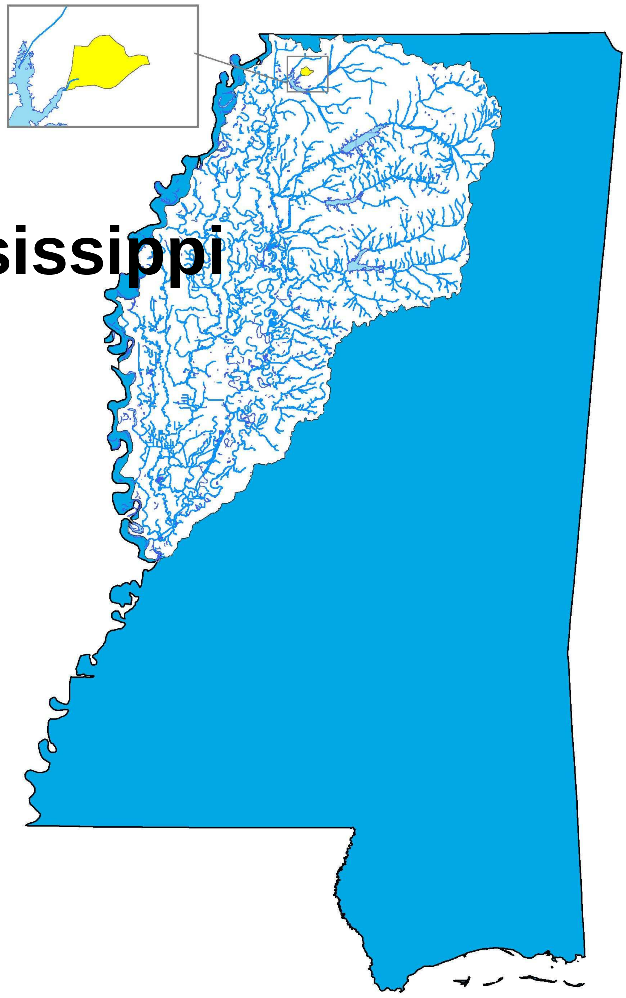
FINAL REPORT
March 2008
ID: 908030701

Total Maximum Daily Load

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

Yazoo River Basin



Desoto County, Mississippi

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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

Table 1. Listing Information

Name	ID	County	HUC	Impaired Use	Causes
Mussucuna Creek	MS306M	Desoto	08030204	Aquatic Life Support	Biological Impairment due to Nutrients and Organic Enrichment / Low Dissolved Oxygen
Location: Near Hernando from Hernando South POTW to Arkabutla Lake Flood Pool					

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

Facility Name	NPDES ID	Permitted Discharge (MGD)	Receiving Water
Hernando South POTW	MS0025160	0.95	Mussucuna Creek

Table 4. Total Maximum Daily Load

Pollutant	WLA (lbs/day)	LA (lbs/day)	MOS	TMDL (lbs/day)
TN	**0**	**37.4 – 74.7**	Implicit	**37.4 – 74.7**
TP	**0**	**2.7-10.7**	Implicit	**2.7-10.7**
TBODu	**0**	**64.7**	Implicit	**64.7**

EXECUTIVE SUMMARY

This TMDL has been developed for Mussucuna 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 Mussucuna 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 point source located in the watershed.

Mississippi does not have numeric criteria in its 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 0.56 to 1.12 mg/l is an applicable target for TN and 0.04 to 0.16 mg/l for TP for water bodies located in Ecoregion 74. 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 Mussucuna Creek Watershed is located in HUC 08030204. Mussucuna Creek begins near Hernando and flows in a southwestern direction from its headwaters to its mouth at the Arkabutla Lake Flood Pool. This TMDL was developed for the impaired segment shown in Figure 2.

Figure 1. Mussucuna Creek near Hernando

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 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 Mussucuna Creek Watershed. TBODu loadings from background and non-point sources in the watershed were accounted for by using an estimated concentration of TBODu and flows based on the critical flow conditions. There is one NPDES permitted discharger located in the watershed that is included as a point source in the model. The location of the watershed for the listed segment is shown in Figure 2.

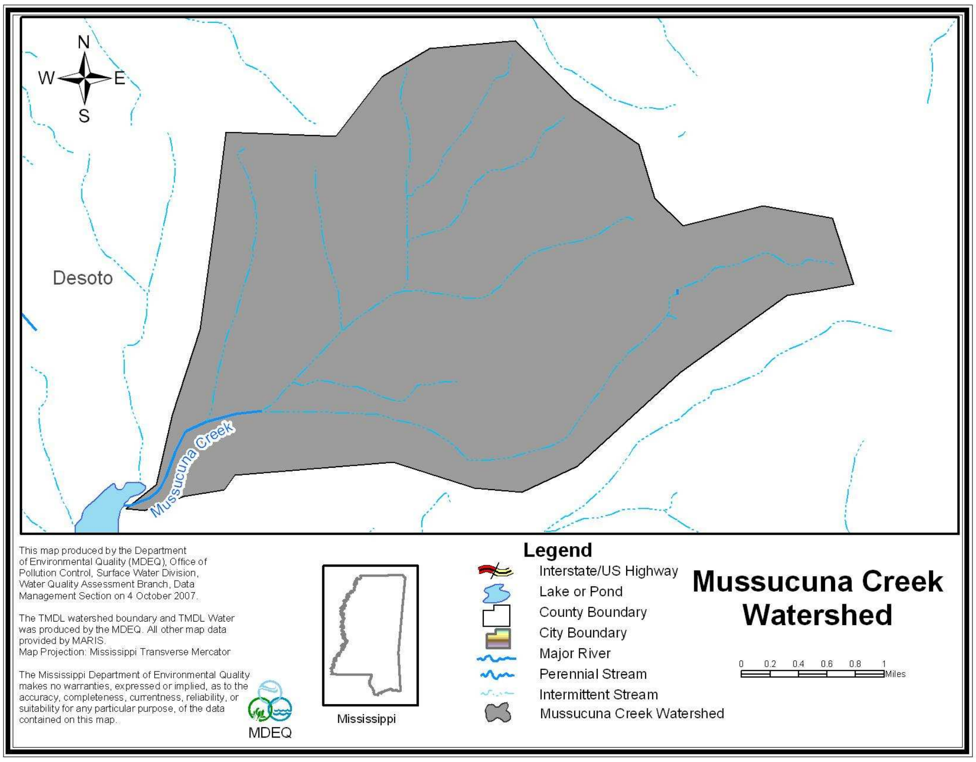


Figure 2. Mussucuna Creek Watershed

According to the model, the current TBODu load in the water body exceeds the assimilative capacity of Mussucuna Creek for organic material at the critical conditions. However, the only point source in the watershed was removed from the stream and connected to the regional system.

Mass balance calculations showed that the nutrient levels were predominantly from the point source. However, even with the removal of the point source, the estimated existing ecoregion concentrations indicate reductions of nutrients from the non-point sources are needed.

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 2006 §303(d) listed segment shown in Figure 3.

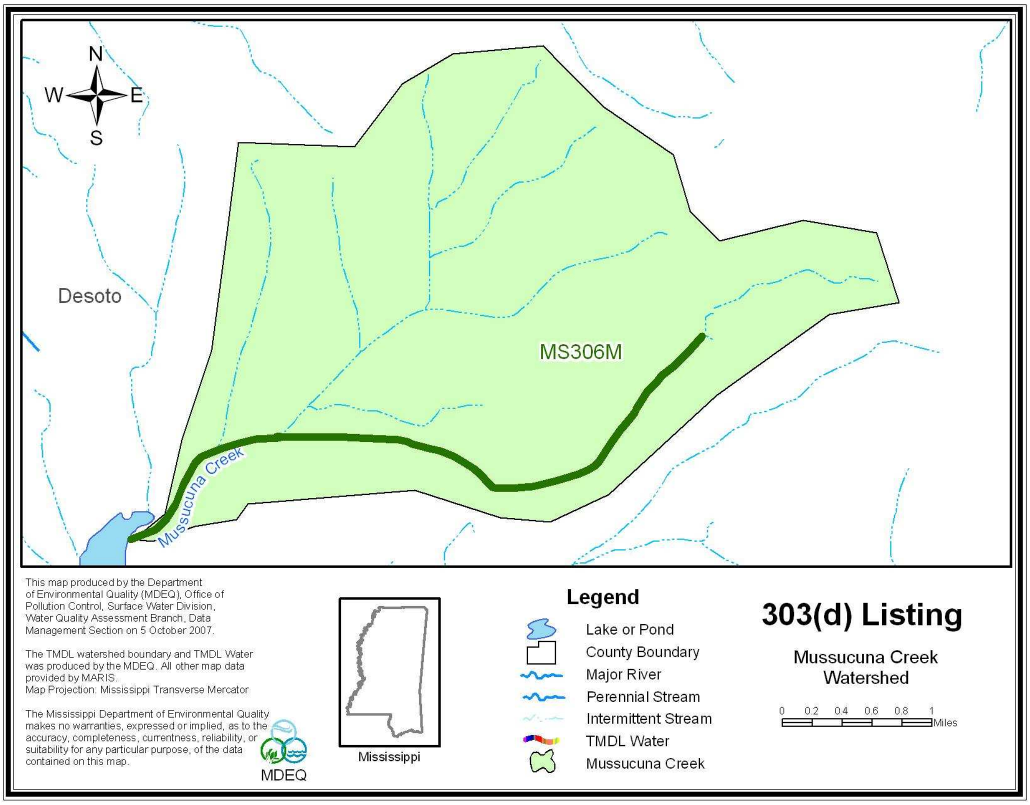


Figure 3. Mussucuna Creek §303(d) Segment

1.2 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.

1.3 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, 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)." 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 were previously collected. 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" (LD) through a defined process in the Mississippi Benthic Index of Stream Quality (M-BISQ) process or stations that resulted in a biological impairment rating of "fully attaining" were used to evaluate natural variability of the data set (MDEQ, 2003).

The M-BISQ, a regionally calibrated benthic index of biotic integrity, was developed through a partnership between MDEQ and Tetra Tech, Inc. in 2001 from 434 wadeable (perennial, 1st-4th order streams) in the state excluding the Yazoo Delta. This index defined five bioregions for the state, and established the 25^{th} percentile of the least disturbed condition for each bioregion as the threshold of impairment of the state of Mississippi's wadeable streams. Each of the two groups—"least disturbed sites" and "fully attaining sites"—was evaluated separately. 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 four 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 ecoregions throughout other basins as well.

For the preliminary target concentration range the means of the data at each of the nutrient sites were taken. Then the 75th and 90th percentiles of the means were taken of the nutrient sites in that ecoregion that are fully supporting for aquatic life support according to the M-BISQ scores. For the estimate of the existing concentrations the median was taken of the data from the 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. This segment of Mussucuna Creek currently has no USGS flow gages. The low flow condition for Mussucuna Creek was determined based on the *Techniques for Estimating 7-Day, 10-Year Low-Flow Characteristics on Streams in Mississippi* (Telis, 1992). The flow in Mussucuna Creek watershed was modeled at critical conditions based on data available from a drainage area coefficient of 0.05 cfs /sq. mile. The 7Q10 was calculated to be 0.47 cfs.

1.6 Selection of a TMDL Endpoint

One of the major components of a TMDL is the establishment of in-stream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. In-stream 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 in-stream conditions and conditions that are expected to restore designated uses. The in-stream 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 in-stream 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 such as this. More specific modeling and calibration are needed in order to obtain accurate diurnal oxygen levels. Therefore, based on the limited data available and the relative simplicity of the model, the daily average target is appropriate.

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 to by EPA and is on schedule according to the approved plan in development of nutrient criteria (MDEQ, 2004). Data were collected for wadeable streams to calculate the nutrient criteria.

MDEQ currently has a Nutrient Task Force (NTF) working on the development of criteria for nutrients. An annual concentration range of 0.56 to 1.12 mg/l is an applicable target for TN and 0.04 to 0.16 mg/l for TP for water bodies located in Ecoregion 74. MDEQ is presenting these ranges as preliminary target values for TMDL development which is subject to revision after the development of numeric nutrient criteria.

WATER BODY ASSESSMENT

2.1 Mussucuna Creek Water Quality Data

Nutrient and DO data for the Mussucuna Creek Watershed were gathered and reviewed. Data exist for IBI Station 756 and monitoring station YZ117. Based upon a completed stressor identification report, the strength of evidence analysis showed low DO to be a primary probable cause of impairment. Some biological metrics also indicated altered food sources (nutrient enrichment. Other non-MBISQ data indicate a low DO (WQS violation) in June 2001 and 2006 recon data also indicate a low DO percent saturation in-stream below the Hernando POTW discharge. No diurnal data are available. All nutrients were much higher than the least disturbed reference site during M-BISQ monitoring. Other non-MBISQ data (1999 - 2002) also indicate highly elevated nutrients. Water color was green and algae seen during IBI02 and 04, 2006 recon and the pre-IBI recon in 2001. Several potential sources exist in the watershed for this cause including agricultural activities (cropland and pasture), scattered unsewered residential areas, urban area from the city of Hernando and one major point source with a history of chronic compliance problems (BOD, DO and ammonia). The locations of the water quality stations are shown in Figure 4, and the available data are summarized in Table 5.

Figure 4. Mussucuna Creek Water Quality Monitoring Station

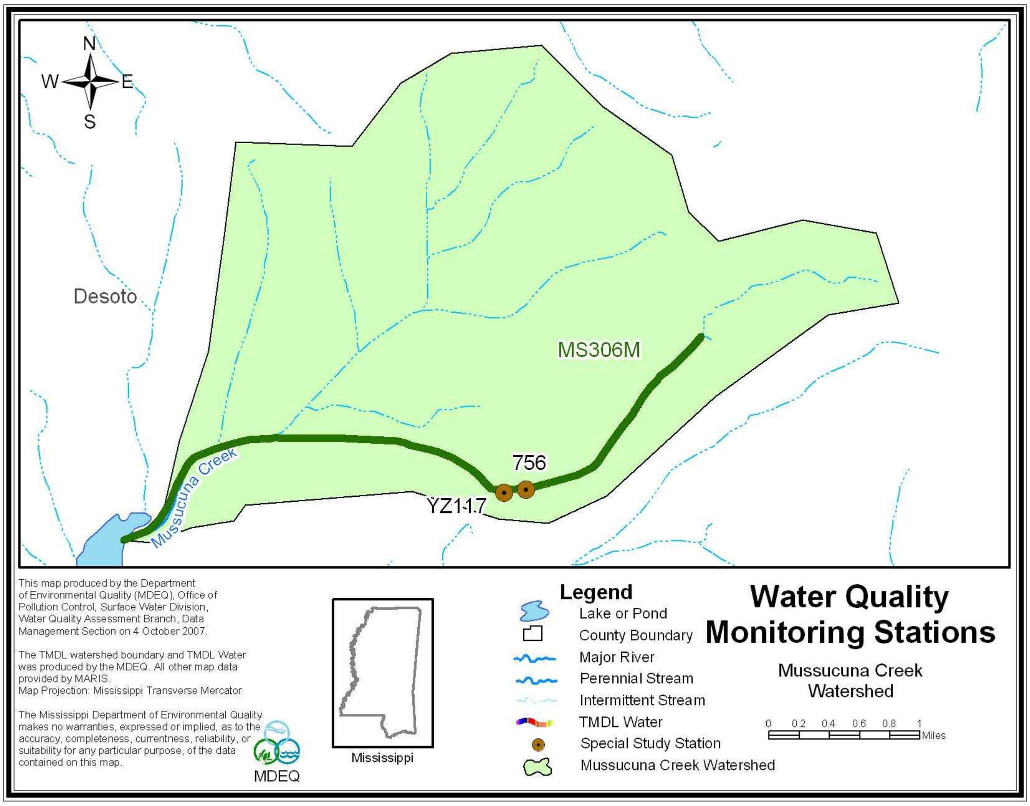


Table 5. Mussucuna Creek Summary Data

Parameter	N	Max	Min	Mean
Dissolved Oxygen	6	12.3	3.5	9.3
Water Temperature	6	32.3	6.7	18.4
Total Phosphorous	8	1.40	0.32	0.95
Total Nitrogen	8	14.9	3.53	7.12

2.2 Assessment of Point Sources

An important step in assessing pollutant sources in the Mussucuna Creek watershed is locating the NPDES permitted sources. There is one facility permitted to discharge into this watershed, Table 6. The DMR data reviewed for this facility indicate that there has been a history of violations for several water quality parameters. Numerous notices of violation were noted for BOD and NH_3-N with averages being 16 mg/L and 5.7 mg/L, respectively for the last 5 years. Additionally, there were compliance sample violations in 2004 for DO and NH_3. It also noted that prior to 2003, there were multiple bypasses of the city of Hernando's South collection system in the area of Mussucuna Creek. The facility performed upgrades to its WWTP but have continued to have water quality violations and bypasses as recently as March of this year. The location of the facility is shown in Figure 5.

Table 6. NPDES Permitted Facilities Treatment Types

Name	NPDES Permit	Treatment Type	Discharge (MGD)	Permitted BOD_5 (mg/l)
Hernando POTW South	MS0025160	Aerated Lagoon	0.95	10

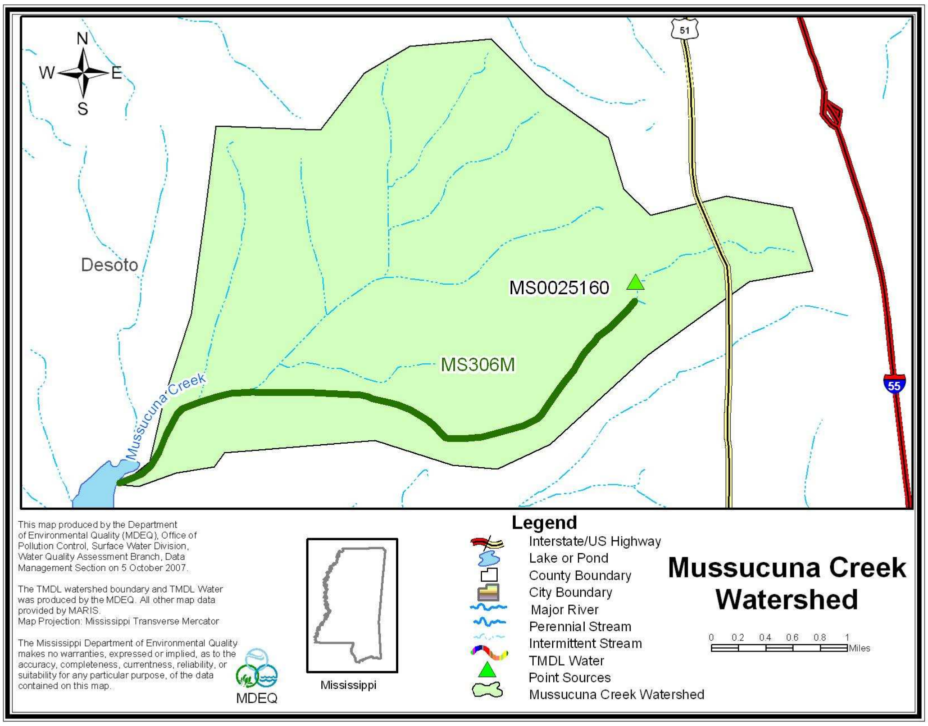


Figure 5. Mussucuna Creek Point Source

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 7 presents typical nutrient loading ranges for various land uses.

Table 7. 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 Mussucuna Creek is approximately 6,051 acres (9.45 square miles). The watershed contains many different landuse types, including urban, forest, cropland, pasture, water, wetlands and clouds. The land use information for the watershed is based on the State of Mississippi's Automated Resource Information System (MARIS), 1997. This data set is based Landsat Thematic Mapper digital images taken between 1992 and 1993. The MARIS data are classified on a modified Anderson level one and two system with additional level two wetland classifications. The area directly surrounding the impaired segment, MS306M, is predominantly cropland. The landuse distribution for Mussucuna Creek is shown in Table 8 and Figure 6.

Table 8. Landuse Distribution for Mussucuna Creek Watershed

Landuse	Urban	Forest	Cropland	Pasture	Scrub/Barren	Water	Wetlands
Acreage	30	752	2416	2134	185	51	483
Percentage	0.5	12.4	39.9	35.3	3.1	0.8	8.0

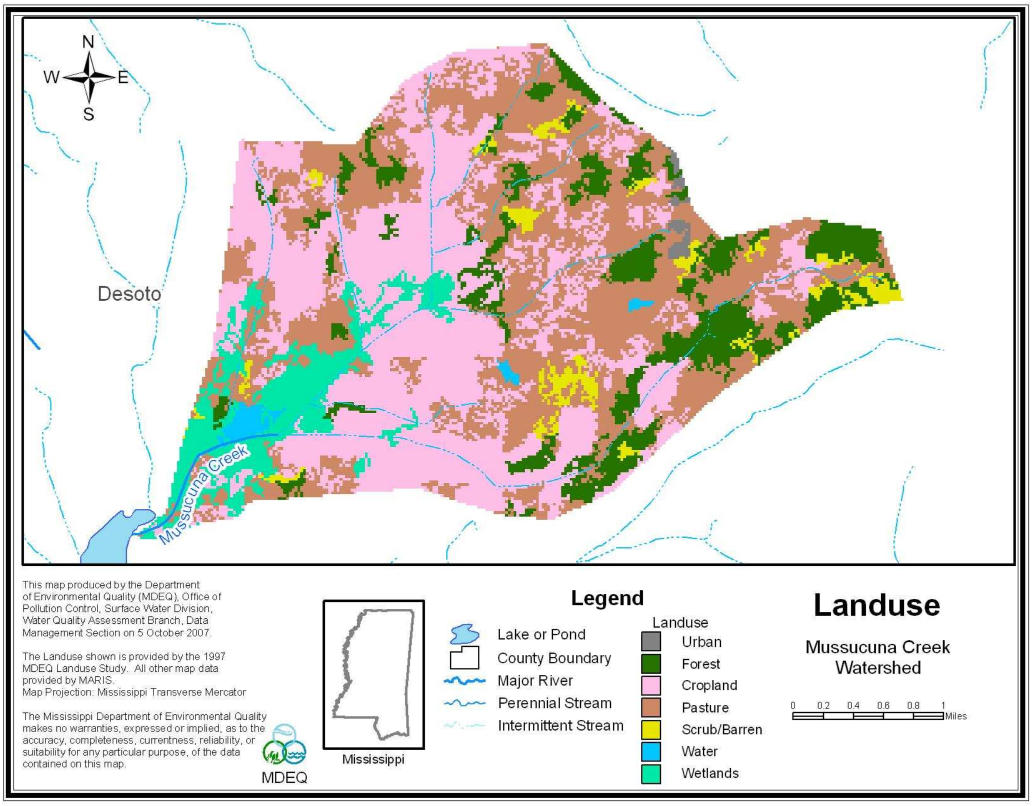


Figure 6. Landuse in Mussucuna Creek Watershed

MODELING PROCEDURE: LINKING THE SOURCES TO THE ENDPOINT

Establishing the relationship between the in-stream 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 in-stream water quality conditions in response to point and non-point source loadings.

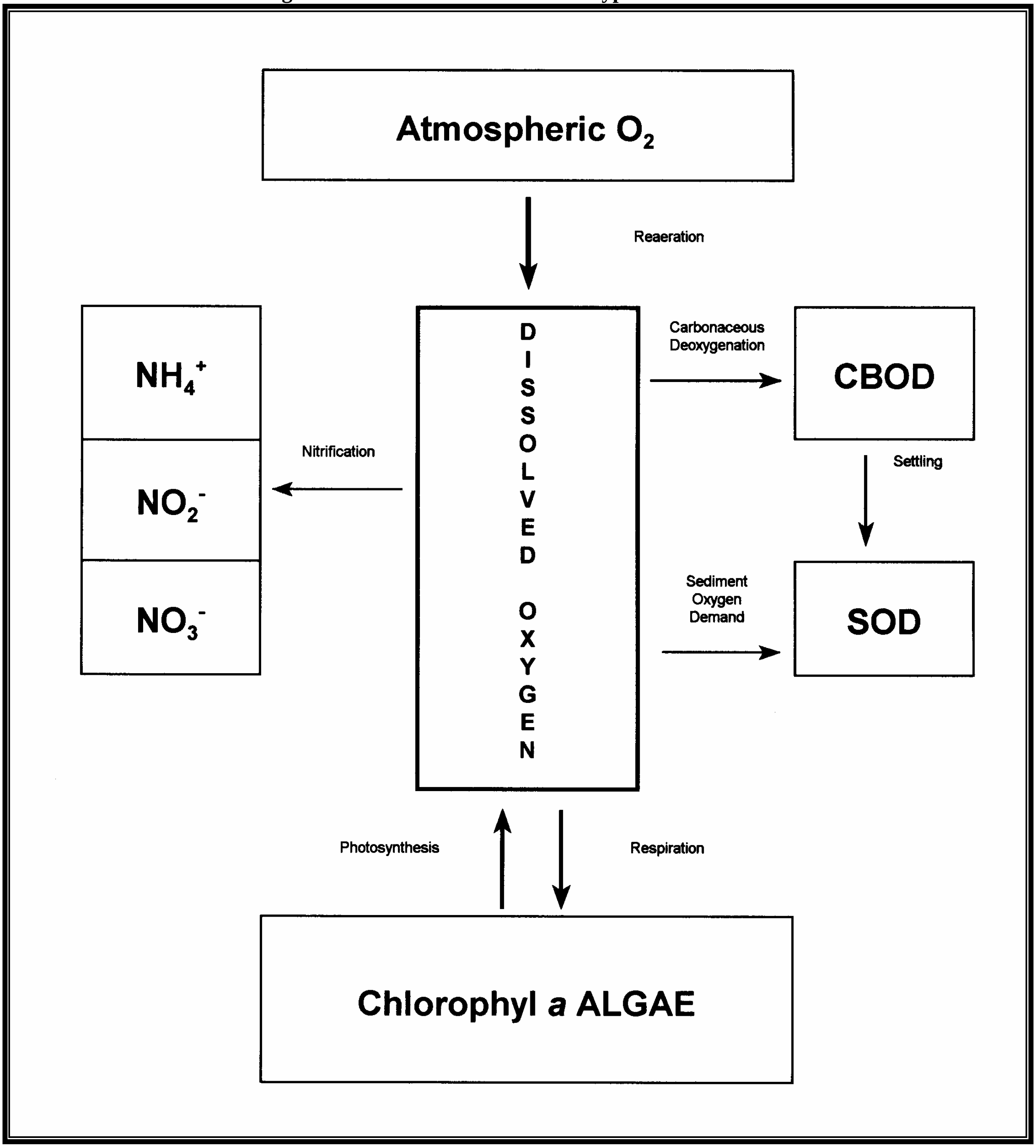
STREAM is a steady-state, daily average computer model that utilizes a modified Streeter-Phelps DO sag equation. In-stream processes simulated by the model include CBODu decay, nitrification, reaeration, sediment oxygen demand, and respiration and photosynthesis of algae. Figure 7 shows how these processes are related in a typical DO model. Reaction rates for the in-stream 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 1.

$$\mathbf{K}_a = \mathbf{C*S*U} \qquad \textbf{(Eq. 1)}$$

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 electronically and input into the model in units of feet/mile.

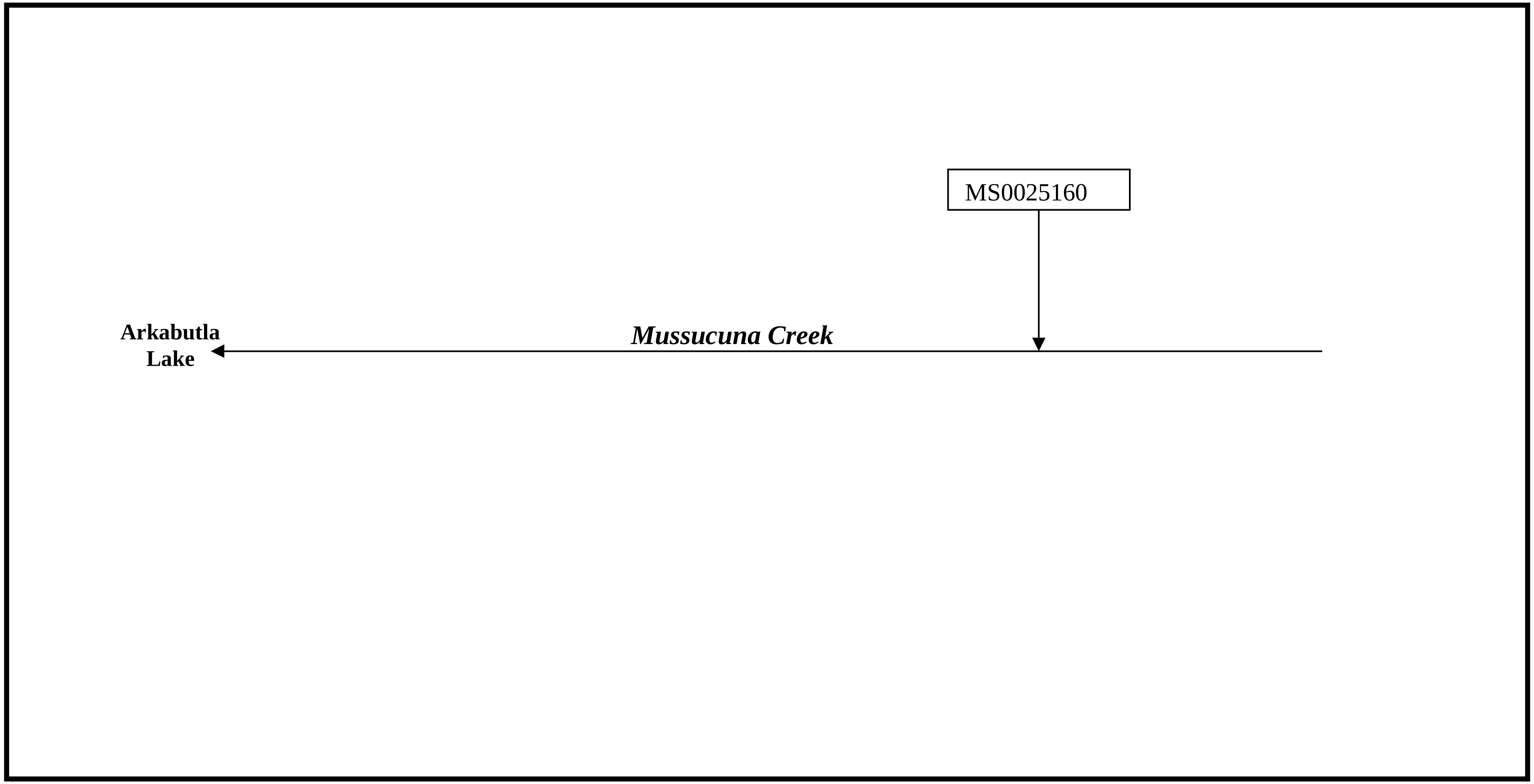
Figure 7. In-stream Processes in a Typical DO Model



3.2 Model Setup

The model for this TMDL includes the §303(d) listed segment of Mussucuna Creek, beginning at the headwaters. A diagram showing the model setup is shown in Figure 8.

Figure 8. Mussucuna 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 in-stream DO was assumed to be 85% of saturation at the stream temperature. The in-stream 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 2.

$$\mathbf{K_{d(T)} = K_{d(20°C)}(1.047)^{T-20}} \qquad \textbf{(Eq. 2)}$$

Where K_d is the CBODu decay rate and T is the assumed in-stream temperature. The assumptions regarding the in-stream 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.

3.3 Source Representation

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 3.

$$\textbf{TBODu = CBODu + NBODu} \qquad \textbf{(Equation 3)}$$

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.

$$\textbf{CBODu = CBOD}_\mathbf{5}\textbf{ * Ratio} \qquad \textbf{(Equation 4)}$$

The CBODu to $CBOD_5$ ratios are given in *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 2001). 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. A CBODu to $CBOD_5$ ratio of 1.5 is appropriate for the Hernando POTW South facility.

In order to determine the NBODu, the ammonia nitrogen (NH_3-N) loads were converted to an oxygen demand using a factor of 4.57 pounds of oxygen per pound of ammonia nitrogen (NH_3-N) oxidized to nitrate nitrogen (NO_3-N). Using this factor is a conservative modeling assumption because it assumes that all of the ammonia is converted to nitrate through nitrification. The sum of CBODu and NBODu is equal to the point source load of TBODu. The maximum permitted load of TBODu from the existing point source is given in Table 9.

Table 9. Point Sources, Maximum Permitted Loads

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)
Hernando South POTW	0.95	10	2	1.5	118.8	15.8	134.6
Total	**0.95**				**118.8**	**15.8**	**134.6**

Direct measurements of background concentrations of CBODu were not available for Mussucuna 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 Mussucuna 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 10.

Table 10. 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)
Mussucuna Creek background load	0.01	1.33	0.11	0.1	0.005	0.12
Mussucuna Creek non-point source load	0.46	1.33	4.9	0.1	0.25	5.15
Total			**5.01**		**0.255**	**5.27**

3.4 Model Calibration

The model used to develop Mussucuna Creek TMDL was not calibrated due to lack of in-stream 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 Mussucuna Creek. The model was first run under regulatory load conditions. Under regulatory load conditions, the loads from the NPDES permitted point source was based on its current location and maximum permit limits, Table 10.

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 permitted facility at its current maximum allowable loads and with estimated non-point source loads. The figure shows the daily average in-stream DO concentrations, beginning at the headwaters at river mile 5.8 and ending at river mile 0.0 at the Arkabutla Lake Floodpool. As shown in the figure, the model predicts that the DO goes slightly below the standard of 5.0 mg/l using the maximum allowable loads.

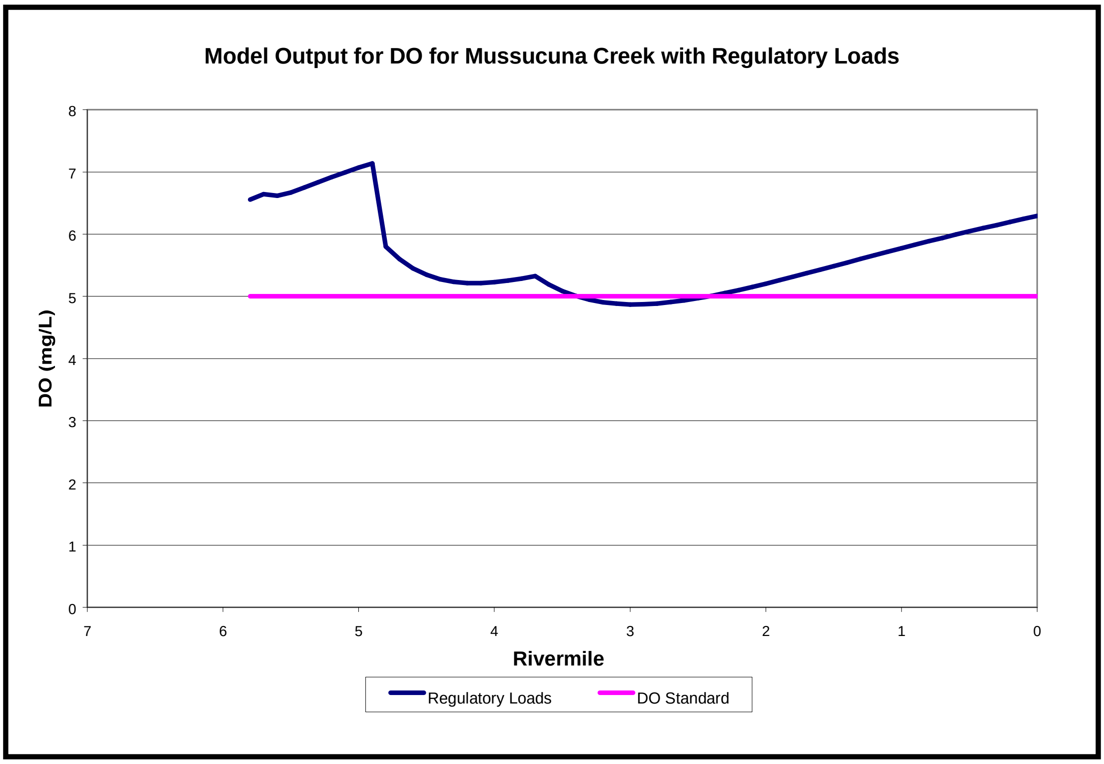


Figure 9. Model Output for DO in Mussucuna Creek, Regulatory Load Scenario

3.5.2 Maximum Load Scenario

The graph of the regulatory load scenario output shows that the predicted DO falls below the DO standard in Mussucuna Creek during critical conditions. However, as of August 2007, Hernando South POTW added a lift station to send its influent to the regional system (DCRUA) and ceased discharging to Mussucuna Creek. Upon removal of the point source load from the model, the DO standard is not violated as shown in Figure 10. Thus, further reductions of TBODu are not necessary.

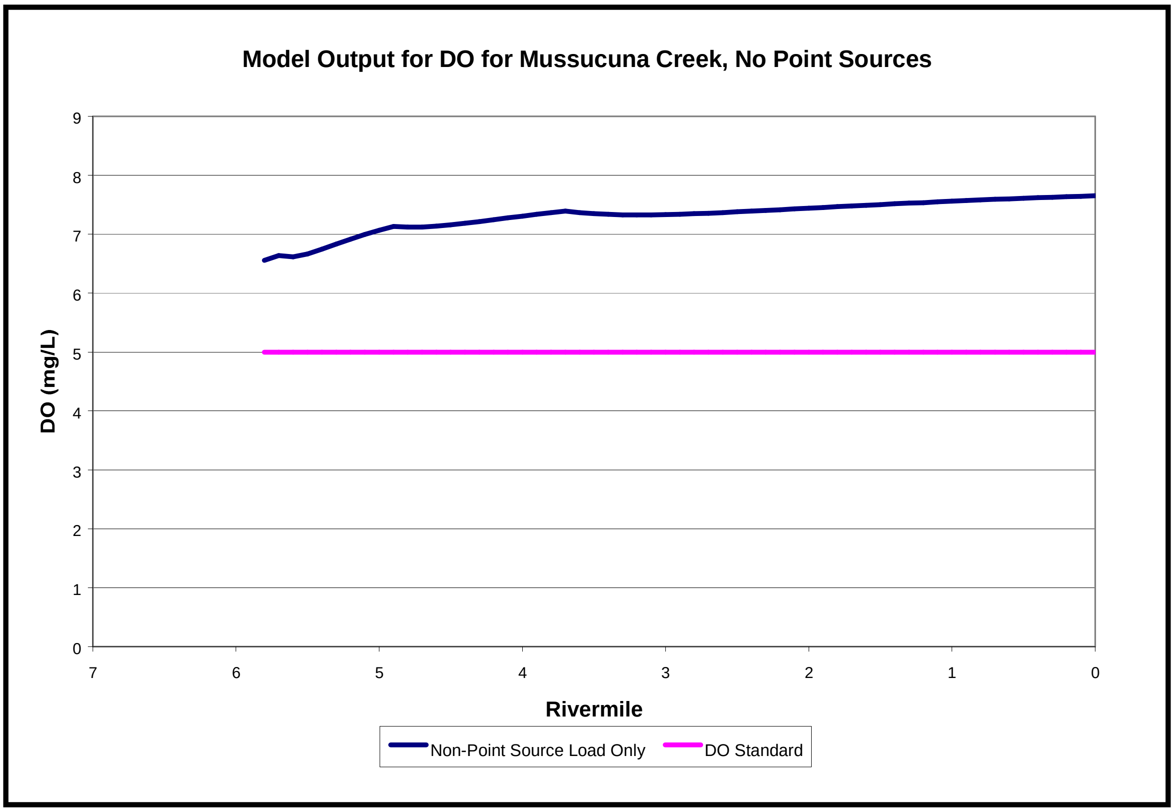


Figure 10. Model Output for Mussucuna Creek for DO, No Point Sources

Calculating the maximum allowable load of TBODu involved increasing the model loads without the point source until the modeled DO was just above 5.0 mg/l. The non-point source loads were increased by a factor of 10.6 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 11. The model results for the maximum load scenario show that the water body has additional assimilative capacity after the point source was removed.

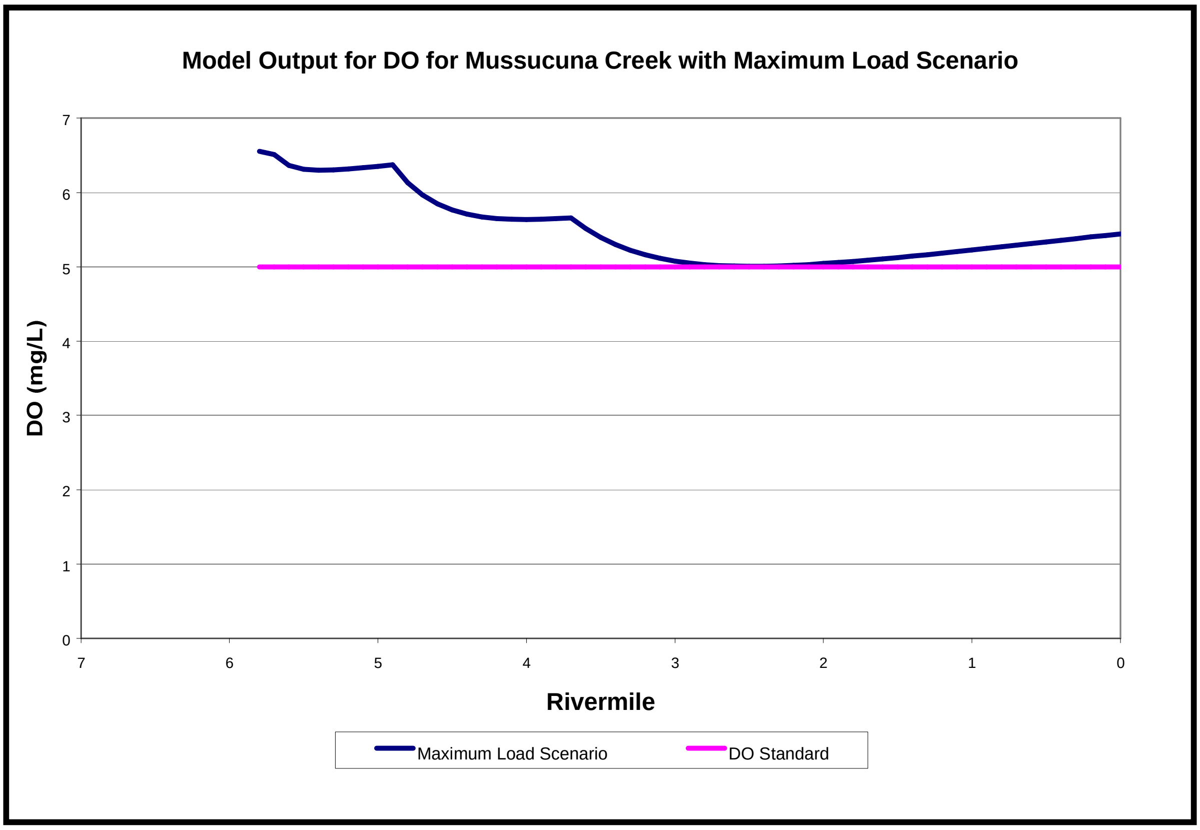


Figure 11. Model Output for Mussucuna Creek for DO, Maximum Load Scenario

3.6 Estimated Existing Load for Total Nitrogen

The estimated existing total nitrogen concentration is based on the median total nitrogen concentrations measured in wadeable streams in Ecoregion 74 with impaired biology and elevated nutrients, which is 1.71 mg/l. The target concentration for TN for Ecoregion 74 is 0.56 to 1.12 mg/l. The average concentration found in this stream is 7.12 mg/L. However, due to the limited amount of data, the targeted reductions will be based on the estimated total nitrogen level for impaired streams in Ecoregion 74.

To convert the estimated existing TN concentration to a TN load, the average annual flow was estimated based on flow data from the USGS gage located on the Coldwater River at the Arkabutla Dam (07278500). The average annual flow for this gage is 1307 cfs. To estimate the amount of flow in Mussucuna Creek, a drainage area ratio was calculated (1307 cfs/1000 square miles = 1.31 cfs/square miles). The ratio was then multiplied by the drainage area of the impaired segment. The existing TN load was then calculated using Equation 5 and summarized in Table 11.

Load (lb/day) = Flow (MGD) *8.34 (conversion factor)* Concentration (mg/L) (Eq. 5)

Table 11. Estimated Existing Total Nitrogen Load for Mussucuna Creek

Water body	Area (sq miles)	Average Annual Flow (cfs)	TN (mg/l)	TN (lbs/day)
Mussucuna Creek	9.45	12.38	1.71	114.1

The existing TN load consists of both point and non-point components. Since many treatment facilities in Mississippi do not have permit limits for nitrogen, nor are they currently required to report effluent nitrogen concentrations, MDEQ used an estimated effluent concentration based on literature values for different treatment types. Table 12 shows the median effluent nitrogen concentrations for four conventional treatment processes. The appropriate concentration for each of the facilities was then used in Equation 5 to estimate the TN load from point sources, Table 13.

Table 12. Median Nitrogen Concentrations in Wastewater Effluents

	Treatment Type			
	Primary	Trickling Filter	Activated Sludge	Stabilization Pond
No. of plants sampled	55	244	244	149
Total N (mg/L)	22.4 ± 1.30	16.4± 0.54	13.6 ±0 .62	11.5 ± 0.84

Source: After Ketchum, 1982 in EPA 823-B-97-002 (USEPA, 1997)

Table 13. NPDES Permitted Facilities Treatment Types with Nitrogen Estimates

Facility Name	Treatment Type	Permitted Discharge (MGD)	TN concentration estimate (mg/l)	TN Load estimate (lbs/day)
Hernando South POTW	Aerated Lagoon	0.95	11.5	91.1
	Total	**0.95**		**91.1**

The TN point source load is estimated to be 91.1 lbs/day, Table 13. The annual average total load based on the estimated total nitrogen concentration of 1.71 mg/l and an annual average flow of 12.38 cfs is 114.1 lbs/day. The point source load was 80% of the total load. Therefore, only 20% of the total load was estimated to come from non-point sources. With the elimination of the point source, MDEQ believes that a significant reduction in TN in the watershed is accomplished. Therefore any load reductions from non-point sources would have an insignificant impact on water quality.

3.7 Estimated Existing Load for Total Phosphorus

The estimated existing total phosphorous concentration is based on the median total phosphorous concentrations measured in wadeable streams in Ecoregion 74 with impaired biology and elevated nutrients, which is 0.16 mg/l. The target concentration for TP for Ecoregion 74 is 0.04 to 0.16 mg/l. The average concentration found in this stream is 0.95 mg/L. However, due to the limited amount of data, the targeted reductions will be based on the estimated total phosphorous level for impaired streams in Ecoregion 74.

To convert the estimated existing total phosphorous concentration to a total phosphorous load, the average annual flow was estimated based on flow data as shown above. The existing TP load was then calculated using Equation 5 and summarized in Table 14.

Table 14. Estimated Existing Total Phosphorus Load for Mussucuna Creek

Stream	Area (sq miles)	Average Annual Flow (cfs)	TP (mg/l)	TP (lbs/day)
Mussucuna Creek	9.45	12.38	0.16	10.7

The existing TP load consists of both point and non-point components. Since many treatment facilities in Mississippi do not have permit limits for phosphorous, nor are they currently required to report effluent phosphorous concentrations, MDEQ used an estimated effluent concentration based on literature values for different treatment types. Table 15 shows the median effluent phosphorous concentrations for four conventional treatment processes. The appropriate concentration for each of the facilities was then used in Equation 5 to estimate the TP load from point sources, Table 16.

Table 15. Median Phosphorous Concentrations in Wastewater Effluents

	Treatment Type			
	Primary	Trickling Filter	Activated Sludge	Stabilization Pond
No. of plants sampled	55	244	244	149
Total P (mg/L)	6.6 ± 0.66	6.9 ± 0.28	5.8 ± 0.29	5.2 ± 0.45

Source: After Ketchum, 1982 in EPA 823-B-97-002 (USEPA, 1997)

Table 16. NPDES Permitted Facilities Treatment Types with Phosphorous Estimates

Facility Name	Treatment Type	Permitted Discharge (MGD)	TP concentration estimate (mg/l)	TP Load estimate (lbs/day)
Hernando South POTW	Aerated Lagoon	0.95	5.2	41.2
	Total	**0.95**		**41.2**

The average TP point source load is estimated to be 41.2 lbs/day. The annual average total load based on the estimated total phosphorous concentration of 0.16 mg/l and an annual average flow of 12.38 cfs is 10.7 lbs/day. The point source load exceeded the total allowed annual average load in the watershed. With the elimination of the point source, MDEQ believes that a significant reduction in TP in the watershed is accomplished. Therefore, any load reductions from non-point sources may have an insignificant impact on water quality.

ALLOCATION

The allocation for this TMDL involves a wasteload allocation for the point source and a load allocation for non-point sources necessary for attainment of water quality standards in the Mussucuna Creek watershed. 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 one point source in the Mussucuna Creek watershed. However, as of August 2007, Hernando POTW South officially removed its discharge from Mussucuna Creek and connected to the regional system. MDEQ supports this concept to provide centralized sewer service to areas of Hernando. This facility was estimated to contribute to the observed Low DO's and the majority of TP and TN being discharged in the watershed. Thus, this regional connection allows the city's nutrient and DO impact to be diminished from the stream and restoration should begin. Future temporary stream monitoring is recommended to verify the impact of the removal of the point source from the stream.

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 17, the load allocation is shown as the non-point sources (the spatially distributed flow entering each reach in the model).

Table 17. Load Allocation, Maximum Scenario

Water Body	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Mussucuna Creek	52.7	12.0	64.7

Based on initial estimates in Sections 2.5 and 2.6, most of the TN and TP loads in this watershed came from the point source. However, best management practices (BMPs) should be encouraged in the watershed to reduce potential nutrient loads from non-point sources. The watershed 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. Table 18 shows the load allocation for TN and TP.

Table 18. Load Allocation for TN and TP

Nutrient	Estimated Nutrient Non-point Source Load (lbs/day)	Allocated Nutrient Non-point Source Load (lbs/day)
TN	23.0	37.4 – 74.7
TP	0.0	2.7-10.7

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 TMDL is implicit.

4.4 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.

4.5 Calculation of the TMDL

The TMDLs were calculated based on Equation 6.

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

In this equation, WLA is the wasteload allocation, LA is the load allocation, and MOS is the margin of safety. The TBODu allocated for the stream is shown in Table 19. Equation 5 was used to calculate the TMDL for TN and TP. The TMDLs needed for nutrients are shown in Table 20. The target concentration was used with the average flow for the watershed to determine the TMDL. The TMDL was then compared to the estimated existing load previously calculated. The estimated existing TN concentration indicates that reductions of 34.5% to 67% would have been needed. The estimated existing TP concentration indicates that reductions of 75% would have been needed. However, due to the removal of the point source, MDEQ believes that a significant reduction of nutrients in the watershed is accomplished. The TMDL for TN is 37.4 – 74.7 lbs/day. The TMDL for TP is 2.7 – 10.7 lbs/day.

Table 19. TMDL for TBODu in Mussucuna Creek

	WLA (lbs/day)	LA (lbs/day)	MOS (lbs/day)	TMDL (lbs/day)
CBODu	0	52.7	Implicit	**52.7**
NBODu	0	12.0	Implicit	**12.0**
TBODu	**0**	**64.7**		**64.7**

Table 20. TMDL for TN and TP in Mussucuna Creek

	WLA (lbs/day)	LA (lbs/day)	MOS (lbs/day)	TMDL (lbs/day)
TN	**0**	37.4 – 74.7	Implicit	37.4 – 74.7
TP	**0**	2.7-10.7	Implicit	2.7-10.7

CONCLUSION

Nutrients were addressed through an estimate of a preliminary TP concentration target range and a preliminary TN concentration target range. Based on the estimated existing and target TN concentrations, this TMDL would have recommended a 34.5% to 67% reduction of the TN loads entering this stream to meet the preliminary target range of 0.56 to 1.12 mg/l. Based on the estimated existing and target TP concentrations, this TMDL would have recommended a 75% reduction of the TP loads entering this stream to meet the preliminary target range of 0.04 to 0.16 mg/l. MDEQ believes that removal of the point source in August 2007 accomplished these reductions. This TMDL recommends temporary monitoring to verify future water quality improvement in the stream.

It is recommended that the Mussucuna 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 creek. 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 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 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 assemblage (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