

Total Maximum Daily Loads For Organic Enrichment/Low DO And Ammonia Toxicity

Richardson Mill Creek thence Potterchitto Creek

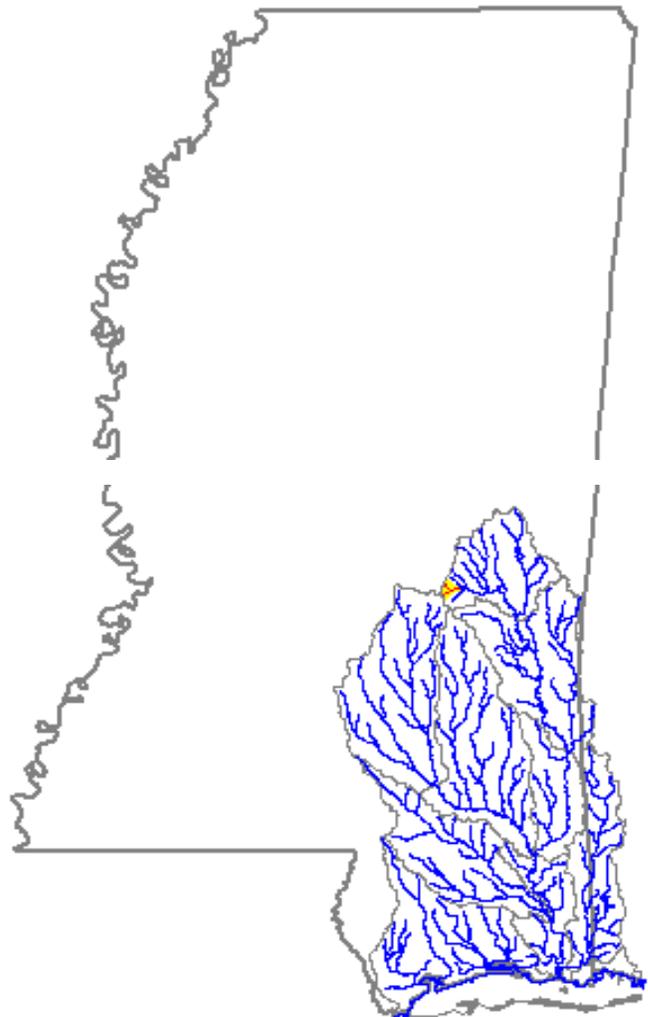
Pascagoula Basin Newton County, Mississippi

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. (*Sierra Club v. Hankinson, No. 97-CV-3683 (N.D. Ga.)*) 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 segments addressed are comprised of monitored segments that have data indicating impairment. 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.

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MONITORED SEGMENT IDENTIFICATION

Name:	Richardson Mill Creek thence Potterchitto Creek
Waterbody ID:	MS057M2
Location:	Near Newton: From headwaters through mouth at Potterchitto Creek to Potterchitto Creek at I-20, east of Newton
County:	Newton County, Mississippi
USGS HUC Code:	03170001
NRCS Watershed:	010
Length:	8 miles
Use Impairment:	Fish and Wildlife
Cause Noted:	Organic Enrichment/Low DO Indicated by Biological Sampling
Priority Rank:	124
NPDES Permits:	There are three NPDES Permits issued for facilities that potentially discharge organic material in the watershed, Table 3.
Pollutant Standard:	Dissolved oxygen 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 streams.
Waste Load Allocation:	177.0 lbs/day of TBODu in the summer (May – October) 251.0 lbs/day of TBODu in the winter (November – April)
Load Allocation:	16.0 lbs/day of TBODu in the summer (May – October) 16.0 lbs/day of TBODu in the winter (November – April)
Margin of Safety:	Implicit modeling assumptions - The model was run for critical, low-flow, high-temperature conditions and checked for seasonality.
Total Maximum Daily Load (TMDL):	193.0 lbs/day of TBODu in the summer (May – October) 267.0 lbs/day of TBODu in the winter (November – April)

MONITORED SEGMENT IDENTIFICATION

Name: Richardson Mill Creek thence Potterchitto Creek

Waterbody ID: MS057M2

Location: Near Newton: From headwaters through mouth at Potterchitto Creek to Potterchitto Creek at I-20, east of Newton

County: Newton County, Mississippi

USGS HUC Code: 03170001

NRCS Watershed: 010

Length: 8 miles

Use Impairment: Fish and Wildlife

Cause Noted: Ammonia Toxicity Indicated by Biological Sampling

Priority Rank: 124

NPDES Permits: There are three NPDES Permits issued for facilities that potentially discharge ammonia in the watershed, Table 3.

Pollutant Standard: Total ammonia as nitrogen (NH₃-N) allocations for effluents will be developed so as to meet the instream water quality criteria for toxicity.

Waste Load Allocation: 13.0 lbs/day of Total Ammonia as Nitrogen (NH₃-N)

Load Allocation: 0.5 lbs/day of Total Ammonia as Nitrogen (NH₃-N)

Margin of Safety: Implicit modeling assumptions - The model was run for critical, low-flow, high-temperature conditions.

Total Maximum Daily Load (TMDL): 13.5 lbs/day of Total Ammonia as Nitrogen (NH₃-N)

EXECUTIVE SUMMARY

A segment of Richardson Mill Creek thence Potterchitto Creek has been placed on the Mississippi 1998 Section 303(d) List of Waterbodies as an impaired waterbody segment. The impairment was detected based on biological monitoring. Biological impairment indicates impairment for waterbodies in which at least one biological assemblage (fish, macroinvertebrates, or algae) indicates less than full support with moderate modification of the biological community noted. Based on an evaluation of available data, it was determined that organic enrichment which causes low instream dissolved oxygen levels and ammonia nitrogen which causes ammonia toxicity are the specific pollutants responsible for the biological impairment in Richardson Mill Creek thence Potterchitto Creek. Thus, this TMDL has been developed for total ultimate biochemical oxygen demand (TBODu) and total ammonia as nitrogen (NH₃-N), based on the applicable state standards for dissolved oxygen and ammonia toxicity.

For this waterbody segment, the applicable state standard specifies that the 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 portion of TBODu which is present in the form of ammonia (NH₃) shall not exceed an instream concentration of 1.47 mg/l, given in *Quality Criteria for Water, 1986*, EPA 440/5-86-001.



Photo 1. Potterchitto Creek near Newton, MS

Richardson Mill Creek thence Potterchitto Creek is a waterbody in the Pascagoula Basin. The headwaters of Richardson Mill Creek begin in Newton County north of Lawrence, MS. It flows in a southeastern direction to its confluence with Potterchitto Creek at Newton, MS. The headwaters of Potterchitto Creek begin near Lawrence, MS. It flows in a northeastern direction for approximately five miles, where it is joined by several small tributaries, including Richardson Mill Creek. Following the confluence with Richardson Mill Creek, Potterchitto Creek flows in an eastern

direction to its confluence with the Chunky River near Chunky, MS. This TMDL, however, has been developed for the section of the Richardson Mill Creek thence Potterchitto Creek found on the 303(d) List. The 8-mile long impaired section is in Newton County near Newton, from the headwaters of Richardson Mill Creek through the mouth at Potterchitto Creek to Potterchitto Creek at Interstate 20, east of Newton.

A modified Streeter-Phelps DO sag model was selected as the modeling framework for performing the TMDL allocations for this study. The model was developed to account for seasonal variations in stream temperature, dissolved oxygen saturation, and carbonaceous biochemical oxygen demand (CBODu) decay rate. A mass-balance approach was used to ensure that the instream concentration of total ammonia (NH₃) did not exceed the water quality criteria for toxicity. The seven-day, ten-year (7Q10) low-flow value from the USGS gage 02475290 on the Potterchitto Creek near Newton was used to establish the hydrologic flow for the modeled segment.

The model used in developing this TMDL included both nonpoint and point sources of TBODu. TBODu loading from nonpoint sources in the watershed was accounted for by using an assumed background concentration of CBODu in the stream as directed in MDEQ Regulations. The background concentration was determined based on *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1995). The Newton POTW facility is the primary discharger of TBODu in the watershed. There are two other NPDES Permitted discharges located in the watershed that are included as point sources in the model. The load and waste load allocations developed for TBODu and total ammonia as nitrogen (NH₃-N) are equal to the maximum assimilative capacity of Potterchitto Creek, as indicated by predictive modeling. Thus, there is no assimilative capacity for additional TBODu and total ammonia as nitrogen (NH₃-N) loading in this waterbody segment. Any future increase in loading of these pollutants will be prohibited in this segment unless it is accompanied by a commensurate reduction in one of the existing NPDES permits within the watershed.

1.0 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 Mississippi Department of Environmental Quality (MDEQ) has identified a segment of Richardson Mill Creek thence Potterchitto Creek as being impaired by TBODu for a length of 8 miles as reported in the Mississippi 1998 Section 303(d) List of Waterbodies. The location of the segment is shown in Figure 1. The TMDL process is designed to restore and maintain the quality of those impaired waterbodies through the establishment of pollutant specific allowable loads. The TMDL process can be used to establish water quality based controls to reduce pollution from both point and nonpoint sources, and restore and maintain the quality of water resources.

The pollutants of concern for this TMDL are total ultimate biochemical oxygen demand (TBODu) and total ammonia as nitrogen (NH₃-N). TBODu is the oxygen consumed by microorganisms while stabilizing or degrading carbonaceous and nitrogenous compounds under aerobic conditions over an extended time period. The carbonaceous compounds are referred to as CBODu, and the nitrogenous compounds are referred to as NBODu. TBODu is the sum of NBODu and CBODu. Ammonia is an inorganic form of nitrogen which is a product of hydrolysis of organic nitrogen and denitrification. Total ammonia refers to both the ionized (NH₄⁺) and unionized (NH₃) forms of ammonia. Under specific conditions of temperature and pH, the unionized component of ammonia can be toxic to aquatic life.

In order to analyze the sources of TBODu in the Richardson Mill Creek thence Potterchitto Creek watershed, the entire drainage area was divided into three separate subwatersheds. The monitored segment is contained primarily within the third, most downstream watershed.

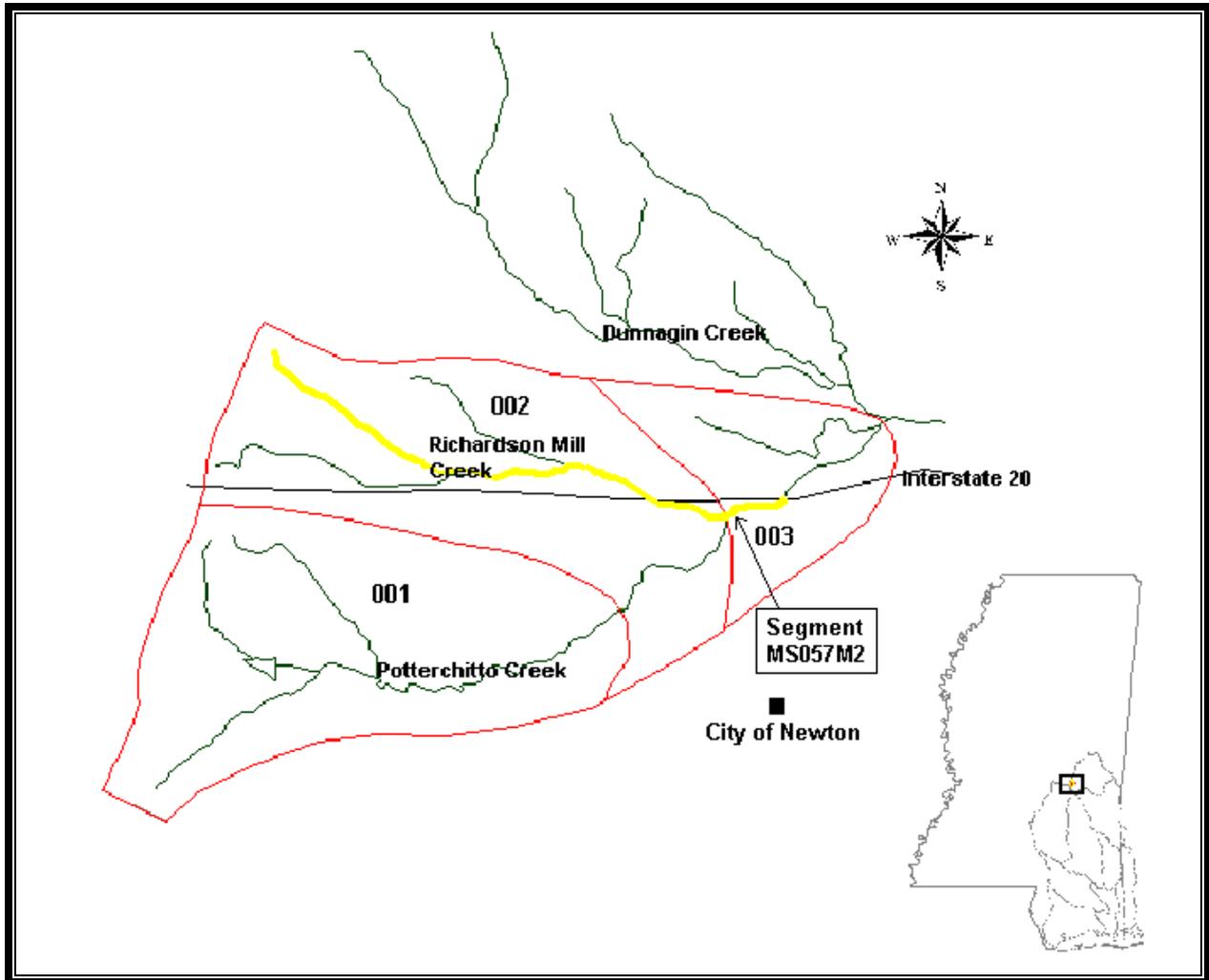


Figure 1. Watershed Divisions for Richardson Mill Creek thence Potterchitto Creek

The listed segment of Richardson Mill Creek thence Potterchitto Creek is in the Pascagoula River Basin Hydrologic Unit Code (HUC) 03170001 in southeastern Mississippi. The drainage area of the listed segment, from the headwaters to the end of the impaired section, is approximately 8,356 acres and lies entirely within Newton County. Figure 2 shows the landuse distribution within the watershed.

The 8,356-acre drainage area of Richardson Mill Creek and Potterchitto Creek contains many different landuse types, including urban, forests, cropland, pasture, barren, and wetlands. The landuse information is based on data collected by the State of Mississippi's Automated Resource Information System (MARIS). This data set is based on Landsat Thematic Mapper digital images taken between 1992 and 1993. Table 1 shows the landuse distribution within each subwatershed in number of acres.



Figure 2. Landuse Map

Table 1. Landuse Distribution in Number of Acres

Subwatershed	Forest	Agricultural	Urban	Barren	Wetland	Total
001	1,114	2,387	190	0	12	3,703
002	1,434	1,728	128	104	8	3,402
003	853	277	79	39	0	1,248
All Watersheds	3,401	4,392	399	144	20	8,356

1.2 Applicable Waterbody Segment Use

Designated beneficial uses and water quality standards are established by the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* regulations. The designated use for Richardson Mill Creek thence Potterchitto Creek as defined by the regulations is Fish and Wildlife Support.

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*. The applicable standard specifies that the dissolved oxygen (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 total ammonia (NH₃) concentration shall not exceed an instream concentration of 1.47 mg/l, given in *Quality Criteria for Water, 1986*, EPA 440/5-86-001. These water quality standards will be used as targeted endpoints to evaluate impairments and establish this TMDL.

2.0 TMDL ENDPOINT AND WATER QUALITY ASSESSMENT

2.1 Selection of a TMDL Endpoint and Critical Condition

One of the major components of a TMDL is the establishment of instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints, therefore, represent the water quality goals that are to be achieved by meeting the load and waste load allocations specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. The instream dissolved oxygen target for this TMDL is a daily average of not less than 5.0 mg/l. The instream total ammonia target for this TMDL is a 4-day average of less than 1.47 mg/l.

Low DO typically occurs during seasonal low flow periods of late summer and early fall. Elevated oxygen demand is of primary concern during dry periods because the effects of low flow, minimum dilution, and high temperatures combine to produce the worst case potential effect on water quality (EPA, 1997). The maximum impact of a TBOD_u load is generally not at the location of the discharge, but at some distance downstream. The point of maximum impact is where the maximum DO deficit occurs and is referred to as the DO sag.

2.2 Discussion of Instream Water Quality

Water quality data available for the listed segment of Richardson Mill Creek thence Potterchitto Creek were collected in May 1994 as part of the Mississippi Lagoon Study by USEPA Region IV and MDEQ. Data collected during this study consisted of analysis of the benthic macroinvertebrate community, habitat evaluations, water chemistry sampling, and continuous in-situ monitoring of instream DO. The data were collected at stations on Richardson Mill Creek both upstream and downstream of the Newton POTW discharge and on Potterchitto Creek upstream of the confluence of Richardson Mill Creek. The water quality data collected through this study showed that disruptions in the benthic macroinvertebrate community were evident in Richardson Mill Creek downstream of the Newton POTW discharge. In addition, the study showed that ammonia toxicity is a concern for aquatic life below the discharge of the Newton POTW facility because the unionized fraction of total ammonia is toxic to fish and other aquatic organisms. During the summer of 1997, MDEQ collected additional water quality data and performed a rapid biological assessment in Potterchitto Creek at Highway 15. The RBA performed at this site indicated no impairment of the biological community. The data collected in 1997 show that the biological community in Richardson Mill Creek thence Potterchitto Creek recovered completely from the upstream impairment before Highway 15. The Highway 15 site is approximately 3 miles downstream of the confluence of Richardson Mill Creek.

This TMDL was developed based on the cause of impairment given in the 1998 303(d) list, biological impairment. The 1998 303 (d) list, which was approved by EPA, supersedes the 1996 303(d) list for the purpose of TMDL development. Biological impairment is not a pollutant, but an indicator of impairment due to a source of pollution. The disruptions of the benthic macroinvertebrate community found in Richardson Mill Creek downstream of the Newton POTW were localized in the area downstream of the discharge. Impairment of the biological community in Potterchitto Creek was not found at Highway 15. Because the effluent from the Newton POTW accounts for more than 50 percent of the total flow in the impaired segment of Richardson Mill

Creek thence Potterchitto Creek, it is the professional judgment of MDEQ that the Newton POTW is the pollutant source causing impairment. The components of the effluent that could cause the noted biological impairment are oxygen demanding substances and total ammonia. Subsequently, MDEQ prepared this TMDL based on the actual causes of biological impairment, organic enrichment/low DO and ammonia toxicity.

The impact of nutrients, a cause given on the 1996 303(d) list, was considered in the determination of TMDLs for total ammonia as nitrogen (NH₃-N) and TBODu. The processes of nitrification (conversion of ammonia nitrogen to nitrate nitrogen) and NBODu decay (a component of TBODu decay) are included in the TMDL modeling and subsequent determination of the seasonal load and waste load allocations. Nutrients are not considered as a separate pollutant. Rather, nutrients are considered within the TBOD and ammonia toxicity modeling.

2.2.1 Inventory of Available Water Quality Monitoring Data

The State's 1998 Section 305(b) Water Quality Assessment Report was reviewed to assess water quality conditions and data available for the watershed. According to the report, Richardson Mill Creek is partially supporting for the use of aquatic life support, and Potterchitto Creek is threatened for the use of aquatic life support. These conclusions were based on biological assessments and instantaneous data collected at stations RM1, RM3, and PC1. Station RM1 is located in Richardson Mill Creek upstream of the Newton POTW discharge point, while RM3 is located in Richardson Mill Creek downstream of the Newton POTW discharge point. Station PC1 is located in Potterchitto Creek upstream of its confluence with Richardson Mill Creek. Water chemistry data collected at these stations are listed below in Table 2.

Table 2. Water Chemistry Data Reported for Richardson Mill Creek and Potterchitto Creek, all values are in mg/l.

Station	Date Collected	TSS	Total NH ₃ -N	NO ₂ + NO ₃	TKN	TP	TN	TOC
PC1	5/25/94	6	0.05	0.29	0.28	0.13	0.57	4.1
RM1	5/25/94	4	0.05	0.13	0.41	0.05	0.54	4.9
RM3	5/25/94	24	2.80	0.28	3.80	2.20	4.08	7.5

2.2.2 Analysis of Instream Water Quality Monitoring Data

Because only a few samples were collected, statistical analysis of the water chemistry data was not completed. However, at the time that these instantaneous samples were collected, it was apparent that the Newton POTW discharge was the primary contributor to organic enrichment of Richardson Mill Creek thence Potterchitto Creek.

3.0 SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential sources of TBODu in the watershed of Richardson Mill Creek thence Potterchitto Creek. The source assessment was used as the basis of development for the model and ultimate analysis of the TMDL allocation options. In evaluation of the sources, loads were characterized by the best available information, monitoring data, literature values, and local management activities. This section documents the available information and interpretation for the analysis.

3.1 Assessment of Point Sources

Point sources of TBODu have their greatest potential impact on water quality during periods of low flow. Thus, a careful evaluation of point sources that discharge TBODu was necessary in order to quantify the degree of impairment present during the low-flow, critical condition period. Three wastewater treatment plants were identified in the Richardson Mill Creek thence Potterchitto Creek watershed, which serve a variety of activities including residential subdivisions and other businesses. Once the permitted dischargers were located, the effluent from each source was characterized based on all available data including information on each facility's wastewater treatment system, permit limits, and discharge monitoring reports.

The Newton POTW facility consists of an aerated lagoon with four cells in series. Aeration is provided to the lagoon cells with a blower, which supplies air to a system of underwater diffuser pipes. The first cell of the aerated lagoon system also contains three floating aerators, which provide additional aeration. The additional aerators were added after the EPA Lagoon Study in 1994. All four of the aerated cells contain an abundant growth of aquatic weeds, which cover approximately forty percent of the surface area of the cells (Photo 2). The aquatic weeds are considered part of the wastewater treatment process. Discharge volumes from the MDOT Newton Project Office and the SAFE Mobile Home Park are significantly smaller than the Newton POTW Facility. The MDOT Newton Project Office uses an activated sludge system for wastewater treatment. A conventional lagoon is used for wastewater treatment at the SAFE Mobile Home Park facility.



Photo 2. Newton POTW Facility, Aquatic Weed Coverage in Cell 3

Discharge monitoring reports (DMRs) are the best data source for characterizing effluent because they report measurements of flow and TBOD₅ present in effluent samples. DMR reports are required on a quarterly basis for the Newton POTW facility. The reports submitted since January 1994 have been examined, and showed only one reported violation in the permit limit for TBOD₅ (17.64 mg/l in June 1994). The DMR reports also show that the facility is currently operating at approximately two-thirds of its total treatment capacity. Based on quarterly DMRs, the effluent produced by the Newton POTW in 1999 had an average TBOD₅ concentration of 8.5 mg/l, an average DO concentration of 7.0 mg/l, and an average flow of 0.44 MGD. DMR reports are not required for the MDOT Newton Project Office and the SAFE Mobile Home Park. The permit limits of each facility included in the model are given in Table 3.

Table 3. Inventory of NPDES Permitted Dischargers

Facility Name	NPDES Permit	Subwatershed	Permitted Flow MGD	NPDES Permit Limits (TBOD ₅ – DO) mg/l	Receiving Waterbody
Newton POTW	MS0036323	002	0.77	10 – 6	Richardson Mill Creek
MDOT Newton Project Office	MS0038926	001	0.003	30 – 6	Potterchitto Creek
SAFE Mobile Home Park	MS0050733	001	0.008	30 – 6	Potterchitto Creek

3.2 Assessment of Nonpoint Sources

Nonpoint loading of CBODu and NBODu in a waterbody results from the transport of the pollutants into receiving waters by overland surface runoff and groundwater infiltration. Landuse activities within the drainage basin, such as agriculture, silvaculture, and urbanization contribute to nonpoint source loading. Other nonpoint pollution sources include atmospheric deposition and natural weathering of rocks and soil.

Direct measurements of nonpoint contributions to the background TBODu load were not collected for the Richardson Mill Creek thence Potterchitto Creek TMDL. The background contributions of CBODu and total ammonia as nitrogen (NH₃-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 concentrations are CBODu = 2.0 mg/l and NH₃-N = 0.1 mg/l.

4.0 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 waterbody responses to flow and loading conditions. In this section, the selection of the modeling tools, setup, and model application are discussed.

4.1 Modeling Framework Selection

A mathematical model, named AFWWIV1, for DO distribution in freshwater streams was used for developing the TMDL. The use of AFWWIV1 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 AFWWIV1 model in TMDL development is its ability to assess instream water quality conditions in response to point and nonpoint source loadings.

The model is a steady-state, daily average computer model that utilizes a modified Streeter-Phelps DO sag equation. Instream processes simulated by the model include CBOD_u decay, nitrification, reaeration, sediment oxygen demand, and respiration and photosynthesis of algae (Figure 3). 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 dissolved oxygen, CBOD_u, and total ammonia 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, which is recommended for small streams with flow less than 10 cfs. The Tsivoglou formulation calculates reaeration (K_a) within each reach according to Equation 1.

$$K_a = CSU \quad \text{(Equation 1)}$$

Where S is the slope in ft/mile, U is the reach velocity in mile/day, and C is the escape coefficient, which is 0.11 for streams with flow less than 10 cfs.

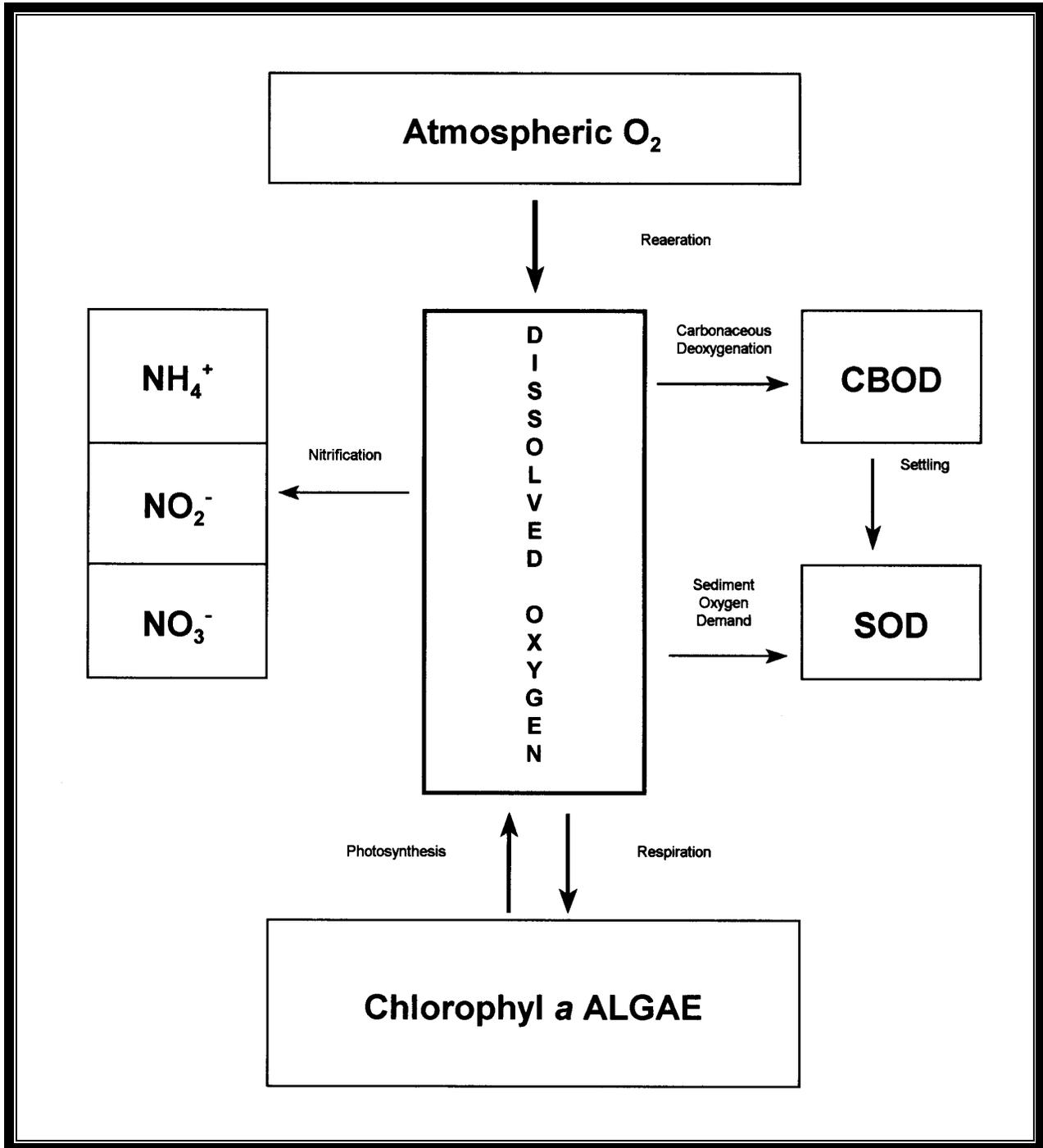


Figure 3. Instream Model Processes in the AFWWIV1 Model

4.2 Model Setup

The Richardson Mill Creek thence Potterchitto Creek TMDL model includes the listed sections of the creek as well as all the drainage areas that are upstream of the segment. The modeled segments were divided into reaches for input into the AFWWIV1 model. Reach divisions should be made when there is a major change in the hydrology of the modeled waterbody such as a large change in slope or the confluence of a tributary or a major point source discharge. Based on these requirements, Richardson Mill Creek thence Potterchitto Creek was modeled according to the setup shown in Figure 4. The slope of each reach was measured from USGS quad maps and input into the

model in feet/mile. Within each reach, the modeled segments must be divided into computational elements. The computational element size used for the Richardson Mill Creek thence Potterchitto Creek model is 0.1 miles. The hydrological and water quality characteristics are calculated and output by the model for each computational element.

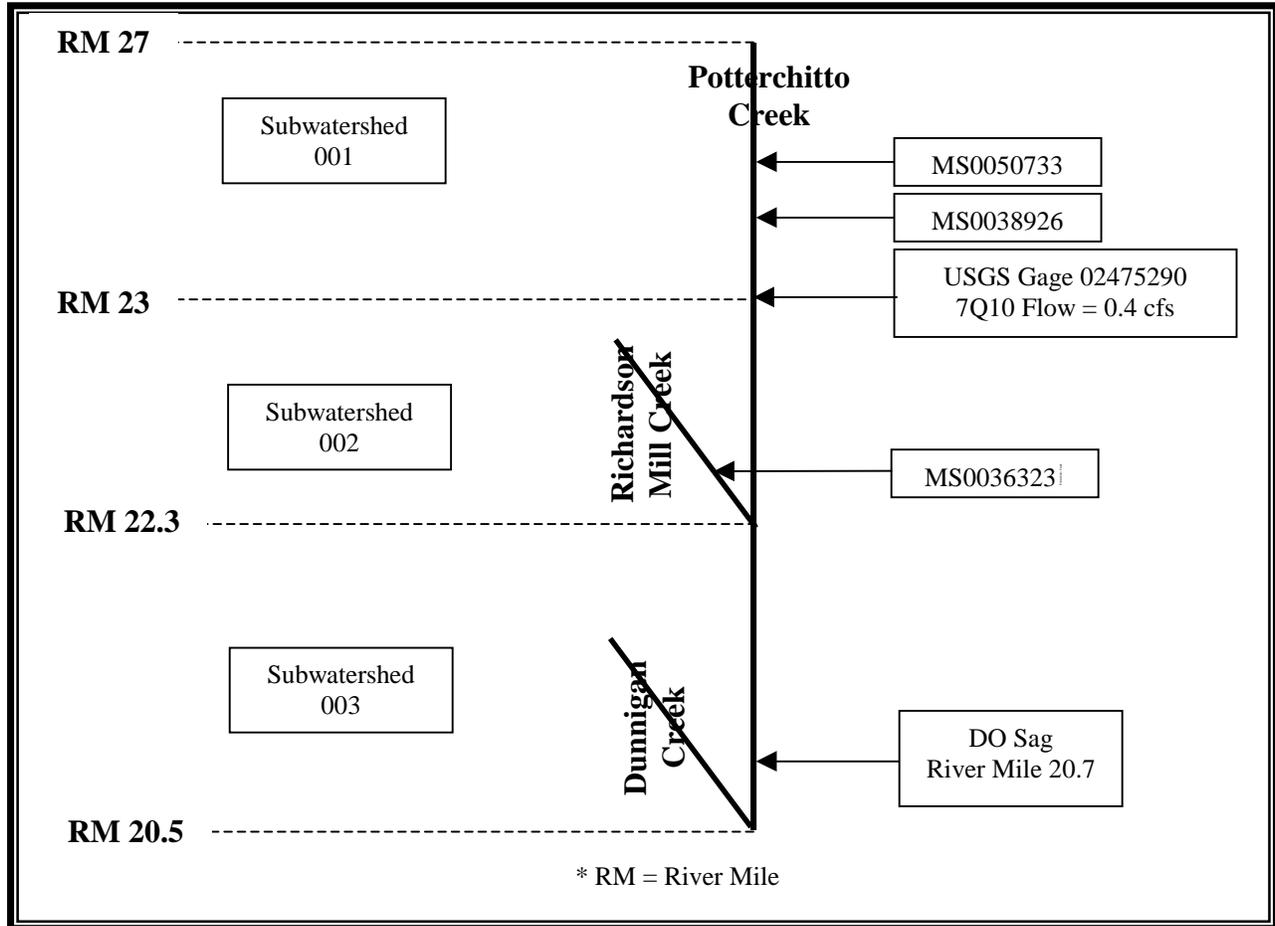


Figure 4. Diagram of Model Setup (Note: not to scale)

4.3 Source Representation

Both point and nonpoint sources were represented in the model. The discharge from NPDES Permitted sources was added as a direct input into the appropriate reach of the waterbody as flow in cfs and a CBODu and total ammonia as nitrogen (NH₃-N) load in lbs/day. Loads for nonpoint sources are input to the model as a spatially distributed input. Spatially distributed inputs, which represent surface water runoff and groundwater infiltration, are modeled as a flow in cfs and CBODu and total ammonia as nitrogen (NH₃-N) loads in lbs/day. The spatially distributed inputs are distributed evenly into each computational element of the reach.

4.4 Selection of Representative Modeling Periods

In order to account for seasonal variations in stream temperature and the stream temperature's effect on the CBODu decay rate and dissolved oxygen saturation, the model was run under both summer and winter temperature conditions. The temperatures used in the model are 26°C in the summer

(May through October) and 20°C in the winter (November through April). The headwater instream dissolved oxygen was assumed to be 85% of saturation at the stream temperature. The instream CBODu decay rate is dependent on temperature, according to Equation 2.

$$Kd_{(T)} = Kd_{(20^{\circ}C)}(1.047)^{T-20} \quad \text{(Equation 2)}$$

Where Kd 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). The temperatures, CBODu decay rates, and DO saturation values used in the model are given in Table 4.

Table 4. Seasonal Model Inputs

	Temperature (°C)	CBODu Decay (Day ⁻¹)	85% DO Saturation (mg/l)
Summer (May – Oct)	26	0.39	7.8
Winter (Nov – April)	20	0.30	8.7

4.5 Model Calibration Process

Due to the lack of water quality monitoring data, the water quality component of the model was not calibrated. Instead, the model inputs were based on assumptions found in *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1994). The hydrological portion of the model was calibrated to simulate low-flow, critical conditions. The USGS gage 0247520, which is located on Potterchitto Creek near Newton, was used to determine the 7Q10 flow in the headwaters of the model. The 7Q10 flow coefficient (7Q10 value in cfs/drainage area in square miles) was used to determine the 7Q10 flow in the modeled reaches which are downstream of the USGS gage.

4.6 Model Results

Figure 5 and Figure 6 show the AFWWIV1 model results for both the summer and winter conditions. The models were run several times, using a trial-and-error process, to determine the maximum TBODu loadings from the Newton POTW Facility which would not violate water quality standards for DO in Richardson Mill Creek thence Potterchitto Creek. Both graphs show the instream DO concentrations in Potterchitto Creek below the confluence with Richardson Mill Creek, beginning with river mile 22.3 and ending with river mile 20.0. The DO sag, or maximum DO deficit, occurs in Potterchitto Creek near Interstate 20, at river mile 20.7. After the confluence of Dunnigan Creek at river mile 20.5, the instream DO increases sharply. The TBODu loadings from the Newton POTW facility included in the model for each season are given in Table 5. The dashed line on both graphs represents the DO standard of 5.0 mg/l.

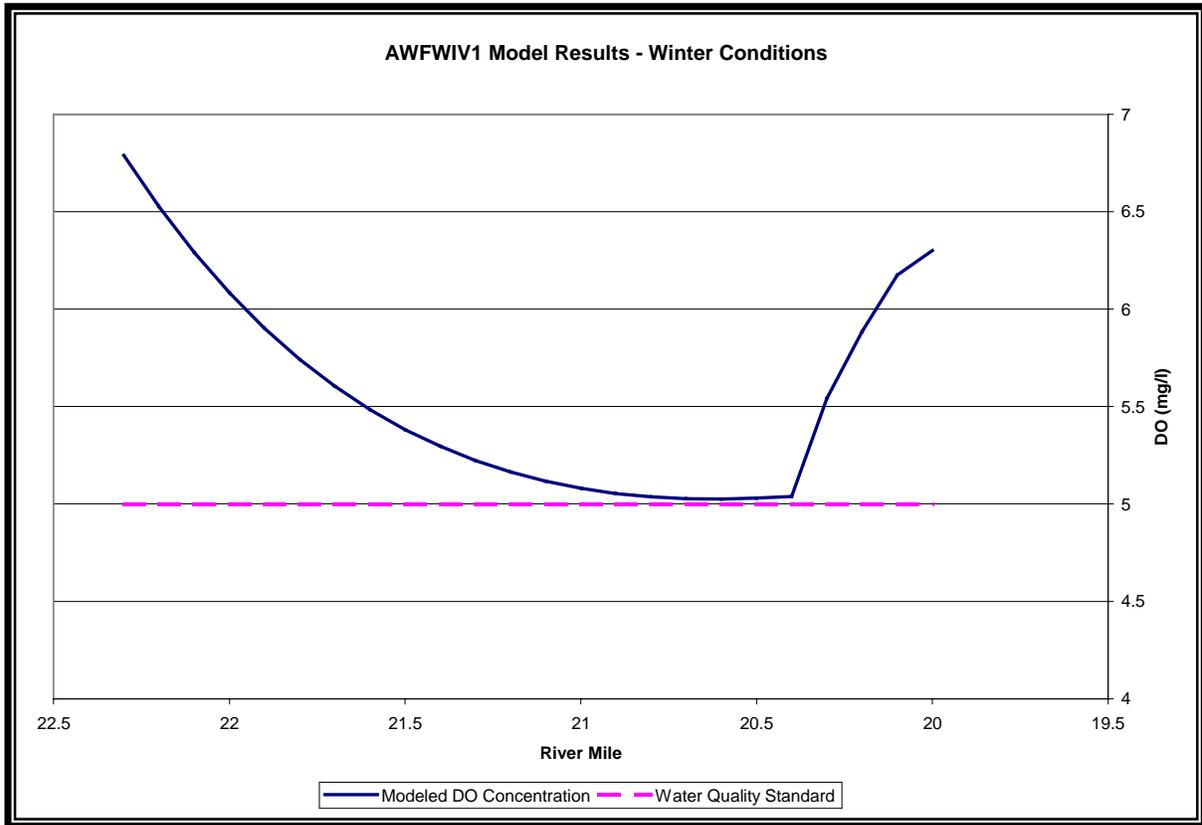


Figure 5. Instream DO Concentrations Under Winter Model Conditions

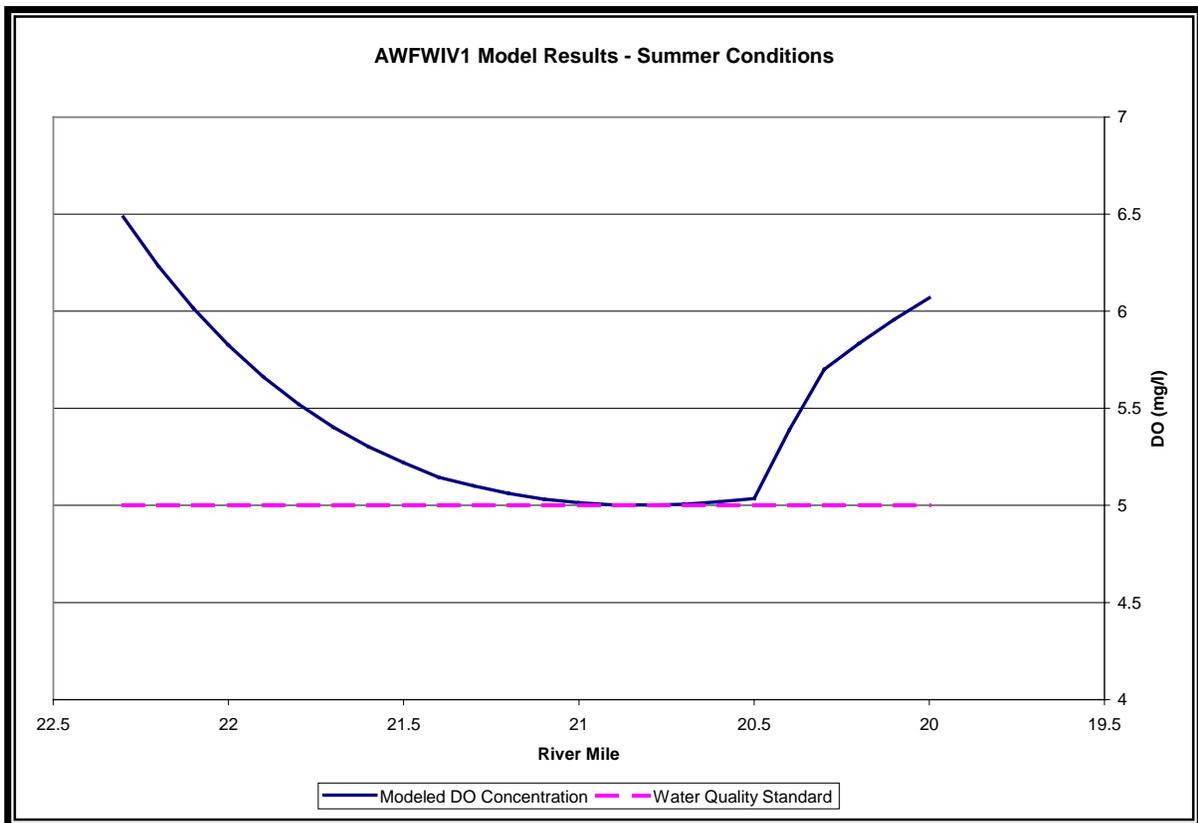


Figure 6. Instream DO Concentrations Under Summer Model Conditions

Table 5. Modeled Loads from the Newton POTW Facility

Season	Flow (MGD)	CBOD ₅ (mg/l)	CBOD ₅ (lbs/day)	CBODu (lbs/day)	Total NH ₃ -N (mg/l)	Total NH ₃ -N (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Summer (May – Oct)	0.77	8	48	110.85	2	12.85	58.73	169.58
Winter (Nov – April)	0.77	12	80	184.75	2	12.85	58.73	243.48

4.7 Evaluation of Ammonia Toxicity

Ammonia must not only be considered due to its effect on dissolved oxygen in the receiving water, but also its toxicity potential. It is recognized that effluent total ammonia as nitrogen (NH₃-N) concentrations may be more restricted due to toxicity than due to oxidation. According to *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1994), the allocations for effluent total ammonia as nitrogen (NH₃-N) concentrations should be developed so as to meet the water quality criteria given in *Quality Criteria for Water, 1986*, EPA 440/5-86-001. The maximum allowable instream total ammonia (NH₃) concentration at a pH of 7.0 and stream temperature of 25°C is 1.47 mg/l total ammonia (NH₃) or 1.20 mg/l total ammonia as nitrogen (NH₃-N). Based on this instream limit, a mass balance calculation was used to determine the maximum allowable total ammonia as nitrogen (NH₃-N) concentration in the Newton POTW effluent (Figure 7). This calculation showed that the permit limit total ammonia as nitrogen (NH₃-N) for the Newton POTW should be approximately 2.0 mg/l. Because the effluent flow from the other two point source facilities included in the model is very small, it was determined that the effluent from these facilities could not impair the receiving stream due to ammonia toxicity.

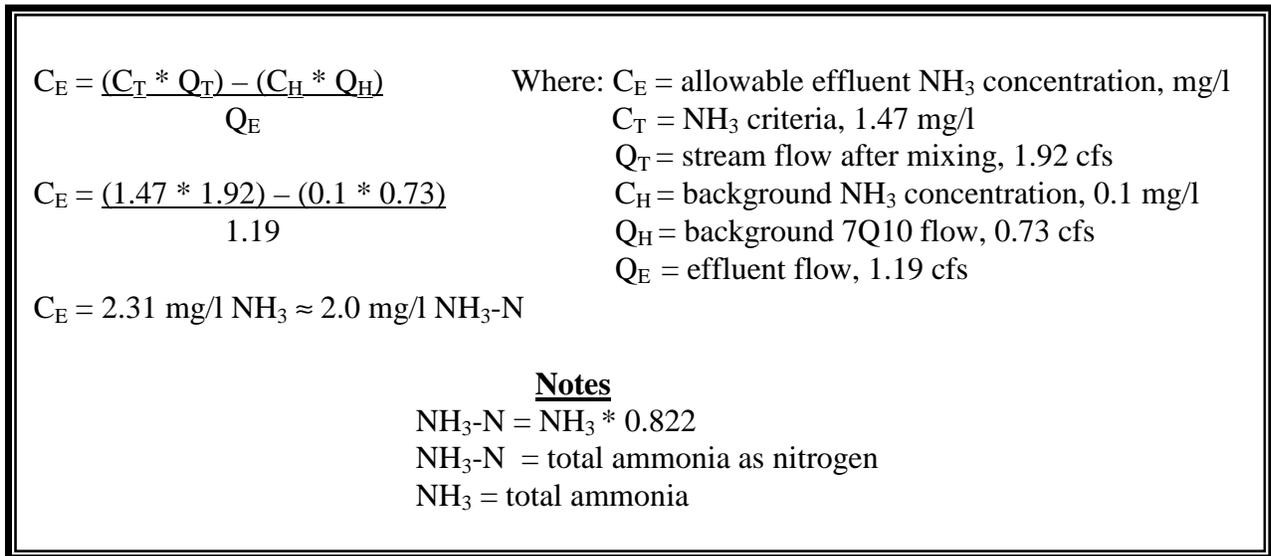


Figure 7. Mass-Balance Calculation

5.0 ALLOCATION

The allocation for this TMDL involves a wasteload allocation for point sources and a load allocation for nonpoint sources necessary for attainment of water quality standards in segment MS057M2. Seasonality was addressed in the TMDL by running the model for both summer and winter conditions. The load and wasteload allocations for Richardson Mill Creek thence Potterchitto Creek were developed as seasonal loads, based on the average of the model results for summer and winter conditions.

5.1 Wasteload Allocations

The three NPDES permitted facilities in the Richardson Mill Creek thence Potterchitto Creek watershed are included in the wasteload allocation. The wasteload allocation in this TMDL includes seasonal loads for TBODu and total ammonia as nitrogen (NH₃-N), Table 6 and Table 7. The DO sag model was used to determine the maximum assimilative capacity of Richardson Mill Creek thence Potterchitto Creek for CBODu. The mass-balance calculation for ammonia toxicity was used to determine the creek’s maximum assimilative capacity for total ammonia as nitrogen (NH₃-N). In order to convert the total ammonia as nitrogen (NH₃-N) concentrations to an oxygen demand, a factor of 4.57 pounds of oxygen per pound of total ammonia as nitrogen (NH₃-N) oxidized to nitrate (NO₃) was used. Using this factor is a conservative modeling assumption because it assumes that all of the ammonia is converted to nitrate through nitrification, which is not necessarily accurate.

The oxygen demand caused by nitrification of ammonia is equal to the NBODu load. The sum of CBODu and NBODu is equal to the wasteload allocation for TBODu.

Table 6. Wasteload Allocations for Summer Conditions (May – October)

Facility Name	Permitted Flow (MGD)	CBOD ₅ (mg/l)	CBODu (lbs/day)	Total NH ₃ -N (mg/l)	Total NH ₃ -N (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Newton POTW	0.77	8	110.85	2	12.85	58.73	169.58
MDOT Newton Project Office	0.003	30	1.86	2	0.05	0.25	2.11
SAFE Mobile Home Park	0.008	30	4.47	2	0.13	0.59	5.06
All Facilities					13.03		176.75

Table 7. Wasteload Allocations for Winter Conditions (November - April)

Facility Name	Permitted Flow (MGD)	CBOD ₅ (mg/l)	CBOD _u (lbs/day)	Total NH ₃ -N (mg/l)	Total NH ₃ -N (lbs/day)	NBOD _u (lbs/day)	TBOD _u (lbs/day)
Newton POTW	0.77	12	184.75	2	12.85	58.73	243.48
MDOT Newton Project Office	0.003	30	1.86	2	0.05	0.25	2.11
SAFE Mobile Home Park	0.008	30	4.47	2	0.13	0.59	5.06
All Facilities					13.03		250.65

Because the NPDES permits are written with a maximum allowable flow in MGD, a maximum CBOD₅ concentration in mg/l, and a maximum total ammonia as nitrogen (NH₃-N) concentration in mg/l, some calculations were necessary to determine the NPDES permit limits which correspond to the wasteload allocation for TBOD_u and total ammonia as nitrogen (NH₃-N). The value of CBOD₅ was converted to CBOD_u by using a CBOD_u to CBOD₅ ratio of 2.3. The ratio of 2.3 is used for advanced secondary wastewater treatment methods, according to *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1994). The current NPDES permit for the Newton facility does not specify limits for total ammonia as nitrogen (NH₃-N) concentrations. Since toxic instream total ammonia (NH₃) concentrations would occur below the Newton POTW discharge point if the effluent had an total ammonia as nitrogen (NH₃-N) concentration greater than 2.0 mg/l, modification of the current permit is recommended to require the total ammonia as nitrogen (NH₃-N) limit of 2.0 mg/l. Effluent total ammonia as nitrogen (NH₃-N) concentrations should be monitored on a quarterly basis and submitted on the quarterly DMR reports for the Newton POTW facility. Table 8 lists the maximum recommended permit limits for the Newton POTW Facility, based on the wasteload allocations.

The effluents from the MDOT Newton Project Office and the SAFE Mobile Home Park constitute less than 5 percent of the total headwater flow and less than 3 percent of the allocated load of TBOD_u. Because the model showed that the effluents from these facilities do not have a significant impact on the DO and total ammonia as nitrogen (NH₃-N) concentrations in Potterchitto Creek, permit modifications are not recommended for these facilities.

Table 8. Recommended Permit Modifications

Facility Name	Permitted Flow MGD	Summer	Winter
		(May – October) (CBOD ₅ – NH ₃ -N – DO) in mg/l	(November – April) (CBOD ₅ – NH ₃ -N – DO) in mg/l
Newton POTW	0.77	8 – 2 – 6	12 – 2 – 6

5.2 Load Allocations

The headwater and spatially distributed loads are included in the load allocation. The TBOD_u concentrations of these loads were determined by using an assumed CBOD₅ concentration of 1.33 mg/l and a total ammonia as nitrogen (NH₃-N) concentration of 0.1 mg/l. These concentrations

should be assumed when reliable field data are not available, according to *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1994). The headwater and spatially distributed flows were calculated for each subwatershed, based on the 7Q10 flow coefficient for the watershed and the watershed size. Then, load allocations were calculated for each subwatershed to determine the CBODu and NBODu loads in lbs/day. Table 9 lists the modeled load allocations. Because the load allocations do not vary by season, they are given on an annual basis.

Table 9. Load Allocation

Subwatershed	Flow (cfs)	CBOD ₅ (mg/l)	CBODu (lbs/day)	Total NH ₃ -N (mg/l)	Total NH ₃ -N (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
001	0.40	1.33	6.61	0.1	0.22	0.99	7.59
002	0.33	1.33	5.45	0.1	0.18	0.81	6.27
003	0.11	1.33	1.82	0.1	0.06	0.27	2.09
All Watersheds					0.46		15.95

5.3 Incorporation of a Margin of Safety (MOS)

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. Conservative assumptions which place a higher demand of DO on the waterbody than may actually be present are considered part of the margin of safety. The assumption that all of the ammonia present in the waterbody is oxidized to NO₃, for example, is a conservative assumption.

5.4 Calculation of the TMDL

The TMDL was calculated based on Equation 3.

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{MOS} \quad (\text{Equation 3})$$

Where WLA is the waste load allocation, LA is the load allocation, and MOS is the margin of safety. All units are in lbs/day of TBODu. The TMDLs for TBODu were calculated on a seasonal basis, and the TMDLs for total ammonia as nitrogen (NH₃-N) were calculated on an annual basis, based on the maximum allowable loading of the pollutants for Richardson Mill Creek thence Potterchitto Creek according to the model. The TMDL calculations are shown in Tables 10-12. As shown in Table 10 and Table 11, TBODu is the sum of CBODu and NBODu. The wasteload allocations incorporate the TBODu and total ammonia as nitrogen (NH₃-N) contributions from identified NPDES Permitted facilities. The load allocations include the headwaters and spatially distributed TBODu and total ammonia as nitrogen (NH₃-N) contributions from surface runoff and groundwater infiltration. The implicit margin of safety for this TMDL is derived from the conservative assumptions used in setting up the model.

Table 10. TMDL for TBODu, for Summer Conditions (May – October)

	WLA (lbs/day)	LA (lbs/day)	MOS	TMDL (lbs/day)
CBODu	117.18	13.88	Implicit	131.06
NBODu	59.57	2.07	Implicit	61.64
TBODu	176.75	15.95	Implicit	192.70

Table 11. TMDL for TBODu for Winter Conditions (November - April)

	WLA (lbs/day)	LA (lbs/day)	MOS	TMDL (lbs/day)
CBODu	191.08	13.88	Implicit	204.96
NBODu	59.57	2.07	Implicit	61.64
TBODu	250.65	15.95	Implicit	266.60

Table 12. TMDL for Total Ammonia as Nitrogen (NH₃-N) for Annual Conditions

	WLA (lbs/day)	LA (lbs/day)	MOS	TMDL (lbs/day)
NH ₃ -N	13.03	0.46	Implicit	13.49

All of the segment’s assimilative capacity for TBODu and total ammonia as nitrogen (NH₃-N) has been assigned to the load allocation for nonpoint sources and the wasteload allocation for permitted point sources. When the NPDES Permitted point sources are discharging at their maximum recommended seasonal permit limit, there is no assimilative capacity for additional loading in this waterbody segment. Thus, any future increase in loading of TBODu or total ammonia as nitrogen (NH₃-N) will be prohibited in this segment unless it is accompanied by a commensurate permit reduction.

6.0 CONCLUSION

6.1 Future Monitoring

MDEQ has adopted the Basin Approach to Water Quality Management, a plan that divides Mississippi's major drainage basins into five groups. During each yearlong cycle, MDEQ resources for water quality monitoring will be focused on one of the basin groups. During the next monitoring phase in the Pascagoula Basin, Richardson Mill Creek and Potterchitto Creek may receive additional monitoring to identify any change in water quality.

This TMDL recommends making several modifications to the current NPDES Permit issued to the Newton POTW Facility. Seasonal permit limits for CBOD₅ concentrations in the effluent should be assigned as 8.0 mg/l in the summer and 12.0 mg/l in the winter. In addition, the DMR requirements specified in the Newton POTW permit should be modified to require monitoring of the facility's effluent for total ammonia as nitrogen concentrations. The results of ammonia monitoring should be submitted with quarterly DMR reports and checked to ensure that the ammonia nitrogen concentration of the Newton POTW effluent does not exceed 2.0 mg/l.

6.2 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 and a newspaper in Newton. The public will be given an opportunity to review the TMDL and submit comments. At the end of the 30-day period, MDEQ will determine the level of interest in the TMDL and make a decision on the necessity of holding a public hearing.

If a public hearing is deemed appropriate, the public will be given a 30-day notice of the hearing to be held at a location near the watershed. That public hearing would be an official hearing of the Mississippi Commission on Environmental Quality, and would be transcribed.

All comments received during the public notice period and at any public hearings become a part of the record of this TMDL. All comments will be considered in the ultimate approval of this TMDL by the Commission on Environmental Quality and for submission of this TMDL to EPA Region IV for final approval.

REFERENCES

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DEFINITIONS

5-Day Biochemical Oxygen Demand: Also called BOD₅, the amount of oxygen consumed by microorganisms while stabilizing or degrading carbonaceous or nitrogenous compounds under aerobic conditions over a period of 5 days.

Activated Sludge: A secondary wastewater treatment process that removes organic matter by mixing air and recycled sludge bacteria with sewage to promote decomposition

Aerated Lagoon: A relatively deep body of water contained in an earthen basin of controlled shape which is equipped with a mechanical source of oxygen and is designed for the purpose of treating wastewater.

Ammonia: Inorganic form of nitrogen (NH₃); product of hydrolysis of organic nitrogen and denitrification. Ammonia is preferentially used by phytoplankton over nitrate for uptake of inorganic nitrogen.

Ammonia Nitrogen: The measured ammonia concentration reported in terms of equivalent ammonia concentration; also called total ammonia as nitrogen (NH₃-N)

Ammonia Toxicity: Under specific conditions of temperature and pH, the unionized component of ammonia can be toxic to aquatic life. The unionized component of ammonia increases with pH and temperature.

Ambient Stations: A network of fixed monitoring stations established for systematic water quality sampling at regular intervals, and for uniform parametric coverage over a long-term period.

Assimilative Capacity: The capacity of a body of water or soil-plant system to receive wastewater effluents or sludge without violating the provisions of the State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters and Water Quality regulations.

Background: The condition of waters in the absence of man-induced alterations based on the best scientific information available to MDEQ. The establishment of natural background for an altered waterbody may be based upon a similar, unaltered or least impaired, waterbody or on historical pre-alteration data.

Biological Impairment: Condition in which at least one biological assemblages (e.g. , fish, macroinvertebrates, or algae) indicates less than full support with moderate to severe modification of biological community noted.

Carbonaceous Biochemical Oxygen Demand: Also called CBOD_u, the amount of oxygen consumed by microorganisms while stabilizing or degrading carbonaceous compounds under aerobic conditions over an extended time period.

Calibrated Model: A model in which reaction rates and inputs are significantly based on actual measurements using data from surveys on the receiving waterbody.

Conventional Lagoon: An un-aerated, relatively shallow body of water contained in an earthen basin of controlled shape and designed for the purpose of treating water.

Critical Condition: Hydrologic and atmospheric conditions in which the pollutants causing impairment of a waterbody have their greatest potential for adverse effects.

Daily Discharge: The "discharge of a pollutant" measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the "daily average" is calculated as the average.

Designated Use: Use specified in water quality standards for each waterbody or segment regardless of actual attainment.

Discharge Monitoring Report: Report of effluent characteristics submitted by a NPDES Permitted facility.

Dissolved Oxygen: The amount of oxygen dissolved in water. It also refers to a measure of the amount of oxygen that is available for biochemical activity in a water body. The maximum concentration of dissolved oxygen in a waterbody depends on temperature, atmospheric pressure, and dissolved solids.

Dissolved Oxygen Deficit: The saturation dissolved oxygen concentration minus the actual dissolved oxygen concentration.

DO Sag: Longitudinal variation of dissolved oxygen representing the oxygen depletion and recovery following a waste load discharge into a receiving water.

Effluent Standards and Limitations: All State or Federal effluent standards and limitations on quantities, rates, and concentrations of chemical, physical, biological, and other constituents to which a waste or wastewater discharge may be subject under the Federal Act or the State law. This includes, but is not limited to, effluent limitations, standards of performance, toxic effluent standards and prohibitions, pretreatment standards, and schedules of compliance.

Effluent: Treated wastewater flowing out of the treatment facilities.

First Order Kinetics: Describes a reaction in which the rate of transformation of a pollutant is proportional to the amount of that pollutant in the environmental system.

Groundwater: Subsurface water in the zone of saturation. Groundwater infiltration describes the rate and amount of movement of water from a saturated formation.

Impaired Waterbody: Any waterbody that does not attain water quality standards due to an individual pollutant, multiple pollutants, pollution, or an unknown cause of impairment.

Land Surface Runoff: Water that flows into the receiving stream after application by rainfall or irrigation. It is a transport method for nonpoint source pollution from the land surface to the receiving stream.

Load Allocation (LA): The portion of a receiving water's loading capacity attributed to or assigned to nonpoint sources (NPS) or background sources of a pollutant

Loading: The total amount of pollutants entering a stream from one or multiple sources.

Mass Balance: An equation that accounts for the flux of mass going into a defined area and the flux of mass leaving a defined area, the flux in must equal the flux out.

Nonpoint Source: Pollution that is in runoff from the land. Rainfall, snowmelt, and other water that does not evaporate become surface runoff and either drains into surface waters or soaks into the soil and finds its way into groundwater. This surface water may contain pollutants that come from land use activities such as agriculture; construction; silviculture; surface mining; disposal of wastewater; hydrologic modifications; and urban development.

Nitrification: The oxidation of ammonium salts to nitrites via *Nitrosomonas* bacteria and the further oxidation of nitrite to nitrate via *Nitrobacter* bacteria.

Nitrogenous Biochemical Oxygen Demand: Also called NBOD_u, the amount of oxygen consumed by microorganisms while stabilizing or degrading nitrogenous compounds under aerobic conditions over an extended time period.

NPDES Permit: An individual or general permit issued by the Mississippi Environmental Quality Permit Board pursuant to regulations adopted by the Mississippi Commission on Environmental Quality under Mississippi Code Annotated (as amended) §§ 49-17-17 and 49-17-29 for discharges into State waters.

Photosynthesis: The biochemical synthesis of carbohydrate based organic compounds from water and carbon dioxide using light energy in the presence of chlorophyll.

Point Source: Pollution loads discharged at a specific location from pipes, outfalls, and conveyance channels from either wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving stream.

Pollution: Contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the State, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance, or leak into any waters of the State, unless in compliance with a valid permit issued by the Permit Board.

Publicly Owned Treatment Works (POTW): A waste treatment facility owned and/or operated by a public body or a privately owned treatment works which accepts discharges which would otherwise be subject to Federal Pretreatment Requirements.

Reaeration: The net flux of oxygen occurring from the atmosphere to a body of water across the water surface.

Regression Coefficient: An expression of the functional relationship between two correlated variables that is often empirically determined from data, and is used to predict values of one variable when given values of the other variable.

Respiration: The biochemical process by means of which cellular fuels are oxidized with the aid of oxygen to permit the release of energy required to sustain life. During respiration, oxygen is consumed and carbon dioxide is released.

Sediment Oxygen Demand: The solids discharged to a receiving water are partly organics, which upon settling to the bottom decompose aerobically, removing oxygen from the surrounding water column.

Storm Runoff: Rainfall that does not evaporate or infiltrate the ground because of impervious land surfaces or a soil infiltration rate than rainfall intensity, but instead flows into adjacent land or waterbodies or is routed into a drain or sewer system.

Streeter-Phelps DO Sag Equation: An equation which uses a mass balance approach to determine the DO concentration in a waterbody downstream of a point source discharge. The equation assumes that the stream flow is constant and that CBOD_u exertion is the only source of DO deficit while reaeration is the only sink of DO deficit.

Total Ultimate Biochemical Oxygen Demand: Also called TBOD_u, the amount of oxygen consumed by microorganisms while stabilizing or degrading carbonaceous or nitrogenous compounds under aerobic conditions over an extended time period.

Total Kjeldahl Nitrogen: Also called TKN, organic nitrogen plus ammonia nitrogen.

Total Maximum Daily Load or TMDL: The calculated maximum permissible pollutant loading to a waterbody at which water quality standards can be maintained.

Waste: Sewage, industrial wastes, oil field wastes, and all other liquid, gaseous, solid, radioactive, or other substances which may pollute or tend to pollute any waters of the State.

Wasteload Allocation (WLA): The portion of a receiving water's loading capacity attributed to or assigned to point sources of a pollutant.

Water Quality Standards: The criteria and requirements set forth in *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. Water quality standards are standards composed of designated present and future most beneficial uses (classification of waters), the numerical and narrative criteria applied to the specific water uses or classification, and the Mississippi antidegradation policy.

Water Quality Criteria: Elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports the present and future most beneficial uses.

Waters of the State: All waters within the jurisdiction of this State, including all streams, lakes, ponds, wetlands, impounding reservoirs, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, situated wholly or partly within or bordering upon the State, and such coastal waters as are within the jurisdiction of the State, except lakes, ponds, or other surface waters which are wholly landlocked and privately owned, and which are not regulated under the Federal Clean Water Act (33 U.S.C.1251 et seq.).

Watershed: The area of land draining into a stream at a given location.

ABBREVIATIONS

7Q10.....	Seven-Day Average Low Stream Flow with a ten-year Occurrence Period
BASINS.....	Better Assessment Science Integrating Point and Nonpoint Sources
BMP	Best Management Practice
CBOD ₅	5-Day Carbonaceous Biochemical Oxygen Demand
CBOD _u	Carbonaceous Ultimate Biochemical Oxygen Demand
CWA	Clean Water Act
DMR.....	Discharge Monitoring Report
EPA	Environmental Protection Agency
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA.....	Load Allocation
MARIS	Mississippi Automated Resource Information System
MDEQ.....	Mississippi Department of Environmental Quality
MGD.....	Million Gallons per Day
MOS	Margin of Safety
NBOD ₅	5-Day Nitrogenous Biochemical Oxygen Demand
NBOD _u	Nitrogenous Ultimate Biochemical Oxygen Demand
NH ₃	Total Ammonia
NH ₃ -N.....	Total Ammonia as Nitrogen
NO ₂ + NO ₃	Nitrite Plus Nitrate
NPDES	National Pollution Discharge Elimination System
NPSM.....	Nonpoint Source Model
RBA.....	Rapid Biological Assessment

TBOD₅.....5-Day Total Biochemical Oxygen Demand
TBOD_uTotal Ultimate Biochemical Oxygen Demand
TKN.....Total Kjeldahl Nitrogen
TN.....Total Nitrogen
TOC.....Total Organic Carbon
TPTotal Phosphorous
USGS.....United States Geological Survey
WLA.....Waste Load Allocation