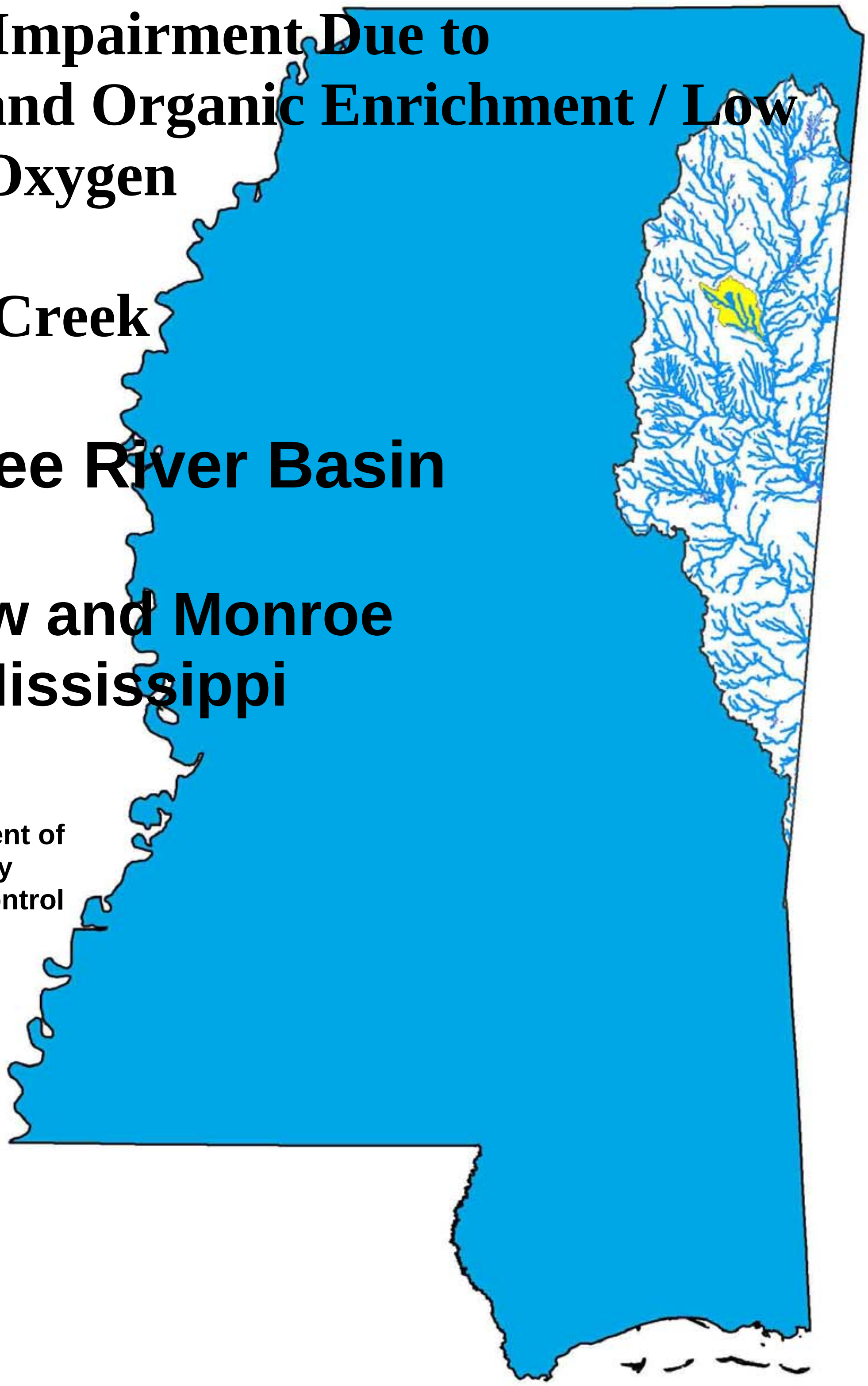
FINAL REPORT
October 2009

Total Maximum Daily Load

Biological Impairment Due to Nutrients and Organic Enrichment / Low Dissolved Oxygen For Mattubby Creek



Tombigbee River Basin

Chickasaw and Monroe County, Mississippi

Prepared By

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FOREWORD

The report contains one or more Total Maximum Daily Loads (TMDLs) for water body segments found on Mississippi's current Section 303(d) List of Impaired Water Bodies. The implementation of the TMDLs contained herein will be prioritized within Mississippi's rotating basin approach.

As additional information becomes available, the TMDLs may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, modifications to the water quality standards or criteria, or changes in landuse within the watershed. In some cases, additional water quality data may indicate that no impairment exists.

Conversion Factors

To convert from	To	Multiply by	To convert from	To	Multiply by
mile^2	acre	640	acre	ft^2	43560
km^2	acre	247.1	days	seconds	86400
m^3	ft^3	35.3	meters	feet	3.28
ft^3	gallons	7.48	ft^3	gallons	7.48
ft^3	liters	28.3	hectares	acres	2.47
cfs	gal/min	448.8	miles	meters	1609.3
cfs	MGD	0.646	tonnes	tons	1.1
m^3	gallons	264.2	µg/l * cfs	gm/day	2.45
m^3	liters	1000	µg/l * MGD	gm/day	3.79

Fraction	Prefix	Symbol	Multiple	Prefix	Symbol
10^{-1}	deci	d	10	deka	da
10^{-2}	centi	c	10^{2}	hecto	h
10^{-3}	milli	m	10^{3}	kilo	k
10^{-6}	micro	:	10^{6}	mega	M
10^{-9}	nano	n	10^{9}	giga	G
10^{-12}	pico	p	10^{12}	tera	T
10^{-15}	femto	f	10^{15}	peta	P
10^{-18}	atto	a	10^{18}	exa	E

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Table 1. Listing Information

Name	ID	County	HUC	Cause	Stressors
Mattubby Creek	MS009ME	Chickasaw, Monroe	03160101	Biological Impairment	Nutrients and Organic Enrichment / Low Dissolved Oxygen
Location: Near Aberdeen from headwaters to the Ten-Tom Waterway					

Table 2. Water Quality Standards

Parameter	Beneficial use	Water Quality Criteria
Nutrients	Aquatic Life Support	Waters shall be free from materials attributable to municipal, industrial, agricultural, or other dischargers producing color, odor, taste, total suspended solids, or other conditions in such degree as to create a nuisance, render the waters injurious to public health, recreation, or to aquatic life and wildlife, or adversely affect the palatability of fish, aesthetic quality, or impair the waters for any designated uses.
Dissolved Oxygen	Aquatic Life Support	DO concentrations shall be maintained at a daily average of not less than 5.0 mg/l with an instantaneous minimum of not less than 4.0 mg/l

Table 3. NPDES Facilities

NPDES ID	Facility Name	Permitted Discharge (MGD)	Receiving Water
MS0058122	Monroe County Board of Supervisors, Wren Industrial Park Sewer System	0.015	Cowpen Creek
MS0025631	Okolona POTW, South	0.66	Unnamed tributary to Mattubby Creek

Table 4. Total Maximum Daily Load

Pollutant	WLA (lbs/day)	LA (lbs/day)	MOS	TMDL (lbs/day)
TN	64.74	680.31	Implicit	745.05
TP	29.28	77.16	Implicit	106.44
TBODu	135.24	0.61	Implicit	135.85

EXECUTIVE SUMMARY

This TMDL has been developed for Mattubby Creek which was placed on the Mississippi 1996 Section 303(d) List of Impaired Water Bodies due to evaluated causes of pesticides, siltation, nutrients, organic enrichment/low dissolved oxygen, and pathogens. MDEQ completed biological monitoring on Mattubby Creek, which indicated biological impairment. It was determined that nutrients and organic enrichment / low dissolved oxygen are probable primary stressors. This TMDL will provide an estimate of the total nitrogen (TN) and total phosphorus (TP) allowable in the stream and will also provide an allocation for TBODu and nutrients for the two point sources located in the watershed.

Mississippi does not have water quality standards for allowable nutrient concentrations. MDEQ currently has a Nutrient Task Force (NTF) working on the development of criteria for nutrients. An annual concentration of 0.7 mg/l is an applicable target for TN and 0.10 mg/l for TP for water bodies located in Ecoregion 65. MDEQ is presenting these concentrations as preliminary target values for TMDL development which is subject to revision after the development of numeric nutrient criteria.

The Mattubby Creek Watershed is located in HUC 03160101 near Aberdeen. Mattubby Creek flows for 28.7 miles in a in a southeasterly direction from its headwaters near Okolona to the confluence with the Tennessee-Tombigbee Waterway in Monroe County.

The Mattubby Creek watershed mass balance calculations showed that the estimated existing nutrient concentration indicates reductions are needed. Because significant reductions in TP are necessary, reduced TP permit limits are recommended in order to protect water quality. MDEQ believes that with these reductions and with the installation of best management practices, the stream will meet water quality standards.

Figure 1. Mattubby Creek

INTRODUCTION

1.1 Background

The identification of water bodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those water bodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR part 130). The TMDL process is designed to restore and maintain the quality of those impaired water bodies through the establishment of pollutant specific allowable loads. This TMDL has been developed for the 2004 §303(d) listed segment shown in Figure 2.

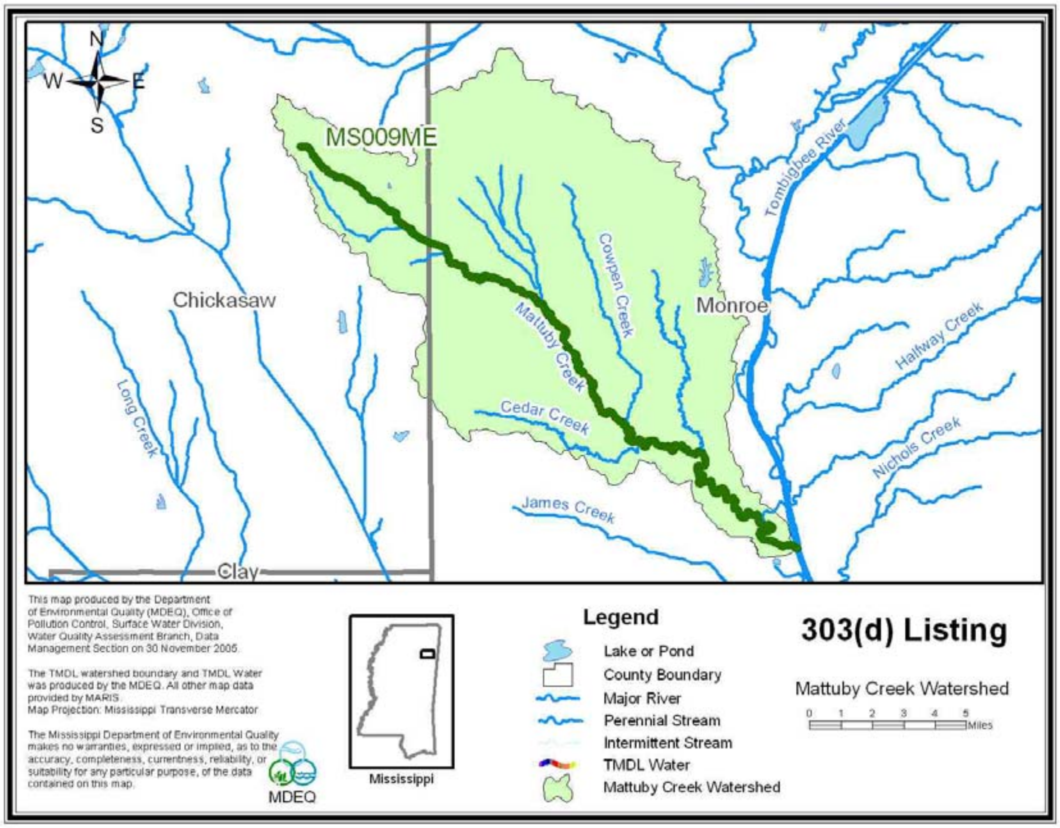


Figure 2. Mattubby Creek §303(d) Segment

The original listing for Mattubby Creek was on the 1996 303(d) list. There were no monitoring data, so the stream remained on the evaluated portion of Mississippi's §303(d) list. MDEQ began a biological monitoring program, the M-BISQ, to monitor this and other evaluated streams to confirm water quality based on the health of the biology in the stream. Mattubby Creek was confirmed as impaired based on the biology.

1.2 Stressor Identification

The impaired segment was listed due to failure to meet minimum water quality criteria for aquatic use support based on biological sampling (MDEQ, 2003). Because of these results, a detailed assessment of the watershed and potential pollutant sources, called a stressor identification report, was developed for each stream. The purpose of the stressor identification process is to identify the stressors and their sources most likely causing degradation of instream biological conditions. The results indicate that nutrients and organic enrichment were probable primary stressors for Mattubby Creek (MDEQ, 2006).

There are no state criteria in Mississippi for nutrients. These criteria are currently being developed by the Mississippi Nutrient Task Force in coordination with EPA Region 4. MDEQ proposed a work plan for nutrient criteria development that has been mutually agreed upon with EPA Region 4 and is on schedule according to the approved timeline for development of nutrient criteria (MDEQ, 2007).

For this TMDL, MDEQ is presenting preliminary target concentrations for TN and TP. The limited data available are greater than these ranges for TN and TP. An annual concentration of 0.7 mg/l is an applicable target for TN and 0.10 mg/l for TP for water bodies located in Ecoregion 65. However, MDEQ is presenting these values as preliminary target values for TMDL development which is subject to revision after the development of nutrient criteria, when the work of the NTF is complete.

1.3 Applicable Water Body Segment Use

The water use classifications are established by the State of Mississippi in the document *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (MDEQ, 2007). The designated beneficial use for the listed segment is fish and wildlife.

1.4 Applicable Water Body Segment Standard

The water quality standard applicable to the use of the water body and the pollutant of concern is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (MDEQ, 2007). Mississippi's current standards contain a narrative criteria that can be applied to nutrients which states "*Waters shall be free from materials attributable to municipal, industrial, agricultural, or other discharges producing color, odor, taste, total suspended or dissolved solids, sediment, turbidity, or other conditions in such degree as to create a nuisance, render the waters injurious to public health, recreation, or to aquatic life and wildlife, or adversely affect the palatability of fish, aesthetic quality, or impair the waters for any designated use* (MDEQ, 2007)."

1.5 Nutrient Target Development

Nutrient data were collected quarterly at 99 discrete sampling stations state wide where biological data already existed. These stations were identified and used to represent a range of stream reaches according to biological health status, geographic location (selected to account for ecoregion, bioregion, basin and geologic variability) and streams that potentially receive non-point source pollution from urban, agricultural, and silviculture lands as well as point source pollution from NPDES permitted facilities.

Nutrient concentration data were not normally distributed; therefore, data were log transformed for statistical analyses. Data were evaluated for distinct patterns of various data groupings (stratification) according to natural variability. Only stations that were characterized as "least disturbed" through a defined process in the M-BISQ process (M-BISQ 2003) or stations that resulted in a biological impairment rating of "fully attaining" were used to evaluate natural variability of the data set. Each of these two groups was evaluated separately ("least disturbed sites" and "fully attaining sites). Some stations were used in both sets, in other words, they were considered "least disturbed" and "fully attaining". The number of stations considered "least disturbed" was 30 of 99, and the number of stations considered "fully attaining" was 53 of 99.

Several analysis techniques were used to evaluate nutrient data. Graphical analyses were used as the primary evaluation tool. Specific analyses used included; scatter plots, box plots, Pearson's correlation, and general descriptive statistics.

In general, natural nutrient variability was not apparent based on box plot analyses according to the 4 stratification scenarios. Bioregions were selected as the stratification scheme to use for TMDLs in the Pascagoula Basin. However, this was not appropriate for some water bodies in smaller bioregions. Therefore, MDEQ now uses ecoregions as a stratification scheme for the water bodies in the remainder of the state.

In order to use the data set to determine possible nutrient thresholds, nutrient concentrations were evaluated as to their correlation with biological metrics. That thorough evaluation was completed prior to the Pascagoula River Basin TMDLs. The methodology and approach were verified. The same methodology was applied to the subsequent bioregions and ecoregions.

For the preliminary target concentration range per each ecoregion, the 75th and 90th percentiles were derived for station mean values of nutrient sites found to be fully supporting of aquatic life support according to the M-BISQ scores. For the estimate of the existing concentrations the 50th percentile (median) was derived for station mean values of sites that were not attaining and had nutrient concentrations greater than the target.

WATER BODY ASSESSMENT

2.1 Mattubby Creek Water Quality Data

Nutrient data for the Mattubby Creek Watershed were gathered and reviewed. The data are given in Table 5. Data exist for the §303(d)-listed segment of Mattubby Creek based on samples collected during the §303(d)/M-BISQ monitoring project at site #151 and data collected as part of MDEQ's ambient monitoring program. The location of the MBISQ Station is shown in Figure 3. Ambient station TB055 is at the same location as MBISQ Station #151.

Table 5. Mattubby Creek Nutrient Data

Station	Date	Time	TN (mg/l)	TP (mg/l)
TB055	6/16/1999	16:00	0.86	0.13
TB055	10/6/1999	14:00	0.23	0.01
TB055	1/11/2000	13:30	3.30	0.12
TB055	4/11/2000	11:00	1.42	0.15
IBI #151	2/22/2001	08:45	1.23	0.12

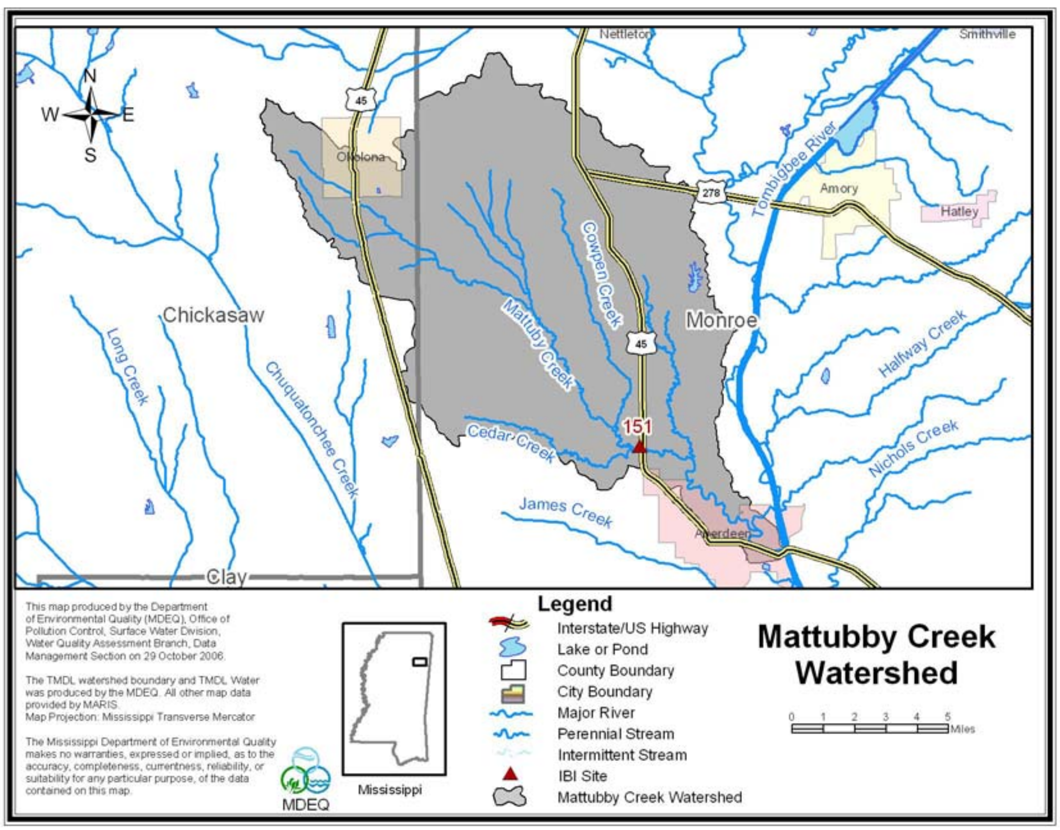


Figure 3. Mattubby Creek Water Quality Monitoring Station

2.2 Assessment of Point Sources

There are 2 NPDES point sources in the watershed included in the TMDL as shown in Figure 4 below.   Table 6 indicates the existing estimates of loads for these outfalls at the maximum daily load scenario.

Table 6. Loads from Point Sources

NPDES	Facility	Flow (MGD)	TN Load (lbs/day)	TP Load (lbs/day)	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
MS0058122	Monroe County Board of Supervisors, Wren Industrial Park Sewer System	**0.015**	**1.44**	**0.65**	**1.88**	**1.14**	**3.02**
MS0025631	Okolona POTW, South	**0.66**	**63.30**	**28.62**	**82.57**	**50.31**	**132.88**
	Total		**64.74**	**29.27**	**84.45**	**51.45**	**135.90**

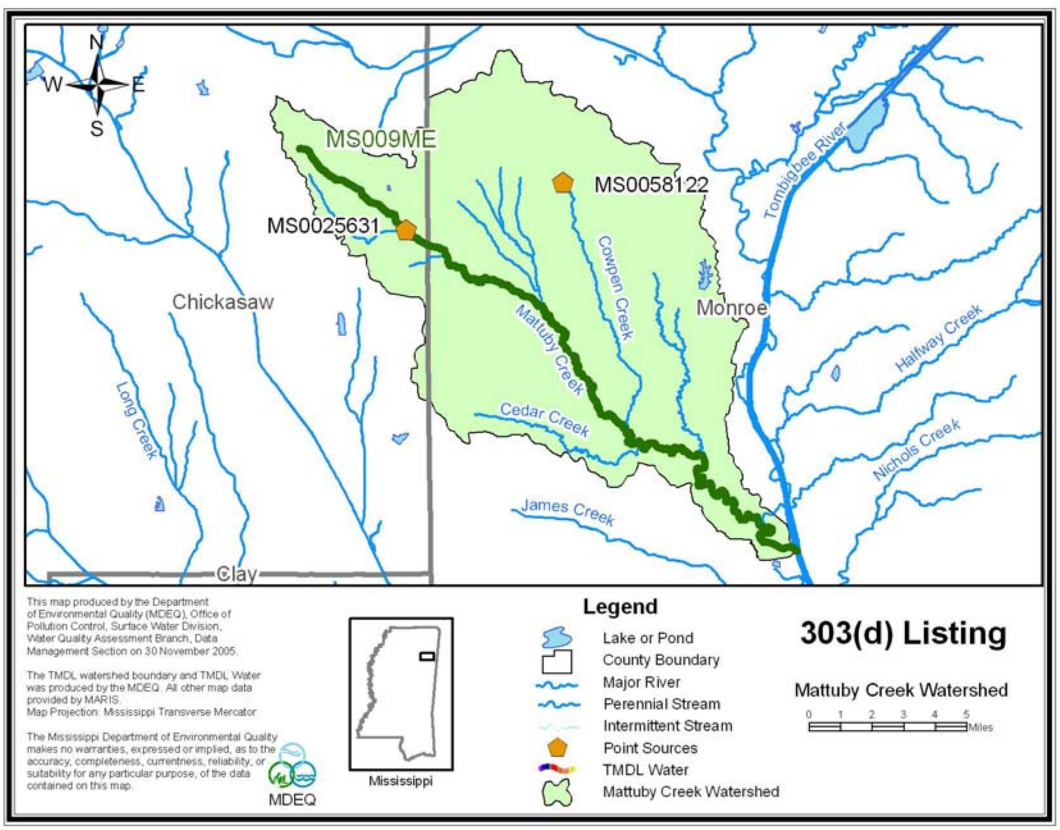


Figure 4. Mattubby Creek Point Sources

2.3 Assessment of Non-Point Sources

Non-point loading of nutrients and organic material in a water body results from the transport of the pollutants into receiving waters by overland surface runoff, groundwater infiltration, and atmospheric deposition. The two primary nutrients of concern are nitrogen and phosphorus. Total nitrogen is a combination of many forms of nitrogen found in the environment. Inorganic nitrogen can be transported in particulate and dissolved phases in surface runoff. Dissolved inorganic nitrogen can be transported in groundwater and may enter a stream from groundwater infiltration. Finally, atmospheric gaseous nitrogen may enter a stream from atmospheric deposition.

Unlike nitrogen, phosphorus is primarily transported in surface runoff when it has been sorbed by eroding sediment. Phosphorus may also be associated with fine-grained particulate matter in the atmosphere and can enter streams as a result of dry fallout and rainfall (USEPA, 1999). However, phosphorus is typically not readily available from the atmosphere or the natural water supply (Davis and Cornwell, 1988). As a result, phosphorus is typically the limiting nutrient in most non-point source dominated rivers and streams, with the exception of watersheds which are dominated by agriculture and have high concentrations of phosphorus contained in the surface runoff due to fertilizers and animal excrement or watersheds with naturally occurring soils which are rich in phosphorus (Thomann and Mueller, 1987).

Watersheds with a large number of failing septic tanks may also deliver significant loadings of phosphorus to a water body. All domestic wastewater contains phosphorus which comes from humans and the use of phosphate containing detergents. Table 7 presents the estimated loads from various land use types in the Pearl Basin based on information from USDA ARS Sedimentation Laboratory (Shields, et. al., 2008).

The watershed contains mainly forest but also has different landuse types, including urban, water, and wetlands. The land use information for the watershed is based on the National Land Cover Database (NLCD). The landuse distribution for the Mattubby Creek Watershed is shown in Table 7 and Figure 5. By multiplying the landuse category size by the estimated nutrient load, the watershed specific estimate can be calculated. Table 7 presents the estimated loads, the target loads, and the reductions needed to meet the TMDLs.

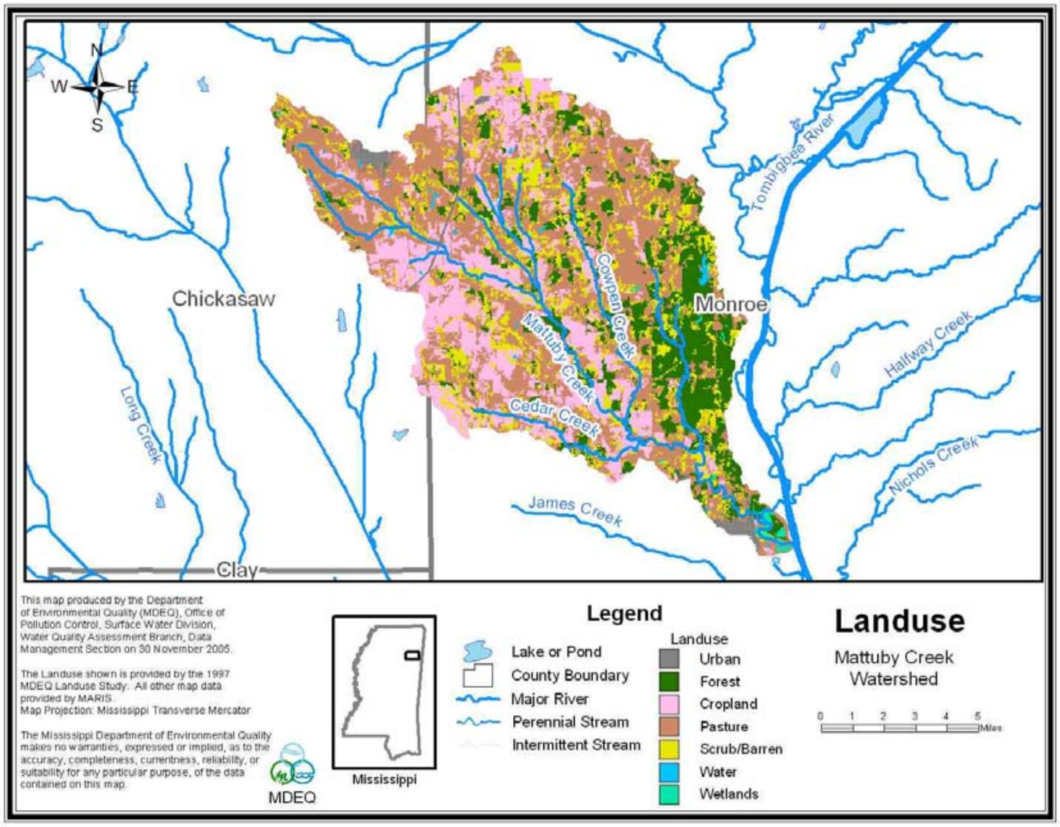


Figure 5. Landuse in Mattubby Creek Watershed

2.4 Estimated Existing Load for Total Nitrogen and Total Phosphorus

The average annual flow was estimated based on flow data from the USGS gage located on the Chuquatonchee Creek near West Point, Mississippi (02440500). The average annual flow for this gage is 797 cfs. To estimate the amount of flow in Mattubby Creek, a drainage area ratio was calculated (797 cfs/505 square miles = 1.58 cfs/square miles). The ratio was then multiplied by the drainage area of the impaired segment. The TMDL target TN and TP loads were then calculated, using Equation 1 and the results are shown in Table 7.

Nutrient Load (lb/day) = Flow (cfs) * 5.394 (conversion factor)* Nutrient Concentration (mg/L)
(Equation 1)

Table 7. TMDL Calculations and Watershed Sizes

Water body	**Mattubby Creek**
Land Use	**TN kg/mile2**
Forest	111.3
Pasture	777.2
Cropland	5179.9
Urban	296.4
Water	257.4
Wetland	265.2
aquaculture	111.3

Land Use	**TP kg/mile2**
Forest	62.1
Pasture	777.2
Cropland	2589.9
Urban	3.1
Water	257.4
Wetland	265.2
aquaculture	62.1

	Water	Urban	Forest	Scrub/Barren	Pasture	Cropland	Wetland	**Total**	
Acres	956.97	4467.47	12990.53	6847.76	24767.89	19731.98	10165.45	79928.05	
Percent	0.01	5.59	16.25	8.57	30.99	24.69	12.72	100.00	
$Miles^2$ in watershed	1.50	6.98	20.30	10.70	38.70	30.83	15.88	124.89	
Flow in cfs based on area	197.32	cfs							
TN Load kg/mi^2 annual avg	257.40	296.40	111.32	111.32	777.20	5179.90	265.20		
TP Load kg/mi^2 annual avg	257.40	3.12	62.10	62.10	777.20	2589.90	265.20		
TN Load kg/day	1.05	5.67	6.19	3.26	82.40	437.54	11.54	547.66	kg/day
TP Load kg/day	1.05	0.06	3.45	1.82	82.40	218.77	11.54	319.10	kg/day
TN target concentration	0.70	mg/l							
TP target concentration	0.10	mg/l							
TN estimated concentration	1.13	mg/l							
TP estimated concentration	0.66	mg/l							
TN target load	745.05	lbs/day							
TP target load	106.44	lbs/day							
TBODu target load	135.90	lbs/day	based on STREAM model output						
TN estimated load per day	1207.39	lbs/day							
TP estimated load per day	703.49	lbs/day							
TN reduction needed	38.29%								
TP reduction needed	84.87%								
TBODu reduction needed	NA								

The land use calculations are based on 2004 data. The nutrient estimates are based on USDA ARS. The TMDL targets are based on EPA guidance for calculation of targets when considering all available data.

MODELING PROCEDURE: LINKING THE SOURCES TO THE ENDPOINT

Establishing the relationship between the instream water quality target and the source loading is a critical component of TMDL development. It allows for the evaluation of management options that will achieve the desired source load reductions. The link can be established through a range of techniques, from qualitative assumptions based on sound scientific principles to sophisticated modeling techniques. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain water body responses to flow and loading conditions. In this section, the selection of the modeling tools, setup, and model application are discussed.

3.1 Modeling Framework Selection

A mathematical model, STeady Riverine Environmental Assessment Model (STREAM), for DO distribution in freshwater streams was used for developing the TMDL. STREAM is an updated version of the AWFWUL1 model, which had been used by MDEQ for many years. The use of AWFWUL1 is promulgated in the *Wastewater Regulations for National Pollutant Discharge Elimination System (NPDES) Permits, Underground Injection Control (UIC) Permits, State Permits, Water Quality Based Effluent Limitations and Water Quality Certification* (MDEQ, 1994). This model has been approved by EPA and has been used extensively at MDEQ. A key reason for using the STREAM model in TMDL development is its ability to assess instream water quality conditions in response to point and non-point source loadings.

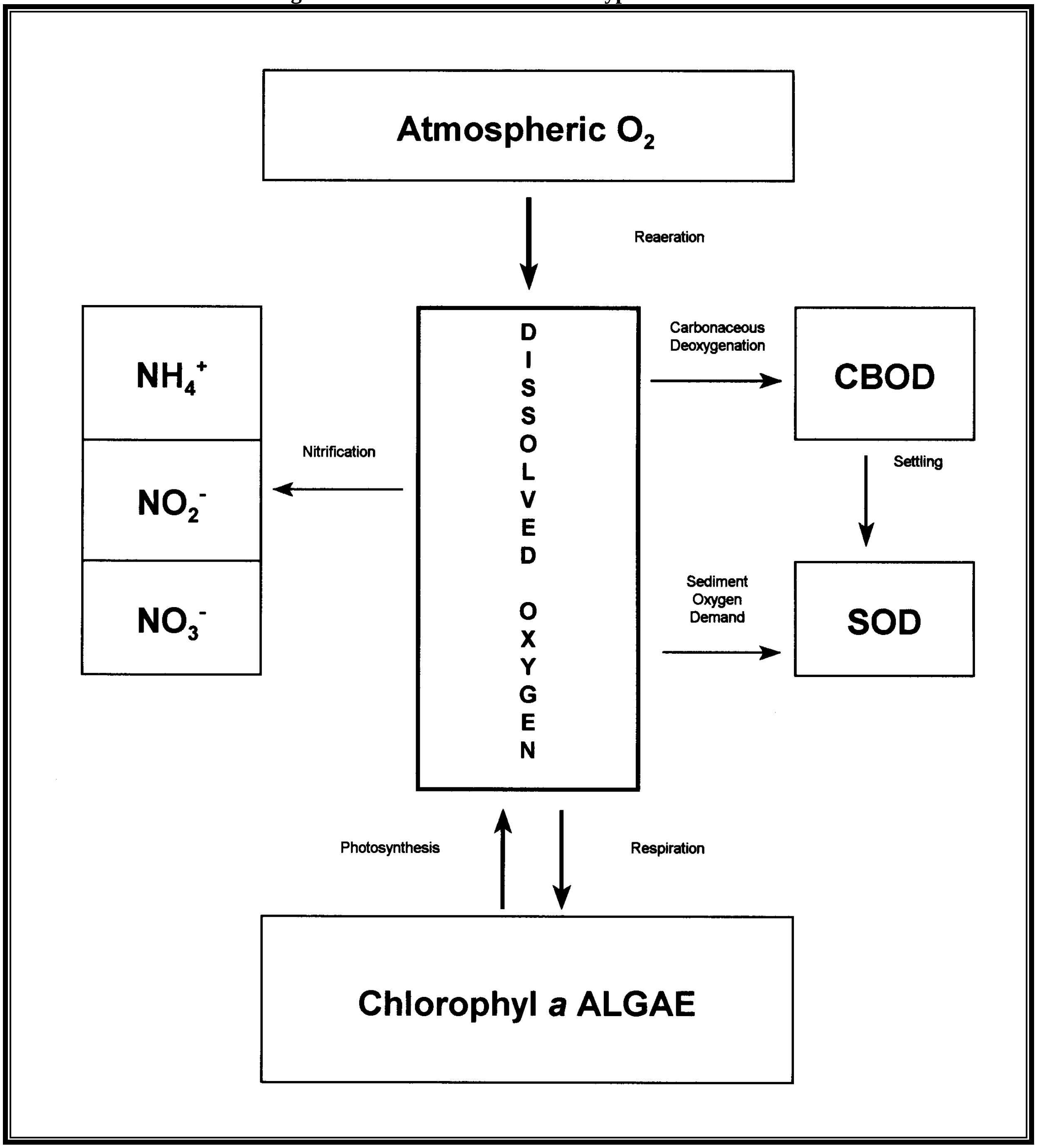
STREAM is a steady-state, daily average computer model that utilizes a modified Streeter-Phelps DO sag equation. Instream processes simulated by the model include CBODu decay, nitrification, reaeration, sediment oxygen demand, and respiration and photosynthesis of algae. Figure 6 shows how these processes are related in a typical DO model. Reaction rates for the instream processes are input by the user and corrected for temperature by the model. The model output includes water quality conditions in each computational element for DO, CBODu, and NH_3-N concentrations. The hydrological processes simulated by the model include stream velocity and flow from point sources and spatially distributed inputs.

The model was set up to calculate reaeration within each reach using the Tsivoglou formulation. The Tsivoglou formulation calculates the reaeration rate, K_a (day^{-1} base e), within each reach according to Equation 2.

$$\mathbf{K_a = C*S*U} \qquad \textbf{(Eq. 2)}$$

C is the escape coefficient, U is the reach velocity in mile/day, and S is the average reach slope in ft/mile. The value of the escape coefficient is assumed to be 0.11 for streams with flows less than 10 cfs and 0.0597 for stream flows equal to or greater than 10 cfs. Reach velocities were calculated using an equation based on slope. The slope of each reach was estimated with the NHD Plus GIS coverage and input into the model in units of feet/mile.

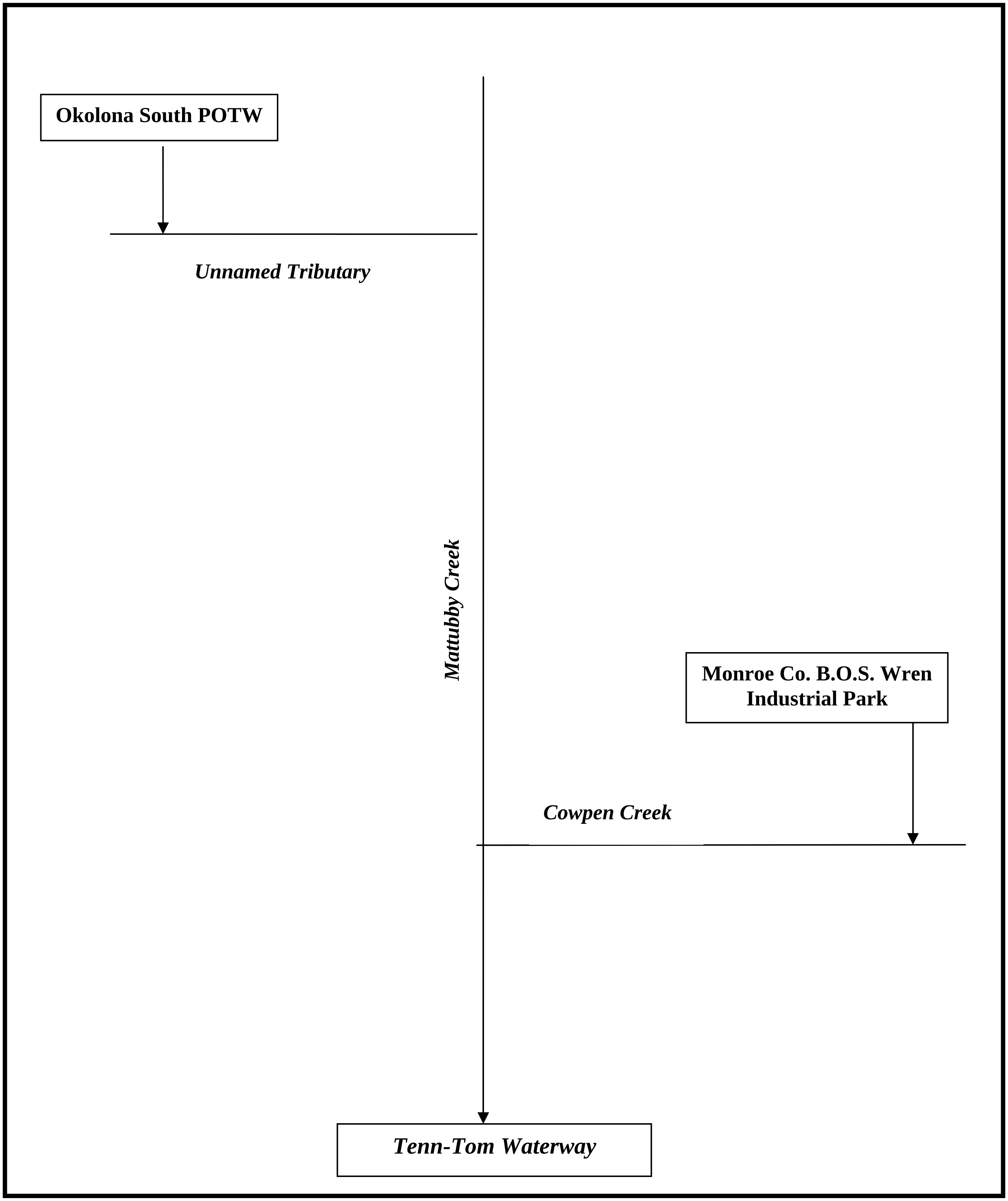
Figure 6. Instream Processes in a Typical DO Model



3.2 Model Setup

The model for this TMDL includes the §303(d) listed segment of Mattubby Creek, beginning at the headwaters. A diagram showing the model setup is shown in Figure 7.

Figure 7. Mattubby Creek Model Setup (Note: Not to Scale)



The water body was divided into reaches for modeling purposes. Reach divisions were made at locations where there is a significant change in hydrological and water quality characteristics, such as the confluence of a point source or tributary. Within each reach, the modeled segments were divided into computational elements of 0.1 mile. The simulated hydrological and water quality characteristics were calculated and output by the model for each computational element.

The STREAM model was setup to simulate flow and temperature conditions, which were determined to be the critical condition for this TMDL. MDEQ Regulations state that when the flow in a water body is less than 50 cfs, the temperature used in the model is 26°C. The headwater instream DO was assumed to be 85% of saturation at the stream temperature. The instream CBODu decay rate at K_d at 20°C was input as 0.3 day^{-1} (base e) as specified in MDEQ regulations. The model adjusts the K_d rate based on temperature, according to Equation 3.

$$\mathbf{K_{d(T)} = K_{d(20°C)}(1.047)^{T-20}} \qquad \textbf{(Eq. 3)}$$

Where K_d is the CBODu decay rate and T is the assumed instream temperature. The assumptions regarding the instream temperatures, background DO saturation, and CBODu decay rate are required by the *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1994). Also based on MDEQ Regulations, the rates for photosynthesis, respiration, and sediment oxygen demand were set to zero because data for these model parameters are not available.

Mattubby Creek currently has no USGS flow gage. The flow in Mattubby Creek watershed was modeled at critical conditions based on a 7Q10 of zero as determined from the USGS Water-Resources Investigation Report 90-4130 Low-Flow and Flow Duration Characteristics of Mississippi Streams (Telis, 1991).

3.3 Source Representation

Both point and non-point sources may be represented in the model. The loads from the NPDES permitted point sources were added as a direct input into the appropriate reaches as a flow in MGD and concentration of $CBOD_5$ and ammonia nitrogen in mg/l.

Organic material discharged to a stream from an NPDES permitted point source is typically quantified as 5-day biochemical oxygen demand (BOD_5). BOD_5 is a measure of the oxidation of carbonaceous and nitrogenous material over a 5-day incubation period. However, oxidation of nitrogenous material, called nitrification, usually does not take place within the 5-day period because the bacteria that are responsible for nitrification are normally not present in large numbers and have slow reproduction rates (Metcalf and Eddy, 1991). Thus, BOD_5 is generally considered equal to $CBOD_5$. Because permits for point source facilities are written in terms of $CBOD_5$ while TMDLs are typically developed using CBODu, a ratio between the two terms is needed, Equation 4.

$$\mathbf{CBODu = CBOD_5 * Ratio} \qquad \textbf{(Eq. 4)}$$

The CBODu to $CBOD_5$ ratios are given in *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1994). These values are recommended for use by MDEQ regulations when actual field data are not available. The value of the ratio depends on the wastewater treatment type.

In order to convert the ammonia nitrogen (NH_3-N) loads to an oxygen demand, a factor of 4.57 pounds of oxygen per pound of ammonia nitrogen (NH_3-N) oxidized to nitrate nitrogen (NO_3-N) was used. Using this factor is a conservative modeling assumption because it assumes that all of the ammonia is converted to nitrate through nitrification. The oxygen demand caused by nitrification of ammonia is equal to the NBODu load. The sum of CBODu and NBODu is equal to the point source load of TBODu. The permitted load of TBODu from the existing point source to be used in the STREAM model is given in Table 8.

Table 8. Point Sources, Maximum Permitted Model Inputs

NPDES	Facility	Flow (MGD)	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
MS0058122	**Monroe Co. B.O.S. Wren Industrial Park**	**0.015**	**1.88**	**1.14**	**3.02**
MS0025631	**Okolona POTW South**	**0.66**	**82.57**	**50.31**	**132.88**
	Total		**84.44**	**51.45**	**135.90**

Direct measurements of background concentrations of CBODu were not available for Mattubby Creek. Because there were no data available, the background concentrations of CBODu and NH_3-N were estimated based on *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1994). According to these regulations, the background concentration used in modeling for BOD_5 is 1.33 mg/l and for NH_3-N is 0.1 mg/l. Non-point source flows are typically included in the model to account for water entering due to groundwater infiltration, overland flow, and small, unmeasured tributaries. However, there are no non-point source flows entering the water body at the critical 7Q10 condition is used for DO modeling.

3.4 Model Calibration

The model used to develop the Mattubby Creek TMDL was not calibrated due to the limited amount of instream monitoring data collected during critical conditions. Future monitoring is essential to improve the accuracy of the model and the results.

3.5 Model Results

Once the model setup was complete, the model was used to predict water quality conditions in the unnamed tributary, Cowpen and Mattubby Creeks. The model was run under regulatory load conditions. Under regulatory load conditions, the loads from the NPDES permitted point sources were based on their current location and loads shown in Table 8.

3.5.1 Regulatory Load Scenario

As shown in the figure, the model predicts that the DO does go below the standard of 5.0 mg/l in Cowpen Creek using the permit based allowable loads, thus reductions are needed to meet the current TMDL. The regulatory load scenario model results are shown in Figure 8. The model predicts that the DO remains above the standard of 5.0 mg/l in the unnamed tributary and Mattubby Creek.

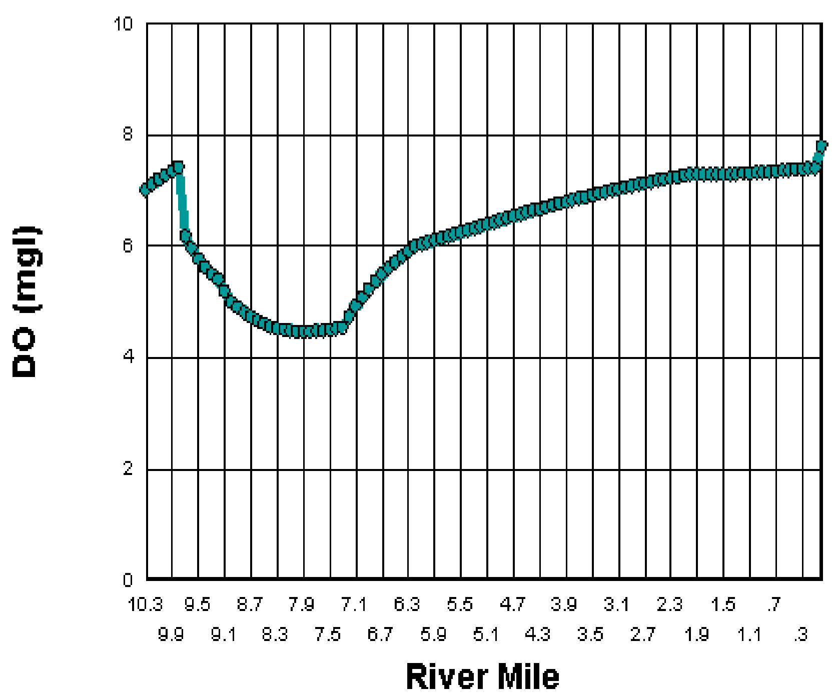


Figure 8. Model Output for Cowpen Creek, Regulatory Load Scenario

3.5.2 Maximum Load Scenario

The graph of the regulatory model output shows that the predicted DO does fall below the DO standard in Cowpen Creek during critical conditions. Thus, reductions of the loads of TBODu are necessary. Calculating the maximum allowable load of TBODu involved decreasing the model loads until the modeled DO remained at or above 5.0 mg/l. The non-point source loads in this model were already removed based on a 7Q10 flow of zero so no non-point source reductions were possible. Thus, the permitted limits were decreased until the modeled DO was 5.0 mg/L. The decreased loads were then used to develop the allowable maximum daily load for this report. The maximum load scenario model results are shown in Figure 9.

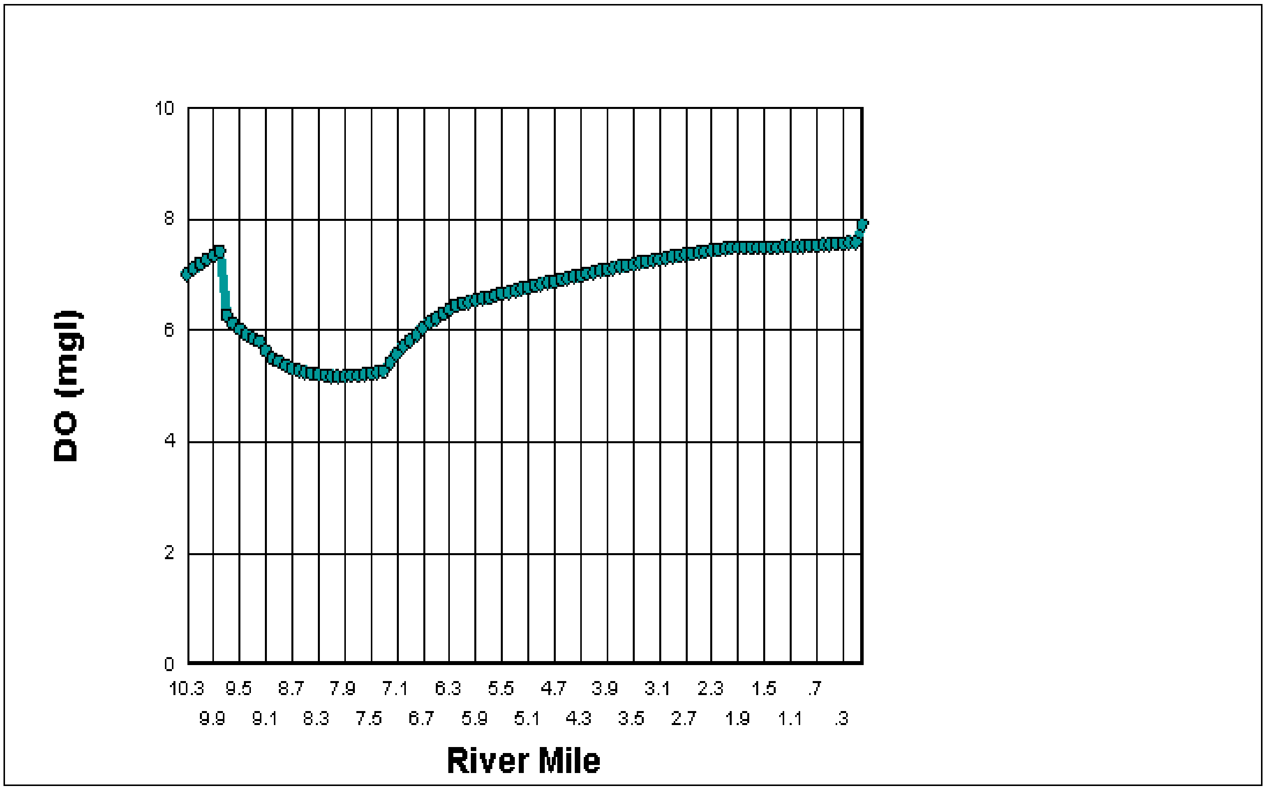


Figure 9. Model Output for Cowpen Creek, Maximum Load Scenario

Facility Name	Flow (MGD)	$CBOD_5$ (mg/l)	NH_3-N (mg/L)	$CBOD_u$: $CBOD_5$ Ratio	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Monroe County Board of Supervisors, Wren Industrial Park Sewer System	0.015	8	1.5	1.5	1.50	0.86	2.36
Okolona POTW, South	0.66	10	2*	1.5	82.57	50.31	132.88

* Proposed Permit Limit

Table 9. Point Sources, Maximum Permitted Loads

ALLOCATION

4.1 Wasteload Allocation

Model results indicate that reductions are needed from one of the point sources. The wasteload allocations for this TMDL are given in Tables 10 and 11. Table 10 shows a TBODu reduction of 21.8% is needed from the Monroe County Board of Supervisors, Wren Industrial Park Sewer System to help Cowpen Creek meet water quality standards. Final effluent limits of 8-1.5-6 ($CBOD_5$- NH_3-N-DO, respectively) are representative of the reduction that is required. Wren Industrial Park Sewer System currently has limits of 10-2-6. Okolona POTW, South has permit limits of 10 BOD_5 and 6 DO with no permit limit for ammonia nitrogen (NH_3-N). Therefore, this TMDL recommends the permit limits for Okolona POTW, South include a limit of 2 mg/L for NH_3-N.

The estimate of existing point source contribution of TN is 64.74lbs and 8.8% of the TMDL target load. The estimate of existing point source contribution of TP is 29.27 lbs and 28% of the TMDL target load. The TN and TP estimated existing concentration will be included as permit limits, but not at a reduced level due to the small relative portion of the TMDL attributable to point sources.

Table 10. TMDL Loads for TN, TP, and TBODu

Permit	Facility	Flow MGD	$CBOD_5$ mg/L	CBODu lbs/day	NH_3-N mg/L	NBODu lbs/day	TBODu lbs/day	% Reduction
MS0058122	**Monroe Co. B.O.S. Wren Industrial Park**	**0.015**	**8**	**1.50**	**1.5**	**0.19**	**2.36**	**21.8**
MS0025631	**Okolona POTW South**	**0.66**	**10**	**82.57**	**2***	**11.01**	**132.88**	**0**

* Proposed Permit Limit

Table 11. TMDL Loads for TN and TP

Permit	Facility	Flow MGD	TN Load lbs/day	TP Load lbs/day
MS0058122	**Monroe Co. B.O.S. Wren Industrial Park**	**0.015**	**1.44**	**0.65**
MS0025631	**Okolona POTW South**	**0.66**	**63.30**	**28.62**
	Total		**64.74**	**29.27**

4.2 Load Allocation

Best management practices (BMPs) should be encouraged in the watersheds to reduce potential TN, and TP loads from non-point sources. The LA for TN and TP was calculated by subtracting the WLA from the TMDL. The load allocation for the TBODu TMDL is has been set to zero because there are no non-point source flows entering the water body at the critical 7Q10 condition which is used for DO modeling.

4.3 Incorporation of a Margin of Safety

The margin of safety is a required component of a TMDL and accounts for the uncertainty about the relationship between pollutant loads and the quality of the receiving water body. The two types of MOS development are to implicitly incorporate the MOS using conservative model assumptions or to explicitly specify a portion of the total TMDL as the MOS. The MOS selected for this model is implicit.

4.4 Calculation of the TMDL

Equation 1 was used to calculate the TMDL for TP and TN (see Table 7). The target concentration was used with the average flow for the watershed to determine the nutrient TMDLs. The STREAM model was used to calculate the TBODu TMDL. The allocations for TN, TP, and TBODu are given in Table 11. These allocations are established to attain the applicable water quality standards.

Table 12. TMDL Loads

	WLA lbs/day	LA lbs/day	MOS	TMDL lbs/day
Total Nitrogen	**64.74**	**680.31**	**Implicit**	**745.05**
Total Phosphorous	**29.27**	**77.16**	**Implicit**	**106.44**
TBODu	**135.24**	**0.61**	**Implicit**	**135.85**

The nutrient TMDL loads were then compared to the estimated existing loads previously calculated. A 38% reduction in TN loading is recommended. Best management practices are encouraged in this watershed to reduce the nonpoint nutrient loads. For TP, an 85% overall reduction is recommended.

4.5 Seasonality and Critical Condition

This TMDL accounts for seasonal variability by requiring allocations that ensure year-round protection of water quality standards, including during critical conditions.

CONCLUSION

The model results indicate that Cowpen Creek is not meeting water quality standards for dissolved oxygen at the present loading of TBODu. The current model used for these calculations does not have adequate data to support all of the assumptions used, however, it is clear that Mattubby Creek is impaired based upon the stressor identification report. A reduction from one of the facilities will be necessary to help meet DO water quality standards. Nutrients were addressed through an estimate of a preliminary TP concentration target and a preliminary TN concentration target.

For the TMDL for TN, and overall reduction of 38.3% is needed to meet the TN target. For the TMDL for TP, an overall 84.9% reduction is needed to meet the TP target. The implementation of BMP activities should reduce the nutrient loads entering the creek. Best management practices are encouraged in this watershed to reduce the nonpoint nutrient loads. This TMDL provides for a 26% reduction in TP from the point sources in order to meet the overall reduction. This TMDL also recommends a 21.3% TBODu reduction from the Monroe Co. B.O.S. Wren Industrial Park to eliminate the DO standards violation in Cowpen Creek. This will provide improved water quality for the support of aquatic life in the water body and will result in the attainment of the applicable water quality standards.

5.1 Next Steps

MDEQ's Basin Management Approach and Nonpoint Source Program emphasize restoration of impaired waters with developed TMDLs. During the watershed prioritization process to be conducted by the Pearl River Basin Team, this TMDL will be considered as a basis for implementing possible restoration projects. The basin team is made up of state and federal resource agencies and stakeholder organizations and provides the opportunity for these entities to work with local stakeholders to achieve quantifiable improvements in water quality. Together, basin team members work to understand water quality conditions, determine causes and sources of problems, prioritize watersheds for potential water quality restoration and protection activities, and identify collaboration and leveraging opportunities. The Basin Management Approach and the Nonpoint Source Program work together to facilitate and support these activities.

The Nonpoint Source Program provides financial incentives to eligible parties to implement appropriate restoration and protection projects through the Clean Water Act's Section 319 Nonpoint Source (NPS) Grant Program. This program makes available around $1.6M each grant year for restoration and protections efforts by providing a 60% cost share for eligible projects.

Mississippi Soil and Water Conservation Commission (MSWCC) is the lead agency responsible for abatement of agricultural NPS pollution through training, promotion, and installation of BMPs on agricultural lands. USDA Natural Resource Conservation Service (NRCS) provides technical assistance to MSWCC through its conservation districts located in each county. NRCS assists animal producers in developing nutrient management plans and grazing management plans. MDEQ, MSWCC, NRCS, and other governmental and nongovernmental organizations work closely together to reduce agricultural runoff through the Section 319 NPS Program.

Mississippi Forestry Commission (MFC), in cooperation with the Mississippi Forestry Association (MFA) and Mississippi State University (MSU), have taken a leadership role in the development and promotion of the forestry industry Best Management Practices (BMPs) in Mississippi. MDEQ is designated as the lead agency for implementing an urban polluted runoff control program through its Stormwater Program. Through this program, MDEQ regulates most construction activities. Mississippi Department of Transportation (MDOT) is responsible for implementation of erosion and sediment control practices on highway construction.

Due to this TMDL, projects within this watershed will receive a higher score and ranking for funding through the basin team process and Nonpoint Source Program described above.

5.2 Public Participation

This TMDL will be published for a 30-day public notice. During this time, the public will be notified by publication in the statewide newspaper. The public will be given an opportunity to review the TMDLs and submit comments. MDEQ also distributes all TMDLs at the beginning of the public notice to those members of the public who have requested to be included on a TMDL mailing list. Anyone wishing to become a member of the TMDL mailing list should contact Kay Whittington at Kay_Whittington@deq.state.ms.us.

All comments should be directed to Kay_Whittington@deq.state.ms.us or Kay Whittington, MDEQ, PO Box 2261, Jackson, MS 39225. All comments received during the public notice period and at any public hearings become a part of the record of this TMDL and will be considered in the submission of this TMDL to EPA Region 4 for final approval.

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