Draft

Total Maximum Daily Load

Evaluation

for

Ogeechee Creek

in the

Ogeechee River Basin

for

Dissolved Oxygen

Submitted to:
The U.S. Environmental Protection Agency
Region 4
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Submitted by:
The Georgia Department of Natural Resources
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EXECUTIVE SUMMARY

The State of Georgia assesses its waterbodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed waterbodies are placed into one of three categories, supporting designated use, not supporting designated use, or assessment pending, depending on water quality assessment results. These waterbodies are found on Georgia's 305(b) list as required by that section of the CWA that defines the assessment process, and are published in Water Quality in Georgia (GA EPD, 2010 – 2011). This document is available on the Georgia Environmental Protection Division (GA EPD) website (www.gaepd.org/Documents/305b.html).

Some of the 305(b) not supporting waterbodies are also assigned to Georgia's 303(d) list, named after that section of the CWA. Waterbodies on the 303(d) list are required to have a Total Maximum Daily Load (TMDL) evaluation for the water quality constituent(s) in violation of the water quality standard. The TMDL in this document is a revision of the 2007 Dissolved Oxygen TMDL for Ogeechee Creek. It was revised to incorporate new water quality monitoring data collected by GA EPD during 2013 in the Ogeechee Creek watershed. The TMDL process establishes the allowable pollutant loadings or other quantifiable parameters for a waterbody based on the relationship between pollutant sources and instream water quality conditions. This allows water quality-based controls to be developed to reduce pollution and restore and maintain water quality.

Every waterbody in the State has one or more designated uses, and each designated use has water quality criteria established to protect it. The State of Georgia has identified a stream segment of Ogeechee Creek as "not supporting" its designated use of "Fishing" due to violation of the dissolved oxygen (DO) water quality criteria. This waterbody was included in the State's 2002 303(d) list. The DO water quality criteria for a waterbody with a "Fishing" designated use are as follows:

> A daily average of 6.0 mg/L and no less than 5.0 mg/L at all times for waters designated as trout streams by the Wildlife Resources Division. A daily average of 5.0 mg/L and no less than 4.0 mg/L at all times for waters supporting warm water species of fish.

Certain waters of the State may have conditions where the DO is naturally lower than the numeric criteria specified above and therefore cannot meet these standards unless naturally occurring loads are reduced or streams are artificially or mechanically aerated. This is addressed in Georgia's *Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03(7) (GA EPD, 2004):

> *Natural Water Quality*. It is recognized that certain natural waters of the State may have a quality that will not be within the general or specific requirements contained herein. These circumstances do not constitute violations of water quality standards. This is especially the case for the criteria for dissolved oxygen, temperature, pH and fecal coliform. NPDES permits and Best Management Practices will be the primary mechanisms for ensuring that the discharges will not create a harmful situation.

United States Environmental Protection Agency (EPA) DO criteria are used to address these situations. Alternative EPA limits are defined as 90 percent of the naturally occurring DO concentration at critical conditions (USEPA, 1986).

> Where natural conditions alone create dissolved oxygen concentrations less than 110 percent of the applicable criteria means or minima or both, the minimum acceptable concentration is 90 percent of the natural concentration.

Accordingly, if the naturally occurring DO exceeds GA EPD numeric limits at critical conditions, then the GA EPD numeric limits apply. If naturally occurring DO is lower than the GA EPD numeric limits, then 90% of the natural DO will become the minimum allowable.

An important part of the TMDL analysis is the identification of potential source categories. Sources are broadly classified as either point or nonpoint sources. A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Nonpoint sources are diffuse, and generally, but not always, involve accumulation of oxygen demanding substances that wash off land surfaces as a result of storm events.

The process of revising the DO TMDL for Ogeechee Creek included developing a computer model for the listed segment. Georgia DOSAG, a steady state water quality model developed by the GA EPD was used. This model was calibrated to data collected in the Ogeechee Creek in the summer of 2002 and verified using data collected in the summer of 2013.

The various oxygen demanding loads and required reduction for Ogeechee Creek are summarized in the table below.

Oxygen Demanding Loads and Required Load Reduction

Stream Segment	Current Load (lbs/day)	TMDL Components				Percent Reduction
		WLA (lbs/day)	WLAsw (lbs/day)	LA (lbs/day)	TMDL (lbs/day)	
Ogeechee Creek	77.9	12.6	NA	21.2	33.8	57

Management practices that may be used to help reduce and/or maintain the Ultimate Oxygen Demand (UOD) loads include:

- Compliance with NPDES permit limits and requirements; and
- Application of Best Management Practices (BMPs) appropriate to reduce nonpoint sources.

The amount of oxygen demanding substances delivered to a stream is difficult to determine. However, the use of these management practices should improve stream water quality, and future monitoring will provide a measurement of TMDL implementation.

1.0 INTRODUCTION

1.1 Background

The State of Georgia assesses its waterbodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed waterbodies are placed into one of three categories depending on water quality assessment results; supporting designated use, not supporting designated use, or assessment pending. These waterbodies are found on Georgia's 305(b) list as required by that section of the CWA that addresses the assessment process, and are published in Water Quality in Georgia (GA EPD, 2010 – 2011). This document is available on the Georgia Environmental Protection Division (GA EPD) website (www.gaepd.org/Documents/305b.html).

A subset of the waterbodies that do not meet designated uses, those in Category 5 on the 305(b) list, are assigned to Georgia's 303(d) list, named after that section of the CWA. Waterbodies included in the 303(d) list are required to have a Total Maximum Daily Load (TMDL) evaluation for the water quality constituent(s) in violation of the water quality criteria. The TMDL in this document is a revision of the 2007 Dissolved Oxygen TMDL for Ogeechee Creek. The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions. This allows water quality based controls to be developed to reduce pollution and restore and maintain water quality.

Table 1 presents the segment of the Ogeechee Creek that is impaired for dissolved oxygen (DO) and was listed on the 2002 303(d) list.

Table 1. Waterbodies Listed on the 2002 303(d) list for Dissolved Oxygen in the Ogeechee Creek Watershed

Stream Segment	Location	Reach ID	Segment Length (miles)	Designated Use
Ogeechee Creek	Rd. S2178 to Ogeechee River near Oliver	R030602020201	7	Fishing

1.2 Watershed Description

The Ogeechee River Basin is located in central to southeastern Georgia, encompassing approximately 5,540 square miles. The Ogeechee River Basin is bordered by the Oconee and Altamaha River Basins to the west and the Savannah River Basin to the east. The Ogeechee River originates in Greene County, in central Georgia. In the headwaters, the North and South Forks of the Ogeechee River join to form the Ogeechee River. The River then flows approximately 245 miles southeast toward the Atlantic Ocean. Ogeechee Creek is located in Screven County and flows southeast to join the Ogeechee River near Oliver, Georgia. The Ogeechee Creek watershed is approximately 146 square miles and is wholly contained in the

Coastal Plain physiographic province. Figure 1 shows the location of Ogeechee Creek and the segment of Ogeechee Creek that is impaired for dissolved oxygen.

The land use characteristics of the Ogeechee Creek watershed were determined using data from the Georgia Land Use Trends (GLUT) for Year 2008. This raster land use trend product was developed by the University of Georgia – Natural Resources Spatial Analysis Laboratory (NARSAL) and follows land use trends for years 1974, 1985, 1991, 1998, 2001, 2005 and 2008. The raster data sets were developed from Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+). Some of the NARSAL land use types were reclassified, aggregated into similar land use types, and used in the final watershed characterization. Table 2 lists the watershed land use distribution for the Ogeechee Creek drainage area.

1.3 Water Quality Standard

The water use classification for the impaired Ogeechee Creek segment is "Fishing." The criterion violated is listed as DO. The potential cause listed was nonpoint sources. The "Fishing" use classification water quality standards for DO, as stated in the State of Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(6)(c)(iii) (GA EPD, 2011), are

> A daily average of 6.0 mg/L and no less than 5.0 mg/L at all times for waters designated as trout streams by the Wildlife Resources Division. A daily average of 5.0 mg/L and no less than 4.0 mg/L at all times for waters supporting warm water species of fish.

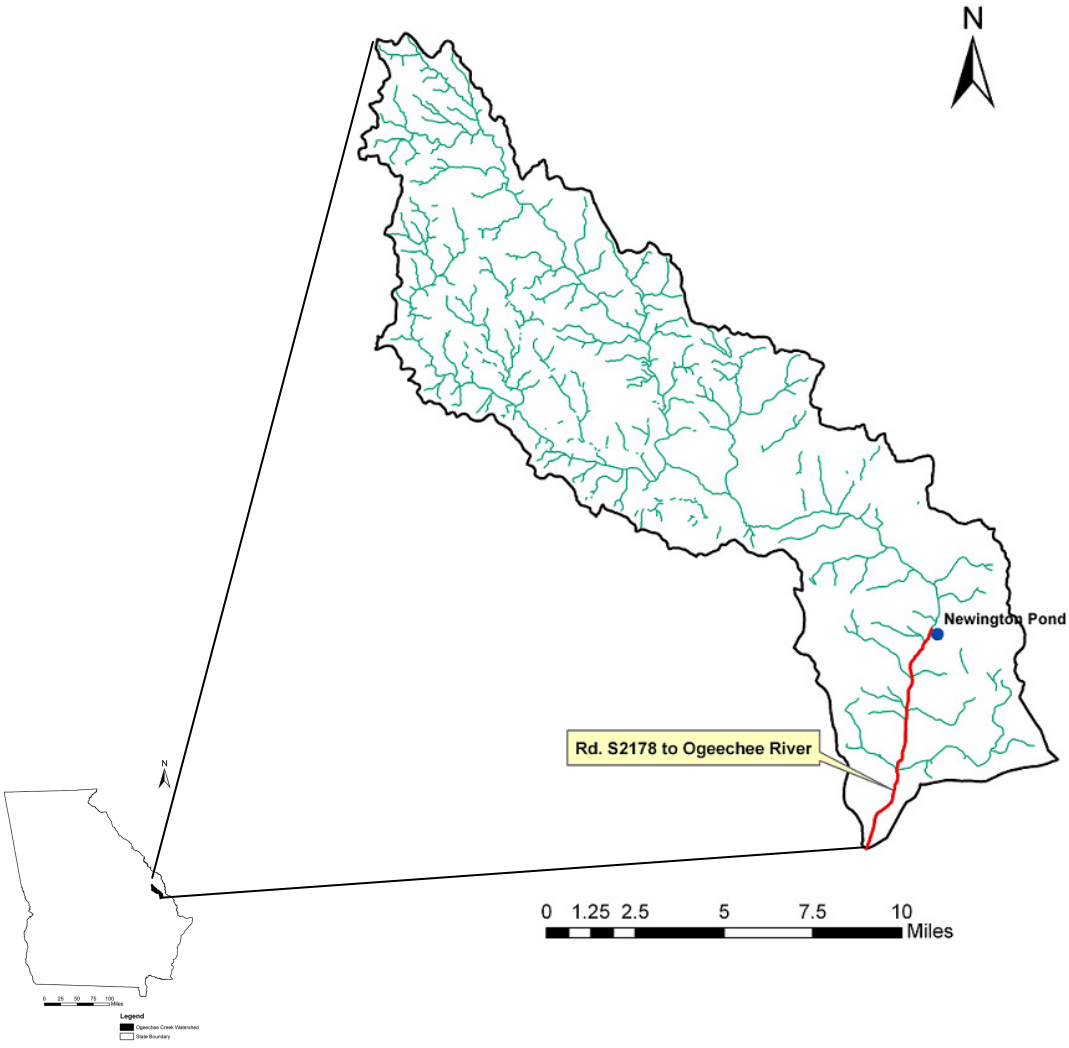
Certain waters of the State may have conditions where DO is naturally lower than the numeric criteria specified above and therefore cannot meet these standards unless naturally occurring loads are reduced or streams are artificially or mechanically aerated. This is addressed in Georgia's *Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03(7) (GA EPD, 2004):

> *Natural Water Quality*. It is recognized that certain natural waters of the State may have a quality that will not be within the general or specific requirements contained herein. These circumstances do not constitute violations of water quality standards. This is especially the case for the criteria for dissolved oxygen, temperature, pH and fecal coliform. NPDES permits and Best Management Practices will be the primary mechanisms for ensuring that the discharges will not create a harmful situation.

United States Environmental Protection Agency (EPA) DO criteria are used to address these situations. Alternative EPA limits are defined as 90 percent of the naturally occurring DO concentration at critical conditions (USEPA, 1986).

> Where natural conditions alone create dissolved oxygen concentrations less than 110 percent of the applicable criteria means or minima or both, the minimum acceptable concentration is 90 percent of the natural concentration.

Accordingly, if the naturally occurring DO exceeds GA EPD numeric limits at critical conditions, then the GA EPD numeric limits apply. If naturally occurring DO is lower than the GA EPD numeric limits, then 90% of the natural DO will become the minimum allowable.



TMDL Evaluation – Dissolved Oxygen Ogeechee Creek	Figure 1. Impaired Segment of Ogeechee Creek

Table 2. Ogeechee Creek Land Coverage

Stream	Land use Categories - Acres (Percent)													
	Open Water	Low intensity Residential	High Intensity Residential	High Intensity Commercial, Industrial, Transportation	Bare Rock, Sand, Clay	Quarries, Strip Mines, Gravel Pits	Transitional	Forest	Row Crops	Pasture, Hay	Other Grasses (Urban, recreational; e.g. parks, lawns)	Woody Wetlands	Emergent Herbaceous Wetlands	Total
Ogeechee Creek	648 (0.7)	1497 (1.6)	481 (0.5)	137 (0.1)	173 (0.2)	- -	3,439 (3.7)	37,183 (39.7)	24,424 (26.1)	4,301 (4.6)	3,263 (3.5)	17,670 (18.9)	429 (0.5)	93,644

2.0 WATER QUALITY ASSESSMENT

Stream segments are placed on the 303(d) list as not supporting their water use classification based on water quality sampling data. A stream is placed on this list if more than 10% of the samples exceed the DO criteria. During 2002, the United States Geological Survey (USGS) collected water quality data at 02202240 Ogeechee Creek at State Road 17 at Oliver, Georgia. Appendix A provides the water quality data for this station, and includes flow, DO, temperature, 5-day Biochemical Oxygen Demand (BOD_5), and ammonia data. These data show that low DO values usually occurred during the summer months when water temperatures are high and the dry weather flows are low or near zero.

During the period from September 4 to September 30, 2013, GA EPD deployed continuous monitors that measured DO, pH, temperature, and conductivity hourly at two locations on Ogeechee Creek. The upstream station was located at Old Creek Road and the downstream station was located at State Road 17. Figure A-3 in Appendix A shows the instream DO measured during this period. GA EPD also collected upstream and downstream water samples that were analyzed for BOD_5, ammonia, and nutrients from February to September 2013. These data were reviewed and analyzed and there are no notable differences between the upstream and downstream data (Table A-2 in Appendix A).

3.0 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of potential source categories. Sources are broadly classified as either point or nonpoint sources. A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Nonpoint sources are diffuse, and generally, but not always, involve accumulation of oxygen demanding substances on land surfaces that wash off as a result of storm events.

3.1 Point Source Assessment

Title IV of the Clean Water Act establishes the National Pollutant Discharge Elimination System (NPDES) permit program. Basically, there are two categories of NPDES permits: 1) municipal and industrial wastewater treatment facilities, and 2) regulated stormwater discharges.

3.1.1 Wastewater Treatment Facilities

In general, municipal and industrial wastewater treatment facilities have NPDES permits with effluent limits. These permit limits are either based on federal and state effluent guidelines (technology-based limits) or water quality standards (water quality-based limits).

EPA has developed technology-based guidelines, which establish a minimum standard of pollution control for municipal and industrial discharges without regard for the quality of the receiving waters. These are based on Best Practical Control Technology Currently Available (BPT), Best Conventional Control Technology (BCT), and Best Available Technology Economically Achievable (BAT). The level of control required by each facility depends on the type of discharge and the pollutant.

The EPA and the states have also developed numeric and narrative water quality standards. Typically, these standards are based on the results of aquatic toxicity tests and/or human health criteria and include a margin of safety. Water quality-based effluent limits are set to protect the receiving stream. These limits are based on water quality standards that have been established for a stream based on its intended use and the prescribed biological and chemical conditions that must be met to sustain that use.

Discharges from municipal and industrial wastewater treatment facilities can contribute oxygen-demanding substances to the receiving waters. The City of Newington is the only NPDES permitted discharge with effluent limits for oxygen consuming substances identified in the Ogeechee Creek watershed upstream from the listed segment. Table 3 provides the permitted flow, BOD_5, ammonia (NH_3), and DO limits for this facility that were recommended in the 2007 DO TMDL for Ogeechee Creek.

The 2007 DO TMDL states “The TMDL will be used to assess permit renewals. If necessary, GA EPD may modify the wasteload allocations (WLAs) during the NPDES permitting process. The assimilative capacity might not be fully allocated for all of the listed segments. Future wasteload allocations might be allowed if the discharge does not result in a concentration lower than 90 percent of the natural dissolved oxygen concentration during critical conditions. However, it should be noted that the Sediment Oxygen Demand (SOD) rates used in the TMDL allocation models were based on model predictions and may need to be verified before WLAs are implemented.”

Combined sewer systems convey a mixture of raw sewage and stormwater in the same conveyance structure to the wastewater treatment plant. These are considered a component of municipal wastewater treatment facilities. When the combined sewage exceeds the capacity of the wastewater treatment plant, the excess is diverted to a combined sewage overflow (CSO) discharge point. There are no permitted CSO outfalls in the Ogeechee River Basin.

Table 3. NPDES Facilities in the Ogeechee Creek Watershed

Facility Name	NPDES Permit No.	Receiving Stream	NPDES Permit Limits			
			Average Monthly Flow (MGD)	Average Monthly BOD_5 (mg/L)	Average Monthly NH_3 (mg/L)	Minimum DO (mg/L)
Newington Pond	GA0050202	Ogeechee Creek	0.045*	5*	1*	6*

* Recommended permit limits in the 2007 DO TMDL for Ogeechee Creek

3.1.2 Regulated Stormwater Discharges

Some stormwater runoff is covered under the NPDES Permit Program as a point source. Some industrial facilities included under the program will have limits similar to traditional NPDES permitted dischargers, whereas others establish controls "to the maximum extent practicable" (MEP). Currently, regulated stormwater discharges that may contain oxygen demanding substances consist of those associated with industrial activities and large, medium, and small municipal separate storm sewer systems (MS4s) that serve populations of 50,000 or more.

3.1.2.1 Industrial General Stormwater NPDES Permit

Stormwater discharges associated with industrial activities are currently covered under the 2012 General Stormwater NPDES Permit (GAR050000), also called the Industrial General Permit (IGP). This permit requires visual monitoring of stormwater discharges, site inspections, implementation of Best Management Practices (BMPs), and record keeping. The IGP requires that stormwater discharging into an impaired stream segment or within one linear mile upstream of, and within the same watershed as, any portion of an impaired stream segment identified as "not supporting" its designated use(s), must satisfy the requirements of Appendix C of the 2012 IGP if the pollutant(s) of concern for which the impaired stream segment has been listed may be exposed to stormwater as a result of industrial activity at the site. If a facility is covered under Appendix C of the IGP, then benchmark monitoring for the pollutant(s) of concern is required. There are no facilities in the Ogeechee Creek with an IGP.

3.1.2.2 MS4 NPDES Permits

Stormwater discharges from MS4s are very diverse in pollutant loadings and frequency of discharge. At present, all cities and counties within the state of Georgia that had a population of greater than 100,000 at the time of the 1990 Census are permitted for their stormwater discharge under Phase I. This includes 58 permittees in Georgia.

Phase I MS4 permits require the prohibition of non-stormwater discharges (i.e., illicit discharges) into the storm sewer systems and controls to reduce the discharge of pollutants to the maximum extent practicable, including the use of management practices, control techniques and systems, as well as design and engineering methods (Federal Register, 1990). A site-specific Stormwater Management Plan (SWMP) outlining appropriate controls is required by and referenced in the permit. There are seven Phase I MS4s in the Ogeechee River Basin (Table 4).

Table 4. Phase I Permitted MS4s in the Ogeechee River Basin

Name	Permit No.	Watershed
Bloomingdale	GAS000207	Ogeechee, Savannah
Chatham County	GAS000206	Ogeechee, Savannah
Garden City	GAS000208	Ogeechee, Savannah
Pooler	GAS000209	Ogeechee, Savannah
Savannah	GAS000205	Ogeechee, Savannah
Thunderbolt	GAS000211	Ogeechee
Tybee Island	GAS000212	Ogeechee, Savannah

Source: NonPoint Source Program, GA EPD, Atlanta, Georgia, 2013

Small MS4s serving urbanized areas are required to obtain a stormwater permit under the Phase II stormwater regulations. An urbanized area is defined as an entity with a residential population of at least 50,000 people and an overall population density of at least 1,000 people per square mile. There are six Phase II MS4s in the Ogeechee River Basin (Table 5).

Table 5. Phase II Permitted MS4s in the Ogeechee River Basin

Permittee	Watershed
Allenhurst	Ogeechee
Flemington	Ogeechee
Hinesville	Ogeechee
Richmond Hill	Ogeechee
Vernonburg	Ogeechee
Walthourville	Ogeechee

Source: NonPoint Source Program, GA EPD, Atlanta, Georgia, 2014

There are no Phase I or Phase II MS4 city or county urbanized areas upstream of the listed segment in the Ogeechee Creek watershed.

3.1.3 Confined Animal Feeding Operations

Under the Clean Water Act, Concentrated Animal Feeding Operations (CAFOs) are defined as point sources of pollution and are therefore subject to NPDES permit regulations. From 1999 through 2001, Georgia adopted rules for permitting swine and non-swine liquid manure animal feeding operations (AFOs). Georgia rules required medium size AFOs with more than 300 animal units (AU) but less than 1000 AU to apply for a non-discharge State land application system (LAS) waste disposal permit. Large operations with more than 1000 AU were required to apply for an NPDES permit (also non-discharge) as a CAFO. The EPA CAFO regulations were successfully appealed in 2005. They were revised to comply with the court's decision that NPDES permits only be required for actual discharges. Georgia's rules were amended on August 7, 2012, to reflect the EPA revisions. The revised state rules will continue LAS permitting of medium size liquid manure AFOs and extend LAS permitting to large liquid manure AFOs with more than 1000 AU, unless they elect to obtain an NPDES permit. There are no known swine and non-swine liquid manure CAFOs located upstream of the listed segment in the Ogeechee Creek watershed.

In 2002, the EPA promulgated expanded NPDES permit regulations for CAFOs that added dry manure poultry operations larger than 125,000 broilers or 82,000 layers. In accordance with the Georgia rule amendment discussed above, the general permit covering these facilities has been terminated and they are no longer covered under any permit. Georgia is consistently among the top three states in the U.S. in terms of poultry operations. The majority of poultry farms are dry manure operations where the manure is stored for a time and then land applied. Freshly stored litter can be a nonpoint source of pollutants. There are no known dry manure poultry operations located upstream of the listed segment in the Ogeechee Creek watershed.

3.2 Nonpoint Source Assessments

In general, nonpoint sources cannot be identified as entering a waterbody through a discrete conveyance at a single location. In dry years, stormwater may not contribute to significant wash off of materials into the streams. Constituents may have washed off of land surfaces in previous months or years and may have either: 1) flushed out of the system along with the water column flow; or 2) settled out and became part of the stream channel bottom.

Historic wash off of settleable materials may accumulate and exert SOD. Constituents of concern from surface washoff include the fractions of ammonia and BOD_5 that become an integral part of channel bottom sediments, thus becoming a potential source of SOD. Table 2 provides the land cover distributions for the listed Ogeechee Creek watershed. These data show that the watershed is predominately forested. Agriculture is the next predominant land use.

In addition to nonpoint sources of SOD associated with land disturbing activities, the Ogeechee Creek may receive significant natural contributions of oxygen demanding organic materials from local wetlands and forested stream corridors. The following are potential sources of naturally occurring organic materials:

- Adjacent wetlands, swamps, and marshes with organically rich bottom sediments; and
- Direct leaf litterfall onto water surfaces and adjacent floodplains from overhanging trees and vegetation.

Leaf litterfall is a major contributor to the amount of dissolved organic matter in the stream water column and the amount of SOD being exerted. Many streams in southern Georgia are also referred to as “blackwater” streams because of highly colored humic substances leached from surrounding marshes and swamps. In addition, low dissolved oxygen in blackwater streams is very common in the summer months when the temperatures are high and the flows are low (Meyer, 1992). The oxygen demanding effects of leaf litterfall are reflected in two ways: 1) by lowering the DO saturation of water entering the channel from adjacent swampy areas caused by decaying vegetation; and 2) by increasing SOD associated with vegetation decaying on stream channel bottoms.

3.2.1 Land Application Systems

Some communities and industries use land application systems (LAS) for wastewater disposal. These facilities are required through LAS permits to dispose of their treated wastewater by land application, and to operate as non-discharging systems, that do not contribute wastewater runoff to surface waters. However, sometimes the soil’s percolation rate is exceeded by over application of wastewater, and/or heavy precipitation is encountered, resulting in runoff. This runoff could contribute oxygen demanding substances to nearby surface waters. Runoff of stormwater might also carry surface residual containing oxygen demanding substances. There are no permitted LAS systems identified in the Ogeechee Creek watershed that could potentially impact the listed segment.

4.0 TECHNICAL APPROACH

The first step of the technical approach for this TMDL was to select the model that can be effectively used to analyze the Ogeechee Creek DO resources. After an appropriate model was selected, data was gathered to develop and calibrate the model. The calibrated model was then used to establish the TMDL during critical conditions. This modeling approach is described in the following sections.

4.1 Model Selection and Structure

Various analyses were performed to correlate the measured low DO concentrations to basic causes such as point and nonpoint contributions, flow conditions, stream and watershed characteristics, seasonal temperature effects, and others. From these analyses, the low DO values were found to coincide with low or zero flows, slow stream velocities, shallow water depths, and high temperatures. Since the impairments noted in 2002 occurred during sustained periods of low flows, a steady-state modeling approach was selected.

Georgia Dissolved Oxygen Sag (DOSAG) is a one-dimensional steady state water quality model that was developed by the GA EPD. The model was selected for the following reasons:

- It conforms to GA EPD standard practices for developing wasteload allocations;
- It works well for low flow and high temperature conditions;
- It can be developed with a limited dataset; and
- It is able to handle branching tributaries and both point and nonpoint source inputs.

Georgia DOSAG computes DO using an enhanced form of the Streeter-Phelps equation (Thomann and Mueller, 1987). The model applies the equation to each stream reach over small incremental distances. The model also provides a complete spatial view of a system, upstream to downstream. This allows the modeler to understand the important differences in stream behavior at various locations throughout a basin. Georgia DOSAG consists of a mainstem and may include an unlimited number of branches. Georgia DOSAG can also include an unlimited number of tributaries, point source discharges, water intakes, and low-head dams.

An updated DOSAG model for Ogeechee Creek was used to revise the 2007 DO TMDL for Ogeechee Creek. In the DOSAG model for the 2007 DO TMDL, the Newington WPCP is modeled as a direct discharge to Ogeechee Creek. However, the facility actually discharges to a ditch that flows to an unnamed tributary that discharges to Ogeechee Creek. The DOSAG model for Ogeechee Creek was updated to include the ditch and unnamed tributary as a branch of the mainstem Ogeechee Creek. This branch is approximately 0.25 mile long. There are no other point source discharges in the Ogeechee Creek watershed.

Two ArcGIS coverages, the USGS 12-digit HUC for Georgia and the National Geographic TOPO! 1:24,000 scale map, were used to determine drainage areas, stream lengths, and elevation for the revised model structure. Appendix B provides a summary of the revised model structure.

4.2 Model Calibration and Validation

The model calibration period was determined from an examination of streamflow and water quality data collected by USGS in Ogeechee Creek at State Road 17 at Oliver during 2002. The combination of the lowest flow, lowest DO, and highest water temperature occurred during June 2002. The average DO and average annual BOD_5 and ammonia values for June were extracted from the 2002 dataset for the sampling station. The average water temperature was 24.9 ^oC and the average streamflow was 0.77 cfs. Table 6 provides a summary of the June 2002 monitoring data used to develop the calibration model.

Table 6. Summary of the June 2002 Monitoring Data for Ogeechee Creek

Monitoring Station	Average BOD_5 (mg/L)	Average NH_3 (mg/L)	Average Flow (cfs)	Average DO (mg/L)	Average Water Temperature (deg C)
02202240 Ogeechee Creek at SR 17 at Oliver, GA	2.7	0.22	0.77	2.1	24.9

The headwater and tributary water quality boundaries were developed from these instream data, the expected low DO saturation values (Meyer, 1992), and the GA EPD standard modeling practices (GA EPD, 1978). Field measured BOD_5 was converted to Ultimate Carbonaceous Biochemical Oxygen Demand ($CBOD_U$) by multiplying by an f-ratio of 2.5 (GA EPD, 1978), and field measured ammonia was converted to Ultimate Nitrogenous Biochemical Oxygen Demand ($NBOD_U$) by multiplying by the stoichiometric conversion factor of 4.57.

Average monthly effluent discharge flows and BOD_5 concentrations for Newington Pond were obtained from 2002 Discharge Monitoring Reports (DMRs). These data were input into the calibration model. The effluent BOD_5 was converted to $CBOD_U$ by multiplying by an f-ratio of 2 if the BOD_5 was greater than 20 mg/L and an f-ratio of 3 if the BOD_5 was 20 mg/L or less (GA EPD, 1978). The effluent ammonia was converted to $NBOD_U$ by multiplying by 4.57. Table 7 is a summary of the effluent data from the facility for June 2002.

Table 7. Summary of NPDES Discharge During June 2002

Facility Name	NPDES Permit No.	Discharge for June 2002			
		Flow (MGD)	BOD_5 (mg/L)	NH_3 (mg/L)	DO (mg/L)
Newington Pond	GA0050202	0.004	34	17.4*	2.0*

*No permit limit or DMR data, assumed value

Stream velocities were calculated using the Velocity Coefficient method, which relates flow (Q) and velocity (V) by the expression $V = cQ^n$. Field measurements recorded when current-meter discharge measurements were made to calibrate the rating curves were analyzed to determine the velocity coefficient (c) and exponent (n). The field measurements collected by USGS in Ogeechee Creek at Oliver included discharge, stream width, cross-sectional area, and velocity. By graphing the flow versus velocity and fitting a power function through the data, the coefficient and exponent can be determined. Similarly, stream depths (D) were calculated using the equation $D = aQ^b$. Depths were obtained by dividing the stream cross-sectional area by the width. Then flows versus depths were graphed and a power function fitted through the data was used to determine the coefficient (a) and exponent (b).

The kinetic rates and input parameters developed during model calibration are provided in Table 8. These parameters include the carbonaceous BOD (CBOD) decay rate, nitrogenous BOD (NBOD) decay rate, SOD rate, and the Tsivoglou reaeration coefficient used to determine stream reaeration. Appendix C provides the $CBOD_5$, NH_3, and DO calibration curves plotted with the data from the monitoring station in the listed segment.

Table 8. Modeling Parameters

Parameter	DOSAG Values
CBOD Decay Rate (1/day)	0.1
NBOD Decay Rate (1/day)	0.1
SOD (g/m^2/day)	0.5 - 1.2
Reaeration Coefficient	0.054

Validation of the model parameters was performed by comparing predicted DO to measured DO collected at two locations on September 15-16, 2013. There was no effluent discharge from the Newington Pond during this period. The stream data for model validation are shown in Table 9.

Table 9. Ogeechee Creek Data for Model Validation

Station	Date	Estimated Streamflow (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (^oC)
Ogeechee Creek at Old Creek Road	9/15/2013	0.9	2.06	23.5
	9/16/2013	0.9	1.74	23.9
Ogeechee Creek at SR 17 at Oliver	9/15/2013	1.1	3.28	24.0
	9/16/2013	1.1	3.08	24.4

Results of the model validation are presented in Figure C-4 in Appendix C.

4.3 Critical Conditions Model

The critical conditions model was used to assess the DO criteria and to determine if there are water quality problems requiring regulatory intervention. The critical conditions model was developed in accordance with GA EPD standard practices (GA EPD, 1978).

Since daily flow data for Ogeechee Creek were limited at best, a low flow analysis of the available flow data from the nearby long-term USGS gage on Black Creek was performed. Flow data were analyzed to determine the 7-day, 10-year minimum flow (7Q10). The productivity factor, in cubic feet per second (cfs) per square mile, was computed by dividing the 7Q10 by the watershed area at the gage. The 7Q10 and incremental flows for the Ogeechee Creek

DOSAG model were calculated by multiplying the productivity factor developed from the USGS Black Creek gage by the modeled stream segment drainage areas.

The critical water temperature was determined using a harmonic curve-fitting procedure on the long-term stream temperature data for Ogeechee River at Oliver. A harmonic sine function was developed for the historical data (Dyar and Alhadeff, 1997). The highest summer-time temperature from the harmonic fit was used to represent the modeled stream segments. Table 10 provides the calculated monthly 7Q10s and water temperatures for Ogeechee Creek where the unnamed tributary enters the Creek.

Table 10. Ogeechee Creek Monthly 7Q10s and Water Temperatures

Month	7Q10 Flow (cfs)	Critical Water Temperature (deg C)
January	2.46	10
February	3.52	12
March	5.16	16
April	0.35	21
May	0.12	25
June	0.12	28
July	0.12	28
August	0.12	28
September	0.23	26
October	0.23	22
November	0.29	16
December	0.76	12
Annual	0.12	28

The Newington Pond discharge was incorporated into the critical conditions model at its current NPDES permit limits (B.1. Flow = 0.045 MGD, BOD_5 = 30 mg/L). Because the NPDES permit for the facility does not have DO and ammonia limits, values of 2 mg/L and 17.4 mg/L were assumed, respectively. Water quality boundaries, the SOD rate, and all other modeling rates and constants were the same as those in the calibration model.

4.4 Natural Conditions Model

For the natural conditions model, all point source discharges were removed from the critical conditions model. All other model parameters remained the same. This model was used to determine the natural DO concentrations during critical conditions. The model predicted the natural DO concentrations, during the critical summer months, to be less than 5.0 mg/L. It is important to note: 1) even though DO was found to be low in the summer of 2002, the results are even lower at standard critical conditions; and 2) the summer of 2002 conditions are very close to critical conditions. Results of the natural conditions run are plotted in the graphs in Appendix C along with the calibration, validation, and TMDL results for comparison.

5.0 TOTAL MAXIMUM DAILY LOADS

A TMDL is the amount of a pollutant that can be assimilated by the receiving waterbody without exceeding the applicable water quality standard. A TMDL is the sum of the individual wasteload allocations (WLAs) from point sources and load allocations (LAs) from nonpoint sources, as well as the natural background (40 CFR 130.2) for a given waterbody. The TMDL must also include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the water quality response of the receiving waterbody (USEPA, 1991). TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measures. For oxygen demanding substances, this TMDL is expressed in lbs/day.

Conceptually, a TMDL can be expressed as follows:

$$TMDL = \Sigma WLAs + \Sigma LAs + MOS$$

This TMDL determines the allowable oxygen demanding loads to the listed segment of Ogeechee Creek. The following sections describe the various oxygen demanding sources that may contribute loads to the TMDL components.

5.1 Waste Load and Load Allocations

The WLA is the portion of the receiving water's loading capacity that is allocated to existing or future point sources. WLAs are provided to the point sources from municipal and industrial wastewater treatment systems, as well as permitted stormwater discharges. There is one NPDES permitted facility in the Ogeechee Creek watershed. Table 11 lists the WLA required to meet the target DO standard.

Table 11. Ogeechee Creek WLA

Facility Name	NPDES Permit No.	Receiving Stream	NPDES Permit Limits			
			Average Monthly Flow (MGD)	Average Monthly BOD_5 (mg/L)	Average Monthly NH_3 (mg/L)	Minimum DO (mg/L)
Ogeechee Creek						
Newington Pond	GA0050202	Ogeechee Creek	0.045	10.0	0.8	6.0

The Georgia DOSAG critical conditions model was used to determine the WLA for the discharge within the listed segment in order to meet the DO standards. The WLA is based on EPA DO Criteria, which states that if the natural DO is less than the standard, then only a 10 percent reduction in the natural condition is allowed. The target limits are defined as 90 percent of the naturally occurring DO concentration at critical conditions. Appendix C contains plots of the DO concentrations resulting from the TMDL loads versus the target DO criteria. Note that if the TMDL plot is higher than the target DO criteria plot, there is additional assimilative capacity in the stream available for future WLA.

When a wasteload allocation predicts the critical DO concentrations to be less 3.0 mg/L, the biological integrity of the stream will need to be evaluated. The biological evaluation should

include a habitat assessment, aquatic macroinvertebrate community assessment, fish community assessment, and in-situ physical and chemical measurements. The most updated Standard Operating Procedures (SOP) should be used for the macroinvertebrate and fish assessments.

The TMDL will be used to assess permit renewals. If necessary, GA EPD may modify the WLA during the NPDES permitting process. The assimilative capacity might not be fully allocated for the listed segment of Ogeechee Creek. Future wasteload allocations might be allowed if the discharge does not result in a concentration lower than 90 percent of the natural dissolved oxygen concentration during critical conditions. However, it should be noted that the decay rates used in the TMDL allocation models were based on model predictions and may need to be verified before WLAs are implemented.

State and Federal Rules define stormwater discharges covered by NPDES permits as point sources. However, stormwater discharges are from diffuse sources and there are multiple stormwater outfalls. Stormwater sources (point and nonpoint) are different than traditional NPDES permitted sources in four respects: 1) they do not produce a continuous (pollutant loading) discharge; 2) their pollutant loading depends on the intensity, duration, and frequency of rainfall events, over which the permittee has no control; 3) the activities contributing to the pollutant loading may include the various allowable activities of others, and control of these activities is not solely within the discretion of the permittee; and 4) they do not incorporate wastewater treatment plants that control specific pollutants to meet numeric limits.

The intent of stormwater NPDES permits is not to treat the water after collection, but to reduce the exposure of stormwater to pollutants by implementing various controls. It would be infeasible and prohibitively expensive to control pollutant discharges from each stormwater outfall. Therefore, stormwater NPDES permits require the establishment of controls or BMPs to reduce pollutants entering the environment.

The Georgia DOSAG Ogeechee Creek model was run under critical conditions, assuming 7Q10 flows and dry weather conditions. Because the critical conditions occur when there are no storm events, no numeric allocation is given to the wasteload allocations from stormwater discharges (WLAsw).

The nonpoint source loads for the existing LA and TMDL were computed from the model boundary conditions, which include the stream, tributary, and headwater model boundaries under critical conditions. The partitioning of allocations between point (WLA) and nonpoint (LA) sources shown in Table 12 is based on modeling results and professional judgment.

5.2 Seasonal Variation

The low flow, high temperature critical conditions incorporated in this TMDL are assumed to represent the most critical design conditions and provide protection of water quality during April-November. This TMDL is expressed as a total load during this critical low flow period. Seasonal limits for December-March will be determined based on the critical monthly flows and water temperatures given in Table 10.

5.3 Margin of Safety

The MOS is a required component of TMDL development. As specified by section 303(d) of the CWA, the MOS must account for any lack of knowledge concerning the relationship

between effluent limitations and water quality. There are two basic methods for incorporating the MOS: 1) implicitly incorporate the MOS using conservative model assumptions to develop allocations, or 2) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations.

For this TMDL, the MOS was implicitly incorporated in the use of the following conservative modeling assumptions:

- Critical 7Q10 flows;
- Hot summer temperatures;
- Conservative reaction rates; and
- The assumption that all point sources continuously discharge at their NPDES permit limits for the same critical period.

Table 12. TMDL Load for Ogeechee Creek under Critical Conditions

Stream Segment	WLA (lbs/day)	WLAsw (lbs/day)	LA (lbs/day)	TMDL (lbs/day)
Ogeechee Creek	12.6	NA	21.2	33.8

Note: TMDL expressed as Ultimate Oxygen Demand (UOD), which includes the Carbonaceous Biochemical Oxygen Demand (CBOD) and the Nitrogenous Biochemical Oxygen Demand (NBOD).
NA = no stormwater discharges associated with MS4s contributing to the listed segment during critical conditions

6.0 RECOMMENDATIONS

6.1 Monitoring

Water quality monitoring is conducted at a number of locations across the State each year. The revised TMDL Implementation Plan for Ogeechee Creek will include monitoring plans which describe pertinent current or impending water quality monitoring activities, recommended future monitoring activities, and suggest procedures for coordinating those activities.

6.2 Reasonable Assurance

The GA EPD is responsible for administering and enforcing laws to protect the waters of the State. The GA EPD is the lead agency for implementing the State's Nonpoint Source Management Program. Regulatory responsibilities that have a bearing on nonpoint source pollution include establishing water quality standards and use classifications, assessing and reporting water quality conditions, and regulating land use activities that may affect water quality. Georgia is working with local governments, agricultural, and forestry agencies such as the Natural Resources Conservation Service, the Georgia Soil and Water Conservation Commission, and the Georgia Forestry Commission, to foster the implementation of BMPs that address nonpoint source pollution. In addition, public education efforts are being targeted to individual stakeholders to provide information regarding the use of BMPs to protect water quality.

6.3 Public Participation

A thirty-day public notice period will be provided for this TMDL. During that time, the availability of the TMDL will be publicly noticed, a copy of the TMDL will be provided on the web, and the public will be invited to provide comments on the TMDL. This TMDL will be modified to address the comments received.

7.0 INITIAL TMDL IMPLEMENTATION PLAN

GA EPD has coordinated with EPA to prepare this Initial TMDL Implementation Plan for this TMDL. GA EPD and EPA have executed a Memorandum of Understanding that documents the schedule for developing the more comprehensive plans. This Initial TMDL Implementation Plan includes a list of BMPs and provides for an initial implementation demonstration project to address one of the major sources of pollutants identified in this TMDL, while State and/or local agencies work with local stakeholders to develop a revised TMDL Implementation Plan. It also includes a process whereby GA EPD and/or Regional Development Centers (RDCs), or other GA EPD contractors (hereinafter, "GA EPD Contractors"), will develop expanded plans (hereinafter, "Revised TMDL Implementation Plans").

This Initial TMDL Implementation Plan, written by GA EPD and for which GA EPD and/or the GA EPD Contractor are responsible, contains the following elements.

1. NPDES permit discharges are a primary source of excessive pollutant loading, where they are a factor. Any WLAs in this TMDL will be implemented in the form of water-quality based effluent limitations in NPDES permits issued under CWA Section 402. [See 40 C.F.R. § 122.44(d)(1)(vii)(B)]. Nonpoint sources are the secondary cause of excessive pollutant loading in most cases. EPA has identified a number of management strategies for the control of nonpoint sources of pollutants, representing some BMPs. The "Management Measure Selector Table" shown below identifies these management strategies by source category and pollutant.

2. GA EPD and the GA EPD Contractor will select and implement one or more BMP demonstration projects for each River Basin. The purpose of the demonstration projects will be to evaluate by River Basin and pollutant parameter the site-specific effectiveness of one or more of the BMPs chosen. GA EPD intends that the BMP demonstration project be completed before the Revised TMDL Implementation Plan is issued. The BMP demonstration project will address the major pollutant categories of concern for the respective River Basin as identified in the TMDLs. The demonstration project need not be of a large scale, and may consist of one or more measures from the Table or equivalent BMP measures proposed by the GA EPD Contractor and approved by GA EPD. Other such measures may include those found in EPA's "*Best Management Practices Handbook*," the *"NRCS National Handbook of Conservation Practices*," or any similar reference, or measures that the volunteers, etc., devise that GA EPD approves. If for any reason the GA EPD Contractor does not complete the BMP demonstration project, GA EPD will take responsibility for doing so.

As part of the Initial TMDL Implementation Plan, the GA EPD brochure entitled *"Watershed Wisdom -- Georgia's TMDL Program*" will be distributed by GA EPD to the GA EPD Contractor for use with appropriate stakeholders for this TMDL.

Management Measure Selector Table

Land Use	Management Measures	*Fecal Coliform*	*Dissolved Oxygen*	*pH*	*Oxygen demanding substances*	*Temperature*	*Toxicity*	*Mercury*	*Metals (copper, lead, zinc, cadmium)*	*PCBs, toxaphene*
Agriculture	1. Oxygen demanding substances & Erosion Control	_	_		_	_				
	2. Confined Animal Facilities	_	_							
	3. Nutrient Management	_	_							
	4. Pesticide Management		_							
	5. Livestock Grazing	_	_		_	_				
	6. Irrigation		_		_	_				
Forestry	1. Preharvest Planning				_	_				
	2. Streamside Management Areas	_	_		_	_				
	3. Road Construction & Reconstruction		_		_	_				
	4. Road Management		_		_	_				
	5. Timber Harvesting		_		_	_				
	6. Site Preparation & Forest Regeneration		_		_	_				
	7. Fire Management	_	_	_	_	_				
	8. Revegetation of Disturbed Areas	_	_	_	_	_				
	9. Forest Chemical Management		_			_				
	10. Wetlands Forest Management	_	_	_		_		_		

Land Use	Management Measures	*Fecal Coliform*	*Dissolved Oxygen*	*pH*	*Oxygen demanding substances*	*Temperature*	*Toxicity*	*Mercury*	*Metals (copper, lead, zinc, cadmium)*	*PCBs, toxaphene*
Urban	1. New Development	–	–		–	–			–	
	2. Watershed Protection & Site Development	–	–		–	–		–	–	
	3. Construction Site Erosion and Oxygen demanding substances Control		–		–	–				
	4. Construction Site Chemical Control		–							
	5. Existing Developments	–	–		–	–			–	
	6. Residential and Commercial Pollution Prevention	–	–							
Onsite Wastewater	1. New Onsite Wastewater Disposal Systems	–	–							
	2. Operating Existing Onsite Wastewater Disposal Systems	–	–							
Roads, Highways and Bridges	1. Siting New Roads, Highways & Bridges	–	–		–	–			–	
	2. Construction Projects for Roads, Highways and Bridges		–		–	–				
	3. Construction Site Chemical Control for Roads, Highways and Bridges		–							
	4. Operation and Maintenance-Roads, Highways and Bridges	–	–			–			–	

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APPENDIX A

Water Quality Data

Figure A-1
Dissolved Oxygen and Temperature Measurements
02202240 Ogeechee Creek at State Road 17 at Oliver, Georgia

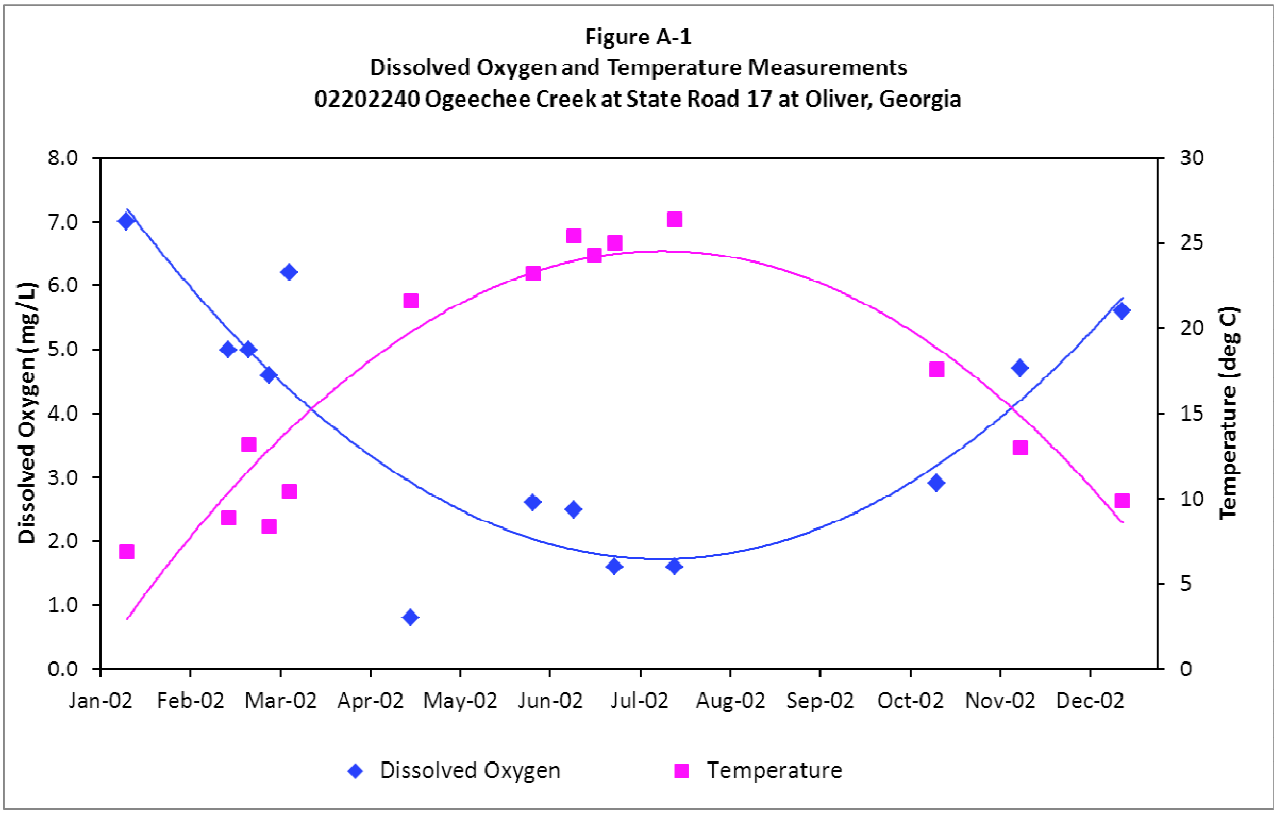


Figure A-2
Dissolved Oxygen and Instantaneous Flow Measurements
02202240 Ogeechee Creek at State Road 17 at Oliver, Georgia

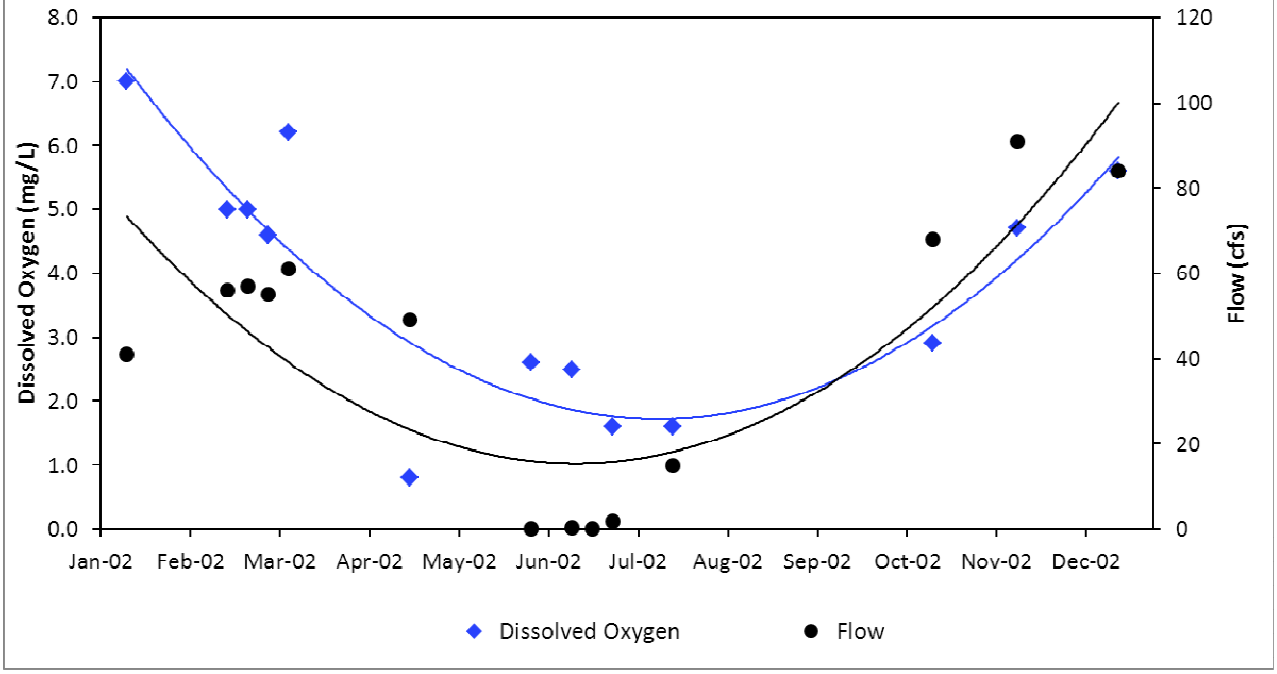


Table A-1. Data for Figures A-1 and A-2

Date	Instantaneous Flow On Sample Day (cfs)	Dissolved Oxygen (mg/L)	Temperature (deg C)	TOC (mg/L)	BOD_5 (mg/L)	Ammonia (mg/L)
10-Jan-02	41.0	7.0	6.9	13.0	1.0	0.04
14-Feb-02	56.0	5.0	8.9	22.0	0.8	<0.01
21-Feb-02	57.0	5.0	13.2			
28-Feb-02	55.0	4.6	8.4			
7-Mar-02	61.0	6.2	10.4	24.0	1.3	0.01
18-Apr-02	49.0	0.8	21.6	25.0	2.1	0.21
30-May-02	0.2	2.6	23.2	26.0	5.0	0.02
13-Jun-02	0.3	2.5	25.4			
20-Jun-02	0.1		24.3			
27-Jun-02	1.9	1.6	25.0	17.0	2.7	0.22
18-Jul-02	15.0	1.6	26.4	36.0	1.6	0.02
16-Oct-02	68.0	2.9	17.6			
14-Nov-02	91.0	4.7	13.0	38.0	2.1	0.02
19-Dec-02	84.0	5.6	9.9	23.0	0.8	<0.01

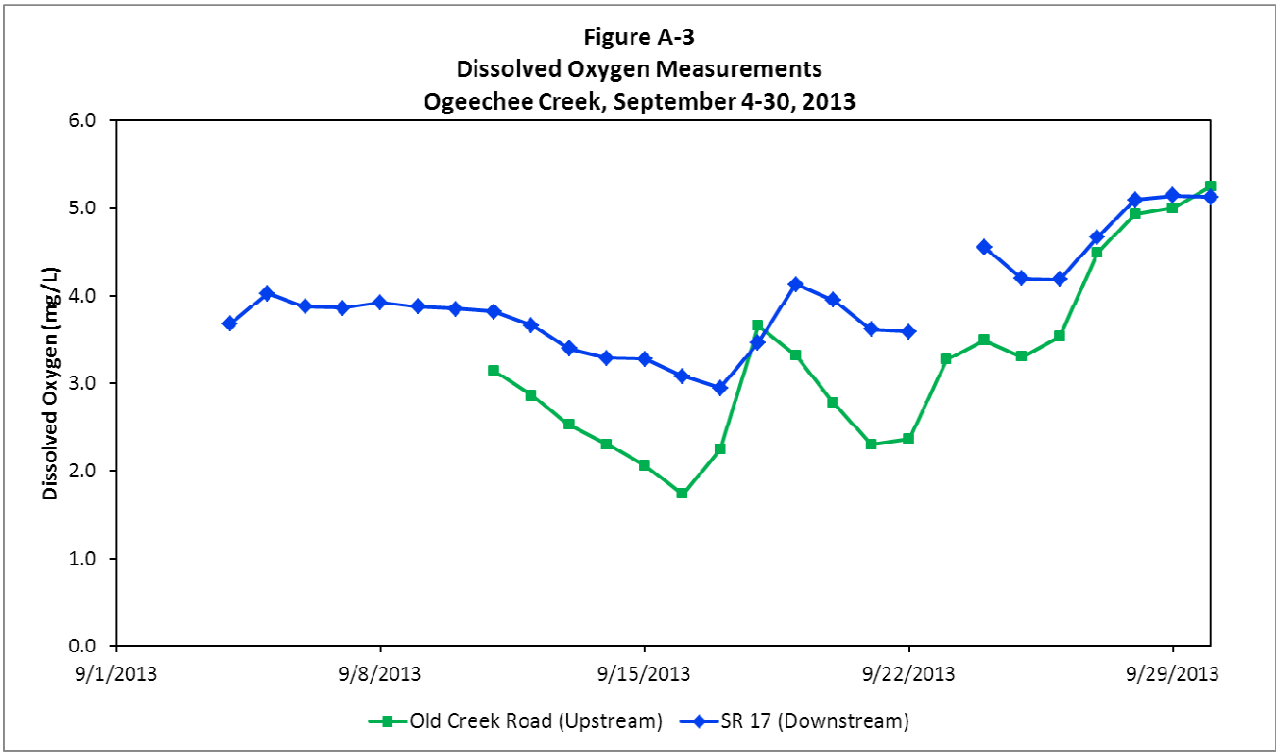


Table A-2. Water quality data at two sites on Ogeechee Creek, February-September 2013

Date	Dissolved Oxygen (mg/L)	TOC (mg/L)	BOD_5 (mg/L)	Ammonia (mg/L)	Total P (mg/L)	Total N (mg/L)
Ogeechee Creek at Old Creek Road near Newington, Georgia						
11-Feb-13	5.72	20	<2	0.18	0.03	1.16
11-Mar-13	7.36	19	<2	<0.03	0.03	0.75
23-Apr-13	6.01	32	<2	0.07	0.05	1.32
14-May-13	4.80	33	<2	0.25	0.07	1.72
26-Jun-13	3.99	36	<2	0.09	0.06	1.44
22-Jul-13	4.91	34	<2	0.08	0.06	1.32
14-Aug-13	2.08	36	<2	0.03	0.08	1.54
11-Sep-13	2.94	25	<2	<0.03	0.07	1.21
Ogeechee Creek at State Road 17 at Oliver, Georgia						
11-Feb-13	7.02	23	<2	<0.03	0.05	0.74
11-Mar-13	7.63	21	<2	<0.03	0.03	0.73
23-Apr-13	6.17	36	2.1	0.06	0.06	1.32
14-May-13	5.27	33	<2	0.12	0.09	1.52
26-Jun-13	4.49	38	<2	0.04	0.07	1.33
22-Jul-13	5.01	35	<2	0.04	0.08	1.35
14-Aug-13	2.92	36	<2	0.05	0.10	1.48
11-Sep-13	3.43	27	<2	<0.03	0.09	1.26

APPENDIX B

Model Structure

Ogeechee Creek Model Structure – Watershed Designation

Reach Type		Reach Name	Reach Length (mile)	Drainage Area (mi^2)	Elevation Change (ft)
Ogeechee Creek					
		Headwater		9.27	
1	S	Headwater to RM 27	2.79	6.44	19.7
2	S	RM 27 to RM 24.5	2.65	4.7	19.7
3	S	RM 24.5 to Unnamed Trib 1	2.63	5.63	16.4
4	T	Unnamed Trib 1	-	3.4	-
5	S	Unnamed Trib 1 to RM 20.6	1.29	4.85	5.4
6	S	RM 20.6 to RM 19.6	0.95	2.74	3.9
7	S	RM 19.6 to RM 18.6	0.99	1.17	4.1
8	S	RM 18.6 to S Fork Ogeechee Ck	1.52	1.43	6.3
9	B	S Fork Ogeechee Creek	-	-	-
10	S	S Fork Ogeechee to Robbins Branch	2.48	1.6	8.1
11	T	Robbins Branch Trib	-	9.93	-
12	S	Robbins Branch to RM 12	2.67	6.1	8.8
13	S	RM 12 to RM 10.4	1.53	6.8	5
14	S	RM 10.4 to RM 9	1.34	5.5	4.4
15	S	RM 9 to Old Creek Road	3.08	15.2	10.5
16	S	Old Creek Road to Unnamed Trib_Newington Pond	0.47	0.34	2.1
17	B	Unnamed Trib_Newington Pond	-	-	-
18	S	UT_Newington Pond to Nancy Branch	2.35	9.7	11.9
19	T	Nancy Branch Trib	-	5.2	-
20	S	Nancy Branch to SR 17	1.97	11.4	10
21	S	SR 17 to Ogeechee River	2.3	2.9	6.5
South Fork Ogeechee Creek					
		Headwater		4.85	
22	S	Headwater to Elevation 207 NGVD	2.3	2.31	23.9
23	S	Elevation 207 NGVD to D/S Stoopto Rd	1.96	1.87	20.5
24	S	D/S Stoopto Rd to Hen Coop Branch	2.38	3.64	20.5
25	T	Hen Coop Branch Trib	-	7.23	-
26	S	Hen Coop Branch to Unnamed Trib 2	3.25	3.36	13.2
27	T	Unnamed Trib 2	-	3.51	-
28	S	Unnamed Trib 2 to Ogeechee Creek	2.4	5.13	10.5
Unnamed Tributary_Newington Pond					
		Headwater		0.14	
29	D	Newington Pond (GA0050202)	-	-	-
30	S	Newington Pond to Ogeechee Creek	0.25	0.03	4.1

APPENDIX C

Calibration, Validation, Natural Conditions, and TMDL Model Curves

Figure C-1
Model Calibration: $CBOD_5$
02202240 Ogeechee Creek at State Road 17 at Oliver, GA

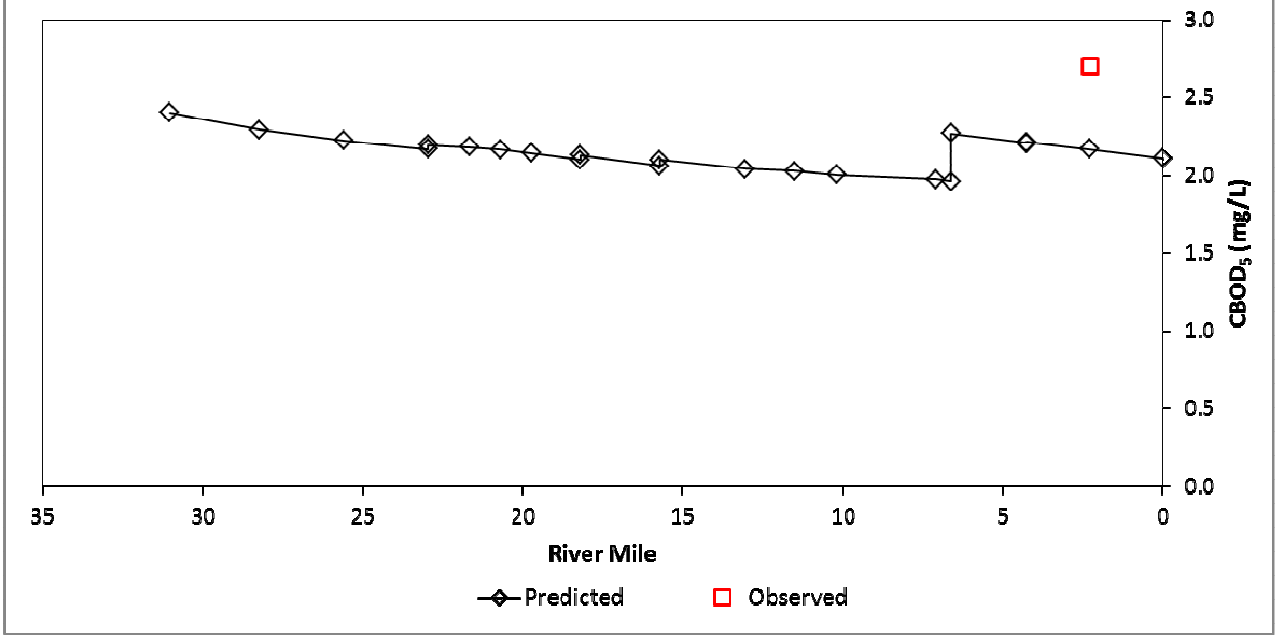


Figure C-2
Model Calibration: NH_3 as N
02202240 Ogeechee Creek at State Road 17 at Oliver, GA

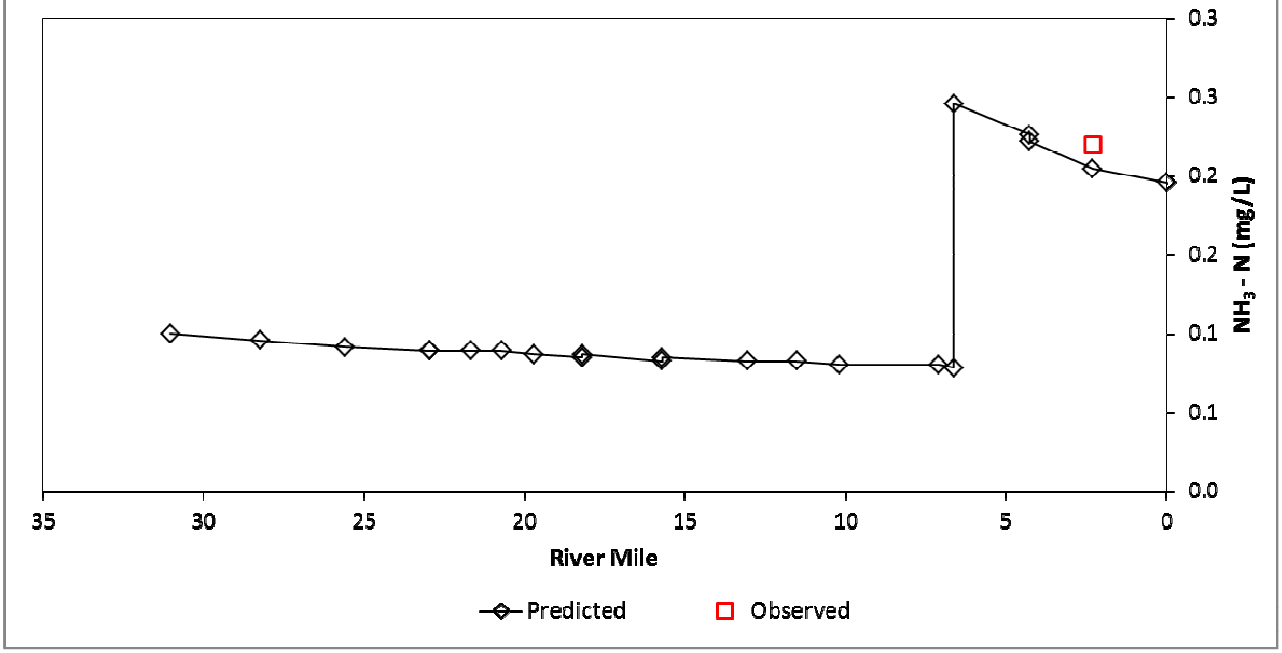


Figure C-3
Model Calibration: DO
02202240 Ogeechee Creek at State Road 17 at Oliver, GA

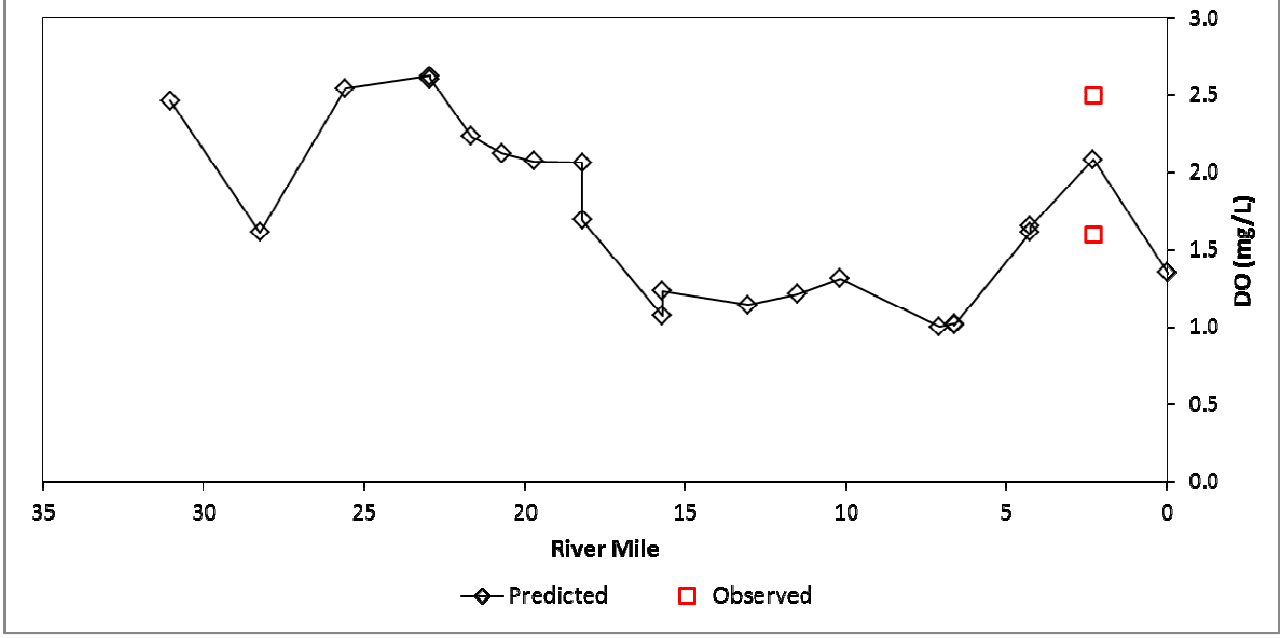


Figure C-4
Model Validation: DO
Ogeechee Creek

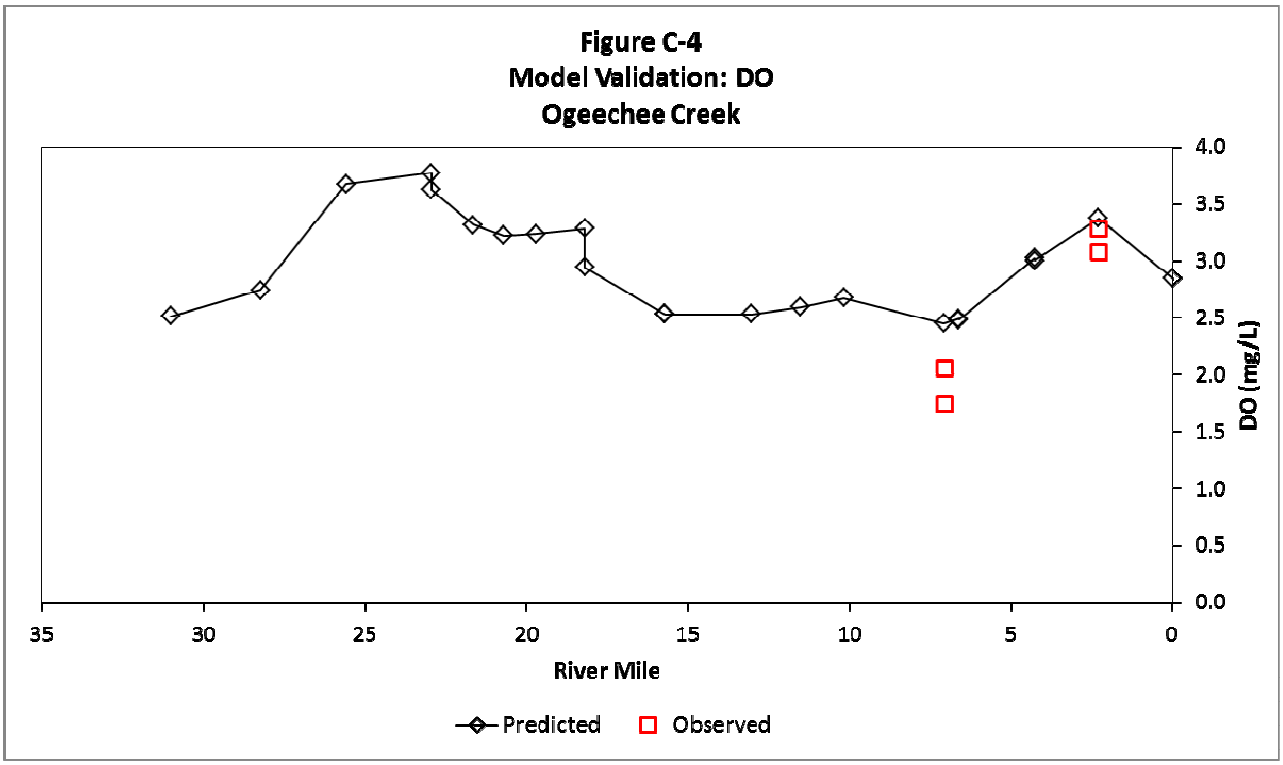
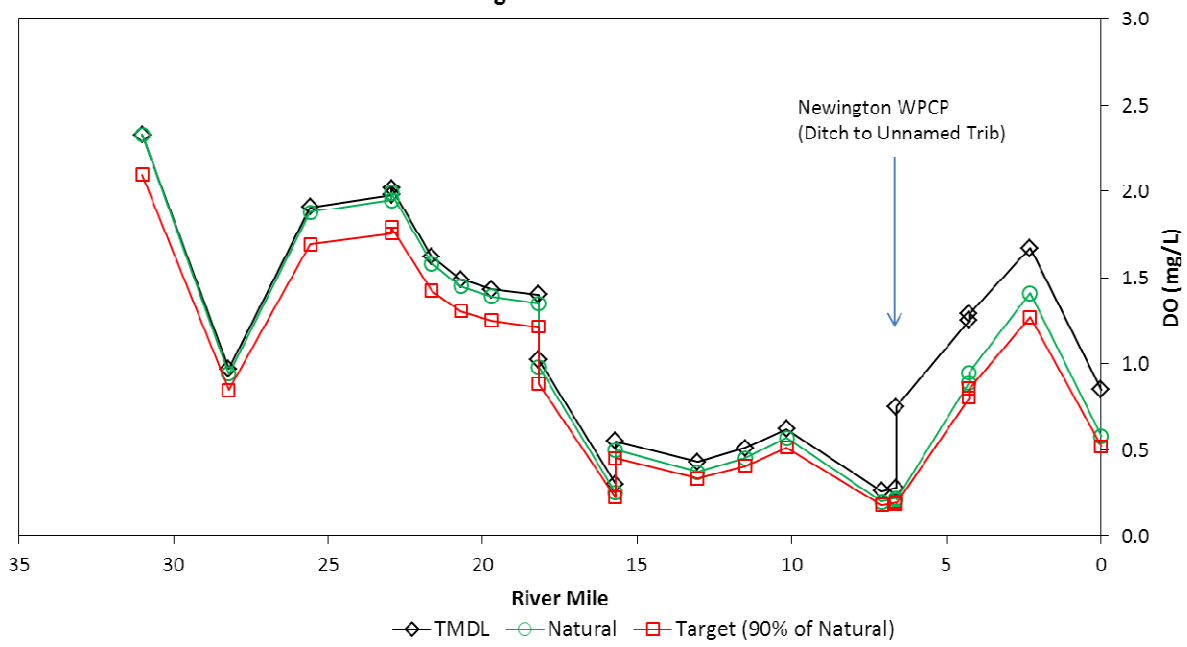


Figure C-5
TMDL Model Results: DO
Ogeechee Creek



APPENDIX D

Daily Oxygen Demanding Substances Load Summary Memorandum

SUMMARY MEMORANDUM
Average Annual Oxygen Demanding Substances Load
Ogeechee Creek

1. 303(d) Listed Waterbody Information

State:	**Georgia**
County:	**Screven**
Major River Basin:	**Ogeechee**
8-Digit Hydrologic Unit Code(s):	**03060202**
Waterbody Name:	**Ogeechee Creek**
Location:	**Rd S2178 to Ogeechee River near Oliver**
Stream Length:	**7 miles**
Watershed Area:	**146 square miles**
Tributary to:	**Ogeechee River**
Ecoregion:	**Southern Coastal Plain**
Constituent(s) of Concern:	**Dissolved Oxygen**
Designated Use:	**Fishing (not supporting designated use)**

Applicable Water Quality Standards:

A daily average of 6.0 mg/L and no less than 5.0 mg/L at all times for waters designated as trout streams by the Wildlife Resources Division. A daily average of 5.0 mg/L and no less than 4.0 mg/L at all times for waters supporting warm water species of fish.

***Natural Water Quality*. It is recognized that certain natural waters of the State may have a quality that will not be within the general or specific requirements contained herein. These circumstances do not constitute violations of water quality standards. This is especially the case for the criteria for dissolved oxygen, temperature, pH and fecal coliform. NPDES permits and Best Management Practices will be the primary mechanisms for ensuring that the discharges will not create a harmful situation.**

2. TMDL Development

Analysis/Modeling:	**Georgia DOSAG – Steady state water quality model developed by Georgia Environmental Protection Division.**
Calibration Data:	**USGS field data for June 2002.**
Critical Conditions:	**(1) 7Q10 flows based on low-flow analysis of available data from the Ogeechee River Basin. (2) Temperatures were derived from historic trend monitoring data in *Stream-Temperature Characteristics in Georgia (Dyar and Alhadeff, 1997).***

(3) No point source discharges at current conditions.
(4) Velocities, kinetic rates, reaeration rates, and boundary conditions as per the guidance provided in the Georgia DOSAG Modeling Procedures Manual.
(5) Same depths, velocities, kinetic rates, reaeration rates, and boundary conditions as calibration conditions.

3. Allocation Watershed/Stream Reach:

Wasteload Allocations (WLA):
Newington Pond **12.6 lbs/day**

Wasteload Allocations (WLAsw): **NA**

Load Allocation (LA): **21.2 lbs/day**

TMDL **33.8 lbs/day**

*** TMDL expressed as Ultimate Oxygen Demand (UOD), which includes Carbonaceous Biochemical Oxygen Demand (CBOD) and Nitrogenous Biochemical Oxygen Demand (NBOD).**

Margin of Safety (MOS): **Implicit, based on the following conservative assumptions:**
(1) Drought streamflows persist through the critical summer months at monthly 7Q10 flow values.
(2) Hot summer temperatures, based on the historical record, persist for the same critical period.
(3) DO saturation, for all flows entering the system, equal those measured during the low DO period in the summer of 2002.
(4) Water depths are shallow, which increases the effect of SOD.
(5) Water velocities are sluggish, which intensifies the effect of BOD decay.
(6) All point sources discharge continuously at their NPDES permit limits for the same critical period.