FINAL REPORT
April 2007
ID: 107043001

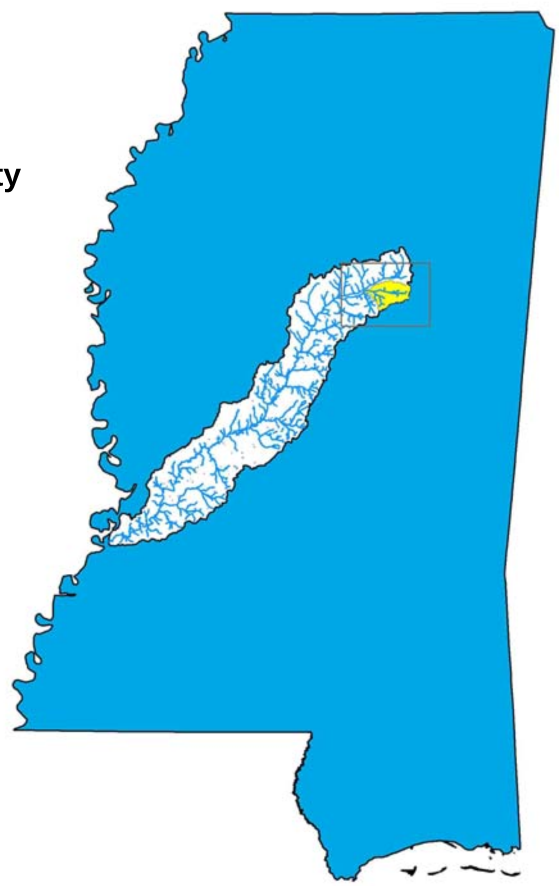
Total Maximum Daily Load

Organic Enrichment/Low Dissolved Oxygen and Nutrients

Big ByWy Creek

Big Black River Basin

Choctaw County, Mississippi



Prepared By

Mississippi Department of Environmental Quality
Office of Pollution Control
TMDL/WLA Branch

MDEQ
PO Box 10385
Jackson, MS 39289-0385
(601) 961-5171
www.deq.state.ms.us

Mississippi Department of
Environmental Quality

FOREWORD

This report has been prepared in accordance with the schedule contained within the federal consent decree dated December 22, 1998. The report contains one or more Total Maximum Daily Loads (TMDLs) for water body segments found on Mississippi's 1996 Section 303(d) List of Impaired Water bodies. Because of the accelerated schedule required by the consent decree, many of these TMDLs have been prepared out of sequence with the State's rotating basin approach. The implementation of the TMDLs contained herein will be prioritized within Mississippi's rotating basin approach.

The amount and quality of the data on which this report is based are limited. As additional information becomes available, the TMDLs may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, 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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TMDL INFORMATION PAGE

i. Listing Information

Name	ID	County	HUC	Cause	Mon/Eval
Big ByWy Creek	MS412BE	Choctaw	08060201	Organic Enrichment / Low DO and Nutrients	Eval
At Stewart from Headwaters to McCurtain Creek					

ii. Water Quality Standard

Parameter	Beneficial use	Water Quality Criteria
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
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.

iii. NPDES Facilities

NPDES ID	Facility Name	Permitted Discharge (MGD)	Receiving Water
MS0023329	Natchez Trace Parkway, Jeff Busby Camper Park	0.012	Unnamed Tributary of Middle ByWy Creek

iv. Total Maximum Daily Load for Big ByWy Creek

	WLA (lbs/day)	LA (lbs/day)	MOS	TMDL (lbs/day)
TBODu	**5.54**	**4.77**	**22.43**	**32.74**
Total Nitrogen	**2.24**	**592.19 to 691.26**	**Implicit**	**594.43 to 693.50**
Total Phosphorous	**0.66**	**58.78 to 98.37***	**Implicit**	**59.44 to 99.07***

EXECUTIVE SUMMARY

This TMDL has been developed for a segment of Big ByWy Creek that is on the Mississippi 2004 §303(d) List of Water Bodies as an evaluated water body segment due to organic enrichment/low dissolved oxygen and nutrients (MDEQ, 2004). The applicable state standard specifies that the dissolved oxygen 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. Additionally, this TMDL will provide an estimate of the total nitrogen (TN) and total phosphorous (TP) allowable in the stream and a preliminary breakdown of the TN and TP load between point and nonpoint sources.

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 range of 0.6 to 0.7 mg/l is an applicable target for TN and 0.06 to 0.10 mg/l for TP for water bodies located in Ecoregion 65. MDEQ is presenting these ranges as preliminary target values for TMDL development which is subject to revision after the development of numeric nutrient criteria.

The Big ByWy Creek Watershed is located in Mississippi (HUC 08060201). The listed portion of Big ByWy Creek begins at the headwaters and flows for approximately 18 miles to the confluence with McCurtain Creek. Big ByWy Creek then continues for approximately 11 more miles to its mouth at the Big Black River. The majority of Big ByWy Creek is channelized. The location of the watershed for the listed segment is shown in Figure 1.

The predictive model used to calculate the dissolved oxygen TMDL is based primarily on assumptions described in MDEQ Regulations. A modified Streeter-Phelps dissolved oxygen sag model was selected as the modeling framework for developing the TMDL allocations. The critical modeling period occurs during the hot, dry summer period. MDEQ used a mass balance approach to estimate nutrient contributions from point and non-point sources.

The TMDL for organic enrichment was quantified in terms of total ultimate biochemical oxygen demand (TBODu). The model used in developing this TMDL included both non-point and point sources of TBODu in the Big ByWy Creek Watershed. TBODu loading from background and non-point sources in the watershed was accounted for by using an estimated concentration of TBODu and flows based on 7Q10 conditions. There is one NPDES permitted discharger located in the watershed that is included as a point source in the model.

According to the model, the current TBOD load in the water body does not exceed the assimilative capacity of Big ByWy Creek for organic material and ammonia nitrogen. Therefore, no reductions in the current permitted loads of organic material are needed for this TMDL report in order to meet water quality limits. The limited nutrient data and estimated existing ecoregion concentrations indicates reduction of nutrients are needed.

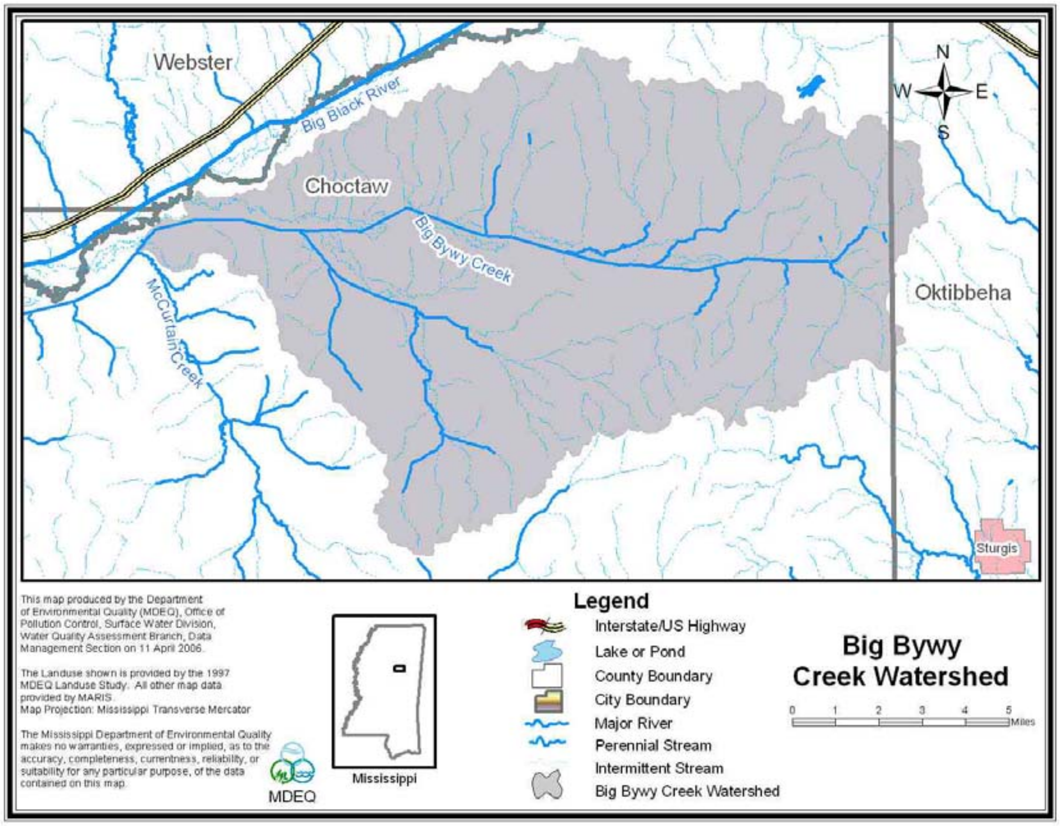


Figure 1. Big ByWy Creek Watershed

INTRODUCTION

1.1 Background

Big ByWy Creek was originally placed on the 303(d) List based on anecdotal information. Mississippi conducted a survey of district conservationists (DCs) in 1988 and 1989 to find candidate watersheds for future §319 funding opportunities. MDEQ requested each DC identify the watersheds of concern in their county based on available information including land use. Numerous DCs responded to the survey and MDEQ created Mississippi's §319 List based on these surveys.

In 1992, MDEQ compiled a §303(d) List based, in part, on the §319 List of watersheds of concern. Therefore, water bodies were included on the §303(d) List based on speculation and not water quality monitoring. MDEQ uses the term "evaluated" to describe these water bodies that were placed on the §303(d) List without monitoring data. At the time, MDEQ considered the evaluated listings from the §319 survey as a placeholder for future monitoring to determine if there was actually impairment in the watershed.

The surveys asked for the presence of agriculture, urban areas, or forestry in the watershed. MDEQ interpreted potential pollutants present on these land uses and listed several broad potential pollutant categories based on the survey results. Every watershed for which agriculture was checked, was listed for several pollutants, including sediment, pesticides, organic enrichment/low dissolved oxygen, and nutrients. Big ByWy Creek was listed for sediment, pesticides, organic enrichment/low dissolved oxygen, and nutrients based on the survey results. Because of a federal court consent decree required for the state of Mississippi, TMDLs for Big ByWy Creek must be developed for these pollutants even though there are no data available.

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 303(d) listed segment shown in Figure 2.

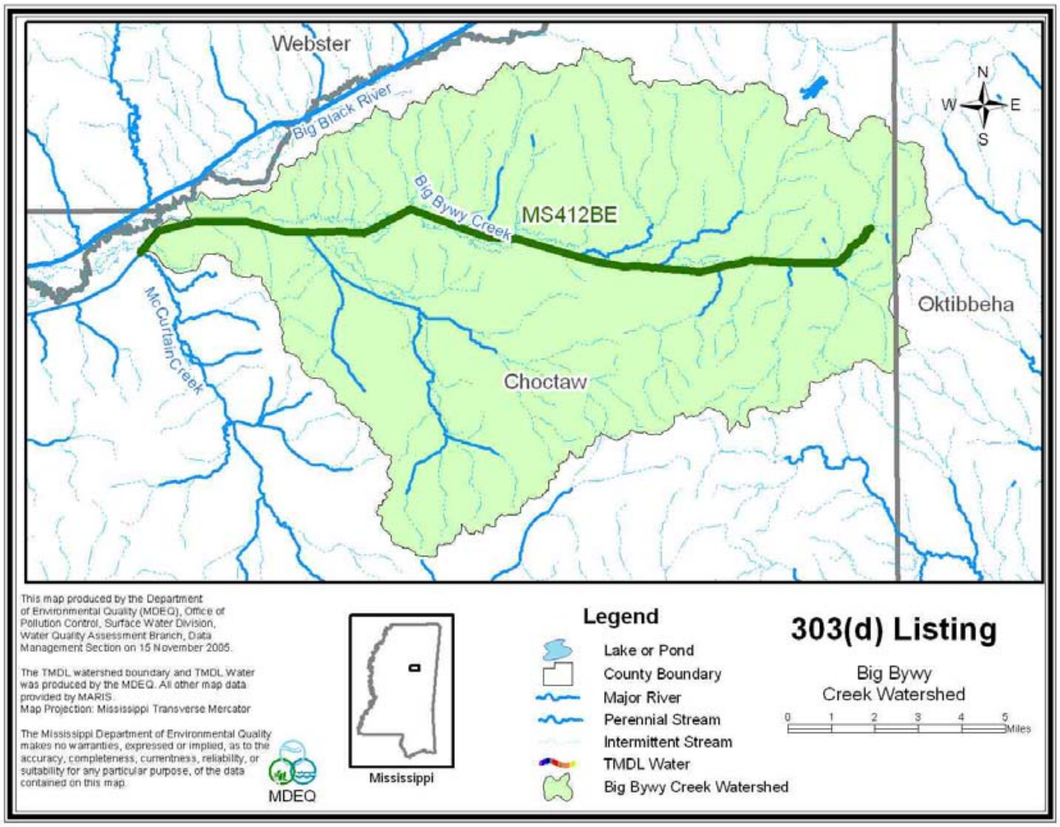


Figure 2. Big ByWy Creek §303(d) Listed Segment

1.2 Applicable Water Body Segment Use

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

1.3 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, 2002). The applicable standard specifies that the dissolved oxygen (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. This water quality standard will be used as a targeted endpoint to evaluate impairments and establish this TBODu TMDL.

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, 2002)." In the 1999

Protocol for Developing Nutrient TMDLs, EPA suggests several methods for the development of numeric criteria for nutrients (USEPA, 1999). In accordance with the 1999 Protocol, "The target value for the chosen indicator can be based on: comparison to similar but unimpaired waters; user surveys; empirical data summarized in classification systems; literature values; or professional judgment." MDEQ believes the most economical and scientifically defensible method for use in Mississippi is a comparison between similar but unimpaired waters within the same region. This method is dependent on adequate data which are being collected in accordance with the EPA approved plan. The initial phase of the data collection process for wadeable streams is complete.

1.4 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 basins and ecoregions.

For the preliminary target concentration range for each ecoregion, the 75th and 90th percentiles were derived from the mean nutrient value at each site 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 from the mean nutrient value at each site of sites that were not attaining and had nutrient concentrations greater than the target

1.5 Selection of a Critical Condition

Low DO typically occurs during seasonal low-flow, high-temperature periods during the late summer and early fall. Elevated oxygen demand is of primary concern during low-flow periods because the effects of minimum dilution and high temperatures combine to produce the worst-case potential effect on water quality (USEPA, 1997). The flow at critical conditions is typically defined as the 7Q10 flow, which is the lowest flow for seven consecutive days expected during a 10-year period. The low flow condition for Big ByWy Creek was determined based on two partial record stations listed in *Low-Flow and Flow-Duration Charactersitics of Mississippi Streams* (Telis, 1991).

1.6 Selection of a TMDL Endpoint

One of the major components of a TMDL is the establishment of instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints, therefore, represent the water quality goals that are to be achieved by meeting the load and wasteload allocations specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. The instream DO target for this TMDL is a daily average of not less than 5.0 mg/l. The instantaneous minimum portion of the DO standard was considered when establishing the instream target for this TMDL. However, it was determined that using the daily average standard with the conservative modeling assumptions would protect the instantaneous minimum standard. The daily average choice is supported by the use of the existing modeling tools in a desktop modeling exercise. More specific modeling and calibration is needed in order to obtain diurnal oxygen levels with any increased accuracy. Therefore, based on the limited data available and the relative simplicity of the model, the daily average target is sufficient.

The maximum impact of oxidation of organic material is generally not at the location of the sources, but at some distance downstream, where the maximum DO deficit occurs. The DO deficit is defined as the difference between the DO concentration at 100% saturation and the actual DO. The point of maximum DO deficit, also called the DO sag, will be used to define the endpoint required for this TMDL. The endpoint for this TMDL will be based on a daily average of not less than 5.0 mg/l at the DO sag during critical conditions.

The TMDL for DO will be quantified in terms of organic enrichment. Organic enrichment is measured in terms of total ultimate biochemical oxygen demand (TBODu). TBODu represents the oxygen consumed by microorganisms while stabilizing or degrading carbonaceous and nitrogenous compounds under aerobic conditions over an extended time period. The carbonaceous compounds are referred to as CBODu, and the nitrogenous compounds are referred to as NBODu. TBODu is equal to the sum of NBODu and CBODu, Equation 1.

$$\mathbf{TBODu = CBODu + NBODu} \qquad \textbf{(Eq. 1)}$$

For this TMDL, MDEQ is presenting preliminary target ranges for TN and TP. There is no data available for TN or TP in the listed segment of Big ByWy Creek. An annual concentration range of 0.6 to 0.7 mg/l is an applicable target for TN and 0.06 to 0.10 mg/l for TP for water bodies located in Ecoregion 65. However, MDEQ is presenting these ranges 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.

WATER BODY ASSESSMENT

2.1 Discussion of Instream Water Quality Data

There are no water quality data available for the listed segment of Big ByWy Creek. There are data available from one site on Big ByWy Creek downstream of the listed segment. The data from site BB039 near Stewart at Huntsville Road is given in Table 1 and the site location is shown in Figure 3.

Table 1. Water Quality Data Collected at Big ByWy Creek, Station BB039

Sample Date	Time	Dissolved Oxygen (mg/l)	Ammonia Nitrogen (mg/l)	$NO_2 + NO_3$ (mg/l)	Total Khejdal Nitrogen (mg/l)	Total Nitrogen (mg/l)	Total Phosphorus (mg/l)
8/3/1999	14:26	6.47	0.28	0.10	0.28	0.38	0.01
12/15/1999	12:15	8.44	0.29	0.21	1.18	1.39	0.17
4/4/2000	10:02	8.53	0.14	0.04	0.79	0.83	0.07

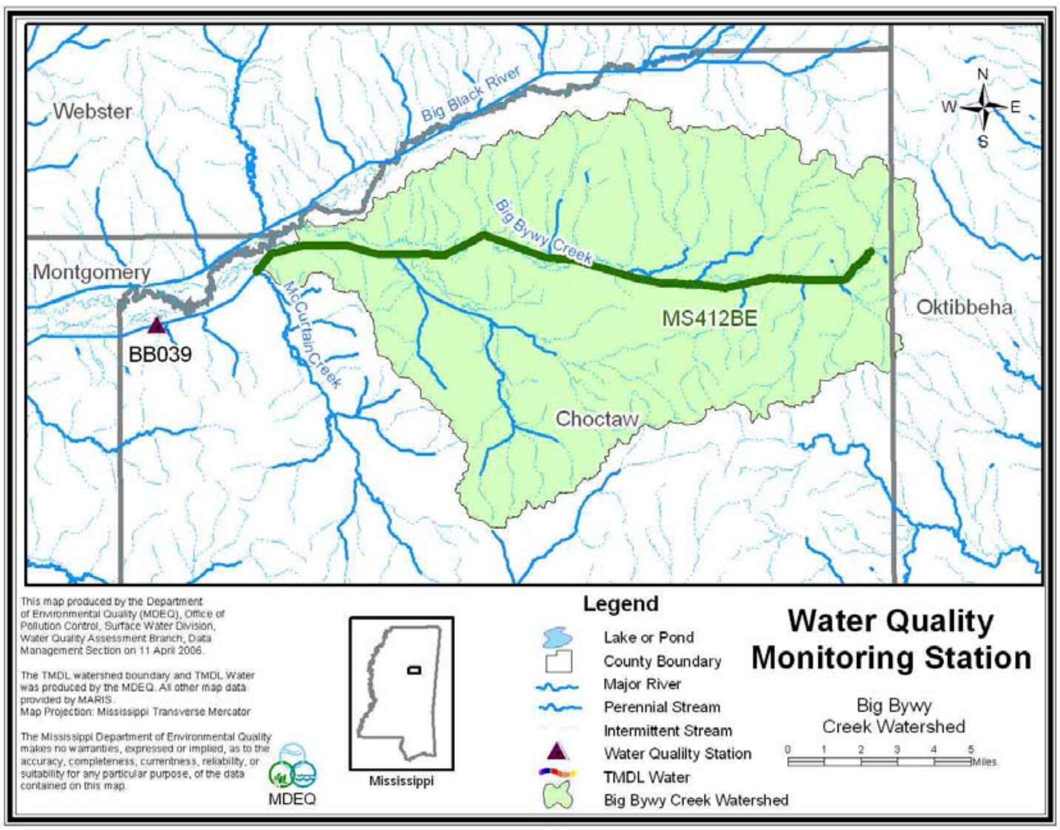


Figure 3. Big ByWy Creek Water Quality Monitoring Station

2.2 Assessment of Point Sources

An important step in assessing pollutant sources in the Big ByWy Creek watershed is locating the NPDES permitted sources. There is one facility permitted to discharge organic material into the Big ByWy Creek watershed, Table 2. The location of the facility is shown in Figure 4.

Table 2. NPDES Permitted Facilities Treatment Types

Name	NPDES Permit	Treatment Type
Natchez Trace Parkway, Jeff Busby Camper Park	MS0023329	Septic Tank / Sand Filters

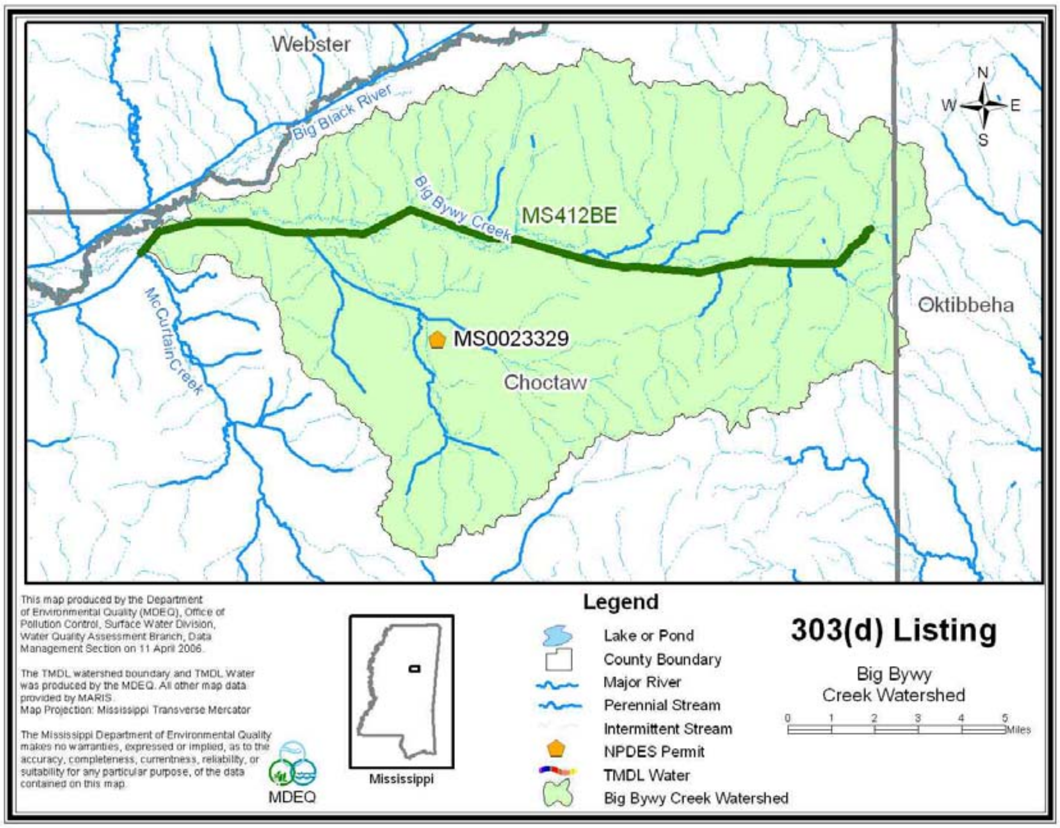


Figure 4. Big ByWy Creek Point Source

The effluent from the facility was characterized based on all available data including information on its wastewater treatment system, permit limits, and discharge monitoring reports. The permit limits as well as the average flows and BOD_5 concentrations, as reported in available discharge monitoring reports (DMRs) for recent years are given in Table 3. The facility is discharging well below its maximum permitted levels.

Table 3. Identified NPDES Permitted Facilities

Name	NPDES Permit	Permitted Discharge (MGD)	Actual Average Discharge (MGD)	Permitted Average BOD_5 (mg/l)	Actual Average BOD_5 (mg/l)	Actual Average CBODu (lbs/day)
Natchez Trace Parkway, Jeff Busby Camper Park	MS0023329	0.012	0.003	30	5.4	0.20

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 stream. All domestic wastewater contains phosphorus which comes from humans and the use of phosphate containing detergents. Table 4 presents typical nutrient loading ranges for various land uses.

Table 4. Nutrient Loadings for Various Land Uses

Landuse	Total Phosphorus [lb/acre-y]			Total Nitrogen [lb/acre-y]		
	Minimum	Maximum	Median	Minimum	Maximum	Median
Roadway	0.53	1.34	0.98	1.2	3.1	2.1
Commercial	0.61	0.81	0.71	1.4	7.8	4.6
Single Family-Low Density	0.41	0.57	0.49	2.9	4.2	3.6
Single Family-High Density	0.48	0.68	0.58	3.6	5.0	5.2
Multifamily Residential	0.53	0.72	0.62	4.2	5.9	5.0
Forest	0.09	0.12	0.10	1.0	2.5	1.8
Grass	0.01	0.22	0.12	1.1	6.3	3.7
Pasture	0.01	0.22	0.12	1.1	6.3	3.7

Source: Horner et al., 1994 in Protocol for Developing Nutrient TMDLs (USEPA 1999)

The drainage area of Big ByWy Creek is approximately 75,700 acres (118 square miles). The watershed contains many different landuse types, including urban, forest, cropland, pasture, water, and wetlands. The landuse information given below is based on data collected by the State of Mississippi's Automated Resource Information System (MARIS) 1997. This data set is based on Landsat Thematic Mapper digital images taken between 1992 and 1993. Forest is the dominant landuse within this watershed. The landuse distribution is shown in Table 5 and Figure 5.

Table 5. Landuse Distribution, Big ByWy Creek Watershed

	Urban	Forest	Cropland	Pasture	Scrub/Barren	Water	Wetlands
Area (acres)	0	40,851	1,999	14,439	16,609	24	1,767
Percentage	0%	54%	3%	19%	22%	0%	2%

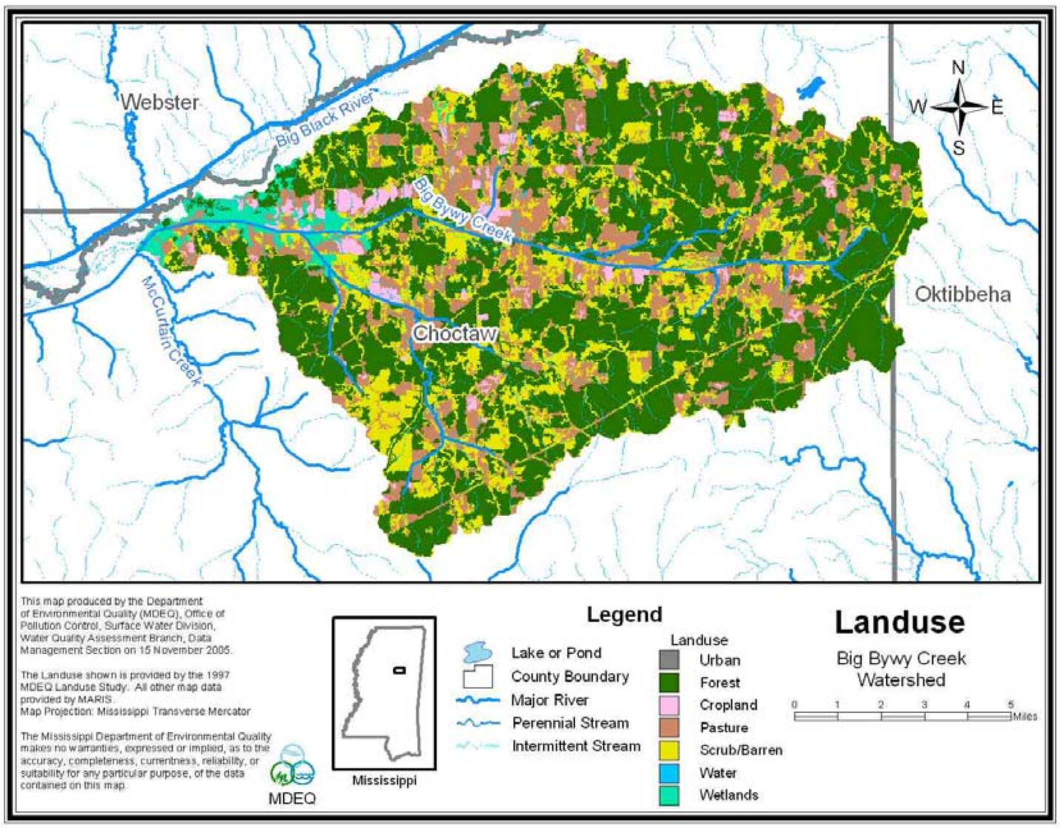


Figure 5. Landuse Distribution for the Big ByWy Creek Watershed

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.

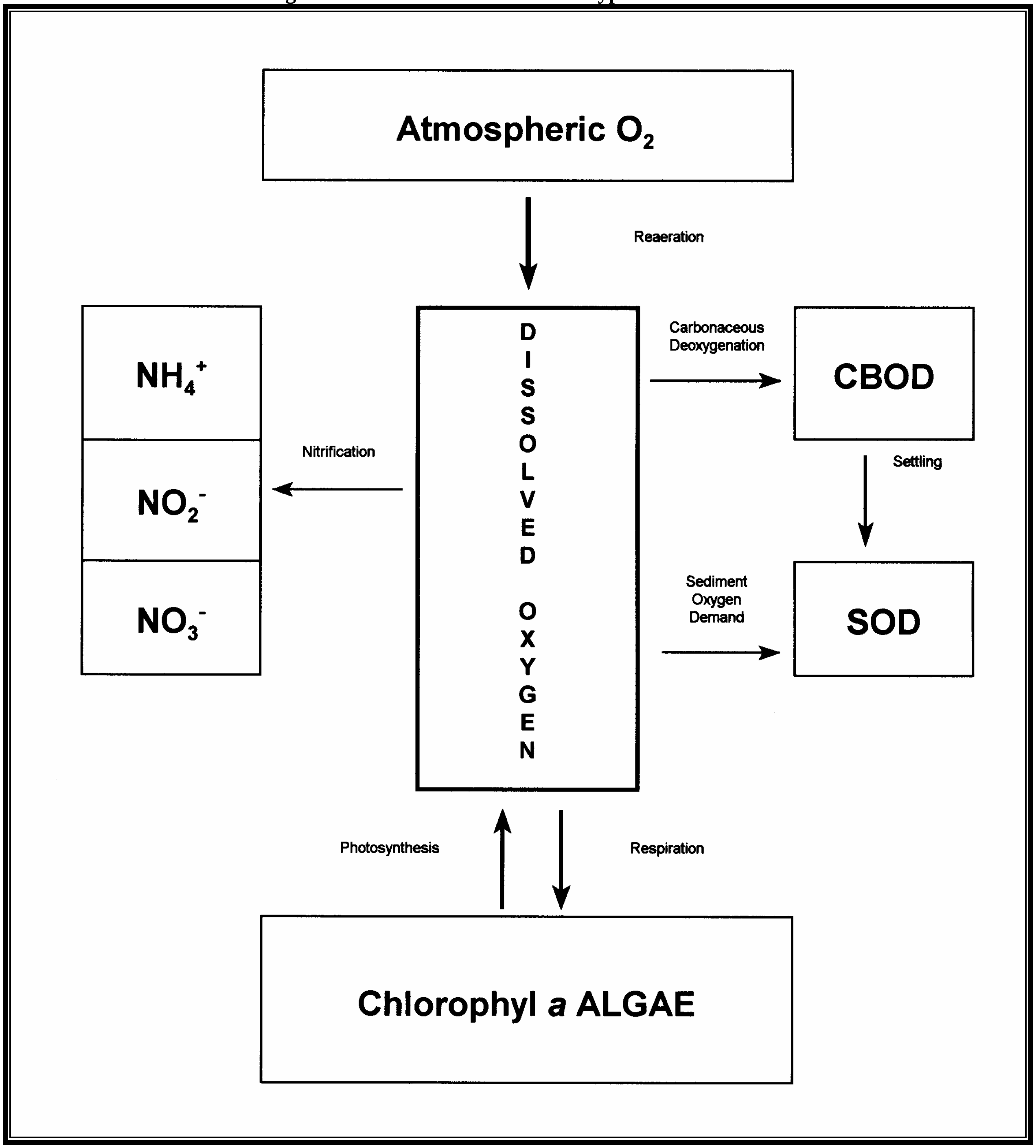
STREAM is a steady-state, daily average computer model that utilizes a modified Streeter-Phelps DO sag equation. Instream processes simulated by the model include CBODu decay, nitrification, reaeration, sediment oxygen demand, and respiration and photosynthesis of algae. Figure 6 shows how these processes 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. Reach velocities were calculated using an equation based on slope. The slope of each reach was estimated electronically and input into the model in units of feet/mile.

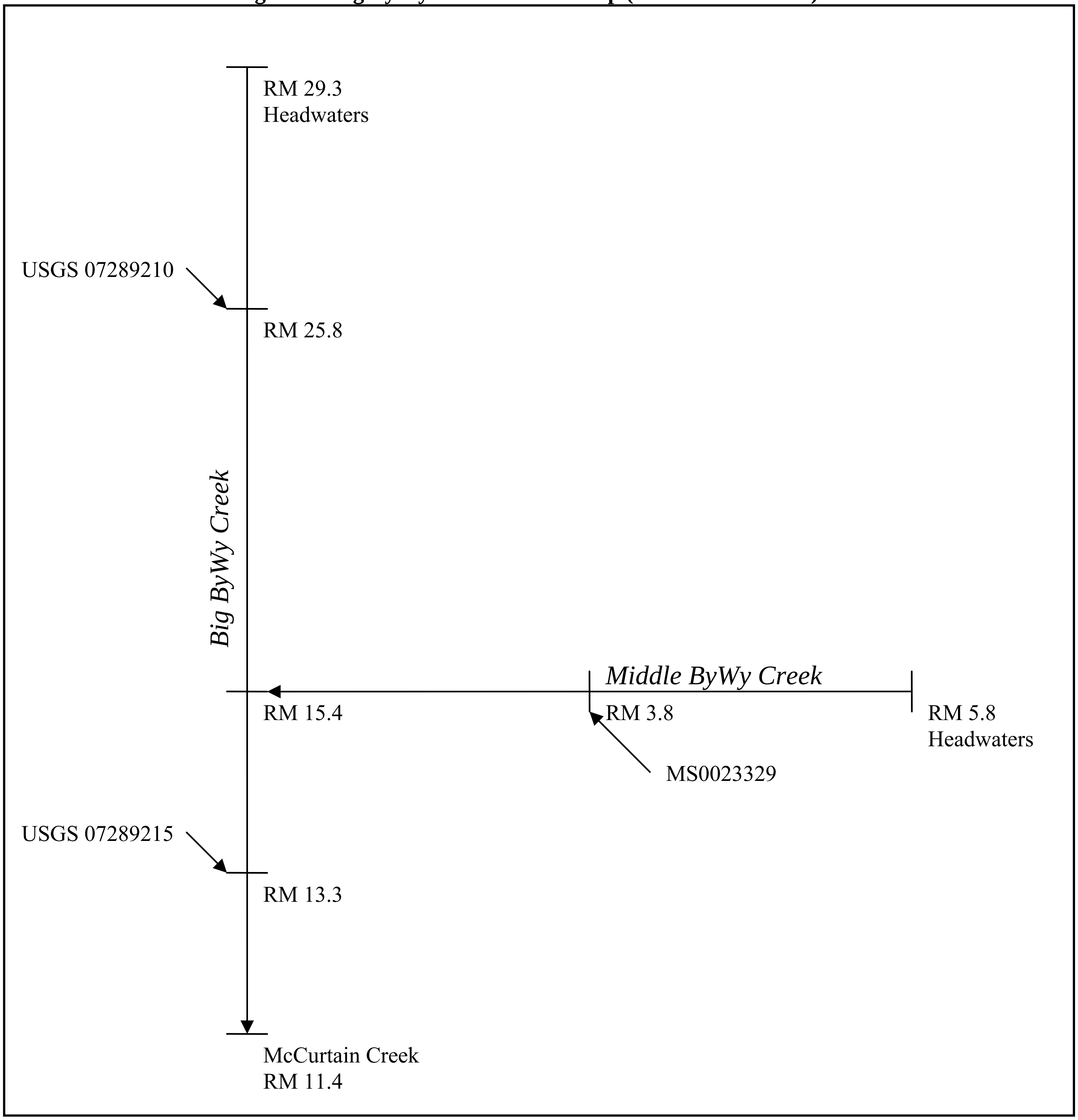
Figure 6. Instream Processes in a Typical DO Model



3.2 Model Setup

The model for this TMDL includes the §303(d) listed segment of Big ByWy Creek, beginning at the headwaters and ending at McCurtain Creek. A diagram showing the model setup is shown in Figure 7. The locations of the confluence of point sources and significant tributaries are shown. Arrows represent the direction of flow in each segment. The numbers on the figure represent approximate river miles (RM). River miles are assigned to water bodies, beginning with zero at the mouth.

Figure 7. Big ByWy 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.

The flow in the Big ByWy Creek watershed was modeled at 7Q10 conditions based on data available from the USGS (Telis, 1991). Big ByWy Creek has two partial record flow gages, 07289210, Big ByWy Ditch near Mathiston, MS with a 7Q10 flow of 0.05 cfs and 07289215, Big ByWy Ditch near Pellez, MS with a 7Q10 flow of 0.3 cfs. The Big ByWy Creek watershed with flow gages is shown in Figure 8.

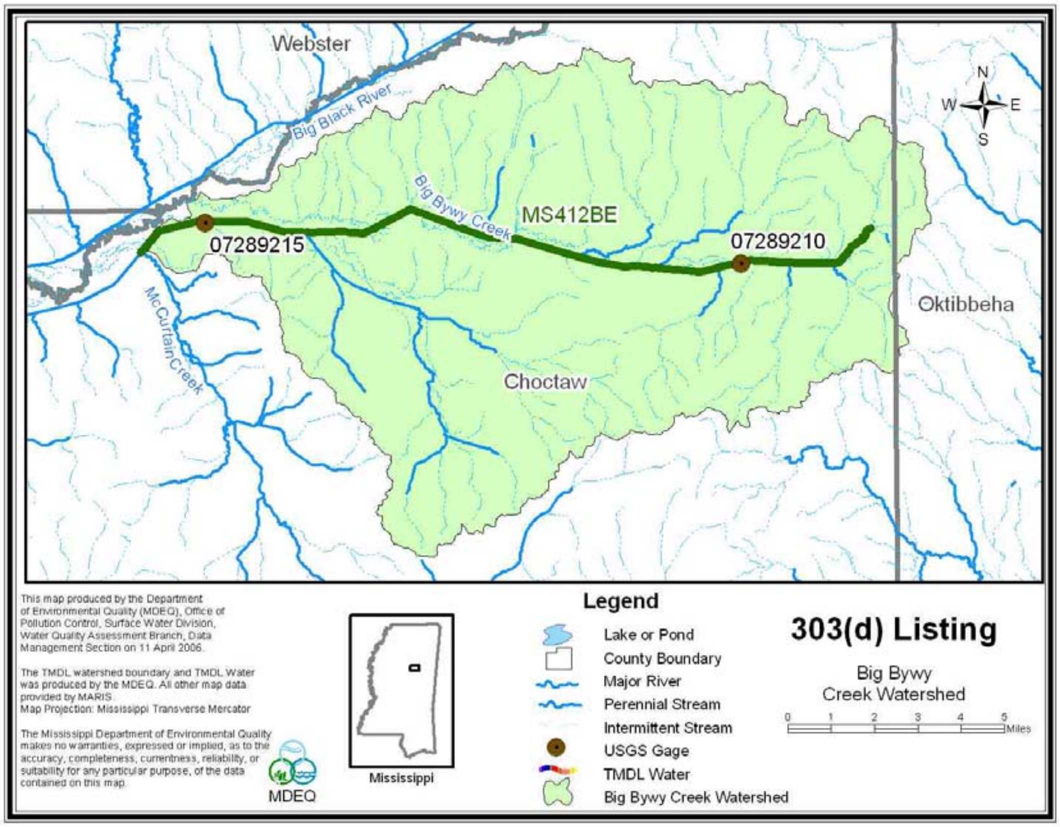


Figure 8. Big ByWy Creek Watershed with USGS Gages

3.3 Source Representation

Both point and non-point sources were represented in the model. The loads from the NPDES permitted source were added as a direct input into the appropriate reach of Middle ByWy Creek as a flow in MGD and concentration of $CBOD_5$ and ammonia nitrogen in mg/l. Spatially distributed loads, which represent non-point sources of flow, $CBOD_5$, and ammonia nitrogen were distributed evenly into each computational element of the modeled water body.

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 BOD_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 treatment type of wastewater. For secondary treatment systems (conventional and aerated lagoons) this ratio is 1.5.

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 maximum permitted loads of TBODu from the existing point source is given in Table 6.

Table 6. Point Sources, Maximum Permitted Loads

Facility	NPDES	Flow (MGD)	$CBOD_5$ (mg/l)	NH_3-N (mg/l)	$CBOD_u$:$CBOD_5$ Ratio	CBODu (lbs/day)	NH_3-N (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Natchez Trace Parkway, Jeff Busby Camper Park	MS0023329	0.012	30	2	1.5	4.61	0.21	0.93	5.54
						4.61		**0.93**	**5.54**

Direct measurements of background concentrations of CBODu were not available for Big ByWy 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. These concentrations were also used as estimates for the CBODu and NH_3-N levels of water entering the water bodies through non-point source flow and tributaries.

Non-point source flows were included in the model to account for water entering due to groundwater infiltration, overland flow, and small, unmeasured tributaries. These flows were estimated based on USGS data for the 7Q10 flow condition in the Big ByWy Creek watershed. The non-point source loads were assumed to be distributed evenly on a river mile basis throughout the modeled reaches as shown in Table 7.

Table 7. Non-Point Source Loads Input into the Model

	Flow (cfs)	$CBOD_5$ (mg/l)	CBODu (lbs/day)	NH_3-N (mg/l)	NBODu (lbs/day)	TBODu (lbs/day)
Big ByWy Background Load	0.01	1.33	0.108	0.1	0.025	0.132
Big ByWy RM 29.3 – RM 28.2	0.02	1.33	0.216	0.1	0.049	0.265
Big ByWy RM 28.2 – RM 25.8	0.03	1.33	0.323	0.1	0.074	0.397
Big ByWy RM 25.8 – RM 22.4	0.05	1.33	0.539	0.1	0.123	0.662
Big ByWy RM 22.4 – RM 16.7	0.08	1.33	0.862	0.1	0.197	1.059
Big ByWy RM 16.7 – RM 15.4	0.02	1.33	0.216	0.1	0.049	0.265
Big ByWy RM 15.4 – RM 13.3	0.03	1.33	0.323	0.1	0.074	0.397
Big ByWy RM 13.3 – RM 11.4	0.03	1.33	0.323	0.1	0.074	0.397
Middle ByWy Background Load	0.01	1.33	0.108	0.1	0.025	0.132
Middle ByWy RM 5.8 – RM 5.4	0.01	1.33	0.108	0.1	0.025	0.132
Middle ByWy RM 5.4 – RM 4.3	0.01	1.33	0.108	0.1	0.025	0.132
Middle ByWy RM 4.3 – RM 3.8	0.01	1.33	0.108	0.1	0.025	0.132
Middle ByWy RM 3.8 – RM 2.5	0.02	1.33	0.216	0.1	0.049	0.265
Middle ByWy RM 2.5 – RM 0.0	0.03	1.33	0.323	0.1	0.074	0.397
			3.88		**0.89**	**4.77**

3.4 Model Calibration

The model used to develop the Big ByWy Creek TMDL was not calibrated due to lack 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 Big ByWy Creek. The model was first run under regulatory load conditions. Under regulatory load conditions, the load from the NPDES permitted point source was set at its current location and maximum permit limits, Table 6.

3.5.1 Regulatory Load Scenario

The regulatory load scenario model results are shown in Figure 9. Figure 9 shows the modeled daily average DO with the NPDES permit at its maximum allowable loads and with estimated non-point source loads. The figure shows the daily average instream DO concentrations, beginning with the headwaters at river mile 29.3 and ending at river mile 11.4 at the confluence with McCurtain Creek. As shown in the figure, the model does not predict that the DO goes below the standard of 5.0 mg/l using the maximum allowable loads.

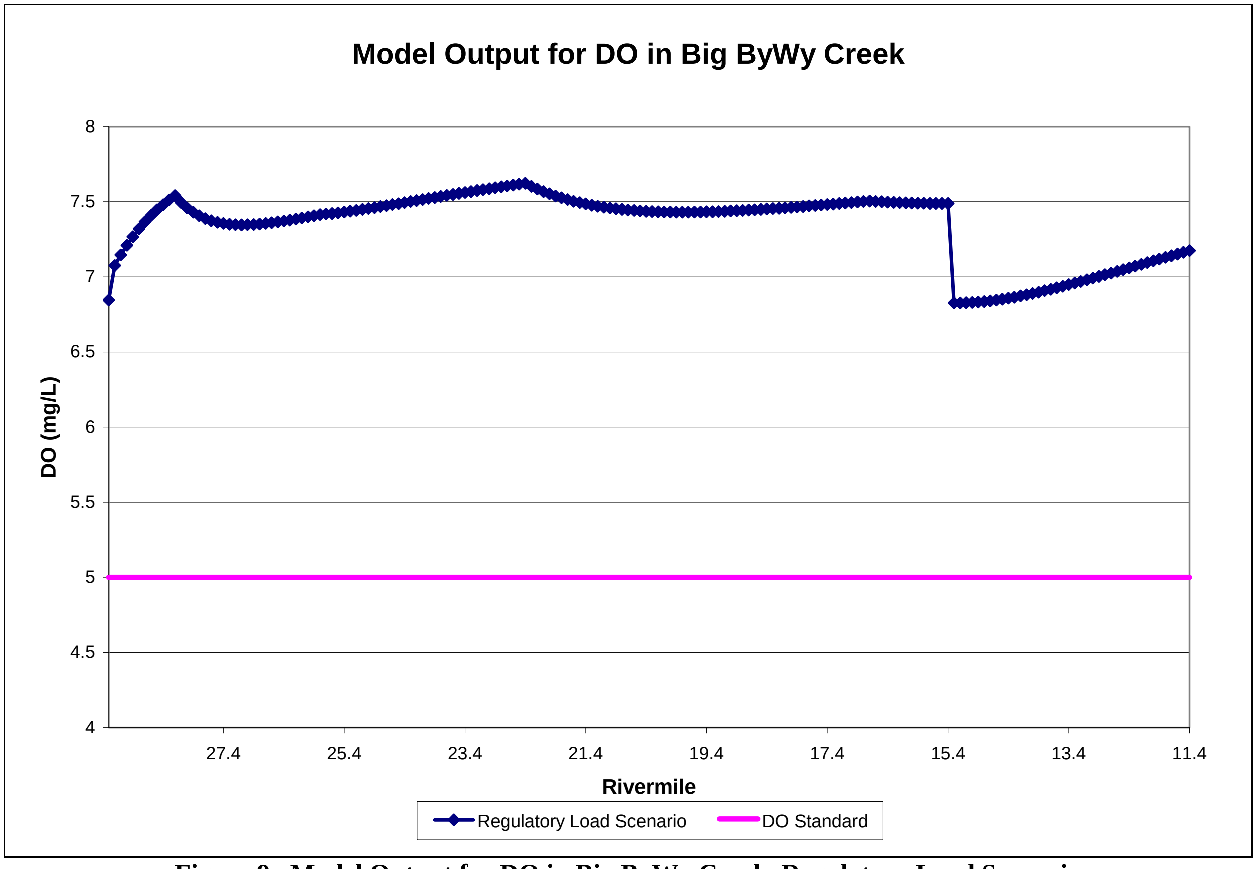


Figure 9. Model Output for DO in Big ByWy Creek, Regulatory Load Scenario

3.5.2 Maximum Load Scenario

The graph of the regulatory load scenario output shows that the predicted DO does not fall below the DO standard in Big ByWy Creek during critical conditions. Thus, reductions from the loads of TBODu are not necessary. Calculating the maximum allowable load of TBODu involved increasing the non-point source loads only and running the model using a trial-and-error process until the modeled DO was just above 5.0 mg/l. The non-point source loads were increased by a factor of 5.98 in this process. The increased loads were used to develop the allowable maximum daily load for this report. The model output for DO with the increased loads is shown in Figure 10.

Figure 10 shows the modeled instream DO concentrations in Big ByWy Creek after application of the selected maximum load scenario at critical conditions. The model results for the maximum load scenario show that the water body does have additional assimilative capacity.

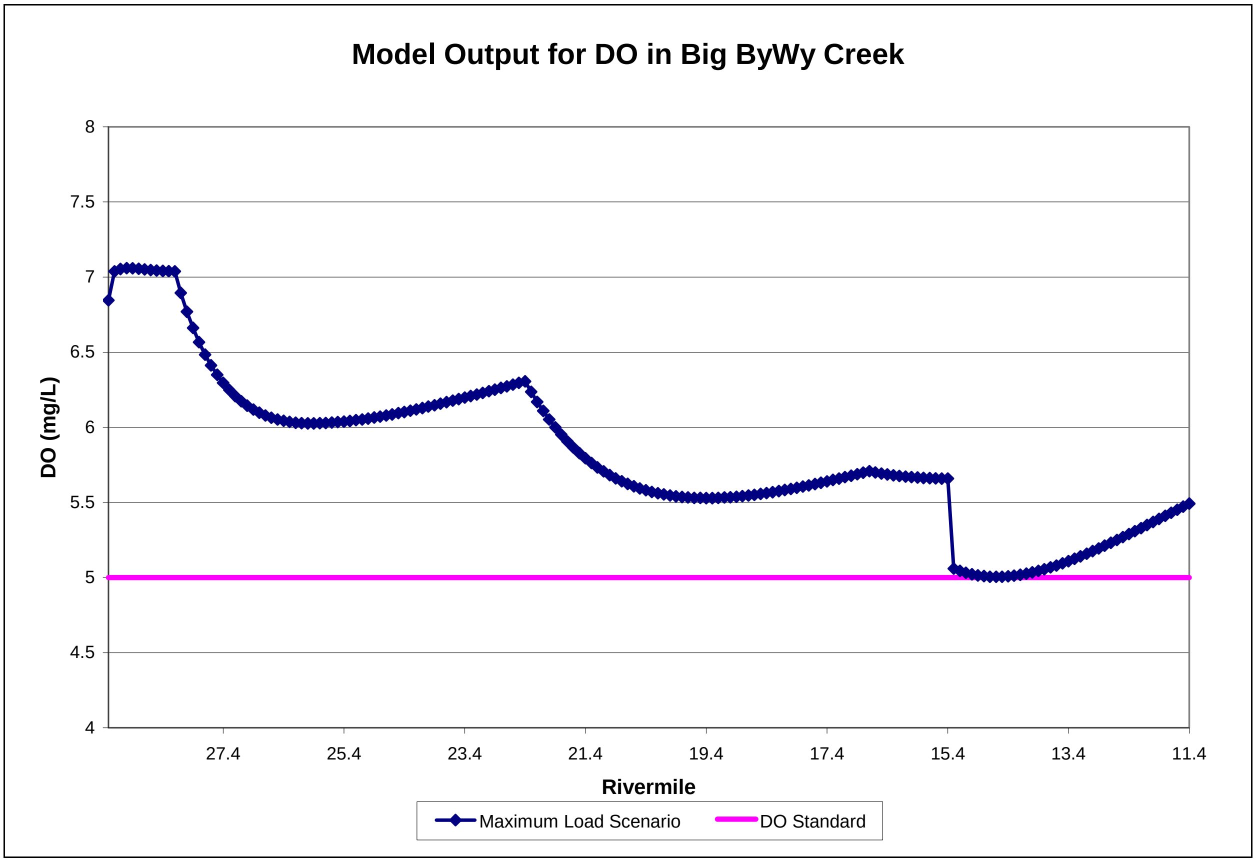


Figure 10. Model Output for Big ByWy Creek for DO, Maximum Load Scenario

3.6 Estimated Existing Load for Total Nitrogen

The estimated existing total nitrogen concentration is based on the median of total nitrogen concentrations measured in wadeable streams in Ecoregion 65 with impaired biology and elevated nutrients, which is 1.38 mg/l. Due to the lack of data, the targeted reductions will be based on the estimated total nitrogen level for impaired streams in Ecoregion 65.

To convert the estimated existing total nitrogen concentration to a total nitrogen load, the average annual flow for Big ByWy Creek was estimated based on USGS monitoring station 07289350 on the Big Black River at West, Mississippi. The annual average flow for the Big Black River at West, Mississippi is 1595.2 cfs, with a drainage area of 1027 square miles. To estimate the amount of flow in Big ByWy Creek, a drainage area ratio for the 07289350 gage watershed was calculated (1595.2 cfs / 1027 square miles = 1.553 cfs/square mile). The ratio was then multiplied by the drainage area in square miles of the impaired segment. Thus, the annual average flow in Big ByWy Creek is estimated as 183.67 cfs. The existing TN load was then calculated, using Equation 5 and the results are shown in Table 8.

Nutrient Load (lb/day) = Flow (cfs) * 5.394 (conversion factor)* Nutrient Concentration (mg/L) (Eq. 5)

Table 8. Estimated Existing Total Nitrogen Load for Big ByWy Creek

Stream	Area (sq miles)	Average Annual Flow (cfs)	TN (mg/L)	TN (lbs/day)
Big ByWy Creek	118.27	183.67	1.38	1367.2

Table 9. NPDES Permitted Facilit7 Treatment Type with Nitrogen Estimate

Facility Name	NPDES	Treatment Type	Permitted Discharge (MGD)	TN concentration estimate (mg/l)	TN Load estimate (lbs/day)
Natchez Trace Parkway, Jeff Busby Camper Park	MS0023329	Septic Tank / Sand Filters	0.012	22.4	2.24
		Total	**0.012**		**2.24**

The TN point source load is estimated to be 2.24 lbs/day, Table 9. The annual average total load based on the estimated total nitrogen concentration of 1.38 mg/l and an annual average flow of 183.67 cfs is 1367.2 lbs/day. The point source load is 0.2% of the total load. Therefore, 99.8% of the estimated existing TN load is from non-point sources.

3.7 Estimated Existing Load for Total Phosphorous

The estimated existing total phosphorous concentration is based on the median total phosphorous concentrations measured in wadeable streams in Ecoregion 65 with impaired biology and elevated nutrients, which is 0.18 mg/l. Due to the lack of data, the targeted reductions will be based on the estimated total phosphorous level for impaired streams in Ecoregion 65.

To convert the estimated existing total phosphorus concentration to a total phosphorus load, the average annual flow for Big ByWy Creek was estimated based on USGS monitoring station 07289350 on the Big Black River at West, Mississippi. As previously described, the annual average flow in Big ByWy Creek is estimated as 183.67 cfs. The existing TP load was then calculated, using Equation 5 and the results are shown in Table 10.

Table 10. Estimated Existing Total Phosphorous Load for Big ByWy Creek

Stream	Area (sq miles)	Average Annual Flow (cfs)	TP (mg/L)	TP (lbs/day)
Big ByWy Creek	118.27	183.67	0.18	178.3

Table 11. NPDES Permitted Facilities Treatment Types with Phosphorus Estimates

Facility Name	NPDES	Treatment Type	Permitted Discharge (MGD)	TP concentration estimate (mg/l)	TP Load estimate (lbs/day)
Natchez Trace Parkway, Jeff Busby Camper Park	MS0023329	Septic Tank / Sand Filters	0.012	6.6	0.66
		Total	**0.012**		**0.66**

The TP point source load is estimated to be 0.66 lbs/day, Table 11. The annual average total load based on the estimated total phosphorus concentration of 0.18 mg/l and an annual average flow of 183.67 cfs is 178.3 lbs/day. The point source load is 0.4% of the total load. Therefore, 99.6% of the estimated existing TP load is from non-point sources.

ALLOCATION

The allocation for this TMDL involves a wasteload allocation for point sources and a load allocation for non-point sources necessary for attainment of water quality standards in Big ByWy Creek, MS412BE. The nutrient portion of this TMDL is addressed through initial estimates of the existing and target TN and TP concentrations.

4.1 Wasteload Allocation

There is currently one NPDES permit issued for Big ByWy Creek watershed. Although this wasteload allocation is based on the current condition of Big ByWy Creek, it is not intended to prevent the issuance of permits for future facilities. This is because the model results show that Big ByWy Creek has additional assimilative capacity for organic material. Future permits will be considered in accordance with Mississippi's *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.*

The NPDES permitted facility is included in the wasteload allocation, Table 12. The estimated load of TN from the point source shown in Table 13 is 0.2% of the entire TN load in the water body as described in Section 3.6. The estimated load of TP from the point source shown in Table 13 is 0.4% of the entire TP load in the water body as described in Section 3.7. Because these estimates are based on literature values, this TMDL recommends quarterly nutrient monitoring for this facility.

Table 12. TBODu Wasteload Allocation

Facility Name	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Natchez Trace Parkway, Jeff Busby Camper Park	4.61	0.93	5.54
	4.61	**0.93**	**5.54**

Table 13. Nutrient WLA for Natchez Trace Parkway, Jeff Busby Camper Park

Nutrient	Existing Estimated Point Source Concentration (mg/l)	Permitted Discharge (MGD))	Existing Estimated Point Source Load (lbs/day)	Allocated Average Point Source Load (lbs/day)	Percent Reduction
TP	6.6	0.012	0.66	0.66	0
TN	22.4	0.012	2.24	2.24	0

4.2 Load Allocation

The headwater and spatially distributed loads are included in the load allocation. The TBODu concentrations of these loads were determined by using an assumed BOD_u concentration of 1.33 mg/l and an NH_3-N concentration of 0.1 mg/l. This TMDL does not require a reduction of the load allocation. In Table 14, the load allocation is shown as the non-point sources (the spatially distributed flow entering each reach in the model).

Table 14. TBODu Load Allocation, Maximum Scenario

	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Background	0.22	0.05	0.27
Non-Point Source	21.92	5.01	26.93
	22.14	**5.06**	**27.20**

Best management practices (BMPs) should be encouraged in the watersheds to reduce potential TN and TP loads from non-point sources. The watersheds should be considered a priority for riparian buffer zone restoration and any nutrient reduction BMPs. For land disturbing activities related to silviculture, construction, and agriculture, it is recommended that practices, as outlined in "Mississippi's BMPs: Best Management Practices for Forestry in Mississippi" (MFC, 2000), "Planning and Design Manual for the Control of Erosion, Sediment, and Stormwater" (MDEQ, et. al, 1994), and "Field Office Technical Guide" (NRCS, 2000), be followed, respectively.

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 for this TMDL is both implicit and explicit.

Conservative assumptions which place a higher demand of DO on the water body than may actually be present are considered part of the margin of safety. The assumption that all of the ammonia nitrogen present in the water body is oxidized to nitrate nitrogen, for example, is a conservative assumption. In addition, the TMDL is based on the critical condition of the water body represented by the low-flow, high-temperature condition. Modeling the water body at this flow provides protection during the worst-case scenario.

The explicit MOS for this report is the difference between the non-point loads calculated in the maximum load scenario and the regulatory load scenario non-point loads. The regulatory load scenario non-point source loads represent an approximation of the loads currently going into Big ByWy Creek at the critical conditions. The maximum non-point source loads are the maximum TBODu loads with a 5.98 increase that allow maintenance of water quality standards. MDEQ has set the explicit MOS as the difference in these loads. The calculated MOS is in Table 15.

Table 15. Calculation of Explicit MOS

	Maximum Non-Point Load	Regulatory Non-Point Load	Margin of Safety
CBODu (lbs/day)	22.14	3.88	18.26
NBODu (lbs/day)	5.06	0.89	4.17
TBODu (lbs/day)	**27.20**	**4.77**	**22.43**

4.4 Seasonality

Seasonal variation may be addressed in the TMDL by using seasonal water quality standards or developing model scenarios to reflect seasonal variations in temperature and other parameters. Mississippi's water quality standards for dissolved oxygen, however, do not vary according to the seasons. This model was set up to simulate dissolved oxygen during the critical condition period, the low-flow, high-temperature period that typically occurs during the summer season. Since the critical condition represents the worst-case scenario, the TMDL developed for critical conditions is protective of the water body at all times. Thus, this TMDL will ensure attainment of water quality standards for each season.

4.5 Calculation of the TMDL

The TMDL was calculated based on Equation 6.

$$\mathbf{TMDL = WLA + LA + MOS} \qquad \textbf{(Eq. 6)}$$

The TMDL for TBODu was calculated based on the current loading of pollutant in Big ByWy Creek, according to the model. The TMDL calculations are shown in Tables 16 and 17. As shown in Table 16 TBODu is the sum of CBODu and NBODu. The wasteload allocations incorporate the CBODu contributions from identified NPDES permitted facilities. The load allocations include the background and non-point sources of TBODu from surface runoff and groundwater infiltration. The implicit margin of safety for this TMDL is derived from the conservative assumptions used in setting up the model, while the explicit margin of safety is calculated based on the maximum loads scenario explained in Section 3.5.2.

Equation 5 was used to calculate the TMDLs for TP and TN. The target concentration ranges, presented in Section 1.6 were used with the average flow for the watershed to determine the TMDLs. The TMDLs, given in Table 17, were then compared to the estimated existing load for the ecoregion, presented in Sections 3.6 and 3.7. The estimated existing TP concentration indicates needed reductions of 44% to 67%. The TMDL for TP is 59.44 – 99.07 lbs/day. The estimated existing total nitrogen concentration indicates needed reductions of 49% to 56%. The TMDL for TN is 594.43 – 693.50 lbs/day.

Table 16. TMDL for TBODu in the Big ByWy Creek Watershed

	WLA (lbs/day)	LA (lbs/day)	MOS (lbs/day)	TMDL (lbs/day)
CBODu	4.61	3.88	18.26	26.75
NBODu	0.93	0.89	4.17	5.99
TBODu	**5.54**	**4.77**	**22.43**	**32.74**

Table 17. TMDL for Nutrients in the Big ByWy Creek Watershed

	WLA (lbs/day)	LA (lbs/day)	MOS (lbs/day)	TMDL (lbs/day)
TP	**0.66**	**58.78 to 98.37***	**Implicit**	**59.44 to 99.07**
TN	**2.24**	**592.19 to 691.26**	**Implicit**	**594.43 to 693.50**

The TMDL presented in this report represents the current load of a pollutant allowed in the water body. Although it has been developed for critical conditions in the water body, the allowable load is not tied to any particular combination of point and non-point source loads. The LA given in the TMDL applies to all non-point sources, and does not assign loads to specific sources.

CONCLUSION

This TMDL is based on a desktop model using MDEQ's regulatory assumptions and literature values in place of actual field data. The model results indicate that Big ByWy Creek is meeting the water quality standard for dissolved oxygen at the present loading of TBODu. Thus, this TMDL does not limit the issuance of new permits in the watershed as long as new facilities do not cause impairment in Big ByWy Creek. Nutrients were addressed through an estimate of a preliminary total phosphorus concentration target range and a preliminary total nitrogen target range. Based on the estimated existing and target total phosphorous concentrations, this TMDL recommends a 44% - 67% reduction of the phosphorous loads entering these streams to meet the preliminary target range of 0.06 to 0.10 mg/l. Based on the estimated existing and target total nitrogen concentrations, this TMDL recommends a 49% - 56% reduction of the nitrogen loads entering these streams to meet the preliminary target range of 0.6 to 0.7 mg/l. This TMDL recommends quarterly nutrient monitoring for the Natchez Trace Parkway, Jeff Busby Camper Park. It is also recommended that the Big ByWy Creek Watershed be considered as a priority watershed for riparian buffer zone restoration and any nutrient reduction BMPs. The implementation of these BMP activities should reduce the nutrient load entering the creeks. This will provide improved water quality for the support of aquatic life in the water bodies and will result in the attainment of the applicable water quality standards.

5.1 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 TMDL 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. TMDL mailing list members may request to receive the TMDL reports through either, email or the postal service. Anyone wishing to become a member of the TMDL mailing list should contact Kay Whittington at (601) 961-5098 or Kay_Whittington@deq.state.ms.us.

All comments should be directed to Kay Whittington at Kay_Whittington@deq.state.ms.us or Kay Whittington, MDEQ, PO Box 10385, Jackson, MS 39289. 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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DEFINITIONS

5-Day Biochemical Oxygen Demand: Also called BOD_5, the amount of oxygen consumed by microorganisms while stabilizing or degrading carbonaceous or nitrogenous compounds under aerobic conditions over a period of 5 days.

Activated Sludge: A secondary wastewater treatment process that removes organic matter by mixing air and recycled sludge bacteria with sewage to promote decomposition

Aerated Lagoon: A relatively deep body of water contained in an earthen basin of controlled shape which is equipped with a mechanical source of oxygen and is designed for the purpose of treating wastewater.

Ammonia: Inorganic form of nitrogen (NH_3); product of hydrolysis of organic nitrogen and denitrification. Ammonia is preferentially used by phytoplankton over nitrate for uptake of inorganic nitrogen.

Ammonia Nitrogen: The measured ammonia concentration reported in terms of equivalent ammonia concentration; also called total ammonia as nitrogen (NH_3-N)

Ammonia Toxicity: Under specific conditions of temperature and pH, the unionized component of ammonia can be toxic to aquatic life. The unionized component of ammonia increases with pH and temperature.

Ambient Stations: A network of fixed monitoring stations established for systematic water quality sampling at regular intervals, and for uniform parametric coverage over a long-term period.

Assimilative Capacity: The capacity of a body of water or soil-plant system to receive wastewater effluents or sludge without violating the provisions of the State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters and Water Quality regulations.

Background: The condition of waters in the absence of man-induced alterations based on the best scientific information available to MDEQ. The establishment of natural background for an altered water body may be based upon a similar, unaltered or least impaired, water body or on historical pre-alteration data.

Biological Impairment: Condition in which at least one biological assemblages (e.g. , fish, macroinvertebrates, or algae) indicates less than full support with moderate to severe modification of biological community noted.

Carbonaceous Biochemical Oxygen Demand: Also called CBODu, the amount of oxygen consumed by microorganisms while stabilizing or degrading carbonaceous compounds under aerobic conditions over an extended time period.

Calibrated Model: A model in which reaction rates and inputs are significantly based on actual measurements using data from surveys on the receiving water body.

Conventional Lagoon: An un-aerated, relatively shallow body of water contained in an earthen basin of controlled shape and designed for the purpose of treating water.

Critical Condition: Hydrologic and atmospheric conditions in which the pollutants causing impairment of a water body have their greatest potential for adverse effects.

Daily Discharge: The "discharge of a pollutant" measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the "daily average" is calculated as the average.

Designated Use: Use specified in water quality standards for each water body or segment regardless of actual attainment.

Discharge Monitoring Report: Report of effluent characteristics submitted by a NPDES Permitted facility.

Dissolved Oxygen: The amount of oxygen dissolved in water. It also refers to a measure of the amount of oxygen that is available for biochemical activity in a water body. The maximum concentration of dissolved oxygen in a water body depends on temperature, atmospheric pressure, and dissolved solids.

Dissolved Oxygen Deficit: The saturation dissolved oxygen concentration minus the actual dissolved oxygen concentration.

DO Sag: Longitudinal variation of dissolved oxygen representing the oxygen depletion and recovery following a waste load discharge into a receiving water.

Effluent Standards and Limitations: All State or Federal effluent standards and limitations on quantities, rates, and concentrations of chemical, physical, biological, and other constituents to which a waste or wastewater discharge may be subject under the Federal Act or the State law. This includes, but is not limited to, effluent limitations, standards of performance, toxic effluent standards and prohibitions, pretreatment standards, and schedules of compliance.

Effluent: Treated wastewater flowing out of the treatment facilities.

First Order Kinetics: Describes a reaction in which the rate of transformation of a pollutant is proportional to the amount of that pollutant in the environmental system.

Groundwater: Subsurface water in the zone of saturation. Groundwater infiltration describes the rate and amount of movement of water from a saturated formation.

Impaired Water body: Any water body that does not attain water quality standards due to an individual pollutant, multiple pollutants, pollution, or an unknown cause of impairment.

Land Surface Runoff: Water that flows into the receiving stream after application by rainfall or irrigation. It is a transport method for non-point source pollution from the land surface to the receiving stream.

Load Allocation (LA): The portion of receiving water's loading capacity attributed to or assigned to non-point sources (NPS) or background sources of a pollutant

Loading: The total amount of pollutants entering a stream from one or multiple sources.

Mass Balance: An equation that accounts for the flux of mass going into a defined area and the flux of mass leaving a defined area, the flux in must equal the flux out.

Non-Point Source: Pollution that is in runoff from the land. Rainfall, snowmelt, and other water that does not evaporate become surface runoff and either drains into surface waters or soaks into the soil and finds its way into groundwater. This surface water may contain pollutants that come from land use activities such as agriculture; construction; silviculture; surface mining; disposal of wastewater; hydrologic modifications; and urban development.

Nitrification: The oxidation of ammonium salts to nitrites via *Nitrosomonas* bacteria and the further oxidation of nitrite to nitrate via *Nitrobacter* bacteria.

Nitrogenous Biochemical Oxygen Demand: Also called NBODu, the amount of oxygen consumed by microorganisms while stabilizing or degrading nitrogenous compounds under aerobic conditions over an extended time period.

NPDES Permit: An individual or general permit issued by the Mississippi Environmental Quality Permit Board pursuant to regulations adopted by the Mississippi Commission on Environmental Quality under Mississippi Code Annotated (as amended) §§ 49-17-17 and 49-17-29 for discharges into State waters.

Photosynthesis: The biochemical synthesis of carbohydrate based organic compounds from water and carbon dioxide using light energy in the presence of chlorophyll.

Point Source: Pollution loads discharged at a specific location from pipes, outfalls, and conveyance channels from either wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving stream.

Pollution: Contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the State, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance, or leak into any waters of the State, unless in compliance with a valid permit issued by the Permit Board.

Publicly Owned Treatment Works (POTW): A waste treatment facility owned and/or operated by a public body or a privately owned treatment works which accepts discharges which would otherwise be subject to Federal Pretreatment Requirements.

Reaeration: The net flux of oxygen occurring from the atmosphere to a body of water across the water surface.

Regression Coefficient: An expression of the functional relationship between two correlated variables that is often empirically determined from data, and is used to predict values of one variable when given values of the other variable.

Respiration: The biochemical process by means of which cellular fuels are oxidized with the aid of oxygen to permit the release of energy required to sustain life. During respiration, oxygen is consumed and carbon dioxide is released.

Sediment Oxygen Demand: The solids discharged to a receiving water are partly organics, which upon settling to the bottom decompose aerobically, removing oxygen from the surrounding water column.

Storm Runoff: Rainfall that does not evaporate or infiltrate the ground because of impervious land surfaces or a soil infiltration rate than rainfall intensity, but instead flows into adjacent land or water bodies or is routed into a drain or sewer system.

Streeter-Phelps DO Sag Equation: An equation which uses a mass balance approach to determine the DO concentration in a water body downstream of a point source discharge. The equation assumes that the stream flow is constant and that CBODu exertion is the only source of DO deficit while reaeration is the only sink of DO deficit.

Technology based effluent limitation (TBEL): A minimum waste treatment requirement, established by the Department, based on treatment technology. The minimum treatment requirements may be set at levels more stringent than that which is necessary to meet water quality standards of the receiving water body.

Total Ultimate Biochemical Oxygen Demand: Also called TBODu, the amount of oxygen consumed by microorganisms while stabilizing or degrading carbonaceous or nitrogenous compounds under aerobic conditions over an extended time period.

Total Kjeldahl Nitrogen: Also called TKN, organic nitrogen plus ammonia nitrogen.

Total Maximum Daily Load or TMDL: The calculated maximum permissible pollutant loading to a water body at which water quality standards can be maintained.

Waste: Sewage, industrial wastes, oil field wastes, and all other liquid, gaseous, solid, radioactive, or other substances which may pollute or tend to pollute any waters of the State.

Wasteload Allocation (WLA): The portion of a receiving water's loading capacity attributed to or assigned to point sources of a pollutant.

Water Quality Standards: The criteria and requirements set forth in *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. Water quality standards are standards composed of designated present and future most beneficial uses (classification of waters), the numerical and narrative criteria applied to the specific water uses or classification, and the Mississippi antidegradation policy.

Water Quality Criteria: Elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports the present and future most beneficial uses.

Waters of the State: All waters within the jurisdiction of this State, including all streams, lakes, ponds, wetlands, impounding reservoirs, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, situated wholly or partly within or bordering upon the State, and such coastal waters as are within the jurisdiction of the State, except lakes, ponds, or other surface waters which are wholly landlocked and privately owned, and which are not regulated under the Federal Clean Water Act (33 U.S.C.1251 et seq.).

Watershed: The area of land draining into a stream at a given location.

ABBREVIATIONS

7Q10 .... Seven-Day Average Low Stream Flow with a Ten-Year Occurrence Period

BMP .... Best Management Practice

$CBOD_5$ .... 5-Day Carbonaceous Biochemical Oxygen Demand

CBODu .... Carbonaceous Ultimate Biochemical Oxygen Demand

CWA .... Clean Water Act

DMR .... Discharge Monitoring Report

DO .... Dissolved Oxygen

EPA .... Environmental Protection Agency

GIS .... Geographic Information System

HUC .... Hydrologic Unit Code

LA .... Load Allocation

MARIS .... Mississippi Automated Resource Information System

MDEQ .... Mississippi Department of Environmental Quality

MGD .... Million Gallons per Day

MOS .... Margin of Safety

NBODu .... Nitrogenous Ultimate Biochemical Oxygen Demand

NH_3 .... Total Ammonia

NH_3-N .... Total Ammonia as Nitrogen

NO_2+ NO_3 .... Nitrite Plus Nitrate

NPDES .... National Pollution Discharge Elimination System

NTF .... Nutrient Task Force

POTW .... Public Owned Treatment Works

RBA .... Rapid Biological Assessment

TBODu..Total Ultimate Biochemical Oxygen Demand

TKN .... Total Kjeldahl Nitrogen

TN .... Total Nitrogen

TOC.. Total Organic Carbon

TP .... Total Phosphorous

USGS .... United States Geological Survey

WLA .... Waste Load Allocation