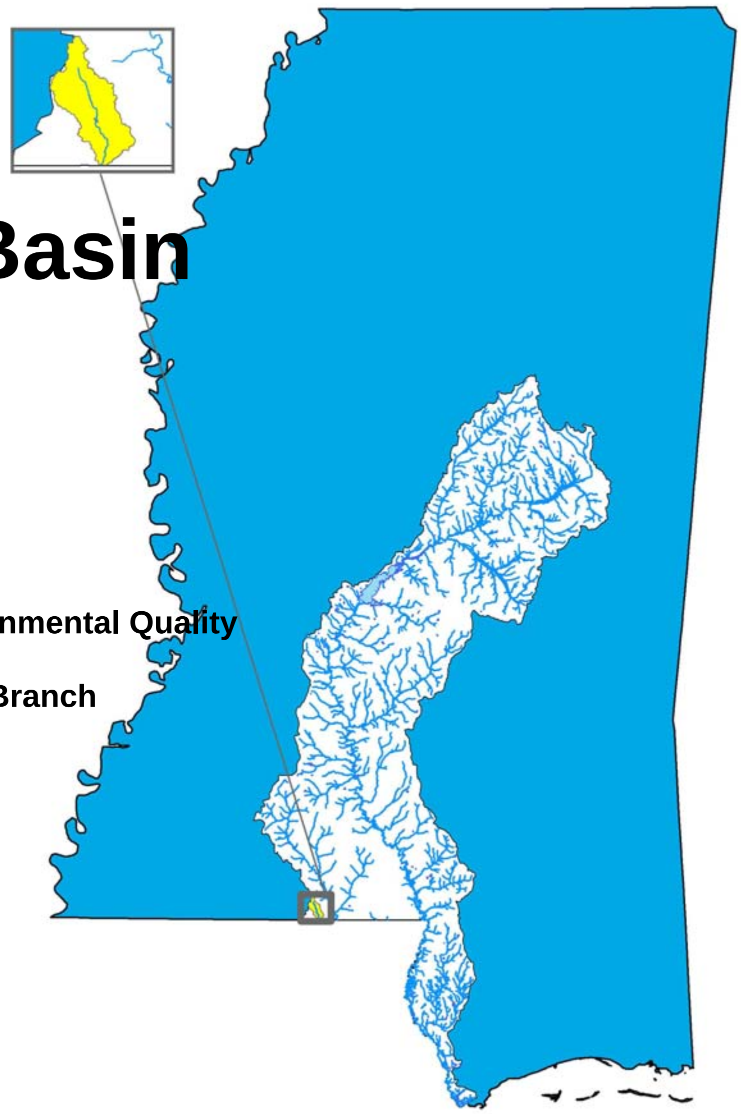
FINAL REPORT
June 2009
509062206

Total Maximum Daily Load
Nutrients and Organic Enrichment / Low DO For Silver Creek



Pearl River Basin
Pike County, Mississippi

Prepared By

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FOREWORD

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

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

Conversion Factors

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

Fraction	Prefix	Symbol	Multiple	Prefix	Symbol
10^{-1}	deci	d	10	deka	da
10^{-2}	centi	c	10^2	hecto	h
10^{-3}	milli	m	10^3	kilo	k
10^{-6}	micro	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	Evaluated Cause
Silver Creek	MS191SE	Pike	03180005	Nutrients and Organic Enrichment / Low DO
Near Smithburg from Headwaters to Louisiana				

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 Silver Creek

	WLA lbs/day	LA lbs/day	MOS	TMDL lbs/day
Total Nitrogen	**0.17**	**77.87**	**Implicit**	**78.04**
Total Phosphorous	**0.07**	**11.08**	**Implicit**	**11.15**
TBODu	**0.97**	**41.92**	**565.94**	**608.83**

Table 4. Point Source Loads for Silver Creek

Permit	Facility	Flow MGD	TN Load lbs/day	TP Load lbs/day	TBODu lbs/day
MS0045578	**Yale Headstart Center**	**0.0015**	**0.17**	**0.07**	**0.97**

EXECUTIVE SUMMARY

This TMDL has been developed for Silver Creek which was placed on the Mississippi 2008 Section 303(d) List of Impaired Water Bodies. Silver Creek was listed due to biological impairment. 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 Silver Creek Watershed is located in HUC 03180005. The listed portion of Silver Creek is near Smithburg from the headwaters to the Louisiana border. The location of the watershed for the listed segment is shown in Figure 1.

The Silver Creek Watershed evaluation indicated that the impairment is due to total phosphorus from nonpoint sources. The limited nutrient data and estimated existing ecoregion concentrations indicate reductions of phosphorus can be accomplished with installation of best management practices.

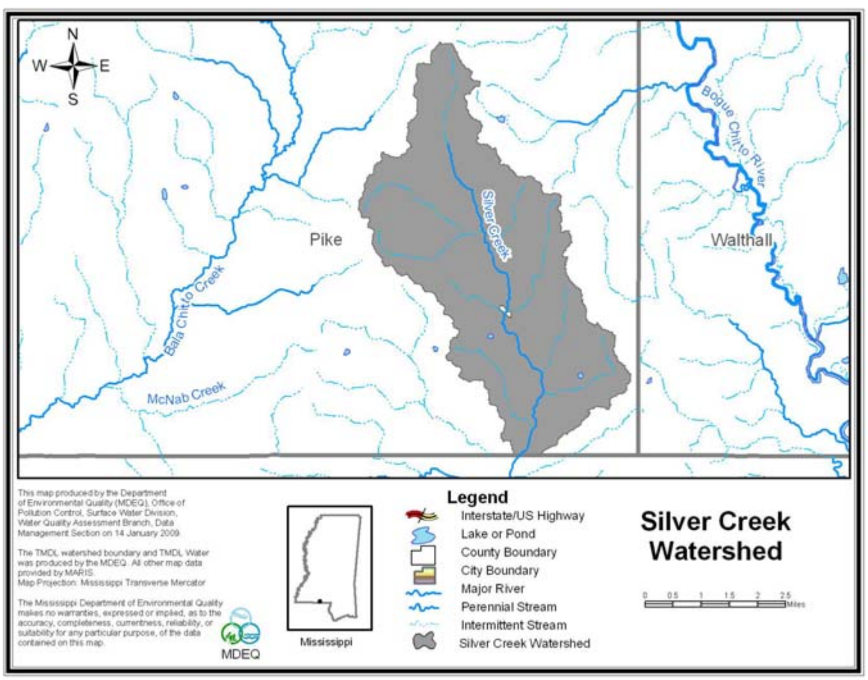


Figure 1. Silver Creek

INTRODUCTION

1.1 Background

The identification of water bodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those water bodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR part 130). The TMDL process is designed to restore and maintain the quality of those impaired water bodies through the establishment of pollutant specific allowable loads. This TMDL has been developed for the 2008 §303(d) listed segment shown in Figure 2.

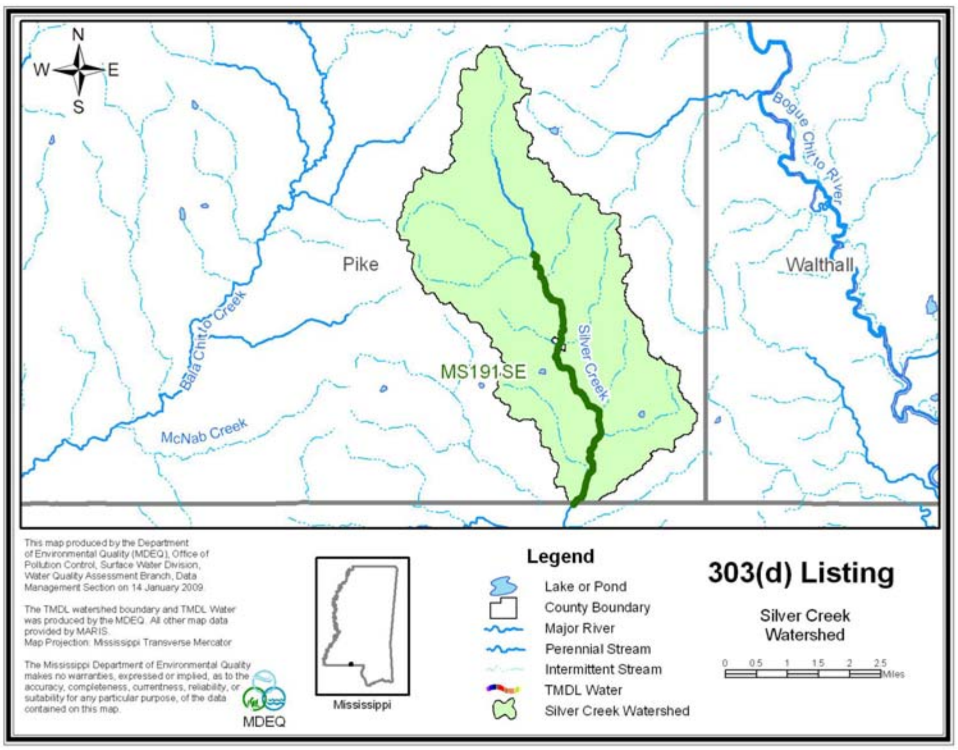


Figure 2. Silver Creek §303(d) Listed Segment

1.2 Listing History

In 2001, Silver Creek was monitored and found to be biologically impaired. A stressor identification report was completed by MDEQ in 2008 (MDEQ, 2008).

There are no state criteria in Mississippi for nutrients. These criteria are currently being developed by the Mississippi Nutrient Task Force in coordination with EPA Region 4. MDEQ proposed a work plan for nutrient criteria development that has been mutually agreed upon with EPA Region 4 and is on schedule according to the approved timeline for development of 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." In addition, the State water quality standard regulations include a natural condition clause which will be used to determine the appropriate DO for Silver Creek under critical conditions. 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.

1.5 Nutrient Target Development

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

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

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

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

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

For the preliminary target concentration range for each ecoregion, the 75th and 90th percentiles were derived from the mean nutrient value at each site found to be fully supporting of aquatic life support according to the M-BISQ scores. For the estimate of the existing concentrations the 50th percentile (median) was derived from the mean nutrient value at each site of sites that were not attaining and had nutrient concentrations greater than the target. For this report, only the 90th percentile was used.

WATER BODY ASSESSMENT

2.1 Water Quality Data

The impaired segment was monitored and found to be biologically impaired. Data exist for IBI Site 726. Based upon this completed stressor identification report, the strength of evidence analysis showed organic enrichment and nutrients to be the probable primary stressors. Physical/chemical data from M-BISQ and 2008 recon indicate low DO and DO% saturation measurements. Nutrients were slightly elevated over the Least Disturbed (LD)/Site Specific Comparators (SSC) reference site. No historical data are available. (MDEQ, 2008)

2.2 Assessment of Point Sources

There is 1 NPDES point source in the watershed included in the TMDL. Table 5 indicates the existing estimates of loads for this outfall at the maximum daily load scenario.

Table 5. Loads from Point Sources

NPDES	Facility	Flow (MGD)	TN Load (lbs/day)	TP Load (lbs/day)	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
MS0045578	**Yale Headstart**	**0.0015**	**0.17**	**0.07**	**0.86**	**0.11**	**0.97**

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. Table 5 presents the estimated loads from various land use types in the Pearl Basin based on information from USDA ARS Sedimentation Laboratory. (Shields, et. al., 2008)

The watershed contains mainly forest and pasture 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 Silver Creek Watershed is shown in Table 5 and Figure 3. By multiplying the landuse category size by the estimated nutrient load, the watershed specific estimate can be calculated. Table 6 presents the estimated loads, the target loads, and the reductions needed to meet the TMDLs.

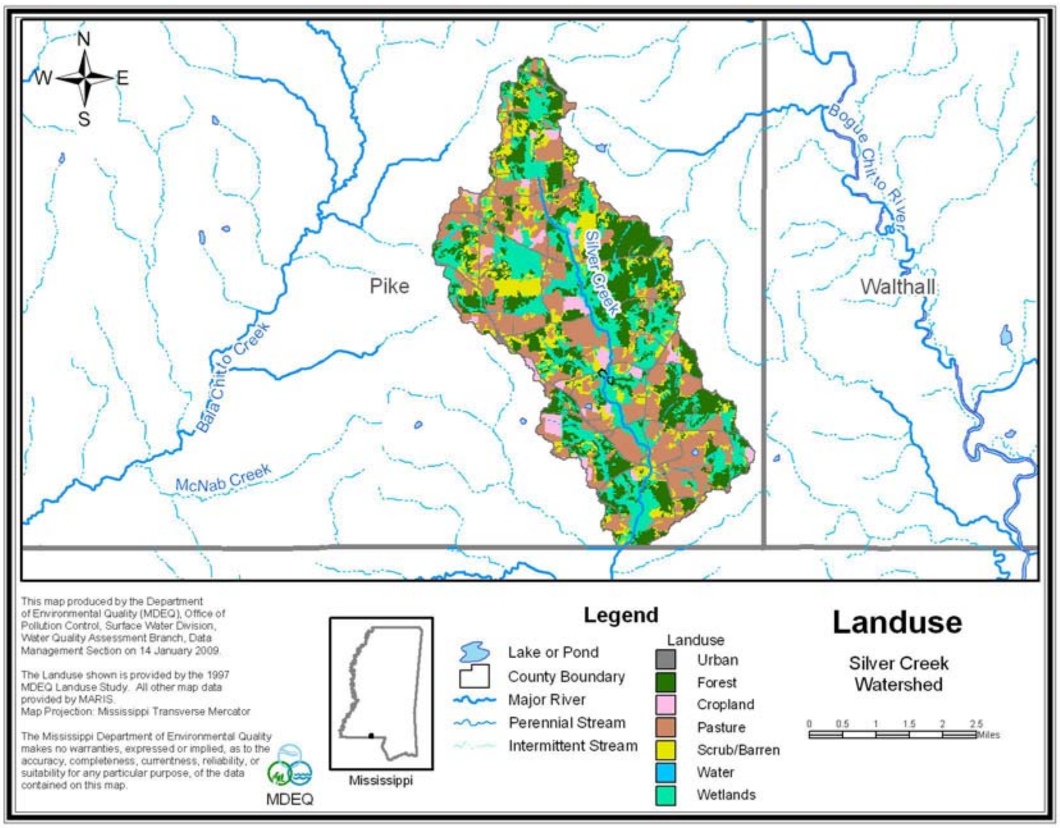
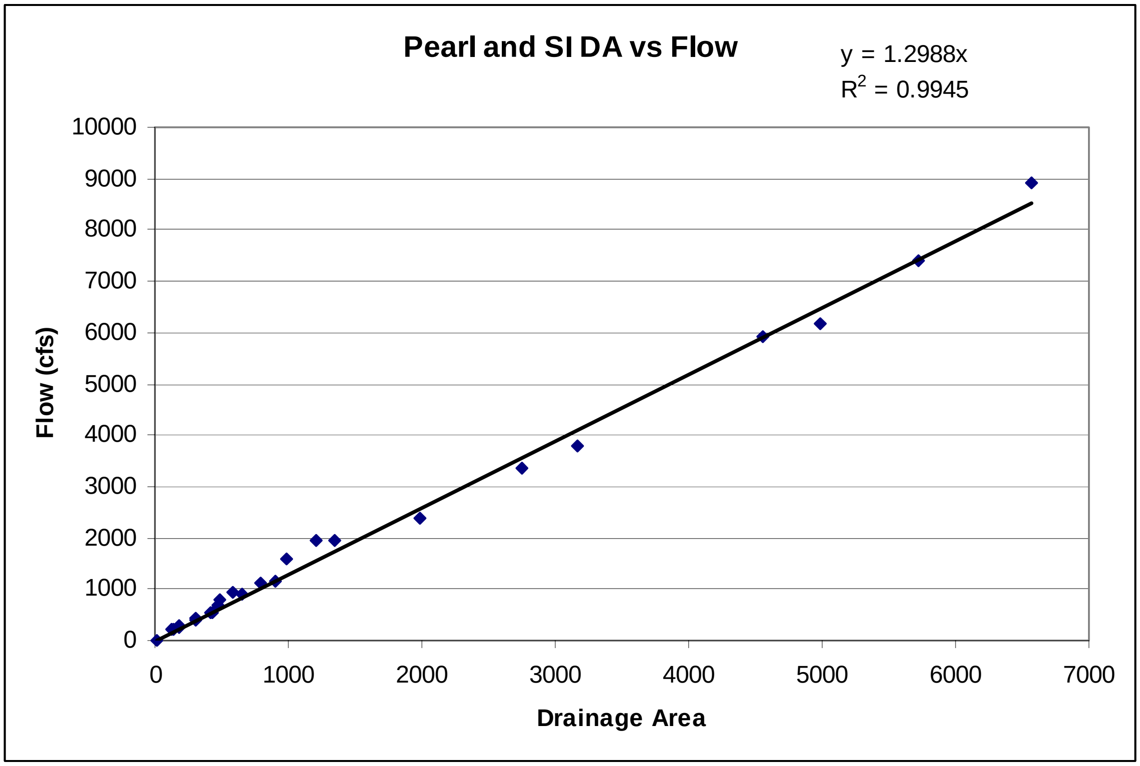


Figure 3. Silver Creek Watershed Landuse

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 below. 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 Silver Creek watershed. The TMDL target TN and TP loads were then calculated, using Equation 1 and the results are shown in Table 6.

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 6. TMDL Calculations and Watershed Sizes

Water body	**Silver Creek**

Land Use	**TN kg/mile2**
Forest	111.3
Pasture	777.2
Cropland	5179.9
Urban	296.4
Water	257.4
Wetland	265.2
aquaculture	111.3

Land Use	**TP kg/mile2**
Forest	62.1
Pasture	777.2
Cropland	2589.9
Urban	3.1
Water	257.4
Wetland	265.2
aquaculture	62.1

	Water	**Urban**	**Scrub/Barren**	**Forest**	**Pasture/Grass**	**Cropland**	**Wetland**	**Total**	
Acres	6.67	561.55	1469.14	2578.45	2761.92	388.08	2419.43	10185.24	
Percent	0.07	5.51	14.42	25.32	27.12	3.81	23.75	100.00	
$Miles^2$ in watershed	0.01	0.88	2.30	4.03	4.32	0.61	3.78	15.91	
Flow in cfs based on area	20.67	cfs							
TN Load kg/mi^2 annual avg	257.40	296.40	111.32	111.32	777.20	5179.90	265.20		
TP Load kg/mi^2 annual avg	257.40	3.12	62.10	62.10	777.20	2589.90	265.20		
TN Load kg/day	0.01	0.71	0.70	1.23	9.19	8.61	2.75	23.19	kg/day
TP Load kg/day	0.01	0.01	0.39	0.69	9.19	4.30	2.75	17.33	kg/day
TN target concentration	0.70	mg/l							
TP target concentration	0.10	mg/l							
TN estimated concentration	0.46	mg/l							
TP estimated concentration	0.34	mg/l							
TN target load	78.04	lbs/day							
TP target load	11.15	lbs/day							
TBODu target load	608.84	lbs/day	based on STREAM model output						
TN estimated load per day	51.13	lbs/day							
TP estimated load per day	38.20	lbs/day							
TN reduction needed	*NA*								
TP reduction needed	70.82%								

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

MODELING PROCEDURE: LINKING THE SOURCES TO THE ENDPOINT

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

3.1 Modeling Framework Selection

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

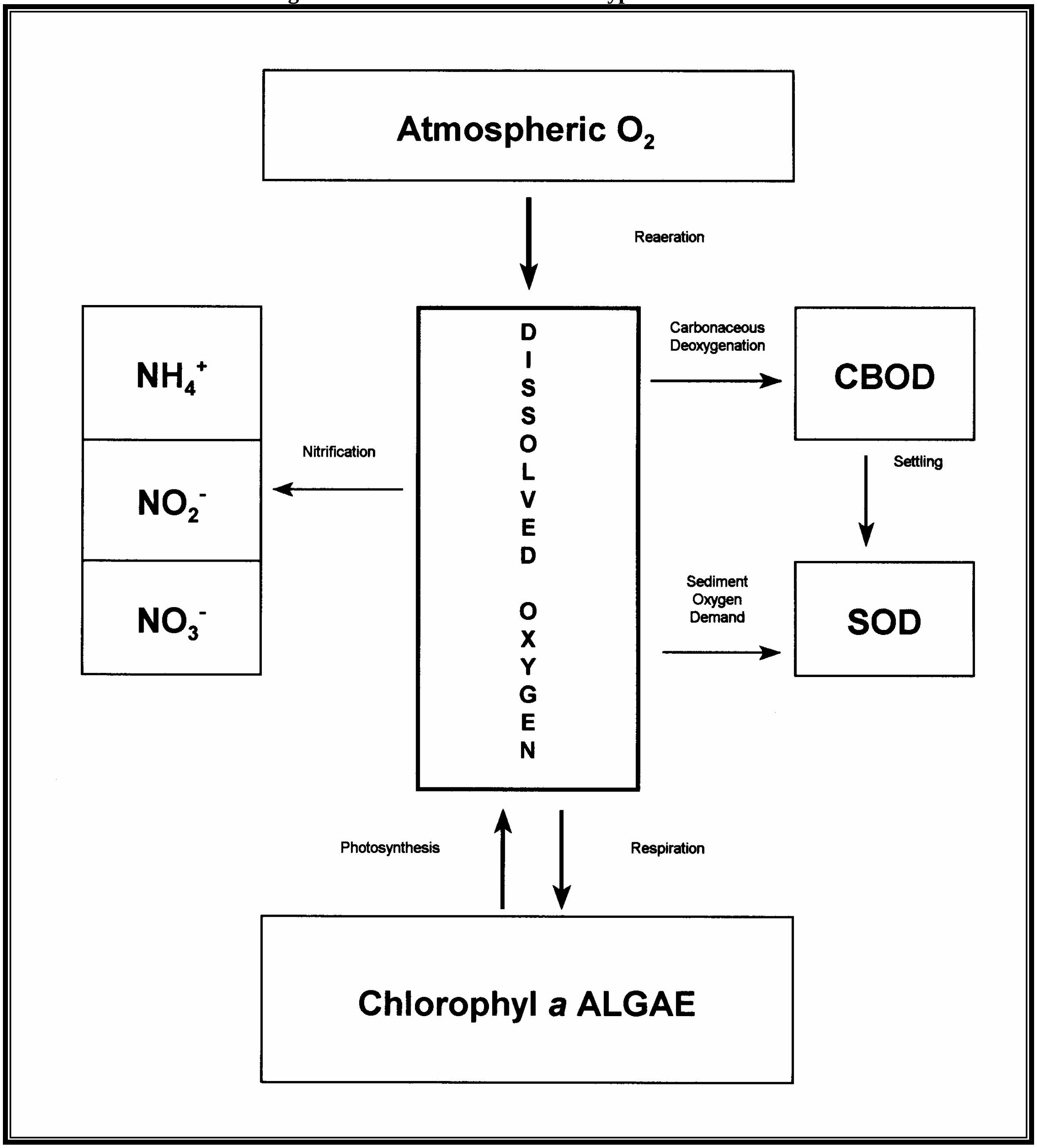
STREAM is a steady-state, daily average computer model that utilizes a modified Streeter-Phelps DO sag equation. Instream processes simulated by the model include CBODu decay, nitrification, reaeration, sediment oxygen demand, and respiration and photosynthesis of algae. Figure 6 shows how these processes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

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

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

C is the escape coefficient, U is the reach velocity in mile/day, and S is the average reach slope in ft/mile. The value of the escape coefficient is assumed to be 0.11 for streams with flows less than 10 cfs and 0.0597 for stream flows equal to or greater than 10 cfs. Reach velocities were calculated using an equation based on slope. The slope of each reach was estimated with the NHD Plus GIS coverage and input into the model in units of feet/mile.

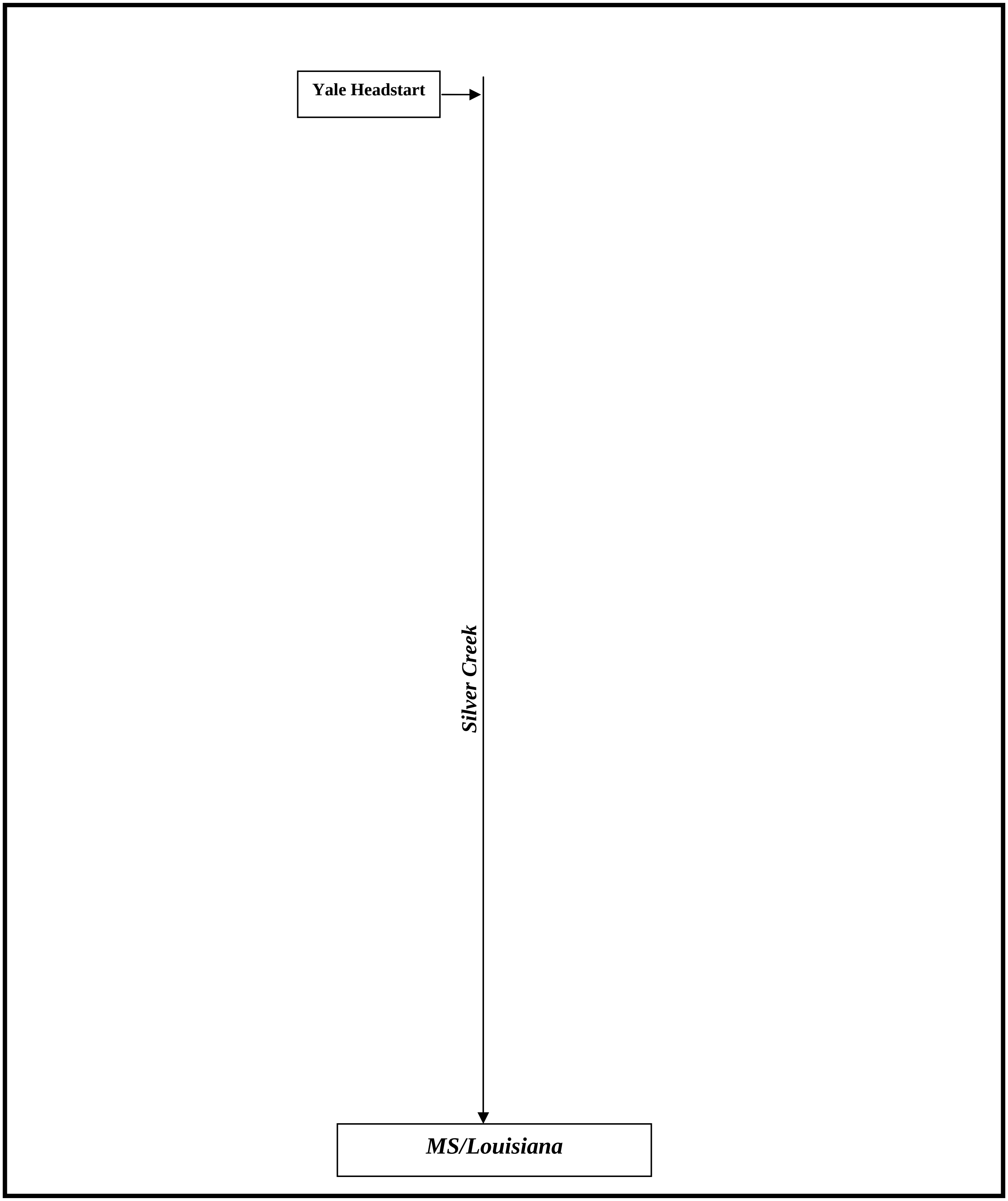
Figure 5. Instream Processes in a Typical DO Model



3.2 Model Setup

The model for this TMDL includes the §303(d) listed segment of Silver Creek, beginning at the headwaters. A diagram showing the model setup is shown in Figure 6.

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



The water body was divided into reaches for modeling purposes. Reach divisions were made at locations where there is a significant change in hydrological and water quality characteristics, such as the confluence of a point source or tributary. Within each reach, the modeled segments were divided into computational elements of 0.1 mile. The simulated hydrological and water quality characteristics were calculated and output by the model for each computational element.

The STREAM model was setup to simulate flow and temperature conditions, which were determined to be the critical condition for this TMDL. MDEQ Regulations state that when the flow in a water body is less than 50 cfs, the temperature used in the model is 26°C. The headwater instream DO was assumed to be 85% of saturation at the stream temperature. The instream CBODu decay rate at K_d at 20°C was input as 0.3 day^{-1} (base e) as specified in MDEQ regulations. The model adjusts the K_d rate based on temperature, according to Equation 3.

$$\mathbf{K_{d(T)} = K_{d(20°C)}(1.047)^{T-20}} \qquad \textbf{(Eq. 3)}$$

Where K_d is the CBODu decay rate and T is the assumed instream temperature. The assumptions regarding the instream temperatures, background DO saturation, and CBODu decay rate are required by the *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1994). Also based on MDEQ Regulations, the rates for photosynthesis, respiration, and sediment oxygen demand were set to zero because data for these model parameters are not available.

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

3.3 Source Representation

Both point and non-point sources were represented in the model. The loads from the NPDES permitted point source was added as a direct input into the appropriate reaches as a flow in MGD and concentration of $CBOD_5$ and ammonia nitrogen in mg/l. Spatially distributed loads, which represent non-point sources of flow, $CBOD_5$, and ammonia-nitrogen were distributed evenly into each computational element of the modeled water body.

Organic material discharged to a stream from an NPDES permitted point source is typically quantified as 5-day biochemical oxygen demand (BOD_5). BOD_5 is a measure of the oxidation of carbonaceous and nitrogenous material over a 5-day incubation period. However, oxidation of nitrogenous material, called nitrification, usually does not take place within the 5-day period because the bacteria that are responsible for nitrification are normally not present in large numbers and have slow reproduction rates (Metcalf and Eddy, 1991). Thus, BOD_5 is generally considered equal to $CBOD_5$. Because permits for point source facilities are written in terms of $CBOD_5$ while TMDLs are typically developed using CBODu, a ratio between the two terms is needed, Equation 4.

$$\mathbf{CBODu = CBOD_5 * Ratio} \qquad \textbf{(Eq. 4)}$$

The CBODu to $CBOD_5$ ratios are given in *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1994). These values are recommended for use by MDEQ regulations when actual field data are not available. The value of the ratio depends on the wastewater treatment type.

In order to convert the ammonia nitrogen (NH_3-N) loads to an oxygen demand, a factor of 4.57 pounds of oxygen per pound of ammonia nitrogen (NH_3-N) oxidized to nitrate nitrogen (NO_3-N) was used. Using this factor is a conservative modeling assumption because it assumes that all of the ammonia is converted to nitrate through nitrification. The oxygen demand caused by nitrification of ammonia is equal to the NBODu load. The sum of CBODu and NBODu is equal to the point source load of TBODu. The permitted load of TBODu from the existing point source to be used in the STREAM model is given in Table 7.

Table 7. Point Sources, Maximum Permitted Model Inputs

NPDES	Facility	Flow (MGD)	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
MS0045578	**Yale Headstart**	**0.0015**	**0.86**	**0.11**	**0.97**

Direct measurements of background concentrations of CBODu were not available for Silver 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 Silver 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 Silver Creek TMDL was not calibrated due to the limited amount of instream monitoring data collected during critical conditions. Future monitoring is essential to improve the accuracy of the model and the results.

3.5 Model Results

Once the model setup was complete, the model was used to predict water quality conditions in Silver Creek. The model was first run under regulatory load conditions. Under regulatory load conditions, the loads from the NPDES permitted point sources were based on their current location and loads shown in Table 7.

3.5.1 Regulatory Load Scenario

At these limits, no reduction was indicated for the point source to meet the current TMDL. As shown in the figure, the model predicts that the DO does not go below the standard of 5.0 mg/l using the permit based allowable loads, thus reductions are not needed to meet the current TMDL. The regulatory load scenario model results are shown in Figure 7.

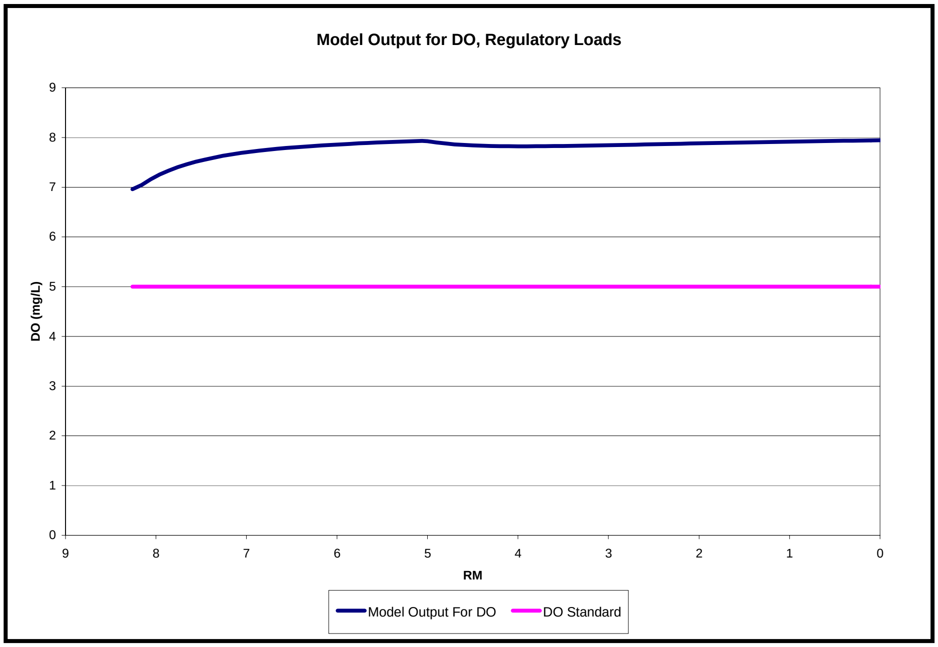


Figure 7. Model Output for DO in Silver Creek, Regulatory Load Scenario

3.5.2 Maximum Load Scenario

The graph of the regulatory model output shows that the predicted DO does not fall below the DO standard in Silver Creek during critical conditions. Although, the graph does not indicate DO violations, the stressor identification report identifies low DO/organic enrichment as a cause of impairment for this water body. MDEQ does not believe that there is assimilative capacity in the stream. However, in order to calculate the maximum allowable load of TBODu, the non-point source load was increased using a trial-and-error process until the modeled DO was at 5.0 mg/l. The non-point source loads were increased by a factor of 14.5 in this process. It is believed that this increase is representative of the non-point source load and will be allocated to the Margin of Safety (MOS) discussed in Section 4.3. The increased loads were used to develop the allowable maximum daily load for this report.

ALLOCATION

4.1 Wasteload Allocation

The organic enrichment and nutrient TMDL indicate that reductions are not needed from the point source. Table 8 indicates the wasteload allocation for this TMDL.

Future permits will be considered in accordance with Mississippi's *Wastewater Regulations for National Pollutant Discharge Elimination System (NPDES) Permits, Underground Injection Control (UIC) Permits, State Permits, Water Quality Based Effluent Limitations and Water Quality Certification*(1994).

Table 8. TMDL Loads for TN, TP, and TBODu

Permit	Facility	Flow MGD	TN Load lbs/day	TP Load lbs/day	CBODu lbs/day	NBODu lbs/day	TBODu lbs/day
MS0045578	**Yale Headstart**	**0.0015**	**0.17**	**0.07**	**0.86**	**0.11**	**0.97**

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 9. The load allocation consists of the estimated loads at the 7Q10 flow multiplied by a factor of 14.5.

For land disturbing activities related to silvaculture, 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 9. Load Allocation

	Flow (cfs)	CBODu (mg/L)	CBODu (lbs/day)	NH3-N (mg/L)	NBODu (lbs/day)	TBODu (lbs/day)
Non-point source	**3.18**	**2**	**494.57**	**0.1**	**113.29**	**607.86**

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 and explicit.

The explicit MOS for this report is the difference between the non-point loads calculated in the maximum load scenario and background non-point loads. The background non-point source loads represent an approximation of the loads currently going into Silver Creek at the critical conditions. The maximum non-point source loads are the maximum TBODu loads with a 14.5 increase that allow maintenance of water quality standards. MDEQ has set the MOS as the difference in these loads to account for the uncertainty in the desktop model that was used to develop this TMDL. Many assumptions based on regulations and literature values were used. The rate of sediment oxygen demand, for example, was set to zero due to lack of monitoring data. Sediment oxygen demand, however, can be a significant factor in the DO balance of a large water body. The STREAM model is a steady state, daily average model that assumes complete mixing throughout the water column. Due to the uncertainty in the model, MDEQ set a large, explicit MOS, shown in Table 10.

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Table 10. Calculation of Explicit MOS

	Maximum Non-Point Load	Background Non-Point Load	Margin of Safety
CBODu (lbs/day)	494.57	34.11	460.46
NBODu (lbs/day)	113.29	7.81	105.48
TBODu (lbs/day)	**607.86**	**41.92**	**565.94**

4.4 Calculation of the TMDL

Equation 1 was used to calculate the TMDL for TP and TN (see Table 6). The target concentration was used with the average flow for the watershed to determine the nutrient TMDLs. The STREAM model was used to calculate the TBODu TMDL. The allocations for TN, TP, and TBODu are given in Table 11. These allocations are established to attain the applicable water quality standards.

Table 11. TMDL Loads

	WLA lbs/day	LA lbs/day	MOS	TMDL lbs/day
Total Nitrogen	**0.17**	**77.87**	implicit	**78.04**
Total Phosphorous	**0.07**	**11.08**	implicit	**11.15**
TBODu	**0.97**	**41.92**	**565.94**	**608.83**

The nutrient TMDL loads were compared to the estimated existing loads previously calculated. A 70.8% reduction in TP loading is recommended based on the Land Use Land Cover estimate provided in Table 6. A TN reduction is not indicated by the estimates in Table 6.

The TN calculations indicate a WLA of 0.17 lbs in Table 9 and a LA of 51.13 lbs in Table 6. This sums to a load of 51.3 lbs/day. The TN TMDL target load is 78.04 lbs/day which indicates a reduction for TN is not needed.

The TP calculations indicate a WLA of 0.07 lbs in Table 6 and a LA of 38.20 lbs in Table 6. This sums to a load of 38.27 lbs/day. The TP TMDL target load is 11.15 lbs which is a reduction of 27.12 lbs or 70.8%. This TP reduction is recommended for the non-point source loads. The same Best Management Practices (BMPs) will control both nutrients. Best management practices are encouraged in this watershed to reduce the nonpoint nutrient loads.

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

Although, the model results indicate that Silver Creek is meeting the water quality standard for DO at the present loading of TBODu, the stressor identification report indicates that low DO/organic enrichment and nutrients are the probable primary stressors. It is noted that the model results are based on a desktop model using MDEQ's regulatory assumptions and literature values in place of actual field data. Thus, MDEQ does not believe that there is TBODu assimilative capacity in the creek. Because of the uncertainty involving the model, MDEQ has given a large MOS as a placeholder for the non-point source TBODu contribution to the creek.

Nutrients were addressed through an estimate of a preliminary TN concentration target and a preliminary TP concentration target. Based on the estimated existing and target TN concentrations, this TMDL does not recommend a reduction of TN loads entering this water body to meet the preliminary TN target of 0.70 mg/l. Based on the estimated existing and target TP concentrations, this TMDL recommends a 70.9 % reduction of the non-point source TP loads entering this water body to meet the preliminary TP target of 0.10 mg/l. Best management practices are encouraged in this watershed to reduce the non-point nutrient loads

5.1 Next Steps

MDEQ's Basin Management Approach and Nonpoint Source Program emphasize restoration of impaired waters with developed TMDLs. During the watershed prioritization process to be conducted by the 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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