Final

Total Maximum Daily Load

Evaluation

for

Lake Lanier

in the

Chattahoochee River Basin

for

Chlorophyll *a*

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 established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into one of three categories, supporting designated use, not supporting designated use or assessment pending, depending on water quality assessment results. These water bodies are found on Georgia's 2014 305(b) list as required by that section of the CWA that defines the assessment process, and are published in *Water Quality in Georgia 2012-2013* (GA EPD, 2014). This document is available on the Georgia Environmental Protection Division (GA EPD) website.

The subset of the water bodies that do not meet designated uses on the 305(b) list are also assigned to Georgia's 303(d) list, named after that section of the CWA. Although the 305(b) and 303(d) lists are two distinct requirements under the CWA, Georgia reports both lists in one combined format called the Integrated 305(b)/303(d) List, which is found in Appendix A of *Water Quality in Georgia 2012-2013* (GA EPD, 2014). Water bodies on the 303(d) list are denoted as Category 5, and 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 TMDLs in this document are based on the 2014 303(d) listing, which is available on the GA EPD website. The TMDL process establishes the allowable pollutant loadings or other quantifiable parameters for a water body based on the relationship between pollutant sources and instream water quality conditions. This allows water quality-based controls to be developed to reduce pollution and restore and maintain water quality.

A TMDL is the sum of the individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources, as well as 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.

For all waters in the Georgia, the *State of Georgia's Rules and Regulations for Water Quality Control* define water use classifications, general and specific water quality criteria, and other rules relating to water quality enhancement. Lake Lanier's water use classifications are Recreation and Drinking Water. At specific locations in five different segments of Lake Lanier, a specific criterion for chlorophyll a has been established. Chlorophyll *a* is a pigment in algae. It is used as an indicator of the potential presence of nutrients in a waterbody that causes excess algal growth. The State of Georgia has identified one segment of Lake Lanier located in the Chattahoochee River Basin as not supporting its designated uses due to chlorophyll *a* violations (Browns Bridge Road (SR 369)). Another segment is listed as assessment pending (Lanier Bridge Road (SR 53)). Based on the 305(b)/303(d) Listing Assessment Methodology included in Appendix A of *Water Quality in Georgia 2012-2013* (GA EPD, 2014), a lake segment is placed on the not support list if during the last five-year assessment period, the chlorophyll *a* growing season (April through October) average exceeds the site-specific criterion two or more times. A segment is placed on the assessment pending list if during the last five-year assessment period the site-specific criteria are exceeded one time. Water quality samples collected monthly during the growing season are used to determine the growing season average. This TMDL addresses the Browns Bridge and Lanier Bridge listings in Hall and Forsyth Counties.

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 accumulated nutrients that wash off land surfaces as a result of storm events.

The process of developing the chlorophyll *a* TMDLs for the Chattahoochee River Basin listed segments includes using two computer models to determine the following:

- The current nutrient loads to the lake under existing conditions;
- The critical nutrient load to the lake under NPDES permits at full capacity;
- The TMDL for similar meteorological conditions to those under which the current critical load was determined; and
- The percent reduction in the current critical nutrient load necessary to achieve the TMDL.

A watershed model for Lake Lanier was developed using the Loading Simulation Program in C++ (LSPC). The watershed model simulates the effects of surface runoff on both water quality and flow and was calibrated to available data. The model also included all major point sources of nutrients. The results of this model were used as tributary flow inputs to the lake hydrodynamic and lake water quality model Environmental Fluid Dynamics Code (EFDC). Hydrodynamic models simulate the transport of water into and out of the lake and the water quality models simulate the fate and transport of nutrients into and out of the lake and the uptake of nutrients by phytoplankton, where the growth and death of phytoplankton is measured through the surrogate parameter chlorophyll *a*. The nutrient loads and required reductions are summarized in the table below.

Total Daily Nutrient Loads and Required Load Reductions

Table 36. Total Daily Nutrient Loads, Wasteloads, and Required Load Reductions

Lake Segment		Lake Lanier – Lanier Bridge GAR031300010818		Lake Lanier – Browns Bridge GAR031300010819	
		Total Nitrogen (lbs/day)	Total Phosphorus (lbs/day)	Total Nitrogen (lbs/day)	Total Phosphorus (lbs/day)
Current Permitted Load	WLA (lbs/day)	1,634	58	2,019	71
	WLAsw (lbs/day)	100	4	143	6
	LA (lbs/day	5,638	227	8,145	322
	Total Load (lbs/day)	7,373	289	10,307	399
Future TMDL Components	WLA (lbs/day)	2,153	23	3,220	32
	WLAsw (lbs/day)	83	3	118	5
	LA (lbs/day)	4,646	188	6,649	269
	MOS (lbs/day)	Implicit	Implicit	Implicit	Implicit
	TMDL (lbs/day)	6,882	214	9,987	305
Percent Reduction WLA		-	60.5%	-	55.9%
Percent Reduction WLAsw		17.6%	17.4%	17.0%	16.7%
Percent Reduction LA		17.6%	17.4%	18.4%	16.7%
Percent Reduction TMDL		6.7%	26.0%	3.1%	23.7%

Management practices that may be used to help reduce nutrient source loads include:

- Compliance with NPDES (wastewater, construction, industrial stormwater, and/or MS4) permit limits and requirements;
- Implementation of recommended Water Quality management practices in the *Coosa-North Georgia Regional Water Plan* (GA EPD, 2017);
- Implementation of required Action Items in the *Water Resource Management Plan* developed by the Metro-North Georgia Water Planning District (MNGWPD, 2017)
- Implementation of *Georgia's Best Management Practices for Forestry* (GFC, 2009);
- Implementation of *Best Management Practices for Georgia Agriculture* (GSWCC, 2013)
- Adoption of National Resource Conservation Service (NRCS) Conservation Practices for agriculture;
- Adoption of proper fertilization practices;
- Adherence to the Surface Mining Land Use Plan prepared as part of the Surface Mining Permit Application;
- Implementation of the *Georgia Better Back Roads Field Manual* (GA RCDC, 2009) and adoption of additional practices for proper unpaved road maintenance;
- Implementation of individual Erosion and Sedimentation Control Plans for land disturbing activities; and application of the *Manual for Erosion and Sediment Control in Georgia* (GSWCC, 2016)
- Implementation of the *Georgia Stormwater Management Manual* (ARC, 2016) to facilitate prevention and mitigation of stream bank erosion due to increased stream flow and velocities caused by urban runoff through structural storm water BMP installation.
- Adherence to DNR River Corridor Protection guidelines;
- Mitigation and prevention of riparian buffer loss due to land disturbing activities;
- Promulgation and enforcement of local natural resource protection ordinances such as land development, stormwater, water protection, protection of environmentally sensitive areas, and others.

The amount of nutrients delivered to a stream is difficult to determine; however, by requiring monitoring, the implementation of these management practices can be measured. The effects of the management practices will improve stream water quality and will 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, supporting designated use, not supporting designated use, or assessment pending, depending on water quality assessment results. 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 2012-2013* (GA EPD, 2014). This document is available on the Georgia Environmental Protection Division (GA EPD) website.

The subset of the water bodies that do not meet designated uses on the 305(b) list are also assigned to Georgia's 303(d) list, also named after that section of the CWA. Although the 305(b) and 303(d) lists are two distinct requirements under the CWA, Georgia reports both lists in one combined format called the Integrated 305(b)/303(d) List, which is found in Appendix A of *Water Quality in Georgia*. Water bodies on the 303(d) list are denoted by Category 5, and 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 loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and in-stream water quality conditions. A TMDL is the sum of the individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources, as well as 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.

Chlorophyll *a* is a pigment in algae. It is used as an indicator of the potential presence of nutrients in a waterbody that cause excess algal growth. In 2006, three segments of Lake Lanier, Flowery Branch, Browns Bridge, and Lanier Bridge, were listed as impaired for chlorophyll *a* (Category 5). These segments remained on the 2008 impaired list and in 2010 all three segments were placed on the assessment pending list (Category 3), since their growing season average chlorophyll *a* levels only exceeded the criteria once in the last 5 years. In 2012, the Flowery Branch and Lanier Bridge segments were moved to the support list (Category 1) and Brown Bridge was moved to the impaired waters list (Category 5). Table 1 presents the current status of the Lake Lanier segments included on the 2014 303(d) list for exceedances of the chlorophyll *a* criteria.

Table 1. Waterbodies on the 2014 303(d) List for Chlorophyll a in Lake Lanier

Lake	Segment Location	Reach ID#	Category	Segment Area (acres)	Designated Use
Lanier Lake	Browns Bridge Road (SR 369)	GAR031300010819	5	5,952	Recreation/ Drinking Water
Lanier Lake	Lanier Bridge Road (SR 53)	GAR031300010818	3	4,928	Recreation/ Drinking Water

1.2 Watershed Description

Lake Lanier lies in the upper Chattahoochee watershed in north-central Georgia, approximately 30 miles northeast of Atlanta. Lake Lanier receives the majority of its inflow from the Chestatee and Chattahoochee Rivers, which start in the north Georgia mountains in Lumpkin and Union Counties, respectively. The Lanier watershed has a drainage area of 1,040 square miles. Downstream from Lake Lanier, the Chattahoochee River flows southwest through Atlanta to West Point Lake, from there it flows south and forms the border between Georgia and Alabama. The Chattahoochee River flows through Walter F. George Reservoir and converges with the Flint River in Lake Seminole, at the Georgia-Florida border and continues south to the Apalachicola Bay in Florida.

Lake Lanier is a US Army Corps of Engineers (USACE) lake, and Buford Dam was completed and has been operational since 1956. The lake has a normal summer pool elevation of 1,071 feet above mean sea level. Lake Lanier is a multi-use reservoir, and its uses include: flood control, hydropower generation, water supply, recreation, fish and wildlife management, and navigation. The cities of Buford, Cumming, and Gainesville, and Forsyth and Gwinnett Counties depend on the lake for water supply to meet the water needs for their populations. Eleven counties are located either completely or partially in the Lake Lanier Watershed, thus making the watershed very important to a wide range of communities.

The Lake Lanier watershed contains parts of the Blue Ridge and Piedmont physiographic provinces that extend throughout the south-eastern United States. The United States Geologic Survey (USGS) has divided the Chattahoochee River Basin into four sub-basins, or Hydrologic Unit Codes (HUCs), numbered 03130001 to 03130004. Figure 1 shows the locations of these sub-basins. Figure 2 shows the impaired segments within the Lake.

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

1.3 State Water Planning

The Georgia Legislature enacted the Metropolitan North Georgia Water Planning District Act in 2001 to create the Metropolitan North Georgia Water Planning District (MNGWPD) to preserve and protect water resources in the 15-county metropolitan Atlanta area. The MNGWPD is charged with the development of comprehensive regional and watershed specific water resource management plans to be implemented by local governments in the metropolitan Atlanta area. The MNGWPD issued its first water resource management plan documents in 2003.

In 2004, the Georgia Legislature enacted the Comprehensive State-wide Water Management Planning Act to ensure management of water resources in a sustainable manner to support the state's economy, to protect public health and natural systems, and to enhance the quality of life for all citizens on a state-wide level. GA EPD later developed the 2008 Comprehensive State-

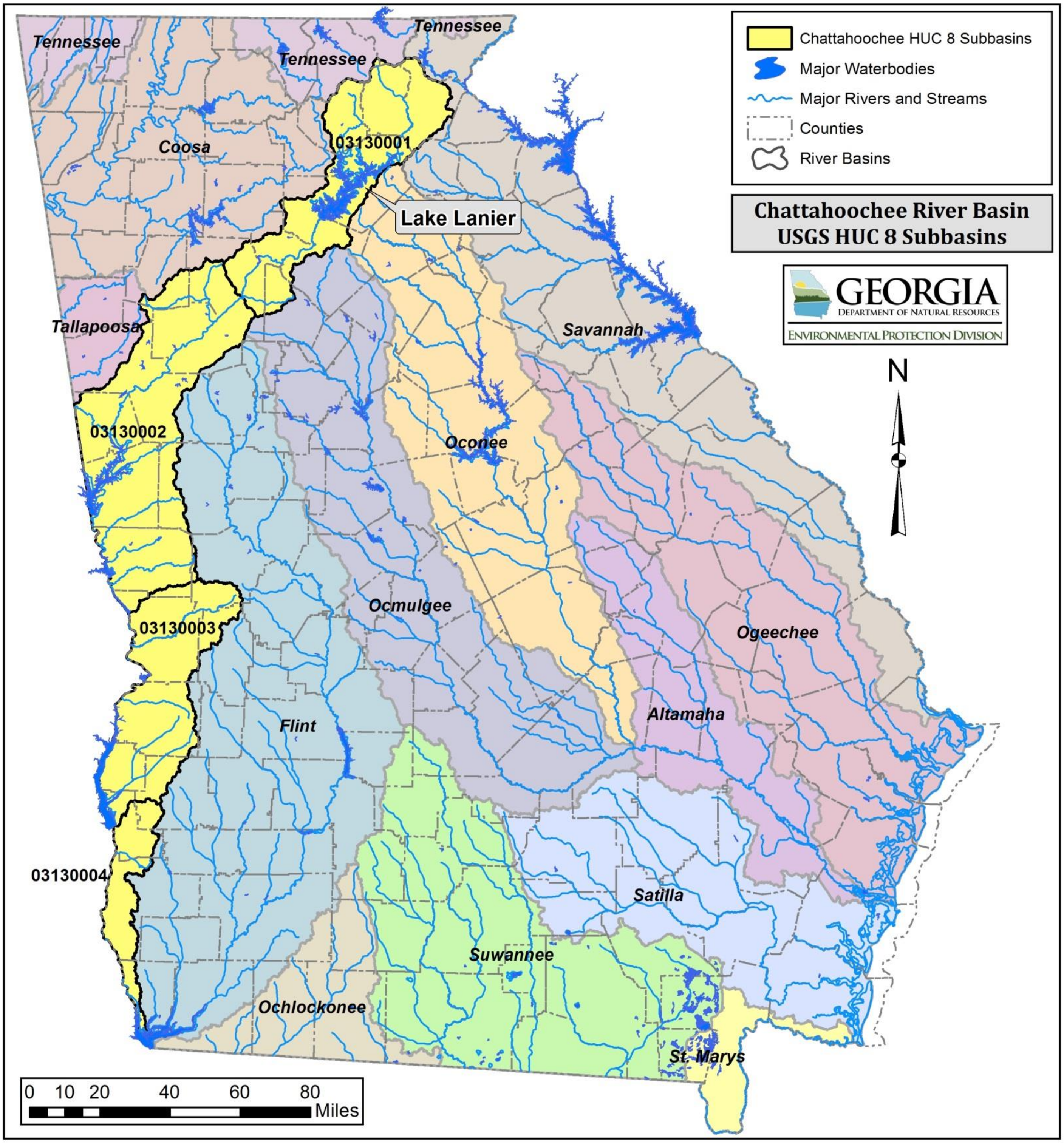


Figure 1. USGS 8-Digit HUCs for Chattahoochee River Basin

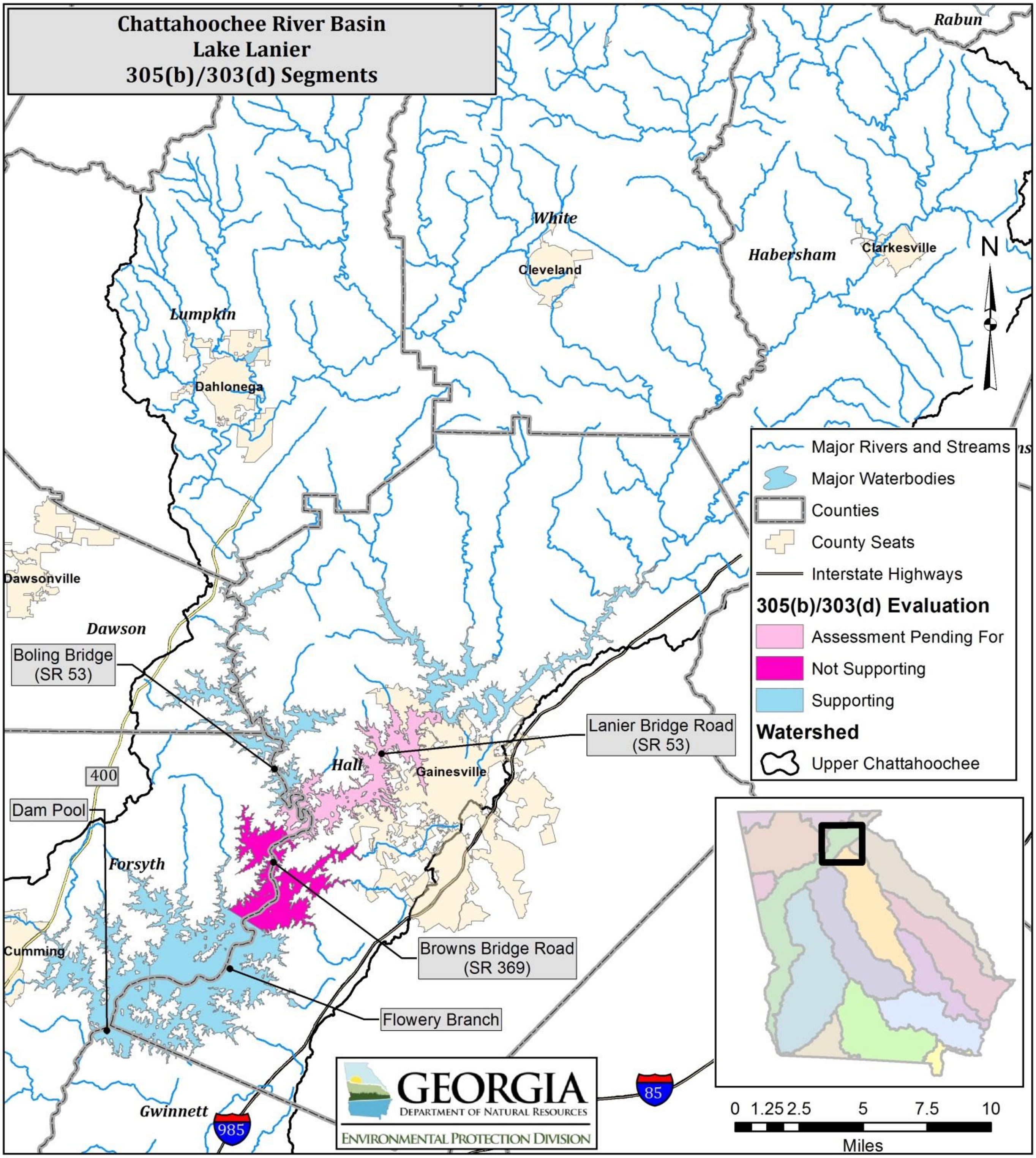


Figure 2. 2014 303(d) Listed Segments in Lake Lanier

Table 2. Lake Lanier Watershed Land Coverage

Stream/Segment	Land Use Categories - Acres (Percent)															
	Open Water	Developed Open Space	Low Intensity Residential	Medium Intensity Residential	High Intensity Residential	Barren	Deciduous Forest	Evergreen Forest	Mixed Forest	Golf Course	Pasture/Hay	Row Crops	Pasture-Chicken	Forested Wetlands	Non-Forested Wetlands	Total
Lake Lanier -	7,839	26,835	10,476	2,962	1,470	14,512	177,755	37,014	22,756	576	28,152	59	37,136	1,335	33	368,910
Lanier Bridge	(2.1%)	(7.3%)	(2.8%)	(0.8%)	(0.4%)	(3.9%)	(48.2%)	(10.0%)	(6.2%)	(0.2%)	(7.6%)	(0.0%)	(10.1%)	(0.4%)	(0.0%)	
Lake Lanier -	5,204	13,772	3,907	822	379	7,132	108,504	23,899	9,845	0	11,239	777	7,766	438	36	193,720
Boling Bridge	(2.7%)	(7.1%)	(2.0%)	(0.4%)	(0.2%)	(3.7%)	(56.0%)	(12.3%)	(5.1%)	(0.0%)	(5.8%)	(0.4%)	(4.0%)	(0.2%)	(0.0%)	
Lake Lanier -	19,786	42,490	15,403	4,054	1,998	22,418	291,000	61,664	33,433	576	40,035	836	45,015	1,776	70	580,554
Browns Bridge	(3.4%)	(7.3%)	(2.7%)	(0.7%)	(0.3%)	(3.9%)	(50.1%)	(10.6%)	(5.8%)	(0.1%)	(6.9%)	(0.1%)	(7.8%)	(0.3%)	(0.0%)	
Lake Lanier -	32,108	47,931	19,741	5,449	2,896	24,993	303,118	63,632	35,236	702	44,415	836	47,702	1,899	81	630,739
Flowery Branch	(5.1%)	(7.6%)	(3.1%)	(0.9%)	(0.5%)	(4.0%)	(48.1%)	(10.1%)	(5.6%)	(0.1%)	(7.0%)	(0.1%)	(7.6%)	(0.3%)	(0.0%)	
Lake Lanier - Dam	41,527	52,076	22,500	5,999	3,241	27,364	309,500	65,802	36,567	925	46,487	836	48,109	1,962	86	662,981
Entire Watershed	(6.3%)	(7.9%)	(3.4%)	(0.9%)	(0.5%)	(4.1%)	(46.7%)	(9.9%)	(5.5%)	(0.1%)	(7.0%)	(0.1%)	(7.3%)	(0.3%)	(0.0%)	

wide Water Management Plan, which established Georgia's ten Regional Water Planning Councils (RWPCs) and laid the groundwork for the RWPCs to develop their own Regional Water Plans. The boundaries of these ten RWPCs, in addition to the MNGWPD, are shown in Figure 3. The listed segments are located within the boundaries of the Metropolitan North Georgia Water Planning District. The Lake Lanier watershed is within the boundaries of the Metropolitan North Georgia Water Planning District and the Coosa - North Georgia Regional Water Planning Council.

In 2011, each RWPC finished development of individualized Regional Water Plans, which were later adopted following GA EPD review. These Regional Water Plans identify a range of actions or management practices to help meet the state's water quality and water supply challenges. The MNGWPD and each RWPC subsequently updated and revised their respective management plan documents in 2017. Implementation of these plans is critical to meeting Georgia's water resource challenges. The specific Regional Water Plan(s) applicable to this TMDL are discussed in Sections 6 and 7.

1.4 Water Quality Standard

The water use classifications for the listed segments in Lake Lanier are Recreation and Drinking Water. The criterion violated is listed as chlorophyll *a*. The potential causes listed include urban runoff, nonpoint sources, and municipal and industrial facilities. The site-specific criteria for Lake Lanier, as stated in the *State of Georgia's Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03(17)(5)(i) (GA EPD, 2015), were revised and approved by EPA in October 2015 and are as follows:

(e) Lake Sidney Lanier: Those waters impounded by Buford Dam and upstream to Belton Bridge Road on the Chattahoochee River, 0.6 miles downstream from State Road 400 on the Chestatee River, as well as other impounded tributaries to an elevation of 1070 feet mean sea level corresponding to the normal pool elevation of Lake Sidney Lanier.

(i) Chlorophyll *a*: For the months of April through October, the average of monthly mid-channel photic zone composite samples shall not exceed the chlorophyll *a* concentrations at the locations listed below more than once in a five-year period:

1.	Upstream from the Buford Dam forebay	5 μg/L
2.	Upstream from the Flowery Branch confluence	6 μg/L
3.	At Browns Bridge Road (State Road 369)	7 μg/L
4.	At Boling Bridge (State Road 53) on Chestatee River	10 μg/L
5.	At Lanier Bridge (State Road 53) on Chattahoochee River	10 μg/L

(ii) pH: Within the range of 6.0-9.5 standard units.

(iii) Total Nitrogen: Not to exceed 4 mg/L as nitrogen in the photic zone.

(iv) Phosphorous: Total lake loading shall not exceed 0.25 pounds per acre-foot of lake volume per year.

(v) Fecal Coliform: Fecal coliform bacteria shall not exceed the Recreation criterion as presented in 391-3-6-.03(6)(b)(i).

(vi) Dissolved Oxygen: A daily average of 5.0 mg/L and no less than 4.0 mg/L at all times at the depth specified in 391-3-6-.03(5)(g).

(vii) Temperature: Water temperature shall not exceed the Recreation criterion as presented in 391-3-6-.03(6) (b)(iv).

(viii) Major Lake Tributaries: For the following major tributaries, the annual total phosphorous loading to Lake Sidney Lanier shall not exceed the following:

1.	Chattahoochee River at Belton Bridge Road	178,000 pounds

2. Chestatee River at Georgia Highway 400 118,000 pounds
3. Flat Creek at McEver Road 14,400 pounds

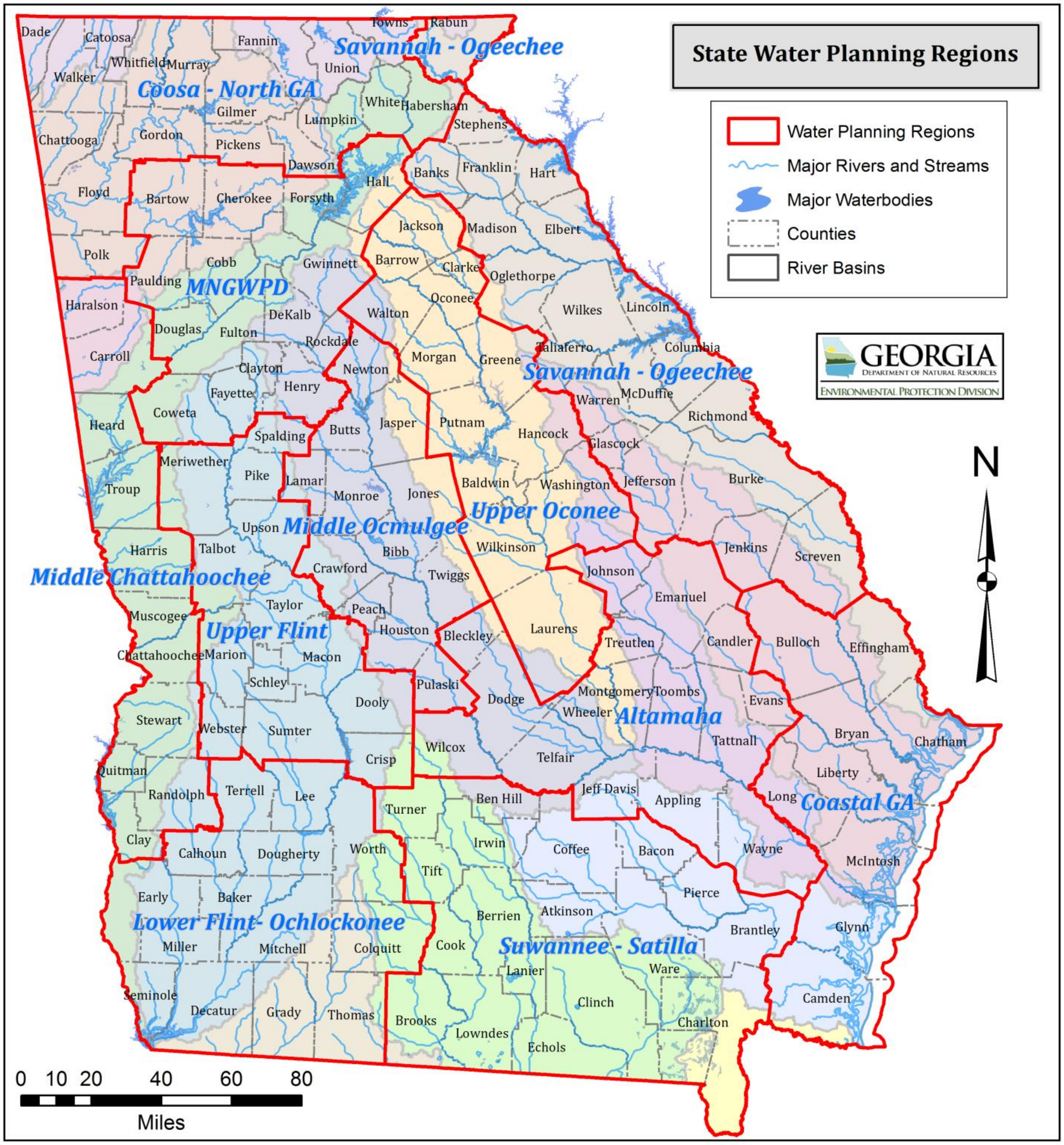


Figure 3. Boundaries of the Regional Water Planning Councils and the Metropolitan North Georgia Water Planning District

2.0 WATER QUALITY ASSESSMENT

In lakes with nutrient and chlorophyll *a* standards, GA EPD collects water quality samples monthly during the growing season, which is from April through October. Lake Lanier is sampled at five locations. Figure 4 shows the locations of the Lake Lanier water quality stations. These data are used to assess water quality standards, see trends in nutrients and chlorophyll *a* levels, and to assist in developing NPDES permits.

Stream segments are placed on the 303(d) list as not supporting their water use classification based on water quality sampling data. A lake segment is placed on the not support list if during the last five-year assessment period, the chlorophyll *a* growing season average exceeds the site-specific criteria two or more times.

The data used to develop these TMDLs were collected during calendar years 2000 through 2013. Appendix A present these data along with other water quality data collected as part of the lake standard monitoring program for calendar years 2000-2013. Appendix B shows plots of the average annual growing season chlorophyll *a* levels at the five monitoring stations.

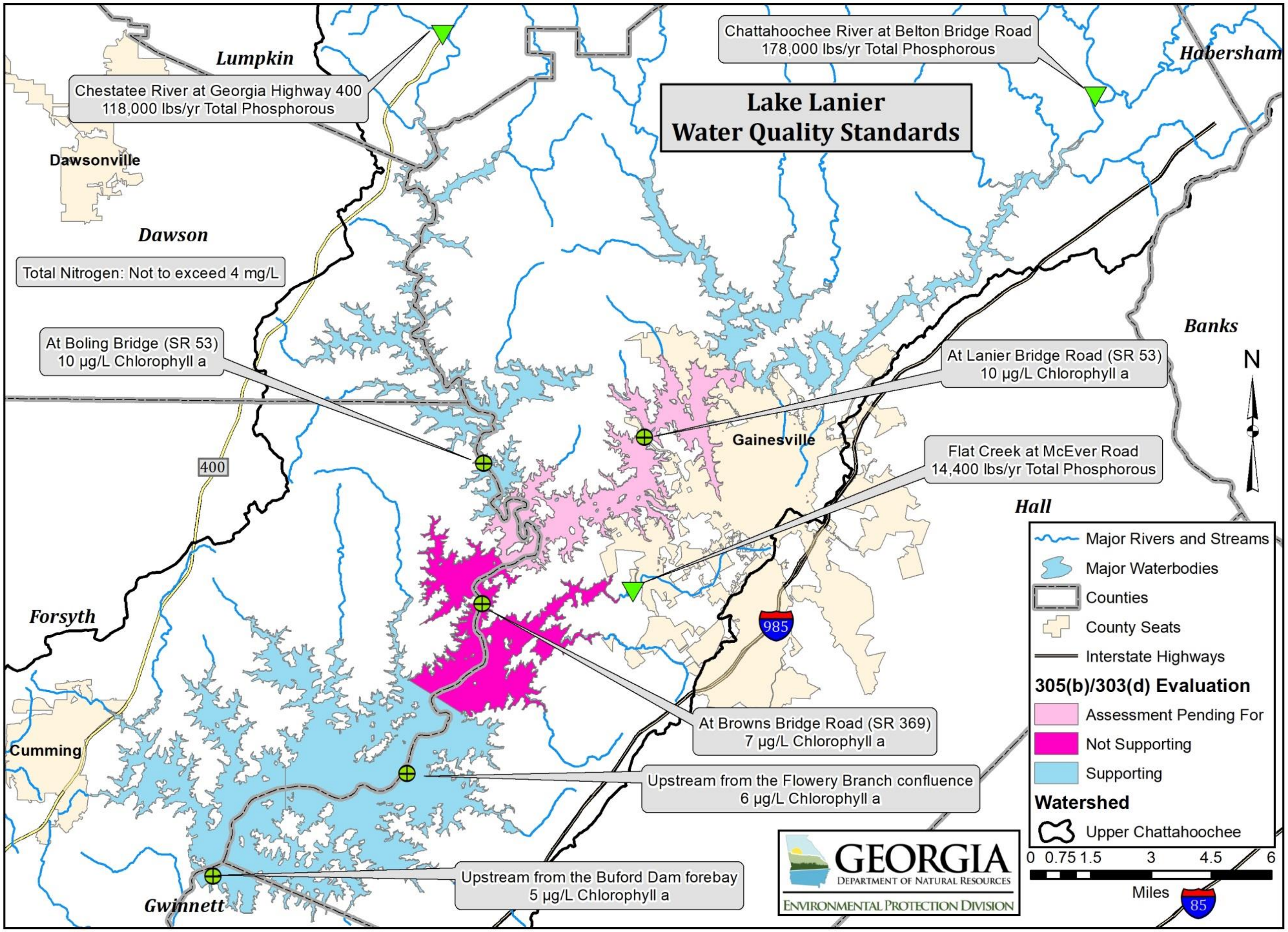


Figure 4. Lake Lanier Water Quality Standards Stations

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 nutrients 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 on water quality standards (water quality-based limits).

The US Environmental Protection Agency (US EPA) has developed technology-based guidelines, which establish a minimum standard of pollution control for municipal and industrial discharges. These are based on Best Practical Control Technology Currently Available (BPT), Best Conventional Control Technology (BCT), and Best Available Technology Economically Achievable (BAT). The level of control required by each facility depends on the type of discharge and the pollutant.

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

Discharges from municipal and industrial wastewater treatment facilities can contribute nutrients to receiving waters. There are 24 point source discharges located in the Lake Lanier watershed, and nine direct point source discharges to the lake, for a total of 33 point source dischargers. Of these point sources, five are major municipal facilities, eight are minor municipal facilities, 14 are private facilities such as schools and hospitals, and six are industrial facilities. Four of the six industrial facilities are rock quarries and should not be a source of nutrients. Of the remaining 27 facilities, 13 have National Pollutant Discharge Elimination System (NPDES) permitted discharges with flows greater than 0.1 MGD. The 14 remaining are classified as Private and Industrial Development (PID) have permitted discharges with flows less than 0.07 MGD. Two facilities, Habersham Mills and Camp Coleman in Cleveland, Georgia, have ceased discharging since 2007, Chattahoochee Bay's permit is terminated, and one permit, Habersham Central High School, was rescinded in September 2013. Figure 5 shows the locations of these point source discharges. Table 3 provides the permitted flows, BOD_5, and nutrient concentrations (total phosphorus [Total P] and ammonia [NH_3]) for the municipal and industrial treatment facilities.

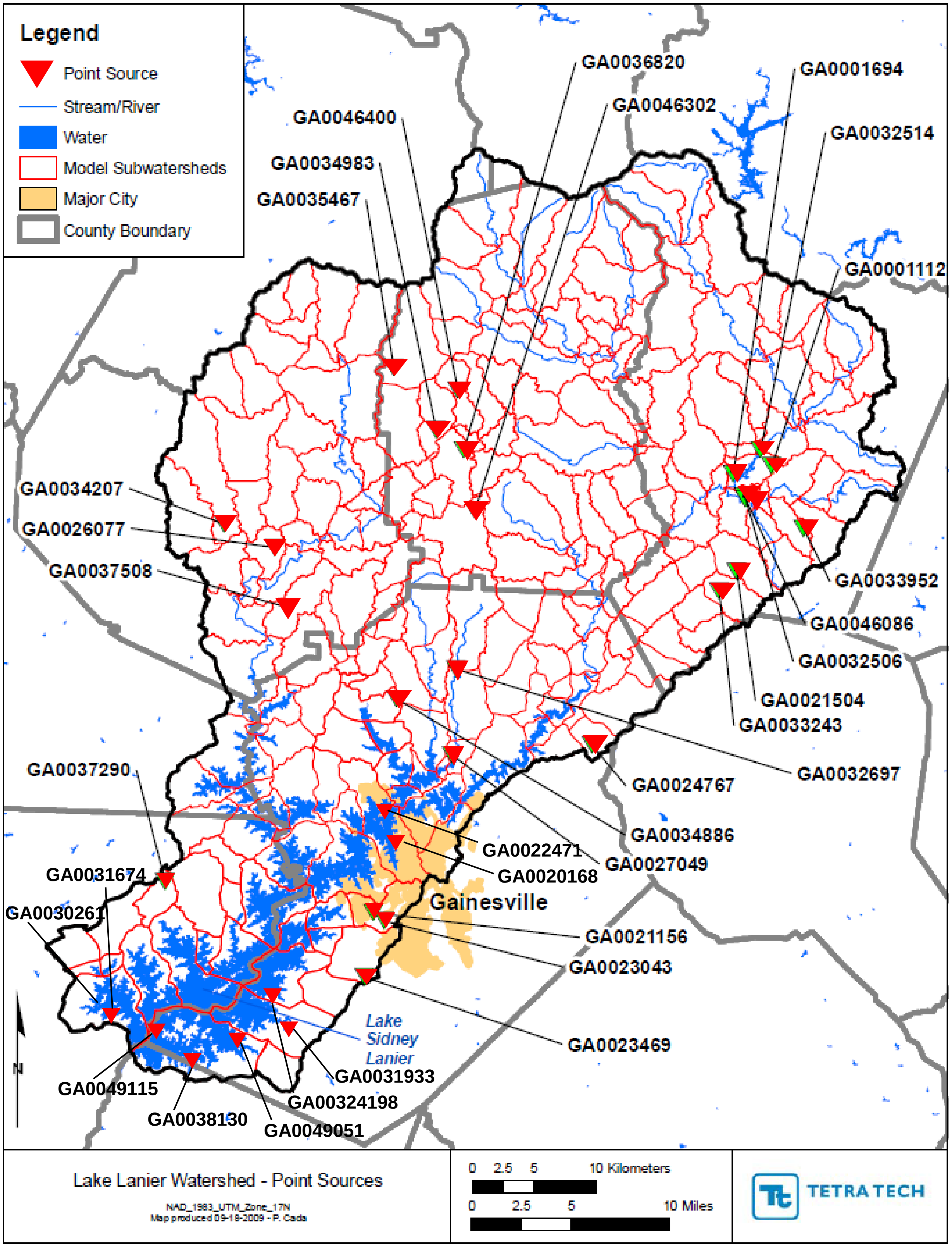


Figure 5. Location of Point Source Discharges

Table 3. NPDES Facilities Discharging to the Lake Lanier Watershed

Facility Name	NPDES Permit No.	Receiving Stream	NPDES Permit Limits			
			Average Monthly Flow (MGD)	BOD_5 (mg/L)	TOTAL PHOSPHORUS (mg/L)	NH_3 (mg/L)
Scovill Fasteners Inc.	GA0001112	Soquee River	Report	NA	4.0 lbs/day	NA
Habersham Mills Inc.	GA0001694	Closed				
Gainesville – Linwood	GA0020168	Lake Lanier	5	2.5*	0.13	0.5
			7	2.5*	0.13	0.5
Gainesville - Flat Creek WPCP	GA0021156	Flat Creek	12	2.5	0.13	0.5
Cornelia WPCP	GA0021504	South Fork of Mud Creek	3	25	1.1	1.5
Chattahoochee Country Club	GA0022471	Lake Lanier	0.0007	30	6.9 kg/yr	
Dixie MHP - Gainesville	GA0023043	Unnamed trib to Flat Creek	0.0043	30	7.6 kg/yr	
Shady Grove MHP	GA0023469	Unnamed trib to Balus Creek	0.0029	30	5.8 kg/yr	
Chattahoochee Bay	GA0024198	terminated				
Dahlonega WPCP	GA0026077	Yahoola Creek	1.44	30	0.13	8
Baker & Glover MHP	GA0027049	Unnamed trib to Little River	0.0072	30	13.5 kg/yr	
			0.011	30	22.1 kg/yr	
Habersham on Lanier	GA0030261	Lake Lanier	0.11	30	0.5	
Cumming – Lanier Beach South	GA0031674	Lake Lanier	0.038	10	0.5	2
Flowery Branch	GA0031933	Lake Lanier	0.4	5	1.3	2
Demorest WPCP	GA0032506	Hazel Creek	0.4	30	0.8	Report
			0.80	15	0.4	5
Clarkesville WPCP	GA0032514	Soquee River	0.75	30	95.94 kg/mnth	17.4
Wauka Mountain Elementary School	GA0032697	East Fork Little River	0.013	30	24 kg/yr	
Baldwin WPCP	GA0033243	South Fork Little Mud Creek	0.8	20 (May-Oct)	1	2.2 (May-Oct)
				30 (Nov-Apr)		4.1 (Nov-Apr)
Habersham Central High School	GA0033952	Rescinded 9/16/2013	0.018	30	168 kg/yr	
Oak Grove MHP	GA0034207	Unnamed Ck to Cane Creek	0.005	30	3.6 kg/yr	
North Hall High School	GA0034886	Unnamed Trib to Wahoo Ck	0.03	30	191.86 kg/yr	
Camp Barney Medintz	GA0034983	Jenny Creek	0.016	30	61 kg/yr	
Camp Coleman - Cleveland	GA0035467	Closed				
Cleveland WPCP	GA0036820	Testnatee Creek	0.75	20	159 kg/mnth	10
Buckhorn Ventures LLC	GA0037209	Trib to Six Mile Creek	Report			
Vulcan Construction Materials - Dahlonega II	GA0037508	Unnamed trib to Long Branch Ck	Report			
Gwinnett County - F Wayne Hill Water Resources Facility	GA0038130	Lake Lanier	40	18**	0.08	0.4

Facility Name	NPDES Permit No.	Receiving Stream	NPDES Permit Limits			
			Average Monthly Flow (MGD)	BOD_5 (mg/L)	TOTAL PHOSPHORUS (mg/L)	NH_3 (mg/L)
Lula Pond WPCP	GA0039039	Hagen Creek	0.375	30	10.4 kg/mnth	2
Hanson Aggregates SE	GA0046086	Hazel Creek	Report			
Long Mountain Quarry	GA0046302	Shoal Creek Tributary	Report			
Mountain Lakes Resort	GA0046400	Lake Qualatchee	0.007	30	3.26	
			0.009	30	2.59	
Lake Lanier Islands	GA0049115	Lake Lanier	0.35	30	0.13	
Cinnamon Cove Condos	GA0049051	Lake Lanier	0.07	30	48.4 kg/yr	

Source: GA EPD * Carbonaceous Biochemical Oxygen Demand (5-day)
** Chemical Oxygen Demand

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 exceeds the capacity of the wastewater treatment plant, the excess is diverted to a combined sewage overflow (CSO) discharge point. There are no permitted CSO outfalls in the Lake Lanier watershed.

3.1.2 Regulated Storm Water Discharges

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

3.1.2.1 Industrial General Stormwater NPDES Permit

Stormwater discharges associated with industrial activities are currently covered under the 2017 NPDES General Permit for Stormwater Discharges Associated with Industrial Activity (GAR050000), also called the Industrial General Permit (IGP). This permit requires visual monitoring of storm water discharges, site inspections, implementation of Best Management Practices (BMPs), and record keeping. The IGP requires that stormwater discharging into an impaired stream segment or within one linear mile upstream of, and within the same watershed as, any portion of an impaired stream segment identified as "not supporting" its designated use(s), must satisfy the requirements of Appendix C of the 2017 IGP if the pollutant(s) of concern for which the impaired stream segment has been listed may be exposed to stormwater as a result of industrial activity at the site. If a facility is covered under Appendix C of the IGP, then benchmark monitoring for the pollutant(s) of concern is required. Delineations of both supporting and not supporting waterbodies are provided on the GA EPD website, and are available in ESRI ArcGIS shapefile format or in KMZ format for use in Google Earth. Interested parties may evaluate their proximity to not supporting waterbodies by utilizing these geospatial files.

3.1.2.2 MS4 NPDES Permits

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 58 permittees in Georgia.

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 three Phase I MS4s in the Lake Lanier watershed (Table 4).

Table 4. Phase I Permitted MS4s in the Lake Lanier Watershed

Name	Permit No.	Watershed
Buford	GAS000104	Chattahoochee, Ocmulgee
Forsyth County	GAS000300	Chattahoochee, Coosa
Gwinnett County	GAS000118	Chattahoochee, Ocmulgee, Oconee

Source: Nonpoint Source Permitting Program, GA DNR, 2015

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 area with a residential population of at least 50,000 people and an overall population density of at least 1,000 people per square mile. There are six Phase II MS4s in the Lake Lanier watershed (Table 5).

Table 5. Phase II Permitted MS4s in the Lake Lanier Watershed

Name	Watershed
Cumming	Chattahoochee
Dawson County	Chattahoochee, Coosa
Flowery Branch	Chattahoochee
Gainesville	Chattahoochee, Oconee
Hall County	Chattahoochee, Oconee
Oakwood	Chattahoochee

Source: Nonpoint Source Permitting Program, GA DNR, 2015

Table 6 provides the total area of the watershed and the percentage of the watershed that is a Phase 1 and/or Phase 2 MS4 urbanized area.

Table 6. Percentage of Lake Lanier Watersheds Located in MS4 Urbanized Areas

Segment	Watershed Area (acres)	Total MS4 Area (acres)	% of Watershed that is MS4 area	Urban MS4 Area (acres)	% of Watershed that is Urban MS4
Lake Lanier - Lanier Bridge	368,910	20,608	5.59%	9,046	2.5%
Lake Lanier-Boling Bridge	193,720	9,409	4.86%	2,585	1.3%
Lake Lanier-Browns Bridge	580,554	40,566	6.99%	14,467	2.5%
Lake Lanier-Flowery Branch	630,739	55,822	8.85%	23,662	3.8%
Lake Lanier - Dam Entire Watershed	662,981	108,840	16.42%	37,325	5.6%

3.1.3 Concentrated Animal Feeding Operations

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

In 2002, the US EPA promulgated expanded NPDES permit regulations for CAFOs that added dry manure poultry operations larger than 125,000 broilers or 82,000 layers. In accordance with the Georgia rule amendment discussed above, the general permit covering these facilities has been terminated and they are no longer covered under any permit. Georgia is consistently among the top three states in the U.S. in terms of poultry operations. The majority of poultry farms are dry manure operations where the manure is stored for a time and then land applied. Freshly stored litter can be a nonpoint source of nutrients. Table 7 presents the dry manure poultry operations in the Lake Lanier watershed.

Table 7. Registered Dry Manure Poultry Operations in the Lake Lanier Watershed

Name	County	Number of Animals (thousands)
Big A Farm	Habersham	294.0
Blacksnake Pullet Farm & Franklin Farm	Habersham	276.1
Brooks Poultry Farm	White	140.0
Chosewood Poultry Farm	Habersham	234.0
Ellis Brothers Farm	White	135.0
Jones Poultry Co.	Forsyth	214.5
Larry Copeland	Habersham	170.0
Little River Farm	Hall	153.0
Michael Shore	White	145.0
Nacoochee Poultry Farm	Habersham	214.1
Phillip Mullinax	Lumpkin	180.0
Shore Farm	Habersham	145.0
T & S Farm	Lumpkin	150.0
T S Farms	Lumpkin	125.0
Tracy Grizzle #2	Lumpkin	282.0
Warbington Egg Farm, Inc.	Forsyth	160.0
West Fork Farm	Hall	153.0

Source: GA Dept. of Agriculture, 2014

3.2 Nonpoint Source Assessment

In general, nonpoint sources cannot be identified as entering a waterbody through a discrete conveyance at a single location. Typical nonpoint sources of nutrients come from materials being washed into the rivers and streams during storm events. Constituents that have washed off of land surfaces in previous months or years have either flushed out of the system along with the water column flow or settled out and became part of the lake bottom. In this manner, settleable material accumulates and may release nutrients into the water column over time. Constituents of concern from surface washoff include the fractions of phosphorus and nitrogen that become an integral part of channel bottom sediments, thus becoming a potential source of nutrients for algae.

Typical nonpoint sources of nutrients include:

- Wildlife
- Agricultural Livestock
  - Application of manure to pastureland and cropland
  - Application of fertilizers
- Urban Development
  - Application of fertilizers
  - Septic systems
  - Land Application Systems
  - Landfills

In urban areas, a large portion of storm water runoff may be collected in storm sewer systems and discharged through distinct outlet structures. For large urban areas, these storm sewer discharge points may be regulated as described in Section 3.1.2.

3.2.1 Wildlife

The significance of wildlife as a source of nutrients in streams varies considerably, depending on the animal species present in the watersheds. Based on information provided by the Wildlife Resources Division (WRD) of GA DNR, the greatest wildlife sources of nutrients are the animals that spend a large portion of their time in or around aquatic habitats. Of these, waterfowl, (especially ducks and geese), are considered to potentially be the most significant source of nutrients, because when present, they are typically found in large numbers on the water surface, they deposit their waste directly into the water, and their feces contain high levels of nutrients. Other animals regularly found around aquatic environments include racoons, beavers, muskrats, and to a lesser extent, river otters and minks. Recently, rapidly-expanding feral swine populations have become a significant presence in the floodplain areas of all the major rivers in Georgia.

White-tailed deer populations are significant throughout the Chattahoochee River Basin. Nutrient contributions from deer to water bodies are generally considered less significant than that of waterfowl, racoons, and beavers. This is because a greater portion of their time is spent in terrestrial habitats. This also holds true for other terrestrial mammals such as squirrels and rabbits, and for terrestrial birds (GA WRD, 2007). However, waste deposited on the land surface that contains nutrients can result in additional nutrient loads to streams during runoff events.

3.2.2 Agricultural Livestock

Manure from agricultural livestock is a potential source of nutrients to streams in the Lake Lanier watershed. The animals grazing on pastureland deposit their feces, which contain nutrients, onto land surfaces, where it can be transported during storm events to nearby streams. Animal access to pastureland varies monthly, resulting in varying nutrient loading rates throughout the year. Beef cattle spend all of their time in pastures, while dairy cattle and hogs are periodically confined. In addition, agricultural livestock will often have direct access to streams that pass through their pastures, and can thus impact water quality in a more direct manner (USDA, 2002).

Table 8 provides the annual estimated number of beef cattle, dairy cattle, goats, horse, swine, sheep, and chickens reported by county. The Natural Resources Conservation Service (NRCS) provided these data.

Table 8. Estimated Agricultural Livestock Populations in the Lake Lanier Watershed

County	Livestock							
	Beef Cattle	Dairy Cattle	Swine	Sheep	Horses	Goats	Chickens Layers	Chickens-Broilers Sold
Dawson	2,800	-	-	100	800	-	-	19,057,500
Forsyth	1,350	-	-	-	-	50	63,000	6,620,250
Gwinnett	3,500	-	-	-	-	550	-	2,496,000
Habersham	10,000	-	-	50	500	4,000	800,000	84,480,000
Hall	8,700	425	-	-	400	3,700	80,000	69,273,600
Lumpkin	2,549	-	-	82	20	158	140,000	12,672,000
Towns	4,500	-	-	25	900	300	-	-
Union	2,500	200	-	-	700	300	50,000	1,500,000
White	5,200	300	-	-	-	140	400,000	26,752,000

Source: NRCS, 2011

3.2.3 Urban Development

Nutrients from urban areas are attributable to multiple sources, including: domestic animals, leaks and overflows from sanitary sewer systems, illicit discharges, septic systems, runoff from lawns where fertilizers have been applied, and leachate from both operational and closed landfills.

Urban runoff can contain high concentrations of nutrients from domestic animals and urban wildlife. Nutrients enter streams by direct washoff from the land surface, or the runoff may be diverted to a storm water collection system and discharged through a discrete outlet structure. For large, medium, and small urban areas (populations greater than 50,000), the storm water outlets are regulated under MS4 permits (see Section 3.1.2). For smaller urban areas, the storm water discharge outlets currently remain unregulated.

In addition to urban animal sources of nutrients, there may be illicit connections to the storm sewer system. As part of the MS4 permitting program, municipalities are required to conduct dry-weather monitoring to identify and then eliminate these illicit discharges. Nutrients may also enter streams from leaky sewer pipes, or during storm events when sanitary sewer overflows discharge.

3.2.3.1 Leaking Septic Systems

A portion of the nutrient contributions in the Lake Lanier watershed may be attributed to septic systems failures and illicit discharges of raw sewage. Table 9 presents the number of septic systems in each county of the Chattahoochee River Basin existing in 2006 and the number existing in 2011 based in part on U.S. Census data, and on the Georgia Department of Human Resources, Division of Public Health data. In addition, an estimate of the number of septic systems installed and repaired during the five-year period from 2007 through 2011 is given. These data show an increase in the number of septic systems in all of counties. Often, this is a reflection of population increases outpacing the expansion of sewage collection systems.

Table 9. Estimated Number of Septic Systems in the Counties in the Lake Lanier Watershed

County	Existing Septic Systems (2006)[1]	Existing Septic Systems (2011)	Number of Septic Systems Installed (2007 to 2011)	Number of Septic Systems Repaired (2007 to 2011)
Dawson	8,954	9,372	418	172
Forsyth	31,946	32,907	961	1173
Gwinnett	64,702	65,192	490	1550
Habersham	14,507	15,259	752	245
Hall	47,108	48,489	1381	1377
Lumpkin	11,462	12,314	852	71
Towns	8,538	9,179	641	43
Union	13,390	14,198	808	182
White	10,717	11,276	559	217

Source: The Georgia Dept. of Human Resources, Division of Public Health, 2012
Notes: [1] Adjusted from State Water Plan values

3.2.3.2 Land Application Systems

Many smaller communities use land application systems (LAS) for treatment and disposal 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 nutrients to nearby surface waters. Some of these facilities may also exceed the ground percolation rate when applying the wastewater, resulting in surface runoff from the field. If not properly bermed, this runoff, which probably contains nutrients, may be discharged to nearby surface waters. There are 17 permitted LAS systems located in the Lake Lanier watershed (Table 10).

Table 10. Permitted Land Application Systems in the Lake Lanier Watershed

LAS Name	Acres	Permit No.	Type	Flow (MGD)
American Proteins Inc.	158	GAJ010572	IND	0.500
Apple Mountain Resort (1)	2.48	GAJ030772	PID	0.030
Apple Mountain Resort (2)	15.0	GAJ030887	PID	0.096
Chestatee Development	212.4	GAJ020192	PID	0.075
DNR-Unicoi State Part	6.0	GAJ020066	PUB	0.075
Fieldale Farms Corp Hall County	NA	GAJ020080	IND	sludge
Helen	66.3	GAJ020157	MUN	0.500
LHR Farms, Inc.	60.4	GAJ010576	IND	0.059
McKinely Manor Subdivision	2.1	GAJ030805	PID	0.016
Mount Vernon Mills, Inc.	8.8	GAJ010528	IND	0.058
North Georgia Water Reuse Facility	11.9	GAJ030857	PID	0.050
PPG Architectural Finishes, Inc.	2.2	GAJ010362	IND	0.400
R-Ranch in the Mountains Owners Assoc.	13.0	GAJ030972	PID	0.100
Sonstegard Foods	NA	GA01-420	IND	sludge
The Retreat at Lake Lanier	9.4	GAJ030685	PID	0.044
URJ Camp Coleman	5.7	GAJ030731	PID	0.025
Wrigley Manufacturing Company	11.5	GAJ010595	IND	0.064

Source: Wastewater Regulatory Program, GA EPD, Atlanta, Georgia, 2015

3.2.3.3 Landfills

Leachate from landfills might contain nutrients that may at some point reach surface waters. Sanitary (or municipal) landfills are the most likely to be a source of nutrients. These types of landfills receive household wastes, animal manure, offal, hatchery and poultry processing plant wastes, dead animals, and other types of wastes. Older sanitary landfills were not lined and most have been closed. Those that remain active and have not been lined operate as construction/demolition landfills. Currently active sanitary landfills are lined and have leachate collection systems. All landfills, excluding inert landfills, are now required to install environmental monitoring systems for groundwater and methane sampling. There are 142 known landfills in the Chattahoochee River Basin. Of these, 18 are active landfills, one is under construction, 3 are in closure and 120 are inactive or closed. There are 9 landfills in the Lake Lanier watershed (Table 11).

Table 11. Landfills in the Lake Lanier Watershed

Name	County	Permit No.	Type	Status
Greenleaf Recycling, LLC	Forsyth	058-013D(C&D)	Construction and Demolition	Operating
Pea Ridge Road PH1	Habersham	068-016D(SL)	Sanitary Landfill	Closed
Pea Ridge Road PH2-3	Habersham	068-017D(SL)	Sanitary Landfill	Closed
SR 13 MSWL	Habersham	068-020D(SL)	Municipal Solid Waste Land	Operating
Barlow Homes Rd. PH2	Lumpkin	093-003D(SL)	Sanitary Landfill	Closed
Duke's Creek	White	154-003D(SL)	Sanitary Landfill	Closed
Clarkesville	Habersham	-	NA	Inactive
Cornelia	Habersham	-	NA	Inactive
Cumming	Forsyth	-	NA	Inactive

Source: Land Protection Branch, GA DNR, 2014

4.0 ANALYTICAL APPROACH

The process of developing the chlorophyll *a* TMDLs for Lake Lanier included developing a computer model for the Lake and its embayments. The model was run for calendar years 2001 through 2012, when water quality data were collected in the Lake. A watershed model of the Lake Lanier watershed was also developed, using LSPC that included all major point sources of nutrients. The watershed model simulates the effects of surface runoff on both water quality and flow and was calibrated to available data. The results of this model were used as tributary flow inputs to the hydrodynamic model EFDC, which simulated the transport of water into and out of the lake. The EFDC water quality model was used to simulate the fate and transport of nutrients into and out of the lake and the uptake by phytoplankton, where the growth and death of phytoplankton is measured through the surrogate parameter chlorophyll *a*. Figure 6 shows how the two models interact with one another and what outputs each model provides. The computer models used to develop this TMDL are described in the following sections.

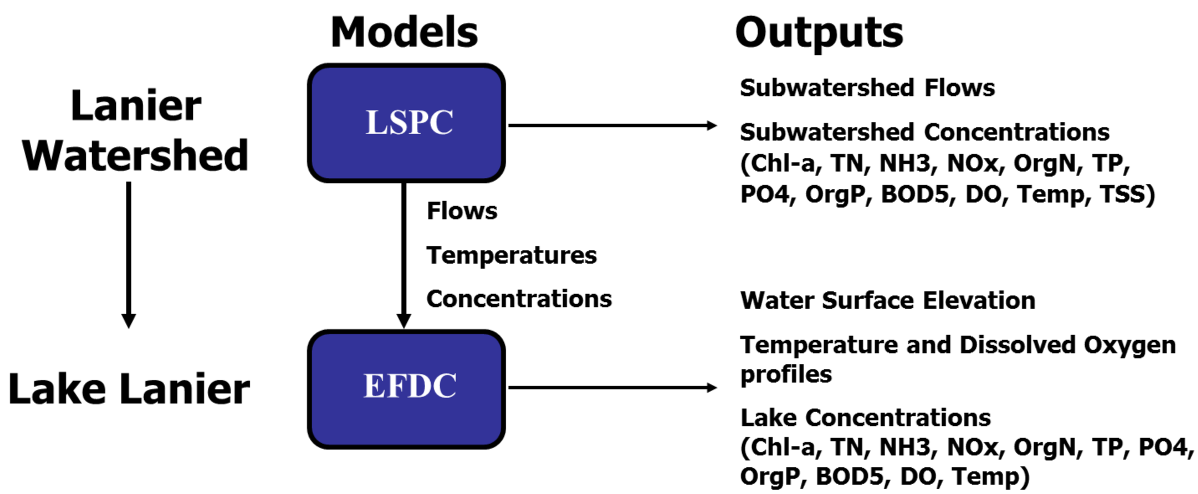


Figure 6. Linkage between LSPC and EFDC

4.1 Watershed Modeling (LSPC)

LSPC is a system designed to support TMDL development for areas impacted by both point and nonpoint sources. It is capable of simulating land-to-stream transport of flow, sediment, metals, nutrients, and other conventional pollutants, as well as temperature and pH. LSPC is a comprehensive data management and modeling system that simulates pollutant loading from nonpoint sources. LSPC utilizes the hydrologic core program of the Hydrological Simulation Program Fortran (HSPF, EPA 1996b), with a custom interface of the Mining Data Analysis System (MDAS), and modifications for non-mining applications such as nutrient and pathogen modeling.

LSPC was used to calculate runoff and hydrologic transport of pollutants based on historic precipitation data. LSPC was configured for the Lake Lanier watershed to simulate the watershed as a series of hydrologically connected sub-watersheds. Configuration of the model involved sub-dividing the Lake Lanier watershed into 225 modeling sub-watersheds, which are shown in Figure 7. Sub-basin delineations were based on elevation data (10 meter National Elevation Dataset from USGS), and stream connectivity from the National Hydrography Dataset.

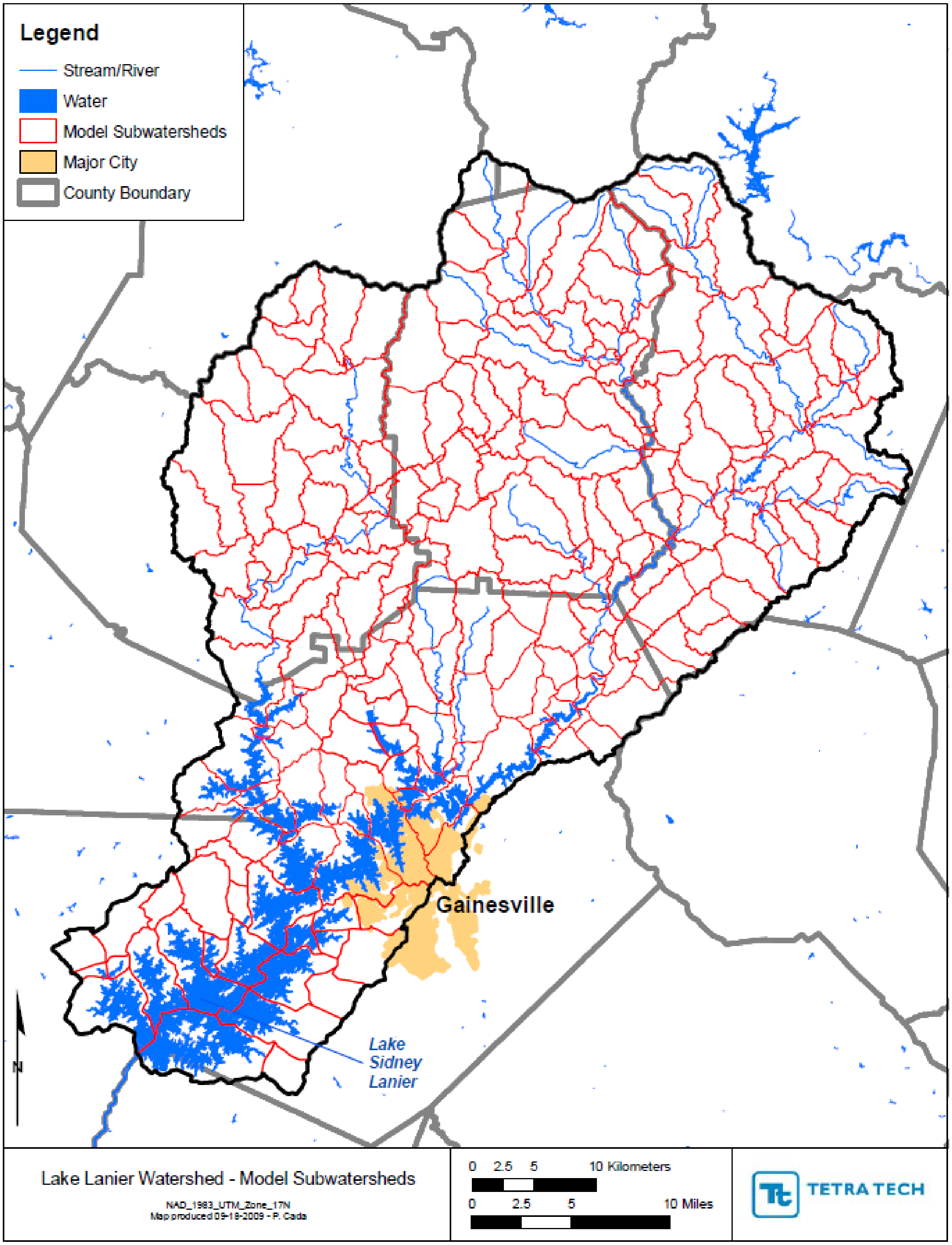


Figure 7. Subdelineated 12-Digit HUC Coverage for the Lake Lanier Watershed

Potential pollutant loadings were determined from mass-balance predictions of available pollutants on the land surface for the land cover distribution in each sub-watershed.

The Lake Lanier watershed LSPC model performed a continuous simulation of flow and water quality for these sub-watersheds using the following data:

- Meteorological data
- Land cover
- Soils
- Stream lengths and slopes
- Point source discharge data
- Water withdrawal data
- USGS flow data
- Water quality data

Meteorological Data

Nonpoint source loadings and hydrological conditions are dependent on weather conditions. Hourly data from weather stations within the boundaries of, or in close proximity to, the sub-watersheds were applied to the watershed model. An ASCII file was generated for each meteorological station used in the hydrological evaluations in LSPC. Each meteorological station file contains atmospheric data used in modeling the hydrological processes. These data include precipitation, air temperature, dew point temperature, wind speed, cloud cover, evaporation, and solar radiation. These data are used directly, or calculated from the observed data. The five meteorological stations used for the Lake Lanier models are listed in Table 12 and shown in Figure 8.

Table 12. Available Meteorological Stations in the Lake Lanier Watershed

Station ID	Station Name	Elevation (ft)	County	Latitude	Longitude
92006	Cleveland	1567	White	34.442	-83.356
92283	Cornelia	1470	Habersham	34.518	-83.529
92408	Cumming 1 ENE	1306	Forsyth	34.208	-84.131
92578	Dawsonville	1343	Dawson	34.421	-84.104
93621	Gainesville	1170	Hall	34.301	-84.860

The Lake Lanier watershed was subdivided into Thiessen polygons, using the meteorological stations as centers, to determine the meteorological station that would be used for each sub-watershed.

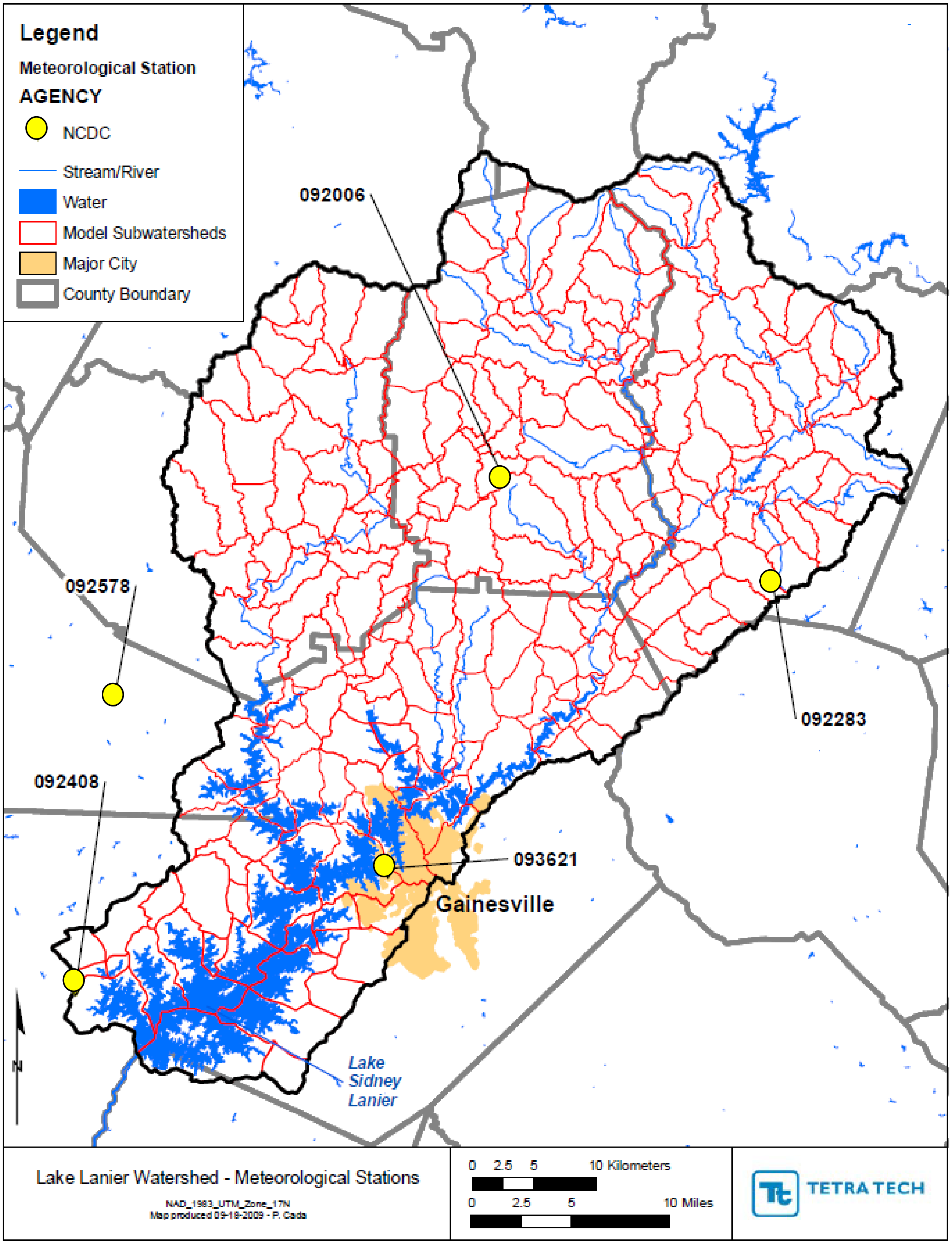


Figure 8. Meteorological Stations Used in the Lake Lanier Watershed Model

Land Cover

The watershed model uses land cover data as the basis for representing hydrology and nonpoint source loading. The land use data used was the 2005 and 2008 GLUT coverage. Figure 9 presents the distribution of land cover within the Lake Lanier watershed, and a breakdown of the watershed by land use is given in Table 2.

The LSPC model requires division of land cover into pervious and impervious land units. For this, the GLUT impervious cover, Figure 10, was intersected with the GLUT land use cover. Any impervious areas associated with utility swaths, developed open space, and developed low intensity, were grouped together into low intensity development impervious. Impervious areas associated with medium intensity development and high intensity development, were kept separate from medium intensity development impervious and high intensity development impervious, respectively. Finally, all impervious areas not already accounted for in the three developed impervious classes were grouped together into a remaining impervious class called catch all for remaining impervious (Table 13). The catch all for remaining impervious class is made up of small bits of imperviousness associated with Clearcut/Sparse (Transitional), Quarries/Strip Mines/Gravel Pits, Bare Rock/Sand/Clay, Deciduous Forest, Evergreen Forest, Mixed Forest, Golf Courses, Pasture/Hay, and Row Crops.

Table 13. Land Cover Percent Impervious and Pervious

Land Categories Represented in the Model	Land Use Code	GLUT Land use Category	% Impervious	% Pervious
Water	11	Open Water	0	100
Urban	20,21,22	Developed Low Intensity	4	96
Urban	23	Developed Medium Intensity	48	52
Urban	24	Developed High Intensity	83	17
Barren & Mining	31	Clearcut/Sparse (Transitional)	0	100
Barren & Mining	33	Quarries/Strip Mines/Gravel Pits	0	100
Barren & Mining	34	Bare Rock/Sand/Clay	0	100
Forest	41	Deciduous Forest	0	100
Forest	42	Evergreen Forest	0	100
Forest	43	Mixed Forest	0	100
Golf	73	Golf Courses	0	100
Pasture	80	Pasture/Hay	0	100
Cropland	83	Row Crops	0	100
Wetland	91	Forested Wetland	0	100
Wetland	93	Non-forested Wetlands	0	100
Failing Septic	888	Failing Septics	0	100
Pasture Chicken	1000	Chicken Pasture	0	100
Remaining Impervious	332	Catch All for Remaining Impervious	100	0

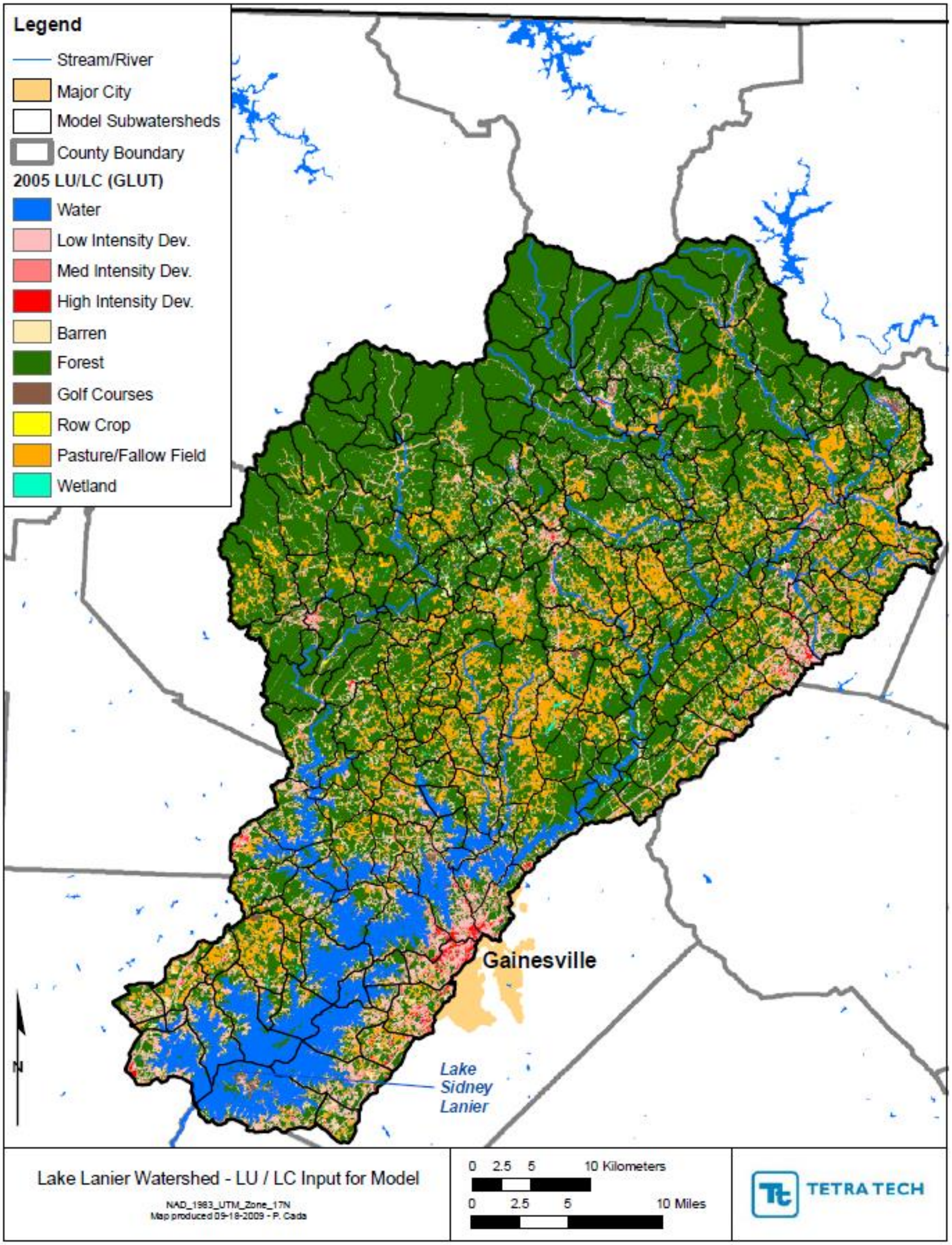


Figure 9. Lake Lanier Watershed Land Cover from 2005 GLUT

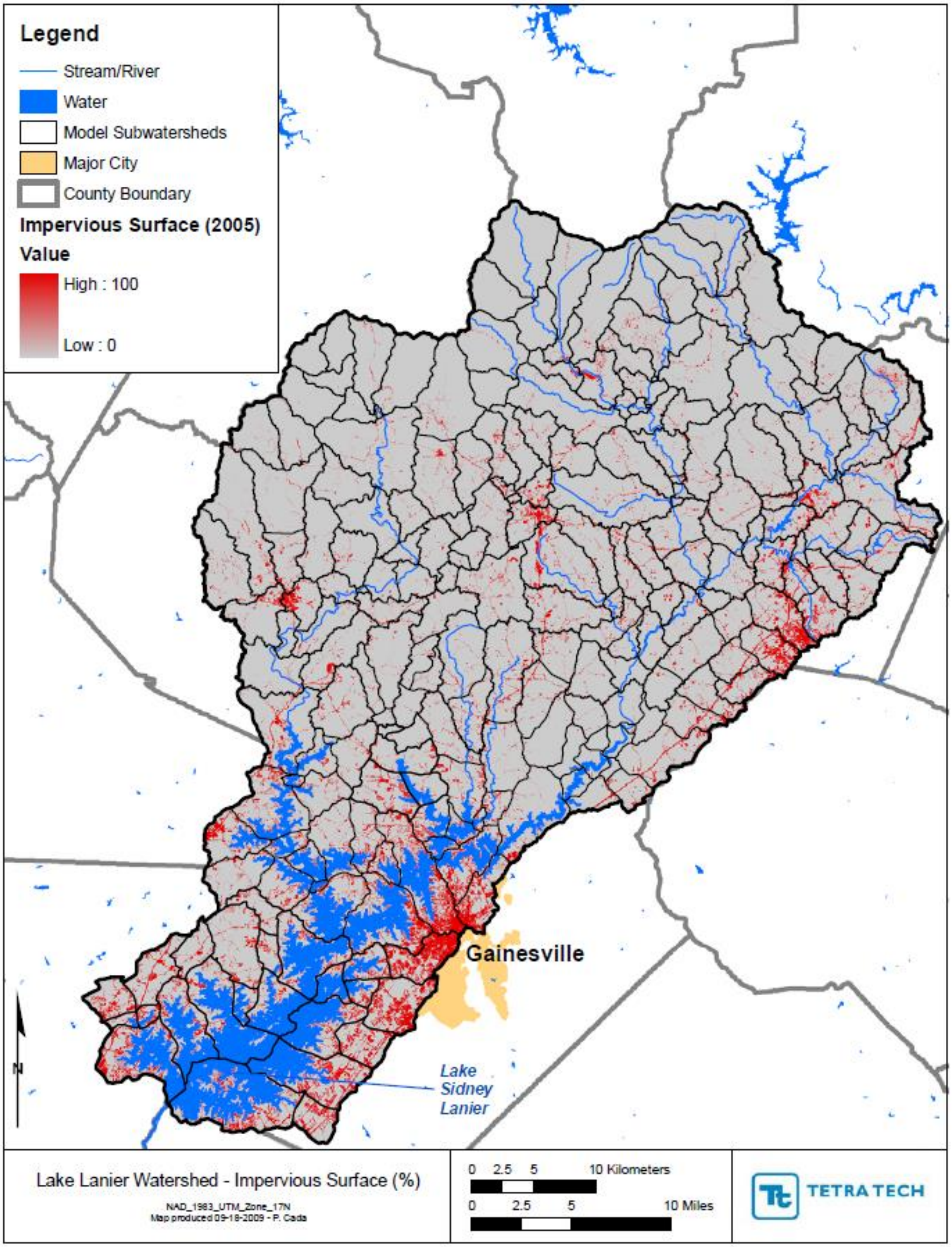


Figure 10. Lake Lanier Watershed Impervious Coverage from 2005 GLUT

Chicken Houses

In the Lake Lanier watershed, an amendment to the land use coverage was made to account for broiler chicken houses. Google Earth imagery was used to map locations and create a Geographic Information System (GIS) point coverage of broiler chicken houses. There are 1540 broiler houses identified in the Lake Lanier watershed. These broiler chicken houses are buildings that currently house, or in the past housed, a large number of birds. It is common for chicken manure to be applied to pasture land. A study conducted by the University of Georgia (UGA) showed pasture land within a 0.75-km radius of a chicken house typically received applications of broiler manure (Lin, 2008). To distinguish regular pasture land from pasture land that receives or has received broiler manure, a 0.75-km radius was drawn around each broiler chicken house, and all pasture land contained within this buffer area was converted to a new land use type known as "Pasture-Chicken" (Figure 11).

It is well known that chicken manure is very high in phosphorus and nitrogen. It was assumed that the pasture land within the buffer area receives 6.73 mg per hectares per year of broiler litter (Lin, 2008), which translates to an average of 16.45 pounds of broiler litter per day. Of the 16.45 lbs per day of broiler litter, 1.3% (Radcliffe, 2008a) was assumed to be total phosphorus (0.214 lbs per day). It was assumed that 0.214 pounds per day was the accumulation rate and the maximum storage was 0.214 pounds, indicating an "instant build-up." To calculate the amount of nitrogen applied to the pasture land used by poultry, it was assumed that of the 16.45 pounds per acre per day of broiler litter, total nitrogen makes up 3.13% (0.515 lbs per day) (Radcliffe 2008). Similar to total phosphorous, it was assumed that the load of total nitrogen, the accumulation rate and the maximum storage value, indicating an "instant build-up".

It is acknowledged that the estimation of chicken houses based on aerial photography includes facilities that are no longer active. Thus, the number of active houses in the watershed, and the corresponding pasture land within the buffer area where manure is currently applied, has most likely been overestimated. Additionally, the model does not account for the significant amount of manure that is transferred out of the watershed for use as a fertilizer in other parts of the State. If information becomes available on the reduction of nutrient levels that result from manure being transferred out of the watershed, or if new information substantially changes the other assumptions described in this section, the TMDL WLA may be adjusted to account for these reductions in the LA loads.

Soils

Soil data for the Lake Lanier watershed were obtained from the State Soil Geographic Data Base (STATSGO). There are four main Hydrologic Soil Groups (Group A, B, C and D). The different soil groups range from soils that have a low runoff potential to soils that have a high runoff potential. The four soils groups are described below:

> Group A Soils Low runoff potential and high infiltration rates even when wet. They consist chiefly of sand and gravel and are well to excessively drained.
> Group B Soils Moderate infiltration rates when wet and consist chiefly of soils that are moderately deep to deep, moderately to well drained, and moderately to moderately course textures.
> Group C Soils Low infiltration rates when wet and consist chiefly of soils having a layer that impedes downward movement of water with moderately fine to fine texture.
> Group D Soils High runoff potential, very low infiltration rates and consist chiefly of clay soils.

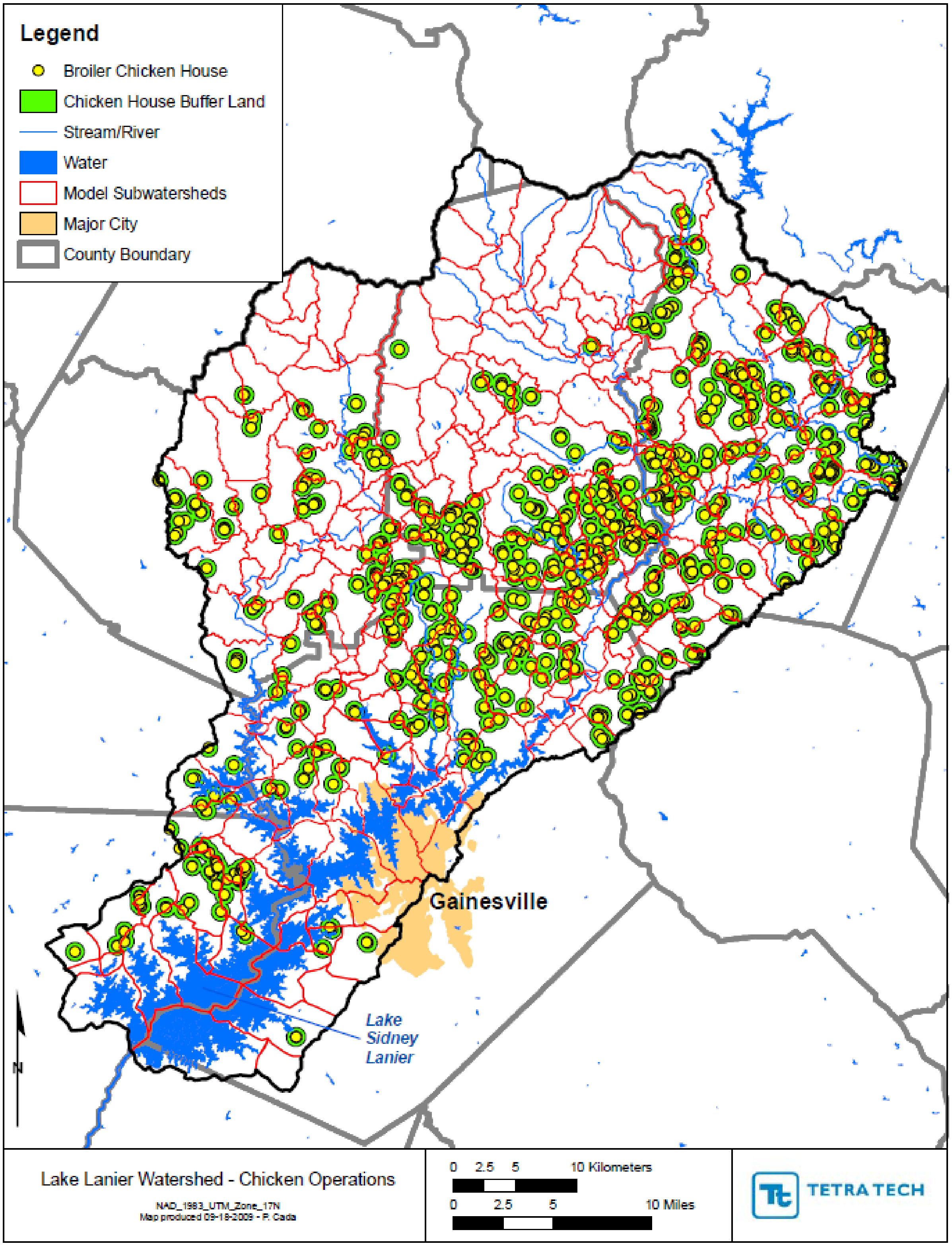


Figure 11. Pasture Chicken Land around Chicken Houses in the Lake Lanier Watershed

In LSPC, each dominant Hydrologic Soil Group within the study watershed gets assigned a default group number. A standard approach for assigning Hydrologic Soil Groups to default group numbers included: Group A equals 1, Group B equals 2, Group C equals 3 and Group D equals 4.

There is one major Hydrologic Soil Group, Groups B, in the Lake Lanier watershed. Figure 12 shows the soil group coverage for the watershed. The total area that each hydrologic soil group covered within each sub-watershed was determined. The hydrologic soil group that had the highest percent of coverage within each sub-watershed represented that sub-watershed in LSPC.

<u>Stream Lengths and Slopes</u>

Each sub-watershed must have a representative reach defined for it. The characteristics for each reach include the length and slope of the reach, the channel geometry, and the connectivity between the sub-watersheds. Length and slope data for each reach was obtained using the Digital Elevation Maps (DEM) and the National Hydrography Dataset (NHD). The channel geometry is described by a bank full width and depth (the main channel), a bottom width factor, a flood plain width factor, and the slope of the flood plain.

LSPC takes the attributes supplied for each reach and develops a function table, FTABLE. This table describes the hydrology of a river reach or reservoir segment by defining the functional relationship between water depth, surface area, water volume, and outflow in the segment. The assumption of a fixed depth, area, volume, and outflow relationship rules out cases where the flow reverses direction or where one reach influences another upstream of it in a time-dependent way. This routing technique falls into the class known as “storage routing” or “kinematic wave” methods. In these methods, momentum is not considered (US EPA, 2007).

For incorporating agricultural water withdrawals into the model, fictitious reaches were created to hold the irrigation water prior to being applied back onto the land. Each sub-watershed that contained irrigated land had its own fictitious reach and this reach was treated like a pot-hole lake. Each of these reaches used the same FTABLE and the outflow for each stage was held at zero. These reaches were not connected to sub-watersheds downstream and merely held water until it was applied back onto the land through the pumping of irrigation water.

<u>Point Sources Discharge Data</u>

There are 24 point source discharges located in the Lake Lanier watershed that have NPDES permits. Of these point sources, eight are municipal facilities, 10 are private facilities such as schools and hospitals, and six are industrial facilities. Two facilities, Habersham Mills and Camp Coleman in Cleveland, Georgia, have ceased discharging since 2007, and one permit, Habersham Central High School, was rescinded in September 2013. Flows and water quality data for these point source discharges were obtained from either the Discharge Monitoring Reports (DMR) or Operating Monitoring Reports (OMR). Data obtained from these reports were input directly into the LSPC model. The sub-watershed that each facility was assigned to and the frequency of the DMR or OMR data are given in Table 14.

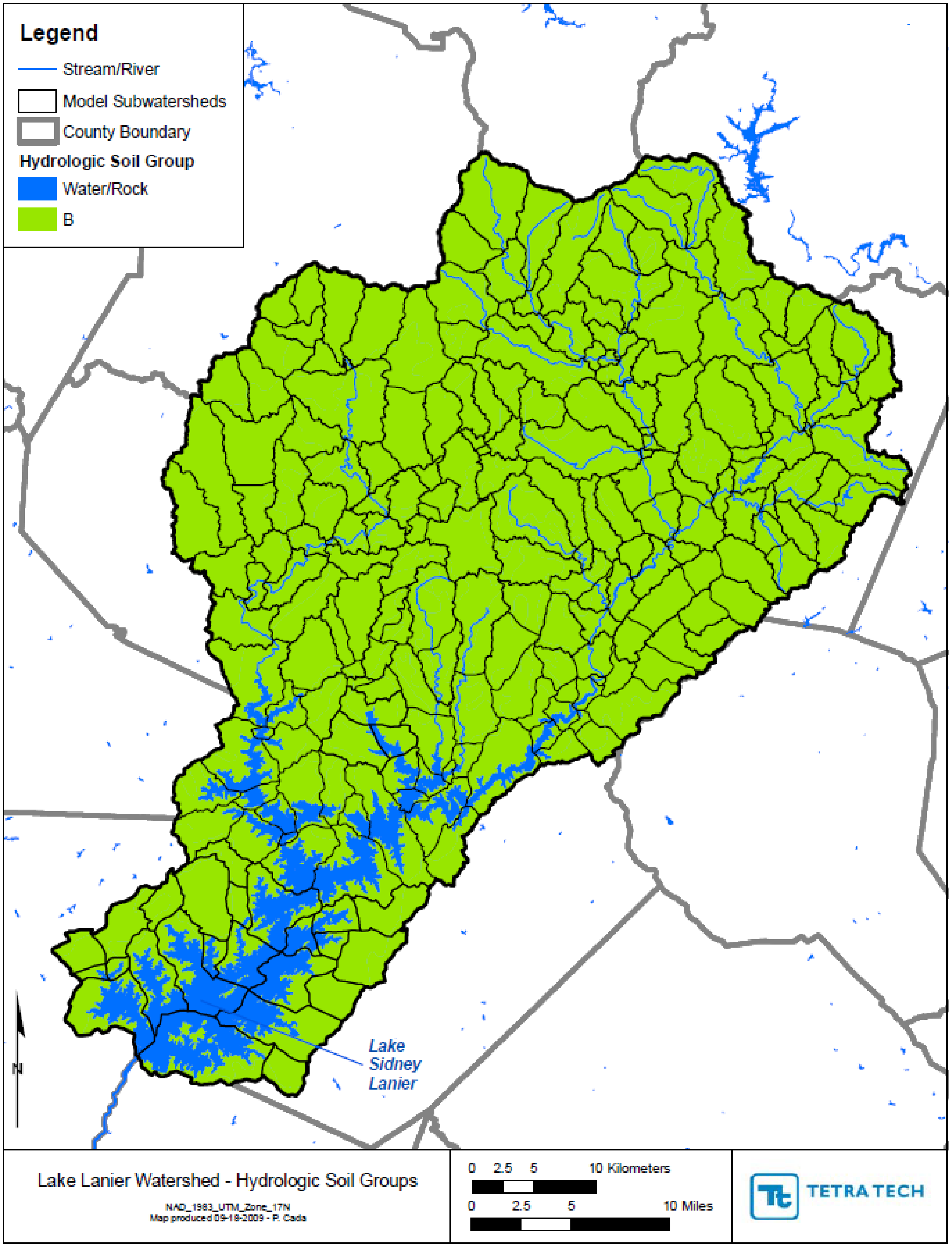


Figure 12. Lake Lanier Watershed Soil Hydrologic Groups

Table 14. Summary of Point Source Discharges to the Lake Lanier Watershed

Permit Number	Facility Name	Facility Type	Receiving Water	Data Frequency	Sub-Watershed
GA0001112	Scovill Fasteners Inc.	IND	Soquee River	Monthly	1178
GA0001694	Habersham Mills Inc.	IND	Soquee River – cease discharging	Constant	1178
GA0021156	Gainesville - Flat Creek WPCP	MUN	Flat Creek	Daily	1222
GA0021504	Cornelia WPCP	MUN	South Fork of Mud Creek	Monthly	1213
GA0023043	Dixie MHP - Gainesville	PID	Unnamed trib to Flat Creek	Constant	1222
GA0023469	Shady Grove MHP	PID	Unnamed trib to Balus Creek	Monthly	1223
GA0026077	Dahlonega WPCP	MUN	Yahoola Creek	Daily	1044
GA0027049	Baker & Glover MHP	PID	Unnamed trib to Little River	Constant	1106
GA0032506	Demorest WPCP	MUN	Hazel Creek	Monthly	1179
GA0032514	Clarkesville WPCP	MUN	Soquee River	Monthly	1181
GA0032697	Wauka Mountain Elementary School	MUN	East Fork Little River	Monthly	111
GA0033243	Baldwin WPCP	MUN	South Fork Little Mud Creek	Monthly	1217
GA0033952	Habersham Central High School	PID	Rescinded 9/16/2013	Monthly	1204
GA0034207	Oak Grove MHP	PID	Unnamed Creek to Cane Creek	Monthly	1036
GA0034886	North Hall High School	PID	Unnamed Trib to Wahoo Creek	Monthly	1095
GA0034983	Camp Barney Medintz	PID	Jenny Creek	Monthly	1077
GA0035467	Camp Coleman - Cleveland	PID	Closed	Constant	1076
GA0036820	Cleveland WPCP	MUN	Testnatee Creek	Monthly	1075
GA0037209	Buckhorn Ventures LLC	IND-RQ	Trib to Six Mile Creek	Monthly	1011
GA0037508	Vulcan Construction Materials - Dahlonega II	IND-RQ	Unnamed trib to Long Branch Ck	Monthly	1035
GA0039039	Lula Pond WPCP	MUN	Hagen Creek	Monthly	1219
GA0046086	Hanson Aggregates SE	IND-RQ	Hazel Creek	Monthly	1179
GA0046302	Long Mountain Quarry	IND-RQ	Shoal Creek Tributary	Monthly	1079
GA0046400	Mountain Lakes Resort	PID	Lake Qualatchee	Monthly	1082

There was not sufficient data to quantify organic and orthophosphate loadings from the point sources. For minor point sources, data from five facilities in the Upper Etowah River watershed were used to determine the phosphorus speciation. These data are given in Table 15.

Table 15. Additional Phosphorus Data Collected at Minor Point Sources

NPDES Number	Facility Name	Permitted Flow (MGD)	Total Phosphorus (mg/L)	Ortho Phosphorus (mg/L)	Ortho Phosphorus/ Total Phosphorus Ratio
GA0024228	Reinhardt College (ceased discharging)	0.024	6.05	3.0	0.50
GA0029955	Tate Housing Authority	0.010	3.40	3.4	1.00
GA0032204	Jasper WPCP	0.800	3.40	3.4	1.00
GA0035866	Sawnee Elementary School	0.030	8.40	8.2	0.98
GA0045818	Tate Elementary School	0.007	1.50	1.4	0.93
				Average Ratio	**0.88**

Using these data, the following equations were applied to minor discharges (< 1.0 MGD) that did not have available orthophosphate data:

Organic Phosphorus = Total Phosphorous * 0.12
Orthophosphate = Total Phosphorous * 0.88

For major dischargers with permitted flows greater than 1.0 MGD, the total phosphorus and orthophosphate data collected at the Cobb County Northwest WRF, also located in in the Upper Etowah River watershed, were used to determine the breakdown of the total phosphorus. From November 2004 through December 2006, there were 784 values of total phosphorus and orthophosphate data collected. The average ratio of orthophosphate data to total phosphorus was 0.66. Therefore, the following equations were used for major discharges that did not have available phosphorus data:

Organic Phosphorus = Total Phosphorous * 0.34
Orthophosphate = Total Phosphorous * 0.66

Compliance Sampling Inspection (CSI) reports data were used to determine values for particular constituents needed for model input that were not reported on the DMR and OMR sheets. For the Gainesville Flat Creek WPCP, ammonia is a measured value and the other nitrogen species are default; so speciation from the CSI reports are utilized to calculate the other nitrogen constituents from the measured ammonia values.

Table 16 provides the water quality concentrations that were input when no data were available for water quality parameters in a point source.

Table 16. Assumed Water Quality Concentrations for Point Sources without Data

Parameter	**Concentration (mg/L)**
Flow	0.1 MGD
Temp	Oct- March – 15 ^{o}C April-September – 25 ^{o}C
DO	5
BOD_5	30.00
TN	14.00
NH3	2.00
NO_3/NO_2	10.00
ORG-N	2.00
TP	1.00
PO_4	0.66 (majors) / 0.88 (minors)
ORG-P	0.34 (majors) / 0.12 (minors)
TSS	30.00

Land Application Systems

A GIS coverage of the Land Application System (LAS) fields was clipped and geo-processed with the Lake Lanier delineated sub-watersheds coverage and incorporated into the GLUT land use. The land use that was associated with LAS acreage for each sub-watershed was subtracted from its original GLUT land use and that area was added to a new land use associated LAS. Great care was taken to ensure that the overall acreage of the watershed was unchanged.

Land application system loading rates were obtained from the Coosa Watershed model that was developed for the Georgia State Water Plan. These land-use loading rates are quite high and were allowed to build up for 3 days before reaching their maximum storage limit.

Septic Tanks

Septic tanks were also considered in the watershed model. The number of septic tanks in each sub-watershed was determined through an area-weighting method. Each sub-watershed was assigned to a county based on where the outlet of the watershed lies. The ratio of the area of the sub-watershed to the area of the county was determined, and this ratio was applied to the total number of septic tanks in the county to determine a number for each sub-watershed. Not all septic tanks were considered to be contributing flow to the system. It was assumed that at any given time, 85% of the septic tanks were non-failing and 15% of the septic tanks were failing. If information becomes available on the nutrient levels due to failing septic tanks, the TMDL WLA may be adjusted to account for these reductions in the LA loads.

For the non-failing septic tanks, these were treated as a source of nutrients through subsurface flow. This was represented as a direct input into the stream, assuming a first order decay rate and an average 60-day travel time from the septic tank to the stream. To represent the non-failing septic tank flow, it was assumed that each septic tank serves a household of 2.8 people and that each person accounts for 70 gallons/day of flow in the septic tank and 15% of the water used in the house never makes it to the septic tank. The non-failing septic tanks were modeled as very small individual point sources for each sub-watershed. Table 17 presents the concentration of septic tank effluent, decay rates for each constituent, and the concentration after 60 days of decay. For phosphorus, it was also assumed that 90% was sorbed to sediment; therefore only 10% of the effluent concentration was used to calculate decay after 60 days.

Table 17. Septic Tank Water Quality Concentrations

Parameter	Effluent Concentration (mg/L)	Decay Rate (1/day)	Concentration at Stream (mg/L)**
BOD_5	105.0	0.16	0.003
Total Nitrogen	70.26	0.1	0.1263
Organic Nitrogen	0.46	0.1	0.0008
Ammonia	10.5	0.1	0.0189
Nitrate+Nitrite	59.3	0.1	0.1066
Total Phosphorus*	0.3	0.014	0.1287
Organic Phosphorus*	0.3	0.014	0.1287
Ortho-Phosphate*	0.0	0.014	0.000
TSS	10.0	0	10
Dissolved Oxygen	--	--	4
Water Temperature	--	--	GW Temp***

* It was assumed that 90% of phosphorus is sorbed to sediment.
** Assumes Septic Flow takes an average of 60 days to reach stream
***Supplied groundwater temperature from temperature component of simulation

The portion of the septic tanks that were considered failing were modeled as a "Failing Septic Tank" land use because it was assumed that no decay occurs and raw effluent is directly applied to the land. It was determined that the average area of a septic field is 6,750 ft^2 (Inspectapedia 2009). The land use that was represented as "Failing Septic Tanks" was subtracted from the Low Intensity Urban Pervious land use for each sub-watershed. For a few of the sub-watersheds subtracting Failing Septic from Low Intensity Urban Pervious resulted in negative values. For these watersheds, all of the Failing Septic Tank area was subtracted from Developed Open Space.

Water Withdrawal Data

There were seven water withdrawals located in the Lake Lanier watershed that were represented in the LSPC model. Six of them are municipal water withdrawals and one is an industrial water withdrawal. Two of the City of Dahlonega's withdrawals have been revoked and in 2008, the city was issued a new withdrawal. Average monthly water withdrawal data from were obtained. The current source water, sub-watershed, and permitted withdrawal for each withdrawal are given in Table 18.

Table 18. Summary of Water Withdrawals in the Lake Lanier Watershed

Permit Number	Withdrawal	Source Water	Sub-Watershed	Permitted Withdrawal 24-Hour Limit (MGD)	Permitted Withdrawal Monthly Average (MGD)
068-1201-01	City of Cornelia	Hazel Creek	1208	4.0	4.00
068-1201-03	City of Clarkesville	Soquee River	1181	1.50	1.00
068-1201-04	City of Baldwin	Chattahoochee River	1141	4	3
093-1202-03	Birchriver Gold , L.P.	Chestatee River	1045	0.43	0.43
093-1204-03	City of Dahlonega	Yahoola Creek Issued 6/6/2008	1046	9.1	6.8
093-1204-01	City of Dahlonega, New Plant	Yahoola Creek-Revoked 4/12/2012	1046	1.50	1.25
093-1204-02	City of Dahlonega, Old Plant	Yahoola Creek – Revoked 12/28/2004	1046	0.5	0.5
154-1202-02	White County Water & Sewer Authority	Turner Creek	1080	2	1.8

Agricultural Water Withdrawals

Two data sources were utilized to determine agricultural irrigation in the Lake Lanier watershed, the Ag Water Pumping report and a GIS coverage of areas receiving irrigation water. The Ag Water Pumping report provided seasonal, regionalized, irrigation depths by source water type based on the results of the multi-year Ag Water Pumping study (Ag Water Pumping 2005). The GIS polygon coverage, created by researchers at the University of Georgia (UGA), was clipped and geo-processed with the Lake Lanier delineated sub-watersheds coverage and incorporated into the GLUT land use.

The total acreage of irrigated lands and the percent of acreage irrigated by surface water are given in Table 19. The land use that was associated with the irrigated acreage for each sub-watershed was subtracted from its original GLUT land use and that area was added to a new land use associated irrigated land. For example, if a sub-watershed has 100 acres of irrigated land of which 85 acres were originally Row Crop, 10 acres were originally Pasture, and 5 acres were originally Forest. The GLUT land use for that sub-watershed would have 85 acres

Table 19. Irrigated Acreage by Sub-Watershed

Sub-Watershed	Irrigation Pond	Irrigation Acreage	Percent Surface Water	AWP Reporting Region
1181	21181	40.50	100	North Georgia
1185	21185	96.33	100	North Georgia

removed from Row Crop and added to Irrigated Row Crop, 10 acres removed from Pasture and added to Irrigated Pasture, and 5 acres removed from Forest and added to Irrigated Forest. Great care was taken to ensure that the overall acreage of the watershed was unchanged. Each sub-watershed containing irrigated land was assigned to an Ag Water Pumping Reporting Region (see Figure 13). The product of the irrigated area and monthly irrigated depth for the North Georgia Reporting Region given in Table 20 produces a monthly volume of water.

Table 20. Irrigation Depth (inches)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
2000	0.25	0.35	0.635	0.8	1.95	2.4	2.4	2.9	1.7	1.45	0.75	0.4
2001	0.15	0.2	0.25	0.6	1.25	1.45	1.45	1.55	1.25	0.95	0.5	0.25
2002	0.25	0.35	0.65	0.8	1.95	2.4	2.4	2.9	1.7	1.45	0.75	0.4
2003	0.15	0.2	0.25	0.6	1.25	1.45	1.45	1.55	1.25	0.95	0.5	0.25
2004	0.15	0.2	0.25	0.6	1.25	1.45	1.45	1.55	1.25	0.95	0.5	0.25
2005	0.15	0.2	0.25	0.6	1.25	1.45	1.45	1.55	1.25	0.95	0.5	0.25
2006	0.25	0.35	0.65	0.8	1.95	2.4	2.4	2.9	1.7	1.45	0.75	0.4
2007	0.25	0.35	0.65	0.8	1.95	2.4	2.4	2.9	1.7	1.45	0.75	0.4
2008	0.25	0.35	0.65	0.8	1.95	2.4	2.4	2.9	1.7	1.45	0.75	0.4
2009	0.15	0.2	0.25	0.6	1.25	1.45	1.45	1.55	1.25	0.95	0.5	0.25
2010	0.15	0.2	0.25	0.6	1.25	1.45	1.45	1.55	1.25	0.95	0.5	0.25
2011	0.25	0.35	0.65	0.8	1.95	2.4	2.4	2.9	1.7	1.45	0.75	0.4
2012	0.25	0.35	0.65	0.8	1.95	2.4	2.4	2.9	1.7	1.45	0.75	0.4

Modeling Parameters

For the Six Mile Creek watershed, the land-use loading rates, maximum storage, interflow and groundwater concentrations were adjusted until the simulated instream concentrations were in range with observed instream concentrations in Six Mile Creek. For this reason, the Six Mile watershed had its own unique land use attributes.

Pollutants simulated by LSPC were biochemical oxygen demand (BOD), total nitrogen (Total N), and total phosphorus (Total P). LSPC requires land cover specific accumulation and washoff rates for each of the modeled water quality parameters. Table 21 provides the rates developed during model calibration for BOD, total nitrogen, and total phosphorus for each land cover type.

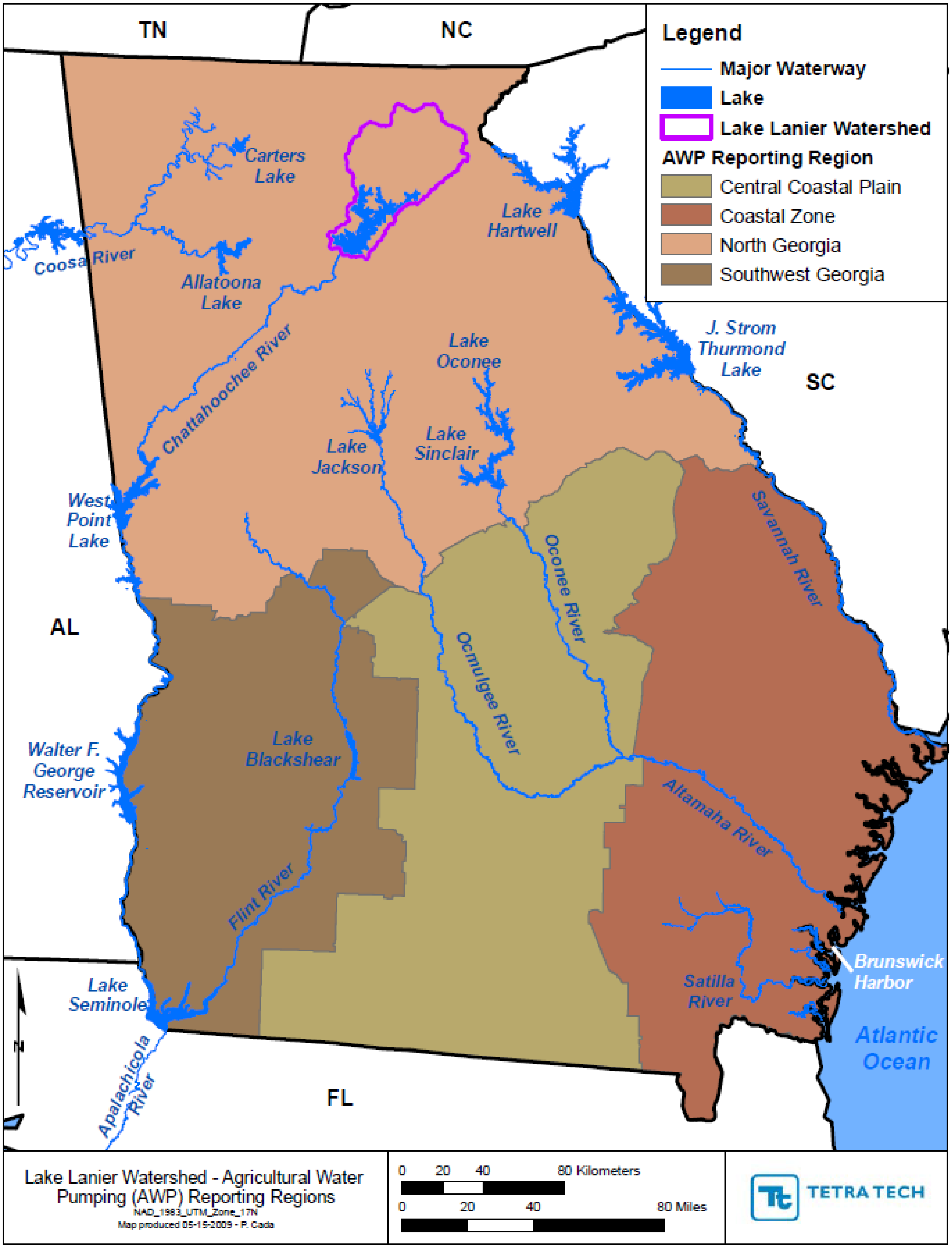


Figure 13. Ag Water Pumping Reporting Regions

Table 21. LSPC Modeling Parameters

Land use	Water Quality Parameter	Rate of Accumulation (lb/acre/day)	Maximum Storage (lb/acre)	Rate Of Surface Runoff Which Will Remove 90% (in/hr)	Concentration In Interflow Outflow (mg/L)	Concentration In Active Groundwater Outflow (mg/L)
Beach	BOD	0.0000	0.0000	0.00	0.0000	0.0000
	Total N	0.0000	0.0000	0.00	0.0000	0.0000
	Total P	0.0000	0.0000	0.00	0.0000	0.0000
Water	BOD	0.0000	0.0000	0.00	0.0000	0.0000
	Total N	0.0000	0.0000	0.00	0.0000	0.0000
	Total P	0.0000	0.0000	0.00	0.0000	0.0000
Low Developed Pervious	BOD	0.183333 - 0.45	0.549999 - 1.35	0.70	3.5 - 5.1	1.6 - 1.6
	Total N	0.036375 - 0.191875	0.1455 - 0.7675	0.60	1.568 - 1.868	1.268 - 1.568
	Total P	0.004 - 0.025	0.012 - 0.075	0.60	0.009 - 0.009	0.01 - 0.01
Low Developed Impervious	BOD	0.183333 - 0.45	0.549999 - 1.35	0.70	0.0000	0.0000
	Total N	0.036375 - 0.191875	0.1455 - 0.7675	0.60	0.0000	0.0000
	Total P	0.004 - 0.025	0.012 - 0.075	0.60	0.0000	0.0000
Medium Developed Pervious	BOD	0.183333 - 0.45	0.549999 - 1.35	0.70	3.5 - 5.1	1.6 - 1.6
	Total N	0.036375 - 0.191875	0.1455 - 0.7675	0.60	1.568 - 1.868	1.268 - 1.568
	Total P	0.004 - 0.025	0.012 - 0.075	0.60	0.009 - 0.009	0.01 - 0.01
Medium Developed Impervious	BOD	0.183333 - 0.45	0.549999 - 1.35	0.70	0.0000	0.0000
	Total N	0.036375 - 0.191875	0.1455 - 0.7675	0.60	0.0000	0.0000
	Total P	0.004 - 0.025	0.012 - 0.075	0.60	0.0000	0.0000
High Developed Pervious	BOD	0.183333 - 0.45	0.549999 - 1.35	0.70	3.5 - 5.1	1.6 - 1.6
	Total N	0.036375 - 0.191875	0.1455 - 0.7675	0.60	1.568 - 1.868	1.268 - 1.568
	Total P	0.004 - 0.025	0.012 - 0.075	0.60	0.009 - 0.009	0.01 - 0.01
High Developed Impervious	BOD	0.183333 - 0.45	0.549999 - 1.35	0.70	0.0000	0.0000
	Total N	0.036375 - 0.191875	0.1455 - 0.7675	0.60	0.0000	0.0000
	Total P	0.004 - 0.025	0.012 - 0.075	0.60	0.0000	0.0000
Barren	BOD	0.183333 - 0.55	0.549999 - 1.65	0.70	1.3 - 2.8	1.6 - 1.6
	Total N	0.036375 - 0.191875	0.1455 - 0.7675	0.60	0.55 - 0.65	0.45 - 0.55
	Total P	0.004 - 0.025	0.012 - 0.075	0.60	0.008 - 0.008	0.0098 - 0.0098
Forest	BOD	0.183333 - 0.55	0.549999 - 1.65	0.70	1.3 - 2.8	1.6 - 1.6
	Total N	0.026375 - 0.181875	0.1055 - 0.7275	0.60	0.35 - 0.45	0.25 - 0.35
	Total P	0.001 - 0.022	0.003 - 0.066	0.60	0.004 - 0.004	0.006 - 0.006
Golf	BOD	0.183333 - 0.45	0.549999 - 1.35	0.70	1.3 - 2.8	1.6 - 1.6
	Total N	0.036375 - 0.191875	0.1455 - 0.7675	0.60	1.568 - 1.868	1.268 - 1.568
	Total P	0.004 - 0.025	0.012 - 0.075	0.60	0.005 - 0.005	0.008 - 0.008
Pasture	BOD	0.183333 - 0.45	0.549999 - 1.35	0.70	1.3 - 3.8	1.6 - 1.6
	Total N	0.084 - 0.61375	0.336 - 2.455	0.60	1.388 - 1.988	1.188 - 1.788
	Total P	0.015 - 0.03	0.045 - 0.09	0.60	0.055 - 0.065	0.075 - 0.075
Crop	BOD	0.183333 - 1.216667	0.549 - 3.650	0.70	1.3 - 3.8	1.6 - 1.6
	Total N	0.084 - 0.61375	0.336 - 2.455	0.60	1.388 - 1.988	1.188 - 1.788
	Total P	0.015 - 0.03	0.045 - 0.09	0.60	0.085 - 0.085	0.075 - 0.075
Forested Wetland	BOD	0.183333 - 0.45	0.549999 - 1.35	0.70	1.3 - 2.8	1.6 - 1.6
	Total N	0.036375 - 0.191875	0.1455 - 0.7675	0.60	0.768 - 0.818	0.768 - 0.818
	Total P	0.004 - 0.025	0.012 - 0.075	0.60	0.004 - 0.004	0.0058 - 0.0058
Non-Forested Wetland	BOD	0.183333 - 0.45	0.549999 - 1.35	0.70	1.3 - 2.8	1.6 - 1.6
	Total N	0.036375 - 0.191875	0.1455 - 0.7675	0.60	0.768 - 0.818	0.768 - 0.818
	Total P	0.004 - 0.025	0.012 - 0.075	0.60	0.004 - 0.004	0.0058 - 0.0058

Land use	Water Quality Parameter	Rate of Accumulation (lb/acre/day)	Maximum Storage (lb/acre)	Rate Of Surface Runoff Which Will Remove 90% (in/hr)	Concentration In Interflow Outflow (mg/L)	Concentration In Active Groundwater Outflow (mg/L)
Other Impervious	BOD	0.183333 - 0.45	0.549999 - 1.35	0.70	0.0000	0.0000
	Total N	0.036375 - 0.191875	0.1455 - 0.7675	0.60	0.0000	0.0000
	Total P	0.004 - 0.025	0.1455 - 0.7675	0.60	0.0000	0.0000
LAS	BOD	0.183333 - 0.45	0.549999 - 1.35	0.70	1.3 - 3.8	1.6 - 1.6
	Total N	1.090375 - 1.090375	4.3615 - 4.3615	0.60	2.088 - 2.688	1.988 - 2.588
	Total P	0.015 - 0.03	0.045 - 0.09	0.60	0.055 - 0.065	0.065 - 0.065
Failing Septic	BOD	0.308644 - 0.308644	1.234 - 1.234	0.70	4.2 - 4.2	1.5 - 1.5
	Total N	0.07098 - 0.07098	0.3549 - 0.3549	0.60	0.46 - 0.46	0.468 - 0.468
	Total P	0.009259 - 0.009259	0.0463 - 0.0463	0.60	0.01 - 0.01	0.012 - 0.012
Irrigated Water	BOD	0.0000	0.0000	0.00	0.0000	0.0000
	Total N	0.0000	0.0000	0.00	0.0000	0.0000
	Total P	0.0000	0.0000	0.00	0.0000	0.0000
Irrigated Urban	BOD	0.183333 - 0.45	0.549999 - 1.35	0.70	3.5 - 5.1	1.6 - 1.6
	Total N	0.036375 - 0.191875	0.1455 - 0.7675	0.60	1.568 - 1.868	1.268 - 1.568
	Total P	0.004 - 0.025	0.012 - 0.075	0.60	0.009 - 0.009	0.01 - 0.01
Irrigated Barren	BOD	0.183333 - 0.55	0.549999 - 1.65	0.70	1.3 - 2.8	1.6 - 1.6
	Total N	0.036375 - 0.191875	0.1455 - 0.7675	0.60	0.55 - 0.65	0.45 - 0.55
	Total P	0.004 - 0.025	0.012 - 0.075	0.60	0.008 - 0.008	0.0098 - 0.0098
Irrigated Forest	BOD	0.183333 - 0.55	0.549999 - 1.65	0.70	1.3 - 2.8	1.6 - 1.6
	Total N	0.026375 - 0.181875	0.1055 - 0.7275	0.60	0.35 - 0.45	0.25 - 0.35
	Total P	0.001 - 0.022	0.003 - 0.066	0.60	0.004 - 0.004	0.006 - 0.006
Irrigated Golf	BOD	0.183333 - 0.45	0.549999 - 1.35	0.70	1.3 - 2.8	1.6 - 1.6
	Total N	0.036375 - 0.191875	0.1455 - 0.7675	0.60	1.568 - 1.868	1.268 - 1.568
	Total P	0.004 - 0.025	0.012 - 0.075	0.60	0.005 - 0.005	0.008 - 0.008
Irrigated Pasture	BOD	0.183333 - 0.45	0.549999 - 1.35	0.70	1.3 - 3.8	1.6 - 1.6
	Total N	0.084 - 0.61375	0.336 - 2.455	0.60	1.388 - 1.988	1.188 - 1.788
	Total P	0.015 - 0.03	0.045 - 0.09	0.60	0.055 - 0.065	0.075 - 0.075
Irrigated Crop	BOD	0.183333 - 1.216667	0.5499 - 3.6500	0.70	1.3 - 3.8	1.6 - 1.6
	Total N	0.084 - 0.61375	0.336 - 2.455	0.60	1.388 - 1.988	1.188 - 1.788
	Total P	0.015 - 0.03	0.045 - 0.09	0.60	0.085 - 0.085	0.075 - 0.075
Irrigated Wetland	BOD	0.183333 - 0.45	0.549999 - 1.35	0.70	1.3 - 2.8	1.6 - 1.6
	Total N	0.036375 - 0.191875	0.1455 - 0.7675	0.60	0.768 - 0.818	0.768 - 0.818
	Total P	0.004 - 0.025	0.012 - 0.075	0.60	0.004 - 0.004	0.0058 - 0.0058
Chicken Land	BOD	0.133333 - 0.4	0.399999 - 1.2	0.70	0.2 - 0.2	1.5 - 1.5
	Total N	0.5148 - 0.5148	0.5148 - 0.5148	0.60	3.101 - 3.901	2.701 - 3.501
	Total P	0.2138 - 0.2138	0.2138 - 0.2138	0.60	0.05 - 0.06	0.066 - 0.066
Six Mile Creek Subwatershed	BOD	0.133333 - 0.4	0.399999 - 1.2	0.70	1.3 - 3.8	1.6 - 1.6
	Total N	30.514 - 30.514	122.06 - 122.06	0.20	50.901 - 90.101	50.901 - 90.101
	Total P	0.015 - 0.03	0.045 - 0.09	0.40	0.055 - 0.065	0.066 - 0.066

Model Calibration

Historical flow data collected at USGS stations located in the Lake Lanier watershed (Table 22) were used to calibrate and validate the LSPC watershed hydrology model. Figure 14 shows the location of these flow gages used for the hydrologic calibrations. Three of the gages had a complete period of record for the simulation period from January 1, 1998 through December 31, 2012, while the last gage contained data from January 18, 2007 thru December 31, 2012. The

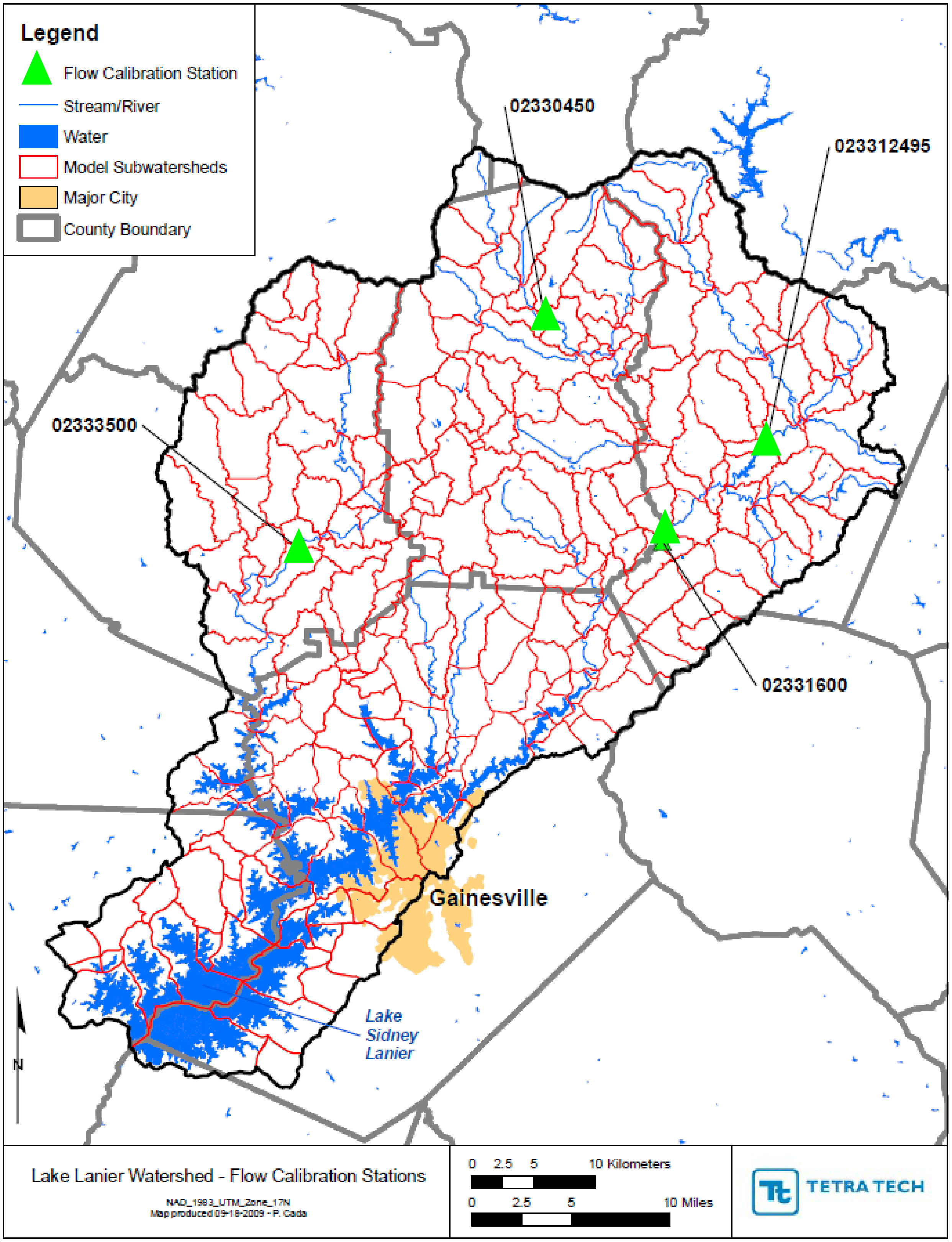


Figure 14. USGS Flow and Monitoring Stations Used in the Calibration of LSPC

Table 22. Flow Stations Used to Calibrate LSPC Hydrology

Station Name	USGS Stations	Drainage Area (mi^2)	Calibration / Validation / Verification
Chattahoochee River at Helen, Georgia	02330450	44.7	Validation
Soque River at GA 197 near Clarkesville, Georgia	023312495	93.9	Validation
Chattahoochee River near Cornelia, Georgia	02331600	315	Calibration
Chestatee River near Dahlonega, Georgia	02333500	153	Calibration

Chestatee River gage near Dahlonega and the Chattahoochee River gage near Cornelia were used for model calibration. The Chattahoochee River gage at Helen and the short term Soque River gage at GA 197 near Clarkesville were used for model validation.

During the calibration process, model parameters were adjusted based on local knowledge of soil types and groundwater conditions, within reasonable constraints as outlined in Technical Note 6 (US EPA 2000), until an acceptable agreement was achieved between simulated and observed stream flow. Key hydrologic model parameters adjusted included: evapo-transpiration, infiltration, upper and lower zone storages, groundwater recession, and losses to the deep groundwater system.

As previously mentioned, to represent watershed loadings and resulting pollutant concentrations in individual stream segments, the Lake Lanier watershed was divided into 225 sub-watersheds. Listed reaches, tributary confluences, and the locations of water quality monitoring sites defined these sub-watersheds, representing hydrologic boundaries. Delineation at water quality monitoring sites allowed comparison of model output to measured data.

Each month, water quality data is collected at the following three locations: Chattahoochee River at Helen, Chattahoochee River near Cornelia, and Chestatee River near Dahlonega. During 2007, GA EPD conducted intensively sampled rivers and streams in the Lake Lanier Watershed. This sampling was conducted at 27 key locations throughout the watershed.

In addition, Dr. Robert C. Fuller from North Georgia College and State University (NGCSU) has collected water quality data for over 20 years on ten tributaries to Lake Lanier. The water quality data included total nitrogen, nitrate+nitrite, ammonia, total Kjeldahl nitrogen (TKN), total phosphorus, orthophosphate, BOD_5, total suspended sediment (TSS), temperature, and dissolved oxygen. The Lake Lanier LSPC model was calibrated and validated to discrete instream water quality data measured. Five of the stations were chosen to be calibration stations. The remaining stations were utilized as validation stations. The list of stations and how they were utilized is given in Table 23 and the station locations are shown in Figures 14, 15 and 16. Calibration and validation plots can be found in Appendices N, R and S of the LSPC Watershed Modeling Report for Lake Lanier.

Table 24 gives the modeled annual total phosphorus load for the major lake tributaries compared to the calculated load based on continuous flow measured at the USGS gages and monthly total phosphorus measured at Chattahoochee River at Belton Bridge Road and the Chestatee River at Georgia Highway 400. In average to above average precipitation years, the calculated annual load is often higher than the modeled load. This may be due to the method of holding Total Phosphorus concentration constant when calculating the annual major tributary load.

Table 23. Monitoring Stations Used to Calibrate LSPC Water Quality

Station Name	Station Number	Calibration / Validation
USGS Stations		
Chattahoochee River at Helen, Georgia	02330450	Calibration
Chattahoochee River near Cornelia, Georgia,	02331600	Calibration
Chestatee River near Dahlonega, Georgia	02335000	Calibration
GA EPD Water Quality Stations		
Chattahoochee River at Bottom Road near Helen	12015101	Validation
Sautee Creek at SR17/255 (Sky Lake Road) near Helen	12016501	Validation
Soquee River at State Road 105 near Demorest	12028001	Validation
Mossy Creek at New Bridge Road near Clermont	12030025	Validation
Mud Creek at Crane Mill Road near Alto	12030031	Validation
Little Mud Creek at Coon Creek Road near Alto	12030041	Validation
Chattahoochee River at Belton Bridge Road near Lula	12030085	Calibration
Flat creek at Glade Farm Road near Lula	12030103	Validation
West Fork Little River at Jess Helton Road near Clermont	12030141	Validation
East Fork Little River at Honeysuckle Road near Clermont	12030151	Validation
Wahoo Creek at Ben Parks Road near Murrayville	12030171	Validation
White Creek at New Bridge Road near Demorest	12030301	Validation
Chestatee River at Roy Grindle Road (CR 49) near Dahlonega	12033901	Validation
Chestatee River at Copper Mines Road near Dahlonega	12034101	Validation
Shoal Creek at Ashbury Mill Road near Cleveland	12034401	Validation
Testnatee Creek at Gene Nix Road near Cleveland	12034691	Validation
Chestatee River at State Road 400 near Dahlonega	12035401	Calibration
Yellow Creek at Yellow Creek Road (CR158) near Murrayville	12036001	Validation
Flat Creek at McEver Road near Gainesville	12038501	Validation
Balus Creek at McEver Road near Oakwood	12038610	Validation
Mud Creek at McEver Road near Flowery Branch	12038781	Validation
Two Mile Creek at Wallace Wood Road near Cumming	12039001	Validation
Big Creek at McEver Road near Buford	12039501	Validation
Sixmile Creek at Burrus Mill Road near Coal Mountain	12039601	Validation
Bald Ridge Creek at Pilgrim Mill Road near Cumming	12039801	Validation
Four Mile Creek at Browns Bridge Road near Cumming	12039811	Validation
Sawnee Creek at Pilgrim Mill Road near Cumming	12039831	Validation
North Georgia College and State University (NGCSU)		
Balus Creek downstream of Old Flowery Branch Road	Balus	Validation
Flat Creek upstream of McEver Road	Flat	Validation
Limestone Creek at Pine Valley Road Bridge	Limestone	Validation
Chattahoochee River at middle of GA 52	Chattahoochee	Validation
Little River at Jim Hood Road culvert	Little River	Validation
Wahoo Creek at Ben Parks Road Bridge	Wahoo	Validation
Squirrel Creek at GA 60 culvert	Squirrel	Validation
Chestatee River South Bound GA 400	Chestatee	Validation
Six Mile Creek at Burrus Mill Road Bridge	Six Mile	Validation
Boling Bridge at center of bridge	Boling Bridge	Validation

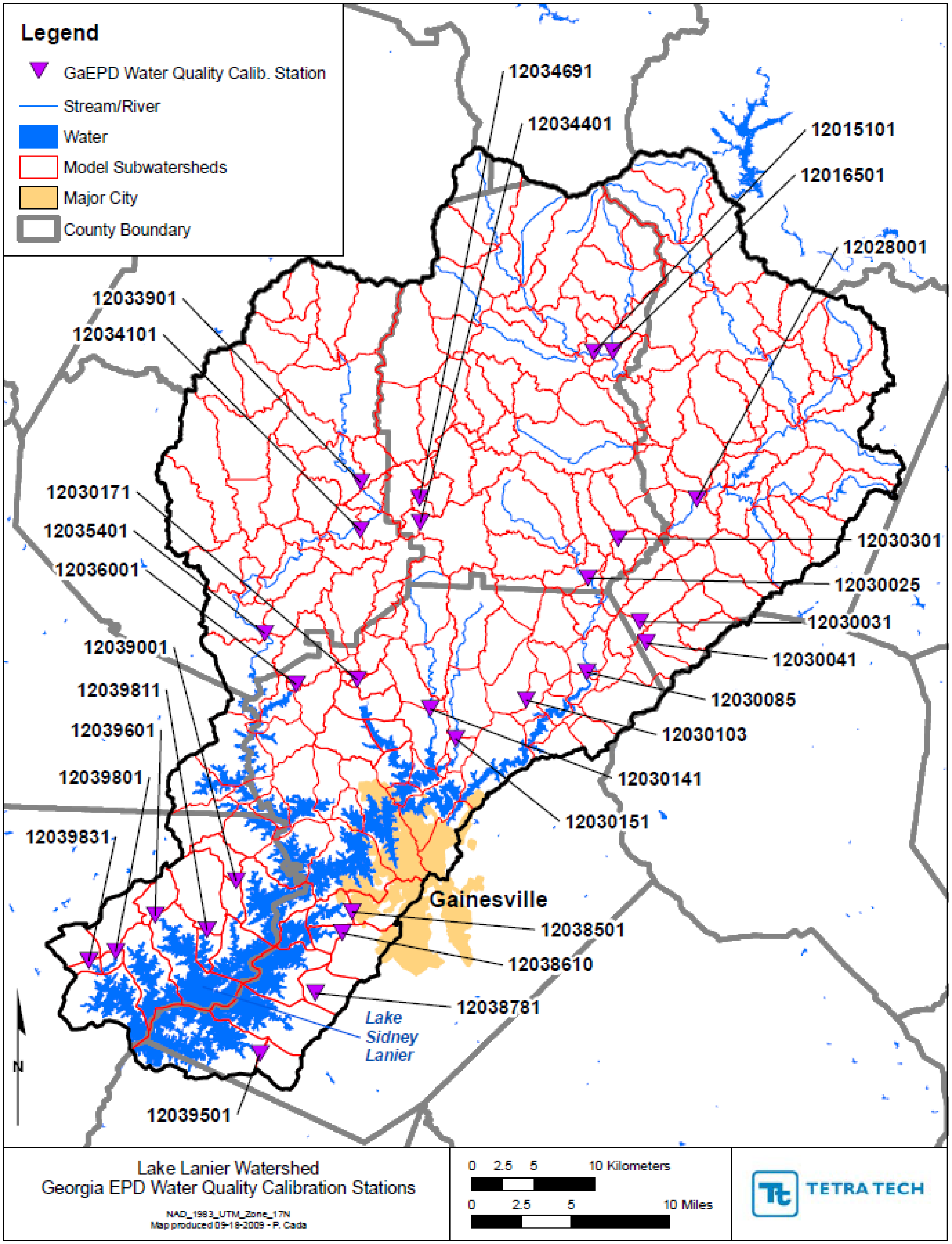


Figure 15. GA EPD Monitoring Stations Used in the Water Quality Calibration of LSPC

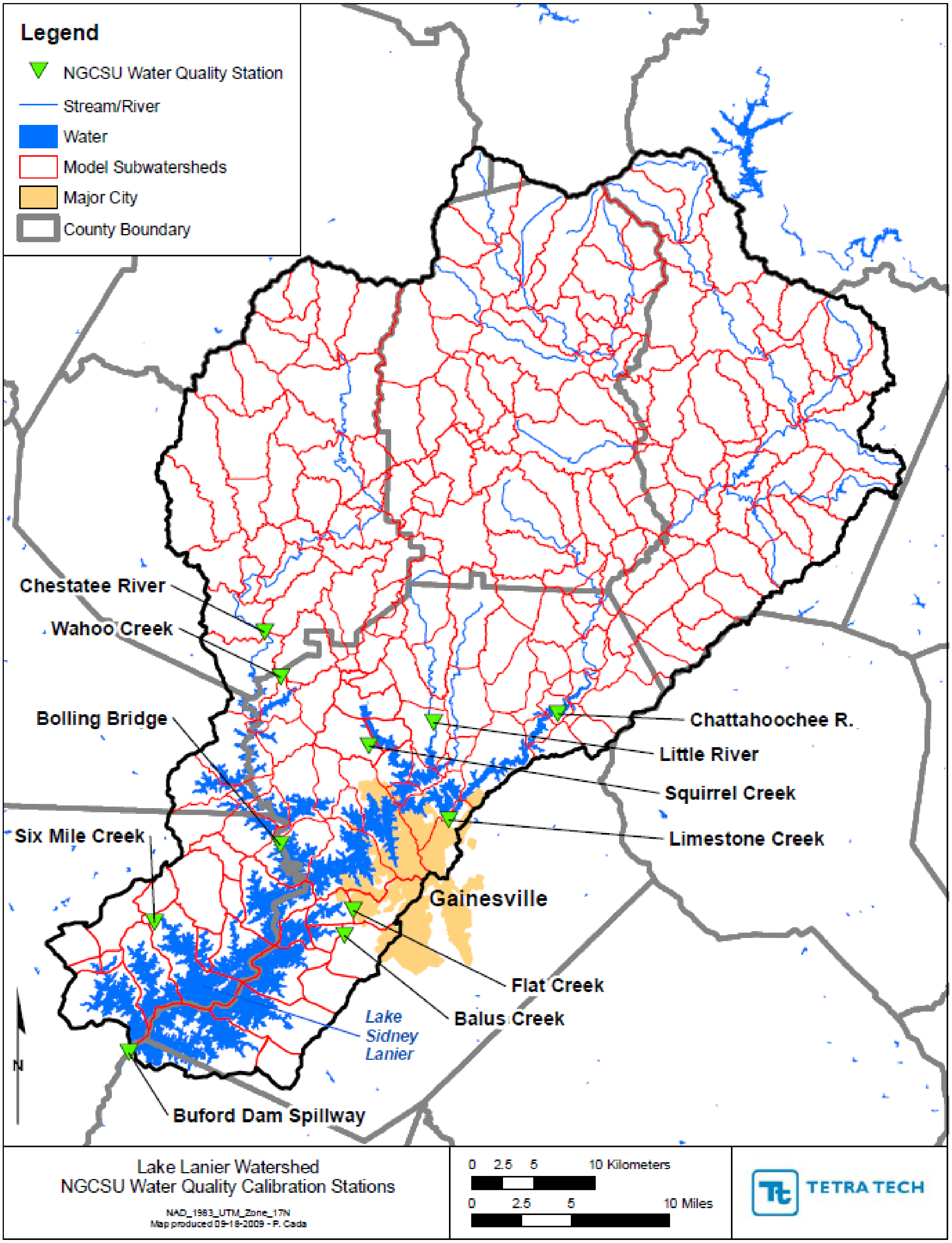


Figure 16. NGCSU Monitoring Stations Used in the Water Quality Calibration of LSPC

Table 24. Modeled and Calculated Annual Average Total Phosphorus Load (lbs/yr) for the Major Tributaries

Station	Standard	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Chattahoochee River at Belton Bridge Rd	Modeled	49,055	66,943	96,676	92,118	89,419	61,821	37,447	49,310	117,152	79,074	60,564	55,829
	Calculated	42,700	59,600	152,300	96,800	171,500	62,200	44,040	68,330	131,215	118,105	68,843	48,351
Chestatee River at Georgia Highway 400	Modeled	23,486	32,040	42,794	32,275	29,828	27,343	13,781	19,305	52,126	30,393	21,854	24,403
	Calculated	10,000	25,400	72,000	51,200	91,400	40,500	17,130	25,120	48,984	55,417	29,382	22,729

4.2 Lake Hydrodynamic Modeling (EFDC)

Bottom elevations and shoreline boundaries define the EFDC model grid. The grid for Lake Lanier covers the entire lake and includes the Chattahoochee River up to USGS station 02331600 (near Cornelia, GA) and the Chestatee River up to USGS station 02333500 (at State Route 52 near Dahlonega, GA)). The bottom elevations for Lake Lanier were obtained from a Kingfisher Map (#301). Once the horizontal grid was developed, bottom elevations were interpolated for each grid cell taking into account the total pool area and volume of the reservoir. Once the bottom elevation was determined for each cell, the stage-area and stage-capacity of Lake Lanier were compared.

A maximum of 10 uniformly distributed (equal height) vertical layers were defined along the deepest region of the main channel of the Lake. The number of layers was selected to have a good resolution of the temperature stratification of the lake along the deepest part of the main channel and to have at least two layers in all embayments. To promote the temperature induced convection, circulation in the embayments the lake had a minimum of 2 layers. The number of layers outside the main channel was defined based on the bathymetry and the water surface elevation at full pool. The height of each layer at full pool was calculated by subtracting the deepest bottom elevation from the water surface elevation and dividing by the maximum number of layers. At each cell, the number of layers was calculated as the total water depth at full pool divided by the layer depth at the deepest region.

The EFDC model requires boundary conditions to simulate circulation and transportation. These conditions include water surface elevations, dam releases, watershed tributary inflows, point source discharges, water withdrawals, and meteorological data. Data for the operation of Buford Dam was obtained from USACE. The USACE provided a 24-hour discharge in cubic feet per second (cfs). Figure 17 shows the daily average and 30-day moving average flow released from Buford Dam for 2001 through 2007.

Tributary Inputs

The results of the LSPC watershed model were used as tributary flow inputs to the Lake hydrodynamic model. Figure 18 shows the model grid for Lake Lanier and the location of the upstream boundaries and watershed inputs.

The watershed flows are an important input for the flow balance of the Lake. Table 25 identifies which EFDC cell each LSPC sub-watershed was input into and the flow type utilized. RO means the in-stream flow value and PERO means the total land outflow from an individual sub-watershed.

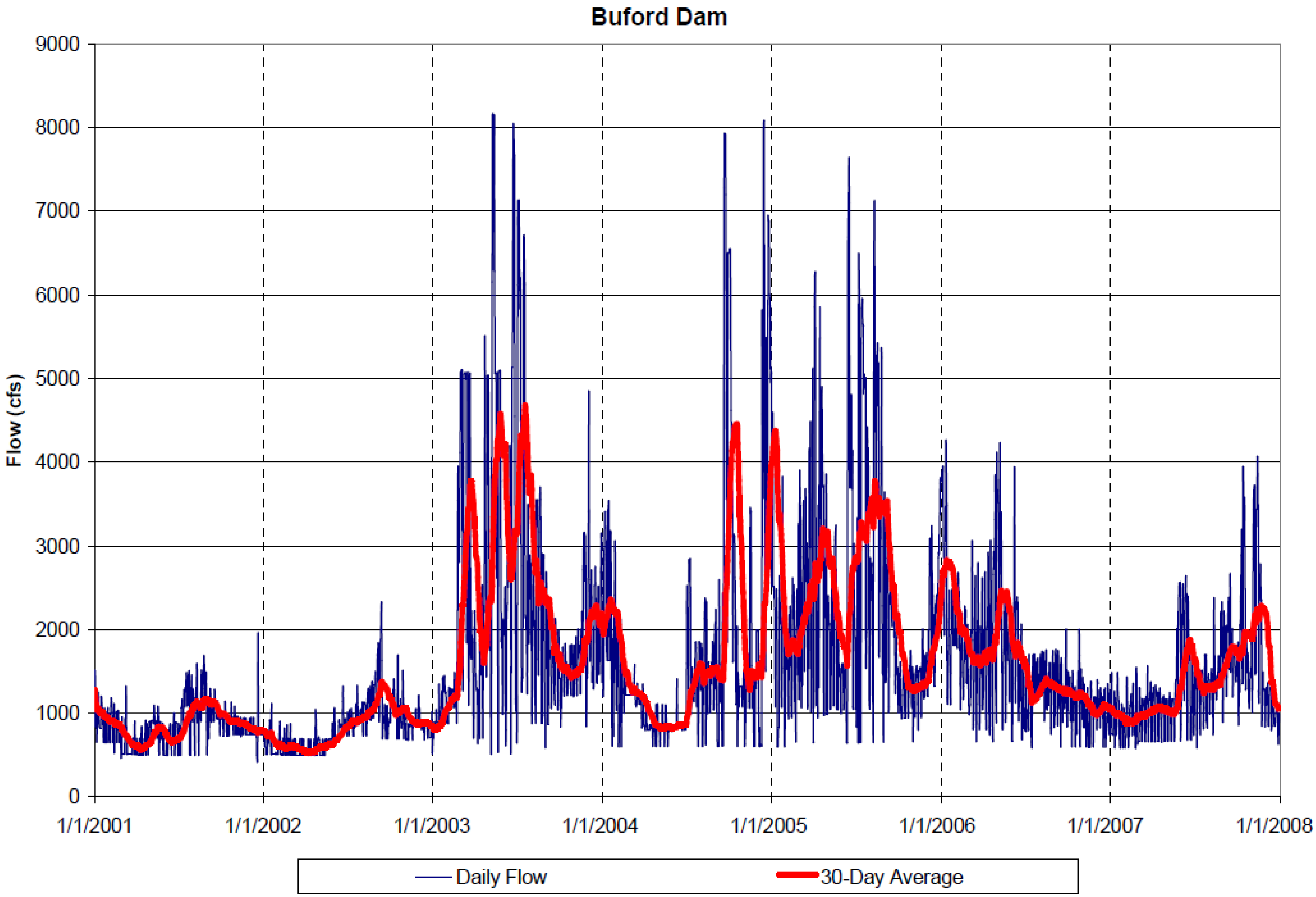


Figure 17. Daily Average and 30-day Moving Average Flow Released from Buford Dam

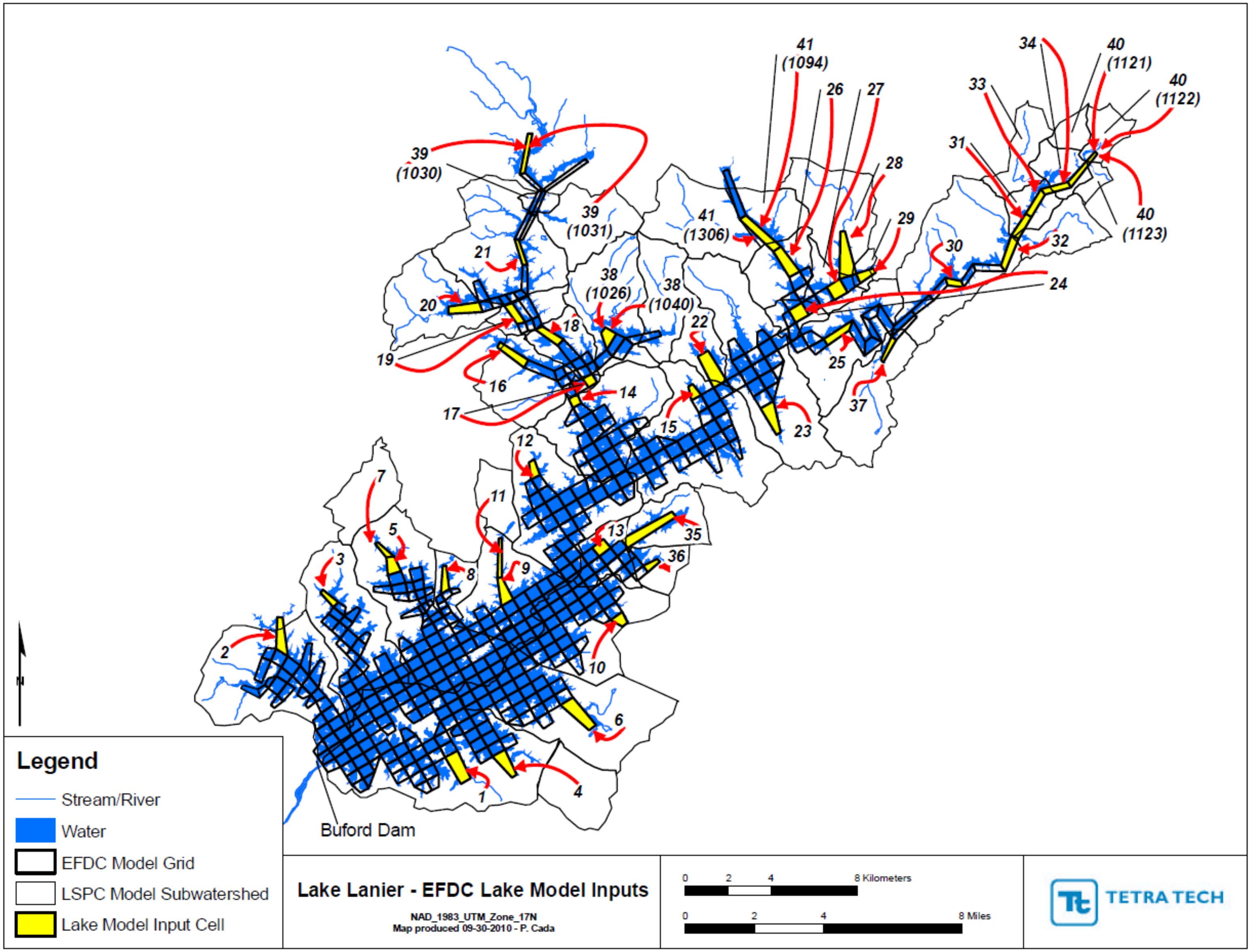


Figure 18. Model Grid for Lake Lanier, Showing the Location of the Upstream Boundary and Tributary Flow Inputs

Table 25. LSPC Watershed Inputs

Figure ID	LSPC Sub-Watershed	EFDC Cell Flow Type		Flow Type
		I-Value	J-Value	
1	1001	40	18	PERO
2	1002	25	13	RO
3	1003	13	19	RO
4	1004	42	21	RO
5	1009	5	23	PERO
6	1010	41	27	RO
7	1011	4	23	RO
8	1012	25	24	RO
9	1014	30	27	PERO
10	1015	37	33	RO
11	1016	29	27	RO
12	1018	23	34	PERO
13	1019	31	35	PERO
14	1020	20	39	PERO
15	1021	24	46	PERO
16	1022	17	37	RO
17	1023	19	41	PERO
18	1025	15	41	PERO
19	1027	13	39	PERO
20	1028	12	36	RO
21	1029	12	43	PERO
22	1088	24	48	RO
23	1089	28	50	PERO
24	1090	23	55	PERO
25	1091	26	56	PERO
26	1092	20	56	PERO
27	1093	23	58	PERO
28	1105	22	59	RO
29	1106	23	60	RO
30	1113	26	65	PERO
31	1114	26	69	PERO
32	1115	26	68	RO
33	1116	26	70	RO
34	1117	26	71	PERO
35	1220	32	37	RO
36	1221	35	37	RO
37	1225	30	64	RO
38	1301	17	44	RO
39	1302	12	47	RO
40	1305	26	72	RO
41	1307	19	56	RO

Point Sources Discharges

There are eight point sources that were included in the EFDC calibration model (Table 26). Daily data were input for the Gainesville – Linwood WPCP (GA0020168) and Flowery Branch WPCP (GA0031933) from January 2001 through December 20007 and monthly data from January 2008 through December 2012. Monthly data were input for Lake Lanier Islands (GA0049115) and Cinnamon Cove (GA0049051) from January 2001 through December 2012. Chattahoochee Country Club (GA0022471) had three measurements in both 2006 and 2007, five measurements in 2010, and one measurement in both 2011 and 2012. These were input into the model for these years and the average for these years was used for January 2001 through December 2012. The remaining point source inputs were input at their design flow and permit limits for the entire simulation.

The Gwinnett County F. Wayne Hill facility (GA0038130) was not included in the calibration of the EFDC model until May 2010 and the data used were monthly. This facility was included in the critical conditions model run needed for the TMDL determination.

Table 26. Point Sources Included in the Lake Lanier Model

Permit Number	Facility Name	Permitted Flow (MGD)	EFDC Cell
GA0049115	Lake Lanier Islands	0.44	(34,14)
GA0049051	Cinnamon Cove Condos	0.021	(41,22)
GA0030261	Habersham on Lanier	0.14	(25,7)
GA0031674	Cumming – Lanier Beach South	0.048	(27,7)
GA0024198	Chattahoochee Bay	0.0018	(39,27)
GA0020168	Gainesville – Linwood	3.375	(26,51)
GA0022471	Chattahoochee Country Club	0.0009	(24,51)
GA0031933	Flowery Branch	0.51	(41,27)
GA0038130	Gwinnett County – F. Wayne Hill Water Resources Facility	40	(41,15)

Water Withdrawals

There are eight water withdrawals located in Lake Lanier. Table 27 provides a summary of these facilities' water withdrawal permits.

Table 27. Water Withdrawals Included in the Lake Lanier Model

Withdrawal	Number Permitted	Permitted Withdrawal 24-Hour Limit (MGD)	Permitted Withdrawal Monthly Average (MGD)	EFDC Cell
City of Buford	069-1290-04	2.50	2.00	(41,20)
City of Cumming	058-1290-07	21.00	18.00	(24,12)
Forsyth County Board of Commissioners	058-1207-06	16.00	14.00	(14,19)
City of Gainesville	069-1290-05	35.00	30.00	(26,55)
Gwinnett County Water and Sewer	069-1290-06	N/A	150.00	(39,15)

Withdrawal	Number Permitted	Permitted Withdrawal 24-Hour Limit (MGD)	Permitted Withdrawal Monthly Average (MGD)	EFDC Cell
McRae and Stoltz	042-1202-01	0.78	0.50	(12,46)
Renaissance Resort	069-1205-02	0.60	0.60	(33,16)
KSL Lake Lanier	069-1205-01	0.60	0.60	(35,18)

Tables 28 give the average monthly water withdrawals used for the permitted model runs for these facilities. To determine these values, the historic monthly withdrawals from the calibration period were increased by the associated increase from the average discharge and permitted discharge.

Table 28. Summary of the Monthly Water Withdrawals

Facility	Monthly Avg (MGD)												Annual Avg
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
City of Buford	1.35	1.29	1.35	1.37	1.49	1.48	1.46	1.55	1.46	1.4	1.31	1.3	1.4
City of Cumming	9.06	9.65	10.21	11.26	13.06	13.46	13.49	14.27	13.43	15.91	12.69	11.42	12.33
Forsyth County Board of Commissioners	4.77	4.15	4.13	5.43	7.72	7.54	6.96	7.57	7.31	5.43	4.62	4.31	5.83
City of Gainesville	16.45	16.06	16.32	17.33	18.87	19.67	19.53	20.19	19.18	17.92	16.66	16.00	17.85
Gwinnett County Water and Sewer	72.98	72.81	75.38	82.84	93.1	95.86	95.7	96.81	94.6	86.56	79.01	73.01	85.32
McRae and Stoltz	0.00	0.00	0.00	0.00	0.03	0.06	0.08	0.07	0.04	0.02	0.01	0.00	0.03
Renaissance Resort	0.01	0.01	0.07	0.12	0.18	0.22	0.17	0.19	0.16	0.06	0.02	0.01	0.1
KSL Lake Lanier	0.00	0.00	0.02	0.05	0.09	0.08	0.06	0.07	0.06	0.05	0.03	0.00	0.04

Meteorological Data

The meteorological inputs included precipitation, evaporation, relative humidity, air pressure, air temperature, solar radiation, cloud cover, wind speed, and wind direction. Evaporation was calculated by EFDC, and solar radiation was calculated from cloud cover. The other meteorological inputs were obtained the National Climatic Data Center (NCDC) station Lee Gilmer Memorial Airport in Gainesville, Georgia (WBAN 53838) due to its close proximity to Lake Lanier.

4.3 Water Quality Lake Modeling (EFDC)

The water quality model developed for Lake Lanier simulated different loading conditions. EFDC was also used for the water quality model. The EFDC model for Lake Lanier was setup using the following variables:

- Organic nitrogen
- Ammonia
- Nitrate-Nitrite
- Organic phosphorus
- Orthophosphate
- Algae (2 species)
- Dissolved oxygen
- Organic carbon
- Silica

The output from the LSPC watershed model was used to represent the runoff to the Lake. The LSPC model was calibrated for temperature, dissolved oxygen, nitrate-nitrate, ammonia, organic nitrogen, ortho-phosphorus, organic phosphorus, total suspended solids, and chlorophyll *a*. LSPC Output parameters do not directly link up with the EFDC input parameters. Therefore, the LSPC outputs were "linked" to EFDC inputs through various equations. Table 29 presents what LSPC parameter is used for each EFDC parameter. Note that the LSPC outputs are in English units, whereas the EFDC inputs are in metric units. Therefore, the factor of 0.4536 was used to convert all the equation from lbs/day to kg/day.

Table 29. Parameter Linkage for LSPC to EFDC

Parameter	LSPC Parameters	EFDC Parameter
Flow	RO or PERO	Flow
Temperature	TEMP	TEMP
Dissolved Oxygen	DOx	DO
Biochemical Oxygen Demand (5-day)	BOD5	DOC, DON, LPON, DOP, LPOP
Nitrate + Nitrite	NO3 + NO2	NOx
Ammonia	TAM	NH4
Organic Nitrogen	ORN	DON, RPON. LPON
Orthophosphate	PO4	PO4
Organic Phosphorus	ORP	DOP, RPOP, LPOP
Phytoplankton	PHYTO	Total Algae = greens (Bg) + diatoms (Bd) + Cyano (Bc)

$$DON = \Big[(ORN * \%\ Dissolved) + \big[\ fDOx * \big[(BOD_5 * fRatio)/S_{BODu\ to\ OrgN} \big]\big]\Big] * flow * C$$

$$RPON = [ORN * \%Particulate] * flow * C$$

$$LPON = [\ fLPOx * [\ (BOD_5 * fRatio)/S_{BODu\ to\ OrgN}]] * flow * C$$

$$NH4 = TAM * flow * C$$

$$NOx = [NO3 + NO2] * flow * CBOD$$

Where:

DON = Dissolved Organic Nitrogen (kg/day)
RPON = Refractory Particulate Organic Nitrogen (kg/day)
LPON = Labile Particulate Organic Nitrogen (kg/day)
NH4 = Ammonium (kg/day)
NOx = Nitrate + Nitrite (kg/day)
ORN = Dead Refractory Organic Nitrogen Concentration from LSPC (mg/L)
BOD5 = Biochemical Oxygen Demand (5-day) Concentration from LSPC (mg/L)
TAM = Total Dissolved Ammonia Concentration from LSPC (mg/l)
NO3 = Nitrate Concentration from LSPC (mg/L)
NO2 = Nitrite Concentration from LSPC (mg/L)
% Dissolved = Percent of ORN that is Dissolved = 0.80
% Particulate = Percent of ORN that is Particulate = 0.20
fDOx = Fraction of Labile Organics in BODu that is Dissolved = 0.50
fLPOx = Fraction of Labile Organics in BODu that is Particulate = 0.50
fRatio = Factor to convert BOD5 to BODu = 3.0
S(BODu to OrgN) = Stoichiometric Value to convert BODu into Labile Organic Nitrogen = 22.90
flow = Flow from LSPC (cfs)
*C = Conversion factor from lbs/day to kg/day * 5.39 = 2.44*

$$DOP = \left[(ORP * \%\ Dissolved) + \left[fDOx * \left[(BOD_5 * fRatio)/S_{BODu\ to\ OrgP} \right]\right]\right] * flow * C$$

$$RPOP = \left[ORP * \%Particulate \right] * flow * C$$

$$LPOP = \left[fLPOx * \left[(BOD_5 * fRatio)/S_{BODu\ to\ OrgP} \right]\right] * flow * C$$

$$PO4_{EFDC} = PO4_{LSPC} * flow * C$$

Where:

DOP = Dissolved Organic Phosphorus (kg/day)
RPOP = Refractory Particulate Organic Phosphorus (kg/day)
LPOP = Labile Particulate Organic Phosphorus (kg/day)
$PO4_{EFDC}$ *= Orthophosphorus (kg/day)*
ORP = Dead Refractory Organic Phosphorus Concentration from LSPC (mg/L)
BOD_5 *= Biochemical Oxygen Demand (5-day) Concentration from LSPC (mg/L)*
$PO4_{LSPC}$ *= Orthophosphorus Concentration from LSPC (mg/L)*
% Dissolved = Percent of ORP that is Dissolved = 0.50
% Particulate = Percent of ORP that is Particulate = 0.50
fDOx = Fraction of Labile Organics in BODu that is Dissolved = 0.50
fLPOx = Fraction of Labile Organics in BODu that is Particulate = 0.50
fRatio = Factor to convert BOD5 to BODu = 3.0
$S_{(BODu\ to\ OrgP)}$ *= Stoichiometric Value to convert BODu into Labile Organic Phosphorus = 165.80*
flow = Flow from LSPC (cfs)
*C = Conversion factor from lbs/day to kg/day * 5.39 = 2.44*

$$Flow = RO\ (Instream\ Flow)\ or\ PERO\ (Overland\ Flow)$$

$$TEMP_{EFDC} = TEMP_{LSPC}$$

$$DO = DOx * flow * C$$

$$DOC = \left((BOD_5 * fRatio)/F_{(BODu\ to\ Carbon)} \right) * flow * C$$

Algae Biomass Equations

$$Bg = \left[\left(PHYTO*cphyto*\left(Green\ Algal\ Fraction\right)\right)\right]*flow*C$$

$$Bd = \left[\left(PHYTO*cphyto*\left(Diatom\ Algal\ Fraction\right)\right)\right]*flow*C$$

$$Bc = \left[\left(PHYTO*cphyto*\left(Cynobacteria\ Algal\ Fraction\right)\right)\right]*flow*C$$

Where:

Flow = Flow into EFDC (cms)
$TEMP_{EFDC}$ *= Temperature (OC)*
DO = Dissolved Oxygen (kg/day)
DOC = Dissolved Organic Carbon (kg/day)
Bg = Green Algae (kg/day)
Bd = Diatom Algae (kg/day)
Bc = Cynobacteria Algae (kg/day)
RO = Instream Flow from LSPC (cfs)
PERO = Overland Flow from LSPC (in-acre/day)
$TEMP_{LSPC}$ *= Temperature from LSPC (OC)*
DOx = Dissolved Oxygen Concentration from LSPC (mg/l)
$_{BOD5}$ *= Biochemical Oxygen Demand (5-day) Concentration from LSPC (mg/l)*
fRatio = Factor to convert BOD5 to BODu = 3.0
$F_{(BODu\ to\ Carbon)}$ *= Stoichiometric Value to convert BODu into Carbon = 2.67*
PHYTO = Phytoplankton Concentration from LSPC (mg/l)
cphyto = Coefficient of Conversion from PHYTO Biomass to Carbon = 0.49
Green Algal Fraction = Fraction of PHYTO that is Green Algal = 0.90
Diatom Algal Fraction = Fraction of PHYTO that is Diatom Algal = 0.10
Cynobacteria Algal Fraction = Fraction of PHYTO that is Cynobacteria Algal = 0.00
flow = Flow from LSPC (cfs)
*C = Conversion factor from lbs/day to kg/day * 5.39 = 2.44*

The EFDC framework allows the user to parameterize by water quality zones. Examples of information that may be used to specify water quality zone include reaeration, sediment oxygen demand, benthic nutrient flux, and more. In 2007 the US EPA Region 4 conducted a study on Lake Lanier and compiled the results into a report entitled *Lake Lanier Production, Respiration, Sediment Oxygen Demand and Sediment Nutrient Fluxes* (US EPA, 2008). In this study, US EPA Region 4 collected sediment oxygen demand (SOD) and nutrient flux data at seven locations in Lake Lanier. Using this information, Lake Lanier was divided into seven zones (Figure 19). These seven zones allowed the kinetics, SOD, and nutrient fluxes to be specified per zone in the EFDC water quality model.

Point Sources Discharge Data

Daily BOD_5, NH_3 , Total P, and DO concentrations were obtained from 2001 - 2012 OMRs for NPDES-permitted facilities that discharge 1.0 MGD or greater. These data were input into the calibration model. Table 30 is a summary of the actual discharges from these facilities for calendar years 2001 through 2012. The Gwinnett County F. Wayne Hill plant was not included in the calibration model until May 2010 since that is when the facility began discharging into Lake Lanier. However, the facility was included in all TMDL modeling scenarios.

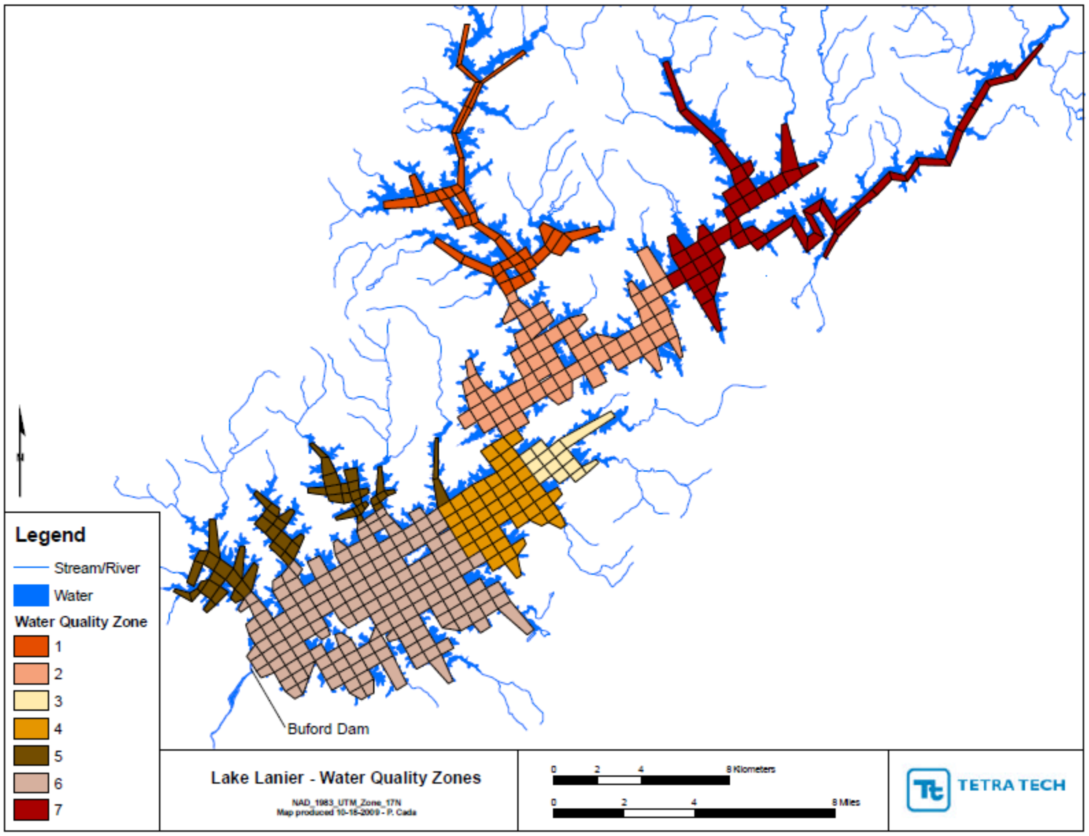


Figure 19. Water Quality Zones in the Lake Lanier EFDC Water Quality Model

Table 30. Summary of the Major Lake NPDES Dischargers

Facility Name	NPDES Permit No.	Average Discharge Data			
		BOD_5 (mg/L)	Total P (mg/L)	NH_3 (mg/L)	DO (mg/L)
Lake Lanier Islands	GA0049115	5.4	2.87	--	--
Cinnamon Cove Condos	GA0049051	3.14	4.18		
Habersham on Lanier	GA0030261	13.8	3.98	--	--
Cumming – Lanier Beach South	GA0031674	2.6	0.6	--	--
Gainesville – Linwood[1]	GA0020168	15.0	4.45	10.42	6.55
Chattahoochee Country Club	GA0022471	9.13	2.3		
Flowery Branch	GA0031933	1.2	0.24	0.47	7.41
Gwinnett County - F Wayne Hill Water Resources Facility	GA0038130	--	--	--	--

[1]Gainesville Linwood's facility has been upgraded and their current permitted limits are given in Table 3

Sediment Oxygen Demand

US EPA Region 4 collected sediment oxygen demand (SOD) data in 2007 (US EPA, 2008). The measured SOD measured at 6 locations ranged from -1.1 to -1.86 g O_2/m^2/day. During model calibration, the SOD values were adjusted by water quality zone until the dissolved oxygen profiles and time series plots for simulated and measured data compared well. The final calibrated SOD values are provided in Table 31.

Table 31. Calibrated Sediment Oxygen Demand Values

Water Quality Zone	Description of Water Quality Zone	Calibrated Sediment Oxygen Demand ($gO_2/m^2/day$)
1	Chestatee River	-3.86
2	Upper Lake	-2.36
3	Mid Lake Embayments	-4.36
4	Mid Lake	-2.54
5	Lower Lake Embayments	-3.86
6	Lower Lake	-1.30
7	Chattahoochee River	-2.36

Nutrient Fluxes

In 2001, US EPA Region collected nutrient flux data on Lake Lanier (USEPA, 2008). These data showed a positive flux of ammonia and phosphorus and a negative flux of nitrate/nitrite, indicating the sediment is releasing phosphorus and ammonia into the water column and the sediment is taking nitrate/nitrite out of the water column. During the calibration, it was observed that the nutrient fluxes, although possibly representative of 2007 conditions, might not be for years 2001 through 2012. When the 2007 ammonia and total phosphorus nutrient rates were applied to 2001 through 2012 conditions, there was too much loading occurring, and when the nitrate+nitrite flux was applied, the sediments were taking too much from the water column. Therefore, the nutrient flux rates were adjusted by water quality zone and by year to better represent the impact of fluxes on the water column. In addition it was observed that the phosphorus fluxes were more critical than the nitrogen fluxes for the calibration, and in fact, fluxes were only applied to phosphorus. It was also observed that the phosphorus fluxes had much more of an impact in the upper portions of the lake, particularly on the Chestatee and Chattahoochee River arms, than in the main body of the lake. Table 32 presents the phosphorus flux by water quality zone and by year for the calibration. Notice the final calibrated phosphorus fluxes are 1-2 orders of magnitude smaller than the measured data.

Table 32. Calibrated Nutrient Flux Values ($g/m^2/day$)

Water Quality Zone	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	-0.0010	-0.0010	-0.0010	-0.0010	-0.0010	-0.0010	-0.0009	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005
2	-0.0010	-0.0010	-0.0020	-0.0025	-0.0020	-0.0010	-0.0009	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005
7	-0.0010	-0.0010	-0.0020	-0.0025	-0.0020	-0.0010	-0.0009	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005

Modeling Parameters

Table 33 provides the reaction rates and parameters used in the EFDC water quality model for the modeled algae species.

Table 33. EFDC Modeling Parameters

Constants and Parameters - Algae	EFDC Card	Cyano	Diatoms	Greens
Nitrogen Half-Saturation (mg/L)	08	NA	0.025	0.025
Phosphorus Half-Saturation (mg/L)	08	NA	0.0015	0.0015
Silica Half-Saturation (mg/L)	08	NA	0.200	N/A
Carbon to Chlorophyll *a* Ratio (mg C/ug Chl *a*)**	09	NA	0.023-0.059	0.023-0.063
Optimal Depth for Growth (m)	09	NA	1.5	2.0
Lower Optimal Temperature for Growth (^oC)	11	NA	10.0	20.5
Upper Optimal Temperature for Growth (^oC)	11	NA	14.5	23
Suboptimal Temperature Coeff for Growth	12	NA	0.01	0.01
Superoptimal Temperature Coeff for Growth	12	NA	0.01	0.01
Reference Temperature for Metabolism (^oC)	13	NA	20	20
Temperature Coeff for Metabolism	13	NA	0.069	0.069
Carbon Dist Coeff for Metabolism	147	NA	0.000	0.000
Half Saturation Constant for DOC Excretion (gO_2/m^3)	14	NA	0.500	0.500
Phosphorus Dist Coeff of RPOP for Metabolism	18	NA	0.000	0.000
Phosphorus Dist Coeff of LPOP for Metabolism	18	NA	0.000	0.000
Phosphorus Dist Coeff of DOP for Metabolism	20	NA	1.000	1.000
Phosphorus Dist Coeff of PO4 for Metabolism	20	NA	0.000	0.000
Nitrogen Dist Coeff of RPON for Metabolism	22	NA	0.000	0.000
Nitrogen Dist Coeff of LPON for Metabolism	22	NA	0.000	0.000
Nitrogen Dist Coeff of DON for Metabolism	24	NA	1.000	1.000
Nitrogen Dist Coeff of DIN for Metabolism	24	NA	0.000	0.000
Nitrogen to Carbon Ratio (mg N/mg C)	24	NA	0.200	0.200
Maximum Growth Rate (1/day) *	45	NA	1.5-3.0	1.5-3.0
Basal Metabolism Rate (1/day)*	45	NA	0.010	0.010
Predation Rate (1/day)*	45	NA	0.130	0.080
Settling Velocity (m/day)	46	NA	0.100	0.050
Settling Velocity for Refractory POM (m/day)	46	0.150		
*- These variables are by Water Quality Zone and are found in the ALGAEGRO.inp file				
** -The C:Chla ratio varied each year				
Constants and Parameters – Light Extinction	**EFDC Card**	**Value**		
Light Extinction for TSS (1/m per g/m^3)	09	0.000		
Light Extinction for Total Suspended Chlorophyll *a* $KeCHL = (0.054 * CHL^{0.6667}) + (0.0088 * CHL)$ Where CHL = Total Chlorophyll *a* Concentration (ug/L)	09	Calculated		
Background Light Extinction Coeff. (1/m)*	45	0.500		
Constants and Parameters – Carbon	**EFDC Card**	**Value**		
Carbon Dist Coeff for Algae Predation - RPOC	14	0.900		
Carbon Dist Coeff for Algae Predation - LPOC	14	0.000		
Carbon Dist Coeff for Algae Predation - DOC	14	0.100		
Minimum Dissolution Rate of RPOC (1/day)	16	0.005		
Minimum Dissolution Rate of LPOC (1/day)	16	0.075		
Minimum Dissolution Rate of DOC (1/day)***	16	0.050		
Constant Relating RPOC Dissolution Rate to Total Chl a	16	0.000		
Constant Relating LPOC Dissolution Rate to Total Chl a	16	0.000		
Constant Relating DOC Dissolution Rate to Total Chl a	16	0.000		
Reference Temperature for Hydrolysis (^OC)	17	20		
Reference Temperature for Mineralization (^OC)	17	20		
Temperature Effect Constant for Hydrolysis	17	0.069		
Temperature Effect Constant for Mineralization	17	0.069		

Constants and Parameters – Carbon	**EFDC Card**	**Value**
Oxic Respiration Half-Saturation Constant for DO (gO_2/m^3)	17	0.500
Half-Saturation Constant for Denitrification (gN/m^3)	17	0.100
Ratio of Denitrification Rate to Oxic DOC Respiration Rate	17	0.500
Constants and Parameters – Phosphorus	**EFDC Card**	**Value**
Phosphorus Dist Coeff for Algae Predation - RPOP	18	0.300
Phosphorus Dist Coeff for Algae Predation - LPOP	18	0.000
Phosphorus Dist Coeff for Algae Predation - DOP	18	0.200
Phosphorus Dist Coeff for Algae Predation – Inorganic DOP	18	0.500
Minimum Hydrolysis Rate of RPOP (1/day)	21	0.005
Minimum Hydrolysis Rate of LPOP (1/day)	21	0.075
Minimum Hydrolysis Rate of DOP (1/day)	21	0.100
Constant Relating Hydrolysis Rate of RPOP to Algae	21	0.000
Constant Relating Hydrolysis Rate of LPOP to Algae	21	0.000
Constant Relating Hydrolysis Rate of DOP to Algae	21	0.200
Constant 1 in determine Phosphorus to Carbon Ratio	21	20
Constant 2 in determine Phosphorus to Carbon Ratio	21	20
Constant 2 in determine Phosphorus to Carbon Ratio	21	350
Constants and Parameters – Nitrogen	**EFDC Card**	**Value**
Nitrogen Dist Coeff for Algae Predation – RPON	22	0.900
Nitrogen Dist Coeff for Algae Predation – LPON	22	0.000
Nitrogen Dist Coeff for Algae Predation – DON	22	0.100
Nitrogen s Dist Coeff for Algae Predation – Inorganic DON	22	0.000
Maximum Nitrification Rate (gN/m^3/day)	25	0.007
Nitrification Half-Saturation Constant for DO	25	1.000
Nitrification Half-Saturation Constant for NH4	25	0.100
Reference Temperature for Nitrification (^oC)	25	27
Suboptimal Temperature Effect Constant for Nitrification	25	0.0045
Superoptimal Temperature Effect Constant for Nitrification	25	0.0045
Minimum Hydrolysis Rate of RPON (1/day)	26	0.005
Minimum Hydrolysis Rate of LPON (1/day)	26	0.075
Minimum Hydrolysis Rate of DON (1/day)	26	0.100
Constant Relating Hydrolysis Rate of RPON to Algae	26	0.000
Constants and Parameters – Nitrogen	**EFDC Card**	**Value**
Constant Relating Hydrolysis Rate of LPON to Algae	26	0.000
Constant Relating Hydrolysis Rate of DON to Algae	26	0.000
Constants and Parameters – Silica	**EFDC Card**	**Value**
Silica Dist. Coeff. for Diatom Predation	27	1.000
Silica Dist. Coeff. for Diatom Metabolism	27	1.000
Silica to Carbon Ratio for Algae Diatoms	27	0.900
Partition Coeff. for Sorbed Dissolved SA	27	0.160
Dissolution Rate of Particulate Silica (PSi) (1/day)	27	0.050
Reference Temperature for PSi Dissolution (OC)	27	20.0
Temperature Effect on PSi Dissolution	27	0.092
Constants and Parameters – Dissolved Oxygen	**EFDC Card**	**Value**
Stoichiometric Algae Oxygen to Carbon (gO_2/gC)	28	2.670
Stoichiometric Algae Oxygen to Nitrogen (gO_2/gN)	28	4.330
Reaeration Constant ***	28	3.933
Temperature Rate Constant for Reaeration***	28	1.024
Reaeration Adjustment Factor***	46	1.000
*- These variables are by Water Quality Zone and are found in the ALGAEGRO.inp file		
*** - These variables are by Water Quality Zone and are found in the KINETICS.inp file		

4.4 Model Calibration and Verification

The simulation period for the hydrodynamic model EFDC was from January 1, 2001 through December 31, 2012. The model simulated water surface elevation, flows, and temperature. To help minimize the difference between simulated and measured water surface elevation, the corrective flow feature of EFDC was applied. This feature allows EFDC to calculate, at a given time scale, the amount of flow required to force a match between the calculated and observed water surface elevations. The "corrective flow," represents the error in volume associated with the model. This flow can be due to a combination of inaccurate readings of flow inputs or outputs, inaccurate estimates of watershed flow, spatial discrepancies in meteorological data, or unaccounted flow terms. Figure 20 shows the water surface elevation calibration at the Lanier Dam forebay for the period 2001 through 2007.

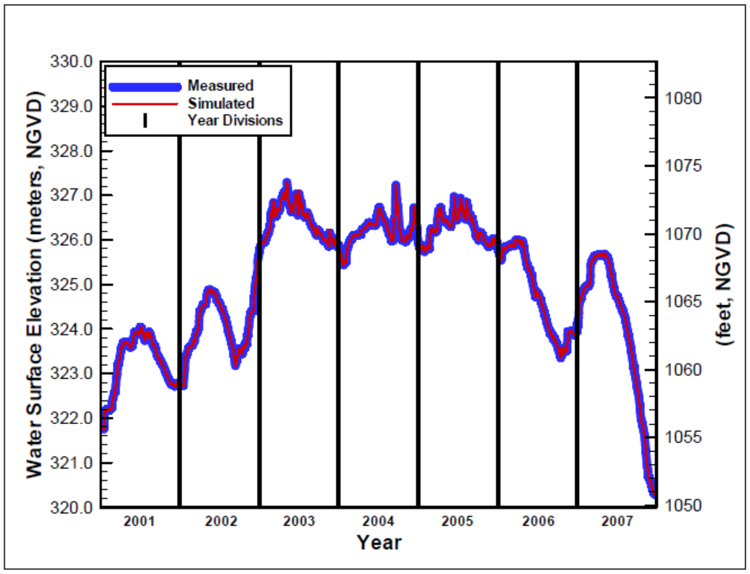


Figure 20. Water Surface Elevation Calibration at the Buford Dam Forebay for the Period 2001-2007

Temperature is simulated in EFDC using solar radiation, atmospheric temperature, heat transfer at the water surface, and the temperature of the hydraulic inputs. The Lake Lanier EFDC model was calibrated to water temperature profile data for 2001 through 2012 measured by GA EPD at five stations throughout the lake. The model captures the stratification very well at all the stations along the main channel of the lake, as well as in the embayment stations. The model tends to slightly over predict the bottom temperature, particularly along the deeper main stem stations. The degree of stratification between bottom and surface is also captured. Figure 21 shows the temperature calibration at the Lanier Dam forebay, during 2006.

The model calibration period was determined from an examination of the GA EPD 2001-2012 water quality data for the lake. The data examined included chlorophyll *a*, nitrogen components, phosphorus components, dissolved oxygen profiles, and water temperature profiles. The calibration models were run using input data for this period, including boundary conditions and meteorological data.

Measured chlorophyll *a*, ortho-phosphate, total phosphorus, total nitrogen, ammonia, and nitrate/nitrate data for the 2001 through 2012 growing seasons were used as instream targets to calibrate the model. Figure 22 shows the chlorophyll *a* calibration curves for the five compliance points for 2001-2012.

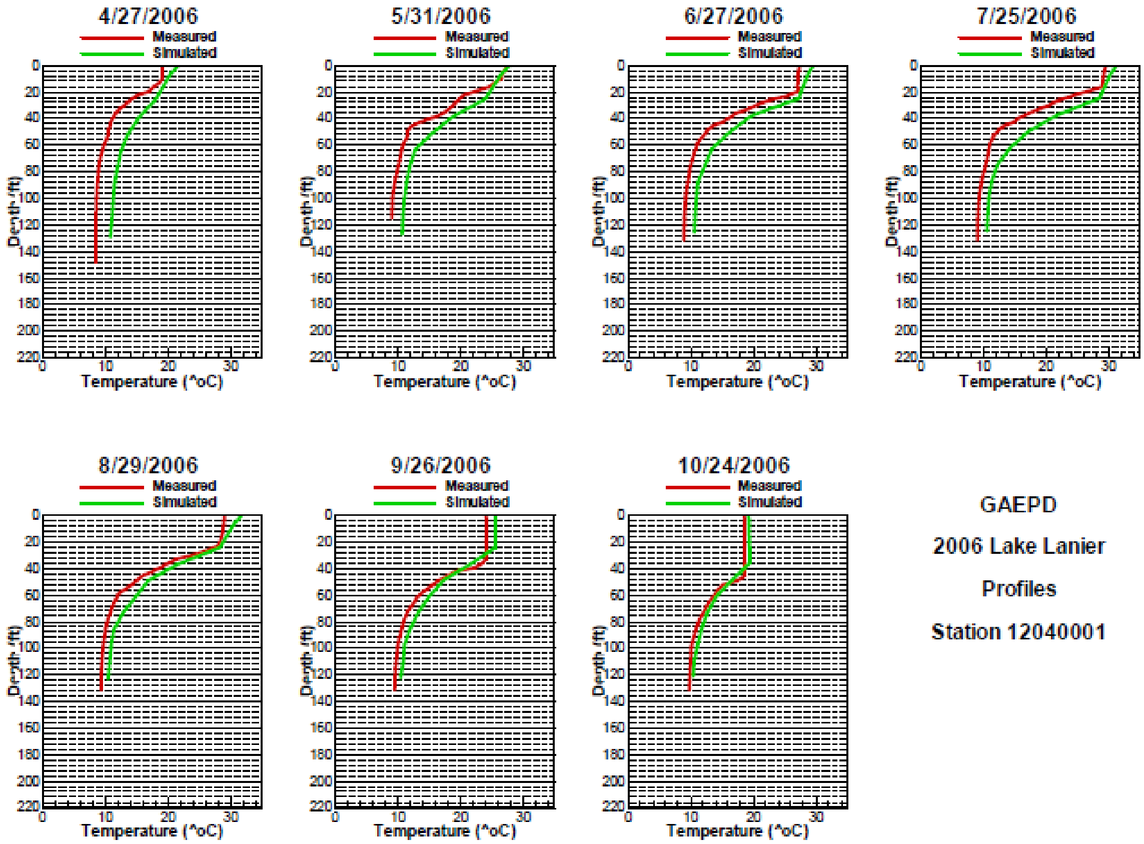
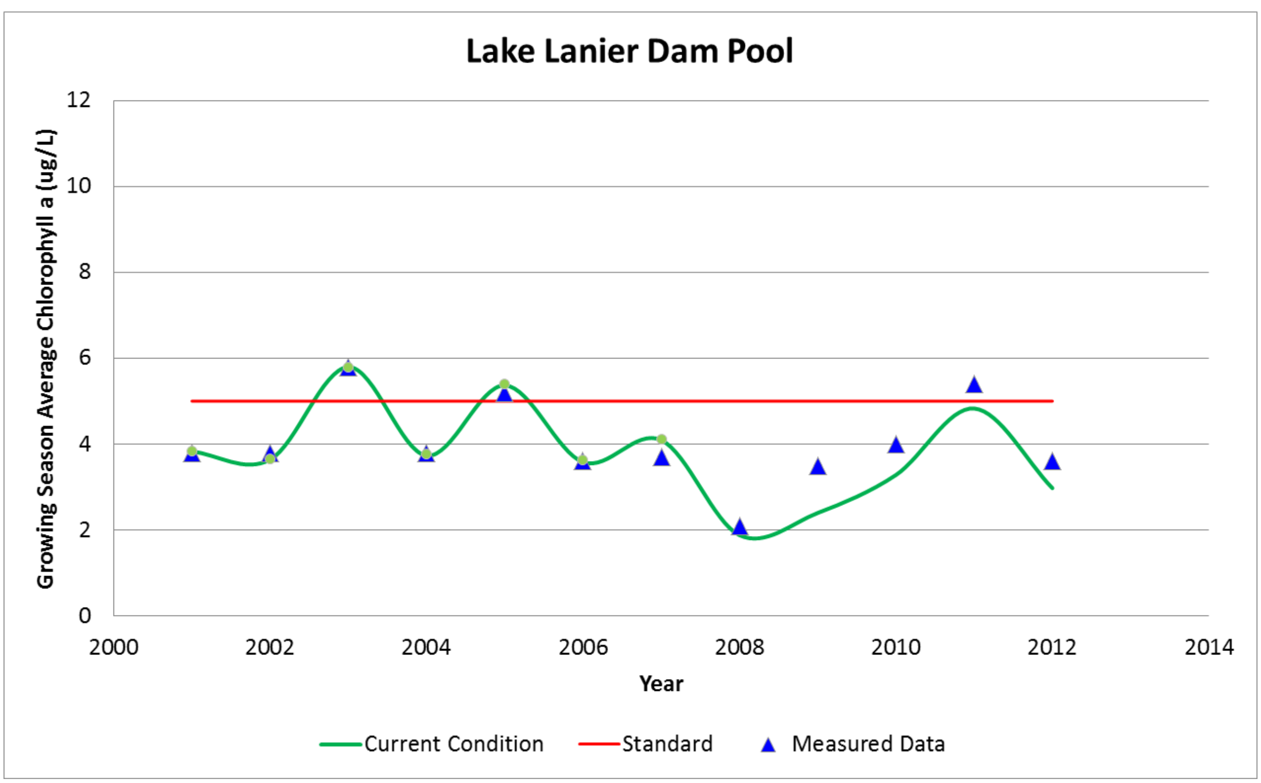
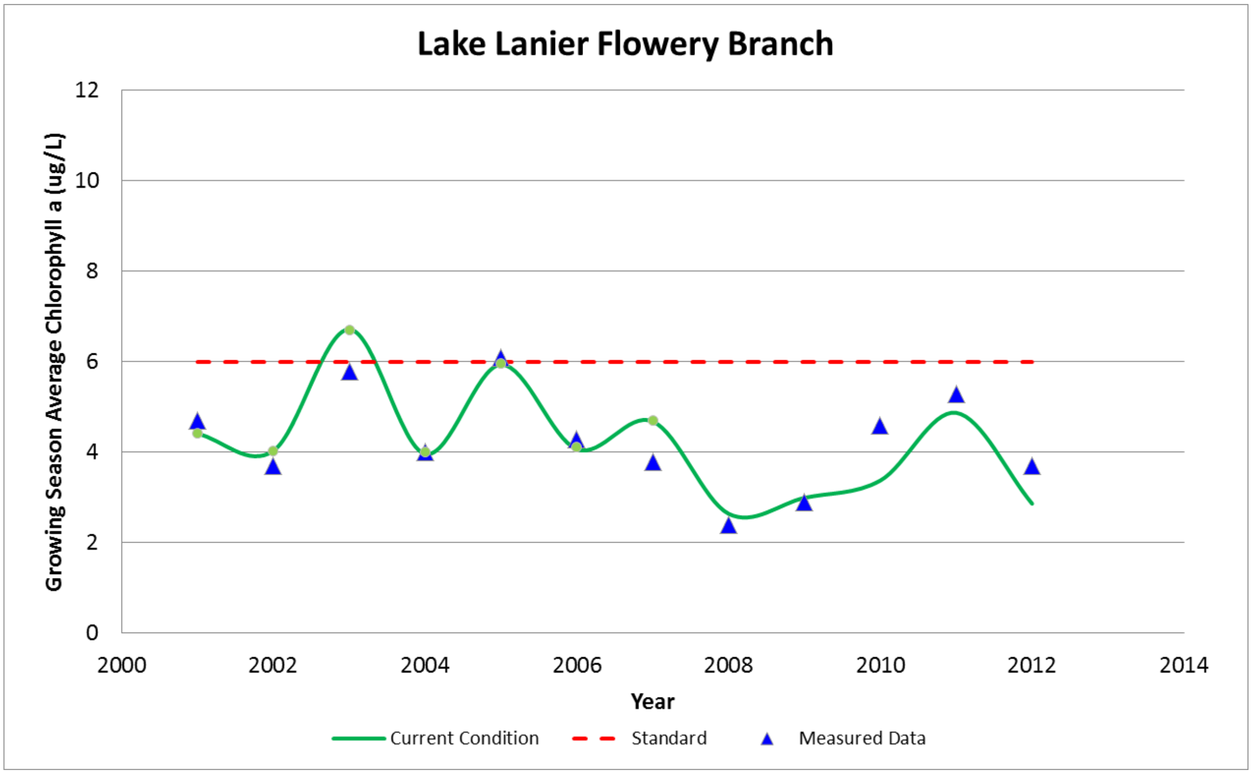
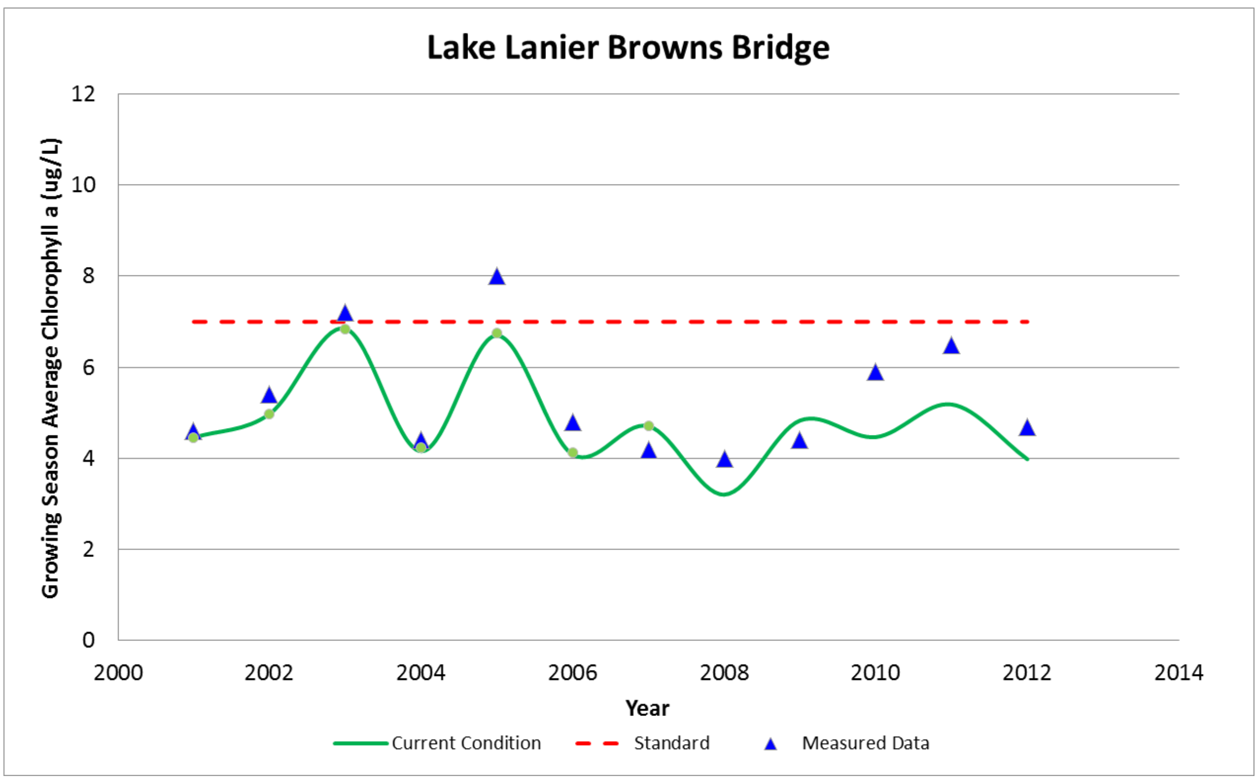
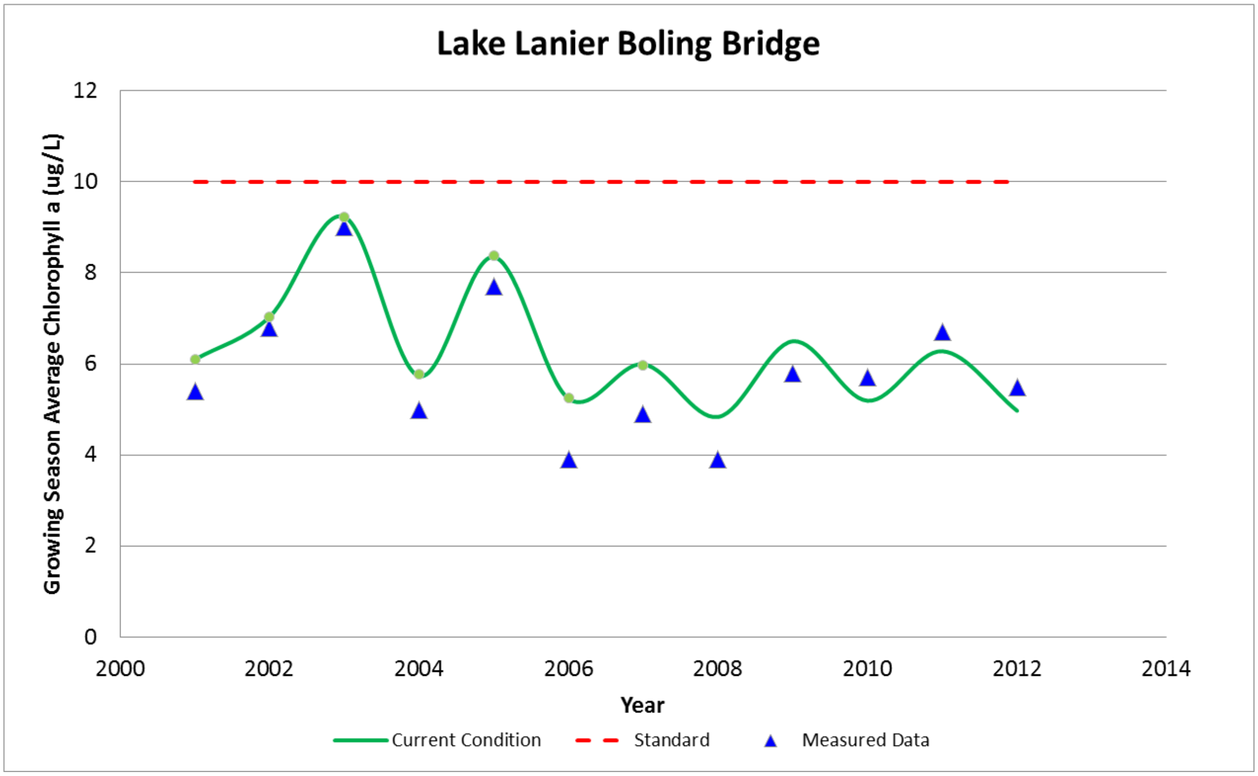


Figure 21. Temperature Calibration at the Buford Dam Forebay for 2006




Lake Lanier Flowery Branch
Growing Season Average Chlorophyll a (ug/L)
0
2
4
6
8
10
12
2000
2002
2004
2006
2008
2010
2012
2014
Year
Current Condition
Standard
Measured Data


Lake Lanier Browns Bridge
Growing Season Average Chlorophyll a (ug/L)
0
2
4
6
8
10
12
2000
2002
2004
2006
2008
2010
2012
2014
Year
Current Condition
Standard
Measured Data



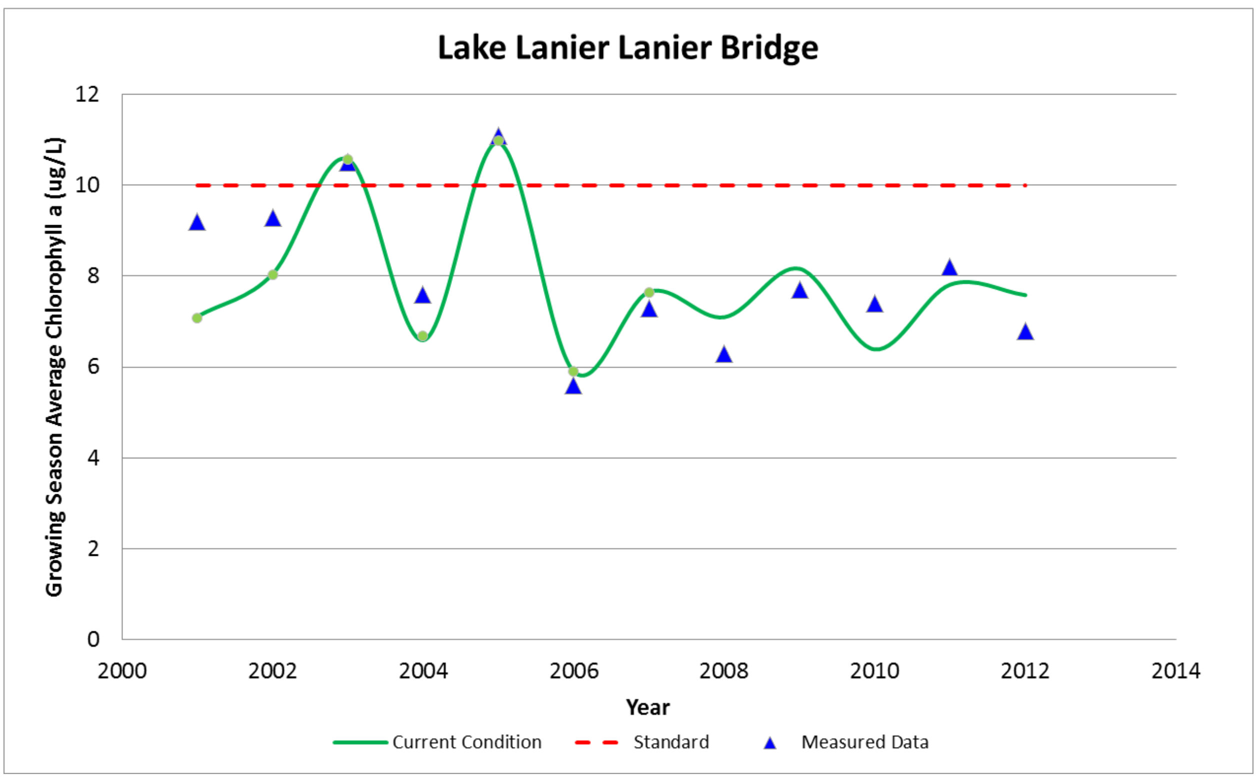


Figure 22. Growing Season Average Chlorophyll *a* Calibration at the Five Lake Lanier Compliance Points for 2001 – 2012

4.5 Critical Conditions Models

The critical conditions model was used to assess the nutrient loads and chlorophyll *a, and* to determine if a problem exists requiring regulatory intervention. Model critical conditions were developed in accordance with GA EPD standard practices (GA EPD, 1978).

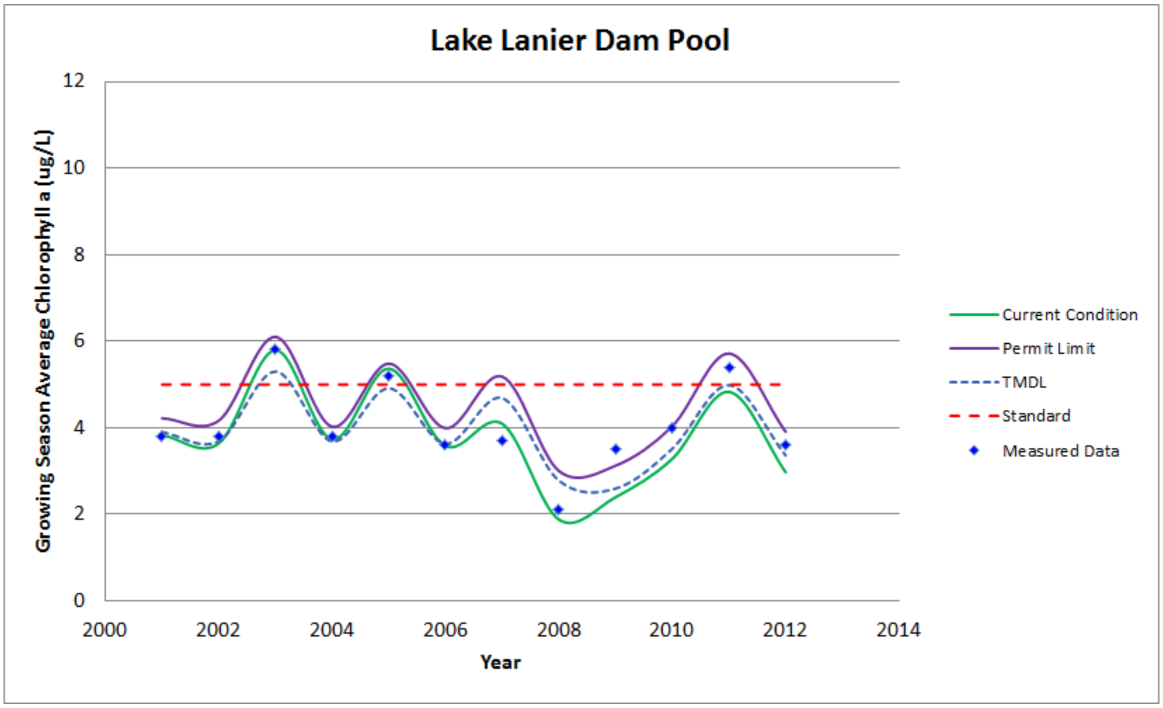
The complex dynamics simulated by the models demonstrated the critical conditions for nutrient uptake and the corresponding algal growth in the embayment. The critical conditions include:

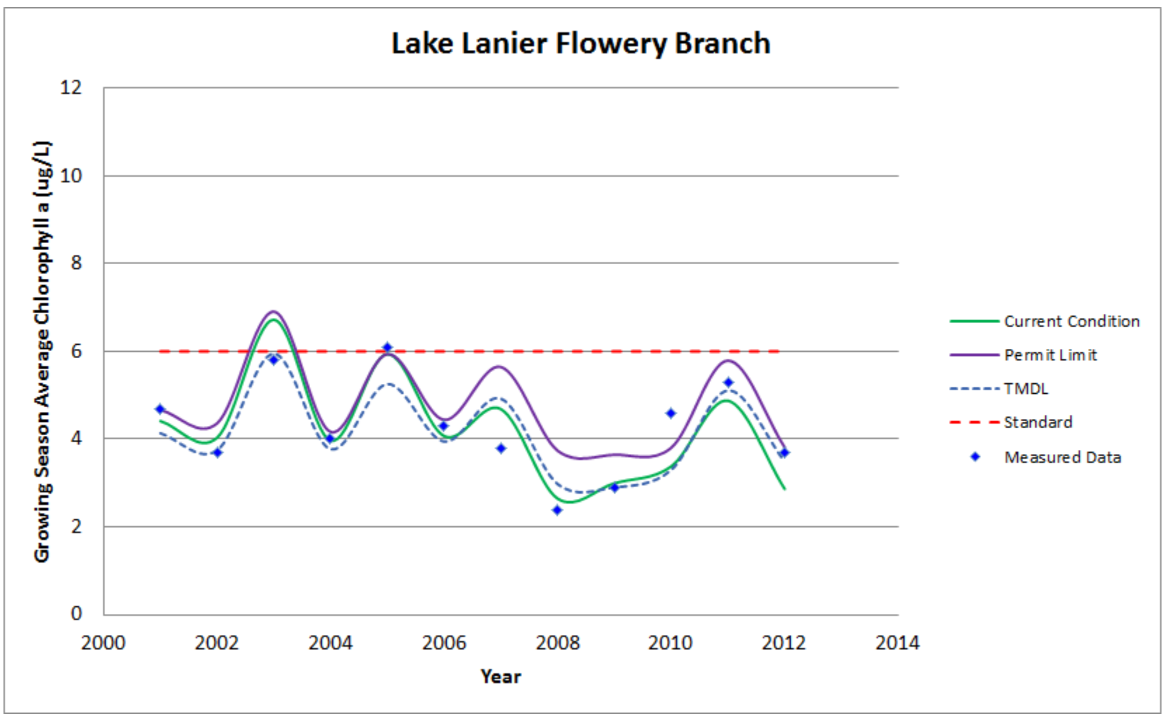
- Meteorological conditions
- Available sunlight
- Watershed flows
- Retention time in embayment
- High water temperatures
- Watershed nutrient loads

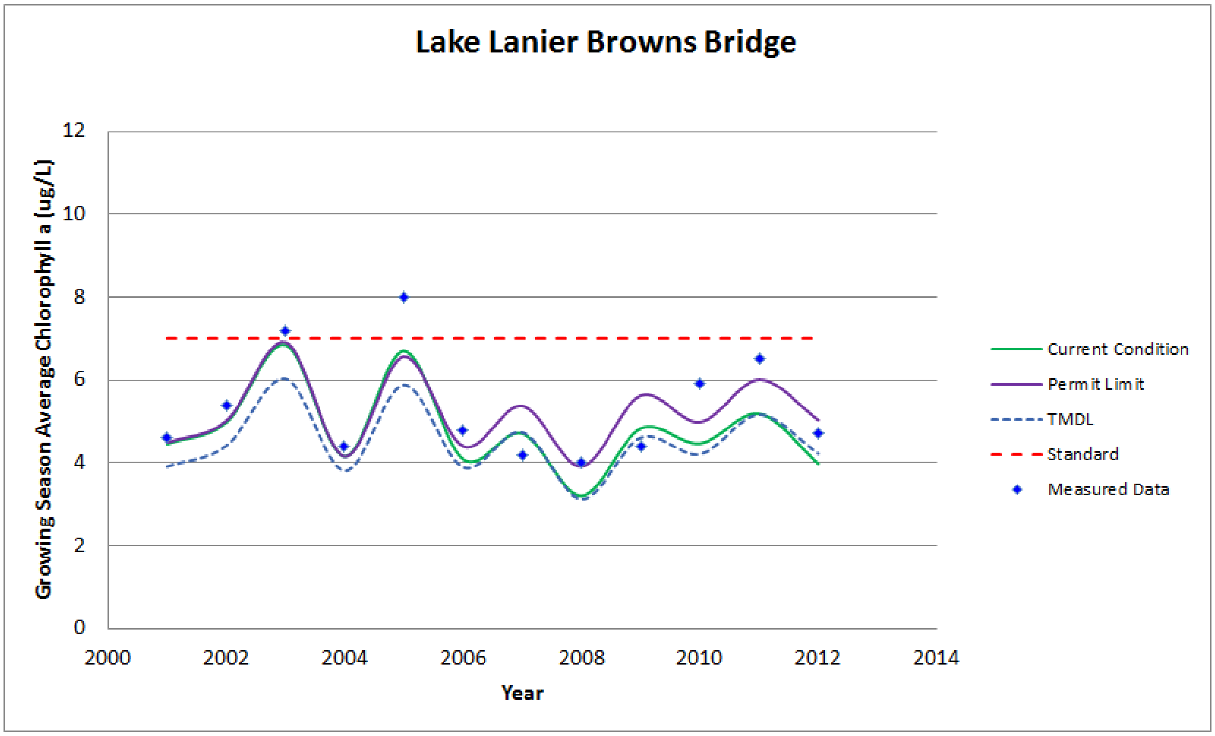
The most critical time period for excess algal growth appears to be the high-flow year when excess nutrients have been delivered to the system. The high-flow critical conditions incorporated in this TMDL are assumed to represent the most critical design conditions thereby providing year-round protection of water quality. During these years, the rainfall is high, sunlight can be unlimited, and nutrient fluxes may be high. The large amounts of nutrients delivered during these high-flow sunny periods can cause algae to bloom and measured chlorophyll *a* can exceed the numeric standards.

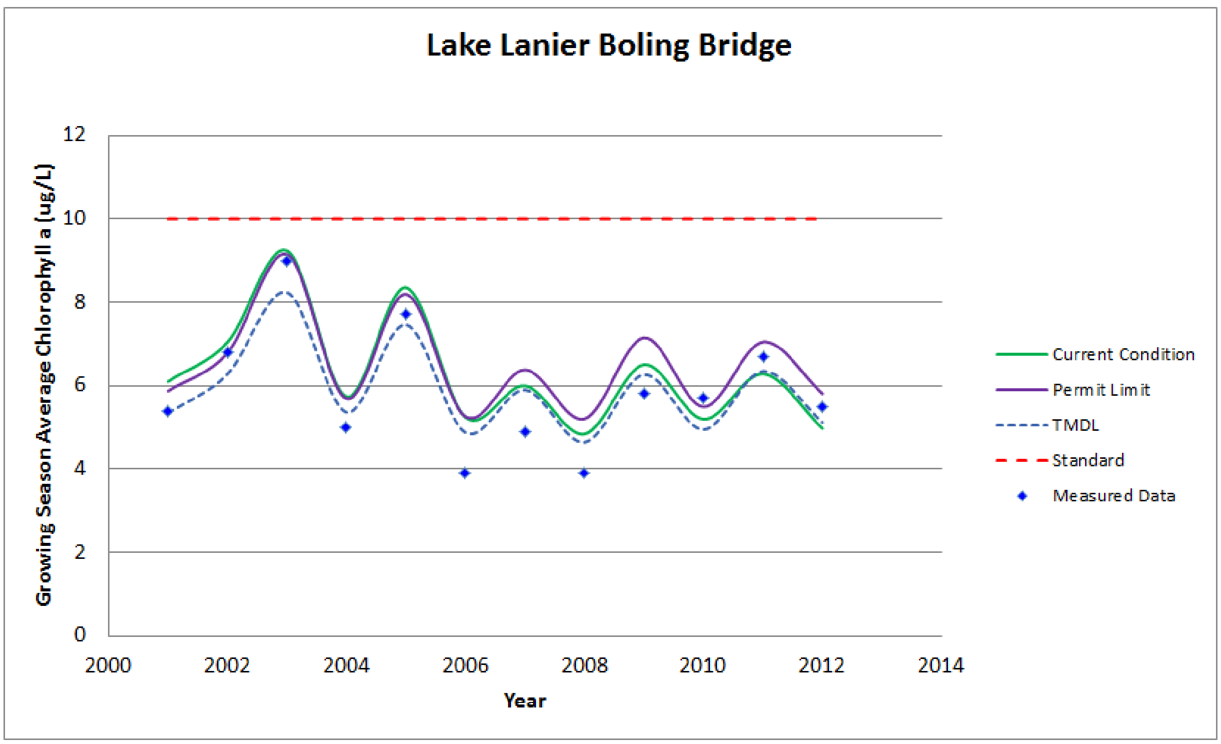
Drought conditions were experienced a couple of times during the period from 2001 through 2012. This simulation period exhibited a wide variety of flow conditions, which included low flows drought conditions in 2001-2002, 2006-2007, and 2012, high flows in 2003, 2005, and 2009-2010, and normal flows in 2004, 2008, and 2011.

The critical condition scenario was run with the NPDES point sources at the full permit loads. The permit limits are listed in Table 3. Results of permit limits runs are plotted in the graphs in Figure 23 along with the current conditions and TMDL results at the five Lake Lanier compliance points for comparison.


Lake Lanier Dam Pool
Growing Season Average Chlorophyll a (ug/L)
12
10
8
6
4
2
0
2000
2002
2004
2006
2008
2010
2012
2014
Year
Current Condition
Permit Limit
TMDL
Standard
Measured Data


Lake Lanier Flowery Branch
Growing Season Average Chlorophyll a (ug/L)
12
10
8
6
4
2
0
2000
2002
2004
2006
2008
2010
2012
2014
Year
Current Condition
Permit Limit
TMDL
Standard
Measured Data


Lake Lanier Browns Bridge
Growing Season Average Chlorophyll a (ug/L)
0
2
4
6
8
10
12
2000
2002
2004
2006
2008
2010
2012
2014
Year
Current Condition
Permit Limit
TMDL
Standard
Measured Data


Lake Lanier Boling Bridge
Growing Season Average Chlorophyll a (ug/L)
0
2
4
6
8
10
12
2000
2002
2004
2006
2008
2010
2012
2014
Year
Current Condition
Permit Limit
TMDL
Standard
Measured Data

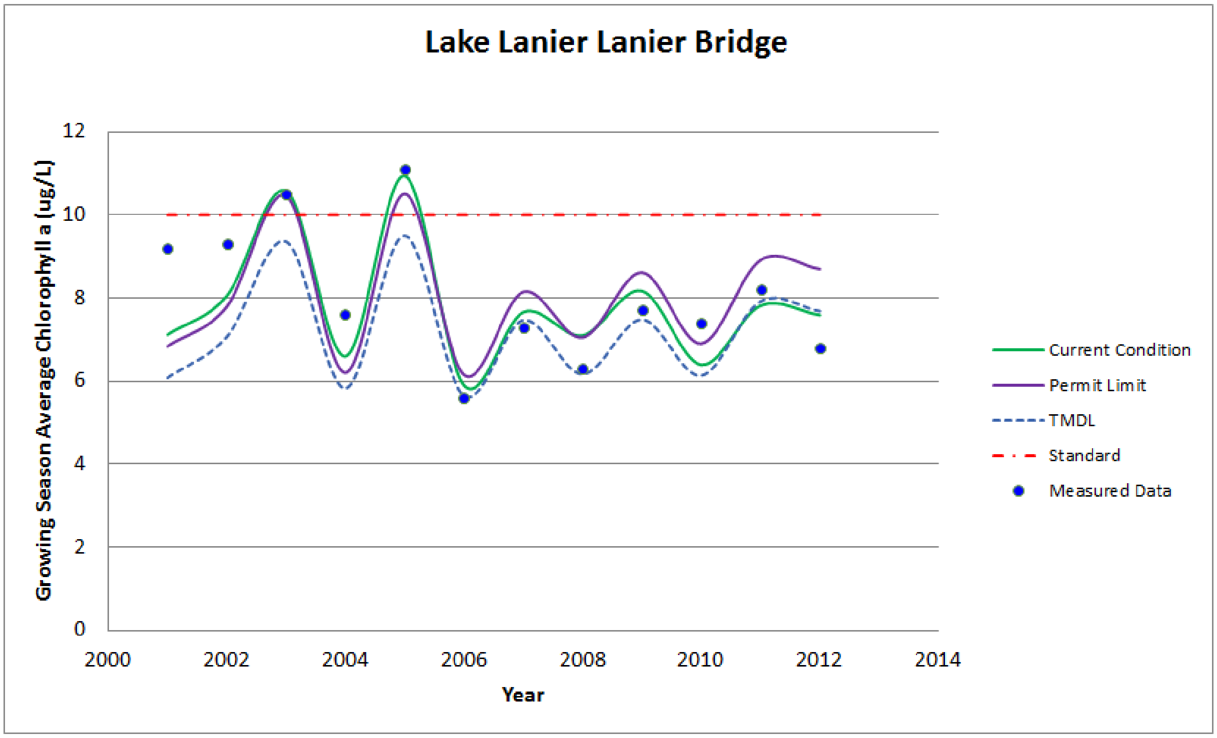


Figure 23. Growing Season Chlorophyll *a* Levels at Existing and Critical Conditions and the TMDL at the Five Lake Lanier Compliance Points

4.5.1 ACF Master Water Control Manual Update

In December 2016, The U.S. Army Corps of Engineers, Mobile District released the Final Environmental Impact Statement (EIS) for the updated Master Water Control Manual, Apalachicola-Chattahoochee-Flint (ACF) River Basin, Alabama, Florida, Georgia. The Manual includes appendices prepared for each of the individual projects in the ACF Basin and is the guide used by the USACE to operate the five reservoir projects on the Chattahoochee River. It also includes a water supply storage assessment addressing reallocation of storage in Lake Lanier. On March 30, 2017 the Corps signed the Record of Decision for the EIS and approved the Water Control Manuals for the individual projects.

A second critical conditions model scenario was run using the lake levels and dam releases that would be expected for the period from 2001-2012, if Buford Dam and Lake Lanier were operated using the recently approved Water Control Manual. This scenario resulted in an additional allowable Total phosphorus load of 6,000 lbs/yr.

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, which in this case, is the growing season average chlorophyll *a* standards. A TMDL is the sum of the individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources, as well as 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. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measures; for nutrients the TMDLs can be expressed as lbs/day or lbs/yr.

A TMDL is expressed as follows:

$$\text{TMDL} = \Sigma\text{WLAs} + \Sigma\text{LAs} + \text{MOS}$$

The TMDL calculates the WLAs and LAs with margins of safety to meet the lake's water quality standards. The allocations are based on estimates that use the best available data and provide the basis to establish or modify existing controls so that water quality standards can be achieved. In developing a TMDL, it is important to consider whether adequate information is available to identify the sources, fate, and transport of the pollutant to be controlled.

TMDLs may be developed using a phased approach, and this approach will be used here. Under a phased approach, the TMDL includes: 1) WLAs that confirm existing limits or lead to new limits, and 2) LAs that confirm existing controls or include implementing new controls (US EPA, 1991). A phased TMDL requires additional data be collected to determine if load reductions required by the TMDL are leading to the attainment of water quality standards. In the next phase, implementation strategies will be reviewed and the TMDLs that are presented below will be refined as necessary.

The TMDL Implementation Plan describes the installation and evaluation of point and nonpoint source control measures, data collection, assessment of water quality standard attainment, and if needed, additional modeling. Future monitoring of the listed segment water quality will then be used to evaluate this phase of the TMDL, and if necessary, to reallocate the loads. The nutrient loads calculated for each listed lake segment include the sum of the total loads from all point and nonpoint sources for the segment.

5.1 Waste Load Allocations

The waste load allocation is the portion of the receiving waterbody's loading capacity that is allocated to existing and future point sources. WLAs are provided to the point sources from municipal and industrial wastewater treatment systems with NPDES effluent limits. The maximum phosphorus and nitrogen loads under current permits for these wastewater treatment facilities are given in Table 34. The four mines do not discharge nutrients at levels above background; therefore, they are not given permit limits, but will be required to monitor nutrient levels in their discharge.

The sum of the Total Phosphorus WLAs is 37,800 lbs/year and the sum of the Total Nitrogen WLAs is 5,234,945 lbs/year, which are the total loads that can be discharged into the Lake Lanier watershed. The TMDLs are based on the sum total of the WLAs discharged into Lake

Lanier and its watershed. It is within the discretion of the Director of Georgia EPD to reallocate WLAs, as long as the total of the individual WLAs add up to the Total WLAs given above.

Table 34 provides the current, interim, and future TMDL nutrient loads. Current TMDL loads are based on current permits plus current wasteload allocation requests. The future TMDL loads are based on the projected water demands and projected wastewater flows included in the 2017 Water Resource Management Plan from the North Metropolitan Georgia Water Planning District. Lake operations used were those in the final USACE Water Control Manual issued in 2016 and adopted in 2017. If Corps operations of the lake change in ways that affect assimilative capacity, the TMDL may be revised. The interim TMDL loads are an example of intermediary loads that might be allocated in the future, but actual allocations will depend on where growth occurs and the timing of future wasteload allocation requests. Depending on future needs, it is possible a point source load could be moved with the associated flow from one point source to another point source.

If there are proposed expansions, then the total WLA would not change. Allowable concentrations may need to be reduced in proportion to the flow. If discharges from the various facilities change from those assumed in this TMDL, then loads may need to be reallocated, which could require pollutant trading. Trading may occur between point sources, between point and non-point sources, or between nonpoint sources as part of the TMDL as long as appropriate credits are documented and maintained so that the TMDL is met. If the total WLA should need to increase, the LA would need to be reduced via pollutant trading. Any trade must be done under the purview of a pollutant trading guidance document for Georgia and it is within the discretion of the Director of Georgia EPD to reallocate WLAs and/or LA within the TMDL in order to meet water quality standards within Lake Lanier.

Please note that the model showed that the lake is phosphorus limited; therefore, an adaptive management approach will be used to implement the nutrient WLAs in NPDES permits. Georgia EPD will incorporate the Total Phosphorus WLAs into NPDES permits within eighteen months and permittees may be given compliance schedules. Using the adaptive management approach, the Total Nitrogen WLAs will not be implemented in permits at this time as long as the Lake Lanier chlorophyll *a* and Total Nitrogen criteria are met. However, there is some concern that single nutrient control can enhance export of the uncontrolled nutrient and degrade downstream water quality. Future monitoring will be conducted to ensure there are no downstream impacts (excess chlorophyll *a* or macrophytes) in the Chattahoochee River or downstream lakes including West Point. If there are violations of the Total Nitrogen and chlorophyll *a* criteria in the future, TMDLs to address these violations will be developed. The Total Nitrogen WLAs will be revised, if necessary, and incorporated into the NPDES permits with compliance schedules to meet these new limits.

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 is not solely within the discretion of the permittee; and 4) they do not have wastewater treatment plants that control specific pollutants to meet numeric limits.

34. Total Nutrient WLAs for the Lake Lanier Facilities

Facility Name	NPDES Permit No.	Receiving Stream/ Reach ID	Current Permit		Current TMDL		Interim TMDL		Future TMDL	
			Total Phosphorus (lbs/yr)	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	Total Nitrogen (lbs/yr)
Gwinnett County - F Wayne Hill Water Resources Facility	GA0038130	Lake Lanier GAR031300010821	9,741	1,509,874	12,176	1,887,342	12,176	1,887,342	14,612	2,264,810
Flowery Branch	GA0031933	Lake Lanier GAR031300010820	158	17,047	265	23,312	441	68,492	528	82,571
Cinnamon Cove Condos - Flowery Branch	GA0049051	Lake Lanier GAR031300010820	107	6,265						
Gainesville - Flat Creek WPCP	GA0021156	Flat Creek GAR031300010819	4,749	456,615	2,922	456,615	2,922	456,615	2,922	456,615
Gainesville - Linwood	GA0020168	Lake Lanier GAR031300010818	2,770	266,359	1,705	266,359	1,705	266,359	1,705	266,359
Hall County	Proposed	Lake Lanier	-	-	-	-	102	15,221	122	19,026
Cumming - Lanier Beach South	GA0031674	Lake Lanier GAR031300010821	58	1,619	1,826	285,384	3,050	475,641	3,653	570,769
Forsyth County	Proposed	Lake Lanier	-	-	1,218	190,256	3,050	475,641	3,562	570,769
Forsyth County	Proposed	Lake Lanier	-	-			1,017	159,815	1,187	190,256
Habersham on Lanier	GA0030261	Lake Lanier GAR031300010821	167	9,845	167	9,845	167	9,845	167	9,845
Lake Lanier Islands	GA0049115	Lake Lanier GAR031300010821	139	31,324	139	31,324	139	31,324	139	31,324
Chattahoochee Country Club	GA0022471	Lake Lanier GAR031300010818	15	63	15	63	15	63	15	63
Spout Springs	Proposed	-	-	-	-	-	386	60,882	463	72,297
Lula Pond WPCP	GA0039039	Hagen Creek GAR031300010818	275	15,982	275	15,982	386	60,882	463	72,297
Cleveland WPCP	GA0036820	Tesnatee Creek GAR031300010705	4,207	50,228	1,142	50,228	1,142	50,228	1,142	50,228
Dahlonega WPCP	GA0026077	Yahoola Creek GAR031300010705	570	87,670	570	87,670	570	87,670	584	146,117
Mountain Lakes Resort	GA0046400	Lake Qualatchee GAR031300010705	71	805	71	805	71	805	71	805
Camp Barney Medintz	GA0034983	Jenny Creek GAR031300010705	201	1,432	201	1,432	201	1,432	201	1,432

Facility Name	NPDES Permit No.	Receiving Stream/ Reach ID	Current Permit		Current TMDL		Interim TMDL		Future TMDL	
			Total Phosphorus (lbs/yr)	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	Total Nitrogen (lbs/yr)
Oak Grove MHP	GA0034207	Unnamed Creek to Cane Ck GAR031300010705	8	447	8	447	8	447	8	447
Clarkesville WPCP	GA0032514	Soquee River GAR031300010818	2,539	67,122	1,142	67,122	1,142	67,122	1,142	67,122
Demorest WPCP	GA0032506	Hazel Creek GAR031300010818	974	71,597	974	71,597	974	71,597	974	71,597
Cornelia WPCP	GA0021504	South Fork of Mud Creek GAR031300010818	10,046	123,286	4,566	118,720	3,425	158,293	1,425	237,440
Baldwin WPCP	GA0033243	South Fork Little Mud Ck GAR031300010818	2,435	39,208	1,218	39,208	1,218	39,208	1,218	39,208
Wauka Mountain Elementary School	GA0032697	East Fork Little River GAR031300010818	53	1,163	53	1,163	53	1,163	53	1,163
North Hall High School	GA0034886	Jnnamed Trib to Wahoo Ck GAR031300010818	423	2,685	423	2,685	423	2,685	423	2,685
Baker & Glover MHP	GA0027049	Unnamed trib to Little Rvr GAR031300010818	49	984	49	984	49	984	49	984
Dixie MHP - Gainesville	GA0023043	Unnamed trib to Flat Ck GAR031300010819	17	385	17	385	17	385	17	385
Shady Grove MHP	GA0023469	Unnamed trib to Balus Ck GAR031300010819	13	264	13	264	13	264	13	264
Scovill Fasteners Inc.	GA0001112	Soquee River GAR031300010818	1,460	8,067	730	8,067	730	8,067	730	8,067
Vulcan Construction Materials - Dahlonega II	GA0037508	Unnamed trib to Long Brch GAR031300010705	-	-	Monitor	Monitor	Monitor	Monitor	Monitor	Monitor
Buckhorn Ventures LLC	GA0037209	Trib to Six Mile Creek GAR031300010820	-	-	Monitor	Monitor	Monitor	Monitor	Monitor	Monitor
Hanson Aggregates SE	GA0046086	Hazel Creek GAR031300010818	-	-	Monitor	Monitor	Monitor	Monitor	Monitor	Monitor
Long Mountain Quarry	GA0046302	Shoal Creek Tributary GAR031300010705	-	-	Monitor	Monitor	Monitor	Monitor	Monitor	Monitor
Future Allocations	-	-	-	-	5,918	1,613,120	2,264	776,474	215	-
		Total	41,244	2,734,533	37,800	5,234,941	37,809	5,234,941	37,800	5,234,941

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 the pollutants entering the environment. The waste load allocations from storm water discharges associated with MS4s (WLAsw) are estimated based on the percentage of urban area in each watershed covered by the MS4 storm water permit. At this time, the portion of each pollutant source that goes directly to a permitted storm sewer and that which goes through non-permitted point sources, or is sheet flow or agricultural runoff, has not been clearly defined. Therefore, it is assumed that approximately 70 percent of storm water runoff from the regulated urban area is collected by the municipal separate storm sewer systems.

Under the phased approach of these TMDLs, future phases of TMDL development will attempt to further define the sources of pollutants and the portion that enters the permitted storm sewer systems. As more information is collected and these TMDLs are implemented, it will become clearer which BMPs are needed and how water quality standards can be achieved.

5.2 Load Allocations

The load allocation is the portion of the receiving water's loading capacity that is attributed to existing or future nonpoint sources or to natural background sources. Nonpoint sources are identified in 40 CFR 130.6 as follows:

- Residual waste;
- Land disposal;
- Agricultural and silvicultural;
- Mines;
- Construction;
- Saltwater intrusion; and
- Urban storm water (non-permitted).

As described above, there are two types of load allocations: loads to the stream independent of precipitation, including sources such as failing septic systems, leachate from landfills, animals in the stream, leaking sewer system collection lines, and background loads; and loads associated with nutrient accumulation on land surfaces that is washed off during storm events, including runoff from saturated LAS fields. To determine the LA, the nutrient accumulation loading rates for each land use and the associated land use areas were used.

5.3 Seasonal Variation

The Georgia lake chlorophyll *a* criteria are based on the growing season average. The most critical time period for excess algal growth appears to be the high-flow years when excess nutrients have been delivered to the system. A wide variety of flow conditions were exhibited during the simulation period, 2001-2012. This included low flow drought conditions in 2001-2002, 2006-2007, and 2012, high flows in 2003, 2005, and 2009-2010, and normal flows in 2004, 2008, and 2011.

The high-flow critical conditions incorporated in this TMDL are assumed to represent the most critical design conditions thereby providing year-round protection of water quality. This TMDL is expressed as a total load based on the nutrient accumulation rate for each land use.

5.4 Margin of Safety

The MOS is a required component of TMDL development. There are two basic methods for incorporating the MOS: 1) implicitly incorporate the MOS using conservative modeling 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 by using the following conservative modeling assumptions:

- Critical low flows into the embayment
- Hot summer temperatures
- Critical meteorological conditions
- Long retention times
- Conservative reaction rates

5.5 Total Nutrient Load

The load reductions for the TMDL are based on recommendations by a group of Lake Lanier partners and stakeholders. This group consisted of various municipal and county utilities, forestry and agricultural partners, and environmental groups. The group was given a modeling tool that provided the decrease in chlorophyll a levels as a result of changes in the Total P loads from point sources (WLA), and agricultural and urban nonpoint sources (LA). The group determined that to meet the chlorophyll *a* limits in the lake at the various compliance points, the Total Phosphorus loads from point sources had to be reduced 8.35%, the urban nutrient accumulation loading rates had to be reduced by 50%, the agricultural nutrient accumulation loading rates, including chicken litter application, had to be reduced by 34%, and the failing septic tanks had to be reduced by 50%. The permitted Total P loads from the following point sources were reduced: Baldwin (50%), Clarkesville (55%), Cleveland (72.8%), and Cornelia (54.5%).

The nutrient load that enters the lake each year is dependent on the annual rainfall. Table 35 presents the annual Total Phosphorus load delivered to the major tributaries compliance points. This table includes the annual load from the current permit model run, as well as the percent reduction needed to meet the TMDL assuming reduction in the total phosphorus loads from the facilities located in the upper watershed and the agricultural, urban and septic loadings outlined above.

Table 36 presents the total load allocation expressed in lbs/day for Lake Lanier compliance points including the 303(d) listed segment. It provides the current loads and corresponding TMDLs, WLAs (WLA and WLA_{sw}), LAs, MOSs, and percent load reductions. The LA and WLA_{sw} are based on each land use accumulation rate. The WLA is the daily amount that can be discharged calculated for the TMDL and will not be used for permitting, but is given for accounting purposes only. To gain a Phosphorus load for future growth, the LA or another WLA would have to be reduced via pollutant trading. The State of Georgia's policy is to support returns of highly treated wastewater to Lake Lanier and its watershed. Increasing return flows in the future, while meeting water quality standards may require tighter limits on concentrations or pollutant trading to reduce another WLA or LA. The relationship between instream water quality and the potential sources of pollutant loading is an important component of TMDL development, and is the basis for later implementation of corrective measures and BMPs.

Table 35. Annual Total Phosphorus Load Delivered to Lake Lanier

Station	Total P Standard (lbs/yr)	Run	Annual Total Phosphorus Load (lbs/yr)											
			2001	2002	2012	2004	2005	2006	2007	2008	2009	2010	2011	2012
Chattahoochee River at Belton Bridge Road	**178,000**	Current Permit	49,722	70,961	98,031	82,413	86,858	62,595	45,550	50,531	119,534	83,816	66,304	64,000
		TMDL	37,163	55,630	78,941	65,653	68,714	49,082	34,140	44,745	102,984	73,206	57,834	56,320
		Reduction	25.3%	21.6%	19.5%	20.3%	20.9%	21.6%	25.0%	11.5%	13.8%	12.7%	12.8%	12.0%
Chestatee River at Georgia Highway 400	**118,000**	Current Permit	19,925	27,022	39,155	31,103	27,009	22,223	14,248	19,602	53,308	30,946	23,129	26,223
		TMDL	15,148	21,525	32,400	25,252	21,314	17,371	10,206	17,045	47,041	27,261	20,312	22,934
		Reduction	24.0%	20.3%	17.3%	18.8%	21.1%	21.8%	28.4%	13.0%	11.8%	11.9%	12.2%	12.5%
Flat Creek at McEver Road	**14,400**	Current Permit l	7,040	7,034	7,718	7,638	7,125	6,472	6,061	5,630	7,317	5,945	5,401	5,536
		TMDL	6,033	6,051	6,442	6,408	6,071	5,691	5,434	4,503	5,546	4,699	4,379	4,468
		Reduction	14.3%	14.0%	16.5%	16.1%	14.8%	12.1%	10.3%	20.0%	24.2%	21.0%	18.9%	19.3%

Table 36. Total Daily Nutrient Loads, Wasteloads, and Required Load Reductions

Lake Segment		Lake Lanier – Lanier Bridge GAR031300010818		Lake Lanier – Boling Bridge GAR031300010705		Lake Lanier – Browns Bridge GAR031300010819		Lake Lanier – Flowery Branch GAR031300010820		Lake Lanier – Dam Forebay GAR031300010821	
		Total Nitrogen (lbs/day)	Total Phosphorus (lbs/day)	Total Nitrogen (lbs/day)	Total Phosphorus (lbs/day)	Total Nitrogen (lbs/day)	Total Phosphorus (lbs/day)	Total Nitrogen (lbs/day)	Total Phosphoru s (lbs/day)	Total Nitrogen (lbs/day)	Total Phosphorus (lbs/day)
Current Permitted Load	WLA (lbs/day)	1,634	58	385	14	2,019	71	3,272	85	7,590	113
	WLAsw (lbs/day)	100	4	20	1	143	6	245	10	361	15
	LA (lbs/day	5,638	227	2,219	89	8,145	322	8,951	355	9,232	370
	Total Load (lbs/day)	7,373	289	2,625	103	10,307	399	12,468	449	17,183	498
Future TMDL Components	WLA (lbs/day)	2,153	23	545	5	3,220	32	4,671	41	14,342	103
	WLAsw (lbs/day)	83	3	14	1	118	5	203	8	310	12
	LA (lbs/day)	4,646	188	1,885	76	6,649	269	7,417	291	7,599	302
	MOS (lbs/day)	Implicit	Implicit	Implicit	Implicit	Implicit	Implicit	Implicit	Implicit	Implicit	Implicit
	TMDL (lbs/day)	6,882	214	2,444	82	9,987	305	12,291	340	22,251	417
Percent Reduction WLA		-	60.5%	-	60.3%	-	55.9%	-	51.6%	-	8.8%
Percent Reduction WLAsw		17.6%	17.4%	32.1%	14.4%	17.0%	16.7%	17.1%	17.9%	14.1%	18.4%
Percent Reduction LA		17.6%	17.4%	15.1%	14.4%	18.4%	16.7%	17.1%	17.9%	17.7%	18.4%
Percent Reduction TMDL		6.7%	26.0%	6.9%	20.5%	3.1%	23.7%	1.4%	24.2%	-	16.3%

6.0 RECOMMENDATIONS

The TMDL process consists of an evaluation of the sub-watersheds for each 303(d) listed stream segment to identify, as best as possible, the sources of the nutrient loads causing the stream to exceed lake standards. The TMDL analysis was performed using the best available data to specify WLAs and LAs that will meet chlorophyll *a* water quality criteria to support the use classification specified for each listed segment.

This TMDL represents part of a long-term process to reduce nutrient loadings to meet water quality standards in Lake Lanier. Implementation strategies will be reviewed and the TMDLs will be refined as necessary in the next phase. The phased approach will support progress toward water quality standard attainment in the future. In accordance with US EPA TMDL guidance, these TMDLs may be revised based on the results of future monitoring and source characterization data efforts. The following recommendations emphasize further source identification and involve the collection of data to support the current allocations and subsequent source reductions. If new information becomes available indicating that revisions in the model on which the TMDL is based are needed, EPD will undertake revisions and may redo the TMDL based on results of the revised model. The TMDL revisions may indicate that higher or lower levels of point source or nonpoint source controls are required to meet the applicable water quality standards.

6.1 Monitoring

Water quality monitoring is conducted at a number of locations across the State each year. Sampling is conducted statewide by EPD personnel in Atlanta, Brunswick, Cartersville, and Tifton. Additional sites are added as necessary.

Compliance with the TMDL will be determined through annual monitoring in the lake and compliance with water quality standards. The TMDL Implementation Plan will also outline an appropriate water quality monitoring program for the Lake Lanier watershed. The monitoring program will be developed to help identify the various nutrient sources. The monitoring program may be used to verify the 303(d) stream segment listings.

6.2 Nutrient Management Practices

Based on the findings of the source assessment, NPDES point source nutrient loads from wastewater treatment facilities in the upper Chattahoochee River watershed do contribute to the impairment of the listed stream segments. The TMDL requires that the Total Phosphorus limit for four facilities be revised. Other significant sources can be nutrient loads from NPDES permitted MS4 areas, which may be significant, but the sources of storm water cannot be easily separated. Sources of nutrients in urban areas include wastes that are attributable to fertilizers, domestic animals, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, leaking septic systems, runoff from improper disposal of waste materials, and leachate from both operational and closed landfills. In agricultural areas, potential sources of nutrients may include CAFOs, animals grazing in pastures, manure application, manure lagoons, and direct access of livestock to streams. Wildlife, especially waterfowl, can also be a significant source of nutrients.

Nutrient management practices are recommended to reduce nutrient source loads to the listed 303(d) stream segments, with the result of achieving the lake chlorophyll *a* standard criteria. These recommended management practices include:

- Compliance with NPDES (wastewater, construction, industrial stormwater, and/or MS4) permit limits and requirements;
- Implementation of recommended Water Quality management practices in the *Coosa-North Georgia Regional Water Plan* (GA EPD, 2017);
- Implementation of required Action Items in the *Water Resource Management Plan* developed by the Metro-North Georgia Water Planning District (MNGWPD, 2017)
- Implementation of *Georgia's Best Management Practices for Forestry* (GFC, 2009);
- Implementation of *Best Management Practices for Georgia Agriculture* (GSWCC, 2013)
- Adoption of National Resource Conservation Service (NRCS) Conservation Practices for agriculture;
- Adoption of proper fertilization practices;
- Adherence to the Surface Mining Land Use Plan prepared as part of the Surface Mining Permit Application;
- Implementation of the *Georgia Better Back Roads Field Manual* (GA RCDC, 2009) and adoption of additional practices for proper unpaved road maintenance;
- Implementation of individual Erosion and Sedimentation Control Plans for land disturbing activities; and application of the *Manual for Erosion and Sediment Control in Georgia* (GSWCC, 2016)
- Implementation of the *Georgia Stormwater Management Manual* (ARC, 2016) to facilitate prevention and mitigation of stream bank erosion due to increased stream flow and velocities caused by urban runoff through structural storm water BMP installation.
- Adherence to DNR River Corridor Protection guidelines;
- Mitigation and prevention of riparian buffer loss due to land disturbing activities;
- Promulgation and enforcement of local natural resource protection ordinances such as land development, stormwater, water protection, protection of environmentally sensitive areas, and others.

6.2.1 Point Source Approaches

Point sources are defined as discharges of treated wastewater or storm water into rivers and streams at discrete locations. The NPDES permit program provides a basis for issuing municipal, industrial, and storm water permits, monitoring and compliance with limitations, and appropriate enforcement actions for violations.

In accordance with GA EPD rules and regulations, all discharges from point source facilities are required to be in compliance with the conditions of their NPDES permit at all times. In the future, municipal and industrial wastewater treatment facilities with the potential for nutrients to be present in their discharge will be permitted if it can be shown that the discharge will met applicable water quality standards, which may require a decrease in non-point source loads or another point source load. This may be allowed under a pollutant-trading program that will allow point to point trading, point to nonpoint source trading and/or nonpoint (agricultural) to nonpoint (urban) source trading. The WLA for wastewater treatment facilities may be increased if there is an appropriate pollutant trade that requires reductions in the nonpoint source load allocation (LA) and maintenance of those reductions or the net WLAs does not change by having a nutrient trade between point sources. Any trade must be done under the purview of a pollutant trading guidance document for Georgia and it is within the discretion of the Director of Georgia EPD to reallocate WLAs and/or LA within the TMDL in order to meet water quality standards within Lake Lanier. In addition, the permits will include monitoring and reporting requirements.

6.2.2 Nonpoint Source Approaches

The GA EPD is responsible for administering and enforcing laws to protect the waters of the State. The GA EPD is the lead agency for implementing the State's Nonpoint Source Management Program. Regulatory responsibilities that have a bearing on nonpoint source pollution include establishing water quality standards and use classifications, assessing and reporting water quality conditions, and regulating land use activities that may affect water quality. Georgia is working with local governments and 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 to 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. The following sections describe, in more detail, recommendations to reduce nonpoint source loads of nutrient in Georgia's surface waters.

GA EPD issues LAS permits that allow facilities to apply wastewater at agronomic rates. If these systems are operated in accordance with their permits and maintain vegetative buffers to mitigate potential stormwater flows for the sites, it is not expected these systems will have an impact on the lake. The modeled assumption that some nutrients from the LAS may washoff these sites during rainfall events is a conservative assumption and does not reflect a conclusion that these LAS may actually impact the lake. Determining whether any individual LAS has an impact on the lake would require a site-specific evaluation.

6.2.2.1 Agricultural Sources

The GA EPD should coordinate with other agencies that are responsible for agricultural activities in the state to address issues concerning nutrient loadings from agricultural lands. It is recommended that information (e.g., livestock populations by sub-watershed, animal access to streams, manure storage and application practices, etc.) be periodically reviewed so that watershed evaluations can be updated to reflect current conditions. It is also recommended that BMPs be utilized to reduce the amount of nutrients transported to surface waters from agricultural sources to the maximum extent practicable.

The following three organizations have primary responsibility for working with farmers to promote soil and water conservation and to protect water quality:

- University of Georgia (UGA) - Cooperative Extension Service;
- Georgia Soil and Water Conservation Commission (GSWCC); and
- Natural Resources Conservation Service (NRCS).

UGA has faculty, County Cooperative Extension Agents, and technical specialists who provide services in several key areas relating to agricultural impacts on water quality.

The GA EPD designated the GSWCC as the lead agency for agricultural Nonpoint Source Management in the State. The GSWCC develops nonpoint source management programs and conducts educational activities to promote conservation and protection of land and water devoted to agricultural uses.

The NRCS works with federal, state, and local governments to provide financial and technical assistance to farmers. The NRCS develops standards and specifications for BMPs that are to be used to improve, protect, and/or maintain our state's natural resources. In addition, every five years, the NRCS conducts the National Resources Inventory (NRI). The NRI is a statistically-based sample of trends in land use and natural resource conditions that covers non-federal land in the United States.

The NRCS is also providing technical assistance to the GSWCC and the GA EPD with the Georgia River Basin Planning Program. Planning activities associated with this program will describe conditions of the agricultural natural resource base once every five years. It is recommended that the GSWCC and the NRCS continue to encourage BMP implementation, education efforts, and river basin surveys with regard to river basin planning.

All farmers should develop and implement a Nutrient Management Plan. In addition, a nutrient management assessment, such as EPA's Clean EAST program or similar initiative, should be utilized to ensure that farmers have implemented appropriate nutrient management plans.

All farmers should conduct a Phosphorus Index test on their farm. The Phosphorus Index is a phosphorus assessment tool that determines the ability of phosphorus to move off the land into a waterbody. The Phosphorus Index is based on eight site characteristics including:

- soil erosion
- irrigation erosion
- runoff class
- soil P test
- P fertilizer application rate
- P fertilizer application method
- organic P source application rate
- organic P source application method

If the Phosphorus Index indicates there is a high potential for phosphorus to move from the site, then BMPs should be utilized to reduce the amount of nutrient transported to surface waters from agricultural sources to the maximum extent practicable. In areas where there are elevated nutrient levels in the soil due to historic manure application, BMP's should be utilized which will minimize the movement of nutrients in storm water. These BMPs may include using riparian buffers, reducing the application rate, planting and harvesting crops, determining the appropriate agronomic rate of manure and fertilizer applications using a Nutrient Management Plan and Phosphorus Index tool, changing the time of application, composting the manure, transporting the manure out of the Lake Lanier watershed to other areas that are nutrient deficient, or incinerating the manure as an alternative fuel source.

6.2.2.2 Urban Sources

Both point and nonpoint sources of nutrients can be significant in the Lake Lanier watershed urban areas. Urban sources of nutrients can best be addressed using a strategy that involves public participation and intergovernmental coordination to reduce the discharge of nutrients to the maximum extent practicable. Management practices, control techniques, public education, and other appropriate methods and provisions may be employed. In addition to water quality monitoring programs, discussed in Section 6.1, the following activities and programs conducted by cities, counties, and state agencies are recommended:

- Uphold requirements that all new and replacement sanitary sewage systems be designed to minimize discharges into storm sewer systems;

- Further develop and streamline mechanisms for reporting and correcting illicit connections, breaks, and general sanitary sewer system problems;

- Sustained compliance with storm water NPDES permit requirements;

- Encourage local governments to implement post construction stormwater ordinances that require the use of green infrastructure/runoff reduction controls to eliminate the discharge of runoff from all storm events up to the first inch for all new construction projects, as well as re-development projects;

- Work with County Health Departments to encourage proper installation and maintenance of septic tanks; and

- Continue efforts to increase public awareness and education towards the impact of human activities in urban settings on water quality, ranging from the consequences of industrial and municipal discharges to the activities of individuals in residential neighborhoods including appropriate application of fertilizers and the use of green infrastructure to reduce and reuse stormwater.

Nutrients, specifically phosphorus, bind to sediment. The phosphorus load delivered to the lake can be reduced by controlling erosion and sedimentation. The Erosion and Sedimentation Act, established in 1975, provides the mechanism for controlling erosion and sedimentation from land-disturbing activities. This Act establishes a permitting process for land-disturbing activities. Many local governments and counties have adopted erosion and sedimentation ordinances and have been given authority to issue and enforce permits for land-disturbing activities. Approximately 113 counties and 237 municipalities in Georgia have been certified as the local issuing authority. In areas where local governments have not been certified as an issuing authority, the GA EPD is responsible for permitting, inspecting, and enforcing the Erosion and Sedimentation Act.

To receive a land-disturbing permit, an applicant must submit an erosion and sedimentation control plan that incorporates specific conservation and engineering BMPs. The *Manual for Erosion and Sediment Control in Georgia*, *adopted in 2016*, developed by the State Soil and Water Conservation Commission, may be used as a guide to develop erosion and sedimentation control plans (GSWCC, 1997).

Local governments, with oversight by the GA EPD and the Soil and Water Conservation Districts, are primarily responsible for implementing the Georgia Erosion and Sedimentation Act, O.C.G.A. §12-7-1 (amended in 2003). It is recommended that the local and State governments continue to work to implement the provisions of the Georgia Erosion and Sedimentation Act across Georgia.

Once the sediment reaches the lake, there are concerns that the bound nutrients may be released back into the water column. It may be possible to reduce this internal nutrient load by removing sediment from the lake or control the conditions that cause the nutrients to be released from the bottom sediments in the lake.

6.3 Reasonable Assurance

Permitted discharges will be regulated through the NPDES permitting process described in this report. This TMDL looked at the impact of these discharges to the lake water quality and did not see any significant effects on dissolved oxygen. With implementation of the TMDL, the lake was shown to meet the lake-specific chlorophyll *a* and nutrient criteria. Therefore, this TMDL can serve as the antidegradation analysis for facilities with expanded WLAs. If new information becomes available that will requires a revision to the TMDL and WLAs, the revised TDML will serve as the antidegradation analysis.

An allocation to a point source discharger does not automatically result in a permit limit or a monitoring requirement. Through its NPDES permitting process, GA EPD will determine whether a new or existing discharger has a reasonable potential of discharging nutrient levels equal to or greater than the total allocated load. The results of this reasonable potential analysis will determine the specific type of requirements in an individual facility's NPDES permit. As part of its analysis, the GA EPD will use its EPA approved 2003 NPDES Reasonable Potential Procedures to determine whether monitoring requirements or effluent limitations are necessary.

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 best management practices to address nonpoint sources. In addition, public education efforts will be targeted to individual stakeholders to provide information regarding the use of best management practices to protect water quality.

6.4 Public Participation

A forty-five-day public notice was provided for this TMDL. During this time, the availability of the TMDL was public noticed, a copy of the TMDL was provided on request, and the public was invited to provide comments on the TMDL.

7.0 INITIAL TMDL IMPLEMENTATION PLAN

December 2017

7.1 Initial TMDL Implementation Plan

This plan identifies applicable statewide programs and activities that may be employed to manage point and nonpoint sources of nutrient loads for two segments in the Chattahoochee River Basin. Local watershed planning and management initiatives will be fostered, supported or developed through a variety of mechanisms. Implementation may be addressed by Watershed Improvement Projects, Section 319 (h) grant projects, the development of watershed assessment and protection plans, and watershed management initiatives. Any watershed plan that addresses impaired water bodies and/or TMDL implementation will replace this initial plan.

7.2 Impaired Segments

This initial plan is applicable to the following waterbodies that were added to Georgia's 305(b) list of impaired waters in *Water Quality in Georgia 2012-2013* (GA EPD, 2014) available on the Georgia Environmental Protection Division (GA EPD) website.

Waterbodies on the 2014 303(d) List for Chlorophyll a in Lake Lanier

Lake	Segment Location	Reach ID#	Category	Segment Area (acres)	Designated Use
Lanier Lake	Browns Bridge Road (SR 369)	GAR031300010819	5	5,952	Recreation/ Drinking Water
Lanier Lake	Lanier Bridge Road (SR 53)	GAR031300010818	3	4,928	Recreation/ Drinking Water

The water use classifications for Lake Lanier are Drinking Water and Recreation. The criterion violated is listed as chlorophyll *a*. The potential causes listed are urban runoff and nonpoint source runoff. The specific criteria for chlorophyll *a* in Lake Lanier, as stated in Georgia's *Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03(17)(e) (GA EPD, 2015) is:

Chlorophyll *a*: For the months of April through October, the average of monthly mid-channel photic zone composite samples shall not exceed the chlorophyll *a* concentrations at the locations listed below:

Upstream from the Buford Dam forebay	5 µg/L
Upstream from the Flowery Branch confluence	6 µg/L
At Browns Bridge Road (State Road 369)	7 µg/L
At Boling Bridge (State Road 53) on Chestatee River	10 µg/L
At Lanier Bridge (State Road 53) on Chattahoochee River	10 µg/L

7.3 Potential Sources

EFDC was used to simulate the fate and transport of nutrients into and out of the embayment and the uptake by phytoplankton, where the growth and death of phytoplankton is measured through the surrogate parameter called chlorophyll *a*.

Phytoplankton contains chlorophyll *a* to carry out photosynthesis. They also need nutrients such as nitrogen and phosphorus to produce food. If nutrient loadings are high, then the number of phytoplankton in a waterbody can increase, thereby increasing the amount of measurable chlorophyll *a* in the water. This can lead to water quality impairments due to excessive nutrients from various sources. Source assessments characterize the known and suspected nutrient sources in the watershed. These generally consist of both point and nonpoint sources.

NPDES permittees discharging treated wastewater are the primary point sources of nutrients. It is recognized that effluent from biological treatment systems that meet their nutrient permit limits is not expected to contribute significantly to nutrient loads.

Nonpoint sources of nutrients are diffuse sources that cannot be identified as entering the water body at a single location. These sources generally involve land use activities that contribute nutrients to streams during rainfall runoff events.

Prior to the implementation of this plan, a detailed assessment of the potential sources should be carried out. This will better determine what practices are needed and where they should be focused. Assessment of the potential sources within the watershed will also help when requesting funding assistance for the implementation of this plan. GA EPD's Nonpoint Source Program has watershed plans for the following watersheds that contain surveys of nonpoint sources of pollution: Soque River; Mud Creek and Little Mud Creek; Chestatee River; Chattahoochee River; and Tesnatee/Town Creek.

Through water quality modeling, it has been determined that the nutrient loading to the lake needs to be reduced. This nutrient loading may be due to activities including, but not limited to, fertilizers (residential, commercial), agriculture, impervious surfaces, failing septic tanks, and others. It is believed that if nutrient loads are not reduced, the lake will continue to degrade over time. Remedies exist for addressing excess nutrients from both point and nonpoint sources, and will be discussed in this plan.

7.4 Management Practices and Activities

Compliance with NPDES permits, the Erosion and Sedimentation Control Act, and local ordinances related to stormwater runoff control will contribute to controlling nutrient delivery from regulated activities, and may help to achieve the reductions necessary to meet the TMDL. Using federal, state, and local laws, enforcement actions are available as a remedy for excess nutrients coming from regulated sources. These may include illicit discharges, wastewater discharges, and excessive nutrient runoff from other land use activities.

Nutrients produced from nonpoint sources such as run-off from domestic lawns, agricultural fields, paved surfaces, illicit discharges, failing septic tanks, and others are not regulated and are, therefore, not subject to most enforcement actions. Best Management Practices (BMPs) may be used to help reduce average annual nutrient loads and achieve water quality standards, as well as improve the overall aquatic health of the system. Table 1 below lists examples of BMPs that address excess nutrients through buffer protection, filtration, or other methods. This is not an exhaustive list, and additional management measures may be proposed, and will be considered as non-point source controls consistent with this plan.

Examples of BMPs for Use in Controlling Nutrients from Non-Point Sources

Name of BMP	Type (Ag, Forestry, Urban, Other.)
Filter Strips	Agriculture
Reduced Tillage System	Agriculture
Exclusion	Agriculture
Timber Bridges	Forestry
Re-vegetation	Forestry
Sediment Basin	Urban
Porous Pavement	Urban
Wet Detention Pond	Urban
Organic Filter	Urban
Streambank Protection and Restoration	Ag, Forestry, Urban, Other
Stream Buffers	Ag, Forestry, Urban, Other
Additional Ordinances	Ag, Forestry, Urban, Other

Management practices that may be used to help maintain average annual nutrient loads at current levels include:

- Compliance with NPDES (wastewater, construction, industrial stormwater, and/or MS4) permit limits and requirements;
- Implementation of recommended Water Quality management practices in the *Coosa-North Georgia Regional Water Plan* (GA EPD, 2017);
- Implementation of required Action Items in the *Water Resource Management Plan* developed by the Metro-North Georgia Water Planning District (MNGWPD, 2017)
- Implementation of *Georgia's Best Management Practices for Forestry* (GFC, 2009);
- Implementation of *Best Management Practices for Georgia Agriculture* (GSWCC, 2013)
- Adoption of National Resource Conservation Service (NRCS) Conservation Practices for agriculture;
- Adoption of proper fertilization practices;
- Adherence to the Surface Mining Land Use Plan prepared as part of the Surface Mining Permit Application;
- Implementation of the *Georgia Better Back Roads Field Manual* (GA RCDC, 2009) and adoption of additional practices for proper unpaved road maintenance;
- Implementation of individual Erosion and Sedimentation Control Plans for land disturbing activities; and application of the *Manual for Erosion and Sediment Control in Georgia* (GSWCC, 2016)
- Implementation of the *Georgia Stormwater Management Manual* (ARC, 2016) to facilitate prevention and mitigation of stream bank erosion due to increased stream flow and velocities caused by urban runoff through structural storm water BMP installation.
- Adherence to DNR River Corridor Protection guidelines;
- Mitigation and prevention of riparian buffer loss due to land disturbing activities;

- Promulgation and enforcement of local natural resource protection ordinances such as land development, stormwater, water protection, protection of environmentally sensitive areas, and others.

Public education efforts target individual stakeholders to provide information regarding the use of BMPs to protect water quality. GA EPD will continue efforts to increase awareness and educate the public about the impact of human activities on water quality.

7.5 Monitoring

GA EPD will continue monitoring of the lake at the five standard sites, as well as the five embayments. Each year, monitoring will be conducted monthly during the growing season (April-October). The Chattahoochee Riverkeeper (CRK), North Georgia College, and the Lake Lanier Association currently monitor the lake. CRK has an approved Sampling Quality Assurance Plan and their data will continue to be used to assess the lake.

Monitoring of nutrients through field tests may be carried out through GA EPD's Adopt-A-Stream Program. Additional monitoring may also be undertaken by stakeholders in the watershed. GA EPD is available to work with those responsible for the monitoring activities, to conduct the necessary training, and take the needed steps to establish a well-organized monitoring program.

7.6 Future Action

This initial TMDL Implementation Plan includes a general approach to pollutant source identification as well as management practices to address pollutants. In the future, GA EPD will continue to determine and assess the appropriate point and nonpoint source management measures needed to achieve the TMDLs, and also to protect and restore water quality in impaired water bodies. EPD will work with stakeholders in the watershed in activities they may undertake to improve information on pollutant source identification, assessment of point and nonpoint source management measures needed to achieve the TMDL, and related actions to protect and restore water quality in impaired water bodies.

For point sources, any wasteload allocations for wastewater treatment plant discharges will be implemented in the form of water quality-based effluent limitations in NPDES permits. Any wasteload allocations for regulated storm water will be implemented in the form of best management practices in the NPDES permits. Contributions of nutrients from regulated communities may also be managed using permit requirements such as watershed assessments, watershed protection plans, and long-term monitoring. These measures will be directed through current point source management programs.

Watershed Improvement Projects (WIPs) can be developed to address nonpoint source pollution. This is a process whereby stakeholders, Regional Commissions or other agencies or local governments, develop a Watershed-Based Plan intended to address water quality at the small watershed level (HUC 12). These plans can be developed as resources, needs, and willing partners become available. The development of these plans may be funded through several grant sources including, but not limited to: Clean Water Act Section 319(h), Section 604(b), and/or Section 106 grant funds. These plans are intended for implementation upon completion.

Any Watershed-Based Plan that specifically addresses water bodies contained within this TMDL, and is accepted by GA EPD, will supersede the Initial TMDL Implementation Plan. The Watershed-Based Plan intended to address this TMDL and other water quality concerns, should contain at minimum the US EPA's 9-Key Elements of Watershed Planning:

1) An identification of the sources or groups of similar sources contributing to nonpoint source pollution to be controlled to implement load allocations or achieve water quality standards. Sources should be identified at the subcategory level with estimates of the extent to which they are present in the watershed (e.g., X numbers of cattle feedlots needing upgrading, Y acres of row crops needing improved sediment control, or Z linear miles of eroded streambank needing remediation);

2) An estimate of the load reductions expected for the management measures;

3) A description of the NPS management measures that will need to be implemented to achieve the load reductions established in the TMDL or to achieve water quality standards;

4) An estimate of the sources of funding needed, and/or authorities that will be relied upon, to implement the plan;

5) An information/education component that will be used to enhance public understanding of and participation in implementing the plan;

6) A schedule for implementing the management measures that is reasonably expeditious;

7) A description of interim, measurable milestones (e.g., amount of load reductions, improvement in biological or habitat parameters) for determining whether management measures or other control actions are being implemented;

8) A set of criteria that can be used to determine whether substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the plan needs to be revised; and;

9) A monitoring component to evaluate the effectiveness of the implementation efforts, measured against the criteria established under item (8).

The public will be provided an opportunity to participate in the development of Watershed-Based Plans that address impaired waters and to comment on them before they are finalized.

GA EPD will continue to offer technical and financial assistance, when and where available, to complete Watershed-Based Plans that address the impaired water bodies listed in this and other TMDL documents. Assistance may include but will not be limited to:

- Assessments of pollutant sources within watersheds;
- Determinations of appropriate management practices to address impairments;
- Identification of potential stakeholders and other partners;
- Developing a plan for outreach to the general public and other groups;
- Assessing the resources needed to implement the plan upon completion; and

- Other needs determined by the lead organization responsible for plan development.

GA EPD will also make this same assistance available, if needed, to proactively address water quality concerns. This assistance may be in the way of financial, technical, or other aid, and may be requested and provided outside of the TMDL process or schedule.

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Appendix A

Lake Lanier Water Quality Monitoring Data

2000 Though 2013 Monitoring Water Quality Stations

Segment	Location	GA EPD Monitoring Station No.	Monitoring Station Description
Lake Lanier	Dam Forebay	1201080902	Upstream from the Buford Dam forebay
Lake Lanier	Flowery Branch (Midlake)	1201080403	Upstream from the Flowery Branch confluence
Lake Lanier	Browns Bride	1201080203	At Browns Bridge Road (State Road 369)
Lake Lanier	Boling Bridge	1201070501	At Boling Bridge (State Road 53) on Chestatee River
Lake Lanier	Lanier Bridge	1201080103	At Lanier Bridge (State Road 53) on Chattahoochee River

Dam Forebay
2000 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/20/00	1.17	0.36	0.19	0.05	0.17	<0.02	<0.04	11.30	15.92
5/17/00	4.19	0.39	0.21	<0.03	0.18	<0.02	<0.04	8.86	21.92
6/14/00	3.78	0.30	0.17	<0.03	0.13	<0.02	<0.04	7.99	27.53
7/11/00	3.49	0.28	0.18	<0.03	0.10	<0.02	<0.04	7.36	28.85
8/16/00	2.02	0.23	0.16	<0.03	0.07	<0.02	<0.04	7.70	28.43
9/13/00	3.15	0.05	<0.1	<0.03	0.04	<0.02	<0.04	8.05	25.74
10/11/00	5.28	0.22	0.15	<0.03	0.07	<0.02	<0.04	8.08	20.10

Dam Forebay
2001 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/4/01	3.27	0.25	0.10	0.03	0.15	<0.02	<0.04	9.72	11.30
5/9/01	5.84	0.48	0.31	<0.03	0.17	<0.02	<0.04	8.30	21.20
6/6/01	4.65	0.47	0.33	<0.03	0.14	<0.02	<0.04	7.90	24.14
7/11/01	2.17	0.26	<0.1	<0.03	0.16	<0.02	<0.04	7.10	27.92
8/8/01	2.79	0.26	0.12	<0.03	0.14	<0.02	<0.04	7.15	27.90
9/6/01	2.79	0.28	0.14	<0.03	0.14	<0.02	<0.04	7.33	27.63
10/3/01	4.96	<.02	<0.1	<0.03	<.02	<0.02	<0.04	7.67	22.34

Dam Forebay
2002 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/3/02	2.2	0.37	0.21	<0.03	0.16	<0.02	<0.04	10.29	15.21
5/16/02	5.3	0.45	0.32	<0.03	0.13	<0.02	<0.04	8.63	21.28
6/5/02	4.7	0.22	<0.1	<0.03	0.12	0.02	<0.04	7.46	26.93
7/10/02	6.4	0.29	0.15	0.03	0.14	<0.02	<0.04	7.12	28.92
8/7/02	3.1	0.34	0.27	<0.03	0.07	0.02	<0.04	7.40	28.85
9/4/02	2.8	0.31	0.25	<0.03	0.06	<0.02	<0.04	7.27	27.46
10/2/02	2.2	0.23	0.19	<0.03	0.04	<0.02	<0.04	7.28	23.88

Dam Forebay
2003 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/2/03	3.10	0.41	0.20	<0.03	0.21	<0.02	<0.04	10.62	12.51
5/6/03	4.96	0.47	0.26	0.03	0.21	<0.02	<0.04	8.39	19.65
6/4/03	2.05	0.38	0.14	<0.03	0.24	<0.02	<0.04	8.20	21.33
7/9/03	4.03	0.35	0.13	<0.03	0.22	<0.02	<0.04	7.72	27.29
8/6/03	11.46	0.36	0.17	<0.03	0.19	<0.02	<0.04	7.72	27.57
9/10/03	8.05	0.30	0.23	<0.03	0.07	<0.02	<0.04	7.84	26.90
10/8/03	6.81	0.23	0.25	<0.03	0.08	<0.02	<0.04	7.04	22.13

Dam Forebay
2004 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/15/04	2.79	0.40	0.19	<0.03	0.21	<0.02	<0.04	10.48	12.90
5/5/04	4.65	0.48	0.28	<0.03	0.20	<0.02	<0.04	10.01	16.77
6/3/04	2.79	0.41	0.25	<0.03	0.16	<0.02	<0.04	8.59	23.61
7/8/04	3.41	0.17	<0.1	<0.03	0.17	<0.02	<0.04	7.57	27.86
8/4/04	2.17	0.38	0.23	<0.03	0.15	0.02	<0.04	7.06	29.57
9/2/04	5.27	NM	NM	<0.03	0.07	NM	<0.04	6.85	27.40
10/7/04	5.27	NM	NM	<0.03	0.07	NM	<0.04	8.67	22.67

Dam Forebay
2005 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/13/05	5.60	0.66	0.41	<0.03	0.25	<0.02	<0.04	10.30	15.68
5/4/05	4.00	0.34	0.11	<0.03	0.23	<0.02	<0.04	9.96	15.98
6/9/05	3.40	0.43	0.23	<0.03	0.20	<0.02	<0.04	7.98	25.60
7/14/05	3.70	0.38	0.22	<0.03	0.16	<0.02	<0.04	7.61	26.39
8/10/05	3.10	0.27	0.19	<0.03	0.08	0.03	<0.04	7.48	28.32
9/14/05	10.00	0.27	0.27	<0.03	<0.02	<0.02	<0.04	8.34	27.11
10/5/05	5.90	0.35	0.35	<0.03	<0.02	<0.02	<0.04	7.75	25.19

Dam Forebay
2006 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/27/06	1.24	0.40	0.18	<0.03	0.22	<0.02	<0.04	9.08	19.13
5/31/06	2.79	0.29	0.10	<0.03	0.19	<0.02	<0.04	9.96	27.09
6/27/06	2.48	0.28	0.10	<0.03	0.18	0.04	<0.04	7.40	27.24
7/25/06	1.00	0.20	0.10	<0.03	0.10	<0.02	<0.04	7.01	29.30
8/29/06	14.25	0.36	0.34	<0.03	0.02	<0.02	<0.04	6.68	28.99
9/26/06	1.24	0.27	0.27	<0.03	<0.02	<0.02	<0.04	6.95	24.10
10/24/06	2.17	0.35	0.19	<0.03	0.08	<0.02	<0.04	7.64	18.49

Dam Forebay
2007 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/17/07	1.40	0.41	0.23	0.07	0.18	<0.02	<0.04	10.47	11.36
5/15/07	4.97	0.38	0.22	<0.03	0.16	0.03	<0.04	8.72	23.78
6/12/07	2.01	0.37	0.22	0.05	0.15	<0.02	<0.04	7.93	26.36
7/10/07	2.10	0.34	<0.20	<0.03	0.14	<0.02	<0.04	7.70	27.60
8/7/07	3.42	0.28	<0.20	<0.03	0.08	<0.02	<0.04	7.55	30.36
9/4/07	10.10	0.29	0.27	<0.03	<0.02	<0.02	<0.04	7.68	29.24
10/2/07	6.53	0.2	<0.20	<0.03	<0.02	<0.02	<0.04	7.91	24.24

Dam Forebay
2008 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/9/08	4.63	0.46	0.33	<0.03	0.13	<0.02	NM	10.47	14.08
5/27/08	2.86	0.5	0.34	<0.03	0.16	0.02	NM	8.73	23.41
6/11/08	1.38	0.37	0.24	<0.03	0.13	0.02	NM	7.44	29.35
7/24/08	1.41	0.41	0.29	<0.03	0.12	0.03	NM	6.67	28.24
8/13/08	1.18	0.29	0.21	<0.03	0.08	<0.02	NM	7.24	27.28
9/11/08	1.3	0.24	<0.20	<0.03	0.04	0.05	NM	7.78	26.92
10/8/08	1.99	0.25	<0.20	<0.03	0.05	0.02	NM	8.58	22.64

Dam Forebay
2009 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/15/09	2.18	0.17	NA	0.03	0.17	<0.02	NM	9.97	12.36
05/27/09	1.43	0.36	0.21	<0.03	0.15	0.03	NM	8.33	21.54
06/10/09	1.48	0.36	<0.20	<0.03	0.16	<0.02	NM	7.4	26.53
07/29/09	2.71	0.33	<0.20	<0.03	0.13	0.03	NM	7.56	26.87
08/20/09	2.61	0.31	0.22	<0.03	0.09	<0.02	NM	7.16	28.48
09/23/09	5.1	0.22	<0.20	<0.03	0.02	<0.02	NM	7.52	24.74
10/21/09	3.54	0.26	<0.20	<0.03	0.06	0.02	NM	7.58	18.95

Dam Forebay
2010 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/13/10	2.41	0.48	0.21	<0.03	0.27	<0.02	<0.04	10.82	17.87
5/20/10	3.30	0.48	0.29	<0.03	0.19	<0.02	<0.04	9.55	22.16
6/10/10	4.79	0.44	0.27	<0.03	0.17	<0.02	NM	8.33	26.37
7/20/10	1.96	0.35	<0.20	<0.03	0.15	<0.02	<0.04	8.13	29.59
8/12/10	2.34	0.35	0.22	<0.03	0.14	<0.02	<0.04	8.13	31.49
9/15/10	4.19	0.25	<0.20	<0.03	0.05	<0.02	NM	7.9	27.35
10/21/10	5.53	0.27	<0.20	<0.03	0.07	<0.02	NM	8.32	20.93

Dam Forebay
2011 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/19/11	4.77	0.27	<0.20	<0.03	0.27	<0.02	NM	10.56	16.11
05/18/10	7.39	0.25	<0.20	<0.03	0.25	<0.02	NM	9.53	19.18
06/01/11	6.38	0.2	<0.20	<0.03	0.2	<0.02	NM	8.86	27.79
07/13/11	2.72	0.16	<0.20	<0.03	0.16	<0.02	NM	8.51	30.95
08/09/11	5.13	0.15	<0.20	<0.03	0.15	<0.02	NM	7.94	29.58
09/08/11	3.43	0.07	<0.20	<0.03	0.07	<0.02	NM	7.79	26.19
10/06/11	4.88	0.27	0.23	<0.03	0.04	<0.02	NM	8.38	21.98

Dam Forebay
2012 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/16/12	2.68	0.48	0.22	<0.03	0.26	<0.02	NM	10.00	18.27
05/15/12	3.53	0.26	<0.20	<0.03	0.26	<0.02	NM	9.23	21.80
06/05/12	1.92	0.19	<0.20	<0.03	0.19	<0.02	NM	8.69	24.35
07/24/12	2.48	0.14	<0.20	<0.03	0.14	<0.02	NM	8.51	30.95
08/16/12	2.16	0.37	0.27	<0.03	0.1	<0.02	NM	8.49	27.87
09/13/12	3.7	0.07	<0.20	<0.03	0.07	<0.02	NM	8.36	26.31
10/25/12	4.20	0.58	0.52	<0.03	0.06	<0.02	NM	8.87	20.79

Dam Forebay
2013 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/24/13	3.87	0.51	0.2	ND	0.31	<0.02	NM	10.00	16.52
05/07/13	2.80	0.5	0.22	ND	0.28	<0.02	NM	9.75	16.17
06/25/13	4.48	0.47	0.31	ND	0.16	<0.02	NM	8.69	24.35
07/17/13	1.19	0.28	0.22	ND	0.06	<0.02	NM	8.26	26.96
08/20/13	7.68	0.32	0.27	ND	0.05	<0.02	NM	7.63	25.20
09/24/13	7.59	0.27	0.24	ND	0.03	<0.02	NM	6.56	24.84
10/25/12	6.05	0.31	0.25	ND	0.06	<0.02	NM	6.26	21.83

Dam Forebay
2010-2013 Cattahoochee Riverkeeper Chlorophyll *a* (µg/L) Monitoring Data

Date	2010	2011	2012	2013
April		6.50	2.58	4.57
May	1.60	8.22	4.05	4.51
June	3.68	3.16	4.12	7.41
July	4.70	3.75	3.58	6.04
August	6.36	6.15	4.83	73.76
September	4.96	6.42	5..24	6.31
October	5.72	6.87	5.37	4.12

Flowery Branch
2000 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/20/00	4.65	0.35	0.17	0.04	0.18	<0.02	<0.04	11.56	16.52
05/17/00	4.01	0.39	0.22	<0.03	0.17	<0.02	<0.04	8.37	22.92
06/14/00	2.99	0.38	0.24	0.04	0.14	0.02	<0.04	7.91	27.51
07/11/00	4.29	0.32	0.20	<0.03	0.12	<0.02	<0.04	7.56	29.03
08/16/00	2.86	0.30	0.22	<0.03	0.08	<0.02	<0.04	7.66	28.96
09/13/00	2.91	0.21	0.13	<0.03	0.08	<0.02	<0.04	8.14	25.57
10/11/00	6.06	0.26	0.18	<0.03	0.08	<0.02	<0.04	8.13	20.28

Flowery Branch
2001 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (μγ/Λ)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/04/01	4.03	0.28	<0.1	0.04	0.18	<0.02	<0.04	10.53	10.91
05/09/01	7.48	0.36	0.16	<0.03	0.20	<0.02	<0.04	9.25	20.24
06/06/01	5.59	0.62	0.33	<0.03	0.29	<0.02	<0.04	7.99	24.26
07/11/01	2.79	0.31	<0.1	<0.03	0.21	<0.02	<0.04	7.28	28.17
08/08/01	5.11	0.30	0.14	<0.03	0.16	<0.02	<0.04	7.40	27.73
09/06/01	3.72	0.28	0.14	<0.03	0.14	<0.02	<0.04	7.62	27.11
10/03/01	4.19	0.21	<0.1	<0.03	0.11	<0.02	<0.04	7.73	22.67

Flowery Branch
2002 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/03/02	3.4	0.38	0.21	0.03	0.17	<0.02	<0.04	9.89	15.73
05/16/02	5.6	0.45	0.29	0.03	0.16	<0.02	<0.04	8.18	21.05
06/05/02	3.4	0.36	0.22	0.03	0.14	<0.02	<0.04	7.44	26.51
07/10/02	4.3	0.27	0.11	<0.03	0.16	<0.02	<0.04	6.91	28.71
08/07/02	4.0	0.23	<0.1	<0.03	0.13	<0.02	<0.04	7.50	28.16
09/04/02	2.9	0.29	0.22	<0.03	0.07	<0.02	<0.04	7.65	26.77
10/02/02	2.8	0.28	0.22	<0.03	0.06	<0.02	<0.04	7.09	23.32

Flowery Branch
2003 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/02/03	6.50	0.38	0.13	<0.03	0.24	<0.02	<0.04	10.20	12.39
05/06/03	3.10	0.50	0.25	0.03	0.25	<0.02	<0.04	8.79	19.48
06/04/03	3.10	0.39	0.15	<0.03	0.24	<0.02	<0.04	8.44	21.85
07/09/03	4.34	0.33	0.11	<0.03	0.22	<0.02	<0.04	8.08	27.13
08/06/03	6.19	0.31	0.11	<0.03	0.20	<0.02	<0.04	7.56	27.82
09/10/03	8.36	0.36	0.23	<0.03	0.13	<0.02	<0.04	7.53	26.38
10/08/03	8.67	0.37	0.29	<0.03	0.08	<0.02	<0.04	7.56	22.10

Flowery Branch
2004 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/15/04	4.03	0.38	0.14	<0.03	0.23	<0.02	<0.04	10.42	12.61
05/05/04	4.96	0.60	0.38	<0.03	0.22	<0.02	<0.04	9.58	17.80
06/03/04	3.10	0.47	0.28	<0.03	0.19	<0.02	<0.04	7.92	24.84
07/08/04	3.41	0.33	0.17	<0.03	0.19	<0.02	<0.04	7.54	27.61
08/04/04	2.79	0.32	0.16	<0.03	0.16	<0.02	<0.04	7.27	29.32
09/02/04	3.72	0.12	NA	<0.03	0.12	NA	<0.04	6.74	27.36
10/07/04	6.19	0.09	NA	<0.03	0.09	NA	<0.04	8.22	22.84

Flowery Branch
2005 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/13/05	5.30	0.52	0.24	<0.03	0.28	<0.02	<0.04	16.24	6.09
05/04/05	5.30	0.38	0.12	<0.03	0.26	<0.02	<0.04	9.84	17.42
06/09/05	4.30	0.52	0.28	<0.03	0.24	<0.02	<0.04	8.29	24.35
07/14/05	5.30	0.38	0.24	<0.03	0.14	<0.02	0.05	7.49	26.46
08/10/05	6.20	0.31	0.20	<0.03	0.11	<0.02	<0.04	7.48	28.32
09/14/05	8.00	0.29	0.25	<0.03	0.04	<0.02	<0.04	8.07	26.88
10/05/05	8.00	0.30	0.25	<0.03	0.05	<0.02	<0.04	7.40	24.52

Flowery Branch
2006 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/27/06	2.48	0.36	0.14	<0.03	0.22	<0.02	<0.04	8.75	19.53
05/31/06	2.48	0.34	0.14	<0.03	0.20	<0.02	<0.04	8.11	26.92
06/27/06	2.79	0.24	0.10	0.06	0.14	<0.02	<0.04	7.60	27.02
07/25/06	1.55	0.22	0.10	<0.03	0.12	0.02	<0.04	7.34	29.18
08/29/06	13.63	0.36	0.34	<0.03	0.02	<0.02	<0.04	7.48	28.32
09/26/06	4.34	0.30	0.28	<0.03	0.02	<0.02	<0.04	7.56	29.17
10/24/06	3.10	0.06	0.22	<0.03	0.06	0.06	<0.04	7.77	18.45

Flowery Branch
2007 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/17/07	2.10	0.4	<0.20	<0.03	0.20	<0.02	<0.04	10.45	12.83
05/15/07	3.70	0.47	0.28	<0.03	0.19	<0.02	<0.04	8.95	22.77
06/12/07	2.94	0.38	0.20	<0.03	0.18	<0.02	<0.04	7.94	26.40
07/10/07	3.76	0.36	<0.20	<0.03	0.16	<0.02	<0.04	7.60	27.41
08/07/07	3.57	0.31	<0.20	<0.03	0.11	<0.02	<0.04	7.45	30.41
09/04/07	6.91	0.23	<0.20	<0.03	0.03	<0.02	<0.04	7.51	28.62
10/02/07	7.62	0.23	<0.20	<0.03	0.03	<0.02	<0.04	7.88	23.76

Flowery Branch
2008 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/09/08	6.72	0.48	0.23	<0.03	0.25	<0.02	NM	10.49	13.79
05/27/08	2.48	0.5	0.3	<0.03	0.2	0.02	NM	8.54	23.68
06/11/08	1.71	0.38	0.2	<0.03	0.18	0.02	NM	7.64	29.08
07/24/08	1.23	0.38	0.25	<0.03	0.13	<0.02	NM	7.17	28.06
08/13/08	1.88	0.4	0.28	<0.03	0.12	<0.02	NM	7.25	27.71
09/11/08	1.36	0.26	0.2	<0.03	0.06	<0.02	NM	7.9	26.48
10/08/08	1.44	0.26	<0.20	<0.03	0.06	<0.02	NM	8.13	22.35

Flowery Branch
2009 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/15/09	2.34	0.21	NA	<0.03	0.21	<0.02	NM	9.81	11.8
05/27/09	1.93	0.4	<0.20	<0.03	0.2	0.1	NM	7.96	22
06/10/09	0.8	0.4	<0.20	<0.03	0.2	0.03	NM	8	26.33
07/29/09	2.33	0.33	<0.20	<0.03	0.13	0.04	NM	7.8	27.29
08/20/09	3.64	0.37	0.24	<0.03	0.13	<0.02	NM	7.33	28.39
09/23/09	5.1	0.23	<0.20	<0.03	0.03	<0.02	NM	7.58	24.35
10/21/09	2.88	0.28	<0.20	<0.03	0.08	<0.02	NM	7.37	18.98

Flowery Branch
2010 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/13/10	3.04	0.56	0.22	<0.03	0.34	<0.02	<0.04	11.07	18.13
05/20/10	2.25	0.53	0.29	<0.03	0.24	<0.02	<0.04	9.02	23.24
06/10/10	1.57	0.42	0.23	<.0.03	0.19	<0.02	NM	8.13	26.75
07/20/10	3.72	0.42	<0.20	<0.03	0.22	<0.02	<0.04	8.05	29.5
08/12/10	1.11	0.37	0.21	<0.03	0.16	<0.02	<0.04	8.04	31.05
09/15/10	5.82	0.25	<0.20	<0.03	0.05	<0.02	NM	7.52	27.46
10/21/10	4.69	0.27	<0.20	<0.03	0.07	<0.02	NM	8.18	21.02

Flowery Branch
2011 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/19/11	2.76	0.28	<0.20	<0.03	0.28	<0.02	NM	10.42	17.24
05/18/11	2.88	0.26	<0.20	<0.03	0.26	<0.02	NM	9.12	20.94
06/01/11	6.06	0.23	<0.20	<0.03	0.23	<0.02	NM	8.85	27.98
07/13/11	4.38	0.18	<0.20	<0.03	0.18	<0.02	NM	8.57	30.73
08/09/11	5.13	0.15	<0.20	0.04	0.15	<0.02	NM	8.11	30.14
09/08/11	7.02	0.04	<0.20	<0.03	0.04	<0.02	NM	8.01	26.11
10/06/11	5.34	0.03	<0.20	<0.03	0.03	<0.02	NM	8.49	22.11

Flowery Branch
2012 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/16/2012	2.93	0.24	<0.20	<0.03	0.25	<0.02	NM	9.72	19.39
5/15/2012	3.21	0.25	<0.20	<0.03	0.25	<0.02	NM	9.25	22.06
6/5/2012	2.06	0.21	<0.20	<0.03	0.21	<0.02	NM	8.7	24.2
7/24/2012	2.54	0.36	0.21	<0.03	0.15	<0.02	NM	8.57	30.73
8/16/2012	2.55	0.39	0.26	<0.03	0.13	<0.02	NM	8.43	28.05
9/13/2012	3.23	0.06	<0.20	<0.03	0.06	<0.02	NM	8.39	26.25
10/25/2012	4.20	0.27	0.21	<0.03	0.06	<0.02	NM	8.71	20.46

Flowery Branch
2013 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/24/13	2.8	0.24	0.24	ND	0.26	<0.02	NM	10.16	15.68
05/07/13	3.00	0.59	0.3	0.07	0.29	<0.02	NM	9.95	16.03
06/25/13	2.14	0.45	0.28	ND	0.17	<0.02	NM	8.70	24.20
07/16/13	0.45	0.26	0.2	ND	0.06	<0.02	NM	8.42	27.03
08/20/13	8.71	0.33	0.24	ND	0.09	<0.02	NM	7.57	25.13
09/24/13	8.22	0.3	0.25	ND	0.05	<0.02	NM	6.57	24.82
10/22/13	4.29	0.44	0.37	ND	0.07	<0.02	NM	6.54	21.70

Flowery Branch
2010-2013 Cattahoochee Riverkeeper Chlorophyll *a* (µg/L) Monitoring Data

Date	2010	2011	2012	2013
April		7.85	3.06	4.45
May	6.07	3.19	4.14	5.32
June	5.43	3.59	4.37	5.86
July	7.61	4.30	4.01	6.9
August	6.52	6.70	4.42	9.33
September	7.83	9.48	7.06	7.98
October	4.40	5.76	4.11	5.01

Browns Bridge
2000 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/20/00	6.06	0.44	0.22	<0.03	0.22	<0.02	<0.04	11.37	17.05
05/17/00	6.63	0.60	0.40	0.05	0.20	0.02	<0.04	8.84	23.33
06/14/00	5.31	0.46	0.23	0.03	0.23	<0.02	<0.04	8.05	27.99
07/11/00	6.34	0.38	0.23	<0.03	0.15	0.03	<0.04	7.76	29.72
08/16/00	5.01	0.29	0.23	<0.03	0.06	<0.02	<0.04	7.96	29.12
09/13/00	5.11	0.18	0.12	<0.03	0.06	<0.02	<0.04	8.21	26.15
10/11/00	7.37	0.19	0.13	<0.03	0.06	<0.02	<0.04	7.83	20.71

Browns Bridge
2001 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/4/2001	5.68	0.39	0.10	0.05	0.29	<0.02	<0.04	10.10	11.40
5/9/2001	8.98	0.39	0.19	<0.03	0.20	<0.02	<0.04	8.90	21.52
6/6/2001	4.03	0.64	0.40	<0.03	0.24	<0.02	<0.04	8.14	25.01
7/11/2001	<1	0.33	<0.1	<0.03	0.23	<0.02	<0.04	7.13	28.58
8/8/2001	<1	0.33	0.15	<0.03	0.18	<0.02	<0.04	7.24	28.70
9/6/2001	4.34	0.25	0.16	<0.03	0.09	<0.02	<0.04	7.36	27.58
10/3/2001	7.43	0.26	0.16	<0.03	0.10	<0.02	<0.04	7.94	22.97

Browns Bridge
2002 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/3/2002	4.6	0.44	0.21	<0.03	0.23	<0.02	<0.04	10.13	16.98
5/16/2002	9.3	0.44	0.28	<0.03	0.16	<0.02	<0.04	8.58	22.13
6/5/2002	3.4	0.30	0.18	<0.03	0.12	<0.02	<0.04	7.44	26.51
7/10/2002	3.4	0.24	0.20	<0.03	0.04	0.02	0.07	7.41	28.93
8/7/2002	6.2	0.16	0.10	<0.03	0.06	<0.02	<0.04	7.33	28.59
9/4/2002	5.8	0.25	0.16	<0.03	0.09	<0.02	<0.04	7.36	27.58
10/2/2002	3.9	0.27	0.24	<0.03	0.03	0.02	<0.04	7.43	23.76

Browns Bridge
2003 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/2/2003	7.12	0.55	0.21	<0.03	0.34	<0.02	<0.04	10.60	13.01
5/6/2003	5.88	0.52	0.24	0.04	0.28	<0.02	<0.04	8.44	19.79
6/4/2003	7.43	0.44	0.23	<0.03	0.21	<0.02	<0.04	8.44	22.88
7/9/2003	5.27	0.38	0.17	<0.03	0.21	<0.02	<0.04	8.02	28.04
8/6/2003	7.12	0.31	0.10	<0.03	0.21	<0.02	<0.04	7.71	28.30
9/10/2003	8.98	0.33	0.21	<0.03	0.12	<0.02	<0.04	7.37	26.87
10/8/2003	8.36	0.34	0.26	<0.03	0.08	<0.02	<0.04	6.49	22.10

Browns Bridge
2004 Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/15/2004	6.81	0.50	0.25	<0.03	0.25	<0.02	<0.04	10.33	14.39
5/5/2004	5.88	0.55	0.32	<0.03	0.23	<0.02	<0.04	9.76	19.01
6/3/2004	2.48	0.53	0.32	<0.03	0.21	<0.02	<0.04	7.96	26.28
7/8/2004	1.86	0.40	0.19	<0.03	0.21	<0.02	<0.04	7.52	28.16
8/4/2004	3.72	0.39	0.23	<0.03	0.16	<0.02	<0.04	7.15	30.10
9/2/2004	6.50	0.08	NA	<0.03	0.08	NA	<0.04	6.79	27.33
10/7/2004	3.41	0.10	NA	<0.03	0.10	NA	<0.04	8.55	22.73

Browns Bridge
2005 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/13/2005	9.30	0.66	0.32	<0.03	0.34	<0.02	<0.04	10.19	16.74
5/4/2005	8.70	0.47	0.18	<0.03	0.29	<0.02	<0.04	9.93	17.90
6/9/2005	4.30	0.51	0.26	<0.03	0.25	<0.02	<0.04	8.36	25.47
7/14/2005	3.70	0.28	0.24	<0.03	0.04	0.04	<0.04	7.72	26.61
8/10/2005	9.90	0.28	0.22	<0.03	0.06	<0.02	<0.04	8.18	28.13
9/14/2005	8.70	0.25	0.21	<0.03	0.04	<0.02	<0.04	8.20	27.03
10/5/2005	11.00	0.25	0.21	<0.03	0.04	<0.02	<0.04	7.38	24.91

Browns Bridge
2006 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/27/2006	2.79	0.62	0.41	<0.03	0.21	<0.02	<0.04	8.90	21.03
5/31/2006	3.72	0.47	0.18	<0.03	0.29	<0.02	<0.04	8.23	27.36
6/27/2006	4.34	0.20	0.15	0.05	0.05	<0.02	<0.04	7.79	27.57
7/25/2006	4.65	0.32	0.22	<0.02	0.10	<0.02	<0.04	7.79	29.52
8/29/2006	11.15	0.03	0.24	<0.03	0.06	<0.02	<0.04	8.18	28.13
9/26/2006	3.72	0.24	0.21	<0.03	0.03	<0.02	<0.04	7.43	24.36
10/24/2006	3.48	0.29	0.26	<0.03	0.03	0.06	<0.04	7.15	18.86

Browns Bridge
2007 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/17/2007	2.70	0.46	0.22	<0.03	0.24	<0.02	<0.04	9.79	13.48
5/15/2007	4.06	0.42	0.23	<0.03	0.19	<0.02	<0.04	8.85	24.45
6/12/2007	3.58	0.36	<0.20	<0.03	0.16	<0.02	<0.04	8.23	26.78
7/10/2007	3.78	0.34	<0.20	<0.03	0.14	<0.02	<0.04	7.97	27.80
8/7/2007	5.27	0.27	<0.20	<0.03	0.07	<0.02	<0.04	7.86	30.60
9/4/2007	6.06	0.23	0.20	<0.03	0.03	0.02	<0.04	7.35	29.18
10/2/2007	5.75	0.22	<0.20	<0.03	<0.02	<0.02	<0.04	7.60	24.14

Browns Bridge
2008 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/09/08	11.02	0.73	0.32	<0.03	0.41	<0.02	NM	10.6	14.19
05/27/08	2.62	0.6	0.33	<0.03	0.27	<0.02	NM	8.65	24.32
06/11/08	2.82	0.44	<0.20	<0.03	0.24	<0.02	NM	7.5	29.58
07/24/08	1.62	0.39	0.22	0.05	0.17	0.05	NM	7.24	28.58
08/13/08	1.97	0.31	0.23	<0.03	0.08	<0.02	NM	7.38	27.79
09/11/08	1.39	0.22	<0.20	<0.03	<0.02	<0.02	NM	8.04	26.69
10/08/08	6.51	0.22	<0.20	<0.03	0.02	<0.02	NM	8.09	22.34

Browns Bridge
2009 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/15/09	2.99	0.32	NA	<0.03	0.32	<0.02	NM	9.67	13.72
05/27/09	1.35	0.44	<0.20	<0.03	0.24	0.07	NM	8.43	21.45
06/10/09	4.47	0.52	0.32	<0.03	0.2	<0.02	NM	7.85	26.89
07/29/09	3.26	0.32	<0.20	<0.03	0.12	0.04	NM	7.54	27.63
08/20/09	5.28	0.28	0.24	<0.03	0.04	0.03	NM	7.57	28.93
09/23/09	5.88	0.22	<0.20	<0.03	<0.02	0.04	NM	7.32	24.64
10/21/09	7.68	0.36	0.24	<0.03	0.12	0.03	NM	7.12	19.32

Browns Bridge
2010 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/13/10	5.85	0.58	0.24	<0.03	0.34	<0.02	<0.04	12.25	18.24
05/20/10	6.23	0.57	0.3	<0.03	0.27	<0.02	<0.04	9.29	23.48
06/10/10	1.76	0.48	0.24	0.04	0.24	<0.02	NM	8.32	27.26
07/20/10	3.31	0.41	<0.20	,0.03	0.21	<0.02	<0.04	8.16	30.29
08/12/10	2.78	0.38	0.23	<0.03	0.15	<0.02	<0.04	8.18	31.59
09/15/10	9.18	0.22	<0.20	<0.03	<0.02	<0.02	NM	NM	27.29
10/21/10	5.59	0.25	<0.20	<0.03	0.05	<0.02	NM	8.05	21.29

Browns Bridge
2011 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/20/11	6. 88	0.62	0.3	<0.03	0.32	<0.02	NM	10.39	18.50
05/17/11	5.76	0.26	<0.20	<0.03	0.26	<0.02	NM	9.56	21.48
06/08/11	3.02	0.43	0.2	<0.03	0.23	<0.02	NM	8.67	29.58
07/19/11	6.60	0.14	<0.20	<0.03	0.14	<0.02	NM	9.18	28.60
08/10/11	6.40	0.09	<0.20	<0.03	0.09	<0.02	NM	8.24	30.17
09/21/11	8.40	0.26	0.26	<0.03	<0.02	<0.02	NM	7.93	24.09
10/26/11	3.71	0.04	<0.20	<0.03	0.04	<0.02	NM	8.75	18.88

Browns Bridge
2012 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/18/2012	5.78	0.25	<0.20	<0.03	0.25	<0.02	NM	10.39	19.8
5/17/2012	5.19	0.25	<0.20	<0.03	0.25	<0.02	NM	9.14	24.27
6/14/2012	4.72	0.18	<0.20	<0.03	0.18	<0.02	NM	9	25.87
7/17/2012	1.93	0.33	0.21	<0.03	0.12	<0.02	NM	8.33	29.51
8/14/2012	4.53	0.07	<0.20	<0.03	0.07	<0.02	NM	8.49	28.58
9/11/2012	3.83	0.03	<0.20	<0.03	0.03	<0.02	NM	8.12	27.34
10/23/2012	3.94	0.33	0.27	0.03	0.06	<0.02	NM	8.24	20.72

Browns Bridge
2013 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/23/13	7.91	0.58	0.25	<0.03	0.33	<0.02	NM	10.43	16.56
05/08/13	8.03	0.52	0.21	<0.03	0.31	<0.02	NM	10.09	16.14
06/25/13	2.54	0.38	0.24	<0.03	0.14	<0.02	NM	9.00	25.87
07/17/13	1.49	0.34	0.24	<0.03	0.1	<0.02	NM	8.33	29.51
08/20/13	10.61	0.28	0.22	<0.03	0.06	<0.02	NM	1.00	7.60
09/24/13	6.02	0.28	0.23	<0.03	0.05	<0.02	NM	6.67	24.83
10/15/13	9.75	0.05	ND	<0.03	0.05	<0.02	NM	7.55	22.91

Browns Bridge
2010-2013 Cattahoochee Riverkeeper Chlorophyll *a* (µg/L) Monitoring Data

Date	2010	2011	2012	2013
April		9.20	4.42	6.14
May	4.64	5.34	4.81	5.91
June	7.84	4.92	4.93	5.76
July	5.80	5.73	4.71	7.41
August	8.05	9.99	6.18	9.87
September	11.52	7.54	7.82	10.00
October	4.49	7.37	3.57	6.17

Boling Bridge
2000 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/20/00	5.64	0.38	0.17	<0.03	0.21	<0.04	<0.02	10.37	18.25
05/17/00	8.02	0.39	0.21	<0.03	0.18	<0.04	0.02	8.91	23.75
06/14/00	5.84	0.34	0.21	0.07	0.13	<0.04	<0.02	8.24	28.69
07/11/00	6.01	0.26	0.21	<0.03	0.05	<0.04	<0.02	7.77	30.15
08/16/00	4.45	0.23	0.21	<0.03	0.02	<0.04	<0.02	7.71	29.02
09/13/00	6.68	0.13	0.11	<0.03	<0.02	<0.04	<0.02	8.07	26.89
10/11/00	4.77	0.19	0.17	0.04	<0.02	<0.04	<0.02	6.76	20.56

Boling Bridge
2001 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/4/2001	7.50	NM	NM	<0.03	0.34	0.03	<0.04	10.62	12.39
5/9/2001	7.42	0.34	<0.1	<0.03	0.24	<0.02	<0.04	8.44	22.92
6/6/2001	4.40	0.42	0.26	<0.03	0.16	<0.02	<0.04	7.85	25.35
7/11/2001	<1	0.22	<0.1	<0.03	0.12	<0.02	<0.04	7.58	29.85
8/8/2001	<1	0.27	0.20	<0.03	0.07	<0.02	<0.04	7.75	29.14
9/6/2001	5.14	0.19	0.17	<0.03	<0.02	<0.02	<0.04	7.40	28.06
10/3/2001	9.60	0.20	<0.1	<0.03	0.10	<0.02	<0.04	7.49	23.46

Boling Bridge
2002 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/3/2002	3.4	0.35	0.19	<0.03	0.16	<0.02	<0.04	10.16	17.24
5/16/2002	16.0	0.38	0.31	<0.03	0.07	<0.02	<0.04	8.93	22.96
6/5/2002	5.3	0.25	0.19	<0.03	0.06	0.03	<0.04	7.60	28.42
7/10/2002	7.4	0.20	0.16	0.03	0.04	0.04	<0.04	7.20	29.63
8/7/2002	5.0	0.14	0.12	<0.03	<0.02	<0.02	<0.04	7.05	29.60
9/4/2002	5.7	0.16	0.14	<0.03	<0.02	<0.02	<0.04	7.14	27.65
10/2/2002	5.2	0.20	0.18	<0.03	<0.02	<0.02	<0.04	7.19	24.34

Boling Bridge
2003 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/2/2003	8.98	0.60	0.34	<0.03	0.26	0.02	<0.04	9.86	14.15
5/6/2003	6.50	0.48	0.24	0.03	0.24	0.02	<0.04	8.07	20.41
6/4/2003	11.15	0.32	0.18	<0.03	0.14	<0.02	<0.04	8.47	23.29
7/9/2003	8.05	0.24	0.15	<0.03	0.09	<0.02	<0.04	8.71	28.31
8/6/2003	11.15	0.16	0.12	<0.03	0.04	<0.02	<0.04	8.01	28.68
9/10/2003	7.12	0.21	0.16	<0.03	0.05	<0.02	<0.04	7.21	27.73
10/8/2003	10.22	0.30	0.27	<0.03	0.03	<0.02	<0.04	6.73	22.20

Boling Bridge
2004 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/15/2004	9.60	0.60	0.23	<0.03	0.22	<0.02	<0.04	10.11	15.21
5/5/2004	6.81	0.54	0.35	<0.03	0.19	<0.02	<0.04	9.59	19.57
6/3/2004	2.17	0.49	0.33	<0.03	0.16	<0.02	<0.04	8.26	26.62
7/8/2004	3.10	0.31	0.20	<0.03	0.11	<0.02	<0.04	7.63	29.38
8/4/2004	1.00	0.25	0.19	<0.03	0.06	<0.02	<0.04	7.08	30.75
9/2/2004	3.72	NM	NM	<0.03	<0.02	NM	<0.04	6.68	27.60
10/7/2004	8.36	NM	NM	<0.03	0.04	NM	<0.04	7.93	22.85

Boling Bridge
2005 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/13/2005	7.10	0.58	0.30	<0.03	0.28	<0.02	<0.04	10.37	18.04
5/4/2005	8.40	0.39	0.17	<0.03	0.22	<0.02	<0.04	9.82	18.80
6/9/2005	6.20	0.40	0.24	0.04	0.16	<0.02	<0.04	7.92	26.28
7/14/2005	9.60	0.45	0.25	<0.03	0.20	0.05	<0.04	7.88	27.35
8/10/2005	9.60	0.22	0.18	<0.03	0.04	<0.02	<0.04	8.27	28.67
9/14/2005	6.50	0.17	0.17	<0.03	<0.02	<0.02	<0.04	7.77	27.30
10/5/2005	6.20	0.20	0.20	<0.03	<0.02	<0.02	<0.04	7.16	25.55

Boling Bridge
2006 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/27/2006	2.48	0.23	0.24	<0.03	0.28	<0.02	<0.04	8.72	21.82
5/31/2006	3.41	0.26	0.10	<0.03	0.16	<0.02	<0.04	8.06	28.05
6/27/2006	2.79	0.40	0.24	<0.03	0.16	<0.02	<0.04	7.96	27.09
7/25/2006	5.88	0.26	0.19	<0.03	0.07	0.06	<0.04	7.60	29.99
8/29/2006	5.57	0.04	0.02	<0.03	0.02	<0.02	<0.04	7.91	29.62
9/26/2006	4.96	0.17	0.02	<0.03	<0.02	<0.02	<0.04	7.03	24.92
10/24/2006	2.17	0.15	0.13	0.06	0.02	<0.02	<0.04	7.09	18.76

Boling Bridge
2007 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/17/2007	3.60	0.49	0.24	<0.03	0.25	<0.02	<0.04	9.92	13.65
5/15/2007	7.64	0.40	0.26	<0.03	0.14	0.03	<0.04	9.07	24.40
6/12/2007	2.80	0.36	0.28	<0.03	0.08	<0.02	<0.04	8.01	27.76
7/10/2007	6.80	0.24	<0.20	<0.03	0.04	<0.02	<0.04	7.96	28.69
8/7/2007	4.58	0.22	<0.20	<0.03	<0.02	<0.02	<0.04	7.43	31.29
9/4/2007	7.05	0.29	0.27	<0.03	<0.02	<0.02	<0.04	6.82	29.25
10/2/2007	7.56	0.22	<0.20	<0.03	<0.02	<0.02	<0.04	7.33	24.84

Boling Bridge
2008 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/09/08	8.16	0.58	0.27	<0.03	0.31	<0.02	NM	10.7	15.15
05/27/08	3.28	0.51	0.31	<0.03	0.2	<0.02	NM	8.64	24.92
06/11/08	2.33	0.38	0.21	<0.03	0.17	0.02	NM	7.22	30.35
07/24/08	3.17	0.28	0.25	<0.03	0.03	<0.02	NM	7.46	29.26
08/13/08	2.09	0.22	0.2	<0.03	<0.02	<0.02	NM	6.77	28.24
09/11/08	1.77	0.22	<0.20	<0.03	<0.02	<0.02	NM	7.94	27.19
10/08/08	6.65	0.22	<0.20	<0.03	<0.02	<0.02	NM	7.74	22.56

Boling Bridge
2009 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/15/09	2.19	0.26	NA	<0.03	0.26	<0.02	NM	9.44	14.51
05/27/09	3.24	0.39	0.22	<0.03	0.17	0.04	NM	8.26	22.89
06/10/09	2.45	0.13	<0.20	<0.03	0.13	<0.02	NM	7.76	27.68
07/29/09	4.74	0.23	<0.20	<0.03	0.03	0.02	NM	7.65	28.16
08/20/09	8.56	<0.22	<0.20	<0.03	<0.02	0.04	NM	7.1	29.29
09/23/09	11.58	0.22	<0.20	<0.03	<0.02	0.02	NM	7.36	25.34
10/21/09	7.99	0.26	<0.20	<0.03	0.06	0.03	NM	7.33	19.1

Boling Bridge
2010 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/13/10	3.53	0.48	<0.20	<0.03	0.28	<0.02	<0.04	10.39	19.02
05/20/10	3.38	0.41	0.20	<0.03	0.21	<0.02	<0.04	9.03	24.3
06/10/10	4.51	0.37	0.26	<0.03	0.11	<0.02	NM	8.63	27.86
07/20/10	1.66	0.31	<0.20	<0.03	0.11	<0.02	<0.04	8.29	30.38
08/12/10	3.86	0.25	<0.20	<0.03	0.05	<0.02	<0.04	8.31	31.84
09/15/10	6.94	0.22	<0.20	<0.03	<0.02	<0.02	NM	NM	27.26
10/21/10	7.59	0.22	<0.20	<0.03	0.02	<0.02	NM	7.96	21.07

Boling Bridge
2011 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/20/11	5.98	0.49	0.25	<0.03	0.24	<0.02	NM	10.19	18.59
05/17/11	6.47	0.17	<0.20	<0.03	0.17	<0.02	NM	9.46	22.13
06/08/11	4.33	0.14	<0.20	<0.03	0.14	<0.02	NM	8.53	30.01
07/19/11	8.24	0.03	<0.20	<0.03	0.03	<0.02	NM	9.10	29.47
08/10/11	7.54	0	<0.20	<0.03	<0.02	<0.02	NM	8.01	30.48
09/21/11	8.32	0.23	0.23	<0.03	<0.02	<0.02	NM	7.08	24.13
10/26/11	5.00	0	<0.20	0.06	<0.02	<0.02	NM	7.76	18.59

Boling Bridge
2012 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/18/2012	7.50	0.2	<0.20	<0.03	0.2	<0.02	NM	10.54	20.37
5/17/2012	4.56	0.18	<0.20	<0.03	0.18	<0.02	NM	9.4	23.82
6/14/2012	5.75	0.31	0.21	<0.03	0.1	<0.02	NM	9.03	26.5
7/17/2012	4.25	0.03	<0.20	<0.03	0.03	<0.02	NM	8.48	29.61
8/14/2012	5.26	0	<0.20	<0.03	<0.02	<0.02	NM	7.88	28.34
9/11/2012	5.00	0	<0.20	<0.03	<0.02	<0.02	NM	7.61	27.39
10/23/2012	5.06	0.04	<0.20	<0.03	0.04	<0.02	NM	8.04	20.53

Boling Bridge
2013 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/23/13	9.79	0.5	0.26	<0.03	0.24	<0.02	NM	10.07	17.95
05/08/13	12.45	0.38	0.20	<0.03	0.18	<0.02	NM	9.68	17.30
06/25/13	7.59	0.26	0.26	<0.03	<0.02	<0.02	NM	9.03	26.50
07/17/13	3.37	0.3	0.30	<0.03	<0.02	<0.02	NM	8.48	29.61
08/20/13	10.00	0.39	0.37	<0.03	0.02	<0.02	NM	7.98	25.66
09/24/13	12.86	0.24	0.24	<0.03	<0.02	<0.02	NM	6.97	25.06
10/15/13	12.60	0	<0.20	<0.03	<0.02	<0.02	NM	7.74	22.99

Boling Bridge
2010-2013 Cattahoochee Riverkeeper Chlorophyll *a* (µg/L) Monitoring Data

Date	2010	2011	2012	2013
April		8.59	7.03	11.52
May	3.49	5.37	5.09	5.13
June	3.56	6.25	6.35	6.93
July	6.19	6.24	5.39	9.38
August	10.03	5.92	4.30	11.00
September	11.97	8.31	7.16	8.33
October	6.92	7.17	4.47	9.61

Lanier Bridge
2000 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/20/00	19.12	0.65	0.36	0.18	0.29	0.02	<0.04	11.44	18.84
05/17/00	8.07	0.59	0.30	<0.03	0.29	<0.02	<0.04	8.88	24.41
06/14/00	10.09	0.36	0.25	0.03	0.11	<0.02	<0.04	8.40	29.14
07/11/00	7.61	0.28	0.24	<0.03	0.04	<0.02	<0.04	7.89	30.53
08/16/00	5.57	0.31	0.28	<0.03	0.03	<0.02	<0.04	7.83	29.66
09/13/00	10.95	0.15	0.13	<0.03	<0.02	<0.02	<0.04	8.34	26.33
10/11/00	6.92	0.30	0.28	0.11	<0.02	<0.02	<0.04	6.34	21.01

Lanier Bridge
2001 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/4/2001	12.39	0.72	0.20	<0.03	0.52	0.03	<0.04	10.39	12.65
5/9/2001	12.69	0.49	0.32	<0.03	0.17	0.02	<0.04	9.80	21.88
6/6/2001	4.65	0.42	0.24	<0.03	0.18	<0.02	<0.04	7.72	26.19
7/11/2001	4.34	0.19	0.10	<0.03	0.09	<0.02	<0.04	7.28	30.61
8/8/2001	9.91	0.32	0.25	<0.03	0.07	<0.02	<0.04	7.42	29.82
9/6/2001	8.67	0.22	0.20	<0.03	<0.02	0.02	<0.04	7.53	28.17
10/3/2001	11.77	0.22	0.20	<0.03	<0.02	<0.02	<0.04	8.00	23.44

Lanier Bridge
2002 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/3/2002	3.4	0.50	0.28	<0.03	0.22	0.02	<0.04	10.39	17.69
5/16/2002	17.0	0.47	0.33	<0.03	0.14	<0.02	<0.04	9.28	23.07
6/5/2002	7.4	0.32	0.24	0.04	0.08	0.02	<0.04	8.47	28.74
7/10/2002	13.0	0.24	0.20	<0.03	0.04	0.02	0.07	7.45	29.45
8/7/2002	8.7	0.18	0.16	<0.03	<0.02	<0.02	<0.04	7.24	29.34
9/4/2002	6.2	0.20	0.18	<0.03	<0.02	0.02	<0.04	7.39	28.07
10/2/2002	9.7	0.27	0.24	<0.03	0.03	0.02	<0.04	8.10	24.01

Lanier Bridge
2003 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/2/2003	11.77	0.82	0.38	<0.03	0.44	0.02	<0.04	10.61	14.30
5/6/2003	6.81	0.74	0.36	0.03	0.38	0.02	<0.04	8.34	20.56
6/4/2003	12.55	0.42	0.26	<0.03	0.16	<0.02	<0.04	9.14	23.51
7/9/2003	9.29	0.36	0.22	<0.03	0.14	<0.02	<0.04	8.23	28.72
8/6/2003	8.52	0.37	0.27	<0.03	0.10	<0.02	<0.04	7.76	28.83
9/10/2003	10.69	0.31	0.26	<0.03	0.05	<0.02	<0.04	7.67	27.18
10/8/2003	13.94	0.38	0.31	<0.03	0.07	<0.02	<0.04	7.54	22.11

Lanier Bridge
2004 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/15/2004	9.29	0.60	0.28	<0.03	0.32	<0.02	<0.04	10.05	14.81
5/5/2004	8.36	0.60	0.34	<0.03	0.26	<0.02	<0.04	9.87	19.88
6/3/2004	7.90	0.50	0.33	<0.03	0.17	<0.02	<0.04	8.07	26.94
7/8/2004	5.42	0.33	0.17	<0.03	0.16	<0.02	<0.04	7.96	28.87
8/4/2004	5.27	0.63	0.50	<0.03	0.13	<0.02	<0.04	7.13	30.92
9/2/2004	3.72	NM	NM	<0.03	0.04	NM	<0.04	6.52	27.20
10/7/2004	13.32	NM	NM	<0.03	0.09	NM	<0.04	8.63	22.86

Lanier Bridge
2005 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (µg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/13/2005	17.00	0.88	0.41	0.05	0.47	0.03	<0.04	12.05	18.73
5/4/2005	20.00	0.53	0.29	<0.03	0.24	0.02	<0.04	10.49	19.34
6/9/2005	9.30	0.53	0.28	<0.03	0.25	<0.02	<0.04	8.62	26.64
7/14/2005	8.00	0.41	0.28	<0.03	0.13	0.05	<0.04	7.58	27.55
8/10/2005	6.50	0.32	0.27	0.04	0.05	<0.02	<0.04	7.89	28.31
9/14/2005	8.70	0.30	0.22	<0.03	0.08	<0.02	<0.04	8.42	27.29
10/5/2005	9.60	0.33	0.28	<0.03	0.05	<0.02	<0.04	7.36	24.87

Lanier Bridge
2006 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/27/2006	3.72	0.50	0.26	<0.03	0.24	<0.02	<0.04	8.63	21.79
5/31/2006	10.84	0.31	0.15	<0.03	0.16	0.02	<0.04	8.05	28.06
6/27/2006	6.97	0.20	0.15	0.05	0.05	<0.02	0.05	8.00	28.14
7/25/2006	1.00	0.35	0.28	<0.03	0.07	0.06	<0.04	7.32	30.30
8/29/2006	8.67	0.33	0.27	0.04	0.06	<0.02	<0.04	8.75	29.66
9/26/2006	4.03	0.30	0.22	<0.03	0.08	<0.02	<0.04	7.04	24.88
10/24/2006	4.03	0.24	0.16	<0.03	0.08	<0.02	<0.04	6.48	18.90

Lanier Bridge
2007 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
4/17/2007	8.10	0.58	0.23	<0.03	0.35	<0.02	<0.04	10.26	14.31
5/15/2007	5.21	0.49	0.28	<0.03	0.21	<0.02	<0.04	8.97	24.72
6/12/2007	10.49	0.41	0.29	<0.03	0.12	<0.02	<0.04	8.50	27.72
7/10/2007	8.72	0.3	0.24	<0.03	0.06	<0.02	<0.04	8.47	28.02
8/7/2007	10.38	0.34	0.32	<0.03	<0.02	<0.02	<0.04	7.27	31.46
9/4/2007	6.09	0.22	<0.20	<0.03	<0.02	0.03	<0.04	6.93	29.67
10/2/2007	8.82	0.22	<0.20	<0.03	<0.02	<0.02	<0.04	7.22	24.50

Lanier Bridge
2008 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/09/08	14.6	0.88	0.32	<0.03	0.56	<0.02	NM	11.09	15.1
05/27/08	5.61	0.64	0.36	<0.03	0.28	0.04	NM	8.91	25.57
06/11/08	3.01	0.45	0.22	<0.03	0.23	<0.02	NM	7.96	30.44
07/24/08	3.49	0.37	0.31	<0.03	0.06	<0.02	NM	7.01	29.26
08/13/08	5.48	0.32	0.3	<0.03	<0.02	<0.02	NM	6.7	28.47
09/11/08	6.1	0.22	<0.20	<0.03	<0.02	0.04	NM	8.02	26.82
10/08/08	6.05	0.26	0.21	<0.03	0.05	<0.02	NM	7.5	22.38

Lanier Bridge
2009 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/15/09	7.23	0.51	NA	<0.03	0.51	<0.02	NM	9.68	14.75
05/27/09	6.99	0.53	0.233	<0.03	0.3	0.06	NM	8.58	22.73
06/10/09	7.01	0.55	0.31	<0.03	0.24	<0.02	NM	7.89	27.82
07/29/09	5.54	0.24	<0.20	<0.03	0.04	0.04	NM	7.51	28.04
08/20/09	6.3	0.27	0.25	<0.03	<0.02	0.03	NM	7.31	29.1
09/23/09	8.13	0.23	<0.20	<0.03	0.03	0.03	NM	7.67	24.78
10/21/09	12.69	0.5	0.27	<0.03	0.23	0.03	NM	7.44	19.07

Lanier Bridge
2010 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (mg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/13/10	5.97	0.68	0.24	<0.03	0.44	0.03	<0.04	12.05	20.21
05/20/10	4.96	0.66	0.28	<0.03	0.38	0.02	<0.04	9.24	24.61
06/10/10	2.56	0.53	0.25	<0.03	0.28	<0.02	NM	8.81	27.97
07/20/10	2.68	0.36	<0.20	<0.03	0.16	0.34	<0.04	8.37	30.75
08/12/10	2.90	0.32	0.2	<0.03	0.12	<0.02	<0.04	8.24	31.94
09/15/10	12.37	0.22	<0.20	<0.03	<0.02	<0.02	NM	NM	27.32
10/21/10	9.84	0.35	0.31	<0.03	0.04	<0.02	NM	8.18	21.31

Lanier Bridge
2011 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/20/11	6.53	0.62	0.25	<0.03	0.37	0.02	NM	10.19	19.10
05/17/11	6.09	0.26	<0.20	<0.03	0.26	<0.02	NM	9.30	22.40
06/08/11	5.23	0.22	<0.20	<0.03	0.22	<0.02	NM	9.10	29.70
07/19/11	10.49	0.09	<0.20	<0.03	0.09	<0.02	NM	9.08	29.09
08/10/11	8.18	0.04	<0.20	<0.03	0.04	<0.02	NM	8.11	30.51
09/21/11	9.20	0.26	0.26	0.08	ND	<0.02	NM	7.01	23.81
10/26/11	8.57	0.1	<0.20	0.07	0.1	<0.02	NM	8.24	18.56

Lanier Bridge
2012 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/18/12	9.01	0.3	<0.20	<0.03	0.3	<0.02	NM	10.36	20.15
05/17/12	6.53	0.28	<0.20	<0.03	0.28	<0.02	NM	9.63	23.97
06/14/12	5.82	0.35	0.2	<0.03	0.15	<0.02	NM	9.06	26.17
07/17/12	5.59	0.3	0.24	<0.03	0.06	<0.02	NM	8.69	29.33
08/14/12	4.31	0.23	0.23	<0.03	<0.02	0.02	NM	8.04	28.19
09/11/12	6.73	0.26	0.26	0.05	<0.02	<0.02	NM	7.66	27.37
10/23/12	6.12	0.42	0.34	<0.03	0.08	<0.02	NM	8.27	20.32

Lanier Bridge
2013 EPD Water Quality Monitoring Data

Date	Chlorophyll *a* (μg/L)	Total N (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2/NO3 (mg/L)	Total P (mg/L)	Ortho P (mg/L)	DO (mg/L)	Water Temp (deg C)
04/23/13	8.16	0.81	0.37	<0.03	0.44	<0.02	NM	9.95	17.43
05/08/13	12.07	0.68	0.3	<0.03	0.38	0.02	NM	9.89	16.70
06/25/13	6.17	0.29	0.29	<0.03	<0.02	<0.02	NM	9.06	26.17
07/17/13	10.27	0.48	0.33	<0.03	0.15	0.02	NM	8.69	29.33
08/20/13	17.11	0.42	0.31	<0.03	0.11	<0.02	NM	8.10	25.13
09/24/13	5.94	0.33	0.31	<0.03	0.02	<0.02	NM	7.31	24.98
10/15/13	14.38	0.3	0.24	<0.03	0.06	<0.02	NM	7.95	22.98

Lanier Bridge
2010-2013 Cattahoochee Riverkeeper Chlorophyll *a* (μg/L) Monitoring Data

Date	2010	2011	2012	2013
April		6.79	6.43	9.41
May	6.59	6.37	9.65	13.00
June	8.02	7.58	6.11	7.37
July	7.00	9.50	6.83	10.63
August	10.74	9.51	5.52	11.00
September	13.15	9.87	8.61	12.00
October	9.80	11.00	7.70	11.00

Appendix B

Average Annual Growing Season Chlorophyll *a* Plots

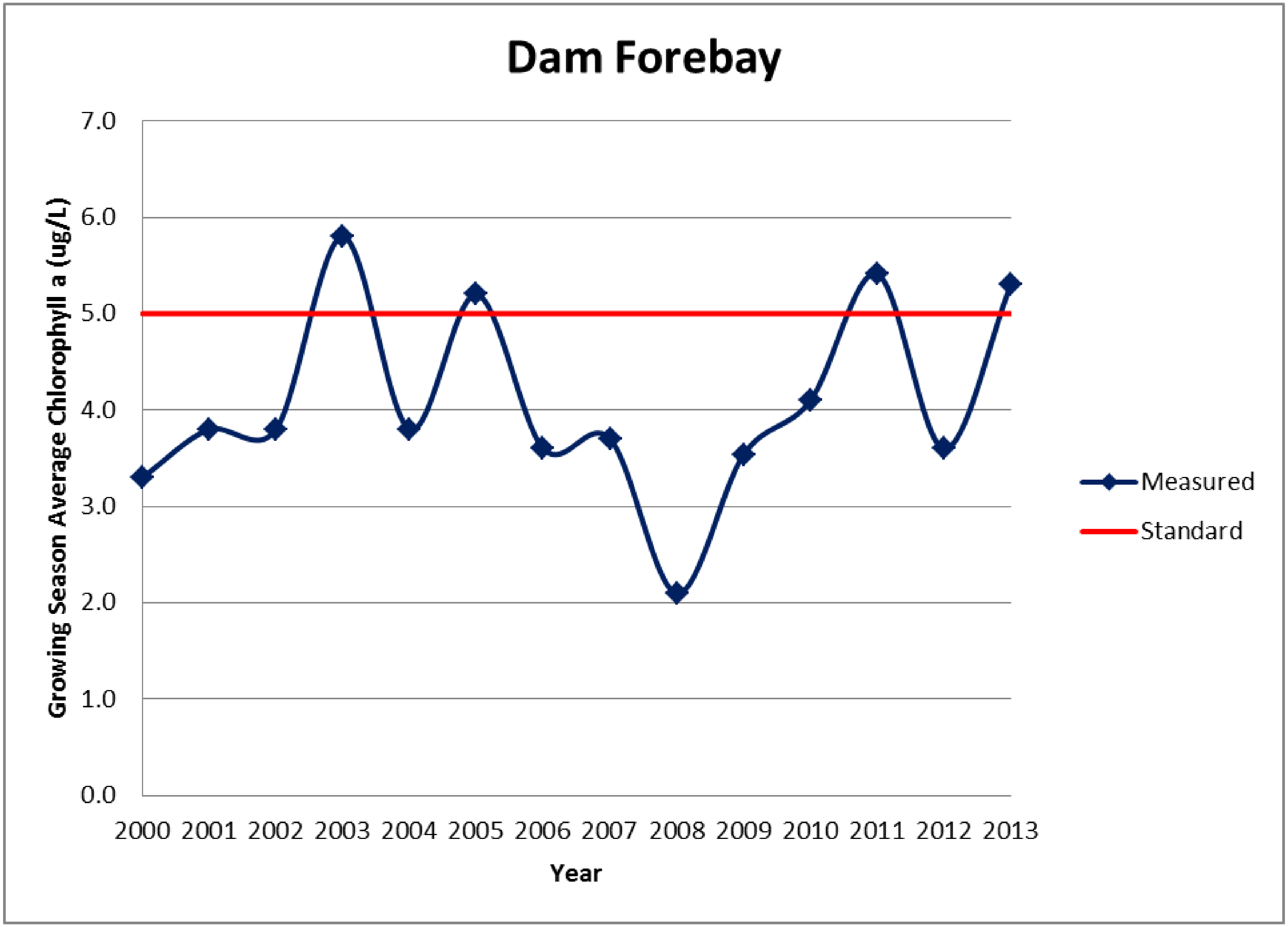
Average Annual Growing Season Chlorophyll *a* (ug/L)

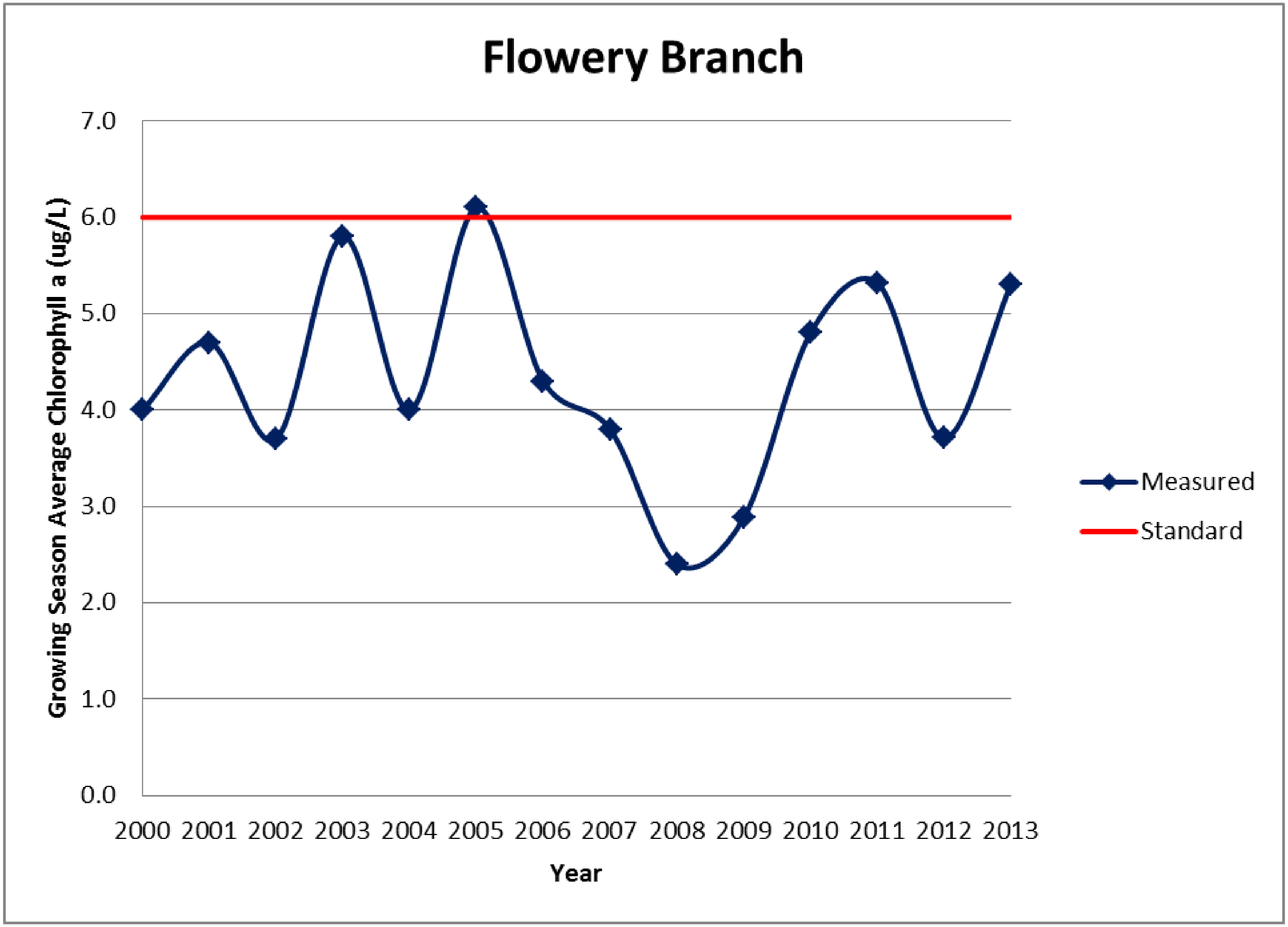
	Standard	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
US Dam Forebay	5	3.3	3.8	3.8	5.8	3.8	5.1	3.6	4.4	2.1	2.7	4.1	5.4	3.6	5.3
Flowery Branch	6	4.0	4.7	3.8	5.8	4.0	6.1	4.3	4.4	2.4	2.7	4.8	5.3	3.7	5.3
Browns Bridge	7	6.0	6.1	5.2	7.2	4.4	7.9	4.8	4.5	4.0	4.4	5.9	6.5	4.7	7.0
Boling Bridge	10	5.9		6.8	9.0	5.0	7.7	3.9	4.9	3.9	5.8	5.7	6.7	5.5	9.3
Lanier Bridge	10	9.8	9.2	9.3	10.5	7.6	11.1	5.6	7.3	6.3	7.7	7.4	8.2	6.8	10.6

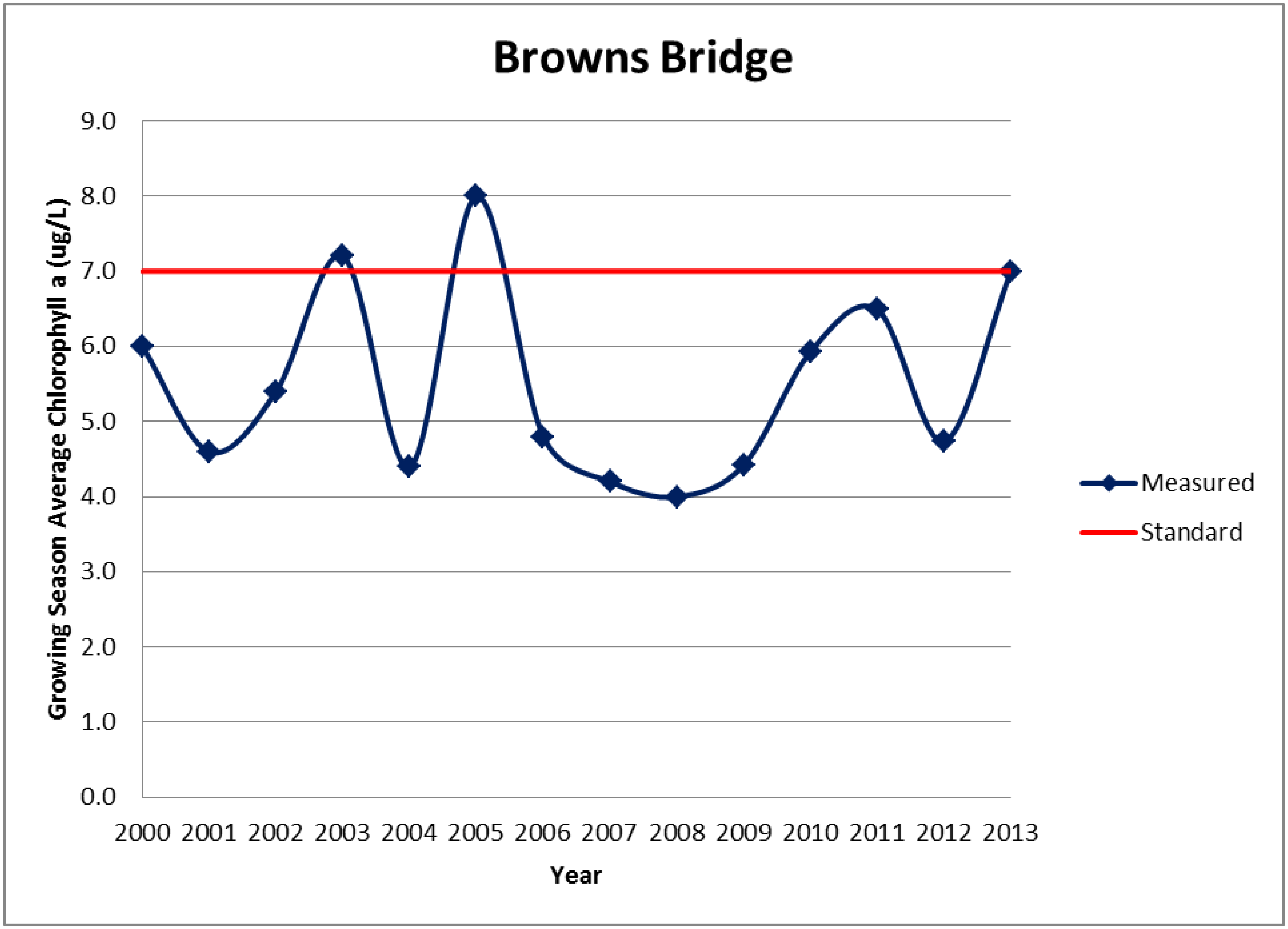
-Growing Season defined as April through October seven month period
-For Years 2000-2006, chlorophyll a is corrected for Pheophytin a Using Spectrophotometric Method. For 2007 and later, Fluorescence, Modified non-acidified Welchmeyer.
-In 2007, Lanier TMDL study included two data set for months of May-Oct. Additional samples analyzed by EPA SESD Athens. Averages of average monthly chlorophyll a represent growing season average entered here.
-For 2010 and later, the Lake Lanier data includes data from Upper Chattahoochee Riverkeeper

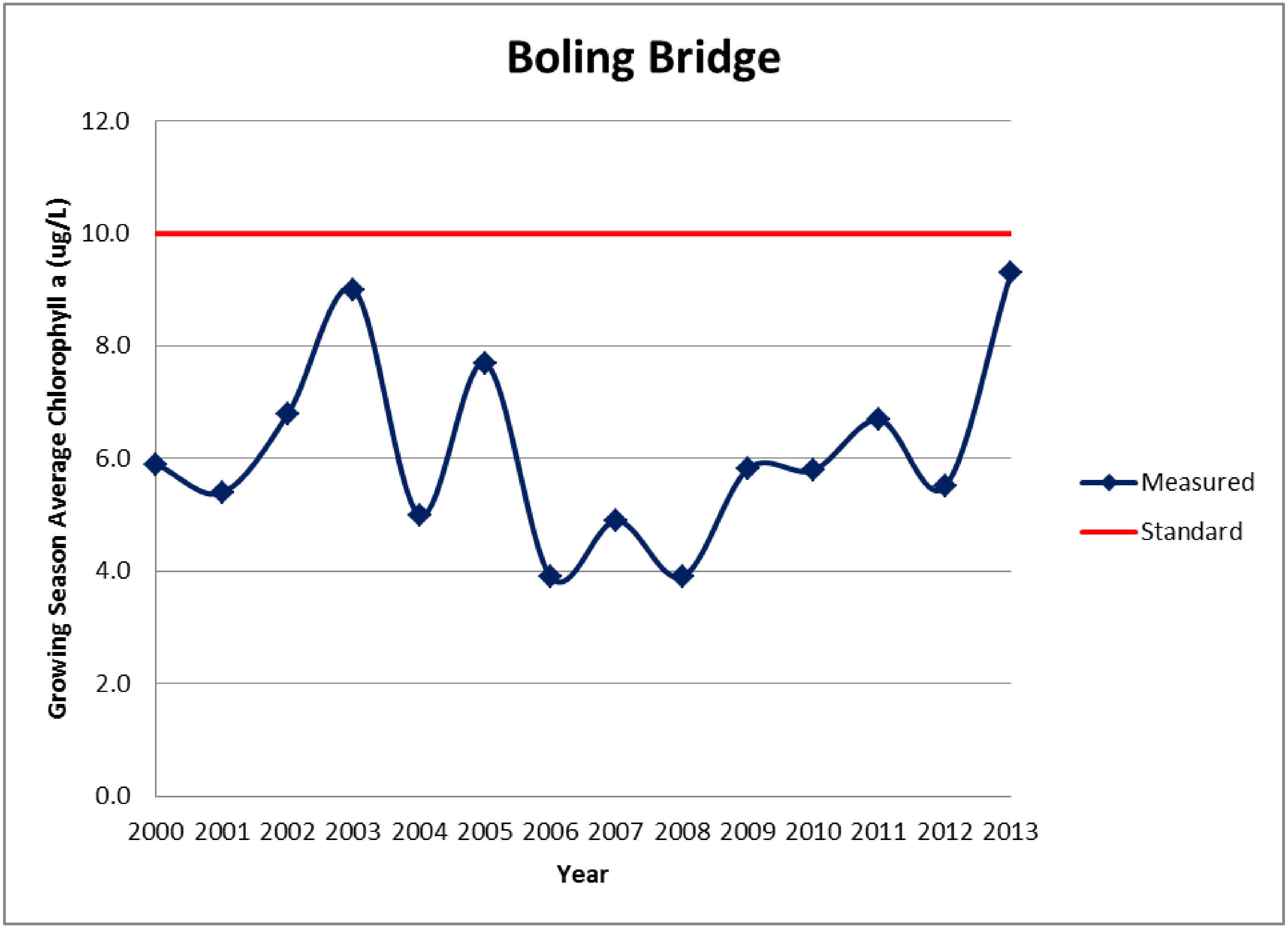
Annual Average Total Phosphorus Load (lbs)

	Standard	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chattahoochee River	178,000	29,200	42,700	59,600	152,300	96,800	171,500	62,200	44,040	68,330	131,215	118,105	68,843	48,351	
Chestatee River	118,000	7,700	10,000	25,400	72,000	51,200	91,400	40,500	17,130	25,120	48,984	55,417	29,382	22.729	
Flat Creek	14,400	10,200	7,500	9,300	10,000	9,500	6,500	2,100	2,000	1,820	2,151	1,766	1,791	704	


Dam Forebay
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Growing Season Average Chlorophyll a (ug/L)
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Year
Measured
Standard


Flowery Branch
Growing Season Average Chlorophyll a (ug/L)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Year
Measured
Standard


Browns Bridge
Growing Season Average Chlorophyll a (ug/L)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Year
Measured
Standard


Boling Bridge
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Growing Season Average Chlorophyll a (ug/L)
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Year
Measured
Standard