

**DRAFT**  
**Total Maximum Daily Load (TMDL)**  
**for**  
**The Town Creek Watershed**  
**In the Tombigbee River Basin of Mississippi**  
**To Address Impairment due to Nutrients**



**Prepared by:**  
**US EPA Region 4**  
**61 Forsyth Street SW**  
**Atlanta, Georgia 30303**

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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 waterbody segments found on Mississippi's 1996 Section 303(d) List of Impaired Waterbodies. 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.

### Conversion Factors

To convert from	To	Multiply by	To convert from	To	Multiply by
mile <sup>2</sup>	acre	640	acre	ft <sup>2</sup>	43560
km <sup>2</sup>	acre	247.1	days	seconds	86400
m <sup>3</sup>	ft <sup>3</sup>	35.3	meters	feet	3.28
ft <sup>3</sup>	gallons	7.48	ft <sup>3</sup>	gallons	7.48
ft <sup>3</sup>	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 <sup>3</sup>	gallons	264.2	µg/l * cfs	gm/day	2.45
m <sup>3</sup>	liters	1000	µg/l * MGD	gm/day	3.79

Fraction	Prefix	Symbol	Multiple	Prefix	Symbol
10 <sup>-1</sup>	Deci	d	10	deka	da
10 <sup>-2</sup>	Centi	c	10 <sup>2</sup>	hecto	h
10 <sup>-3</sup>	Milli	m	10 <sup>3</sup>	kilo	k
10 <sup>-6</sup>	Micro	µ	10 <sup>6</sup>	mega	M
10 <sup>-9</sup>	Nano	n	10 <sup>9</sup>	giga	G
10 <sup>-12</sup>	Pico	p	10 <sup>12</sup>	tera	T
10 <sup>-15</sup>	Femto	f	10 <sup>15</sup>	peta	P
10 <sup>-18</sup>	Atto	a	10 <sup>18</sup>	exa	E

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## TMDL INFORMATION PAGE

**Table i. Listing Information**

ID	Name	County	Impairment	HUC	Mon/Eval
MS013TE	Town Creek	Union, Lee, Pontotoc	Nutrients	03160102	Evaluated
Location: Near Nettleton from headwaters to watershed 016 boundary					

**Table ii. Applicable Mississippi Water Quality Standards**

Parameter	Beneficial use	Narrative Water Quality Criteria
Nutrients	Aquatic Life Support	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)."
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 iii. NPDES Facilities in the Watershed**

NPDES ID	Facility Name	Permitted Discharge	Receiving Water	City	County
MS0020940	Plantersville POTW	0.275	Town Creek	Plantersville	Lee
MS0021733	Saltillo POTW	0.98	Sand Creek	Saltillo	Lee
MS0022845	Webb Utility Systems—Indian Hills Subdivision	0.134	Little Sand Creek	Tupelo	Lee
MS0023302	Natchez Trace Tupelo, Headquarters	.025	Tributary of Mud Creek	Tupelo	Lee
MS0023655	Guntown POTW	0.2	Sand Creek	Guntown	Lee
MS0033235	East Union Attendance Center	0.03	Bridge Creek	Ellistown	Union
MS0033464	Mississippi Department of Wildlife—Fisheries and Parks, Tombigbee State Park	0.007	Town Creek	Tupelo	Lee
MS0034444	Elvis Presley Park	0.015	Middle Tulip Creek	Tupelo	Lee
MS0036111	Tupelo POTW	10.5	Town Creek	Tupelo	Lee
MS0039501	Super 8 Motel—Belden Inn	0.004	Town Creek	Tupelo	Lee
MS0042048	Verona POTW	1.05	Coonewah Creek	Verona	Lee
MS0048046	City of Tupelo, Deer Park Estates Facility	0.027	West Tulip Creek	Tupelo	Lee
MS0052639	Garden Park Estates	0.072	Yonaba Creek	Saltillo	Lee

NPDES ID	Facility Name	Permitted Discharge	Receiving Water	City	County
MS0055972	Heardtown Estates Subdivision	0.085	Bustaloba Creek	Tupelo	Lee
MS0060011	Sherman POTW*	0.2	Town Creek	Sherman	Pontotoc

**Table iv. Total Maximum Daily Loads**

Parameter	WLA (lbs/day)	LA (lbs/day)	MOS	TMDL (lbs/day)
TN	209	946	implicit	1155
TP	22	180.4	implicit	202.4
BOD	1045	2574	implicit	3619

## EXECUTIVE SUMMARY

The State of Mississippi originally placed Town Creek on the Mississippi 1996 Section 303(d) List of Impaired Waterbodies due to evaluated causes of pesticides, siltation, nutrients, and organic enrichment (OE)/low dissolved oxygen (Low DO). The Mississippi Department of Environmental Quality (MDEQ) was not able to complete biological monitoring on Town Creek as it is a non-wadeable stream. MDEQ submitted, and EPA approved, a delisting package for OE/Low DO based on recent monitoring data that showed that the water quality standards for DO were being attained in Town Creek. This TMDL addresses impairment due to nutrients in Town Creek by providing an estimate of the total nitrogen (TN) and total phosphorus (TP) loads allowable in the stream for point sources and non-point sources in the Town Creek watershed.

Mississippi does not have numeric water quality standards for allowable nutrient concentrations; however, MDEQ is currently working on the development of numeric nutrient criteria to be adopted in State water quality standards. A Nutrient Task Force (NTF) has been established to assist the State in this effort, and MDEQ is progressing according to the State's Nutrient Criteria Development Plan, which has been mutually agreed upon with EPA.

In the *1999 Protocol for Developing Nutrient TMDLs*, EPA suggests several methods for the development of TMDL targets for nutrients (USEPA, 1999). According to this document, "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." Mississippi's method is based on a comparison between similar but unimpaired waters within the same region. This method is dependent on adequate data and utilizes data collected in support of nutrient criteria development, as per the plan mutually agreed upon with EPA. Based on MDEQ's methodology and studies, an annual concentration range of 0.6 to 0.7 mg/l is an applicable target for Total Nitrogen and 0.06 to 0.10 mg/l for Total Phosphorus in Ecoregion 65.

The limited nutrient data and estimated ecoregion concentrations indicate reductions of nutrients are needed. The allocations proposed for Town Creek are the results of a water quality model EPA developed for the impaired streams. The EPA Water Quality Analysis Simulation Program, Version 7 (WASP7.2) was applied as the in-stream water quality model. The purpose of the modeling exercise was to determine reductions in nutrient loads that would have to occur in order to protect the designated use of the streams, and achieve water quality standards. Point and non-point sources were reduced in the WASP model so that simulated DO concentrations continued to achieve water quality standards and simulated in-stream TN and TP concentrations reflected Ecoregion 65 target levels. Chlorophyll-a concentration in the water column was simulated in the model as a surrogate for the total productivity of the system. The target chlorophyll-a concentration was in the range expected in a "natural" or least-disturbed condition. In the absence of site specific chlorophyll-a data and in consideration of the modeling work and technical analysis completed for the TMDL development process, water column chlorophyll-a concentrations less than 20 micrograms per liter are indicative of conditions that should be protective of aquatic life in these Mississippi waters. In recognition of the lack of data available for Town Creek as well as the absence of numeric nutrient criteria for these waters, EPA is asking for comments on the approach used in this report to determine the TMDL.

# 1. INTRODUCTION

## 1.1 Background

The identification of waterbodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those waterbodies 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 waterbodies through the establishment of pollutant specific allowable loads. This TMDL has been developed for the 2006 §303(d) listed segment shown in Figure 2.

**Town Creek is listed as an evaluated waterbody impaired due to nutrients, organic enrichment (OE)/low dissolved oxygen (low DO). EPA approved a delisting package submitted by MDEQ for OE/Low DO as recent monitoring data showed that DO standards were being attained in Town Creek. Town Creek is in the Tombigbee River Basin, which comprises east-central Mississippi. The drainage area for the Town Creek watershed is approximately 375.8 square miles. The watershed is predominantly comprised of forest and**

agricultural lands. A map of the watershed is provided in

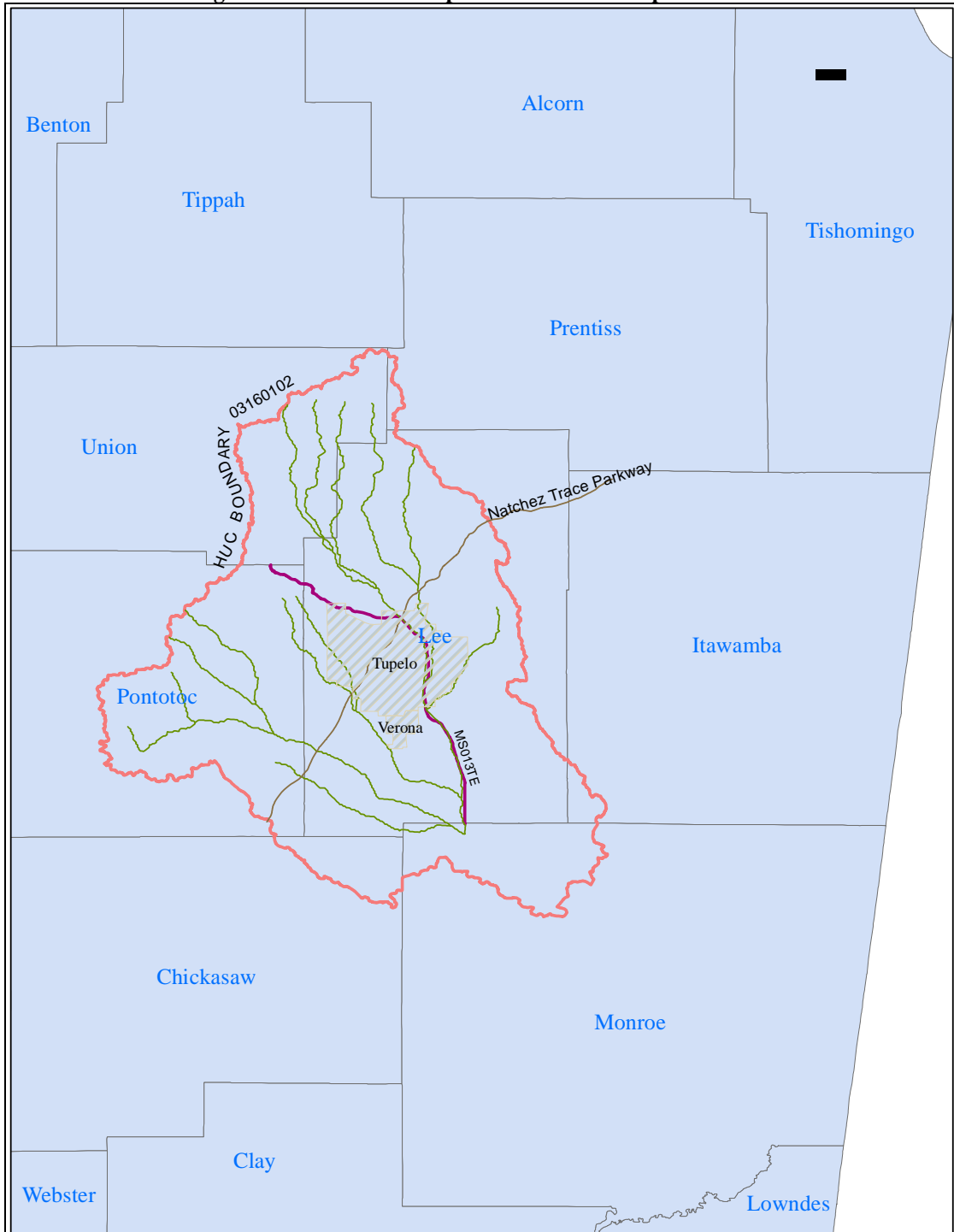


Figure 1.

## 1.2 Applicable Waterbody Segment Use

The designated beneficial use for the listed segment is fish and wildlife. 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).

### **1.3 Applicable Waterbody Segment Standard**

The water quality standard applicable to the use of the waterbody 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)."

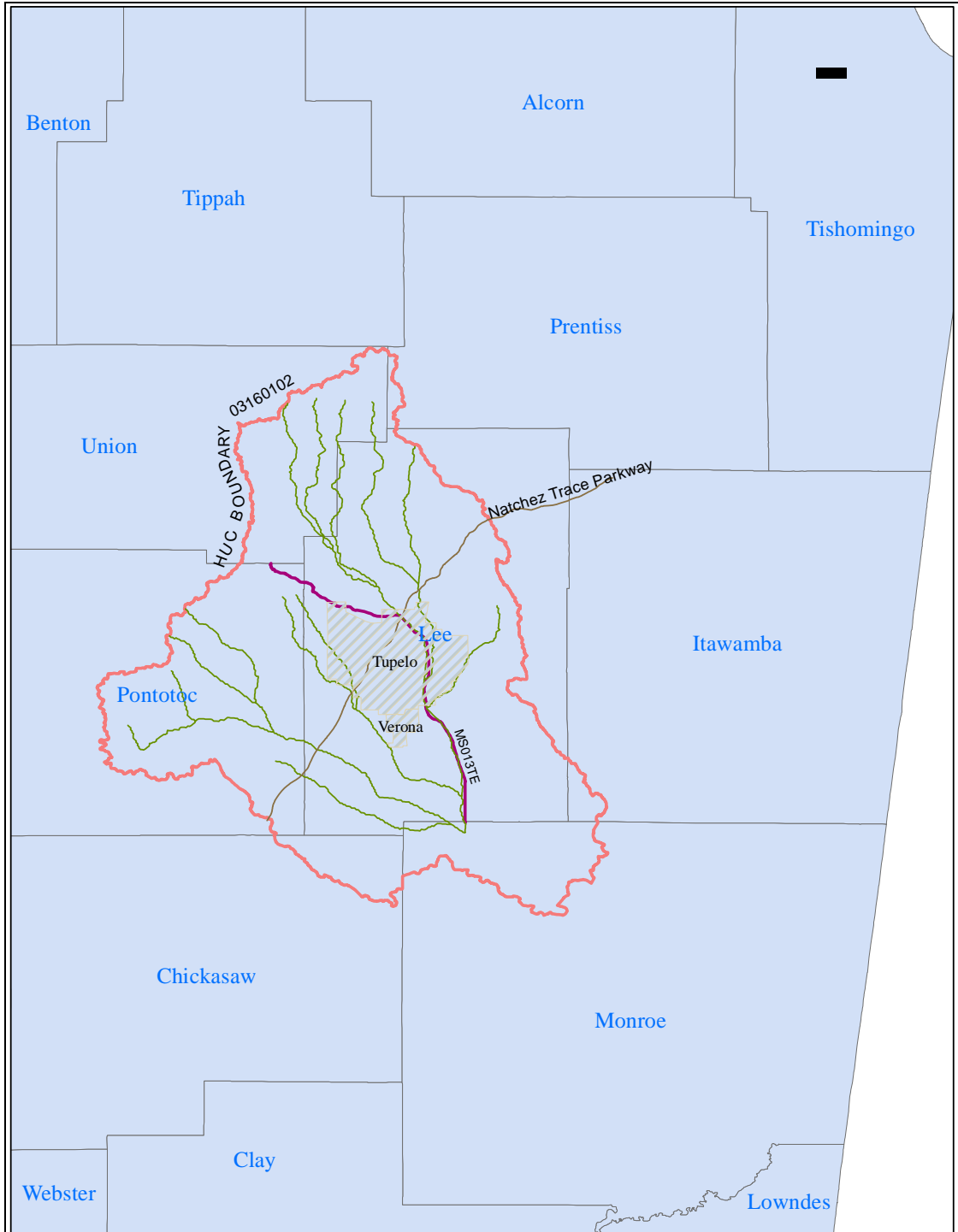








Figure 1. Map of the Listed Segment, Town Creek

Legend

-  Cities of Tupelo and Verona
-  Natchez Trace Parkway
-  MS Waterbodies-Unimpaired
-  MS013TE--Town Creek
-  HUC 03160102
-  Counties

## 1.4 Nutrient Target Development

Since there are no specific numeric criteria for nutrients in Mississippi, the State's narrative water quality standard must be translated to quantify a level of nutrients that are protective of aquatic life. Numeric criteria for Total Nitrogen (TN) and Total Phosphorus (TP) are currently being developed by the Mississippi Nutrient Task Force (NTF) in coordination with EPA Region 4. MDEQ has a State nutrient criteria development plan that has been mutually agreed upon with EPA and MDEQ and is on schedule according to that plan in development of nutrient criteria (MDEQ, 2004). Data were collected for wadeable streams to calculate the nutrient criteria.

In the *1999 Protocol for Developing Nutrient TMDLs*, EPA suggests several methods for the development TMDL targets for nutrients (USEPA, 1999). According to this document, "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." Mississippi's method is based on a comparison between similar but unimpaired waters within the same region. This method is dependent on adequate data and utilizes data collected in support of nutrient criteria development as per the plan mutually agreed upon with EPA. The initial phase of the data collection process for wadeable streams in Mississippi is complete.

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 nonpoint 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 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 25th 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.

For the preliminary target concentration range, the means of the data at each of the nutrient sites were taken. The 75<sup>th</sup> and 90<sup>th</sup> percentiles of the means of the nutrient sites in that ecoregion fully supporting aquatic life were selected 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. In Ecoregion 65, 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 is an applicable target for TP.

## **1.5 Pollutants of Concern: Total Nitrogen and Total Phosphorus**

The following is an adaptation of the State of Washington Department of Ecology's *Citizen's Guide to Understanding and Monitoring in Streams and Lakes* and provides a brief description and basic understanding of the pollutants of concern for this TMDL report:

The two primary nutrients of concern are nitrogen and phosphorus. Both elements commonly are measured in several forms. Phosphorus can be reported as total phosphorus (TP), which includes a particulate form and a dissolved form. The dissolved form is measured and reported as soluble reactive phosphate (SRP), phosphate ( $\text{PO}_4^{-3}$ ), or orthophosphate (ortho-P); all different terms used to describe the fraction of TP that is soluble, and therefore more immediately available to organisms for growth.

Nitrogen can be reported as total nitrogen (TN), either measured directly or calculated from its constituents, which are organic-N, ammonia-N (unionized or ionized), nitrite-N, and nitrate-N. Of these, organic-N and ammonia-N are measured as total Kjeldahl nitrogen (TKN), while nitrite+nitrogen ( $\text{NO}_2^-$ ) and nitrate-nitrogen ( $\text{NO}_3^-$ ), are usually measured as nitrate+nitrite-nitrogen ( $\text{NO}_3^- + \text{NO}_2^-$ ). As is the case with TP, there are fractions of TN that are more bioavailable. TKN includes the organic form of TN, which is less immediately bioavailable for growth versus the more readily available component of TKN, which is  $\text{NH}_3$  or  $\text{NH}_4^+$ . Together, the fractions of  $\text{NH}_3$  or  $\text{NH}_4^+$  and  $\text{NO}_3^- + \text{NO}_2^-$  represent forms of nitrogen that are most immediately available for growth.

Organically bound TP and TN, while not immediately available, can be converted to bioavailable forms at predictable rates; and may be significant drivers of primary productivity. One chemical form of an element can be converted into another, and the conditions under which the conversion occurs are influenced by many factors; such as pH, temperature, oxygen concentration, and biological activity. The original form of the nutrient and the prevailing physical conditions will determine if an increase in total nutrient concentrations will result in higher available nutrient

concentrations and therefore, a corresponding immediate increase in growth or productivity. If nutrients enter the stream as organic matter, that has to be decomposed before the nutrients can be utilized for additional growth. This process consumes oxygen and is important due to its effect on the rate of decomposition. During warmer months, nutrients enter the system as intact organic matter and decompose relatively quickly as compared to cold, wet-weather months when decomposition is slow. These dynamics are further complicated by the fact that increased growth leads to greater numbers of organisms that need even more nutrients. So, as nutrients become available they are often immediately utilized.

Increases in anthropogenic nutrient concentrations and their impacts are considered nutrient pollution. Municipal and industrial discharges usually contain nutrients, and overland flow from developed watersheds contains nutrients from lawn and garden fertilizers as well as the additional organic debris so easily washed from urban surfaces. Agricultural areas also significantly contribute to nutrient increases through poor manure management, fertilizing practices, and increased nutrient-bearing soil erosion from plowed surfaces.

Increased nutrient loading typically results in increased algal growth, where sufficient conditions of light, temperature, substrate and flow (residence time) are met. And, the resulting enhanced growth in algal biomass will occur locally and/or downstream. In flowing stream segments where conditions are right, attached forms of algae tend to dominate, i.e., periphyton attached to rocks, logs, aquatic macrophytes, and other substrate. In slower flowing streams, algae suspended in the water column, i.e., phytoplankton, may tend to dominate. Excessive growths of algae, both periphyton and phytoplankton, can adversely affect other aquatic life through habitat/life cycle disruption and exaggerated fluctuations of normal dissolved oxygen cycles; eventually resulting in a DO crash. In addition, unsightly conditions, odors and poor habitat conditions for aquatic organisms can also be attributed to excessive algae (WDOE, 1994).

## 2.0 WATERBODY ASSESSMENT

### 2.1 Town Creek Water Quality Data

Nutrient data for the Town Creek Watershed were collected in September 1999. The data are presented in Table 1.

**Table 1. Town Creek Instream Nutrient Data**

Station	TN (mg/l)	TP (mg/l)
TUP 1	2.9	0.1
TUP 1	2.7	0.2
TUP 1	2.6	0.1
TUP 1	2.7	0.1
TUP 2	7.8	1.8
TUP 2	9.4	2.1
TUP 2	6.3	1.1
TUP 2	8.4	1.51
TUP 3	5.2	1
TUP 3	7.2	1.1
TUP 3	6.1	1
TUP 4	4.8	0.9
TUP 4	4.7	0.8
TUP 4	5.6	0.8
AVERAGE	5.03	0.83

### 2.2 Assessment of Point Sources

An important step in assessing pollutant sources in the Town Creek watershed is locating the NPDES permitted sources. There are nineteen facilities permitted to discharge into the Town of the nineteen facilities (labeled “terminated” in Table 2) are no longer discharging in the Town Creek watershed. Out of the active permitted dischargers, three wastewater treatment facilities (WWTFs) represent the greatest effluent contributors (by flow) to Town Creek.

**Table 2. NPDES Permitted Facilities in the Town Creek watershed**

NPDES ID	Facility Name	Permitted Discharge	Receiving Water	City	County
MS0002178	Krueger International Inc, Tupelo	Terminated	NA	Tupelo	Lee
MS0020940	Plantersville POTW	0.275	Town Creek	Plantersville	Lee
MS0021733	Saltillo POTW	0.98	Sand Creek	Saltillo	Lee
MS0022845	Webb Utility Systems—Indian Hills Subdivision	0.134	Little Sand Creek	Tupelo	Lee
MS0023302	Natchez Trace Tupelo, Headquarters	0.025	Tributary of Mud Creek	Tupelo	Lee
MS0023655	Guntown POTW	0.2	Sand Creek	Guntown	Lee
MS0033235	East Union Attendance Center	0.03	Bridge Creek	Ellistown	Union

NPDES ID	Facility Name	Permitted Discharge	Receiving Water	City	County
MS0033464	Mississippi Department of Wildlife—Fisheries and Parks, Tombigbee State Park	0.007	Town Creek	Tupelo	Lee
MS0034444	Elvis Presley Park	0.015	Middle Tulip Creek	Tupelo	Lee
MS0035246	Oak Grove Mobile Home Park	Terminated	NA	Plantersville	Lee
MS0036111	Tupelo POTW	10.5	Town Creek	Tupelo	Lee
MS0039501	Super 8 Motel—Belden Inn	0.004	Town Creek	Tupelo	Lee
MS0042048	Verona POTW	1.05	Coonewah Creek	Verona	Lee
MS0042471	Tri State Mack Truckwash	Terminated	NA	Tupelo	Lee
MS0046621	Crafton Warehouse	Terminated	NA	Tupelo	Lee
MS0048046	City of Tupelo, Deer Park Estates Facility	0.027	West Tulip Creek	Tupelo	Lee
MS0052639	Garden Park Estates	0.072	Yonaba Creek	Saltillo	Lee
MS0055972	Heardtown Estates Subdivision	0.085	Bustaloba Creek	Tupelo	Lee
MS0060011	Sherman POTW	0.2	Town Creek	Sherman	Pontotoc

Table 3 and



Figure 2 present all the point sources permitted to discharge to the Town Creek watershed. For the water quality model for Town Creek, EPA included only the active NPDES dischargers as the inactive facilities would have to recommence discharging in order to have an impact on water

quality in Town Creek. The location of Sherman POTW is not represented on

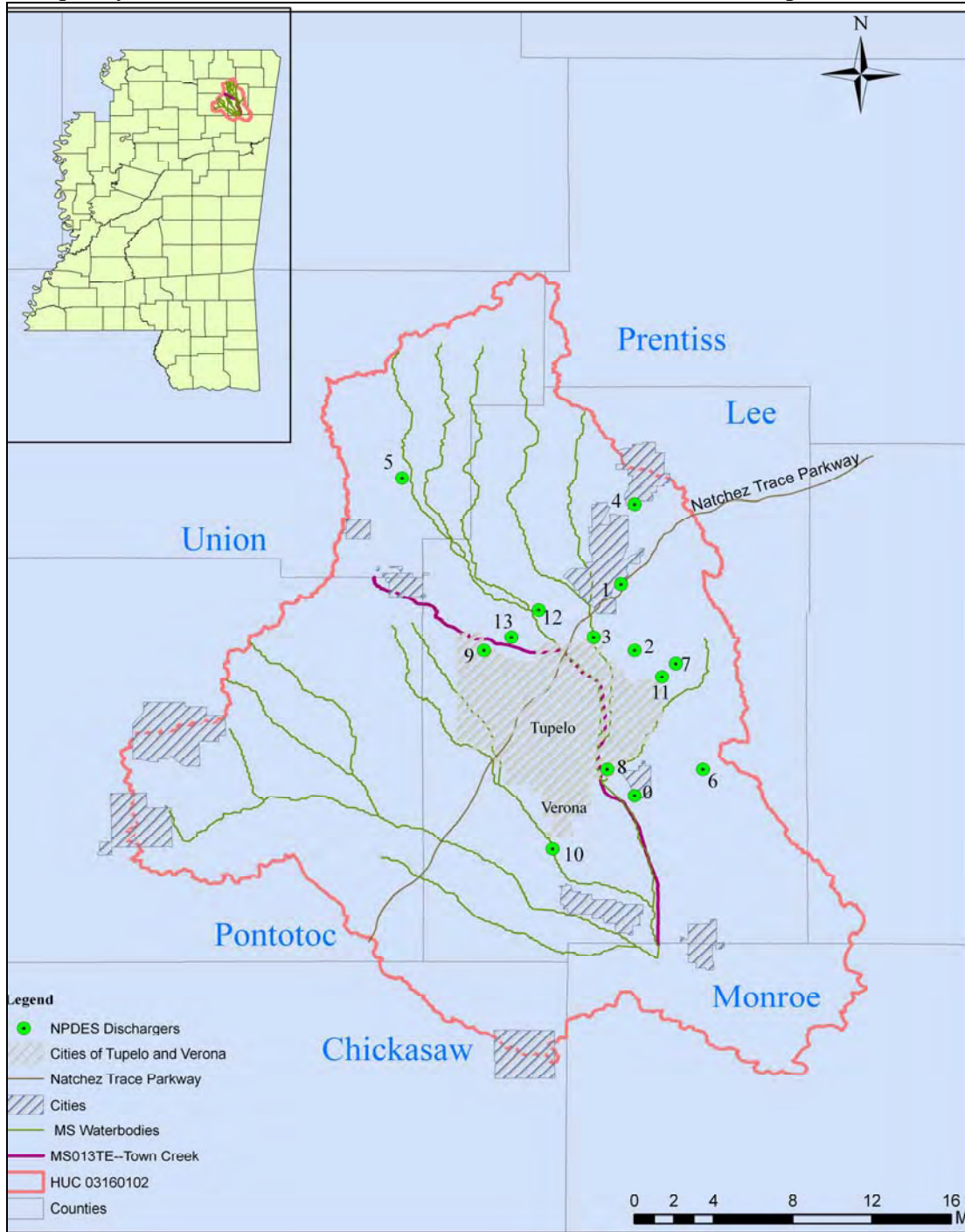


Figure 2, as it is not geo-referenced. Table 4 presents BOD<sub>5</sub> and ammonia permit limits for the significant NPDES facilities discharging in the Town Creek watershed.



Figure 2. NPDES dischargers in the Town Creek watershed included in the water quality model

Table 3. NPDES facilities used in the Town Creek watershed water quality model

Map Number	NPDES ID	Facility Name	Permitted Discharge	Receiving Water	City	County
0	MS0020940	Plantersville POTW	0.275	Town Creek	Plantersville	Lee
1	MS0021733	Saltillo POTW	0.98	Sand Creek	Saltillo	Lee

Map Number	NPDES ID	Facility Name	Permitted Discharge	Receiving Water	City	County
2	MS0022845	Webb Utility Systems— Indian Hills Subdivision	0.134	Little Sand Creek	Tupelo	Lee
3	MS0023302	Natchez Trace Tupelo, Headquarters	.025	Tributary of Mud Creek	Tupelo	Lee
4	MS0023655	Guntown POTW	0.2	Sand Creek	Guntown	Lee
5	MS0033235	East Union Attendance Center	0.03	Bridge Creek	Ellistown	Union
6	MS0033464	Mississippi Department of Wildlife—Fisheries and Parks, Tombigbee State Park	0.007	Town Creek	Tupelo	Lee
7	MS0034444	Elvis Presley Park	0.015	Middle Tulip Creek	Tupelo	Lee
8	MS0036111	Tupelo POTW	10.5	Town Creek	Tupelo	Lee
9	MS0039501	Super 8 Motel—Belden Inn	0.004	Town Creek	Tupelo	Lee
10	MS0042048	Verona POTW	1.05	Coonewah Creek	Verona	Lee
11	MS0048046	City of Tupelo, Deer Park Estates Facility	0.027	West Tulip Creek	Tupelo	Lee
12	MS0052639	Garden Park Estates	0.072	Yonaba Creek	Saltillo	Lee
13	MS0055972	Heardtwn Estates Subdivision	0.085	Bustaloba Creek	Tupelo	Lee
Not on map	MS0060011	Sherman POTW*	0.2	Town Creek	Sherman	Pontotoc

\*Sherman POTW is not geo-referenced and is not presented on the map, but it was used in the model.

**Table 4. BOD<sub>5</sub> and Ammonia Permit Levels and nutrient levels for Significant NPDES Facilities**

Facility	Flow (MGD)	BOD <sub>5</sub> (mg/L)	NH <sub>3</sub> -N (mg/L)	TN* (mg/L)	TP* (mg/L)
Tupelo POTW	10.5	10.0	2.0	10.0	5.0
Saltillo POTW	1.0	10.0	2.0	10.0	5.0
Verona POTW	1.0	10.0	2.0	10.0	5.0

\*Estimated nutrient levels based on literature values

## 2.3 Assessment of Non-Point Sources

The two primary nutrients of concern are nitrogen and phosphorus. TN 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. In agricultural areas, studies have indicated that human activities have increased nitrate concentrations in ground water. In urban areas, it is likely that nitrogen sources are relatively localized when compared with the generally more intensive and widespread use of fertilizers on cropland. The greater the percentage of impervious surfaces in a watershed (usually more predominant in urban areas) generally results in surface runoff of nutrient-laden water, rather than seepage to ground water (USGS, 1999). 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 may be a limiting nutrient in 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). Table 5 presents an estimate of typical nutrient loading ranges associated with various land uses. Figure 3 presents a diagrammatic representation of the types of land uses in the Town Creek watershed by percentage.

**Table 5. Nutrient Loadings for Various Land Uses**

Landuse	Total Phosphorus (lb/acre-yr)			Total Nitrogen (lb/acre-yr)		
	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. in 1994 in Protocol for Developing Nutrient TMDLs (USEPA 1999)

The drainage area of the Town Creek watershed is approximately 240,514 acres. The watersheds contain many different landuse types, including urban, forest, cropland, pasture, water, and wetlands. The land use information for the watershed is based on the 1999 National Land Cover Dataset (NLCD). The land use categories were grouped into the land uses of urban, forest, cropland, pasture, disturbed, wetlands, and water. In both watersheds, the area directly surrounding the creeks is predominantly rural and dominated by pastureland. Landuse distribution in the watersheds is summarized in Table 6.

**Table 6. Landuse in Town Creek Watershed**

Landuse	Town Creek	
	Percentage	Area (acres)
Agriculture - Cropland	17%	119744
Agriculture - Pasture	11%	75701
Barren or Mining	0%	127
Forest	58%	411384
Transitional	3%	18310
Urban	1%	4806
Water/Wetlands	11%	75914
TOTAL	100%	240,514

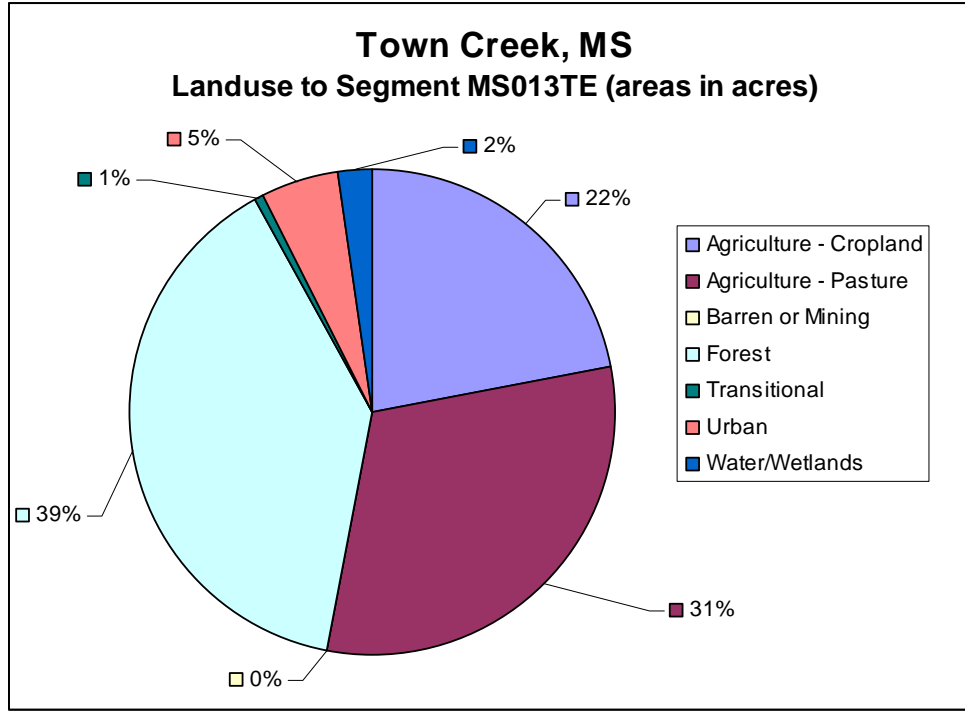


Figure 3. Pie chart representing land use types of Town Creek watershed by percentages

### 3.0 ANALYTICAL APPROACH

#### 3.1 Introduction

Town Creek was listed as an evaluated stream that was impaired due to nutrients. Even though the stream is not impaired for Low DO, the TMDL allocations were determined by analyzing the effects of TN and TP loads on in-stream response variables of algal biomass and achieving the DO standard. Excess chlorophyll-a (Chl *a*) concentration was used as a surrogate for total productivity of the system resulting from nutrient enrichment. The EPA Water Quality Analysis Simulation Program, Version 7 (WASP7.2) was applied as the in-stream water quality model (Wool et. al., 2001). WASP7.2 contains an eutrophication component that simulates complex nutrient transport and cycling in the streams, as well as models any dissolved oxygen sag resulting from point source discharges. The purpose of the modeling exercise was to determine the level of reductions in nutrient loads that would have to occur in order to protect the designated use and achieve water quality standards in Town Creek. For existing conditions, the NPDES facilities were assumed to have existing effluent BOD<sub>5</sub> concentrations of 10.0 mg/L and nutrient concentrations of 10.0 and 5.0 mg/L for TN and TP, respectively; however, to achieve in-stream nutrient concentrations in the range of those expected in Ecoregion 65, the effluent concentration from the facilities was reduced to 2.0 mg/L of TN and 0.2 mg/L of TP. Non-point source loads of TN and TP were calculated using EPA's Simple Method for estimating watershed loads. Pollutant loads were reduced until model simulations indicated that the DO criteria and nutrient targets were attained in stream.

#### 3.2 Simple Method for Estimating Non-point Source Loads

Average annual non-point source loads of BOD<sub>5</sub> and nutrients were estimated using a spreadsheet based on EPA's Simple Method formula from the Better Assessment Science Integrating Point and Non-point Sources (BASINS) Pollutant Loading (PLOAD) model (USEPA, 2001):

$$LP = \sum_u (P * PJ * RV_u * C_u * A_u * 2.72 / 12)$$

Where: LP = Pollutant load, lbs

P = Precipitation, inches/year

PJ = Ratio of storms producing runoff (default = 0.9)

RV<sub>u</sub> = Runoff Coefficient for land use type u, inches of runoff/inches of rain

RV<sub>u</sub> = 0.05 + (0.009 \* I<sub>u</sub>); I<sub>u</sub> = percent imperviousness

C<sub>u</sub> = Event Mean Concentration for land use type u, milligrams/liter

A<sub>u</sub> = Area of land use type u, acres

The PLOAD model was used to estimate nutrient loadings to Town Creek based on existing land use conditions. The 1999 National Land Cover Dataset (NLCD) is the most recent data available to reflect land use conditions in the Town Creek watershed.

The PLOAD model uses average annual rainfall and event mean concentrations (EMCs) to estimate pollutant loading transported off a particular land use. The EMC is the measure of pollutant levels during a runoff event, and is expressed as the loading for a specific constituent

divided by the stormwater volume. The model assumes all lands are connected to the stream, resulting in a conservative estimate of average annual loads. An annual average rainfall of approximately 55 inches was assumed to fall on the impaired watershed, based on mean annual rainfall information available in the NHDplus dataset. The default ratio of 0.9 for storms producing runoff was assumed in the model. Land use data entered into the spreadsheet were based on the 1999 land use/cover features categorized according to the NLCD (see Table 6). EMC values assumed for the various land uses are shown in Table 7 and represent default values contained in the BASINS PLOAD model (USEPA, 2001).

**Table 7. EMCs for Storm Events**

Land Use	BOD <sub>5</sub> (mg/l)	Total N (mg/l)	Total P (mg/l)
Forest/rural open	1.00	0.30	0.060
Urban open	5.0	1.10	0.20
Agriculture	4.0	2.30	0.350
Low-density residential	4.0	1.60	0.200
Medium-density residential	7.0	2.40	0.50
High-density residential	3.0	2.30	0.350
Communication and transportation	2.00	1.00	0.10
Rangeland	2.00	1.00	0.10
Water	1.00	0.30	0.060
Wetlands	5.0	1.10	0.20

The PLOAD model was used to estimate nutrient concentrations expected to runoff the watershed in the absence of development. In this scenario, disturbed landuses in the watershed were changed to least disturbed conditions (i.e., wetland and forest). Results of this scenario indicate annual average TN and TP concentrations of 0.45 and 0.07 mg/L, respectively. The predicted TN and TP concentrations are within the range of concentrations identified by MDEQ as preliminary nutrient criteria for the ecoregion; therefore, the upper limits of the ecoregion values (i.e., TN of 0.7 mg/L and TP of 0.1 mg/L) were selected as in-stream water quality targets in the TMDL analysis.

### 3.3 WASP Model

The WASP model helps users interpret and predict water quality responses to natural phenomena and man-made pollution for various pollution management decisions. WASP is a dynamic compartment-modeling program for aquatic systems, including both the water column and the underlying benthos. The time-varying processes of advection, dispersion, point and diffuse mass loading and boundary exchange are represented in the basic program. This analysis used the conventional pollutant (eutrophication) module. The conventional pollutant module represents the reaction kinetics for nutrients (nitrogen, phosphorus), carbon sources (detritus, algae, and three CBOD groups), algal growth and dissolved oxygen. The WASP model was used to provide an estimate for the existing growing season in-stream Chl *a* concentrations based on least disturbed land use conditions. The WASP model estimated growing season Chl *a* concentrations to be less than 20 µg/L, which should be protective of aquatic health.

### 3.3.1 WASP Segmentation

Segmentation of the WASP model is based on data included in the National Hydrography Dataset Plus (NHDPlus) GIS coverage, and is provided in Table 8. Segments of Town Creek were assumed to have rectangular shape. Cross-sectional area was calculated by multiplying the depth by the width. The volume of each segment was calculated by multiplying the cross-sectional area by the segment length.

**Table 8. Parameterization of Stream Segments Used in the WASP model**

Segment	Length (m)	Width (m)	Depth (m)	Volume (m <sup>3</sup> )
1Flat	4478	6	1	16121
2Flat	5467	11	1	36082
3Flat	3291	11	1	21721
1Town	4655	122	2	1362984
2Town	5217	143	2	1790474
3Town	3417	149	3	1323746
4Town	4513	141	3	1654466
5Town	4536	194	3	2639952
6Town	3752	215	3	2581376
7Town	4041	220	3	2844864
8Town	4014	205	3	2633184
9Town	10000	210	3	6720000
10Town	10000	220	3	7040000

### 3.3.2 WASP Parameterization and Loadings

The WASP model was parameterized using standard rates, constants and environmental parameters. Daily flows used in the model were estimated using flows recorded at a nearby U.S. Geological Survey (USGS) Gage # 72435020 on Town Creek. A weighted drainage area approach is used to estimate streamflow in Town Creek. The USGS hydro separation program (HYSEP) was used to separate estimated flows into storm and base flows. Base flows in the model were assigned BOD<sub>5</sub>, TN and TP concentrations based on the 25<sup>th</sup> percentile of measured data. Storm flows were assigned values based on PLOAD results and default EMC values. EMC values in the WASP model were adjusted until simulated annual average storm load were comparable to the PLOAD annual load results. Pollutant watershed loadings were entered in the model on a daily time scale based on results from the PLOAD and USGS HYSEP spreadsheets. For existing conditions, point source dischargers were represented in the model by using constant loadings based upon facility design flow and estimates of effluent concentrations, which were set at TN and TP limits of 10.0 and 5.0 mg/L, respectively. In the TMDL scenario it was necessary to reduce these limits to achieve the nutrient targets.

Average annual non-point source loads of TN, TP, and BOD<sub>5</sub> generated from the PLOAD spreadsheet (in lb/yr) were converted to units of kilograms per day (kg/day) for input to the water quality model. The PLOAD results for TN were partitioned into ammonia, nitrate, and organic nitrogen; and TP was partitioned into orthophosphate and organic phosphorus. TN was partitioned as follows: 60% nitrate-nitrite; 15% ammonia-nitrogen; and 25% organic nitrogen.

TP was partitioned as follows: 80% orthophosphorus; and 20% organic phosphorus. In the water quality model BOD<sub>5</sub> is simulated as CBOD, and represents the complete biochemical oxidation of organic matter. Table 9 contains the average annual non-point source loads assumed in the WASP model for existing conditions.

**Table 9. Average Annual Non-point Source Loads**

Parameter	NPS Load (kg/day)	NPS Load (lbs/day)
BOD <sub>5</sub>	5620	12364
TN	3260	7172
TP	530	1166

### 3.4 Model Results for Existing Conditions

The WASP model for Town Creek was set up with time varying model stresses such as flows and pollutant loads. This allows the model to simulate both low flow and wet weather conditions. A ten-year simulation period was used to model two scenarios: (1) represent existing loads of BOD<sub>5</sub> and nutrients from point and non-point sources; and (2) reduce all sources so that the water quality standard for DO continues to be attained and nutrient targets are attained. In these TMDLs, the nutrient targets are an in-stream TN concentration of 0.7 mg/L, a TP concentration of 0.1 mg/L, and Chl *a* concentrations comparable to values calculated from the WASP analysis using a least disturbed landuse condition. The model was run with and without the NPDES facilities to evaluate their impact on in-stream water quality.

A “critical zone” was identified in the model where DO was the lowest and Chl *a* concentrations were the highest. Achieving water quality standards at this segment in the model ensures compliance with standards at all other modeled segments. Model results presented in

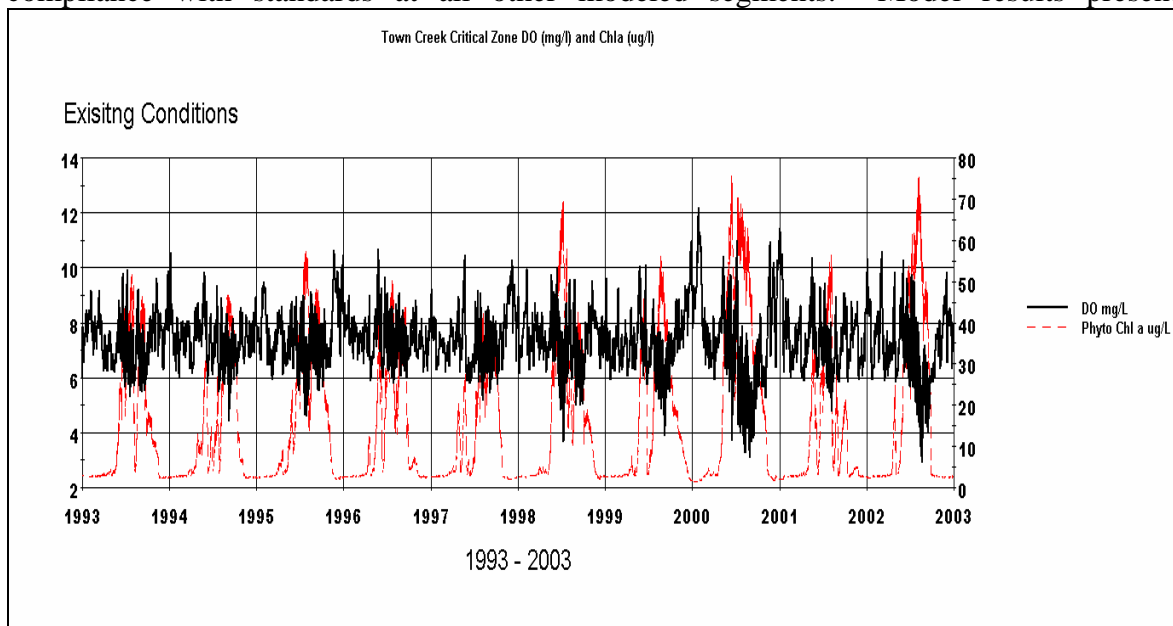


Figure 4 depict the predicted DO and Chl *a* water quality in Town Creek at the critical zone under existing loads for BOD<sub>5</sub> and nutrients. As previously noted, Town Creek was recently delisted for Organic Enrichment/Low DO based on recent monitoring data. The model for existing conditions does indicate DO values that do not meet the water quality standard over the

ten year period. However, the model was run over a ten year period from 1993-2003 and therefore, does not include the most recent monitoring data that indicate that a DO impairment no longer exists in Town Creek.

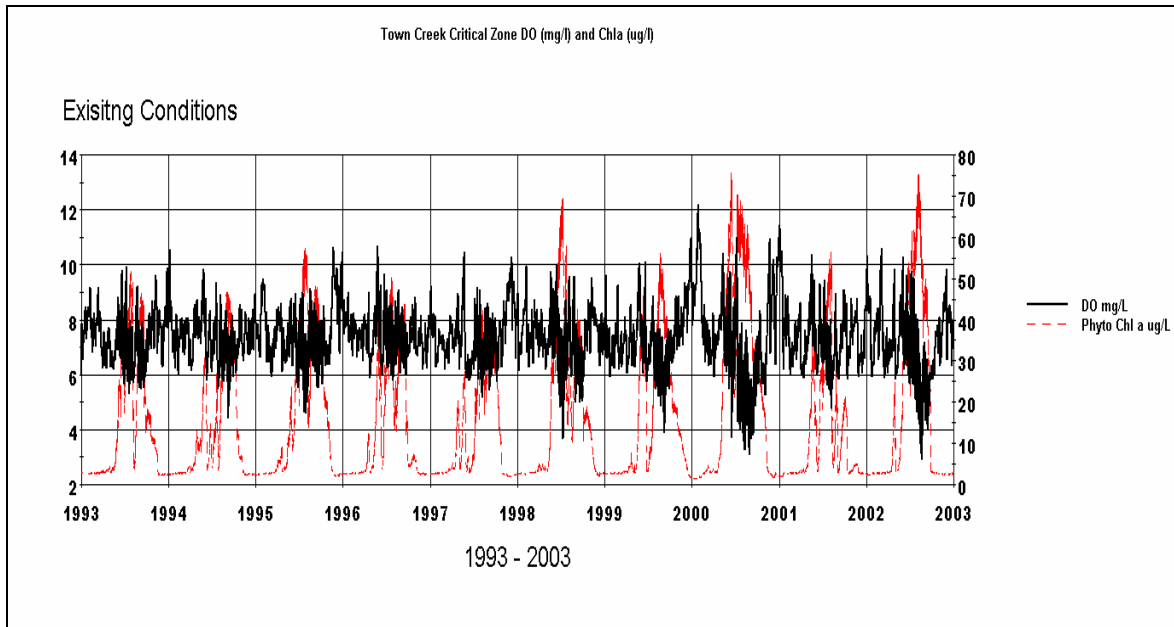


Figure 4. Predicted DO Concentrations For Existing Conditions

Table 10 summarizes average annual loads simulated in the model for TN, TP, and BOD<sub>5</sub>. These loads include both natural and anthropogenic sources. Point sources loads are calculated by multiplying the facility design flow by the assumed effluent concentration.

Table 10. Average Annual Loads for Existing Conditions

Parameter	Existing Point Source Load (kg/day)	Existing Point Source Load (lbs/day)	Existing Non-point Source Load (kg/day)	Existing Non-point Source Load (lbs/day)
<i>Town Creek Watershed</i>				
TN	95	209	3260	7172
TP	10	22	530	1166
BOD <sub>5</sub>	475	1045	5620	12364

## 4.0 DEVELOPMENT OF THE TMDL

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (WLA), non-point source loads (LA), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\text{TMDL} = \Sigma \text{WLAs} + \Sigma \text{LAs} + \text{MOS}$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and WQS achieved. 40 CFR §130.2 (i) states that TMDLs are expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measures.

The TMDLs for Town Creek Watershed are expressed as the allowable loadings of TN, TP, and BOD<sub>5</sub> that are still expected to achieve the DO standard and an algal biomass protective of aquatic health (Table 11). The in-stream target concentrations for TN and TP are 0.7 and 0.1 mg/L, respectively, and are expressed as average annual concentrations. The target Chl *a* concentration is 20 µg/L, expressed as a growing season average.

Table 11. TMDL Components

Parameter	TMDL (kg/day)	TMDL (lbs/day)	WLA (kg/day)	WLA (lbs/day)	LA (kg/day)	LA (lbs/day)	NPS Percent Reduction
<i>Town Creek Watershed</i>							
BOD	1645	3619	475	1045	1170	2574	50%
TN	525	1155	95	209	430	946	50%
TP	92	202.4	10	22	82	180.4	50%

The TMDL scenario was achieved by reducing effluent BOD, TN, and TP concentrations to 10-2-0.2 for the significant NPDES facilities and a 50 percent reduction from non-point sources. Simulated DO and Chl *a* concentrations for this scenario are shown in Figure 5. As previously noted, the nutrient impairment in Town Creek is addressed by reducing BOD and nutrient loads to attain the DO standard and average annual in-stream nutrient targets (i.e., 0.7 mg/l TN and 0.1 mg/l TP). This reduction scenario results in a growing season average Chl *a* concentration of 20 µg/l. EPA believes these in-stream nutrient and Chl *a* concentrations should be protective of aquatic health for this system.

As previously noted, Town Creek was recently delisted for Organic Enrichment/Low DO based on recent monitoring data. Model results for existing conditions indicate simulated DO values that do not meet the water quality standard over a portion of the ten year period. However, the modeling period was from 1993-2003 and does not include the

time period of the most recent monitoring data. The TMDL provides WLAs for BOD based on modeling results, not on in-stream DO data that indicated that DO water quality standards are now being attained in Town Creek.

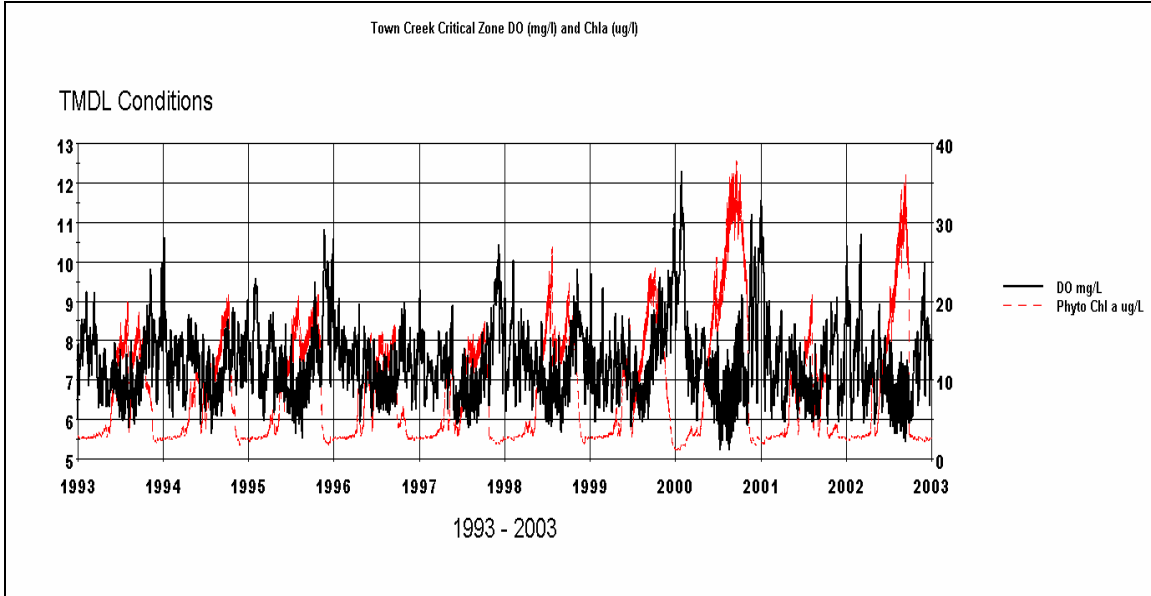


Figure 5. Predicted DO and Chl *a* Concentrations for TMDL Conditions

Figure 5 shows that the DO improved to meet the 5.0 mg/l water quality standard and the resultant Chl *a* values with a 50 percent reduction in all nutrient loads from non-point sources and significant NPDES facilities set at effluent concentrations of 2 and 0.2 for TN and TP, respectively. Table 12 presents TN, TP, and Chl *a* concentrations for existing and TMDL conditions at the critical zone in the Town Creek model.

Table 12. Instream Nutrient and Chl *a* concentrations for Existing and TMDL Conditions

	Annual Average TN (mg/l)	Annual Average TP (mg/l)	Growing Season Chl <i>a</i> (µg/l)
Existing Conditions at Critical Zone	3.8	1.5	60
TMDL Conditions at Critical Zone	0.7	0.1	20

### 4.1 Wasteload Allocation

Facilities regulated by the NPDES program (including MS4 areas, if any) are assigned a WLA. The WLAs are expressed separately for continuous discharge facilities (e.g., waste water treatment plants) and MS4 areas, as the former discharges during all weather conditions, and the latter discharges in response to storm events. There are no MS4 areas in the Town Creek watershed.

The WLAs for Town Creek require reductions of TN, including ammonia, TP, and BOD<sub>5</sub> to achieve the water quality standard for DO, and in-stream nutrient Chl *a* concentrations assumed to be protective of aquatic health for this system. The WLA for the facilities is

based upon the facilities continuing to meet the daily minimum DO limitation currently required by their permit. In the absence of facility specific nutrient data and a calibrated water quality model, the WLAs call for reductions of effluent concentrations from the significant dischargers presented in Table 4 to 10-2-0.2 in order to achieve water quality and protect aquatic life in Town Creek. EPA recommends that the State conduct effluent discharge studies in order to verify the targets proposed in the TMDL. As previously noted, the TMDL provides WLAs for BOD based on modeling results, not on in-stream DO data that indicated that DO water quality standards are now being attained in Town Creek.

## **4.2 Load Allocation**

The primary mode for transport of nutrients to streams is during a storm event. Modification of the land surface from a pervious land cover to an impervious surface results in higher peak flow rates that wash nutrient enriched water into the stream. The load allocation calls for reductions in average annual nutrient loadings from non-point sources throughout the watershed equal to the percent reductions provided in Table 11. These reductions are expected to allow DO concentrations to continue to meet standards and nutrient loads to attain the targets.

## **4.3 Determination of Watershed Load Reductions**

The TMDL scenario was achieved by reducing effluent concentrations from the NPDES facilities to 10-2-0.2 and a 50 percent reduction from nonpoint sources. Best management practices (BMPs) should be encouraged in the watershed to reduce potential TN and TP loads from non-point sources. The watershed should be considered a priority for riparian buffer zone restoration and other nutrient reduction BMPs. For land disturbing activities related to silviculture, construction, and agriculture, it is recommended that practices, as outlined in *Mississippi's BMPs: Best Management Practices for Forestry in Mississippi* (MFC, 2000), *Planning and Design Manual for the Control of Erosion, Sediment, and Stormwater* (MDEQ, et. al, 1994), and *Field Office Technical Guide* (NRCS, 2000), be followed, respectively.

## **4.4 Margin of Safety**

TMDLs shall include a margin of safety (MOS) that takes into account any lack of knowledge about the pollutant loading and in-stream water quality. In this case the measured water quality was used directly to determine the reduction to meet the water quality standard. In this case the lack of knowledge concerns the data, and how well it represents the true water quality. There are two methods for incorporating a MOS in the analysis: 1) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or 2) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. An implicit MOS was incorporated in the analyses through the use of conservative modeling assumptions.

## **4.5 Critical Conditions and Seasonal Variation**

The critical conditions can be defined as the environmental conditions requiring the largest reduction to meet standards. By achieving the reduction for critical conditions, water quality standards should be achieved during all other times. Critical conditions are accounted for in the water quality model by selecting the segment requiring the greatest reductions in pollutant loads. By targeting this segment for reductions all other segments in the model meet water quality standards. Seasonal variation must also be considered to ensure that water quality standards will be met during all seasons of the year. Seasonal variation was considered by targeting the growing season as this is when the greatest nutrient loadings enter the creek. In addition, the model scenario used a time period of ten years and accounts for numerous seasons.

## 5.0 CONCLUSION

The TMDL allocations proposed for Town Creek are the result of a water quality model scenario developed by EPA for the impaired streams. Point and non-point source contributions were reduced in the WASP model so that simulated DO concentrations continued to achieve water quality standards and simulated in-stream TN and TP concentrations reflected Ecoregion 65 target levels. In recognition of the lack of data available for Town Creek as well as the absence of numeric nutrient criteria for these waters, EPA is asking for comments on the approach used in this report to determine the TMDL.

In the absence of facility specific nutrient data and a calibrated water quality model, the WLAs call for reductions of effluent concentrations from the significant dischargers presented in Table 4 to 10-2-0.2 in order to achieve water quality and protect aquatic life in Town Creek. EPA recommends that the State conduct effluent discharge studies in order to verify the targets proposed in the TMDL. As previously noted, the TMDL provides WLAs for BOD based on modeling results, not on in-stream DO data that indicated that DO water quality standards are now being attained in Town Creek.

The TMDL calls for a 50% reduction in nonpoint source loads of BOD, TN and TP. It is recommended that Town Creek be considered as a priority for riparian buffer zone restoration and other nutrient reduction BMPs. Implementation of these BMPs should reduce the nutrient load entering the creek. This will provide improved water quality for the support of aquatic life in the waterbodies and will result in the attainment of the applicable water quality standards.

### 5.1 Public Participation

This draft TMDL is being proposed for public review and comment for a 30-day period. The EPA is notifying the public by publishing a notice of the TMDL through a legal ad in the statewide newspaper, the Clarion-Ledger. EPA is also providing an e-mail to members of the public who have requested that MDEQ include them on a TMDL mailing list. The TMDL is also available for review and comment on EPA Region 4's website: (<http://www.epa.gov/Region4/water/tmdl/mississippi/>).

The public may request a copy of the TMDL report by mail from:

Attention: Ms Sibyl Cole,  
U.S. EPA Region 4, Water Management Division  
61 Forsyth Street, S.W.  
Atlanta, Georgia 30303

The public may also submit comments by mail at the address listed above or by email at [cole.sibyl@epa.gov](mailto:cole.sibyl@epa.gov) or by phone at 404-562-9437. All comments received during the public notice period will become a part of the public record for this TMDL.

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