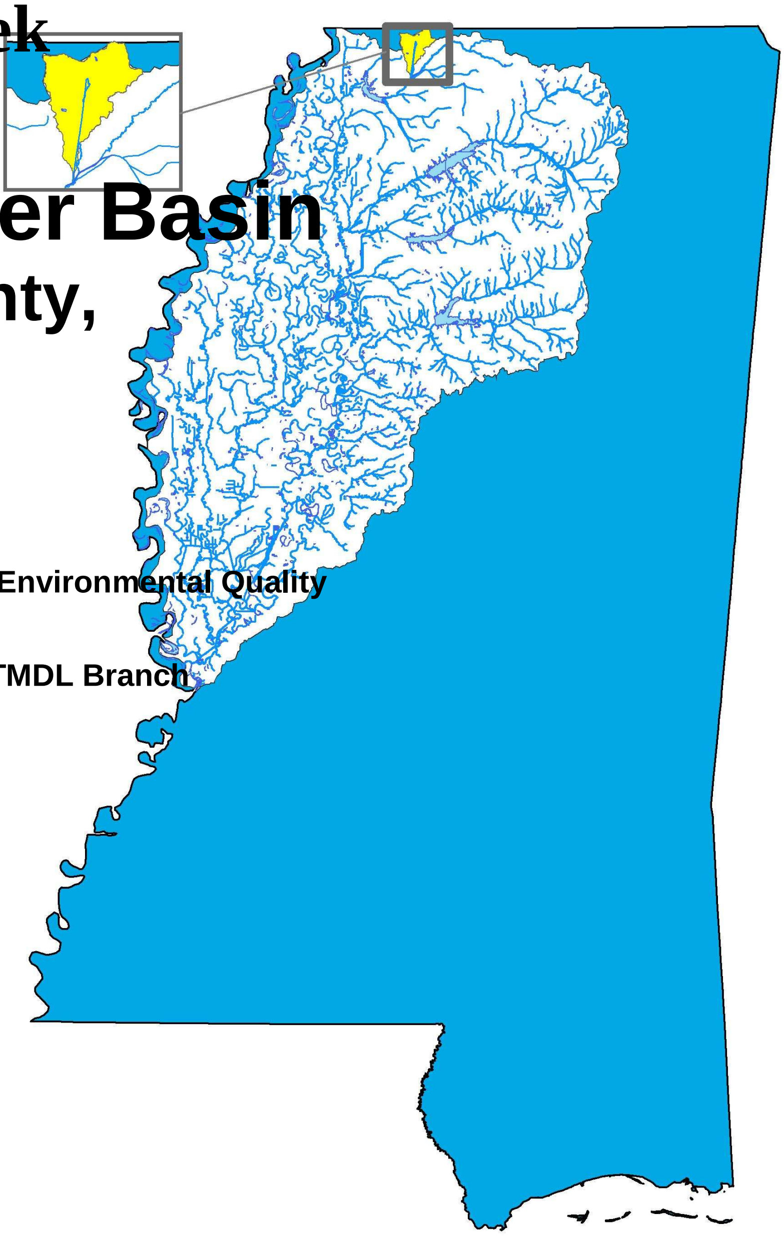
FINAL REPORT
June 2008
ID: 908063009

Total Maximum Daily Load

For Biological Impairment Due to Ammonia Toxicity, Total Nitrogen, Total Phosphorous and Organic Enrichment / Low Dissolved Oxygen In Camp Creek



Yazoo River Basin

Desoto County, Mississippi

Prepared By

Mississippi Department of Environmental Quality
Office of Pollution Control
Standards, Modeling, and TMDL 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	μ	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

TABLE OF CONTENTS

FIGURES

TABLES

TMDL INFORMATION PAGE

Table 1. Listing Information

Name	ID	County	HUC	Impaired Use	Causes
Camp Creek	MS299E	DeSoto	08030204	Aquatic Life Support	Biological Impairment due to OE/Low DO, Nutrients, and Ammonia Toxicity
Near Alphaba from watershed 298 boundary to the Coldwater River					

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
Ammonia Toxicity	Aquatic Life Support	Ammonia toxicity shall be evaluated according to EPA guidelines published in *1999 Update of Ambient Water Quality Criteria for Ammonia*; EPA document number EPA-822-R-99-014.

Table 3. Total Maximum Daily Load for Camp Creek

	WLA lbs/day	LA lbs/day	MOS	TMDL lbs/day
TBODu	**512.55**	**24.89**	Implicit	**537.44**
Total Nitrogen*	**318.18**	**222.11**	Implicit	**540.29**
Total Phosphorous	**47.30**	**29.91**	Implicit	**77.21**

***Allowable ammonia toxicity levels are greater than TN TMDL and are therefore included in the TN TMDL**

Table 4. Identified NPDES Permitted Facilities

Name	NPDES Permit	Permitted Discharge (MGD)	Receiving Water
Bridgetown Subdivison	MS0028185	0.264	Bean Patch Creek
Olive Branch POTW, Ross Road	MS0029513	3.0	Camp Creek
Summers Place Subdivision	MS0048470	0.023	unnamed tributary of Bean Patch Creek
Pinehurst Subdivision	MS0048780	0.0825	Bean Patch Creek
Village of Ceder View	MS0050091	0.05	unnamed tributary of Camp Creek
College Hill Subdivision	MS0051764	0.138	Camp Creek
Olive Branch, City of, Oakwood	MS0054852	0.032	unnamed tributary of Camp Creek
Carters Plantation Subdivision	MS0055280	0.02	unnamed tributary of Camp Creek
Belmore Lakes Subdivision	MS0056375	0.08	unnamed tributary of Camp Creek

EXECUTIVE SUMMARY

This TMDL was developed for Camp Creek which was placed on the Mississippi 2006 Section 303(d) List of Impaired Water Bodies due to evaluated causes of pesticides, nutrients, siltation, and organic enrichment/low dissolved oxygen. MDEQ completed biological monitoring on Camp Creek that indicated the stream is impaired. It was determined that nutrients, organic enrichment / low dissolved oxygen, and ammonia toxicity 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 total ultimate biochemical oxygen demand (TBODu) for the point sources located in the watershed. Ammonia nitrogen levels will be evaluated in this TMDL using criteria established for ammonia nitrogen toxicity. The allowable ammonia toxicity levels were found to be greater than the TN levels allowed. Therefore, the TN loads also control for ammonia toxicity.

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. Since the watershed is primarily in Ecoregion 74. An annual concentration range of 1.12 mg/l is an applicable target for TN and 0.16 mg/l for TP for water bodies located in Ecoregion 74. MDEQ is presenting these targets as preliminary target values for TMDL development which is subject to revision after the development of numeric nutrient criteria.

The Camp Creek watershed is located in HUC 08030204. Segment MS299E of Camp Creek begins at the watershed 298 boundary and flows south to the Coldwater River. Figure 1 shows Camp Creek near Alphaba. The location of the watershed for the listed segment is shown in Figure 2.

Figure 1. Camp Creek at M-BISQ station #10

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 usually occurs during the hot, dry summer period. The TMDL for organic enrichment was quantified in terms of TBODu. The model used in developing this TMDL included both non-point and point sources of TBODu in the Camp 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 are nine NPDES permitted dischargers located in the watershed that are included as point sources in the model.

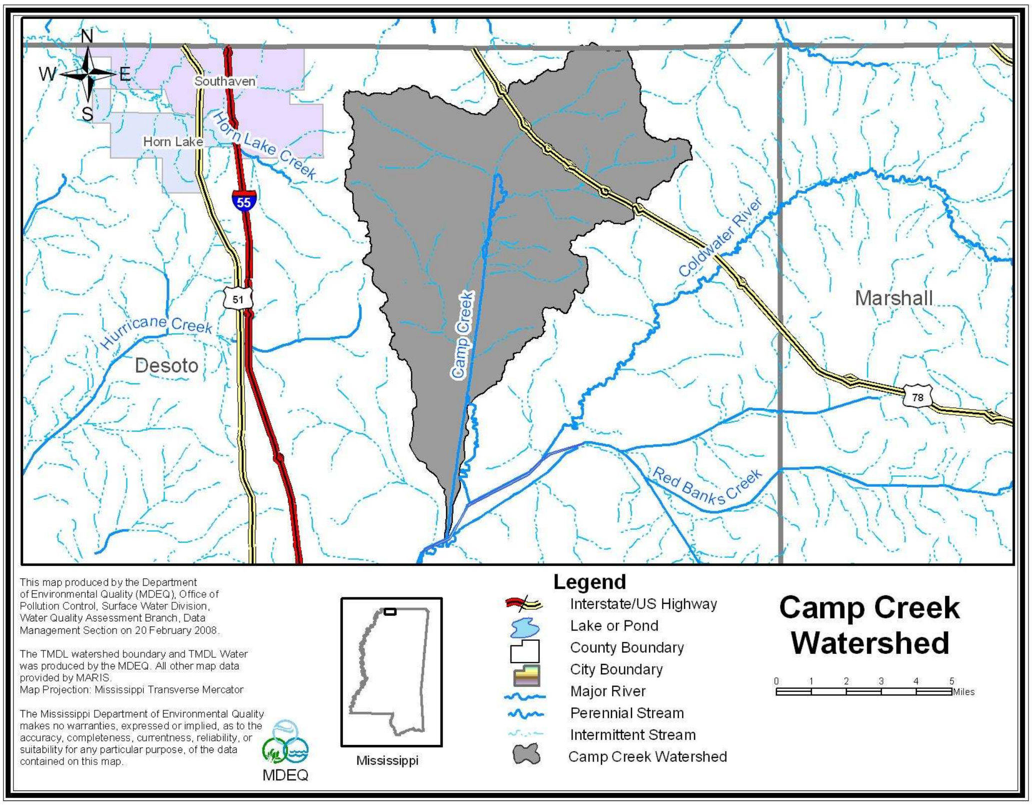


Figure 2. Camp Creek Watershed

According to the model, the levels of NH_3-N are below toxicity levels but the current TBODu load in the water body exceeds the assimilative capacity of Camp Creek for organic material at the critical conditions. Therefore, permit reductions are recommended in order to protect water quality.

Mass balance calculations showed that the estimated existing TP and TN concentrations indicate reductions of nutrients are needed from both point sources and non- point sources.

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.

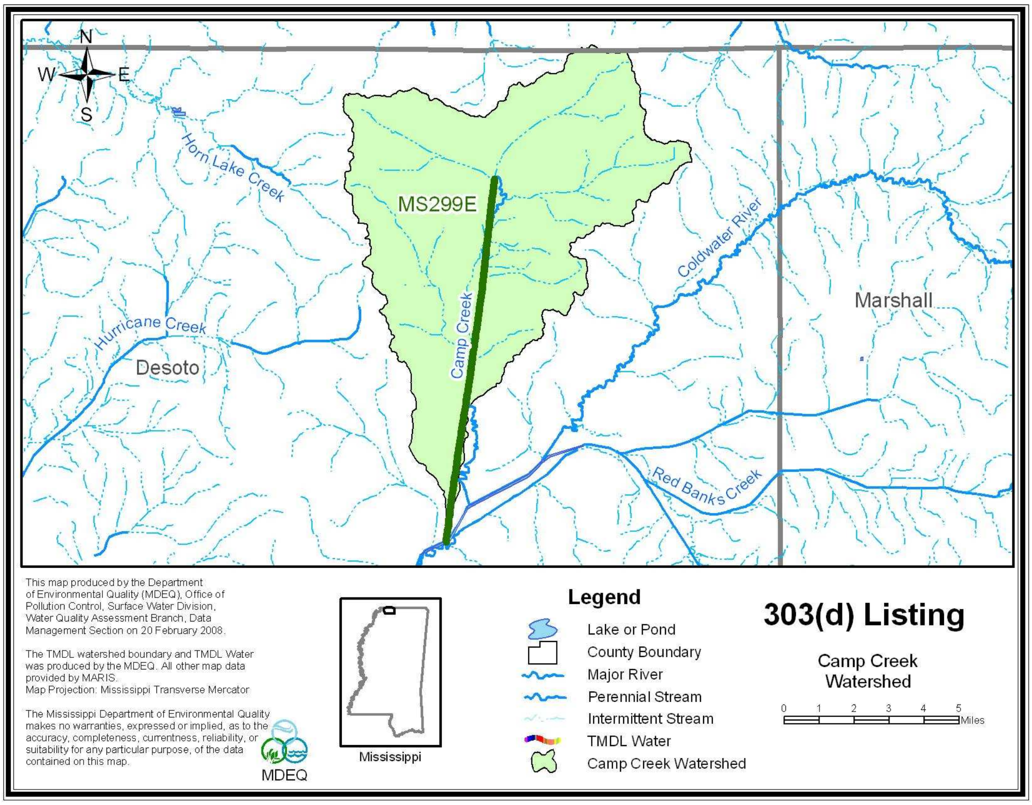


Figure 3. Camp Creek §303(d) Listed Segment

1.2 Applicable Water Body Segment Use

The water use classifications are established by the State of Mississippi in the document *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 standards applicable to the use of the water body and the pollutant of concern are defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (MDEQ, 2007).

The standard for dissolved oxygen states, "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."

The water quality standard for ammonia nitrogen toxicity is included in this TMDL. Ammonia nitrogen concentrations can be evaluated using the methods in *1999 Update of Ambient Water Quality Criteria for Ammonia* (EPA-822-R-99-014).

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 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 ecoregions.

For the preliminary target concentration range for each ecoregion, the 75^{th} and 90^{th} 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. For this report, the 90^{th} percentile for Ecoregion 74 was used.

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 critical low flow period for Camp Creek is 3.09 cfs for the entire watershed and was determined based on *Techniques for Estimating 7-Day, 10-Year Low-Flow Characteristics on Streams in Mississippi* (Telis, 1992). However, the critical low flow for Camp Creek at the point of discharge of the Olive Branch POTW is 0 cfs.

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 target for ammonia nitrogen is a concentration less than 2.82 mg/l. 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 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.

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.

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

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, 2007). Data were collected for wadeable streams to calculate the nutrient criteria.

For this TMDL, MDEQ is presenting preliminary targets for TN and TP. Since the watershed is primarily in Ecoregion 74, an annual concentration of 1.12 mg/l is an applicable target for TN and 0.16 mg/l for TP for water bodies located in this ecoregion. However, MDEQ is presenting these targets 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 Camp Creek Water Quality Data

Nutrient and DO data for the Camp Creek Watershed were gathered and reviewed. Data exist for M-BISQ stations #10 and #11. Based upon the completed stressor identification report, the primary probable causes of impairment are low DO, nutrients, and ammonia toxicity. During the M-BISQ monitoring, the total organic carbon and nutrients (TN and TP) were higher than the least disturbed (LD) reference site and site specific comparators (SSC). Physical/chemical data from the M-BISQ station #10 indicate DO and DO% saturation measurements were lower than LD and all SSC during the non-critical season. At M-BISQ station #11, DO measurements were comparable to LD and SSC during the non-critical season, however DO% saturation measurements were lower. Ammonia Nitrogen data indicate exceedance of the criteria at M-BISQ station #10. A few potential sources exist: agriculture (crops and cattle), several residential subdivisions and one major point source, and moderate and high density residential (urban encroachment from city of Olive Branch with major development). Nutrient monitoring was also performed as part of the nutrient criteria development program. The locations of the M-BISQ stations are shown in Figure 4 and the available data are given in Table 5.

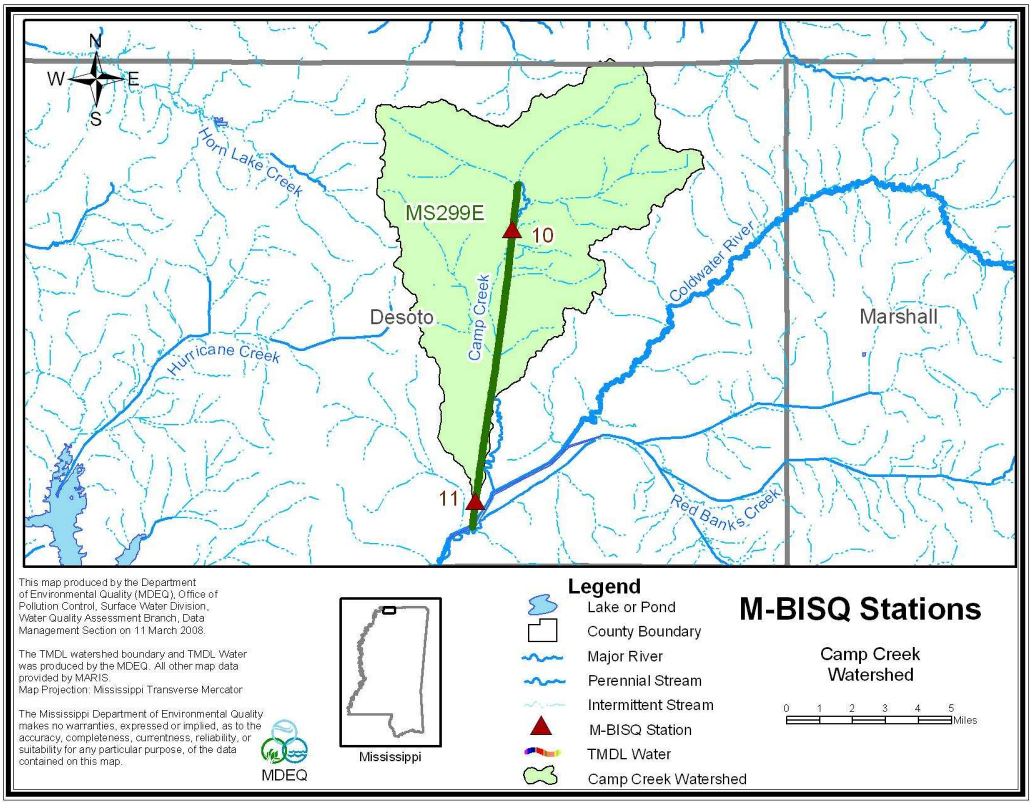


Figure 4. Camp Creek M-BISQ Stations

Table 5. Camp Creek Available Data

Station	Program	Date	TN (mg/L)	TP (mg/L)	DO (mg/L)	Ammonia Nitrogen (mg/L)	Temperature (oC)
10	M-BISQ	1/28/2001	11.26	0.5	10.3	8.87	5.6
10	Nutrient	3/22/2004	2.84	0.32	9.77	0.87	15.76
10	Nutrient	4/7/2004	10.44	0.66	11.18	6.24	17.47
10	Nutrient	8/18/2004	17.99	1.32	13.55	15.1	31.55
10	Nutrient	9/8/2004	34.2	1.32	12.78	11.2	26.57
11	M-BISQ	1/28/2001	6.85	0.67	11.7	4.0	6.2
11	Nutrient	3/22/2004	1.53	0.22	7.17	0.13	15.32
11	Nutrient	4/7/2004	1.26	0.1	10.68	0.1	16
11	Nutrient	8/16/2004	4.75	0.28	7.17	2.44	22.26
11	Nutrient	9/8/2004	3.77	0.16	6.52	0.14	23.42

2.2 Assessment of Point Sources

An important step in assessing pollutant sources in Camp Creek watershed is locating the NPDES permitted sources. There are nine facilities permitted to discharge into this portion of the Camp Creek watershed, Table 6.

Table 6. NPDES Permitted Facilities Treatment Types

Name	NPDES Permit	Treatment Type
Bridgetown Subdivison	MS0028185	activated sludge
Olive Branch POTW, Ross Road	MS0029513	oxidation ditch
Summers Place Subdivision	MS0048470	atu & artificial wetland
Pinehurst Subdivision	MS0048780	aerated lagoon
Village of Ceder View	MS0050091	aerated lagoon
College Hill Subdivision	MS0051764	aerated lagoon & artificial wetland
Olive Branch, City of, Oakwood	MS0054852	aerated lagoon
Carters Plantation Subdivision	MS0055280	aerated lagoon
Belmore Lakes Subdivision	MS0056375	aerated lagoon

The effluent from the facilities was characterized based on all available data including information on their wastewater treatment system, permit limits, and discharge monitoring reports. The permit limits are given in Table 7.

Table 7. Identified NPDES Permitted Facilities

Name	NPDES Permit	Permitted Discharge (MGD)	Permitted Average BOD_5 (mg/l)	Permitted Ammonia (mg/l)
Bridgetown Subdivison	MS0028185	0.264	30	-
Olive Branch POTW, Ross Road	MS0029513	3.0	6.5	2
Summers Place Subdivision	MS0048470	0.023	30	-
Pinehurst Subdivision	MS0048780	0.0825	30	-
Village of Ceder View	MS0050091	0.05	30	-
College Hill Subdivision	MS0051764	0.138	10	2
Olive Branch, City of, Oakwood	MS0054852	0.032	30	-
Carters Plantation Subdivision	MS0055280	0.02	30	-
Belmore Lakes Subdivision	MS0056375	0.08	30	-

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.

The drainage area of Camp Creek is approximately 39,520 acres or 61.8 square miles. The watershed contains many different landuse types, including urban, forest, cropland, pasture, and wetlands. The landuse information given below is based on data collected by the Multi-Resolution Land Characteristics (MRLC) Consortium. This data set is the National Land Cover Database (NLCD) 2001 and is based on satellite imagery from 2001. Urban is the dominant landuse within this watershed, although forest and cropland are also prevalent in the watershed. The landuse distribution for the Camp Creek Watershed is shown in Table 9 and Figure 5. Please refer to Section 3.7, Table 12 for nutrient calculations utilizing the distributed landuse values for Camp Creek that are shown below.

Table 9. Landuse Distribution for the Camp Creek Watershed

	Urban	Forest	Cropland	Pasture	Scrub / Barren	Water	Wetlands	Total
Camp Creek Acreage	10,059	8,547	8,251	4,953	5,125	380	2,205	39,520
Percentage	25	22	21	12	13	1	6	100

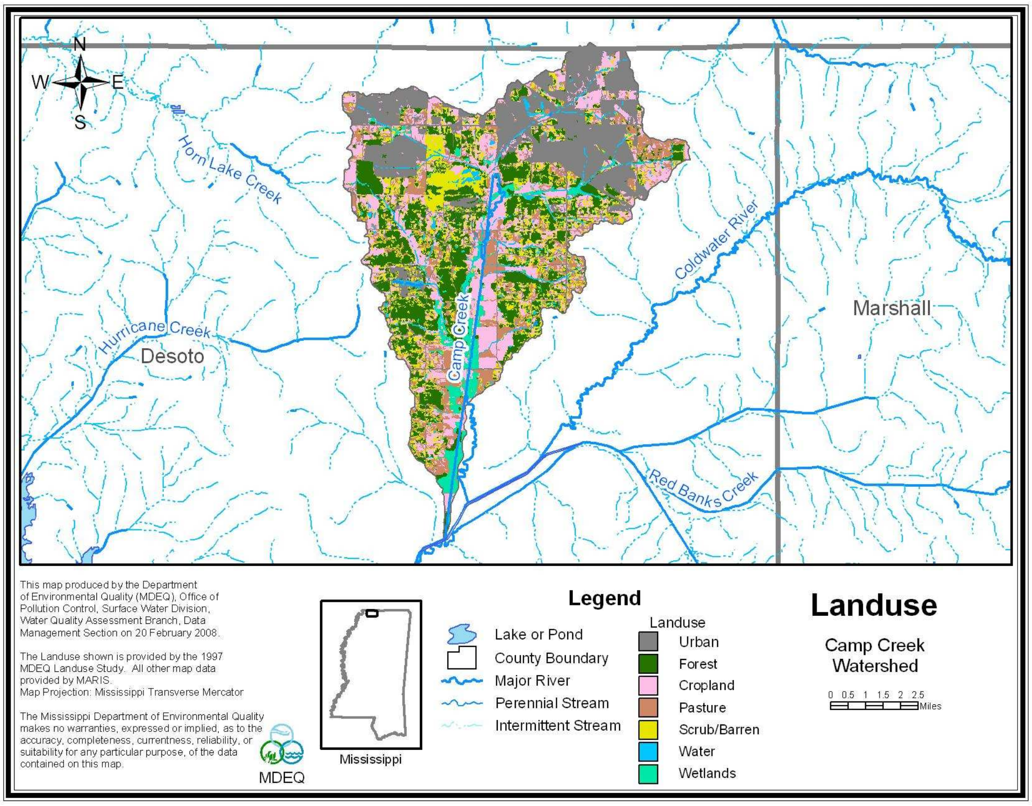


Figure 5. Camp Creek Watershed Landuse

MODELING PROCEDURE: LINKING THE SOURCES TO THE ENDPOINT

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

3.1 Modeling Framework Selection

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

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

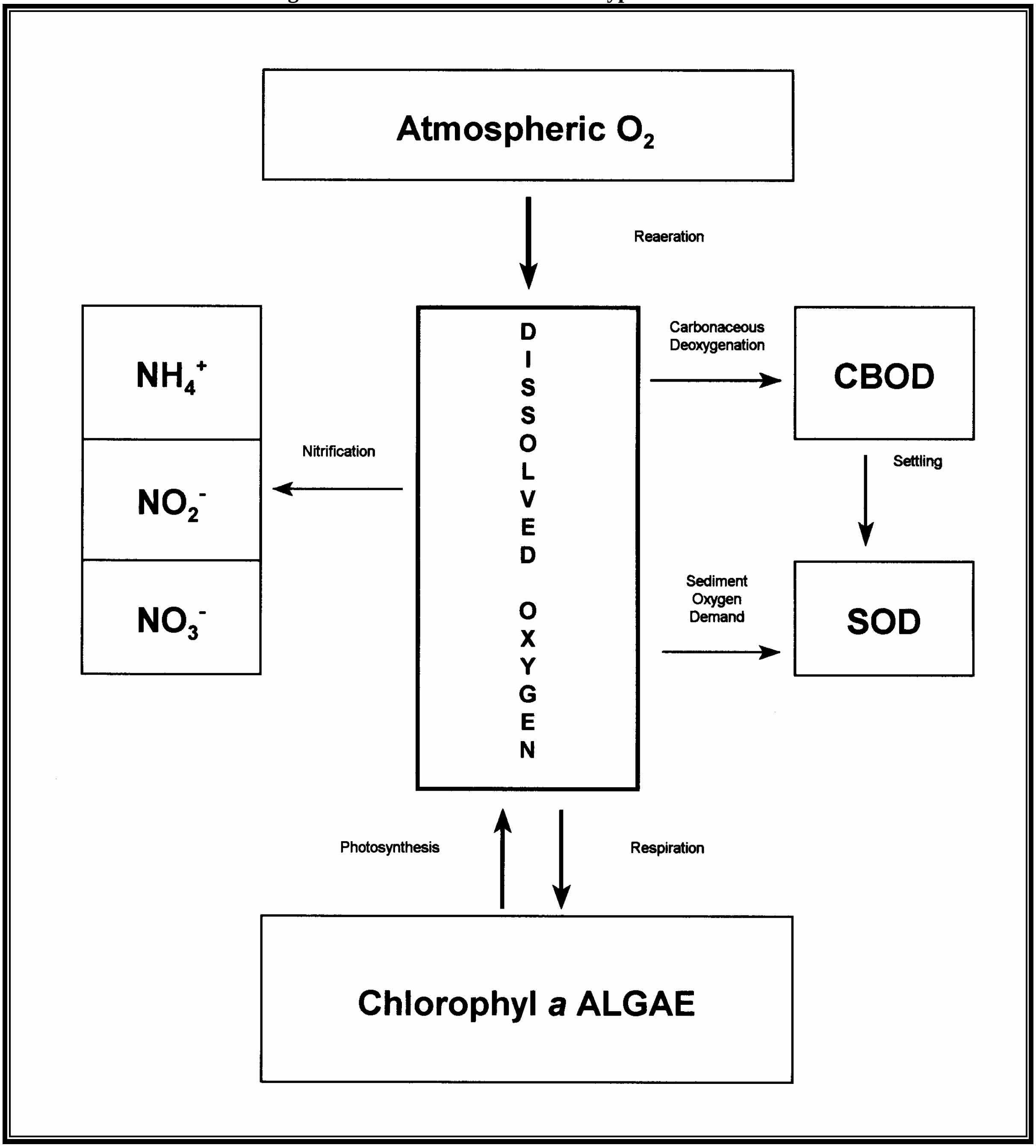
The model was set up to calculate reaeration within each reach using the Tsivoglou formulation. The Tsivoglou formulation calculates the reaeration rate, K_a (day^{-1} base *e*), within each reach according to Equation 2.

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

C is the escape coefficient, U is the reach velocity in mile/day, and S is the average reach slope in ft/mile. The value of the escape coefficient is assumed to be 0.11 for streams with flows less than 10 cfs and 0.0597 for stream flows equal to or greater than 10 cfs. Reach velocities were

calculated using an equation based on slope. The slope of each reach was estimated electronically and input into the model in units of feet/mile.

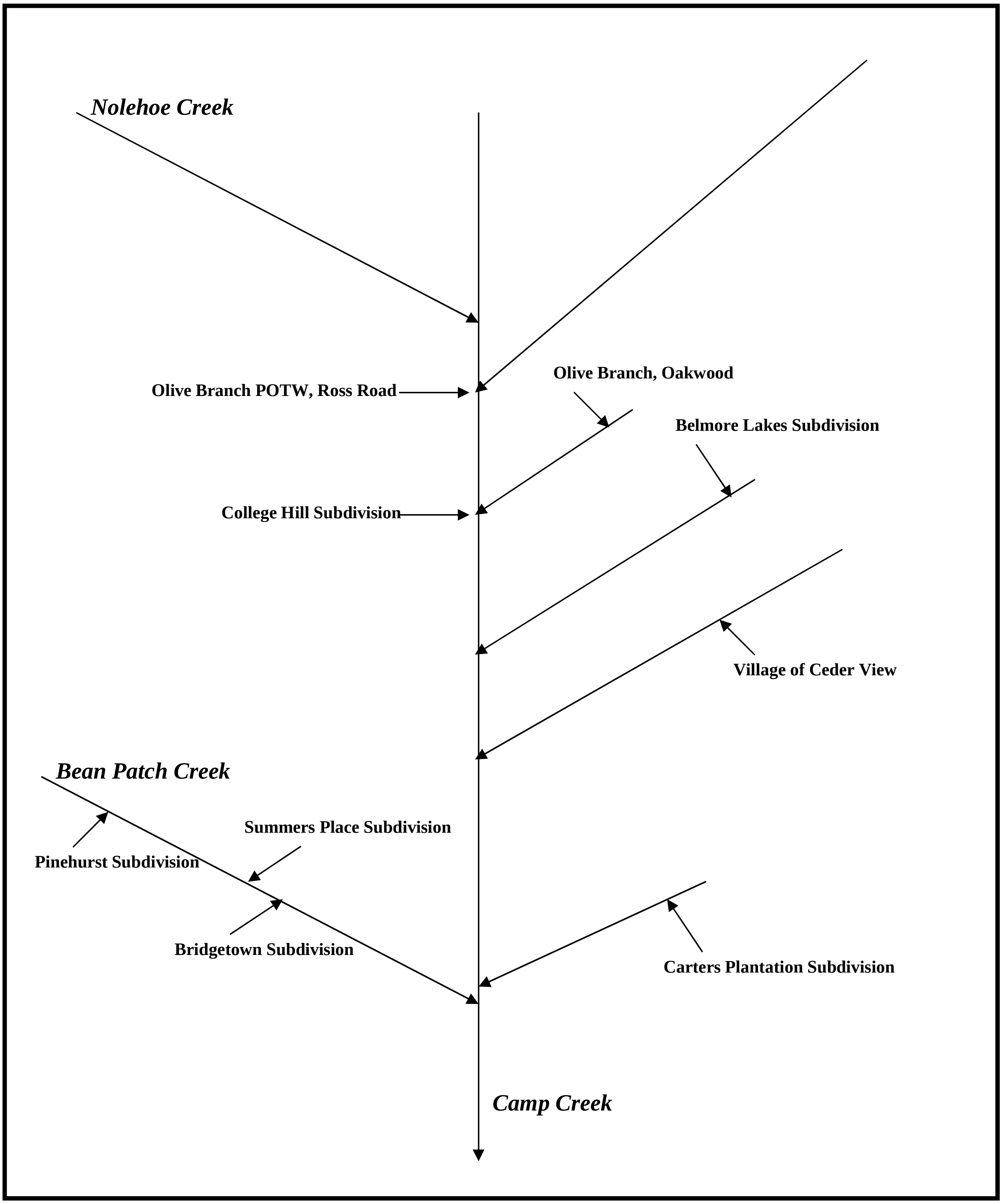
Figure 6. Instream Processes in a Typical DO Model



3.2 Model Setup

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

Figure 7. Camp 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.

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

3.3 Source Representation

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

In order to convert the ammonia nitrogen (NH_3-N) loads to an oxygen demand, a factor of 4.57 pounds of oxygen per pound of ammonia nitrogen (NH_3-N) oxidized to nitrate nitrogen (NO_3-N) was used. Using this factor is a conservative modeling assumption because it assumes that all of the ammonia is converted to nitrate through nitrification. The oxygen demand caused by nitrification of ammonia is equal to the NBODu load. The sum of CBODu and NBODu is equal to the point source load of TBODu. The maximum permitted loads of TBODu from the existing point sources to be used in the STREAM model are given in Table 10.

Table 10. Point Sources, Maximum Permitted Model Inputs

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)
Bridgetown Subdivison	0.264	30	2	2.3	151.914	4.403	20.123	172.037
Olive Branch POTW, Ross Road	3	6.5	2	2.3	374.029	50.037	228.671	602.700
Summers Place Subdivision	0.023	30	2	2.3	13.235	0.384	1.753	14.988
Pinehurst Subdivision	0.0825	30	2	1.5	30.961	1.376	6.288	37.249
Village of Ceder View	0.05	30	2	1.5	18.764	0.834	3.811	22.575
College Hill Subdivision	0.138	10	2	1.5	17.263	2.302	10.519	27.782
Olive Branch, City of, Oakwood	0.032	30	2	1.5	12.009	0.534	2.439	14.448
Carters Plantation Subdivision	0.02	30	2	1.5	7.506	0.334	1.524	9.030
Belmore Lakes Subdivision	0.08	30	2	1.5	30.022	1.334	6.098	36.120
				Total	**655.702**		**281.227**	**936.929**

Direct measurements of background concentrations of CBODu were not available for Camp 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 Camp 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 11.

Table 11. 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)
Camp Creek background	0.08	1.33	0.86	0.1	0.2	1.06
Camp Creek nps	1.80	1.33	19.40	0.1	4.43	23.83
Total			**20.26**		**4.63**	**24.89**

3.4 Model Calibration

The model used to develop Camp 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 Camp Creek. The model was first run under regulatory load conditions. Under regulatory load conditions, the loads from the NPDES permitted point sources were based on their current location and loads shown in Table 10.

3.5.1 Regulatory Load Scenario

The regulatory load scenario model results are shown in Figure 8. Figure 8 shows the modeled daily average DO with the NPDES permitted facilities at their current maximum allowable loads and with estimated non-point source loads. The figure shows the daily average instream DO concentrations, beginning at the headwaters and ending at the mouth with the Coldwater River. As shown in the figure, the model predicts that the DO goes below the standard of 5.0 mg/l using the maximum allowable loads, thus reductions are needed. Regulatory load scenario model output for ammonia nitrogen is shown in Figure 9. The modeled ammonia nitrogen is below the water quality standard of 2.82 mg/l NH_3-N, however monitored ammonia data indicate reductions are needed.

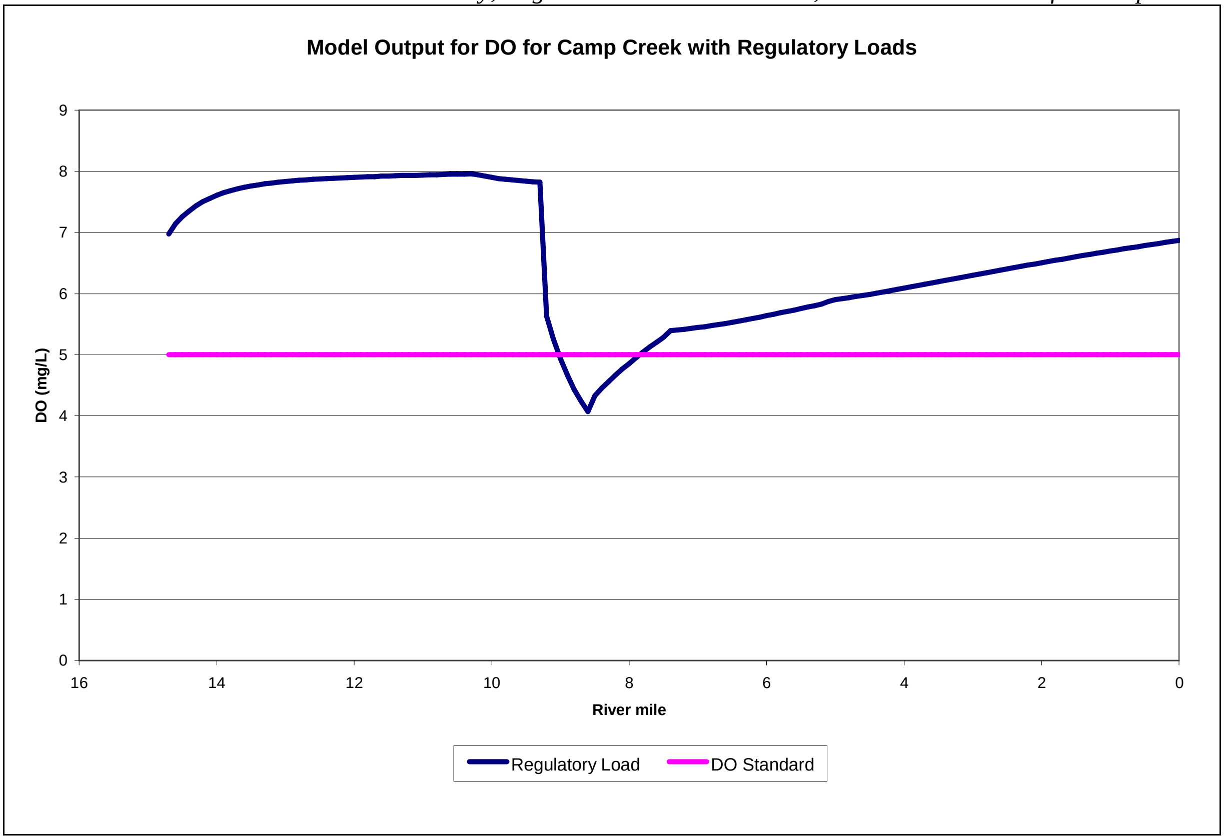


Figure 8. Model Output for DO in Camp Creek, Regulatory Load Scenario

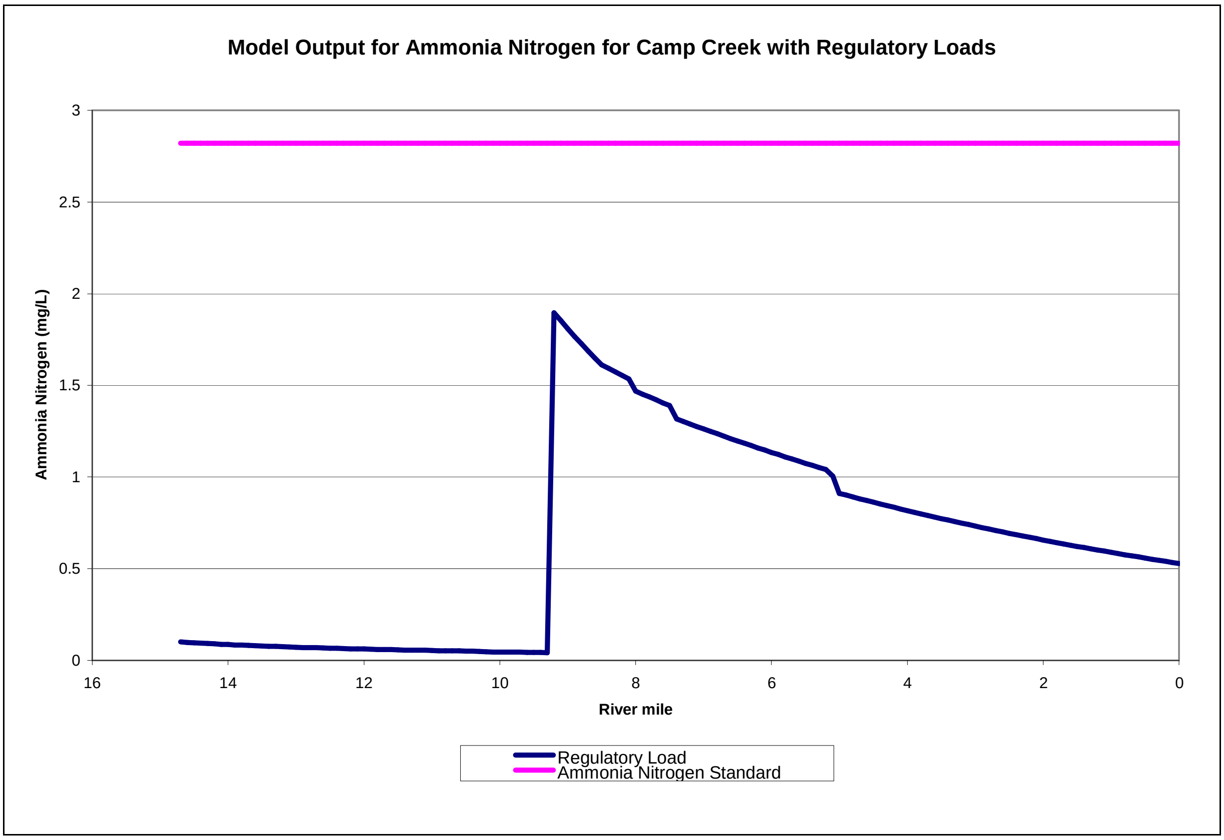


Figure 9. Model Output for Ammonia Nitrogen in Camp Creek, Regulatory Load Scenario

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 Camp Creek during critical conditions. Thus, reductions of the loads of TBODu are necessary. Calculating the maximum allowable load of TBODu involved decreasing the model loads until the modeled DO was just above 5.0 mg/l. The non-point source loads in this model were already set at background conditions based on MDEQ regulations so no non point source reductions were necessary. Thus, the permitted limits were reduced until the modeled DO was 5.0 mg/L. The decreased loads were then used to develop the allowable maximum daily load for this report. The model output for DO with the permit reductions is shown in Figure 10.

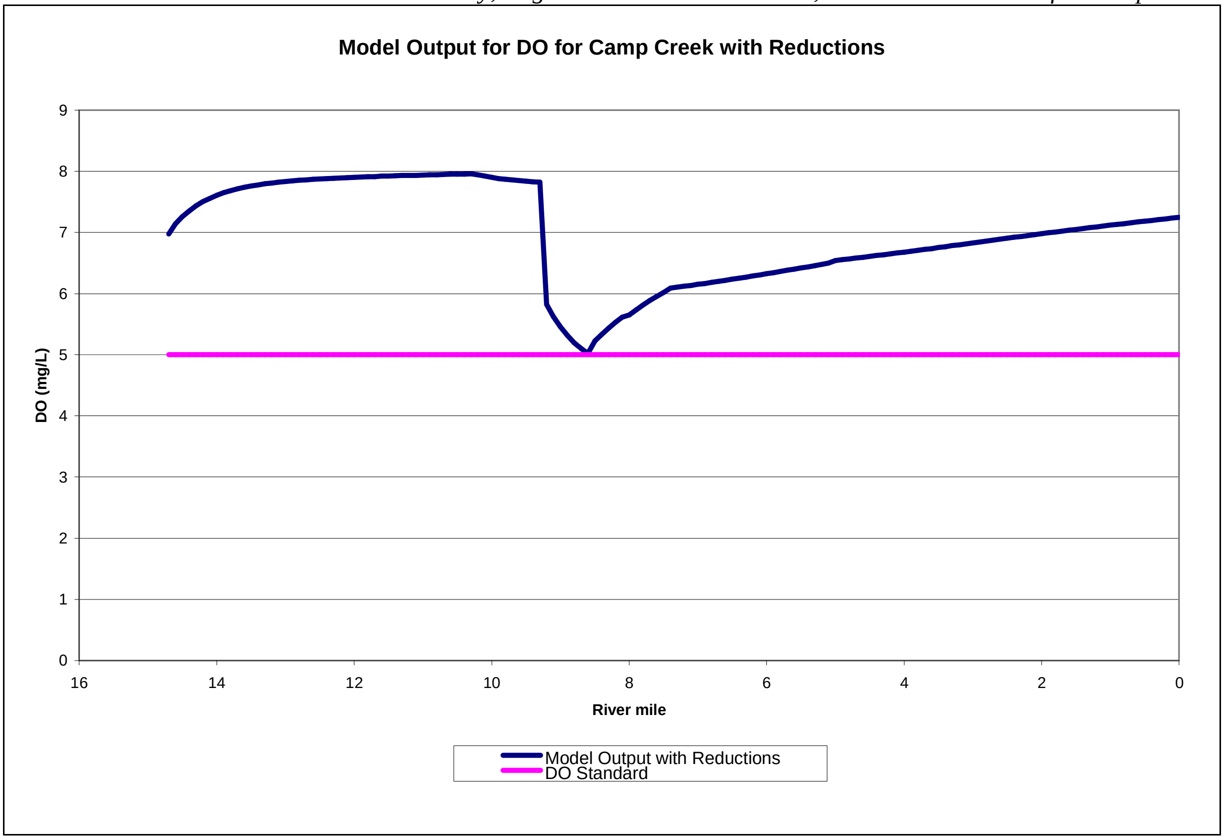


Figure 10. Model Output for DO in Camp Creek, Maximum Load Scenario

3.6 Evaluation of Ammonia Toxicity

Ammonia must not only be considered due to its effect on dissolved oxygen in the receiving water, but also its toxicity potential. Ammonia nitrogen concentrations can be evaluated using the criteria given in 1999 Update of Ambient Water Quality Criteria for Ammonia (EPA-822-R-99-014). The maximum allowable instream ammonia nitrogen (NH_3-N) concentration at a pH of 7.0 and stream temperature of 26°C is 2.82 mg/l. Based on the model results from the maximum load scenario, Figure 11, this standard was not exceeded in Camp Creek.

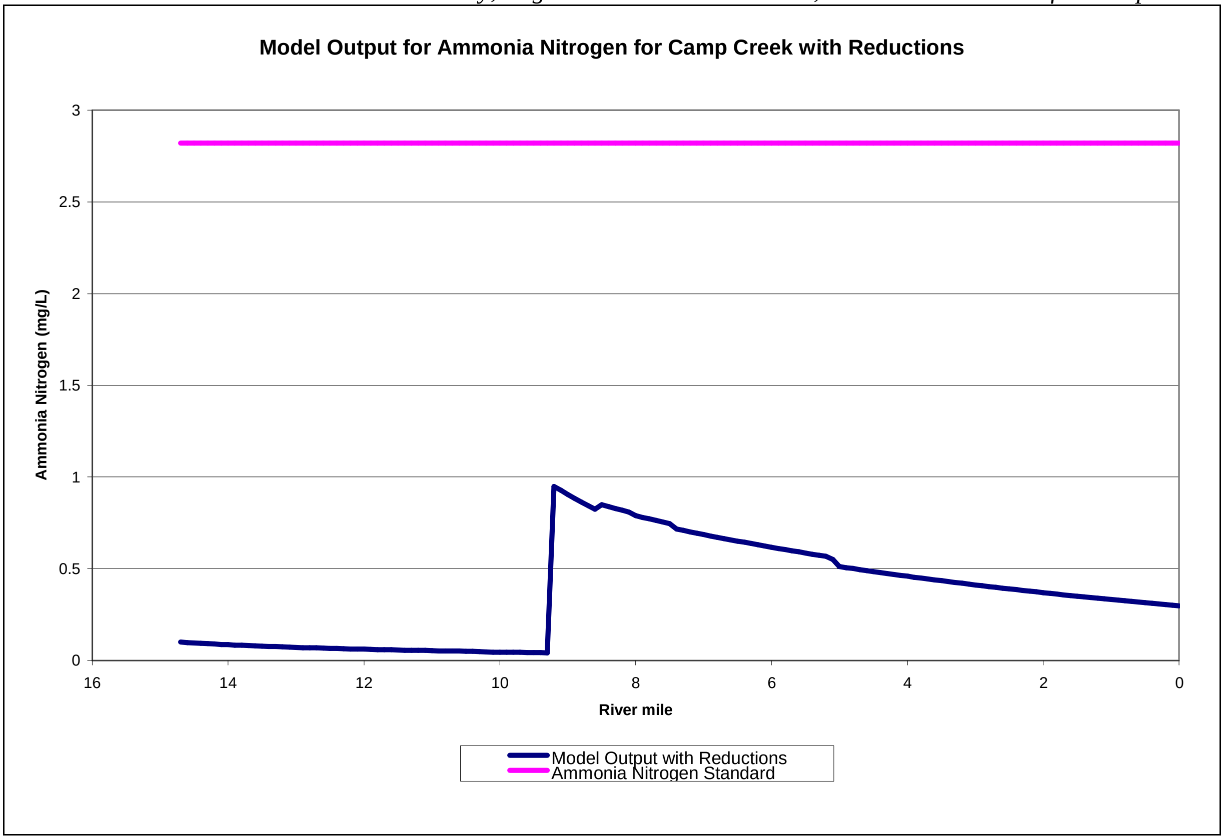


Figure 11. Model Output for Ammonia Nitrogen in Camp Creek with Maximum Loads

3.7 Estimated Existing Load for Total Nitrogen and Total Phosphorus

The average annual flow in the watershed was estimated based on flow data from USGS gage 07277700 located on Hickahala Creek. The average annual flow for this gage is 189.3 cfs. To estimate the amount of flow in Camp Creek, a drainage area ratio was calculated (189.3 cfs/121 square miles = 1.56 cfs/square miles). The ratio was then multiplied by the drainage area of the impaired segment. The TMDL for TN and TP loads were then calculated using Equation 5 and the results are shown in Tables 12.

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

Table 12. Estimated Existing Total Nitrogen and Total Phosphorous Loads for Camp Creek

Water body	**Camp Creek**		**Water**	**Urban**	**Scrub / Barren**	**Forest**	**Pasture / Grass**	**Cropland**	**Wetland**	**Total**	
		Acres	379.6	10058.5	8546.9	5125.3	4953.0	8250.8	2205.3	39,519.3	
Land Use	**TN kg/mile²**	Percent (%)	0.96%	25.45%	21.63%	12.97%	12.53%	20.88%	5.58%	100.00%	
Forest	111.3	Miles² in watershed	0.6	15.7	13.4	8.0	7.7	12.9	3.4	61.7	
Pasture	777.2	Flow in cfs based on area	96.3								
Cropland	5179.9										
Urban	296.4	TN Load kg/day	0.4	12.8	4.1	2.4	16.5	183.0	2.5	221.6	kg/day
Water	257.4	TP Load kg/day	0.4	0.1	2.3	1.4	16.5	91.5	2.5	114.6	kg/day
Wetland	265.2										
Scrub/Barren	111.3	TN target concentration	1.12	mg/l							
		TP target concentration	0.16	mg/l							
Land Use	**TP kg/mile²**										
Forest	62.1	TN target load	581.95	lbs/day							
Pasture	777.2	TP target load	83.14	lbs/day							
Cropland	2589.9										
Urban	3.12	TN estimated load per day	488.62	lbs/day							
Water	257.4	TP estimated load per day	252.75	lbs/day							
Wetland	265.2										
Scrub/Barren	62.1	TN estimated concentration	0.94	mg/l							
		TP estimated concentration	0.49	mg/l							
		TN reduction needed	0.00%								
		TP reduction needed	67.11%								

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

The existing TN and TP loads consists of both point and non-point components. Since many treatment facilities in Mississippi do not have permit limits for nutrients, nor are they currently required to report effluent nitrogen or phosphorous concentrations, MDEQ used an estimated effluent concentration based on literature values for different treatment types. Table 13 shows the median effluent nitrogen and phosphorous concentrations for four conventional treatment processes. The appropriate concentration for each of the facilities was then used in Equation 5 to estimate the TN and TP loads from point sources, Table 14.

Table 13. Median Nitrogen and 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
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 14. NPDES Permitted Facilities with Nitrogen and Phosphorous Estimates

Facility Name	NPDES	Permitted Discharge (cfs)	TN (mg/l)	TN Load estimate (lbs/day)	TP (mg/l)	TP Load estimate (lbs/day)
Bridgetown Subdivison	MS0028185	0.408	13.60	29.96	5.80	12.78
Olive Branch POTW, Ross Road	MS0029513	4.642	11.50	287.93	5.20	130.19
Summers Place Subdivision	MS0048470	0.036	13.60	2.61	5.80	1.11
Pinehurst Subdivision	MS0048780	0.128	11.50	7.92	5.20	3.58
Village of Ceder View	MS0050091	0.077	11.50	4.80	5.20	2.17
College Hill Subdivision	MS0051764	0.214	11.50	13.24	5.20	5.99
Olive Branch, City of, Oakwood	MS0054852	0.050	11.50	3.07	5.20	1.39
Carters Plantation Subdivision	MS0055280	0.031	11.50	1.92	5.20	0.87
Belmore Lakes Subdivision	MS0056375	0.124	11.50	7.68	5.20	3.47
	Total			**359.13**		**161.55**

The TN and TP point source loads given in Table 14 are estimated to be 359.13 and 161.55 lbs/day, respectively. The TN point source load is 74% of the TN watershed load, and the TP point source load is 64% of the TP watershed load.

ALLOCATION

The allocation for this TMDL involves a wasteload allocation for the point sources and a load allocation for the non-point sources necessary for attainment of water quality standards in Camp Creek.

4.1 Wasteload Allocation

There are currently nine NPDES permits issued for the Camp Creek watershed. It is anticipated that Bridgetown Subdivision, Pinehurst Subdivision, and Oakwood will be connecting to the Desoto County Regional Utility Authority (DCRUA) regional system which currently discharges to Short Fork Creek in a different watershed. The loads for these three facilities are not included in the WLA for Camp Creek. The NPDES permitted facilities included in the wasteload allocation are shown in Table 15. A permit reduction is necessary for some of the facilities in order to meet TBODu water quality standards, as shown in Figure 8. Table 16 gives the estimated permit limits from each point source that is equivalent to the necessary reductions.

Table 15. Wasteload Allocation

Facility Name	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)	Perent Reduction
Olive Branch POTW, Ross Road	287.71	114.34	402.05	33%
Summers Place Subdivision	13.23	1.75	14.99	0%
Village of Ceder View	18.76	3.81	22.58	0%
College Hill Subdivision	17.26	10.52	27.78	0%
Carters Plantation Subdivision	7.51	1.52	9.03	0%
Belmore Lakes Subdivision	30.02	6.10	36.12	0%
Total	**374.50**	**138.04**	**512.55**	

Table 16. Wasteload Allocation Estimated Permit Limits

NPDES	Flow (MGD)	$CBOD_5$ (mg/l)	NH_3-N (mg/l)	DO (mg/l)
Olive Branch POTW, Ross Road	3.0	5	1	6
Summers Place Subdivision	0.023	30	2	6
Village of Ceder View	0.05	30	2	6
College Hill Subdivision	0.138	10	2	6
Carters Plantation Subdivision	0.02	30	2	6
Belmore Lakes Subdivision	0.08	30	2	6

Table 17 gives the nutrient wasteload allocation for the TMDL. The table gives the estimated load of TN from the point sources as described in Section 3.6. Table 17 also gives the estimated load of TP from the point as also described in Section 3.6. The TN reduction is 0%, and the TP reduction is 67.11%. These reductions are reflected in the nutrient wasteload allocation listed in the table below.

Table 17. Nutrient Wasteload Allocation

Facility Name	Existing Estimated TN Point Source Load (lbs/day)	Allocated Average TN Point Source Load (lbs/day)	Existing Estimated TP Point Source Load (lbs/day)	Allocated Average TP Point Source Load (lbs/day)
Bridgetown Subdivison	29.96	0	12.78	0
Olive Branch POTW, Ross Road	287.93	287.93	130.19	42.82
Summers Place Subdivision	2.61	2.61	1.11	0.37
Pinehurst Subdivision	7.92	0	3.58	0
Village of Ceder View	4.80	4.80	2.17	0.71
College Hill Subdivision	13.24	13.24	5.99	1.97
Olive Branch, City of, Oakwood	3.07	0	1.39	0
Carters Plantation Subdivision	1.92	1.92	0.87	0.29
Belmore Lakes Subdivision	7.68	7.68	3.47	1.14
Total	**359.13**	**318.18**	**161.55**	**47.30**

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 BOD load allocation. In Table 18, the load allocation is shown as the non-point sources (the spatially distributed flow entering each reach in the model).

Table 18. Load Allocation, Maximum Scenario

	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Background	0.86	0.2	1.06
Non-Point Source	19.40	4.43	23.83
	20.26	**4.63**	**24.89**

Although, reductions are not required for the TBODu non-point source loads, best management practices (BMPs) should be encouraged in the watershed. 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 19 shows the load allocation for TN and TP. The overall TN reduction is 0%, and the overall TP reduction is 67.1%. These reductions are reflected in the nutrient load allocation in the table below.

Table 19. Load Allocation for Estimated TN and TP

Nutrient	Estimated Nutrient Nonpoint Source Load (lbs/day)	Allocated Nutrient Nonpoint Source Load (lbs/day)	Percent Reduction %
TN	128.78	222.11	0.0
TP	90.90	29.91	67.11

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 implicit.

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 when Sardis spillway is closed for

inspections. Modeling the water body at this flow provides protection during the worst-case scenario.

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, which occurs during the hot, dry summer period. 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.

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

The TMDL for TBODu was calculated based on the current loading of pollutant in Camp Creek, according to the model. The TMDL calculations are shown in Tables 20 and 21. As shown in Table 20, the 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.

Equation 5 was used to calculate the TMDL for TP and TN. The TMDLs given in Table 21 were then compared to the estimated existing load presented in Sections 3.6. The estimated existing TP concentration indicates needed reductions of 67.11%. The estimated existing total nitrogen concentration indicates no reductions are needed.

Table 20. TMDL for TBODu in Camp Creek Watershed

	WLA (lbs/day)	LA (lbs/day)	MOS (lbs/day)	TMDL (lbs/day)
CBODu	**374.50**	**20.26**	Implicit	**394.76**
NBODu	**138.04**	**4.63**	Implicit	**142.67**
TBODu	**512.55**	**24.89**	Implicit	**537.44**

Table 21. TMDL for Nutrients in Camp Creek Watershed

	WLA (lbs/day)	LA (lbs/day)	MOS (lbs/day)	TMDL (lbs/day)
TN	**318.18**	**222.11**	Implicit	**540.29**
TP	**47.30**	**29.91**	Implicit	**77.21**

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 Camp Creek is not meeting water quality standards for dissolved oxygen at the present loading of TBODu. The current model used for these calculations does not have adequate data to support all of the assumptions used, however, it is clear that the stream is impaired. The TMDL, therefore, recommends no increases in loads for Camp Creek or issuance of new permits in the watershed. This TMDL recommends TBODu reductions from the current loads of some of the point sources in the watershed to eliminate the DO standards violation in the stream. This TMDL does not recommend a reduction in the estimated existing TN concentration, but does recommend a 67.11% reduction in the estimated existing TP concentration to both point and nonpoint sources to reduce nutrient impairment in the watershed. It is anticipated that within the next three months Bridgetown Subdivision, Pinehurst Subdivision, and Oakwood will be connecting to the Desoto County Regional Utility Authority (DCRUA) regional system which currently discharges to Short Fork Creek in a different watershed. With the elimination of the point sources that are connecting to the regional system and the reductions to the remaining point sources, MDEQ believes that a significant reduction in TP, ammonia nitrogen, and organic enrichment in the watershed will return the stream to meeting water quality standards.

It is recommended that the Camp 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 Next Steps

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

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

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

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

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

5.2 Public Participation

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

All comments should be directed to Kay Whittington 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.

REFERENCES

Davis and Cornwell. 1998. *Introduction to Environmental Engineering.* McGraw-Hill.

MDEQ. 2007. *Stressor Identification Report for Camp Creek.* Office of Pollution Control.

MDEQ. 2004. *Mississippi's Plan for Nutrient Criteria Development.* Office of Pollution Control.

MDEQ. 2003. Development and Application of the Mississippi Benthic Index of Stream Quality (M-BISQ). June 30, 2003. Prepared by Tetra Tech, Inc., Owings Mills, MD, for the Mississippi Department of Environmental Quality, Office of Pollution Control, Jackson, MS. (*For further information on this document, contact Randy Reed [601-961-5158*).

MDEQ. 2007. *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters.* Office of Pollution Control.

MDEQ. 1994. *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.* Office of Pollution Control.

Metcalf and Eddy, Inc. 1991. *Wastewater Engineering: Treatment, Disposal, and Reuse 3rd ed.*
New York: McGraw-Hill.

Shields, F.D. Jr., Cooper, C.M., Testa, S. III, Ursic, M.E., 2008. *Nutrient Transport in the Yazoo River Basin, Mississippi*. USDA ARS National Sedimentation Labortory, Oxford, Mississippi.

Telis, Pamela A. 1992. *Techniques for Estimating 7-Day, 10-Year Low Flow Characteristics for Ungaged Sites on Streams in Mississippi.* U.S. Geological Survey, Water Resources Investigations Report 91-4130.

Thomann and Mueller. 1987. *Principles of Surface Water Quality Modeling and Control*.
New York: Harper Collins.

USEPA. 2000. *Stressor Identification Guidance Document*. EPA/822/B-00/025. Office of Water, Washington, DC.

USEPA. 1999. *Protocol for Developing Nutrient TMDLs*. EPA 841-B-99-007. Office of Water (4503F), United States Environmental Protection Agency, Washington D.C. 135 pp.