FINAL REPORT
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Total Maximum Daily Load
Biological Impairment Due to Nutrients and Organic Enrichment / Low Dissolved Oxygen For Cedar Creek

Tombigbee River Basin
Lowndes County, Mississippi

Prepared By

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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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Table 1. Listing Information

Name	ID	County	HUC	Cause	Stressors
Cedar Creek	MS031CE	Lowndes	03160106	Biological Impairment	Nutrients and Organic Enrichment / Low Dissolved Oxygen
Near Trinity from Headwaters to the Ten-Tom Waterway					

Table 2. Water Quality Standards

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

Table 3. Total Maximum Daily Load for Cedar Creek

	WLA lbs/day	LA lbs/day	MOS	TMDL lbs/day
TBODu	0.0	0.0	Implicit	0.0
Total Nitrogen	0.0	60.6 – 70.7	Implicit	60.6 – 70.7
Total Phosphorous	0.0	6.1 – 10.1	Implicit	6.1 – 10.1

EXECUTIVE SUMMARY

This TMDL has been developed for Cedar Creek which was placed on the Mississippi 1996 Section 303(d) List of Impaired Water Bodies due to evaluated causes of nutrients and organic enrichment / low dissolved oxygen. MDEQ completed biological monitoring on Cedar Creek, which indicated biological impairment. A stressor identification report was developed (MDEQ, 2006). It was determined that nutrients, organic enrichment / low dissolved oxygen and sediment are primary probable stressors. Sediment will be addressed in a separate TMDL report. This TMDL will provide an estimate of the total nitrogen (TN) and total phosphorus (TP) allowable in the stream.

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 Cedar Creek Watershed is located in HUC 03160106. The listed portion of Cedar Creek begins at the headwaters and flows for approximately 12 miles to the Ten-Tom Waterway. The location of the watershed for the listed segment is shown in Figure 1.

Because the critical 7Q10 flow of Cedar Creek is zero, a predictive model was not needed to determine that this stream is not an appropriate receiving water body for waste water effluent. The TBODu TMDL was set to zero. The limited nutrient data and estimated existing ecoregion concentrations indicates reductions of nutrients are needed.

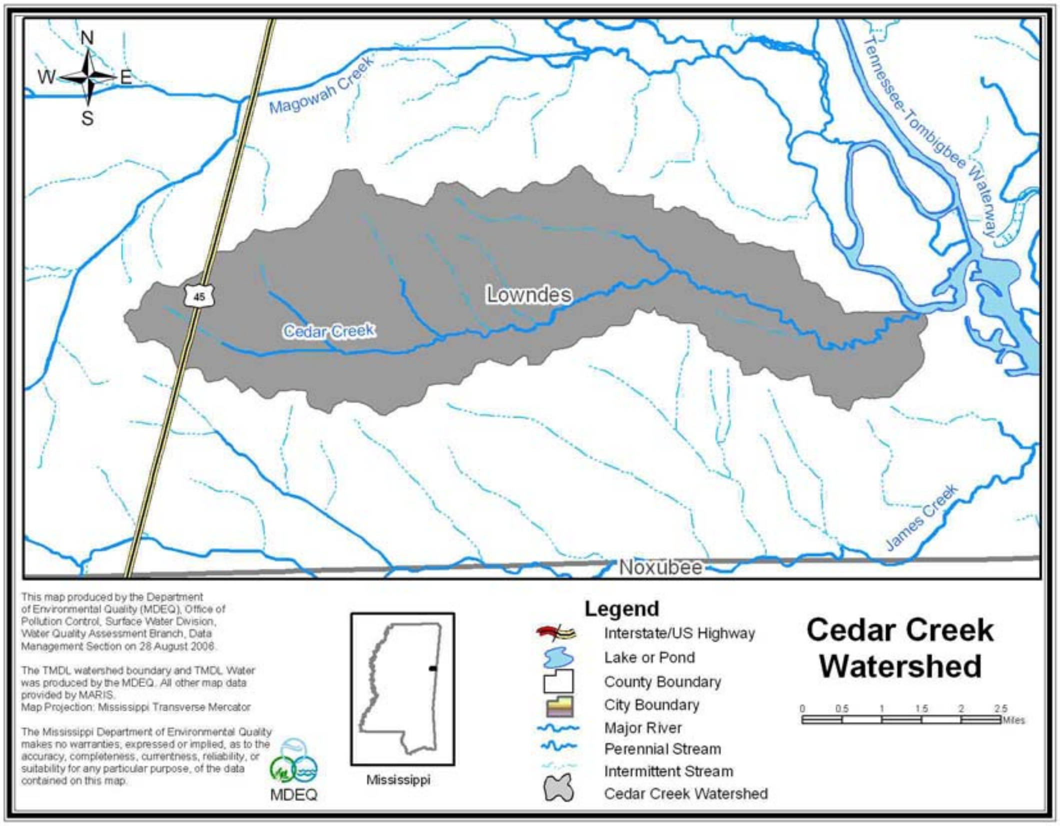

Figure 1. Cedar Creek

INTRODUCTION

1.1 Background

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

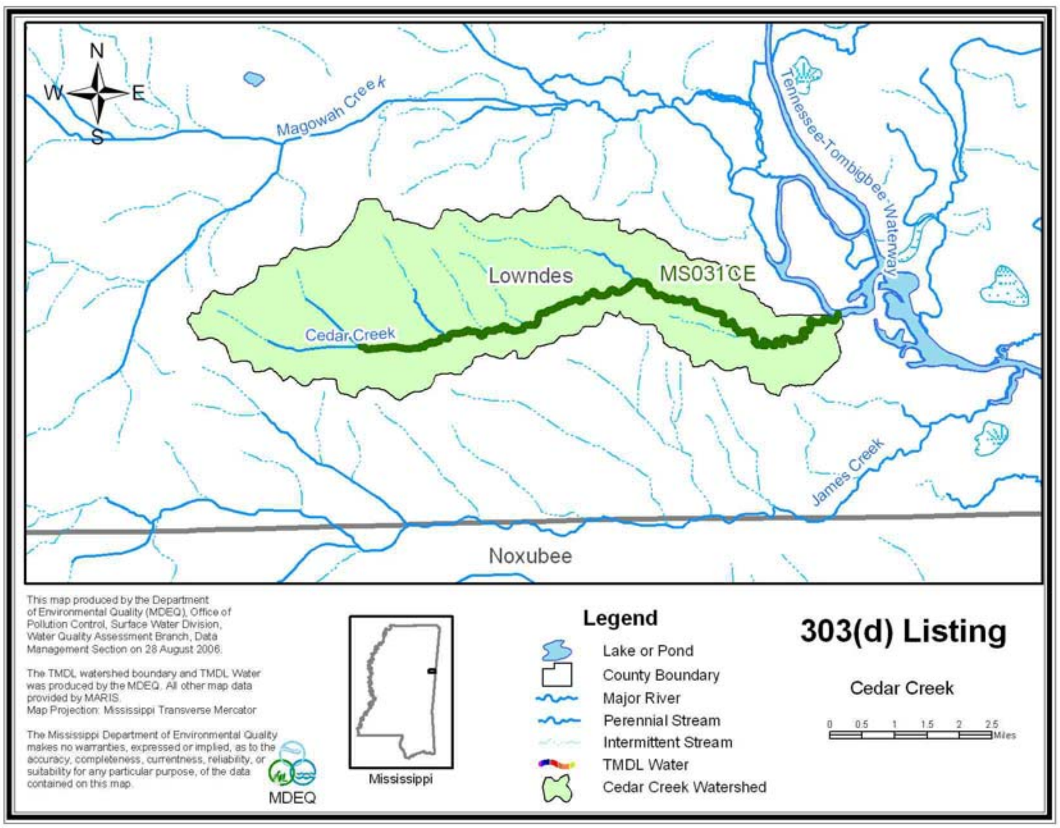

Figure 2. Cedar Creek §303(d) Listed Segment

The original listing was for the McCowers Creek drainage area, MS031E. MDEQ began a biological monitoring program, the M-BISQ, to monitor this and other evaluated streams to confirm water quality based on the health of the biology in the stream. Cedar Creek, MS031CE, was confirmed as impaired based on the biology.

1.2 Stressor Identification

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

There are no state criteria in Mississippi for nutrients. These criteria are currently being developed by the Mississippi Nutrient Task Force in coordination with EPA Region 4. MDEQ proposed a work plan for nutrient criteria development that has been approved 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.

For this TMDL, MDEQ is presenting preliminary target ranges for TN and TP. The limited data available are greater than these ranges for TN with TP also showing some elevation. 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.

1.3 Applicable Water Body Segment Use

The water use classifications are established by the State of Mississippi in the document *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (MDEQ, 2003). The designated beneficial use for the listed segments is fish and wildlife.

1.4 Applicable Water Body Segment Standard

The water quality standard applicable to the use of the water body and the pollutant of concern is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (MDEQ, 2003).

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.

1.5 Nutrient Target Development

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

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

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

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

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

For the preliminary target concentration range 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.

WATER BODY ASSESSMENT

2.1 Cedar Creek Water Quality Data

Nutrient data for the Cedar Creek Watershed were gathered and reviewed. Data exist for the §303(d)-listed segment of Cedar Creek based on samples collected in the creek during the §303(d)/M-BISQ monitoring project at site #766 in 2002 given in Table 4. Site #766 is located near Trinity at Highway 792 in Lowndes County. Data also exist at the ambient monitoring station #TB059 in 1999 and 2000 located on Cedar Creek near Trinity at Nashville Ferry Road given in Table 5. The locations of MBISQ Station #766 and the ambient station #TB059 are shown in Figure 3.

Table 4. Water Quality Data Collected at Cedar Creek, MBISQ Station #766

Sample Date	Time	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)
1/29/2002	16:00	0.10	2.76

Table 5. Water Quality Data Collected at Cedar Creek, Ambient Station #TB059

Sample Date	Time	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)
6/15/1999	11:20	0.11	0.87
1/10/2000	16:30	0.03	3.73
4/10/2000	14:30	0.16	2.31
7/17/2000	16:20	0.10	1.43

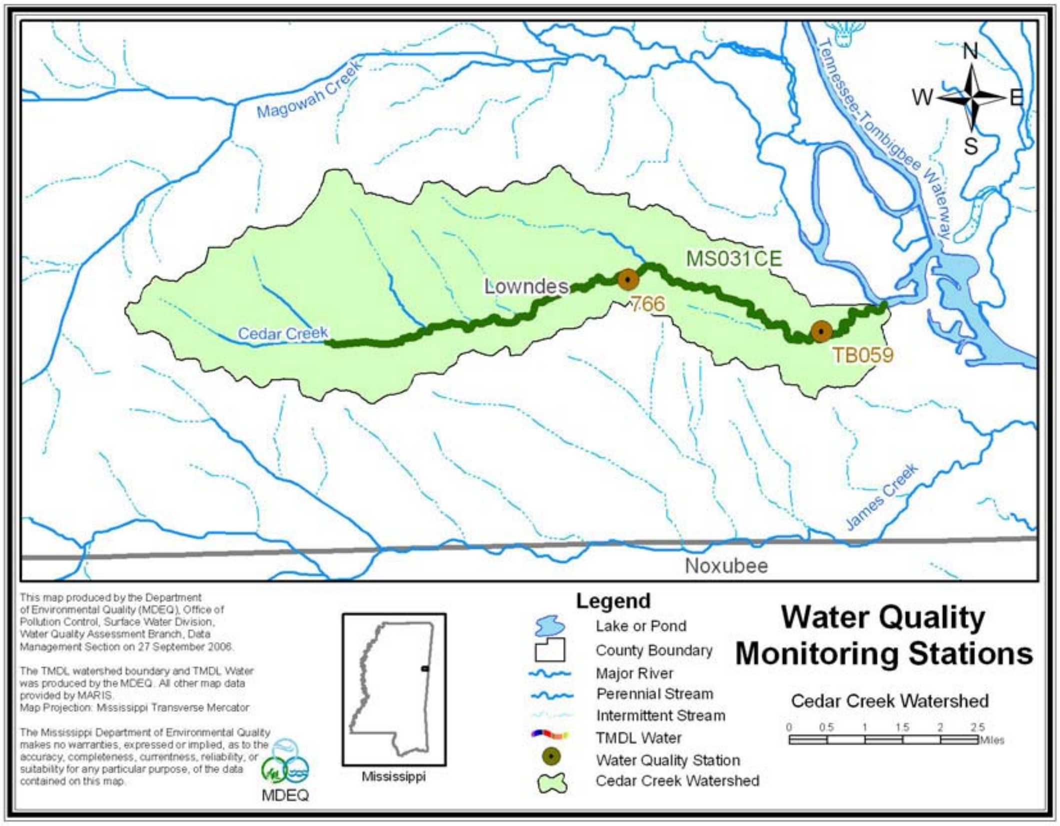

Figure 3. Cedar Creek Water Quality Monitoring Stations

2.2 Assessment of Point Sources

There are no point sources in the watershed.

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 6 presents typical nutrient loading ranges for various land uses.

Table 6. 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 Cedar Creek is approximately 11,322 acres or 17.69 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. Pasture is the dominant landuse within this watershed. The landuse distribution for the Cedar Creek Watershed is shown in Table 7 and Figure 4.

Table 7. Landuse Distribution for the Cedar Creek Watershed

In Acres	Urban	Forest	Cropland	Pasture	Scrub/Barren	Water	Wetlands
Cedar Creek	0	1,163	728	4,476	2,291	176	2,488
Percentage	0	10.3	6.4	39.5	20.2	1.6	22.0

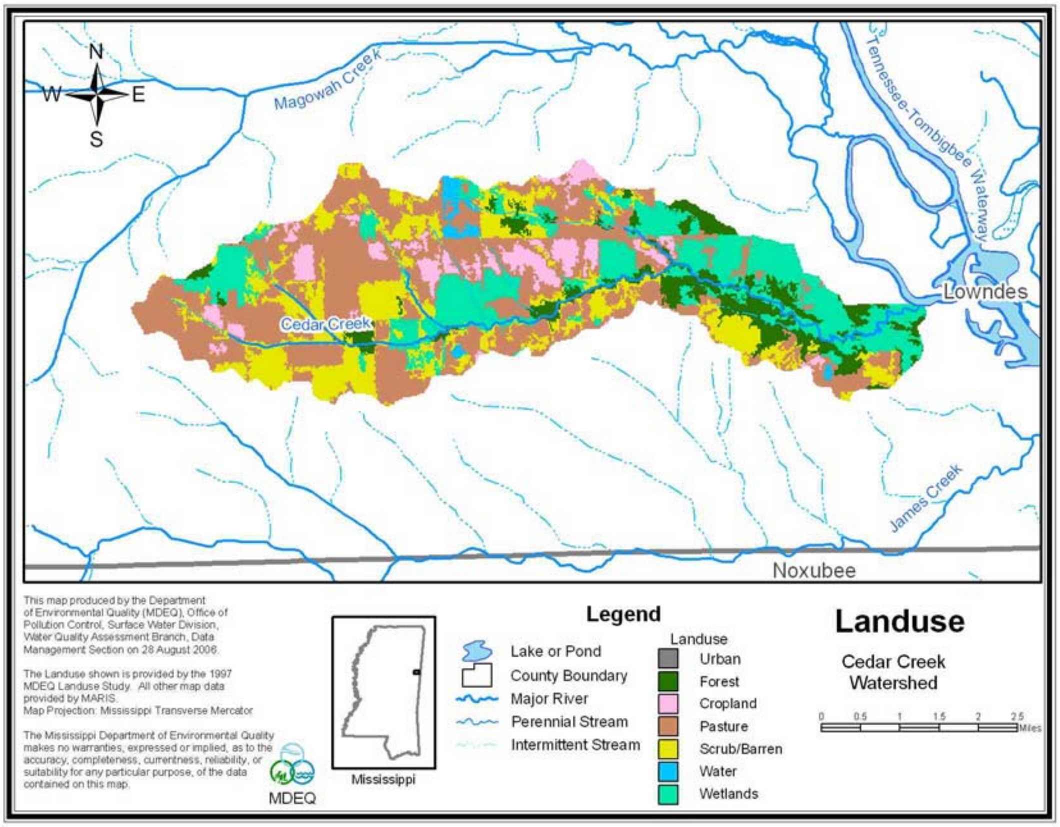

Figure 4. Cedar Creek Watershed Landuse

2.4 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 65 with impaired biology and elevated nutrients, which is 1.38 mg/l. The concentration found in this stream during the M-BISQ monitoring is above this, 2.76 mg/l. The ambient monitoring data also indicate elevated TN. Due to the limited amount 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 Cedar Creek was estimated based on USGS monitoring station 02443710 on Cedar Creek near Trinity, Mississippi. The annual average flow for Cedar Creek near Trinity, Mississippi is 12.18 cfs, with a drainage area of 11.5 square miles. To estimate the amount of flow in Cedar Creek, a drainage area ratio for the 02443710 gage watershed was calculated (12.18 cfs / 11.5 square miles = 1.059 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 Cedar Creek is estimated as 18.73 cfs. The existing TN load was then calculated, using Equation 1 and the results are shown in Table 8.

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

Table 8. Estimated Existing Total Nitrogen Load for Cedar Creek

Stream	Area (sq miles)	Average Annual Flow (cfs)	TN (mg/L)	TN (lbs/day)
Cedar Creek	17.69	18.73	1.38	139.4

2.5 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. The concentration found in this stream during the M-BISQ monitoring is below this. Ambient monitoring on Cedar Creek indicates total phosphorous within the target range and slightly elevated but below the estimated existing concentration. 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 Cedar Creek was estimated based on USGS monitoring station 02443710 on Cedar Creek near Trinity, Mississippi. As previously described, the annual average flow in Cedar Creek is estimated as 18.73 cfs. The existing TP load was then calculated, using Equation 1 and the results are shown in Table 9.

Table 9. Estimated Existing Total Phosphorous Load for Cedar Creek

Stream	Area (sq miles)	Average Annual Flow (cfs)	TP (mg/L)	TP (lbs/day)
Cedar Creek	17.69	18.73	0.18	49.50

ALLOCATION

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

3.1 Wasteload Allocation

There are no point sources in the impaired segments. Therefore the waste load allocation has been set to zero for these TMDLs. 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.*

3.2 Load Allocation

Best management practices (BMPs) should be encouraged in the watersheds to reduce potential TN and TP loads from non-point sources. The 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.

3.3 Incorporation of a Margin of Safety

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

3.4 Calculation of the TMDL

A predictive model was not used to calculate the dissolved oxygen TMDL due to the 7Q10 flow being zero. The TBODu TMDL has been set to zero. Equation 1 was used to calculate the TMDL for TP and TN. 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 TP concentration indicates needed reductions of 44% to 67%. The TMDL for TP is 6.1 – 10.1 lbs/day. The estimated existing total nitrogen concentration indicates needed reductions of 49% to 56%. The TMDL for TN is 60.6 – 70.7 lbs/day.

Table 10. TN, TP, and TBODu Total Maximum Daily Load based on Ecoregion Range for Cedar Creek

	Area (sq miles)	Average Annual Flow (cfs)	Concentration (mg/l)	Load (lbs/day)
TN	17.69	18.73	0.6 – 0.7	60.6 – 70.7
TP	17.69	18.73	0.06 – 0.10	6.1 – 10.1
TBODu	17.69	18.73	0.0	0.0

3.5 Seasonality and Critical Condition

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

CONCLUSION

Nutrients were addressed through an estimate of a preliminary total phosphorous concentration target range and a preliminary total nitrogen concentration 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. It is recommended that the Cedar 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.

4.1 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 Greg Jackson at Greg_Jackson@deq.state.ms.us.

All comments should be directed to Greg Jackson at Greg_Jackson@deq.state.ms.us or Greg Jackson, 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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