Total Maximum Daily Load

Evaluation

for

Five Stream Segments

in the

Altamaha River Basin

for

Dissolved Oxygen

Submitted to:
The U.S. Environmental Protection Agency
Region 4
Atlanta, Georgia

Submitted by:
The Georgia Department of Natural Resources
Environmental Protection Division
Atlanta, Georgia

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EXECUTIVE SUMMARY

The State of Georgia assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into one of three categories with respect to designated uses: 1) supporting, 2) partially supporting, or 3) not supporting. These water bodies 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, 2000-2001).

Some of the 305(b) partially and not supporting water bodies are also assigned to Georgia's 303(d) list, also named after that section of the CWA. Water bodies 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 process establishes the allowable pollutant loadings or other quantifiable parameters for a water body based on the relationship between pollutant sources and in-stream water quality conditions. This allows water quality-based controls to be developed to reduce pollution and to restore and maintain water quality.

The State of Georgia has identified five (5) stream segments, located in the Altamaha River Basin, as water quality limited due to dissolved oxygen. These waterbodies were included in the State's draft 2006 303(d) list. This report presents the dissolved oxygen TMDLs for these segments.

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.

The process of developing the dissolved oxygen TMDL for the Altamaha River Basin included developing computer models for the listed segments. Georgia DOSAG, a steady state water quality model developed by the Georgia Environmental Protection Division (GA EPD) was used for the freshwater segments. These models were calibrated to data collected in the Altamaha River Basin in the summer of 2004.

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

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

The amount of oxygen demanding substances delivered to a stream is difficult to determine. However, by requiring and monitoring the implementation of these practices, such efforts will improve stream water quality and represent a beneficial measure of TMDL implementation.

1.0 INTRODUCTION

1.1 Background

The State of Georgia assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into one of three categories with respect to designated uses: 1) supporting, 2) partially supporting, or 3) not supporting. These water bodies 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, 2000-2001).

Some of the 305(b) partially and not supporting water bodies are also assigned to Georgia's 303(d) list, also named after that section of the CWA. Water bodies on the 303(d) list are required to have a Total Maximum Daily Load (TMDL) evaluation for the constituent(s) in violation of the water quality standard. The TMDL process establishes the allowable pollutant loadings or other quantifiable parameters for a water body based on the relationship between pollutant sources and in-stream water quality conditions. This allows water quality-based controls to be developed to reduce pollution and to restore and maintain water quality.

The State of Georgia has identified five (5) stream segments located in the Altamaha River Basin as water quality limited due to dissolved oxygen. These waterbodies were included in the State's draft 2006 303(d) list. This report presents the Dissolved Oxygen TMDLs for the listed segments in the Altamaha River Basin identified in Table 1.

Table 1. Waterbodies Listed For Dissolved Oxygen in the Altamaha River Basin

Stream Segment	Location	Segment Length (miles)	Designated Use	Listing
Cypress Creek	Rolands Pond to Ohoopee River (Johnson Co)	4	Fishing	PS
Nealy Creek	Headwaters to Little Ohoopee River (Washington/Johnson Co)	9	Fishing	PS
Ohoopee Creek	Dyers Creek to Big Cedar Creek (Washington/Johnson Co)	15	Fishing	PS
Ohoopee Creek	Big Cedar Creek to Cypress Creek (Johnson Co)	2	Fishing	PS
Sardis Creek	Headwaters to little Ohoopee River (Emanuel Co)	10	Fishing	NS

Notes:
PS = Partially Supporting designated use
NS = Not Supporting designated use

1.2 Watershed Description

The Altamaha River Basin is located in southeastern Georgia, encompassing approximately 2,440 square miles. The Ogeechee River Basin to the east and the Satilla River Basin to the west border the Altamaha River Basin. The Altamaha River is formed where the Ocmulgee River joins the Oconee River near the city of Hazelhurst. The Ohoopee River, which originates in Washington County, flows into the Altamaha River approximately 40 miles downstream of the confluence. The Altamaha River then flows in a southeastern direction to the Atlantic Ocean. The Altamaha River Basin contains parts of the Southeastern Plain and Southern Coastal Plain physiographic provinces, which extend throughout the southeastern United States.

The USGS has divided the Altamaha River Basin into two sub-basins, or Hydrologic Unit Codes (HUCs). Figure 1 shows the location of these sub-basins. Figure 2 shows the locations of the five listed dissolved oxygen segments in the Altamaha River Basin and the associated counties.

The land use characteristics of the Altamaha River Basin watersheds were determined using data from the National Land Cover Dataset (NLCD) for Georgia. This coverage is based on Landsat Thematic Mapper digital images developed in 2001. The classification is based on a modified Anderson level one and two system. Table 2 lists the land cover distribution and associated percent land cover.

1.3 Water Quality Standard

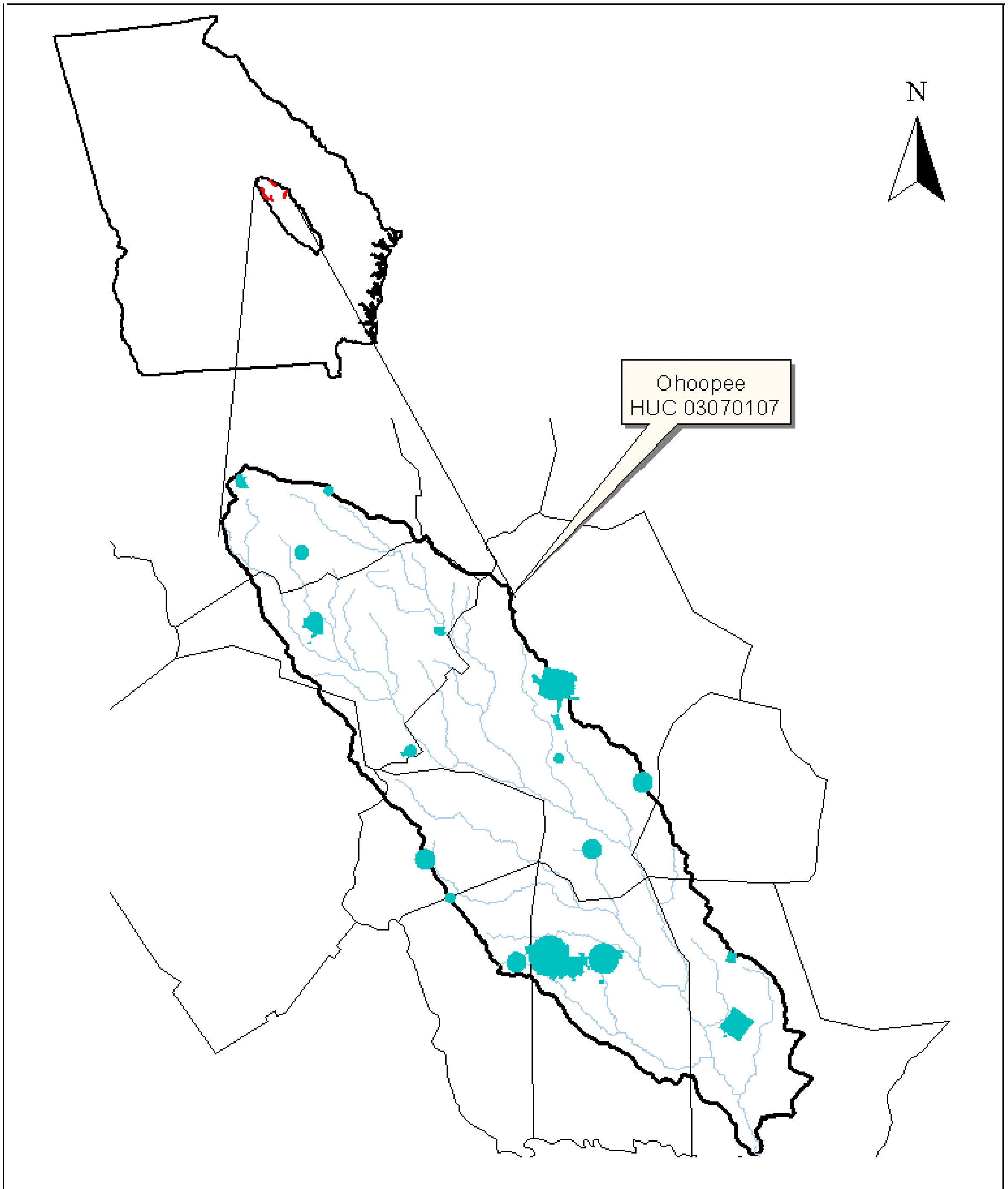
The water use classification for the listed stream segments in the Altamaha River Basin is “Fishing.” No segments in the Altamaha River Basin are classified as trout streams. The criterion violated is listed as dissolved oxygen. The potential cause listed includes municipal, urban, and nonpoint source runoff. The use classification water quality standards for dissolved oxygen, as stated in *Georgia’s Rules and Regulations for Water Quality Control* (GA EPD, 2005), Chapter 391-3-6-.03(6)(c)(i) 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 dissolved oxygen 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, 2005):

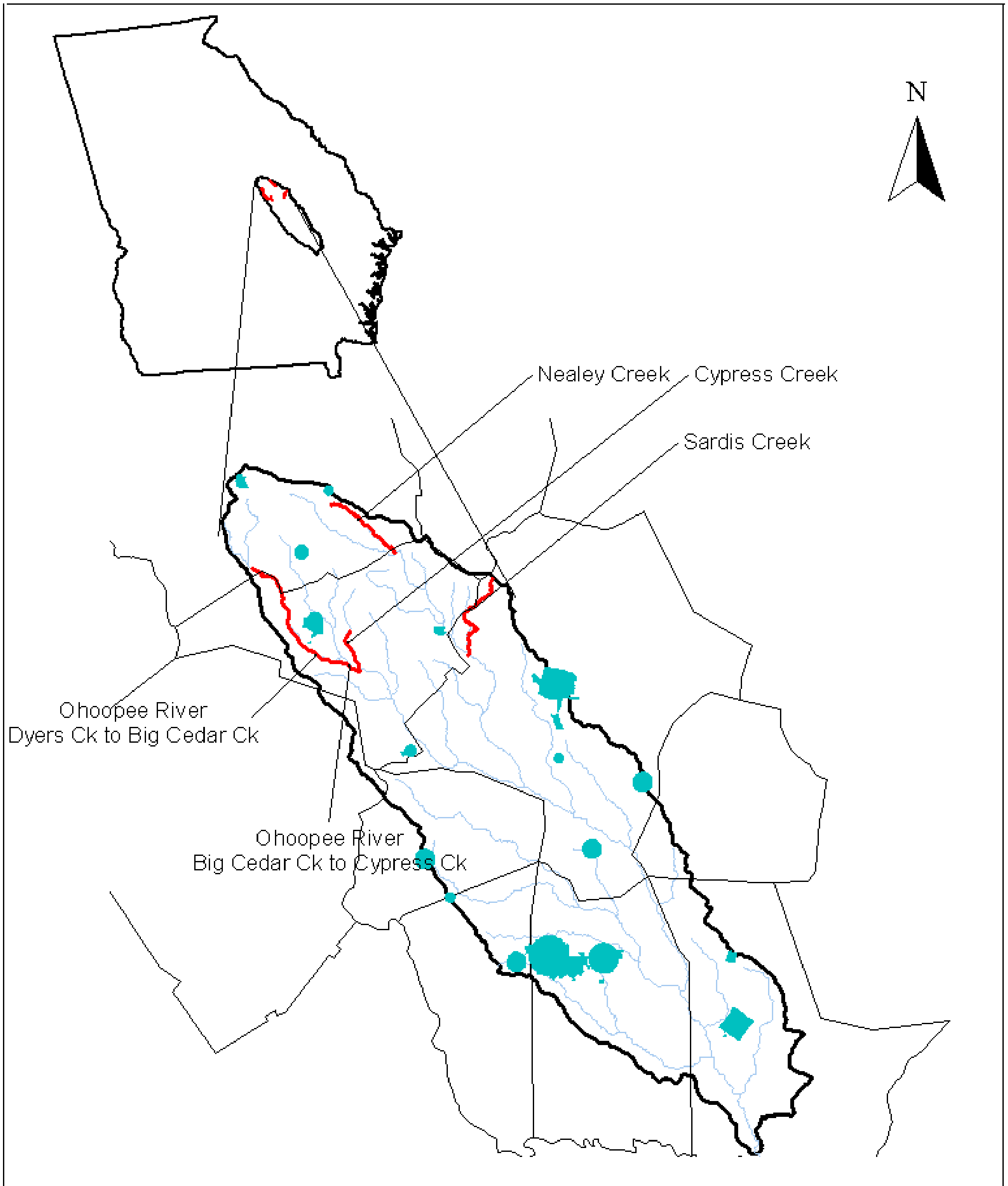
> *Natural Water Quality*. It is recognized that certain natural waters of the State may have a quality that will not be within the general or specific requirements contained herein. These circumstances do not constitute violations of water quality standards. This is especially the case for the criteria 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.

EPA dissolved oxygen criteria are used to address these situations. Alternative EPA limits are defined as 90 percent of the naturally occurring dissolved oxygen concentration at critical conditions (USEPA, 1986).



TMDL Evaluation - DO
Altamaha River Basin

Figure 1. Location of the Ohoopee River Basin



TMDL Evaluation - DO Altamaha River Basin	Figure 2. Location of the Listed Segments

Table 2. Altamaha River Basin Land Coverage

Stream/Segment	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	Forest	Row Crops	Pasture, Hay	Other Grasses (Urban, recreational; e.g. parks, lawns)	Woody Wetlands	Emergent Herbaceous Wetlands	Total
Cypress Creek	44	357	20	0	0	0	4,208	1,058	1,331	912	1,176	83	9,189
	(0.5)	(3.9)	(0.2)	(0.0)	(0.0)	(0.0)	(45.8)	(11.5)	(14.5)	(9.9)	(12.8)	(0.9)	(100.0)
Nealy Creek	23	203	2	0	0	0	5,430	537	509	833	768	43	8,348
	(0.3)	(2.4)	(0.0)	(0.0)	(0.0)	(0.0)	(65.0)	(6.4)	(6.1)	(10.0)	(9.2)	(0.5)	(100.0)
Ohoopee River	165	2157	257	110	2	24	23,550	6,775	7,014	4,877	5,268	350	50,548
Dyers Creek to Big Cedar Creek	(0.3)	(4.3)	(0.5)	(0.2)	(0.0)	(0.0)	(46.6)	(13.4)	(13.9)	(9.6)	(10.4)	(0.7)	(100.0)
Ohoopee River	207	2729	364	116	0	8	32,761	7,193	7,191	5,718	7,706	570	64,563
Big Cedar Creek to Cypress Creek	(0.3)	(4.2)	(0.6)	(0.2)	(0.0)	(0.0)	(50.7)	(11.1)	(11.1)	(8.9)	(11.9)	(0.9)	(100.0)
Sardis Creek	22	415	34	3	0	0	6,767	1,848	1,276	1,906	411	80	12,761
	(0.2)	(3.3)	(0.3)	(0.0)	(0.0)	(0.0)	(53.0)	(14.5)	(10.0)	(14.9)	(3.2)	(0.6)	(100.0)

> 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 is greater than 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.

2.0 WATER QUALITY ASSESSMENT

During 2004, the United States Geological Survey (USGS) collected water quality data at twenty-eight USGS and GAEPD stations in the Altamaha River Basin. Figure 3 shows the GA EPD/USGS water quality and USGS flow stations that were sampled during 2004. Of these, a total of twenty-three stations had DO standard violations in 2004. Appendix A provides the water quality data for these stations, and includes flow, DO, temperature, total organic carbon, 5-day biochemical oxygen demand, and NH_3 data.

In general, these data show that low dissolved oxygen values usually occurred during the summer months as shown in Figure 4. Furthermore, these values were usually limited to headwater streams where the drainage areas are relatively small and dry weather flows are low, intermittent, or zero. In larger watersheds where the flows are higher, the dissolved oxygen concentrations usually met the minimum standard of 4.0 mg/L and the daily average of 5.0 mg/L.

All field data relevant to the Altamaha River Basin were compiled by GA EPD and included in electronic database files. The data are managed using either the Water Resources Database (WRDB), a software database that was developed by GA EPD or the EXCEL database management software. Project data files contain the following information:

1. Historic trend monitoring data through 2004;
2. 2004 GA EPD/USGS water quality data; and
3. Historic USGS daily average flow data through December 31, 2004.

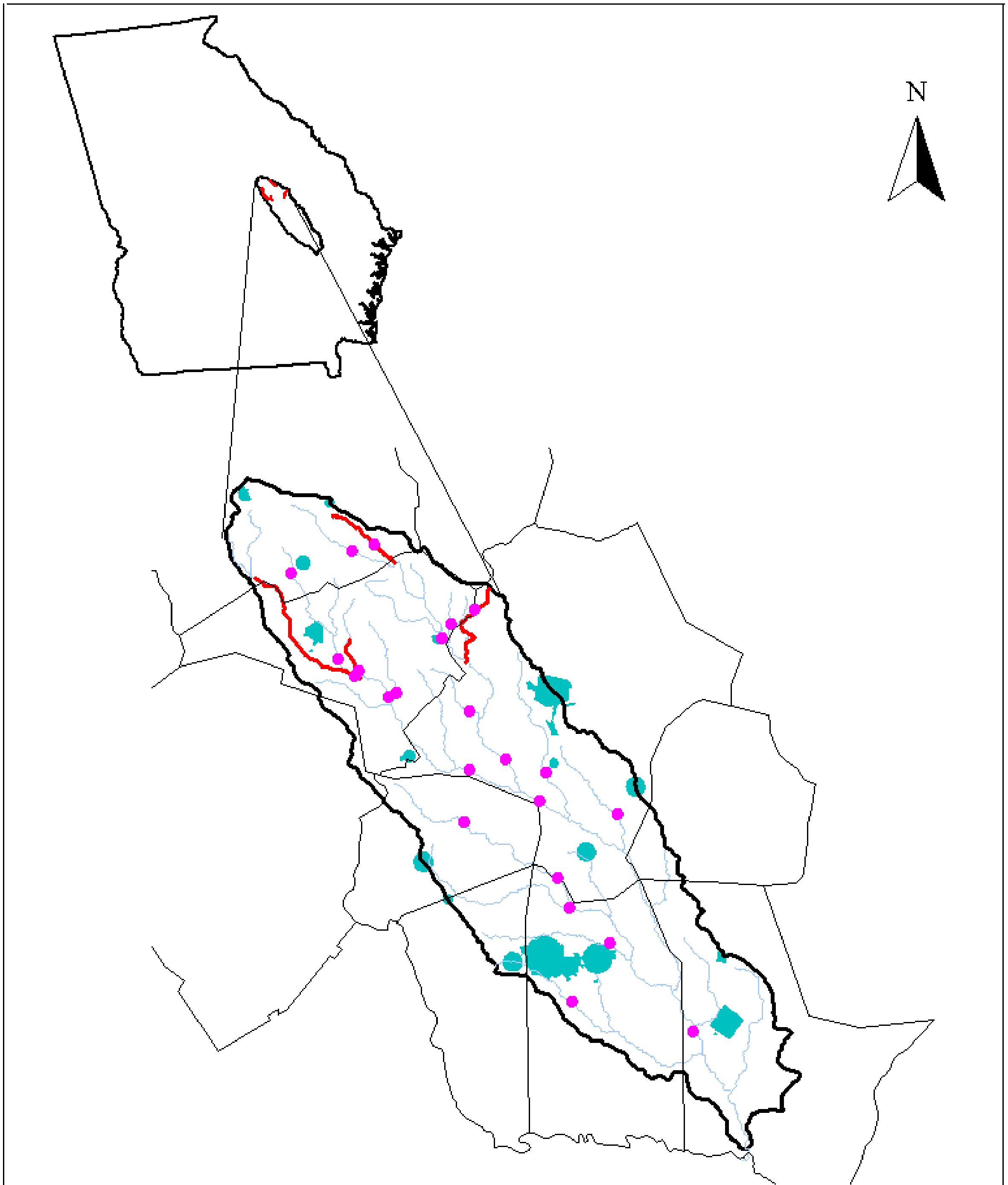


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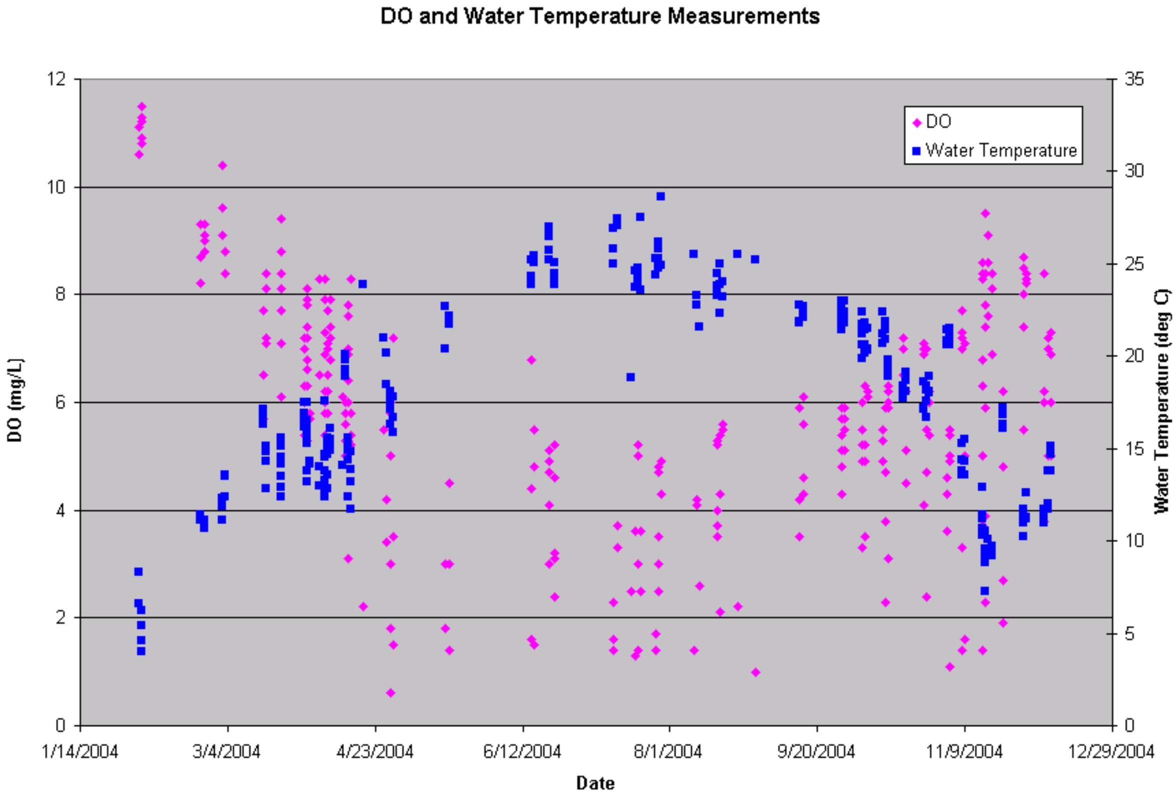
Figure 3. 2004 USGS Water Quality Monitoring Stations Located in the Ohoopee River Basin

Figure 4. 2004 Dissolved Oxygen and Temperature Data for the Altamaha River Basin Monitoring Stations



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 storm water discharges.

3.1.1 Wastewater Treatment Facilities

In general, industrial and municipal 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 limits, 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.

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.

Municipal and industrial wastewater treatment facilities' discharges may contribute oxygen-demanding substances to the receiving waters. There are eight NPDES permitted discharges with effluent limits for oxygen consuming substances identified in the Altamaha River Basin watershed. Two of these discharges are classified as major, with discharges of 1.0 million gallons per day (MGD) or more. Figure 5 provides the locations of NPDES discharges and Table 3 provides the permitted flows, as well as the 5-day Biochemical Oxygen Demand (BOD_5), ammonia (NH_3), and DO concentrations for the municipal and industrial treatment facilities.

Combined sewer systems convey a mixture of raw sewage and storm water in the same conveyance structure to the wastewater treatment plant. These are considered a component of municipal wastewater treatment facilities. When the combined sewage and storm water exceed 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 Altamaha River Basin.

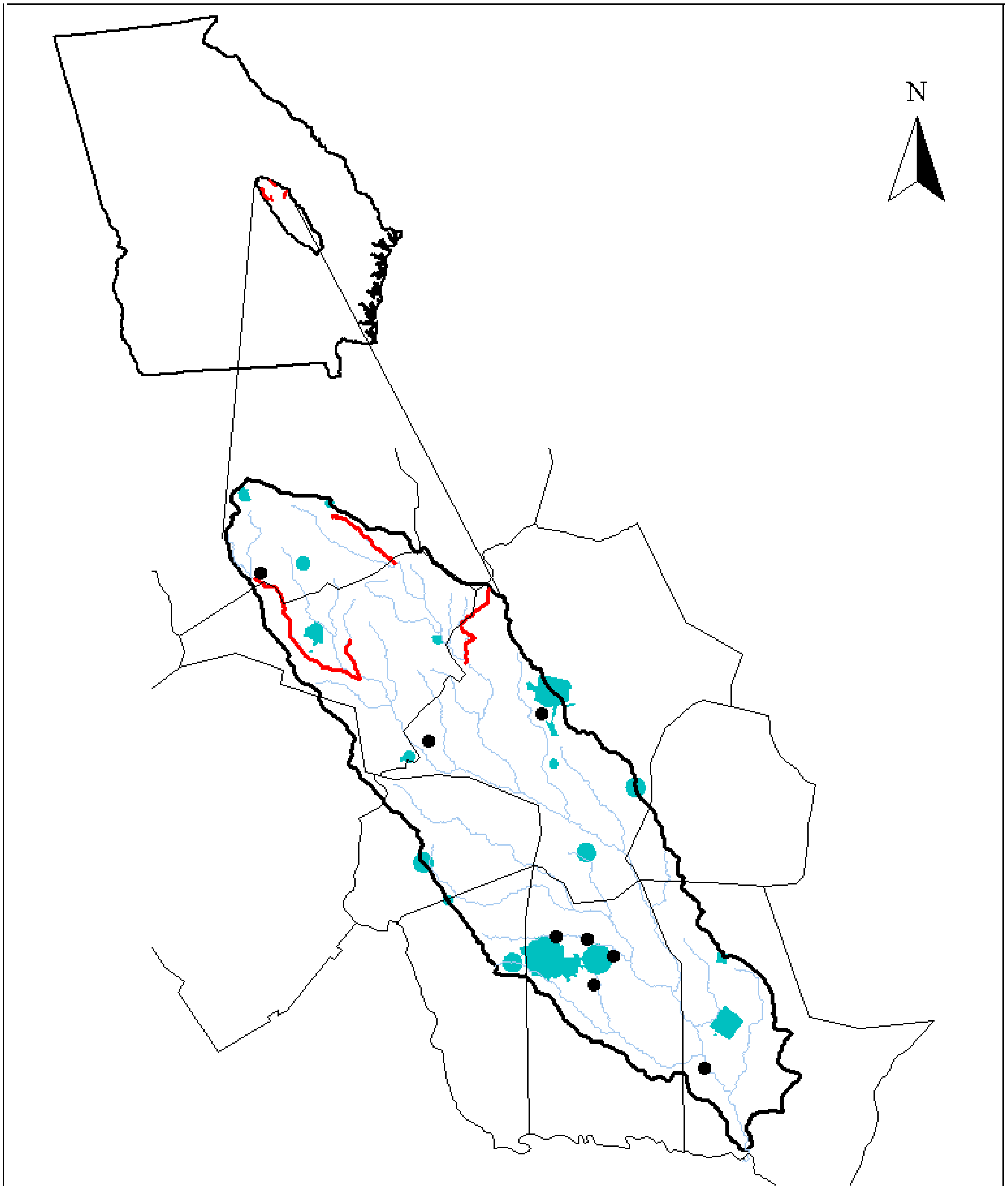


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Figure 5. Location of the NPDES Discharges in the Ohoopee River Basin

Table 3. NPDES Facilities in the Altamaha River Basin

<table>
<tr><th rowspan="2">Facility Name</th><th rowspan="2">NPDES Permit No.</th><th rowspan="2" colspan="2">Receiving Stream</th><th colspan="4">NPDES Permit Limits</th></tr>
<tr><th>Average Monthly Flow (MGD)</th><th>Average Monthly BOD_5 (mg/L)</th><th>Average Monthly NH_3 (mg/L)</th><th>Minimum DO (mg/L)</th></tr>
<tr><td>Tennille WTF</td><td>GA0049956</td><td colspan="2">Dyers Creek</td><td>0.45</td><td>15</td><td>1.1</td><td>6</td></tr>
<tr><td>Doc Rogers Correct. Inst. WTF</td><td>GA0026900</td><td colspan="2">Ohoopee River</td><td>0.85</td><td>30</td><td>17.4</td><td>2</td></tr>
<tr><td>Wrightsville WTF</td><td>GA0032395</td><td colspan="2">Big Cedar Creek</td><td>0.745</td><td>30</td><td>17.4</td><td>5</td></tr>
<tr><td>Swainesboro WPCP</td><td>GA0020346</td><td colspan="2">Yam Grandy Creek</td><td>3.0</td><td>30</td><td>17.4</td><td>2</td></tr>
<tr><td>Santa Claus WTF</td><td>GA0050059</td><td colspan="2">Rocky Creek</td><td>0.01</td><td>30</td><td>-</td><td>5</td></tr>
<tr><td rowspan="3">Lyon No. 1 East</td><td rowspan="3">GA0033405</td><td rowspan="3">Pendleton Creek</td><td>Jan - Apr</td><td rowspan="3">0.67</td><td>20</td><td>10</td><td>5</td></tr>
<tr><td>May - Nov</td><td>10</td><td>2</td><td>5</td></tr>
<tr><td>Dec</td><td>20</td><td>10</td><td>5</td></tr>
<tr><td rowspan="9">Lyons No.2 North</td><td rowspan="9">GA0033391</td><td rowspan="9">Swift Creek</td><td>Jan</td><td rowspan="9">0.67</td><td>10</td><td>6.5</td><td>5</td></tr>
<tr><td>Feb - Mar</td><td>15</td><td>8.7</td><td>2</td></tr>
<tr><td>Apr</td><td>10</td><td>3.5</td><td>5</td></tr>
<tr><td>May</td><td>7.5</td><td>2</td><td>5</td></tr>
<tr><td>Jun</td><td>5</td><td>1</td><td>5</td></tr>
<tr><td>Jul - Sep</td><td>5</td><td>1</td><td>6</td></tr>
<tr><td>Oct</td><td>7.5</td><td>1.5</td><td>5</td></tr>
<tr><td>Nov</td><td>7.5</td><td>2.5</td><td>5</td></tr>
<tr><td>Dec</td><td>10</td><td>5</td><td>5</td></tr>
<tr><td rowspan="8">Vidalia WTF</td><td rowspan="8">GA0025488</td><td rowspan="8">Swift Creek</td><td>Jan</td><td rowspan="8">1.88</td><td>20</td><td>15</td><td>5</td></tr>
<tr><td>Feb</td><td>30</td><td>17.4</td><td>2</td></tr>
<tr><td>Mar</td><td>30</td><td>14.4</td><td>2</td></tr>
<tr><td>Apr</td><td>20</td><td>7</td><td>5</td></tr>
<tr><td>May</td><td>15</td><td>2</td><td>5</td></tr>
<tr><td>Jun - Oct</td><td>10</td><td>2</td><td>6</td></tr>
<tr><td>Nov</td><td>15</td><td>4</td><td>5</td></tr>
<tr><td>Dec</td><td>15</td><td>7</td><td>5</td></tr>
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3.1.2 Regulated Storm Water Discharges

Some storm water runoff is covered under the NPDES Permit Program. It is considered a diffuse source of pollution. Unlike other NPDES permits that establish end-of-pipe limits, storm water NPDES permits establish controls "to the maximum extent practicable" (MEP). Currently, regulated storm water discharges that may contain oxygen demanding substances consist of those associated with industrial activities, including construction sites one acre or greater, and large, medium, and small municipal separate storm sewer systems (MS4s) that serve populations of 50,000 or more.

Storm water discharges associated with industrial activities are currently covered under a General Storm Water NPDES Permit. This permit requires visual monitoring of storm water discharges, site inspections, implementation of BMPs, and record keeping.

Storm water 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 storm water discharge under Phase I. This includes 60 permittees, with about 45 located in the greater Atlanta metro area.

Phase I MS4 permits require the prohibition of non-storm water 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 Storm Water Management Plan (SWMP) outlining appropriate controls is required by and referenced in the permit. There are no Phase I MS4s in the Altamaha River Basin.

As of March 10, 2003, small MS4s serving urbanized areas are required to obtain a storm water permit under the Phase II storm water 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. Thirty counties and 56 communities are permitted under the Phase II regulations in Georgia. There are no counties or communities located in the Altamaha River Basin that are covered by the Phase II General Storm Water Permit.

3.1.3 Confined Animal Feeding Operations

Confined livestock and confined animal feeding operations (CAFOs) are characterized by high animal densities. This results in large quantities of fecal material being contained in a limited area. Processed agricultural manure from confined hog, dairy cattle, and select poultry operations is generally collected in lagoons. It is then applied to pastureland and cropland as a fertilizer during the growing season, at rates that often vary monthly. Runoff during storm events may carry surface residual containing oxygen demanding substances to nearby surface waters.

In 1990, the State of Georgia began registering CAFOs. Many of the CAFOs were issued land application or NPDES permits for treatment of wastewaters generated from their operations. The type of permit issued depends on the operation size (i.e., number of animal units). Table 4 presents the swine and non-swine (primarily dairies) CAFOs located in the Altamaha River Basin that are registered or have land application permits.

Table 4. Registered CAFOs in the Altamaha River Basin

Name	County	Animal Type	Total No. of Animals	Permit No.
Clint Oliver Farms	Tattnall	Swine	2400	GAU700000
E & S Dairy	Wayne	Dairy		
Joe Kennedy Farm	Toombs	Beef cattle	500	GAU700000
Young Dairy	Washington	Dairy		

Sources: Permitting Compliance and Enforcement Program, GA EPD, 2004
GA Dept. of Agriculture, 2006

3.2 Nonpoint Source Assessments

In general, nonpoint sources cannot be identified as entering a waterbody through a discrete conveyance at a single location. Typical nonpoint sources of oxygen demanding substances come from materials being washed into the rivers and streams during storm events. In 2004, many streams in the Altamaha River Basin were dry, or had ponded areas and stagnant pools. If these conditions existed during the monitoring period, the streams were not sampled. Due to the lack of rainfall typical during the summer of 2004, stormwater did not contribute to significant wash off of materials into the streams. Constituents that may have washed off of land surfaces in previous months or years had either flushed out of the system along with the water column flow or settled out and became part of the stream channel bottom.

In this manner, historic wash off of settleable materials accumulates and exerts sediment oxygen demand (SOD). Constituents of concern from surface washoff include the fractions of NH_3 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 Altamaha River watersheds. These data show that the watersheds are predominately forested, with approximately 52.2 percent (ranging from 45.8 to 65 percent) of forest land use. Agriculture is the next predominate land use, with approximately 11.4 percent row crops (ranging from 6.4 to 14.5 percent) and approximately 11.1 percent pasture (ranging from 6.1 to 14.5 percent). Approximately 9.5 percent (ranging from 8.9 to 14.9 percent) of the land use in these watersheds is woody wetlands. Urban land use makes up approximately 14.7 percent (ranging from 13.8 to 18.5 percent) of these watersheds.

In addition to nonpoint sources of SOD associated with land disturbing activities, most of the streams in the Altamaha River Basin receive significant natural contributions of oxygen demanding organic materials from local wetlands and forested stream corridors. The following sources of naturally occurring organic materials have been identified:

- 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

Many smaller communities use land application systems (LAS) for treatment of their sanitary wastewater. These facilities are required through LAS permits to treat all their wastewater by land application and are to be properly operated as non-discharging systems that contribute no runoff to nearby surface waters. However, runoff during storm events may carry surface residual containing oxygen demanding substances to nearby surface waters. Some of these facilities may also exceed the ground percolation rate when applying their wastewater, resulting in surface runoff. If not properly bermed, this runoff, which contains oxygen demanding substances, may discharge to nearby surface waters. There are six permitted LAS systems located in the Altamaha River Basin (Table 5).

Table 5. Permitted Land Application Systems in the Altamaha River Basin

LAS Name	County	Permit No.	Type	Flow (MGD)
Crider Poultry Emanuel	Emanuel	GA01-300	Industrial	1
Reidsville Sherwood Forest	Tattnall	GA02-058	Municipal	0.5
Reidsville-Lynntown Road	Tattnall	GA02-255	Municipal	0.18
Screven WPCP	Wayne	GA02-140	Municipal	0.1
Stillmore WPCP	Emanuel	GA02-075	Municipal	-
Swainsboro LAS	Emanuel	GA02-257	Municipal	1.86

Source: Permitting Compliance and Enforcement Program, GA EPD, Atlanta, Georgia, 2006

4.0 TECHNICAL APPROACH

The first step of the technical approach for these TMDLs was to select the models that can be effectively used to analyze the Altamaha River DO resources. After appropriate models are selected, data is gathered to develop and calibrate the models. The calibrated models are then used to establish the TMDL during critical conditions. The 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. Inflows of very low DO waters from adjacent marshes and forested swamps compounded the situation. Since the impairments noted in 2004 occurred during sustained periods of low flows, a steady-state modeling approach was selected.

Further analyses of the listed segments revealed that two different water quality models were required based on the geographic, hydrologic, and water quality characteristics. It was determined that Georgia DOSAG would be used.

USGS quadrangle maps and navigational maps along with Arcview and MapInfo spatial graphics files were used to develop drainage areas, stream lengths, bed slopes, segment geometry, and other physical input data for each model. Appendix B provides a summary of each model structure.

Georgia 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 up to six branches. DOSAG can also include tributaries, water intakes, and dams, as well as point sources. One DOSAG model was developed to represent the five listed segments in the Altamaha River Basin.

4.2 Model Calibration

The model calibration period was determined from an examination of the USGS 2004 water quality data for the listed segments. The data examined included streamflow, DO, water temperature, BOD_5, and NH_3. The combination of the lowest flow, lowest DO, and highest water temperature defined the critical modeling period. For the listed segments, June through

September was found to be the critical period. The calibration models were run to simulate an average DO from this period.

The average summer DO and average annual BOD_5 and NH_3 values were extracted from the 2004 dataset for each sampling station. Table 6 provides a summary of the 2004 monitoring data used to develop data for the model calibration.

Table 6. Summary of the 2004 Monitoring Data for the Altamaha River Basin

Monitoring Station	Avg Annual BOD_5 (mg/L)	Avg Annual NH_3 (mg/L)	Avg Summer Flow (cfs)	Avg Summer DO (mg/L)	Max Summer Temp (deg C)
Ohoopee River Basin Mainstem					
Ohoopee River at Harts Ford Rd 02225143	-	-	0.93	3.70	24.90 (July)
Ohoophee River at Dude Sumner Rd, near Wrightsville 02225163	1.33	0.049	32.83	3.90	27.40 (July)
Ohoopee River at Pullens Bridge Rd, near Wrightsville 02225165	1.23	0.041	31.12	4.55	27.10 (July)
Ohoopee River at US Hwy 221, near Norristown 02225190	-	-	0.60	3.38	25.20 (July)
Ohoopee River at GA 297, near Swainsboro 02225270	-	-	495.5	5.0	25.8 (July)
Ohoopee River Basin Tributaries					
Big Cedar Creek at Liberty Church Rd 02225157	-	-	3.41	3.4	26.2 (July)
Cypress Creek at Liberty Church Rd, near Wrightsville 02225164	1.73	0.322	3.27	2.83	25.4 (June)
Neels Creek at Jump Run Rd, near Wrightsville 02225167	1.45	0.035	15.00	6.10	22.5 (Sept)
Little Ohoopee River at Bartow Dublin Rd, near Harrison 02225198	-	-	25.41	4.27	28.6 (July)
Nealey Creek at Bartow Dublin Rd, near Pringle 02225199	2.2	0.110	1.0	3.4	25.7 (June)
Little Ohoopee River at GA 57, near Kite 02225235	-	-	2.2	3.4	24.8 (July)
Sardis Creek at Page Garrett Rd, near Kite 02225238	1.91	0.090	2.34	2.40	26.9 (July)
Flat Creek at Cow Ford Bridge Rd, near Norristown 02225245	1.67	0.123	2.87	5.02	25.8 (July)
Little Ohoopee River at GA 56, Convena 02225255	-	-	174.0	4.93	25.3 (July)
Rocky Creek at Lyon Center Rd, near Lyons 02225585	-	-	0.20	4.40	24.6 (July)
Yam Grandy Creek at GA 297, near Nunez 02225291	-	-	0.13	2.20	23.9 (July)
Jacks Creek at GA 46, near Stillmore 02225318	-	-	214.0	1.35	25.3 (July)
Pendleton Creek at US 221, near Soperton 02225348	-	-	0.63	5.30	23.3 (Aug)
Pendleton Creek near Normantown 02225360	-	-	16.7	1.6	25.5 (Aug)

Headwater and tributary water quality boundaries were developed from these instream field data, expected low DO saturation values (Meyer, 1992), and GA EPD standard modeling practices (GA EPD, 1978). 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 NH_3 was converted to Ultimate Nitrogenous Biochemical Oxygen Demand ($NBOD_U$) by multiplying by the stoichiometric conversion factor of 4.57. Water temperatures were varied across the basin in accordance with the summer sampling data.

Average monthly discharge flows, BOD_5, NH_3, and DO concentrations for the discharges were obtained from 2004 Discharge Monitoring Reports (DMRs). These data were input into the calibration model. BOD_5 was converted to $CBOD_U$ by multiplying by an f-ratio of 2 if the BOD_5 is greater than 20 mg/L and an f-ration of 3 if the BOD_5 is 20 mg/L or less (GA EPD, 1978). NH_3 was converted to $NBOD_U$ by multiplying by 4.57. Table 7 is a summary of the actual discharges from these facilities for calendar year 2004.

Table 7. Summary of NPDES Discharges During 2004

Facility Name	NPDES Permit No.	Actual Discharge for Calendar Year 2004			
		Flow (MGD)	BOD_5 (mg/L)	NH_3 (mg/L)	DO (mg/L)
Tennille WTF	GA0049956	0.21	5.95	0.29	6.45
Doc Rogers Correct. Inst. WTF	GA0022900	0.65	5.4	0.05	6.0
Wrightsville WTF	GA0032395	0.42	19	3.2	8.3
Swainesboro WPCP	GA0020346	1.06	3.75	1.38	3.03
Santa Claus WTF	GA0050059	0.01	30	17.4	5
Lyons No. 1 East	GA0033405	0.46	3.1	0.32	7.4
Lyon No. 2 North	GA0033391	0.35	4.0	0.26	7.07
Vidalia WTF	GA0025488	0.51	6.63	0.22	3.39

* no permit limit or DMR data, assumed value

In shallow streams, SOD is an important part of the oxygen budget. However, there are no field SOD measurements in the Altamaha River Basin. In the South 4 Basins (Satilla, Ochlockonee, Suwannee, and St Mary's), there are several SOD measurements that ranged from 0.9 to 1.9 $g/m^2/day$. An examination of South 4 SOD results was performed in order to develop realistic SOD values that could be applied to the Altamaha DOSAG models.

Results from the 1998 South 4 calibrated models of existing conditions were compiled and summarized. An average value of existing SOD was determined to be 1.35 $g/m^2/day$. This represented 12 models that had mixed land uses and varying degrees of point source activity. When the same 12 models were analyzed under natural conditions (assuming zero point source discharges and completely forested watersheds), SOD averaged 1.25 $g/m^2/day$. These two values were adopted for the Altamaha models to represent SOD for: 1) mixed land uses, including agriculture; and 2) natural or totally forested watersheds, respectively. From this, the anthropogenic nonpoint source contributions, those caused by land disturbing activities, are accounted for in the 0.1 $g/m^2/day$ difference between the two adopted SOD values.

Stream velocities were calculated using the soil equation based on either the Atlantic Coastal Flatwoods or Southern Coast Plain soil provinces coefficients. 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.

Table 8. Modeling Parameters

Parameter	DOSAG Values
CBOD Decay Rate (1/day)	0.1
NBOD Decay Rate (1/day)	0.25
SOD (g/m^2/day)	1.25-1.35
Reaeration Coefficient	0.054

The Altamaha River Basin DOSAG models were calibrated at locations where the USGS collected discrete water quality data during 2004. Appendix C provides the DO calibration curves plotted with the data from monitoring stations in the listed segments.

4.3 Critical Conditions Models

The critical conditions models were used to assess the dissolved oxygen standard and to determine if problems exist requiring regulatory intervention. Model critical conditions were developed in accordance with GA EPD standard practices (GA EPD, 1978).

None of the five listed segments in the Altamaha River Basin had both water quality and daily flow data. Since low flow data were limited, low flow analyses of the available Altamaha River Basin flow data were performed. Data from long-term USGS gages were analyzed to determine 7-day, 10-year minimum flows (7Q10s). Productivity factors, in cubic feet per second (cfs) per square mile, were computed by dividing the 7Q10s by the watershed areas at the gages. Table 9 summarizes the low-flow analyses and Figure 6 shows the proximity of these USGS long-term gages to the listed stream segments. The 7Q10 productivity factors developed from the USGS data were used to develop model input for the Altamaha River Basin DOSAG models by multiplying them by the listed segment watershed drainage areas.

Critical water temperatures were determined by examining the 2004 water quality data and the long-term trend monitoring data. Harmonic sine functions were developed for the historical data from all of the long-term monitoring stations. The highest summer-time temperature from either the 2004 water quality data or the harmonic fit was used to represent each of the listed segments.

Point sources were incorporated into the critical conditions models at their current NPDES permit limits. For NPDES permits that do not have DO and/or NH_3 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 calibrated models.

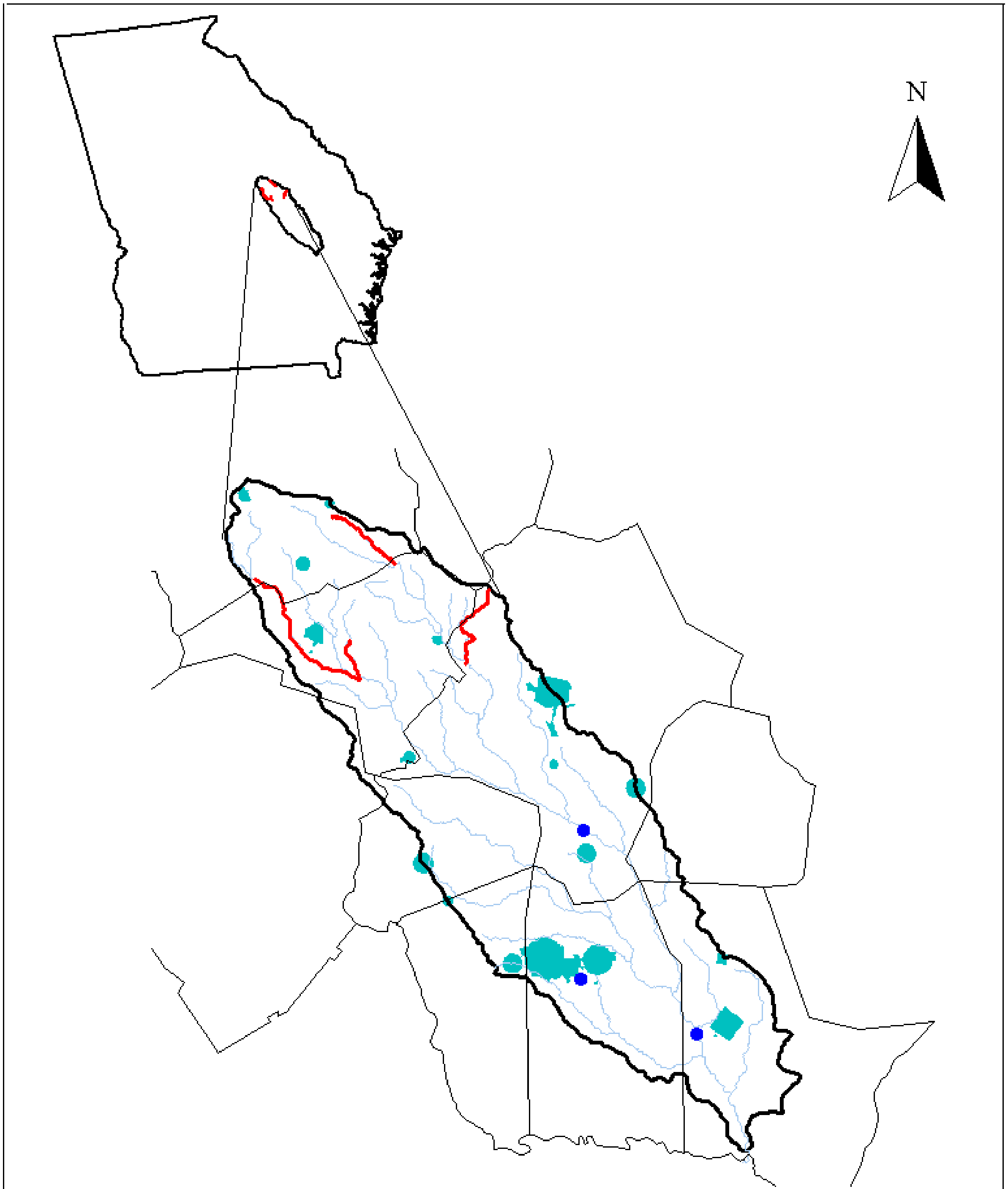
Table 9. Low-Flow Analysis Summary for the Altamaha River Basin

DO TMDL Segment	7Q10 (cfs)	Drainage Area (sq. miles)	Productivity Factor (cfs/sq. mile)
OHOOPEE HUC 03070107			
Cobb Creek near Lyons, Georgia 02225100	0	69	0.000
Ohoopee River near Oak Park, Georgia 02225300	10	620	0.016
Ohoopee River near Reidsville, Georgia 02225500	34	1,110	0.030

Source: USGS website http://ga2.er.usgs.gov/lowflow/

4.4 Natural Conditions Models

For the natural conditions models, two changes were made to the critical conditions models. First, the SOD was changed from 1.35 g/m^2/ day to 1.25 g/m^2/day to reflect the change from mixed land uses to natural or completely forested land uses. Second, all point source discharges were completely removed from the model. All other model parameters remained the same. These models were used to determine the natural dissolved oxygen concentrations during critical conditions. These models predicted the natural dissolved oxygen 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 2004, the results are even lower at standard critical conditions; and 2) the summer of 2004 conditions are very close to critical conditions and compare favorably with the target of 90 percent of the natural DO standard. Results of natural conditions runs are plotted in the graphs in Appendix C along with the calibration, critical conditions and TMDL results for comparison.



TMDL Evaluation - DO
Altamaha River Basin

Figure 6. Location of the USGS Low Flow Gaging Stations in the Ohoopee River Basin

5.0 TOTAL MAXIMUM DAILY LOADS

A Total Maximum Daily Load (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 waste load 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 water body (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 segments in the Altamaha River Basin. The following sections describe the various oxygen demanding sources, which may contribute loads to the TMDL components.

5.1 Waste Load and Load Allocations

The waste load allocation (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 storm water discharges. There are eight existing NPDES permitted facilities in the Altamaha River watershed that effect instream dissolved oxygen. The waste load allocations are provided in Table 10.

The Georgia DOSAG critical conditions model was used to determine the WLAs for the discharges upstream from or within the listed segments in order to meet the DO standards. Allocations are based on the EPA Dissolved Oxygen Criteria, which states that if the natural dissolved oxygen is less than the standard (5.0 mg/L) then a 10 percent reduction in the natural condition is allowed. The target limits are defined as 90 percent of the naturally occurring dissolved oxygen concentration at critical conditions. Appendix C contains plots of the DO concentrations resulting from the TMDL loads versus the target DO Standard. Note that if the TMDL plot is higher than the target DO Standard plot, there is additional assimilative capacity in the stream available for future WLA.

When a wasteload allocation predicts the critical dissolved oxygen 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 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 SOD rates

Table 10. Altamaha River Basin WLAs

Facility Name	NPDES Permit No.	Receiving Stream	WLA Limits			
			Average Monthly Flow (MGD)	Average Monthly BOD_5 (mg/L)	Average Monthly NH_3 (mg/L)	Minimum DO (mg/L)
Tennille WTF	GA0049956	Dyers Creek	0	-	-	-
Doc Rogers Correct. Inst. WTF	GA0022900	Ohoopee River	0.85	5	1	6
Wrightsville WTF	GA0032395	Big Cedar Creek	0.745	5	1	6
Swainesboro WPCP	GA0020346	Yam Grandy Creek	3	5	1	6
Santa Claus WTF	GA0050059	Rocky Creek	0.01	30	17.4	5
Lyon No. 1 East	GA0033405	Pendleton Creek	0.67	5	1	6
Vidalia WTF	GA0025488	Swift Creek	1.88	5	1	6
Lyons No.2 North	GA0033391	Swift Creek	0.67	5	1	6

used in the TMDL allocation models were based on predictions and may need to be verified before WLAs are implemented.

State and Federal Rules define storm water discharges covered by NPDES permits as point sources. However, storm water discharges are from diffuse sources and there are multiple storm water outfalls. Storm water 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 are 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 storm water NPDES permits is not to treat the water after collection, but to reduce the exposure of storm water to pollutants by implementing various controls. It would be infeasible and prohibitively expensive to control pollutant discharges from each storm water outfall. Therefore, storm water NPDES permits require the establishment of controls or BMPs to reduce pollutants entering the environment.

The Georgia DOSAG 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 waste load allocations from storm water discharges associated with MS4s (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 11 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 to provide year-round protection of water quality. This TMDL is expressed as a total load during the critical low flow period.

5.3 Margin of Safety

The MOS is a required component of TMDL development. As specified by section 303(d) of the CWA, the margin of safety 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 11. TMDL Loads for the Altamaha River Basin under Critical Conditions

Stream Segment	WLA (lbs/day)	WLAsw (lbs/day)	LA (lbs/day)	TMDL (lbs/day)
Cypress Creek	-	NA	31.74	31.74
Nealy Creek	-	NA	18.39	18.39
Ohoopee Creek – Dyers Creek to Big Cedar Creek	-	NA	67.04	67.04
Ohoopee Creek – Big Cedar Creek to Cypress Creek	121.6	NA	128.24	249.84
Sardis Creek	-	NA	139.5	139.5

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 storm water 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 GA EPD has adopted a basin approach to water quality management that divides Georgia's major river basins into five groups. This approach provides for additional sampling work to be focused on one of the five basin groups each year, and offers a five-year planning and assessment cycle (GA EPD, 1996). The Ocmulgee, Oconee, and Altamaha River Basins were the basins of focused monitoring in 2004 and will again receive focused monitoring in 2009.

The revised TMDL Implementation Plans for the listed streams in the Altamaha River Basin 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 TMDL implementation will be conducted using a phased approach. Permitted discharges will be regulated through the NPDES permitting process described in this report. The permittee may be required to perform temperature and dissolved oxygen monitoring upstream and downstream of the point source. The target WLA reduction needed may not be implemented until sufficient data has been collected to verify the model assumptions. If it is determined that the model assumptions need to be modified, the target WLA reductions will be re-evaluated based on the new data collected during critical conditions, and the TMDL will be reallocated.

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 was provided for this TMDL. During that time, the availability of the TMDL was publicly noticed, a copy of the TMDL was provided upon request, and the public was invited to provide comments on the TMDL. This TMDL was modified to address the comments received.

7.0 INITIAL TMDL IMPLEMENTATION PLAN

The GA EPD has coordinated with EPA to prepare this Initial TMDL Implementation Plan for this TMDL. The GA EPD has also established a plan and schedule for development of a more comprehensive implementation plan after this TMDL is established. The 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 wasteload allocations 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. The 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. The 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.

3. 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. Also, a copy of the video of that same title will be provided to the GA EPD Contractor for its use in making presentations to appropriate stakeholders on TMDL Implementation Plan development.

4. If for any reason the GA EPD Contractor does not complete one or more elements of a Revised TMDL Implementation Plan, GA EPD will be responsible

for getting that (those) element(s) completed, either directly or through another contractor.

5. The deadline for development of a Revised TMDL Implementation Plan is the end of September 2009.

6. The GA EPD Contractor helping to develop the Revised TMDL Implementation Plan, in coordination with GA EPD, will work on the following tasks involved in converting the Initial TMDL Implementation Plan to a Revised TMDL Implementation Plan:

   A. Generally characterize the watershed;
   B. Identify stakeholders;
   C. Verify the present problem to the extent feasible and appropriate (e.g., local monitoring);
   D. Identify probable sources of pollutant(s);
   E. For the purpose of assisting in the implementation of the load allocations of this TMDL, identify potential regulatory or voluntary actions to control pollutant(s) from the relevant nonpoint sources;
   F. Determine measurable milestones of progress;
   G. Develop a monitoring plan, taking into account available resources, to measure effectiveness; and
   H. Complete and submit to GA EPD the Revised TMDL Implementation Plan.

7. The public will be provided an opportunity to participate in the development of the Revised TMDL Implementation Plan and to comment on it before it is finalized.

8. The Revised TMDL Implementation Plan will supersede this Initial TMDL Implementation Plan once GA EPD approves the Revised TMDL Implementation Plan.

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 Water Temperature Measurements
Ohoopee River at Harts Ford Rd 02225143

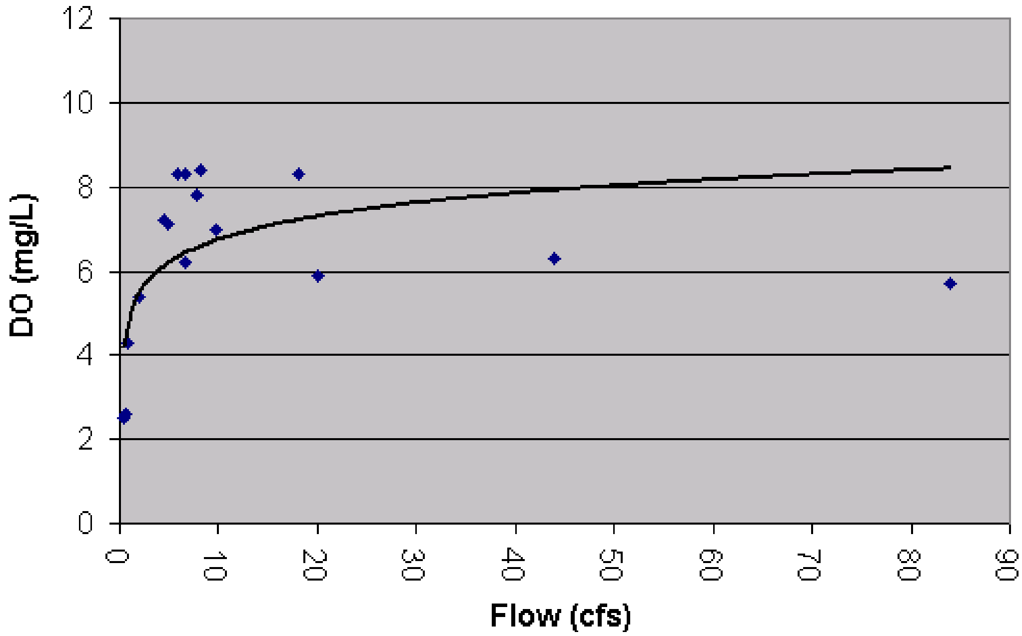


Table A-1. Data for Figure A-1

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)
4/4/2004	18	8.3	13
4/6/2004	6.6	8.3	12.4
4/15/2004	5.8	8.3	11.7
4/29/2004	4.5	7.2	15.9
7/22/2004	0.38	2.5	23.6
7/29/2004	0.84	4.3	24.9
8/11/2004	0.51	2.6	21.6
8/18/2004	2	5.4	22.3
9/28/2004	84	5.7	21.4
10/6/2004	44	6.3	20.2
10/13/2004	20	5.9	20.9
10/27/2004	9.8	7	16.7
11/9/2004	4.8	7.1	13.6
11/16/2004	7.8	7.8	9.2
11/22/2004	6.6	6.2	16.3
12/6/2004	8.2	8.4	11

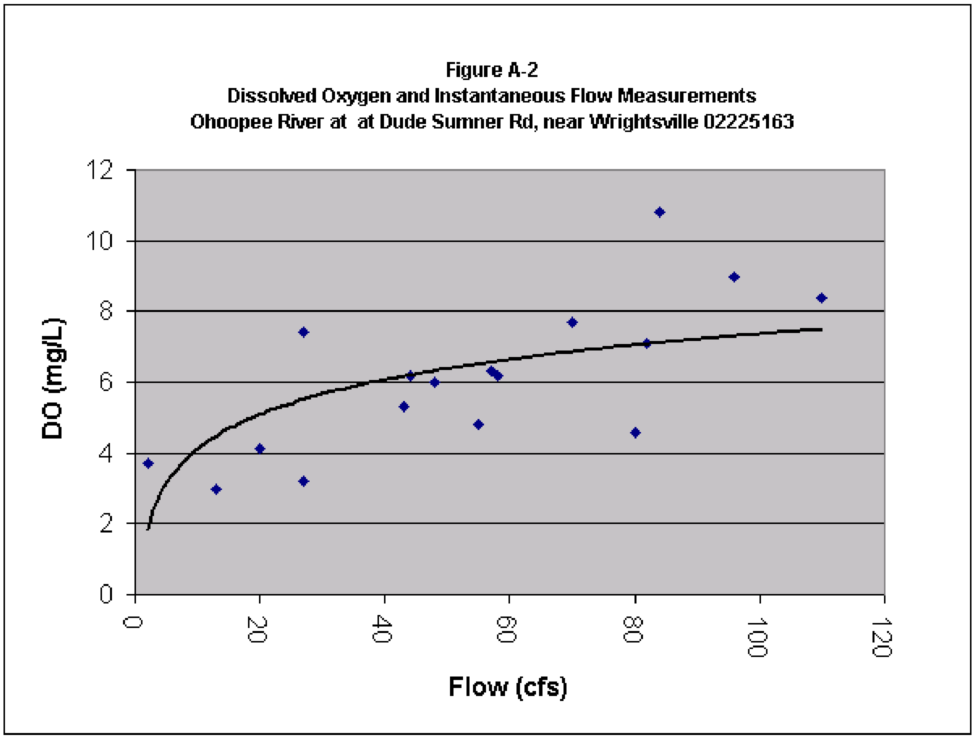


Table A-2. Data for Figure A-2

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)	TOC (mg/L)	BOD_5 (mg/L)	Ammonia (mg/L)
2/4/2004	84	10.8	5.4	6.2	0.8	0.03
2/25/2004	96	9	11.1	5.2	1	0.03
3/3/2004	110	8.4	13.6			
3/17/2004	82	7.1	14.8			
3/22/2004	70	7.7	14.2	6.7	1	0.02
3/31/2004	57	6.3	15.7			
4/7/2004	44	6.2	15.6			
4/14/2004	43	5.3	15.6	6.5	0.6	0.09
5/18/2004	13	3	21.7	5.9	1.1	0.11
6/16/2004	55	4.8	25.1	6.8	0.5	0.08
6/21/2004	20	4.1	27			
6/23/2004	27	3.2	25.1			
7/14/2004	2	3.7	27.4	6.1	1.8	0.04
8/18/2004						
8/25/2004						
8/31/2004						
9/15/2004	80	4.6	22.7	20	2	0.039
10/19/2004	58	6.2	18.1	13	2	0.03
11/16/2004	27	7.4	9	8.8	1.8	0.03
12/8/2004	48	6	14.7	8.6	2	0.035

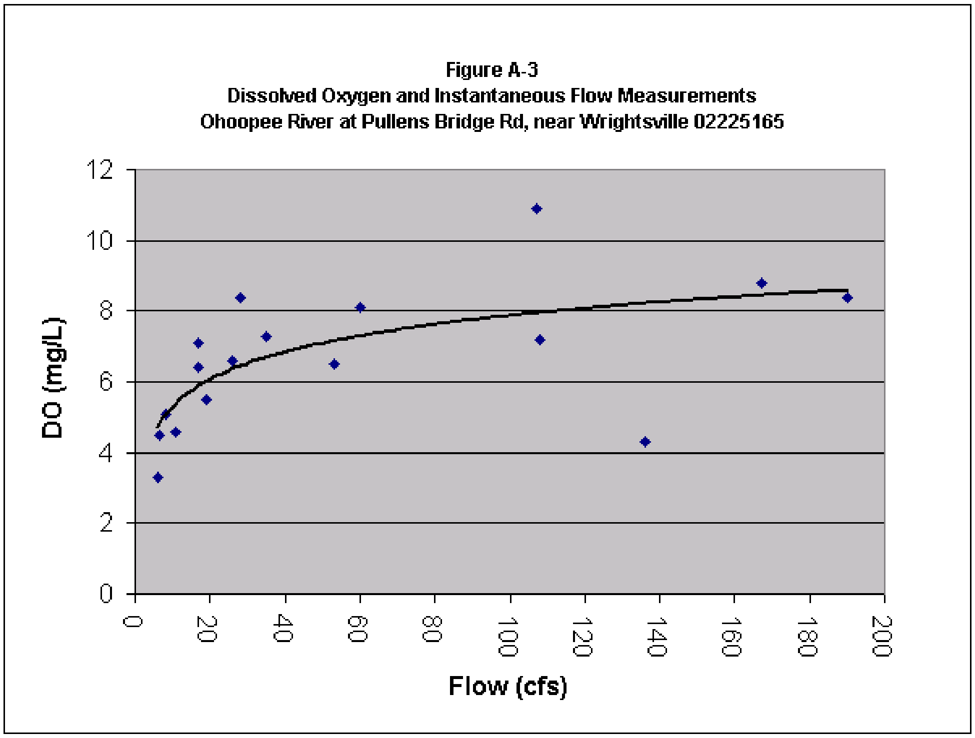


Table A-3. Data for Figure A-3

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)	TOC (mg/L)	BOD_5 (mg/L)	Ammonia (mg/L)
2/4/2004	107	10.9	6.2	6.1	0.6	0.03
2/25/2004	167	8.8	11.1	5.6	1	0.02
3/3/2004	190	8.4	13.5			
3/17/2004	108	7.2	15.1			
3/22/2004	60	8.1	15.6	6.9	0.9	0.01
3/31/2004	26	6.6	16.2			
4/7/2004	17	7.1	14.7			
4/14/2004	17	6.4	15.4	6.3	0.4	0.07
5/18/2004	6.6	4.5	22.2	5.2	0.9	0.04
6/16/2004	19	5.5	25.1	6.4	0.6	0.06
6/21/2004	8.2	5.1	26.9			
6/23/2004	11	4.6	25.1			
7/14/2004	5.9	3.3	27.1	4.9	2	0.096
8/18/2004						
8/25/2004						
8/31/2004						
9/15/2004	136	4.3	22.5	21	1.8	0.029
10/19/2004	53	6.5	18.1	14	2	0.03
11/16/2004	28	8.4	9.6	15	1.6	0.034
12/8/2004	35	7.3	13.8	9.3	1.7	0.032

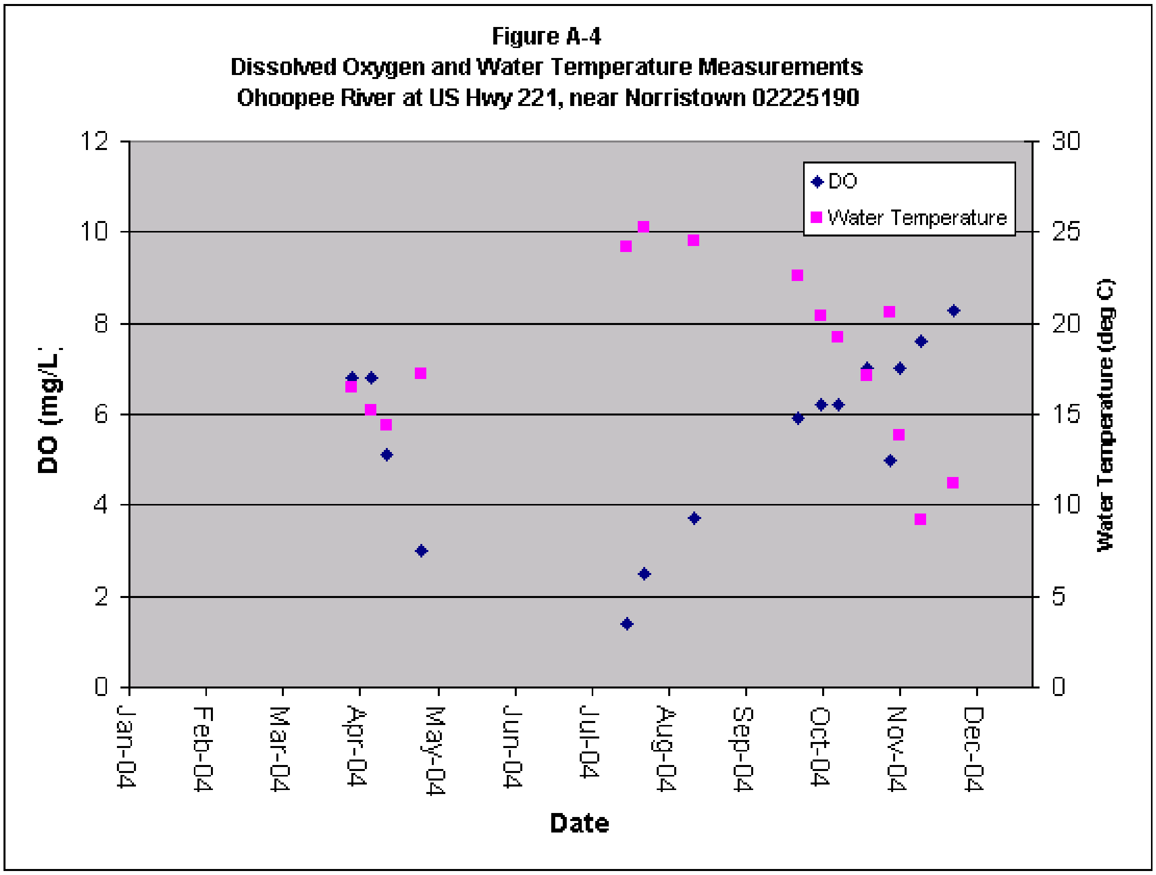


Table A-4. Data for Figure A-4

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)
3/31/2004	>19	6.8	16.5
4/8/2004	>19	6.8	15.2
4/14/2004	>19	5.1	14.4
4/28/2004	>19	3	17.2
7/21/2004		1.4	24.2
7/28/2004	>19	2.5	25.2
8/10/2004			
8/17/2004	0.6	3.7	24.5
9/28/2004	>19	5.9	22.6
10/7/2004	>19	6.2	20.4
10/14/2004	>19	6.2	19.2
10/26/2004	>19	7	17.1
11/4/2004	>19	5	20.6
11/8/2004	>19	7	13.8
11/17/2004		7.6	9.2
11/30/2004	>19	8.3	11.2

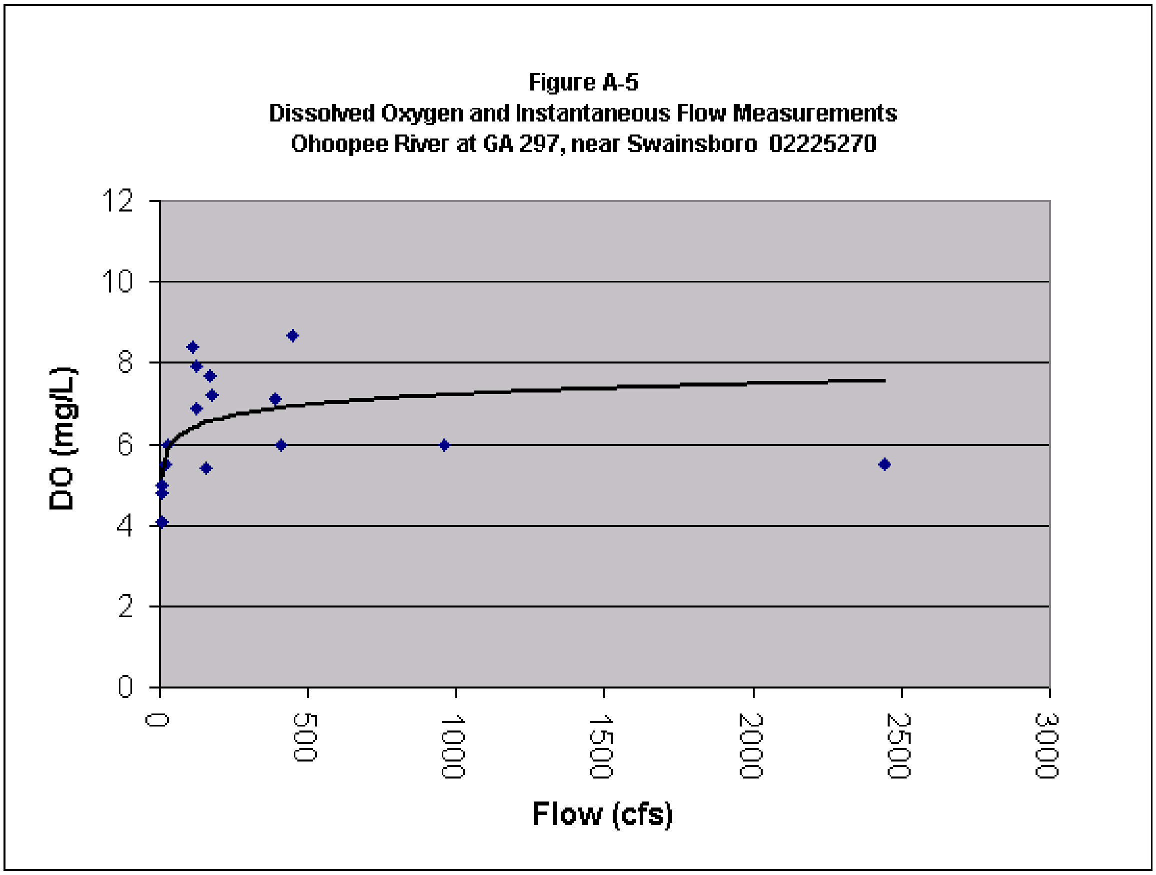


Table A-5. Data for Figure A-5

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)
3/31/2004	177	7.2	16.1
4/8/2004	122	7.9	14.9
4/14/2004	126	6.9	15.6
4/28/2004	29	6	18.1
7/21/2004	7.4	5	24.3
7/28/2004	9.3	4.8	25.8
8/10/2004	3.9	4.1	23.3
8/19/2004	17	5.5	24
9/29/2004	2440	5.5	22
10/5/2004	958	6	21.2
10/14/2004	408	6	19.4
10/26/2004	390	7.1	17.1
11/4/2004	158	5.4	20.8
11/8/2004	170	7.7	13.8
11/15/2004	108	8.4	11.2
11/29/2004	450	8.7	11.4

Figure A-6
Dissolved Oxygen and Water Temperature Measurements
Big Cedar Creek at Liberty Church Rd 02225157

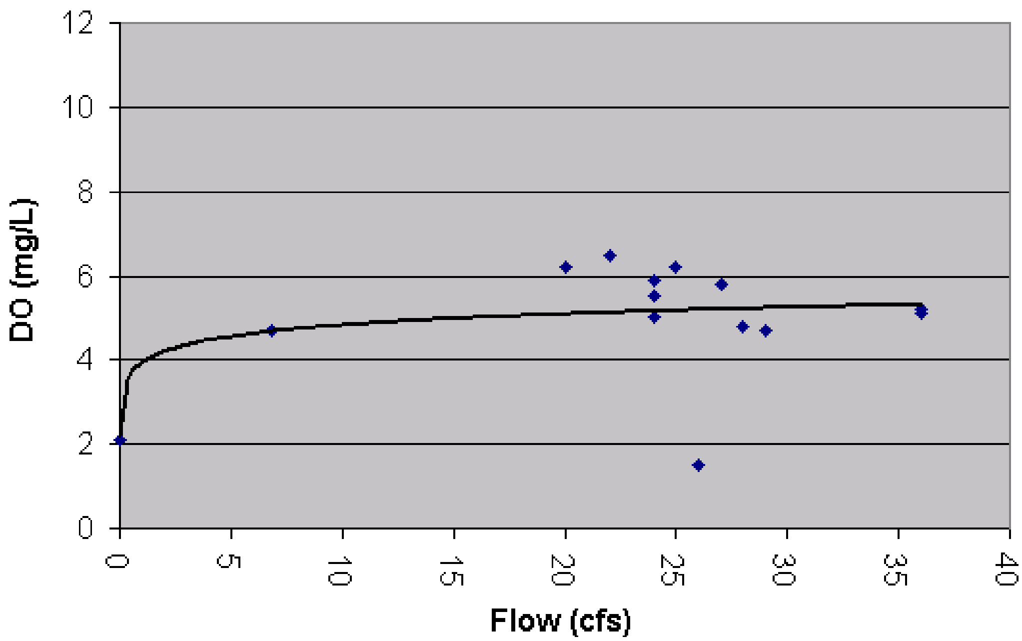


Table A-6. Data for Figure A-6

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)
4/4/2004	22	6.5	14
4/6/2004	20	6.2	13.8
4/15/2004	27	5.8	13.2
4/29/2004	26	1.5	16.7
7/21/2004			
7/28/2004	6.8	4.7	26.2
8/10/2004			
8/18/2004	0.01	2.1	23.9
9/28/2004	36	5.1	22
10/6/2004	36	5.2	20.6
10/13/2004	29	4.7	21.4
10/27/2004	24	5.5	17.6
11/9/2004	24	5	14.3
11/16/2004	24	5.9	9.5
11/22/2004	28	4.8	16.1
12/6/2004	25	6.2	11.2

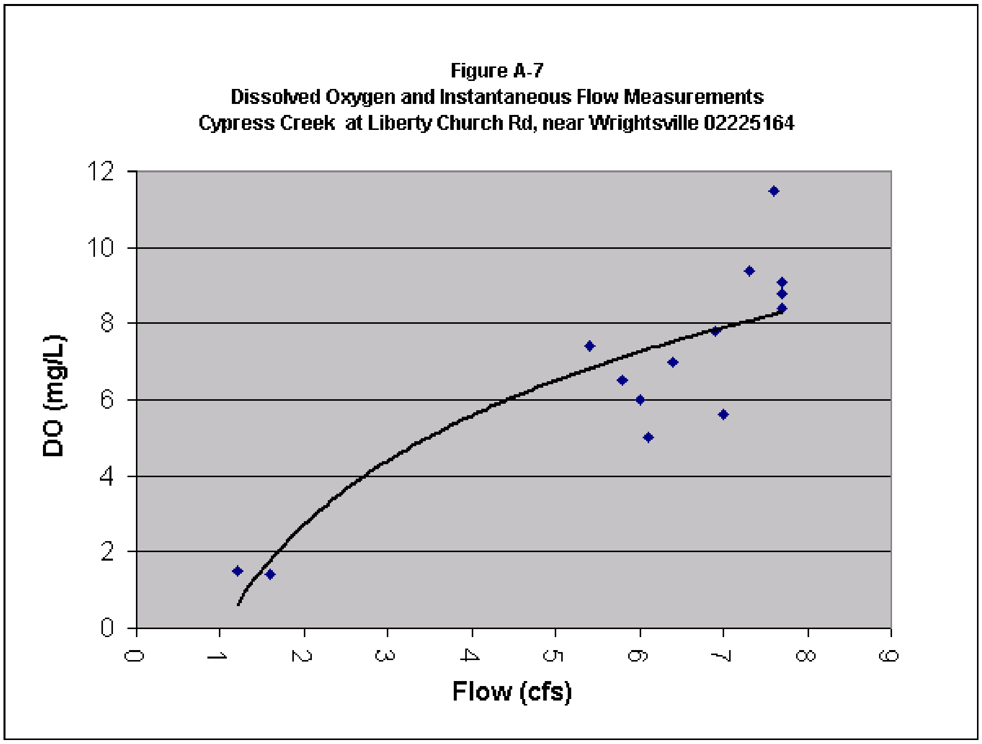


Table A-7. Data for Figure A-7

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)	TOC (mg/L)	BOD_5 (mg/L)	Ammonia (mg/L)
2/4/2004	7.6	11.5	4.6	6.7	0.6	0.05
2/25/2004	7.7	9.1	10.7	5.4	1	0.03
3/3/2004	7.7	8.8	12.4			
3/17/2004	7.7	8.4	12.8			
3/22/2004	7.3	9.4	13.5	7.5	1.1	0.03
3/31/2004	6.9	7.8	13.8			
4/7/2004	5.8	6.5	12.8			
4/14/2004	6	6	12.4	8.9	1	0.14
5/18/2004	1.6	1.4	21.7	12	2.5	0.82
6/16/2004	1.2	1.5	25.4	11	2.7	1.9
6/21/2004						
6/23/2004						
7/14/2004						
8/18/2004						
8/25/2004						
8/31/2004						
9/15/2004	7	5.6	22.1	19	1.6	0.034
10/19/2004	6.4	7	17.7	15	2	0.07
11/16/2004	5.4	7.4	7.3	12	2.7	0.092
12/8/2004	6.1	5	14.8	11	2.1	0.056

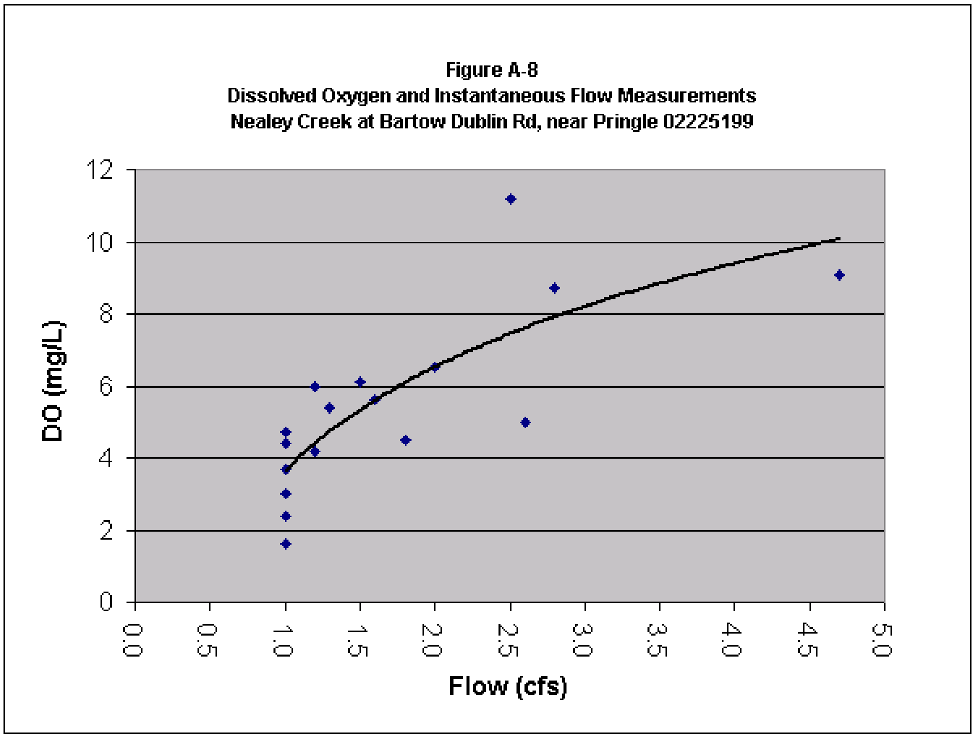


Table A-8. Data for Figure A-8

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)	TOC (mg/L)	BOD_5 (mg/L)	Ammonia (mg/L)
2/4/2004	2.5	11.2	4	7.3	0.7	0.04
2/24/2004	2.8	8.7	11.1	8.8	0.3	0.02
3/2/2004	4.7	9.1	11.1			
3/16/2004	2.0	6.5	17.1			
3/22/2004	1.5	6.1	12.9	11	2.2	0.06
3/30/2004	1.3	5.4	16.6			
4/6/2004	1.2	6	12.5			
4/13/2004	1.6	5.6	18.9	14	1.1	0.08
5/17/2004	1.0	3	20.4	14	1.9	0.27
6/15/2004	1.0	4.4	24.3	11	3	0.32
6/21/2004	1.0	4.7	25.7			
6/23/2004	1.0	2.4	24.5			
7/13/2004	1.0	1.6	25	12	5.5	0.29
8/17/2004						
8/24/2004						
8/30/2004						
9/14/2004	1.2	4.2	21.8	25	2.3	0.032
10/20/2004	1.8	4.5	18.1	23	2.4	0.03
11/15/2004	1.0	3.7	10.3	22	2.9	0.041
12/7/2004	2.6	5	12	18	2.3	0.032

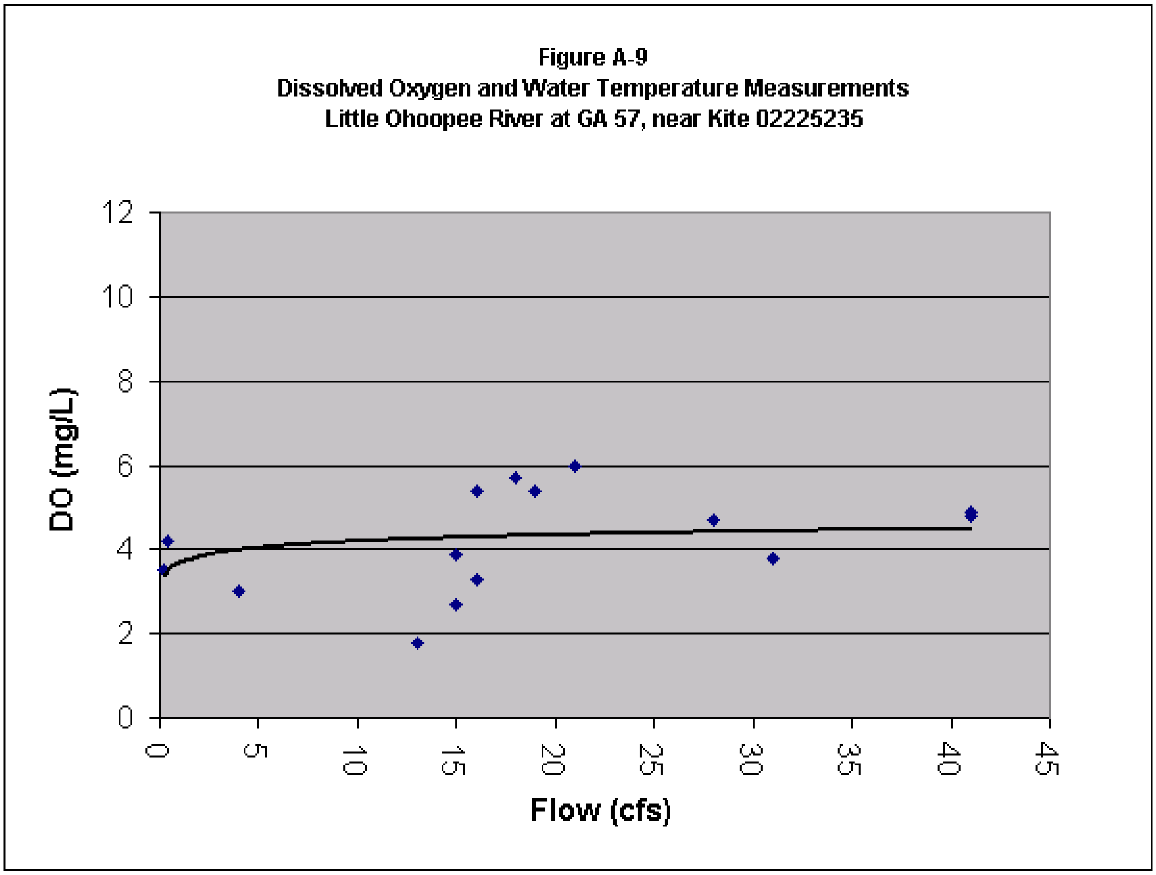


Table A-9. Data for Figure A-9

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)
4/1/2004	18	5.7	14.3
4/6/2004	19	5.4	14.5
4/15/2004	16	5.4	13.9
4/28/2004	13	1.8	17.8
7/21/2004		3	24.8
7/28/2004	4	3	24.8
8/10/2004	0.36	4.2	22.8
8/17/2004	0.23	3.5	23.4
9/28/2004	41	4.8	22.4
10/6/2004	41	4.9	21.4
10/13/2004	31	3.8	21.9
10/27/2004	28	4.7	18.2
11/8/2004	16	3.3	14.4
11/16/2004	15	3.9	10.5
11/22/2004	15	2.7	16.8
12/6/2004	21	6	11.6

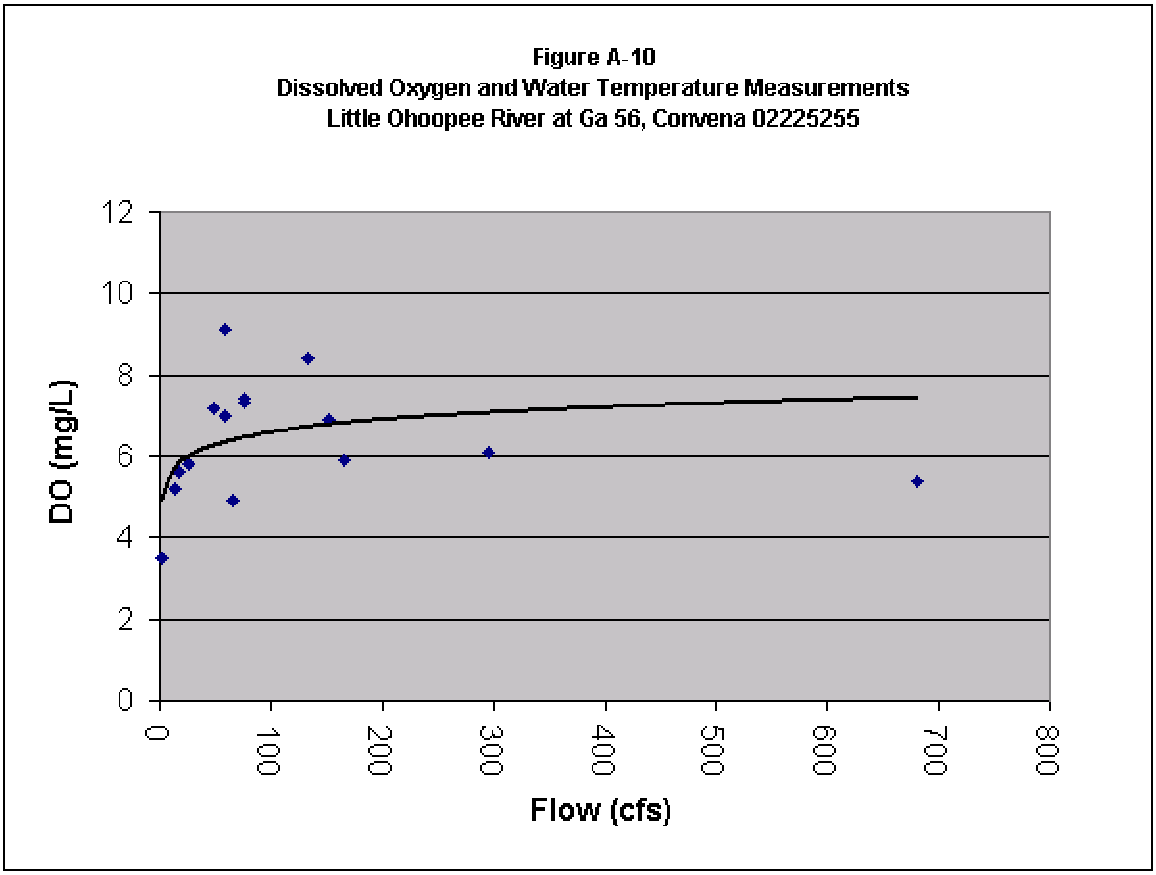


Table A-10. Data for Figure A-10

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)
3/31/2004	76	7.4	16.4
4/8/2004	49	7.2	15.5
4/14/2004	58	7	14.9
4/28/2004	26	5.8	17.6
7/21/2004	14	5.2	23.9
7/28/2004	2.2	3.5	25.3
8/10/2004			
8/19/2004	17	5.6	23.2
9/28/2004	681	5.4	22.6
10/7/2004	295	6.1	20.3
10/14/2004	166	5.9	19
10/26/2004	152	6.9	17.1
11/4/2004	65	4.9	21
11/8/2004	76	7.3	13.6
11/17/2004	58	9.1	9.2
11/30/2004	133	8.4	11.3

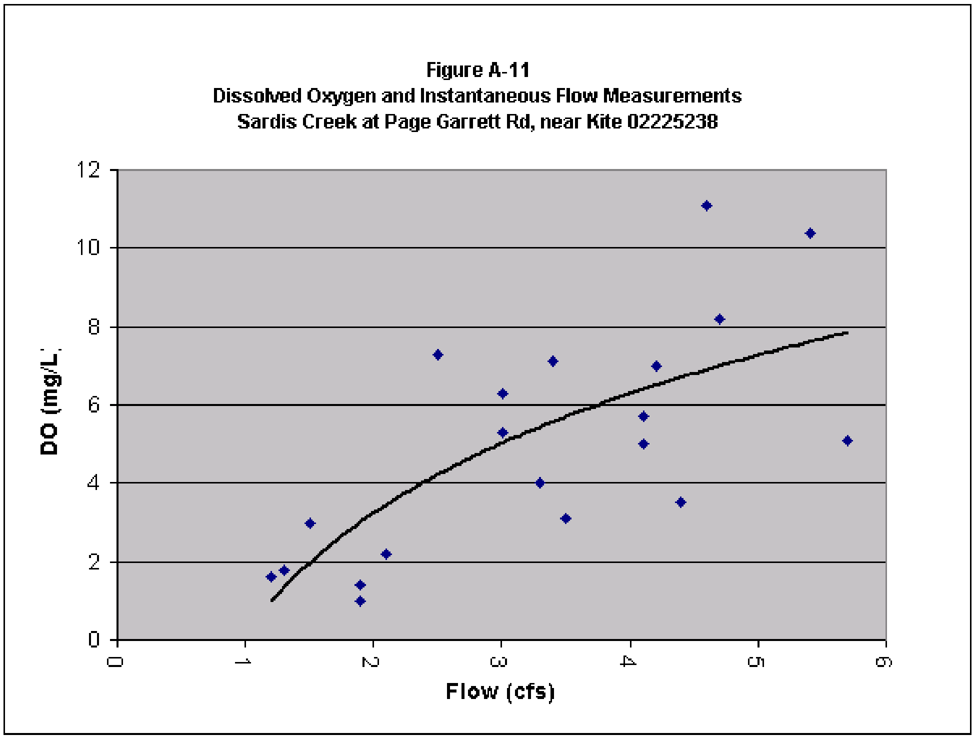


Table A-11. Data for Figure A-11

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)	TOC (mg/L)	BOD_5 (mg/L)	Ammonia (mg/L)
2/3/2004	4.6	11.1	8.3	4.5	0.8	0.03
2/24/2004	4.7	8.2	11.2	5.3	0.1	0.02
3/2/2004	5.4	10.4	12.3			
3/16/2004	4.1	5.7	16.7			
3/22/2004	3.4	7.1	14.5	6.6	2.1	0.03
3/30/2004	3	6.3	17.5			
4/6/2004	2.5	7.3	14.7			
4/13/2004	3	5.3	20.1	7.3	1.4	0.03
5/17/2004	1.3	1.8	22.7	12	3.3	0.16
6/15/2004	1.2	1.6	25.2	11	2.9	0.39
6/21/2004	1.5	3	26.5			
6/23/2004	3.5	3.1	23.9			
7/13/2004	1.9	1.4	26.9	16	2.3	0.12
8/17/2004	3.3	4	24.5	17	2	<.100
8/24/2004	2.1	2.21	25.5			
8/30/2004	1.9	1	25.2			
9/14/2004	4.4	3.5	22.8	15	2	<.100
10/20/2004	5.7	5.1	19.1	18	2	<.030
11/15/2004	4.1	5	11.4	11	2	0.033
12/7/2004	4.2	7	11.7	6.7	2	0.032

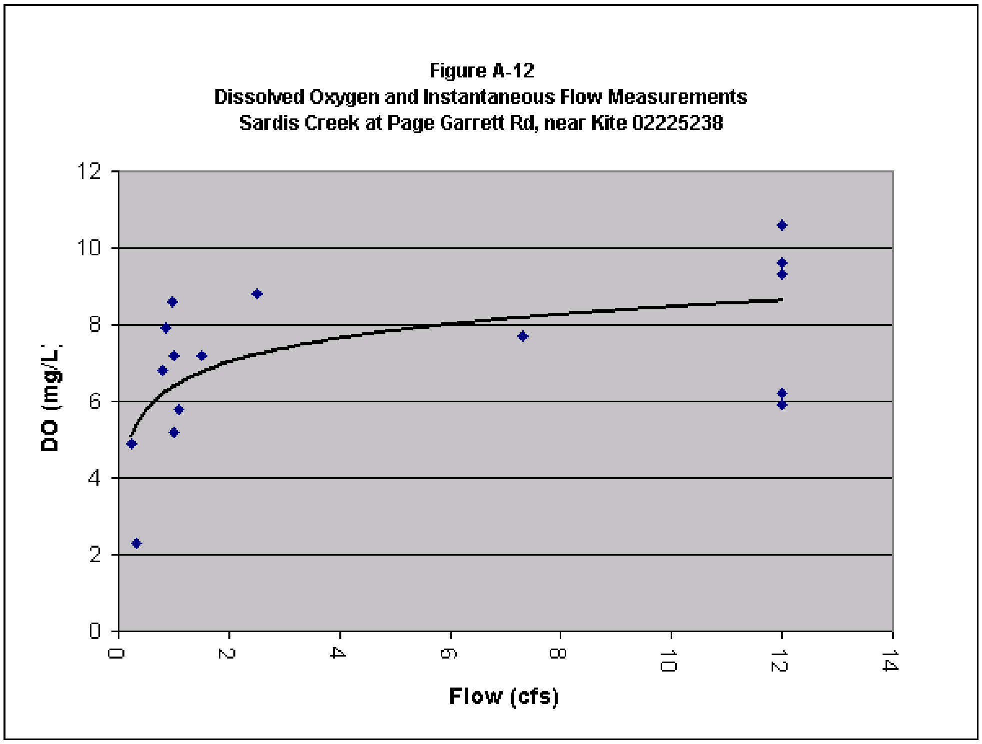


Table A-12. Data for Figure A-12

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)	TOC (mg/L)	BOD_5 (mg/L)	Ammonia (mg/L)
2/3/2004	12	10.6	6.6	7.7	0.9	0.07
2/24/2004	12	9.3	11.4	6.9	0.4	0.03
3/2/2004	12	9.6	11.9			
3/16/2004	7.3	7.7	16.3			
3/22/2004	2.5	8.8	12.4	11	1.4	0.01
3/30/2004	1.5	7.2	16.2			
4/6/2004	0.84	7.9	13.3			
4/13/2004	1.1	5.8	19.3	12	1.1	0.11
5/17/2004						
6/15/2004	0.81	6.8	23.9	14	2.9	0.4
6/21/2004	0.23	4.9	25.2			
6/23/2004	1	5.2	24.2			
7/13/2004	0.33	2.3	25.8	24	2.5	0.26
8/17/2004						
8/24/2004						
8/30/2004						
9/14/2004	12	5.9	21.9	27	1.7	0.26
10/20/2004	12	6.2	18.7	22	2.2	0.03
11/15/2004	0.96	8.6	10.7	14	1.9	0.029
12/7/2004	1	7.2	13.8	12	1.7	0.029

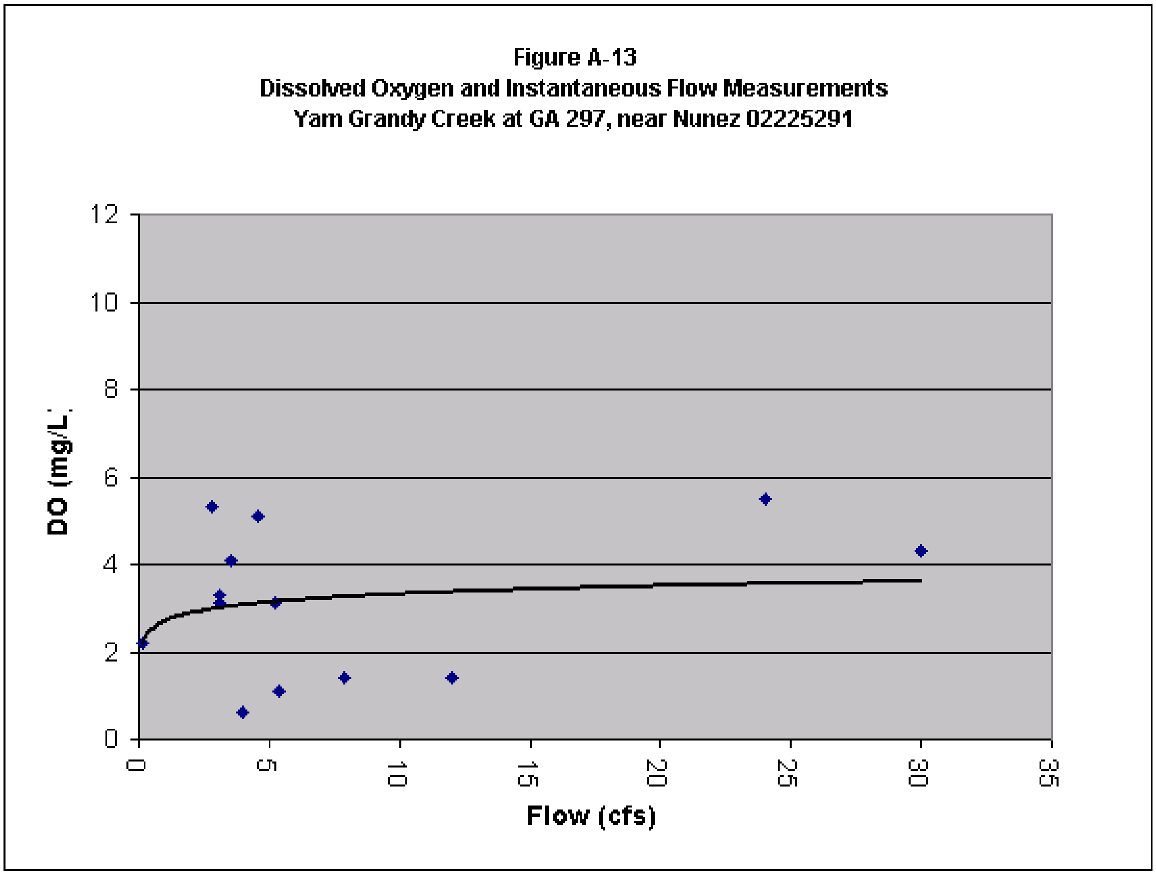


Table A-13. Data for Figure A-13

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)
3/31/2004	2.8	5.3	15.3
4/7/2004	4.6	5.1	15.4
4/14/2004	5.2	3.1	14.4
4/28/2004	4	0.6	17.1
7/21/2004			
7/28/2004			
8/10/2004			
4/19/2004	0.13	2.2	23.9
9/28/2004	30	4.3	23
10/5/2004	3.1	3.3	21.6
10/14/2004	3.1	3.1	18.9
10/26/2004	3.5	4.1	17.2
11/4/2004	5.4	1.1	21.1
11/8/2004	7.9	1.4	13.8
11/15/2004	12	1.4	11.3
11/29/2004	24	5.5	11

Figure A-14
Dissolved Oxygen and Instantaneous Flow Measurements
Jacks Creek at GA 46, near Stillmore 02225318

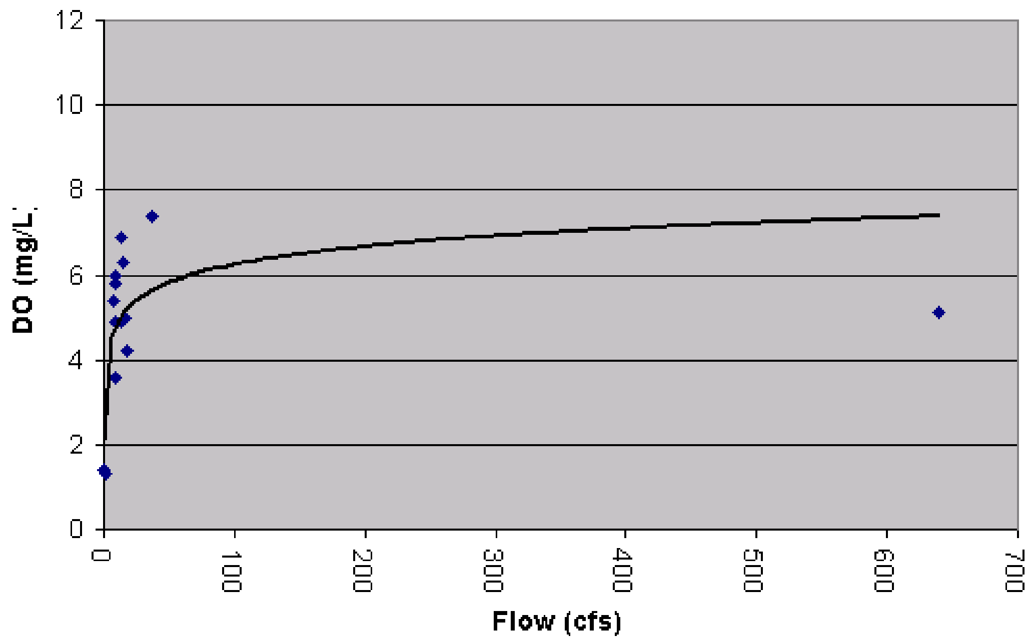


Table A-14. Data for Figure A-14

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)
3/30/2004	9.1	6	16.7
4/7/2004	9.5	5.8	14.9
4/13/2004	16	5	19.8
4/27/2004	17	4.2	18.5
7/20/2004	2	1.3	23.7
7/27/2004	0.1	1.4	25.3
8/9/2004			
8/17/2004			
9/29/2004	640	5.1	21.8
10/5/2004	13	4.9	19.9
10/12/2004	8.2	4.9	20.7
10/28/2004	6.8	5.4	18
11/3/2004	9.1	3.6	20.8
11/15/2004	14	6.3	10.3
11/18/2004	13	6.9	9.6
11/29/2004	37	7.4	10.2

Figure A-15
Dissolved Oxygen and Instantaneous Flow Measurements
Rocky Creek at Lyon Center Rd, near Lyons 02225585

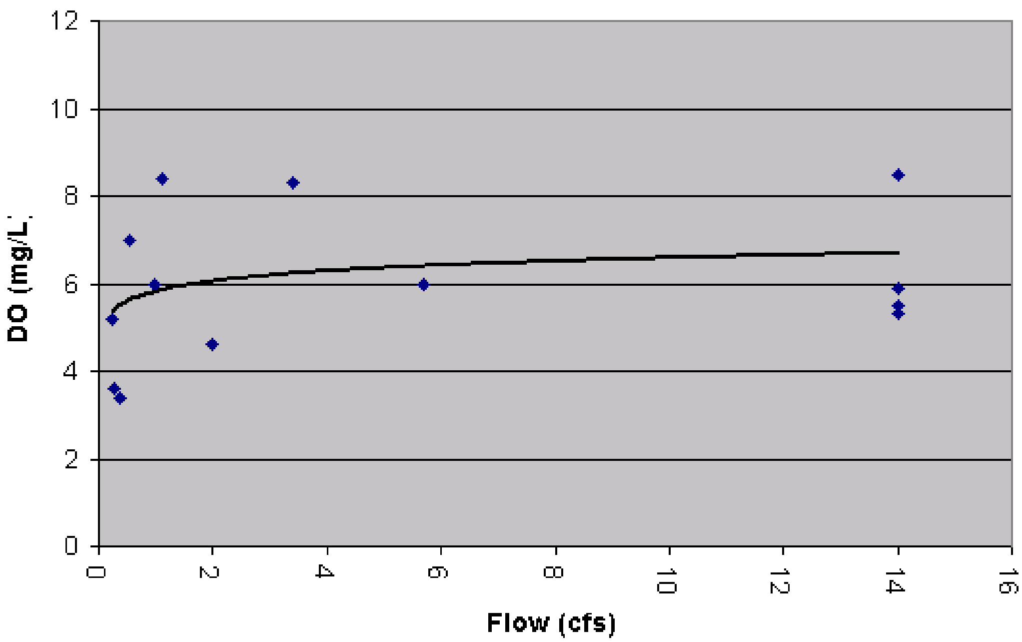


Table A-15. Data for Figure A-15

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)
3/30/2004	0.55	7	16.9
4/7/2004	0.55	7	15
4/13/2004	0.96	6	20
4/27/2004	0.38	3.4	20.2
7/20/2004	0.26	3.6	24.6
7/27/2004			
8/9/2004			
8/17/2004	0.22	5.2	23.8
9/29/2004	14	5.9	23
10/5/2004	14	5.5	21.7
10/12/2004	14	5.3	22.4
10/28/2004	5.7	6	18.9
11/3/2004	2	4.6	21.4
11/15/2004	3.4	8.3	12.9
11/18/2004	1.1	8.4	9.7
11/29/2004	14	8.5	11.7

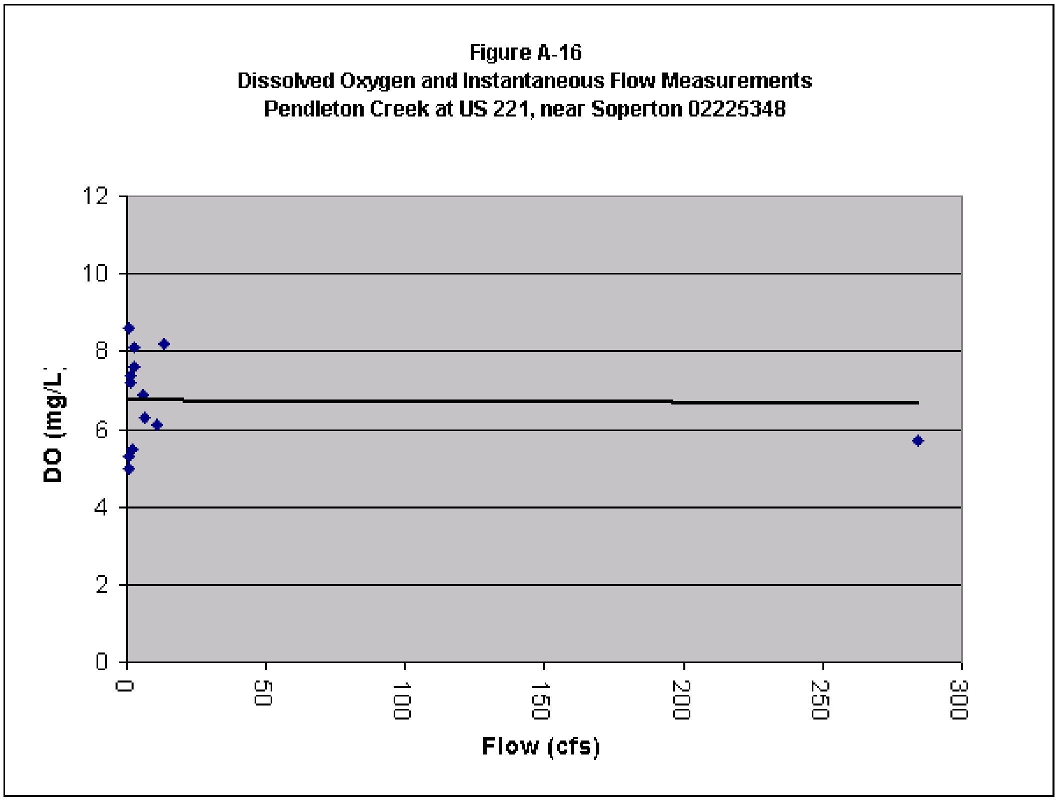


Table A-16. Data for Figure A-16

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)
3/31/2004	2.7	8.1	17.5
4/8/2004	1.3	7.4	16.1
4/14/2004	2.7	7.6	15.3
4/28/2004	0.47	5	16.3
7/20/2004			
7/27/2004			
8/9/2004			
8/17/2004	0.63	5.3	23.3
9/29/2004	284	5.7	22.4
10/7/2004	11	6.1	21.5
10/14/2004	6.2	6.3	19.8
10/26/2004	5.6	6.9	18.6
11/4/2004	1.6	5.5	21.5
11/8/2004	1.5	7.2	15.3
11/17/2004	0.94	8.6	10.1
11/30/2004	13	8.2	12.6

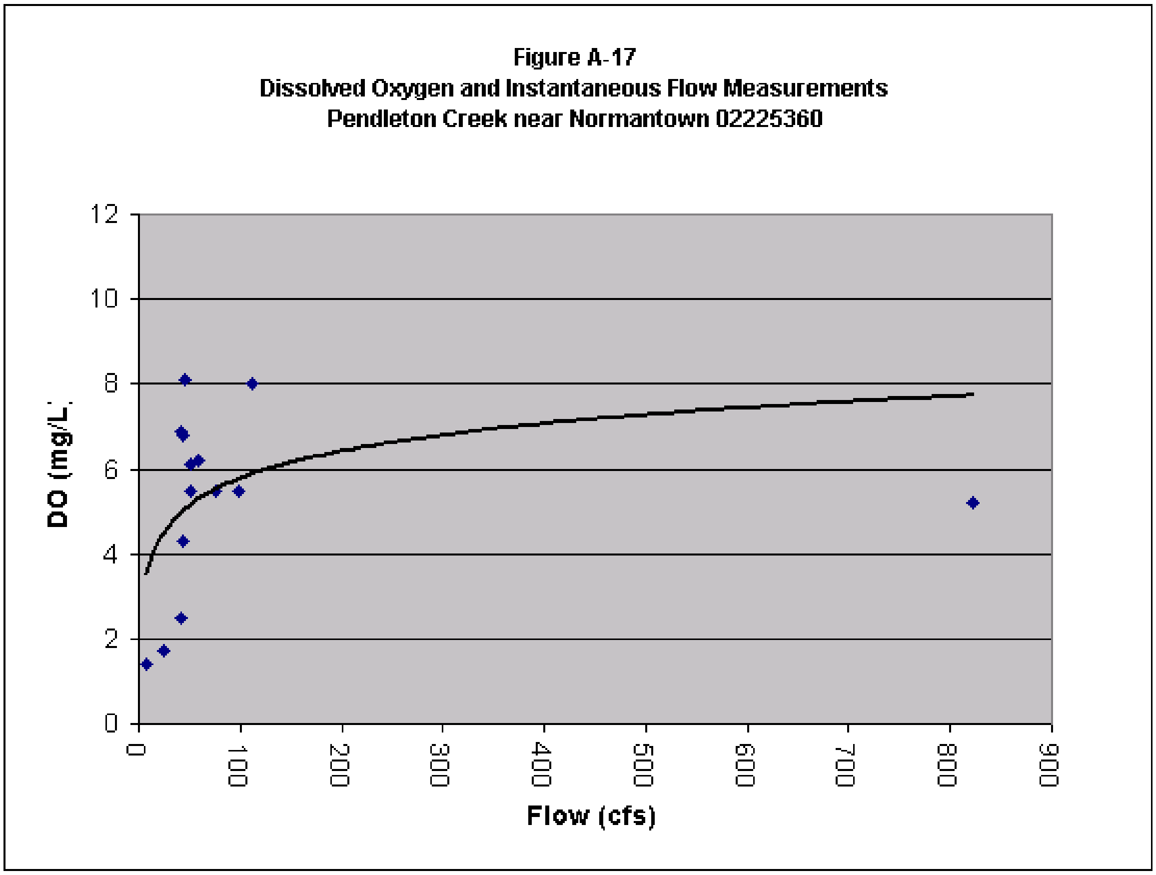


Table A-17. Data for Figure A-17

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)
4/6/2004	42	6.9	17.6
4/12/2004	51	6.1	14.1
4/26/2004	51	5.5	21
7/19/2004	41	2.5	18.8
7/27/2004	25	1.7	24.4
8/9/2004	8.4	1.4	25.5
8/17/2004			
9/29/2004			
10/5/2004	822	5.2	22.4
10/5/2004	99	5.5	20.6
10/12/2004	76	5.5	21.2
10/28/2004	59	6.2	18.1
11/3/2004	43	4.3	20.6
11/15/2004	44	6.8	10.7
11/18/2004	45	8.1	9.2
11/29/2004	111	8	11.1

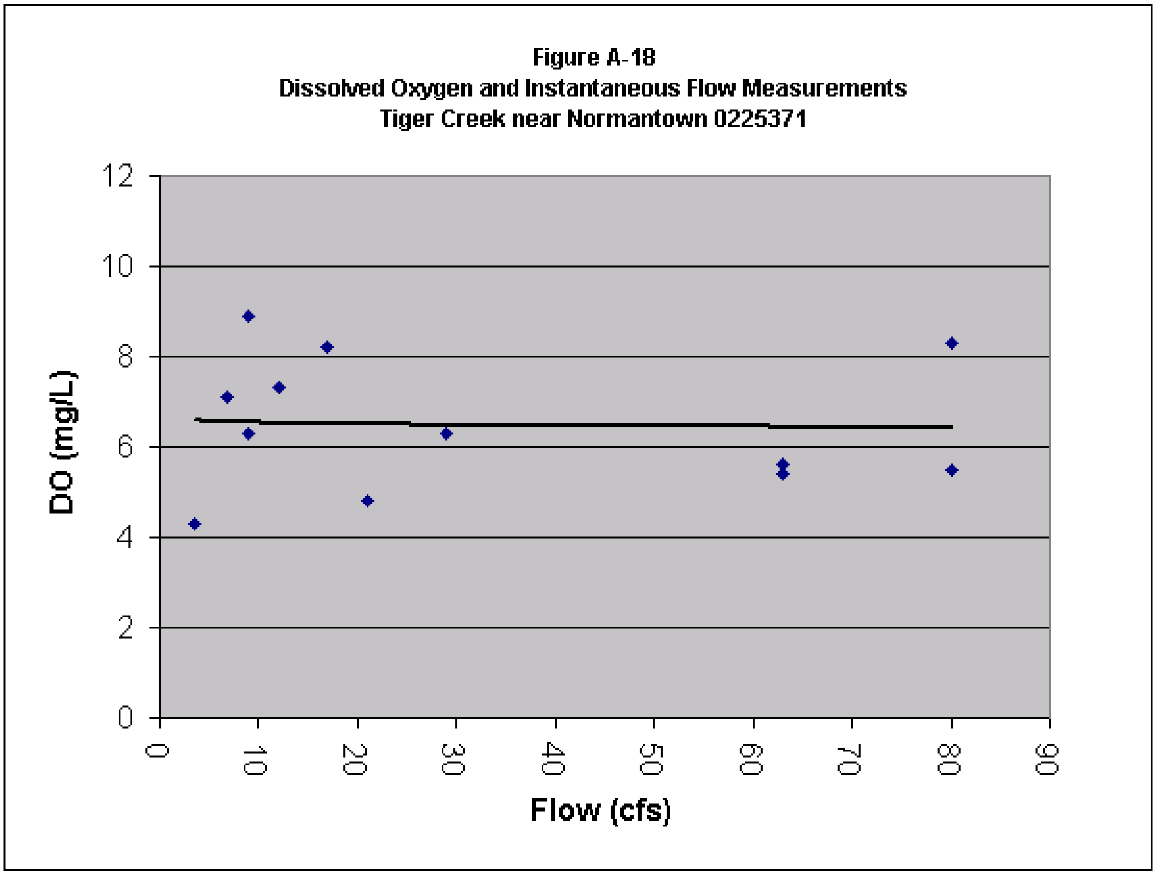


Table A-18. Data for Figure A-18

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)
3/30/2004	12	7.3	17.1
4/7/2004	6.8	7.1	13.7
4/13/2004	9	6.3	20.7
4/27/2004	3.5	4.3	18.1
7/20/2004			
7/27/2004			
8/9/2004			
8/17/2004			
9/29/2004	80	5.5	22.2
10/5/2004	63	5.6	20
10/12/2004	63	5.4	21.1
10/28/2004	29	6.3	18.1
11/3/2004	21	4.8	20.9
11/15/2004	17	8.2	10.3
11/18/2004	9	8.9	9.5
11/29/2004	80	8.3	10.4

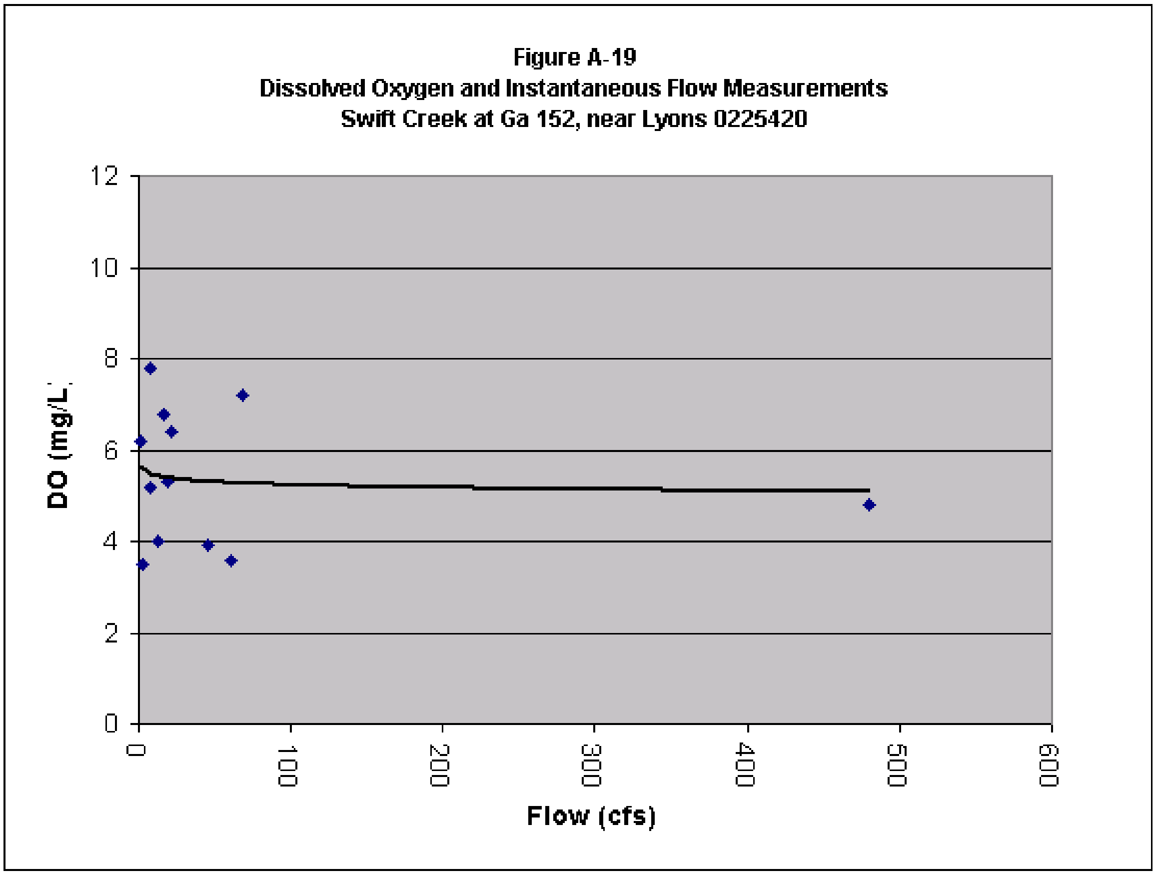


Table A-19. Data for Figure A-19

Date	Instantaneous Flow on Sample Day (cfs)	Dissolved Oxygen (mg/L)	Water Temperature (deg C)
3/30/2004	1.6	6.2	17.3
4/7/2004	7.5	5.2	16.6
4/13/2004	22	6.4	21.7
4/27/2004	2.2	3.5	19.4
7/20/2004			
7/27/2004			
8/9/2004			
8/17/2004			
9/29/2004	480	4.8	22.4
10/5/2004	61	3.6	21
10/12/2004	45	3.9	21.7
10/28/2004	19	5.3	18.4
11/3/2004	13	4	21.6
11/15/2004	16	6.8	11.3
11/18/2004	7.5	7.8	10.5
11/29/2004	68	7.2	11.1

APPENDIX B

Model Structure

B-1. Ohoopee Creek Model Structure – Watershed Designation

Reach/ Type		Reach Name	Reach Length (mile)	Drainage Area (mi^2)	Elevation Change(ft)
Ohoopee River – Main Branch					
		Headwater		1.186	
1	D	Tennille WTF	0	0	0
2	S	Tennille WTF to Unnamed Trib	3.726	2.197	41
3	S	Unnamed to Andrews Pond Creek	2.626	3.556	35
4	S	Andrews Pond Creek to Ohoopee River	3.933	3.778	35
5	T	Ohoopee River Tributary	0	24.44	0
6	S	Ohoopee River to Harts Ford Rd (USGS 02225143)	0.81	1.14	10
7	S	Harts Ford Rd to County Road 89	5.38	15.25	34
8	S	CR 89 to Big Cedar Creek	9.128	26.93	46
9	B	Junction. Big Cedar Creek	0	0	0
10	S	Big Cedar Creek to Dude Sumner Rd (USGS 02225163)	1.25	1.3	10
11	S	Dude Sumner Rd to Cypress Creek	0.78	5.47	10
12	B	Junction. Cypress Creek	0	0	0
13	S	Cypress Creek to Pullens Bridge Rd (USGS 02225165)	4.3	10.9	19.7
14	S	Pullens Bridge Rd to Randall/Neels Creeks	0.65	0.44	3.3
15	T	Randall Creek Tributary	0	23.46	0
16	T	Neels Creek Tributary	0	19.15	0
17	S	Neels Creek to US 80 (ds)	6.013	37.94	16
18	S	US 80 to Mulepen Creek	5.97	17.44	19
19	T	Mulepen Creek Tributary	0	19.58	0
20	S	Mulepen to US Hwy 221 (USGS 02225190)	1.3	0.8	1
21	S	US Hwy 221 to Little Ohoopee River	5.66	20.03	17
22	B	Junction. Little Ohoopee River	0	0	0
23	S	Little Ohoopee River to State Rd 297 (USGS 02225270)	1.93	11	6.6
24	S	State Rd 297 to Yam Grandy Creek	3.56	8.19	5.4
25	B	Junction. Yam Grandy Creek	0	0	0
26	S	Yam Grandy Creek to Jacks Creek	8.514	15.18	20
27	T	Jacks Creek Tributary	0	65.45	0
28	S	Jacks Creek to Beaver Creek	9.362	23.9	15
29	T	Beaver Creek Tributary	0	19.44	0
30	S	Beaver Creek to USGS Sta. 02225340	7.156	22.45	15
31	S	USGS 02225340 to Pendleton Creek	4.945	10.33	10
32	B	Junction. Pendleton Creek	0	0	0
33	S	Pendleton Creek to Brazells Creek	5.458	14.7	8
34	T	Brazells Creek Tributary	0	31.96	0
35	S	Brazells Creek to Rocky Creek	3.007	19.21	3
36	B	Junction. Rocky Creek	0	0	0
37	S	Rocky Creek to Doc Rogers Correct. Inst. WTF	3.871	10.89	5
38	D	Doc Rogers Correct. Inst. WTF	0	0	0
39	S	Doc Rogers Correct. Inst. WTF to Thomas Creek	2.903	3.515	4
40	T	Thomas Creek Tributary	0	43.74	0
41	S	Thomas Creek to Battle Creek	2.908	3.336	5
42	T	Battle Creek Tributary	0	29.89	0
43	S	Battle Creek to Four Acre Creek	3.916	5.583	6
44	T	Four Acre Creek Tributary	0	9.427	0
45	S	Four Acre Creek to Altamaha River	3.053	1.751	2

Big Cedar Creek Branch					
		Headwaters		5.0	
46	T	Little Cedar Creek Tributary 1	0	8.045	0
47	S	Little Cedar Cr 1 to L. Cedar Ck 2	6.068	9.201	35
48	T	Little Cedar Creek Tributary 2	0	15.33	0
49	T	Unnamed Tributary	0	1.993	0
50	D	Wrightsville WTF	0	0	0
51	S	Wrightsville WTF to Liberty Church Road (USGS 02225157)	2.09	2	9.8
52	S	Liberty Church Road to Ohoopee River	1	2.3	4.8
Cypress Creek Branch					
		Headwater		11.43	
53	S	Headwater to Rolands Pond	1.5	3.29	5
54	S	Rolands Pond to Flat Rock Branch	2.82	2.37	8
55	T	Flat Rock Branch Tributary	0	2.31	0
56	S	Flat Rock Branch to Liberty Church Road (USGS 02225164)	1	1.2	6.6
57	S	Liberty Church Road to Ohoopee River	0.84	0.5	9.4
Little Ohoopee River Branch					
		Headwater		4.6	
58	S	Nealey Creek Headwaters to USGS 02225199	2.25	3.29	16
59	S	USGS Station 02225199 to Little Ohoopee River	3.25	5.64	26
60	T	Little Ohoopee River	0	30.91	0
61	S	Little Ohoopee to Smith Creek	7.306	16.26	25
62	T	Smith Creek Tributary	0	11.99	0
63	S	Smith Creek to Swain Creek	3.262	2.51	11
64	T	Swain Creek Tributary	0	10.79	0
65	T	Battleground Creek Tributary	0	20.11	0
66	S	Battleground Creek to GA 57 (USGS 022225235)	2.04	21.2	10
67	S	GA 57 to Sardis Creek	3.73	14.02	13
68	B	Sardis Creek Tributary	0	20.25	0
69	S	Sardis to Crooked Creek	1.572	2.554	2
70	T	Crooked Creek Tributary	0	14.23	0
71	S	Crooked to Flat Creek	6.348	25.21	21
72	T	Flat Creek Tributary	0	17.66	0
73	S	Flat Creek to USGS Sta. 02225255	5.791	18.74	14
74	S	USGS 02225255 to Ohoopee River	4.221	9.301	12
Yam Grandy Creek Branch					
		Headwater		6.96	
75	D	Swainesboro WPCP	0	0	0
76	S	Swainesboro WPCP to Empire Expway North	1.74	3.08	25
77	S	Empire Expwy (N) to Hammock Branch	1.22	0.97	15
78	T	Hammock Branch Tributary	0	2.26	0
79	S	Hammock Branch to Yam Grandy Creek	0.99	0.43	25
80	T	Yam Grandy Creek Tributary	0	22.98	0
81	S	Crooked to Open Creek	3.17	6.011	11
82	T	Open Creek Tributary	0	7.597	0
83	S	Open Creek to GA HWY 297 (USGS 022225291)	1.024	1.48	1
84	S	GA HWY 297 to Ohoopee River	6	16	18

Rocky Creek Branch					
		Headwater		13.49	
85	S	Headwaters to Lyons Center Rd (USGS 02225585)	4.93	10	13
86	S	Lyons Center Road to USGS 02225590	1.7	3.65	10
87	S	USGS 02225590 to Little Rocky Creek	3.947	10.09	23
88	T	Little Rocky Creek Tributary	0	17.68	0
89	D	Santa Claus WTF	0	0	0
90	S	Santa Claus WTF to Unnamed Creek	4.643	10.11	18
91	S	Unnamed to Unnamed Creek	2.62	11.46	14
Sardis Creek Branch					
		Headwater		5.22	
93	S	Headwater to USGS Station 02225338	0.55	0.9	7
94	S	USGS station 02225238 to unnamed trib LEW	0.91	0.89	16
95	T	Unnamed Tributary from left	0	6.71	0
96	S	Unnanmed Trib to Second Street	3.8	5.44	13
97	S	Second Street to Little Ohoopee River	2.24	2.45	20
Pendleton Creek Branch					
		Headwaters		44.69	
98	S	Pendleton Headwaters to Wildwood Dam	5.8	26.3	8
99	S	Wildwood Dam to Long Creek	5.127	8.483	25
100	T	Long Creek Tributary	0	8.9	0
101	S	Long Creek to Mill Creek	2.195	1.667	5
102	T	Mill Creek Tributary	0	9.362	0
103	S	Mill Creek to USGS 02225360	1.1	1.1	1
104	S	USGS 02225360 to Tiger Creek	3.81	8.225	10
105	B	Junction. Tiger Creek	0	0	0
106	S	Tiger Creek to Little Reedy Creek	2.667	3.494	7
107	T	Little Reedy Creek Tributary	0	9.566	0
108	S	Little Reedy Creek to Reedy Creek	2.069	2.144	7
109	T	Reedy Creek Tributary	0	19.77	0
110	S	Reedy Creek to Swift Creek	6.397	8.514	16
111	B	Junction. Swift Creek	0	0	0
112	S	Swift Creek to Lyons No. 1 East WTF	1.222	4.686	7
113	D	Lyons No. 1 East WTF	0	0	0
114	S	Lyons No. 1 East WTF to Little Creek	1.587	6.73	3
115	T	Little Creek Tributary	0	7.76	0
116	S	Little Creek to Ohoopee River	6.109	8.341	20
Tiger Creek Branch					
		Headwater		15.78	
117	S	Tiger Creek Headwaters to Bobtail Creek	3.053	6.905	22
118	T	Bobtail Creek Tributary	0	9.07	0
119	S	Bobtail Creek to Naked Creek	1.163	2.334	10
120	T	Naked Creek Tributary	0	4.813	0
121	S	Naked Creek to SR 297	4.761	18.04	18
122	S	SR 279 to Victory Drive (USGS 0225371)	5.4	10	20
123	S	Victory Drive to Pendleton Creek	0.6	0.67	2

Swift Creek Branch					
		Headwater		25.17	
124	S	Swift Headwaters to Vidalia WTF	2.189	8.641	9
125	D	Vidalia WTF	0	0	0
126	S	Vidalia WTF to Lyons No. 2 North WTF	4.858	16.36	29
127	D	Lyons No. 2 North WTF	0	0	0
128	S	Lyons No. 2 North WTF to GA 152 (USGS 02225420)	1	1	25
129	S	GA 152 to Pendleton Creek	3.7	4.94	23

Note: S: Stream
T: Tributary
B: Branch
D: Discharge

APPENDIX C

Calibration, Natural Conditions, and TMDL Model Curves

Figure C-1
DOSAG Model Results
Ohoopee River

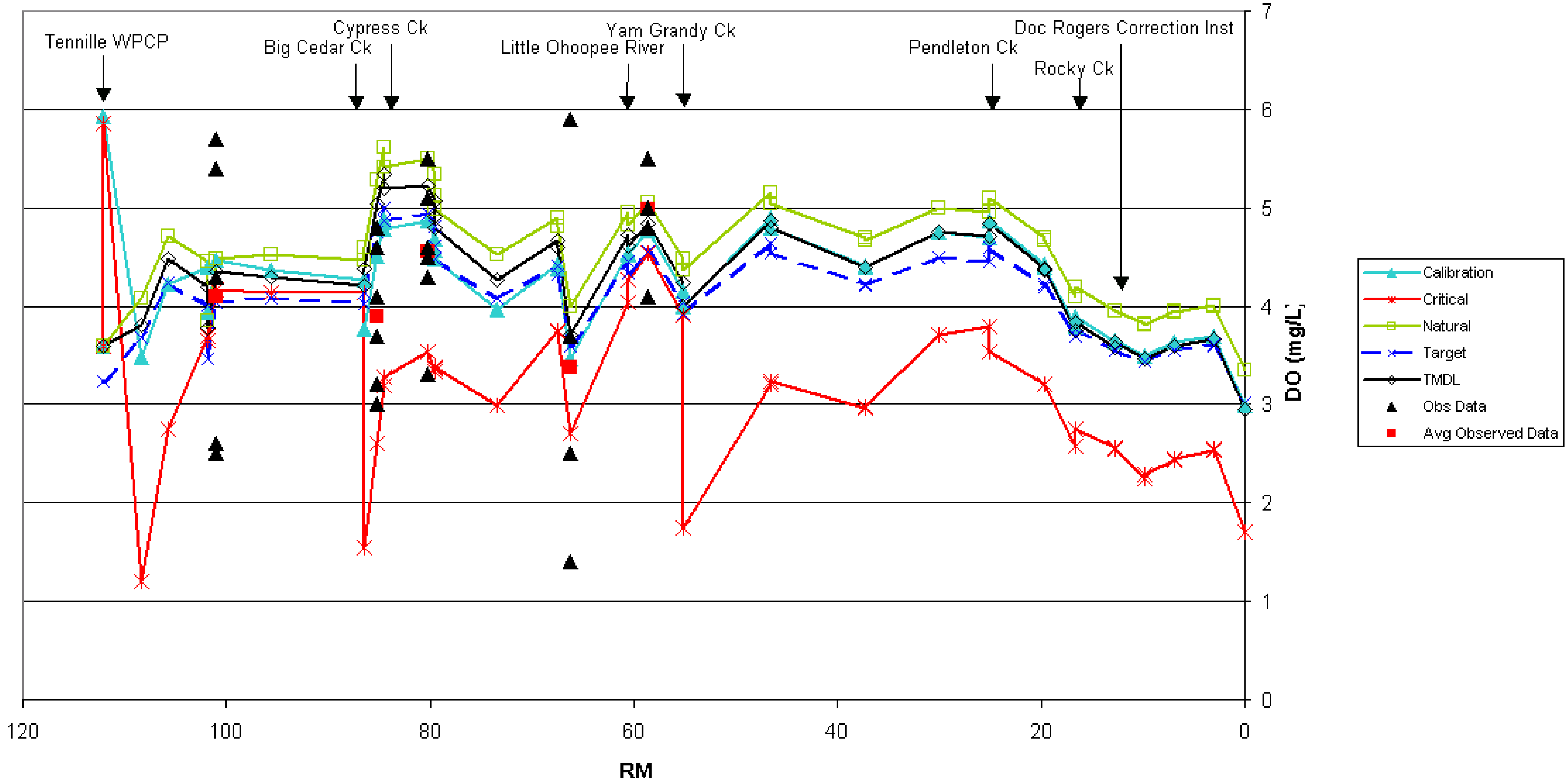


Figure C-2
DOSAG Model Results
Big Cedar Creek

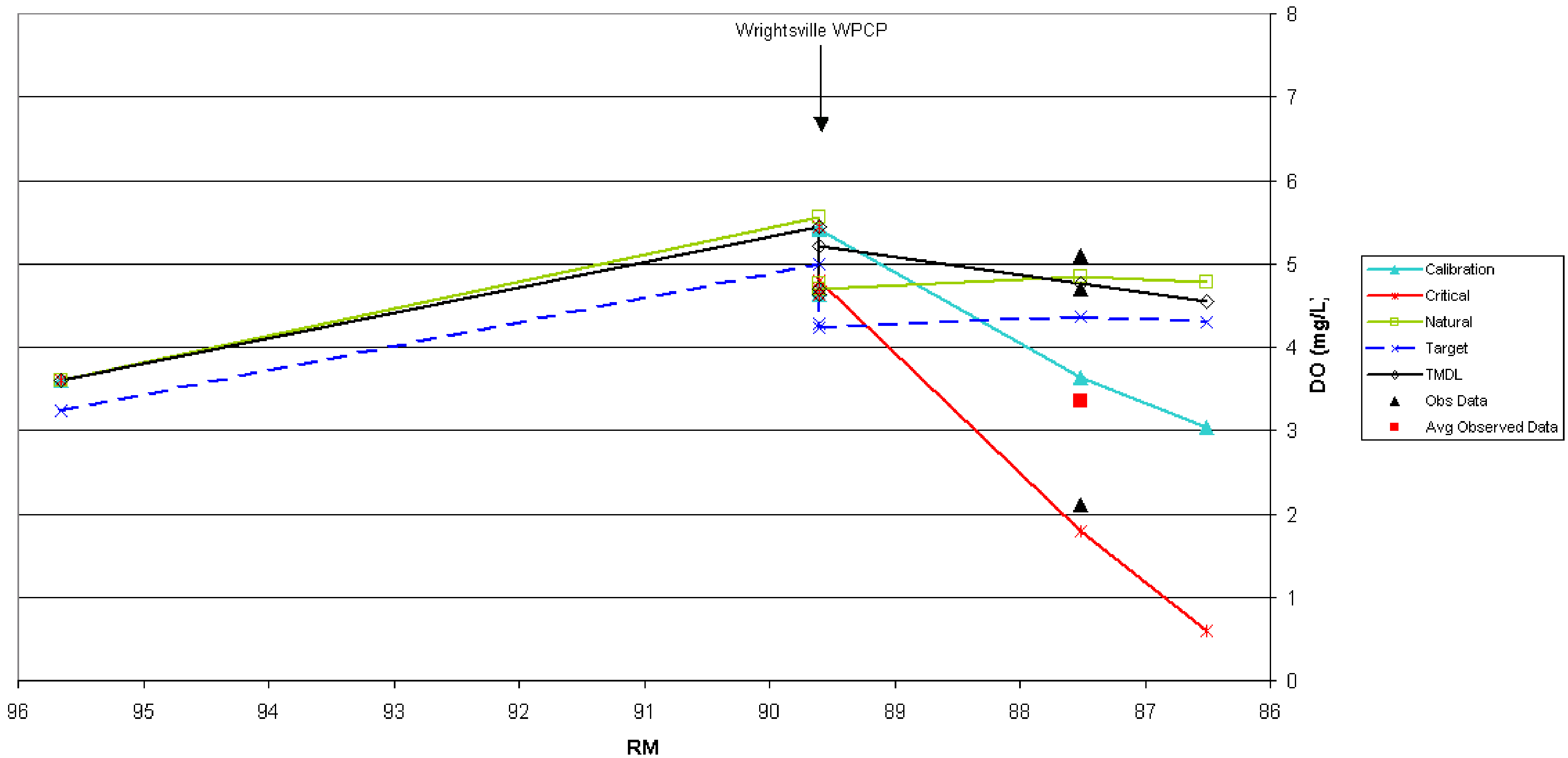


Figure C-3
DOSAG Model Results
Cypress Creek

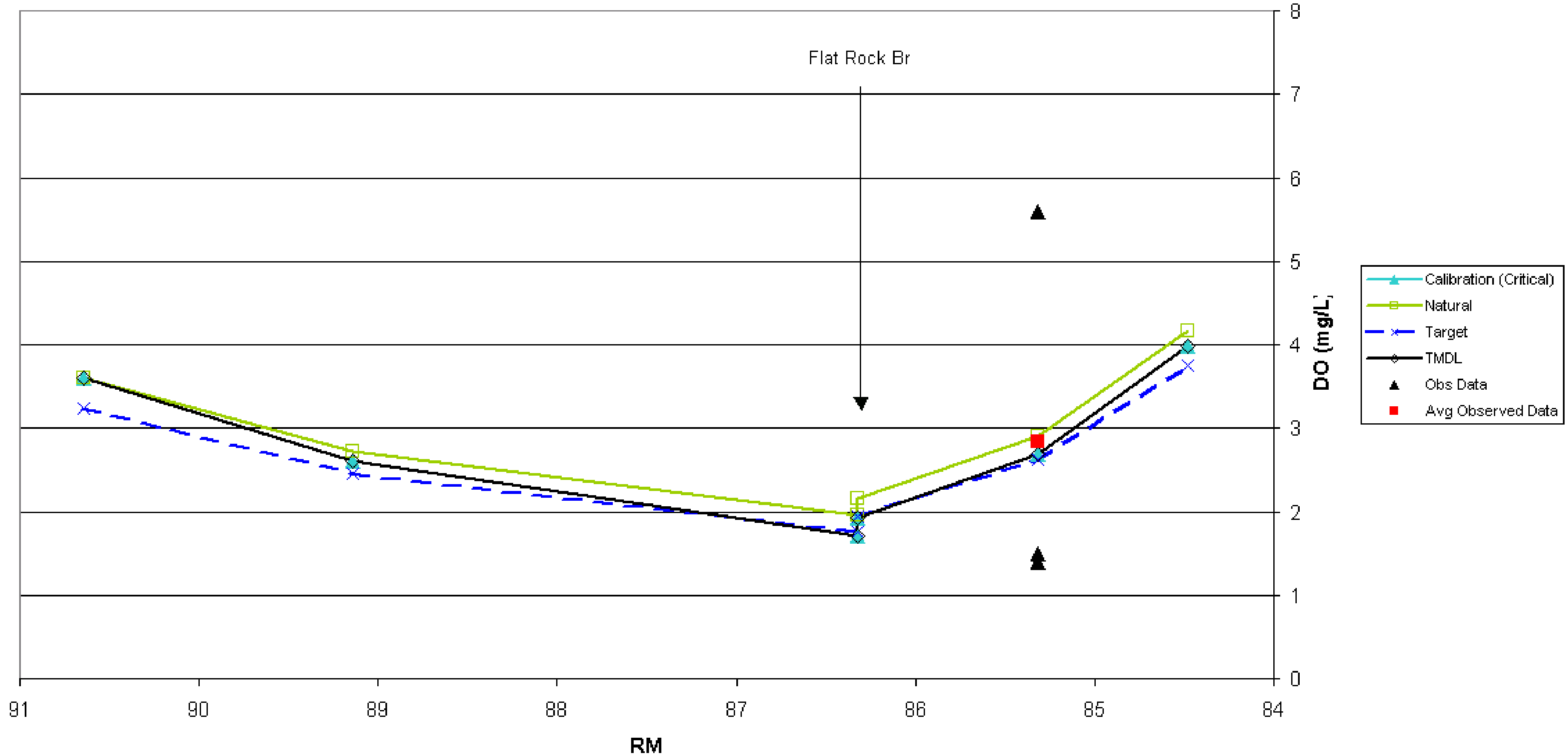


Figure C-4
DOSAG Model Results
Nealey Creek and Little Ohoopee Creek

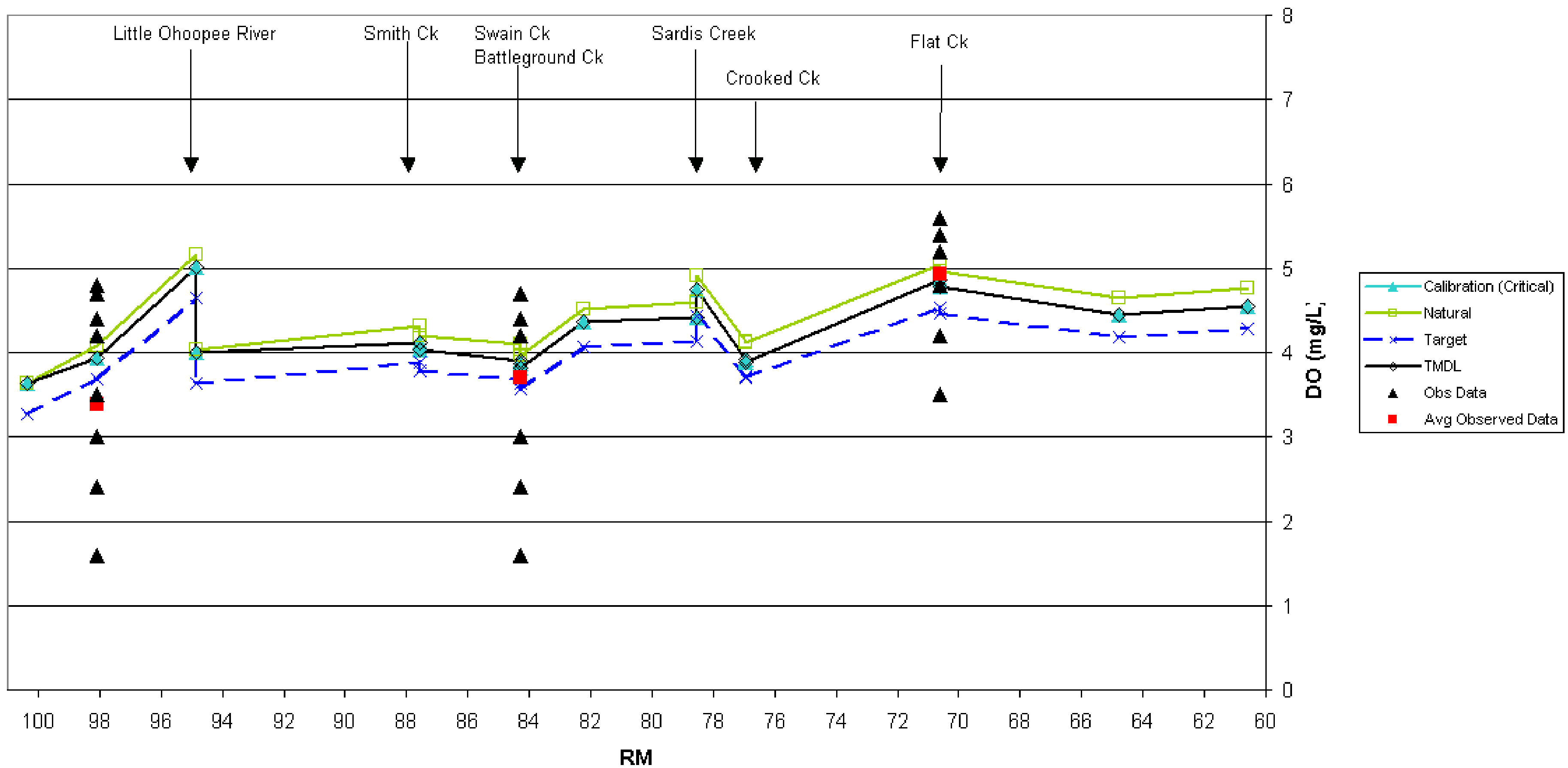


Figure C-5
DOSAG Model Results
Sardis Creek

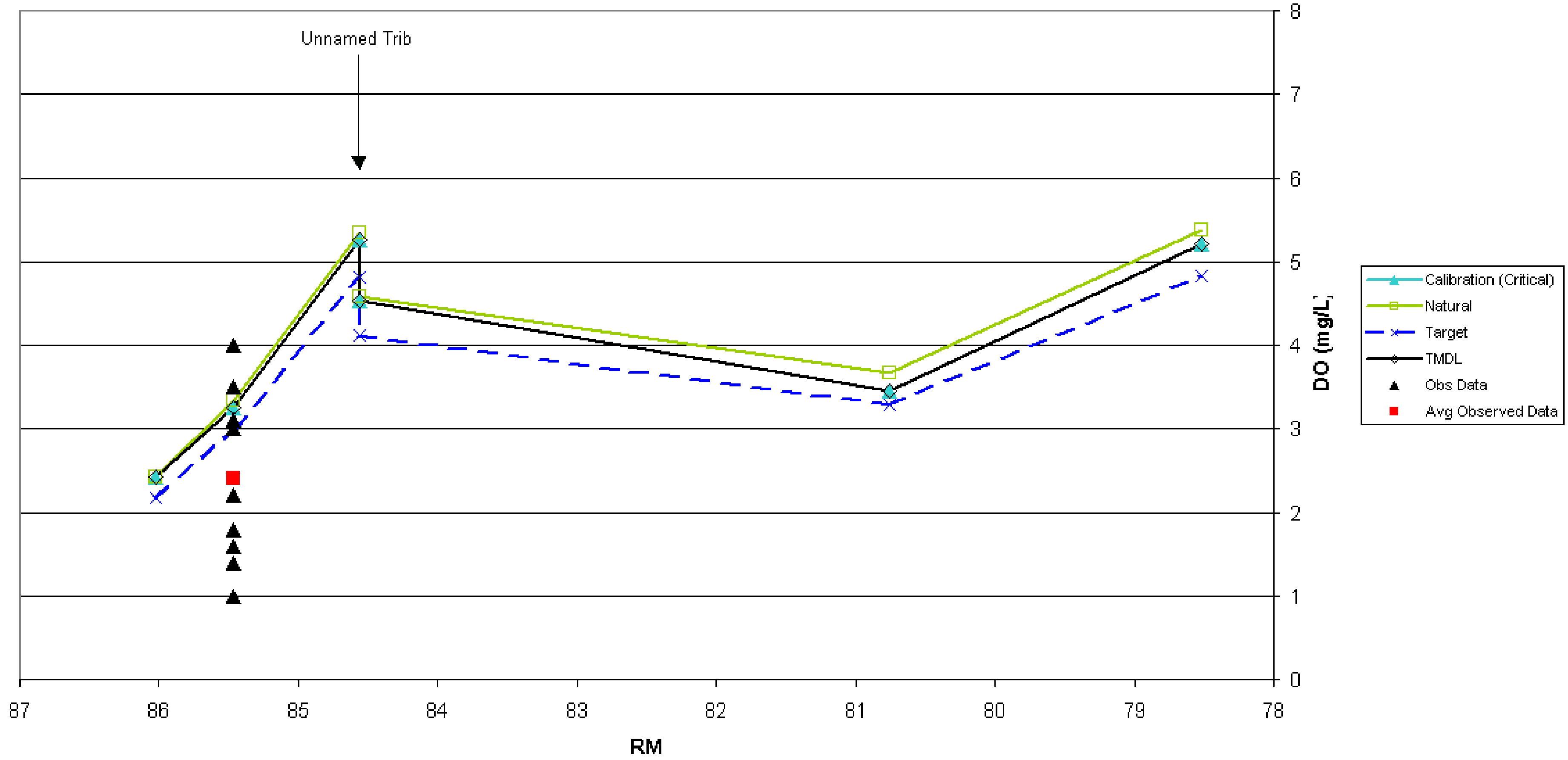


Figure C-6
DOSAG Model Results
Yam Grandy Creek

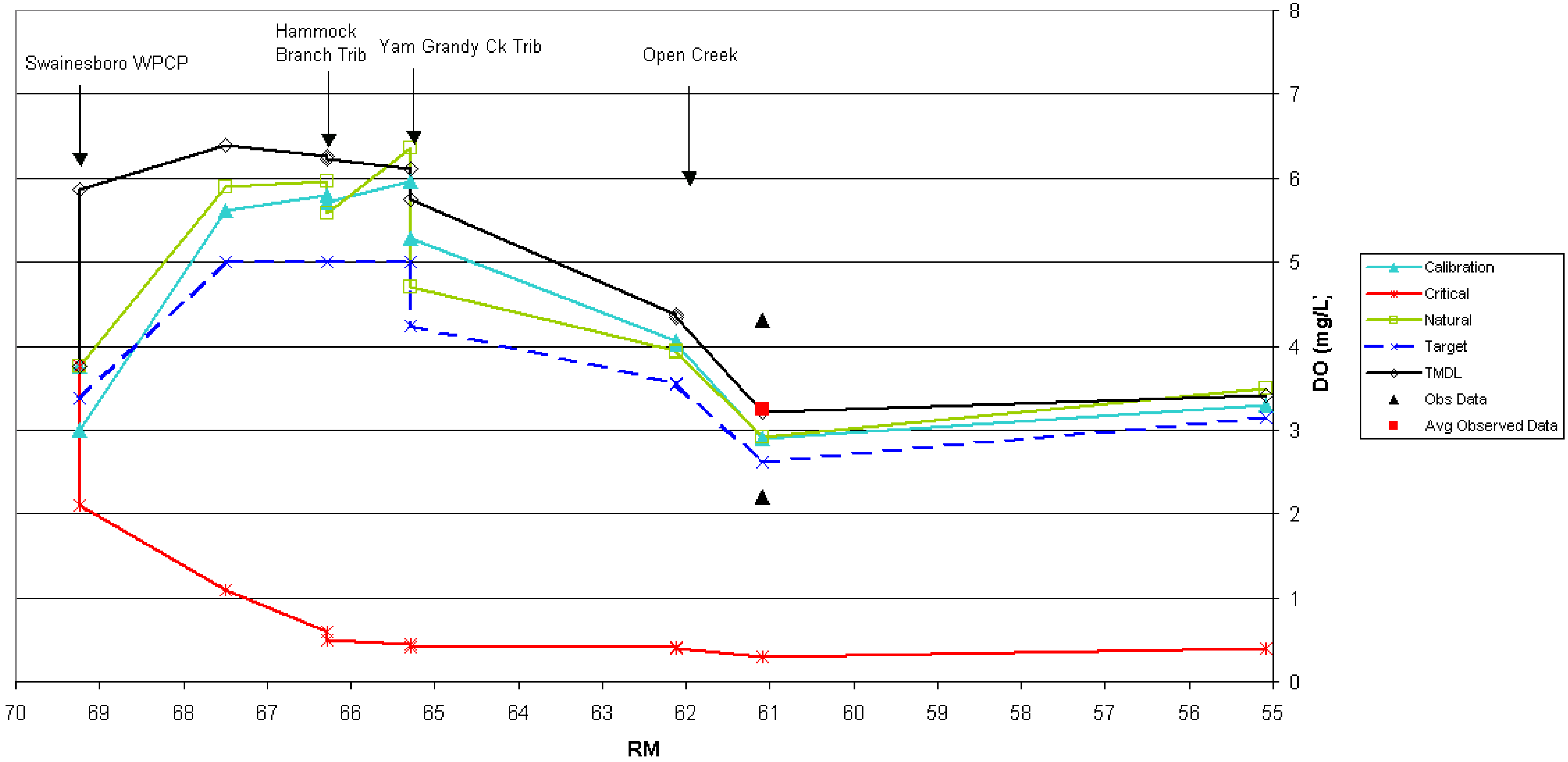


Figure C-7
DOSAG Model Results
Pendelton Creek

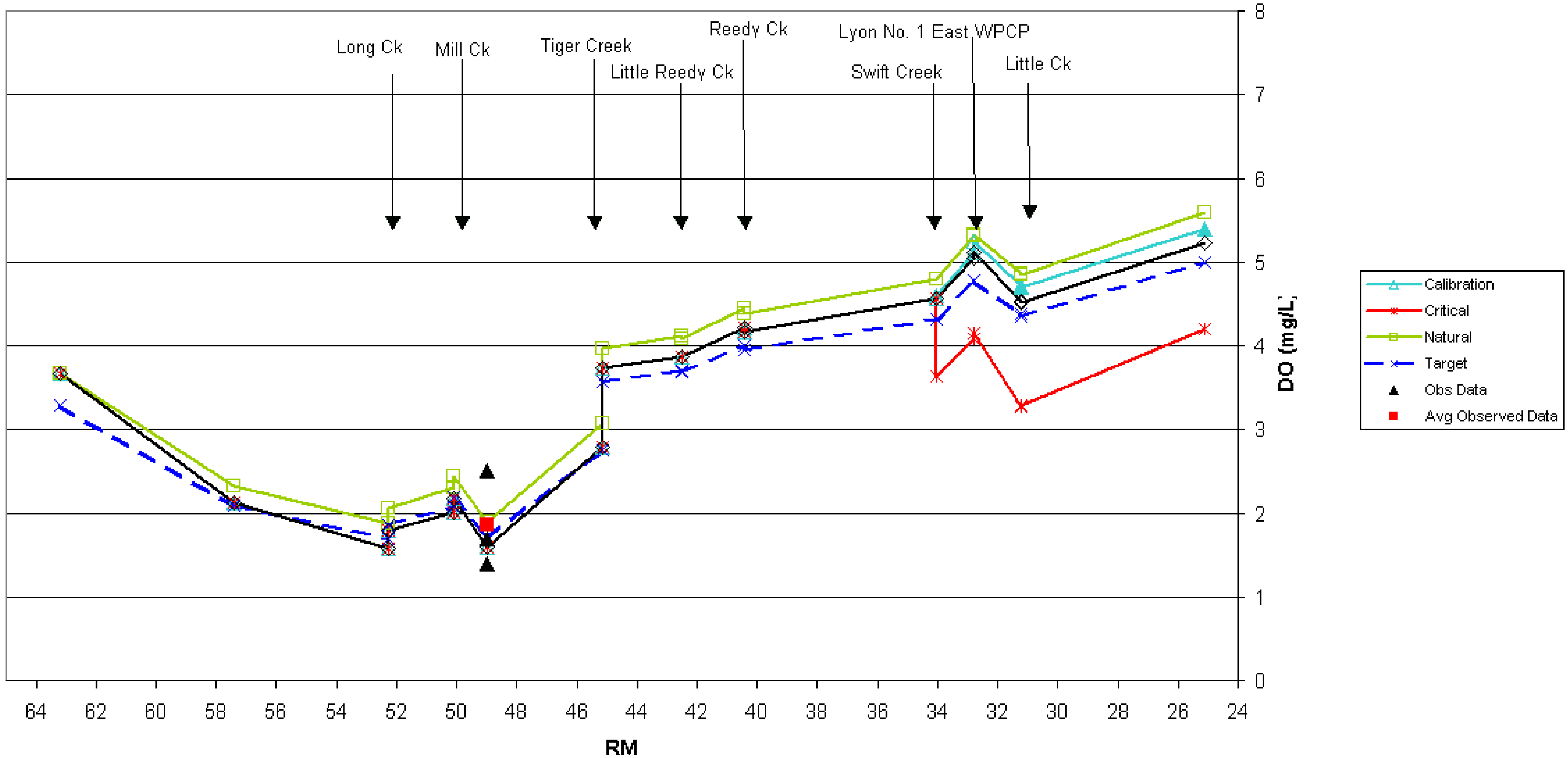


Figure C-8
DOSAG Model Results
Tiger Creek

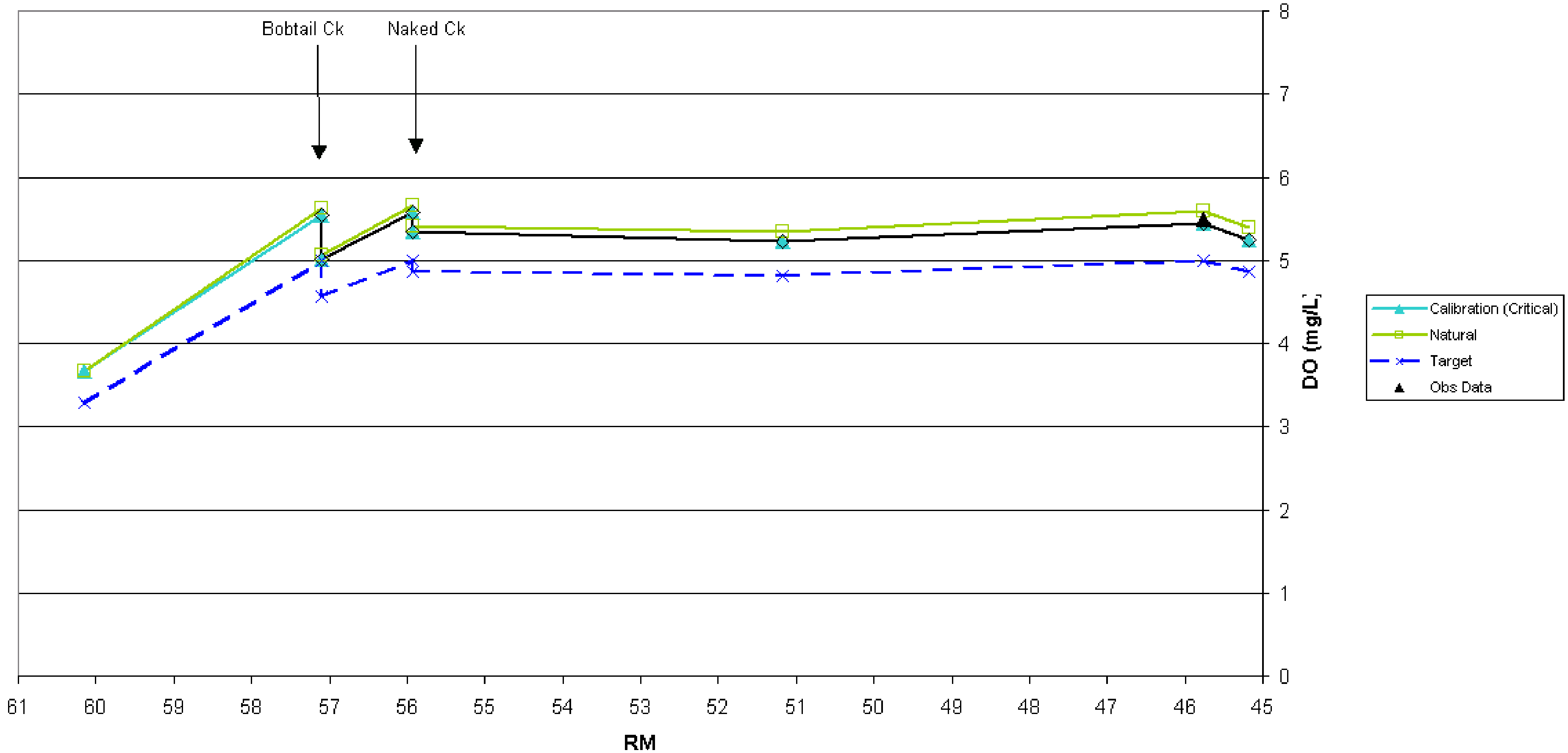


Figure C-9
DOSAG Model Results
Swift Creek

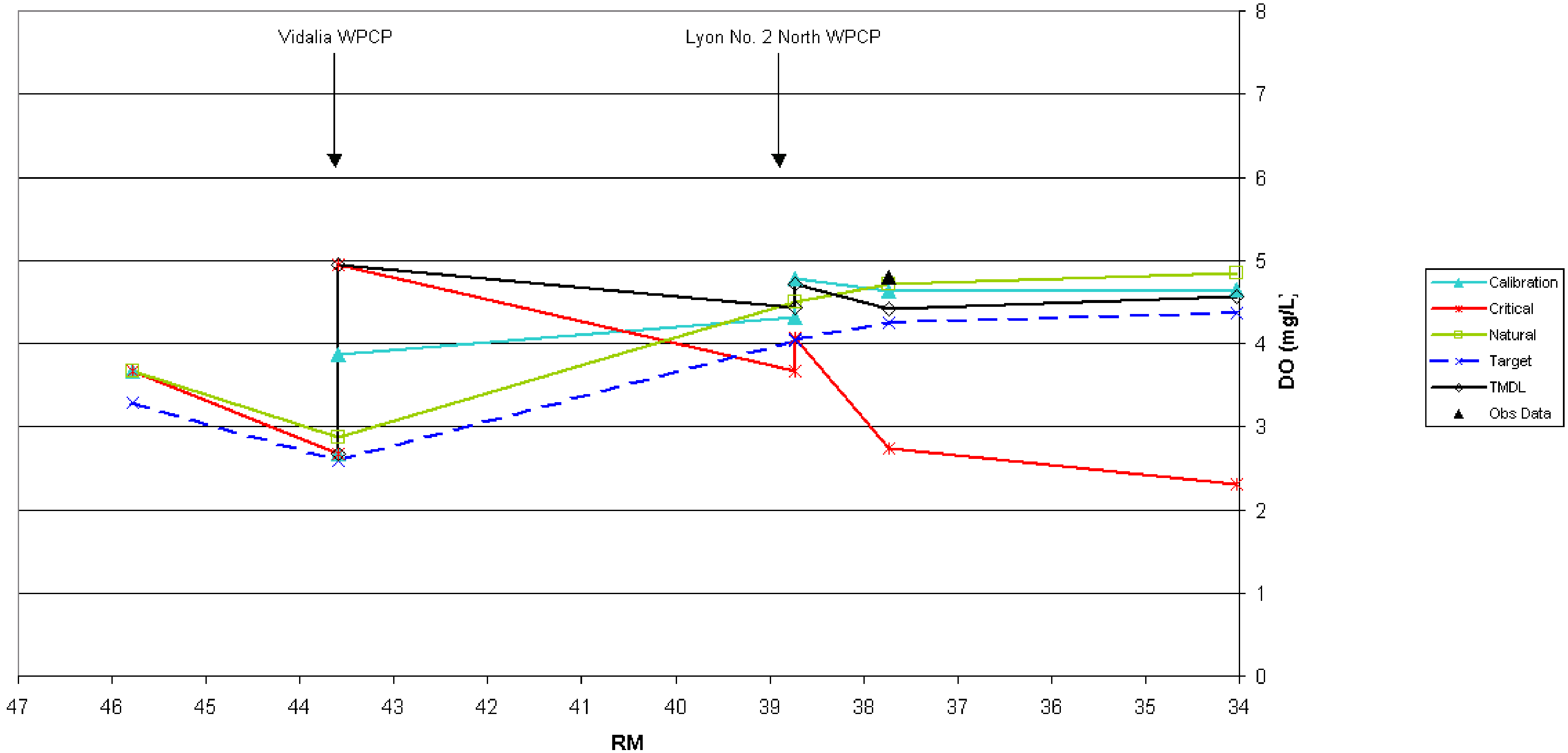
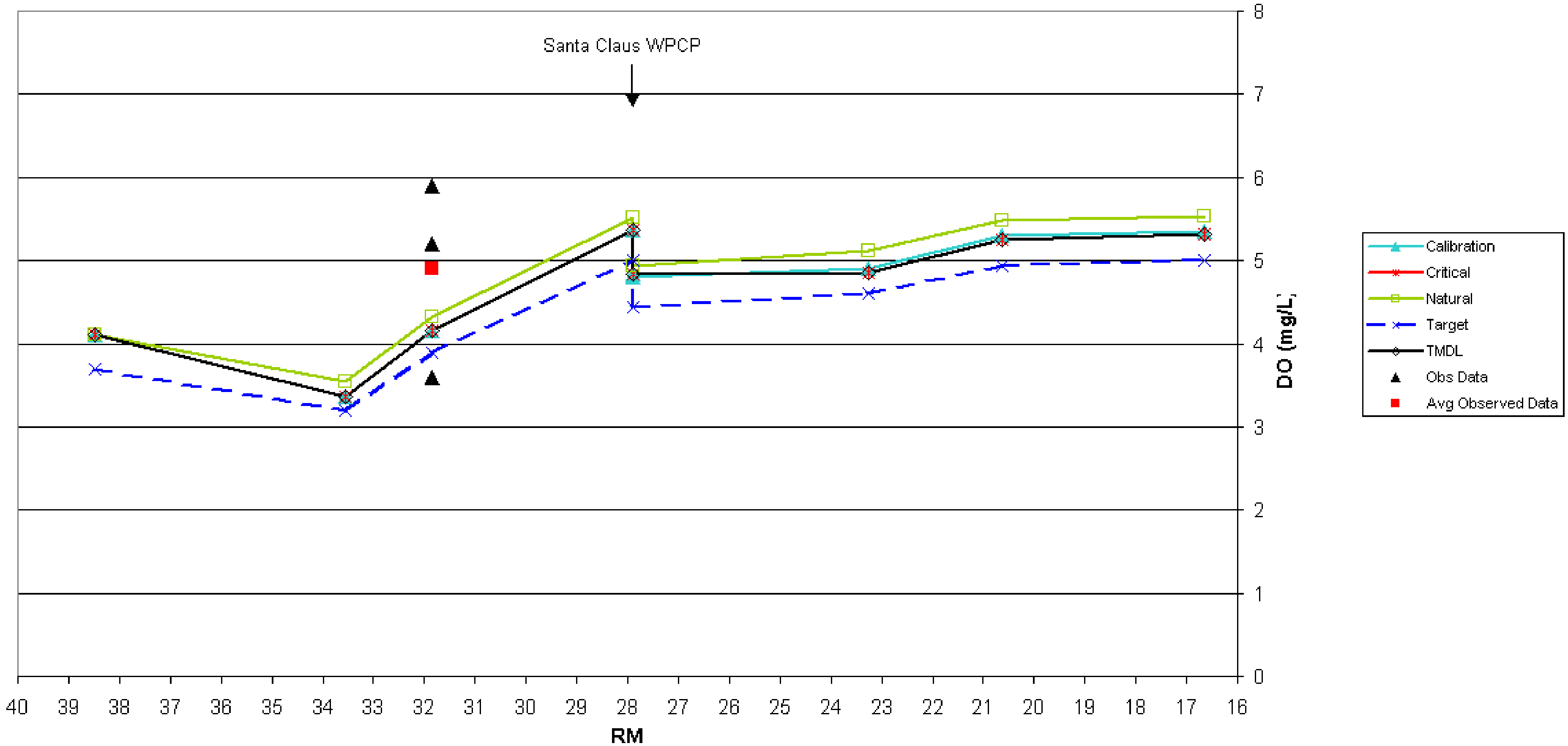


Figure C-10
DOSAG Model Results
Rocky Creek



APPENDIX D

Daily Oxygen Demanding Substances Load Summary Memorandum

SUMMARY MEMORANDUM
Average Annual Oxygen Demanding Substances Load
Cypress Creek

1. 303(d) Listed Waterbody Information

State:	**Georgia**
County:	**Johnson**
Major River Basin:	**Altamaha**
8-Digit Hydrologic Unit Code(s):	**03070107**
Waterbody Name:	**Cypress Creek**
Location:	**Rolands Pond to Ohoopee River**
Stream Length:	**4 miles**
Watershed Area:	**14.4 square miles**
Tributary to:	**Altamaha River**
Ecoregion:	**Southern Coastal Plain**
Constituent(s) of Concern:	**Dissolved Oxygen**
Designated Use:	**Fishing (partially 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 from summer 2004.**
Critical Conditions:	**(1) 7Q10 flows based on low-flow analysis of available data from the Altamaha River Basin.** **(2) Temperatures were derived from historic trend monitoring data in *Stream-Temperature Characteristics in Georgia (USGS, 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):	**NA**
Wasteload Allocations (WLAsw):	**NA**
Load Allocation (LA):	**31.74 lbs/day**
TMDL	**31.74 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) Low flow 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 2004.
(4) Water depths are shallow, generally one foot, 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.

SUMMARY MEMORANDUM
Average Annual Oxygen Demanding Substances Load
Nealey Creek

1. 303(d) Listed Waterbody Information

State:	**Georgia**
County:	**Washington and Johnson**
Major River Basin:	**Altamaha**
8-Digit Hydrologic Unit Code(s):	**03070107**
Waterbody Name:	**Nealey Creek**
Location:	**Headwaters to Little Ohoopee River**
Stream Length:	**9 miles**
Watershed Area:	**13.04 square miles**
Tributary to:	**Altamaha River**
Ecoregion:	**Southern Coastal Plain**
Constituent(s) of Concern:	**Dissolved Oxygen**
Designated Use:	**Fishing (partially 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 from summer 2004.**
Critical Conditions:	**(1) 7Q10 flows based on low-flow analysis of available data from the Altamaha River Basin.** **(2) Temperatures were derived from historic trend monitoring data in *Stream-Temperature Characteristics in Georgia (USGS, 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):	**NA**
Wasteload Allocations (WLAsw):	**NA**
Load Allocation (LA):	**18.39 lbs/day**
TMDL	**18.39 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) Low flow 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 2004.
(4) Water depths are shallow, generally one foot, 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.

SUMMARY MEMORANDUM
Average Annual Oxygen Demanding Substances Load
Ohoopee River

1. 303(d) Listed Waterbody Information

State: Georgia
County: Washington and Johnson

Major River Basin: Altamaha
8-Digit Hydrologic Unit Code(s): 03070107

Waterbody Name: Ohoopee River
Location: Dyers Creek to Big Cedar Creek
Stream Length: 15 miles
Watershed Area: 78.98 square miles
Tributary to: Altamaha River
Ecoregion: Southern Coastal Plain

Constituent(s) of Concern: Dissolved Oxygen

Designated Use: Fishing (partially 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 from summer 2004.

Critical Conditions:
(1) 7Q10 flows based on low-flow analysis of available data from the Altamaha River Basin.
(2) Temperatures were derived from historic trend monitoring data in *Stream-Temperature Characteristics in Georgia (USGS, 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):	**0 lbs/day Tennille WTF**
Wasteload Allocations (WLAsw):	**NA**
Load Allocation (LA):	**67.04 lbs/day**
TMDL	**67.04 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) Low flow 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 2004.
(4) Water depths are shallow, generally one foot, 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.

SUMMARY MEMORANDUM
Average Annual Oxygen Demanding Substances Load
Ohoopee River

1. 303(d) Listed Waterbody Information

State:	**Georgia**
County:	**Johnson**
Major River Basin:	**Altamaha**
8-Digit Hydrologic Unit Code(s):	**03070107**
Waterbody Name:	**Ohoopee River**
Location:	**Big Cedar Creek to Cypress Creek**
Stream Length:	**2 miles**
Watershed Area:	**100.88 square miles**
Tributary to:	**Altamaha River**
Ecoregion:	**Southern Coastal Plain**
Constituent(s) of Concern:	**Dissolved Oxygen**
Designated Use:	**Fishing (partially 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 from summer 2004.**
Critical Conditions:	**(1) 7Q10 flows based on low-flow analysis of available data from the Altamaha River Basin.** **(2) Temperatures were derived from historic trend monitoring data in *Stream-Temperature Characteristics in Georgia (USGS, 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):	**121.6 lbs/day Wrightsville**
Wasteload Allocations (WLAsw):	**NA**
Load Allocation (LA):	**128.24 lbs/day**
TMDL	**249.84 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) Low flow 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 2004.
(4) Water depths are shallow, generally one foot, 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.

SUMMARY MEMORANDUM
Average Annual Oxygen Demanding Substances Load
Sardis Creek

1. 303(d) Listed Waterbody Information

State:	**Georgia**
County:	**Emanuel**
Major River Basin:	**Altamaha**
8-Digit Hydrologic Unit Code(s):	**03070107**
Waterbody Name:	**Sardis Creek**
Location:	**Headwaters to Little Ohoopee River**
Stream Length:	**10 miles**
Watershed Area:	**19.94 square miles**
Tributary to:	**Altamaha 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.

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(5) Same depths, velocities, kinetic rates, reaeration rates, and boundary conditions as calibration conditions.

3. Allocation Watershed/Stream Reach:

Wasteload Allocations (WLA):	**NA**
Wasteload Allocations (WLAsw):	**NA**
Load Allocation (LA):	**139.5 lbs/day**
TMDL	**139.5 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) Low flow 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.
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