-Escambia-Peace (Alabama) system. Many subregions had one or more samples of TKN of 11 mg/L or higher in the Gulf rivers of Region 03.

Organic Nitrogen is not reported in every subregion. Mean ambient Organic N ranged from .083 mg/L in spring in the Suwanee River system (Subregion 11) to 2.962 mg/L in spring in the Tombigbee system, the latter strongly influenced by the highest individual sampling in the region in 1989 of

13.6 mg/L. The second highest concentration reported was 9.85 mg/L in summer, also in the Tombigbee system.

For Region 03's gulf coast river systems overall, quarterly means of ambient total phosphorus ranged from .180 mg/L for the fall season to .337 mg/L in winter. Ambient TKN varied from a low of .739 mg/L in fall to 1.298 mg/L during the spring. Organic nitrogen means (with many subregions not reporting) were lowest in fall (.780 mg/L) and highest in summer (.982 mg/L). Again, the general trend shows a very slight decrease from Table A2, which included some nonambient samples.

Table B-1

USGS Region Summaries: Mean Ambient Nitrogen and Phosphorus Concentrations by Region

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
03	TP[2]	.337 (766)	.305 (713)	.219 (615)	.180 (427)
Southeast (Gulf	TKN	1.106 (630)	1.298 (704)	1.131 (641)	.739 (371)
of Mexico River	OrgN	.808 (214)	.888 (197)	.982 (177)	.780 (112)
Systems Only)	TOTN	1.062 (98)	1.311 (46)	*	*
05	TP	.268 (845)	.130 (1404)	.206 (2068)	.309 (916)
Ohio River	TKN	.599 (585)	.549 (1278)	.649 (1843)	.697 (670)
System	OrgN	*	*	*	*
06	TP	.187 (113)	.084 (381)	.070 (569)	.172 (85)
Tennessee	TKN	.450 (72)	.471 (146)	.421 (136)	.282 (94)
	OrgN	.385 (33)	.260 (298)	.228 (488)	.380 (12)
07	TP	.396 (1160)	.286 (2566)	.350 (3074)	.394 (1012)
Upper Miss	TKN	1.758 (549)	1.419 (1344)	1.587 (1408)	1.104 (591)
	OrgN	1.033 (53)	1.576 (194)	1.418 (234)	.638 (46)
08	TP	.196 (1016)	.187 (1014)	.186 (1021)	.179 (714)
Lower Miss	TKN	.856 (681)	.901 (699)	.828 (669)	.711 (606)
	OrgN	*	*	*	*
10	TP	1.630 (953)	.335 (1346)	1.641 (1569)	.418 (562)
Missouri River	TKN	1.929 (434)	1.341 (635)	4.853 (856)	1.526 (201)
System	OrgN	.543 (7)	*	*	*
11	TP	.301 (794)	.274 (964)	.429 (1153)	.526 (423)
Arkansas -	TKN	1.129 (435)	1.007 (499)	1.296 (619)	1.433 (248)
Red - White	OrgN	.486 (20)	.464 (112)	1.342 (89)	.496 (32)
River System	TOTN	2.016 (124)	1.031 (132)	1.434 (176)	1.597 (49)
12	TP	.730 (572)	.279 (453)	.436 (391)	.755 (148)
Texas Gulf	TKN	1.003 (403)	.747 (358)	.911 (438)	.809 (148)
	OrgN	*	*	*	*

Table B-1 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
13	TP[2]	.154 (86)	.126 (180)	.259 (92)	.337 (29)
Rio Grande	TKN	.580 (59)	.553 (175)	.783 (90)	.672 (29)
System	OrgN	.155 (19)	.294 (142)	.305 (48)	.328 (6)
	TOTN	.637 (15)	.687 (132)	.644 (48)	.513 (6)

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen
TOTN = Total Nitrogen

Table B-2

Partial USGS Region 03: Southeast Gulf Coast River Systems
Mean Ambient Nitrogen and Phosphorus
Concentrations by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Partial	TP[2]	.227 (90)	.298 (105)	.251 (96)	.086 (67)
Caloosahatchee	TKN	1.171 (96)	1.230 (106)	1.530 (93)	1.153 (66)
L. Okeechobee	OrgN	.946 (64)	1.102 (60)	1.153 (61)	1.006 (57)
10	TP	.371 (168)	.549 (118)	.664 (43)	.342 (39)
Peace (FL) -	TKN	1.055 (164)	1.101 (120)	1.388 (42)	.909 (39)
Tampa Bay	OrgN	.842 (103)	.944 (50)	2.474 (7)	2.864 (5)
	TOTN	1.062 (98)	1.311 (46)	*	*
11	TP	.667 (61)	.351 (57)	.494 (32)	.594 (29)
Suwanee	TKN	.555 (26)	.787 (34)	.745 (20)	.577 (7)
	OrgN	.446 (7)	.083 (7)	.431 (7)	.255 (4)
12	TP	.897 (27)	.599 (17)	.352 (22)	.438 (12)
Ochlockonee	TKN	2.877 (7)	1.886 (5)	.661 (8)	.607 (3)
	OrgN	.651 (19)	.782 (19)	.572 (16)	.338 (20)
13	TP	.275 (185)	.191 (190)	.148 (198)	.142 (117)
Apalachicola	TKN	.816 (29)	.700 (47)	.602 (48)	.416 (23)
	OrgN	.193 (11)	.440 (11)	.356 (10)	.145 (11)
14	TP	.505 (68)	.542 (73)	.252 (42)	.060 (52)
Choctawhatchee	TKN	1.454 (98)	2.927 (110)	1.015 (70)	.583 (60)
- Escambia	OrgN	.812 (10)	.650 (13)	.693 (20)	.544 (11)
15	TP	.178 (96)	.106 (93)	.107 (89)	.087 (51)
Coosa - Alabama	TKN	1.104 (49)	.746 (80)	1.450 (110)	.422 (52)
	OrgN	*	.317 (29)	.295 (37)	.087 (4)
16	TP	.133 (26)	.098 (22)	.074 (25)	.085 (22)
Tombigbee -	TKN	.786 (106)	1.056 (159)	1.034 (170)	.550 (79)
Mobile Bay	OrgN	*	2.962 (8)	2.401 (19)	*

Table B-2 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
17	TP[2]	.065 (16)	.054 (10)	.107 (35)	.739 (8)
Pascagoula	TKN	1.713 (24)	.613 (15)	.768 (39)	2.060 (12)
	OrgN	*	*	*	*
18	TP	.111 (29)	.096 (27)	.099 (31)	.113 (28)
Pearl	TKN	1.044 (31)	.814 (27)	.892 (31)	.730 (28)
	OrgN	*	*	*	*
Region 03	TP	.337 (766)	.305 (713)	.219 (615)	.180 (427)
(Partial)	TKN	1.106 (630)	1.298 (704)	1.131 (641)	.739 (371)
	OrgN	.808 (214)	.888 (197)	.982 (177)	.780 (112)
	TOTN	1.062 (98)	1.311 (46)	*	*

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring: April 1 - June 30
Summer: July 1 - September 30
Fall: October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen
TOTN = Total Nitrogen

<u>Table B3 - Region 05</u>: The Ohio River System*

Again we should point out that the Tennessee River system, which joins the Ohio shortly before it flows into the Mississippi, has been given its own separate region (06) by the USGS. For the rest of the Ohio system, Region 05, quarterly mean concentrations for ambient total phosphorus in the subregions varied from a low of .032 mg/L in the fall in the Kentucky-Licking rivers area (several other subregions again also had seasonal means below .1 mg/L) to 1.147 mg/L, also in the fall, in the Middle Ohio Subregion (09). The maximum individual samples were 35.7 mg/L in the fall in the Middle Ohio area, 16.0 mg/L in the fall in Subregion 06, the Scioto River area, and 15.36 mg/L in winter in the Wabash River Subregion (12).

Mean ambient TKN in Region 05 in 1989 ranged on a seasonal basis from a low of .16 mg/L in the springtime in the Monongahela area (Subregion 02), to 1.55 mg/L in the winter in Subregion 12 (Wabash). Maximum single readings of TKN were 37.0 mg/L in spring, 34.0 mg/L in the fall, and 20.0 mg/L in summer in Subregions 05 (Kanawha River), 12 (Wabash), and 09 (Middle Ohio), respectively.

Organic nitrogen was not measured in Region 05 in 1989.

For the region as a whole, mean ambient total phosphorus in the Ohio Region varied from a low of .130 mg/L in spring to .309 mg/L in the fall. TKN was steady overall, though not in all subregions: it ranged from .549 mg/L in the spring to a high of .697 mg/L in the fall.

* Excluding the Tennessee tributary system (Region 06).

Table B-3

USGS Region 05: Ohio River System
Mean Ambient Nitrogen and Phosphorus Concentrations by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01 Allegheny	TP[2]	.045 (73)	.066 (74)	.060 (79)	.052 (79)
	TKN	.217 (3)	.242 (4)	.330 (3)	.330 (3)
	OrgN	*	*	*	*
02 Monongahela	TP	.075 (64)	.093 (61)	.076 (69)	.113 (60)
	TKN	.240 (26)	.160 (24)	.371 (27)	.301 (18)
	OrgN	*	*	*	*
03 Upper Ohio	TP	.152 (97)	.133 (95)	.128 (120)	.136 (110)
	TKN	.585 (49)	.463 (59)	.491 (78)	.453 (64)
	OrgN	*	*	*	*
04 Muskingum	TP	.182 (36)	.088 (129)	.273 (367)	.169 (60)
	TKN	.644 (48)	.397 (164)	.679 (372)	.429 (68)
	OrgN	*	*	*	*
05 Kanawha	TP	.098 (71)	.093 (108)	.107 (156)	.087 (109)
	TKN	.349 (79)	.558 (159)	.377 (174)	.442 (119)
	OrgN	*	*	*	*
06 Scioto	TP	.205 (45)	.148 (85)	.402 (112)	1.102 (84)
	TKN	1.033 (36)	.689 (74)	.585 (127)	.901 (104)
	OrgN	*	*	*	*
07 Big Sandy - Guyandotte	TP	.082 (51)	.055 (74)	.059 (105)	.042 (33)
	TKN	.258 (75)	.207 (111)	.255 (124)	.217 (58)
	OrgN	*	*	*	*
08 Great Miami	TP	.128 (21)	.220 (66)	.300 (221)	.313 (17)
	TKN	.797 (29)	.835 (105)	.656 (233)	.537 (16)
	OrgN	*	*	*	*

Table B-3 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Middle Ohio	TP[2]	.162 (23)	.088 (91)	.173 (119)	1.147 (40)
	TKN	.468 (36)	.332 (106)	.678 (160)	.557 (53)
	OrgN	*	*	*	*
10 Kentucky - Licking	TP	.193 (43)	.121 (73)	.154 (66)	.032 (13)
	TKN	.495 (44)	.407 (87)	.424 (78)	.582 (15)
	OrgN	*	*	*	*
11 Green	TP	.064 (25)	.085 (34)	.042 (46)	*
	TKN	.436 (26)	.451 (53)	.379 (51)	*
	OrgN	*	*	*	*
12 Wabash	TP	.682 (197)	.189 (298)	.232 (400)	.305 (259)
	TKN	1.550 (52)	1.032 (144)	1.098 (239)	1.448 (118)
	OrgN	*	*	*	
13 Cumberland	TP	.059 (23)	.132 (37)	.071 (39)	.144 (8)
	TKN	.228 (19)	.584 (30)	.353 (33)	.441 (5)
	OrgN	*	*	*	*
14 Lower Ohio	TP	.324 (76)	.144 (179)	.224 (169)	.264 (44)
	TKN	.664 (63)	.593 (158)	.932 (144)	.820 (29)
	OrgN	*	*	*	*
Region 05	TP	.268 (845)	.130 (1404)	.206 (2068)	.309 (916)
	TKN	.599 (585)	.549 (1278)	.649 (1843)	.697 (670)
	OrgN	*	*	*	*

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table B4 - Region 06: **Tennessee River System**

Flowing into the Ohio and thence to the Mississippi, the Tennessee River and its tributaries comprise one of the smaller USGS hydrologic Regions. The Tennessee River system was one of the less polluted areas in 1989, in terms of nitrogen and phosphorus, when samples are limited strictly to ambient observations, as before in Appendix A which included some nonambient data.

Mean ambient total phosphorus concentrations presented quarterly for the four subregions ranged from .05 mg/L in the summer in the Middle Tennessee-Elk Subregion (03), with several seasonal means below .1 mg/L, to .47 mg/L in the winter in the Lower Tennessee Subregion (04). The highest individual 1989 measurements of TP (total phosphorus) were 2.4 mg/L in the Middle Tennessee-Hiwassee area (Subregion 02), in the spring season, and 2.34 mg/L in the Lower Tennessee area in winter.

Quarterly ambient TKN means varied from a low of .16 mg/L in the spring in the Middle Tennessee-Hiwassee Subregion, to 1.76 mg/L in the Middle Tennessee-Elk Subregion, also in the spring. The maximum sample readings were 4.0 mg/L and 3.9 mg/L in spring and winter, respectively, in the Middle Tennessee-Elk area.

Seasonal ambient mean organic nitrogen, reported in most subregions and seasons, ranged from .19 mg/L in the Middle Tennessee-Hiwassee area in summer (for data with sufficient observations), to .54 mg/L in fall in the Middle Tennessee-Elk subsystem. The highest individual concentration was 4.0 mg/L in the Middle Tennessee-Elk area in the spring.

For the entire Tennessee Valley, ambient total phosphorus varied from a low of .07 mg/L in summer to a high of .19 mg/L in winter; TKN from .28 mg/L in fall to .47 mg/L in spring; and Organic Nitrogen from .23 mg/L in summer to .385 mg/L in winter.

Table B-4

USGS Region 06: Tennessee River System
Mean Ambient Nitrogen and Phosphorus Concentrations by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01	TP[2]	.110 (69)	.082 (82)	.086 (97)	.100 (47)
Upper Tennessee	TKN	.322 (57)	.347 (106)	.315 (110)	.278 (85)
	OrgN	.396 (23)	*	.292 (15)	.307 (7)
02	TP	.314 (29)	.072 (209)	.066 (223)	.182 (21)
Middle Tennessee	TKN	.465 (6)	.164 (20)	.500 (1)	*
- Hiwassee	OrgN	.310 (4)	.198 (196)	.190 (209)	.095 (2)
03	TP	.097 (7)	.089 (73)	.051 (232)	.172 (12)
Middle Tennessee	TKN	1.717 (6)	1.762 (14)	1.007 (19)	.320 (6)
- Elk	OrgN	.438 (4)	.380 (102)	.255 (262)	.537 (10)
04	TP	.468 (8)	.219 (17)	.292 (17)	.336 (13)
Lower	TKN	.320 (3)	.668 (6)	.486 (6)	.343 (3)
Tennessee	OrgN	.310 (2)	*	.180 (2)	.420 (1)
Region 06	TP	.187 (113)	.084 (381)	.070 (569)	.172 (85)
	TKN	.450 (72)	.471 (146)	.421 (136)	.282 (94)
	OrgN	.385 (33)	.260 (298)	.228 (488)	.380 (12)

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table B5 - Region 07: Upper Mississippi River System

Again, the Upper Mississippi system includes the upper reaches of the mighty river which eventually drains nearly two-thirds of the surface water in the 48 contiguous states, and all of its tributaries in Minnesota, Wisconsin, Iowa, northern Missouri and Illinois which join it upstream of the Missouri River (Region 10) on the western bank and the Ohio River (Region 05) on the eastern bank.

Ambient nutrient concentrations are also highly variable in the Upper Mississippi Region, still without a consistent trend either seasonally or from upstream to downstream. Mean ambient total phosphorus in each subregion ranged in 1989 from .05 mg/L in winter in the St. Croix River Subregion (03) and in the fall in the Wisconsin Subregion (07) to a high of .95 mg/L in the winter in the Chippewa area (Subregion 05). The highest individual phosphorus sample was 29.8 mg/L in the Minnesota River system (Subregion 02), in the summer, with several samples at or above 10 mg/L in various subregions.

Mean ambient TKN among the subregions ranged from .57 mg/L in the fall season in the Upper Mississippi-Black-Root system (Subregion 04) to 3.69 mg/L in winter in the Iowa-Skunk-Wapsipinicon area (Subregion 08). There was a slight trend of increasing concentrations from upstream to downstream in some seasons. Maximum concentrations were found at 28 mg/L in the spring in the Upper Mississippi-Blackroot area (04) and the Minnesota system in summer, 27 mg/L in the fall in the Lower Illinois River (13), and 25 mg/L in summer in the Kaskaskia-Meramec area (14).

The means for organic nitrogen, reported in fewer than half of the subregions, varied from a low of .4 mg/L in the St. Croix River area in winter to 3.77 mg/L in the Des Moines River subsystem (Subregion 10) in spring. The highest individual ambient concentrations were 27.3 mg/L in summer in the Minnesota River area, 26.5 mg/L in the spring in Subregion 04, the Upper Mississippi-Black-Root, and 24.0 mg/L in spring in the Des Moines River Subregion (10).

For Region 07 overall the mean ambient total phosphorus was fairly steady, ranging from .286 mg/L in spring to .396 mg/L in winter. Mean TKN varied only from 1.1 mg/L in the fall to 1.76 mg/L in winter. Seasonal means for ambient organic nitrogen (for those subregions reporting) ranged from a low of .64 mg/L in the fall to 1.58 mg/L in the spring.

Table B-5

USGS Region 07: Upper Mississippi River System
Mean Ambient Nitrogen and Phosphorus Concentrations by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01 Mississippi Headwaters	TP[2]	.318 (103)	.210 (343)	.347 (422)	.215 (49)
	TKN	2.196 (74)	.929 (132)	1.248 (182)	1.168 (19)
	OrgN	.946 (15)	.964 (50)	.947 (49)	.615 (13)
02 Minnesota R.	TP	.299 (70)	.185 (155)	.524 (176)	.813 (23)
	TKN	2.316 (26)	1.819 (74)	2.617 (100)	1.352 (13)
	OrgN	1.396 (20)	1.244 (51)	2.078 (51)	.852 (13)
03 St. Croix R.	TP	.051 (73)	.152 (169)	.306 (151)	.083 (36)
	TKN	.895 (11)	1.526 (104)	2.116 (69)	1.011 (26)
	OrgN	.397 (3)	.888 (12)	.745 (11)	.483 (3)
04 Upper Miss.-Black-Root	TP	.367 (34)	.714 (146)	.321 (131)	.180 (56)
	TKN	1.191 (34)	2.611 (146)	1.381 (129)	.570 (54)
	OrgN	.653 (12)	2.195 (43)	.823 (44)	.512 (13)
05 Chippewa	TP	.950 (85)	.617 (196)	.647 (207)	.072 (65)
	TKN	.778 (46)	.768 (130)	1.033 (93)	.679 (32)
	OrgN	*	*	*	*
06 Upper Mississippi -Maquaketa-Plum-Escambia	TP	.410 (21)	.222 (30)	.703 (36)	.184 (24)
	TKN	1.860 (15)	.844 (16)	2.583 (30)	.733 (18)
	OrgN	*	*	*	*
07 Wisconsin R.	TP	.190 (63)	.234 (118)	.488 (153)	.050 (43)
	TKN	1.353 (32)	1.029 (58)	1.307 (41)	.770 (46)
	OrgN	*	*	*	*
08 Upper Mississippi-Iowa-Skunk-Wapsipinicon	TP	.785 (55)	.366 (94)	.464 (157)	.623 (57)
	TKN	3.692 (26)	1.896 (34)	1.508 (51)	1.189 (28)
	OrgN	1.193 (3)	1.602 (25)	1.402 (61)	.550 (4)

Table B-5 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Rock R.	TP[2]	.349 (162)	.134 (227)	.223 (427)	.280 (90)
	TKN	3.053 (32)	1.213 (62)	2.481 (21)	1.433 (21)
	OrgN	*	*	*	*
10 DesMoines R.	TP	.725 (13)	.599 (36)	.538 (51)	.898 (12)
	TKN	1.750 (14)	1.454 (13)	1.848 (14)	1.500 (12)
	OrgN	*	3.769 (13)	2.744 (18)	*
11 Upper Miss. - Salt	TP	.129 (14)	.451 (25)	.177 (18)	136 (9)
	TKN	1.180 (5)	1.088 (8)	.925 (8)	.900 (1)
	OrgN	*	*	*	*
12 Upper Illinois	TP	.424 (195)	.298 (381)	.238 (492)	.576 (183)
	TKN	1.939 (128)	1.545 (231)	1.461 (279)	1.397 (143)
	OrgN	*	*	*	*
13 Lower Illinois	TP	.419 (136)	.230 (322)	.324 (294)	.542 (182)
	TKN	1.200 (35)	1.318 (128)	1.561 (140)	1.436 (61)
	OrgN	*	*	*	*
14 Upper Miss.-Kaskaskia-Meramec	TP	.280 (136)	.195 (324)	.292 (359)	.375 (183)
	TKN	.996 (71)	1.171 (208)	1.614 (251)	.987 (117)
	OrgN	*	*	*	*
Region 07	TP	.396 (1160)	.286 (2566)	.350 (3074)	.394 (1012)
	TKN	1.758 (549)	1.419 (1344)	1.587 (1408)	1.104 (591)
	OrgN	1.033 (53)	1.576 (194)	1.418 (234)	.638 (46)

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table B6 - Region 08: Lower Mississippi River System Excluding the Arkansas-White-Red System

Remembering that Region 08, the Mississippi and its tributaries below the Missouri and Ohio systems, excludes the Arkansas-White-Red (Region 11), ambient concentrations again show few individual samples with high phosphorus or nitrogen, and the mean concentrations are perhaps lower than some might expect from the river draining our nation's entire heartland.

Seasonal ambient mean concentrations for the nine subregions for total phosphorus ranged from .07 mg/L in the spring season in the Lower Mississippi-Big Black-Escambia Subregion (06) to a high of only .446 mg/L in the fall in the Lower Mississippi-St. Francis area (Subregion 02). The highest individual sample in 1989 had a 6.3 mg/L concentration of phosphorus, in the fall in the Lower Red-Ouachita Subregion (04).

Ambient TKN subregion means varied from a low of .44 mg/L in the summer in Subregions 03 (Lower Miss-Yazoo) and 06 (Lower Miss-Big Black) to a high of 1.46 mg/L in Subregion 08 in the spring, for subregions and seasons with at least three observations. The maximum single ambient samples had concentrations of 11.26 mg/L TKN in the Louisiana Coastal area (Subregion 08) in the summer, and 10.8 mg/L in the fall in the Lower Red-Ouachita Subregion (04).

Organic nitrogen was not measured in Region 08 in 1989.

For Region 08 as a whole, mean ambient total phosphorus was seasonally steady, varying only from a low of .179 in the fall to .196 in the winter. TKN ranged only from .711 in the fall to .9 in the spring. These and the subregion means are generally lower than those for the measurements taken upstream, particularly from the Missouri River system (Region 10) and the Arkansas-White-Red rivers system (Region 11), and even somewhat lower in general than those for the Upper Mississippi Region. Several possible interpretations are suggested in Appendix A, with a combination of processes most likely.

Table B-6

USGS Region 08: Lower Mississippi River System Excluding Arkansas-White-Red (Region 11)
Mean Ambient Nitrogen and Phosphorus Concentrations by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01	TP[2]	.161 (23)	.114 (43)	.143 (33)	.105 (14)
Lower Mississippi	TKN	1.100 (1)	.684 (13)	.892 (18)	.500 (1)
R. - Hatchie	OrgN	*	*	*	*
02	TP	.188 (87)	.259 (60)	.398 (100)	.446 (43)
Lower Miss.-	TKN	.815 (13)	.797 (21)	.872 (17)	.713 (11)
St. Francis	OrgN	*	*	*	*
03	TP	.262 (243)	.190 (292)	.181 (209)	.192 (82)
Lower Miss.-	TKN	.483 (138)	.507 (125)	.440 (107)	.513 (82)
Yazoo	OrgN	*	*	*	*
04	TP	.089 (294)	.097 (279)	.132 (325)	.131 (229)
Lower Red -	TKN	.526 (199)	.621 (226)	.726 (204)	.569 (197)
Ouachita	OrgN	*	*	*	*
05	TP	.286 (94)	.330 (86)	.205 (91)	.159 (92)
Boeuf -	TKN	1.373 (91)	1.320 (85)	1.131 (91)	1.014 (91)
Tensas	OrgN	*	*	*	*
06	TP	.193 (7)	.073 (6)	.110 (4)	*
Lower Miss.-	TKN	1.257 (7)	.517 (6)	.443 (3)	6.340 (1)
Big Black	OrgN	*	*	*	*
- Escambia					
07	TP	.198 (66)	.218 (56)	.184 (65)	.176 (64)
Lower Miss.-	TKN	1.005 (58)	1.127 (49)	.945 (57)	.640 (52)
Lake Maurepas	OrgN	*	*	*	*
08	TP	.274 (103)	.277 (103)	.178 (97)	.174 (101)
Louisiana	TKN	1.303 (89)	1.460 (91)	1.009 (89)	.721 (90)
Coastal	OrgN	*	*	*	*

Table B-6 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Lower Mississippi R.	TP[2]	.199 (99)	.193 (89)	.174 (97)	.198 (89)
	TKN	1.081 (85)	1.172 (83)	.963 (83)	.883 (81)
	OrgN	*	*	*	*
Region 8	TP	.196 (1016)	.187 (1014)	.186 (1021)	.179 (714)
	TKN	.856 (681)	.901 (699)	.828 (669)	.711 (606)
	OrgN	*	*	*	*

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table B7 - Region 10: The Missouri River System

The thirty subregions of the Missouri system have some of the highest individual ambient sample concentrations in the study, and some of the higher subregion means. Its upper reaches are frozen and therefore not sampled in the winter and fall seasons. Though it is the largest geographic USGS Region, the smaller flow of water from the Missouri system than the Ohio means that less impact is actually felt in the Gulf of Mexico.

The lowest ambient subregion mean concentration in Region 10 for total phosphorus in 1989 was .024 mg/L in Subregion 06, the Missouri-Poplar area, in the fall, for those subregions and seasons with sufficient observations. The highest means were 18.12 mg/L and 11.16 mg/L in the summer and winter, respectively, in the Cheyenne River subsystem (Subregion 12). Both of these high means were dominated by extremely high individual samples with 830.0 mg/L summer and 1102.0 mg/L winter concentrations, the maximum observations for the region. The next highest single sample was 30.9 mg/L in summer in the Missouri-White Subregion (14).

Seasonal ambient means for TKN in Region 10 ranged from a low of .30 mg/L in the fall in the Missouri-Nishnabotna Subregion (24) to 153.76 mg/L in the Cheyenne Subregion in summer, the latter again dominated by a single sample measurement, of 1300.0 mg/L, the maximum for the region. The next highest individual sample concentrations were 39.0 mg/L in the summer and 32.0 mg/L in the fall, both in the South Platte Subregion (19). Means quoted are for subregions and seasons with sufficient observations.

Organic nitrogen was measured in only one subregion of the thirty, and in only one season.

For the entire Missouri Region as a whole, the seasonal ambient mean total phosphorus varied from .335 mg/L in the spring to a high of 1.641 mg/L in summer; TKN seasonal means ranged from 1.341 mg/L in the spring to 4.853 mg/L in the summer.

Table B-7

USGS Region 10: Missouri River System
Mean Ambient Nitrogen and Phosphorus Concentrations by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01 Saskatchewan	TP[2]	*	.020 (1)	.020 (1)	*
	TKN	*	.300 (1)	.200 (1)	*
	OrgN	*	*	*	*
02 Missouri Headwaters	TP	*	.097 (4)	.135 (2)	*
	TKN	*	*	*	*
	OrgN	*	*	*	*
03 Missouri - Marias	TP	.030 (3)	.036 (12)	.052 (8)	.030 (3)
	TKN	.367 (3)	.420 (10)	.367 (6)	.300 (2)
	OrgN	*	*	*	*
04 Missouri - Musselshell	TP	.040 (5)	.046 (9)	.037 (10)	.040 (4)
	TKN	.520 (5)	.432 (8)	.472 (9)	.360 (5)
	OrgN	*	*	*	*
05 Milk	TP	.698 (5)	.075 (4)	.053 (3)	.033 (6)
	TKN	2.640 (5)	.700 (4)	.833 (3)	.600 (4)
	OrgN	*	*	*	*
06 Missouri-Poplar-Escambia	TP	.079 (8)	.057 (11)	.051 (12)	.024 (8)
	TKN	1.225 (8)	.736 (11)	.873 (15)	.700 (8)
	OrgN	*	*	*	*
07 Upper Yellowstone	TP	.035 (2)	.063 (6)	.028 (5)	.030 (2)
	TKN	.400 (2)	.550 (2)	.450 (2)	1.900 (1)
	OrgN	*	*	*	*
08 Big Horn	TP	.112 (22)	.097 (48)	.057 (39)	.075 (15)
	TKN	.589 (19)	2.413 (23)	.695 (22)	.350 (6)
	OrgN	*	*	*	*

Table B-7 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Powder - Tongue	TP[2]	.084 (28)	.179 (69)	.654 (31)	.859 (19)
	TKN	.500 (11)	.557 (23)	.514 (7)	.860 (10)
	OrgN	*	*	*	*
10 Lower Yellowstone	TP	.893 (3)	.038 (4)	.046 (5)	.037 (3)
	TKN	1.533 (3)	1.050 (2)	.720 (5)	.425 (4)
	OrgN	*	*	*	*
11 Missouri - Little Missouri	TP	.510 (1)	.454 (6)	.079 (7)	.036 (6)
	TKN	2.600 (1)	1.318 (5)	.850 (2)	.600 (3)
	OrgN	*	*	*	*
12 Cheyenne	TP	11.159 (102)	.195 (138)	18.120 (100)	.222 (87)
	TKN	1.155 (11)	.647 (42)	153.760 (17)	.555 (5)
	OrgN	*	*	*	*
13 Missouri - Oahe	TP	.254 (62)	.243 (87)	.169 (109)	.084 (26)
	TKN	1.993 (26)	1.624 (30)	2.097 (23)	.725 (8)
	OrgN	*	*	*	*
14 Missouri - White	TP	.458 (20)	.945 (30)	3.201 (25)	.316 (14)
	TKN	.625 (4)	.899 (7)	1.484 (8)	.540 (2)
	OrgN	*	*	*	*
15 Niobrara	TP	.168 (34)	.145 (47)	.351 (119)	.138 (22)
	TKN	1.167 (3)	1.237 (18)	1.201 (90)	2.286 (12)
	OrgN	*	*	*	*
16 James	TP	.543 (41)	.369 (75)	.820 (155)	.664 (19)
	TKN	2.798 (30)	1.798 (44)	2.878 (136)	1.750 (3)
	OrgN	*	*	*	*
17 Missouri - Big Sioux	TP	.798 (41)	.380 (48)	.584 (51)	.923 (38)
	TKN	1.133 (3)	.718 (9)	1.149 (8)	.815 (4)
	OrgN	*	*	*	*
18 North Platte	TP	.160 (37)	.122 (72)	.235 (70)	.167 (22)
	TKN	1.066 (15)	1.484 (37)	1.269 (45)	2.779 (15)
	OrgN	*	*	*	*

Table B-7 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
19 South Platte	TP[2]	1.133 (87)	.591 (126)	.293 (181)	.620 (111)
	TKN	5.162 (55)	1.514 (75)	1.734 (127)	2.162 (67)
	OrgN	*	*	*	*
20 Platte	TP	.692 (25)	.723 (33)	.618 (24)	.427 (11)
	TKN	2.216 (19)	2.035 (32)	1.987 (22)	1.799 (11)
	OrgN	*	*	*	*
21 Loup	TP	.240 (41)	.256 (43)	.395 (44)	.182 (4)
	TKN	1.056 (8)	.895 (11)	2.032 (13)	.397 (3)
	OrgN	*	*	*	*
22 Elkhorn	TP	.426 (17)	.353 (18)	.744 (19)	.197 (3)
	TKN	1.334 (14)	1.269 (18)	2.621 (18)	1.303 (3)
	OrgN	*	*	*	*
23 Missouri - Little Sioux	TP	.498 (26)	.540 (24)	1.487 (26)	.688 (8)
	TKN	1.354 (19)	1.574 (24)	2.036 (26)	1.600 (7)
	OrgN	.543 (7)	*	*	*
24 Missouri - Nishnabotna	TP	.215 (30)	.310 (43)	.277 (72)	.186 (16)
	TKN	1.220 (11)	2.096 (13)	1.340 (9)	.300 (4)
	OrgN	*	*	*	*
25 Republican	TP	.159 (26)	.298 (35)	.689 (49)	.211 (11)
	TKN	.853 (3)	1.110 (9)	1.261 (25)	1.040 (1)
	OrgN	*	*	*	*
26 Smoky Hill	TP	.373 (39)	.360 (61)	1.119 (80)	.231 (24)
	TKN	.625 (4)	1.167 (6)	1.270 (15)	*
	OrgN	*	*	*	*
27 Kansas	TP	.536 (197)	.408 (190)	.553 (175)	.449 (45)
	TKN	1.523 (133)	1.383 (125)	1.505 (88)	.867 (9)
	OrgN	*	*	*	*
28 Chariton - Grand	TP	.144 (7)	.177 (24)	.393 (35)	.100 (3)
	TKN	.829 (7)	1.241 (19)	1.039 (36)	.600 (3)
	OrgN	*	*	*	*

Table B-7 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
29 Gasconade - Osage	TP[2]	.091 (27)	.107 (52)	.149 (94)	.288 (18)
	TKN	.489 (9)	.674 (16)	3.335 (72)	.200 (1)
	OrgN	*	*	*	*
30 Lower Missouri	TP	1.814 (17)	1.093 (26)	.976 (18)	1.387 (14)
	TKN	.567 (3)	.800 (11)	.663 (6)	*
	OrgN	*	*	*	*
Region 10	TP	1.630 (953)	.335 (1346)	1.641 (1569)	.418 (562)
	TKN	1.929 (434)	1.341 (635)	4.853 (856)	1.526 (201)
	OrgN	.543 (7)	*	*	*

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table B8 - Region 11: The Arkansas-White-Red System

When only ambient nutrient samples are included, the Arkansas-White-Red River Region still appears to be one of the regions with higher nutrient concentrations, with some individual samples measuring very high.

Total ambient phosphorus seasonal means for Region 11's subregions ranged from a low of .03 mg/L in the Upper Cimarron Subregion (04) in the winter, to a high of 1.622 mg/L in the Lower Canadian area, Subregion 09, in the fall. The highest individual measurement of TP in 1989 was 12.4 mg/L in the summertime in Subregion 11, the Lower Arkansas area.

Seasonal means of ambient TKN varied from a low of .374 mg/L in the Lower Canadian Subregion in the spring, to reports of 3.974 mg/L in winter in Subregion 02, the Upper Arkansas, for subregions with a sufficient number of samples per season. The maximum single observation of TKN in 1989 was 31.0 mg/L in summer in the Upper Arkansas area, with many individual samples having concentrations over 10 mg/L.

Organic nitrogen was measured in four subregions in Region 11. The lowest mean ambient subregion organic N was .065 mg/L in spring for the Lower Canadian Subregion (09). The highest subregion mean was 1.755 mg/L in Subregion 08 (Upper Canadian). Many samples were quite high in organic nitrogen as well as TKN; the maximum individual organic N reading was 26.28 mg/L in summer in the Upper Canadian area.

For the entire Region 11, mean ambient total phosphorus concentrations for 1989 ranged from a low of .274 in spring to .526 in the fall; TKN varied from 1.007 in spring to 1.433 in the fall; and organic nitrogen ranged from a low of .464 in spring to 1.342 in summer.

- Subregion 11 (Lower Arkansas) had the highest individual total nitrogen concentrations in all four seasons, with a maximum of 21.68 in the summer.

Table B-8

USGS Region 11: Arkansas-White-Red System
Mean Ambient Nitrogen and Phosphorus Concentrations by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01 Upper White	TP[2]	.117 (154)	.153 (181)	.296 (135)	.773 (43)
	TKN	1.057 (60)	.714 (72)	.742 (65)	.941 (31)
	OrgN	*	*	*	*
02 Upper Arkansas	TP	1.081 (14)	.429 (27)	.342 (28)	.082 (5)
	TKN	3.974 (35)	1.676 (41)	1.868 (73)	4.155 (33)
	OrgN	*	*	*	*
03 Middle Arkansas	TP	.624 (60)	.708 (68)	.306 (107)	.409 (41)
	TKN	1.500 (1)	.900 (1)	2.600 (1)	*
	OrgN	*	*	*	*
04 Upper Cimarron	TP	.026 (5)	.058 (10)	.044 (16)	.070 (2)
	TKN	.533 (6)	.500 (6)	.500 (2)	.400 (2)
	OrgN	*	*	*	*
05 Lower Cimarron	TP	.367 (7)	.187 (3)	.700 (5)	*
	TKN	1.286 (8)	.867 (3)	.560 (7)	*
	OrgN	*	*	*	*
	TOTN	1.898 (5)	*	.902 (5)	*
06 Arkansas - Keystone	TP	.160 (5)	.105 (2)	.347 (7)	*
	TKN	.846 (5)	1.000 (2)	.787 (4)	*
	OrgN	*	*	*	*
	TOTN	1.147 (3)	*	.920 (3)	*
07 Neosho - Verdigris	TP	.588 (100)	.412 (123)	.568 (148)	.534 (60)
	TKN	.683 (34)	.687 (12)	.702 (21)	.893 (7)
	OrgN	.360 (1)	.515 (2)	.470 (3)	.395 (2)
	TOTN	.980 (10)	*	.530 (9)	*
08 Upper Canadian	TP	.015 (2)	.126 (90)	.408 (42)	.010 (1)
	TKN	.300 (2)	.684 (77)	1.789 (42)	.400 (1)
	OrgN	*	.441 (91)	1.755 (38)	*
	TOTN	*	.682 (91)	2.022 (38)	*

Table B-8 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Lower Canadian	TP[2]	.599 (13)	.204 (6)	1.622 (48)	.197 (13)
	TKN	1.435 (11)	.374 (7)	3.240 (46)	.821 (14)
	OrgN	*	.065 (4)	1.302 (34)	.619 (12)
	TOTN	2.698 (5)	1.080 (4)	.992 (12)	.851 (12)
10 North Canadian	TP	.450 (14)	.116 (37)	.198 (40)	.120 (1)
	TKN	1.093 (12)	1.344 (28)	1.048 (24)	.400 (1)
	OrgN	*	*	*	*
	TOTN	2.357 (7)	*	.929 (7)	*
11 Lower Arkansas	TP	.265 (236)	.361 (224)	.560 (315)	.776 (146)
	TKN	.800 (156)	1.112 (127)	1.093 (180)	1.276 (91)
	OrgN	.493 (19)	.705 (15)	.507 (14)	.451 (17)
	TOTN	2.091 (84)	1.886 (37)	1.438 (90)	1.839 (37)
12 Red Headwaters	TP	.133 (8)	.114 (5)	.192 (6)	.020 (1)
	TKN	.635 (6)	1.020 (5)	.826 (8)	.500 (1)
	OrgN	*	*	*	*
	TOTN	3.010 (1)	*	.700 (1)	*
13 Red-Washita	TP	.450 (19)	.083 (3)	.231 (13)	.377 (3)
	TKN	1.459 (14)	.733 (3)	.882 (13)	.650 (2)
	OrgN	*	*	*	*
	TOTN	2.526 (5)	*	1.677 (6)	*
14 Red-Sulphur	TP	.126 (157)	.139 (185)	.157 (243)	.213 (107)
	TKN	.793 (85)	1.081 (115)	.964 (133)	.800 (65)
	OrgN	*	*	*	*
	TOTN	1.488 (4)	*	1.000 (5)	*
Region 11	TP	.301 (794)	.274 (964)	.429 (1153)	.526 (423)
	TKN	1.129 (435)	1.007 (499)	1.296 (619)	1.433 (248)
	OrgN	.486 (20)	.464 (112)	1.342 (89)	.496 (32)
	TOTN	2.016 (124)	1.031 (132)	1.434 (176)	1.597 (49)

* No samples taken

( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring: April 1 - June 30
Summer: July 1 - September 30
Fall: October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen
TOTN = Total Nitrogen

Table B9 - Region 12: The Texas Gulf Region

Again, the Texas Gulf Region consists of several individual river systems flowing into the Gulf of Mexico, from the Sabine River on the Texas-Louisiana state line westward to the Nueces near the southern tip of Texas. Though all quarterly means are identical to those in Table A9, we present them again for continuity.

Subregion seasonal mean concentrations for ambient total phosphorus ranged from .02 mg/L in summer in Subregion 11, the Nueces-Southwestern Texas Coastal area, to the highest mean of 1.5 mg/L in the summer in the Central Texas Coastal Subregion (10), for subregions and seasons with three or more observations. Several quarterly means were below .1 mg/L in this region. Maximum individual measurements in 1989 were 8.2 mg/L in the Central Texas Coastal area in winter, 7.7 mg/L in the Galveston Bay-San Jacinto Subregion (04) in spring and 7.6 mg/L in winter in the same subregion.

Quarterly ambient TKN means varied from a low of .37 mg/L in summer in the Nueces-Southwestern Texas Coastal Subregion to 1.63 mg/L in Subregion 05, the Brazos Headwaters, for subregions and seasons with sufficient data. The highest individual samples had TKN concentrations of 17.0 mg/L in winter in the Galveston Bay-San Jacinto Subregion, 16.0 mg/L in winter in Subregion 09, the Lower Colorado-San Bernard Coastal Subregion, and 14.0 mg/L in summer in the Middle Brazos Subregion (06).

Organic nitrogen was not reported in Region 12. For the entire Texas Gulf Region seasonal means of ambient total phosphorus varied from a low of .28 in spring to .76 in the fall; TKN means ranged from .75 in the spring to 1.0 in the winter.

Table B-9

USGS Region 12: Texas Gulf Region
Mean Ambient Nitrogen and Phosphorus Concentrations by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01 Sabine	TP[2]	.109 (18)	.125 (17)	.066 (11)	.110 (11)
	TKN	.905 (14)	.851 (14)	.849 (13)	.736 (11)
	OrgN	*	*	*	*
02 Neches	TP	.492 (12)	.252 (10)	.068 (5)	.055 (4)
	TKN	.640 (10)	1.557 (7)	.760 (5)	.500 (4)
	OrgN	*	*	*	*
03 Trinity	TP	.772 (95)	.301 (62)	.255 (72)	2.231 (17)
	TKN	1.019 (76)	.910 (59)	.826 (74)	1.118 (17)
	OrgN	*	*	*	*
04 Galveston Bay - San Jacinto	TP	1.325 (149)	.670 (70)	.527 (139)	.689 (49)
	TKN	1.241 (81)	1.126 (43)	1.088 (139)	.829 (49)
	OrgN	*	*	*	*
05 Brazos Headwaters	TP	.045 (5)	.063 (5)	.037 (3)	.010 (1)
	TKN	.675 (4)	.500 (2)	1.633 (3)	.400 (1)
	OrgN	*	*	*	*
06 Middle Brazos	TP	.440 (63)	.183 (56)	.434 (53)	1.334 (8)
	TKN	.865 (57)	.663 (49)	1.112 (65)	1.150 (8)
	OrgN	*	*	*	*
07 Lower Brazos	TP	.127 (59)	.082 (50)	.064 (48)	1.030 (3)
	TKN	.691 (54)	.580 (56)	.735 (60)	.700 (3)
	OrgN	*	*	*	*
08 Upper Colorado	TP	.060 (2)	.080 (1)	.145 (2)	.060 (1)
	TKN	1.000 (2)	.600 (1)	2.150 (2)	.500 (1)
	OrgN	*	*	*	*

Table B-9 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Lower Colorado - San Bernard Coastal	TP[2]	.426 (68)	.105 (99)	.099 (22)	.290 (25)
	TKN	1.264 (66)	.509 (87)	.557 (35)	.711 (28)
	OrgN	*	*	*	*
10 Central Texas Coastal	TP	.811 (73)	.464 (56)	1.491 (33)	.646 (27)
	TKN	.919 (32)	.809 (33)	.682 (36)	.687 (24)
	OrgN	*	*	*	*
11 Nueces - Southwestern Texas Coastal	TP	.547 (28)	.188 (27)	.020 (3)	.075 (2)
	TKN	.414 (7)	.714 (7)	.367 (6)	.750 (2)
	OrgN	*	*	*	*
Region 12	TP	.730 (572)	.279 (453)	.436 (391)	.755 (148)
	TKN	1.003 (403)	.747 (358)	.911 (438)	.809 (148)
	OrgN	*	*	*	*

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table B10 - Region 13: The Rio Grande System

The Rio Grande Region has a few subregions (especially the Rio Grande-Elephant Butte and Mimbres areas near its headwaters), we should remember, with a large number of samples in some seasons of 1989, while some other subregions have very few observations for some nutrients as noted in Table 9. The quarterly means for subregions again do not have as much variability in nutrient concentrations as some other regions.

Mean ambient total phosphorus ranged from a low of .026 mg/L in the Lower Rio Grande valley in the winter to .59 mg/L in summer in the Rio Grande-Armistad Subregion (04), for those subregions with several observations per season. The maximum individual sample in 1989 was 4.7 mg/L in the fall in the Elephant Butte area (Subregion 02).

Mean ambient TKN concentrations by subregion varied from .381 mg/L in the Upper Pecos Subregion in wintertime to 1.825 mg/L in summer in Subregion 04, the Rio Grande-Armistad area, again for those subregions and seasons with sufficient sampling. The highest single sample was in the spring in the Rio Grande-Elephant Butte Subregion (02):. 17.2 mg/L.

Organic nitrogen is measured in only a few subregions. The lowest mean of ambient samples for a subregion and season with sufficient sampling was .149 mg/L in winter in the Elephant Butte area; the highest such mean was .507 in spring in the Rio Grande-Mimbres Subregion (03). A 3.7 mg/L reading was the maximum single measurement, in the same Elephant Butte Subregion in spring.

For the entire Rio Grande system, 1989 total phosphorus means ranged from a low of .126 mg/L in spring to a high of .337 mg/L in fall. Ambient TKN means varied from .553 mg/L in spring to a seasonal high of .783 in summer. Ambient organic nitrogen, for those subregions reporting, ranged from .155 in winter to .328 in the fall.

Table B-10

USGS Region 13: Rio Grande System
Mean Ambient Nitrogen and Phosphorus Concentrations by Subregion

1989: All data in mg/L

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01	TP[2]	.084 (11)	.082 (8)	.075 (10)	.107 (3)
Rio Grande	TKN	.300 (1)	.550 (2)	.600 (1)	.600 (2)
Headwaters	OrgN	*	*	*	*
02	TP	.201 (25)	.142 (106)	.324 (60)	.514 (14)
Rio Grande -	TKN	.455 (23)	.529 (113)	.717 (68)	.756 (13)
Elephant Butte	OrgN	.149 (17)	.227 (107)	.305 (48)	.352 (4)
	TOTN	.637 (15)	.645 (97)	.644 (48)	.560 (4)
03	TP	.489 (9)	.091 (36)	.155 (2)	.310 (1)
Rio Grande -	TKN	1.317 (6)	.614 (35)	1.000 (2)	.400 (1)
Mimbres	OrgN	*	.507 (34)	*	*
	TOTN	*	.812 (34)	*	*
04	TP	.147 (12)	.305 (2)	.590 (3)	.720 (2)
Rio Grande -	TKN	.667 (12)	.600 (3)	1.825 (4)	.933 (3)
Armistad	OrgN	*	*	*	*
05	TP	.025 (2)	*	.030 (2)	.040 (1)
Rio Grande	TKN	.400 (2)	.400 (1)	.400 (2)	.200 (1)
Closed Basins	OrgN	*	*	*	*
06	TP	.050 (9)	.069 (11)	.120 (12)	.042 (6)
Upper	TKN	.381 (8)	.526 (13)	.800 (10)	.527 (6)
Pecos	OrgN	.205 (2)	.240 (1)	*	.280 (2)
	TOTN	*	.460 (1)	*	.420 (2)
07	TP	.025 (2)	.010 (1)	.010 (2)	*
Lower Pecos	TKN	.500 (2)	.400 (1)	1.150 (2)	.200 (1)
	OrgN	*	*	*	*
08	TP	.050 (8)	.147 (7)	*	*
Rio Grande -	TKN	.350 (2)	.825 (4)	*	*
Falcon	OrgN	*	*	*	*

Table B-10 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09	TP[2]	.026 (7)	.132 (9)	.050 (1)	.110 (2)
Lower	TKN	.750 (2)	.567 (3)	.700 (1)	.850 (2)
Rio Grande	OrgN	*	*	*	*
Region 13	TP	.154 (86)	.126 (180)	.259 (92)	.337 (29)
	TKN	.580 (59)	.553 (175)	.783 (90)	.672 (29)
	OrgN	.155 (19)	.294 (142)	.305 (48)	.328 (6)
	TOTN	.637 (15)	.687 (132)	.644 (48)	.513 (6)

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen
TOTN = Total Nitrogen

APPENDIX C

Regional Estimates of Gulf Coast Loadings

Appendix C: Brief Interpretation of Tables C2-C10: Ambient Loadings

(Table C1 is included for easy reference only. It is identical to Table 7.)

Table C2 - Region 03 (Partial): Nutrient Loadings in the Gulf Coast River Systems of the Southeast Region

Again we must point out that analysis of Region 03 for the Gulf of Mexico Project includes only part of subregion 09 and all of subregions 10-18, those whose waterways flow into the Gulf of Mexico. As was the case with nutrient concentrations, there is a wide range of nutrient loadings in this part of the Southeast Region. All data is in pounds per day (lbs/day).

Mean total phosphorus loadings ranged from a seasonal low of 1 (one) lb/day in the spring in subregion 14, the Choctawhatchee-Escambia system, to a high of 30,551 lbs/day in subregion 16, the Tombigbee-Mobile Bay system. The second and third highest quarterly phosphorus means, however, are 5,360 lbs/day in spring, again in the Tombigbee-Mobile Bay subregion, and 3,944 lbs/day in subregion 13, the Apalachicola River system, again in the spring. The highest individual samples found in this region were 180,147 lbs/day in subregion 16, the Tombigbee-Mobile Bay area in winter; 54,477 lbs/day in the spring and 29,660 lbs/day in winter, both in subregion 15, the Coosa-Alabama Rivers system. Note that the Coosa-Alabama system feeds into the Tombigbee not far upstream of Mobile Bay, and apparently accounts for much of the higher nutrient pollution in subregion 16.

Quarterly ambient mean Total Kjeldahl Nitrogen (TKN) loadings varied from a low of 50 lbs/day in the spring in subregion 14, the Choctawhatchee-Escambia system, to 71,003 lbs/day in the winter in the Tombigbee-Mobile Bay subregion. The highest individual measurements were 359,225 lbs/day in the winter in the Tombigbee-Mobile Bay subregion; 217,908 lbs/day in spring and 197,736 lbs/day in winter in the Coosa-Alabama system. This pattern is similar to that for phosphorus loadings.

Organic nitrogen loadings were measured in too few subregions and seasons of the partial Region 03 to provide a meaningful comparison.

For Region 03's Gulf Coast river systems in total, seasonal means of ambient total phosphorus loadings ranged from a low of 1,364 lbs/day in the summer to 4,315 lbs/day in the winter. Ambient TKN mean loadings varied from 3,983 lbs/day in the summer to 13,197 lbs/day in the winter. Organic nitrogen was not measured in all seasons.

Table C-1

USGS Region Summaries: Mean Ambient Nitrogen and Phosphorus Loadings by Region

1989: All data in lbs/day

Region	Nutrient	Winter	Spring	Summer	Fall[1]
03 Southeast (Gulf of Mexico River Systems Only)	TP[2]	4315 (180)	2295 (170)	1364 (169)	1538 (111)
	TKN	13197 (90)	11345 (100)	3983 (92)	5829 (28)
	OrgN	*	8 (14)	6 (22)	.5 (4)
05 Ohio River System	TP	84856 (281)	50621 (311)	9806 (333)	10742 (128)
	TKN	153703 (249)	152129 (270)	37560 (312)	48096 (118)
	OrgN	*	*	*	*
06 Tennessee	TP	2816 (8)	237 (37)	777 (22)	14070 (4)
	TKN	9502 (4)	1169 (33)	756 (20)	5717 (1)
	OrgN	14025 (2)	107 (3)	20581 (5)	67798 (1)
07 Upper Mississippi	TP	5670 (276)	5017 (440)	7451 (293)	1450 (133)
	TKN	40311 (199)	61588 (218)	44435 (195)	8823 (109)
	OrgN	250 (1)	6161 (10)	40 (9)	86 (3)
08 Lower Mississippi	TP	5158 (192)	19097 (246)	15455 (185)	41987 (16)
	TKN	904023 (26)	329792 (37)	144973 (25)	133620 (15)
	OrgN	*	*	*	*
10 Missouri River System	TP	2148 (426)	1006 (541)	2209 (339)	379 (146)
	TKN	5606 (311)	5288 (401)	10671 (216)	1760 (103)
	OrgN	111 (3)	*	*	*
11 Arkansas - Red - White River System	TP	5775 (196)	5488 (187)	3687 (118)	1078 (30)
	TKN	26267 (117)	32327 (124)	14924 (128)	3963 (54)
	OrgN	*	*	*	*
12 Texas Gulf	TP	1845 (199)	2409 (183)	1689 (168)	696 (90)
	TKN	3598 (171)	12000 (160)	6736 (171)	902 (74)
	OrgN	*	*	*	*

Table C-1 (continued)

Region	Nutrient	Winter	Spring	Summer	Fall[1]
13 Rio Grande System	TP[2]	345 (37)	229 (30)	829 (38)	176 (26)
	TKN	1243 (31)	1231 (30)	2554 (38)	627 (24)
	OrgN	*	*	*	*

* No samples taken
( ) = Number of samples

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table C-2

Partial USGS Region 03: Southeast Gulf Coast River Systems
Mean Ambient Nitrogen and Phosphorus
Loadings by Subregion

1989: All data in lbs/day

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Partial	TP[2]	51 (3)	57 (4)	102 (4)	*
Caloosahatchee	TKN	1854 (3)	1355 (4)	747 (4)	*
L. Okeechobee	OrgN	*	*	*	*
10	TP	297 (38)	136 (26)	353 (17)	5 (2)
Peace (FL) -	TKN	557 (39)	143 (24)	399 (16)	122 (2)
Tampa Bay	OrgN	*	*	*	*
11	TP	343 (23)	444 (22)	477 (22)	387 (19)
Suwanee	TKN	1796 (6)	3401 (5)	4979 (4)	5018 (3)
	OrgN	*	*	*	*
12	TP	350 (11)	1040 (11)	881 (11)	396 (9)
Ochlockonee	TKN	1417 (3)	6220 (2)	379 (2)	670 (2)
	OrgN	*	*	*	*
13	TP	2283 (35)	3944 (35)	2659 (37)	3536 (36)
Apalachicola	TKN	13038 (8)	28226 (9)	8416 (7)	19830 (6)
	OrgN	*	*	*	*
14	TP	973 (4)	1 (6)	373 (4)	690 (4)
Choctawhatchee	TKN	11261 (4)	50 (13)	1433 (10)	8344 (3)
- Escambia	OrgN	*	1 (4)	3 (5)	*
15	TP	3792 (47)	3192 (46)	1620 (56)	846 (35)
Coosa - Alabama	TKN	23896 (14)	19459 (27)	6621 (31)	265 (9)
	OrgN	*	7 (6)	5 (12)	.5 (4)
16	TP	30551 (16)	5360 (14)	770 (16)	11 (6)
Tombigbee -	TKN	71003 (9)	25965 (10)	3377 (15)	64 (3)
Mobile Bay	OrgN	*	14 (4)	9 (5)	*

Table C-2 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
17	TP[2]	1209 (2)	1047 (4)	822 (1)	*
Pascagoula	TKN	6881 (3)	11387 (4)	2941 (2)	*
	OrgN	*	*	*	*
18	TP	250 (1)	548 (2)	231 (1)	*
Pearl	TKN	1877 (1)	5483 (2)	1384 (1)	*
	OrgN	*	*	*	*
Region 03	TP	4315 (180)	2295 (170)	1364 (169)	1538 (111)
(Partial)	TKN	13197 (90)	11345 (100)	3983 (92)	5829 (28)
	OrgN	*	8 (14)	6 (22)	.5 (4)

* No samples taken
( ) = Number of measurements

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table C3 - Region 05: Nutrient Loadings in the Ohio River System*

Region 05, extending from far southwestern New York State through West Virginia to western Kentucky and eastern Illinois. Even without its tributary Tennessee River system, which flows into the western most part of the Ohio and encompasses Region 06, the Ohio River system has some of the largest flows of water contributing to some of the higher nutrient loadings flowing toward the Gulf of Mexico. The nutrient concentrations were not generally high, but the loadings certainly are.

For Region 05, seasonal means for ambient total phosphorus loadings ranged from a low of 161 lbs/day in the summer in the Cumberland subregion (13) to 843,190 lbs/day in the Lower Ohio River area (subregion 14), which carries the waters of all of the Ohio's tributaries. Other high means include 267,766 lbs/day in the spring, again in the Lower Ohio, and 143,031 lbs/day in the spring in the Middle Ohio area, subregion 09. The highest individual measurements were 11,030,000 lbs/day in the winter and 1,023,000 lbs/day in spring both in the Lower Ohio subregion.

The mean quarterly ambient TKN loadings in 1989 for Region 05's subregions varied from lows of 896 lbs/day in the fall in the Wabash River area (subregion 12), based on only three measurements, and 1280 lbs/day in the summer in subregion 10, the Kentucky-Lickings Rivers area, to highs of 1,010,000 lbs/day in the winter and 626,217 lbs/day in the spring, both in the Lower Ohio area. The Middle Ohio subregion also had some very high loadings of TKN. The highest individual measurements of TKN in the Ohio River region in 1989 were 4,989,000 lbs/day in winter and 2,669,000 lbs/day in spring, both again in the Lower Ohio, or most downstream, subregion of USGS Region 05.

Organic nitrogen loadings were not measured in Region 05 in 1989.

For the region overall, mean quarterly ambient total phosphorus loadings ranged from 9,806 lbs/day in the summer to 84,856 lbs/day in the winter. Comparable mean TKN loadings varied from a low of 37,560 lbs/day in the summer to 153,703 lbs/day in the winter. Spring loadings were nearly as high, averaging 152,129 lbs/day.

* Excluding the Tennessee tributary system (Region 06)

Table C-3

USGS Region 05: Ohio River System
Mean Ambient Nitrogen and Phosphorus Loadings by Subregion

1989: All data in lbs/day

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01 Allegheny	TP[2]	3285 (2)	12273 (3)	1397 (3)	1778 (3)
	TKN	27069 (2)	54612 (3)	14971 (3)	20867 (3)
	OrgN	*	*	*	*
02 Monongahela	TP	2188 (19)	1304 (20)	1650 (10)	715 (13)
	TKN	12927 (19)	5393 (19)	12278 (10)	4238 (13)
	OrgN	*	*	*	*
03 Upper Ohio	TP	27849 (31)	27967 (34)	5099 (28)	5359 (31)
	TKN	112720 (30)	104911 (34)	32487 (31)	39743 (29)
	OrgN	*	*	*	*
04 Muskingum	TP	2892 (18)	4956 (19)	1461 (16)	1017 (12)
	TKN	6786 (16)	34744 (11)	6407 (8)	1573 (6)
	OrgN	*	*	*	*
05 Kanawha	TP	5676 (23)	5717 (26)	2524 (25)	1157 (23)
	TKN	27049 (23)	28363 (24)	13641 (25)	7248 (22)
	OrgN	*	*	*	*
06 Scioto	TP	2243 (4)	4289 (6)	2199 (8)	1892 (2)
	TKN	18475 (4)	16758 (6)	6575 (8)	2738 (2)
	OrgN	*	*	*	*
07 Big Sandy - Guyandotte	TP	6224 (15)	1823 (16)	2433 (17)	194 (8)
	TKN	14293 (18)	5746 (16)	6322 (18)	1488 (7)
	OrgN	*	*	*	*
08 Great Miami	TP	12848 (2)	16239 (3)	5939 (31)	2494 (5)
	TKN	111349 (2)	71259 (3)	13689 (32)	4268 (5)
	OrgN	*	*	*	*

Table C-3 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall1
09 Middle Ohio	TP[2]	90446 (21)	143031 (30)	34260 (36)	35243 (15)
	TKN	241053 (22)	324903 (32)	121295 (37)	129833 (15)
	OrgN	*	*	*	*
10 Kentucky - Licking	TP	25680 (41)	3013 (38)	509 (44)	701 (3)
	TKN	38952 (42)	12434 (40)	1280 (48)	2273 (3)
	OrgN	*	*	*	*
11 Green	TP	6267 (18)	2123 (15)	547 (20)	*
	TKN	33910 (19)	10333 (19)	3182 (20)	*
	OrgN	*	*	*	*
12 Wabash	TP	2560 (51)	5142 (53)	4596 (42)	172 (3)
	TKN	18274 (12)	54153 (12)	24321 (18)	896 (3)
	OrgN	*	*	*	*
13 Cumberland	TP	2629 (13)	2807 (12)	161 (13)	*
	TKN	15787 (15)	18209 (13)	7774 (15)	*
	OrgN	*	*	*	*
14 Lower Ohio	TP	843190 (23)	267766 (36)	32770 (40)	60640 (10)
	TKN	1010000 (25)	626217 (38)	112307 (39)	224193 (10)
	OrgN	*	*	*	*
Region 05	TP	84856 (281)	50621 (311)	9806 (333)	10742 (128)
	TKN	153703 (249)	152129 (270)	37560 (312)	48096 (118)
	OrgN	*	*	*	*

* No samples taken
( ) = Number of measurements

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

<u>Table C4 - Region 06</u>: Nutrient Loadings in the Tennessee River System

The relatively small (geographically) Tennessee Region, whose waters eventually flow into the Gulf of Mexico via the Mississippi, had lower nutrient concentrations than most other regions under study. Loadings of phosphorus and nitrogen are also lower in many cases, but we are hampered by the lack of abundant data for 1989 in its four subregions.

The lowest mean ambient total phosphorus loading for a season and subregion with more than three measurements (see numbers in parentheses) was 142 lbs/day in the spring in the Upper Tennessee valley, subregion 01. Most seasonal means were below 1000 lbs/day, but many are calculated from very few measurements. The highest such mean phosphorus loading was 808 lbs/day in winter in the Middle Tennessee-Hiwassee area (subregion 02); the highest means are all calculated from very few measurements. The highest individual readings were 55,085 lbs/day in the fall and 11,927 lbs/day in the summer, both in the Middle Tennessee-Elk subregion, and 9,348 lbs/day in the winter in the Upper Tennessee.

Quarterly means for ambient TKN loadings ranged (for seasons and subregions with sufficient data) from 1,088 lbs/day in summer in the Upper Tennessee subregion to a high of 2,0581 lbs/day in summer in the Middle Tennessee-Elk area (subregion 03). Again the highest and lowest means are based on few cases. The highest individual measurements were 33,512 lbs/day in winter and 15,615 lbs/day in spring, both in the Upper Tennessee, and 9,288 lbs/day in the spring in the Lower Tennessee.

Organic nitrogen loadings were measured in only one subregion of Region 06 in 1989. Again, the lack of sufficient data -- no nutrient loadings at all were measured in some of the four subregions and seasons in 1989, for all of the nutrient measurements studied -- make analysis of loadings in this region difficult. The lack of data in the Lower Tennessee (subregion 04) is especially important and unfortunate.

For Region 06 as a whole, mean ambient total phosphorus loadings varied from 237 lbs/day in the spring to 14070 lbs/day in winter, the latter based on only four measurements. Mean TKN loadings ranged from 756 lbs/day in the summer to 9502 lbs/day in winter, the latter again calculated from only four measurements. Organic nitrogen means are entirely from one subregion.

Table C-4

USGS Region 06: Tennessee River System
Mean Ambient Nitrogen and Phosphorus Loadings by Subregion

1989: All data in lbs/day

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01	TP[2]	5261 (2)	142 (32)	233 (13)	800 (1)
Upper Tennessee	TKN	18387 (2)	1107 (25)	1088 (13)	5717 (1)
	OrgN	*	*	*	*
02	TP	808 (4)	231 (2)	428 (4)	197 (2)
Middle Tennessee	TKN	618 (2)	526 (1)	485 (1)	*
- Hiwassee	OrgN	*	*	*	*
03	TP	4389 (2)	*	6137 (2)	55086 (1)
Middle Tennessee	TKN	*	130 (4)	98 (4)	*
- Elk	OrgN	14025 (2)	107 (3)	20581 (5)	67798 (1)
04	TP	*	1255 (3)	30 (3)	*
Lower	TKN	*	3287 (3)	54 (2)	*
Tennessee	OrgN	*	*	*	*
Region 06	TP	2816 (8)	237 (37)	777 (22)	14070 (4)
	TKN	9502 (4)	1169 (33)	756 (20)	5717 (1)
	OrgN	14025 (2)	107 (3)	20581 (5)	67798 (1)

* No samples taken
( ) = Number of measurements

[1] Winter runoff: January 1 - March 31
Spring: April 1 - June 30
Summer: July 1 - September 30
Fall: October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table C5 - Region 07: Nutrient Loadings in the Upper Mississippi River System

The Upper Mississippi and its tributaries have loadings measurements of phosphorus and TKN for most of the 14 subregions of Region 07, with abundant data in most seasons and subregions south of Minnesota and Wisconsin.

The lowest mean seasonal ambient loadings of total phosphorus were 1 (one) lb/day in spring, summer and fall in the St. Croix River area (subregion 03). Many very low means are found in the upper reaches of Region 07. The highest such mean phosphorus loadings were 168,700 lbs/day in summer, 41,852 lbs/day in spring, and 39,010 lbs/day in winter, all in subregion 14, the Upper Mississippi-Kaskaskia-Meramec area. This is the most downstream subregion of the Upper Mississippi Region. The highest individual measurements in this region in 1989 were 757,986 lbs/day in summer; 214,079 lbs/day in winter and 213,593 lbs/day in spring, all in subregion 14, the area farthest downstream in the Upper Mississippi Region.

For seasons and subregions with sufficient data, mean seasonal ambient loadings of TKN ranged from lows of 5 lbs/day in the spring in the St. Croix River subregion (based on 7 measurements) and 13 lbs/day in winter in the same subregion (9 measurements) to high means of 592,921 lbs/day (5 measurements) in summer, 468,096 lbs/day (6 measurements) and 385,236 lbs/day (7 measurements) in winter, all in subregion 14. Several other seasonal mean loadings of TKN were over 40,000 lbs/day through much of the region, notably in subregion 11, the Upper-Mississippi-Salt River area. The highest single measurements in 1989 were 938,732 lbs/day in the spring in the Upper Mississippi-Maquaketa-Plum-Escambia subregion (06); 850,489 lbs/day in the winter in the Upper Mississippi-Salt subregion (11); and 689,054 lbs/day in the Upper Mississippi-Iowa-Skunk-Wapsipinicon subregion (08).

Organic nitrogen loadings were measured too infrequently in Region 07 in 1989 to allow for seasonal comparisons.

For the entire Region 07 mean total phosphorus loadings ranged from a low of 1,450 lbs/day in the fall to 7,451 lbs/day in the summer. TKN means varied from 8,823 lbs/day in the fall to a high of 61,588 lbs/day in the spring. Organic nitrogen loadings were sparsely measured in 1989.

Table C-5

USGS Region 07: Upper Mississippi River System
Mean Ambient Nitrogen and Phosphorus Loadings
by Subregion

1989: All data in lbs/day

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01 Mississippi Headwaters	TP[2]	6 (48)	10 (163)	9 (33)	2 (4)
	TKN	32 (39)	311 (3)	69 (3)	*
	OrgN	*	*	19 (2)	*
02 Minnesota R.	TP	*	*	15 (2)	3 (1)
	TKN	*	*	66 (2)	9 (1)
	OrgN	*	*	.1 (1)	8 (1)
03 St. Croix R.	TP	4 (11)	1 (8)	1 (10)	1 (11)
	TKN	*	5 (7)	*	13 (9)
	OrgN	*	*	*	*
04 Upper Miss.-Black-Root	TP	4521 (6)	6767 (38)	10308 (10)	5529 (8)
	TKN	24088 (6)	44804 (38)	47399 (10)	28435 (8)
	OrgN	250 (1)	6161 (10)	80 (4)	22 (1)
05 Chippewa	TP	365 (5)	4810 (5)	1459 (3)	251 (6)
	TKN	9178 (3)	94796 (2)	36370 (1)	6375 (1)
	OrgN	*	*	*	*
06 Upper Mississippi - Maquaketa - Plum - Escambia	TP	5992 (15)	22112 (19)	7238 (20)	3973 (16)
	TKN	38408 (15)	193737 (16)	44589 (17)	25024 (18)
	OrgN	*	*	*	*
07 Wisconsin R.	TP	3700 (3)	1490 (3)	743 (2)	459 (2)
	TKN	60534 (2)	20855 (3)	11542 (2)	3945 (2)
	OrgN	*	*	*	*
08 Upper Miss.-Iowa-Skunk-Wapsipinicon	TP	4239 (48)	5853 (41)	1897 (26)	262 (16)
	TKN	46742 (23)	43123 (25)	11897 (27)	848 (22)
	OrgN	*	*	.7 (2)	227 (1)

Table C-5 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Rock R.	TP[2]	2181 (13)	1307 (17)	2299 (35)	192 (17)
	TKN	16701 (11)	34536 (6)	37463 (12)	17039 (1)
	OrgN	*	*	*	*
10 DesMoines R.	TP	331 (12)	549 (13)	161 (13)	111 (12)
	TKN	1222 (13)	1658 (13)	1232 (13)	1024 (12)
	OrgN	*	*	*	*
11 Upper Miss. - Salt	TP	32076 (5)	22208 (9)	38095 (8)	32 (1)
	TKN	284790 (5)	168821 (8)	188262 (8)	359 (1)
	OrgN	*	*	*	*
12 Upper Illinois	TP	5079 (81)	4203 (96)	3518 (106)	2386 (30)
	TKN	24650 (71)	24977 (82)	16332 (84)	7301 (30)
	OrgN	*	*	*	*
13 Lower Illinois	TP	9358 (17)	7820 (16)	13805 (20)	360 (6)
	TKN	1514 (4)	95190 (9)	67615 (11)	540 (3)
	OrgN	*	*	*	*
14 Upper Miss.- Kaskaskia-Meramec	TP	39010 (12)	41852 (12)	168700 (5)	106 (1)
	TKN	385236 (7)	468096 (6)	592921 (5)	441 (1)
	OrgN	*	*	*	*
Region 07	TP	5670 (276)	5017 (440)	7451 (293)	1450 (133)
	TKN	40311 (199)	61588 (218)	44435 (195)	8823 (109)
	OrgN	250 (1)	6161 (10)	40 (9)	86 (3)

* No samples taken
( ) = Number of measurements

[1] Winter runoff: January 1 - March 31
Spring: April 1 - June 30
Summer: July 1 - September 30
Fall: October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table C6 - Region 08: Nutrient Loadings in the Lower Mississippi Region

While the concentrations of nutrients in the Lower Mississippi may have been lower than some would expect, the nutrient loadings, as expected, include some of the highest in the Gulf of Mexico drainage area. This is particularly true in the vast expanse of flowing water which comprises the downstream portions of Region 08. Unfortunately, one subregion, the Boeuf-Tensas subregion (05) has no nutrient loadings measurements for 1989, and several show no data for the fall season.

The lowest quarterly means of ambient total phosphorus loadings, for subregions and seasons with more than three observations, were 124 lbs/day in the fall in the Lower Mississippi-St. Francis area (subregion 02) and 197 lbs/day in the summer in the Lower Mississippi-Yazoo area (subregion 03). The highest such means are found in the Lower Mississippi-Lake Maurepas area (subregion 07), just downstream from the point where the Mississippi and Atchafalaya Rivers split: 809,535 lbs/day in winter, 519,710 lbs/day in spring with only 3 measurements, and 432,527 lbs/day in summer. The highest individual measurements of phosphorus loadings were 1,753,000 lbs/day in subregion 07 in the winter; 1,062,000 lbs/day in the winter in subregion 06, the Lower Mississippi-Big Black-Escambia area which is mostly just upstream of the Mississippi-Atchafalaya split; and 1,047,000 lbs/day in the summer in subregion 07.

The TKN measurements in the lower reaches of Region 08 are very high in general. Through the entire region they are highly variable. The lowest seasonal mean is 16 lbs/day in the spring in the Lower Mississippi-St. Francis subregion. The highest seasonal subregion TKN means are in subregions with a low number of measurements, but these are consistently high: 2,143,000 lbs/day in the winter in the Lower Mississippi-Lake Maurepas subregion (3 measurements); 1,880,000 lbs/day in winter in the Lower Mississippi-Big Black-Escambia area (4 measurements-subregion 06) and 1,715,000 lbs/day in winter in the Lower Mississippi River (2 measurements -subregion 09) which includes its huge delta. The highest single measurements of TKN in 1989 were 4,047,000 lbs/day in subregion 06; 3,536,000 lbs/day in subregion 07; and 3,430,000 lbs/day in subregion 09, all in winter.

Organic nitrogen loadings were not measured in the Lower Mississippi Region.

The seasonal means for total phosphorus for Region 08 as a whole varied from a low of 15,455 lbs/day in the summer to 51,518 lbs/day in the winter. For TKN, mean seasonal loadings throughout the region ranged from 133,620 lbs/day in the fall to 944,023 lbs/day in the winter. Winter appears to be the season with the highest nutrient pollutant loadings for the Lower Mississippi, in terms of both seasonal means and extremely high individual measurements.

Table C-6

USGS Region 08: Lower Mississippi River System Excluding Arkansas-White-Red (Region 11)
Mean Ambient Nitrogen and Phosphorus Loadings by Subregion

1989: All data in lbs/day

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01 Lower Mississippi R. - Hatchie	TP[2]	*	698 (3)	5 (3)	*
	TKN	*	2252 (3)	51 (2)	*
	OrgN	*	*	*	*
02 Lower Mississippi-St. Francis	TP	22042 (32)	6806 (25)	2814 (28)	124 (8)
	TKN	96790 (4)	16 (9)	2195 (4)	587 (8)
	OrgN	*	*	*	*
03 Lower Mississippi-Yazoo	TP	5849 (94)	1441 (164)	197 (96)	*
	TKN	167746 (3)	110572 (2)	45577 (1)	*
	OrgN	*	*	*	*
04 Lower Red - Ouachita	TP	1491 (45)	1747 (32)	804 (40)	152 (2)
	TKN	14721 (5)	10807 (8)	10203 (8)	3035 (2)
	OrgN	*	*	*	*
05 Boeuf - Tensas	TP	*	*	*	*
	TKN	*	*	*	*
	OrgN	*	*	*	*
06 Lower Mississippi-Big Black-Escambia	TP	474423 (4)	49376 (4)	497 (2)	*
	TKN	1880000 (4)	484683 (4)	2132 (1)	*
	OrgN	*	*	*	*
07 Lower Mississippi-Lake Maurepas	TP	809535 (5)	519710 (3)	432527 (4)	*
	TKN	2143000 (3)	814123 (2)	659917 (2)	*
	OrgN	*	*	*	*

Table C-6 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
08 Louisiana Coastal (incl. Atchafalaya)	TP[2]	200640 (10)	130900 (12)	76923 (10)	95470 (1)
	TKN	1031000 (5)	570777 (6)	204154 (5)	445525 (1)
	OrgN	*	*	*	*
09 Lower Mississippi R.	TP	308804 (2)	301958 (3)	114467 (2)	191674 (3)
	TKN	1715000 (2)	1632000 (3)	572763 (2)	774006 (2)
	OrgN	*	*	*	*
Region 8	TP	51518 (192)	19097 (246)	15455 (185)	41987 (16)
	TKN	904023 (26)	329792 (37)	144973 (25)	133620 (15)
	OrgN	*	*	*	*

* No samples taken
( ) = Number of measurements

[1] Winter runoff: January 1 - March 31
Spring: April 1 - June 30
Summer: July 1 - September 30
Fall: October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

<u>Table C7 - Region 10</u>: Nutrient Loadings in the Missouri River System

We found the concentrations of nutrients in the Missouri River system to be generally quite high. However, with smaller and slower flows of water than in some other regions the nutrient loadings are nearly all quite slow. We should note again that the uppermost reaches of this region are rarely sampled, particularly in fall and winter when they may be frozen. Some other subregions have no loadings measured in the fall.

For subregions and seasons with a sufficient number of measurements, the lowest total phosphorus loadings means were found in subregion 6, the Missouri-Poplar-Escambia area: .25 lbs/day in winter, .45 lbs/day in summer and 3 lbs/day in the spring. Many of the Missouri system's 30 subregions had seasonal phosphorus means lower than 100 lbs/day, and the majority were below 1,000 lbs/day on average. A few high mean phosphorus loadings push up the regional averages, however: 117,623 lbs/day based on 3 measurements in winter in the Lower Yellowstone subregion (10), 49,482 lbs/day (2 observations) in the most downstream Lower Missouri subregion (30) in the summer, and 10,289 lbs/day (18 observations) in the winter in the Missouri-Nishnabotna area, subregion 24. The highest single measurements of phosphorus loadings in Region 10 were 352,429 lbs/day in the winter in subregion 10; 90,917 lbs/day in the summer in the Kansas River area, subregion 27; and 64,466 lbs/day in subregion 30, the farthest downstream, also in the summer.

Generally, seasonal mean ambient TKN loadings were also quite low in the Missouri system. The lowest mean loadings for subregions and seasons with sufficient data for 1989 were 9 lbs/day in the summer and 22 lbs/day in the fall, both in subregion 06, and 24 lbs/day in the summer in the James River area, subregion 16. The highest such mean seasonal TKN loadings were 81,123 lbs/day in spring in subregion 30, and 32,071 lbs/day in spring, 30,671 lbs/day in winter and 28,081 lbs/day in summer, all in subregion 24. Note, however, the highest seasonal means: 187,056 lbs/day in summer (2 measurements) and 101,960 lbs/day in winter (3 measurements), both in the Lower Missouri subregion 30. The highest individual measurements of TKN were 359,441 lbs/day in subregion 27, the Kansas River area in summer; 266,452 lbs/day in the spring in subregion 30, the Lower Missouri; and 223,302 lbs/day in the winter in subregion 24, the Missouri-Nishnabotna area.

Organic nitrogen loadings were measured in only one season and subregion in the Missouri system in 1989.

For all of Region 10 the seasonal mean total phosphorus loadings varied from 379 lbs/day in the fall to 2,209 lbs/day in the summer. Mean TKN loadings ranged from 1,760 lbs/day in the fall to 10,671 lbs/day in the summer. Many individual subregions, however, had their high or low means in other seasons.

Table C-7

USGS Region 10: Missouri River System
Mean Ambient Nitrogen and Phosphorus Loadings by Subregion

1989: All data in lbs/day

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01 Saskatchewan	TP[2]	*	375 (1)	50 (1)	*
	TKN	*	257 (1)	497 (1)	814 (1)
	OrgN	*	*	*	*
02 Missouri Headwaters	TP	*	265 (4)	104 (2)	*
	TKN	*	*	*	*
	OrgN	*	*	*	*
03 Missouri - Marias	TP	291 (3)	128 (12)	57 (8)	367 (3)
	TKN	2986 (3)	2531 (10)	1137 (6)	4045 (2)
	OrgN	*	*	*	*
04 Missouri - Musselshell	TP	294 (4)	621 (7)	1001 (5)	918 (4)
	TKN	3845 (4)	6667 (7)	5327 (7)	4659 (5)
	OrgN	*	*	*	*
05 Milk	TP	5867 (5)	49 (4)	19 (3)	13 (6)
	TKN	19822 (5)	232 (4)	240 (3)	164 (4)
	OrgN	*	*	*	*
06 Missouri - Poplar - Escambia	TP	163 (8)	3 (11)	.45 (12)	.25 (8)
	TKN	1051 (8)	52 (11)	9 (15)	22 (8)
	OrgN	*	*	*	*
07 Upper Yellowstone	TP	360 (2)	2318 (6)	843 (5)	332 (2)
	TKN	3844 (2)	17934 (2)	18150 (2)	25620 (1)
	OrgN	*	*	*	*
08 Big Horn	TP	89 (22)	163 (42)	180 (39)	116 (21)
	TKN	1299 (19)	6934 (23)	2689 (22)	1673 (6)
	OrgN	*	*	*	*

Table C-7 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Powder - Tongue	TP[2]	25 (28)	232 (69)	686 (31)	1022 (16)
	TKN	236 (11)	338 (23)	267 (7)	540 (10)
	OrgN	*	*	*	*
10 Lower Yellowstone	TP	117623 (3)	1779 (4)	157 (5)	489 (3)
	TKN	32914 (3)	183 (2)	2623 (5)	4891 (4)
	OrgN	*	*	*	*
11 Missouri - Little Missouri	TP	131 (1)	105 (4)	3 (2)	.2 (3)
	TKN	670 (1)	399 (4)	26 (2)	3 (3)
	OrgN	*	*	*	*
12 Cheyenne	TP	273 (16)	11 (47)	12 (10)	16 (8)
	TKN	809 (10)	45 (41)	279 (7)	129 (3)
	OrgN	*	*	*	*
13 Missouri - Oahe	TP	75 (4)	65 (7)	1910 (4)	3 (7)
	TKN	490 (4)	509 (7)	410 (4)	33 (7)
	OrgN	*	*	*	*
14 Missouri - White	TP	114 (4)	727 (7)	733 (5)	49 (3)
	TKN	405 (2)	1295 (3)	741 (3)	337 (1)
	OrgN	*	*	*	*
15 Niobrara	TP	647 (17)	793 (13)	281 (13)	278 (10)
	TKN	9380 (2)	4944 (5)	4776 (6)	4045 (1)
	OrgN	*	*	*	*
16 James	TP	1592 (4)	772 (21)	6 (6)	4 (2)
	TKN	5640 (4)	3673 (21)	24 (6)	36 (2)
	OrgN	*	*	*	*
17 Missouri - Big Sioux	TP	3994 (3)	192 (5)	186 (2)	151 (2)
	TKN	14116 (2)	1713 (2)	1909 (2)	423 (1)
	OrgN	*	*	*	*
18 North Platte	TP	335 (17)	371 (23)	619 (17)	91 (7)
	TKN	1692 (14)	3250 (19)	3231 (18)	1712 (5)
	OrgN	*	*	*	*

Table C-7 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
19	TP[2]	2018 (13)	415 (11)	385 (17)	491 (10)
South Platte	TKN	6194 (13)	1779 (11)	1636 (20)	2436 (8)
	OrgN	*	*	*	*
20	TP	4795 (18)	3289 (19)	6347 (17)	2454 (4)
Platte	TKN	19616 (14)	16430 (17)	23182 (17)	8065 (4)
	OrgN	*	*	*	*
21	TP	657 (26)	324 (15)	528 (10)	472 (3)
Loup	TKN	918 (7)	397 (7)	1623 (9)	432 (2)
	OrgN	*	*	*	*
22	TP	1544 (15)	865 (15)	2025 (15)	1301 (1)
Elkhorn	TKN	4931 (12)	3403 (15)	13350 (14)	1752 (1)
	OrgN	*	*	*	*
23	TP	145 (11)	367 (8)	244 (8)	491 (7)
Missouri -	TKN	397 (8)	840 (8)	767 (8)	1207 (7)
Little Sioux	OrgN	111 (3)	*	*	*
24	TP	10289 (18)	9268 (16)	5463 (12)	136 (4)
Missouri -	TKN	30671 (11)	32071 (13)	28081 (9)	272 (4)
Nishnabotna	OrgN	*	*	*	*
25	TP	97 (8)	43 (9)	257 (8)	*
Republican	TKN	928 (2)	410 (7)	1257 (7)	*
	OrgN	*	*	*	*
26	TP	84 (4)	233 (6)	1284 (3)	*
Smoky Hill	TKN	394 (4)	1773 (6)	7102 (3)	*
	OrgN	*	*	*	*
27	TP	548 (146)	635 (127)	5493 (65)	453 (9)
Kansas	TKN	1973 (27)	2545 (111)	23758 (58)	1053 (9)
	OrgN	*	*	*	*
28	TP	66 (7)	373 (9)	17 (6)	11 (2)
Chariton -	TKN	422 (7)	1636 (7)	190 (5)	60 (3)
Grand	OrgN	*	*	*	*

Table C-7 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
29 Gasconade - Osage	TP[2]	365 (14)	129 (10)	719 (6)	.2 (1)
	TKN	5468 (9)	1973 (7)	2817 (8)	.1 (1)
	OrgN	*	*	*	*
30 Lower Missouri	TP	11906 (5)	14133 (9)	49482 (2)	*
	TKN	101960 (3)	81123 (7)	187056 (2)	*
	OrgN	*	*	*	*
Region 10	TP	2148 (426)	1006 (541)	2209 (339)	379 (146)
	TKN	5606 (311)	5288 (401)	10671 (276)	1760 (103)
	OrgN	111 (3)	*	*	*

* No samples taken
( ) = Number of measurements

[1] Winter runoff: January 1 - March 31
Spring: April 1 - June 30
Summer: July 1 - September 30
Fall: October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

<u>Table C8 - Region 11</u>: Nutrient Loadings in the Arkansas-White-Red System

The Arkansas-White-Red system of rivers flowing from eastern Colorado through southern Kansas, Oklahoma and Texas to the lower Mississippi is another system which had relatively high concentrations of nutrients in 1989. Again, however, the loadings which account for flow of water, as well as concentrations of nutrients, are generally fairly low. The lack of abundant data in some subregions is again a problem in analyzing the data, particularly in the fall season, as a perusal of Table C8 shows.

The lowest ambient total phosphorus mean loadings in Region 11 were 6 lbs/day in the fall season in the Upper Cimarron area (subregion 04) and 17 lbs/day in the winter in the Red River Headwaters (subregion 12), for those subregions and seasons with more than three measurements. The highest such phosphorus loadings were 12,061 lbs/day in the winter and 11,246 lbs/day in the spring, both in the Lower Arkansas (subregion 11). The highest individual measurements of phosphorus in 1989 were 95,362 lbs/day in the spring in subregion 11; 77,298 lbs/day in the spring in subregion 14, the Missouri-White rivers area; and 64,725 lbs/day in the winter, again in subregion 11.

For TKN, the lowest ambient mean loadings for subregions and seasons with more than three measurements were 31 lbs/day in the fall and 60 lbs/day in winter, both in the Upper Cimarron subregion. The highest mean TKN loadings are all found in the Lower Arkansas subregion: 115,933 lbs/day in the spring, 104,942 lbs/day in the winter and 61,345 lbs/day in the summer. All of these means are for those subregions and seasons with more than three measurements. The highest individual measurements of TKN loadings in 1989 were 513,487 lbs/day in the spring, 392,677 lbs/day in winter and 267,963 lbs/day in the summer, all in subregion 11, the Lower Arkansas River area.

Ambient organic nitrogen loadings were not measured in Region 11 in 1989.

For all of Region 11 mean ambient total phosphorus loadings varied from a low of 1,078 lbs/day in the fall to 5,775 lbs/day in the winter. Mean TKN loadings ranged from a low of 3,963 lbs/day in the fall to 32,327 lbs/day in the spring. It should be noted that some subregions, especially the Upper White (subregion 01), the Upper Arkansas (subregion 02), the Neosho-Verdigris (subregion 07), the Lower Arkansas (subregion 11) and the Red-Sulphur (subregion 14) were more often measured for total phosphorus and/or TKN in 1989. Region means are therefore heavily influenced by those in some of these subregions.

Table C-8

USGS Region 11: Arkansas-White-Red System
Mean Ambient Nitrogen and Phosphorus Loadings
by Subregion

1989: All data in lbs/day

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01	TP[2]	1198 (44)	1255 (40)	289 (32)	433 (2)
Upper White	TKN	15821 (13)	20136 (19)	1986 (13)	1571 (1)
	OrgN	*	*	*	*
02	TP	59 (2)	201 (4)	102 (2)	109 (3)
Upper	TKN	1302 (28)	827 (29)	430 (50)	1187 (30)
Arkansas	OrgN	*	*	*	0
03	TP	54 (1)	51 (1)	498 (1)	*
Middle	TKN	1359 (1)	1141 (1)	4796 (1)	*
Arkansas	OrgN	*	*	*	*
04	TP	3 (5)	5 (6)	2 (2)	6 (4)
Upper	TKN	60 (6)	96 (6)	29 (2)	31 (4)
Cimarron	OrgN	*	*	*	*
05	TP	10736 (2)	4199 (2)	1030 (2)	*
Lower	TKN	41028 (3)	16063 (3)	1535 (2)	*
Cimarron	OrgN	*	*	*	*
06	TP	1052 (2)	2443 (2)	27670 (1)	*
Arkansas -	TKN	11227 (2)	35362 (2)	202914 (1)	*
Keystone	OrgN	*	*	*	*
07	TP	374 (17)	718 (19)	536 (11)	82 (1)
Neosho -	TKN	3277 (6)	16350 (4)	40142 (4)	*
Verdigris	OrgN	*	*	0 (1)	*
08	TP	6 (2)	5 (1)	28 (3)	.5 (1)
Upper	TKN	113 (2)	145 (1)	182 (3)	91 (1)
Canadian	OrgN	*	*	*	*
09	TP	154 (5)	83 (4)	4766 (7)	1209 (2)
Lower	TKN	487 (4)	295 (4)	11066 (7)	1887 (2)
Canadian	OrgN	*	*	*	*

Table C-8 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
10 North Canadian	TP[2]	1245 (5)	500 (3)	1719 (2)	98 (1)
	TKN	10678 (5)	1000 (3)	5537 (2)	328 (1)
	OrgN	*	*	*	*
11 Lower Arkansas	TP	12061 (63)	11246 (63)	5847 (66)	4508 (4)
	TKN	104942 (20)	115933 (25)	61345 (22)	22928 (4)
	OrgN	*	*	*	*
12 Red Headwaters	TP	17 (5)	41 (5)	43 (6)	4 (1)
	TKN	167 (5)	313 (5)	247 (7)	89 (1)
	OrgN	*	*	*	*
13 Red-Washita	TP	208 (10)	162 (4)	464 (8)	91 (3)
	TKN	1442 (5)	1027 (4)	3409 (7)	575 (2)
	OrgN	*	*	*	*
14 Red-Sulphur	TP	8487 (33)	7275 (32)	5895 (25)	1278 (8)
	TKN	29518 (17)	28203 (18)	3898 (7)	9949 (8)
	OrgN	*	*	*	*
Region 11	TP	5775 (196)	5488 (187)	3689 (168)	1078 (30)
	TKN	26267 (117)	32327 (124)	14924 (128)	3963 (54)
	OrgN	*	*	*	*

* No samples taken
( ) = Number of measurements

[1] Winter runoff: January 1 - March 31
Spring April 1 - June 30
Summer July 1 - September 30
Fall October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table C9 - Region 12: Nutrient Loadings in the Texas Gulf Rivers

In the Texas Gulf rivers we generally found relatively low concentrations of nutrients; in this region the same pattern holds true for nutrient loadings, though it should be noted that some subregions had a limited number of measurements.

The lowest quarterly mean ambient total phosphorus loadings, for those subregions and seasons with more than three measurements, were 2 lbs/day in winter and 3 lbs/day in summer, both in the Brazos Headwaters, subregion 05. The highest such total phosphorus loadings were 8,307 lbs/day in the spring and 6,694 lbs/day in the summer, both in the Trinity River area (subregion 03), and 4,705 lbs/day in the summer in the Sabine River area, subregion 01. The highest individual measurements of total phosphorus in 1989 were 51,694 lbs/day in the summer, 41,403 lbs/day in the spring, and 37,224 lbs/day in the winter, all in Trinity River subregion (03).

Ambient TKN loadings in the Texas Gulf Region were almost as highly variable in 1989. The lowest seasonal mean TKN loadings were 18 lbs/day in the winter in the Brazos Headwaters; 55 lbs/day in subregion 11, the Nueces-Southwestern Texas Coastal subregion, also in winter; and 59 lbs/day in the fall in subregion 06, the Middle Brazos River area. (Other low means were from three or fewer measurements.) The highest mean TKN loadings were 82,949 lbs/day in the summer in the Sabine River area, subregion 01; 59,510 lbs/day in the spring, and 50,844 lbs/day in the summer, both in the Neches River subergion (02). The highest single measurements of TKN in 1989 were 344,388 lbs/day in the spring in the Trinity River subregion; 329,381 lbs/day in the spring and 226,538 lbs/day in the summer, both in the Neches River subregion.

Organic nitrogen loadings were not measured in Region 12 in 1989.

For the Texas Gulf region as a whole, seasonal mean total phosphorus loadings varied from 696 lbs/day in the fall to 2,409 lbs/day in the spring. TKN loadings ranged from 902 lbs/day in the fall to 12,000 lbs/day in the spring. Again, some subregions and seasons had more measurements than others, but the differences are not as great as in a few other regions.

Table C-9

USGS Region 12: Texas Gulf Region
Mean Ambient Nitrogen and Phosphorus Loadings
by Subregion

1989: All data in lbs/day

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01 Sabine	TP[2]	1418 (5)	2786 (4)	4705 (4)	282 (3)
	TKN	13560 (5)	22156 (4)	82949 (4)	1586 (3)
	OrgN	*	*	*	*
02 Neches	TP	3724 (10)	1526 (7)	2918 (5)	3908 (4)
	TKN	16282 (8)	59510 (7)	50844 (5)	5426 (3)
	OrgN	*	*	*	*
03 Trinity	TP	4197 (42)	8307 (38)	6694 (29)	640 (13)
	TKN	5170 (31)	29923 (38)	15952 (30)	764 (8)
	OrgN	*	*	*	*
04 Galveston Bay - San Jacinto	TP	1309 (51)	2465 (11)	368 (50)	496 (4)
	TKN	3710 (34)	6595 (9)	520 (50)	664 (4)
	OrgN	*	*	*	*
05 Brazos Headwaters	TP	2 (5)	47 (2)	3 (6)	.01 (1)
	TKN	18 (4)	159 (2)	19 (3)	.5 (1)
	OrgN	*	*	*	*
06 Middle Brazos	TP	115 (14)	99 (18)	119 (15)	139 (13)
	TKN	106 (13)	219 (12)	90 (11)	59 (11)
	OrgN	*	*	*	*
07 Lower Brazos	TP	148 (8)	442 (9)	845 (9)	666 (4)
	TKN	214 (7)	3892 (10)	3853 (8)	1157 (3)
	OrgN	*	*	*	*
08 Upper Colorado	TP	8 (2)	11 (1)	.3 (2)	2 (1)
	TKN	131 (2)	84 (1)	5 (2)	15 (1)
	OrgN	*	*	*	*

Table C-9 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Lower Colorado - San Bernard Coastal	TP[2]	861 (31)	517 (43)	293 (12)	535 (19)
	TKN	2921 (32)	3339 (42)	1006 (19)	1318 (19)
	OrgN	*	*	*	*
10 Central Texas Coastal	TP	1793 (28)	1221 (39)	751 (33)	870 (24)
	TKN	1205 (28)	1014 (30)	260 (34)	258 (19)
	OrgN	*	*	*	*
11 Nueces - Southwestern Texas Coastal	TP	11 (3)	52 (11)	56 (3)	83 (4)
	TKN	55 (7)	1170 (5)	301 (5)	1421 (2)
	OrgN	*	*	*	*
Region 12	TP	1845 (199)	2409 (183)	1689 (168)	696 (90)
	TKN	3598 (171)	12000 (160)	6736 (171)	902 (74)
	OrgN	*	*	*	*

* No samples taken
( ) = Number of measurements

1 Winter runoff: January 1 - March 31
Spring: April 1 - June 30
Summer: July 1 - September 30
Fall: October 1 - December 31

2 TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

Table C10 - Region 13: **Ambient Nutrient Loadings in the Rio Grande System**

Several of the nine subregions in the Rio Grande region had very sparse measurements of phosphorus and nitrogen in 1989. The Rio Grande-Elephant Butte and Upper Pecos subregions, both upstream reaches, have higher numbers of measurements.

The lowest mean ambient total phosphorus loadings were 12 lbs/day in the fall and 27 lbs/day in the winter, both in the Upper Pecos River system, subregion 06. This data is for subregions and seasons with more than three measurements. The highest such mean phosphorus loadings in 1989 were 1,209 lbs/day in the summer and 612 lbs/day in the winter, both in subregion 2, the Rio Grande-Elephant Butte area, and 543 lbs/day in the winter in the Rio Grande-Mimbres subregion (03), again for those means based on more than three measurements. The highest individual measurements of ambient total phosphorus loadings were 15,534 lbs/day in the summer in the Rio Grande-Elephant Butte subregion; 5,874 lbs/day in the summer in subregion 04, the Rio Grande-Armistead area; and 2,662 lbs/day in the winter, again in the Rio Grande-Elephant Butte area.

Mean ambient TKN loadings were also relatively low in 1989. For subregions and seasons with sufficient data the lowest mean TKN loadings were 173 lbs/day in the winter, 224 lbs/day in the fall and 388 lbs/day in the summer, all in the Upper Pecos subregion. The highest such mean TKN loadings were 6,657 lbs/day in the summer in the Rio Grande-Armistad subregion and 2,935 lbs/day in the Rio Grande-Elephant Butte subregion, again the summer. The highest single measurements of TKN in Region 13 in 1989 were 35,599 lbs/day in the summer in the Rio Grande-Elephant Butte subregion; 17,621 lbs/day in summer in the Rio Grande-Armistad subregion; and 10,469 lbs/day in the winter in subregion 09, the Lower Rio Grande River as it nears the Gulf of Mexico.

Ambient organic nitrogen loadings were not measured in the Rio Grande region in 1989.

In 1989 seasonal mean total phosphorus loadings for the entire Rio Grande system varied from a low of 176 lbs/day in the fall to 829 lbs/day in the summer. Mean TKN loadings ranged from 627 lbs/day in the fall to a high of 2,554 lbs/day in the summer. We must again caution that all data analysis of this region is hampered by the lack of ample data in many subregions.

Table C-10

USGS Region 13: Rio Grande System
Mean Ambient Nitrogen and Phosphorus Loadings
by Subregion

1989: All data in lbs/day

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
01	TP[2]	167 (1)	298 (2)	26 (1)	58 (2)
Rio Grande	TKN	626 (1)	1429 (2)	139 (1)	269 (2)
Headwaters	OrgN	*	*	*	*
02	TP	612 (10)	346 (8)	1209 (17)	114 (10)
Rio Grande -	TKN	1350 (8)	2114 (8)	2935 (18)	465 (9)
Elephant Butte	OrgN	*	*	*	*
03	TP	543 (7)	391 (1)	795 (2)	140 (1)
Rio Grande -	TKN	1051 (6)	2932 (1)	6144 (2)	180 (1)
Mimbres	OrgN	*	*	*	*
04	TP	349 (4)	556 (2)	2869 (3)	1222 (2)
Rio Grande -	TKN	1857 (4)	1430 (3)	6657 (4)	2116 (3)
Armistad	OrgN	*	*	*	*
05	TP	3 (2)	*	3 (2)	4 (1)
Rio Grande	TKN	52 (2)	50 (1)	40 (2)	20 (1)
Closed Basins	OrgN	*	*	*	*
06	TP	27 (6)	123 (9)	67 (10)	12 (6)
Upper	TKN	173 (5)	713 (11)	388 (8)	224 (5)
Pecos	OrgN	*	*	*	*
07	TP	25 (2)	15 (2)	5 (2)	*
Lower Pecos	TKN	483 (2)	265 (1)	617 (2)	145 (1)
	OrgN	*	*	*	*
08	TP	250 (2)	243 (3)	*	155 (2)
Rio Grande -	TKN	*	*	*	*
Falcon	OrgN	*	*	*	*

Table C-10 (continued)

Subregion	Nutrient	Winter	Spring	Summer	Fall[1]
09 Lower Rio Grande	TP[2]	271 (2)	47 (3)	53 (1)	171 (2)
	TKN	5630 (2)	592 (3)	740 (1)	1248 (2)
	OrgN	*	*	*	*
Region 13	TP	345 (37)	229 (30)	829 (38)	176 (26)
	TKN	1243 (31)	1231 (30)	2554 (38)	627 (24)
	OrgN	*	*	*	*

* No samples taken
( ) = Number of measurements

[1] Winter runoff: January 1 - March 31
Spring: April 1 - June 30
Summer: July 1 - September 30
Fall: October 1 - December 31

[2] TP = Total Phosphorus
TKN = Total Kjeldahl Nitrogen
OrgN = Organic Nitrogen

APPENDIX D

Regional Comparisons of Geographic Areas in USGS and Purdue Water Quality Model

Appendix D: USGS Regions/Subregions Comprising Purdue Water Quality Model River Systems[1]

USGS Regions (2-digit) or Subregions (4-digit)	Purdue Water Quality Model River System #
0309 - Partial, 0310	12
0311, 0312, 0313	13
0314, 0315, 0316, 0317, 0318	14
05, 06, 07, 08, 10, 11 - All Subregions	18
1201, 1202, 1203, 1204	19
1205, 1206, 1207, 1208, 1209, 1210, 1211	20
13 - All Subregions	21

1 See Table 1, Appendix E of report for names of rivers, lakes and reservoirs included in each.

APPENDIX E

Summary Estimates of Concentrations from Purdue Water Quality Model

Appendix E: Table 1 - Purdue University Water Quality Model Summary For Gulf of Mexico Drainage Area

Table 1 : PURDUE UNIVERSITY WATER QUALITY MODEL
1990 Estimated TP, TKN

ATTENUATING POLLUTANTS IN RIVER SYSTEM 12:
USGS Subregions 0309 (Partial), 0310

WATER BODY POINT			CONCENTRATION TP MG/L	CONCENTRATION TKN MG/L
		(Arbitrary) STANDARD	0.2	1.5
300801	LAKE KISSIMEE	WINTER	0.000	0.00
		SPRING	< 0.001	< 0.01
		SUMMER	< 0.001	< 0.01
		FALL	< 0.001	0.00
105001	KISSIMEE	WINTER	>20.000	>10.00
		SPRING	5.229	6.74
		SUMMER	4.111	5.09
		FALL	>20.000	>10.00
105002	KISSIMEE	WINTER	11.576	>10.00
		SPRING	3.557	5.39
		SUMMER	1.018	1.45
		FALL	2.223	3.94
300801	LAKE OKEECHOBEE	WINTER	0.000	0.00
		SPRING	0.000	0.00
		SUMMER	< 0.001	< 0.01
		FALL	< 0.001	0.00
105101	CALOOSAHATCHIE	WINTER	0.033	0.13
		SPRING	0.036	0.13
		SUMMER	0.004	0.02
		FALL	0.011	0.04
105102	CALOOSAHATCHIE	WINTER	1.600	>10.00
		SPRING	1.956	>10.00
		SUMMER	0.182	1.62
		FALL	0.492	4.38
105201	PEACE	WINTER	0.108	0.39
		SPRING	0.198	0.66
		SUMMER	0.077	0.25
		FALL	0.216	0.71
105202	PEACE	WINTER	0.144	0.60
		SPRING	0.260	1.03
		SUMMER	0.102	0.39
		FALL	0.280	1.09

WATER BODY POINT		CONCENTRATION TP MG/L	CONCENTRATION TKN MG/L
	STANDARD	0.2	1.5
201701 TAMPA BAY	WINTER	1.772	4.73
	SPRING	0.463	1.25
	SUMMER	0.779	2.10
	FALL	0.922	2.31
500201 GULF OF MEX.-SFL	WINTER		
	SPRING		
	SUMMER		
	FALL		

SUMMARY FOR RIVER SYSTEM 12
(USGS Subregions
0309 [Partial], 0310)

	PCT OF RIVER MILES STD NOT MET TP	PCT OF RIVER MILES STD NOT MET TKN
WINTER	100.	100.
SPRING	100.	57.
SUMMER	100.	24.
FALL	100.	42.

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1 5
105501	OCHLOCHONEE	WINTER	0.267	2.33
		SPRING	0.506	3 87
		SUMMER	0.830	6.24
		FALL	1.742	>10.00
105502	OCHLOCHONEE	WINTER	0.208	1.80
		SPRING	0.290	2.28
		SUMMER	0.494	3.71
		FALL	0.626	4.30
105601	FLINT(GA)	WINTER	0.176	1.36
		SPRING	0.314	2.23
		SUMMER	0.582	3.49
		FALL	0.837	4.87
105602	FLINT(GA)	WINTER	0.142	1.33
		SPRING	0.226	2.00
		SUMMER	0.375	2.91
		FALL	0.718	5.48
105603	FLINT(GA)	WINTER	0.326	3.09
		SPRING	0.523	4.63
		SUMMER	0.806	6.36
		FALL	1.217	8.60
105604	FLINT(GA)	WINTER	0.303	2.85
		SPRING	0.508	4.57
		SUMMER	0.821	6.72
		FALL	1.264	>10.00
301001	BLACKSHEAR RES	WINTER	0.143	1.31
		SPRING	0.263	2.04
		SUMMER	0.346	1.77
		FALL	0.520	2.38
105605	FLINT(GA)	WINTER	0.137	1.22
		SPRING	0.251	1.82
		SUMMER	0.329	1.50
		FALL	0.492	2.02

WATER BODY POINT		STANDARD	CONCENTRATION TP MG/L 0 2	TKN MG/L 1.5
105705	CHATTAHOOCHEE	WINTER	0.237	1.16
		SPRING	0.325	1.23
		SUMMER	0.419	0.87
		FALL	0.479	1.28
105706	CHATTAHOOCHEE	WINTER	0.252	1.45
		SPRING	0.350	1.69
		SUMMER	0.455	1.63
		FALL	0.535	2.22
301301	WALTER GEORGE RES	WINTER	0.139	0.62
		SPRING	0.119	0.21
		SUMMER	0.085	< 0.01
		FALL	0.080	0.02
105707	CHATTAHOOCHEE	WINTER	0.187	1.16
		SPRING	0.201	1.14
		SUMMER	0.200	1.37
		FALL	0.224	1.74
105708	CHATTAHOOCHEE	WINTER	0.202	1.45
		SPRING	0.233	1.61
		SUMMER	0.262	2.12
		FALL	0.300	2.64
301401	WOODRUFF RES	WINTER	0.153	1.31
		SPRING	0.211	1.47
		SUMMER	0.237	1.12
		FALL	0.262	1.39
105801	APALICHICOLA	WINTER	0.127	1.01
		SPRING	0.159	0.95
		SUMMER	0.164	0.60
		FALL	0.208	0.90
105802	APALICHICOLA	WINTER	0.114	0.92
		SPRING	0.144	0.66
		SUMMER	0.149	0.59
		FALL	0.191	0.88

ATTENUATING POLLUTANTS IN RIVER SYSTEM 14.
USGS Subregions 0314 - 0318

WATER BODY POINT			CONCENTRATION TP MG/L	CONCENTRATION TKN MG/L
		STANDARD	0.2	1.5
105901	CHOCTAWATCHEE	WINTER	0.115	1.12
		SPRING	0.139	1.19
		SUMMER	0.265	1.88
		FALL	0.277	2.09
105902	CHOCTAWATCHEE	WINTER	0.137	1.40
		SPRING	0.150	1.43
		SUMMER	0.300	2.84
		FALL	0.364	3.35
106001	YELLOW	WINTER	0.198	1.81
		SPRING	0.307	2.71
		SUMMER	0.735	5.37
		FALL	0.763	6.11
106002	YELLOW	WINTER	0.268	2.27
		SPRING	0.410	3.32
		SUMMER	1.087	7.95
		FALL	1.132	8.64
108101	CONECUH	WINTER	0.187	2.04
		SPRING	0.320	3.28
		SUMMER	0.797	7.18
		FALL	1.447	>10.00
108102	ESCAMBIA	WINTER	0.055	0.53
		SPRING	0.080	0.69
		SUMMER	0.175	1.07
		FALL	0.315	2.23
108103	ESCAMBIA	WINTER	0.055	0.53
		SPRING	0.080	0.89
		SUMMER	0.175	1.07
		FALL	0.315	2.23
201801	PENSACOLA BAY	WINTER	0.101	0.69
		SPRING	0.153	0.91
		SUMMER	0.283	1.19
		FALL	0.467	2.28

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
106302	COOSA	WINTER	0.420	1.55
		SPRING	0.552	1.95
		SUMMER	1.194	3.75
		FALL	1.329	4.30
301701	WEISS RES	WINTER	0.536	1.77
		SPRING	0.628	1.63
		SUMMER	0.973	1.00
		FALL	1.294	2.21
106303	COOSA	WINTER	0.537	1.77
		SPRING	0.611	1.52
		SUMMER	1.024	1.35
		FALL	1.320	2.40
106304	COOSA	WINTER	0.561	1.81
		SPRING	0.600	1.43
		SUMMER	1.010	1.25
		FALL	1.310	2.29
301801	LOGAN MARTIN RES	WINTER	0.485	1.58
		SPRING	0.692	1.67
		SUMMER	1.150	1.09
		FALL	1.335	2.00
106305	COOSA	WINTER	0.546	1.73
		SPRING	0.781	1.90
		SUMMER	1.409	1.98
		FALL	1.579	2.78
106306	COOSA	WINTER	0.547	1.73
		SPRING	0.785	1.89
		SUMMER	1.394	1.91
		FALL	1.560	2.89
301901	MITCHELL RES	WINTER	0.373	1.08
		SPRING	0.443	0.75
		SUMMER	0.388	0.08
		FALL	0.430	0.20

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1 5
106503	BLACK WARRIOR	WINTER	0.539	5.64
		SPRING	0.883	6.52
		SUMMER	2.198	9.98
		FALL	2.226	>10.00
106601	TOMBIGBEE	WINTER	0.354	3.84
		SPRING	0.554	5.34
		SUMMER	1.660	>10.00
		FALL	1.154	9.75
106602	TOMBIGBEE	WINTER	0.321	3.53
		SPRING	0.661	7.06
		SUMMER	3.360	>10.00
		FALL	2.463	>10.00
302101	LAKE DEMOPOLIS	WINTER	0.335	3.58
		SPRING	0.638	5.77
		SUMMER	2.388	>10.00
		FALL	2.124	>10.00
106603	TOMBIGBEE	WINTER	0.284	2.76
		SPRING	0.522	3.62
		SUMMER	1.306	2.35
		FALL	1.224	4.21
106604	TOMBIGBEE	WINTER	0.239	2.25
		SPRING	0.436	2.97
		SUMMER	0.889	2.61
		FALL	0.956	3.71
106605	TOMBIGBEE	WINTER	0.237	2.20
		SPRING	0.461	3.22
		SUMMER	0.932	3.02
		FALL	0.893	4.05
106701	MOBILE	WINTER	0.198	1.40
		SPRING	0.360	2.03
		SUMMER	0.750	2.80
		FALL	0.783	3.57

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1 5
107001	PASAGOULA	WINTER	0.072	0.64
		SPRING	0.146	1 11
		SUMMER	0.488	2.43
		FALL	0.535	3.11
107002	PASAGOULA	WINTER	0.072	0.64
		SPRING	0.146	1.11
		SUMMER	0.488	2.43
		FALL	0.535	3.11
107101	PEARL	WINTER	0.398	4.05
		SPRING	1.465	>10.00
		SUMMER	9.935	>10.00
		FALL	5.504	>10.00
302201	ROSS BARNETT RES	WINTER	0.320	2.46
		SPRING	0.647	2.78
		SUMMER	0.007	< 0.01
		FALL	0.220	0.03
107102	PEARL	WINTER	0.608	3.88
		SPRING	1.870	>10.00
		SUMMER	13.505	>10.00
		FALL	4.989	>10.00
107103	PEARL	WINTER	0.387	2.40
		SPRING	1.028	4.93
		SUMMER	3.028	6.77
		FALL	3.189	>10.00
107104	PEARL	WINTER	0.161	0.91
		SPRING	0.408	1.74
		SUMMER	0.662	1.73
		FALL	1.057	3.74
107105	PEARL	WINTER	0.148	0.84
		SPRING	0.374	1.60
		SUMMER	0.607	1.58
		FALL	0.970	3.43

ATTENUATING POLLUTANTS IN RIVER SYSTEM 18
USGS Regions 05, 06, 07, 08, 10, 11 -
Entire Mississippi River System

WATER BODY POINT			CONCENTRATION TP MG/L	CONCENTRATION TKN MG/L
		STANDARD	0.2	1.5
311001	MILLE LAC LAKE	WINTER	< 0.001	< 0.01
		SPRING	< 0.001	< 0.01
		SUMMER	< 0.001	< 0.01
		FALL	< 0.001	< 0.01
303301	BIG STONE LAKE	WINTER	1.309	9.86
		SPRING	0.503	3.36
		SUMMER	0.592	3.03
		FALL	1.285	5.70
110201	MINNESOTA	WINTER	8.156	>10.00
		SPRING	1.714	>10.00
		SUMMER	2.167	>10.00
		FALL	5.312	>10.00
110202	MINNESOTA	WINTER	12.145	>10.00
		SPRING	2.004	>10.00
		SUMMER	2.343	>10.00
		FALL	7.545	>10.00
110203	MINNESOTA	WINTER	14.629	>10.00
		SPRING	2.261	>10.00
		SUMMER	2.601	>10.00
		FALL	6.362	>10.00
110204	MINNESOTA	WINTER	11.691	>10.00
		SPRING	2.122	>10.00
		SUMMER	2.588	>10.00
		FALL	6.784	>10.00
110205	MINNESOTA	WINTER	11.652	>10.00
		SPRING	2.134	>10.00
		SUMMER	2.591	>10.00
		FALL	6.636	>10.00
110301	ST CROIX (MIN)	WINTER	0.469	5.87
		SPRING	0.151	1.82
		SUMMER	0.158	1.78
		FALL	0.253	2.98

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
303601	PETENWELL RES	WINTER	0.106	1.33
		SPRING	0.083	0.82
		SUMMER	0.098	0.23
		FALL	0.080	0.72
110503	WISCONSIN	WINTER	0.545	5.27
		SPRING	0.326	2.84
		SUMMER	0.571	3.50
		FALL	0.328	2.74
110504	WISCONSIN	WINTER	0.741	7.43
		SPRING	0.427	3.99
		SUMMER	0.822	6.58
		FALL	0.433	3.86
303601	LAKE MENDOTA	WINTER	3.779	>10.00
		SPRING	1.377	>10.00
		SUMMER	3.264	>10.00
		FALL	1.189	9.44
110601	ROCK	WINTER	10.707	>10.00
		SPRING	3.787	>10.00
		SUMMER	9.364	>10.00
		FALL	3.289	>10.00
110602	ROCK	WINTER	7.262	>10.00
		SPRING	2.651	>10.00
		SUMMER	4.780	>10.00
		FALL	2.388	>10.00
110603	ROCK	WINTER	6.467	>10.00
		SPRING	3.060	>10.00
		SUMMER	5.693	>10.00
		FALL	2.755	>10.00
110604	ROCK	WINTER	7.360	>10.00
		SPRING	2.753	>10.00
		SUMMER	3.682	>10.00
		FALL	2.158	>10.00

WATER BODY POINT			CONCENTRATION	
			TP	TKN
			MG/L	MG/L
		STANDARD	0.2	1.5
110902	IOWA	WINTER	>20.000	>10.00
		SPRING	15.368	>10.00
		SUMMER	7.970	>10.00
		FALL	11.068	>10.00
303701	COALVILLE RES	WINTER	>20.000	>10.00
		SPRING	12.297	>10.00
		SUMMER	6.762	>10.00
		FALL	8.637	>10.00
110903	IOWA	WINTER	>20.000	>10.00
		SPRING	11.510	>10.00
		SUMMER	6.662	>10.00
		FALL	8.302	>10.00
110904	IOWA	WINTER	13.001	>10.00
		SPRING	5.661	>10.00
		SUMMER	5.516	>10.00
		FALL	5.307	>10.00
111001	S SKUNK	WINTER	>20.000	>10.00
		SPRING	10.297	>10.00
		SUMMER	4.183	>10.00
		FALL	2.825	>10.00
111002	S SKUNK	WINTER	>20.000	>10.00
		SPRING	10.811	>10.00
		SUMMER	10.801	>10.00
		FALL	12.427	>10.00
111003	SKUNK	WINTER	>20.000	>10.00
		SPRING	9.396	>10.00
		SUMMER	11.080	>10.00
		FALL	13.957	>10.00
111101	DES MOINES	WINTER	>20.000	>10.00
		SPRING	3.238	>10.00
		SUMMER	2.820	>10.00
		FALL	3.278	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
111303	KANKAKEE	WINTER	2.048	>10.00
		SPRING	1.317	>10.00
		SUMMER	2.359	>10.00
		FALL	1.482	>10.00
111401	FOX(ILL)	WINTER	8.505	>10.00
		SPRING	3.378	>10.00
		SUMMER	5.018	>10.00
		FALL	5.018	>10.00
111402	FOX(ILL)	WINTER	9.058	>10.00
		SPRING	3.619	>10.00
		SUMMER	3.665	>10.00
		FALL	3.665	>10.00
111403	FOX(ILL)	WINTER	10.499	>10.00
		SPRING	3.608	>10.00
		SUMMER	3.645	>10.00
		FALL	3.645	>10.00
111501	SANGAMON	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
111502	SANGAMON	WINTER	8.821	>10.00
		SPRING	6.073	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
111503	SANGAMON	WINTER	9.524	>10.00
		SPRING	6.532	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
111601	ILLINOIS	WINTER	4.081	>10.00
		SPRING	2 164	>10.00
		SUMMER	2.426	>10.00
		FALL	2.432	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0 2	1.5
111602	GALLATIN	WINTER	8.126	>10.00
		SPRING	3.561	>10.00
		SUMMER	2.563	>10.00
		FALL	5.335	>10.00
305201	CANYON FERRY RES	WINTER	0.072	0.71
		SPRING	0.135	0.42
		SUMMER	0.062	0.02
		FALL	0.073	0.21
111601	TETON	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
111602	TETON	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
112001	MARAIS	WINTER	>20.000	>10.00
		SPRING	7.743	>10.00
		SUMMER	8.352	>10.00
		FALL	>20.000	>10.00
112002	MARAIS	WINTER	>20.000	>10.00
		SPRING	7.740	>10.00
		SUMMER	8.343	>10.00
		FALL	>20.000	>10.00
303601	TIBER RES	WINTER	< 0.001	< 0.01
		SPRING	0.171	0.22
		SUMMER	0.101	< 0.01
		FALL	0.104	0.14
112003	MARAIS	WINTER	5.240	>10.00
		SPRING	1.162	8.16
		SUMMER	1.047	7.68
		FALL	1.363	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0 2	1 5
112204	BIG HORN	WINTER	3.123	>10.00
		SPRING	2.206	9.42
		SUMMER	3.101	>10.00
		FALL	3.164	>10.00
112301	SHOSHONE	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	18.300	>10.00
		FALL	>20.000	>10.00
112302	SHOSHONE	WINTER	11.714	>10.00
		SPRING	13.278	>10.00
		SUMMER	12.186	>10.00
		FALL	18.312	>10.00
112401	POWDER	WINTER	>20.000	>10.00
		SPRING	12.682	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
112402	POWDER	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
112403	POWDER	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
112404	POWDER	WINTER	>20.000	>10.00
		SPRING	15.528	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
304101	YELLOWSTONE LAKE	WINTER	0.081	0.20
		SPRING	0.119	0.16
		SUMMER	0.071	0.09
		FALL	0.120	0.17

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
112601	LITTLE MISSOURI	WINTER	>20.000	>10.00
		SPRING	12.321	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
112602	LITTLE MISSOURI	WINTER	>20.000	>10.00
		SPRING	8.802	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
112603	LITTLE MISSOURI	WINTER	>20.000	>10.00
		SPRING	12.032	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
112604	LITTLE MISSOURI	WINTER	>20.000	>10.00
		SPRING	16.431	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
112701	HEART	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
112702	HEART	WINTER	>20.000	>10.00
		SPRING	8.183	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
112801	CANNONBALL	WINTER	>20.000	>10.00
		SPRING	12.874	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
112802	CANNONBALL	WINTER	>20.000	>10.00
		SPRING	5.594	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00

WATER BODY POINT		STANDARD	CONCENTRATION TP MG/L 0.2	CONCENTRATION TKN MG/L 1.5
113202	WHITE(SD)	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
113301	NIOBRARA	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
113302	NIOBRARA	WINTER	8.281	>10.00
		SPRING	8.289	>10.00
		SUMMER	10.973	>10.00
		FALL	9.458	>10.00
113303	NIOBRARA	WINTER	6.928	>10.00
		SPRING	7.103	>10.00
		SUMMER	8.908	>10.00
		FALL	7.707	>10.00
113304	NIOBRARA	WINTER	4.984	>10.00
		SPRING	3.167	9.57
		SUMMER	4.558	>10.00
		FALL	4.018	>10.00
113401	JAMES(SD)	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
113402	JAMES(SD)	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
113403	JAMES(SD)	WINTER	>20.000	>10.00
		SPRING	2.492	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0 2	1.5
113602	LITTLE SIOUX	WINTER	>20.000	>10.00
		SPRING	13.322	>10.00
		SUMMER	18.289	>10.00
		FALL	>20.000	>10.00
113603	LITTLE SIOUX	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
113701	LARAMIE	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
113702	LARAMIE	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
113801	N PLATTE	WINTER	18.991	>10.00
		SPRING	14.231	>10.00
		SUMMER	7.936	>10.00
		FALL	17.458	>10.00
304201	PATHFINDER RES	WINTER	< 0.001	< 0.01
		SPRING	0.002	< 0.01
		SUMMER	0.108	< 0.01
		FALL	0.004	< 0.01
113802	N PLATTE	WINTER	13.816	>10.00
		SPRING	10.434	>10.00
		SUMMER	5.954	7.59
		FALL	12.741	>10.00
113803	N PLATTE	WINTER	10.881	>10.00
		SPRING	6.625	7.59
		SUMMER	5.607	7.39
		FALL	10.860	>10.00

WATER BODY POINT			CONCENTRATION TP MG/L	CONCENTRATION TKN MG/L
		STANDARD	0.2	1.5
113904	S PLATTE	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
113905	S PLATTE	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
114001	NFK LOUP	WINTER	0.635	8.83
		SPRING	0.494	6.70
		SUMMER	0.842	>10.00
		FALL	0.584	7.77
114002	NFK LOUP	WINTER	6.904	>10.00
		SPRING	5.095	>10.00
		SUMMER	10.738	>10.00
		FALL	8.312	>10.00
114003	LOUP	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
114101	ELKHORN	WINTER	>20.000	>10.00
		SPRING	9.953	>10.00
		SUMMER	11.952	>10.00
		FALL	>20.000	>10.00
114102	ELKHORN	WINTER	>20.000	>10.00
		SPRING	14.322	>10.00
		SUMMER	17.512	>10.00
		FALL	>20.000	>10.00
114201	PLATTE	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
114701	KANSAS	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	13.648	>10.00
		FALL	10.123	>10.00
114702	KANSAS	WINTER	11.195	>10.00
		SPRING	7.093	>10.00
		SUMMER	7.138	>10.00
		FALL	5.037	>10.00
114703	KANSAS	WINTER	11.921	>10.00
		SPRING	5.661	>10.00
		SUMMER	6.794	>10.00
		FALL	4.286	>10.00
114801	GRAND(MISSOURI)	WINTER	>20.000	>10.00
		SPRING	17.580	>10.00
		SUMMER	>20.000	>10.00
		FALL	19.909	>10.00
114802	GRAND(MISSOURI)	WINTER	>20.000	>10.00
		SPRING	15.187	>10.00
		SUMMER	>20.000	>10.00
		FALL	18.051	>10.00
114803	GRAND(MISSOURI)	WINTER	>20.000	>10.00
		SPRING	15.555	>10.00
		SUMMER	>20.000	>10.00
		FALL	18.149	>10.00
114901	CHARITON	WINTER	>20.000	>10.00
		SPRING	18.113	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
114902	CHARITON	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0 2	1.5
115101	GASCONADE	WINTER	2.334	>10.00
		SPRING	1.985	>10.00
		SUMMER	6.828	>10.00
		FALL	1.719	>10.00
115102	GASCONADE	WINTER	1.625	>10.00
		SPRING	1.376	>10.00
		SUMMER	6.003	>10.00
		FALL	1.187	9.82
115201	MISSOURI	WINTER	0.434	2.77
		SPRING	0.392	1.90
		SUMMER	0.340	1.64
		FALL	0.446	2.32
115202	MISSOURI	WINTER	1.319	4.98
		SPRING	1.177	3.83
		SUMMER	1.167	3.47
		FALL	1.301	4.38
115203	MISSOURI	WINTER	4.628	>10.00
		SPRING	2.960	>10.00
		SUMMER	2.878	>10.00
		FALL	4.230	>10.00
115204	MISSOURI	WINTER	5.628	>10.00
		SPRING	3.534	>10.00
		SUMMER	3.461	>10.00
		FALL	5.271	>10.00
305301	FT PECK RES	WINTER	< 0.001	< 0.01
		SPRING	< 0.001	< 0.01
		SUMMER	< 0.001	< 0.01
		FALL	< 0.001	< 0.01
115205	MISSOURI	WINTER	1.242	9.89
		SPRING	1.128	8.67
		SUMMER	1.518	>10.00
		FALL	1.676	>10.00

WATER BODY POINT		STANDARD	CONCENTRATION TP MG/L 0 2	TKN MG/L 1 5
305701	LEWIS AND CLARK LAKE	WINTER	1.050	5.48
		SPRING	0.865	2.48
		SUMMER	0.935	1.60
		FALL	1.085	3.44
115211	MISSOURI	WINTER	1.338	8.30
		SPRING	1.144	4.74
		SUMMER	1.149	2.95
		FALL	1.218	4.69
115212	MISSOURI	WINTER	3.482	>10.00
		SPRING	2.318	>10.00
		SUMMER	2.159	8.97
		FALL	2.201	>10.00
115213	MISSOURI	WINTER	6.810	>10.00
		SPRING	3.918	>10.00
		SUMMER	3.927	>10.00
		FALL	3.789	>10.00
115214	MISSOURI	WINTER	11.214	>10.00
		SPRING	6.637	>10.00
		SUMMER	5.963	>10.00
		FALL	5.977	>10.00
115215	MISSOURI	WINTER	12.112	>10.00
		SPRING	7.177	>10.00
		SUMMER	6.577	>10.00
		FALL	6.253	>10.00
115216	MISSOURI	WINTER	11.449	>10.00
		SPRING	6.719	>10.00
		SUMMER	6.205	>10.00
		FALL	5.771	>10.00
115217	MISSOURI	WINTER	10.374	>10.00
		SPRING	6.567	>10.00
		SUMMER	5.918	>10.00
		FALL	5.418	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
305901	CARLYLE LAKE	WINTER	1.154	5.92
		SPRING	0.550	0.67
		SUMMER	< 0.001	< 0.01
		FALL	< 0.001	< 0.01
115303	KASKASKIA	WINTER	2.308	>10.00
		SPRING	3.509	>10.00
		SUMMER	12.638	>10.00
		FALL	12.638	>10.00
115304	KASKASKIA	WINTER	1.242	6.32
		SPRING	1.881	7.90
		SUMMER	6.950	>10.00
		FALL	6.950	>10.00
115401	CLARION	WINTER	1.947	6.73
		SPRING	1.249	4.24
		SUMMER	1.390	4.54
		FALL	3.427	>10.00
115402	CLARION	WINTER	3.955	>10.00
		SPRING	2.715	8.94
		SUMMER	3.085	9.99
		FALL	6.704	>10.00
115501	CONEMAUGH	WINTER	2.793	>10.00
		SPRING	1.412	>10.00
		SUMMER	2.414	>10.00
		FALL	5.236	>10.00
115502	CONEMAUGH	WINTER	2.889	>10.00
		SPRING	1.403	>10.00
		SUMMER	2.440	>10.00
		FALL	5.247	>10.00
308101	CONEMAUGH RES	WINTER	3.699	>10.00
		SPRING	1.992	>10.00
		SUMMER	2.860	>10.00
		FALL	5.852	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
306301	CHEAT LAKE	WINTER	0.120	0.80
		SPRING	0.118	0.60
		SUMMER	0.228	1.35
		FALL	0.258	1.88
115801	MONONGAHELA	WINTER	0.898	3.31
		SPRING	0.908	2.88
		SUMMER	1.237	2.48
		FALL	1.478	4.04
115802	MONONGAHELA	WINTER	0.818	3.48
		SPRING	0.581	2.27
		SUMMER	1.023	3.17
		FALL	1.397	5.09
115901	MAHONING	WINTER	1.937	>10.00
		SPRING	0.796	>10.00
		SUMMER	2.062	>10.00
		FALL	1.439	>10.00
115902	MAHONING	WINTER	3.603	>10.00
		SPRING	1.401	>10.00
		SUMMER	3.898	>10.00
		FALL	3.008	>10.00
116001	BEAVER(PA)	WINTER	4.150	>10.00
		SPRING	2.406	>10.00
		SUMMER	4.807	>10.00
		FALL	5.212	>10.00
116002	BEAVER(PA)	WINTER	2.910	>10.00
		SPRING	1.874	>10.00
		SUMMER	2.925	>10.00
		FALL	3.836	>10.00
116101	MOHICAN	WINTER	4.264	>10.00
		SPRING	1.410	>10.00
		SUMMER	2.634	>10.00
		FALL	1.552	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
116501	HOCKING	WINTER	8.415	>10.00
		SPRING	7.128	>10.00
		SUMMER	13.192	>10.00
		FALL	>20.000	>10.00
116502	HOCKING	WINTER	4.445	>10.00
		SPRING	5.210	>10.00
		SUMMER	10.378	>10.00
		FALL	>20.000	>10.00
116601	GREENBRIER	WINTER	1.288	4.21
		SPRING	1.185	3.78
		SUMMER	1.914	4.92
		FALL	1.814	5.70
116602	GREENBRIER	WINTER	0.804	2.02
		SPRING	0.684	2.19
		SUMMER	0.953	2.87
		FALL	1.120	3.48
116701	NEW	WINTER	1.278	8.87
		SPRING	1.063	5.55
		SUMMER	1.378	7.20
		FALL	2.143	>10.00
308401	CLAYTON RES	WINTER	0.513	2.28
		SPRING	0.471	1.88
		SUMMER	0.543	1.40
		FALL	0.667	2.08
116702	NEW	WINTER	0.825	3.21
		SPRING	0.741	2.88
		SUMMER	0.666	2.44
		FALL	1.212	3.71
308501	BLUESTONE RES	WINTER	0.665	2.45
		SPRING	0.610	2.13
		SUMMER	0.861	2.42
		FALL	1.032	3.18

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
117101	TUG FORK	WINTER	0.206	0.79
		SPRING	0.253	0.93
		SUMMER	0.389	1.23
		FALL	0.563	1.90
117102	TUG FORK	WINTER	0.268	1.03
		SPRING	0.380	1.49
		SUMMER	1.060	3.80
		FALL	1.101	4.12
117201	LEVISA FORK	WINTER	1.227	4.73
		SPRING	1.847	8.91
		SUMMER	6.570	>10.00
		FALL	4.356	>10.00
117202	LEVISA FORK	WINTER	2.918	>10.00
		SPRING	3.690	>10.00
		SUMMER	>20.000	>10.00
		FALL	12.981	>10.00
117301	BIG SANDY	WINTER	2.008	7.74
		SPRING	2.346	8.87
		SUMMER	9.957	>10.00
		FALL	8.516	>10.00
117302	BIG SANDY	WINTER	1.994	7.69
		SPRING	2.350	8.88
		SUMMER	9.943	>10.00
		FALL	8.576	>10.00
117401	SCIOTO	WINTER	4.365	>10.00
		SPRING	2.119	9.53
		SUMMER	4.932	>10.00
		FALL	2.778	>10.00
117402	SCIOTO	WINTER	3.509	>10.00
		SPRING	1.814	8.52
		SUMMER	7.176	>10.00
		FALL	3.043	>10.00

WATER BODY POINT		STANDARD	CONCENTRATION TP MG/L 0.2	TKN MG/L 1 5
117801	MIAMI	WINTER	14.077	>10.00
		SPRING	5.579	>10.00
		SUMMER	>20.000	>10.00
		FALL	7.188	>10.00
117802	MIAMI	WINTER	8.013	>10.00
		SPRING	3.780	>10.00
		SUMMER	15.528	>10.00
		FALL	4.958	>10.00
117803	MIAMI	WINTER	9.405	>10.00
		SPRING	4.279	>10.00
		SUMMER	18.129	>10.00
		FALL	6.522	>10.00
117901	KENTUCKY	WINTER	2.383	9.10
		SPRING	2.377	8.74
		SUMMER	11.998	>10.00
		FALL	9.864	>10.00
117902	KENTUCKY	WINTER	1.838	6.81
		SPRING	1.973	6.87
		SUMMER	9.191	>10.00
		FALL	7.508	>10.00
117903	KENTUCKY	WINTER	1.820	6.65
		SPRING	1.461	4.88
		SUMMER	5.838	8.01
		FALL	4.231	9.72
117904	KENTUCKY	WINTER	1.748	6.27
		SPRING	1.324	4.31
		SUMMER	5.757	9.13
		FALL	3.881	9.06
117905	KENTUCKY	WINTER	1.772	6.35
		SPRING	1.325	4.31
		SUMMER	5.709	8.93
		FALL	3.867	9.00

WATER BODY POINT			CONCENTRATION	
			TP	TKN
			MG/L	MG/L
		STANDARD	0.2	1.5
118201	WHITE(IND)	WINTER	11.006	>10.00
		SPRING	7.098	>10.00
		SUMMER	>20.000	>10.00
		FALL	7.209	>10.00
118202	WHITE(IND)	WINTER	4.501	>10.00
		SPRING	2.787	>10.00
		SUMMER	10.915	>10.00
		FALL	3.850	>10.00
118203	WHITE(IND)	WINTER	5.482	>10.00
		SPRING	3.068	>10.00
		SUMMER	10.498	>10.00
		FALL	3.005	>10.00
118204	WHITE(IND)	WINTER	4.334	>10.00
		SPRING	2.458	>10.00
		SUMMER	8.454	>10.00
		FALL	3.166	>10.00
118205	WHITE(IND)	WINTER	3.462	>10.00
		SPRING	1.418	7.39
		SUMMER	6.261	>10.00
		FALL	3.272	>10.00
118301	EMBARRAS	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	6.229	>10.00
118302	EMBARRAS	WINTER	12.168	>10.00
		SPRING	8.103	>10.00
		SUMMER	>20.000	>10.00
		FALL	10.184	>10.00
118303	EMBARRAS	WINTER	18.167	>10.00
		SPRING	11.874	>10.00
		SUMMER	>20.000	>10 00
		FALL	14.538	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0 2	1.5
118501	CUMBERLAND	WINTER	1.263	4.88
		SPRING	1.476	5.65
		SUMMER	6.254	>10.00
		FALL	7.247	>10.00
118502	CUMBERLAND	WINTER	1.349	5.42
		SPRING	1.427	5.69
		SUMMER	7.892	>10.00
		FALL	7.804	>10.00
306701	LAKE CUMBERLAND	WINTER	0.052	0.22
		SPRING	0.070	0.16
		SUMMER	0.008	< 0.01
		FALL	0.016	< 0.01
118503	CUMBERLAND	WINTER	0.092	0.53
		SPRING	0.094	0.37
		SUMMER	0.094	0.57
		FALL	0.106	0.66
118504	CUMBERLAND	WINTER	0.080	0.69
		SPRING	0.081	0.49
		SUMMER	0.112	1.23
		FALL	0.105	1.15
306601	OLD HICKORY LAKE	WINTER	0.132	0.81
		SPRING	0.122	0.80
		SUMMER	0.210	0.73
		FALL	0.202	1.02
118505	CUMBERLAND	WINTER	0.273	1.83
		SPRING	0.235	1.41
		SUMMER	0.559	2.87
		FALL	0.510	3.02
118506	CUMBERLAND	WINTER	0.284	2.00
		SPRING	0.264	1.69
		SUMMER	0.720	4.38
		FALL	0.592	3.97

WATER BODY POINT		CONCENTRATION TP MG/L	CONCENTRATION TKN MG/L
	STANDARD	0.2	1.5
118801 CLINCH	WINTER	3.271	>10.00
	SPRING	3.917	>10.00
	SUMMER	6.976	>10.00
	FALL	8.945	>10.00
118802 CLINCH	WINTER	3.112	>10.00
	SPRING	4.302	>10.00
	SUMMER	11.535	>10.00
	FALL	9.833	>10.00
307301 NORRIS LAKE	WINTER	0.281	0.92
	SPRING	0.023	0.01
	SUMMER	0.046	< 0.01
	FALL	0.083	0.04
118803 CLINCH	WINTER	0.325	1.08
	SPRING	0.158	0.48
	SUMMER	0.169	0.41
	FALL	0.219	0.53
118804 CLINCH	WINTER	0.322	1.06
	SPRING	0.150	0.44
	SUMMER	0.164	0.37
	FALL	0.211	0.49
118901 LITTLE TENNESSEE	WINTER	0.400	2.14
	SPRING	0.529	2.83
	SUMMER	0.738	3.95
	FALL	0.721	3.88
307401 FONTANA LAKE	WINTER	0.061	0.32
	SPRING	0.032	0.07
	SUMMER	0.037	0.01
	FALL	0.056	0.12
118902 LITTLE TENNESSEE	WINTER	0.414	1.50
	SPRING	0.627	2.04
	SUMMER	0.520	1.55
	FALL	0.444	1.40

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
119201	TENNESSEE	WINTER	0.292	1.13
		SPRING	0.225	0.78
		SUMMER	0.364	0.78
		FALL	0.294	0.84
119202	TENNESSEE	WINTER	0.268	1.04
		SPRING	0.224	0.78
		SUMMER	0.287	0.82
		FALL	0.287	0.84
307901	GUNTERSVILLE LAKE	WINTER	0.255	1.14
		SPRING	0.220	0.92
		SUMMER	0.269	0.67
		FALL	0.269	0.88
119203	TENNESSEE	WINTER	0.303	1.84
		SPRING	0.416	1.68
		SUMMER	0.526	1.67
		FALL	0.506	1.83
308001	WHEELER LAKE	WINTER	0.458	1.91
		SPRING	0.484	1.77
		SUMMER	0.570	1.24
		FALL	0.577	1.86
308101	WILSON LAKE	WINTER	0.443	1.88
		SPRING	0.511	1.91
		SUMMER	0.644	1.50
		FALL	0.618	2.05
119204	TENNESSEE	WINTER	0.409	1.80
		SPRING	0.457	1.72
		SUMMER	0.540	1.11
		FALL	0.541	1.75
119205	TENNESSEE	WINTER	0.396	1.75
		SPRING	0.454	1.73
		SUMMER	0.513	1.07
		FALL	0.508	1.87

WATER BODY POINT		CONCENTRATION TP MG/L	TKN MG/L
	STANDARD	0.2	1.5
119308 OHIO	WINTER	0.900	3.86
	SPRING	0.708	2.48
	SUMMER	1.041	1.36
	FALL	1.006	2.43
119309 OHIO	WINTER	0.855	3.63
	SPRING	0.837	2.21
	SUMMER	1.082	1.72
	FALL	1.028	2.83
119310 OHIO	WINTER	0.708	2.97
	SPRING	0.530	1.74
	SUMMER	0.857	1.00
	FALL	0.828	1.89
119311 OHIO	WINTER	0.684	3.30
	SPRING	0.536	2.08
	SUMMER	0.905	1.77
	FALL	0.868	2.88
119312 OHIO	WINTER	0.686	3.31
	SPRING	0.535	2.07
	SUMMER	0.901	1.78
	FALL	0.864	2.87
119401 SFK OBION	WINTER	8.239	>10.00
	SPRING	7.408	>10.00
	SUMMER	8.363	>10.00
	FALL	5.376	>10.00
119402 OBION	WINTER	2.841	>10.00
	SPRING	3.789	>10.00
	SUMMER	4.110	>10.00
	FALL	3.281	>10.00
119501 HATCHIE	WINTER	0.392	4.58
	SPRING	0.339	3.28
	SUMMER	1.072	8.12
	FALL	0.283	2.51

WATER BODY POINT		STANDARD	CONCENTRATION TP MG/L 0 2	CONCENTRATION TKN MG/L 1 5
308601	NORFOLK RES	WINTER	< 0.001	< 0.01
		SPRING	< 0.001	< 0.01
		SUMMER	< 0.001	< 0.01
		FALL	< 0.001	< 0.01
119801	BLACK(ARK)	WINTER	1.378	>10.00
		SPRING	0.764	5.90
		SUMMER	3.048	>10.00
		FALL	1.132	8.88
119802	BLACK(ARK)	WINTER	0.352	3.13
		SPRING	0.202	1.57
		SUMMER	0.776	4.98
		FALL	0.290	2.25
119803	BLACK(ARK)	WINTER	0.517	3.98
		SPRING	0.298	1.94
		SUMMER	0.782	4.16
		FALL	0.281	1.83
119804	BLACK(ARK)	WINTER	0.515	3.97
		SPRING	0.297	1.94
		SUMMER	0.779	4.13
		FALL	0.280	1.82
308701	GREERS FERRY RES	WINTER	< 0.001	< 0.01
		SPRING	< 0.001	< 0.01
		SUMMER	< 0.001	< 0.01
		FALL	< 0.001	< 0.01
119901	WHITE(ARK)	WINTER	0.701	4.53
		SPRING	0.879	5.68
		SUMMER	5.565	>10.00
		FALL	0.808	5.87
308301	BEAVER RES	WINTER	< 0.001	< 0.01
		SPRING	< 0.001	< 0.01
		SUMMER	< 0.001	< 0.01
		FALL	< 0.001	< 0.01

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0 2	1.5
308801	GREAT SALT PLAINS L	WINTER	2.668	>10.00
		SPRING	0.540	0.08
		SUMMER	2.718	0.28
		FALL	2.944	2.10
120002	SALT FK ARKANSAS	WINTER	6.384	>10.00
		SPRING	8.332	>10.00
		SUMMER	6.289	>10.00
		FALL	7.184	>10.00
120101	WALNUT	WINTER	1.806	>10.00
		SPRING	0.425	4.98
		SUMMER	0.556	5.47
		FALL	2.078	>10.00
120102	WALNUT	WINTER	5.128	>10.00
		SPRING	1.181	>10.00
		SUMMER	1.547	>10.00
		FALL	5.783	>10.00
120201	CIMARRON	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
120202	CIMARRON	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
120203	CIMARRON	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
120204	CIMARRON	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
308001	JOHN REDMOND RES	WINTER	4.599	>10.00
		SPRING	3.572	>10.00
		SUMMER	3.908	4.18
		FALL	2.688	3.14
120402	NEOSHO	WINTER	5.839	>10.00
		SPRING	4.412	>10.00
		SUMMER	5.181	9.90
		FALL	7.025	>10.00
120403	NEOSHO	WINTER	5.850	>10.00
		SPRING	5.238	>10.00
		SUMMER	5.813	>10.00
		FALL	13.280	>10.00
120404	NEOSHO	WINTER	4.872	>10.00
		SPRING	7.303	>10.00
		SUMMER	10.069	>10.00
		FALL	5.134	>10.00
309101	LAKE OF CHEROKEES	WINTER	0.204	1.18
		SPRING	0.032	< 0.01
		SUMMER	0.004	< 0.01
		FALL	0.011	< 0.01
309201	LAKE FT GIBSON	WINTER	0.171	1.03
		SPRING	0.101	0.26
		SUMMER	0.088	0.03
		FALL	0.075	0.13
120501	BEAVER(TX)	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
120502	BEAVER(TX)	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0 2	1.5
309401	CONCHOS RES	WINTER	0.000	0.00
		SPRING	0.000	0.00
		SUMMER	0.000	0.00
		FALL	0.000	0.00
309501	UTE RES	WINTER	< 0.001	< 0.01
		SPRING	< 0.001	< 0.01
		SUMMER	0.802	0.25
		FALL	0.305	0.22
120802	CANADIAN	WINTER	17.260	>10.00
		SPRING	>20.000	>10.00
		SUMMER	1.776	9.74
		FALL	2.381	>10.00
309801	SANFORD RES	WINTER	< 0.001	< 0.01
		SPRING	< 0.001	0.00
		SUMMER	0.000	0.00
		FALL	0.000	0.00
120803	CANADIAN	WINTER	7.340	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
120804	CANADIAN	WINTER	12.930	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
120805	CANADIAN	WINTER	14.895	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
120806	CANADIAN	WINTER	15.254	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00

WATER BODY POINT		STANDARD	CONCENTRATION TP MG/L 0.2	CONCENTRATION TKN MG/L 1.5
120705	ARKANSAS	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
120706	ARKANSAS	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
120707	ARKANSAS	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
120708	ARKANSAS	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
120709	ARKANSAS	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
309901	KAW LAKE	WINTER	0.407	1.58
		SPRING	0.063	< 0.01
		SUMMER	0.038	< 0.01
		FALL	0.148	< 0.01
120710	ARKANSAS	WINTER	3.053	>10.00
		SPRING	4.086	>10.00
		SUMMER	4.592	>10.00
		FALL	3.875	>10.00
310001	KEYSTONE LAKE	WINTER	0.594	4.47
		SPRING	0.227	0.08
		SUMMER	0.432	0.01
		FALL	0.498	0.29

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0 2	1 5
120717	ARKANSAS	WINTER	0.582	1.62
		SPRING	1.309	2.99
		SUMMER	2.468	4.90
		FALL	0.874	1.44
310301	SARDIS RES	WINTER	0.037	0.18
		SPRING	< 0.001	< 0.01
		SUMMER	0.018	< 0.01
		FALL	0.073	0.08
120801	TALLAHATCHIE	WINTER	3.292	>10.00
		SPRING	3.854	>10.00
		SUMMER	1.590	7.24
		FALL	1.878	8.85
120802	TALLAHATCHIE	WINTER	2.127	>10.00
		SPRING	2.540	>10.00
		SUMMER	2.094	>10.00
		FALL	1.311	7.64
120803	YAZOO	WINTER	1.870	>10.00
		SPRING	2.171	>10.00
		SUMMER	2.092	8.85
		FALL	1.398	7.35
120804	YAZOO	WINTER	2.268	>10.00
		SPRING	2.841	>10.00
		SUMMER	2.598	9.89
		FALL	1.817	9.20
120805	YAZOO	WINTER	2.259	>10.00
		SPRING	2.833	>10.00
		SUMMER	2.592	9.86
		FALL	1.810	9.18
120901	BIG BLACK	WINTER	0.328	3 74
		SPRING	0.598	8.27
		SUMMER	3.618	>10.00
		FALL	3.948	>10.00

WATER BODY POINT		STANDARD	CONCENTRATION TP MG/L 0.2	CONCENTRATION TKN MG/L 1.5
121201	PEASE	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
121202	PEASE	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
121301	N FK WICHITA	WINTER	>20.000	>10.00
		SPRING	8.598	>10.00
		SUMMER	15.024	>10.00
		FALL	7.601	>10.00
310601	LAKE KEMP	WINTER	< 0.001	< 0.01
		SPRING	< 0.001	< 0.01
		SUMMER	< 0.001	< 0.01
		FALL	0.208	0.05
121302	WICHITA	WINTER	2.659	>10.00
		SPRING	2.005	>10.00
		SUMMER	2.005	>10.00
		FALL	0.519	2.48
121401	WASHITA	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
121402	WASHITA	WINTER	13.490	>10.00
		SPRING	11.725	>10.00
		SUMMER	>20.000	>10.00
		FALL	8.791	>10.00
121403	WASHITA	WINTER	7.942	>10.00
		SPRING	9.073	>10.00
		SUMMER	>20.000	>10.00
		FALL	5.133	>10.00

WATER BODY POINT		STANDARD	CONCENTRATION TP MG/L 0 2	CONCENTRATION TKN MG/L 1.5
121801	BAYOU BARTHOLOMEW	WINTER	2.092	>10.00
		SPRING	3.656	>10.00
		SUMMER	13.646	>10.00
		FALL	4.540	>10.00
121802	BAYOU BARTHOLOMEW	WINTER	3.487	>10.00
		SPRING	5.444	>10.00
		SUMMER	>20.000	>10.00
		FALL	6.790	>10.00
121901	BAYOU LAFOURCHE(ULA)	WINTER	1.104	6.25
		SPRING	0.447	3.03
		SUMMER	0.433	2.67
		FALL	1.865	>10.00
121902	BAYOU LAFOURCHE(ULA)	WINTER	2.494	>10.00
		SPRING	0.892	7.05
		SUMMER	1.552	>10.00
		FALL	5.756	>10.00
310401	LAKE OUACHITA	WINTER	< 0.001	< 0.01
		SPRING	< 0.001	< 0.01
		SUMMER	< 0.001	< 0.01
		FALL	< 0.001	< 0.01
122001	OUACHITA	WINTER	0.427	1.05
		SPRING	1.355	2.53
		SUMMER	1.077	1.71
		FALL	0.512	1.13
122002	OUACHITA	WINTER	0.144	0.64
		SPRING	0.297	0.99
		SUMMER	0.505	1.40
		FALL	0.115	0.47
122003	OUACHITA	WINTER	0.811	1.05
		SPRING	1.769	1.72
		SUMMER	5.333	3.05
		FALL	0.848	0.88

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1 5
122106	RED(S)	WINTER	0.408	1.47
		SPRING	1.504	3.58
		SUMMER	3.316	5.46
		FALL	0.726	2.07
122107	RED(S)	WINTER	0.296	1.23
		SPRING	0.917	2.37
		SUMMER	1.946	3.58
		FALL	0.590	1.85
122108	RED(S)	WINTER	0.239	1.14
		SPRING	0.560	2.00
		SUMMER	1.098	2.94
		FALL	0.567	2.10
122109	RED(S)	WINTER	0.251	1.09
		SPRING	0.800	2.83
		SUMMER	1.308	4.40
		FALL	0.567	2.19
310001	LEECH LAKE	WINTER	0.020	0.19
		SPRING	0.014	0.10
		SUMMER	0.014	0.03
		FALL	0.016	0.08
122201	MISSISSIPPI	WINTER	0.879	8.85
		SPRING	0.455	4.49
		SUMMER	0.889	6.30
		FALL	1.015	9.83
122202	MISSISSIPPI	WINTER	0.703	7.55
		SPRING	0.266	2.66
		SUMMER	0.341	2.92
		FALL	0.464	4.44
122203	MISSISSIPPI	WINTER	1.639	>10.00
		SPRING	0.709	5.76
		SUMMER	0.876	4.47
		FALL	1.467	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0 2	1.5
122212	MISSISSIPPI	WINTER	3.711	>10.00
		SPRING	2.417	9.85
		SUMMER	3.088	5.64
		FALL	2.808	9.24
122213	MISSISSIPPI	WINTER	1.026	8.22
		SPRING	0.860	2.59
		SUMMER	1.408	1.28
		FALL	1.276	3.19
122214	MISSISSIPPI	WINTER	0.824	5.10
		SPRING	0.695	1.82
		SUMMER	1.116	0.83
		FALL	1.019	2.20
122215	MISSISSIPPI	WINTER	0.725	4.38
		SPRING	0.610	1.54
		SUMMER	0.980	0.89
		FALL	0.892	1.94
122216	MISSISSIPPI	WINTER	0.603	3.46
		SPRING	0.505	1.12
		SUMMER	0.806	0.65
		FALL	0.733	1.45
122217	MISSISSIPPI	WINTER	0.546	2.80
		SPRING	0.448	0.92
		SUMMER	0.691	0.55
		FALL	0.651	1.21
122218	MISSISSIPPI	WINTER	0.515	2.55
		SPRING	0.434	0.88
		SUMMER	0.619	0.54
		FALL	0.592	1.07
122219	MISSISSIPPI	WINTER	0.498	2.30
		SPRING	0.412	0.77
		SUMMER	0.571	0.48
		FALL	0.561	0.91

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
122501	BAYOU LAFOURCHE	WINTER	10.209	>10.00
		SPRING	11.407	>10.00
		SUMMER	9.545	>10.00
		FALL	8.884	9.38
122502	BAYOU LAFOURCHE	WINTER	10.209	>10.00
		SPRING	11.407	>10.00
		SUMMER	9.545	>10.00
		FALL	8.884	9.38
122601	BAYOU TECHE	WINTER	1.381	7.75
		SPRING	1.191	5.79
		SUMMER	1.838	7.89
		FALL	2.525	>10.00
122602	BAYOU TECHE	WINTER	1.381	7.75
		SPRING	1.191	5.79
		SUMMER	1.838	7.89
		FALL	2.525	>10.00
500204	GULF OF MEX.-LA	WINTER		
		SPRING		
		SUMMER		
		FALL		

SUMMARY FOR RIVER SYSTEM 16
(USGS Regions 05, 06, 07, 08, 10, 11: Mississippi River System)

	PCT OF RIVER MILES STD NOT MET	
	TP	TKN
WINTER	32.	23.
SPRING	19.	13.
SUMMER	24.	16.
FALL	27.	18.

WATER BODY POINT			CONCENTRATION TP MG/L	CONCENTRATION TKN MG/L
		STANDARD	0.2	1 5
122802	NECHES	WINTER	1.298	>10.00
		SPRING	2.086	>10.00
		SUMMER	6.698	>10.00
		FALL	2.482	>10.00
311401	STAINHAGEN LAKE	WINTER	0.295	2.22
		SPRING	0.251	1.26
		SUMMER	0.305	0.87
		FALL	0.341	1.15
122803	NECHES	WINTER	0.152	0.99
		SPRING	0.134	0.56
		SUMMER	0.143	0.41
		FALL	0.154	0.51
122804	NECHES	WINTER	0.105	0.69
		SPRING	0.102	0.43
		SUMMER	0.121	0.35
		FALL	0.131	0.44
202401	SABINE LAKE	WINTER	0.165	0.88
		SPRING	0.227	0.92
		SUMMER	0.326	1.21
		FALL	0.304	1.20
311501	BRIDGEPORT RES	WINTER	< 0.001	< 0.01
		SPRING	< 0.001	< 0.01
		SUMMER	0.004	< 0.01
		FALL	< 0.001	< 0.01
311601	GARZA/LITTLE ELM RES	WINTER	0.039	0.03
		SPRING	< 0.001	< 0.01
		SUMMER	< 0.001	< 0.01
		FALL	< 0.001	< 0.01
311701	LAVON RES	WINTER	0.182	1.05
		SPRING	0.000	0.00
		SUMMER	0.000	0.00
		FALL	0.081	< 0.01

WATER BODY POINT		CONCENTRATION	
		TP MG/L	TKN MG/L
	STANDARD	0.2	1.5
202501 GALVESTON BAY	WINTER	0.674	2.41
	SPRING	2.770	8.46
	SUMMER	5.774	>10.00
	FALL	5.400	>10.00
500205 GULF OF MEX.-LA/TX	WINTER		
	SPRING		
	SUMMER		
	FALL		

SUMMARY FOR RIVER SYSTEM 19
(USGS Subregions 1201 - 1204)

	PCT OF RIVER MILES STD NOT MET	
	TP	TKN
WINTER	39.	17.
SPRING	82.	71.
SUMMER	100.	74.
FALL	73.	87.

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
123202	LEON	WINTER	13.234	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
312101	BELTON RES	WINTER	0.218	0.22
		SPRING	0.010	< 0.01
		SUMMER	< 0.001	< 0.01
		FALL	0.007	< 0.01
123203	LITTLE(TX)	WINTER	2.854	>10.00
		SPRING	5.371	>10.00
		SUMMER	10.088	>10.00
		FALL	5.751	>10.00
123301	BRAZOS	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	15.439	>10.00
312201	POSSUM KINGDOM RES	WINTER	< 0.001	< 0.01
		SPRING	< 0.001	< 0.01
		SUMMER	< 0.001	< 0.01
		FALL	0.182	< 0.01
123302	BRAZOS	WINTER	1.270	9.67
		SPRING	2.849	>10.00
		SUMMER	1.142	7.37
		FALL	0.538	2.84
123303	BRAZOS	WINTER	1.577	>10.00
		SPRING	3.256	>10.00
		SUMMER	1.420	9.71
		FALL	0.625	3.58
312301	WHITNEY RES	WINTER	0.250	0.79
		SPRING	0.005	< 0.01
		SUMMER	0.070	< 0.01
		FALL	0.009	< 0.01

WATER BODY POINT		STANDARD	CONCENTRATION TP MG/L 0.2	CONCENTRATION TKN MG/L 1.5
312401	SAN ANGELO RES	WINTER	< 0.001	0.00
		SPRING	< 0.001	0.00
		SUMMER	< 0.001	< 0.01
		FALL	< 0.001	< 0.01
312501	TWIN BUTTES RES	WINTER	< 0.001	< 0.01
		SPRING	< 0.001	< 0.01
		SUMMER	< 0.001	0.00
		FALL	< 0.001	< 0.01
123501	CONCHO	WINTER	0.000	0.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
123502	CONCHO	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
123801	SAN SABA	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
123802	SAN SABA	WINTER	0.030	>10.00
		SPRING	16.827	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
123701	LLANO	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
123702	LLANO	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
123905	COLORADO(TX)	WINTER	2.115	>10.00
		SPRING	0.888	9.10
		SUMMER	1.913	>10.00
		FALL	4.475	>10.00
123906	COLORADO(TX)	WINTER	1.613	>10.00
		SPRING	1.213	>10.00
		SUMMER	1.834	>10.00
		FALL	3.938	>10.00
123907	COLORADO(TX)	WINTER	1.246	>10.00
		SPRING	0.938	7.65
		SUMMER	1.344	8.16
		FALL	3.009	>10.00
123908	COLORADO(TX)	WINTER	2.741	>10.00
		SPRING	3.470	>10.00
		SUMMER	8.190	>10.00
		FALL	9.864	>10.00
124001	GUADALUPE	WINTER	8.675	>10.00
		SPRING	5.083	>10.00
		SUMMER	9.146	>10.00
		FALL	15.272	>10.00
312901	CANYON RES	WINTER	0.124	0.20
		SPRING	0.314	0.82
		SUMMER	0.009	< 0.01
		FALL	0.021	< 0.01
124002	GUADALUPE	WINTER	0.744	9.74
		SPRING	0.509	3.98
		SUMMER	0.574	7.88
		FALL	1.244	>10.00
124003	GUADALUPE	WINTER	1.495	>10.00
		SPRING	0.801	4.41
		SUMMER	1.306	7.71
		FALL	2.791	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
124203	NUECES	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
124204	NUECES	WINTER	>20.000	>10.00
		SPRING	6.807	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
313001	LAKE CORPUS CHRISTI	WINTER	< 0.001	< 0.01
		SPRING	0.177	< 0.01
		SUMMER	< 0.001	< 0.01
		FALL	0.965	1.87
202601	CORPUS CHRISTI BAY	WINTER	6.095	>10.00
		SPRING	0.838	3.00
		SUMMER	8.151	>10.00
		FALL	9.059	>10.00
500206	GULF-MID TX	WINTER		
		SPRING		
		SUMMER		
		FALL		

SUMMARY FOR RIVER SYSTEM 20
(USGS Subregions 1205 - 1211)

	PCT OF RIVER MILES STD NOT MET	
	TP	TKN
WINTER	24.	21.
SPRING	31.	20.
SUMMER	30.	23.
FALL	41.	28.

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
124404	PECOS	WINTER	>20.000	>10.00
		SPRING	6.876	>10.00
		SUMMER	8.166	>10.00
		FALL	12.183	>10.00
124405	PECOS	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
124406	PECOS	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
124407	PECOS	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
124501	RIO GRANDE	WINTER	11.490	>10.00
		SPRING	17.375	>10.00
		SUMMER	>20.000	>10.00
		FALL	11.016	>10.00
124502	RIO GRANDE	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
124503	RIO GRANDE	WINTER	15.723	>10.00
		SPRING	17.923	>10.00
		SUMMER	>20.000	>10.00
		FALL	18.536	>10.00
124504	RIO GRANDE	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
124512	RIO GRANDE	WINTER	>20.000	>10.00
		SPRING	3.504	>10.00
		SUMMER	3.511	>10.00
		FALL	>20.000	>10.00
313501	AMISTED RES	WINTER	0.000	0.00
		SPRING	< 0.001	< 0.01
		SUMMER	< 0.001	< 0.01
		FALL	0.000	0.00
124513	RIO GRANDE	WINTER	>20.000	>10.00
		SPRING	1.387	8.56
		SUMMER	1.388	8.24
		FALL	>20.000	>10.00
124514	RIO GRANDE	WINTER	>20.000	>10.00
		SPRING	0.840	3.07
		SUMMER	0.850	2.70
		FALL	12.882	>10.00
124515	RIO GRANDE	WINTER	>20.000	>10.00
		SPRING	1.892	8.74
		SUMMER	1.894	8.10
		FALL	>20.000	>10.00
124518	RIO GRANDE	WINTER	>20.000	>10.00
		SPRING	1.882	8.87
		SUMMER	1.884	8.11
		FALL	>20.000	>10.00
313601	FALCON RES	WINTER	0.000	0.00
		SPRING	< 0.001	< 0.01
		SUMMER	< 0.001	< 0.01
		FALL	< 0.001	0.00
124517	RIO GRANDE	WINTER	>20.000	>10.00
		SPRING	0.532	2.74
		SUMMER	0.532	2.81
		FALL	8.897	>10.00

WATER BODY POINT			CONCENTRATION	
			TP MG/L	TKN MG/L
		STANDARD	0.2	1.5
114402	SMOKY HILL	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
304501	CEDAR BLUFF RES	WINTER	< 0.001	< 0.01
		SPRING	< 0.001	< 0.01
		SUMMER	< 0.001	< 0.01
		FALL	< 0.001	< 0.01
114403	SMOKY HILL	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
304601	KANOPOLIS RES	WINTER	0.198	1.53
		SPRING	0.648	0.40
		SUMMER	1.354	0.10
		FALL	2.555	4.14
114404	SMOKY HILL	WINTER	15.035	>10.00
		SPRING	10.959	>10.00
		SUMMER	8.460	>10.00
		FALL	8.230	>10.00
114405	SMOKY HILL	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
114501	SFK REPUBLICAN	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00
114502	REPUBLICAN	WINTER	>20.000	>10.00
		SPRING	>20.000	>10.00
		SUMMER	>20.000	>10.00
		FALL	>20.000	>10.00