TMDLS FOR SEGMENTS LISTED FOR MERCURY IN FISH TISSUE FOR THE OUACHITA RIVER BASIN, AND BAYOU BARTHOLOMEW, ARKANSAS AND LOUISIANA TO COLUMBIA

Prepared for

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EXECUTIVE SUMMARY

The Arkansas and Louisiana 1998 Section 303(d) Lists include segments and subsegments in the Ouachita River basin that are impaired due to excess concentrations of mercury in fish. Additional waterbodies in the Ouachita River basin that are not included on the 1998 Section 303(d) List are subject mercury related fish consumption advisories. While there have been no known violations of the numeric mercury water quality standard and fishable designated use for these waterbodies, these segments and subsegments are not meeting the narrative water quality standard and designated uses of fishable water bodies. A basin-wide approach is being used in this TMDL due to similar ecoregions and watershed characteristics and because of similar causative factors such as atmospheric and geologic contributions.

The Ouachita River basin is in the Ouachita Mountain, South Central Plain, and Mississippi Alluvial Plain ecoregions. It has gently rolling topography, with hilly uplands, flatwood uplands, terraces, and floodplains. Land use in the basin is 71% forest with 13% in wetlands. There is one NPDES point source with permit mercury limits in the basin. There are seven air emission point sources with permit mercury limits. The geology of the Ouachita Mountains contains rocks with relatively high, naturally occurring mercury concentrations. The soils in the basin reflect this geology and also receive mercury from atmospheric deposition.

Both Arkansas and Louisiana have numeric mercury water quality standards of 0.012 μg/L. There have been no known violations of the numeric water quality standards, but clean sampling procedures and ultra-trace level analyses have not been used. There are fish consumption advisories in the lower Ouachita River basin and Bayou Bartholomew in both Arkansas and Louisiana because of mercury contamination of fish. The Action Level in Arkansas for fish consumption advisories is 1 mg/kg. While Louisiana does not have an established Action Level, fish tissue mercury concentrations of approximately 0.5 mg/kg have historically triggered fish consumption advisories as a result of risk assessments for individual water bodies. Safe target levels for all fish species in this TMDL are 0.8 mg/kg in Arkansas and 0.4 mg/kg in Louisiana, using a 20% Margin of Safety (MOS) for the Action Levels.

The TMDL was developed using a two-step approach. The first step estimated the mercury loads from the NPDES facility with a permit mercury limit, municipal wastewater treatment facilities, local emission point sources, atmospheric deposition, and watershed nonpoint sources and natural background. In the second step, maximum fish tissue mercury concentrations measured in the Ouachita and Saline River and tributaries were used to estimate the reduction in fish tissue mercury needed to achieve the safe target levels. A linear relationship was assumed between mercury in fish and mercury loading to the basin. This reduction to achieve safe target levels was then used to determine the reduction needed in mercury loading.

The predominant sources of mercury loading to the Ouachita River basin are from atmospheric deposition and watershed nonpoint source and background loads. Less than 1% of the load came from the point source wasteloads. A reduction factor of 2 (i.e., reduction to 50% of current total mercury load) would reduce maximum fish tissue concentrations to fish tissue safe target levels in Arkansas, and a reduction factor of 3 would reduce maximum fish tissue concentrations to fish tissue safe target levels in Louisiana. The TMDL for mercury loading for Arkansas to achieve the target safe levels for fish tissue mercury concentrations is 274,103 g/year. The TMDL for total mercury loading for Louisiana to achieve the target safe levels for fish tissue mercury concentrations is 182,735 g/year. Estimated likely reductions in mercury loading to the Ouachita River basin as a result of implementation of mercury emission regulations and erosion BMPs were calculated. These reductions were not able to achieve the mercury TMDLs based on reduction factors calculated using maximum mercury tissue concentrations in largemouth bass. These reductions did result in basin mercury loads that were less than TMDLs based on reduction factors calculated using average mercury tissue concentrations in largemouth bass. The TMDL for Arkansas based on average mercury tissue concentrations in largemouth bass is 365,470 g/yr. The TMDL for Louisiana based on average mercury tissue concentrations in largemouth bass is 304,559 g/yr. Using the average mercury tissue concentrations to estimate required reductions in mercury loads is less protective than using the maximum mercury tissue concentrations, but is considered adequate to protect human health from effects due to long term exposure. However, it is likely to be decades before this load can be achieved.

This TMDL was developed using the best available information on mercury levels in the environment and waste streams, and current water quality standards. As new information becomes available that would have a bearing on the assumptions on which this TMDL is based, this TMDL may need to be revised in the future.

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1.0 INTRODUCTION

The Arkansas 1998 Section 303(d) List included 5 segments (15 reaches) and the Louisiana 1998 Section 303(d) List included 1 subsegment (reach) impaired due to excess concentrations of mercury in fish within the Ouachita River watershed. Table 1.1 (all tables and figures are located at the end of their respective chapter) identifies segments contained on the 303(d) List due to elevated mercury in fish and where fish consumption advisories have been issued by the state. Figure 1.1 shows the hydrologic unit codes that make up the drainage basin for the listed segments.

This watershed is of critical concern because of litigation over the 303(d) process in both Arkansas and Louisiana and the pervasiveness of mercury contamination. While there have been no known violations of the numeric water quality standard and the fishable designated use for these waterbodies in either state, these segments and subsegments are not meeting the narrative water quality standard and designated uses of fishable water bodies. Therefore, development of a TMDL is required. Because of similar ecoregion and watershed characteristics, and because of potentially similar causative factors such as atmospheric and geologic contributions, a basin-wide approach has been used to develop the TMDL. This TMDL is being conducted under EPA Contract #68-C-99-249, Work Assignment #0-52.

Table 1.1. Ouachita River segments on 303(d) List or where fish consumption advisories have been issued.

Waterbody Name	Segment/Reach	On 303(d) List	Fish Cons. Advisory	Priority
Arkansas				
Ouachita River	08040201-002	Yes	Yes	Low
	08040201-004	Yes	Yes	Low
	08040202-002	Yes	Yes	Low
	08040202-003	Yes	Yes	Low
	08040202-004	Yes	Yes	Low
Felsenthal National Wildlife Refuge	08040202	No	Yes	Low
Ouachita River Oxbow Lakes below Camden	08040202	No	Yes	Low
Saline River	08040203-001	Yes	No	Low
	08040204-001	Yes	Yes	Low
	08040204-002	Yes	Yes	Low
	08040204-004	Yes	Yes	Low
	08040204-006	Yes	Yes	Low
Moro Creek	08040201-001	Yes	Yes	Low
Champagnolle Creek	08040201-003	Yes	Yes	Low
Little Champagnolle	08040202-003	No	Yes	Low
Bayou Bartholomew	08040205-002	Yes	Yes	High
	08040205-012	Yes	Yes	High
Cutoff Creek	08040205-007	Yes	Yes	Low
Louisiana				
Ouachita River - Arkansas State Line to Columbia	Subsegment 080101	Yes	Yes	2
Bayou Bartholomew	Subsegment 080401	No	Yes	-
	Subsegment 080402	No	Yes	-

Figure 1.1. Drainage basin for the study area.

2.0 DESCRIPTION OF WATERBODIES

The TMDL development is based on a basin-wide approach to the Ouachita River watershed. For this TMDL, the Ouachita River watershed has been defined to include the Ouachita River, Saline River, Bayou Bartholomew, and their tributaries located within the hydrologic unit code's (HUC) 08040201, 08040202, 08040203, 08040204, 08040205 (includes Louisiana Subsegments 080401 and 080402), and 08040207 (includes Louisiana Subsegment 080101) (Figure 2.1).

The Saline River and Ouachita River headwaters are in the Ouachita Mountain ecoregion and arise in the Ouachita Mountains of west central Arkansas. The upper section of each river drains a portion of the Ouachita Mountains, which are composed mostly of sandstone and shale. Near Malvern, Arkansas, the Ouachita River enters the South Central Plain ecoregion where the character of the river changes. Here the river gradient decreases significantly, and the river gradually changes into more of a lowland stream (lower riffle to pool ratio) (Figure 2.2). The Saline River enters the South Central Plain ecoregion near Benton, Arkansas, where the character of the river has similar changes to those of the Ouachita River.

The headwaters of Bayou Bartholomew begin northwest of Pine Bluff, Arkansas in the Mississippi Alluvial Plain ecoregion. Bayou Bartholomew meanders through southeast Arkansas and into northeast Louisiana before emptying into the Ouachita River near Sterlington, Louisiana. The watershed is located within both the South Central Plain and the Mississippi Alluvial Plain ecoregions.

2.1 Topography

The following description of the topography of the watershed was taken from county soil surveys (USDA 1958; 1967; 1968; 1972; 1973; 1976; 1979; 1980). The majority of the Ouachita and Saline Rivers watershed is in the South Central Plain ecoregion. The topography of this area can be described as nearly level or gently rolling to hilly uplands, terraces, and floodplains. Slopes are mainly 1% to 8% but can range from 0% to 20%. The Bayou Bartholomew watershed is in the Mississippi Alluvial Plain and South Central Plain ecoregions. The topography of this area can be described as level to moderately steep, with the main topographic divisions consisting of rolling uplands, flatwood uplands, terraces, and floodplains. Slopes are mainly 1% to 8%, but range from 0% to 20%.

2.2 Soils

Soil characteristics for the watershed are also provided by the county soil surveys (USDA 1958; 1967; 1968; 1972; 1973; 1976; 1979; 1980). Most of the soils in the watershed are classified as loamy. Soil series that are common in the watershed area are Amy, Cahaba, Ouachita, Pheba, Savannah, Smithton, and Ruston. These soils are classified as silty loams or sandy loams.

2.3 Land Use

Land use in the watershed is predominantly forest land (Figure 2.3). Areas and approximate percentages of each land use in the watershed are listed in Table 2.1.

Prior to development, the watershed basin was predominantly covered with thick growths of hardwoods and pines. Only a small part of the basin was prairie. As settlers arrived in the early 1800s, agriculture grew steadily until the outbreak of World War II, and then declined. In the 1930s, reforestation efforts were begun to restore once cleared land to woodland. Lumbering has become the chief source of income. Much of the forested land is managed for the production of pulpwood, poles, and saw logs.

Farming practices are fairly uniform throughout the basin. Rice and cotton are typically planted in April through May and soybeans are planted later in May through June. Wheat is planted in October and November. Irrigation is primarily by flooding. Rice is flooded in May, soybeans are irrigated in June through July, and cotton is irrigated in July. Rice fields are typically drained in late August through September. Much of the land is bare from November through March.

2.4 Description of Hydrology

USGS daily stream flow data were retrieved for gages in the Ouachita River near Camden, Arkansas, in the Saline River near Rye, Arkansas, in Bayou Bartholomew near Garrett Bridge, Arkansas, and in the Ouachita River at the Arkansas/Louisiana state line. Basic information and summary statistics for these gages are summarized in Table 2.2.

Average annual precipitation for the watershed is approximately 54 inches (Hydrosphere 2000). Mean monthly precipitation totals for the watershed are shown on Figure 2.4. The mean monthly precipitation values are highest for January and lowest for August. Precipitation data from three stations within each of the five HUCs was used to calculate the annual and monthly mean precipitation for the watershed.

2.5 Point Sources

Information on NPDES point source discharges in the watershed was obtained by searching the Permit Compliance System (PCS) on the EPA website. The PCS search identified a total of 176 facilities with NPDES permits within the watershed. Of these 176 permitted facilities, 43 were city municipal wastewater treatment plants (WWTPs). ENSCO, Inc. (NPDES permit no. AR0037800) located in Union County was the only facility that was identified as having an NPDES permit limit for mercury. ENSCO has a facility flow rate of 1.29 MGD and a permit limit of 0.2 µg/L for total recoverable mercury. None of the other NPDES facilities had permit mercury limits. However, ADEQ used clean sampling procedures and ultra-trace level analyses to sample for mercury in five municipal WWTPs in Arkansas during 1995 (Allen Price, personal communication 2001). The average mercury concentration for these WWTPs was 15 ng/L. Clean sampling procedures and ultra trace level analyses have not been used to sample any other types of facilities, so no information is available on mercury for these facilities. A listing of the NPDES permitted facilities in included in Appendix A.

Information on local air emission sources in the airshed (airshed is defined as all counties within 100 km of the Ouachita River watershed boundary) was obtained by searching the National Toxics Inventory (NTI) emission inventory on the EPA website. The NTI emission inventory includes point sources, area sources, and mobile sources. A search was done of the maximum achievable control technology (MACT) source category, which includes the number of sources and total hazardous air pollutant (HAP) emissions for each MACT source category included in the NTI. The database search for the airshed resulted in 373 air emission sources in 11 MACT source categories. The MACT standards are emission limitations developed under Section 112(d) of the Clean Air Act (National Emissions Standards for Hazardous Air Pollutants). The limitations are based on the best demonstrated control technology or practices in similar sources to be applied to major sources emitting one or more of the listed toxic pollutants. A listing of the air emission sources is included in Appendix B.

Table 2.1. Acreage and percent of land use categories in the Ouachita River basin.

Land Use	10^6 Acres (mi^2)	Percent
Forest	3.62 (5,657)	70.5
Pasture	0.4 (635)	7.9
Cropland	0.33 (514)	6.4
Wetland (forest/nonforested)	0.66 (1,026)	12.8
Water	0.02 (32)	0.4
Urban and Other	0.10 (155)	1.9
TOTAL	5.13 (8,020)	100

Table 2.2. Information for stream flow gaging stations.

	Ouachita River near Camden, Arkansas	Saline River near Rye, Arkansas	Bayou Bartholomew at Garrett Bridge, Arkansas	Ouachita River at Arkansas/Louisiana State Line
USGS gage number	07362000	07363500	07364133	07364100
Descriptive location	Ouachita County on US Highway 79 at Camden, 3.4 miles downstream from Ecore Fabre Bayou, at mile 354.1	Bradley County on State Highway 15, 3.6 miles southwest of Rye, at mile 71.0	Located in Lincoln County on downstream side of bridge on State Hwy 54, 1.9 miles upstream from Flat Creek at Garrett Bridge	Union City near Arkansas/Louisiana state line
Drainage area (mi^2)	5,357	2,102	380	10,787
Period of record	Oct. 1928 to Sept. 2000	Oct. 1937 to Sept. 2000	Oct. 1987 to April 2001	April 1958 to Sept. 1998
Mean flow (cfs)	7,653	2,601	565	4,581
Minimum flow (cfs)	125	4	0.3	190
Maximum flow (cfs)	238,000	72,500	5,210	19,200
Flow (cfs) that is exceeded:				
80% of the time	1,180	125	51	1,500
50% of the time	3,420	672	205	3,020
20% of the time	11,200	4,340	912	7,250

Figure 2.1. Ouachita River basin and associated HUC codes included in the TMDL.

Differences in stream characteristics above and below Camden, which is the

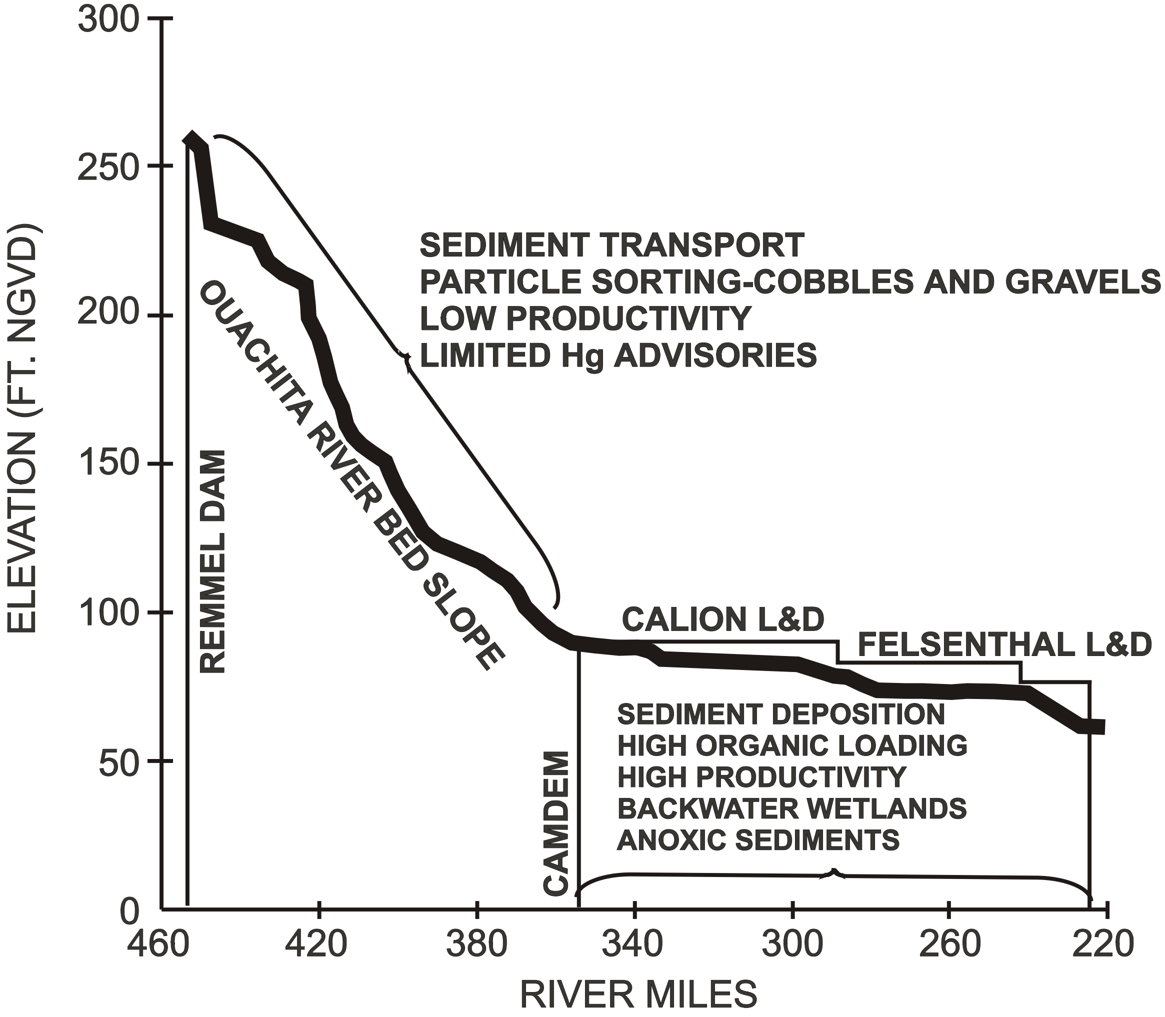


Figure 2.2.

general vicinity where consumption advisories begin in the southern half of the state.

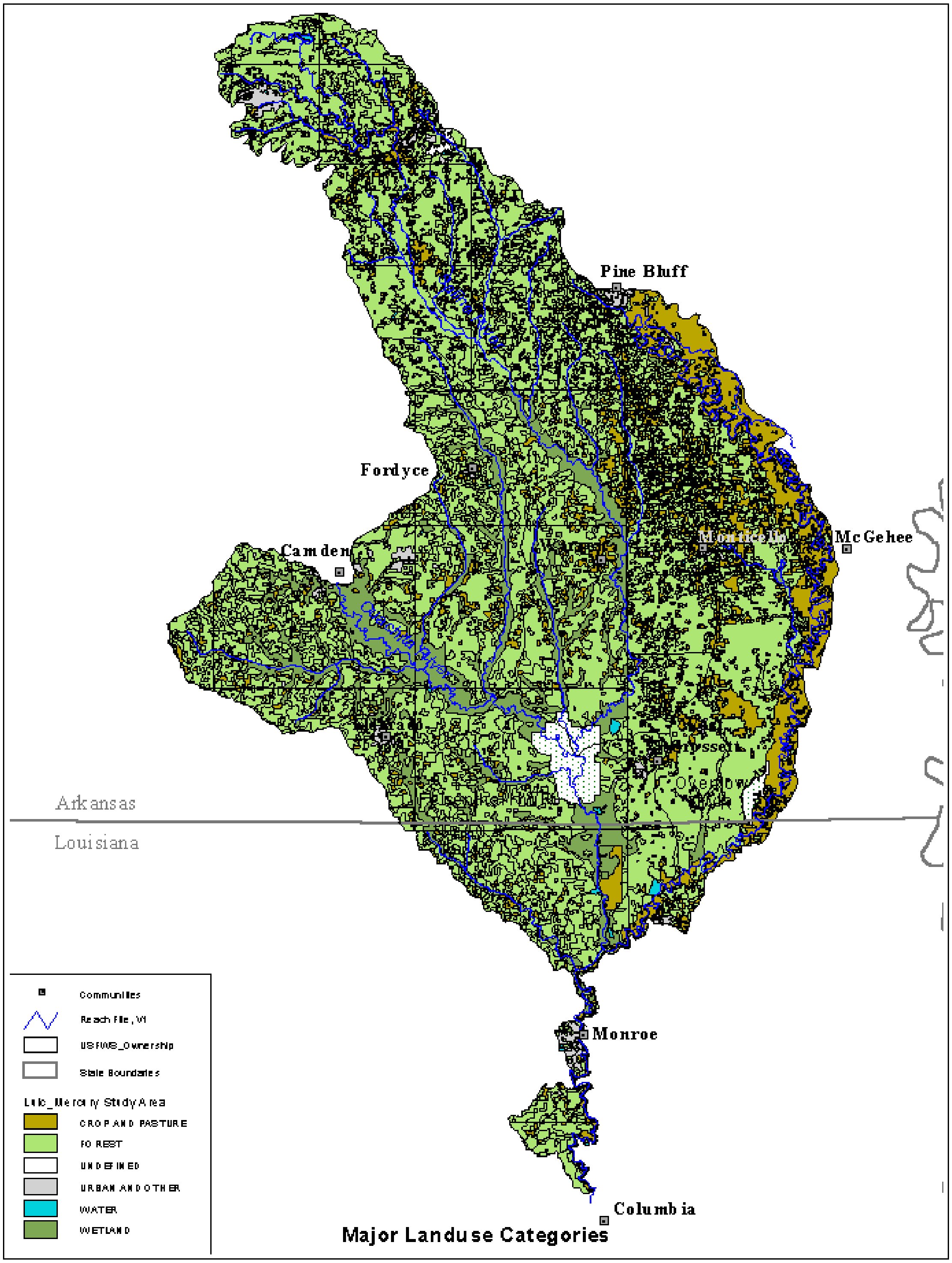
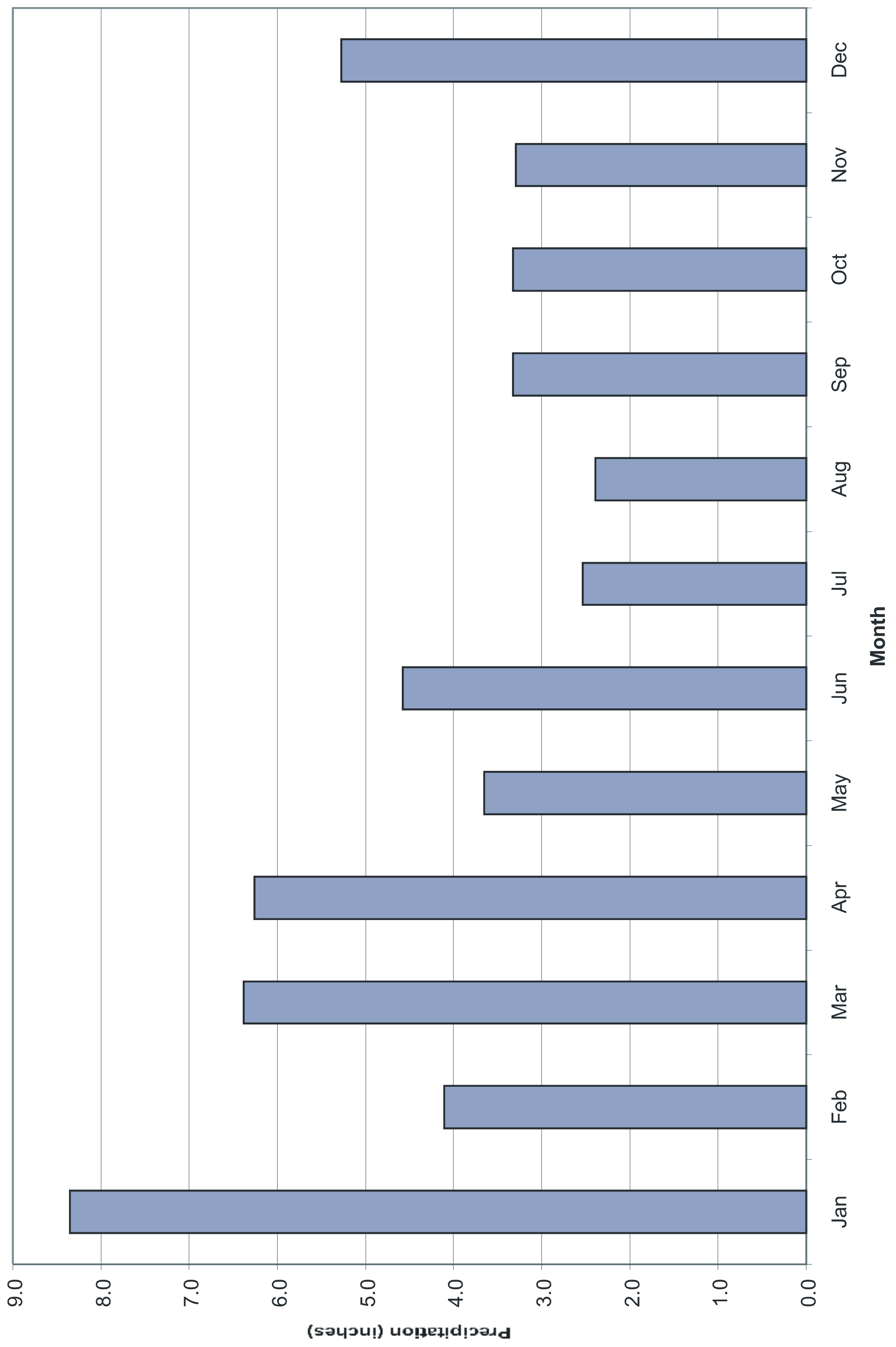


Figure 2.3. Land use within the Ouachita River basin.


Precipitation (inches)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

3.0 WATER QUALITY STANDARDS AND EXISTING WATER QUALITY CONDITIONS

3.1 Water Quality Standards

The State of Arkansas has developed water quality standards for waters of the State (ADEQ 1998). The standards are defined according to ecoregions and designated uses of the waterbodies. The Ouachita River basin lies within three ecoregions: the Ouachita Mountain ecoregion, the South Central Plain ecoregion, and the Mississippi Alluvial Plain ecoregion. Designated uses for the Ouachita River basin from Remmel Dam to the State of Arkansas Line include primary and secondary contact recreation, protection and propagation of fisheries, shellfish and other forms of aquatic life, domestic, industrial and agricultural water supply. Some waterbodies within the Ouachita basin are also designated as extraordinary resource waters, natural and scenic waterways, and ecologically sensitive waterbodies. The mercury water quality standard for Arkansas waters for all ecoregions is 0.012 μg/L, expressed as total recoverable mercury. Although this water quality standard is to protect aquatic life, it was developed to protect humans from consuming aquatic life contaminated by mercury. There is no correction factor for hardness or other constituent concentrations. The narrative standard for toxic substances in Section 2.508 (Regulation No. 2, ADEQ 1998) is “Toxic substances shall not be present in receiving waters, after mixing, in such quantities as to be toxic to human, animal, plant, or aquatic life or to interfere with the normal propagation, growth, and survival of the indigenous aquatic biota.”

The State of Louisiana has developed water quality standards for the State (LDEQ 1999). The designated uses for the Ouachita River from the State of Arkansas/Louisiana Line to Columbia Lock and Dam are primary and secondary contact recreation, propagation of fish and wildlife, and drinking water supply. Subsegment 080401 of Bayou Bartholomew is also designated as outstanding natural resource waters. The mercury water quality standard is 0.012 μg/L as total recoverable mercury. There is no correction factor for hardness or other constituent concentrations. The narrative standard for toxic substances in Chapter 11 (IX Water Quality Regulations, LDEQ 1999) is “No substances shall be present in the waters of the state or the sediments underlying said waters in quantities that alone or in combination will be toxic to human, plant, or animal life or significantly increase health risks due to exposure to the substances or consumption of contaminated fish or other aquatic life."

3.2 Existing Water Quality Conditions

There have been no exceedances of the mercury water quality standard in the Ouachita River basin in Arkansas or Louisiana because of mercury. The analytical procedures used previously had a detection limit of 0.2 µg/L and all samples were less than the detection limit.

However, there are fish consumption advisories for mercury contamination in portions of the Ouachita River, Saline River, and Bayou Bartholomew drainage areas in Arkansas and in the Ouachita River and Bayou Bartholomew from the Arkansas/Louisiana State Line to Columbia Lock and Dam, Louisiana. The fish consumption Action Level in Arkansas is based on the previous FDA guideline of 1 mg/kg. While Louisiana does not have an established Action Level, fish tissue mercury concentrations of approximately 0.5 mg/kg have triggered fish consumption advisories. Louisiana has a risk-based guideline for fish consumption advisories. The location of these fish consumption advisories are shown on Figure 3.1. Average composite bass fish mercury concentrations for the stations sampled in these waterbodies are also shown on Figure 3.1.

EPA recently promulgated a criterion for methyl-mercury in fish tissue. The EPA criterion is 0.3 mg/kg of methyl mercury in fish tissue (EPA 2001). The states will need to consider adopting this criterion as part of their triennial review.

This TMDL uses fish tissue monitoring data as a means to determine whether the "fishable" use is being met and the reductions needed to achieve the designated use. The "fishable" use is not attained if: (1) the fish and wildlife propagation is impaired and/or (2) if there is a significant human health risk from consuming fish and shellfish resources. The waters identified here, as indicated above, were either listed in the 1998 303(d) Lists based on elevated fish tissue mercury concentrations, and/or are in violation of narrative standards for toxic substances in both states. To achieve the designated use, the fish tissue mercury concentrations of 1.0 mg/kg (Arkansas) and 0.5 mg/kg (Louisiana) should not be exceeded. Therefore, the target level for all fish species in this TMDL will be 0.8 mg/kg (Arkansas) and 0.4 mg/kg (Louisiana). This incorporates a 20% Margin of Safety (MOS) in the analyses (Section 5.0).

3.3 Fish Sampling and Analysis

Both Arkansas and Louisiana followed the sampling protocols recommended in *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories,* Vol 1 (EPA 1995). Fish were collected from 1993 through 1999 throughout the Ouachita River basin, including the Ouachita River and its tributaries and lakes within the basin (Armstrong et al. 1995, LDEQ 1999). Fish mercury concentrations are listed in Table 3.1 and shown on Figure 3.1.

Water quality data were obtained for both Arkansas and Louisiana from the EPA STORET system. The stations, agency code, HUC, and period of record (POR) for this study are listed in Table 3.2. Water quality data are also summarized on Figures 3.2 through 3.4 for sulfate, total organic carbon (TOC), and pH. These three constituents have been demonstrated to be correlated with fish mercury concentrations and can affect the bioaccumulation and bioavailability of mercury for methylation and subsequent uptake of methylmercury through the food chain (Armstrong et al. 1995, EPA 1998). The overlapping ranges of moderate sulfate and TOC concentrations with lower pH values in the lower portion of the Ouachita River basin provides an environment conducive to microorganisms that methylate mercury (Armstrong et al. 1995). These conditions likely contribute to the elevated fish mercury concentrations in this area. In addition, significant wetland acreage is also located in this portion of the Ouachita River basin. Wetland ecosystems have conditions that are particularly suited to organisms that methylate mercury (Rudd 1995). Felsenthal National Wildlife Refuge (NWR) contains about 16,000 acres of wetlands and mercury concentrations per unit size of fish are higher in Felsenthal NWR than in other water bodies in Arkansas (Armstrong et al. 1995).

Table 3.2. Water quality monitoring stations in the Ouachita River basin, agencies, HUC, and POR.

ID	Station	Agency	HUC	POR
50357	OUA137A	1116APCC	08040201	94-97
50039	OUA02	1116APCC	08040206	92-present
50042	OUA05	1116APCC	08040206	92-present
50046	OUA08A	1116APCC	08040202	92-present
50285	OUA08B	1116APCC	08040202	92-97
50094	OUA10A	1116APCC	08040204	92-present
50277	OUA117	1116APC	08040204	92-present
50278	OUA118	1116APCC	08040204	92-present
50358	OUA137B	1116APCC	08040201	94-97
50359	OUA137C	1116APCC	08040201	94-97
50360	OUA137D	1116APCC	08040201	94-97
50276	OUA16	1116APCC	08040203	92-present
50261	OUA18	1116APCC	08040203	92-present
50158	OUA26	1116APCC	08040203	92-present
50159	OUA27	1116APCC	08040201	92-present
50160	OUA28	1116APCC	08040201	92-present
50189	OUA37	1116APCC	08040201	92-present
50193	OUA42	1116APCC	08040203	92-present
50194	OUA43	1116APCC	08040204	92-present
50266	OUA47	1116APCC	08040201	92-present
05UWS030	UWCHCO1	21ARAPCC	08040201	94-96
B080190020	580010018	21LA10RS	08040206	92-98
S081465010	58010068	21LA10RS	08040206	92-98
S080190020	58010018	21LA10RS	08040206	92-98
B083305010	58010015	21LA10RS	08040206	92-98
50051	OUA13	1116APCC	08040205	90-98
50165	OUA33	1116APCC	08040205	90-98
05UWS036	UWBYB01	21ARAPCC	08040205	94-96
05UWS040	UWBYB02	21ARAPCC	08040205	94-98
05UWS041	UWBYB03	21ARAPCC	08040205	94-98
05UWS038	UWCOC01	21ARAPCC	08040205	94-98
05UWS039	UWCOC02	21ARAPCC	08040205	94-98

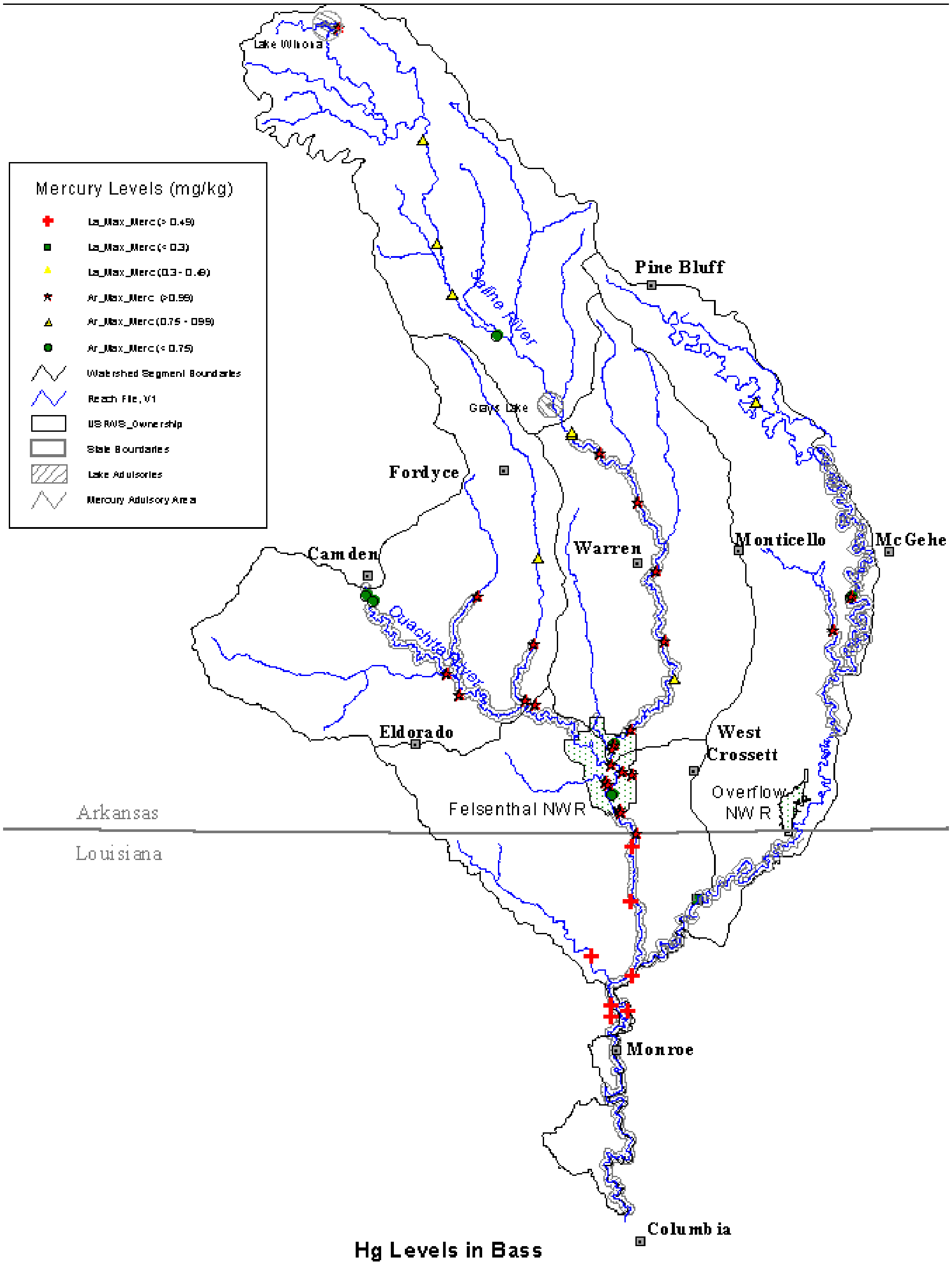


Figure 3.1. Fish consumption advisory areas in the Ouachita River basin. Fish tissue Hg concentrations for composite samples are shown on the map. NOTE: LA uses a risk-based level of 0.5 mg/kg Hg in fish tissue while AR Action Level is 1.0 mg/kg.

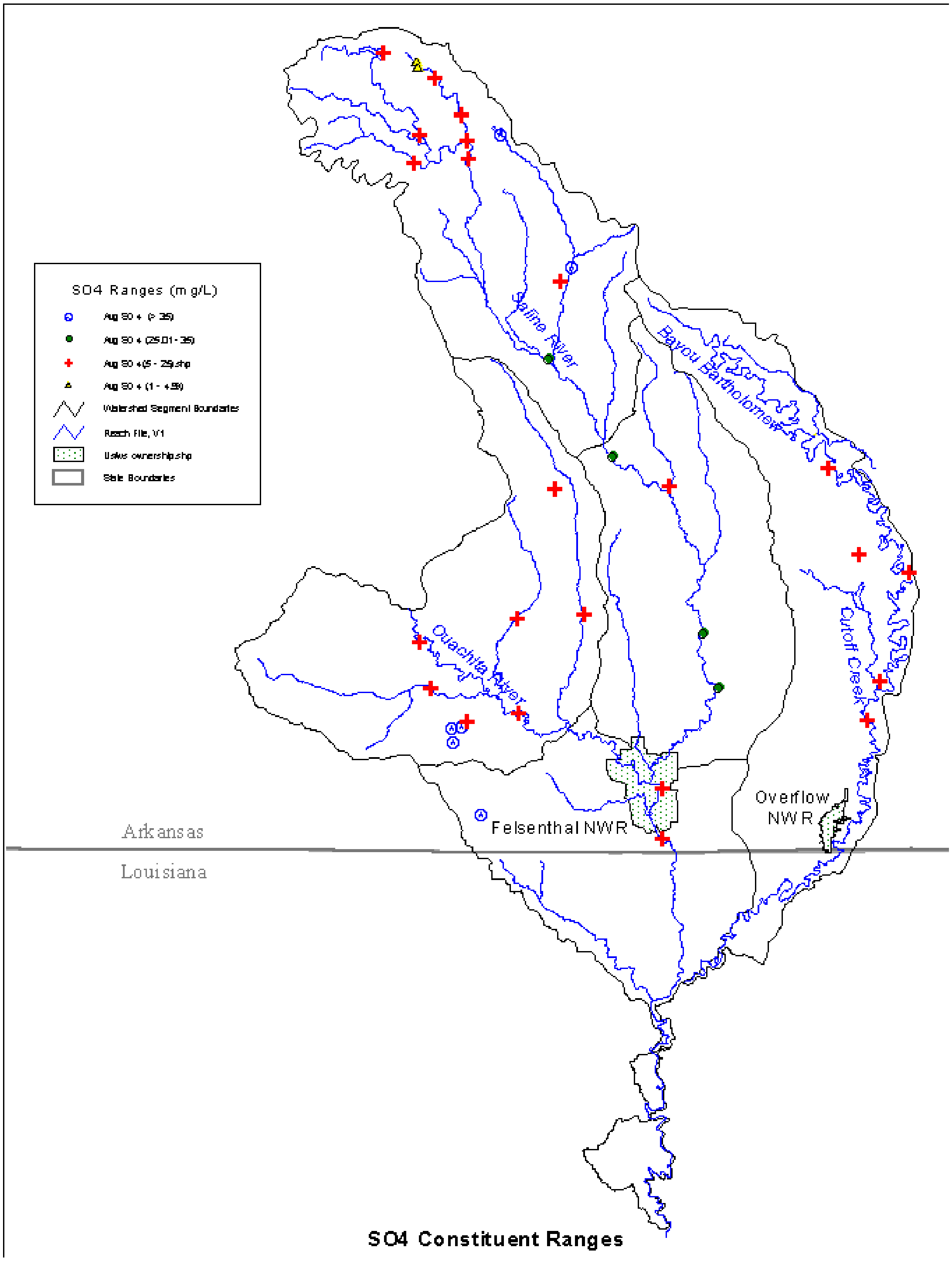


Figure 3.2. Average sulfate concentration (mg/L) ranges in the Ouachita River basin. Higher sulfate concentrations might stimulate sulfate reducing bacteria and increase mercury methylation.

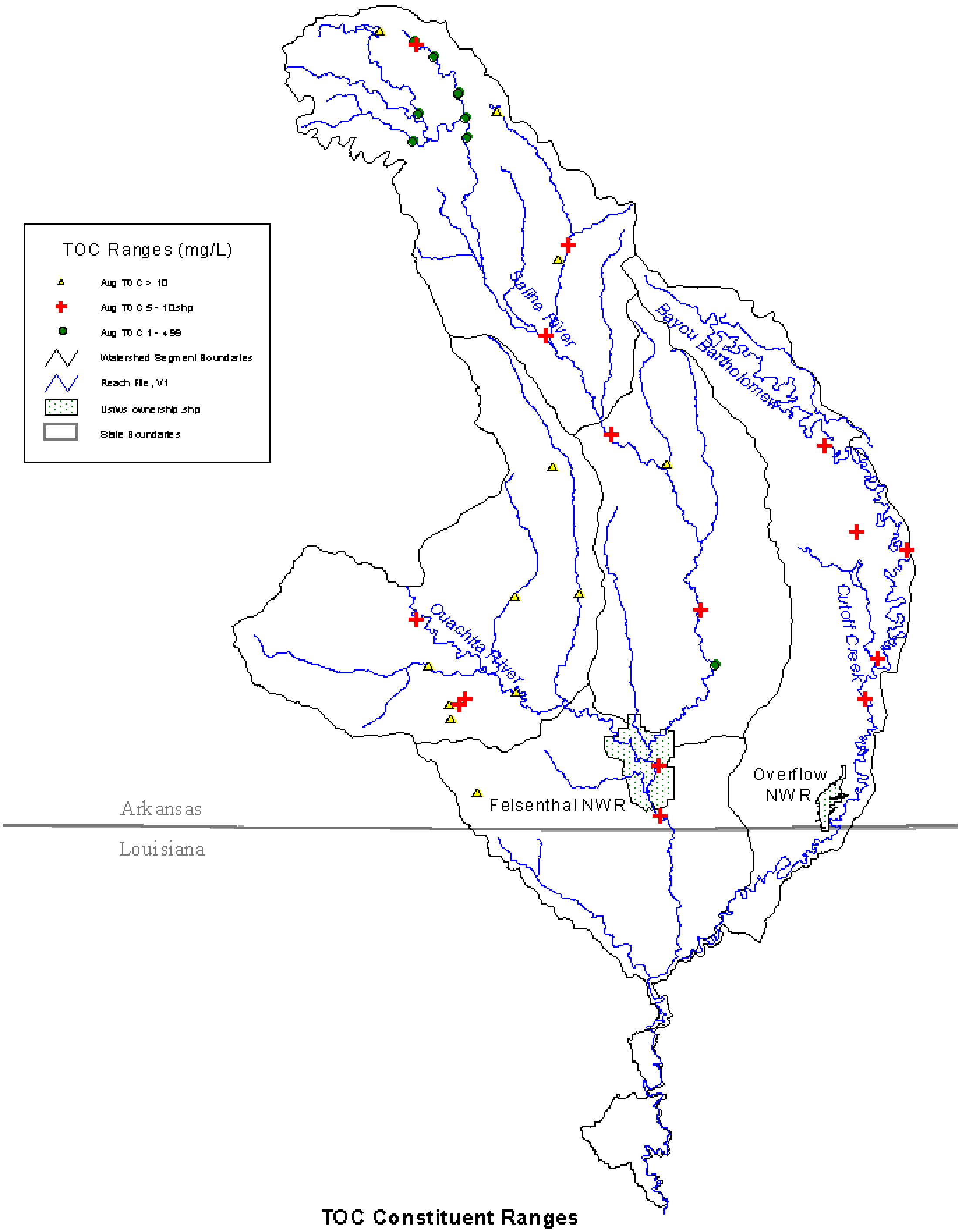


Figure 3.3. Average TOC concentration (mg/L) ranges in the Ouachita River basin. TOC can serve both as a carbon source for bacteria and also chelate Hg so it is less biologically available.

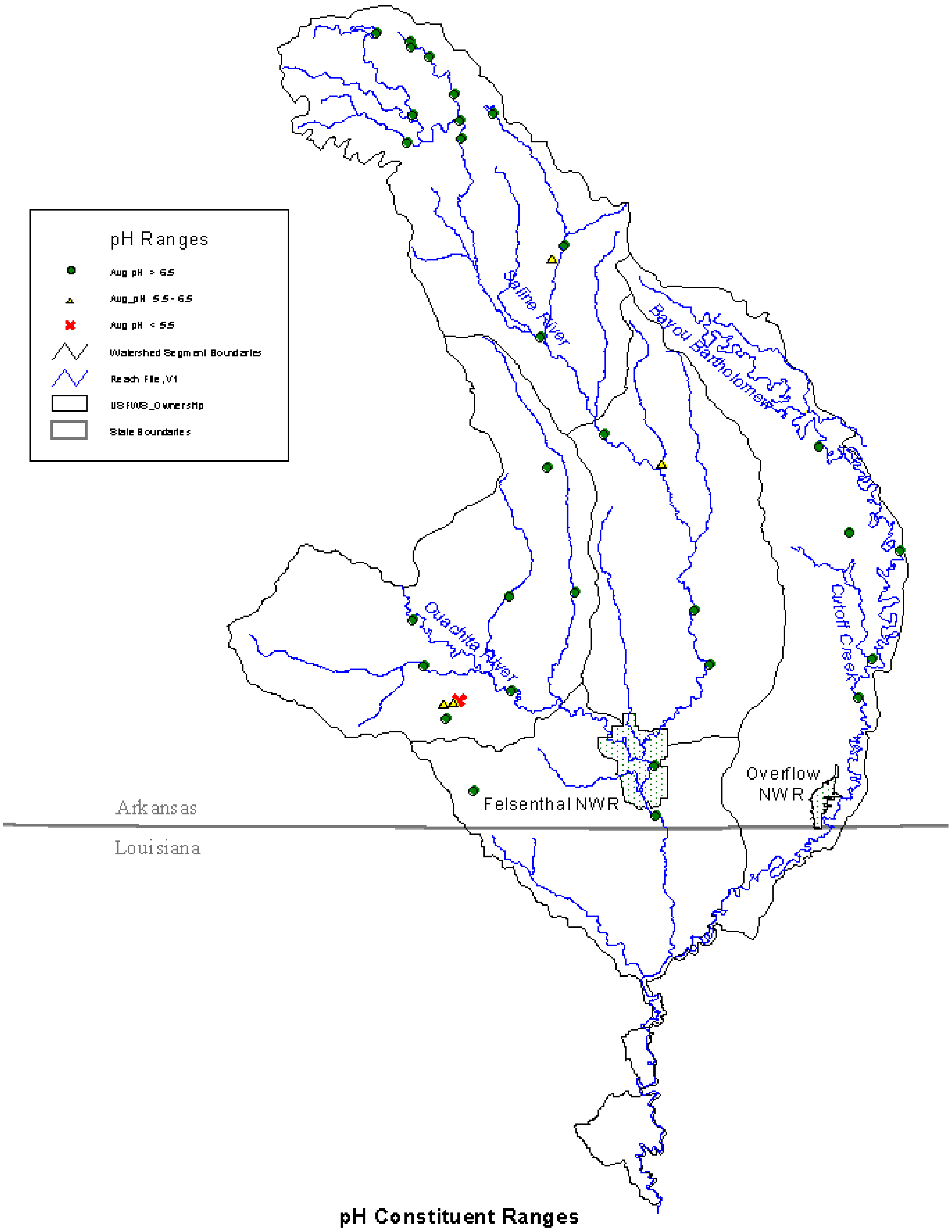


Figure 3.4. Average pH value ranges for Ouachita River basin. Lower pH values (e.g., <5.5) can be associated with higher methylmercury concentrations.

4.0 DEVELOPMENT OF THE TMDL

4.1 Loading Capacity

The loading capacity of water bodies differs based on a site specific basis due to (1) inputs or load of mercury to the waterbody, (2) environmental conditions within the waterbody that mediate methylation and bioaccumulation, and (3) the food web or food chain through which mercury bioaccumulates (Armstrong et al. 1995). Currently, the waterbody concentrations of mercury and methylmercury are unknown. In the future, clean sampling and analysis procedures might facilitate the estimation of loading capacity through water column monitoring.

4.2 Conceptual Framework

Mercury is unlike many other metals because it has a volatile phase at ambient temperatures and can be transported in a gaseous, soluble, or particulate form (Figure 4.1). Mercury is emitted to the atmosphere in both elemental gaseous Hg(0) and divalent Hg(ii) forms. Anthropogenic direct emissions, natural emissions, and indirect re-emission of previously deposited mercury are major sources of mercury to the atmosphere (Figure 4.1). Gaseous Hg(0) is relatively insoluble and is capable of being transported long distances. However, ozone or other oxidizing agents in the atmosphere can convert Hg(0) to Hg(II). Hg(II) is much more soluble and can sorb onto particulates, resulting in both wet and dry mercury deposition within local (i.e., 100 km from the source, EPA 2001) and regional areas (EPRI 1994). Some Hg(II) can also be chemically reduced to Hg(0). Hg(0) can be transported long distances and contribute to regional and global background concentrations.

Local sources of atmospheric mercury are typically within about a 100 km radius of a site (EPA 2001). Regional sources of atmospheric mercury are loosely defined as other sources within a geographical area such as the Southeast, South, or Upper Midwest, while global sources include intercontinental contributions of mercury. Atmospheric mercury deposition can include contributions from all three sources.

In addition to atmospheric deposition, mercury can also enter waterbodies from point source effluent discharges and watershed nonpoint source contributions. These watershed nonpoint sources include both naturally occurring mercury (e.g., geology, soils), and anthropogenic mercury in soils from atmospheric deposition, current and historical (Figure 4.1).

The primary mercury species of concern for bioaccumulation and biomagnification through the food chain, is the organic or methylmercury form (Figure 4.2). It is the transformation of inorganic mercury to organic or methylmercury that results in its accumulation and biological magnification through the food chain (Figure 4.2). Methylmercury binds with protein in muscle tissue of fish and other living organisms. Methylmercury is lost very slowly from fish tissue, on the order of years (Trudel and Rasmussen 1997). Therefore, methylmercury concentrations continue to biomagnify or increase in concentration throughout the life of the fish as long as methylmercury is in the environment and in its prey species. Older, larger fish typically have higher mercury concentrations than younger, smaller fish.

Recent studies have found that although mercury sulfur complexes have low solubilities in water, complex polysulfidic mercury compounds have greater solubilities than would be indicated from considering only cinnabar, the mercury sulfide ore (Benoit et al. 1999, Paquette and Hely 1995). In addition, it is likely the neutral HgS compound moves across microbial cell membranes where the mercury is methylated or transformed from inorganic to organic mercury (Benoit et al. 2000). These microorganisms, such as sulfur reducing bacteria, live in anaerobic or zero dissolved oxygen environments in the sediments of wetlands, streams, rivers, and lakes or reservoirs. Reservoirs with anaerobic hypolimnions can also be suitable environments for methylating mercury. In addition, new reservoirs (i.e., less than 15 to 20 years old) create environments that are particularly suitable for methylating bacteria so fish tissue mercury concentrations in new reservoirs are typically higher than fish tissue mercury concentrations in older reservoirs. Wetlands also create environments that are very conducive to mercury methylation. This is important in Arkansas and Louisiana both because new reservoirs have been constructed in the Ouachita River basin and because there are extensive areas of wetlands in the Ouachita River basin, such as Felsenthal National Wildlife Refuge. Wetlands and new reservoirs contribute to elevated fish tissue mercury concentrations in the basin.

A number of studies have been done on sources of mercury exposure to fish in Arkansas (Armstrong et al. 1995, Lin and Scott 1997, Scott and McKimmey 1997, Shirley 1992). This work has led to the conclusion that the geology of the area contributes to mercury in Arkansas water bodies. Mercury concentrations in the Ouachita Mountains geologic formations ranged from 0.01 mg/kg to 3.0 mg/kg (Stone et al. 1995). Mercury was mined commercially in areas south of the Ouachita Mountains. The Ouachita River basin receives drainage from these areas of known high mercury geology (Figure 4.3). The mercury studies in Arkansas also found a high incidence of higher mercury concentrations in soils located over geologic formations with high mercury concentrations (Armstrong et al. 1995). Underlying parent geological material contributes to the formation of the overlying soils, particularly in these watersheds that have thin soils. The idea that mercury from geologic sources is contributing to high mercury levels in sediments and fish is well documented and accepted by the scientific community in Arkansas. Therefore, geologic sources are included in the mercury loading estimate and TMDL.

In summary, TMDLs for mercury must consider that mercury can exist as a gas as well as in solution or particulate forms. Mercury loads arise from atmospheric deposition contributed by both local and regional/global emission sources, point source effluent discharges, natural geological formations, and soils. However, after deposition or loading to the system, mercury can also be lost through volatilization and re-enter the atmospheric pool. It is the organic form as methylmercury that is biologically accumulated and magnified through the food chain. Once in fish, it is lost very slowly and continues to accumulate through time.

4.3 TMDL Formulation

A two step approach was used to estimate loading capacity and the reductions required to achieve the designated fishable use in the Ouachita River basin waterbodies. Loading was estimated from both point and nonpoint sources in the first step, while reductions were estimated based on safe fish tissue Hg concentrations in the second step.

4.3.1 Source Loading Estimates

Mercury sources to the Ouachita River and its tributaries included both nonpoint and point sources, corresponding with load and wasteload allocations, respectively.

4.3.2 Nonpoint Sources

Load allocation for nonpoint sources included regional atmospheric deposition inputs, local source contributions, and watershed geologic/erosional inputs and watershed soil/erosional inputs.

4.3.2.1 Atmospheric Deposition

Data for regional atmospheric deposition was obtained from the National Atmospheric Deposition Program website. There are no mercury deposition monitoring stations in the state of Arkansas, therefore the two monitoring stations closest to the watershed were utilized (for a map showing locations of all the NADP mercury deposition monitoring sites, see http://nadp.sws.uiuc.edu/mdn/sites.asp). Data from monitoring locations LA10, in Franklin Parish, Louisiana, and TX21, in Gregg County, Texas, were used to represent atmospheric deposition of Hg in the watershed (Figure 4.4). Station LA10 is approximately 70 miles from Felsenthal NWR and Station TX21 is approximately 175 miles from Felsenthal NWR. Station LA10 had data available for 1999 and station TX21 had data available for 1996 through 1999. The data from these stations is summarized in Table 4.1. The average value of the wet deposition at these two stations was 11.4 $\mu g/m^2/yr$. An estimate of the total atmospheric deposition was based on the assumption that dry deposition ranges from 40% to 60% of wet deposition (EPA 2001). Assuming that dry deposition is 50% of wet deposition results in a total atmospheric deposition rate of 17.1 $\mu g/m^2/yr$. Wet deposition is the mercury removed from the atmosphere during rain events. Dry deposition is the mercury removed from the atmosphere on dust particles, sorption to vegetation, gaseous uptake by plants or other processes during non-rainfall periods (EPA 1997).

Precipitation data was also available from the NADP website (NADP 2000) and is summarized in Table 4.1. This data was compared with precipitation data for the Ouachita River watershed obtained from Hydrosphere (2000) summarized in Table 4.1 (see Appendix C Ouachita River Precipitation Estimate). The Ouachita River watershed had more precipitation than the NADP stations (Table 4.1). Since wet deposition of mercury is related to precipitation, an area receiving more precipitation could be assumed to receive a greater loading of mercury through wet deposition. Therefore, the mercury deposition for the NADP stations was adjusted based on the precipitation data from the NADP sites and the Ouachita River watershed. A ratio of 1.24 was obtained by dividing the average annual precipitation of the Ouachita River watershed (1.33 m/yr) by the average annual precipitation at stations LA10 and TX21 (1.07 m/yr). Multiplying the total atmospheric deposition rate of 17.1 µg/m^2/yr by the ratio of 1.24 resulted in a precipitation corrected total atmospheric deposition rate of 21.2 µg/m^2/yr for the watershed. Since the dry deposition was assumed to be 50% of the wet deposition, it was included in the adjustment. The corrected total atmospheric deposition rate was within the range predicted for this area (3-30 µg/m^2/yr) by the RELMAP model (EPA 1997). These data and calculations discussed above are shown in Table 4.1.

The precipitation corrected atmospheric deposition of 21.2 µg/m^2/yr was used to determine the atmospheric deposition mercury loading to streams, lakes, reservoirs, and wetlands. Table 4.2 shows the area of each of the 5 HUCs that are included in this TMDL and Subsegment 080101 covered by streams, lakes, reservoirs, and wetlands (BASINS Version 2.0 1999). The sum of the stream, lake, reservoir, and wetland areas was multiplied by 21.2 µg/m^2/yr to obtain an atmospheric mercury load of 58,961 g/yr.

4.3.2.2 Local and Regional Source Atmospheric Deposition

The Louisiana and Texas mercury deposition monitoring stations, include both local emission sources similar to those in Arkansas and regional/global input. Local atmospheric deposition for the watershed was estimated based on data from the EPA Office of Air Quality Planning and Standards National Toxics Inventory (NTI) database. The NTI is a complete national inventory of stationary and mobile sources that emit hazardous air pollutants (HAPs). Data from the NTI web site was downloaded using Maximum Achievable Control Technology (MACT) report format. The MACT report includes the number of sources and total 1996 HAP emissions for each MACT source category included in the NTI. MACT standards for emission limitations were developed under section 112(d) of the Clean Air Act. The limitations are based on the best demonstrated control technology or practices in similar sources to be applied to major sources emitting one or more of the listed toxic pollutants.

In this TMDL study, local sources are defined as sources within the watershed and within all counties within a distance of 100 km around the watershed boundary. The area within which these local sources are located is referred to as the “airshed”. The NTI MACT report format has sources listed by county, therefore the airshed boundary is determined by county boundaries and if a portion of a county falls within 100 km of the watershed, then the entire county is included as part of the airshed. The airshed boundary for the watershed is shown on Figure 4.5. The airshed contains 160,672 km^2. The mercury emissions for each MACT category found within the airshed and the Hg(II) emissions calculated from the MACT data that contribute to the local atmospheric deposition are shown in Table 4.3. MACT categories not included in Table 4.3 (e.g., medical waste incineration) were not present in the airshed, but could contribute to the global/regional atmospheric mercury load.

The distance from the emission source, the forms of the mercury in the emissions, other pollutants in the emissions and the atmosphere, and the weather patterns of precipitation are important factors in determining where mercury released to the air will deposit. Divalent mercury (Hg(II)) is the dominant form of mercury in both rainfall and most dry deposition processes. An estimate of the Hg(II) emitted from MACT category sources in the airshed was calculated based on source speciation percentages. Since the watershed is only a fraction of the airshed the emitted mercury may or may not fall within the watershed boundary. Therefore, the mercury deposition rate to the watershed due to local sources was determined by dividing the Hg(II) emissions of the airshed (233,811 g/yr) by the airshed area (160,672 km^2). This calculation is a simplification of the methodology used in the Savannah River mercury TMDL (EPA 2001). The global/regional deposition rate was set equal to the precipitation corrected deposition rate (21.2 μg/m^2/yr) minus the local source deposition rate (1.46 μg/m^2/yr). Based on the analysis of the local sources, approximately 7% (4,053 g/yr) of the Hg deposition can be attributed to local sources and 93% (54,909 g/yr) can be attributed to global/regional sources.

4.3.2.3 Watershed Geologic Erosion and Previously Deposited Mercury Loading

Sediment load for the watershed was based on erosion rates of agricultural, barren, and forestland areas. The land use areas were based on information from Basins 2.0. Erosion rates were estimated based on information from USDA Natural Resource Conservation Service (Bloodworth and Berc 1998), Handbook of Nonpoint Pollution (Novotny and Chesters 1981), and Ozark-Ouachita Highlands Assessment Report (USDA FS 1999). Cropland erosion rates average 3.4 tons/year. Cropland with highly erodible soils have rates of 6.2 to 6.4 tons/year and cropland with soils that are not highly erodible have rates of 2.3 to 2.4 tons/year. Forestland erosion rates ranged from 0.2 to 0.8 tons/year. There was a small percentage of urban and barren land within the watershed. The areas associated with urban and barren land uses were included in the calculations with cropland erosion rates applied. Table 4.4 shows the total area, agricultural area, forestland area, and barren land area for each of the 5 HUCs and subsegment 080101. Percentages of land use are also included. Table 4.5 shows the sediment loads calculated by multiplying the erosion rates by the land use areas within each HUC and subsegment 080101, resulting in a tons/year of sediment.

Mercury contributions from both geologic/erosional and soil/erosional sources were estimated based on the estimated sediment loads, and are shown in Table 4.6. Given that geologic weathering contributes to soils, a portion of the mercury in soil would come from mercury sources in the underlying geology. In this TMDL study the portion of soil mercury contributed by geologic sources (soil/geologic erosion) was estimated and labeled as the background load. In addition, on-going and historical atmospheric mercury deposition over the past several decades, if not centuries, has also contributed mercury to the soils. While some of this mercury was likely re-emitted to the atmosphere, some of this previously deposited mercury would sorb to the soils and be transported to receiving waters. This portion of the load was the soil/deposited mercury erosion load.

Indirect atmospheric mercury contributions in overland flow during rain events was not estimated. The majority of the watershed is forested (Table 4.4), and overland flow during rain events in forested lands is minimal (Waring and Schlesinger 1985). Therefore, it was assumed that indirect atmospheric contributions via overland flow during rain events would not be significant.

A number of measurements of mercury in rock formations in the Ouachita Mountains (Stone et al. 1995) and soils in the Ouachita River basin (Figure 4.6) were available (Armstrong et al. 1995). Mercury concentrations measured in both rock and soils in Arkansas exhibited a large degree of variability (Figure 4.7). To get an idea of the range of possible soil/geologic erosion and soil/deposited mercury erosion loads, three loads were calculated. The upper boundary load was calculated using 90th percentile rock (0.25 mg/kg) and soil (0.3 mg/kg) mercury concentrations measured in Arkansas. The lower boundary load was calculated using 10th percentile rock (0.01 mg/kg) and soil (0.02 mg/kg) mercury concentrations from the same data set. The load considered to be most realistic was calculated using the geometric mean of shale (0.09 mg/kg) and soil (0.16 mg/kg) mercury concentrations. Shale mercury was used for the most likely load calculation because it is very common in the Ouachita Mountains and is the most easily erodible rock analyzed (Armstrong et al. 1995). Therefore it was deemed the most likely to contribute to the load.

Estimates of the soil/geologic erosion mercury load were calculated by multiplying the rock mercury concentration by the tons of sediment per year to obtain the mercury in g/yr. The soil/deposited mercury erosion load was estimated by multiplying the non-geologic soil mercury concentration by the tons of sediment per year. The non-geologic soil mercury concentration was calculated as the soil mercury concentration minus the rock mercury concentration. Therefore, the upper boundary non-geologic soil mercury concentration was 0.05 mg/kg, the lower boundary concentration was 0.01 mg/kg, and the most likely concentration was 0.07 mg/kg. The loads calculated using these soil and rock concentrations are shown in Table 4.6.

4.4 Point Sources

There was only one NPDES permitted source with mercury limits in its permit. The point source discharge receiving stream is Boggy Creek. Boggy Creek drains to Bayou de Loutre. There is no fish advisory for Boggy Creek or Bayou de Loutre. To estimate the wasteload allocation, the NPDES point source discharge was assumed to be discharging at its permit mercury limit 24 hours/day, 7 days/week. This assumption is considered conservative because it is unlikely this occurs. In addition, it is assumed there was no mixing zone and an end-of-pipe wasteload allocation was used. This is consistent with the Great Lakes Initiative for managing bioaccumulative pollutants. Dilution is not assumed because of the persistence and non-conservative nature of mercury.

Municipal wastewater treatment facilities were also assumed to discharge some mercury because mercury at low levels has been measured in POTWs in Arkansas and other US regions. ADEQ conducted a monitoring study of five POTWs in Arkansas using clean sampling procedures and ultra-trace level analyses and found an average concentration of about 15 ng/L in municipal discharges (Allen Price, ADEQ, personal communication 2001). This mercury concentration was assumed for the municipal facilities within the basin and mercury wasteloads estimated for these sources.

4.4.1 NPDES Point Source

Table 4.7 shows the results of calculations for NPDES sources. ENSCO, Inc., AR, was the only NPDES permitted source found with a mercury limit in their permit. Their permit limit is 200 ng/L and their discharge was listed as 1.29 MGD. Multiplying these values together, and converting units, resulted in a mercury loading of 356 g/yr.

4.4.2 Municipal Wastewater Discharges

An estimate of the contribution of mercury to the watershed from municipal wastewater treatment (WWT) plants was also calculated (Table 4.8). The list of city municipal WWT plants was obtained from the PCS search done for NPDES permitted facilities (see Appendix A). An assumption was made for the mercury concentration in the wastewater discharge. The concentration used was 15 ng/L, which was multiplied by the discharge from the city WWT plants. Discharge rates were included in the results of the PCS search. The result was a mercury loading of 586 g/yr.

4.5 Fish Tissue Concentration Estimation

Load reduction estimates were obtained using the maximum observed fish tissue concentrations and back calculating the decrease in fish tissue concentration needed to result in a safe target fish tissue mercury concentration.

If the mercury body burden of the primary fish species of concern were reduced to <0.5 or <1.0 mg/kg in Louisiana and Arkansas, respectively, the water bodies would achieve their designated, fishable uses. Therefore, the mercury reduction required to achieve the designated uses was based on the required reduction in fish tissue mercury concentrations needed to achieve the safe target levels of 0.4 and 0.8 mg/kg fish tissue mercury concentrations in the Louisiana and Arkansas portions of the Ouachita River basin waterbodies, respectively. These safe target level tissue concentrations provide a 20% MOS for the state fish tissue mercury criteria. A linear relationship was assumed between mercury source reduction and reductions in fish tissue mercury concentrations. This relationship, is consistent with steady-state assumptions and the use of bioaccumulation factors. However, interactions of both inorganic and organic mercury with sulfide, organic carbon, and other water quality constituents can affect its bioavailability for both methylation and uptake (Armstrong et al. 1995; EPA 1997, 1998). In order to establish the reduction needed in key species, the worst case body burden was divided by the target safe level tissue mercury concentration. The worse case body burden was the highest average mercury concentration of filet samples of bass species sampled from the listed waters (Table 4.9). A hazard quotient is directly applied to estimate the load reduction (RF), as illustrated in the following equations:

RF = MC/SC, where
RF = Reduction Factor
MC = Measured tissue mercury concentration (worst case species of bass and water body average concentration, mg/kg wet weight)
SC = Safe tissue mercury concentration (with MOS, mg/kg wet weight)

and,

TMDL = (EL/RF) x SF, where
TMDL = total maximum daily load (average value in $ng/m^2/d$)
RF = Reduction Factor
EL = Existing total load (includes point and nonpoint sources)
SF = Site specific factor(s) (requires study, but could be based on measured sulfate, organic carbon, alkalinity or pH values that influence mercury methylation and bioaccumulation. Assumed to be 1 in this study).

This approach follows and builds on the precedence established in *Mercury TMDLs for Segments Within Mermentau and Vermillion-Teche River Basins* (EPA 2000).

To estimate the tota mercury (THg) and methylmercury (MeHg) concentrations that might be occurring in the water column, the average bioaccumulation factor (BAF) used in the EPA (1997) Mercury Report to Congress was used to back calculate to water MeHg concentrations (Table 4.10). The ratio of MeHg/THg is typically in the range of 0.1 to 0.3 (EPA 1998), so a MeHg/THg ratio of 0.2 was used to estimate water THg concentrations (Table 4.10). Both the MeHg and THg concentrations appeared to be reasonable estimates of concentrations that might be expected in the Ouachita River basin.

4.6 Estimate of Fish Tissue Concentration From Sediment Mercury Concentrations

Sediment mercury concentrations were measured in the Ouachita River as part of the Arkansas Mercury Task Force assessment (Armstrong et al. 1995). These measured concentrations were used to estimate the mercury concentrations that might occur in fish in the system, both to assess the long-term potential of the sediments as a reservoir for mercury and to assess the potential of the sediments to contribute sufficient mercury to exceed mercury target safe levels in fish.

Sediment mercury concentration was measured in the Ouachita River and found to be relatively constant at about 0.05 mg/kg from Remmel Dam to Felsenthal National Wildlife Refuge (Figure 4.8). Estimates of the partitioning coefficient (K_d) and an equation for the relationship between sulfide concentrations and MeHg were obtained from Benoit et al. (2000).

The first step was to determine the amount of total dissolved mercury (C_w) based on the sediment concentration of 0.05 mg/kg (C_s). The relationship of K_d being equal to C_s divided by C_w was used to calculate the total dissolved mercury concentration. Then, the equation shown in Figure 4.9 was used to determine the fraction of dissolved mercury present as mercury sulfide (HgS^0) where x equals the log molar concentration of sulfide in the water. The resulting HgS^0 concentration is assumed to be bioavailable for conversion to MeHg. Finally, the bioaccumulation factor of $6.8x10^6$ was applied to determine the fish tissue concentration.

Two K_d values were used to develop a range of sulfide concentrations that would be expected to result in fish tissue concentrations ranging from approximately 0.5 to 3.0 mg/kg. Table 4.11 shows the results of using a K_d equal to $1x10^4$ and Table 4.12 shows the results of using a K_d equal to $1x10^5$. Sediment mercury concentrations are sufficient to result in the range of mercury concentrations found in the fish in the Ouachita River basin.

4.7 Current Load

The total mercury load to the Ouachita River and its tributaries on both an annual and a daily basis is shown in Table 4.13. The municipal and NPDES permitted point source contributions are very small (<1%) compared to the atmospheric and watershed nonpoint source contributions. The upper boundary and most likely soil/deposited mercury erosion and soil/geologic erosional mercury loads account for the majority of the mercury load to the Ouachita River basin. With the lower boundary soil/deposited mercury erosion and soil/geologic erosional mercury loads, regional atomospheric deposition accounts for the majority of the mercury load to the Ouachita River basin. Therefore, soils, geology, and regional air deposition are the primary contributors to the mercury load in the Ouachita River basin.

4.8 TMDL

Based on the required reductions to achieve mercury target safe levels in fish, mercury loads to the Ouachita River basin should be reduced by a factor of 2 in Arkansas and 3 in Louisiana. The difference in mercury load reduction required in the two states reflects the difference in Action Levels for issuing fish consumption advisories. In Arkansas, the Action Level is 1.0 mg/kg, while in Louisiana the risk-based guideline for issuing fish consumption advisories is 0.5 mg/kg. While the Action Levels are different, recommended fish consumption for the general public in the advisory area is similar between the two states. The target mercury loads calculated using the Arkansas and Louisiana reduction factors are shown in Table 4.13. The load allocations for the Arkansas TMDL are shown in Table 4.14. The load allocations for the Louisiana TMDL are shown in Table 4.15. Annual mercury loads are used in the load allocations because the concern with this TMDL study is the long term accumulation of mercury, rather than short term acute toxicity events.

The total non-point source mercury load allocations were determined by reducing the loading rates for the regional sources of atmospheric deposition, local sources of atmospheric deposition, and soil/deposited mercury erosion until the total basin mercury load was less than the target basin mercury load (from Table 4.13). The same percent reduction was applied to all three of the sources (regional sources of atmospheric deposition, local sources of atmospheric deposition and soil/deposited mercury erosion). The background load was not reduced based on the assumption that the erosion rates for the rock to soil cannot be reduced. The total maximum loads and margins of safety were calculated from the target basin loads calculated in Table 4.13. Since the explicit margin of safety for this TMDL study was 20% (see Section 4.3), the target basin loads would be 80% of the total maximum load. Therefore the total maximum loads were calculated as the target basin loads divided by 0.8. The margins of safety were calculated as 0.2 times the total maximum loads.

Felsenthal NWR, Arkansas, also requires a factor of 3 reduction to achieve safe target levels, but Felsenthal is a special system in Arkansas. Felsenthal NWR is a relatively new reservoir, with impoundment occurring in 1985. New reservoirs typically have elevated concentrations of mercury in fish, but there is a decline in concentration after about 20 to 30 years with fish reaching concentrations sustained by external mercury loadings in about 25 to 30 years (Anderson et al. 1995). Fish mercury concentrations in Felsenthal NWR would be expected to decrease in the future, but the system should continue to be managed as a special system for mercury and fish consumption advisories.

4.8.1 Wasteload Allocation

The analysis of NPDES point sources in the watershed indicates that the cumulative loading of mercury from these facilities is less than 1% of the total estimated current loading. Even if this TMDL were to allocate none of the calculated allowable load to NPDES point sources (i.e., a wasteload allocation of zero), the applicable water quality standards for mercury would not be attained in the waterbody because of the very high mercury loadings from nonpoint and background sources. At the same time, however, EPA recognizes that mercury is an environmentally persistent bioaccumulative toxic with detrimental effects to human fetuses even at minute quantities, and as such, should be eliminated from discharges to the extent practicable. Taking these two considerations into account, this TMDL, therefore, provides that mercury contributions from the city municipal WWTPs not exceed the mercury water quality standard for Arkansas and Louisiana (12 ng/L). No change in mercury limits is provided for the NPDES point source with permit limits for mercury.

4.8.2 Load Allocation

If the nonpoint source and background mercury loads happen to be like those shown as the upper boundary and the most likely conditions, it would not be likely that the mercury loading to the Ouachita River basin could be reduced to the proposed total maximum loads. The background mercury load would be too great. Even with 100% reduction of the nonpoint source loads, the Ouachita River basin mercury load is greater than the proposed total maximum load.

However, if the nonpoint source and background mercury loads are more like those shown as the lower boundary conditions, it could be possible to reduce the Ouachita River basin mercury loading to the proposed total maximum load. A 65% reduction of nonpoint source inputs would be required to meet the Arkansas proposed total maximum load, and an 87% reduction of nonpoint source inputs would be required to meet the Louisiana proposed total maximum load.

Existing MACT regulations of mercury emissions will account for some of the needed reductions in mercury deposition in the Ouachita River basin. Final rules for mercury emissions are in effect for four of the MACT categories identified as local mercury sources to the Ouachita River basin. Table 4.16 lists these MACT categories and the expected reductions in their mercury emissions as a result of the implementation of the final rules. Overall, local sources of mercury deposition would be expected to be reduced by 22%. Existing regulations reducing mercury emissions from municipal waste combustion, medical waste incineration, and hazardous waste combustion are expected to reduce national mercury emissions by about 50% (see Section 6.0). Therefore, regional sources of atmospheric mercury deposition could also be expected to be reduced by about 50%.

Tables 4.17 and 4.18 show the mercury load allcations taking into account reductions in the atomospheric mercury load as a result of implementation of MACT regulations. In these tables the local atmospheric deposition load has been set to 78% of the current local atmospheric deposition load (shown in Table 4.13) to reflect the expected 22% reduction. The regional atmospheric deposition load in Tables 4.17 and 4.18 has been set to 50% of the current regional atmospheric deposition load (shown in Table 4.13) to reflect the expected 50% reduction. These tables also show reduced loads for the soil/deposited mercury source. Reducing atmospheric deposition should result in less mercury in soils from atmospheric deposition. The sum of the reduced atmospheric deposition load to the basin (Tables 4.17 and 4.18) is about 48% less than the current atmospheric deposition load to the basin (Table 4.13). Therefore, the soil/deposited mercury loading rate shown in Tables 4.17 and 4.18 was also reduced by 48% from the current soil/deposited mercury loading rate (Table 4.13). In almost all scenarios shown in Tables 4.17

and 4.18 the total basin mercury loads are greater than the target basin mercury loads. Therefore, the target basin mercury load cannot be met without further reductions in the mercury load. Mercury emission limits for additional source categories are either proposed or planned (EPA 2002a). Therefore, further reductions would be expected in both local and regional atmospheric mercury loads to the basin in the future. It is uncertain what the magnitude of these reductions would be.

Additional reductions in the basin mercury load may be possible with the application of best management practices (BMPs) to reduce erosion. Reducing erosion would reduce both the soil/deposited mercury erosion and the soil/geologic erosion mercury loads. Table 4.19 shows the reduced sediment loads to the Ouachita River basin that would occur if the erosion rates for agricultural and barren land uses were the same as the erosion rate for forestland (0.2 tons/acre/yr). This erosion rate is equivalent to approximately a 90% reduction in erosion from the agricultural and barren lands. Although it is not likely that implementing BMPs would actually reduce erosion rates on agricultural or barren lands this much, the erosion rate of 0.2 tons/acre/yr was used to show the best possible conditions for the basin. Tables 4.20 and 4.21 show load allocations using the reduced sediment load to calculate soil/deposited mercury and soil/geologic erosion mercury loads along with the expected reductions in atmospheric deposition used in Tables 4.16 and 4.17. The background loads in Tables 4.20 and 4.21 are about 30% lower than the background loads in the previous tables. The reductions brought the total basin mercury load to within 5% to 9% of the Arkansas reduction target basin load. The reduced total basin mercury loads were still over 45% greater than the Louisiana reduction target basin load.

Although it appears that these reductions will not reduce maximum fish tissue concentrations to the State action levels, they can reduce the average fish tissue concentrations to the State action levels. Table 4.22 lists the average of largemouth bass tissue mercury concentrations measured in the basin, and the reduction factors that would be required to reduce the average concentrations to the target concentrations used in this TMDL study. The average of these reduction factors was used to calculate the target total basin loads shown in Tables 4.23 and 4.24. The average of the Arkansas reduction factors was 1.5. The average of the Louisiana reduction factors was 1.8. Table 4.23 shows that the reduced basin mercury loads shown in Tables 4.20 and 4.21 are less than the Arkansas target basin load calculated using the reduction factor of 1.5. Table 4.24 shows that the reduced basin mercury loads shown in Tables 4.20 and 4.21 are less than the Louisiana target basin loads for the most likely and lower boundary scenarios calculated using the reduction factor of 1.8.

4.8.3 Unallocated Reserve

The conservative estimates used throughout these analyses, including the conservative reduction factors should provide an unallocated reserve for mercury loading to the Ouachita River and its tributaries.

Table 4.1. Deposition estimates for the Ouachita River basin.

NADP Data Summary			**Precipitation Data (1997 - 1999)**		**NADP Data Summary**		
Station	**Year**	**Rain Gauge (m/yr)**	**HUC**	**Avg. Precip. (m/yr)**	**Station**	**Year**	**Wet Total Hg Deposition (µg/m^2/yr)**
TX21	1996	0.75	8040201	1.31	TX21	1996	9.0
TX21	1997	1.34	8040202	1.29	TX21	1997	13.0
TX21	1998	1.08	8040203	1.32	TX21	1998	11.6
TX21	1999	0.89	8040204	1.32	TX21	1999	10.3
LA10	1999	1.30	8040205	1.18	LA10	1999	13.3
			8040207	1.54			
	Average	1.07	Average	1.33		Average	11.4

Dry + Wet = Average wet x 1.5 = 17.1 µg/m^2/yr
Atmospheric Deposition Correction Factor = 1.24
Precipitation Corrected Total Atmospheric Deposition Rate = 21.2 µg/m^2/yr

Table 4.2. Mercury deposition load to streams, lakes, reservoirs, and wetlands in the Ouachita River basin.

		Atmospheric Deposition to Lakes, Reservoirs, Wetlands			
Subbasin	**Streams (acres)**	**Lakes Reservoirs (acres)**	**Wetlands (acres)**	**Lakes Reservoirs & Wetlands (km^2)**	**Hg Deposition (g/yr)**
8040201	–*	1,597	265,811	1,082.16	22,987
8040202	3,383	5,269	180,740	766.44	16,281
8040203	–	4,172	11,502	63.43	1.347
8040204	–	2,033	152,706	626.21	13,302
8040205	1,460	2,386	46,139	20228	4,297
Subsegment 08010	4,463	434	3,802	35.20	748
Total	9,306	15,891	660,700	2,775.72	58,961
Regional	(19.8 µg/m^2/yr)				54,909
Local	(1.46 µg/m^2/yr)				4,053

*No estimate of areas in streams and canals available in the BASINS land use data for these subbasins.

Table 4.3. Local source emissions within the airshed based on NTI MACT report data.

MACT Category	Number of Point Sources*	Total Emissions (lbs/yr)	Total Emission (kg/yr)	Hg(II) Speciation Percentage	Hg(II) (g/yr)
0102 - Industrial Combustion Coord Rule: Industrial Boilers	44	65.35	29.64	30%	8,893
0103 - Industrial Combustion Coord Rule: Institutional/Commercial Boilers	1	16.22	7.36	30%	2,207
0105 - Industrial Combustion Coord Rule: Stationary Internal Combustion Engines	0	0.05	0.02	10%	2
0410 - Portland Cement Manufacturing	5	460.5	208.9	10%	20,890
0502 - Petroleum Refineries - Catalytic Cracking, Catalytic Reforming, & Sulfur Plant Units	2	2.09	0.95	30%	284
0801 - Hazardous Waste Incineration	2	200.8	91.10	20%	18,220
0802 - Municipal Landfills	0	0.76	0.35	0%	-
1626 - Pulp & Paper Production	14	462.1	209.6	30%	62,882
1803 - Utility Boilers: Coal	2	872.0	395.5	30%	118,660
1805 - Utility Boilers: Oil	5	0.56	0.25	30%	76
1807 - Industrial Combustion Coord Rule: Industrial, Commercial & Other Waste Incineration	0	18.70	8.48	20%	1,697
Total	75	2,099	952.2		233,811

*No estimate available for number of nonpoint sources.

Table 4.4. Erosion estimates for the Ouachita River basin, by subbasin.

Sources of erosion within the watershed								
		Agricultural Land		Forest Land		Barren Land		
Subbasin	Subbasin Area (acre)	(acre)	(% of Basin Area)	(acre)	(% of Basin Area)	(acre)	(% of Basin Area)	Total Percent of Basin
8040201	1,162,920	68,607	5.9	802,703	69	9,405	0.8	76
8040202	825,028	54,119	6.6	570,188	69	1,014	0.1	76
8040203	1,097,220	90,928	8.3	955,312	87	20,572	1.9	97
8040204	967,583	118,368	12.0	688,661	71	334	0.0	83
8040205	1,080,000	403,618	37.4	603,832	56	1,216	0.1	93
080101	97,482	11,523	11.8	66,457	68	–	0.0	80

Total Watershed	**5,230,233**	**747,163**	**14.3**	**3,687,153**	**70**	**32,541**	**0.6**	**85**

Table 4.5. Sediment load estimated for Ouachita River basin, by subbasin.

Sediment Loading							
	Agricultural Land		Forest Land		Barren Land		
Subbasin	Erosion Rate (tons/acre/ year)	Sediment (tons/year)	Erosion Rate (tons/ acre/year)	Sediment (tons/year)	Erosion Rate (tons/ acre/year)	Sediment (tons/year)	Total Sediment (tons/year)
8040201	2.4	164,657	0.2	160,541	2.4	22,572	347,769
8040202	2.4	129,886	0.2	114,038	2.4	2,434	246,357
8040203	2.4	218,227	0.2	191,062	2.4	49,373	458,662
8040204	2.4	284,083	0.2	137,732	2.4	802	422,617
8040205	2.4	968,683	0.2	120,766	2.4	2,918	1,092,368
080101	2.4	27,656	0.2	13,291	2.4	–	40.947
Total Watershed		1,793,192		737,431		78,098	2,608,721

Table 4.6. Load estimated from geologic sources in Ouachita River basin, by subbasin.

		Upper Boundary		Most Likely		Lower Boundary	
Subbasin	Total Sediment (tons/yr)	Geologic/ Erosional (g/yr)	Soil/ Erosional (g/yr)	Geologic/ Erosional (g/yr)	Soil/ Erosional (g/yr)	Geologic/ Erosional (g/yr)	Soil/ Erosional (g/yr)
8040201	347,769	78,874	15,775	28,395	22,085	3,155	3,155
8040202	246,357	55,874	11,175	20,115	15,645	2,235	2,235
8040203	458,662	104,025	20,805	37,449	29,127	4,161	4,161
8040204	422,617	95,850	19,170	34,506	26,838	3,834	3,834
8040205	1,092,368	247,749	49,550	89,190	69,370	9,910	9,910
080101	40,947	9,287	1,857	3,343	2,600	371	371
Total Watershed	2,608,721	591,658	118,332	212,997	165,664	23,666	23,666

Table 4.7. Mercury load estimated from NPDES permitted source, assuming permit limit equals the mercury concentration in the effluent.

HUC	Discharge (MGD)	Permit Limit Hg (ng/L)	Mercury (ng/day)	Mercury (g/yr)
ENSCO	1.29	200	9.77E+08	356

Table 4.8. Mercury load estimated from municipal wastewater treatment plants assuming an average concentration of 15 ng/L.

HUC	City Discharge (MGD)	Estimated HG (ng/L)	Mercury (ng/day)	Mercury (g/yr)
8040201	7.75	15	4.40E+08	161
8040202	7.44	15	4.22E+08	154
8040203	9.49	15	5.39E+08	197
8040204	3.62	15	2.05E+08	75
Total	28.3		1.61E+08	586

Table 4.9. Reduction Factor (RF) and percent reduction of current tissue mercury concentration needed to achieve fishable designated use.

Location	Maximum LMB Hg Concentration (mg/kg)	RF to Achieve Target Level*	Percent Reduction of Current Fish Tissue Mercury Concentration Needed to Achieve Target Level
Lake Winona	1.48	1.9	46
Grays Lake	1.08	1.4	26
Saline River			
Below L'Aigle Creek	1.78	2.2	55
Highway 4	1.72	2.2	53
Mt. Elba	1.87	2.3	57
Eagle Creek	1.79	2.2	55
Ouachita River			
Pigeon Hill	1.4	1.8	43
Champagnolle Creek	1.34	1.7	40
Moro Creek Hwy 160	1.56	2.0	49
Coffee Creek	1.20	1.5	33
Felsenthal	2.64	3.3	70
Hwy 82	2.41	3.0	67
Below Felsenthal	1.36	1.7	41
State Line, LA	1.02	2.6	61
Sterlington, LA	1.24	3.1	68
Riverton, LA	1.07	2.7	63

* Target Safe Level - 0.8 mg/kg AR, 0.4 mg/kg LA

Table 4.10. Water methylmercury concentrations back-calculated from fish tissue mercury concentrations. Total mercury concentrations estimated from MeHg: THg ratio.

Location	Maximum LMB Hg Concentration (mg/kg)	MeHg Conc. in Water Back-Calculated from BAF** (ng/L)	Total Hg Conc. in Water from MeHg:THg Ratio+ (ng/L)
Lake Winona	1.48	0.2	2.0
Grays Lake	1.08	0.2	2.0
Saline River			
Below L'Aigle Creek	1.78	0.3	3.0
Highway 4	1.72	0.2	2.0
Mt. Elba	1.87	0.3	3.0
Eagle Creek	1.79	0.3	3.0
Ouachita River			
Pigeon Hill	1.4	0.2	2.0
Champagnolle Creek	1.34	0.2	2.0
Moro Creek Hwy 160	1.56	0.2	2.0
Coffee Creek	1.20	0.2	2.0
Felsenthal	2.64	0.4	4.0
Hwy 82	2.41	0.4	4.0
Below Felsenthal	1.36	0.2	2.0
State Line, LA	1.02	0.2	2.0
Sterlington, LA	1.24	0.2	2.0
Riverton, LA	1.07	0.2	2.0

** BAF = 6.8 X 10^6 geometric mean (EPA 1997)

+ 0.2 MeHg:THg ratio used for conversion to THg

Table 4.16. Reductions in local atmospheric mercury sources based on existing MACT regulations.

MACT Category	Percent Reduction	Source	Current Hg(II) Load (g/yr)	Expected Hg(II) Load (g/yr)
410 - Portland Cement Manufacturing	24%	HAP metals reduction Table 7, Federal Register, June 4, 1999 Vol. 64 No. 113	20,890	15,876
0801 - Hazardous Waste Incineration	55%	EPA Hazardous Waste Combustion FAQs website	18,220	8,199
1626 - Pulp & Paper Products	59%	Table VII-2 Federal Register April 15, 1998 Vol. 63, No. 72	62,882	25,781
1807 - Industrial Combustion Coord Rule: Industrial, Commercial, and Other Waste Incineration	34%	Table 4 Federal Register December 1, 2000 Vol. 65	1,697	1,120
Airshed total local source mercury load			233,811	181,099

Table 4.19. Sediment load estimated for Ouachita River basin, by subbasin, with reduced erosion rates for agricultural and barren land..

Sediment Loading							
	Agricultural Land		Forest Land		Barren Land		
Basin Code	Erosion Rate (tons/acre/ year)	Sediment (tons/year)	Erosion Rate (tons/ acre/year)	Sediment (tons/year)	Erosion Rate (tons/ acre/year)	Sediment (tons/year)	Total Sediment (tons/year)
8040201	0.2	16,466	0.2	160,541	2.4	2,572	179,263
8040202	0.2	12,989	0.2	114,038	2.4	243	127,270
8040203	0.2	21,823	0.2	191,062	2.4	4,937	217,822
8040204	0.2	28,408	0.2	137,732	2.4	80	166,221
8040205	0.2	968,683	0.2	120,766	2.4	2,918	1,092,368
Subsegment 080101	0.2	2,766	0.2	13,291	2.4	–	16.057
Total Watershed		1,051,134		737,431		10,436	1,799,001

Table 4.22. Reduction Factor of average tissue mercury concentration needed to achieve fishable designated use.

Location	Average LMB Hg Concentration (mg/kg)	RF to Achieve Target Safe Level*
Lake Winona	0.74	0.9
Grays Lake	1.08	1.4
Saline River		
Below L'Aigle Creek	1.78	2.2
Highway 4	1.21	1.5
Mt. Elba	0.91	1.1
Eagle Creek	1.49	1.8
Ouachita River		
Pigeon Hill	1.18	1.5
Champagnolle Creek	1.01	1.3
Moro Creek Hwy 160	1.56	2.0
Coffee Creek	1.12	1.4
Felsenthal	1.13	1.4
Hwy 82	1.14	1.4
Below Felsenthal	1.36	1.5
State Line, LA	0.65	1.6
Sterlington, LA	0.98	2.4
Riverton, LA	0.52	1.8

* Target Safe Level - 0.8 mg/kg AR, 0.4 mg/kg LA

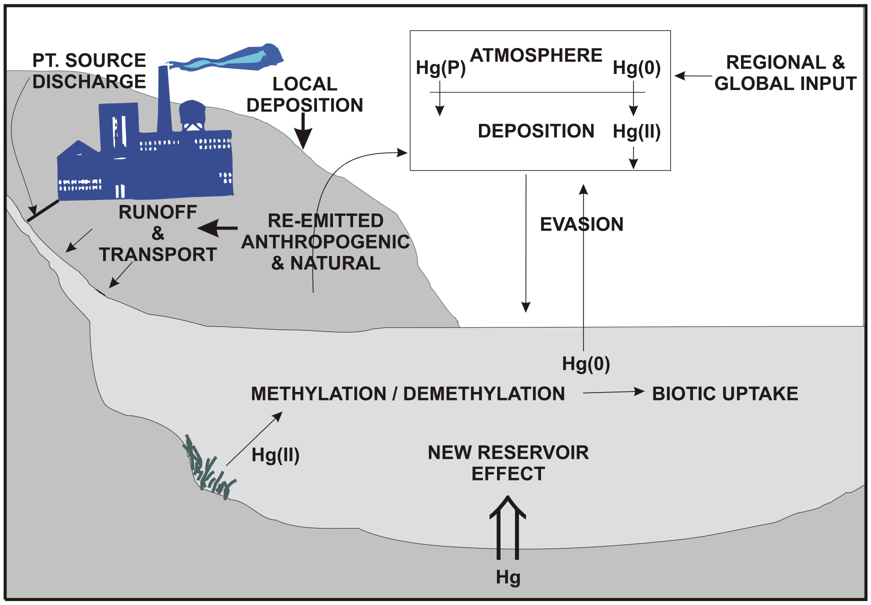


Figure 4.1. General mercury cycle showing atmospheric transport and deposition, point, nonpoint source and natural background contributions, and the effects of new reservoirs on mercury release into the environment (after Mason et al. 1994).

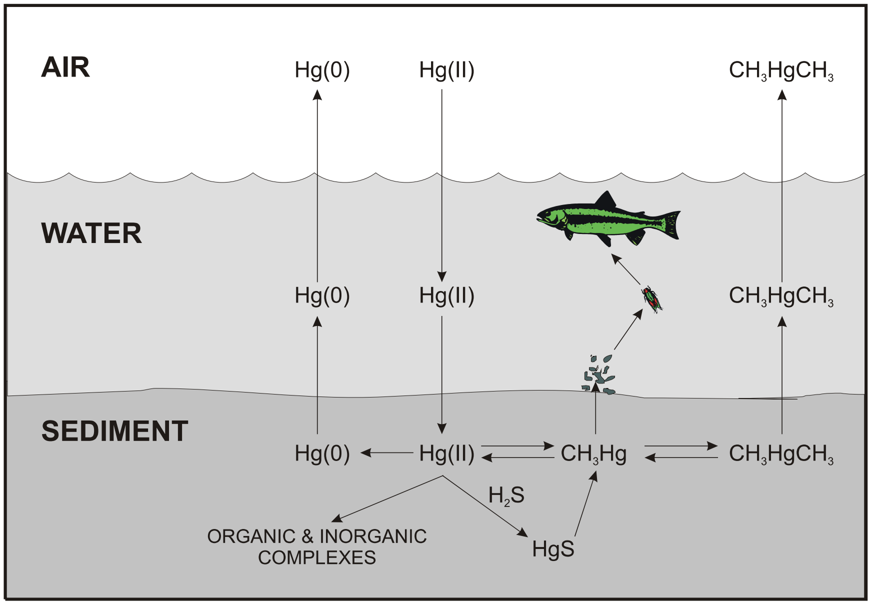


Figure 4.2. Pathways for mercury species through the aquatic ecosystem, including methylation and demethylation, evasion or loss from the water to the atmosphere, and sedimentation and burial in the sediment (after Winfrey and Rudd 1990).

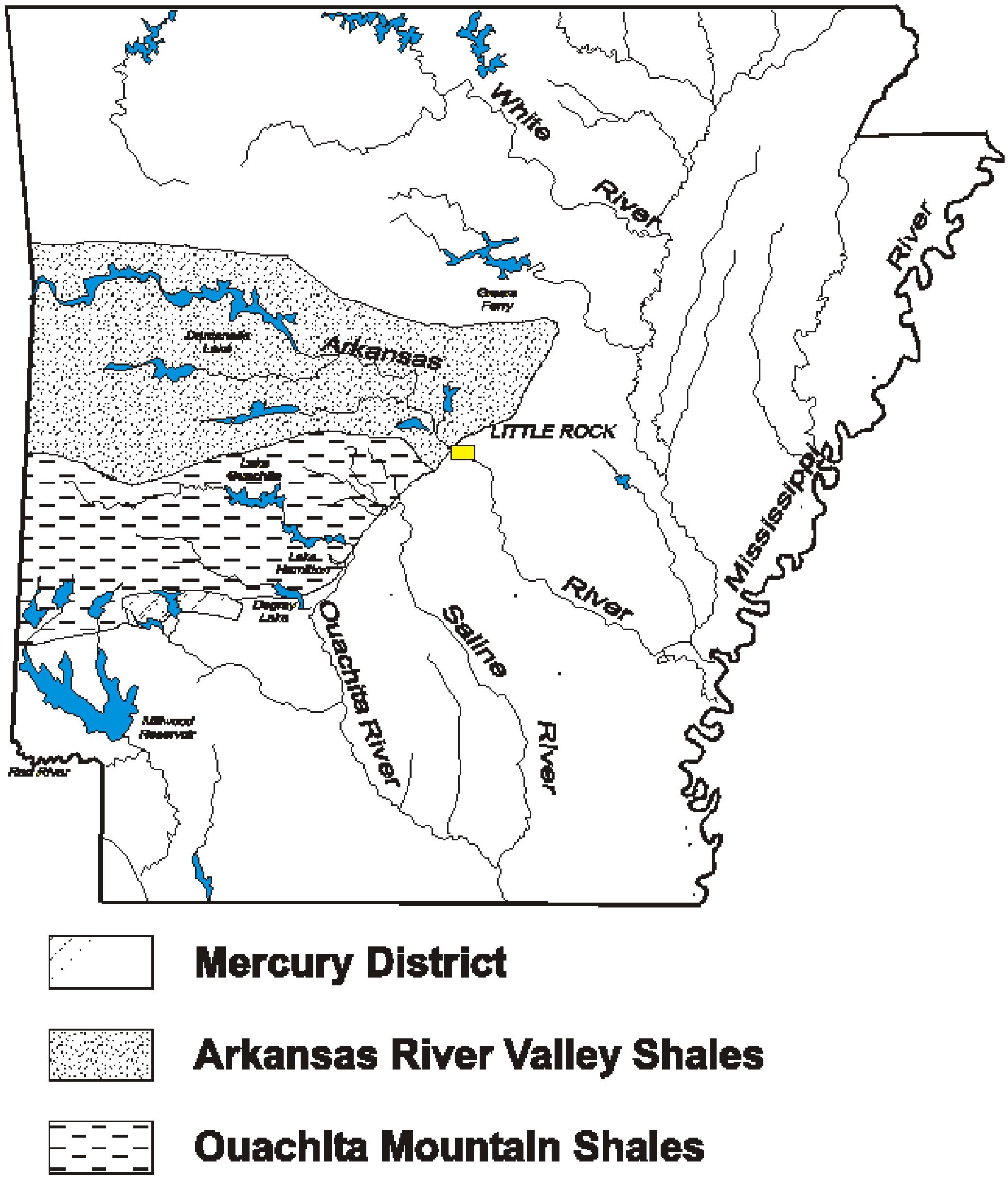


Figure 4.3. Shale formations and mercury district in Arkansas and relation to the Ouachita River basin from Armstrong et al. (1995).

Figure 4.4. Location of NADP monitoring stations LA10 Franklin Parish, LA and TX21 Gregg County, TX.

Figure 4.5. Airshed boundary for the Ouachita River basin watershed.

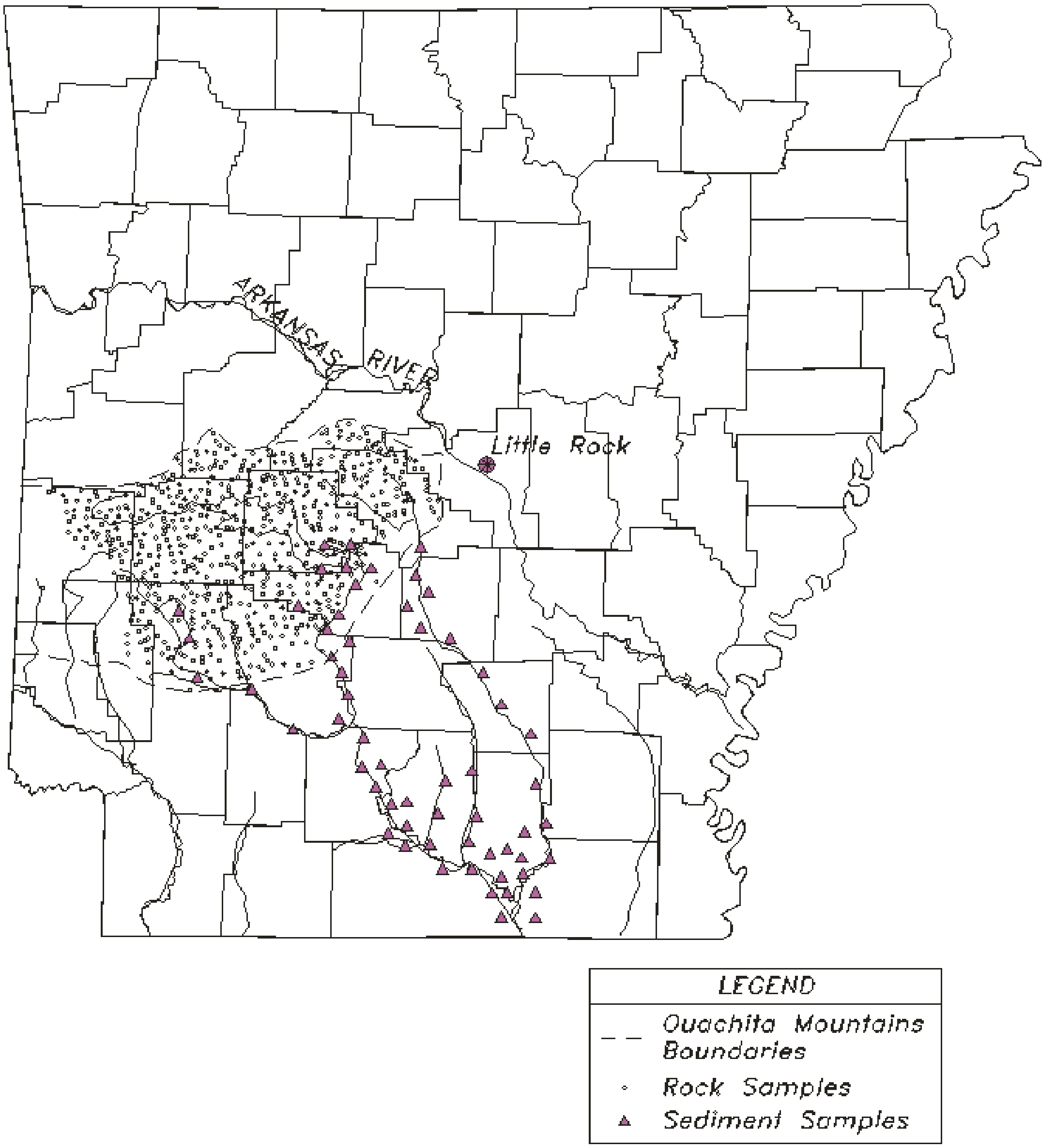


Figure 4.6. Sediment (triangle) and rock (dot) sampling locations for mercury analysis (Stone et al. 1995, Armstrong et al. 1995).

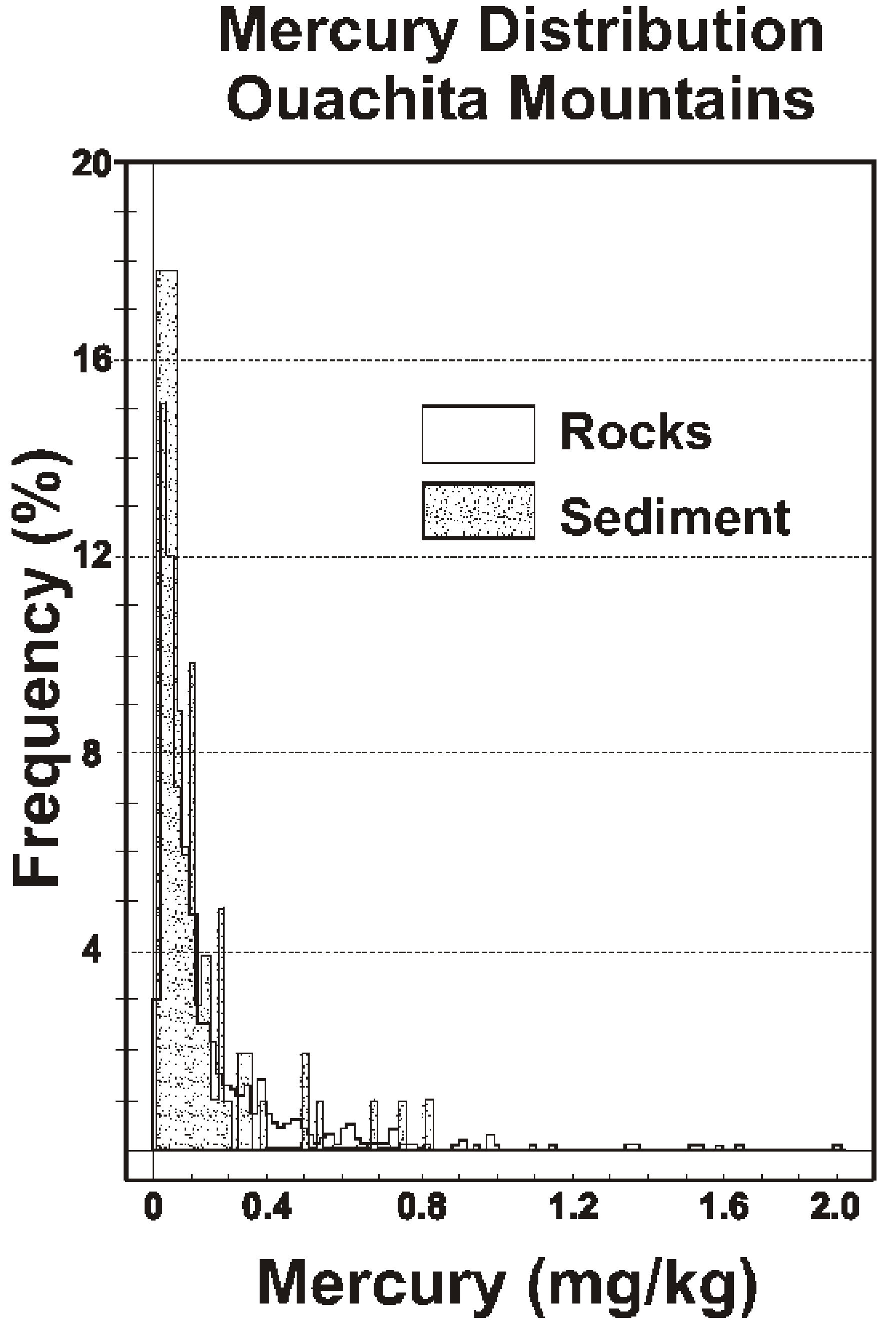


Figure 4.7. Distribution of mercury concentrations in sediment and rock samples from Stone et al. (1995).

Average extractable Total Hg concentration in sediment along the Ouachita River.

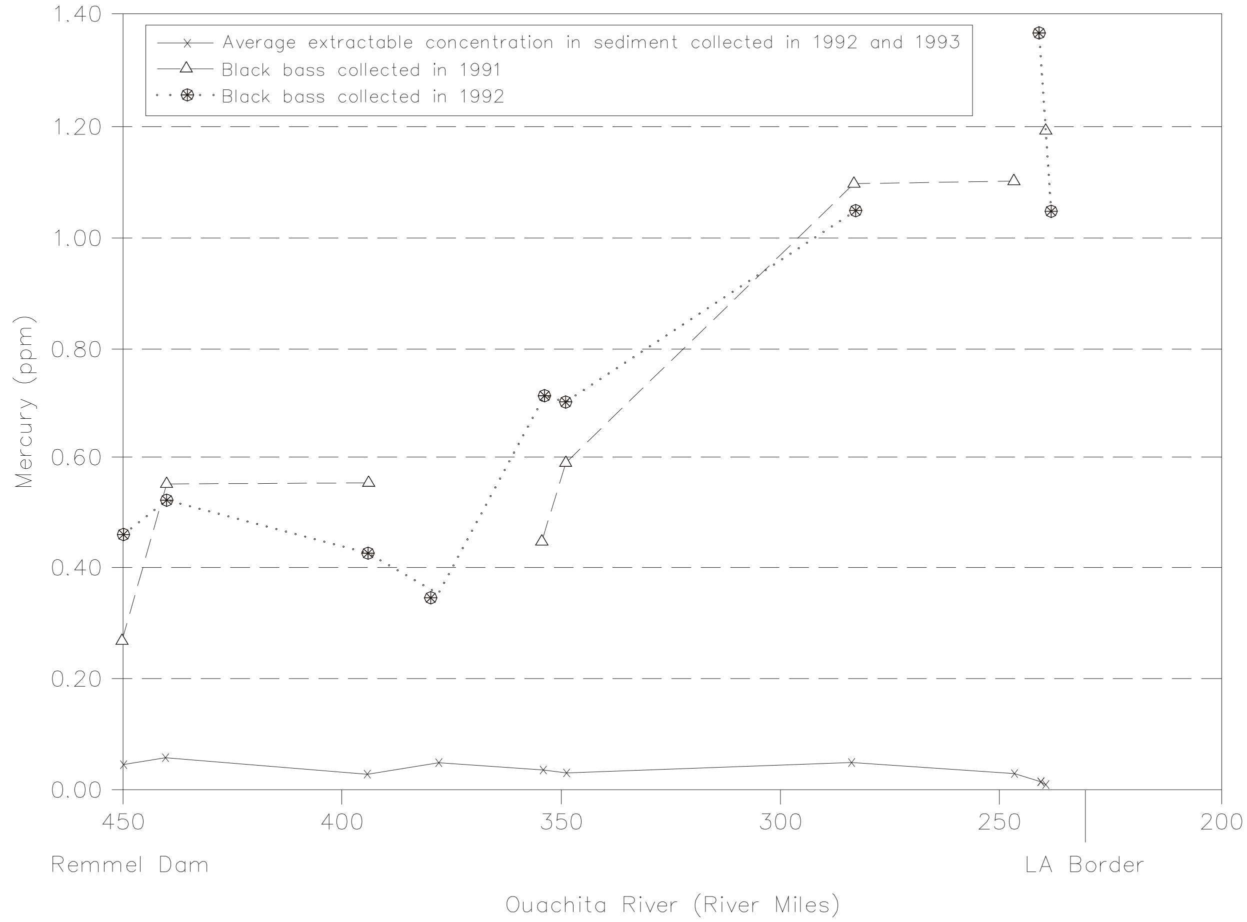


Figure 4.8.

Largemouth bass Hg concentration increase from upstream to downstream (Armstrong et al. 1995).

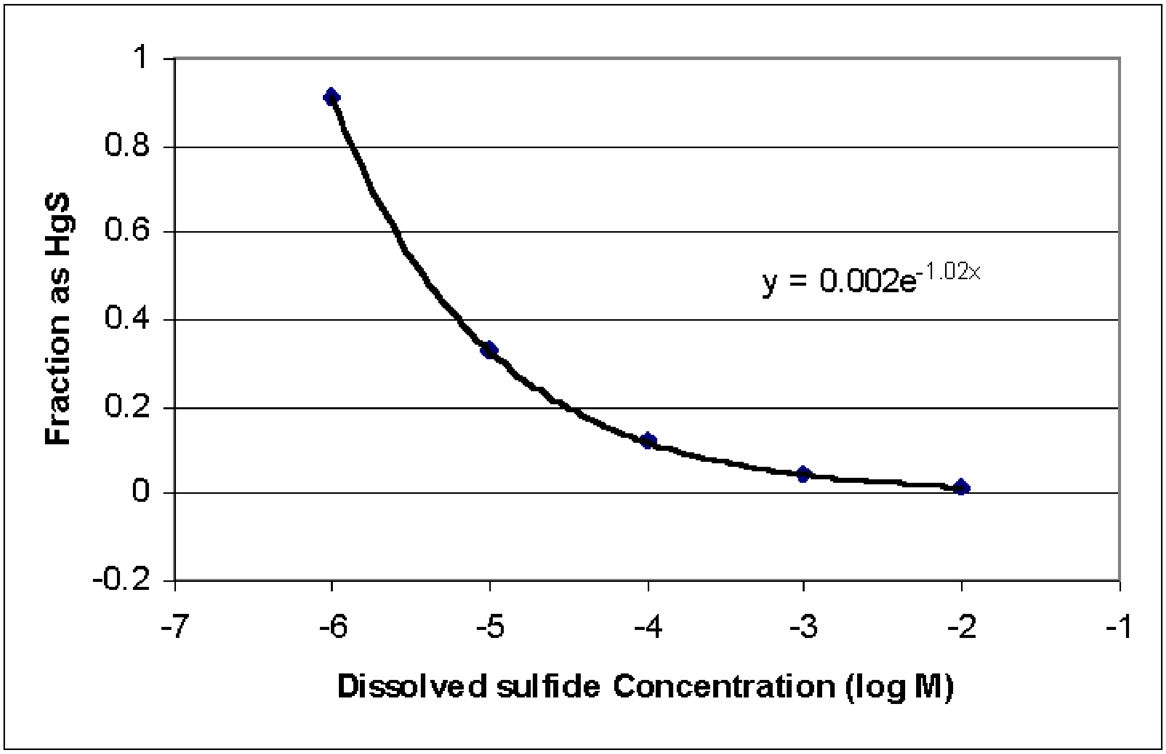


Figure 4.9. Relationship between neutral HgS concentration which is biologically available for methylation and the sulfide concentration in the water (after Benoit et al. 2000).

5.0 MARGIN OF SAFETY, SEASONAL VARIATIONS, AND CRITICAL CONDITIONS

5.1 Margin of Safety

An MOS accounts for any lack of knowledge or uncertainty concerning the relationship between load allocations and water quality. In this case, it accounts for uncertainty and variability related to fish tissue mercury concentrations, estimates of loading and the assumption of a linear relationship between fish tissue concentration and system load. These TMDLs incorporate MOS factored into the reduction factors, the wasteload allocations, and the load allocations through conservative assumptions. Use of safe target levels of 0.4 mg/kg and 0.8 mg/kg, for Louisiana and Arkansas respectively, results in an explicit MOS of 20% for both Louisiana and Arkansas TMDLs. In addition, implicit MOS is included because maximum fish tissue mercury concentrations were used for estimating reductions rather than fish tissue mercury concentration averaged for fish exceeding the Action Levels at each station. An advantage of using a regional approach is that waters which may be threatened by mercury (as opposed to impaired) are also protected.

5.2 Seasonal Variations and Critical Conditions

Wet deposition is greatest in the winter and spring seasons. Mercury loads fluctuate based on the amount and distribution of rainfall, and variability of localized and regional/global sources. While an average daily load is established here, the average annual load is of greatest significance because mercury bioaccumulates over the life of the fish and the resulting risk to human health from fish consumption is a long-term phenomenon. Thus, daily or weekly inputs are less meaningful than total annual loads over many years. The use of annual loads allows for integration of short-term and seasonal variability. Inputs should continue to be estimated through wet deposition and additional monitoring.

Mercury methylation is expected to be highest during the summer. High temperatures promote biological activity and lakes and reservoirs are stratified with anoxic hypolimnions. Based on the enhanced methylation and higher predator feeding rates during this period, mercury bioaccumulation is expected to be greatest during the summer. However, given the long depuration times for fish and relatively mild winters in southern Arkansas and northern Louisiana, seasonal changes in fish tissue mercury body burden are expected to relatively small. Inherent variability of mercury concentrations between individual fish of the same and/or different size categories is expected to be greater than seasonal variability.

Because of local geology, soils, natural vegetation, and topography, some areas of the Ouachita River and its tributaries are more susceptible to mercury methylation than others. For example, the steeper gradients in the upper portion of the Ouachita and Saline Rivers, without impoundments, results in generally lower fish tissue mercury concentrations. In the lower portion of the Ouachita and Saline Rivers and their tributaries, organic matter and sulfate concentrations are higher, and alkalinity and pH values are lower, which makes the systems more susceptible to mercury methylation. In addition, reservoirs have been created in the lower Ouachita River that also likely contribute to the increased mercury concentrations in fish. Felsenthal NWR is a relatively new reservoir and it has extensive wetland areas throughout the Refuge. Both of these factors contribute to mercury methylation. Felsenthal NWR should be managed as a special system for mercury bioaccumulation and fish consumption advisories.

6.0 REASONABLE ASSURANCE: ONGOING AND FUTURE REDUCTIONS IN EMISSIONS

Reasonable assurance is needed that water quality standards will be attained. Mechanisms to assess and control mercury loads, including strategies and regulatory controls, which would be national in scope, will aid implementation of TMDLs for specific basins. In addition, this TMDL will be reassessed periodically and may be modified to take into account available data and information, and the state of the science.

As rules and standards pursuant to the Clean Air Act have been developed, proposed, and promulgated since 1990, compliance by emitting sources as well as actions taken voluntarily have already begun to reduce emissions of mercury to the air across the US. EPA expects a combination of ongoing activities will continue to reduce mercury emissions to the air over the next decade. EPA currently regulates emissions of mercury and other HAPs under the MACT program of Section 112 of the Clean Air Act, and under a corresponding new source performance standard (NSPS) program under Sections 111 and 129 of the Act. Section 112 authorizes EPA to address categories of major sources of HAPs, including mercury, by issuing emissions standards that, for new sources, are at least as stringent as the emissions control achieved by the best performing similar source in the category, and, for existing sources, are at least as stringent as the average of the best performing top 12% (or 5 facilities, whichever is greater) of similar sources. EPA may also apply these standards to smaller area sources, or choose to apply less stringent standards based on generally available control technologies (GACT). Sections 111 and 129 direct EPA to establish MACT-equivalent standards for each category of new and existing solid waste incineration units, regulating several specified air pollutants, including mercury. In addition, in 1996 the US eliminated the use of mercury in most batteries under the Mercury Containing and Rechargeable Battery Management Act. This action is reducing the mercury content of the waste stream which is further reducing mercury emissions from waste combustion. In addition, voluntary measures to reduce use of mercury containing products, such as the voluntary measures committed to by the American Hospital Association, also will contribute to reduced emissions from waste combustion.

Based on the EPA's NTI, the highest emitters of mercury to the air include coal-burning electric utilities, municipal waste combustors, medical waste incinerators (MWIs), chlor-alkali plants, and hazardous waste combustors (HWCs). EPA has issued a number of regulations under Sections 112, 111, and 129 to reduce mercury pollution from several of these source categories. Relevant regulations that EPA has established to date under the Clean Air Act include, among others, those listed below.

- The source category of municipal waste combustion (MWC) emitted about 20% of total national mercury emissions into the air in 1990. EPA issued final regulations under Sections 111 and 129 for large MWCs on October 31, 1995. Large combustors or incinerators must comply with the rule by December 2000. These regulations reduce mercury emissions from these facilities by about 90% from 1990 emission levels.

- MWIs emitted about 24% of total national mercury emissions into the air in 1990. EPA issued emission standards under Sections 111 and 129 for MWIs on August 15, 1997. When fully implemented, in 2002, EPA's final rule will reduce mercury emissions from MWIs by about 94% from 1990 emission levels.

- HWCs emitted about 2.5% of total national mercury emissions in 1990. In February 1999, EPA issued emission standards under Section 112 for these facilities, which include incinerators, cement kilns, and light weight aggregate kilns that burn hazardous waste. When fully implemented, these standards will reduce mercury emissions from HWCs by more than 50% from 1990 emission levels.

These promulgated regulations, when fully implemented and considered together with the actions discussed above that will reduce the mercury content of waste, are expected to reduce national mercury emissions caused by human activities by about 50% from 1990 levels.

In February 2002 President Bush announced the Clear Skies Initiative. This initiative proposed to reduce mercury emissions from power plants (electric utilities) by 69%. An intermediate cap of 26 tons of mercury per year was proposed for 2010. Current mercury emissions from power plants are 48 tons per year.

EPA expects to propose a regulation under Section 112 that will limit mercury emissions from chlor-alkali plants, chlorine production facilities which use the mercury cell technology. In addition, under the Integrated Urban Air Toxics Strategy, which was published in 1999, EPA is developing emissions standards under Section 112 for categories of smaller sources of air toxics, including mercury, that pose the greatest risk to human health in urban areas. These standards are expected to be issued by 2004.

It is possible that the cumulative effect of additional standards and voluntary actions will reduce mercury emissions from human activities in the US by more than 50% from 1990 levels. However, whether the overall, total percent reduction in national mercury emissions in the future will exceed 50% cannot be estimated at this time. EPA will continue to track emissions of mercury and evaluate additional approaches to reduce releases of mercury into the environment.

A large portion of the mercury load comes from erosion of soils and geologic sources. Implementing best management practices (BMPs) in the watershed to reduce erosion would be expected to reduce the mercury load to the system. Reductions in atmospheric mercury will also reduce the accumulation of mercury in soils from atmospheric deposition. This will further reduce the mercury load to the system from soil erosion.

Because of the persistence of mercury in tissue, it could take decades for mercury levels in predatory fish to drop as a result of reductions in mercury loading to the system. In addition, geology or other characteristics (such as DO levels) may cause some sites (such as Felsenthal NWR) to react more slowly to reductions in mercury loading. Therefore, an adaptive management approach is recommended for the portion of the Ouachita River system included in this TMDL study. This approach would include public education on the potential effects and sources of mercury, implementation of BMPs, and management of fisheries based on local characteristics. The goal should be to move toward use attainment while protecting human health.

The environmental indicators with which to evaluate success will be monitoring of wet deposition rates at the LA10 site and fish tissue mercury concentrations in both states.

7.0 PUBLIC PARTICIPATION

When EPA establishes a TMDL, 40 CFR §130.7(d)(2) requires EPA to publicly notice and seek comment concerning the TMDL. This TMDL was prepared under contract to EPA. After completion of this draft TMDL, EPA will commence preparation of a notice seeking comments, information and data from the general and affected public. If comments, data, or information are submitted during the public comment period, then the TMDL may be revised accordingly. After considering public comment, information, and data, and making any appropriate revisions, EPA will transmit the revised TMDL to the Arkansas Department of Environmental Quality, and to the Louisiana Department of Environmental Quality for incorporation into the ADEQ and LDEQ current water quality management plans.

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