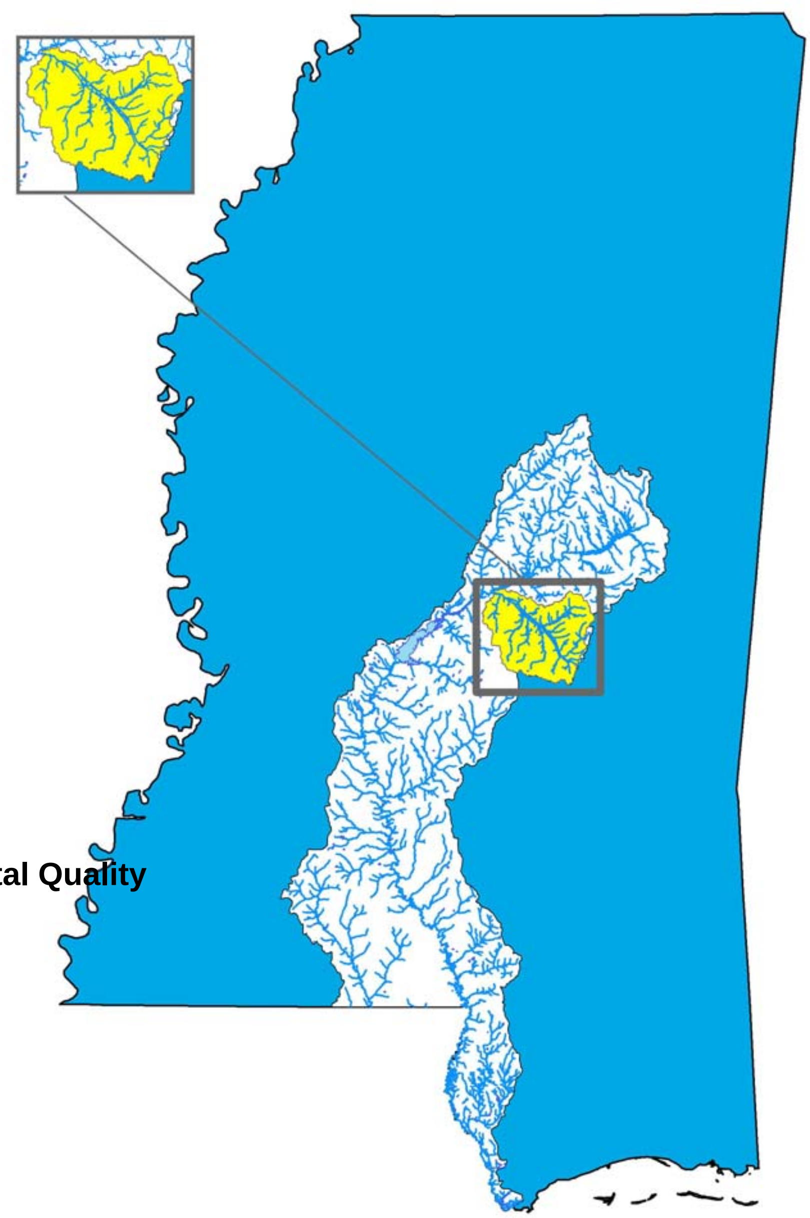
FINAL REPORT
June 2009
509062904

# Total Maximum Daily Load

## Nutrients and Organic Enrichment / Low Dissolved Oxygen For Tuscolameta, Tallabogue, and Shockaloo Creeks



# Pearl River Basin

## Scott and Leake Counties, Mississippi

**Prepared By**

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# FOREWORD

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

The amount and quality of the data on which this report is based are limited. As additional information becomes available, the TMDLs may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, or changes in landuse within the watershed. In some cases, additional water quality data may indicate that no impairment exists.

**Conversion Factors**

| To convert from | To | Multiply by | To convert from | To | Multiply by |
|---|---|---|---|---|---|
| $mile^2$ | acre | 640 | acre | $ft^2$ | 43560 |
| $km^2$ | acre | 247.1 | days | seconds | 86400 |
| $m^3$ | $ft^3$ | 35.3 | meters | feet | 3.28 |
| $ft^3$ | gallons | 7.48 | $ft^3$ | gallons | 7.48 |
| $ft^3$ | liters | 28.3 | hectares | acres | 2.47 |
| cfs | gal/min | 448.8 | miles | meters | 1609.3 |
| cfs | MGD | 0.646 | tonnes | tons | 1.1 |
| $m^3$ | gallons | 264.2 | µg/l * cfs | gm/day | 2.45 |
| $m^3$ | liters | 1000 | µg/l * MGD | gm/day | 3.79 |

| Fraction | Prefix | Symbol | Multiple | Prefix | Symbol |
|---|---|---|---|---|---|
| $10^{-1}$ | deci | d | 10 | deka | da |
| $10^{-2}$ | centi | c | $10^2$ | hecto | h |
| $10^{-3}$ | milli | m | $10^3$ | kilo | k |
| $10^{-6}$ | micro | 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 |

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**Table 1. Listing Information**

| Name | ID | County | HUC | Cause |
|---|---|---|---|---|
| **Tuscolameta Creek** | MS144E | Scott, Leake | 03180001 | Nutrients and Organic Enrichment / Low DO |
| Near Walnut Grove from confluence of Big and Little Canal to the Pearl River | | | | |
| **Tallabogue Creek** | MS142E1 | Scott | 0318001 | Nutrients and Organic Enrichment / Low DO |
| Near Forest from Headwaters to the confluence with Little Canal | | | | |
| **Shockaloo Creek** | MS143E | Scott | 0318001 | Nutrients and Organic Enrichment / Low DO |
| Near Forest from Headwaters to the confluence with Little Canal | | | | |

**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 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 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. Natural conditions are defined as background water quality conditions due only to non-anthropogenic sources. The criteria herein apply specifically with regard to substances attributed to sources (discharges, nonpoint sources, or instream activities) as opposed to natural phenomena. Waters may naturally have characteristics outside the limits established by these criteria. Therefore, naturally occurring conditions that fail to meet criteria should not be interpreted as violations of these criteria. |

**Table 3. Total Maximum Daily Load for Tuscolameta Creek**

| | WLA lbs/day | LA lbs/day | MOS | TMDL lbs/day |
|---|---|---|---|---|
| Total Nitrogen | **1419.42** | **1341.81** | **Implicit** | **2761.23** |
| Total Phosphorous | **387.76** | **6.70** | **Implicit** | **394.46** |
| TBODu | **1304.32** | **66.09** | **Implicit** | **1370.41** |

**Table 4. Point Sources in the Tuscolameta Creek Watershed**

| Permit | Facility | Flow MGD | TBODu lbs/day |
|---|---|---|---|
| **MS0049034** | **100 Travel Center** | **0.0020** | **1.10** |
| **MS0025194** | **Lake POTW** | **0.12** | **6.34** |
| **MS0020362** | **Forest POTW** | **4.9** | **938.47** |
| **MS0048194** | **The Sawmill Restaruant** | **0.0035** | **1.83** |
| **MS0056103** | **Lady Forest Farms Inc., Forest Hatchery** | **0.0198*** | **5.70** |
| **MS0020982** | **Walnut Grove POTW** | **0.194** | **85.46** |
| **MS0046931** | **Tyson Foods Inc., River Valley Animal Foods, Forest** | **0.6096*** | **173.71** |
| **MS0026727** | **Sebastapol Water Association** | **0.0750** | **15.09** |
| **MS0002615** | **Peco Farms of Mississippi, LLC** | **0.8956*** | **62.36** |
| **MS0038393** | **Scott Central Attendance Center** | **0.025** | **14.26** |
| | **Total** | | **1304.32** |

*Long-term Average Flow

# EXECUTIVE SUMMARY

This TMDL has been developed for Shockaloo, Tallabogue, and Tuscolameta Creeks which were placed on the Mississippi 2008 Section 303(d) List of Impaired Water Bodies. Tuscolameta and Tallabogue Creeks were originally listed as evaluated on the 1996 §303(d) List of Impaired Waters. Shockaloo Creek was listed as monitored on the 1996 List. The water bodies remained on the 1998 §303(d) List. The MDEQ Mississippi Benthic Index of Stream Quality (M-BISQ) project (MDEQ 2003), which began in 2001, provided the biological data used in water quality assessment and stressor identification for this water body. A stressor identification report indicated that organic enrichment / low dissolved oxygen, nutrients, and sediment were the primary probable stressors for the stream. Sediment will be addressed in a separate TMDL report. This TMDL will provide an estimate of the total biochemical oxygen demand (TBODu), total nitrogen (TN), and total phosphorus (TP) allowable in this water body.

Mississippi does not have water quality standards for allowable nutrient concentrations. MDEQ currently has a Nutrient Task Force (NTF) working on the development of criteria for nutrients. An annual concentration of 0.7 mg/l is an applicable target for TN and 0.10 mg/l for TP for water bodies located in ecoregion 65. MDEQ is presenting these preliminary target values for TMDL development which are subject to revision after the development of numeric nutrient criteria.

The Tuscolameta Creek Watershed is located in HUC 03180002. This larger watershed also contains the watershed of two additional §303(d) listed segments; Tallabogue Creek and Shockaloo Creek. The listed portion of Tuscolameta Creek is near Forest from the confluence of Big and Little Canal to the Pearl River. The listed portions of Tallabogue and Shockaloo Creeks extend from their respective headwaters to the confluence with Little Canal. The location of the watershed and the §303(d) listed segments are shown in Figure 1.

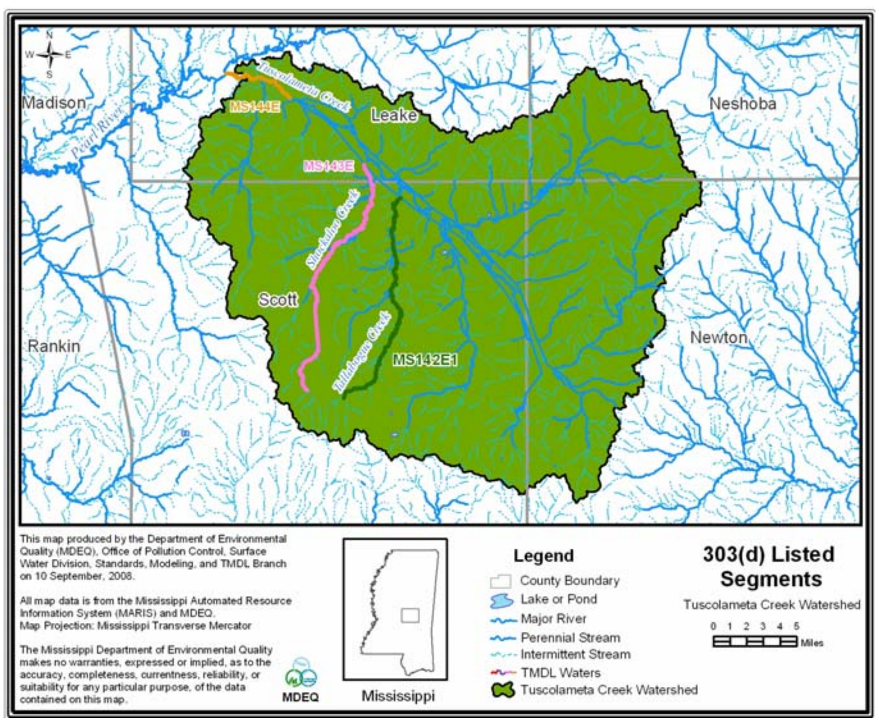



**Figure 1. Tuscolameta Creek Watershed and 303(d) Listed Segments**

The Tuscolameta Creek watershed mass balance calculations showed that the estimated existing TP and TN concentrations indicate reductions of nutrients are needed. According to the STREAM model, the current TBODu load in the water body exceeds the assimilative capacity of some water bodies in the watershed for organic material at critical conditions. Therefore, permit limits for TN, TP and TBODu are recommended in order to protect water quality. There are currently 10 NPDES permitted facilities in the watershed. MDEQ believes that a significant reduction in TN and TP are necessary.

# 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 §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 2008 §303(d) listed segments shown in Figure 1.

## 1.2 Listing History

Tuscolameta Creek (MS144E), Shockaloo Creek (MS143E) and Tallabogue Creek (MS142E1) are listed on the Mississippi 2008 §303(d) List of Water Bodies (MDEQ 2008) for impairment of aquatic life use support due to biological impairment. Tallabogue and Tuscolameta Creeks were listed as evaluated on the 1996 §303(d) List. Shockaloo Creek was listed as monitored for unionized ammonia, nutrients, organic enrichment/low DO, pH, temperature, oil & grease, and TSS based primarily on review of evaluated anecdotal information. The MDEQ Mississippi Benthic Index of Stream Quality (M-BISQ) project (MDEQ 2003), which began in 2001, provided the biological data used in water quality assessment and stressor identification for these water bodies. M-BISQ sampling from Phase 1 of the project (2001) indicated biological impairment for Shockaloo, Tallabogue, and Tuscolameta Creeks based on benthic community assemblage conditions. The U.S. Environmental Protection Agency (USEPA) Stressor Identification process (USEPA 2000) was used to identify most probable stressors causing biological impairment. Using this process Shockaloo, Tallabogue, and Tuscolameta Creeks were determined to be biologically impaired due to organic enrichment and nutrients. A stressor identification report was completed by MDEQ in 2008 and details the findings.

There are no state numeric criteria in Mississippi for nutrients. These numeric criteria are currently being developed by the Mississippi Nutrient Task Force in coordination with EPA Region 4. MDEQ proposed a work plan for numeric nutrient criteria development that has been mutually agreed upon with EPA Region 4 and is on schedule according to the approved timeline for development of numeric nutrient criteria (MDEQ, 2007).

## 1.3 Applicable Water Body Segment Use

The water use classifications are established by the State of Mississippi in the document *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (MDEQ, 2007). The designated beneficial use for the listed segments is Fish and Wildlife.

## 1.4 Applicable Water Body Segment Standards

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

*Waters* (MDEQ, 2007). Mississippi's current standards contain a narrative criteria that can be applied to nutrients which states "*Waters shall be free from materials attributable to municipal, industrial, agricultural, or other discharges producing color, odor, taste, total suspended or dissolved solids, sediment, turbidity, or other conditions in such degree as to create a nuisance, render the waters injurious to public health, recreation, or to aquatic life and wildlife, or adversely affect the palatability of fish, aesthetic quality, or impair the waters for any designated use* (MDEQ, 2007)."

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.

## 1.5 Nutrient Target Development

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*."

For this TMDL, MDEQ is presenting preliminary targets for TN and TP. An annual concentration 0.7 mg/l is an applicable target for TN and 0.1 mg/l for TP for water bodies located in ecoregion 65. However, MDEQ is presenting these preliminary target values for TMDL development which are subject to revision after the development of numeric nutrient criteria, when the work of the NTF is complete.

# WATER BODY ASSESSMENT

## 2.1 Water Quality Data

The impaired segments were monitored and found to be biologically impaired due to organic enrichment and nutrients. Based upon these completed stressor identification reports, the strength of evidence analysis showed low DO to be a primary probable cause of impairment for all three listed segments. Some biological metrics also indicated altered food sources (nutrient enrichment). Physical/chemical data from M-BISQ (Table 5) and quarterly monitoring (Table 6) indicate nutrients were elevated over the preliminary targets for TN and TP. Some potential sources exist in the watershed for this cause including urban runoff and chronic septic issues, point source discharges, and extensive hydrologic alteration (ponding) enabling minimal reaeration.

**Table 5. M-BISQ Chemical Data**

| Chemical Parameters | Tuscolameta Creek | Tallabogue Creek | Shockaloo Creek |
|---|---|---|---|
| Nitrate-Nitrite (mg/l) | 0.71 | 5.17 | 0.43 |
| Total Kjeldahl Nitrogen (mg/l) | 1.20 | 1.64 | 0.98 |
| Total Phosphorus (mg/l) | 0.49 | 1.00 | 0.15 |

**Table 6. Quarterly Monitoring Data**

| | Tuscolameta Creek (IBI #259) Period of Record: March 2004 – September 2005 | | | | Tallabogue Creek (IBI #323) Period of Record: April 2004 -- October 2005 | | | |
|---|---|---|---|---|---|---|---|---|
| Chemical Parameters | N | Max | Min | Mean | N | Max | Min | Mean |
| Nitrate-Nitrite (mg/l) | 4 | 3.07 | 0.61 | 1.4 | 4 | 57.9 | 0.15 | 16.5 |
| Total Kjeldahl Nitrogen (mg/l) | 8 | 1.28 | 0.55 | 0.9 | 7 | 1.51 | 0.94 | 1.2 |
| Total Phosphorus (mg/l) | 8 | 1.93 | 0.36 | 0.8 | 8 | 4.53 | 0.45 | 2.3 |

## 2.2 Assessment of Point Sources

There are 10 NPDES permitted point sources in the watershed included in the TMDL shown in Figure 2 below. Table 7 indicates the existing estimates of the BOD loads for the modeled outfalls at the maximum daily load scenario (See section 3.5.2).

**Table 7. BOD Loads from Point Sources**

| NPDES | Facility | Flow (MGD) | CBODu (lbs/day) | NBODu (lbs/day) | TBODu (lbs/day) |
|---|---|---|---|---|---|
| MS0049034 | 100 Travel Center | 0.002 | 0.73 | 0.37 | 1.10 |
| MS0025194 | Lake POTW | 0.12 | 43.66 | 14.78 | 58.44 |
| MS0020362 | Forest POTW | 4.9 | 939.69 | 373.42 | 1313.12 |
| MS0048194 | Sawmill Restaurant, The | 0.0035 | 1.21 | 0.62 | 1.83 |
| MS0056103 | Lady Forest Farms, Inc., Forest Hatchery* | 0.0198 | 4.18 | 1.53 | 5.70 |
| MS0020982 | Walnut Grove POTW | 0.194 | 72.77 | 36.95 | 109.71 |
| MS0046931 | Tyson Foods, Inc., River Valley Animal Foods, Forest* | 0.6096 | 127.20 | 46.50 | 173.71 |
| MS0026727 | Sebastopol Water Association | 0.075 | 9.38 | 5.71 | 15.09 |
| MS0002615 | Peco Farms of Mississippi, LLC* | 0.8956 | 112.06 | 34.14 | 146.20 |
| MS0038393 | Scott Central Attendance Center | 0.025 | 9.46 | 4.80 | 14.26 |
| | Total | | 1320.34 | 518.83 | 1839.16 |

*Long-Term Average Flows

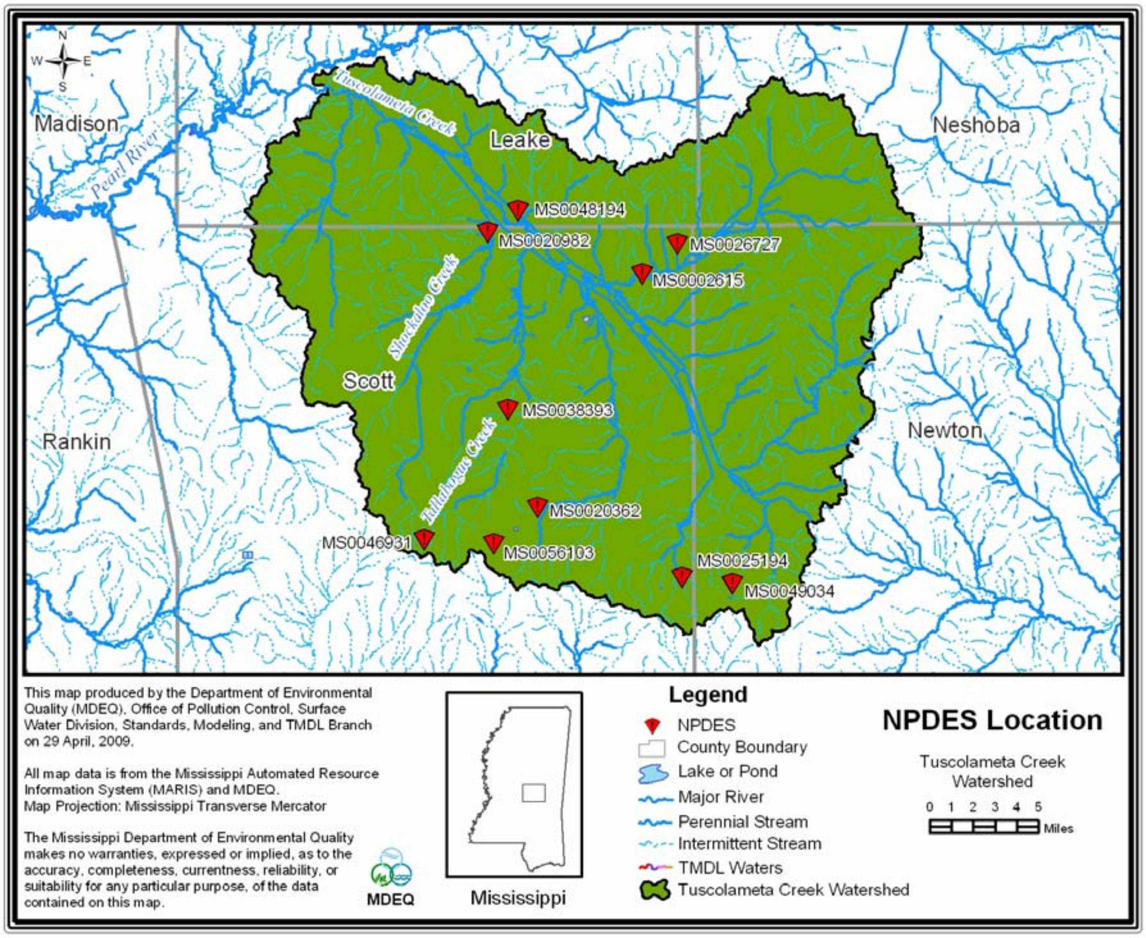



**Figure 2. NPDES Point Sources in the Tuscolameta Creek Watershed**

## 2.3 Assessment of Non-Point Sources

Non-point loading of nutrients and organic material in a water body results from the transport of the pollutants into receiving waters by overland surface runoff, groundwater infiltration, and atmospheric deposition. The two primary nutrients of concern are nitrogen and phosphorus. Total nitrogen is a combination of many forms of nitrogen found in the environment. Inorganic nitrogen can be transported in particulate and dissolved phases in surface runoff. Dissolved inorganic nitrogen can be transported in groundwater and may enter a water body from groundwater infiltration. Finally, atmospheric gaseous nitrogen may enter a water body 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 water body. All domestic wastewater contains phosphorus which comes from humans and the use of phosphate containing detergents (Shields, et. Al., 2008).

The watershed contains mainly forest land but also has different landuse types, including urban, water, and wetlands. The land use information for the watershed is based on the National Land Cover Database (NLCD). The landuse distribution for the Tuscolameta Creek Watershed is shown in Table 8 and Figure 3. Table 8 presents the estimated loads and the target loads to meet the TMDLs.

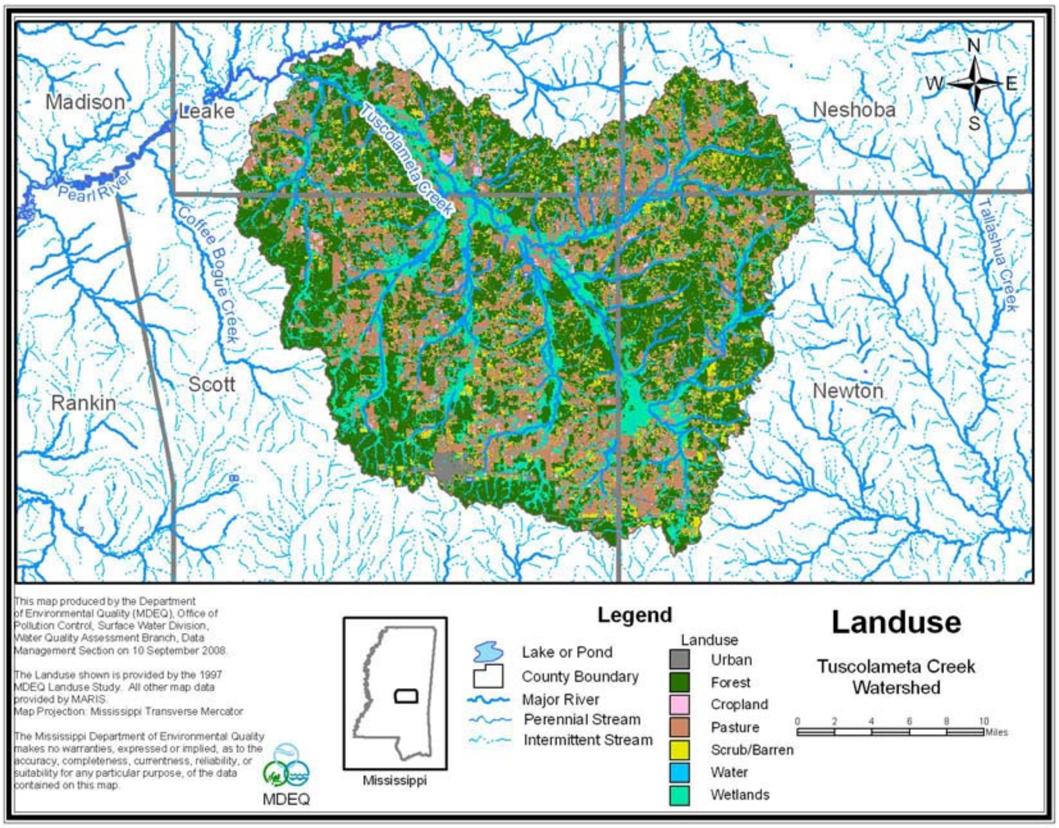



**Figure 3. Tuscolameta Creek Watershed Landuse**

## 2.4 Estimated Existing Load for Total Nitrogen and Total Phosphorus

The average annual flow in the watershed was calculated by utilizing the flow vs. watershed area graph shown in Figure 4. All available gages were compared to the watershed size. A very strong correlation between flow and watershed size was developed for the Pearl and South Independent Streams Basins. The equation for the line that best fits the data was then used to estimate the annual average flow for the Tuscolameta Creek watershed. The TMDL targets were calculated using Equation 1. Tuscolameta Creek was assessed as inconclusive but potentially impaired in 2001 as the score fell below the M-BISQ impairment threshold but above the reference condition minimum score for the bioregion. Three attempts were made to re-sample the site (2003, 2004, and 2005) but were unsuccessful due to high water during all three subsequent visits. The 2001 water quality data were used to estimate the existing load because this sample provides the only data that can be directly correlated to a biological sample.

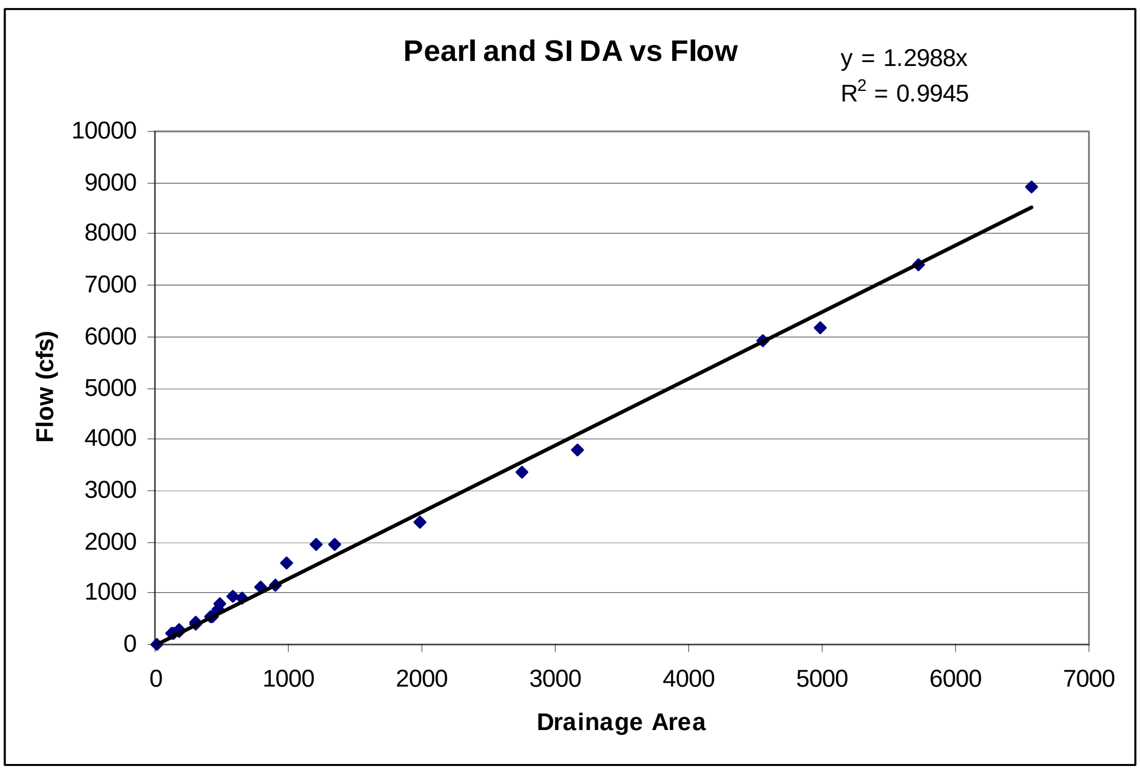



**Figure 4. Pearl and South Independent Drainage Area to Flow Comparison**

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

**Table 8. TMDL Calculations and Watershed Size**

| | Water | Urban | Scrub/Barren | Forest | Pasture/Grass | Cropland | Wetland | Total |
|---|---|---|---|---|---|---|---|---|
| Acres | 1617.9 | 17740.9 | 31940.1 | 162297.1 | 81724.1 | 5617.9 | 59417.0 | 360,355.0 |
| Percent | 0.45% | 4.92% | 8.86% | 45.04% | 22.68% | 1.56% | 16.49% | 100.00% |
| $Miles^2$ in watershed | 2.5 | 27.7 | 49.9 | 253.6 | 127.7 | 8.8 | 92.8 | 563.1 |
| Flow in cfs based on area | 731.3 | cfs | | | | | | |
| | | | | | | | | |
| TN target concentration | 0.7 | mg/l | | | | | | |
| TP target concentration | 0.1 | mg/l | | | | | | |
| | | | | | | | | |
| TN target load | 2761.23 | lbs/day | | | | | | |
| TP target load | 394.46 | lbs/day | | | | | | |
| TBODu target load | 1370.41 | lbs/day | based on STREAM model output | | | | | |
| | | | | | | | | |
| TN existing concentration | 1.91 | mg/l | | | | | | |
| TP existing concentration | 0.49 | mg/l | | The land use calculations are based on 2004 data. The TMDL targets are based on EPA guidence for calculation of targets when considering all available data. | | | | |
| | | | | | | | | |
| TN reduction needed | 63.00% | | | | | | | |
| TP reduction needed | 80.00% | | | | | | | |
| TBOD reduction needed | 29.00% | | | | | | | |

# 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.

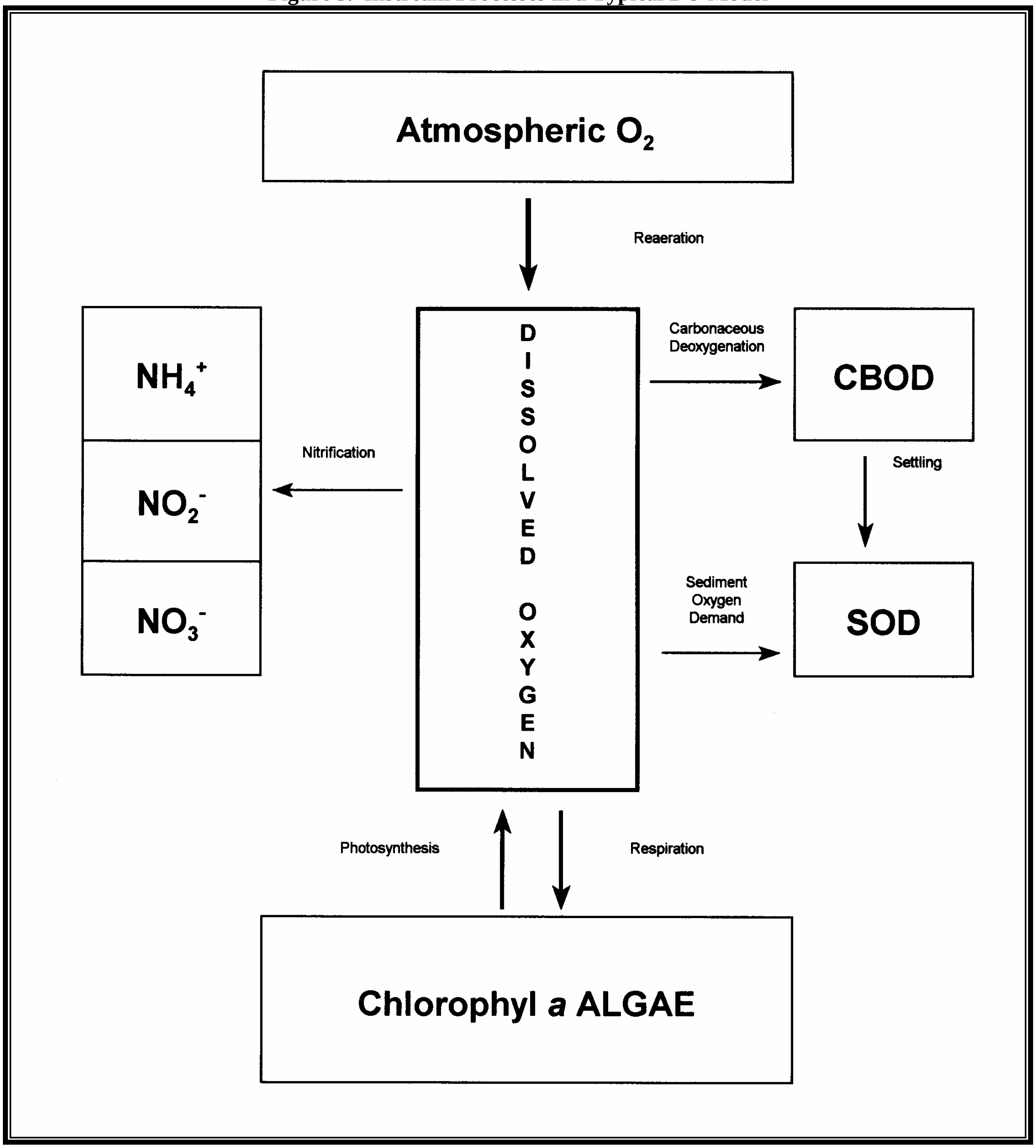
STREAM is a steady-state, daily average computer model that utilizes a modified Streeter-Phelps DO sag equation. Instream processes simulated by the model include CBODu decay, nitrification, reaeration, sediment oxygen demand, and respiration and photosynthesis of algae. Figure 5 shows how these processes 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 with the NHD Plus GIS coverage and input into the model in units of feet/mile.

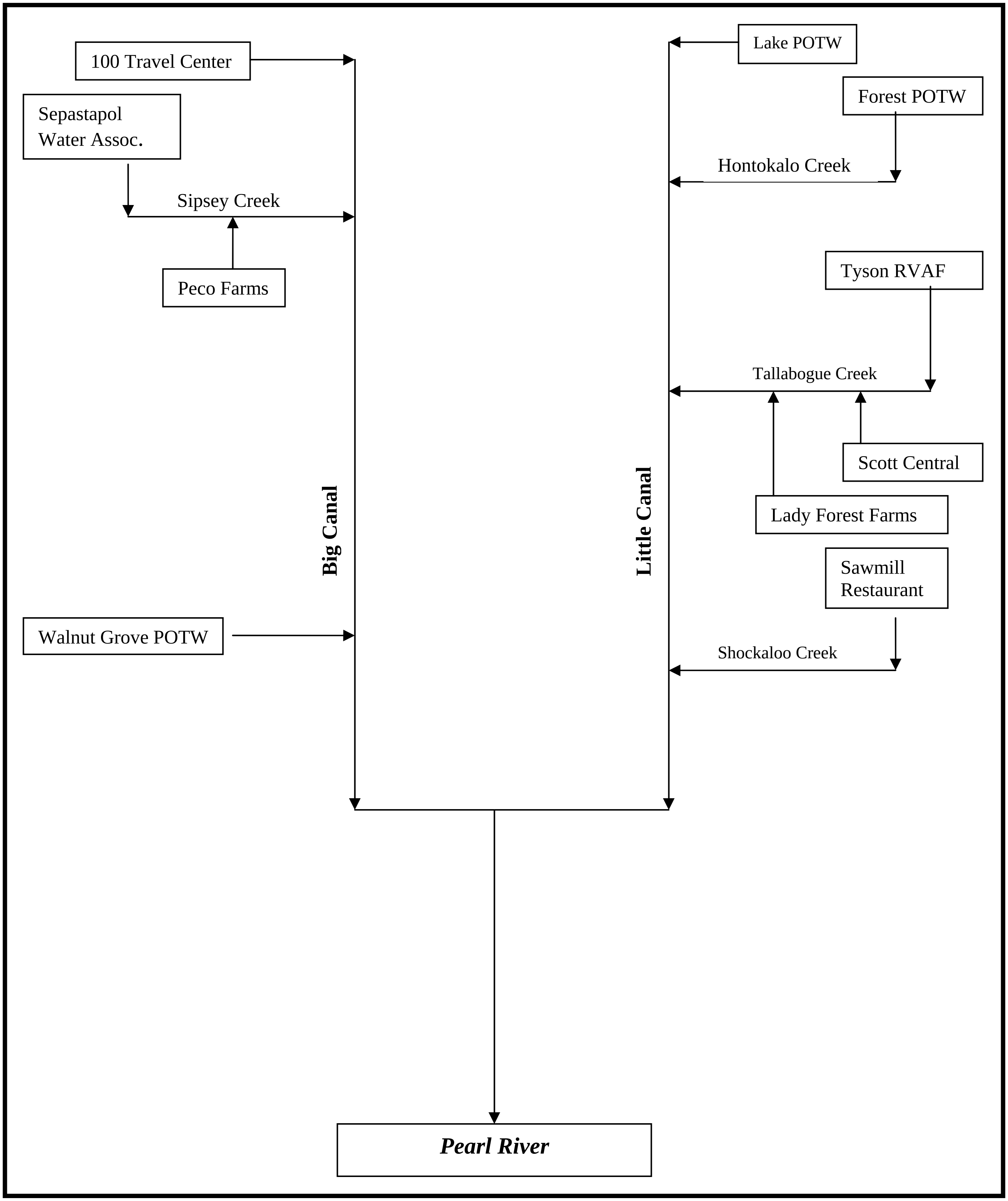
**Figure 5. Instream Processes in a Typical DO Model**




## Model Setup

The model for this TMDL includes the §303(d) listed segments of Tuscolameta Creek, Tallabogue Creeks, and Shockaloo Creek beginning at the headwaters. This a conservative measure that simulates the input of both point and non-point sources at the same location. The model also includes tributaries that receive discharge from point sources. A diagram showing the model setup is shown in Figure 6.

**Figure 6. Tuscolameta Creek Model Setup (Note: Not to Scale)**



Each 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.

Tuscolameta Creek currently has a continuous USGS flow gage. The flow in Tuscolameta Creek watershed was modeled at critical conditions based on the 7Q10 from this gage which is listed in the USGS Water-Resources Investigation Report 90-4130 *Low-Flow and Flow Duration Characteristics of Mississippi Streams* (Telis, 1991).

## Source Representation

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

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 $CBOD_5$ while TMDLs are typically developed using CBODu, a ratio between the two terms is needed, Equation 4.

$$\textbf{CBODu} = \textbf{CBOD}_5 * \textbf{Ratio} \qquad \textbf{(Eq. 4)}$$

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 permitted loads of TBODu from the existing point sources to be used in the STREAM model are given in Table 9.

**Table 9. Point Sources, Maximum Permitted Model Inputs**

| NPDES | Facility | Flow (MGD) | CBODu (lbs/day) | NBODu (lbs/day) | TBODu (lbs/day) |
|---|---|---|---|---|---|
| MS0049034 | 100 Travel Center | 0.002 | 0.73 | 0.37 | 1.10 |
| MS0025194 | Lake POTW | 0.12 | 43.66 | 14.78 | 58.44 |
| MS0020362 | Forest POTW | 4.9 | 939.69 | 373.42 | 1313.11 |
| MS0048194 | Sawmill Restaurant, The | 0.0035 | 1.21 | 0.62 | 1.83 |
| MS0056103 | Lady Forest Farms, Inc., Forest Hatchery* | 0.0198 | 4.17 | 1.53 | 5.70 |
| MS0020982 | Walnut Grove POTW | 0.194 | 72.76 | 36.95 | 109.71 |
| MS0046931 | Tyson Foods, Inc., River Valley Animal Foods, Forest* | 0.6096 | 127.20 | 46.51 | 173.71 |
| MS0026727 | Sebastopol Water Association | 0.075 | 9.38 | 5.71 | 15.09 |
| MS0002615 | Peco Farms of Mississippi, LLC* | 0.8956 | 112.06 | 34.14 | 146.20 |
| MS0038393 | Scott Central Attendance Center | 0.025 | 9.46 | 4.80 | 14.26 |
| | Total | | 1320.34 | 518.82 | 1839.16 |

*Long-term average flow

Direct measurements of background concentrations of CBODu were not available for Tuscolameta Creek. Because there were no data available, the background concentrations of CBODu and $NH_3$-N were estimated based on *Empirical Stream Model Assumptions for*

*Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1994). According to these regulations, the background concentration used in modeling for $BOD_5$ is 1.33 mg/l and for $NH_3$-N is 0.1 mg/l. These concentrations were also used as estimates for the CBODu and $NH_3$-N levels of water entering the water bodies through non-point source flow and tributaries.

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

## 3.4 Model Calibration

The model used to develop the Tuscolameta Creek TMDL was not calibrated due to the limited amount of instream monitoring data collected during critical conditions. Future monitoring would be necessary 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 the modeled waterbodies. 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 the loads shown in Table 9.

### 3.5.1 Regulatory Load Scenario

As shown in the figures below, the model predicts that the DO does go below the standard of 5.0 mg/l using the permit based allowable loads in Hontokalo Creek, Little Canal, Sipsey Creek, and Big Canal. Thus reductions are needed to meet the current TMDL. The regulatory load scenario model results are shown in Figures 7-10 below.

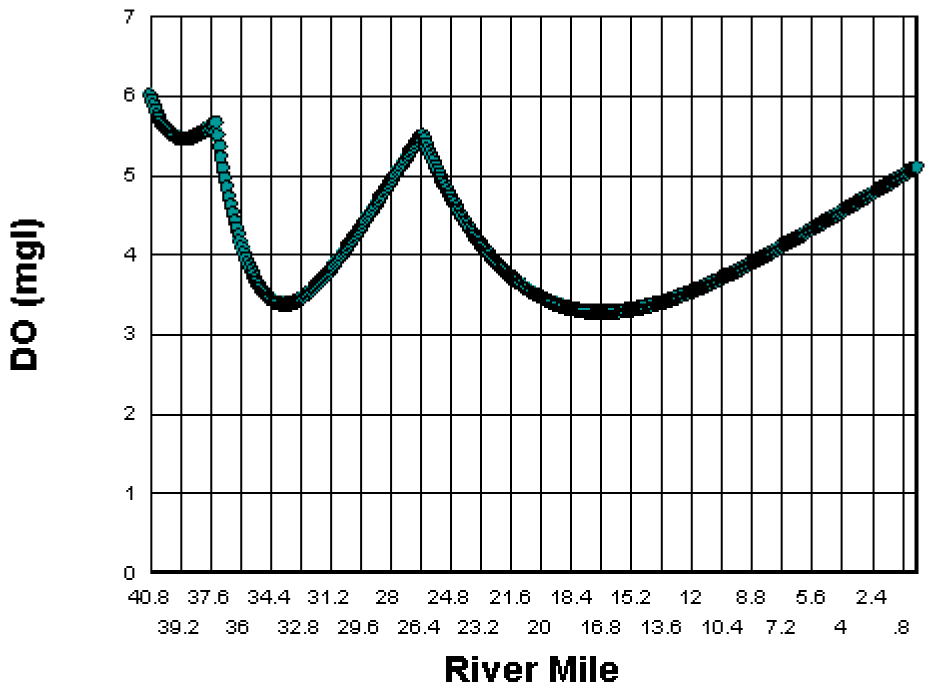



**Figure 7. Model Output for DO in Hontokalo Creek, Regulatory Load Scenario**

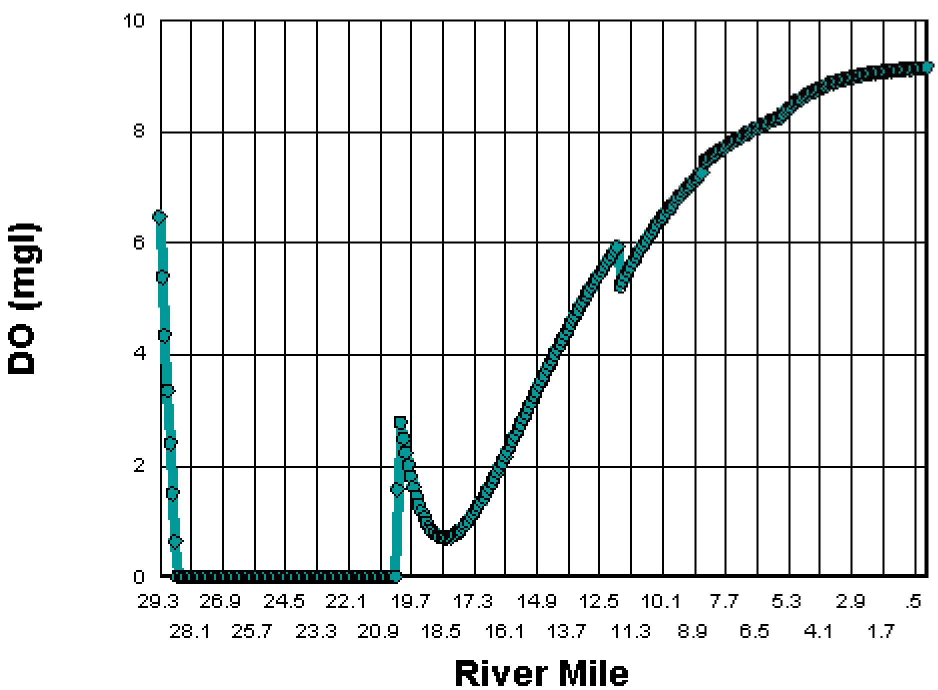



**Figure 8. Model Output for DO in Little Canal, Regulatory Load Scenario**

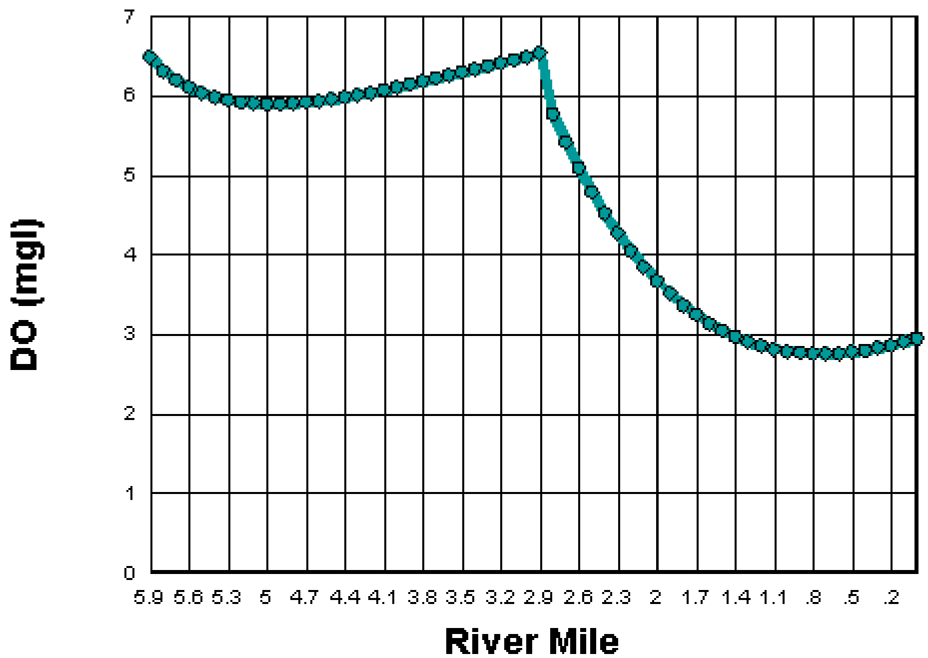



**Figure 9. Model Output for DO in Sipsey Creek, Regulatory Load Scenario**

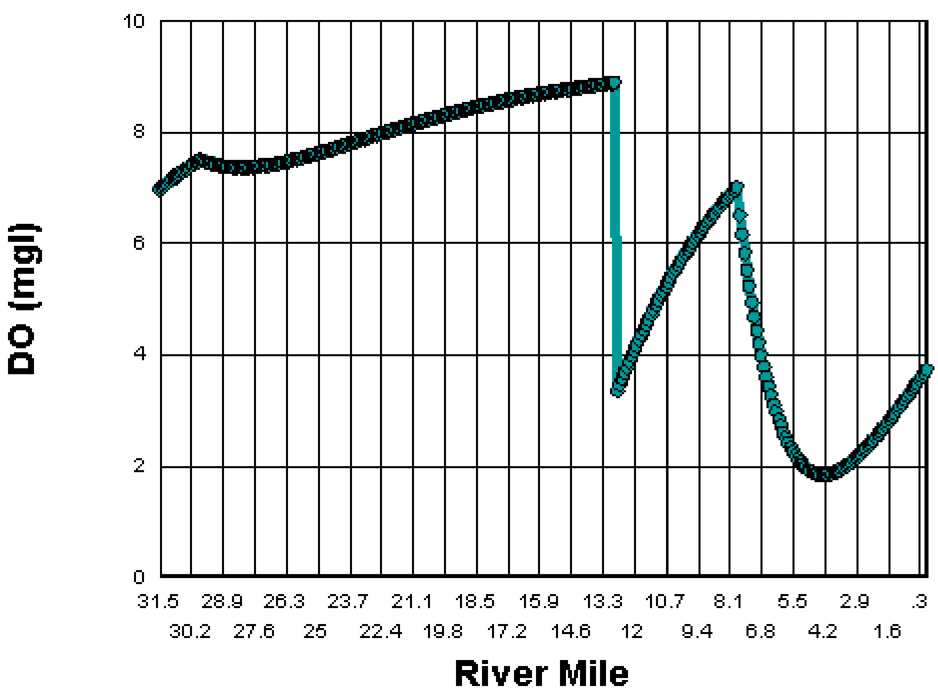



**Figure 10. Model Output for DO in Big Canal, Regulatory Load Scenario**

### Maximum Load Scenario

The graph of the regulatory load scenario output shows that the predicted DO does fall below the DO standard of 5.0 mg/l in Hontokalo Creek, Little Canal, Sipsey Creek, and Big Canal during critical conditions. Thus, reductions of the loads of TBODu are necessary. Calculating the maximum allowable load of TBODu involved decreasing the model input loads in the model until the modeled DO was 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 decreased until the modeled DO remained at or above 5.0 mg/L. The decreased loads were then used to develop the allowable maximum daily load for this report.

# ALLOCATION

## 4.1 Wasteload Allocation

The organic enrichment and nutrient TMDLs indicate that reductions are needed from the point sources to meet water quality standards for DO. TBODu load reductions from Forest POTW, Lake POTW, Walnut Grove POTW, and Peco Farms are necessary as shown in Table 9 below. While expressed in lbs/day below, inputs to the model are based on the following concentrations (CBOD-NBOD-DO); Forest POTW (8-1-6), Lake POTW (4-1-6), Walnut Grove POTW (20-5-6) and Peco Farms (5-1-6). These reductions are necessary to meet the water quality standard for DO of 5 mg/l as shown in Figures 11-14. To develop the TN and TP WLA's the in-stream nutrient concentrations were compared to the target concentrations. A 63% reduction in TN and an 80% reduction in TP are necessary to meet the target concentration. These reductions were then applied to develop the WLA. The TN calculations indicate a WLA of 1419.42 lbs/day. The TP calculations indicated a WLA of 387.76 lbs/day.

**Table 10. TMDL Loads for TBODu**

| NPDES | Facility | Flow (MGD) | CBODu (lbs/day) | NBODu (lbs/day) | TBODu (lbs/day) | % Reduction |
|---|---|---|---|---|---|---|
| MS0049034 | 100 Travel Center | 0.002 | 0.73 | 0.37 | 1.10 | -- |
| MS0025194 | Lake POTW | 0.12 | 3.38 | 2.96 | 6.34 | 89 |
| MS0020362 | Forest POTW | 4.9 | 751.75 | 186.71 | 938.47 | 29 |
| MS0048194 | Sawmill Restaurant, The | 0.0035 | 1.21 | 0.62 | 1.83 | -- |
| MS0056103 | Lady Forest Farms, Inc., Forest Hatchery* | 0.0198 | 4.17 | 1.53 | 5.70 | -- |
| MS0020982 | Walnut Grove POTW | 0.194 | 48.51 | 36.95 | 85.46 | 22 |
| MS0046931 | Tyson Foods, Inc., River Valley Animal Foods, Forest* | 0.6096 | 127.20 | 46.51 | 173.71 | -- |
| MS0026727 | Sebastopol Water Association | 0.075 | 9.38 | 5.71 | 15.09 | -- |
| MS0002615 | Peco Farms of Mississippi, LLC* | 0.8956 | 56.03 | 6.33 | 62.36 | 57 |
| MS0038393 | Scott Central Attendance Center | 0.025 | 9.46 | 4.80 | 14.26 | -- |
| | Total | | 1011.83 | 292.49 | 1304.32 | |

*Long-term Average

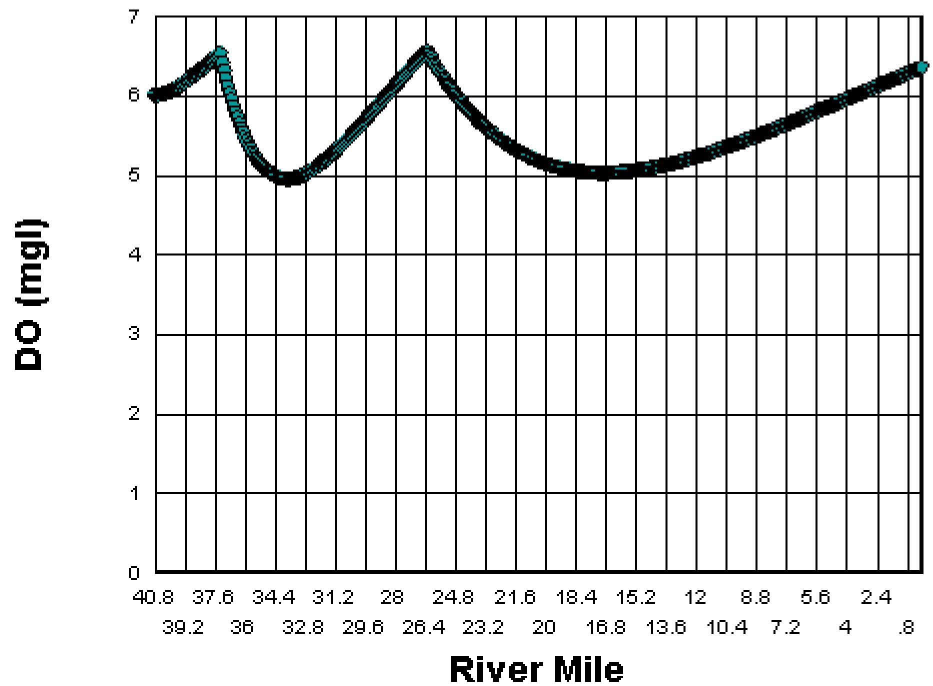



**Figure 11. Model Output for DO in Hontokalo Creek, Reduced Load Scenario**

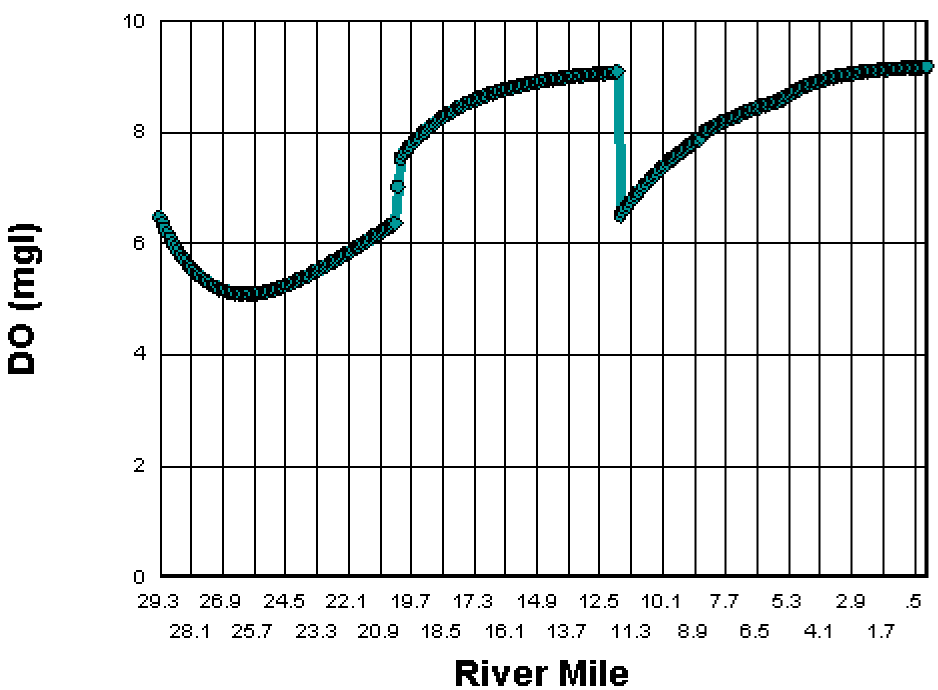



**Figure 12. Model Output for DO in Little Canal, Reduced Load Scenario**

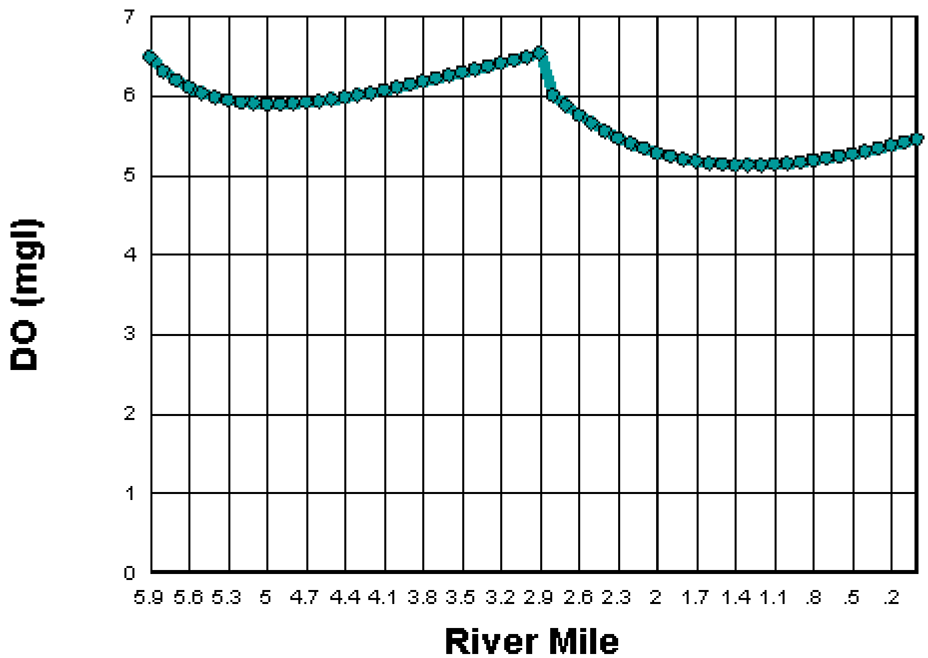



**Figure 13. Model Output for DO in Sipsey, Reduced Load Scenario**

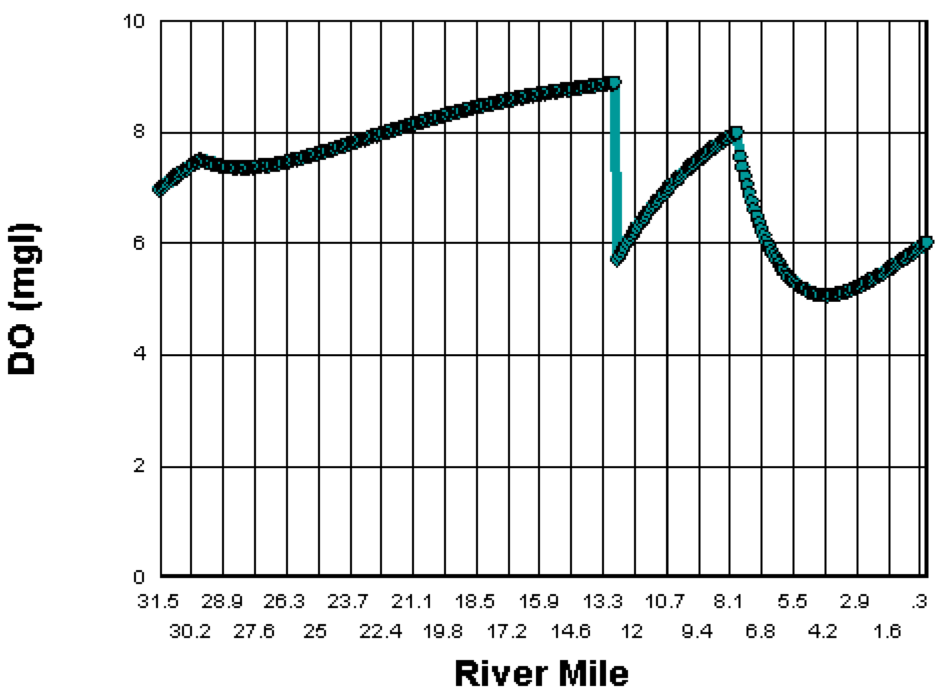



**Figure 14. Model Output for DO in Big Canal, Reduced Load Scenario**

## 4.2 Load Allocation

Best management practices (BMPs) should be encouraged in the watersheds to reduce potential TBODu, TN, and TP loads from non-point sources. The LA for TN and TP was calculated by subtracting the WLA from the TMDL. The LA for TBODu is shown in Table 10. 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 11. Load Allocation**

| | Flow (cfs) | CBODu (mg/L) | CBODu (lbs/day) | NH3-N (mg/L) | NBODu (lbs/day) | TBODu (lbs/day) |
|---|---|---|---|---|---|---|
| **Background Load** | **5.0** | **2** | **53.76** | **0.1** | **12.33** | **66.09** |
| | **Total** | | **1.01** | | **0.23** | **1.25** |

## 4.3 Incorporation of a Margin of Safety

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

## 4.4 Calculation of the TMDL

Equation 1 was used to calculate the TMDL for TP and TN (see Table 8). The target concentration was used with the average flow for the watershed to determine the nutrient TMDLs. The STREAM model was used to determine the TBODu TMDL necessary to meet the water quality standard for DO. The allocations for TN, TP, and TBODu are given in Table 12. These allocations are established to attain the applicable water quality standards.

**Table 12. TMDL Loads**

| | WLA lbs/day | LA lbs/day | MOS | TMDL lbs/day |
|---|---|---|---|---|
| Total Nitrogen | **1419.42** | **1341.81** | **Implicit** | **2761.23** |
| Total Phosphorous | **387.76** | **6.70** | **Implicit** | **394.46** |
| TBODu | **1304.32** | **66.09** | **Implicit** | **1370.41** |

The in-stream nutrient concentrations were compared to the target concentrations. A 63% reduction in TN and an 80% reduction in TP are recommended. The TN calculations indicate a WLA of 1419.42 lbs and a LA of 1341.81 lbs. This sums to a load of 2761.23 lbs/day. The TP calculations indicate a WLA of 387.76 lbs and a LA of 6.70 lbs in Table 11. This sums to a load of 394.46 lbs/day.

## 4.5 Seasonality and Critical Condition

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

# CONCLUSION

The model results indicate that Hontokalo Creek, Little Canal, Big Canal, and Sipsey Creek, are not meeting water quality standards for dissolved oxygen at the present loading of TBODu. A reduction from some of the facilities will be necessary to meet water quality standards. Nutrients were addressed through an evaluation of TP and TN concentrations and a preliminary TN and TP concentration target.

For the TMDL for TN, an overall 63% reduction is needed to meet the TN target. For the TMDL for TP, an overall 80% reduction is needed to meet the TP target. The implementation of BMP activities should also reduce the nutrient loads entering the creek. Best management practices are encouraged in this watershed to reduce the nonpoint nutrient loads.

## 5.1 Next Steps

MDEQ has initiated talks with the point sources and other stakeholders in the watershed that may be affected by the actions recommended in this TMDL. MDEQ intends to continue these discussions to insure an equitable distribution of the WLA during the TMDL Implementation Phase. MDEQ also believes that this reduction will address the elevated nutrient levels observed.

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 Pearl 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@deq.state.ms.us or Kay Whittington, MDEQ, PO Box 2261, Jackson, MS 39225. All comments received during the public notice period and at any public hearings become a part of the record of this TMDL and will be considered in the submission of this TMDL to EPA Region 4 for final approval.

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