

# **TMDL FOR TURBIDITY FOR WHITE OAK CREEK, AR**

**FINAL January  
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**Revised July  
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TMDL FOR TURBIDITY FOR  
WHITE OAK CREEK, AR

Prepared for

EPA Region VI  
Water Quality Protection Division  
Permits, Oversight, and TMDL Team  
Dallas, TX 75202

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## EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to identify waterbodies that are not meeting water quality standards and to develop total maximum daily pollutant loads for those waterbodies. A total maximum daily load (TMDL) is the amount of a pollutant that a waterbody can assimilate without exceeding the established water quality standards for that pollutant. Through a TMDL, pollutant loads can be allocated to point sources and nonpoint sources discharging to the waterbody.

The study area for this report is the White Oak Creek watershed in central Arkansas. The study area is part of the Arkansas Department of Environmental Quality (ADEQ) Planning Segment 3F and is located within the Arkansas River Valley ecoregion. Land use in the study area is about 50% pasture, 34% forest, and 15% urban.

White Oak Creek is included on the draft 2004 Arkansas 303(d) list as not supporting the aquatic life use due to exceedances of numeric criteria for turbidity. The applicable numeric criteria for turbidity for this reach are 21 NTU (“primary” value) and 40 NTU (“storm-flow” value).

ADEQ historical water quality data were available for one location on White Oak Creek. These data were analyzed for long term trends, seasonal patterns, relationships between concentration and stream flow, and relationships between turbidity and total suspended solids (TSS). These analyses showed that the highest values of turbidity and TSS occurred between May and November and during low flow conditions. Also, higher turbidity levels tended to correspond with higher TSS values.

This TMDL was expressed using TSS as a surrogate for turbidity because turbidity cannot be expressed as a mass load. Two regressions between TSS and turbidity were developed using the ADEQ data. Using the base flow regression equation with the turbidity criterion values, the target TSS concentration of 12 mg/L (corresponding to the primary turbidity criterion of 21 NTU) was identified. Using the storm-flow regression equation with the turbidity criterion values, the target TSS concentration of 14 mg/L (corresponding to the storm-flow turbidity criterion of 40 NTU) was identified.

The TMDL in this report was developed using the load duration curve methodology. This method illustrates allowable loading at a wide range of stream flow conditions. The steps for applying this methodology for the TMDL in this report were:

1. Developing a flow duration curve,
2. Converting the flow duration curve to a load duration curve,
3. Plotting observed loads with the load duration curve,
4. Calculating the TMDL components, and
5. Calculating percent reductions.

The load duration curve was developed using multiple target TSS concentrations because Arkansas has different turbidity criteria for different flow conditions. The target TSS concentration corresponding to the primary turbidity criterion was applied between the 100% exceedance of stream flow and the 60% exceedance of stream flow. The target TSS concentration corresponding to the storm-flow turbidity criterion was applied between the 60% exceedance of stream flow and the 0% exceedance of stream flow.

The wasteload allocation (WLA) for point source contributions was set to not applicable (NA) ~~zero~~ because no permitted discharges to White Oak Creek were identified. If any continuous point sources are identified in the future, their wasteload allocation (WLA) for turbidity would also be designated as NA. This is because turbidity is primarily influenced by inorganic particles, typically measured as total suspended solids (TSS), while continuous point sources (such as domestic wastewater) primarily discharge organic solids. These organic suspended solids are already regulated by ADEQ through point source permitting to ensure compliance with dissolved oxygen water quality standards. New permits would not be restricted by this turbidity TMDL.

An implicit margin of safety (MOS) was incorporated through the use of conservative assumptions. The primary conservative assumption was calculating the TMDL assuming that TSS is a conservative parameter and does not settle out of the water column. The TMDL and percent reductions needed are summarized in Table ES.1.

Table ES.1. Summary of TMDL and percent reduction.

Reach ID	Stream Name	Flow Category	Loads (tons/day of TSS)				Percent Reduction Needed
			WLA	LA	MOS	TMDL	
11110203-927	White Oak Creek	Base flow	<del>0</del> - <u>NA</u>	0.015	<del>0</del> - <u>Implicit</u>	0.015	30%
		Storm-flow	<del>0</del> <u>NA</u>	0.557	<del>0</del> - <u>Implicit</u>	0.557	13%

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## 1.0 INTRODUCTION

This report presents a total maximum daily load (TMDL) for siltation/turbidity for White Oak Creek in central Arkansas. This stream reach was included on the Arkansas Department of Environmental Quality (ADEQ) draft 2004 Arkansas 303(d) list (ADEQ 2005a) as not supporting the designated use of aquatic life. The sources of contamination and causes of impairment from the 303(d) listing are shown below in Table 1.1. The TMDL in this report was developed in accordance with Section 303(d) of the Federal Clean Water Act and the Environmental Protection Agency's (EPA) regulations in 40 CFR 130.7.

The purpose of a TMDL is to determine the pollutant loading that a waterbody can assimilate without exceeding the water quality standards for that pollutant and to establish the load reduction that is necessary to meet the standard in a waterbody. The TMDL is the sum of the wasteload allocation (WLA), the load allocation (LA), and a margin of safety (MOS). The WLA is the load allocated to point sources of the pollutant of concern. The LA is the load allocated to nonpoint sources, including natural background. The MOS is a percentage of the TMDL that takes into account any lack of knowledge concerning the relationship between pollutant loadings and water quality.

Table 1.1. 303(d) listing for stream reach in this task order.

Reach No.	Stream Name	Sources	Causes	Category	Priority
11110203-927	White Oak Creek	Unknown	Siltation/turbidity	5a	Low



## **2.0 BACKGROUND INFORMATION**

### **2.1 General Information**

The study area for this report is the White Oak Creek watershed in central Arkansas, near Atkins (see Figure A.1 in Appendix A). The White Oak Creek watershed is in the Arkansas River Valley ecoregion and in ADEQ Planning Segment 3F. White Oak Creek is also in United States Geological Survey (USGS) Hydrologic Unit 11110203. The study area covers 11.6 square miles in Pope County.

### **2.2 Soils and Topography**

The soils and topography information was obtained from the soil survey for Pope County (United States Department of Agriculture (USDA) 1981). The soils in the study area are predominantly loamy, but gravelly and stony soils are also present. The topography of most of the study area is flat with a few rolling hills and ridges and broad valleys.

### **2.3 Land Use**

Land use data for the study area were obtained from the GEOSTOR database, which is maintained by the Center for Advanced Spatial Technology (CAST) at the University of Arkansas in Fayetteville. These data were based on satellite imagery from 1999. The spatial distribution of these land use is shown on Figure A.2 (located in Appendix A) and land use percentages are shown in Table 2.1. These data indicate that the most of the study area consists of pasture, forest, or urban land.

Table 2.1. Land use percentages for the study area.

<b>Land use</b>	<b>Percentage of study area</b>
Urban	14.7%
Barren/Fallow	0.6%
Water	0.6%
Forest (all types)	34.1%
Soybeans	0.3%
Pasture	49.7%
Total	100.0%

## 2.4 Description of Hydrology

Average precipitation for the study area is about 47 inches per year (USGS 1985). There were no USGS flow gages on White Oak Creek so a nearby gage had to be used. The USGS gage on Cadron Creek near Guy, Arkansas (07261000) was chosen since it was close to White Oak Creek and in the same ecoregion. Information about this flow gage is summarized in Table 2.2.

Table 2.2. Information for USGS stream flow gaging station (USGS 2005a).

Gage name:	Cadron Creek near Guy, AR
Gage number:	07261000
Descriptive location:	US Highway 65 bridge, 4.3 miles southwest of Guy, 10.5 miles upstream from Cove Creek
Period of record:	October 1954 – September 2004
Drainage area:	169 square miles
Mean daily flow:	269 cfs
Median daily flow:	86 cfs

## 2.5 Water Quality Standards

Water quality standards for Arkansas waterbodies are listed by ecoregion in Regulation No. 2 (APCEC 2004a). White Oak Creek is in the Arkansas River Valley ecoregion. Designated uses for White Oak Creek include primary and secondary contact recreation; public, industrial, and agricultural water supply; and perennial Arkansas River Valley fishery (where the drainage area is 10 square miles or more).

Section 2.503 of Regulation No. 2 provides both a narrative criterion and numeric criteria that apply to siltation/turbidity. The general narrative criterion is: “There shall be no distinctly visible increase in turbidity of receiving waters attributable to municipal, industrial, agricultural, other waste discharges or instream activities.” The numeric turbidity criterion for streams in the Arkansas River Valley ecoregion are 21 NTU (“primary” value) and 40 NTU (“storm-flow” value). The regulation also states that “the non-point source runoff shall not result in the exceedance of the in stream storm-flow values in more than 20% of the ADEQ ambient monitoring network samples taken in not less than 24 monthly samples.”

As specified in EPA's regulations at 40 CFR 130.7(b)(2), applicable water quality standards include antidegradation requirements. Arkansas' antidegradation policy is listed in Sections 2.201 through 2.204 of Regulation No. 2. These Sections impose the following requirements:

- Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.
- Water quality that exceeds standards shall be maintained and protected unless allowing lower water quality is necessary to accommodate important economic or social development, although water quality must still be adequate to fully protect existing uses.
- For outstanding state or national resource waters, those uses and water quality for which the outstanding waterbody was designated shall be protected.
- For potential water quality impairments associated with a thermal discharge, the antidegradation policy and implementing method shall be consistent with Section 316 of the Clean Water Act.

## **2.6 Nonpoint Sources**

In the 2004 303(d) list, the source of turbidity for White Oak Creek is listed as unknown. However, it is likely that some sources of turbidity for White Oak Creek are similar to the sources of turbidity in the southern part of the Piney Creek watershed, which is located about 20 to 25 miles west of White Oak Creek and is in the same ecoregion. According to an ADEQ study of the Piney Creek watershed (ADEQ 1999), sources of turbidity include agriculture, silviculture activities, unpaved roads, and streambank erosion.

Because the White Oak Creek watershed includes urban areas, it is likely that urban runoff is a source of turbidity for White Oak Creek.

## **2.7 Point Sources**

Information for point source discharges in the study area was obtained by searching the Permit Compliance System on the EPA web site (PCS 2005). The search yielded no facilities with point source discharges to White Oak Creek. However the 305(b) report (ADEQ 2002) states “A municipal and industrial discharge also existed in White Oak Creek, however both were supposedly eliminated although evidence of continued discharges exist.”

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## 3.0 EXISTING WATER QUALITY FOR TURBIDITY AND TSS

### 3.1 General Description of Data

Turbidity and TSS data have been collected by ADEQ at one site in the study area. The location of this sampling site is shown on Figure A.1 (located in Appendix A). TSS data are discussed here because TSS is needed as a surrogate parameter for expressing the siltation/turbidity TMDL. These turbidity and TSS data were obtained from the ADEQ web site (ADEQ 2005b) and are summarized in Table 3.1. The individual data are listed in Table B.1 and shown graphically as time series plots on Figures B.1 and B.2 (located in Appendix B).

Table 3.1. Summary of ADEQ data for turbidity and TSS.

Station	Description	Parameter	Count	Min.	Median	Average	Max.
ARK0053	White Oak Creek near Atkins, Arkansas	Turbidity	162	1.1	23.0	30.3	250
		TSS	165	1.0	8.0	15.2	220

Table B.1 includes a comparison between the observed turbidity data and the numeric water quality criteria. This comparison required the observed data to be separated into base flow data (to be compared with the “primary” criterion) and storm-flow data (to be compared with the “storm-flow” criterion). It was assumed here that the lowest 40% of stream flow values represent flow conditions without significant influence from storm runoff and that stream flow values above the 40th percentile would have some influence from storm runoff. The turbidity data were considered to be base flow data when the flow on the sampling day at the USGS gage on Cadron Creek near Guy was 46cfs or less (the 40<sup>th</sup> percentile flow, or the flow that was exceeded 60% of the time). The turbidity data were considered to be storm-flow data when the flow on the sampling day at the USGS gage on Cadron Creek near Guy was more than 46 cfs. Table B.1 shows that during 1990 through 2005, the turbidity data at station ARK0053 exceeded the applicable criteria 41% of the time during base flow conditions and 17% of the time during storm-flow conditions.

### **3.2 Seasonal Patterns**

Seasonal plots of turbidity and TSS are shown on Figures C.1 and C.2 (located in Appendix C). These plots show slight seasonal patterns; the highest turbidity and TSS values were measured between May and November.

### **3.3 Relationships Between Concentration and Flow**

Plots of turbidity and TSS versus stream flow were also developed to examine any correlation between these two parameters and flow (Figures D.1 and D.2, located in Appendix D). These plots showed no consistent relationship between concentration and flow, although the highest values of TSS and turbidity occurred during low flow conditions.

### **3.4 Relationships Between TSS and Turbidity**

Plots and regression analyses were used to examine relationships between TSS and turbidity. The regressions were performed using the natural logarithms of the data (rather than the raw data values) because most data such as turbidity and TSS fit a lognormal distribution better than a normal distribution.

Separate plots and regression analyses were developed for base flow conditions and storm-flow conditions to be consistent with the numeric criteria for turbidity. The plot and linear regression for base flow conditions (Figure E.1) uses only the base flow data. The plot and linear regression for storm-flow conditions (Figure E.2) uses all of the data regardless of flow on the sampling day. The data collected under base flow conditions were included in the storm-flow regression in order to maximize the accuracy of the lower end of the regression line that corresponds to turbidity values near the numeric criteria.

Both plots show some correlation, with higher turbidity levels tending to correspond with higher TSS concentrations. The results of the linear regression analyses are summarized in Table 3.2.

Table 3.2. Results of regressions between TSS and turbidity.

Sampling Station	Category	Regression Equation	Number of Data	R <sup>2</sup>	Significance Level (P value)
ARK0053	Base flow	$\ln \text{TSS} = 0.7067 * \ln \text{Turbidity} + 0.3034$	70	0.55	$1.41 \times 10^{-13}$
	Storm-flow	$\ln \text{TSS} = 0.6876 * \ln \text{Turbidity} + 0.0920$	160	0.43	$6.75 \times 10^{-21}$

The strength of the linear relationship is measured by the coefficient of determination ( $R^2$ ) calculated during the regression analysis (Zar 1996). The  $R^2$  value is the percentage of the total variation in  $\ln$  TSS that is explained or accounted for by the fitted regression ( $\ln$  turbidity). For example, in the base flow regression above, 55% of the variation in TSS is accounted for by turbidity and the remaining 45% of variation in TSS is unexplained. The unexplained portion is attributed to factors other than the measured value of turbidity.

These regressions show a majority of the measurement of the turbidity (NTU) is explained by the measured concentration of TSS. The perfect explanation of the measurement of turbidity to the measurement of TSS would require collecting and analyzing a large amount of data. A number of the items effecting this perfect explanation of the relationship would need to be known. A partial list of the items effecting the relationship follows:

- Velocity of the water at the time of sampling;
- Carbonaceous biochemical oxygen demand (CBOD) concentration;
- Ammonia concentration;
- Nitrate concentration;
- Phosphorus concentration;
- Algal mass in the water column;
- Bacteria mass in the water;
- Measured color of the water;
- Mass of the organic component of the TSS;
- Mass of the material passing through the filter during the TSS analysis;
- Grain size distribution of the inorganic portion of the TSS;
- Specific gravity of the different sizes of inorganic solids particles;
- Hydrograph for the stream;
- Position on the hydrograph (i.e., rising limb, falling limb) at the time of sampling;
- Number of overlapping rainfall events represented by this sample day;

- Magnitude of each of the rainfall events represented by this sample day; and
- Lags of the overlapping rainfall events represented by this sample day.

The collection of the above data would not change the fact that inorganic particles represented in the TSS measurements is the major contributor to the turbidity reading and is the major constituent reduced when sediment BMPs are applied to nonpoint sources. The BMPs used on nonpoint sources for sediment also reduce the load of many of the unexplained contributors in the regression. The effort to have a perfect explanation of turbidity may not result in a better selection of BMPs. The regressions presented above between TSS and turbidity are adequate for the preparation of this TMDL. A stakeholder group of knowledgeable persons from the watershed may need additional information to set a plan of action for this TMDL.

The correlations between turbidity and TSS for White Oak Creek were considered to be acceptable; the  $R^2$  values for these regressions (0.55 and 0.43) are within the range of  $R^2$  values for turbidity and TSS from other approved TMDLs in Arkansas (FTN 2001, FTN 2003, FTN 2005).

The statistical significance of the regression was evaluated by computing the “P value” for the slope of the regression line. The P value is essentially the probability that the slope of the regression line is really zero. Thus, a low P value indicates that a non-zero slope calculated from the regression analysis is statistically significant. For these regressions, the P values are quite small and are considered good. The large number of data points caused the statistical significance of the regressions to be good even though the correlation was not extremely strong.

## **4.0 TMDL DEVELOPMENT**

### **4.1 Seasonality and Critical Conditions**

EPA's regulations at 40 CFR 130.7 require the determination of TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. Also, both Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 require TMDLs to consider seasonal variations for meeting water quality standards. The historical data analysis in Section 3 showed little or no correlation between turbidity levels and either season of the year or stream flow. Therefore, there is not a critical season or a single critical flow for this TMDL. The methodology used to develop this TMDL (load duration curve) addresses allowable loading for a wide range of flow conditions.

### **4.2 Water Quality Targets**

Turbidity is an expression of the optical properties in a water sample that cause light to be scattered or absorbed and may be caused by suspended matter, such as clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, and plankton and other microscopic organisms (Standard Methods 1999). Turbidity cannot be expressed as a load as preferred for TMDLs. To achieve a load based value, turbidity is often correlated with a surrogate parameter such as TSS that may be expressed as a load. In general, activities that generate varying amounts of suspended sediment will proportionally change or affect turbidity (EPA 1991). Research by Relyea et. al. (2000) states, "increased turbidity by sediments can reduce stream primary production by reducing photosynthesis, physically abrading algae and other plants, and preventing attachment of autotrophs to substrate surfaces".

For the turbidity TMDL in this report, the relationships between turbidity and TSS presented in Table 3.2 were used to develop target TSS concentrations (i.e., numeric endpoints for the TMDL). The two target TSS concentrations developed for this TMDL were 12 mg/L (using the base flow regression and the primary turbidity criterion of 21 NTU) and 14 mg/L (using the storm-flow regression and the storm-flow turbidity criterion of 40 NTU). The discussion in Section 3.1 associating the primary turbidity criterion with the base flow portion of

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the duration curve is the basis for using the descriptor “base flow” in this document for the conditions when the primary turbidity criterion should apply.

### **4.3 Methodology for TMDL Calculations**

The methodology used for the TMDL in this report is the load duration curve. Because loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired loads over all flow conditions, rather than fixed at a single value. The basic elements of this procedure are documented on the Kansas Department of Health and Environment web site (KDHE 2005). This method was used to illustrate allowable loading at a wide range of flows. The steps for how this methodology was applied for the TMDL in this report can be summarized as follows:

1. Develop a flow duration curve (Section 4.4);
2. Convert the flow duration curve to load duration curves (Section 4.5);
3. Plot observed loads with load duration curves (Section 4.6);
4. Calculate TMDL, MOS, WLA, and LA (Sections 4.7-4.9); and
5. Calculate percent reductions (Section 4.10).

### **4.4 Flow Duration Curve**

A flow per unit area duration curve was developed for the whole study area (see Table F.1 in Appendix F for details). Daily stream flow measurements from Cadron Creek near Guy (USGS Gage No. 07261000) were sorted in increasing order and the percent exceedance of each flow was calculated. The flow was divided by the drainage area of the gage to get a flow per square mile. The flow per unit area duration curve is shown on Figure F.1 in Appendix F.

### **4.5 Load Duration Curves**

Each flow per unit area from the flow duration curve was multiplied by the appropriate TSS target concentration to develop plots of allowable load versus flow exceedance (load duration curves). The water quality standards for Arkansas (APCEC 2004a) do not specify a range of flows or flow exceedances for which each of the turbidity criteria (primary and storm-flow) is applicable. As discussed in Section 3.1, it was assumed here that the lowest 40%

of stream flow values represent flow conditions without significant influence from storm runoff and that stream flow values above the 40<sup>th</sup> percentile would have some influence from storm runoff. Therefore, the TSS target corresponding to the primary turbidity criterion was applied to the lowest 40% of flows (from 100% exceedance of stream flow to 60% exceedance of stream flow) and the TSS target corresponding to the storm-flow turbidity criterion was applied from 60% exceedance of stream flow to 0% exceedance of stream flow. The load duration curves for storm-flow conditions and base flow conditions are shown on Figures F.2 and F.3 (in Appendix F).

#### **4.6 Observed Loads**

The observed loads per unit of drainage area for White Oak Creek were calculated for each sampling day. Each observed load per unit of drainage area was calculated by simply multiplying the observed TSS concentration times the flow per unit of drainage area on the sampling day (with a conversion factor incorporated).

The load duration plots (Figures F.2 and F.3) provide visual comparisons between observed and allowable loads under different flow conditions. Observed loads that are plotted above the load duration curve represent conditions where observed water quality concentrations exceed the target concentrations. Observed loads below the load duration curve represent conditions where observed water quality concentrations were less than target concentrations (i.e., not exceeding water quality criteria).

#### **4.7 TMDL and MOS**

The allowable load per unit area for storm-flow conditions was calculated as the TSS target for storm-flow conditions (14 mg/L) multiplied times the flow per unit area at the 30% flow exceedance. The 30% flow exceedance was used because it is considered to represent a typical flow value for storm-flow conditions (it is the midpoint along the flow duration curve between 0% and 60%). The allowable load per unit area for base flow conditions was calculated as the TSS target for base flow conditions (12 mg/L) multiplied times the flow per unit area at the 80% flow exceedance. The 80% flow exceedance was used because it is considered to

represent a typical flow value for base flow conditions (it is the midpoint along the flow duration curve between 60% and 100%). The TMDL was calculated as the allowable load per unit area multiplied times the total drainage area at the downstream end of the reach. These calculations are shown at the bottom of Table F.1.

Both Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 require TMDLs to include a MOS to account for uncertainty in available data or in the actual effect that controls will have on the loading reductions and receiving water quality. The MOS may be expressed explicitly as unallocated assimilative capacity or implicitly through conservative assumptions used in establishing the TMDL. For this TMDL, an implicit MOS was incorporated through the use of conservative assumptions. The primary conservative assumption was calculating the TMDL assuming that TSS is a conservative parameter and does not settle out of the water column.

#### **4.8 Point Source Loads**

The WLA for point sources was set to NA ~~zero~~ because no point source discharges to White Oak Creek were identified.

#### **4.9 Nonpoint Source Loads**

The LA for nonpoint sources, including natural background, results in being equal to the TMDL because the WLA was NA ~~zero~~ and the MOS was implicit.

#### **4.10 Percent Reductions**

In addition to calculating allowable loads, estimates were made for percent reductions of nonpoint source loads that are needed. For each observed TSS load that exceeded the allowable load at that flow (i.e., each observed TSS load above the allowable load curve in Figures F.2 and F.3), a uniform percent reduction was applied until the number of TSS loads exceeding the allowable loads was less than or equal to an acceptable number. For storm-flow conditions, the acceptable number of exceedances was 20% of the number of storm-flow data. This percentage (20%) was based on the Arkansas water quality standards, which state that “the non-point source

runoff shall not result in the exceedance of the in stream storm-flow values in more than 20% of the ADEQ ambient monitoring network samples taken in not less than 24 monthly samples.” (APCEC 2004a). For base flow conditions, the acceptable number of exceedances was 25% of the number of base flow data. This percentage (25%) was based on the ADEQ assessment criteria for turbidity (ADEQ 2002, ADEQ 2005a). For both storm-flow and base flow conditions, whenever the appropriate percentage multiplied by the number of observed values yielded a fractional number (e.g., 25% x 38 = 9.5), the allowable number of exceedances was rounded up to the next whole number (e.g., 9.5 rounded up to 10) in accordance with the ADEQ assessment criteria (ADEQ 2002, ADEQ 2005a). The calculations for percent reductions are shown in Tables F.2 and F.3.

These percent reductions and the results of the TMDL calculations are summarized in Table 4.1 below. These calculations indicated that nonpoint source load reductions are necessary during both base flow and storm-flow conditions.

Table 4.1. Summary of turbidity TMDL.

Reach ID	Stream Name	Flow Category	Loads (tons/day of TSS)				Percent Reduction Needed
			WLA	LA	MOS	TMDL	
11110203-927	White Oak Creek	Base flow	<del>0</del> <u>NA</u>	0.01	<del>0</del> <u>Implicit</u>	0.015	30%
		Storm-flow	<del>0</del> <u>NA</u>	0.55	<del>0</del> <u>Implicit</u>	0.557	13%

The percent reductions in Table 4.1 were calculated using methodology that is slightly different than the assessment criteria used by ADEQ to develop the 2004 303(d) list. The ADEQ assessment was performed using turbidity data that were categorized as either base flow or storm-flow values based on the month of the year in which the values were measured. The percent reductions in Table 4.1 were calculated using TSS data that were categorized as either base flow or storm-flow values based on stream flow data on each sampling day. Even with these differences, both the ADEQ assessment and the TMDL analysis indicated White Oak Creek is impaired.

#### **4.11 Future Growth**

For this turbidity TMDL, typical point source discharges that might occur in the future would not need a WLA because the surrogate being used for turbidity (TSS) is considered to represent inorganic suspended solids (i.e., soil and sediment particles from erosion or sediment resuspension). The suspended solids discharged by most point sources are assumed to consist primarily of organic solids rather than inorganic solids. Discharges of organic suspended solids from point sources are already addressed by ADEQ through their permitting of point sources to maintain water quality standards for dissolved oxygen. Therefore, future growth for new point source discharges would not be restricted by this turbidity TMDL.

## 5.0 OTHER RELEVANT INFORMATION

In accordance with Section 106 of the federal Clean Water Act and under its own authority, ADEQ has established a comprehensive program for monitoring the quality of the State's surface waters. ADEQ collects surface water samples at various locations, utilizing appropriate sampling methods and procedures for ensuring the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, to develop a long-term data base for long term trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program is used to develop the state's biennial 305(b) report (*Water Quality Inventory*) and the 303(d) list of impaired waters, which are issued as a single document titled Arkansas Integrated Water Quality Monitoring and Assessment Report.

## **6.0 PUBLIC PARTICIPATION**

When EPA establishes a TMDL, federal regulations require EPA to publicly notice and seek comment concerning the TMDL. Pursuant to a May 2000 consent decree, this TMDL was prepared under contract to EPA. After development of the draft version of this TMDL, EPA prepared a notice seeking comments, information, and data from the general public and affected public. No comments, data, or information were submitted during the public comment period. EPA has transmitted the final TMDL to ADEQ for implementation and for incorporation into ADEQ's current water quality management plan.

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# **APPENDIX A**

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**Maps**

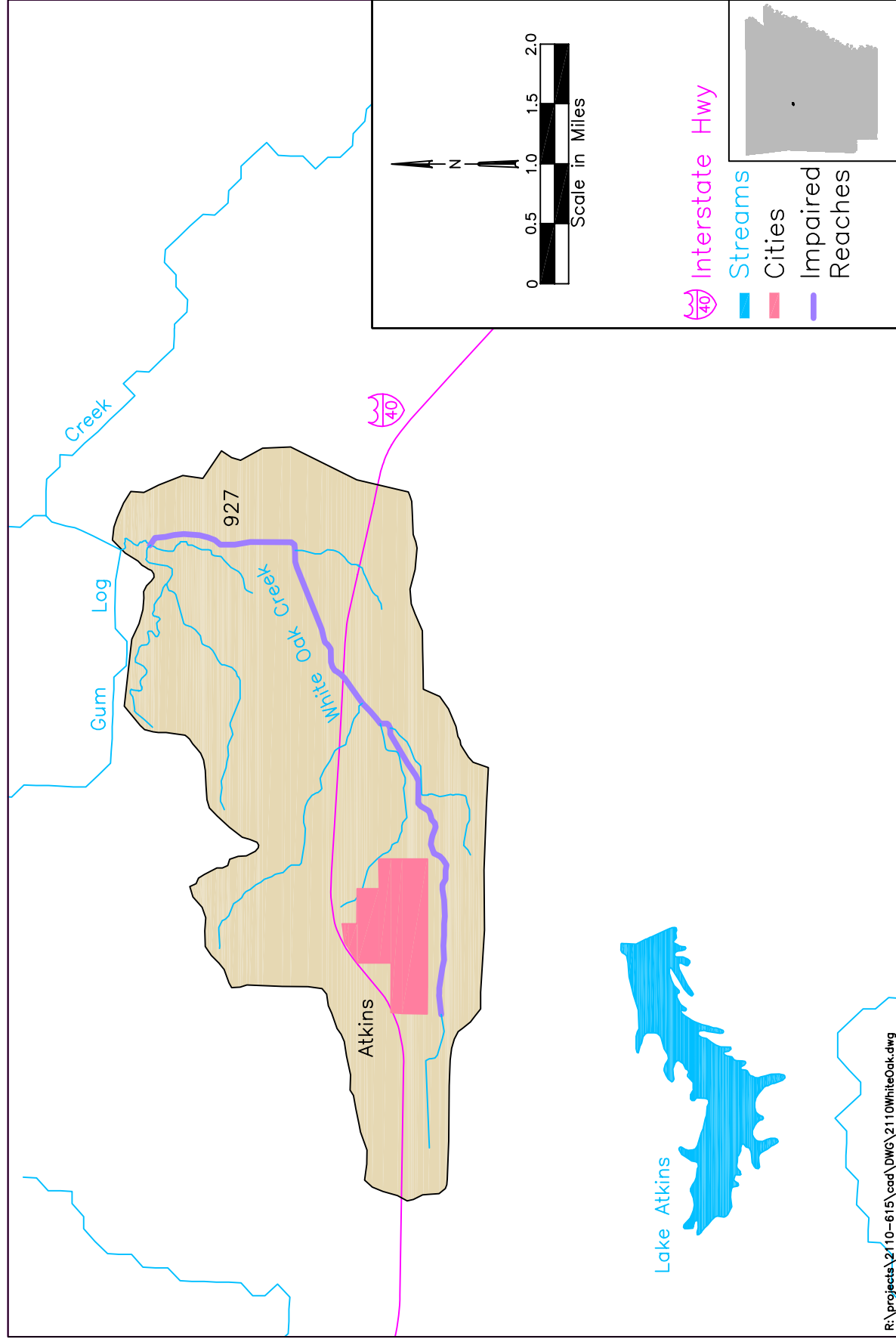


Figure A.1. Map of study area

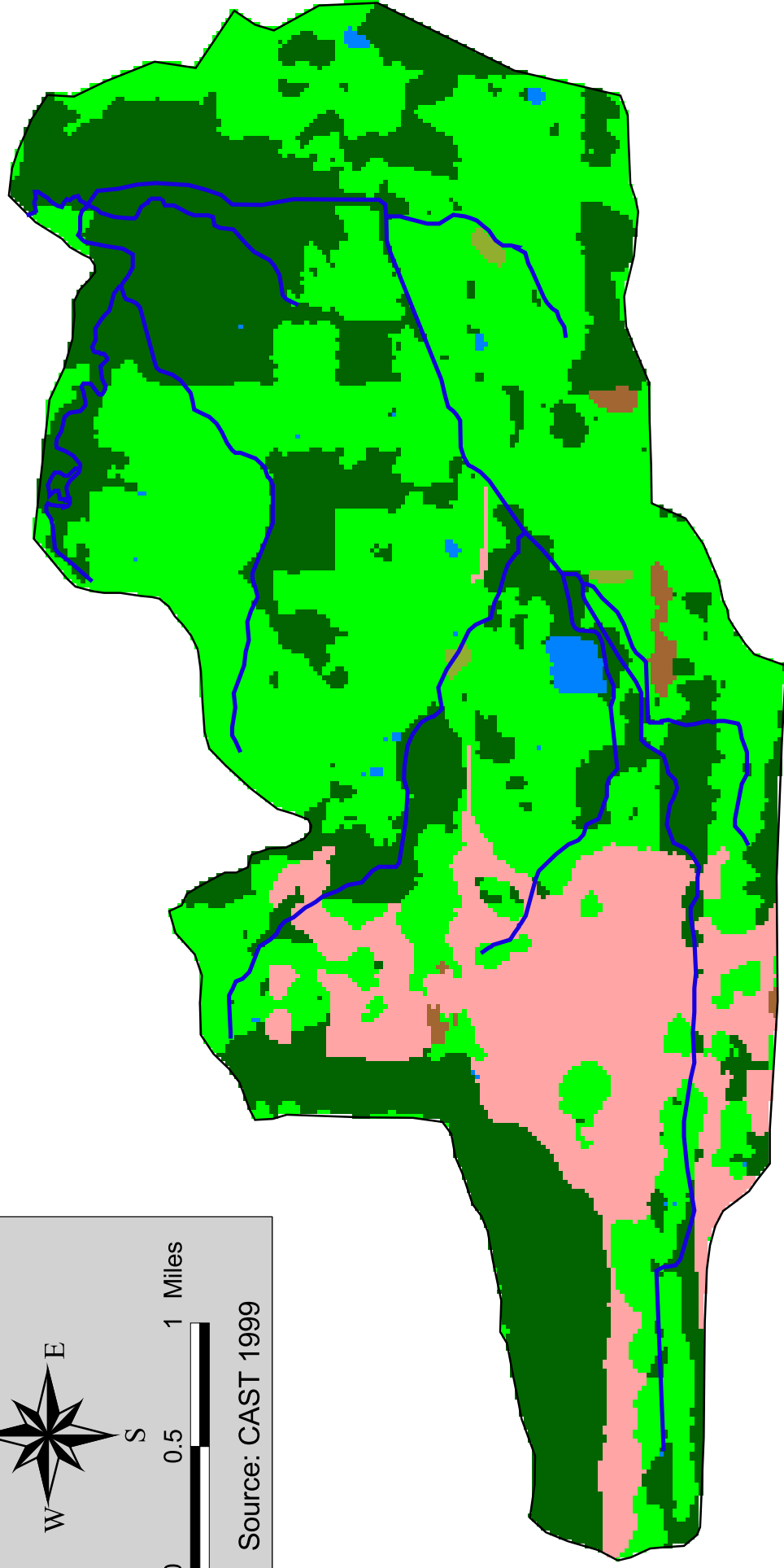
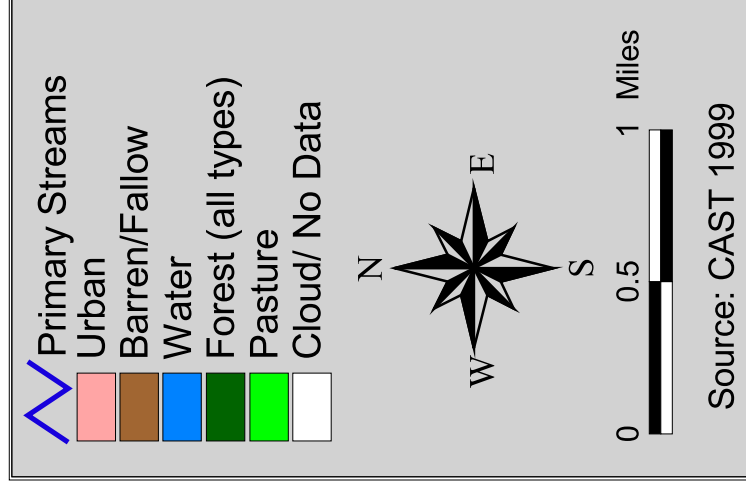


Figure A.2 Land use in White Oak Creek drainage area.

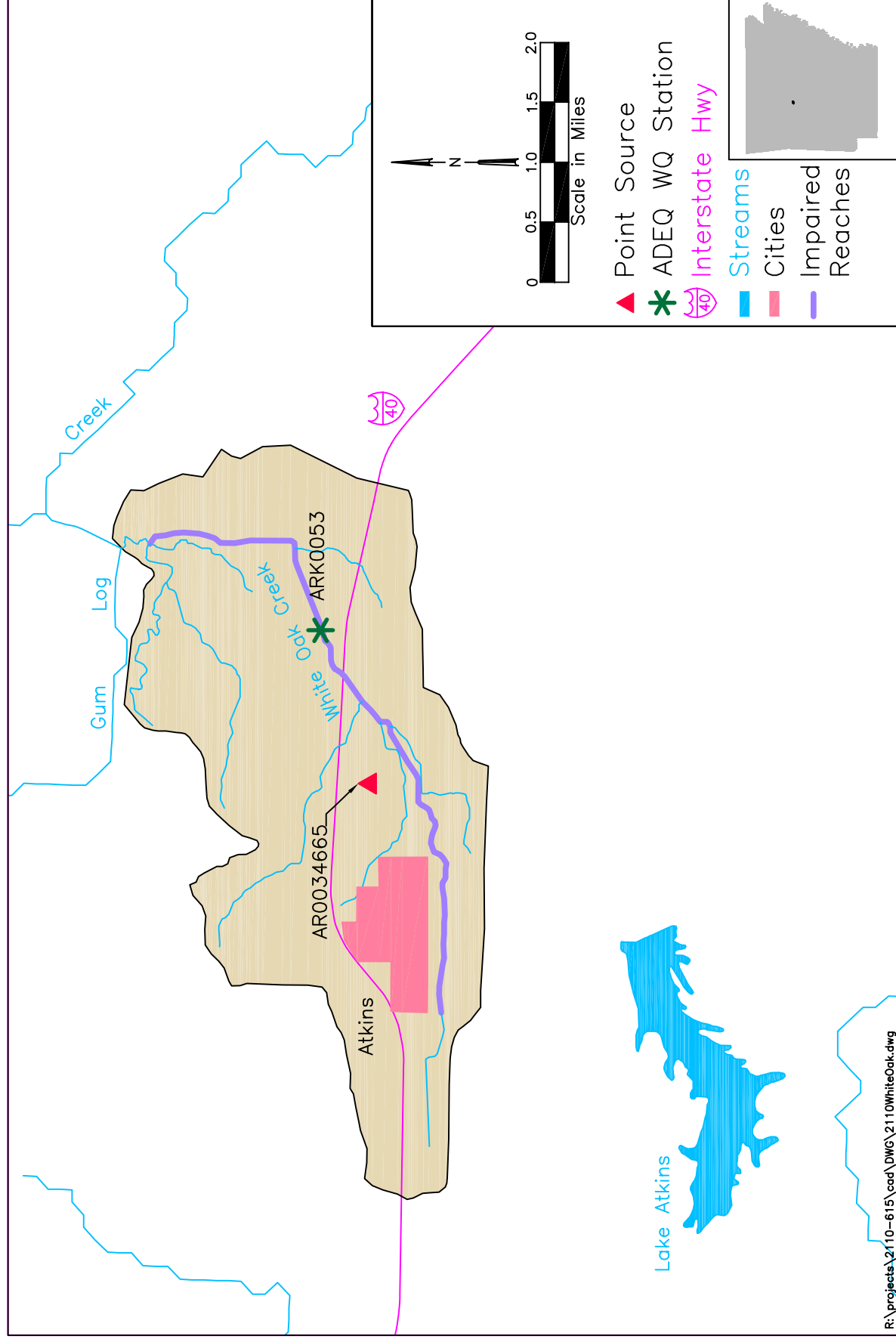


Figure A.3. Map of water quality stations and point sources in the study area

# **APPENDIX B**

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## **Long Term Plots of Turbidity and TSS**

Table B.1. Observed Turbidity and TSS Data for White Oak Creek at ARK0053.

Date	Observed turbidity (NTU)	Observed TSS (mg/L)	Flow at USGS gage(cfs)	Flow per unit area (cfs/mi2)	Load per unit area (lbs/day/mi2)	Percent of days flow exceeded	Applicable category	Applicable water quality standard (NTU)	Turbidity meeting base flow standard?	Turbidity meeting storm-flow standard?
9/18/1995	24	32.5	1.00E-03	5.92E-06	1.04E-03	98.12%	Base flow	21	No	
7/27/1998	5.4	4.5	1.00E-03	5.92E-06	1.44E-04	98.12%	Base flow	21	Yes	
9/28/1998	4.3	4.5	1.00E-03	5.92E-06	1.44E-04	98.12%	Base flow	21	Yes	
9/13/1999	43	27	1.00E-03	5.92E-06	8.62E-04	98.12%	Base flow	21	No	
10/4/1999	29	8	1.00E-03	5.92E-06	2.55E-04	98.12%	Base flow	21	No	
11/29/1999	45	12.5	2.00E-02	1.18E-04	7.98E-03	96.11%	Base flow	21	No	
9/29/1997	13	9.5	4.00E-02	2.37E-04	1.21E-02	95.84%	Base flow	21	Yes	
8/9/1999	26	24	5.00E-02	2.96E-04	3.83E-02	95.71%	Base flow	21	No	
10/30/2000	6.1	7	5.00E-02	2.96E-04	1.12E-02	95.71%	Base flow	21	Yes	
10/16/1995	6.5	6	6.00E-02	3.55E-04	1.15E-02	95.60%	Base flow	21	Yes	
10/9/2000	88	31.5	9.00E-02	5.33E-04	9.05E-02	95.39%	Base flow	21	No	
9/21/1992	220	220	1.90E-01	1.12E-03	1.33E+00	94.52%	Base flow	21	No	
10/20/1992	5.4	4	1.90E-01	1.12E-03	2.43E-02	94.52%	Base flow	21	Yes	
10/15/2002	3.6	1	2.00E-01	1.18E-03	6.38E-03	94.31%	Base flow	21	Yes	
10/29/2001	10	3.3	2.20E-01	1.30E-03	2.32E-02	94.10%	Base flow	21	Yes	
8/14/2000	19	21	3.70E-01	2.19E-03	2.48E-01	93.32%	Base flow	21	Yes	
9/17/2001	22	12.8	3.90E-01	2.31E-03	1.59E-01	93.25%	Base flow	21	No	
10/8/1991	14	10	4.40E-01	2.60E-03	1.40E-01	92.87%	Base flow	21	Yes	
10/17/1994	6.1	5	4.60E-01	2.72E-03	7.34E-02	92.81%	Base flow	21	Yes	
9/18/1990	4.6	5	5.00E-01	2.96E-03	7.98E-02	92.60%	Base flow	21	Yes	
8/24/1998	7.3	5	7.10E-01	4.20E-03	1.13E-01	91.65%	Base flow	21	Yes	
8/24/1992	3.6	4	8.70E-01	5.15E-03	1.11E-01	91.08%	Base flow	21	Yes	
8/25/1997	13	12.5	1.00E+00	5.92E-03	3.99E-01	90.41%	Base flow	21	Yes	
7/12/1993	14	22	1.10E+00	6.51E-03	7.72E-01	89.98%	Base flow	21	Yes	
8/16/1993	4.6	5	1.10E+00	6.51E-03	1.76E-01	89.98%	Base flow	21	Yes	
9/13/1993	3.4	2	1.20E+00	7.10E-03	7.66E-02	89.65%	Base flow	21	Yes	
11/1/1999	81	32.5	1.20E+00	7.10E-03	1.24E+00	89.65%	Base flow	21	No	
7/16/2001	45	14.5	1.20E+00	7.10E-03	5.55E-01	89.65%	Base flow	21	No	
11/6/1995	29	2.5	1.30E+00	7.69E-03	1.04E-01	89.33%	Base flow	21	No	
9/24/1991	250	67	2.00E+00	1.18E-02	4.28E+00	87.34%	Base flow	21	No	

Date	Observed turbidity (NTU)	Observed TSS (mg/L)	Flow at USGS gage(cfs)	Flow per unit area (cfs/mi2)	Load per unit area (lbs/day/mi2)	Percent of days flow exceeded	Applicable category	Applicable water quality standard (NTU)	Turbidity meeting base flow standard?	Turbidity meeting storm-flow standard?
9/7/2004	27	17.5	2.00E+00	1.18E-02	1.12E+00	87.34%	Base flow	21	No	
8/5/1996	35	18.5	2.30E+00	1.36E-02	1.36E+00	86.64%	Base flow	21	No	
8/20/2001	25	9.8	2.50E+00	1.48E-02	7.82E-01	86.21%	Base flow	21	No	
9/3/2002	6.4	3.8	2.50E+00	1.48E-02	3.03E-01	86.21%	Base flow	21	Yes	
7/30/1991	7.2	7	2.80E+00	1.66E-02	6.25E-01	85.61%	Base flow	21	Yes	
8/21/1995	5.9	7	2.80E+00	1.66E-02	6.25E-01	85.61%	Base flow	21	Yes	
7/21/1997	2.6	8	3.00E+00	1.78E-02	7.66E-01	85.11%	Base flow	21	Yes	
6/21/1999	5.2	3	3.70E+00	2.19E-02	3.54E-01	83.92%	Base flow	21	Yes	
11/9/1998	21	8	4.00E+00	2.37E-02	1.02E+00	83.46%	Base flow	21	Yes	
6/22/1998	32	11.5	4.70E+00	2.78E-02	1.72E+00	82.49%	Base flow	21	No	
9/26/1994	6.4	4	5.00E+00	2.96E-02	6.38E-01	82.11%	Base flow	21	Yes	
11/26/2001	34	17	5.00E+00	2.96E-02	2.71E+00	82.11%	Base flow	21	No	
12/4/1995	19	10.5	6.00E+00	3.55E-02	2.01E+00	80.81%	Base flow	21	Yes	
6/26/1995	5.8	7.5	6.40E+00	3.79E-02	1.53E+00	80.26%	Base flow	21	Yes	
7/23/1991	18	32	6.50E+00	3.85E-02	6.64E+00	80.13%	Base flow	21	Yes	
7/19/1999	21	25.5	6.70E+00	3.96E-02	5.45E+00	79.84%	Base flow	21	Yes	
7/17/2000	7.2	9	8.70E+00	5.15E-02	2.50E+00	77.39%	Base flow	21	Yes	
10/26/1998	22	4	9.00E+00	5.33E-02	1.15E+00	77.00%	Base flow	21	No	
8/6/2002	5.6	4	9.00E+00	5.33E-02	1.15E+00	77.00%	Base flow	21	Yes	
8/3/2004	12.2	6.8	1.10E+01	6.51E-02	2.39E+00	75.27%	Base flow	21	Yes	
8/29/1994	8.4	3	1.30E+01	7.69E-02	1.24E+00	73.82%	Base flow	21	Yes	
11/16/1992	45	17	1.70E+01	1.01E-01	9.22E+00	71.15%	Base flow	21	No	
10/27/1997	33	10.5	1.80E+01	1.07E-01	6.03E+00	70.56%	Base flow	21	No	
7/24/1995	180	200.5	2.00E+01	1.18E-01	1.28E+02	69.39%	Base flow	21	No	
7/1/2002	6.8	9	2.00E+01	1.18E-01	5.74E+00	69.39%	Base flow	21	Yes	
6/2/1997	26	24.5	2.20E+01	1.30E-01	1.72E+01	68.27%	Base flow	21	No	
6/4/2001	13	6.7	2.40E+01	1.42E-01	5.13E+00	67.32%	Base flow	21	Yes	
11/12/2002	20.2	4.8	2.40E+01	1.42E-01	3.68E+00	67.32%	Base flow	21	Yes	
7/18/1994	24	12.5	2.50E+01	1.48E-01	9.97E+00	66.87%	Base flow	21	No	
7/1/1996	36	24	2.50E+01	1.48E-01	1.91E+01	66.87%	Base flow	21	No	
7/29/2003	19.5	8.5	2.50E+01	1.48E-01	6.78E+00	66.87%	Base flow	21	Yes	
11/17/1997	60	5	2.60E+01	1.54E-01	4.15E+00	66.40%	Base flow	21	No	



Date	Observed turbidity (NTU)	Observed TSS (mg/L)	Flow at USGS gage(cfs)	Flow per unit area (cfs/mi2)	Load per unit area (lbs/day/mi2)	Percent of days flow exceeded	Applicable category	Applicable water quality standard (NTU)	Turbidity meeting base flow standard?	Turbidity meeting storm-flow standard?
9/23/1996	30	8.5	3.00E+01	1.78E-01	8.14E+00	64.94%	Base flow	21	No	
6/2/1992		12	3.10E+01	1.83E-01	1.19E+01	64.50%	Base flow	21		
4/30/2001	4.4	6	3.20E+01	1.89E-01	6.13E+00	64.13%	Base flow	21	Yes	
12/15/1997	36	2	3.30E+01	1.95E-01	2.11E+00	63.88%	Base flow	21	No	
7/27/1992	110	96	3.40E+01	2.01E-01	1.04E+02	63.61%	Base flow	21	No	
6/7/1993	6.1	6	3.60E+01	2.13E-01	6.89E+00	62.81%	Base flow	21	Yes	
6/8/2004	8.29	4.8	3.80E+01	2.25E-01	5.82E+00	62.21%	Base flow	21	Yes	
7/6/2004	32.8	7.8	3.80E+01	2.25E-01	9.46E+00	62.21%	Base flow	21	No	
5/11/1992	7.9	12	4.10E+01	2.43E-01	1.57E+01	61.37%	Base flow	21	Yes	
5/17/1999	21	11	4.70E+01	2.78E-01	1.65E+01	59.75%	Storm-flow	40		Yes
12/11/2000		2.7	4.70E+01	2.78E-01	4.05E+00	59.75%	Storm-flow	40		
6/3/2002	32	11.8	4.70E+01	2.78E-01	1.77E+01	59.75%	Storm-flow	40		Yes
11/19/1990	7	19	5.00E+01	2.96E-01	3.03E+01	58.96%	Storm-flow	40		Yes
6/5/2000	12	8.5	5.30E+01	3.14E-01	1.44E+01	58.14%	Storm-flow	40		Yes
2/11/2003	18.2	3.2	5.30E+01	3.14E-01	5.41E+00	58.14%	Storm-flow	40		Yes
5/30/1994	32	14	5.50E+01	3.25E-01	2.46E+01	57.64%	Storm-flow	40		Yes
5/19/1997	34	56	5.50E+01	3.25E-01	9.83E+01	57.64%	Storm-flow	40		Yes
12/7/1998	34	8.5	5.50E+01	3.25E-01	1.49E+01	57.64%	Storm-flow	40		Yes
6/2/2003	128	63	6.10E+01	3.61E-01	1.23E+02	56.20%	Storm-flow	40		No
5/21/1991	46	36	6.20E+01	3.67E-01	7.12E+01	56.02%	Storm-flow	40		No
6/30/2003	8.02	2.7	6.70E+01	3.96E-01	5.77E+00	54.92%	Storm-flow	40		Yes
5/6/2002	13	8.3	7.00E+01	4.14E-01	1.85E+01	54.15%	Storm-flow	40		Yes
10/28/1996	58	24	7.10E+01	4.20E-01	5.44E+01	53.87%	Storm-flow	40		No
1/31/2000	13	7.5	7.20E+01	4.26E-01	1.72E+01	53.67%	Storm-flow	40		Yes
3/8/1999	7	1.8	7.40E+01	4.38E-01	4.25E+00	53.25%	Storm-flow	40		Yes
1/8/2001	30	11.5	8.50E+01	5.03E-01	3.12E+01	50.71%	Storm-flow	40		Yes
2/13/1995	12	2	8.90E+01	5.27E-01	5.68E+00	49.89%	Storm-flow	40		Yes
4/27/1998	51	29	9.00E+01	5.33E-01	8.33E+01	49.61%	Storm-flow	40		No
1/15/1996	19	4	9.10E+01	5.38E-01	1.16E+01	49.32%	Storm-flow	40		Yes
5/22/1995	8.1	4	9.60E+01	5.68E-01	1.23E+01	48.22%	Storm-flow	40		Yes
1/14/2002	23	7	1.01E+02	5.98E-01	2.26E+01	47.18%	Storm-flow	40		Yes
12/14/1992	29	12	1.05E+02	6.21E-01	4.02E+01	46.42%	Storm-flow	40		Yes

Date	Observed turbidity (NTU)	Observed TSS (mg/L)	Flow at USGS gage(cfs)	Flow per unit area (cfs/mi2)	Load per unit area (lbs/day/mi2)	Percent of days flow exceeded	Applicable category	Applicable water quality standard (NTU)	Turbidity meeting base flow standard?	Turbidity meeting storm-flow standard?
1/3/1994	19	5	1.05E+02	6.21E-01	1.68E+01	46.42%	Storm-flow	40		Yes
2/9/1998	35	8	1.05E+02	6.21E-01	2.68E+01	46.42%	Storm-flow	40		Yes
10/23/1990	6	2	1.08E+02	6.39E-01	6.89E+00	45.98%	Storm-flow	40		Yes
1/14/2003	16.1	2.5	1.12E+02	6.63E-01	8.93E+00	45.16%	Storm-flow	40		Yes
12/16/2002	71.7	2.7	1.14E+02	6.75E-01	9.82E+00	44.83%	Storm-flow	40		No
4/1/2003	20.2	7.2	1.23E+02	7.28E-01	2.83E+01	43.23%	Storm-flow	40		Yes
3/4/1996	21	2.5	1.30E+02	7.69E-01	1.04E+01	42.06%	Storm-flow	40		Yes
4/6/1992	23	6	1.31E+02	7.75E-01	2.51E+01	41.83%	Storm-flow	40		Yes
3/12/1991	20	10	1.32E+02	7.81E-01	4.21E+01	41.69%	Storm-flow	40		Yes
2/8/1993		11	1.32E+02	7.81E-01	4.63E+01	41.69%	Storm-flow	40		
1/11/1999	22	3	1.36E+02	8.05E-01	1.30E+01	41.02%	Storm-flow	40		Yes
2/26/1991	16	7	1.44E+02	8.52E-01	3.22E+01	39.79%	Storm-flow	40		Yes
10/18/1993	105	62	1.50E+02	8.88E-01	2.97E+02	38.81%	Storm-flow	40		No
4/21/1997	13	3.5	1.51E+02	8.93E-01	1.69E+01	38.59%	Storm-flow	40		Yes
3/3/1992	13	8	1.61E+02	9.53E-01	4.11E+01	37.08%	Storm-flow	40		Yes
1/28/1992	16	6	1.68E+02	9.94E-01	3.22E+01	36.17%	Storm-flow	40		Yes
3/1/2004	23.1	9.2	1.80E+02	1.07E+00	5.28E+01	34.27%	Storm-flow	40		Yes
3/29/1993		46	1.84E+02	1.09E+00	2.70E+02	33.76%	Storm-flow	40		
4/2/2001	18	10	1.85E+02	1.09E+00	5.90E+01	33.65%	Storm-flow	40		Yes
5/3/1994	61	29	1.86E+02	1.10E+00	1.72E+02	33.53%	Storm-flow	40		No
4/3/2000	24	9.5	1.98E+02	1.17E+00	6.00E+01	32.06%	Storm-flow	40		Yes
3/11/2003	23.4	4.7	1.98E+02	1.17E+00	2.97E+01	32.06%	Storm-flow	40		Yes
1/29/1991	1.1	2	1.99E+02	1.18E+00	1.27E+01	31.93%	Storm-flow	40		Yes
1/29/1991	20	11	1.99E+02	1.18E+00	6.99E+01	31.93%	Storm-flow	40		Yes
10/29/1991	110	108	2.00E+02	1.18E+00	6.89E+02	31.77%	Storm-flow	40		No
11/9/2004	18.3	5.2	2.08E+02	1.23E+00	3.45E+01	30.83%	Storm-flow	40		Yes
4/17/1995	22	3.5	2.19E+02	1.30E+00	2.45E+01	29.70%	Storm-flow	40		Yes
2/5/2001	14	2.5	2.19E+02	1.30E+00	1.75E+01	29.70%	Storm-flow	40		Yes
3/6/2000		15	2.26E+02	1.34E+00	1.08E+02	28.94%	Storm-flow	40		
2/2/2004	29	5	2.26E+02	1.34E+00	3.61E+01	28.94%	Storm-flow	40		Yes
6/3/1996	49	22.5	2.38E+02	1.41E+00	1.71E+02	27.78%	Storm-flow	40		No
4/1/1996	39	15.5	2.40E+02	1.42E+00	1.19E+02	27.55%	Storm-flow	40		Yes

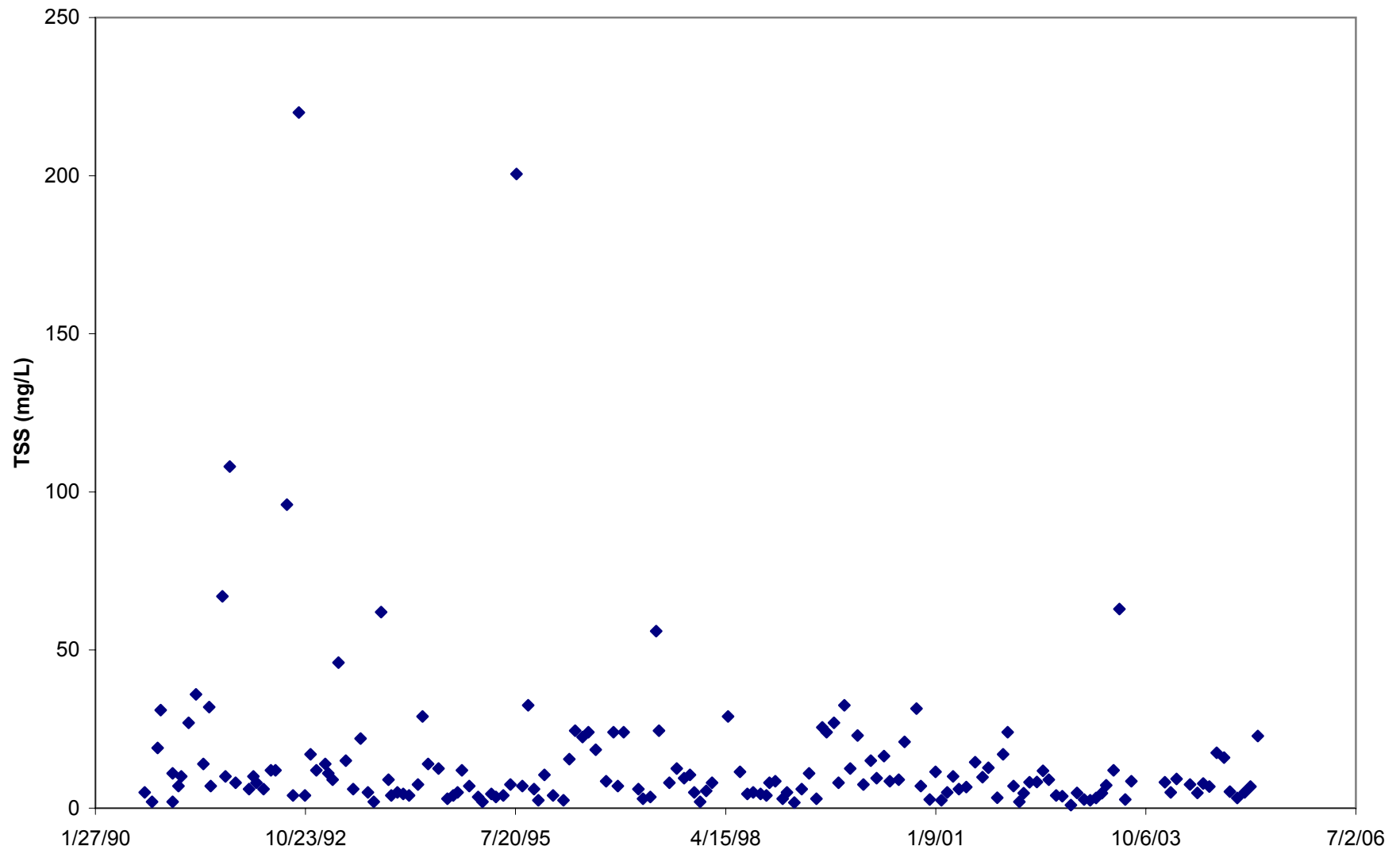
Date	Observed turbidity (NTU)	Observed TSS (mg/L)	Flow at USGS gage(cfs)	Flow per unit area (cfs/mi2)	Load per unit area (lbs/day/mi2)	Percent of days flow exceeded	Applicable category	Applicable water quality standard (NTU)	Turbidity meeting base flow standard?	Turbidity meeting storm-flow standard?
3/27/1995	13	4.5	2.50E+02	1.48E+00	3.59E+01	26.71%	Storm-flow	40		Yes
1/5/2004	29.2	8.2	2.50E+02	1.48E+00	6.54E+01	26.71%	Storm-flow	40		Yes
3/22/2005	60	22.8	2.62E+02	1.55E+00		25.65%	Storm-flow	40		No
3/4/2002	27	4.7	2.69E+02	1.59E+00	4.03E+01	25.03%	Storm-flow	40		Yes
12/14/2004	19	3.2	2.72E+02	1.61E+00	2.78E+01	24.73%	Storm-flow	40		Yes
5/8/2000	40	16.5	2.74E+02	1.62E+00	1.44E+02	24.58%	Storm-flow	40		Yes
4/12/1999	19	6	2.79E+02	1.65E+00	5.34E+01	24.17%	Storm-flow	40		Yes
4/11/1994	20	7.5	2.98E+02	1.76E+00	7.13E+01	22.75%	Storm-flow	40		Yes
2/15/2005	27.2	6.8	3.09E+02	1.83E+00	6.71E+01	21.96%	Storm-flow	40		Yes
1/18/2005	18.8	5	3.12E+02	1.85E+00	4.98E+01	21.73%	Storm-flow	40		Yes
4/29/1996	43	24.5	3.29E+02	1.95E+00	2.57E+02	20.70%	Storm-flow	40		No
2/11/2002	24	2	3.29E+02	1.95E+00	2.10E+01	20.70%	Storm-flow	40		Yes
12/12/1994	28	7	3.30E+02	1.95E+00	7.37E+01	20.63%	Storm-flow	40		Yes
1/23/1995	23	3.5	3.32E+02	1.96E+00	3.71E+01	20.49%	Storm-flow	40		Yes
2/18/1992	26	10	3.69E+02	2.18E+00	1.18E+02	18.50%	Storm-flow	40		Yes
11/25/1991	28	8	3.70E+02	2.19E+00	9.45E+01	18.43%	Storm-flow	40		Yes
11/18/1996	40	7	3.80E+02	2.25E+00	8.49E+01	17.96%	Storm-flow	40		Yes
1/12/1998	30	5.5	3.82E+02	2.26E+00	6.70E+01	17.86%	Storm-flow	40		Yes
5/3/2004	31.3	7.5	3.87E+02	2.29E+00	9.26E+01	17.69%	Storm-flow	40		Yes
12/4/1990	58	31	3.93E+02	2.33E+00	3.89E+02	17.33%	Storm-flow	40		No
2/28/1994	22	4	4.49E+02	2.66E+00	5.73E+01	14.95%	Storm-flow	40		Yes
3/17/1997	24	3	4.60E+02	2.72E+00	4.40E+01	14.64%	Storm-flow	40		Yes
3/24/1998	34		4.70E+02	2.78E+00		14.26%	Storm-flow	40		Yes
3/1/1993	26	9	5.23E+02	3.09E+00	1.50E+02	12.65%	Storm-flow	40		Yes
1/31/1994	26	4.5	5.26E+02	3.11E+00	7.55E+01	12.59%	Storm-flow	40		Yes
11/22/1993	37	9	6.00E+02	3.55E+00	1.72E+02	10.74%	Storm-flow	40		Yes
2/24/1997	29	6	6.00E+02	3.55E+00	1.15E+02	10.74%	Storm-flow	40		Yes
1/25/1993	31	14	6.47E+02	3.83E+00	2.89E+02	9.83%	Storm-flow	40		Yes
10/12/2004	50.6	16	6.66E+02	3.94E+00	3.40E+02	9.50%	Storm-flow	40		No
2/1/1999	27	5	6.70E+02	3.96E+00	1.07E+02	9.43%	Storm-flow	40		Yes
5/6/2003	83.4	12	6.79E+02	4.02E+00	2.60E+02	9.28%	Storm-flow	40		No
3/5/2001	23	5	6.86E+02	4.06E+00	1.09E+02	9.08%	Storm-flow	40		Yes

Date	Observed turbidity (NTU)	Observed TSS (mg/L)	Flow at USGS gage(cfs)	Flow per unit area (cfs/mi2)	Load per unit area (lbs/day/mi2)	Percent of days flow exceeded	Applicable category	Applicable water quality standard (NTU)	Turbidity meeting base flow standard?	Turbidity meeting storm-flow standard?
12/6/1993	29	4	9.00E+02	5.33E+00	1.15E+02	6.24%	Storm-flow	40		Yes
4/1/2002	26	8.2	9.05E+02	5.36E+00	2.37E+02	6.17%	Storm-flow	40		Yes
5/3/1993	40	15	1.12E+03	6.63E+00	5.36E+02	4.35%	Storm-flow	40		Yes
4/16/1991	32	27	1.31E+03	7.75E+00	1.13E+03	3.41%	Storm-flow	40		Yes
11/7/1994	53	12	1.40E+03	8.28E+00	5.36E+02	3.05%	Storm-flow	40		No
6/25/1991	22	14	1.51E+03	8.93E+00	6.75E+02	2.72%	Storm-flow	40		Yes
12/16/1996	33	24	1.60E+03	9.47E+00	1.23E+03	2.54%	Storm-flow	40		Yes
1/3/2000	37	23	4.03E+03	2.38E+01	2.96E+03	0.52%	Storm-flow	40		Yes
12/17/2001	42	24	9.85E+03	5.83E+01	7.54E+03	0.06%	Storm-flow	40		No

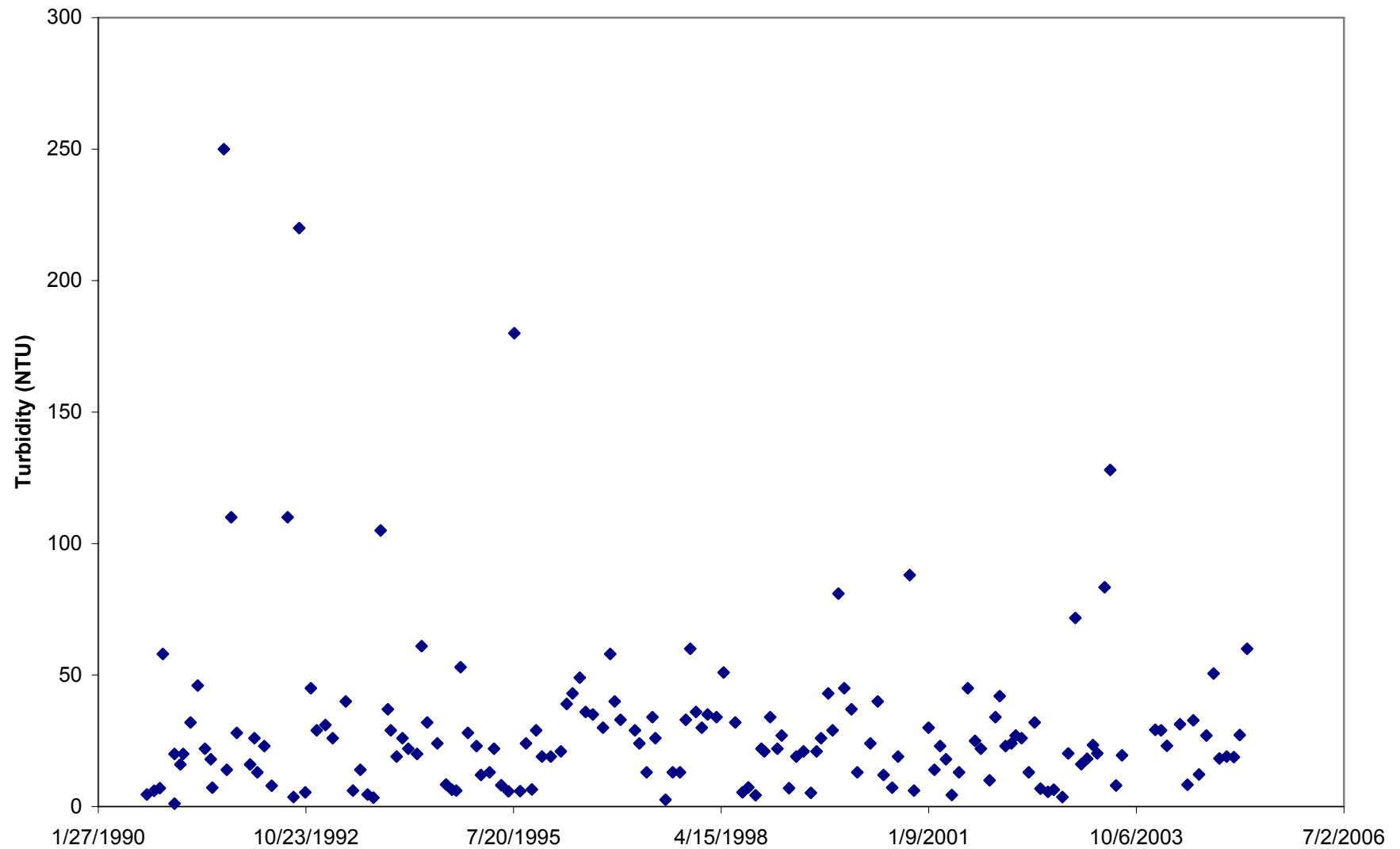
Number exceeding applicable water quality standard for turbidity = 29 16  
 Total number of observations in each category = 70 92  
 Percent exceeding applicable water quality standard for turbidity = 41% 17%

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**Figure B.1. Observed Long Term TSS for White Oak Creek near Atkins, AR(ARK0053)**



**Figure B.2. Observed Long Term Turbidity for White Oak Creek near Atkins, AR(ARK0053)**

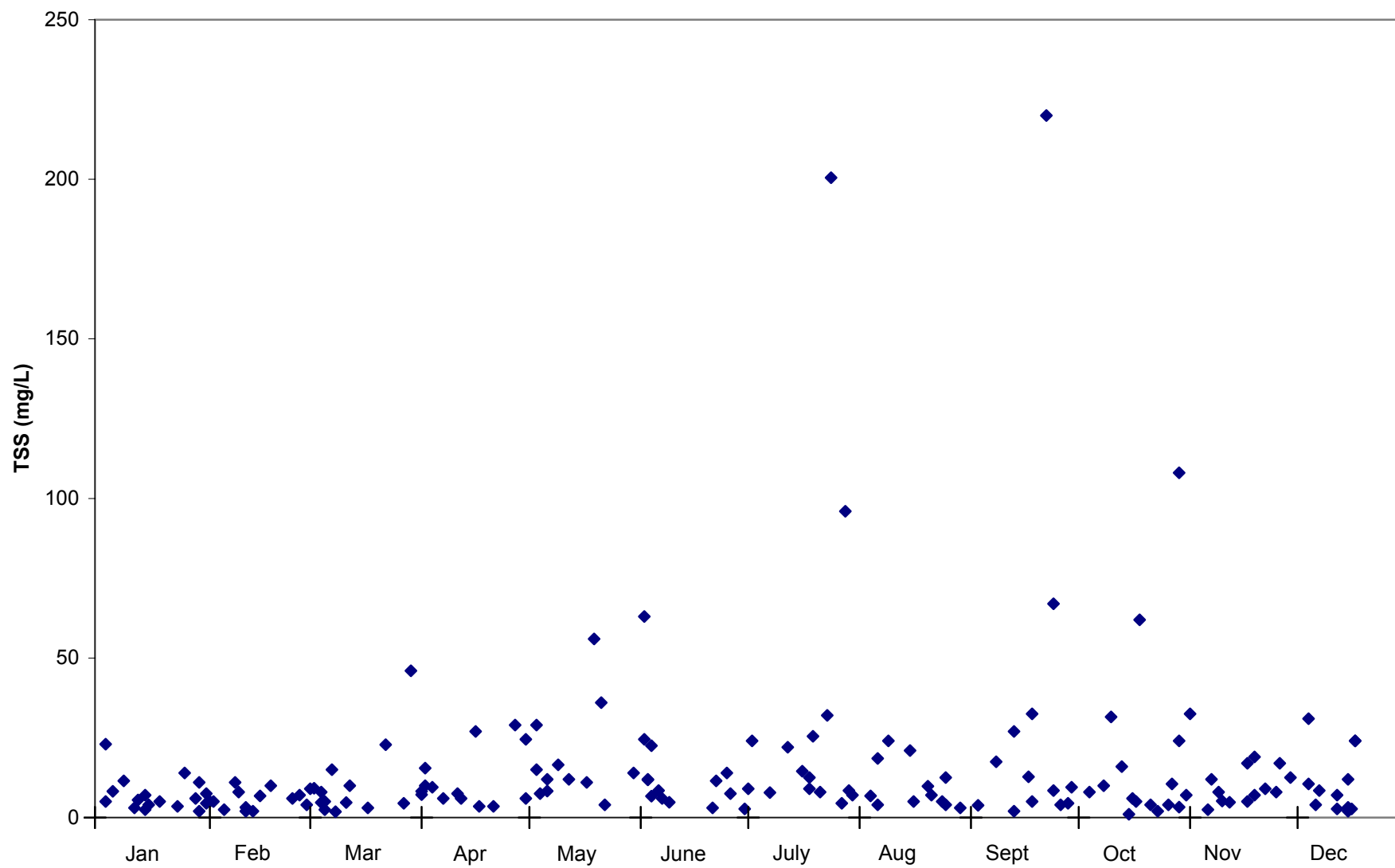


# **APPENDIX C**

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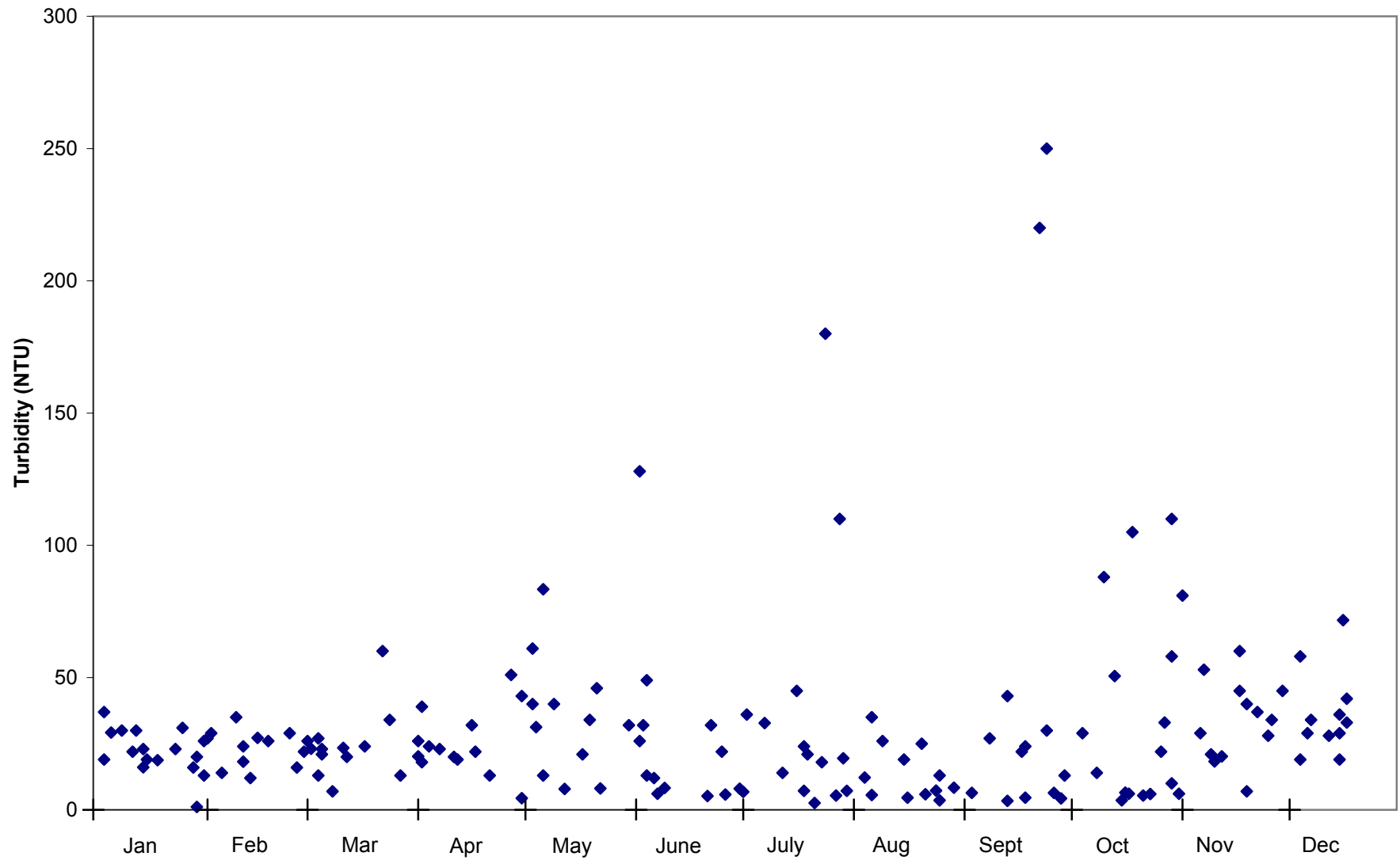
## **Seasonal Plots of Turbidity and TSS**

**Figure C.1. Observed Seasonal TSS for White Oak Creek near Atkins, AR(ARK0053)**





**Figure C.2. Observed Seasonal Turbidity for White Oak Creek near Atkins, AR(ARK0053)**

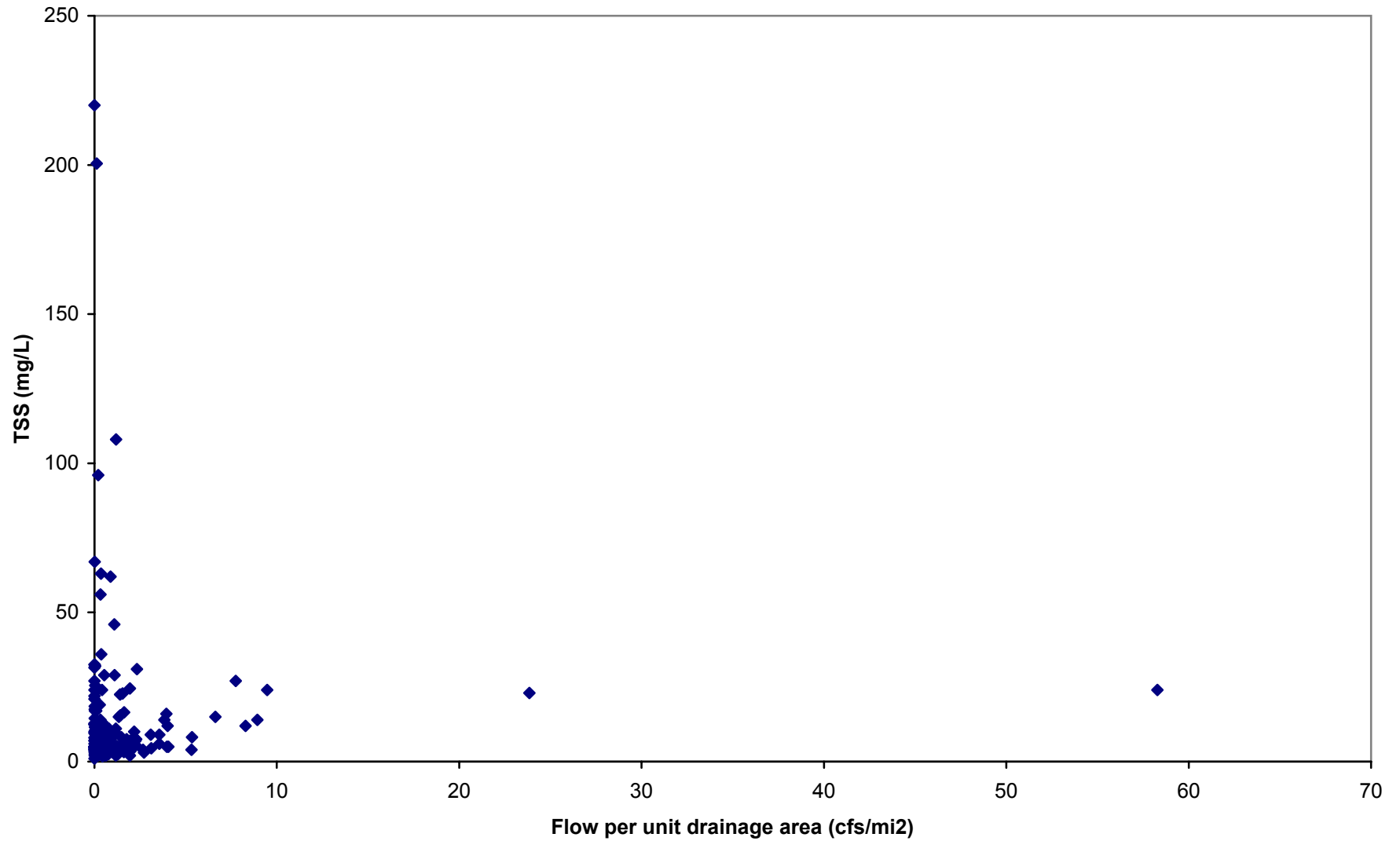


# **APPENDIX D**

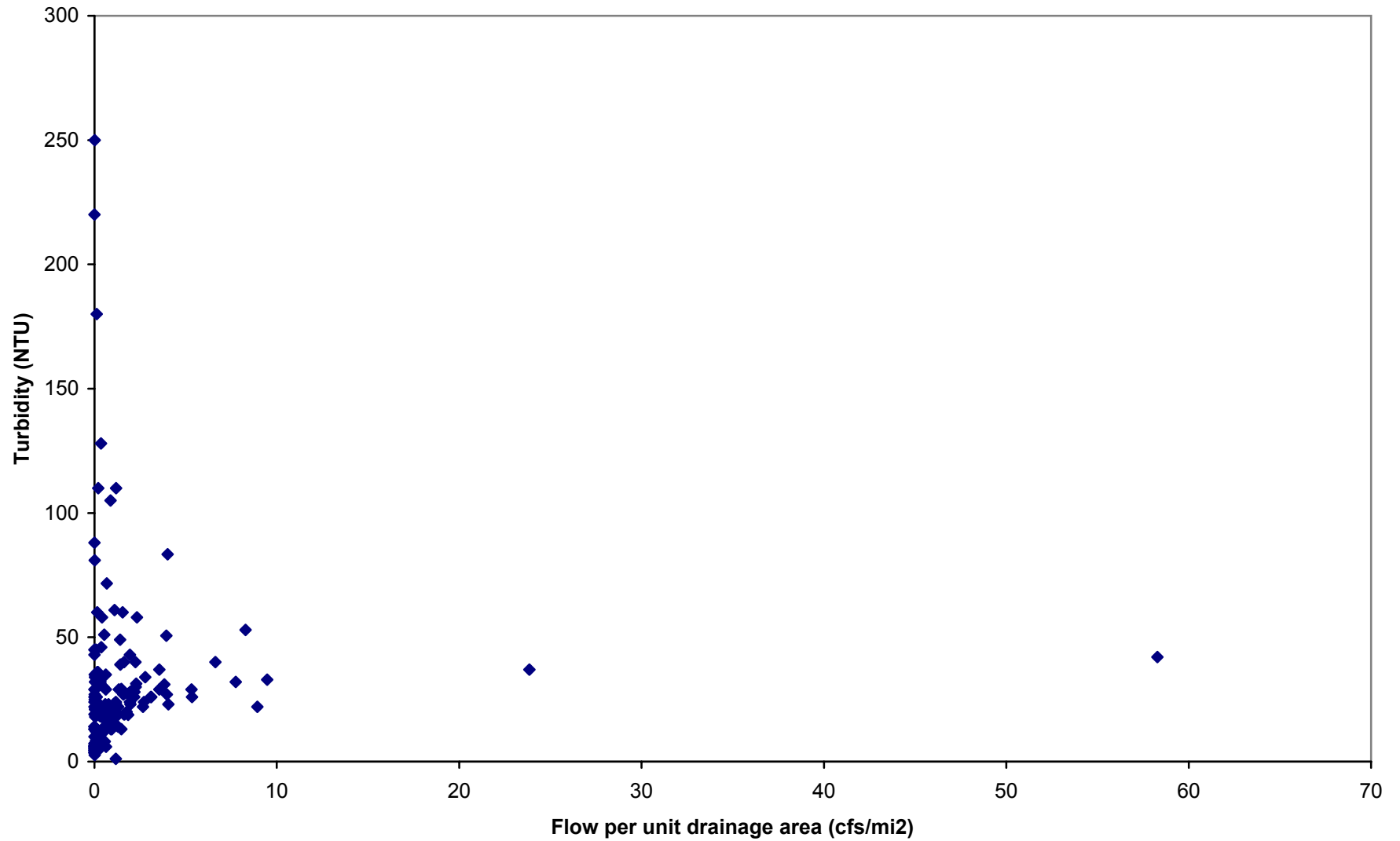
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**Plots of Turbidity and TSS vs Flow**

Figure D.1. TSS vs flow for White Oak near Atkins, AR (ARK0053)



**Figure D.2. Turbidity vs flow for White Oak near Atkins, AR (ARK0053)**



# **APPENDIX E**

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**Plots of TSS vs Turbidity**

Figure E.1. Base flow regression for TSS vs Turbidity for White Oak Creek (ARK0053)

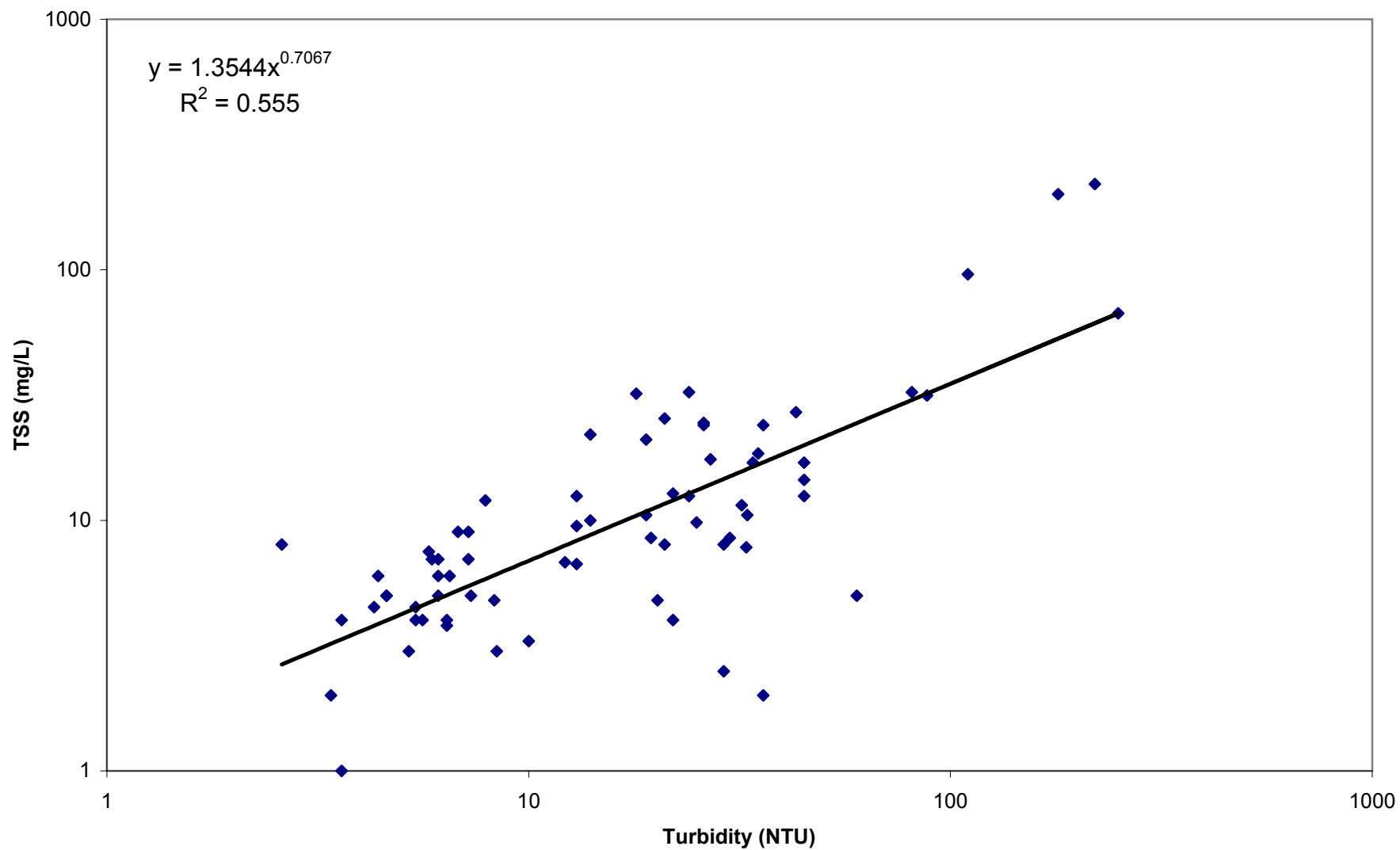
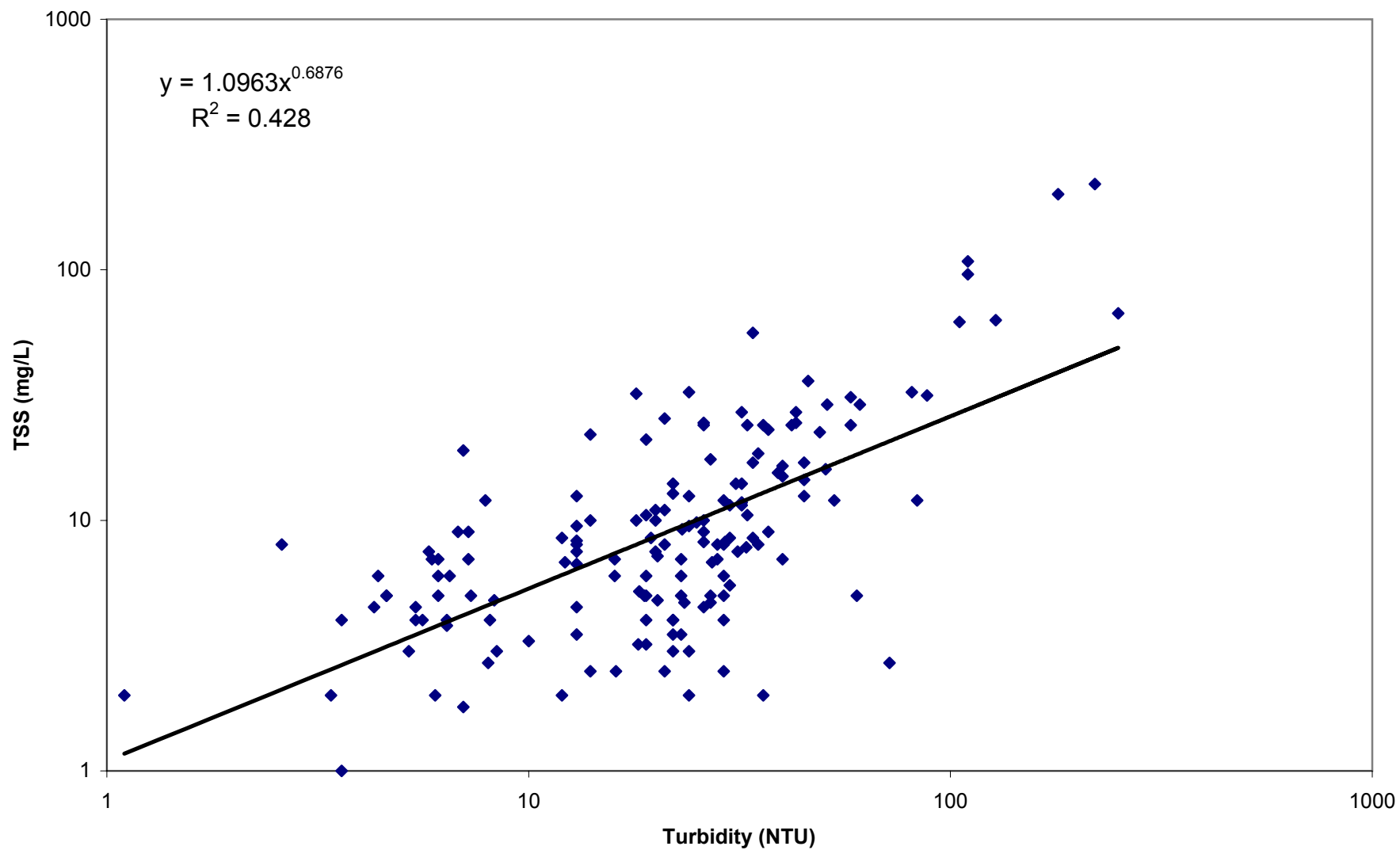


Figure E.2. Storm-flow regression for TSS vs Turbidity for White Oak Creek (ARK0053)



# **APPENDIX F**

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## **Load Duration Curves and TMDL Calculations**



**Figure F.1. Flow Duration Curve for Cadron Creek near Guy, AR (07261000)**

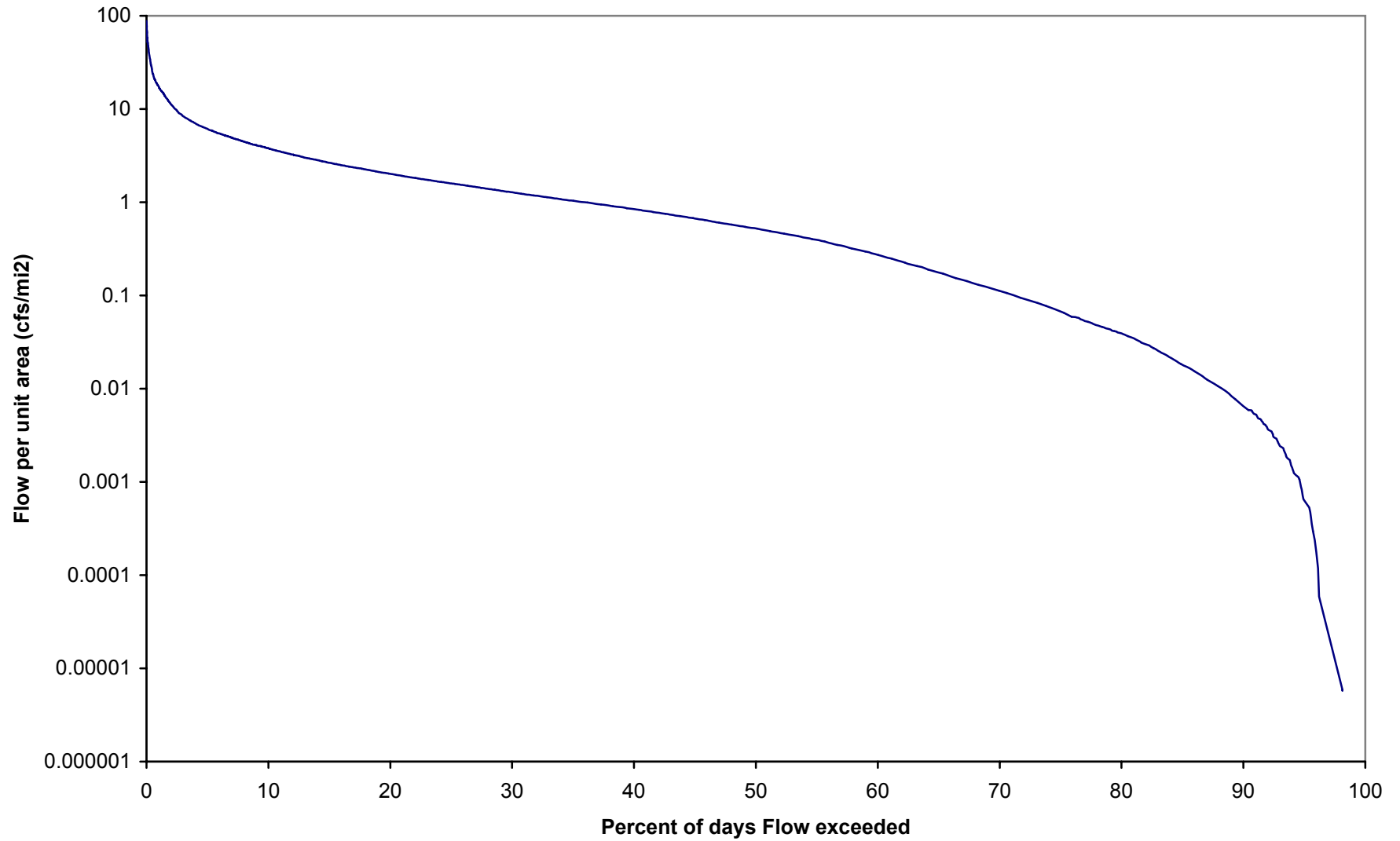


Figure F.2. Storm-flow Load Duration Curve for White Oak

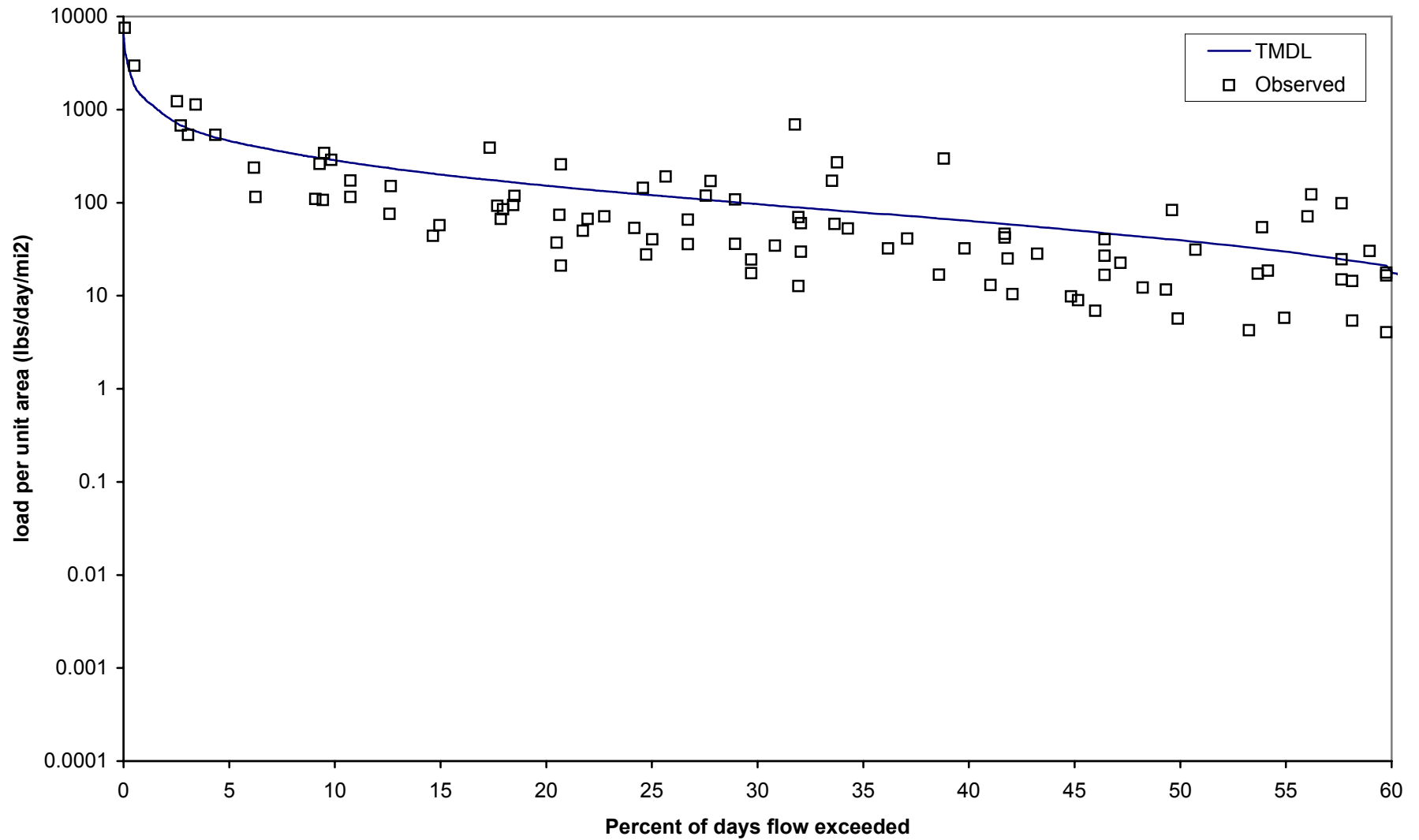


Figure F.3. Base flow Load Duration Curve for White Oak

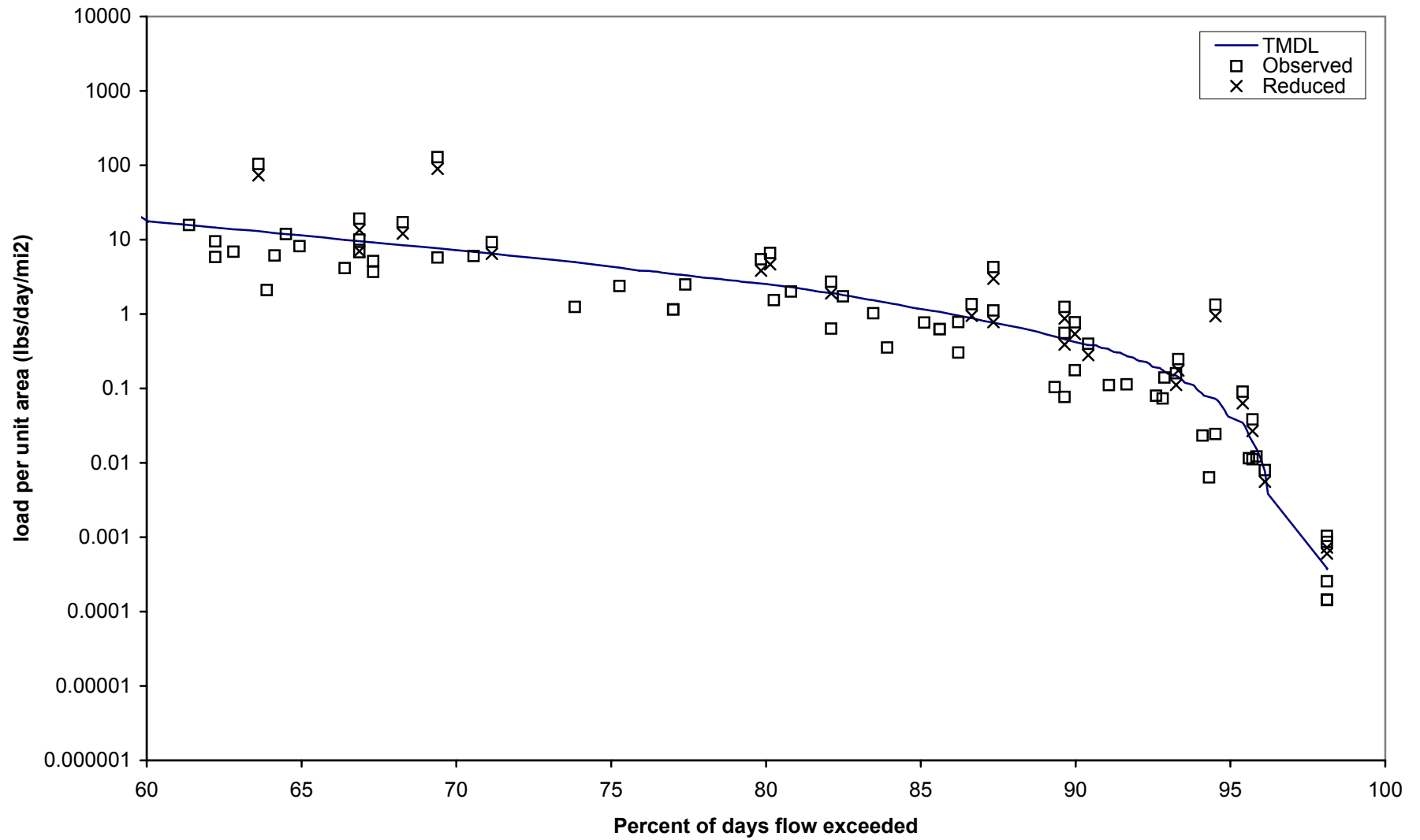


Table F.1. Calculations for allowable load for White Oak Creek.  
drainage area at USGS flow gage = 169 mi2, (Cadron Creek near Guy)

Date	Flow at gage (cfs)	Flow (cfs/mi2)	Percent of days flow exceeded	WQ Standard type	WQ Standard (NTU)	WQ Target TSS (mg/L)	Allowable TSS load (lbs/day/mi2)
10/01/1954	0.001	5.92E-06	98.12%	Base flow	21	12	3.83E-04
10/02/1954	0.001	5.92E-06	98.12%	Base flow	21	12	3.83E-04
10/03/1954	0.001	5.92E-06	98.12%	Base flow	21	12	3.83E-04

The rows between 98.12 and 80.01 percent flow exceedances are not shown for the sake of brevity.

11/25/1995	6.6	3.91E-02	80.01%	Base flow	21	12	2.53E+00
11/26/1998	6.6	3.91E-02	80.01%	Base flow	21	12	2.53E+00
08/29/2004	6.6	3.91E-02	80.01%	Base flow	21	12	2.53E+00

The rows between 80.01 and 60.04 percent flow exceedances are not shown for the sake of brevity.

06/06/2004	46	2.72E-01	60.04%	Base flow	21	12	1.76E+01
07/02/2004	46	2.72E-01	60.04%	Base flow	21	12	1.76E+01
07/05/2004	46	2.72E-01	60.04%	Base flow	21	12	1.76E+01
05/15/1955	47	2.78E-01	59.75%	Storm-flow	40	14	2.10E+01
12/04/1955	47	2.78E-01	59.75%	Storm-flow	40	14	2.10E+01
12/05/1955	47	2.78E-01	59.75%	Storm-flow	40	14	2.10E+01

The rows between 59.75 and 30.10 percent flow exceedances are not shown for the sake of brevity.

01/31/1998	215	1.27E+00	30.10%	Storm-flow	40	14	9.61E+01
12/23/1998	215	1.27E+00	30.10%	Storm-flow	40	14	9.61E+01
03/21/2004	215	1.27E+00	30.10%	Storm-flow	40	14	9.61E+01

The rows between 30.10 and 0.01 percent flow exceedances are not shown for the sake of brevity.

12/03/1982	13400	7.93E+01	0.01%	Storm-flow	40	14	5.99E+03
05/14/1968	14300	8.46E+01	0.01%	Storm-flow	40	14	6.39E+03
12/04/1982	14800	8.76E+01	0.00%	Storm-flow	40	14	6.61E+03

Flow per unit area in middle of base flow range (80% exceedance) =	0.039	cfs/mi2
Cumulative drainage area at downstream end of reach 927 =	11.6	mi2
Flow at downstream end of reach 927 for base flow conditions =	0.453	cfs
Target TSS for base flow conditions for reach 927 =	12	mg/L
Allowable TSS load for base flow conditions for reach 927 =	0.015	tons/day

Flow per unit area in middle of stormwater range (30% exceedance) =	1.272	cfs/mi2
Cumulative drainage area at downstream end of reach 927 =	11.6	mi2
Flow at downstream end of reach 927 for stormwater conditions =	14.76	cfs
Target TSS for stormwater conditions for reach 927 =	14	mg/L
Allowable TSS load for stormwater conditions for reach 927 =	0.557	tons/day

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TABLE F.2. CALCULATIONS FOR PERCENT REDUCTION FOR STORM-FLOW CONDITIONS  
FOR WHITE OAK CREEK (STATION ARK0053)

Storm-flow target TSS conc. = 14 mg/L Error check for reduction is / is not needed: ok  
Percent reduction needed = 13% Error check for less or more reduction needed: ok

<u>Category</u>	<u>Date</u>	<u>Observed TSS at ARK0033 (mg/L)</u>	<u>Flow per unit area on sampling day (cfs/mi2)</u>	<u>Percent exceedance for flow on sampling day</u>	<u>Current TSS load (lbs/day)/mi2</u>	<u>Reduced TSS load (lbs/day)/mi2</u>	<u>Allowable TSS load (lbs/day)/mi2</u>	<u>Reduced load less than or equal to allow. load?</u>
Storm-flow	6/3/2002	11.8	2.78E-01	59.75%	17.70	15.40	21.00	Yes
Storm-flow	12/11/2000	2.7	2.78E-01	59.75%	4.05	3.52	21.00	Yes
Storm-flow	5/17/1999	11.0	2.78E-01	59.75%	16.50	14.35	21.00	Yes
Storm-flow	11/19/1990	19.0	2.96E-01	58.96%	30.32	26.37	22.34	No
Storm-flow	2/11/2003	3.2	3.14E-01	58.14%	5.41	4.71	23.68	Yes
Storm-flow	6/5/2000	8.5	3.14E-01	58.14%	14.38	12.51	23.68	Yes
Storm-flow	12/7/1998	8.5	3.25E-01	57.64%	14.92	12.98	24.57	Yes
Storm-flow	5/19/1997	56.0	3.25E-01	57.64%	98.28	85.51	24.57	No
Storm-flow	5/30/1994	14.0	3.25E-01	57.64%	24.57	21.38	24.57	Yes
Storm-flow	6/2/2003	63.0	3.61E-01	56.20%	122.63	106.69	27.25	No
Storm-flow	5/21/1991	36.0	3.67E-01	56.02%	71.22	61.97	27.70	No
Storm-flow	6/30/2003	2.7	3.96E-01	54.92%	5.77	5.02	29.93	Yes
Storm-flow	5/6/2002	8.3	4.14E-01	54.15%	18.54	16.13	31.27	Yes
Storm-flow	10/28/1996	24.0	4.20E-01	53.87%	54.38	47.31	31.72	No
Storm-flow	1/31/2000	7.5	4.26E-01	53.67%	17.23	14.99	32.17	Yes
Storm-flow	3/8/1999	1.8	4.38E-01	53.25%	4.25	3.70	33.06	Yes
Storm-flow	1/8/2001	11.5	5.03E-01	50.71%	31.19	27.14	37.97	Yes
Storm-flow	2/13/1995	2.0	5.27E-01	49.89%	5.68	4.94	39.76	Yes
Storm-flow	4/27/1998	29.0	5.33E-01	49.61%	83.29	72.46	40.21	No
Storm-flow	1/15/1996	4.0	5.38E-01	49.32%	11.62	10.11	40.65	Yes
Storm-flow	5/22/1995	4.0	5.68E-01	48.22%	12.25	10.66	42.89	Yes
Storm-flow	1/14/2002	7.0	5.98E-01	47.18%	22.56	19.63	45.12	Yes
Storm-flow	2/9/1998	8.0	6.21E-01	46.42%	26.80	23.32	46.91	Yes
Storm-flow	1/3/1994	5.0	6.21E-01	46.42%	16.75	14.58	46.91	Yes

<u>Category</u>	<u>Date</u>	Observed TSS at ARK0033 <u>(mg/L)</u>	Flow per unit area on sampling day <u>(cfs/mi2)</u>	Percent exceedance for flow on sampling day <u>(%)</u>	Current TSS load <u>(lbs/day)/mi2</u>	Reduced TSS load <u>(lbs/day)/mi2</u>	Allowable TSS load <u>(lbs/day)/mi2</u>	Reduced load less than or equal to allow. load?
Storm-flow	12/14/1992	12.0	6.21E-01	46.42%	40.21	34.98	46.91	Yes
Storm-flow	10/23/1990	2.0	6.39E-01	45.98%	6.89	6.00	48.25	Yes
Storm-flow	1/14/2003	2.5	6.63E-01	45.16%	8.93	7.77	50.04	Yes
Storm-flow	12/16/2002	2.7	6.75E-01	44.83%	9.82	8.55	50.93	Yes
Storm-flow	4/1/2003	7.2	7.28E-01	43.23%	28.26	24.59	54.95	Yes
Storm-flow	3/4/1996	2.5	7.69E-01	42.06%	10.37	9.02	58.08	Yes
Storm-flow	4/6/1992	6.0	7.75E-01	41.83%	25.08	21.82	58.52	Yes
Storm-flow	2/8/1993	11.0	7.81E-01	41.69%	46.33	40.31	58.97	Yes
Storm-flow	3/12/1991	10.0	7.81E-01	41.69%	42.12	36.65	58.97	Yes
Storm-flow	1/11/1999	3.0	8.05E-01	41.02%	13.02	11.33	60.76	Yes
Storm-flow	2/26/1991	7.0	8.52E-01	39.79%	32.17	27.98	64.33	Yes
Storm-flow	10/18/1993	62.0	8.88E-01	38.81%	296.77	258.19	67.01	No
Storm-flow	4/21/1997	3.5	8.93E-01	38.59%	16.86	14.67	67.46	Yes
Storm-flow	3/3/1992	8.0	9.53E-01	37.08%	41.10	35.76	71.93	Yes
Storm-flow	1/28/1992	6.0	9.94E-01	36.17%	32.17	27.98	75.05	Yes
Storm-flow	3/1/2004	9.2	1.07E+00	34.27%	52.84	45.97	80.41	Yes
Storm-flow	3/29/1993	46.0	1.09E+00	33.76%	270.09	234.98	82.20	No
Storm-flow	4/2/2001	10.0	1.09E+00	33.65%	59.03	51.36	82.65	Yes
Storm-flow	5/3/1994	29.0	1.10E+00	33.53%	172.13	149.75	83.10	No
Storm-flow	3/11/2003	4.7	1.17E+00	32.06%	29.70	25.84	88.46	Yes
Storm-flow	4/3/2000	9.5	1.17E+00	32.06%	60.02	52.22	88.46	Yes
Storm-flow	1/29/1991	2.0	1.18E+00	31.93%	12.70	11.05	88.90	Yes
Storm-flow	1/29/1991	11.0	1.18E+00	31.93%	69.85	60.77	88.90	Yes
Storm-flow	10/29/1991	108.0	1.18E+00	31.77%	689.27	599.66	89.35	No
Storm-flow	11/9/2004	5.2	1.23E+00	30.83%	34.51	30.03	92.92	Yes
Storm-flow	2/5/2001	2.5	1.30E+00	29.70%	17.47	15.20	97.84	Yes
Storm-flow	4/17/1995	3.5	1.30E+00	29.70%	24.46	21.28	97.84	Yes
Storm-flow	2/2/2004	5.0	1.34E+00	28.94%	36.06	31.37	100.97	Yes
Storm-flow	3/6/2000	15.0	1.34E+00	28.94%	108.18	94.11	100.97	Yes
Storm-flow	6/3/1996	22.5	1.41E+00	27.78%	170.88	148.67	106.33	No

<u>Category</u>	<u>Date</u>	Observed TSS at ARK0033 <u>(mg/L)</u>	Flow per unit area on sampling day <u>(cfs/mi2)</u>	Percent exceedance for flow on sampling day <u>(%)</u>	Current TSS load <u>(lbs/day)/mi2</u>	Reduced TSS load <u>(lbs/day)/mi2</u>	Allowable TSS load <u>(lbs/day)/mi2</u>	Reduced load less than or equal to allow. load?
Storm-flow	4/1/1996	15.5	1.42E+00	27.55%	118.71	103.28	107.22	Yes
Storm-flow	1/5/2004	8.2	1.48E+00	26.71%	65.42	56.91	111.69	Yes
Storm-flow	3/27/1995	4.5	1.48E+00	26.71%	35.90	31.23	111.69	Yes
Storm-flow	3/22/2005	22.8	1.55E+00	25.65%	190.62	165.84	117.05	No
Storm-flow	3/4/2002	4.7	1.59E+00	25.03%	40.34	35.10	120.18	Yes
Storm-flow	12/14/2004	3.2	1.61E+00	24.73%	27.78	24.16	121.52	Yes
Storm-flow	5/8/2000	16.5	1.62E+00	24.58%	144.27	125.51	122.41	No
Storm-flow	4/12/1999	6.0	1.65E+00	24.17%	53.42	46.47	124.64	Yes
Storm-flow	4/11/1994	7.5	1.76E+00	22.75%	71.32	62.05	133.13	Yes
Storm-flow	2/15/2005	6.8	1.83E+00	21.96%	67.05	58.33	138.05	Yes
Storm-flow	1/18/2005	5.0	1.85E+00	21.73%	49.78	43.31	139.39	Yes
Storm-flow	2/11/2002	2.0	1.95E+00	20.70%	21.00	18.27	146.98	Yes
Storm-flow	4/29/1996	24.5	1.95E+00	20.70%	257.22	223.78	146.98	No
Storm-flow	12/12/1994	7.0	1.95E+00	20.63%	73.71	64.13	147.43	Yes
Storm-flow	1/23/1995	3.5	1.96E+00	20.49%	37.08	32.26	148.32	Yes
Storm-flow	2/18/1992	10.0	2.18E+00	18.50%	117.75	102.44	164.85	Yes
Storm-flow	11/25/1991	8.0	2.19E+00	18.43%	94.46	82.18	165.30	Yes
Storm-flow	11/18/1996	7.0	2.25E+00	17.96%	84.88	73.85	169.76	Yes
Storm-flow	1/12/1998	5.5	2.26E+00	17.86%	67.04	58.33	170.66	Yes
Storm-flow	5/3/2004	7.5	2.29E+00	17.69%	92.62	80.58	172.89	Yes
Storm-flow	12/4/1990	31.0	2.33E+00	17.33%	388.77	338.23	175.57	No
Storm-flow	2/28/1994	4.0	2.66E+00	14.95%	57.31	49.86	200.59	Yes
Storm-flow	3/17/1997	3.0	2.72E+00	14.64%	44.04	38.31	205.50	Yes
Storm-flow	3/1/1993	9.0	3.09E+00	12.65%	150.20	130.68	233.65	Yes
Storm-flow	1/31/1994	4.5	3.11E+00	12.59%	75.53	65.71	234.99	Yes
Storm-flow	2/24/1997	6.0	3.55E+00	10.74%	114.88	99.94	268.05	Yes
Storm-flow	11/22/1993	9.0	3.55E+00	10.74%	172.32	149.92	268.05	Yes
Storm-flow	1/25/1993	14.0	3.83E+00	9.83%	289.05	251.47	289.05	Yes
Storm-flow	10/12/2004	16.0	3.94E+00	9.50%	340.04	295.83	297.53	Yes
Storm-flow	2/1/1999	5.0	3.96E+00	9.43%	106.90	93.00	299.32	Yes

<u>Category</u>	<u>Date</u>	Observed TSS at ARK0033 <u>(mg/L)</u>	Flow per unit area on sampling day <u>(cfs/mi2)</u>	Percent exceedance for flow on sampling day	Current TSS load <u>(lbs/day)/mi2</u>	Reduced TSS load <u>(lbs/day)/mi2</u>	Allowable TSS load <u>(lbs/day)/mi2</u>	Reduced load less than or equal to allow. load?
Storm-flow	5/6/2003	12.0	4.02E+00	9.28%	260.01	226.21	303.34	Yes
Storm-flow	3/5/2001	5.0	4.06E+00	9.08%	109.45	95.22	306.47	Yes
Storm-flow	12/6/1993	4.0	5.33E+00	6.24%	114.88	99.94	402.07	Yes
Storm-flow	4/1/2002	8.2	5.36E+00	6.17%	236.81	206.02	404.31	Yes
Storm-flow	5/3/1993	15.0	6.63E+00	4.35%	536.10	466.41	500.36	Yes
Storm-flow	4/16/1991	27.0	7.75E+00	3.41%	1128.68	981.95	585.24	No
Storm-flow	11/7/1994	12.0	8.28E+00	3.05%	536.10	466.41	625.45	Yes
Storm-flow	6/25/1991	14.0	8.93E+00	2.72%	674.59	586.89	674.59	Yes
Storm-flow	12/16/1996	24.0	9.47E+00	2.54%	1225.37	1066.07	714.80	No
Storm-flow	1/3/2000	23.0	2.38E+01	0.52%	2957.80	2573.28	1800.40	No
Storm-flow	12/17/2001	24.0	5.83E+01	0.06%	7543.67	6562.99	4400.48	No

Total number of values = 95  
 Allowable % of exceedances = 20%  
 Allowable no. of exceedances = 19  
 No. of exceedances before reductions = 23  
 No. of exceedances after reductions = 19

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TABLE F.3. CALCULATIONS FOR PERCENT REDUCTION FOR BASE FLOW CONDITIONS  
FOR WHITE OAK CREEK (STATION ARK0053)

Base flow target TSS conc. = 12 mg/L Error check for reduction is / is not needed: ok  
Percent reduction needed = 30% Error check for less or more reduction needed: ok

<u>Category</u>	<u>Date</u>	<u>Observed TSS at ARK0033 (mg/L)</u>	<u>Flow per unit area on sampling day (cfs/mi2)</u>	<u>Percent exceedance for flow on sampling day</u>	<u>Current TSS load (lbs/day)/mi2</u>	<u>Reduced TSS load (lbs/day)/mi2</u>	<u>Allowable TSS load (lbs/day)/mi2</u>	<u>Reduced load less than or equal to allow. load?</u>
Base flow	9/7/2004	17.5	1.18E-02	87.34%	1.12	0.78	0.77	No
Base flow	8/3/2004	6.8	6.51E-02	75.27%	2.39	1.67	4.21	Yes
Base flow	7/6/2004	7.8	2.25E-01	62.21%	9.46	6.62	14.55	Yes
Base flow	6/8/2004	4.8	2.25E-01	62.21%	5.82	4.07	14.55	Yes
Base flow	7/29/2003	8.5	1.48E-01	66.87%	6.78	4.75	9.57	Yes
Base flow	11/12/2002	4.8	1.42E-01	67.32%	3.68	2.57	9.19	Yes
Base flow	10/15/2002	1.0	1.18E-03	94.31%	0.01	0.00	0.08	Yes
Base flow	9/3/2002	3.8	1.48E-02	86.21%	0.30	0.21	0.96	Yes
Base flow	8/6/2002	4.0	5.33E-02	77.00%	1.15	0.80	3.45	Yes
Base flow	7/1/2002	9.0	1.18E-01	69.39%	5.74	4.02	7.66	Yes
Base flow	11/26/2001	17.0	2.96E-02	82.11%	2.71	1.90	1.91	Yes
Base flow	10/29/2001	3.3	1.30E-03	94.10%	0.02	0.02	0.08	Yes
Base flow	9/17/2001	12.8	2.31E-03	93.25%	0.16	0.11	0.15	Yes
Base flow	8/20/2001	9.8	1.48E-02	86.21%	0.78	0.55	0.96	Yes
Base flow	7/16/2001	14.5	7.10E-03	89.65%	0.56	0.39	0.46	Yes
Base flow	6/4/2001	6.7	1.42E-01	67.32%	5.13	3.59	9.19	Yes
Base flow	4/30/2001	6.0	1.89E-01	64.13%	6.13	4.29	12.25	Yes
Base flow	10/30/2000	7.0	2.96E-04	95.71%	0.01	0.01	0.02	Yes
Base flow	10/9/2000	31.5	5.33E-04	95.39%	0.09	0.06	0.03	No
Base flow	8/14/2000	21.0	2.19E-03	93.32%	0.25	0.17	0.14	No
Base flow	7/17/2000	9.0	5.15E-02	77.39%	2.50	1.75	3.33	Yes
Base flow	11/29/1999	12.5	1.18E-04	96.11%	0.01	0.01	0.01	Yes
Base flow	11/1/1999	32.5	7.10E-03	89.65%	1.24	0.87	0.46	No
Base flow	10/4/1999	8.0	5.92E-06	98.12%	0.00	0.00	0.00	Yes

<u>Category</u>	<u>Date</u>	Observed TSS at ARK0033 <u>(mg/L)</u>	Flow per unit area on sampling day <u>(cfs/mi2)</u>	Percent exceedance for flow on sampling day <u>(lbs/day)/mi2</u>	Current TSS load <u>(lbs/day)/mi2</u>	Reduced TSS load <u>(lbs/day)/mi2</u>	Allowable TSS load <u>(lbs/day)/mi2</u>	Reduced load less than or equal to <u>allow. load?</u>
Base flow	9/13/1999	27.0	5.92E-06	98.12%	0.00	0.00	0.00	No
Base flow	8/9/1999	24.0	2.96E-04	95.71%	0.04	0.03	0.02	No
Base flow	7/19/1999	25.5	3.96E-02	79.84%	5.45	3.82	2.57	No
Base flow	6/21/1999	3.0	2.19E-02	83.92%	0.35	0.25	1.42	Yes
Base flow	11/9/1998	8.0	2.37E-02	83.46%	1.02	0.71	1.53	Yes
Base flow	10/26/1998	4.0	5.33E-02	77.00%	1.15	0.80	3.45	Yes
Base flow	9/28/1998	4.5	5.92E-06	98.12%	0.00	0.00	0.00	Yes
Base flow	8/24/1998	5.0	4.20E-03	91.65%	0.11	0.08	0.27	Yes
Base flow	7/27/1998	4.5	5.92E-06	98.12%	0.00	0.00	0.00	Yes
Base flow	6/22/1998	11.5	2.78E-02	82.49%	1.72	1.21	1.80	Yes
Base flow	12/15/1997	2.0	1.95E-01	63.88%	2.11	1.47	12.64	Yes
Base flow	11/17/1997	5.0	1.54E-01	66.40%	4.15	2.90	9.96	Yes
Base flow	10/27/1997	10.5	1.07E-01	70.56%	6.03	4.22	6.89	Yes
Base flow	9/29/1997	9.5	2.37E-04	95.84%	0.01	0.01	0.02	Yes
Base flow	8/25/1997	12.5	5.92E-03	90.41%	0.40	0.28	0.38	Yes
Base flow	7/21/1997	8.0	1.78E-02	85.11%	0.77	0.54	1.15	Yes
Base flow	6/2/1997	24.5	1.30E-01	68.27%	17.20	12.04	8.42	No
Base flow	9/23/1996	8.5	1.78E-01	64.94%	8.14	5.70	11.49	Yes
Base flow	8/5/1996	18.5	1.36E-02	86.64%	1.36	0.95	0.88	No
Base flow	7/1/1996	24.0	1.48E-01	66.87%	19.15	13.40	9.57	No
Base flow	12/4/1995	10.5	3.55E-02	80.81%	2.01	1.41	2.30	Yes
Base flow	11/6/1995	2.5	7.69E-03	89.33%	0.10	0.07	0.50	Yes
Base flow	10/16/1995	6.0	3.55E-04	95.60%	0.01	0.01	0.02	Yes
Base flow	9/18/1995	32.5	5.92E-06	98.12%	0.00	0.00	0.00	No
Base flow	8/21/1995	7.0	1.66E-02	85.61%	0.63	0.44	1.07	Yes
Base flow	7/24/1995	200.5	1.18E-01	69.39%	127.96	89.57	7.66	No
Base flow	6/26/1995	7.5	3.79E-02	80.26%	1.53	1.07	2.45	Yes
Base flow	10/17/1994	5.0	2.72E-03	92.81%	0.07	0.05	0.18	Yes
Base flow	9/26/1994	4.0	2.96E-02	82.11%	0.64	0.45	1.91	Yes
Base flow	8/29/1994	3.0	7.69E-02	73.82%	1.24	0.87	4.98	Yes

<u>Category</u>	<u>Date</u>	Observed TSS at ARK0033 <u>(mg/L)</u>	Flow per unit area on sampling day <u>(cfs/mi2)</u>	Percent exceedance for flow on sampling day <u>(%)</u>	Current TSS load <u>(lbs/day)/mi2</u>	Reduced TSS load <u>(lbs/day)/mi2</u>	Allowable TSS load <u>(lbs/day)/mi2</u>	Reduced load less than or equal to allow. load?
Base flow	7/18/1994	12.5	1.48E-01	66.87%	9.97	6.98	9.57	Yes
Base flow	9/13/1993	2.0	7.10E-03	89.65%	0.08	0.05	0.46	Yes
Base flow	8/16/1993	5.0	6.51E-03	89.98%	0.18	0.12	0.42	Yes
Base flow	7/12/1993	22.0	6.51E-03	89.98%	0.77	0.54	0.42	No
Base flow	6/7/1993	6.0	2.13E-01	62.81%	6.89	4.82	13.79	Yes
Base flow	11/16/1992	17.0	1.01E-01	71.15%	9.22	6.46	6.51	Yes
Base flow	10/20/1992	4.0	1.12E-03	94.52%	0.02	0.02	0.07	Yes
Base flow	9/21/1992	220.0	1.12E-03	94.52%	1.33	0.93	0.07	No
Base flow	8/24/1992	4.0	5.15E-03	91.08%	0.11	0.08	0.33	Yes
Base flow	7/27/1992	96.0	2.01E-01	63.61%	104.16	72.91	13.02	No
Base flow	6/2/1992	12.0	1.83E-01	64.50%	11.87	8.31	11.87	Yes
Base flow	5/11/1992	12.0	2.43E-01	61.37%	15.70	10.99	15.70	Yes
Base flow	10/8/1991	10.0	2.60E-03	92.87%	0.14	0.10	0.17	Yes
Base flow	9/24/1991	67.0	1.18E-02	87.34%	4.28	2.99	0.77	No
Base flow	7/30/1991	7.0	1.66E-02	85.61%	0.63	0.44	1.07	Yes
Base flow	7/23/1991	32.0	3.85E-02	80.13%	6.64	4.65	2.49	No
Base flow	9/18/1990	5.0	2.96E-03	92.60%	0.08	0.06	0.19	Yes

Total number of values = 71  
 Allowable % of exceedances = 25%  
 Allowable no. of exceedances = 18  
 No. of exceedances before reductions = 24  
 No. of exceedances after reductions = 17

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