Review Draft

Synopsis Report
Assimilative Capacity Resource Assessment

PREPARED BY:

Georgia Environmental
Protection Division
4220 International Parkway
Suite 101
Atlanta, Georgia 30354

May 2017
Revision 0 – Draft

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Revision History

The following table presents the revision history of the Assimilative Capacity Resource Assessment Report.

Table i-1 Revision History of Current Assimilative Capacity Assessment Report

Revision Number	Release Date	Comments
0	March 2010	Initial Release of the Synopsis Report Current Assimilative Capacity Assessment. **Note that the results in this document and the associated appendices were DRAFT and were subject to change.**
1	April 2011	Addendum to the Synopsis Report Current Assimilative Capacity Assessment. The addendum included results for the Chattahoochee and Flint River Basins. **Note that the results in this document and the associated appendices were DRAFT and were subject to change.**
2	May 2017	Updated Synopsis Report Assimilative Capacity Resource Assessment. **Note that the results in this document and the associated appendices are DRAFT and are subject to change.**

Acknowledgements

The Georgia Environmental Protection Division acknowledges the tremendous efforts of the Tetra Tech Team, including Tetra Tech, Wilson Engineering, and Natural Resources Engineering in the development of the models, analysis of the results, staff support, and in the preparation of this document. Without their assistance and dedication to this project, this effort could not have been completed.

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SUMMARY OF RESULTS

In support of the Georgia Comprehensive State-wide Water Management Plan (GA State Water Plan), the Surface Water Quality (or Assimilative Capacity) Resource Assessment was used to determine the capacity of Georgia's surface waters to absorb pollutants without unacceptable degradation of water quality. Assimilative Capacity is defined as the amount of pollutant load that can be discharged to a specific waterbody without exceeding water quality standards or criteria. In other words, the assimilative capacity is used to define the ability of a waterbody to naturally absorb and use a discharged substance without water quality becoming impaired or aquatic life being harmed. The assimilative capacity resource assessment included developing water quality models of selected streams, rivers, lakes and estuaries throughout the State of Georgia. Results from these models were compared with applicable water quality standards.

The current assimilative capacity results focus on dissolved oxygen, nutrients, specifically nitrogen and phosphorus, and chlorophyll *a*. The water quality models were used to evaluate the impacts of current wastewater and industrial discharges and withdrawals, landuse, and meteorological conditions on the waterbody.

Generally, the future condition results show that there is available assimilative capacity, since the future permit limits used must met instream water quality standards as required by the Clean Water Act. This may have required changes in the permit limits.

MODELS USED FOR ASSIMILATIVE CAPACITY RESOURCE ASSESSMENT

For the Assimilative Capacity Resource Assessment, four different models were developed.

GA Dosag

Georgia Dosag (GA Dosag) is a steady state model used to predict dissolved oxygen (DO) concentrations in a stream or river during critical time periods which include low flow and high temperatures.

GaEst

Georgia Estuary (GaEst) is a steady state mid-tide model used to predict the dissolved oxygen sag curve in the vicinity of waste discharge points in Georgia estuaries.

EPD RIV-1

Georgia EPD RIV-1 (EPD RIV-1) is a hydrodynamic water quality model used to predict the DO concentrations in rivers downstream of dams that have highly variable streamflow.

LSPC

The Loading Simulation Program C++ (LSPC) is a watershed model used to simulate both flow and water quality, from nonpoint and point sources in watersheds. LSPC was used to simulate various water quality parameters including temperature, dissolved oxygen, and nutrients.

EFDC

The Environmental Fluid Dynamics Code (EFDC) is a hydrodynamic and water quality model used to simulate both flow and water quality in lakes and estuaries. EFDC was used to simulate various water quality parameters including temperature, dissolved oxygen, nutrients, and chlorophyll *a*.

WATER QUALITY STANDARDS

For DO, the state cold water fishing standard that applies to Georgia's streams that have been designated as either primary or secondary trout streams is a daily average of 6.0 mg/L not less than 5.0 mg/L. The freshwater fishing standard, which applies in all areas of the state that support warm water fish species, is a daily average of 5.0 mg/L not less than 4.0 mg/L. The coastal fishing DO standard is a daily average of 5.0 mg/L not less than 4.0 mg/L unless the natural DO is less than these values and then the standard allows for a 0.1 mg/L deficit or up to a 10% deficit if the biological community is not adversely effected. Below the fall line in the Coastal Plain, it is recognized that there can be streams with naturally low DO levels in the summertime. For these waters, GAEPD has allowed a 10% deficit down to 3.0 mg/L and below 3.0 mg/L, a 0.1 mg/L DO deficit.

There are six lakes in Georgia that have lake standards, Lanier, West Point, Walter F. George, Jackson, Allatoona and Carters. The 1992 Georgia Lake Law required that standards be set for growing season average chlorophyll *a* levels, major tributary annual total phosphorus loads, total lake phosphorus loading, and a total nitrogen limit for the lake. In addition, the law required standards be set for DO, temperature, pH, and fecal coliform, but only chlorophyll *a* and nutrient standards were examined. The associated water quality standards for these lakes can be found in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(17)(c) and Chapter 391-3-6-.03(17)(d), respectively.

DISSOLVED OXYGEN RESULTS

Ga Dosag, EPD-RIV-1, and GaEst models were developed for those waterbodies that currently have wastewater treatment plant discharges on them. For future discharges, these tools will be expanded to include additional stream segments if necessary. These models were calibrated to measured streamflow, instream DO levels, and chemical sampling data. Baseline critical, low flow (7Q10), high temperature condition models were run using 2014 permitted effluent limits. The results of these models were compared to the applicable Georgia DO standards. The following tables provides a summary of the results for each river basin.

River Basin	**Available Assimilative Capacity (River Miles) under Current Conditions**				
	Very Good	**Good**	**Moderate**	**Limited**	**None or Exceeded**
Altamaha	171	67	52	105	65
Chattahoochee	472	67	101	16	13
Coosa	500	89	61	25	24
Flint	589	268	85	26	101
Ochlockonee	81	26	19	10	12
Ocmulgee	1096	357	202	122	125
Oconee	575	144	54	22	59
Ogeechee	218	313	368	50	19
St. Marys	0	0	20	28	35
Satilla	89	98	53	42	73
Savannah	434	86	81	20	73
Suwannee	339	104	65	2	99
Tallapoosa	128	11	1	1	0
Tennessee	66	14	1	0	6
Total	4758	1644	1163	469	704

River Basin	Available Assimilative Capacity (River Miles) under Future Conditions				
	Very Good	Good	Moderate	Limited	None or Exceeded
Altamaha	186	94	54	127	0
Chattahoochee	472	67	101	16	12
Coosa	500	89	62	25	24
Flint	629	291	115	36	0
Ochlockonee	110	22	9	1	5
Ocmulgee	731	189	128	68	36
Oconee	575	144	54	22	59
Ogeechee	237	374	374	61	10
St. Marys	2	3	27	39	11
Satilla	170	39	79	54	12
Savannah	549	80	22	9	9
Suwannee	409	155	21	25	0
Tallapoosa	134	5	1	1	0
Tennessee	66	14	1	6	0
Total	186	94	54	127	0

EFDC models were developed for Ossabaw, Altamaha, Brunswick Harbor, St. Andrews, and St Mary's, estuaries. The models were setup and calibrated to temperature, salinity and DO data collected from 2001 through 2012. The model inputs included point sources that discharge directly to the harbor and/or estuaries, meteorological data, marsh loadings, sediment oxygen demand, nutrient fluxes, tidal forcing's, and watershed flows and loads developed from an LSPC watershed model. The results of the current and future Brunswick Harbor and St Mary's models indicate that there is limited to no more assimilative capacity in these systems. The other estuaries, Ossabaw, Altamaha, and St. Andrews, have good to moderate available assimilative capacity.

NUTRIENT RESULTS

LSPC watershed models were developed for the Chattahoochee, Flint and Ochlockonee, Coosa, Tallapoosa, Tennessee, Lower Savannah, Ogeechee, Oconee, Ocmulgee, Altamaha, Suwannee, Satilla, and St Mary's watersheds. The watershed models were simulated for the 15-year period from January 1, 1998 through December 31, 2012. This time period was selected as it captured three drought periods (1999-2001, 2006-2008, and 2011-2012) and several wet years including 2003, 2005, and 2009. The models were calibrated to DO, temperature, sediment and nutrients.

EFDC models were developed for lakes Lanier, West Point, Walter F. George, Blackshear, Chehaw/Worth, Seminole, Carters, Allatoona, Chatuge, Nottely, Blue Ridge, Oconee, Sinclair, and Jackson. The simulation period for the models was over a 12-year period – from January 1, 2001 through December 31, 2012. This period was chosen because it overlaps the data collection efforts by GAEPD, which occur monthly during the growing season (April through October). The models were calibrated to water level, DO, temperature, nutrients, and chlorophyll *a*.

Coosa River

The LSPC current and future condition model results show that the Coosa River exceeded its growing season median concentration for total phosphorus established in the Lake Weiss Total Maximum Daily Load (TMDL) at the Georgia-Alabama State line each year from 2001 through 2012. However, monitoring data shows that the growing season median total phosphorus target was met in 2016.

Lake Lanier

The Lake Lanier EFDC current condition model results, representative of the draft TMDL, show its chlorophyll *a* water quality criteria are met in all stations. Only in one year, upstream from the Buford Dam forebay, the growing season average concentration of chlorophyll *a* was exceeded in the EFDC current condition model results. This exceedance does not violate the water quality criteria which allows for one exceedance in a five-year period. In the future, the proposed point and nonpoint source reductions recommended in the draft TMDL will need to be implemented for the lake to continue to meet its water quality standards.

West Point Lake

The EFDC current condition model results show that West Point Lake is meeting its growing season average concentration of chlorophyll *a* in the two stations where site specific criteria have been set for each year from 2001 through 2012. In the future, West Point Lake should meet its water quality standards if future permit limits and upstream lake TMDLs are implemented.

Lake Walter F. George

The Lake Walter F. George EFDC current and future condition model results show exceedances of the growing season average concentration of chlorophyll *a* in some years at both stations where site specific criteria have been established. Standards have recently been revised in the lake upstream from Walter F. George (West Point Lake) and the Walter F. George's lake criteria will have to be re-evaluated in light of the permit limits used to establish West Point Lake's new criteria. In addition, nutrient permit limits will need to be established for all dischargers to the Water F. George watershed.

Lake Blackshear

There are no site specific chlorophyll *a* criteria for Lake Blackshear. The EFDC current conditions model results indicate chlorophyll *a* concentrations in the range of 2 to 18 μg/L for the modeled period from 2001 through 2012. The future conditions model results indicate chlorophyll *a* concentrations in the range of 2 to 16 μg/L.

Lake Chehaw

There are no site specific chlorophyll *a* criteria for Lake Chehaw (formerly Lake Worth). The EFDC current conditions model results indicate chlorophyll *a* concentrations in the range of 2 to 14 μg/L for the modeled period from 2001 through 2012. The future conditions model results indicate chlorophyll *a* concentrations in the range of 2 to 8 μg/L.

Lake Seminole

There are no Georgia site specific chlorophyll *a* criteria for Lake Seminole. The EFDC current conditions model results indicate chlorophyll *a* concentrations in the range of 6 to 23 μg/L, depending on the station location, for the modeled period from 2001 through 2012. The future conditions model results indicate chlorophyll *a* concentrations in the range of 4 to 22 μg/L. The EFDC current conditions model results in the dam forebay, where Florida has an annual geomean chlorophyll *a* concentration criteria of 20 μg/L, are in the range of 9 to 14 μg/L.

Carters Lake

The EFDC current conditions model results show that Carters Lake meets its growing season average concentration of chlorophyll *a* in all years at both stations where site specific standards have been established. The current conditions scenario for Carters Lake is representative of the TMDL. In the future, the proposed point and nonpoint source reductions recommended in the TMDL will need to be implemented for the lake to continue to meet its water quality standards.

Lake Allatoona

The EFDC current conditions model results, representative of the TMDL, show Lake Allatoona's chlorophyll *a* water quality criteria are met in stations. The current conditions model results do show exceedances of the growing season average concentration of chlorophyll *a* at 2 out of 5 stations (Allatoona Creek and Etowah River). However, these exceedances do not violate the water quality criteria, which allows for one exceedance in a five-year period and for concentrations to be rounded down to the nearest whole number. For example, a growing season average chlorophyll *a* concentration of 14.49 μg/L would meet a standard of 14 μg/L. In the future, the proposed point and nonpoint source reductions recommended in the draft TMDL will need to be implemented for the lake to continue to meet its water quality standards.

Lake Chatuge

There are no site specific chlorophyll *a* criteria for Lake Chatuge. The EFDC current and future conditions model results indicate chlorophyll *a* concentrations in the range of 2 to 5 μg/L for the modeled period from 2001 through 2012.

Lake Nottely

There are no site specific chlorophyll *criteria* for Lake Nottely. The EFDC current conditions model results indicate chlorophyll *a* concentrations in the range of 4 to 9 μg/L for the modeled period from 2001 through 2012. The future conditions model results indicate chlorophyll *a* concentrations in the range of 4 to 10 μg/L.

Lake Blue Ridge

There are no site specific chlorophyll *a* criteria for Lake Blue Ridge. The EFDC current and future conditions model results indicate chlorophyll *a* concentrations in the range of 2 to 4 μg/L for the modeled period from 2001 through 2012.

Lake Oconee

There are no lake specific standards for Lake Oconee. The EFDC current conditions model results for Lake Oconee have a range of growing season average chlorophyll *a* concentration of 6 to 33 μg/L depending on the station location, with the highest concentrations occurring at the Lake Oconee Highway 44 station. GAEPD is in the process of developing water quality standards for Lake Oconee and may require nutrient management in the future that will affect the results of the future condition model results.

Lake Sinclair

There are no lake specific standards for Lake Sinclair. The EFDC current conditions model results for Lake Sinclair have a range of growing season average chlorophyll *a* concentrations of 1 to 12 µg/L depending on the station location. GAEPD is in the process of developing water quality standards for Lake Oconee and may require nutrient management in the future that will affect the results of the future condition model results.

Lake Jackson

The EFDC current and future conditions model results indicate that Lake Jackson is meeting its growing season average concentration of chlorophyll *a* at the Mid-lake station every year from 2001 through 2012.

CONCLUSIONS

All of the results in this assessment are based on current wastewater discharges and water withdrawals. The draft results for the Assimilative Capacity Resource Assessment indicate that of the over 8,700 river miles evaluated for dissolved oxygen, 73% have Good to Very Good assimilative capacity for dissolved oxygen. This means many of these streams have greater than 0.5 mg/L of dissolved oxygen above the standard and/or natural dissolved oxygen levels and will likely to be able to assimilate additional wastewater discharges in the future; although, downstream effects will still need to be evaluated using the modeling tools developed. Of the 27% of streams miles that have Moderate to No assimilative capacity, which means these streams have 0.5 mg/L or less available dissolved oxygen, most of these streams are located in South Georgia, below the fall line, where the topography is flat and reaeration is low. The results of the Brunswick Harbor and St Mary's models indicate that there is limited to no more assimilative capacity in these systems. The Ossabaw, Altamaha, and St. Andrews estuaries have good to moderate available assimilative capacity. Any new or expanded treatment facilities in these streams may require plant upgrades in the future. The Savannah Harbor and Coosa River at the Georgia-Alabama state line have exceeded their available dissolved oxygen assimilative capacity. TMDLs, or a 5R Restoration Plan, has been developed for both of these waterbodies.

The Coosa Watershed Model indicates that the Coosa River at the Georgia-Alabama state line exceeds the available assimilative capacity for total phosphorus, which was developed in the Lake Weiss 2008 TMDL. However, monitoring data shows that the growing season median total phosphorus target was met in 2016. Of the fourteen lakes evaluated, six lakes (Lake Lanier, West Point Lake, Lake Walter F. George, Carters Lake, Lake Allatoona, and Lake Jackson) have chlorophyll *a* standards. The lake models, except West Point Lake and Lake Jackson, have shown exceedances of the chlorophyll *a* standards. However, TMDLs have been developed for Lake Allatoona and Carters and a TMDL is in the process of being developed for Lake Lanier. These TMDLs show that these lakes will meet their chlorophyll *a* criteria with point source and nonpoint source nutrient reductions. The models developed for the other lakes assessed indicate that the lakes in the Flint and Tennessee River Basins are in good condition. Lake Sinclair results also appear in good condition; however the Lake Oconee draft results indicate that Lake Oconee may have a chlorophyll *a* issues in the future if nutrient management is not address from both point and nonpoint sources.

1.0 INTRODUCTION

In support of the Georgia Comprehensive State-wide Water Management Plan (GA State Water Plan), the Surface Water Quality (or Assimilative Capacity) Resource Assessment was used to determine the capacity of Georgia's surface waters to absorb pollutants without unacceptable degradation of water quality. Assimilative Capacity is defined as the amount of pollutant load that can be discharged to a specific waterbody without exceeding water quality standards or criteria. In other words, the assimilative capacity is used to define the ability of a waterbody to naturally absorb and use a discharged substance without water quality becoming impaired or aquatic life being harmed. The assimilative capacity resource assessment included developing water quality models of selected streams, rivers, lakes and estuaries throughout the State of Georgia.

The assimilative capacity results presented in this synopsis focus on dissolved oxygen, nutrients, specifically nitrogen and phosphorus, and chlorophyll *a* for current and future conditions. The water quality models were used to evaluate the impacts of current wastewater and industrial discharges and withdrawals, landuse, and meteorological conditions on the waterbody. The water quality models that have been developed and used for the current assimilative capacity are presented in Figure 1-1. This includes stream, river, watershed, lake and estuary models.

This report presents the results from the various models developed for the Assimilative Capacity Resource Assessment. Section 2 presents an overview of the models developed for the resource assessment. Section 3 and 4 present the detailed results of the dissolved oxygen and nutrient analysis, respectively. Appendix A presents a detailed description of the model methodology and modeling assumptions that were made. Appendix B presents the dissolved oxygen results from GA Dosag, GaEst, EPD Riv-1, and EFDC estuary models. Appendix C present results of the nutrient loading for the rivers at the State line and the lake nutrient concentrations and chlorophyll *a* levels, respectively. Appendices D through W illustrate the results of the nutrient and biochemical oxygen demand (BOD) analysis by watershed.

This report provides an update from the March 2010 *Synopsis Report Current Assimilative Capacity Resource Assessment and the April 2011 Addendum to Synopsis Report Current Assimilative Capacity Resource Assessment*. More recent work has been done to extend models through 2012 with the exception of the Lower Savannah watershed model (Loading Simulation Program in C++ [LSPC]).

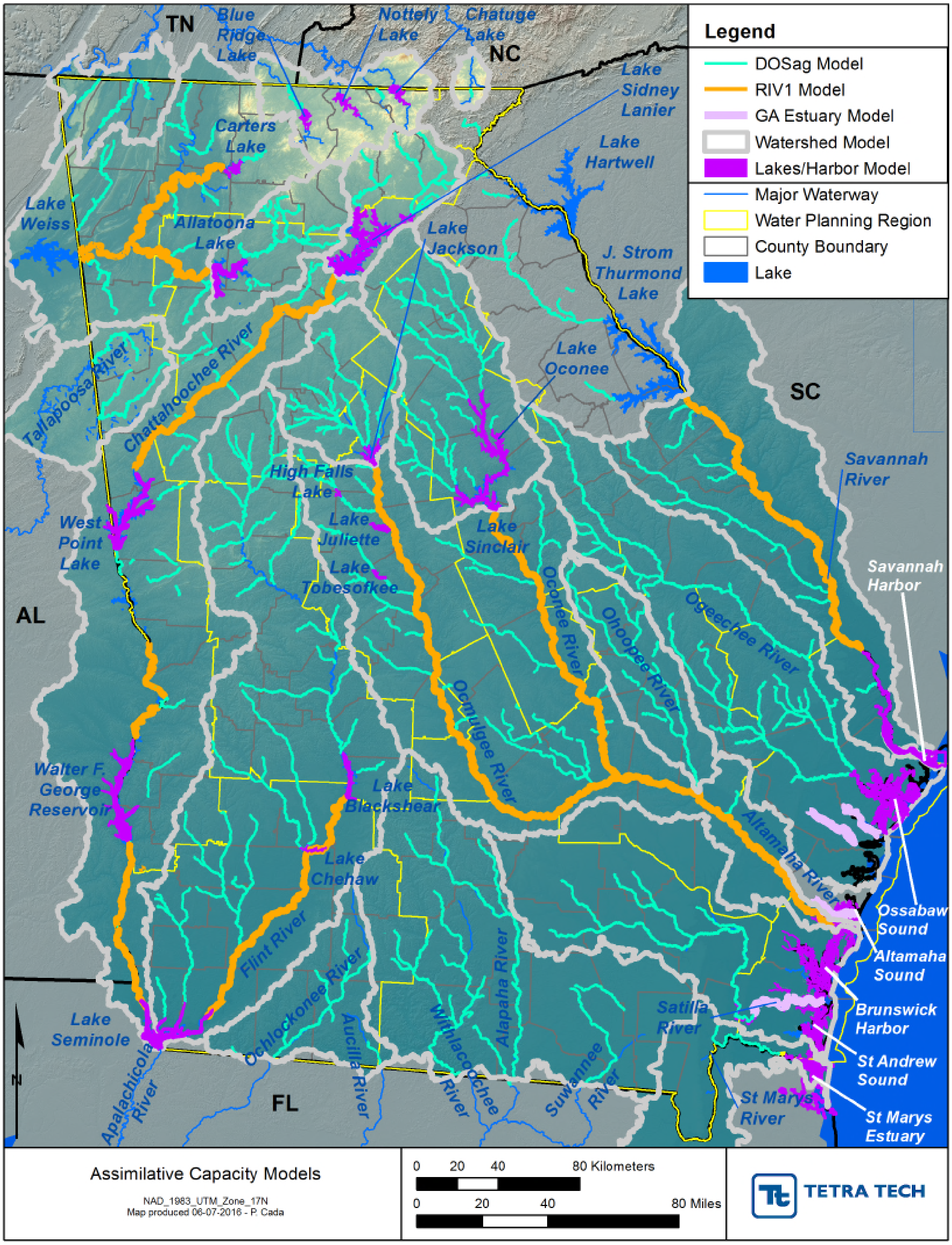

Figure 1-1 Available Assimilative Capacity Models

2.0 MODELS USED FOR RESOURCE ASSESSMENT

The following section briefly describes the models that were used for the Assimilative Capacity Resource Assessment. Appendix A presents a detailed description of the model methodology and modeling assumptions made.

2.1. GA Dosag

Georgia Dosag is a steady-state, one-dimensional Streeter-Phelps model originally developed in 1976 by GAEPD in cooperation with the Georgia District of the U.S. Geological Survey. The primary purpose of the model is to predict dissolved oxygen (DO) concentrations in a branching river system, taking into account carbonaceous and nitrogenous biochemical oxygen demand (BOD) contributions from headwater inflow, tributary inflows, lateral inflows, benthic demand, and multiple wastewater discharges.

2.2. GaEst

Georgia Estuary (GaEst) was developed for GAEPD to compute the dissolved oxygen sag curve in the vicinity of waste discharge points in Georgia estuaries. GaEst is a modified steady-state, branching, one-dimensional, tidally-averaged model for coastal waters that is a management tool used to predict water quality under various present and future conditions. It is one of the tools that GAEPD uses in conducting estuary analyses in order to determine the available assimilative capacity and total maximum daily load that can be placed on the estuary's resources by wastewater dischargers and nonpoint sources.

2.3. EPDRiv1

EPDRiv1 is a dynamic one-dimensional (longitudinal) water quality model for streams based on the U.S. Army Corps of Engineers' CE-QUAL-RIV1 developed by the Waterways Experiment Station. GAEPD used the original CE-QUAL-RIV1 computer code consisting of separate hydrodynamic (RIV1H) and water quality (RIV1Q) programs as the computational engine in developing a modeling system that also includes a model preprocessor, post-processor, and other model development tools.

2.4. LSPC

The Loading Simulation Program C++ (LSPC) is a comprehensive data management and modeling system that is capable of representing loading, both flow and water quality, from nonpoint and point sources, and simulating in-stream processes. It is capable of simulating flow, sediment, metals, nutrients, pesticides, and other conventional pollutants, as well as temperature and pH for pervious and impervious lands and waterbodies. LSPC represents the hydrological and water quality conditions in the watersheds and is configured to simulate the watershed as a series of hydrologically connected subwatersheds.

2.5. EFDC

The Environmental Fluid Dynamics Code (EFDC) is a hydrodynamic and water quality modeling package for simulating one-dimensional, two-dimensional, and three-dimensional flow and transport in surface water systems including: rivers, lakes, estuaries, reservoirs, wetlands, and nearshore to shelf scale coastal regions. The EFDC model was originally developed for estuarine and coastal applications and is considered public domain software. The three-dimensional hydrodynamics and water quality of lakes and estuaries were modeled using EFDC.

2.6. Model Calibration and Validation

Each model went through a rigorous calibration and validation process. Calibration of each of the models was performed by adjusting model parameters, within reasonable constraints, until an acceptable agreement was achieved between simulated and measured flow and water quality data. The model parameters were adjusted based on local knowledge, previous experience, literature data, and best professional judgment. Model validation is the process of taking the model parameters that have been calibrated, applying those parameters to other areas or time periods, and comparing the simulated and measured flow and water quality data. Model validation is sometimes called model verification, as essentially you are validating or verifying that model parameters calibrated in one model will produce acceptable results in another model. The measured data used in the calibration and validation process were collected from various sources including but not limited to USGS flow gages, GAEPD water quality sampling stations (both stream, river and lake), and local watershed studies.

2.7. Model Scenarios

The following six model scenarios were evaluated for the Assimilative Capacity Resource Assessment:

- Calibration Scenario
- Current Permit (Current Condition)
- Current Conditions with Point Sources and Water Withdrawals Removed (Current NPS)
- Natural Conditions (All Forested Watershed and No Point Sources and Water Withdrawals)
- Future Permit (Future Condition)
- Future Conditions with Point Sources and Water Withdrawals Removed (Future NPS)

A description of each of the types of model scenarios is listed below.

2.7.1.Calibration Scenario

The Calibration Scenario represents results produced from the calibrated models. The models were calibrated to the available field data. Discharge and withdrawal input corresponded to same time period that the measured data were collected. Landuse data were based on the 2008 Georgia Land Use Trends (GLUT) project produced by the University of Georgia’s Natural Resources Spatial Analysis Laboratory, with the exception of the Lake Lanier watershed model. The Lake Lanier watershed model used a combined 2005 and 2008 GLUT where the modeled period from 1997 through 2007 used the 2005 GLUT and the modeled period 2008 through 2012 used the 2008 GLUT.

2.7.2.Current Permit (Current Condition)

The Current Permit Scenario represents results produced from the calibrated models with landuse consistent with the Calibration Scenario and point sources at their current 2014 National Pollutant Discharge Elimination System (NPDES) permitted limits, including updates from approved Total Maximum Daily Loads (TMDLs). This scenario is referenced as the “current” condition throughout this report. For Lakes Allatoona, Carters, and Lanier, whose NPDES permit limits have already been established or are in the process of being developed via TMDLs, those permit limits are incorporated in the current condition scenario. Current conditions for these lakes also include nonpoint source reductions defined or being developed in the TMDLs.

2.7.3. Current Conditions with Point Sources and Water Withdrawals Removed (Current NPS)

The Current Conditions with Point Sources and Water Withdrawals Removed Scenario represents results produced from the calibrated models with landuse consistent with the Calibration Scenario and point sources and water withdrawals removed. This scenario represents a current nonpoint source condition and includes nonpoint source reductions for Lakes Allatoona, Carters, and Lanier that have been developed or are being developed in the TMDLs.

2.7.4. Natural Conditions

The Natural Conditions Scenario represents results produced from the calibrated models with point sources and water withdrawals removed and the landuse changed to forest and wetland conditions assuming hydric soils. Hydric soils assume saturation consistent with soil conditions found in wetlands where they may be permanently or seasonally saturated by water. This scenario represents a natural condition without the anthropogenic effects of man.

2.7.5. Future Permit (Future Condition)

The Future Permit Scenario represents results produced from the calibrated models with landuse produced from the 2050 GLUT and point sources at their future 2050 NPDES permitted limits. This scenario is referenced as the “future” condition throughout this report. For Lakes Allatoona, Carters, and Lanier, NPDES permit limits have already been established or are in the process of being developed via TMDLs, and those limits are incorporated in the future condition scenario. Future conditions for these lakes also include nonpoint source reductions defined or being developed in the TMDLs.

2.7.6. Future Conditions with Point Sources and Water Withdrawals Removed (Future NPS)

The Future Conditions with Point Sources and Water Withdrawals Removed Scenario represents results produced from the calibrated models with 2050 landuse and point sources and water withdrawals removed. This scenario represents a future nonpoint source condition and includes nonpoint source reductions for Lakes Allatoona, Carters, and Lanier that have been developed or are being developed in the TMDLs.

3.0 DISSOLVED OXYGEN RESULTS

The following section presents the dissolved oxygen results for the Assimilative Capacity Resource Assessment. More details results are presented in Appendix B.

3.1. Water Quality Standards

The criteria for dissolved oxygen (DO) that is applicable to waters within the State designated as Drinking Water Supplies, Recreation, and Fishing, as stated in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(6)(ii) are: A daily average of 6.0 mg/L and no less than 5.0 mg/L at all times for waters designated as trout streams by the Wildlife Resources Division. A daily average of 5.0 mg/L and no less than 4.0 mg/L at all times for waters supporting warm water species of fish.

For waters designed as Coastal Fishing, the criteria are a daily average of 5.0 mg/L and no less than 4.0 mg/L. If it is determined that the "natural DO" in the waterbody is less than the values stated above, then the criteria would revert to the "natural DO" and the water quality standard would allow for up to a 0.10 mg/L deficit from "natural." Up to a 10% deficit will be allowed if it is demonstrated that resident aquatic species shall not be adversely affected.

The specific criteria for dissolved oxygen in Georgia's lakes including Lanier, West Point, Walter F. George, Allatoona, Carters, and Jackson as stated in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(17) are: 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).

GAEPD has a modeling strategy that is used for developing wasteload allocations in areas where the natural DO is lower that the warm water DO criteria. It allows for a 10% deficit in waters where the natural DO is above 3.3 mg/L and 0.1 mg/L deficit in waters where the natural DO is 3.3 mg/L or below.

Figure 3-1 presents the scale used to show the dissolved oxygen results available above the standard or the natural DO in the streams that were modeled.

🟥	**< 0.0 mg/L of DO Available** **None or exceeded capacity**
🟪	**0.0 mg/L of DO Available** **At Assimilative Capacity**
🟧	**> 0.0 mg/L to < 0.2 mg/L of DO Available** **Limited**
🟨	**0.2 mg/L to < 0.5 mg/L of DO Available** **Moderate**
🟩	**0.5 mg/L to < 1.0 mg/L of DO Available** **Good**
🟦	**≥ 1.0 mg/L of DO Available** **Very Good**

Figure 3-1 Description of Dissolved Oxygen Results

3.2. Chattahoochee River Watershed

Figure 3-2 shows the results of the DO assimilative capacity analysis for all the streams that were modeled in the Chattahoochee River Basin.

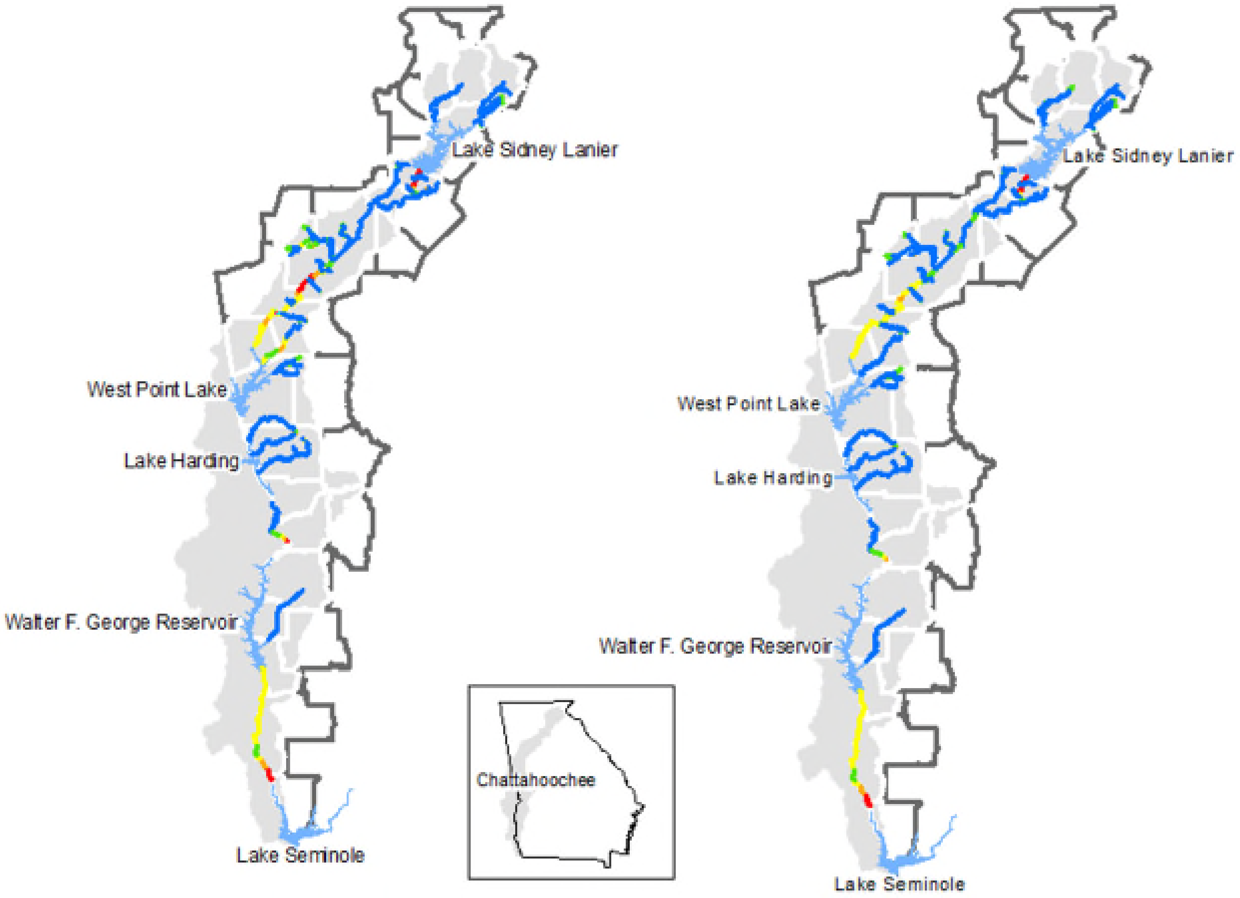

Figure 3-2 Current (left) and Future (right) Conditions of Dissolved Oxygen Models in the Chattahoochee River Watershed

3.3. Flint and Ochlockonee River Watersheds

Figure 3-3 shows the results of the DO assimilative capacity analysis for all the streams that were modeled in the Flint and Ochlockonee River Basins.

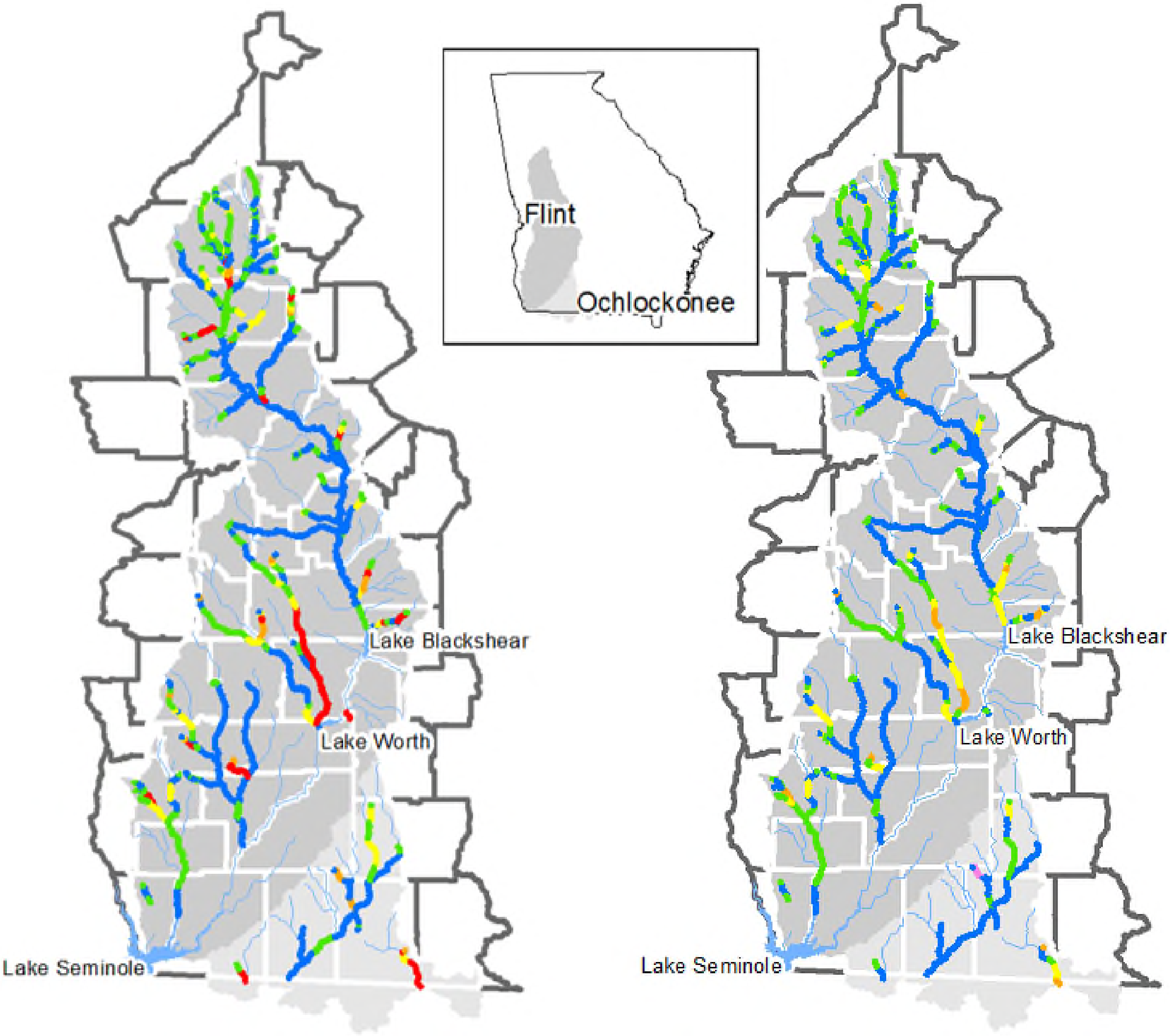

Figure 3-3 Current (left) and Future (right) Conditions of Dissolved Oxygen Models in the Flint and Ochlockonee River Watersheds

3.4. Coosa, Tallapoosa, and Tennessee River Watersheds

Figure 3-4 shows the results of the DO assimilative capacity analysis for all the streams that were modeled in the Coosa, Tallapoosa, and Tennessee River Basins.

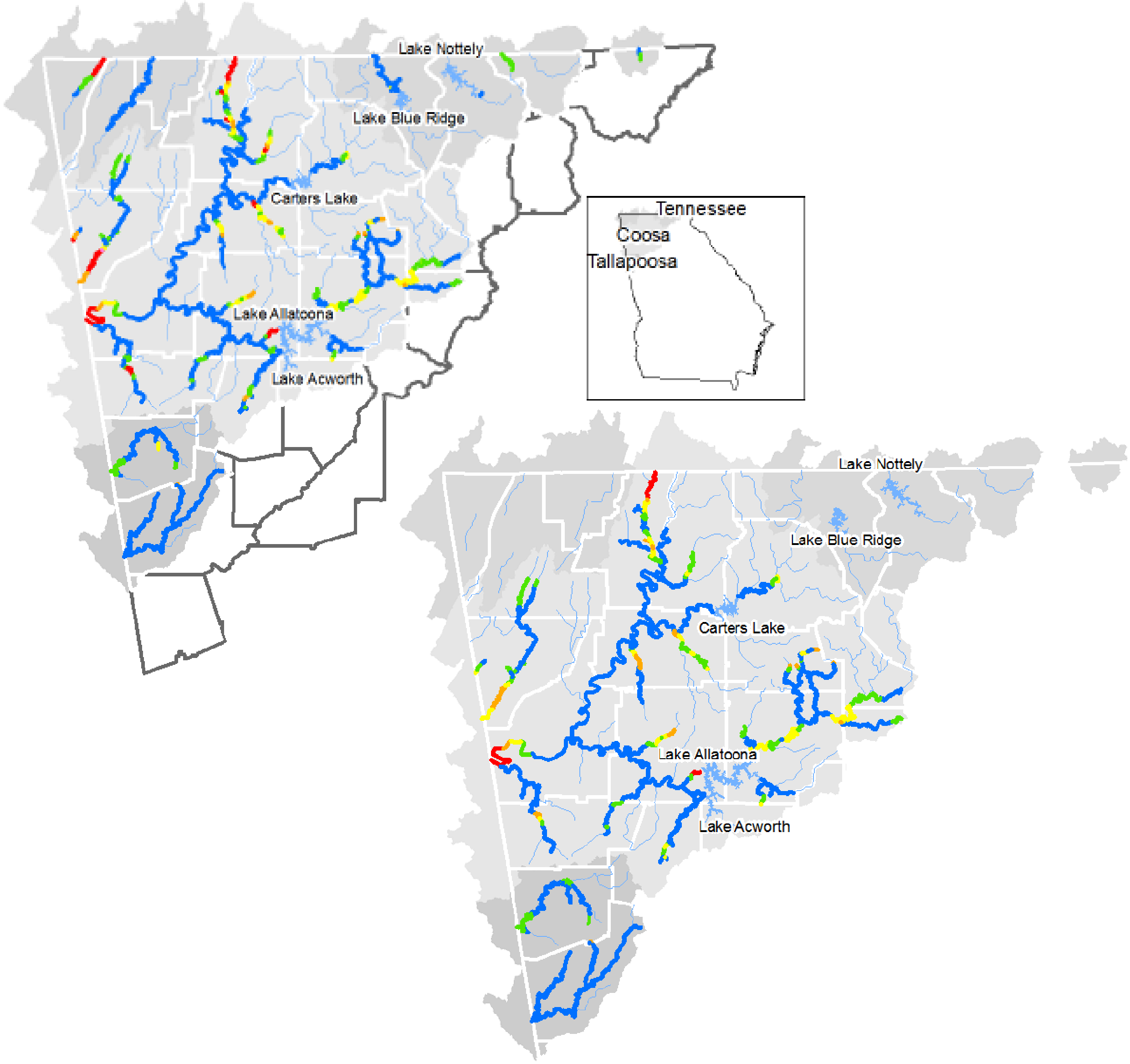

Figure 3-4 Current (upper left) and Future (lower right) Conditions of Dissolved Oxygen Models in the Coosa, Tallapoosa, and Tennessee River Watersheds

3.5. Savannah and Ogeechee River Watersheds

Figure 3-5 shows the results of the DO assimilative capacity analysis for all the streams that were modeled in the Savannah and Ogeechee River Basins.

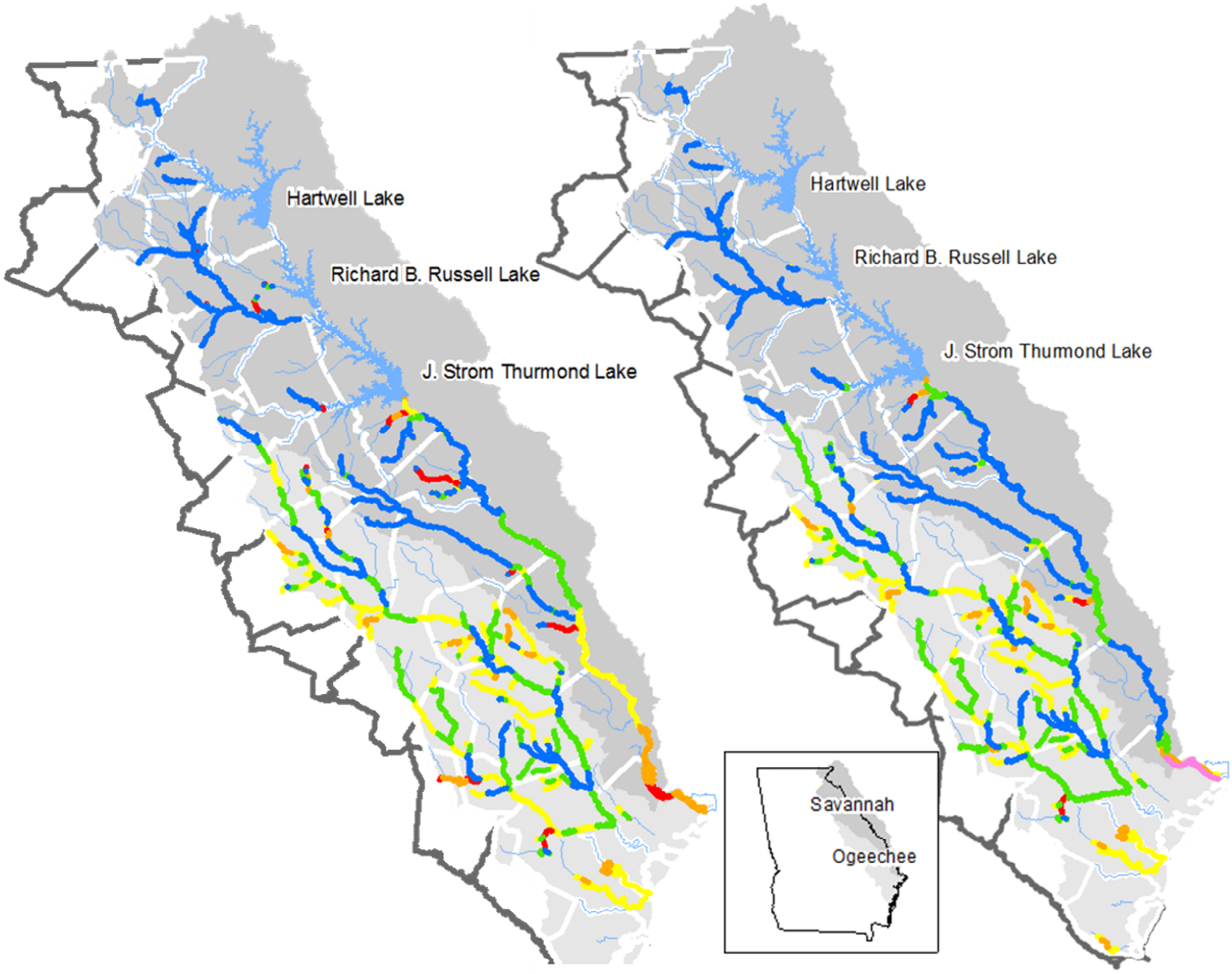

Figure 3-5 Current (left) and Future (right) Conditions of Dissolved Oxygen Models in the Savannah and Ogeechee River Watersheds

3.6. Oconee, Ocmulgee, and Altamaha River Watersheds

Figure 3-6 shows the results of the DO assimilative capacity analysis for all the streams that were modeled in the Oconee, Ocmulgee, and Altamaha River Basins.

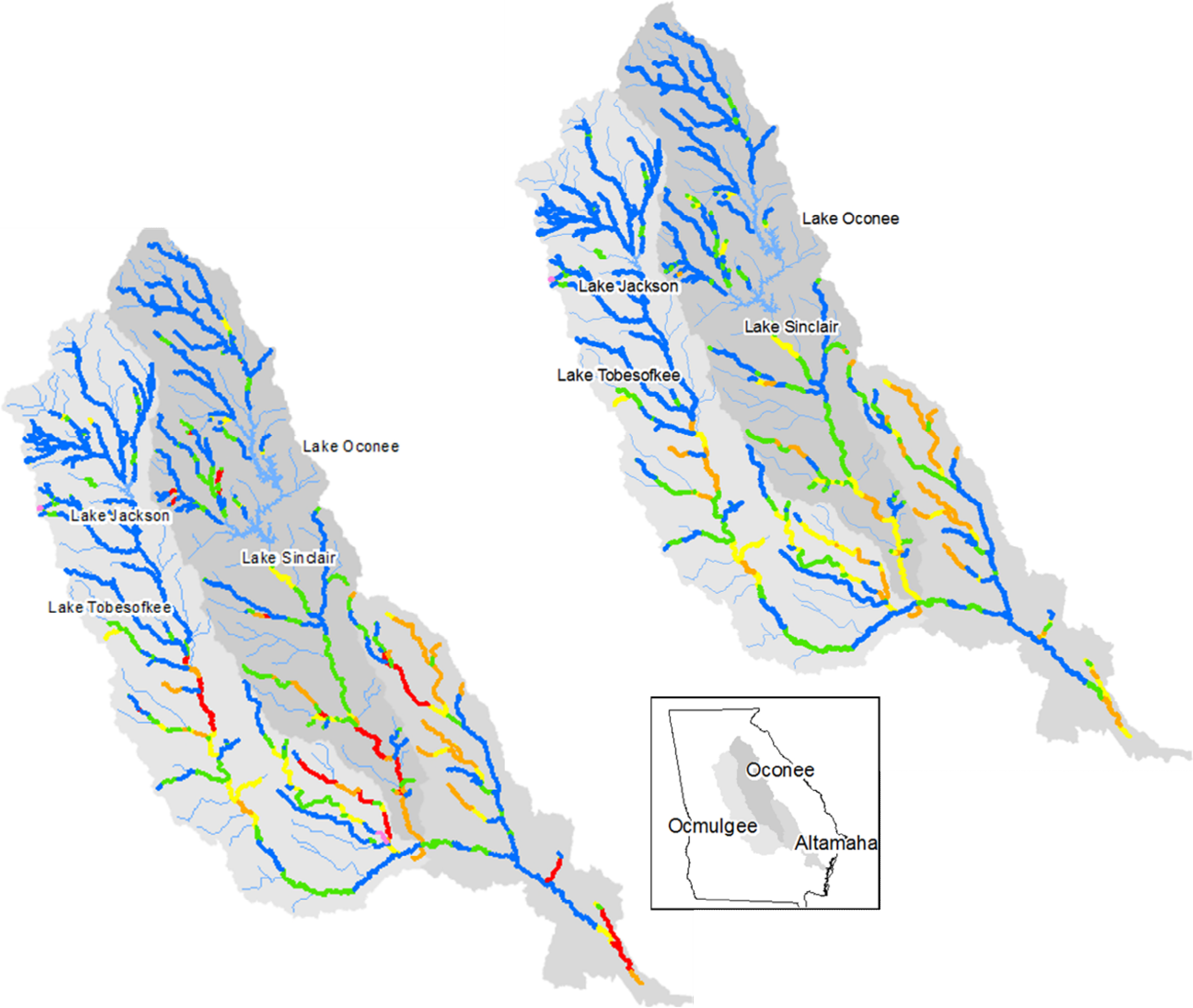

Figure 3-6 Current (lower left) and Future (upper right) Conditions of Dissolved Oxygen Models in the Oconee, Ocmulgee and Altamaha River Watersheds

3.7. Suwannee, Satilla, and St. Mary's River Watersheds

Figure 3-7 shows the results of the DO assimilative capacity analysis for all the streams that were modeled in the Suwannee, Satilla, and St. Mary's River Basins.

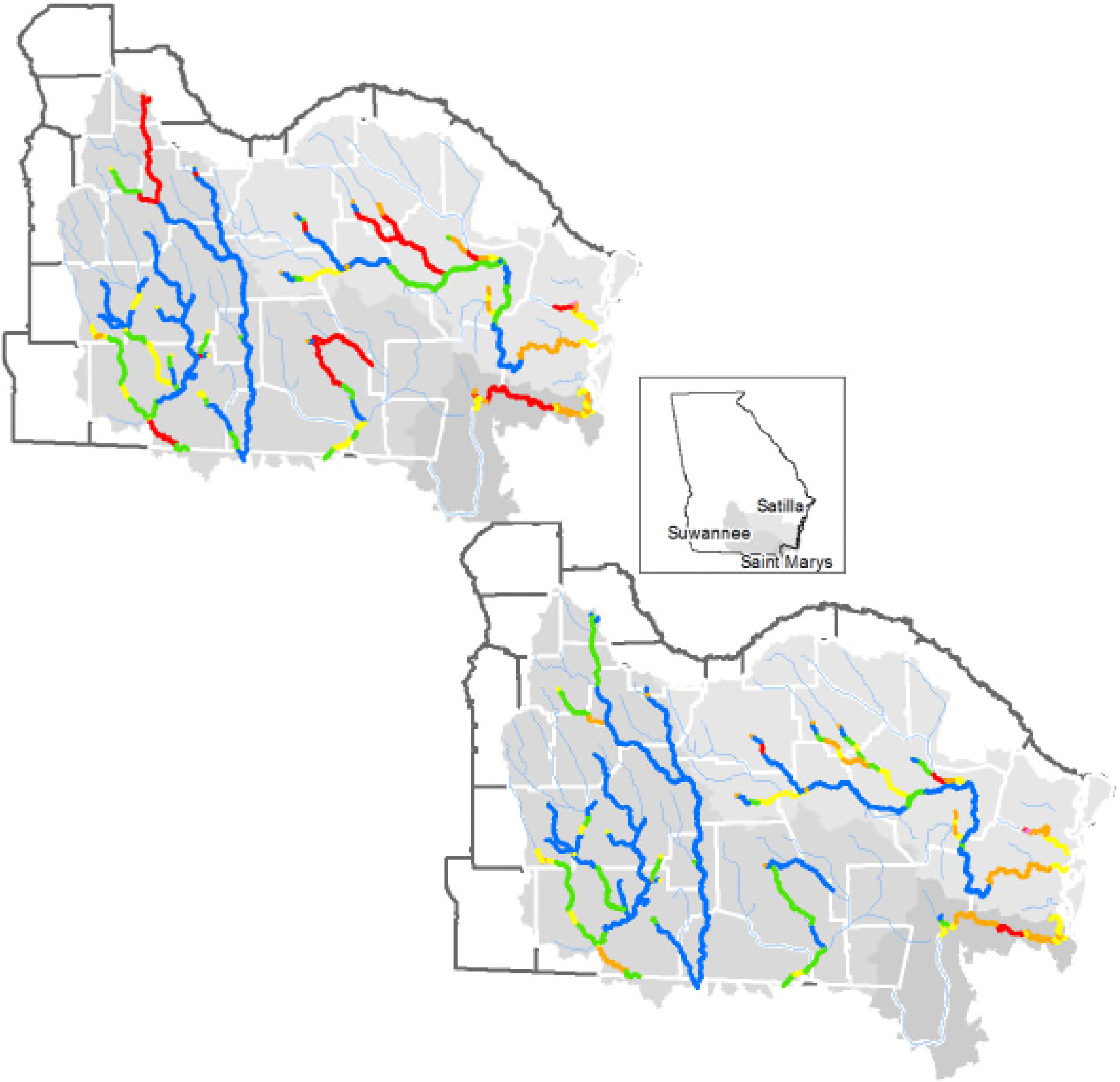

Figure 3-7 Current (upper left) and Future (lower right) Conditions of Dissolved Oxygen Models in the Suwannee, Satilla, and St. Mary's River Watersheds

3.8. Estuaries

Figure 3-8 shows the results of the DO assimilative capacity analysis for current and 2050 conditions in Georgia estuaries.

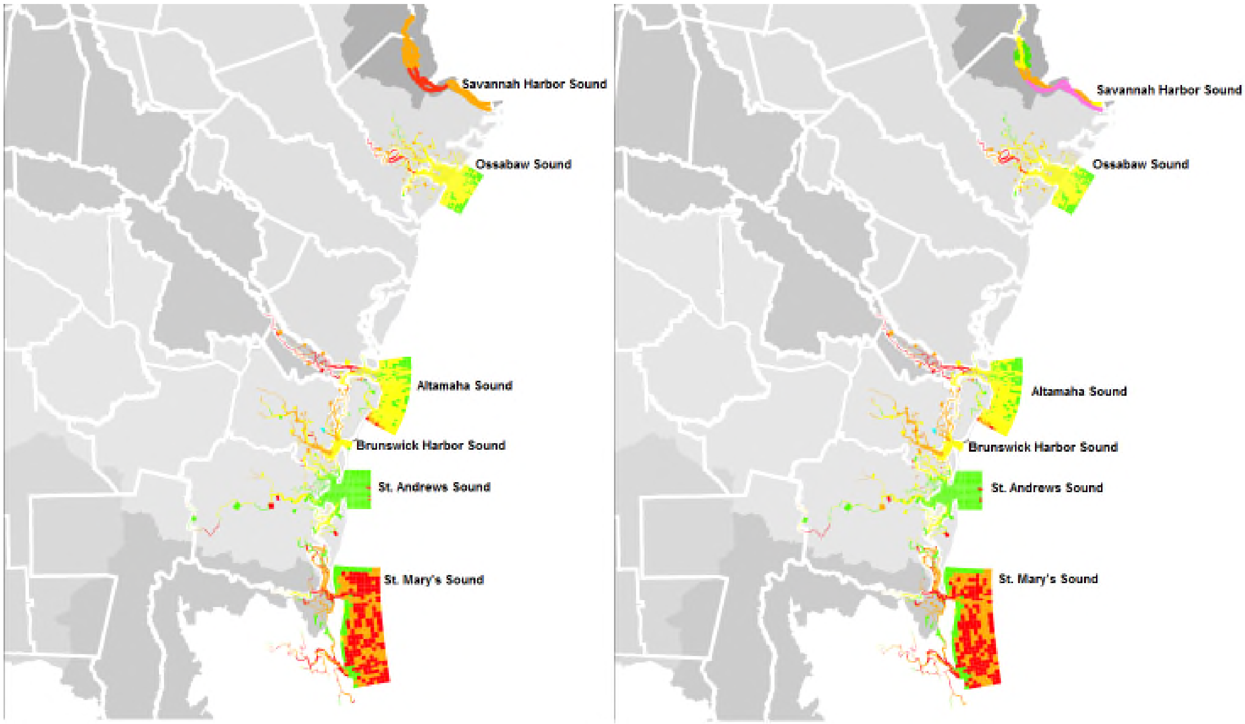

Figure 3-8 Available Dissolved Oxygen in Georgia Estuaries for Current (left) and Future (right) Conditions

4.0 NUTRIENT AND CHLOROPHYLL RESULTS

The following section presents the nutrient results for the Current Assimilative Capacity Resource Assessment. More details results, including cumulative watershed loadings, are presented in Appendix C.

4.1. Water Quality Standards

The applicable water quality standards that were used for the Current Assimilative Capacity Resource Assessment are presented below.

4.1.1.Riverine

4.1.1.1. Coosa River

EPA established a Total Maximum Daily Load (TMDL) for Lake Weiss in October 2008 that set the TMDL target for Total Phosphorus on the Coosa River at the Georgia and Alabama state line to a growing season median concentration of 0.060 mg/L (EPA, 2008).

4.1.2. Lake

4.1.2.1. Lake Lanier

The Lake Sidney Lanier criteria for nutrients and chlorophyll *a*, as stated in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(17)(e) are:

(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

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

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

(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 lbs/yr
2.	Chestatee River at Georgia Highway 40	118,000 lbs/yr
3.	Flat Creek at McEver Road	14,400 lbs/yr

4.1.2.2. West Point Lake

The West Point Lake criteria for nutrients and chlorophyll *a*, as stated in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(17)(a) are:

(i) Chlorophyll *a*: For the months of April through October, the average of monthly 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 Dam in the Forebay	22 μg/L
2.	LaGrange Water Intake	24 μg/L

(iii) Total Nitrogen: Not to exceed 4.0 mg/L as nitrogen in the photic zone.

(iv) Total Phosphorus: Total lake loading shall not exceed 2.4 pounds per acre-foot of lake volume per year.

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

1.	Yellow Jacket Creek at Hammet Road	11,000 lbs/yr
2.	New River at Hwy 100	14,000 lbs/yr
3.	Chattahoochee River at U.S. 27	1,400,000 lbs/yr

4.1.2.3. Lake Walter F. George

The Lake Walter F. George criteria for nutrients and chlorophyll *a*, as stated in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(17)(b) are:

(i) Chlorophyll *a*: For the months of April through October, the average of monthly photic zone composite samples shall not exceed 18 μg/L at mid-river at U.S. Highway 82 or 15 μg/L at mid-river in the dam forebay more than once in a five-year period.

(iii) Total Nitrogen: Not to exceed 3.0 mg/L as nitrogen in the photic zone.

(iv) Total Phosphorus: Total lake loading shall not exceed 2.4 pounds per acre-foot of lake volume per year.

(viii) Major Lake Tributary: The annual total phosphorous loading to Lake Walter F. George, monitored at Chattahoochee River at Georgia Highway 39, shall not exceed 2,000,000 pounds.

4.1.2.4. Carters Lake

The Carters Lake criteria for nutrients and chlorophyll *a*, as stated in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(17)(f) are:

(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.	Carters Lake upstream from Woodring Branch	10 μg/L
2.	Carters Lake at Coosawattee River embayment mouth	10 μg/L

(iii) Total Nitrogen: Not to exceed 4.0 mg/L as nitrogen in the photic zone.

(iv) Total Phosphorus: Total lake loading shall not exceed 172,500 pounds or 0.46 pounds per acre-foot of lake volume per year.

(viii) Major Lake Tributaries: For the following major tributaries, the annual total phosphorous loading at the compliance monitoring location shall not exceed the following:

1.	Coosawattee River at Old Highway 5	151,500 lbs/yr
2.	Mountaintown Creek at U.S. Highway 76	16,000 lbs/yr

4.1.2.5. Lake Allatoona

The Lake Allatoona criteria for nutrients and chlorophyll *a*, as stated in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(17)(d) are:

(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 Dam	10 μg/L
2.	Allatoona Creek upstream from I-75	12 μg/L
3.	Mid-Lake downstream from Kellogg Creek	10 μg/L
4.	Little River upstream from Highway 205	15 μg/L
5.	Etowah River upstream from Sweetwater Creek	14 μg/L

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

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

1.	Etowah River at State Highway 5 spur and 140, at the USGS gage	340,000 lbs/yr
2.	Little River at State Highway 5 (Highway 754)	42,000 lbs/yr
3.	Noonday Creek at North Rope Mill Road	38,000 lbs/yr
4.	Shoal Creek at State Highway 108 (Fincher Road)	12,500 lbs/yr

4.1.2.6. Lake Jackson

The Lake Jackson specific criteria for nutrients and chlorophyll *a*, as stated in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(17)(c) are:

(i) Chlorophyll *a*: For the months of April through October, the average of monthly mid-channel photic zone composite samples shall not exceed 20 μg/L at a location approximately 2 miles downstream of the confluence of the South and Yellow Rivers at the junction of Butts, Newton and Jasper Counties more than once in a five-year period.

(iii) Total Nitrogen: Not to exceed 4.0 mg/L as nitrogen in the photic zone.

(iv) Phosphorous: Total lake loading shall not exceed 5.5 pounds per acre-foot of lake volume per year.

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

1.	South River at Island Shoals:	179,000 lbs/yr
2.	Yellow River at Georgia Highway 212:	116,000 lbs/yr
3.	Alcovy River at Newton Factory Bridge Road:	55,000 lbs/yr
4.	Tussahaw Creek at Fincherville Road.:	7,000 lbs/yr

4.2. Riverine Results

4.2.1.Coosa River

Figure 4-1 and Figure 4-2 show the modeled calibration and median growing season Total Phosphorus concentrations for the Coosa River at the Georgia-Alabama state line for each year for each modeled scenario.

4.3. Lake Results

4.3.1. Lake Lanier

Figure 4-3 through Figure 4-12 illustrate two figures for each location in Lake Lanier with a chlorophyll *a* water quality standard. The first figures for each location show the modeled calibration results compared with the growing season average of measured data. The second figures for each location show the other modeled scenarios (Current, Current NPS, Natural, Future, and Future NPS) along with the location's standard. Comparing the Lake Lanier Future NPS with the Current NPS illustrates landuse changes and include reductions from the draft TMDL. Comparing the Current and Future scenarios illustrates both landuse reductions (the draft TMDL) and applies NPDES permit limits based on the draft TMDL. Tables of the modeled growing season average chlorophyll *a* levels, along with other nutrient parameters, are included in Appendix C.

4.3.2.West Point Lake

Figure 4-13 through Figure 4-16 illustrate two figures for each location in West Point Lake with a chlorophyll *a* water quality standard. The first figures for each location show the modeled calibration results compared with the measured data. The second figures for each location show the other modeled scenarios (Current, Current NPS, Natural, Future, and Future NPS) along with the location's standard. Tables of the modeled growing season average chlorophyll *a* levels, along with other nutrient parameters, are included in Appendix C.

4.3.3.Lake Walter F. George

Figure 4-17 through Figure 4-20 illustrate two figures for each location in Lake Walter F. George with a chlorophyll *a* water quality standard. The first figures for each location show the modeled calibration results compared with the measured data. The second figures for each location show the other modeled scenarios (Current, Current NPS, Natural, Future, and Future NPS) along with the location's standard. Tables of the modeled growing season average chlorophyll *a* levels, along with other nutrient parameters, are included in Appendix C.

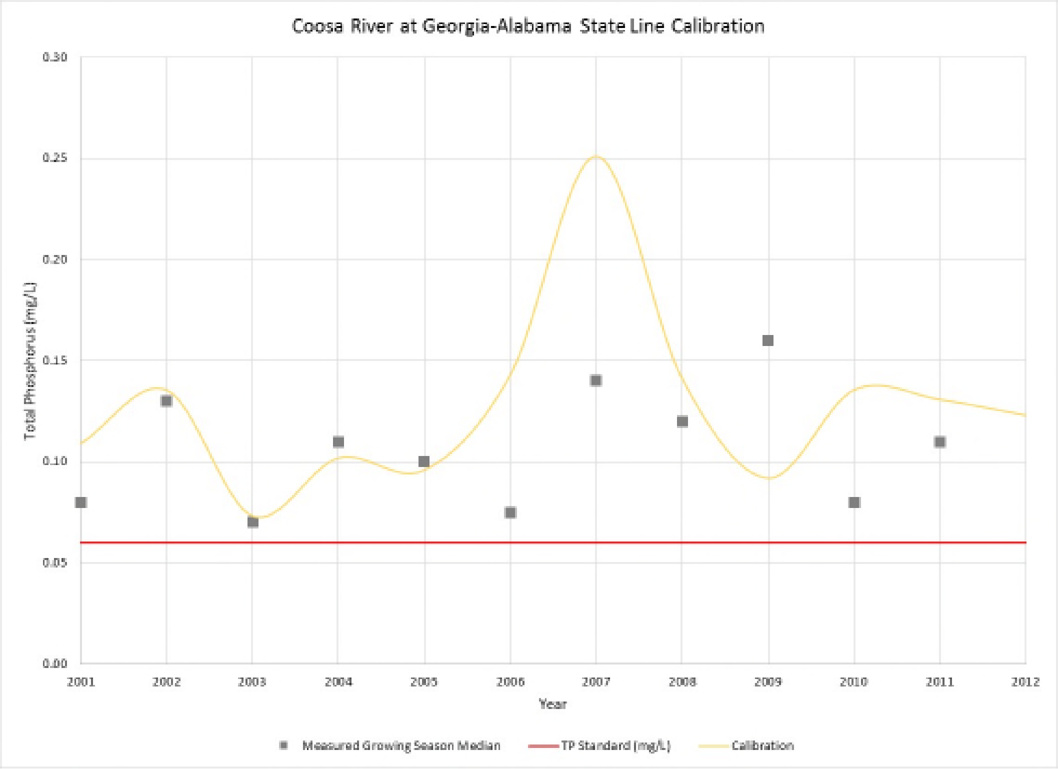

Figure 4-1 Coosa River Growing Season Median Concentration of Total Phosphorus (mg/L) at the Georgia-Alabama State Line Calibration

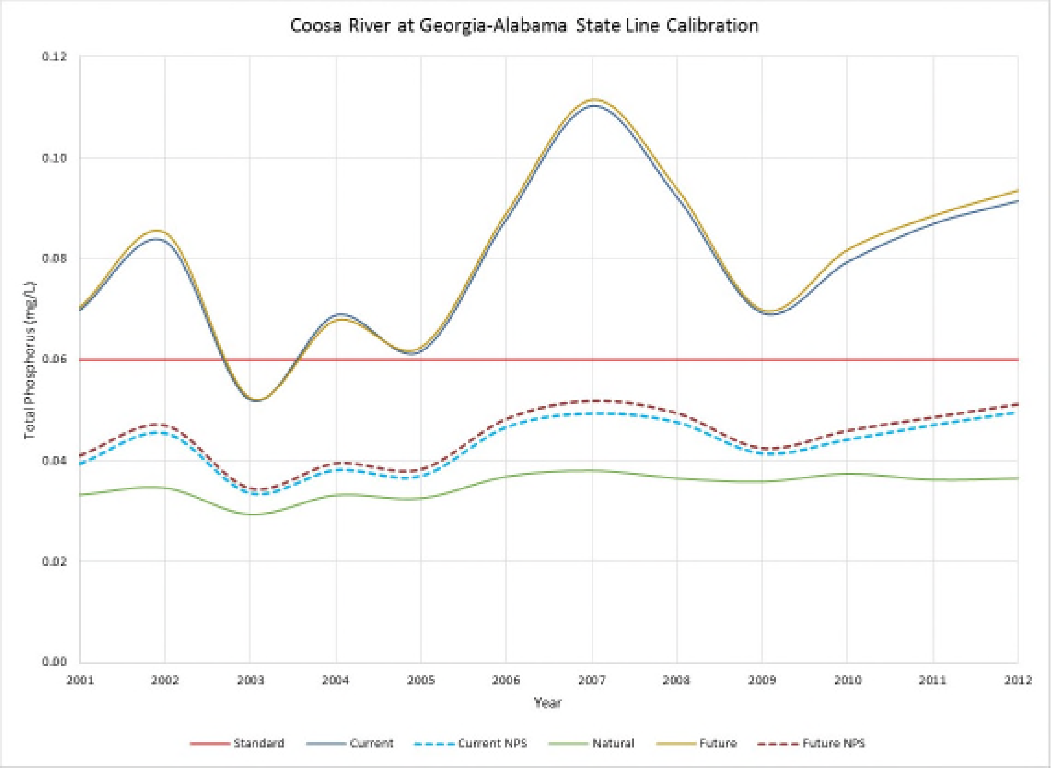

Figure 4-2 Coosa River Growing Season Median Concentration of Total Phosphorus (mg/L) at the Georgia-Alabama State Line Scenarios

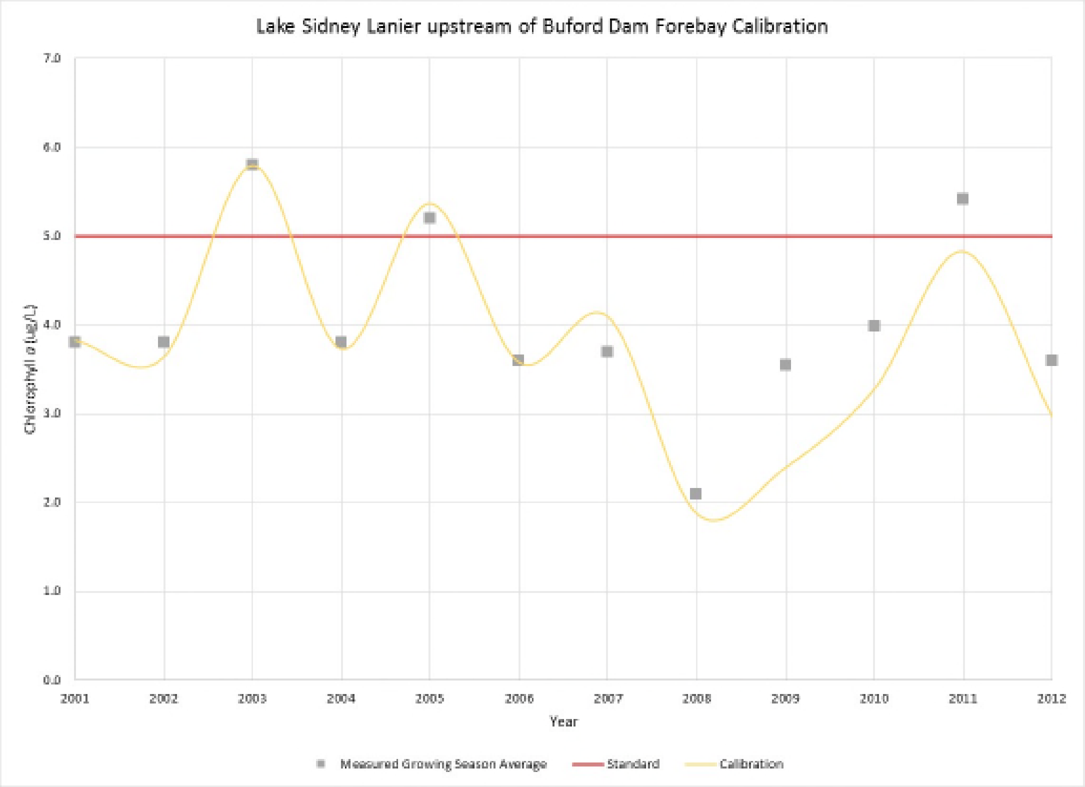

Figure 4-3 Lake Lanier Upstream from the Buford Dam Forebay Calibration

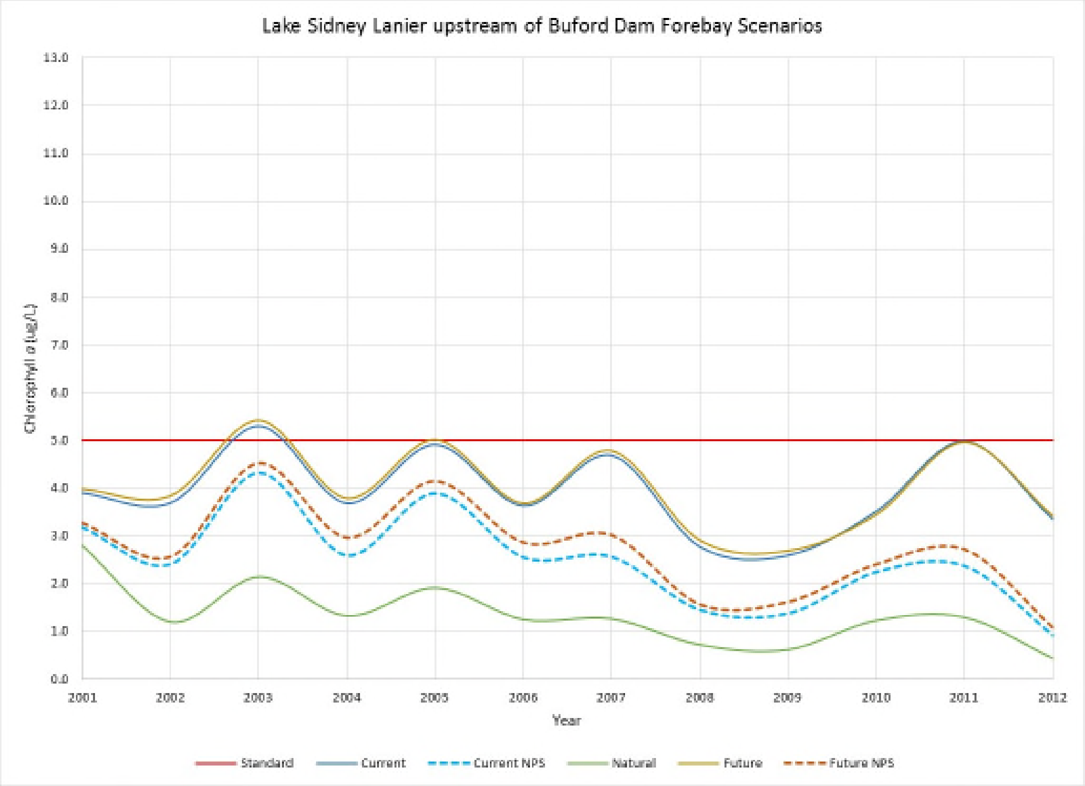

Figure 4-4 Lake Lanier Upstream from the Buford Dam Forebay Scenarios—the scenarios presented include draft TMDL reductions

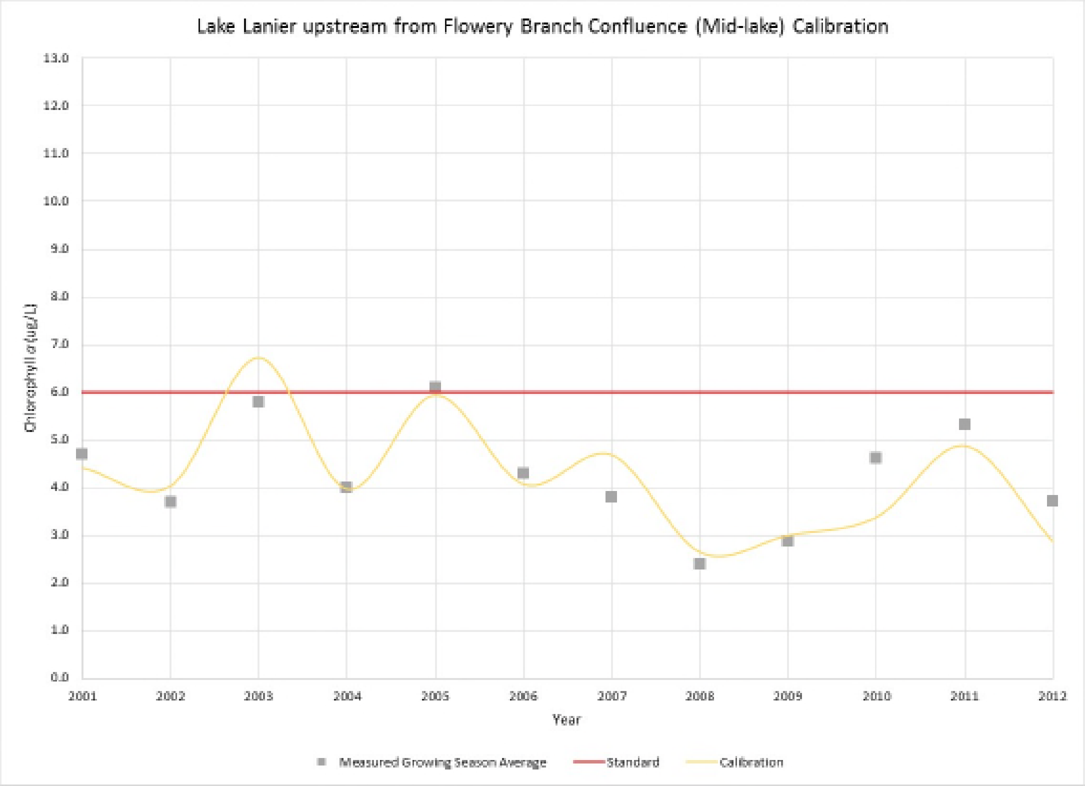

Figure 4-5 Lake Lanier Upstream from the Flowery Branch confluence (Mid-lake) Calibration

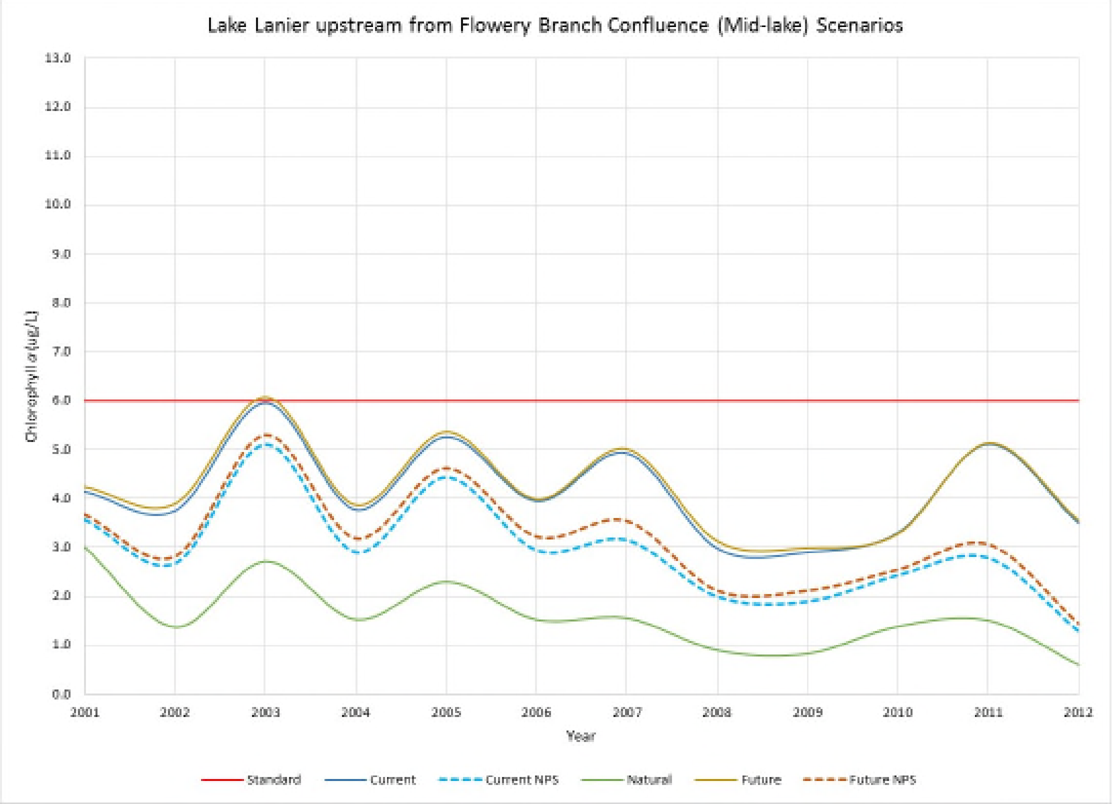

Figure 4-6 Lake Lanier Upstream from the Flowery Branch confluence (Mid-lake) Scenarios—the scenarios presented include draft TMDL reductions

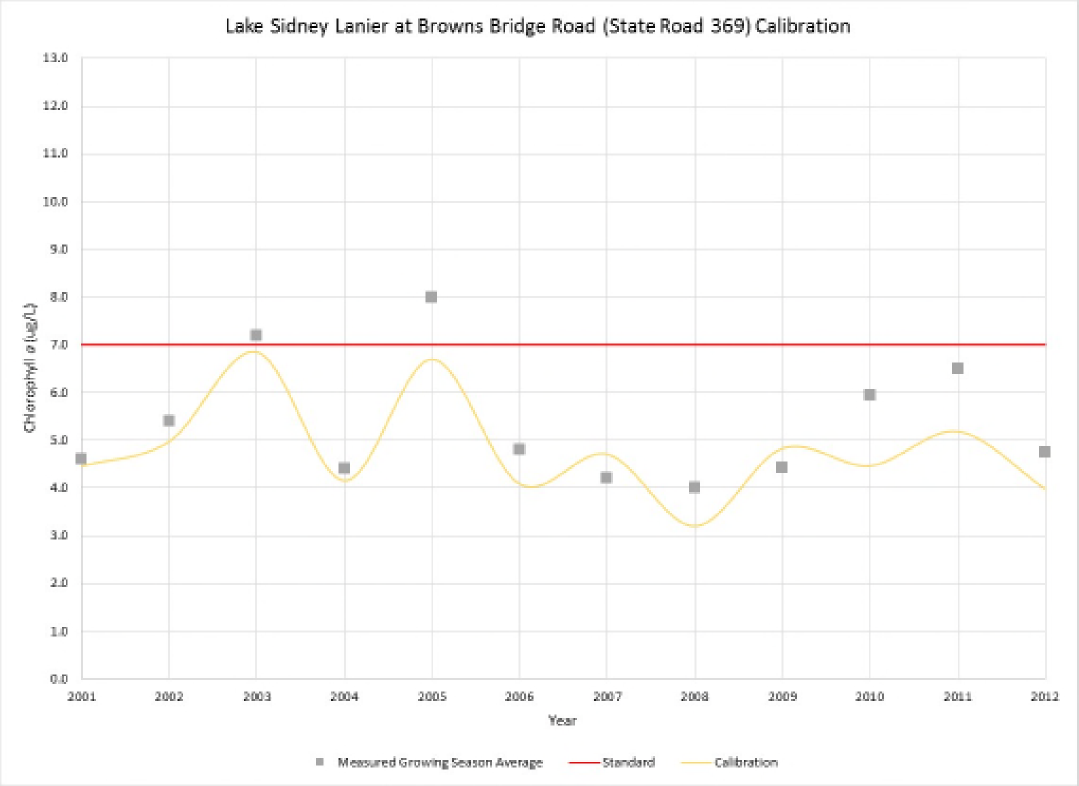

Figure 4-7 Lake Lanier at Browns Bridge Road (State Road 369) Calibration

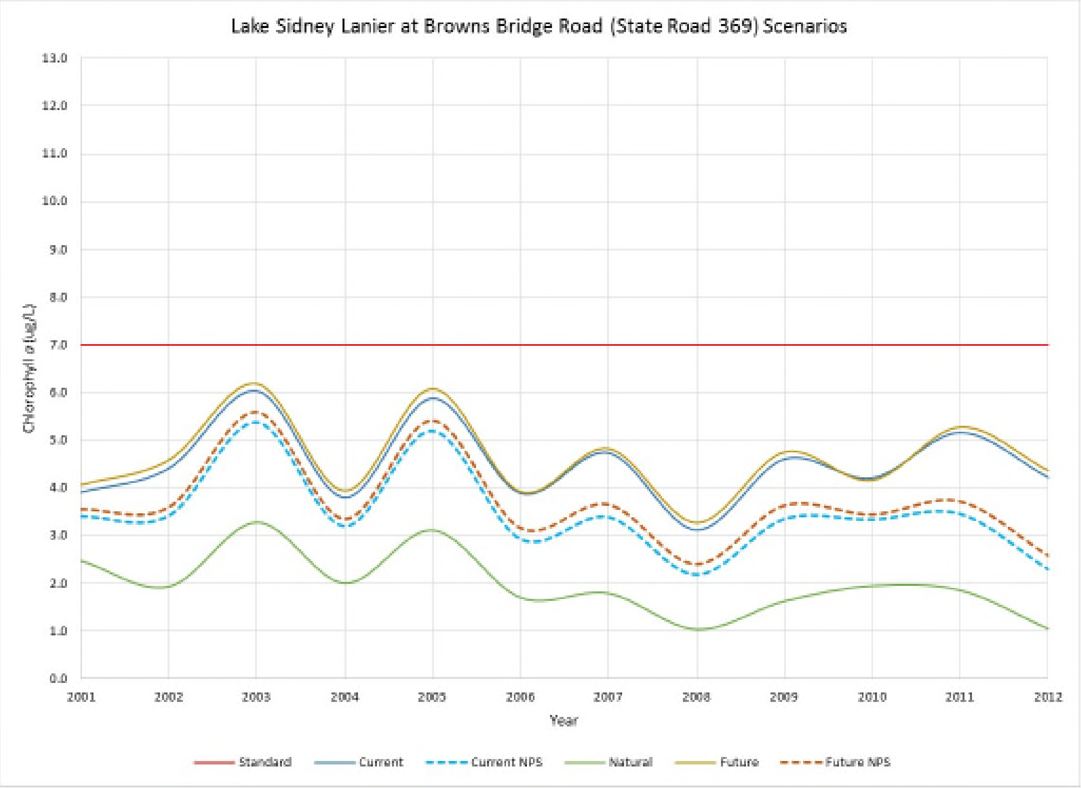

Figure 4-8 Lake Lanier at Browns Bridge Road (State Road 369) Scenarios—the scenarios presented include draft TMDL reductions

Figure 4-9 Lake Lanier at Boling Bridge (State Road 53) on Chestatee River Calibration

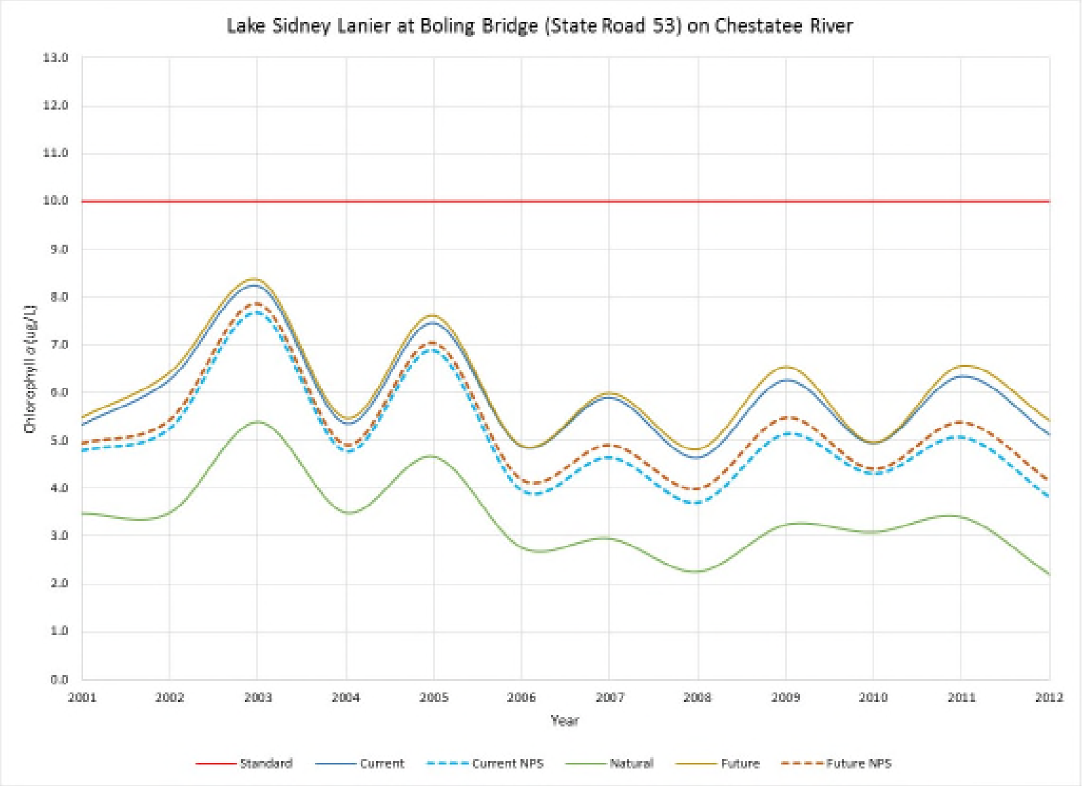

Figure 4-10 Lake Lanier at Boling Bridge (State Road 53) on Chestatee River Scenarios—the scenarios presented include draft TMDL reductions

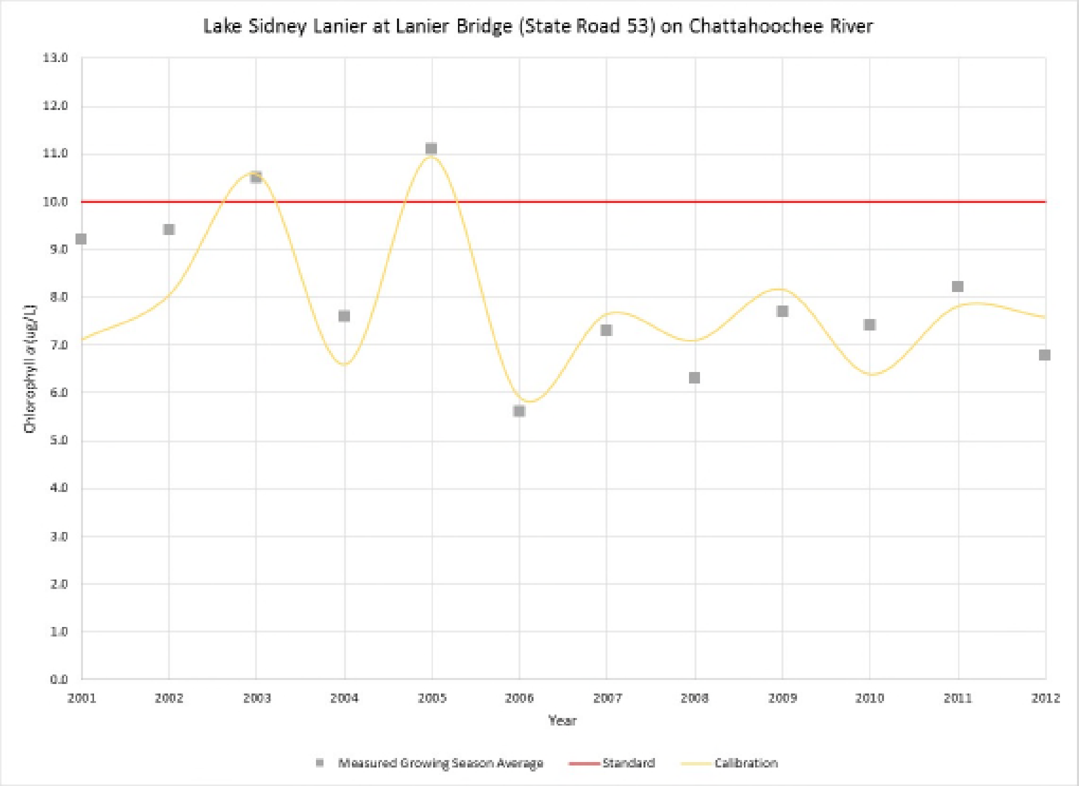

Figure 4-11 Lake Lanier at Lanier Bridge (State Road 53) on Chattahoochee River Calibration

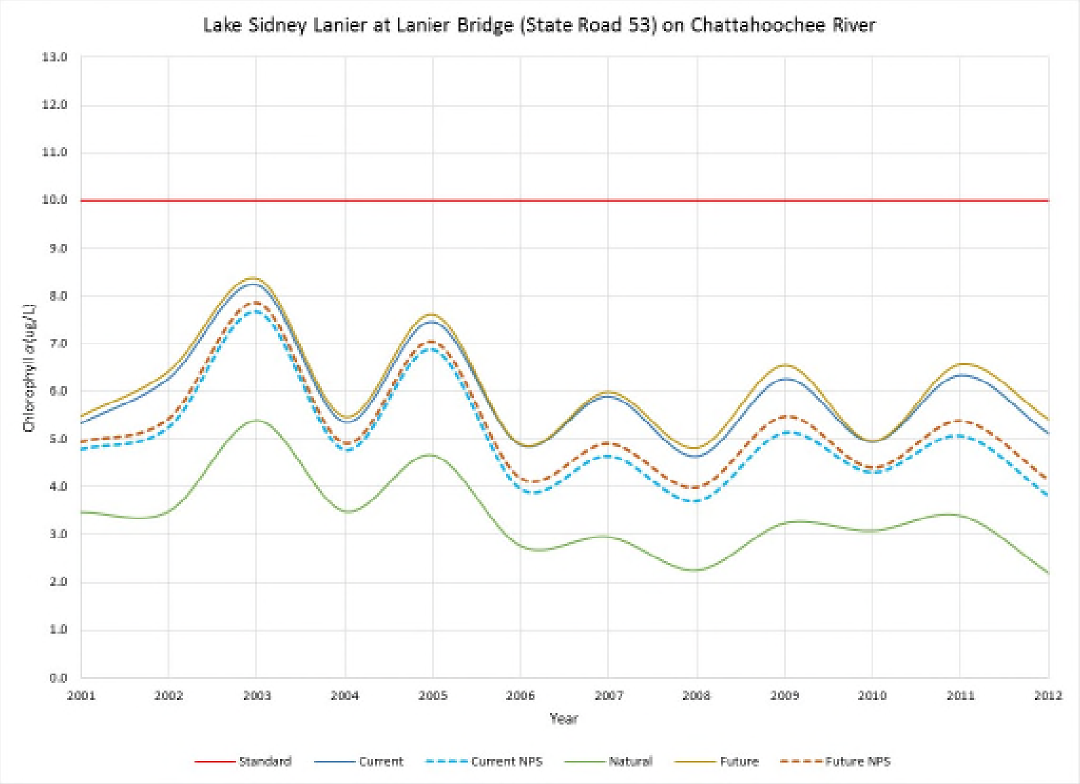

Figure 4-12 Lake Lanier at Lanier Bridge (State Road 53) on Chattahoochee River Scenarios—the scenarios presented include draft TMDL reductions

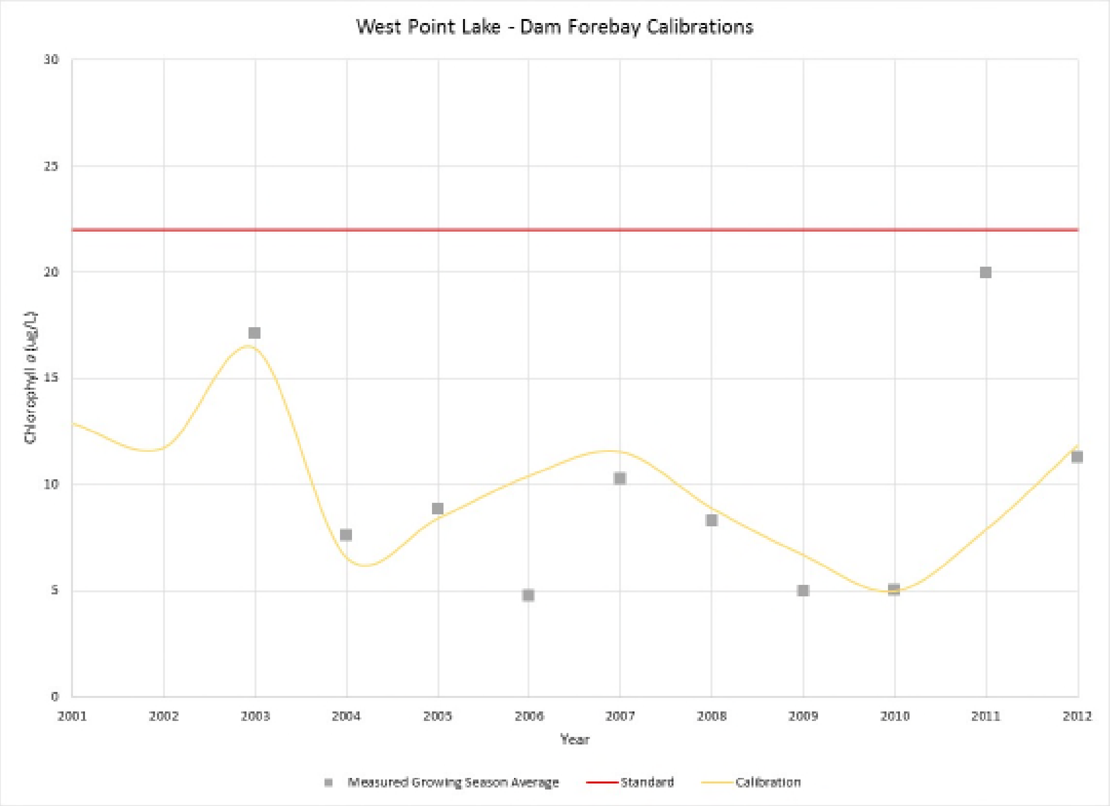

Figure 4-13 West Point Lake Upstream from the Dam Forebay Calibration

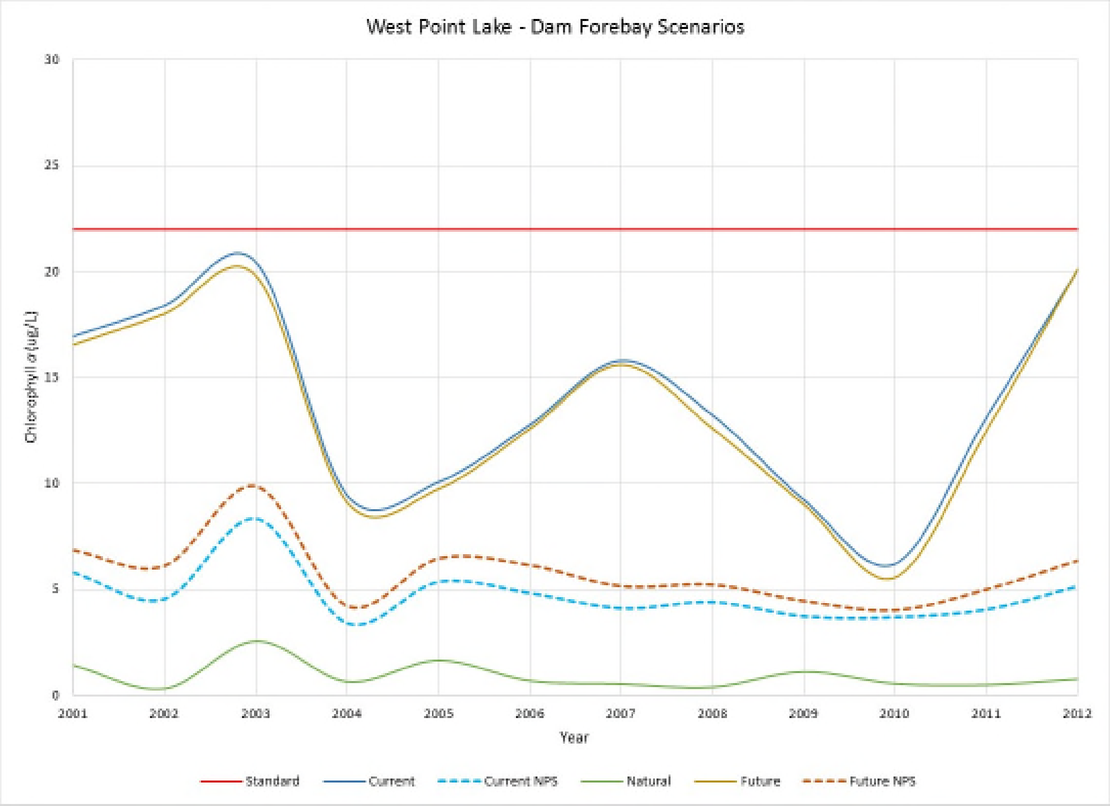

Figure 4-14 West Point Lake Upstream from the Dam Forebay Scenarios

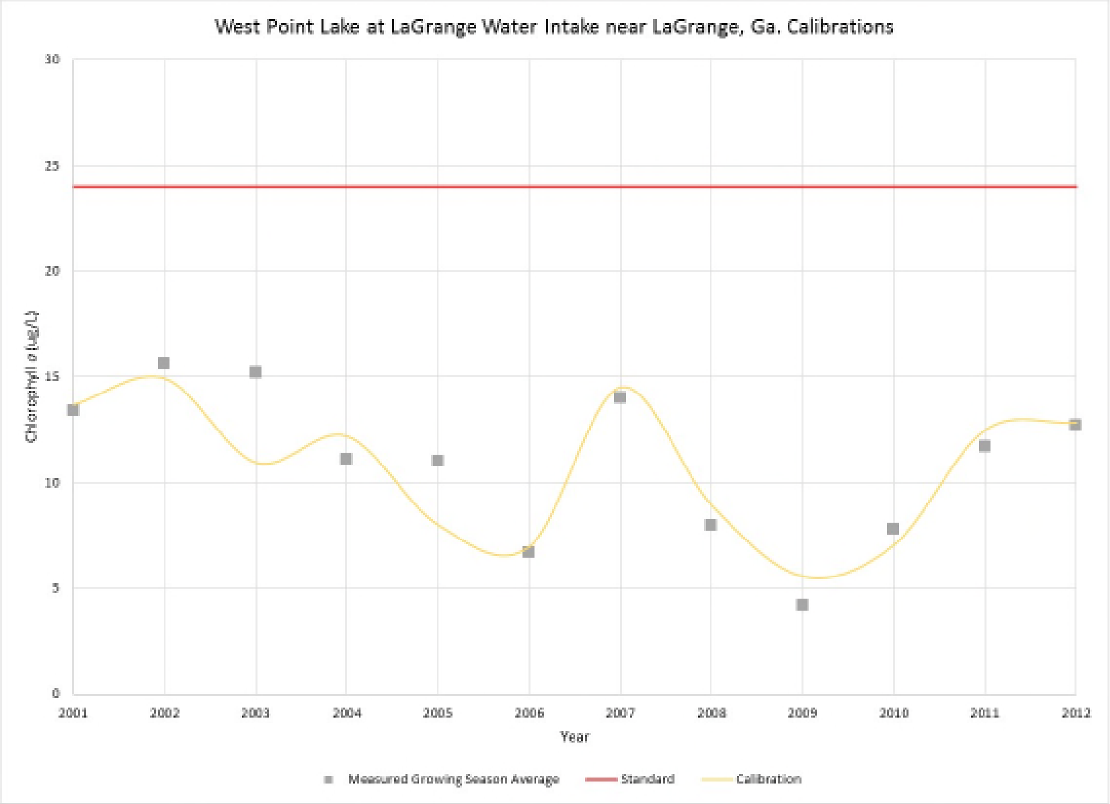

Figure 4-15 West Point Lake at the LaGrange Water Intake Calibration

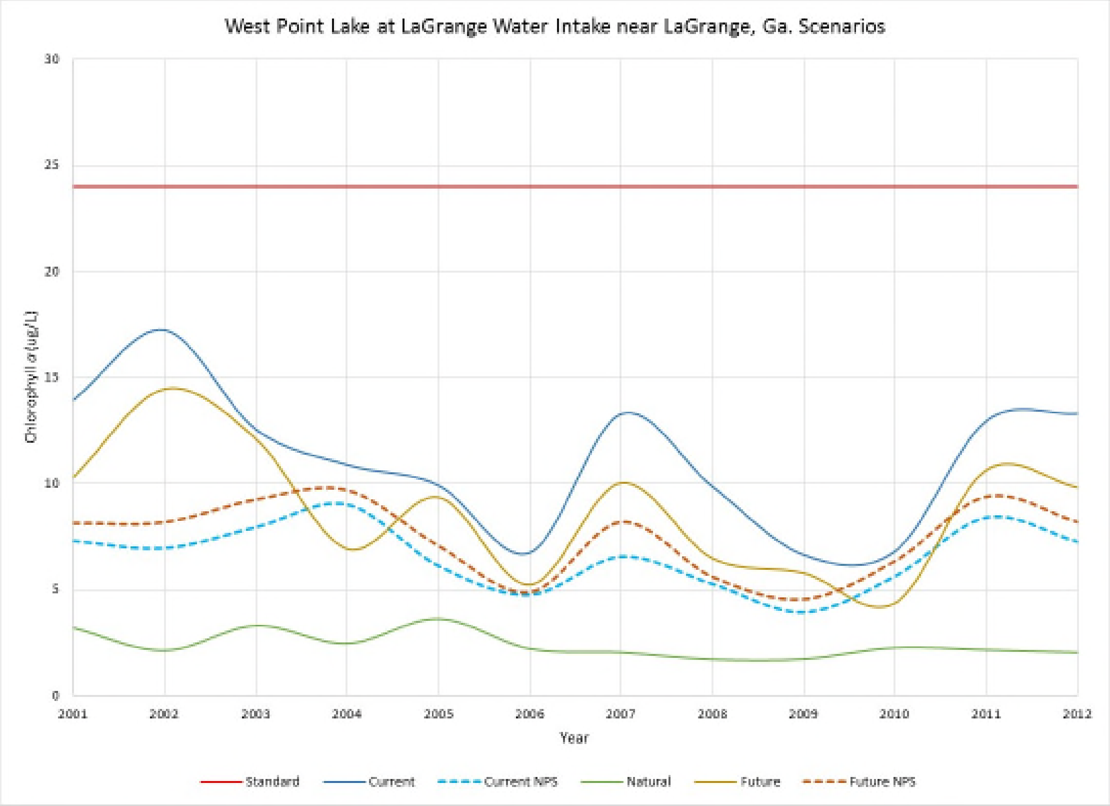

Figure 4-16 West Point Lake at the LaGrange Water Intake Scenarios

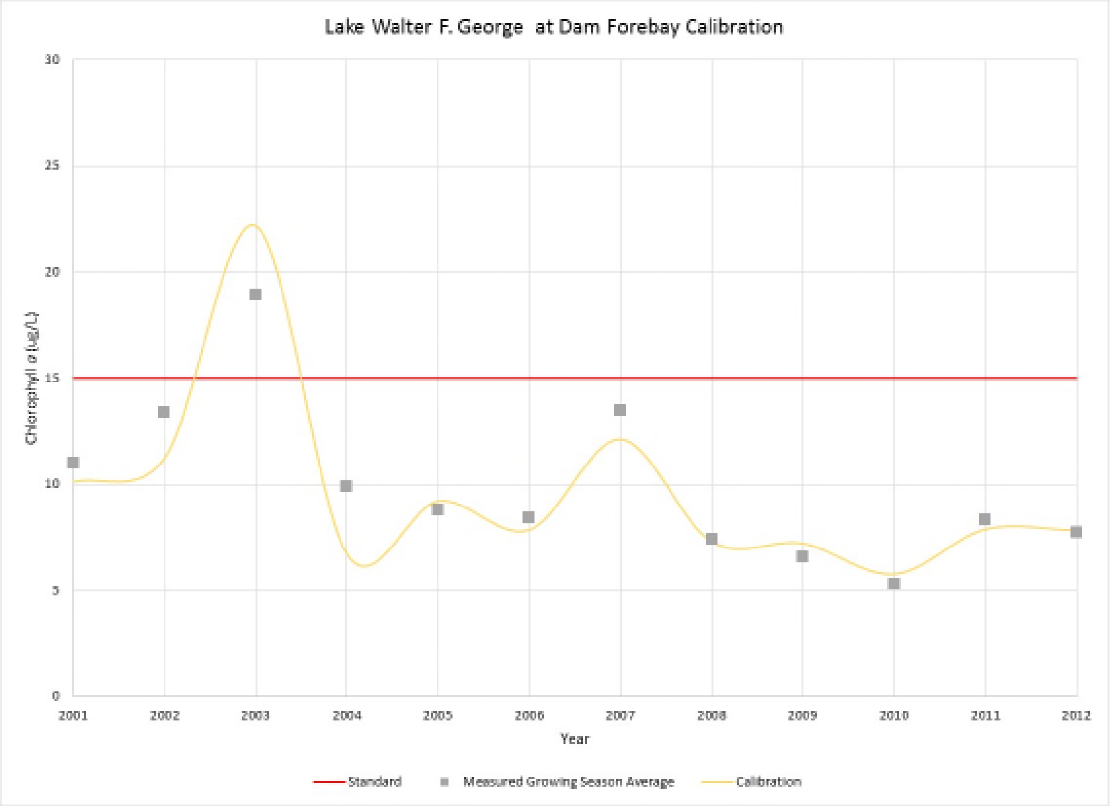

Figure 4-17 Lake Walter F. George at mid-river in the Dam Forebay Calibration

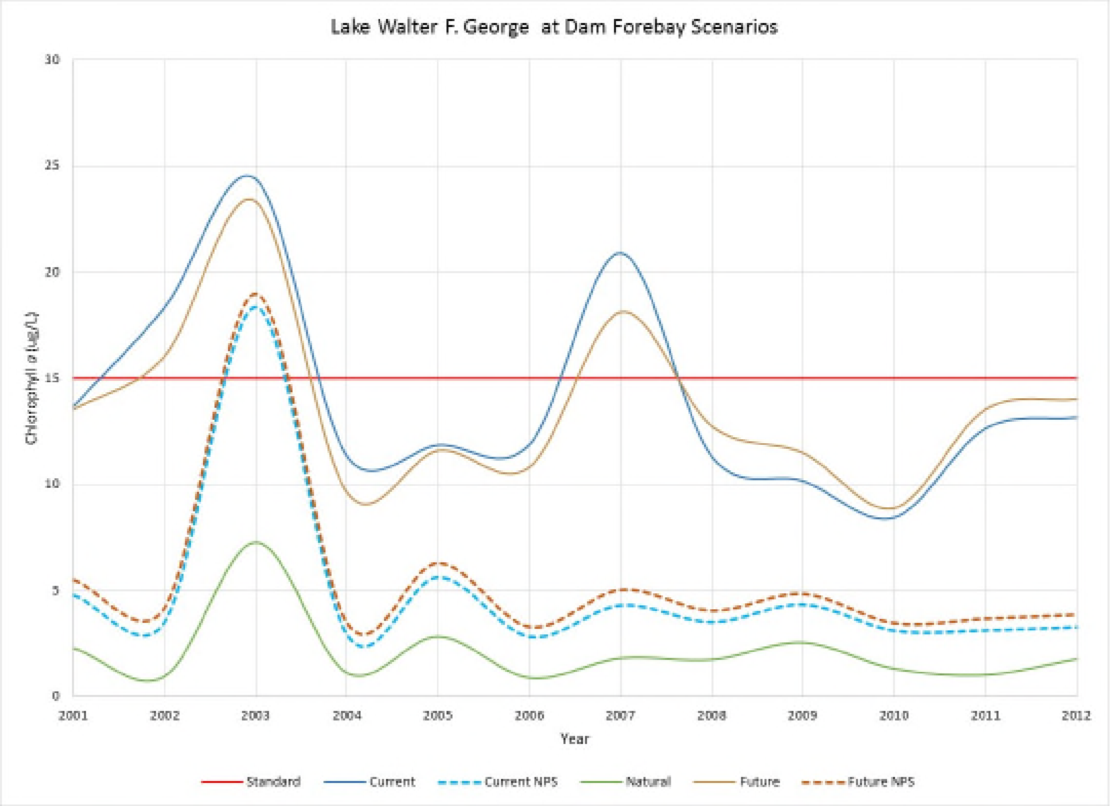

Figure 4-18 Lake Walter F. George at mid-river in the Dam Forebay Scenarios

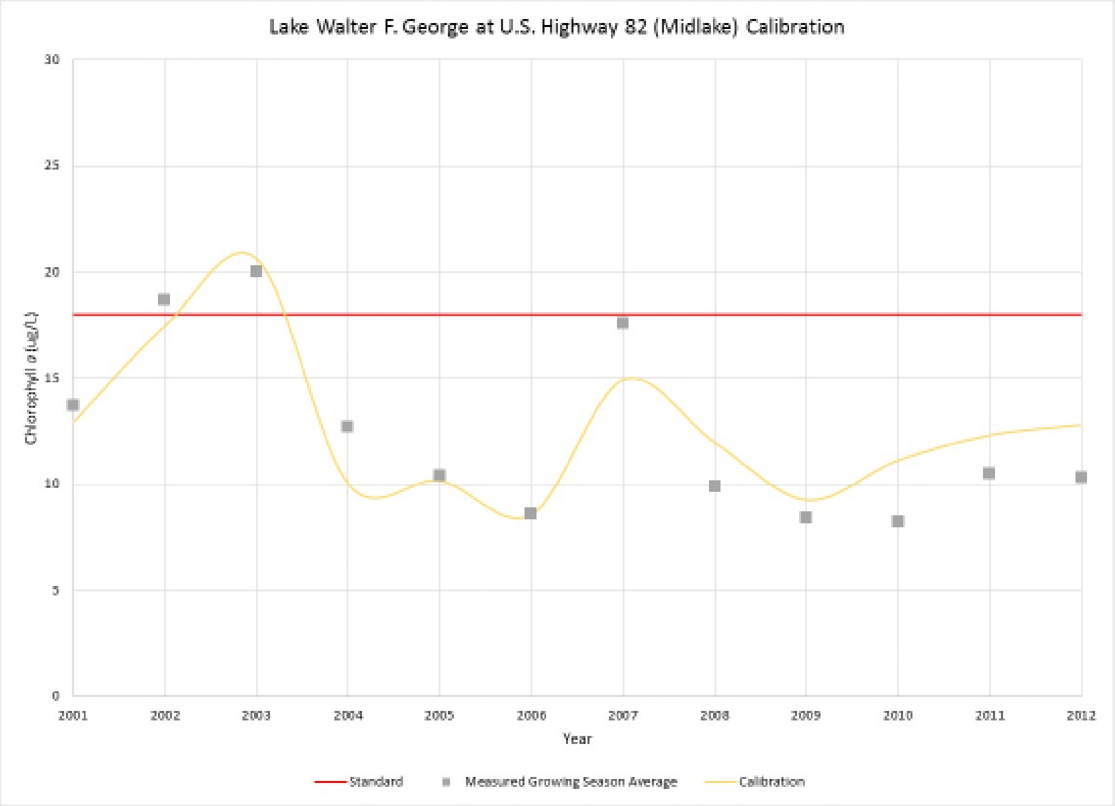

Figure 4-19 Lake Walter F. George at mid-river at U.S. Highway 82 Calibration

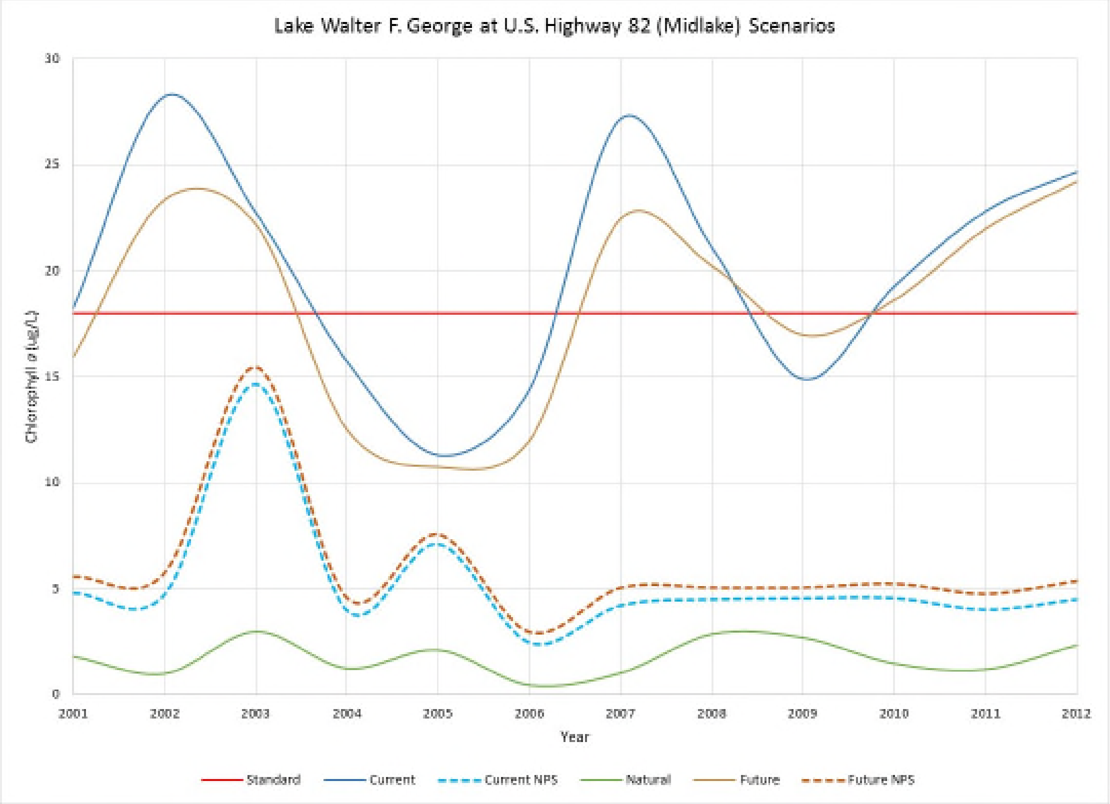

Figure 4-20 Lake Walter F. George at mid-river at U.S. Highway 82 Scenarios

4.3.4. Lake Blackshear

Figure 4-21 through Figure 4-24 illustrate the chlorophyll *a* measured and modeled in the Lake Blackshear dam forebay and mid-lake; there is no chlorophyll *a* standard for comparison. The first figures for each location show the modeled calibration results compared with the measured data. The second figures for each location show the other modeled scenarios (Current, Current NPS, Natural, Future, and Future NPS). Tables of the modeled growing season average chlorophyll *a* levels, along with other nutrient parameters, are included in Appendix C.

4.3.5.Lake Chehaw

Figure 4-25 through Figure 4-28 illustrate the chlorophyll *a* measured and modeled in Lake Chehaw (formally Lake Worth), also known as, Flint River Reservoir; there is no chlorophyll *a* standard for comparison. The first figures for each location show the modeled calibration results compared with the available measured data collected from 2010 through 2012. The second figures for each location show the other modeled scenarios (Current, Current NPS, Natural, Future, and Future NPS). Tables of the modeled growing season average chlorophyll *a* levels, along with other nutrient parameters, are included in Appendix C.

4.3.6.Lake Seminole

Figure 4-29 through Figure 4-34 illustrate the chlorophyll *a* measured and modeled in Lake Seminole; Georgia does not have a chlorophyll *a* standard for comparison. The first figures for each location show the modeled calibration results compared with the available measured data collected from 2010 through 2012. The second figures for each location show the other modeled scenarios (Current, Current NPS, Natural, Future, and Future NPS). Tables of the modeled growing season average chlorophyll *a* levels, along with other nutrient parameters, are included in Appendix C.

Florida does have a lake criteria set for the dam forebay of Lake Seminole. Table presents the annual geomean of each scenario for comparison with Florida's annual chlorophyll *a* geomean criteria of 20 μg/L.

Table 4-1 Annual Geomean Chlorophyll *a* (μg/L) at the Lake Seminole Forebay for each Scenario

Scenario	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Calibration	6	7	8	6	5	6	5	5	5	4	8	7
Current	7	10	10	9	6	8	8	7	7	5	11	11
Current NPS	3	3	6	4	4	3	2	3	3	2	3	3
Natural	0	1	1	0	1	0	0	0	0	0	0	0
Future	7	9	9	8	6	7	7	7	6	5	11	11
Future NPS	3	3	6	4	4	3	2	3	3	2	3	3

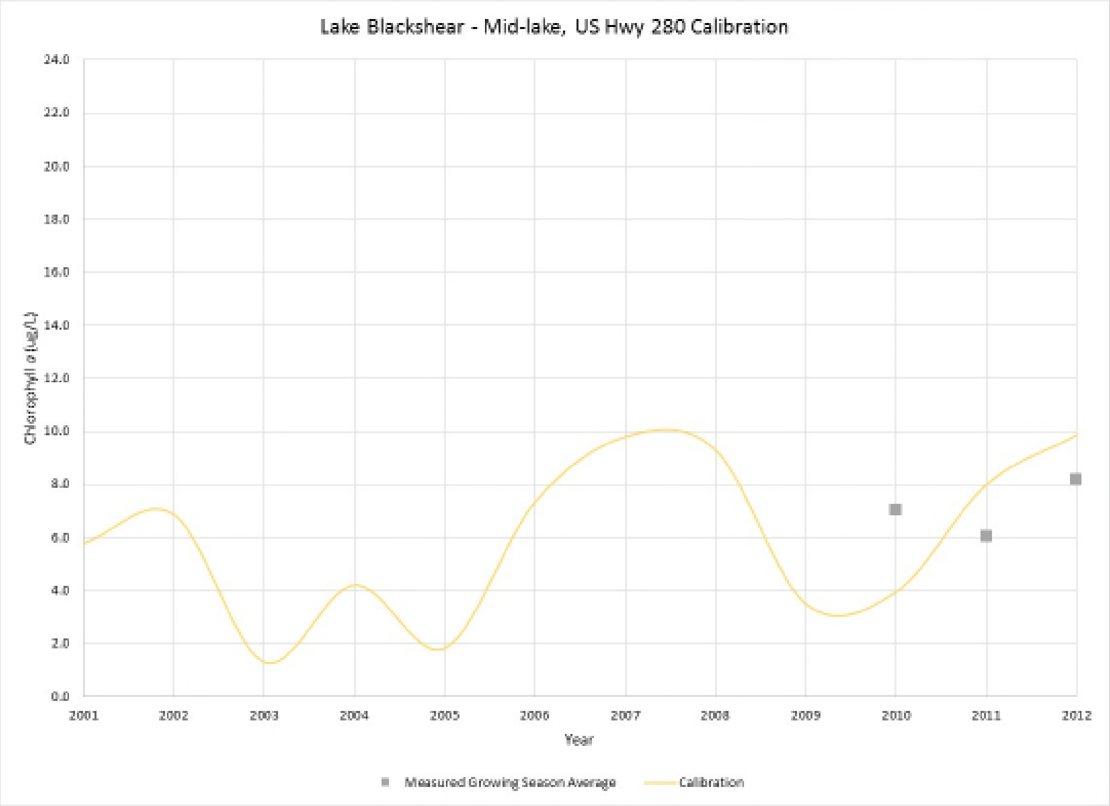

Figure 4-21 Lake Blackshear – Mid-lake, US Hwy 280 Calibration

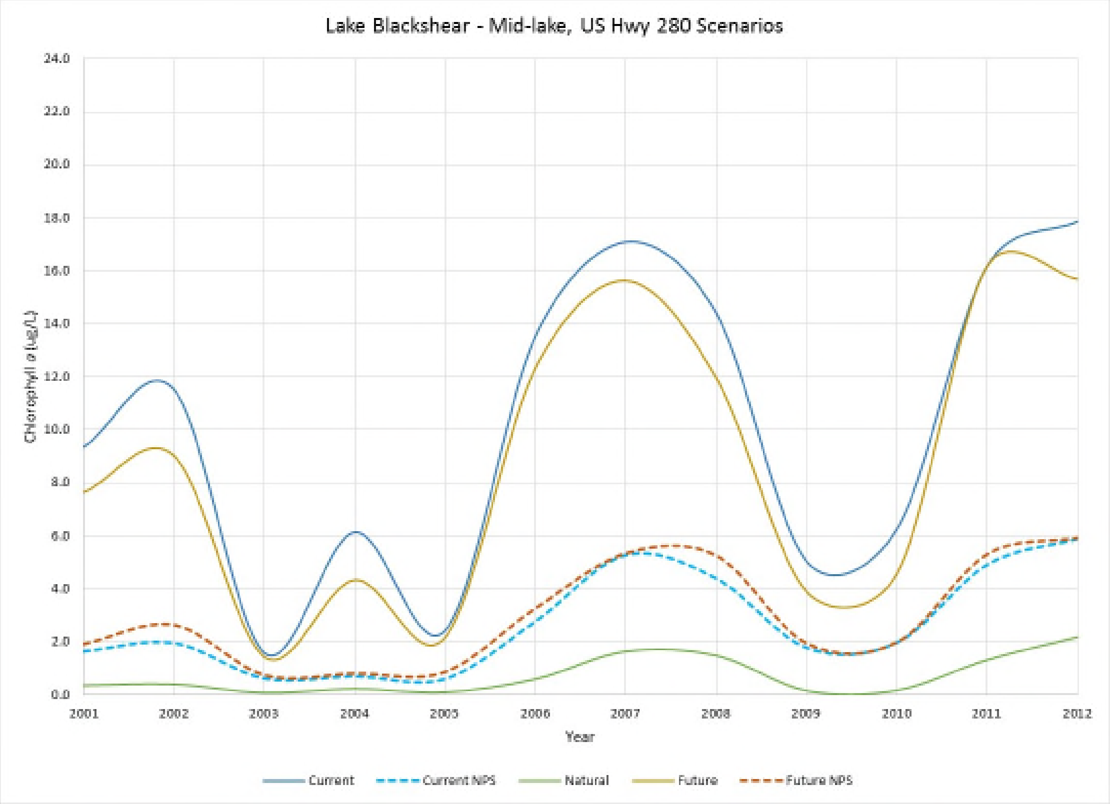

Figure 4-22 Lake Blackshear – Mid-lake, US Hwy 280 Scenarios

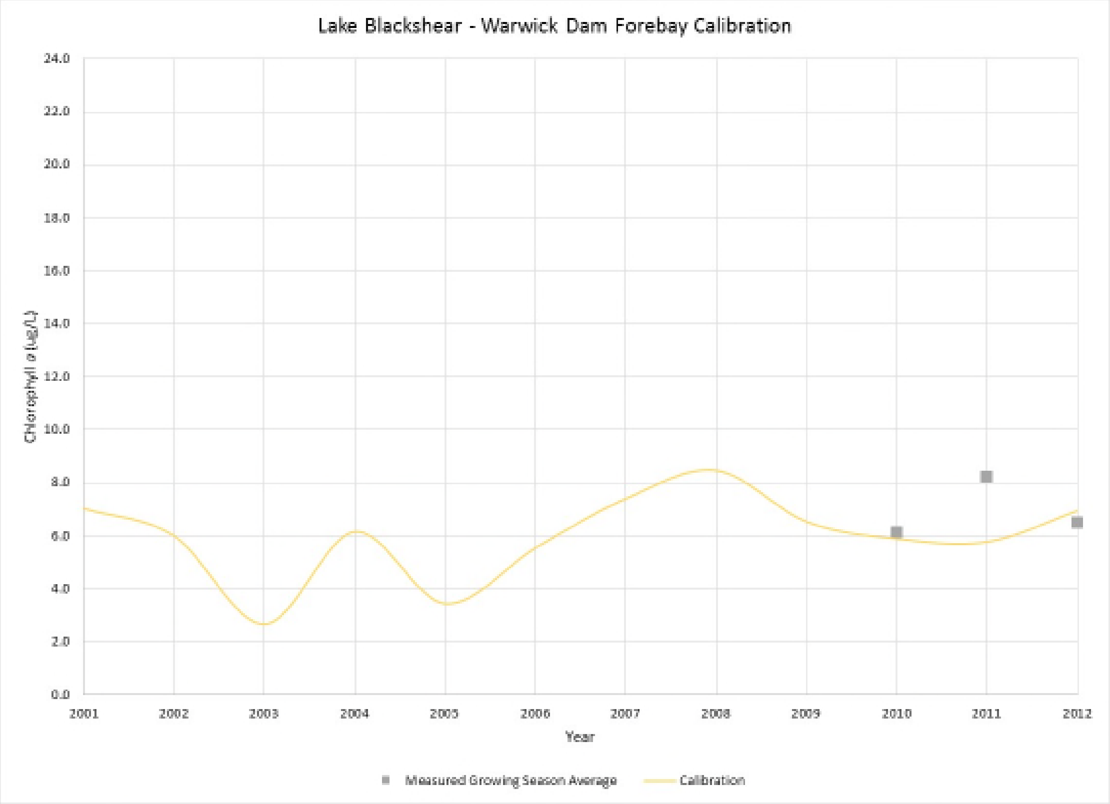

Figure 4-23 Lake Blackshear Dam Forebay Calibration

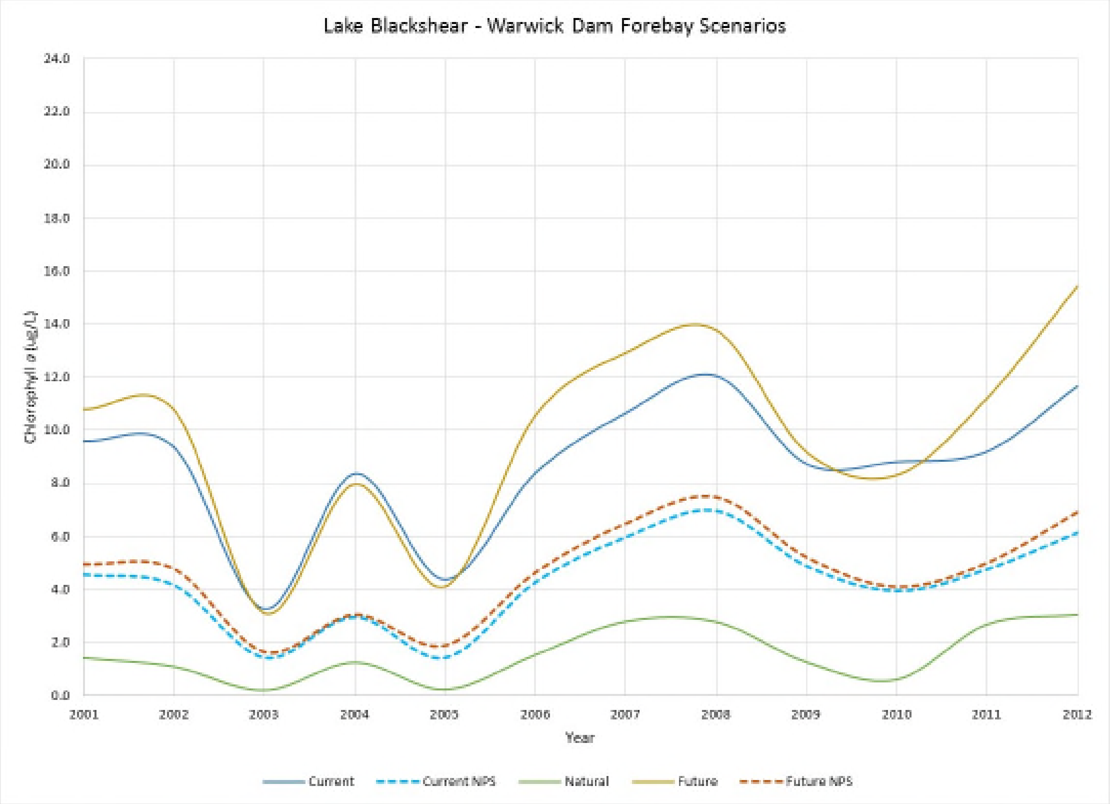

Figure 4-24 Lake Blackshear Dam Forebay Scenarios

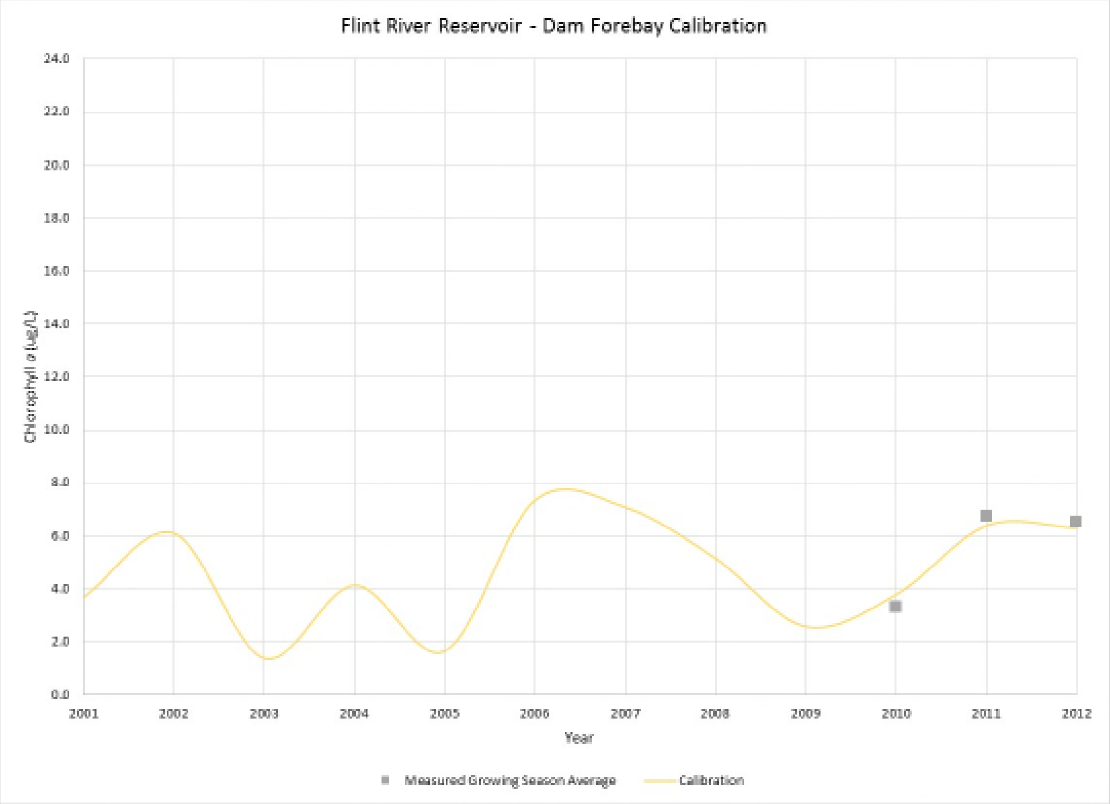

Figure 4-25 Lake Chehaw/Flint River Reservoir, Forebay, Calibration

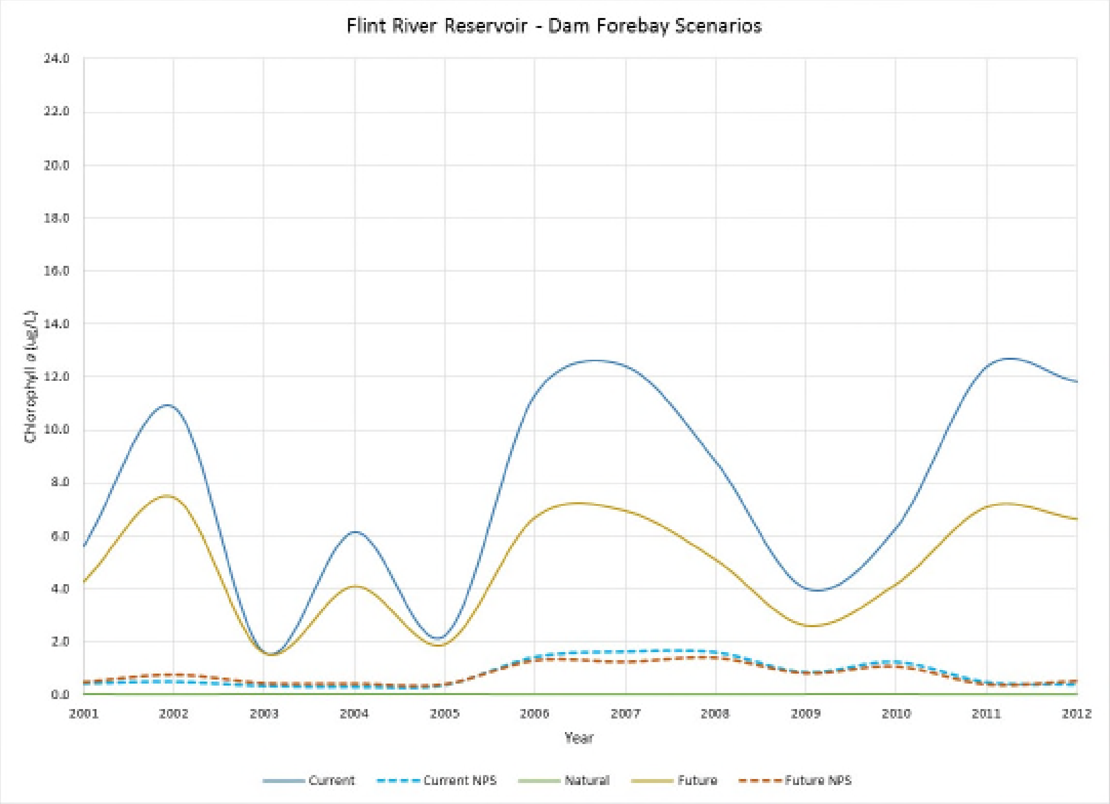

Figure 4-26 Lake Chehaw/ Flint River Reservoir, Forebay, Scenarios

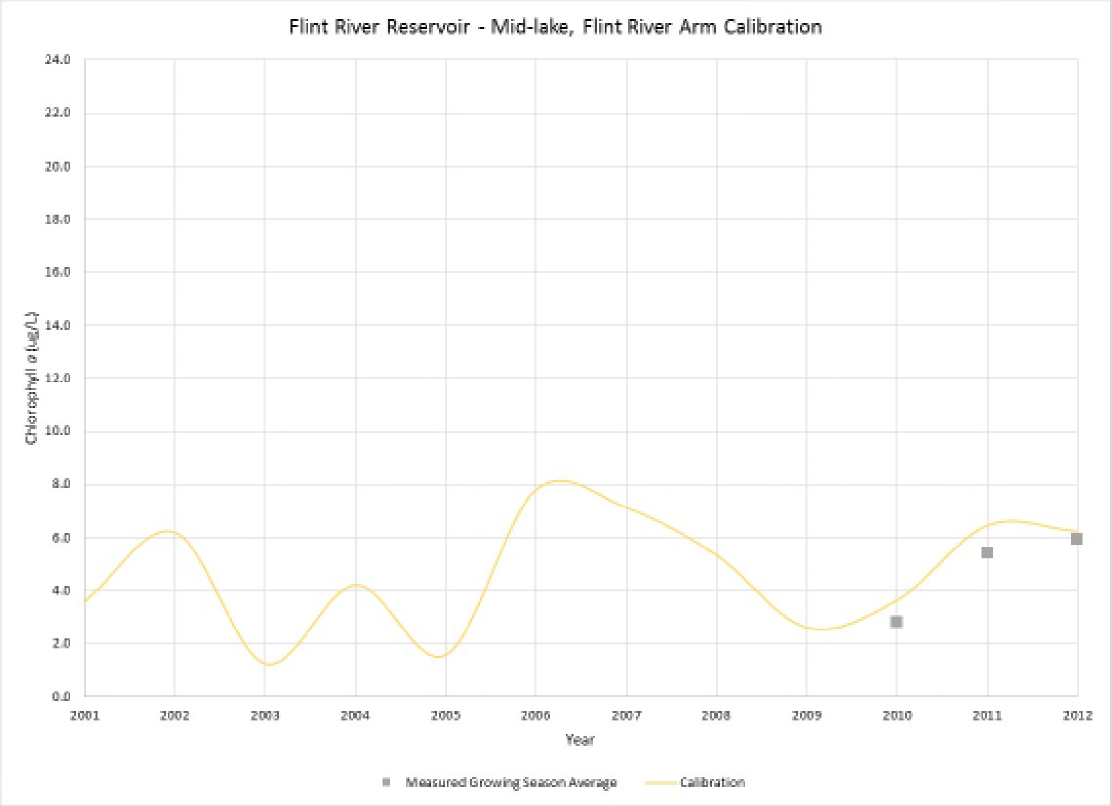

Figure 4-27 Lake Chehaw/Flint River Reservoir, Mid-lake, Calibration

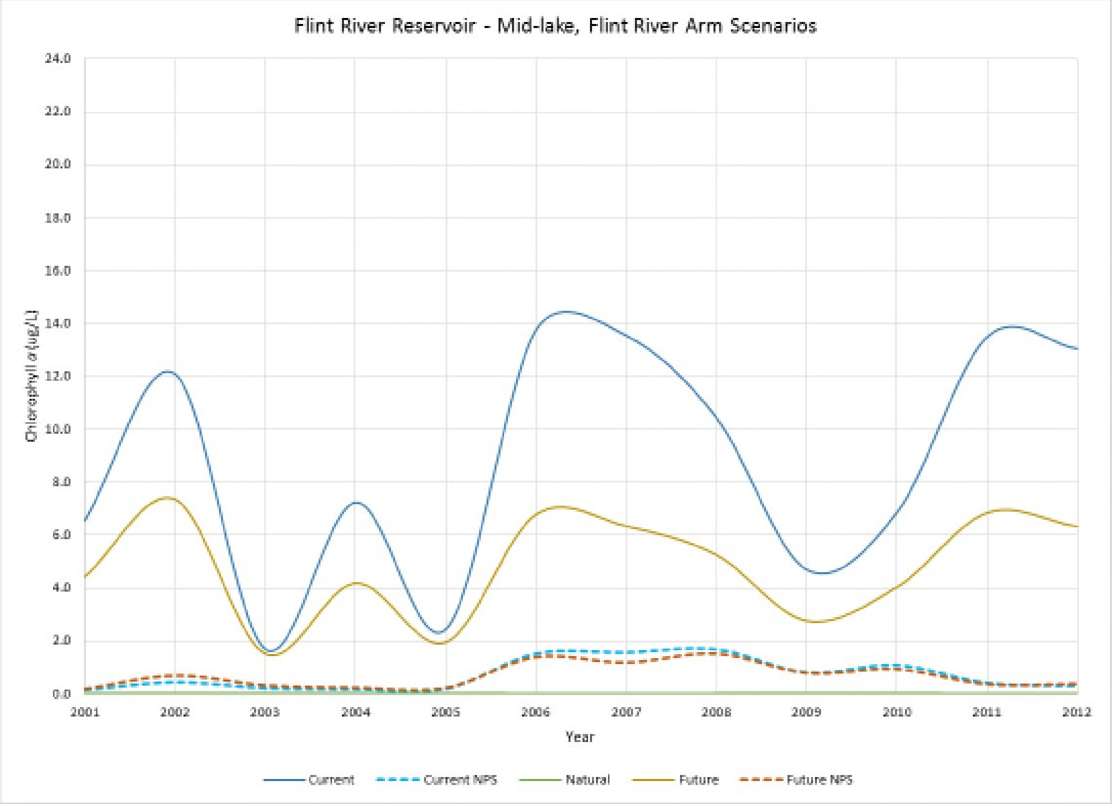

Figure 4-28 Lake Chehaw/ Flint River Reservoir, Mid-lake, Scenarios

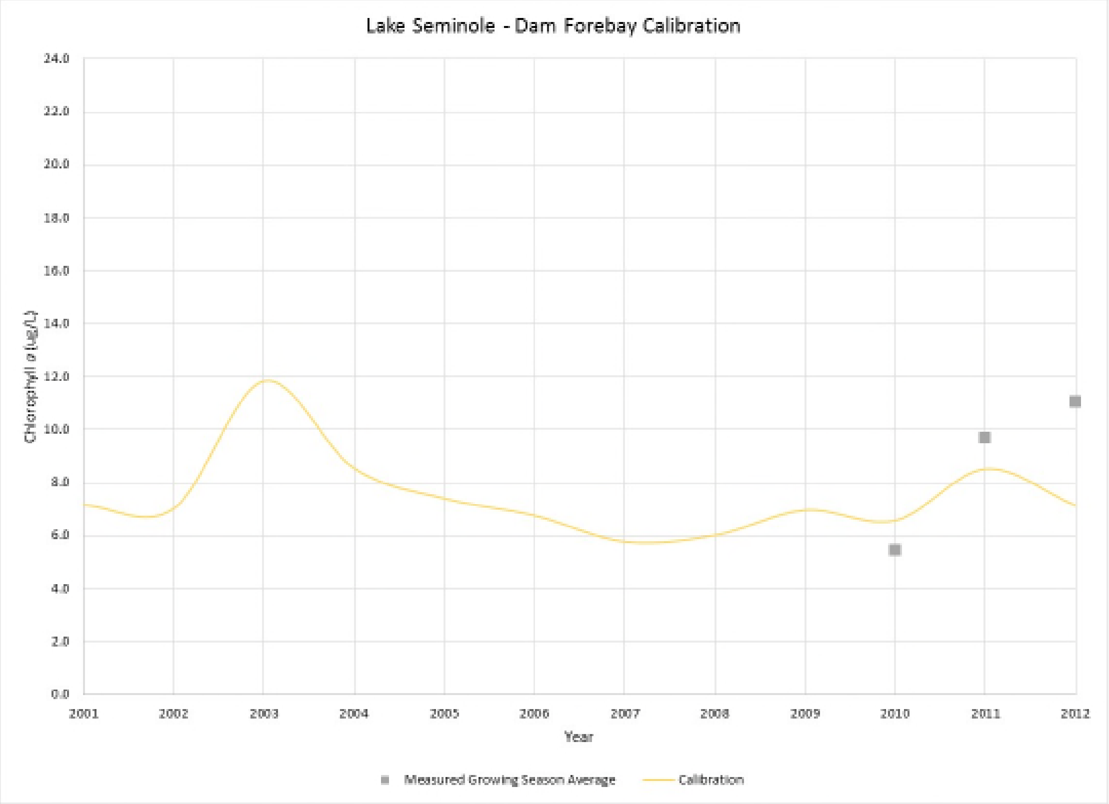

Figure 4-29 Lake Seminole Dam Forebay Calibration

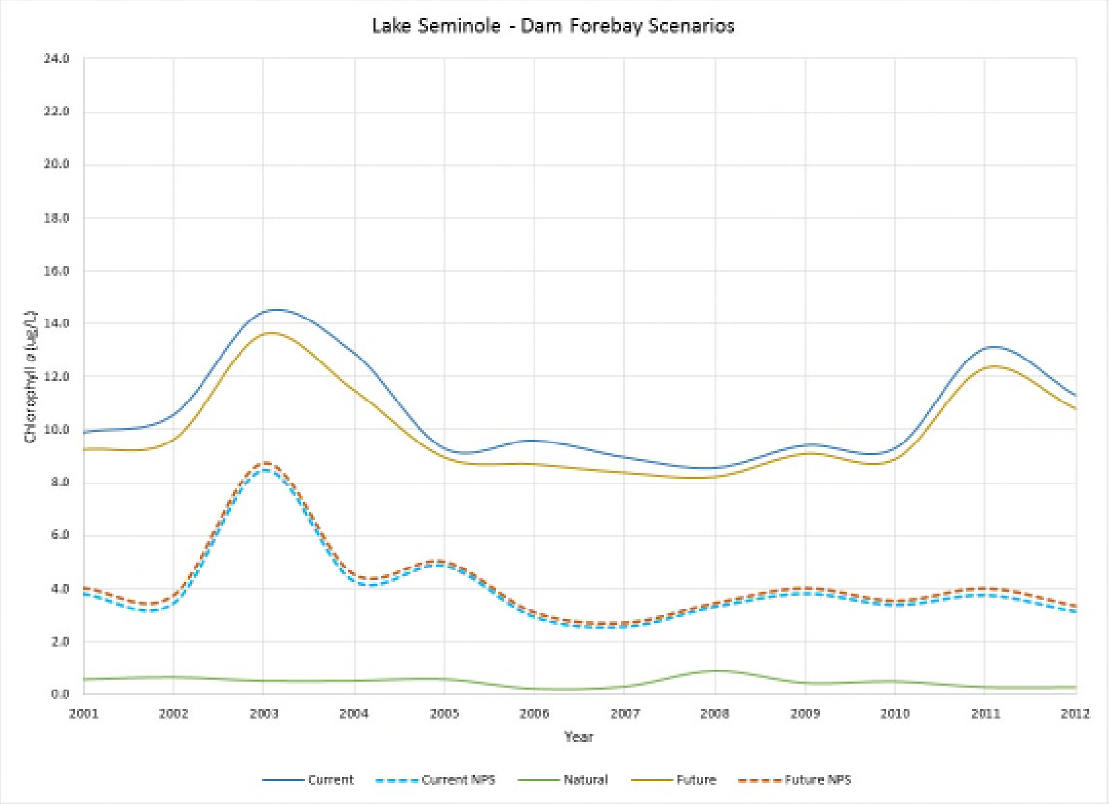

Figure 4-30 Lake Seminole Dam Forebay Scenarios

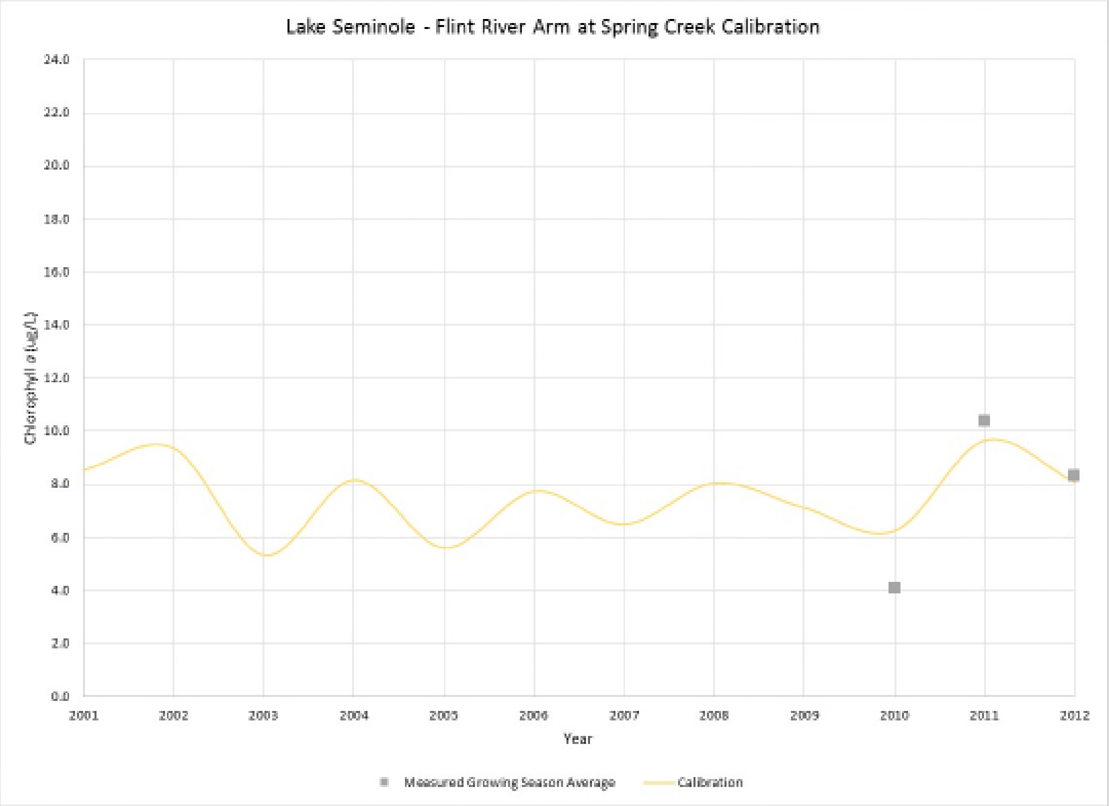

Figure 4-31 Flint River arm of Lake Seminole at Spring Creek Calibration

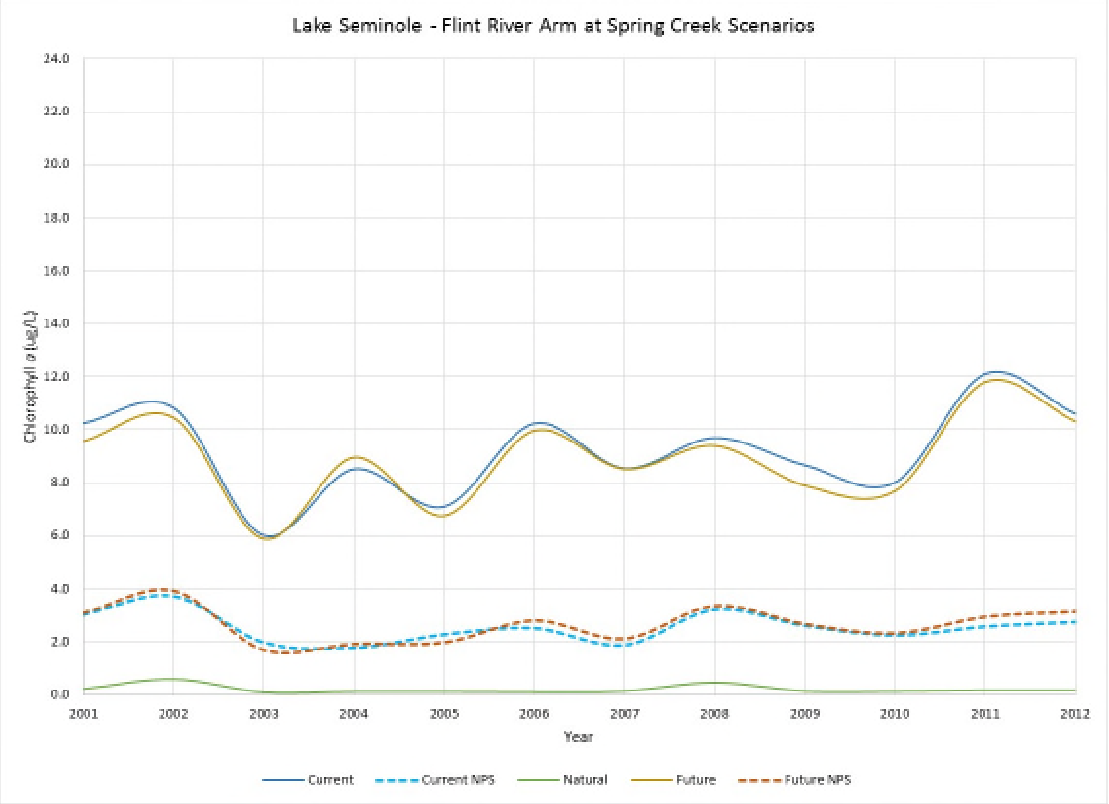

Figure 4-32 Flint River arm of Lake Seminole at Spring Creek Scenarios

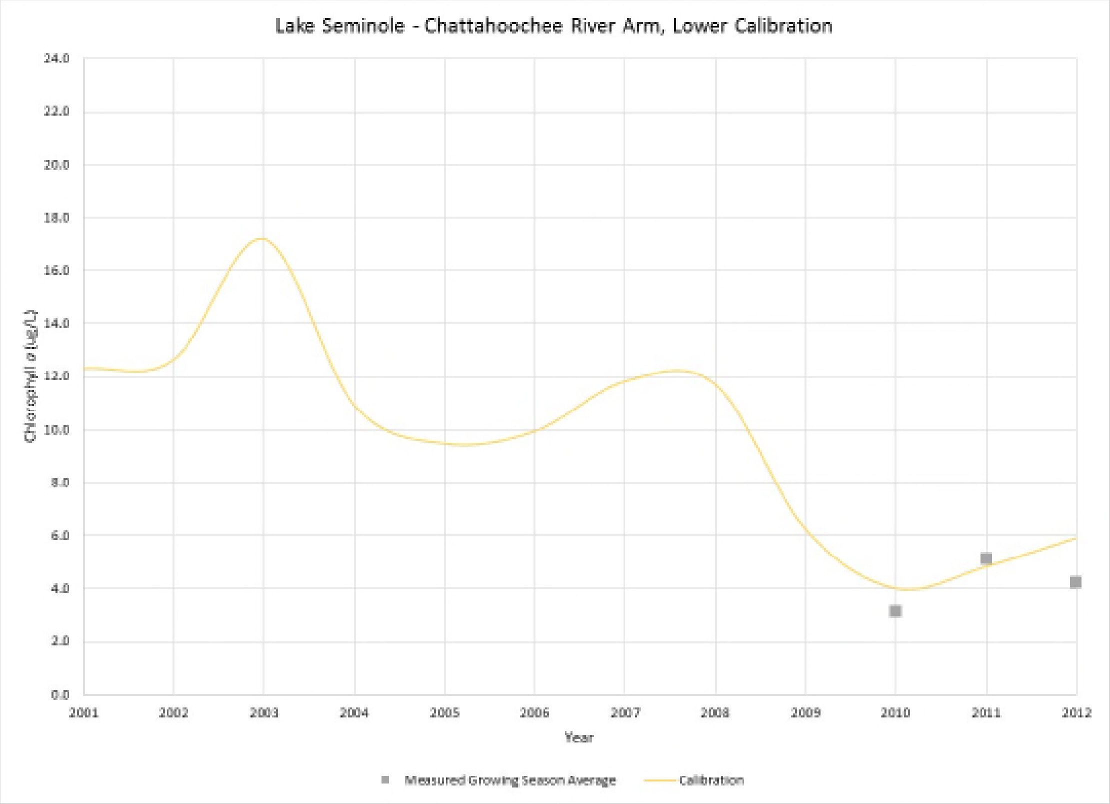

Figure 4-33 Chattahoochee River arm of Lake Seminole Calibration

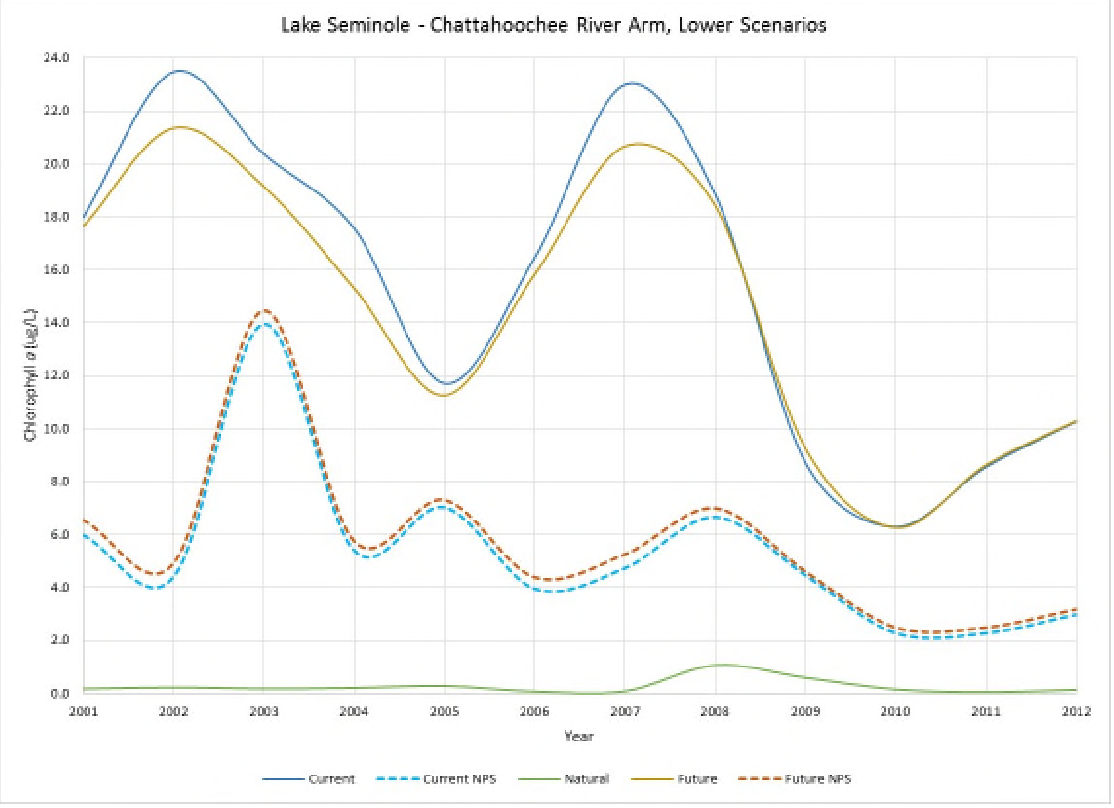

Figure 4-34 Chattahoochee River arm of Lake Seminole Scenarios

4.3.7. Carters Lake

Figure 4-35 through Figure 4-38 illustrate two figures for each location in Carters Lake. The first figures for each location show the modeled calibration results compared with the measured data. The second figures for each location show the other modeled scenarios (Current, Current NPS, Natural, Future, and Future NPS) along with the location's standard. Comparing the Carters Lake Future NPS with the Current NPS illustrates landuse changes and include reductions from the TMDL. Comparing the Current and Future scenarios applies upstream NPDES permit limits based on the TMDL and a 40 percent TMDL reduction from agricultural land. Tables of the modeled growing season average chlorophyll *a* levels, along with other nutrient parameters, are included in Appendix C.

4.3.8. Lake Allatoona

Figure 4-39 through Figure 4-48 illustrate two figures for each location in Lake Allatoona with a chlorophyll *a* water quality standard. The first figures for each location show the modeled calibration results compared with the measured data. The second figures for each location show the other modeled scenarios (Current, Current NPS, Natural, Future, and Future NPS) along with the location's standard. Comparing the Lake Allatoona Future NPS with the Current NPS illustrates landuse changes and include reductions from the TMDL. Comparing the Current and Future scenarios illustrates both landuse reductions (the TMDL) and applies NPDES permit limits based on the TMDL. Tables of the modeled growing season average chlorophyll *a* levels, along with other nutrient parameters, are included in Appendix C.

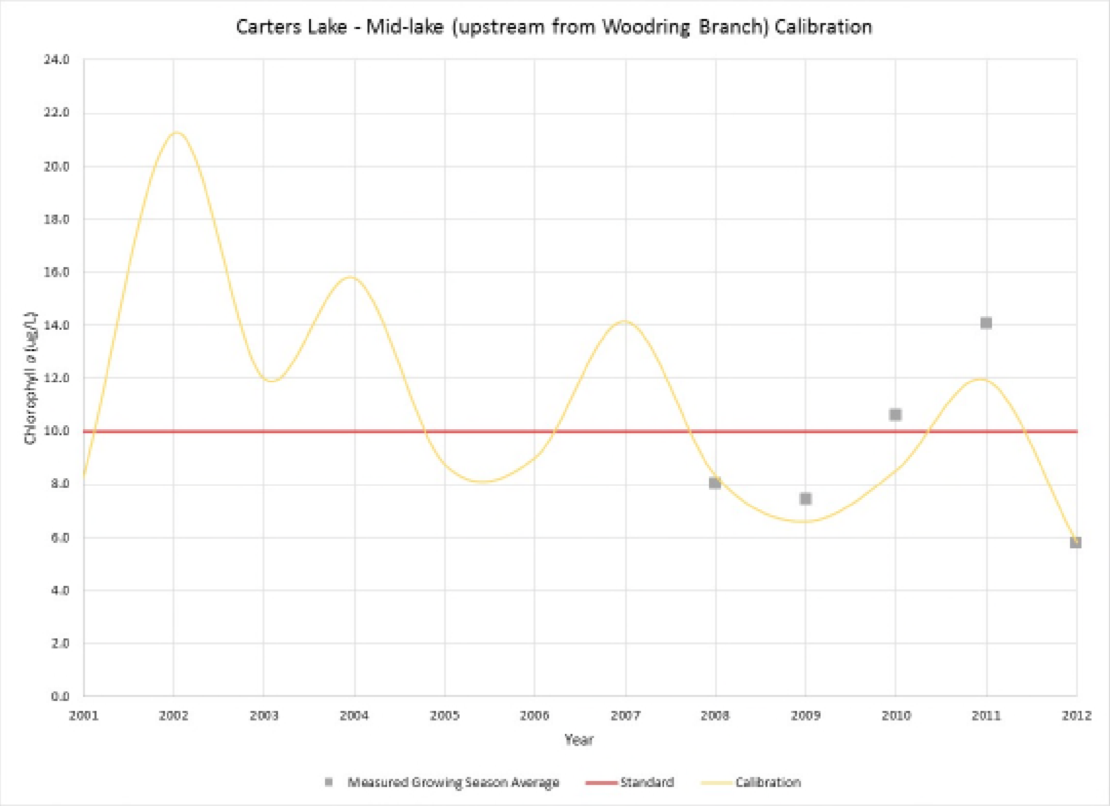

Figure 4-35 Carters Lake Upstream from Woodring Branch (Mid-lake) Calibration

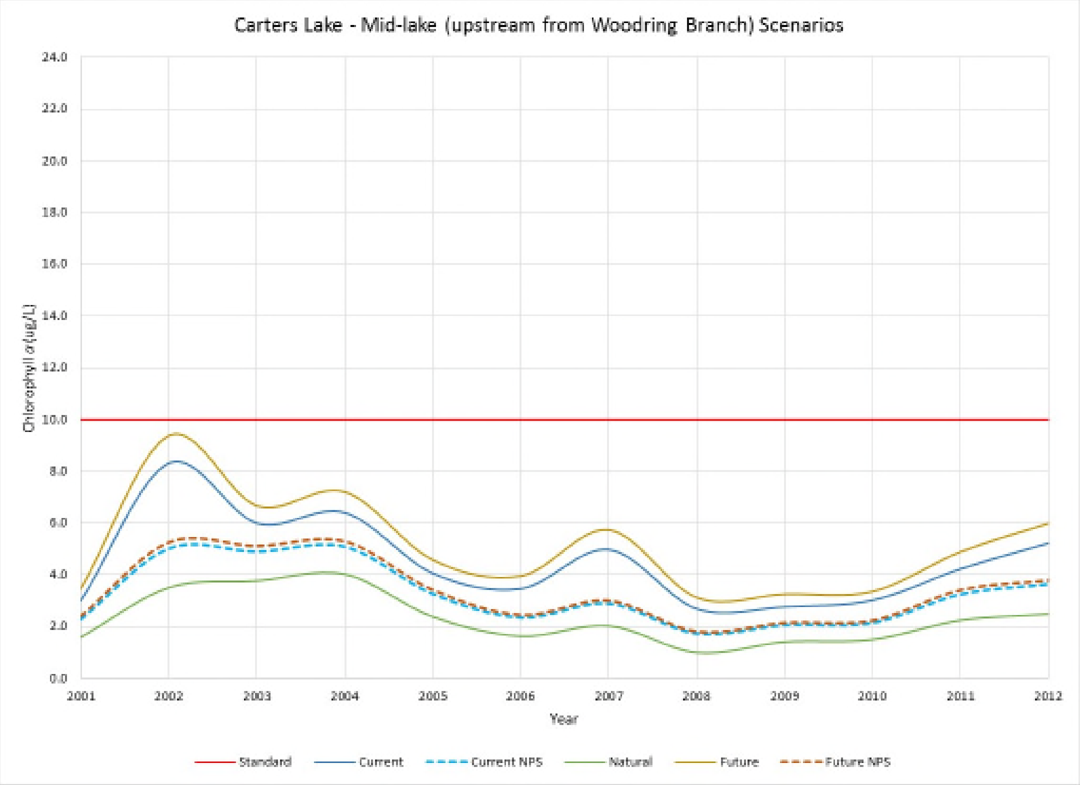

Figure 4-36 Carters Lake Upstream from Woodring Branch (Mid-lake) Scenarios—the scenarios presented include TMDL reductions

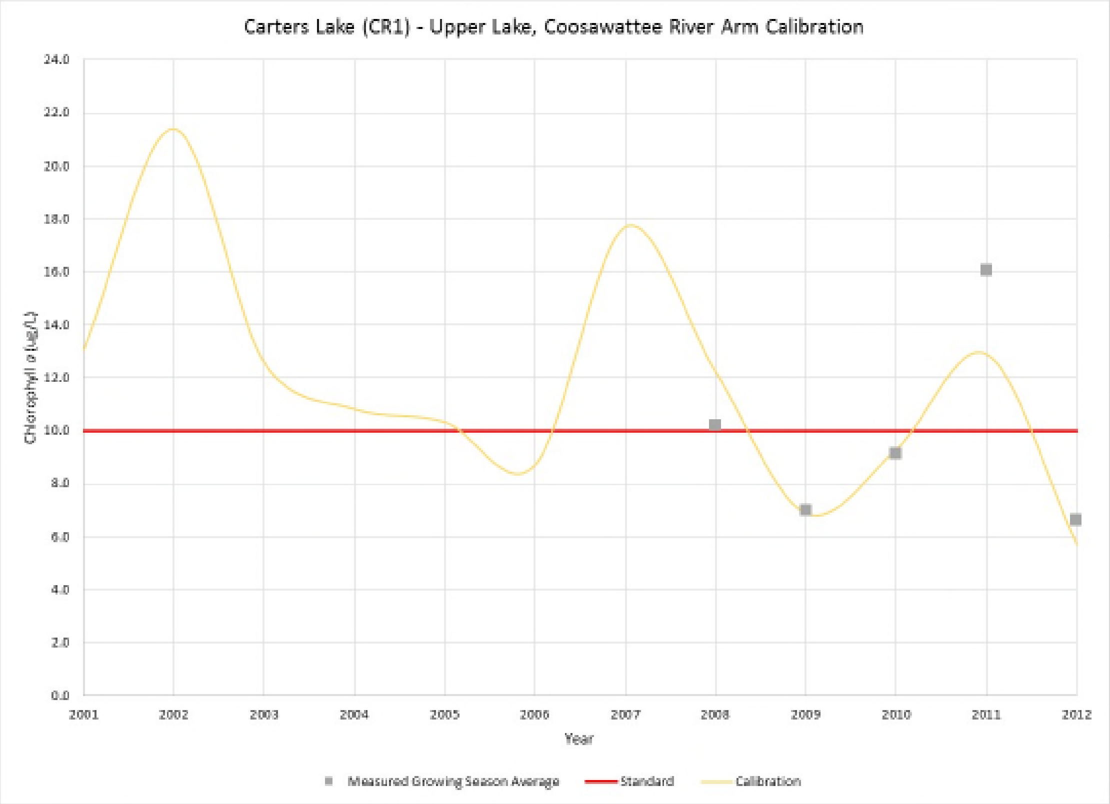

Figure 4-37 Carters Lake at Coosawattee River Embayment Mouth (Upper Lake) Calibration

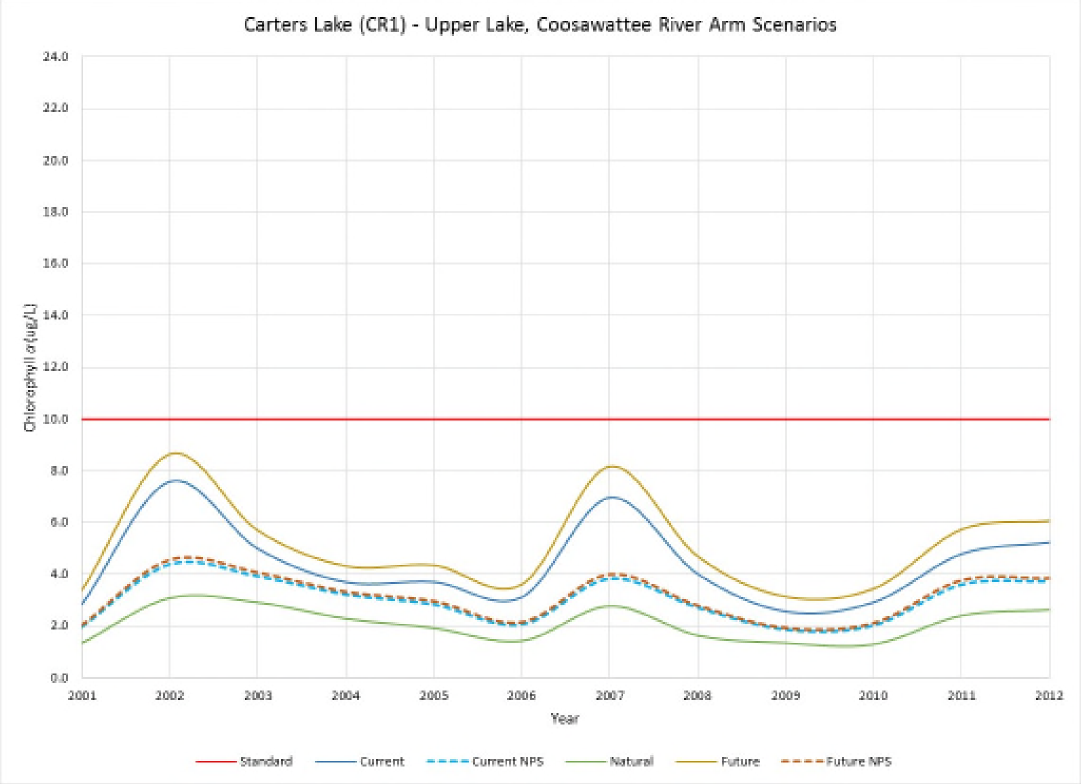

Figure 4-38 Carters Lake at Coosawattee River Embayment Mouth (Upper Lake) Scenarios—the scenarios presented include TMDL reductions

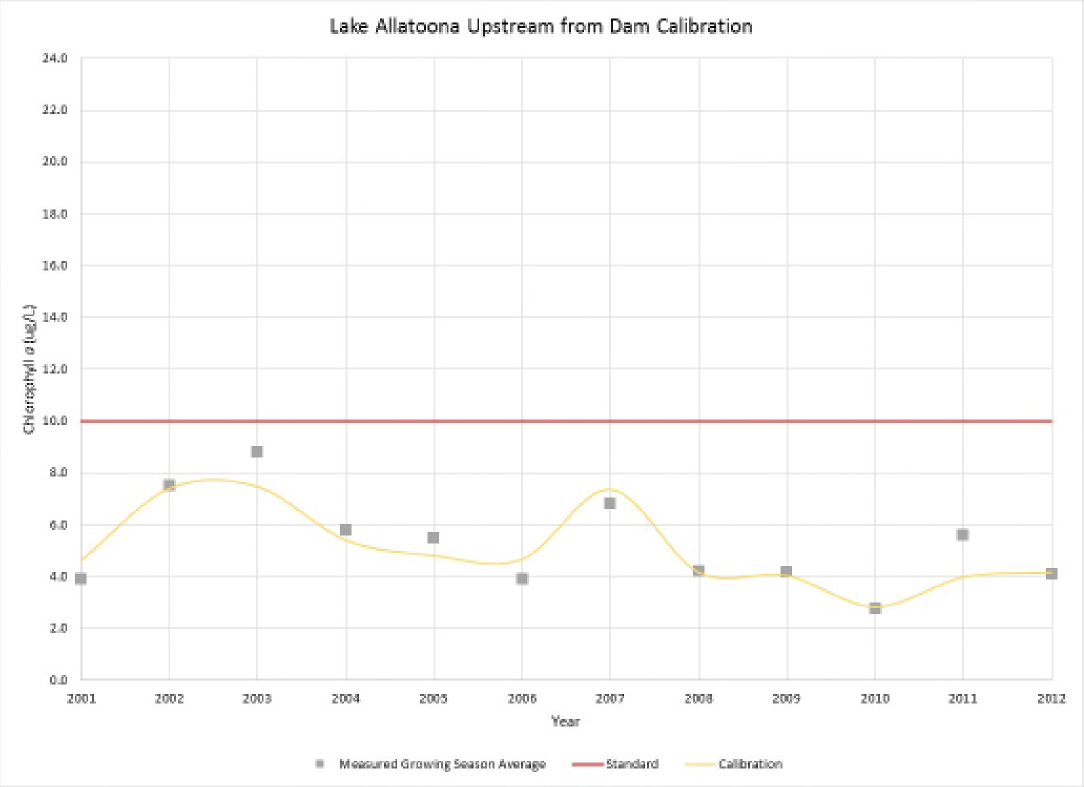

Figure 4-39 Lake Allatoona Upstream from the Dam Calibration

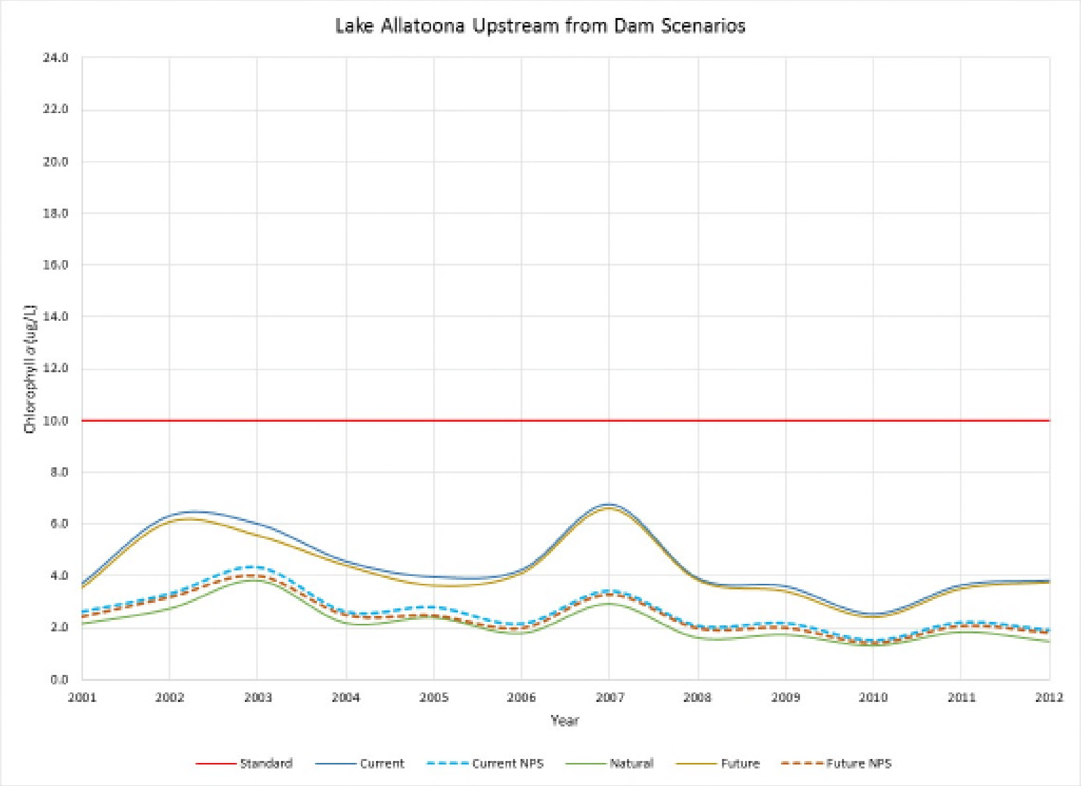

Figure 4-40 Lake Allatoona Upstream from the Dam Scenarios—the scenarios presented include TMDL reductions

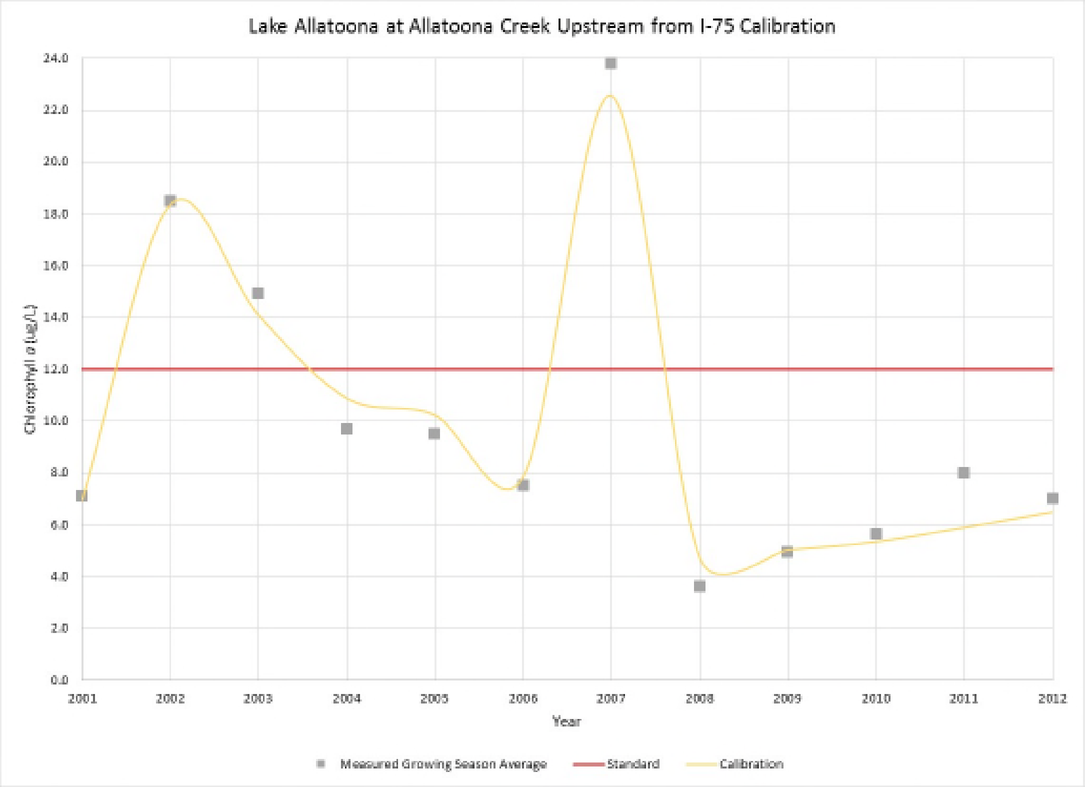

Figure 4-41 Lake Allatoona at Allatoona Creek upstream from I-75 Calibration

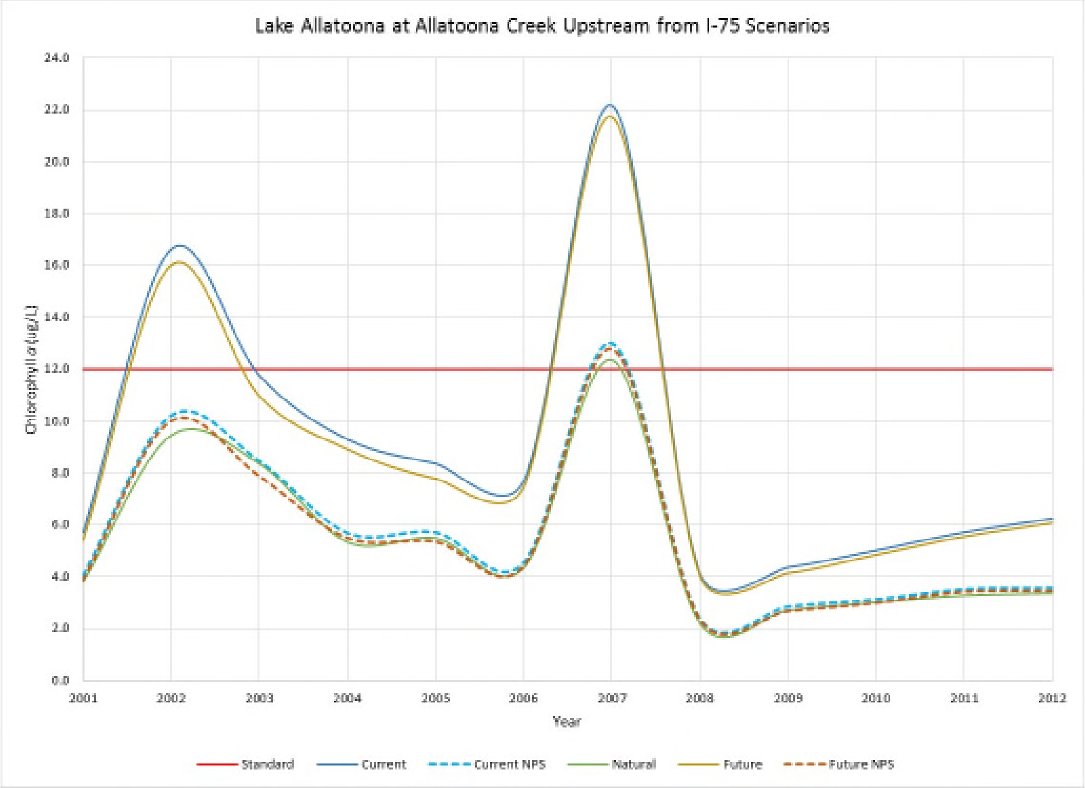

Figure 4-42 Lake Allatoona at Allatoona Creek upstream from I-75 Scenarios—the scenarios presented include TMDL reductions

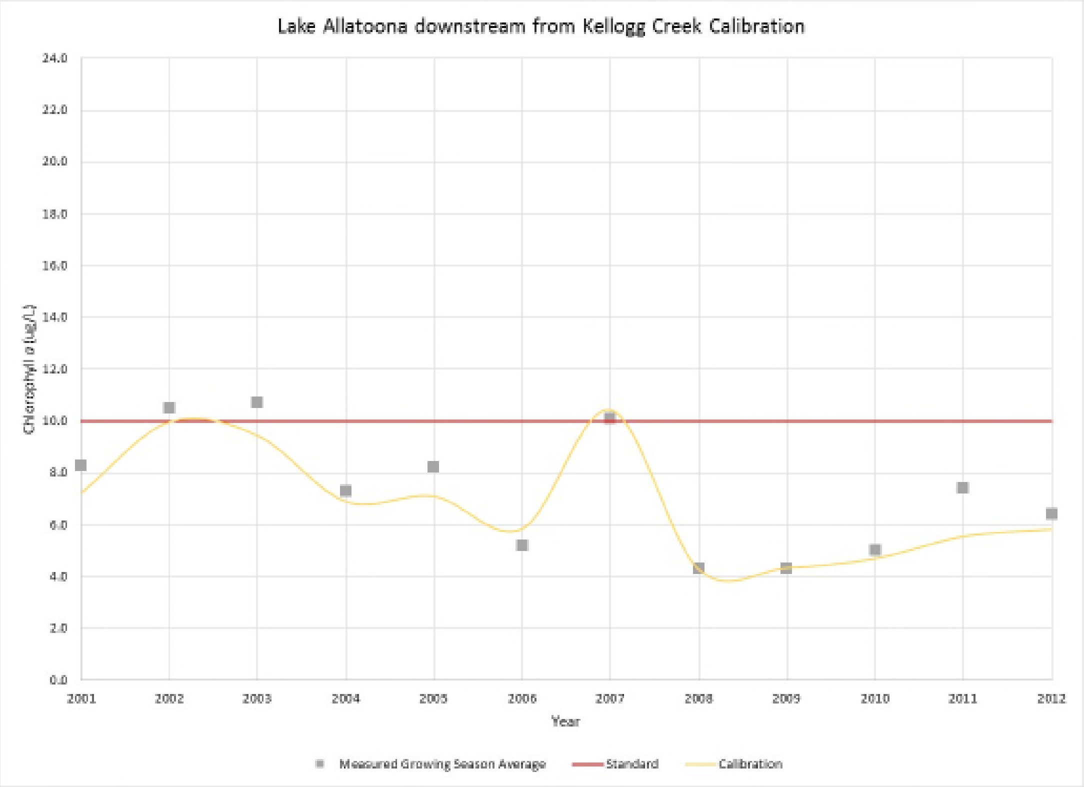

Figure 4-43 Lake Allatoona at Mid-Lake downstream from Kellogg Creek Calibration

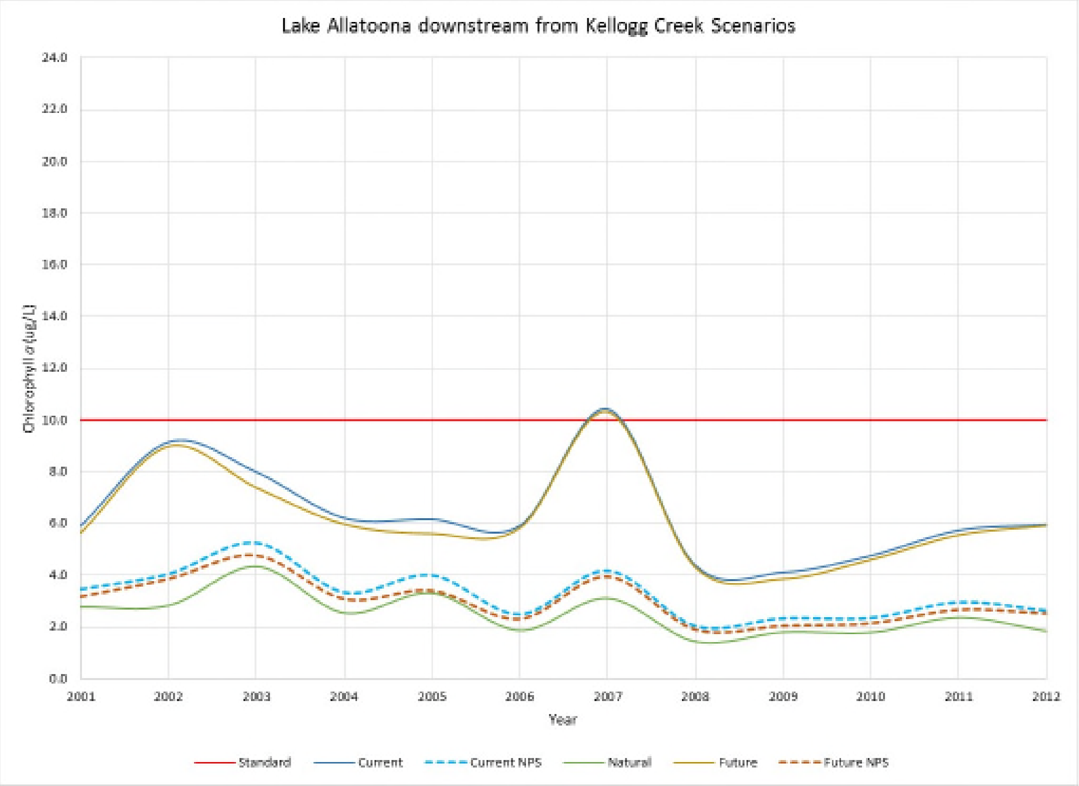

Figure 4-44 Lake Allatoona at Mid-Lake downstream from Kellogg Creek Scenarios—the scenarios presented include TMDL reductions

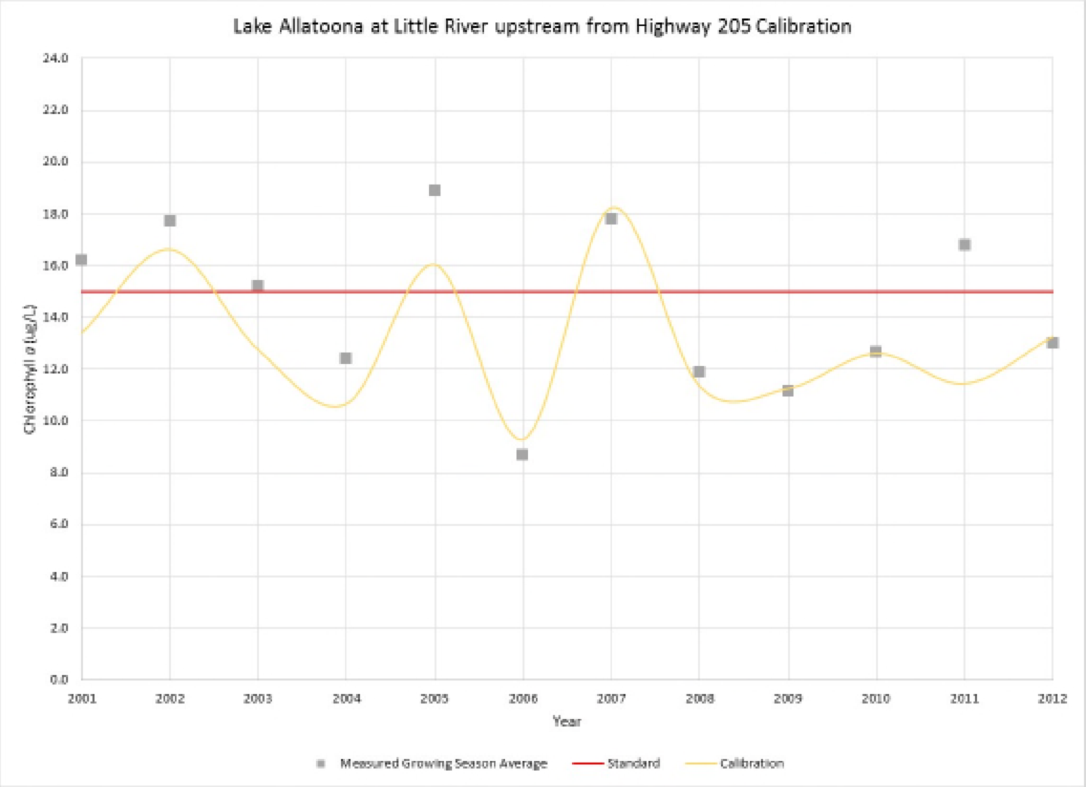

Figure 4-45 Lake Allatoona at Little River upstream from Highway 205 Calibration

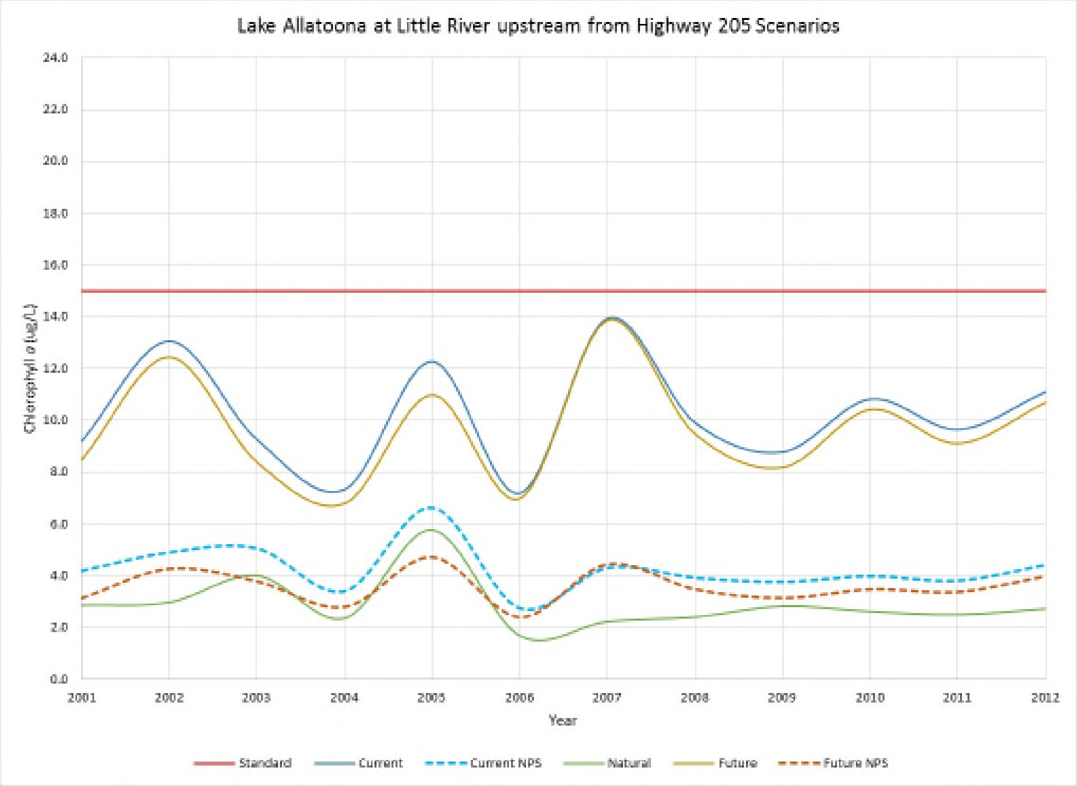

Figure 4-46 Lake Allatoona at Little River upstream from Highway 205 Scenarios—the scenarios presented include TMDL reductions

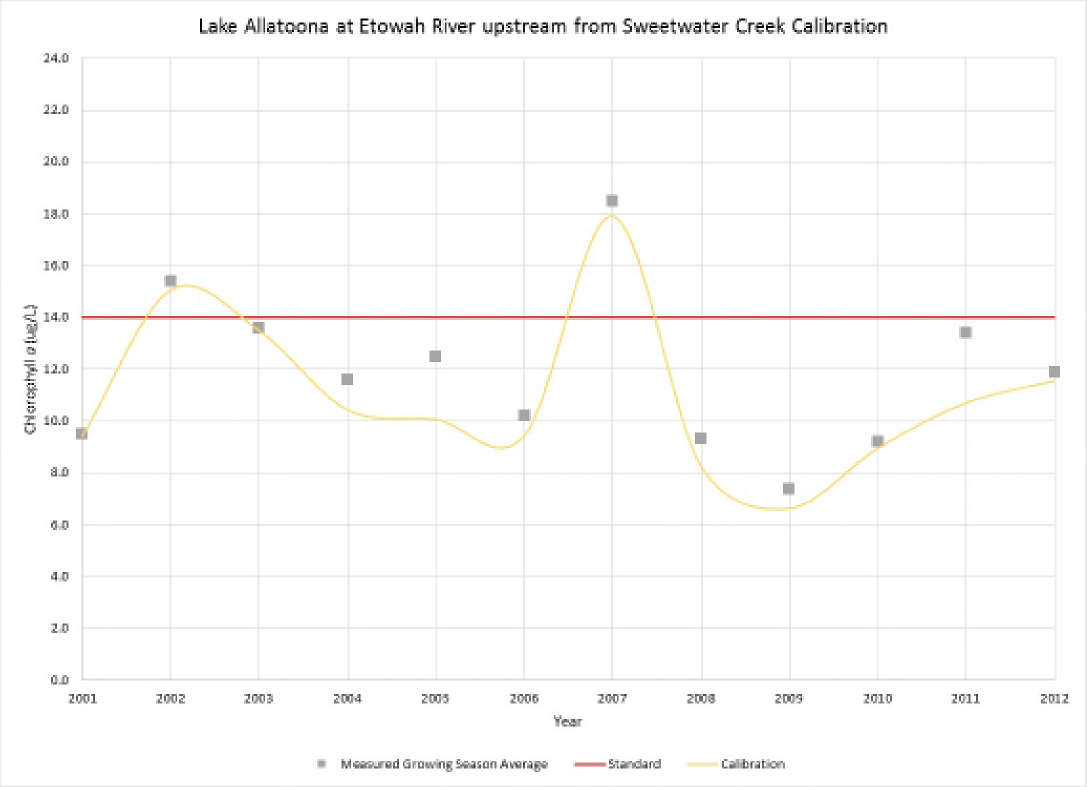

Figure 4-47 Lake Allatoona at Etowah River upstream from Sweetwater Creek Calibration

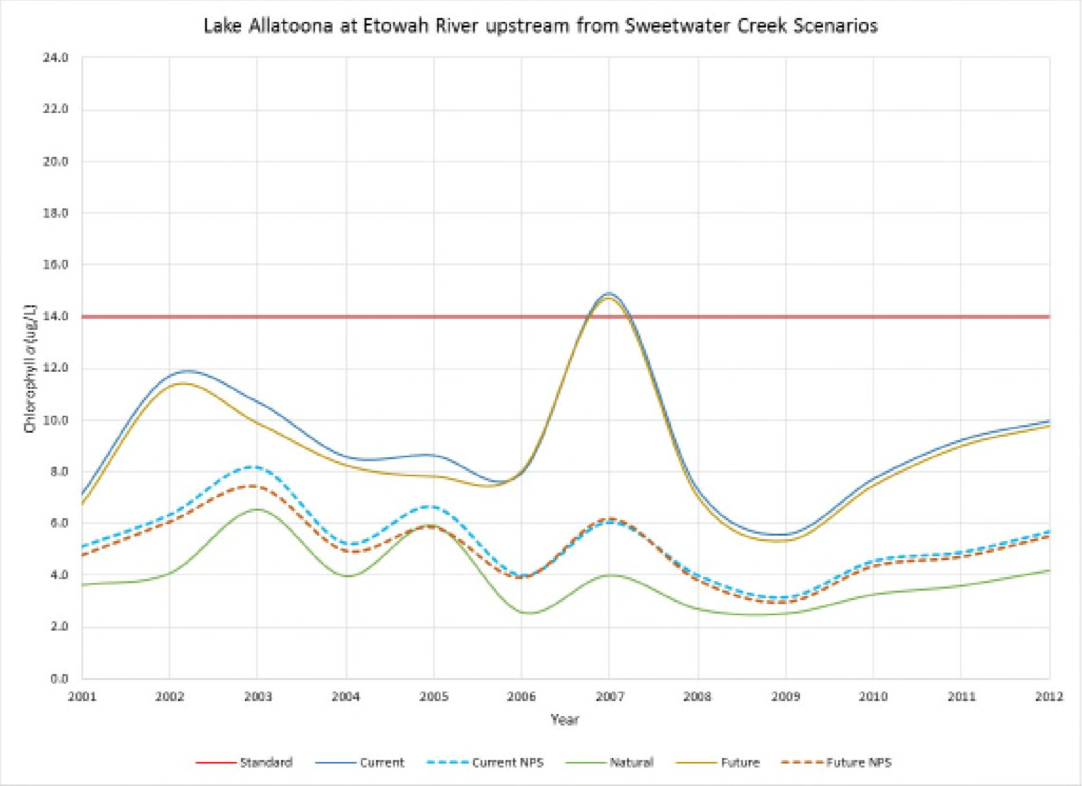

Figure 4-48 Lake Allatoona at Etowah River upstream from Sweetwater Creek Scenarios—the scenarios presented include TMDL reductions

4.3.9. Lake Chatuge

Figure 4-49 and Figure 4-50 illustrate the chlorophyll *a* measured and modeled in Lake Chatuge; there is no chlorophyll *a* water quality standard for comparison. The first figure shows the modeled calibration results compared with the available measured data collected in 2011. The second figure shows the other modeled scenarios (Current, Current NPS, Natural, Future, and Future NPS). Tables of the modeled growing season average chlorophyll *a* levels, along with other nutrient parameters, are included in Appendix C.

4.3.10. Lake Nottely

Figure 4-51 through Figure 4-54 illustrate the chlorophyll *a* measured and modeled at two locations in Lake Nottely; there is no chlorophyll *a* water quality standard for comparison. The first figures for each location show the modeled calibration results compared with the available measured data collected in 2011 and 2012. The second figures for each location show the other modeled scenarios (Current, Current NPS, Natural, Future, and Future NPS). Tables of the modeled growing season average chlorophyll *a* levels, along with other nutrient parameters, are included in Appendix C.

4.3.11. Lake Blue Ridge

Figure 4-55 through Figure 4-58 illustrate the chlorophyll *a* measured and modeled at two locations in Lake Blue Ridge; there is no chlorophyll *a* water quality standard for comparison. The first figures for each location show the modeled calibration results compared with the available measured data collected in 2011 and 2012. The second figures for each location show the other modeled scenarios (Current, Current NPS, Natural, Future, and Future NPS). Tables of the modeled growing season average chlorophyll *a* levels, along with other nutrient parameters, are included in Appendix C.

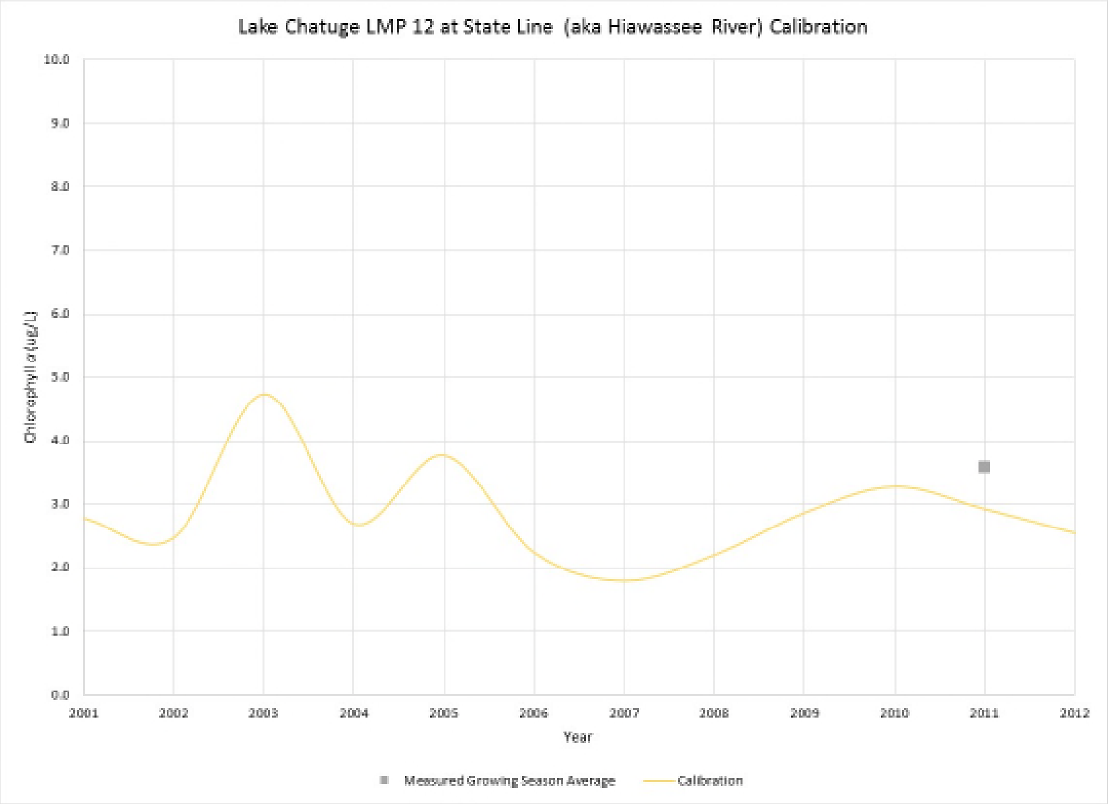

Figure 4-49 Lake Chatuge at the State Line Calibration

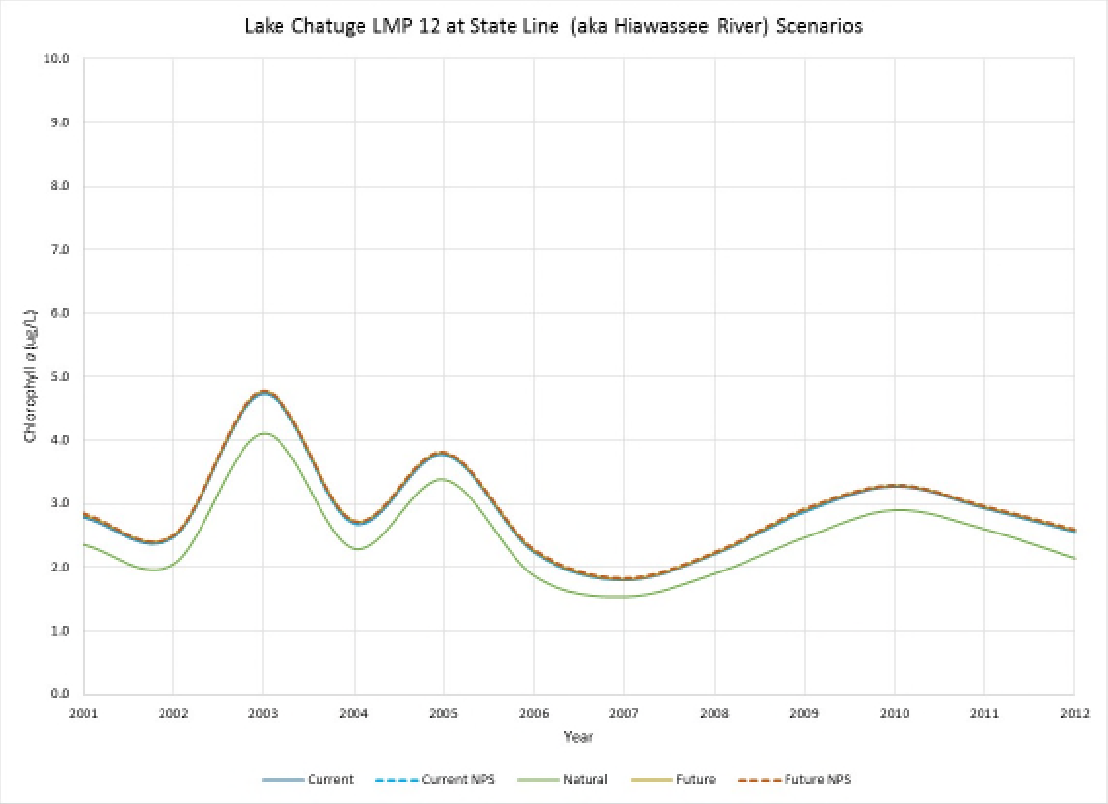

Figure 4-50 Lake Chatuge at the State Line Scenarios

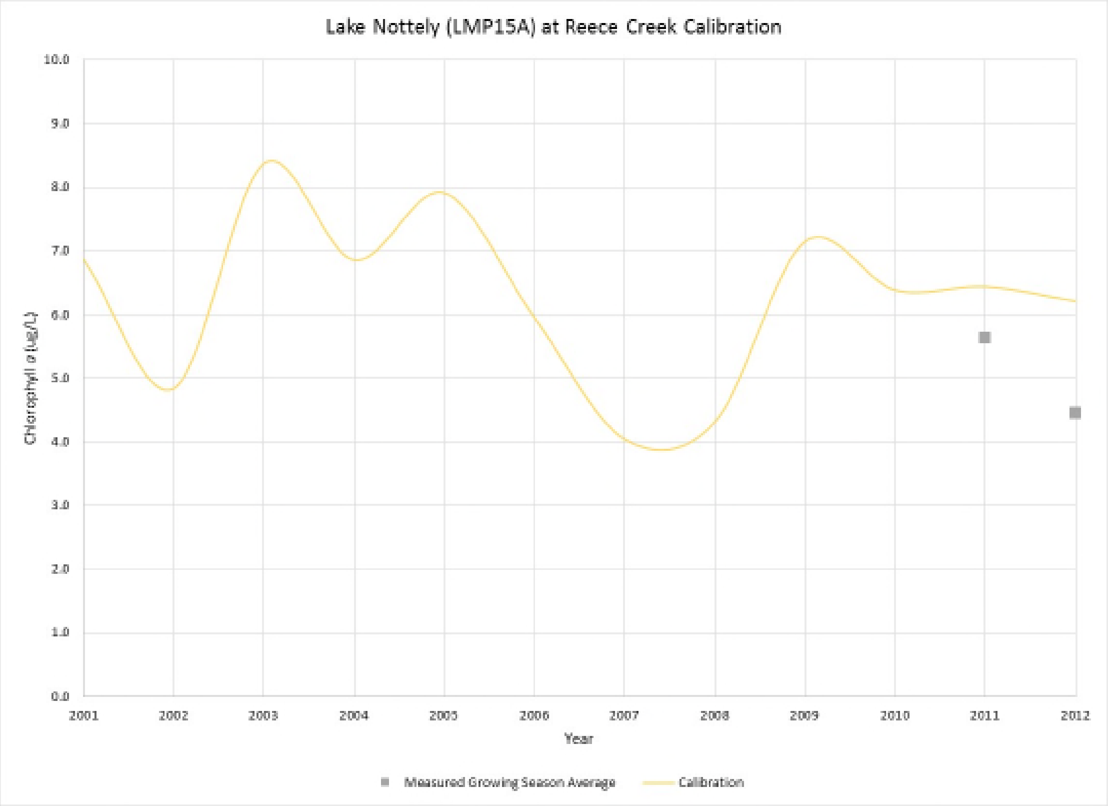

Figure 4-51 Lake Nottely (LMP15A) at Reece Creek Calibration

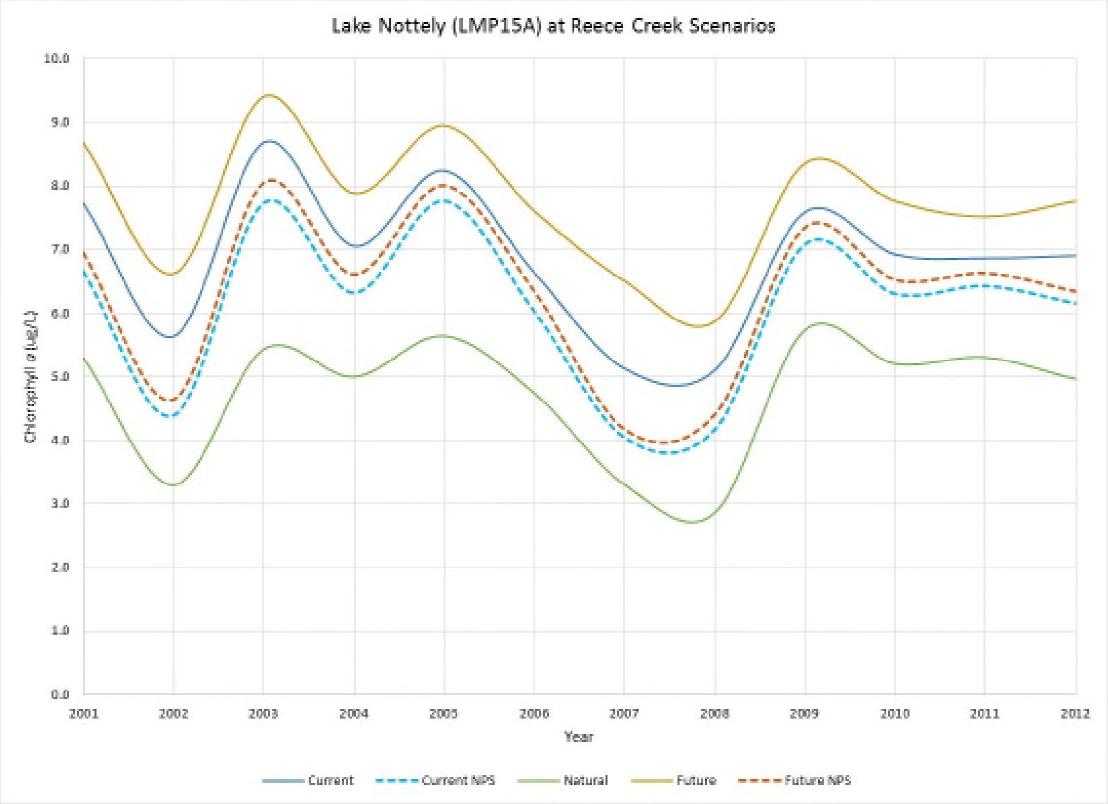

Figure 4-52 Lake Nottely (LMP15A) at Reece Creek Scenarios

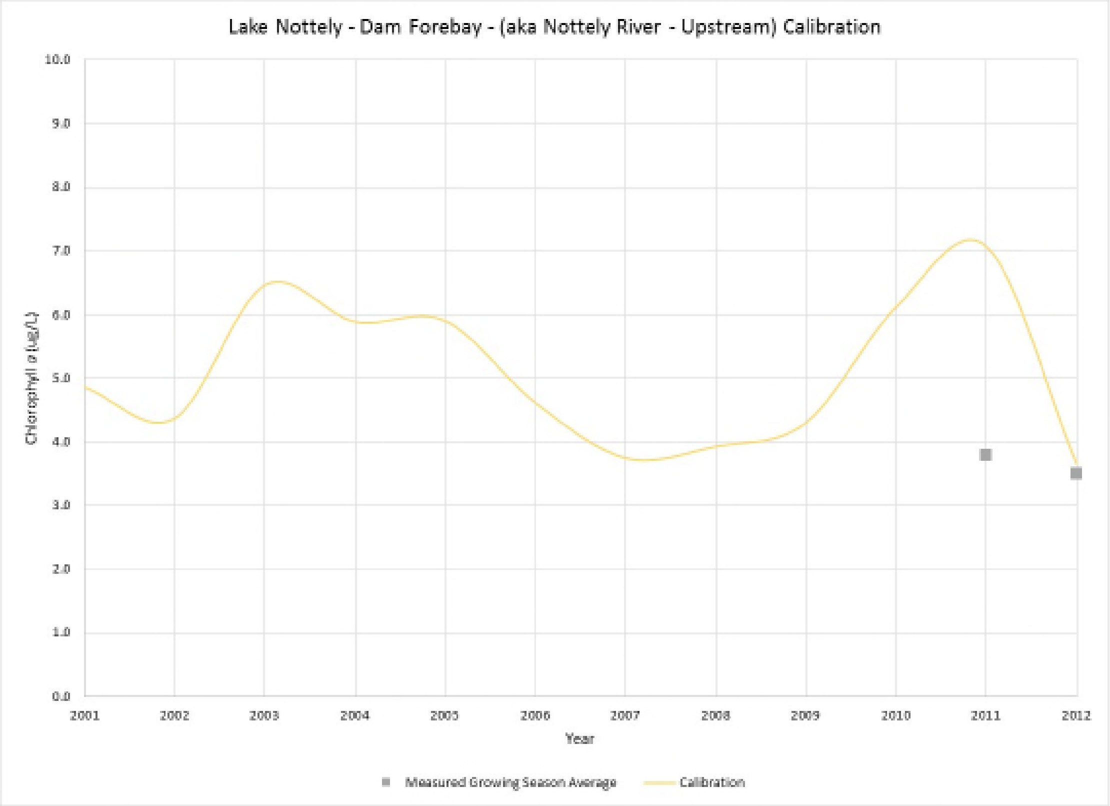

Figure 4-53 Lake Nottely – Dam Forebay (aka Nottely River-Upstream) Calibration

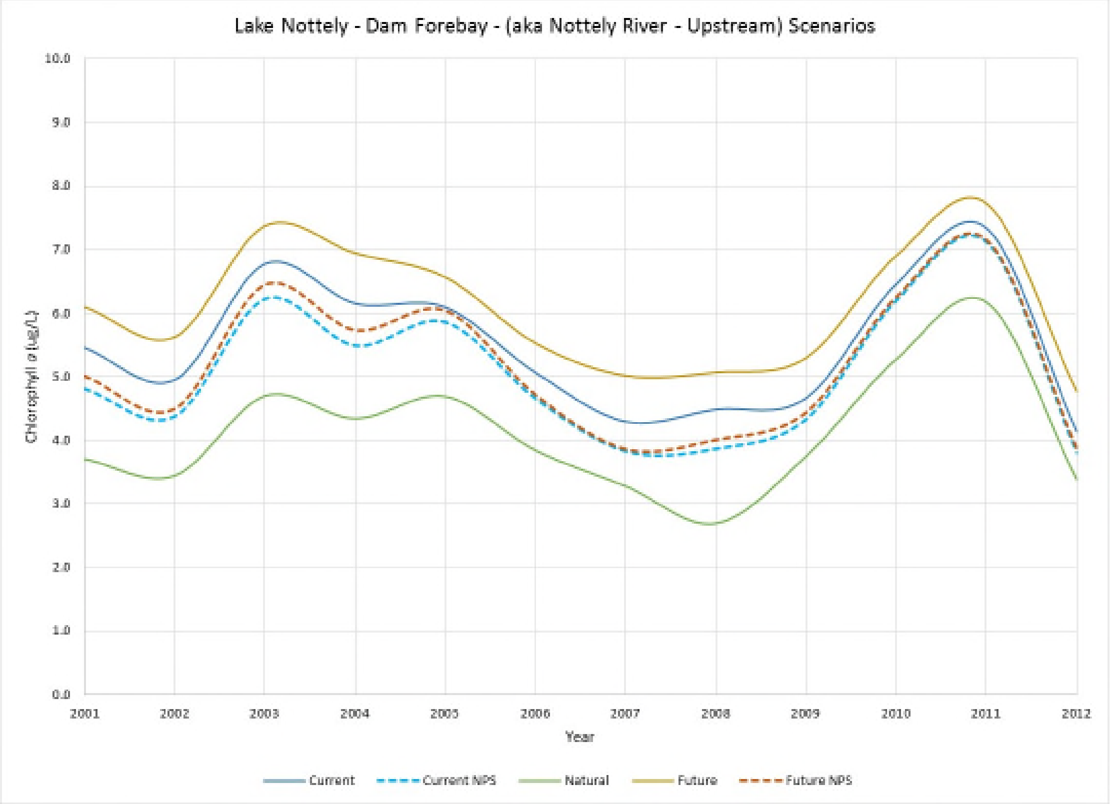

Figure 4-54 Lake Nottely – Dam Forebay (aka Nottely River-Upstream) Scenarios

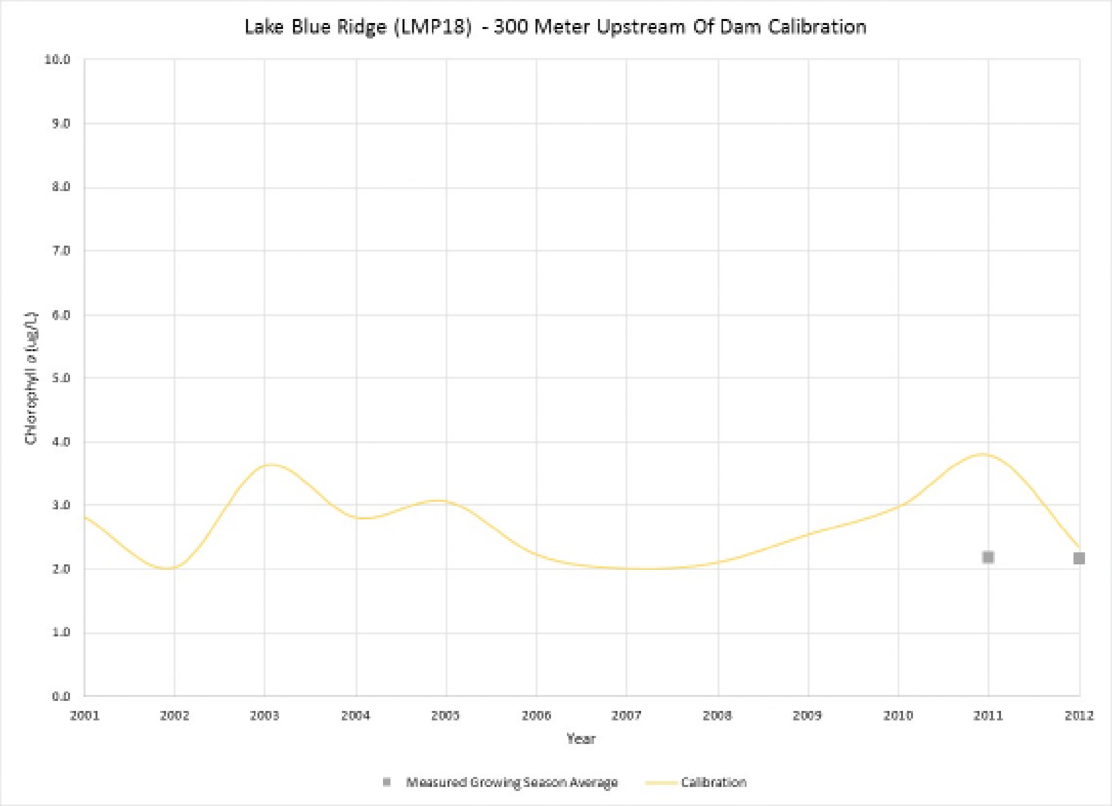

Figure 4-55 Lake Blue Ridge (LMP18) – 300 Meters Upstream of the Dam Calibration

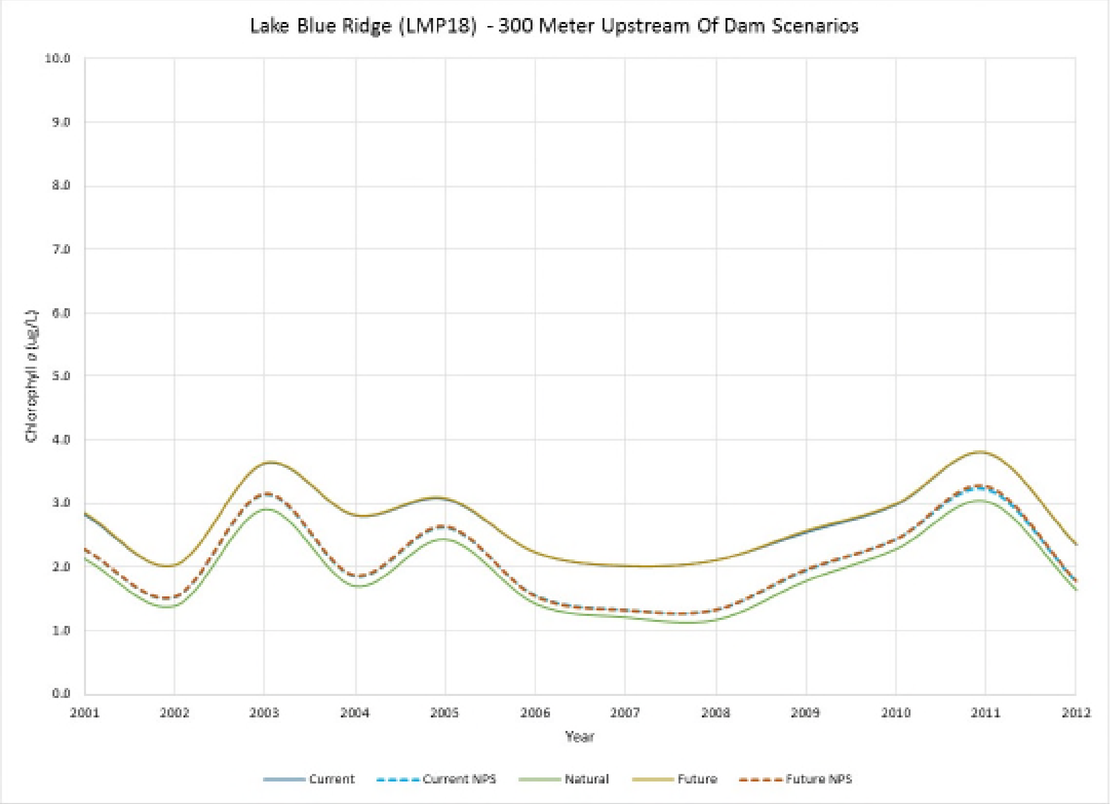

Figure 4-56 Lake Blue Ridge (LMP18) – 300 Meters Upstream of the Dam Scenarios

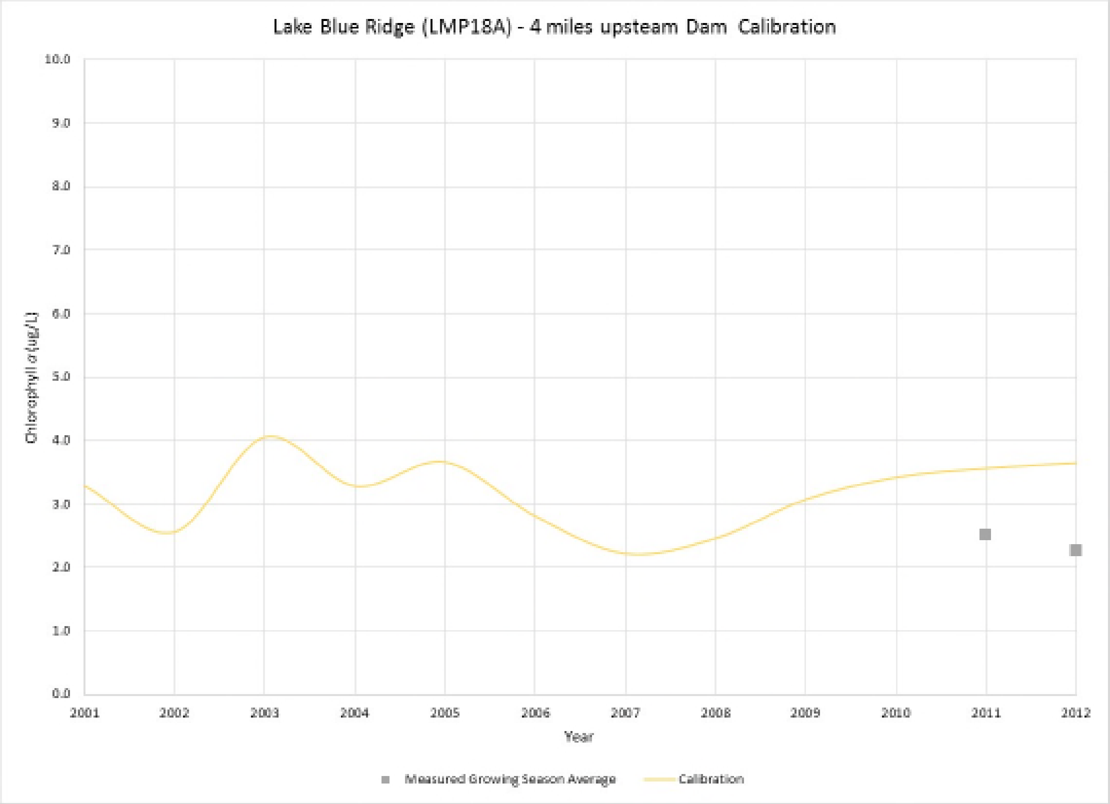

Figure 4-57 Lake Blue Ridge (LMP18A) – 4 Miles Upstream of the Dam Calibration

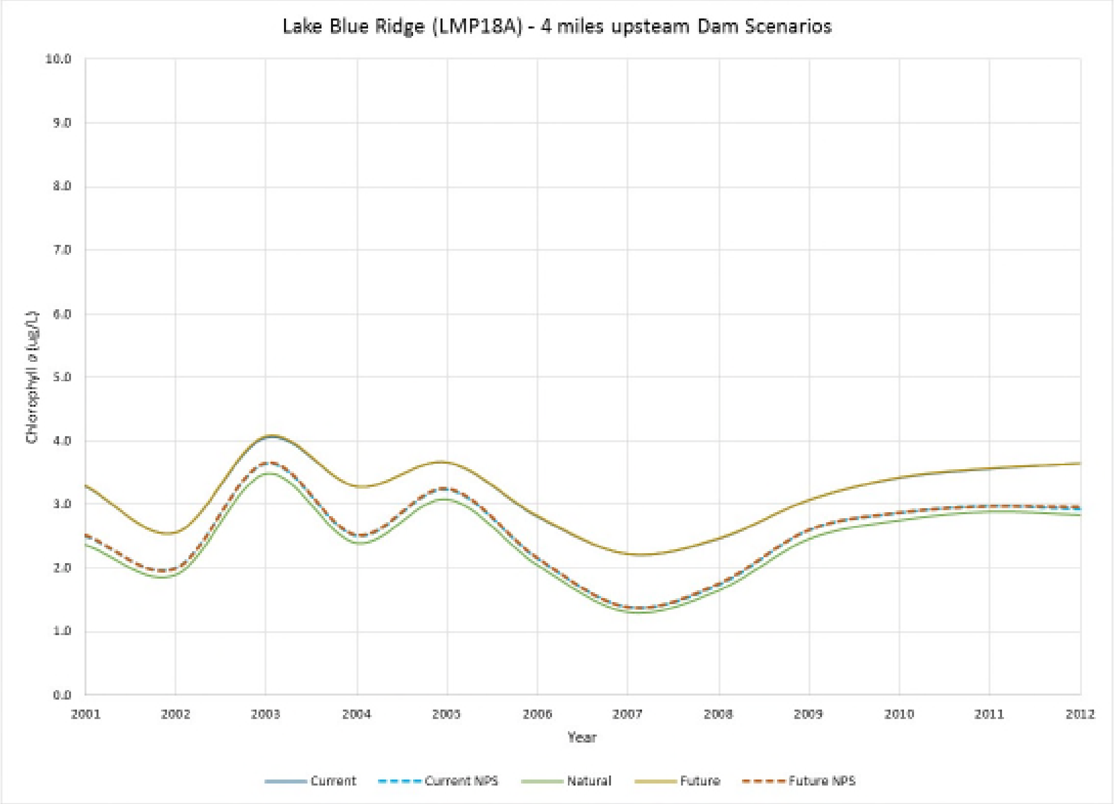

Figure 4-58 Lake Blue Ridge (LMP18A) – 4 Miles Upstream of the Dam Scenarios

4.3.12. Lake Oconee

Figure 4-59 through Figure 4-64 illustrate the chlorophyll *a* measured and modeled in Lake Oconee; there is no chlorophyll *a* water quality standard for comparison. The first figures for each location show the modeled calibration results compared with the available measured data collected from 2010 through 2012. The second figures for each location show the other modeled scenarios (Current, Current NPS, Natural, Future, and Future NPS). Tables of the modeled growing season average chlorophyll *a* levels, along with other nutrient parameters, are included in Appendix C.

4.3.13. Lake Sinclair

Figure 4-65 through Figure 4-70 illustrate the chlorophyll *a* measured and modeled in Lake Sinclair; there is no chlorophyll *a* water quality standard for comparison. The first figures for each location show the modeled calibration results compared with the available measured data collected from 2010 through 2012. The second figures for each location show the other modeled scenarios (Current, Current NPS, Natural, Future, and Future NPS). Tables of the modeled growing season average chlorophyll *a* levels, along with other nutrient parameters, are included in Appendix C.

4.3.14. Lake Jackson

Figure 4-71 through Figure 4-74 illustrate two figures for each location in Lake Jackson. Figure 4-73 and Figure 4-74 also include the chlorophyll *a* water quality standard at mid-lake near the confluence of Alcovy River and Yellow/South Rivers. The first figures for each location show the modeled calibration results compared with the available measured data collected from 2010 through 2012. The second figures for each location show the other modeled scenarios (Current, Current NPS, Natural, Future, and Future NPS). Tables of the modeled growing season average chlorophyll *a* levels, along with other nutrient parameters, are included in Appendix C.

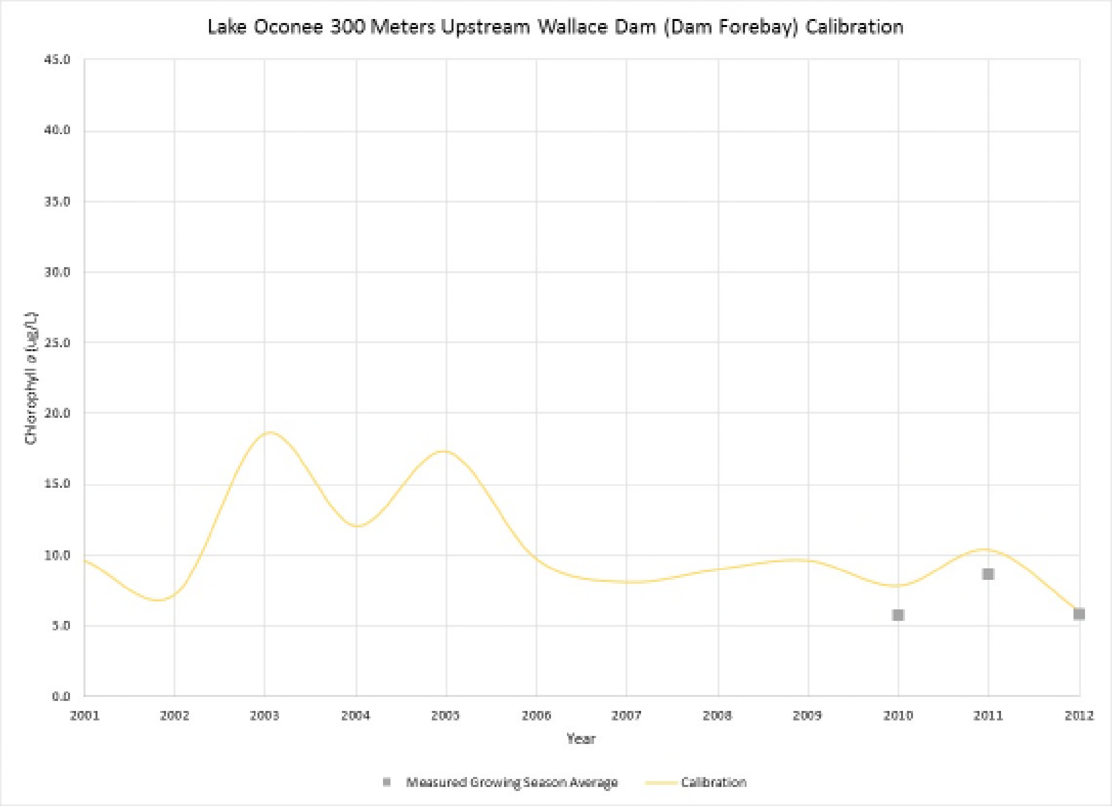

Figure 4-59 Lake Oconee 300 Meters Upstream of Wallace Dam (Dam Forebay) Calibration

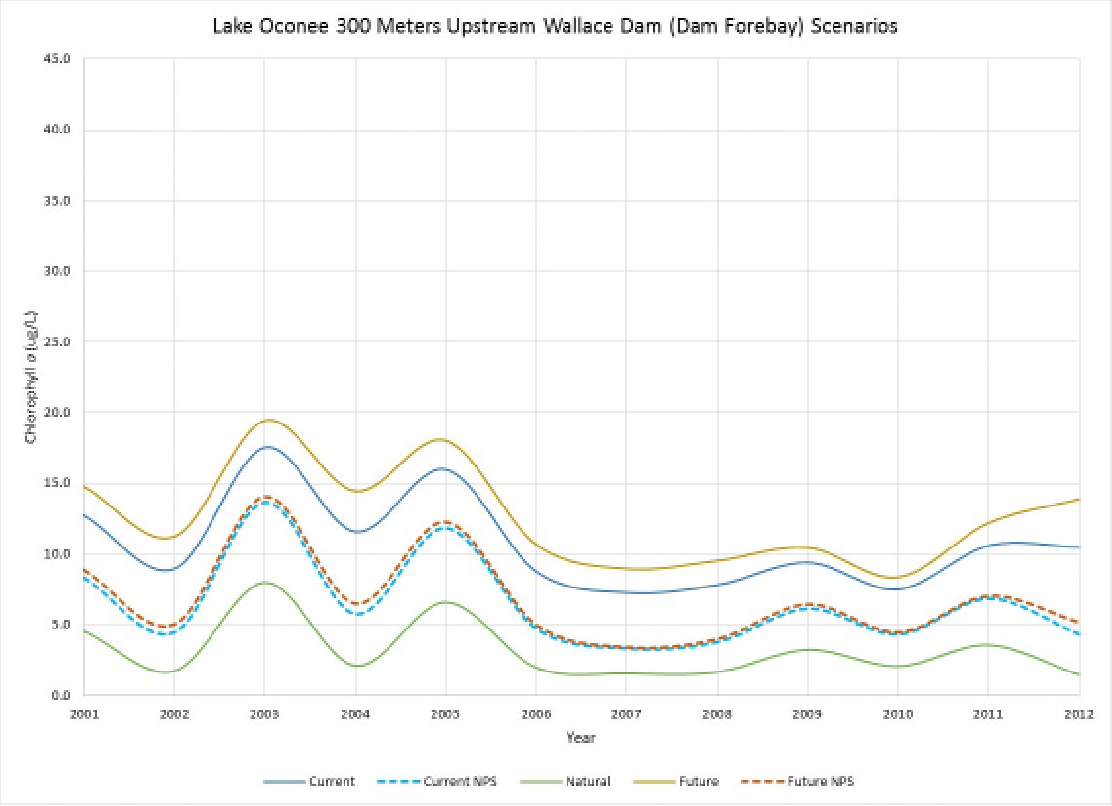

Figure 4-60 Lake Oconee 300 Meters Upstream of Wallace Dam (Dam Forebay) Scenarios

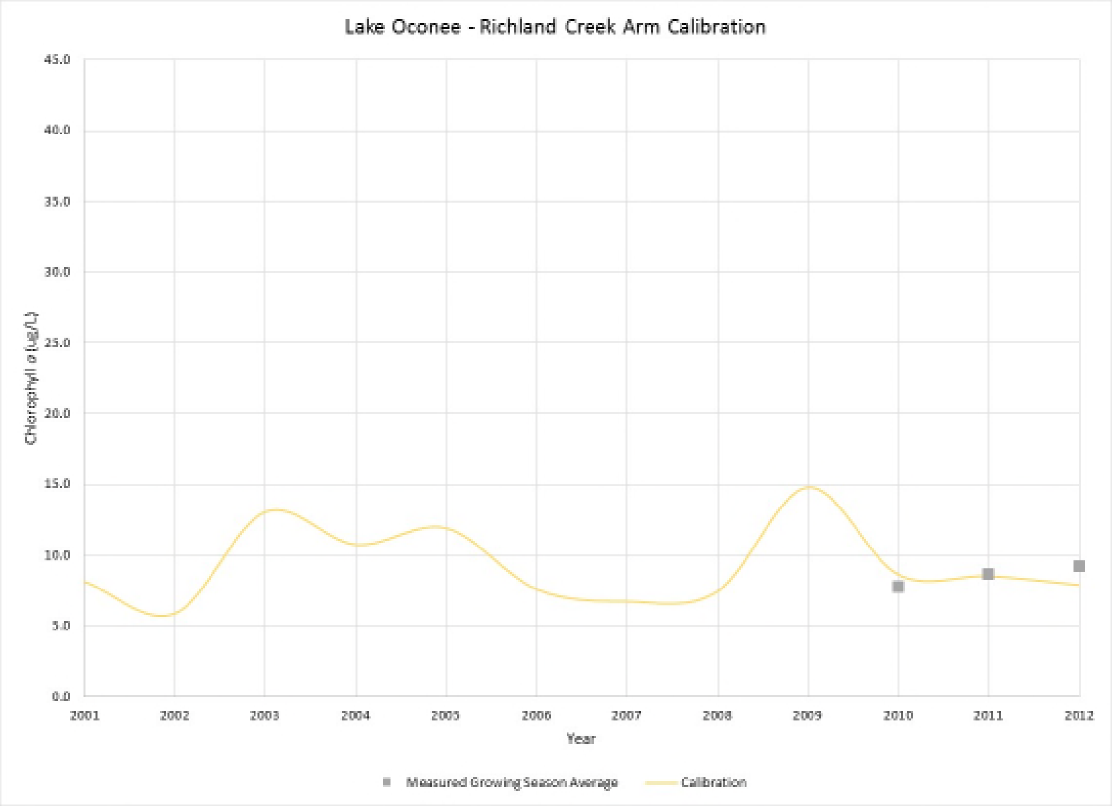

Figure 4-61 Lake Oconee – Richland Creek Arm Calibration

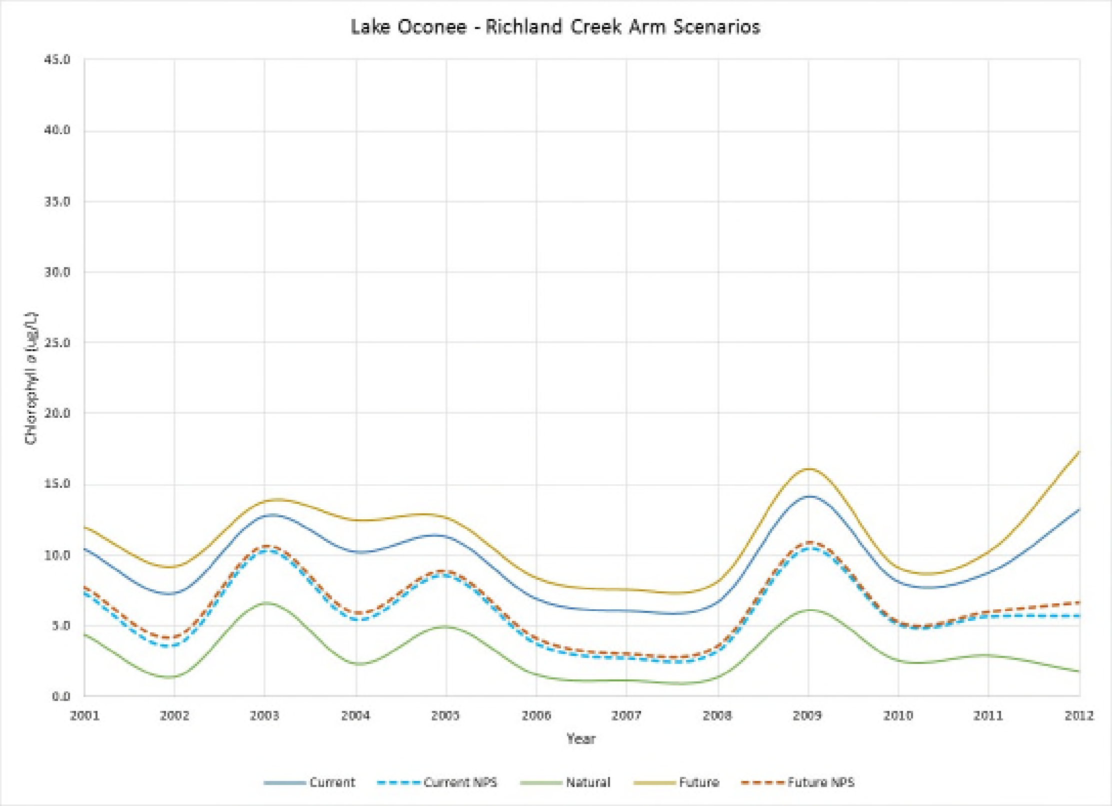

Figure 4-62 Lake Oconee – Richland Creek Arm Scenarios

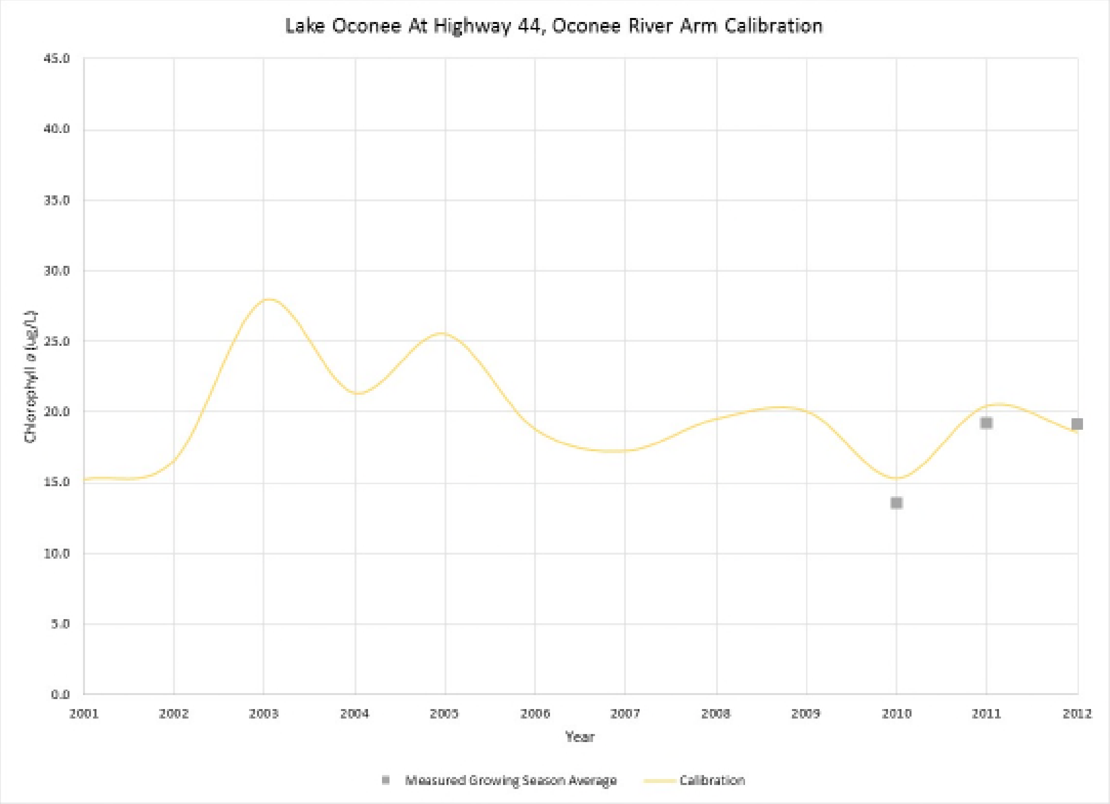

Figure 4-63 Lake Oconee at Highway 44, Oconee River Arm Calibration

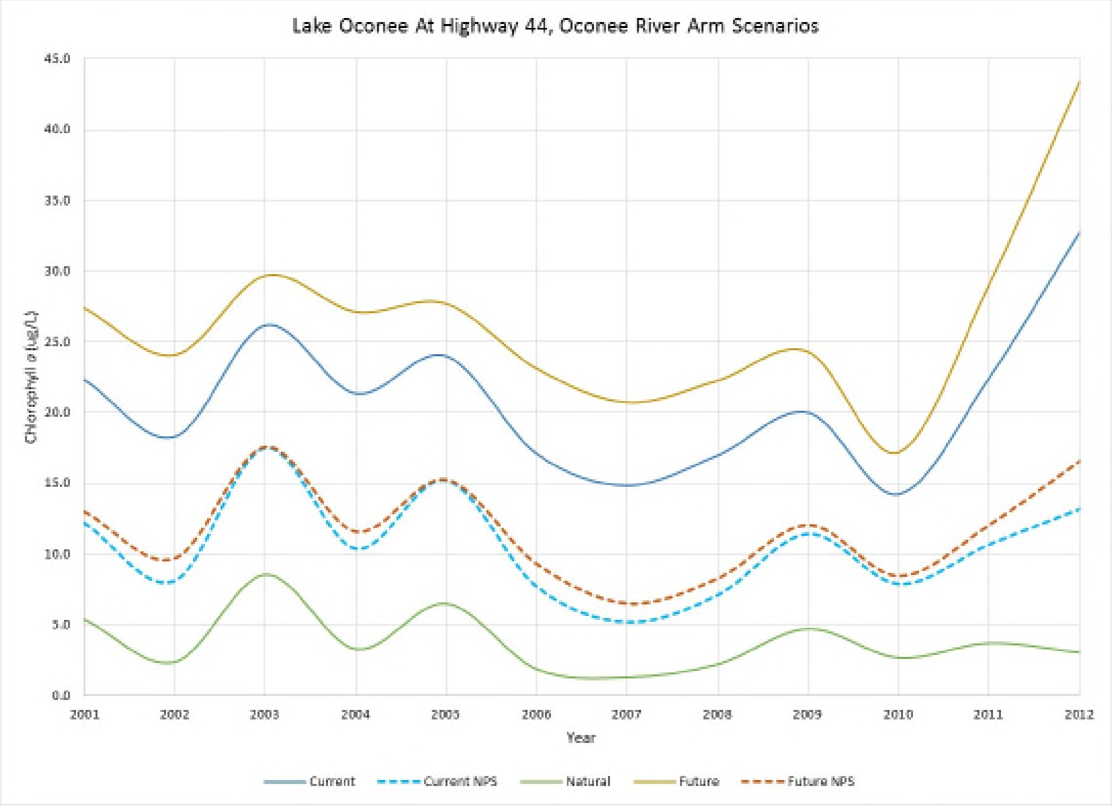

Figure 4-64 Lake Oconee at Highway 44, Oconee River Arm Scenarios

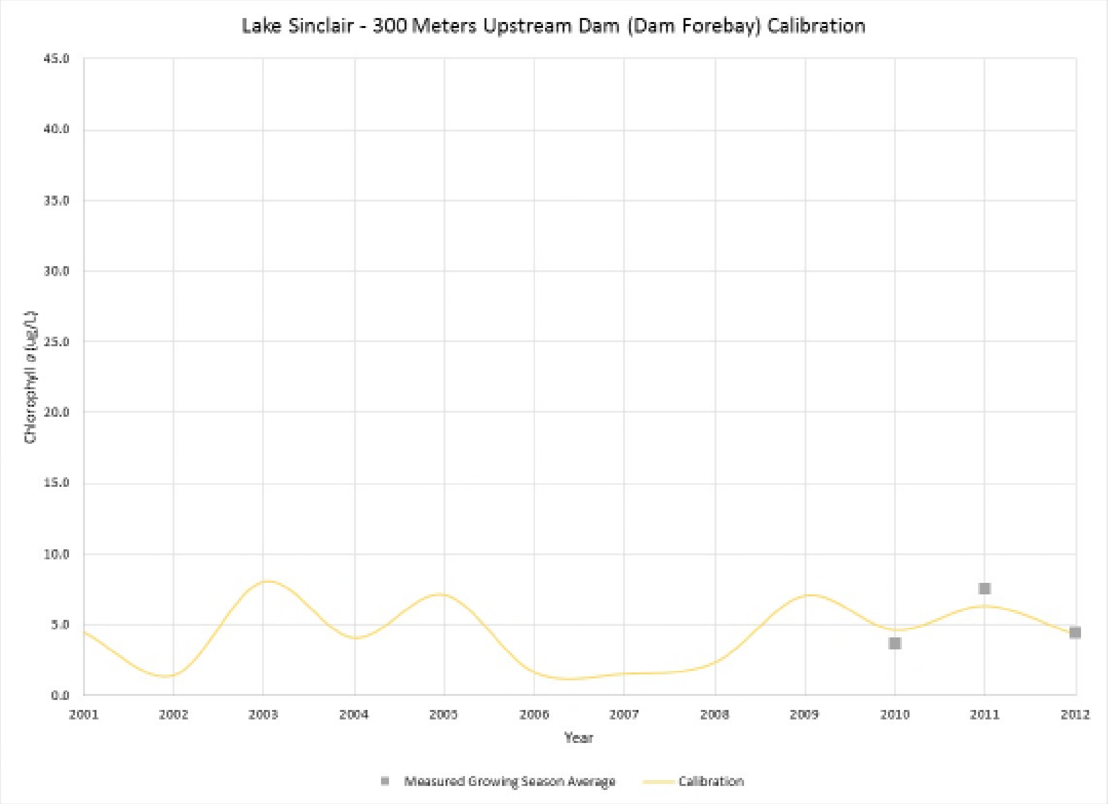

Figure 4-65 Lake Sinclair - 300 Meters Upstream Dam (Dam Forebay) Calibration

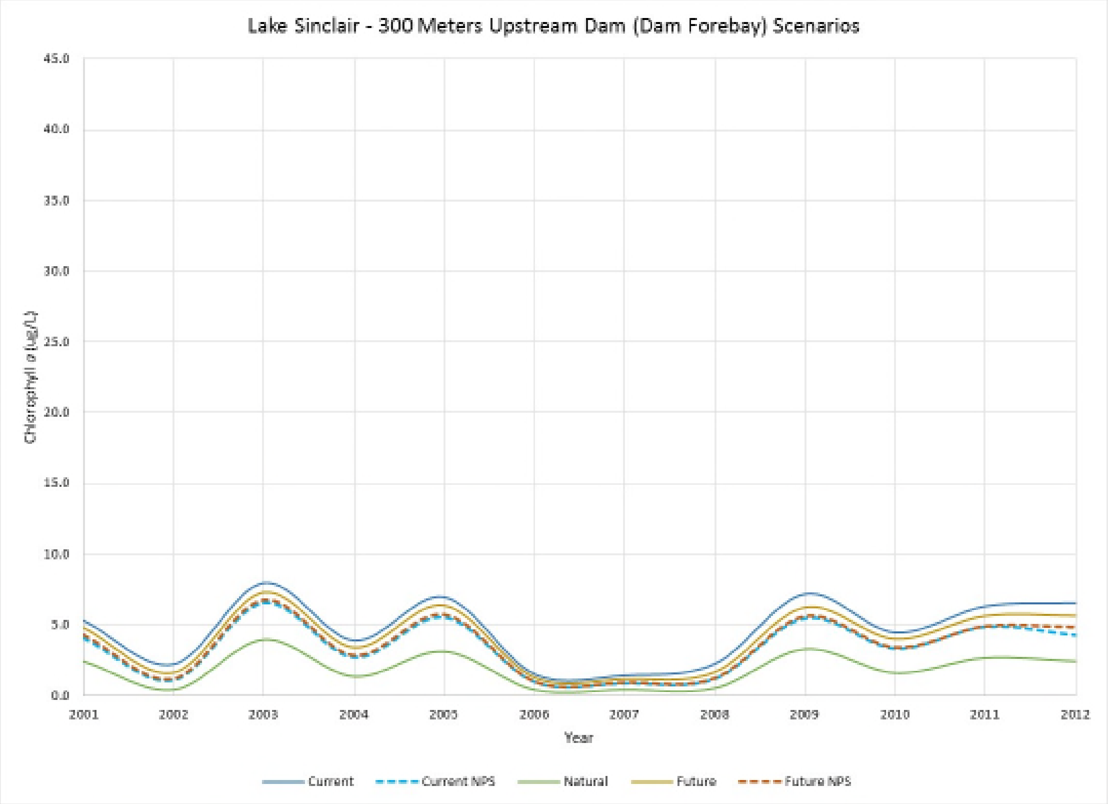

Figure 4-66 Lake Sinclair - 300 Meters Upstream Dam (Dam Forebay) Scenarios

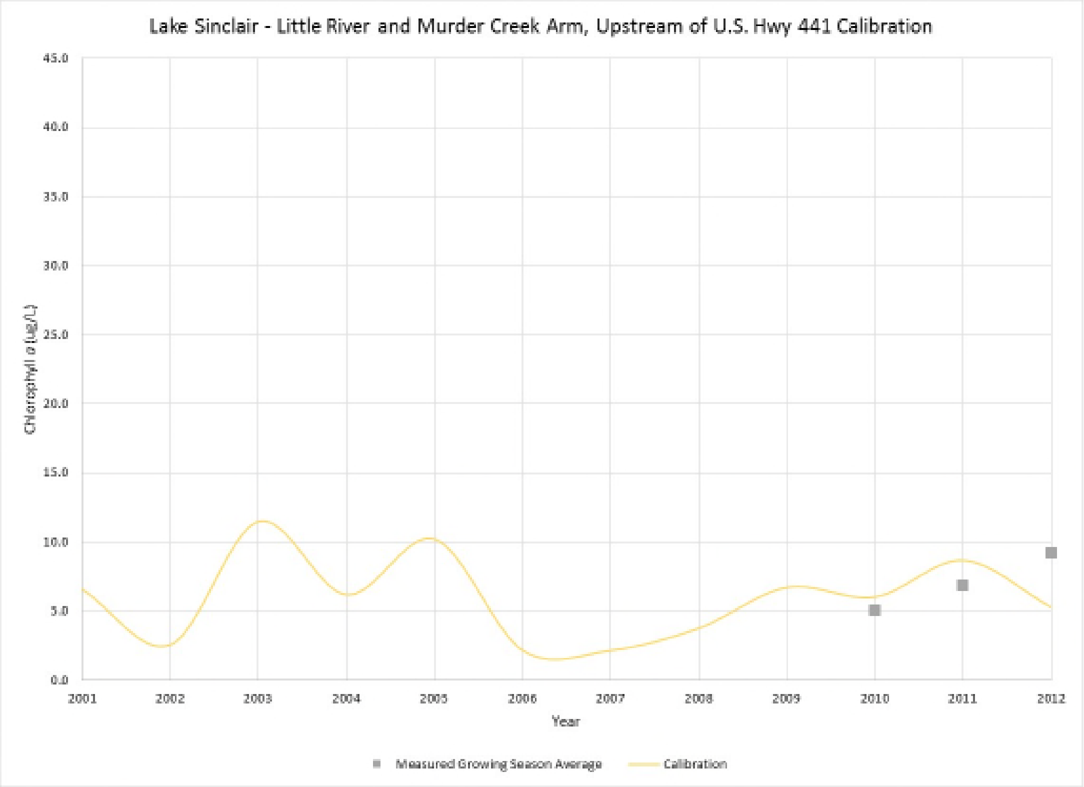

Figure 4-67 Lake Sinclair – Little River and Murder Creek Arm, Upstream of U.S. Hwy 441 Calibration

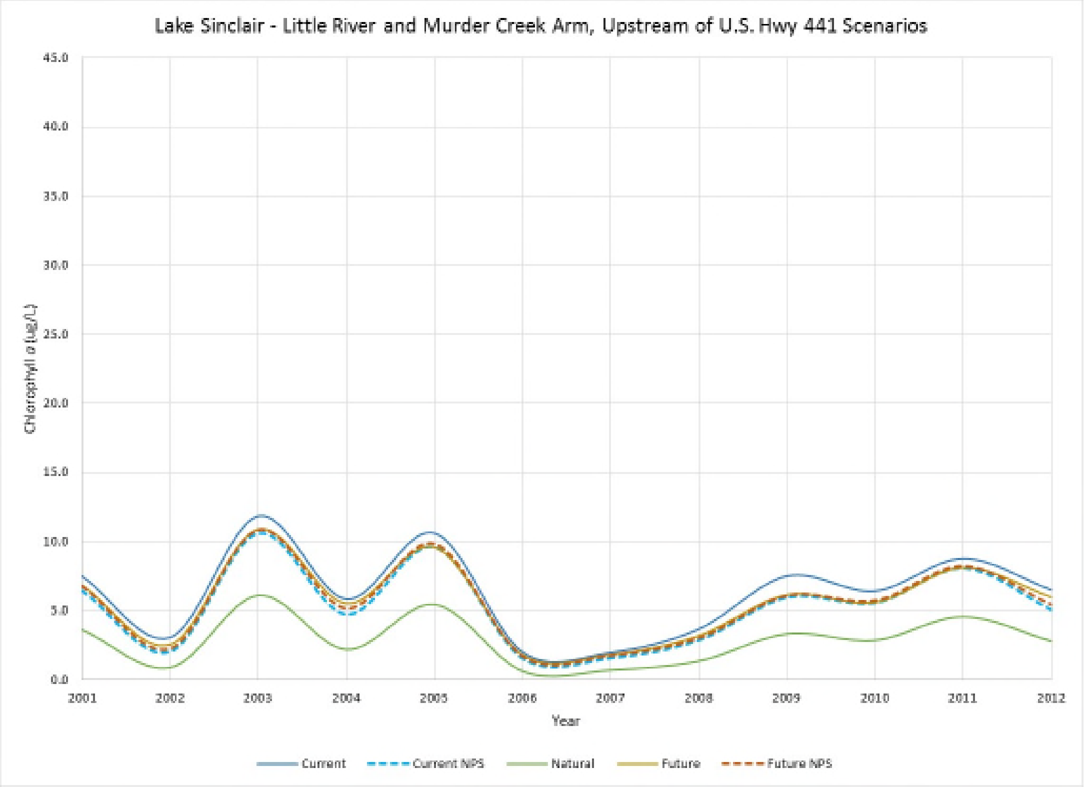

Figure 4-68 Lake Sinclair – Little River and Murder Creek Arm, Upstream of U.S. Hwy 441 Scenarios

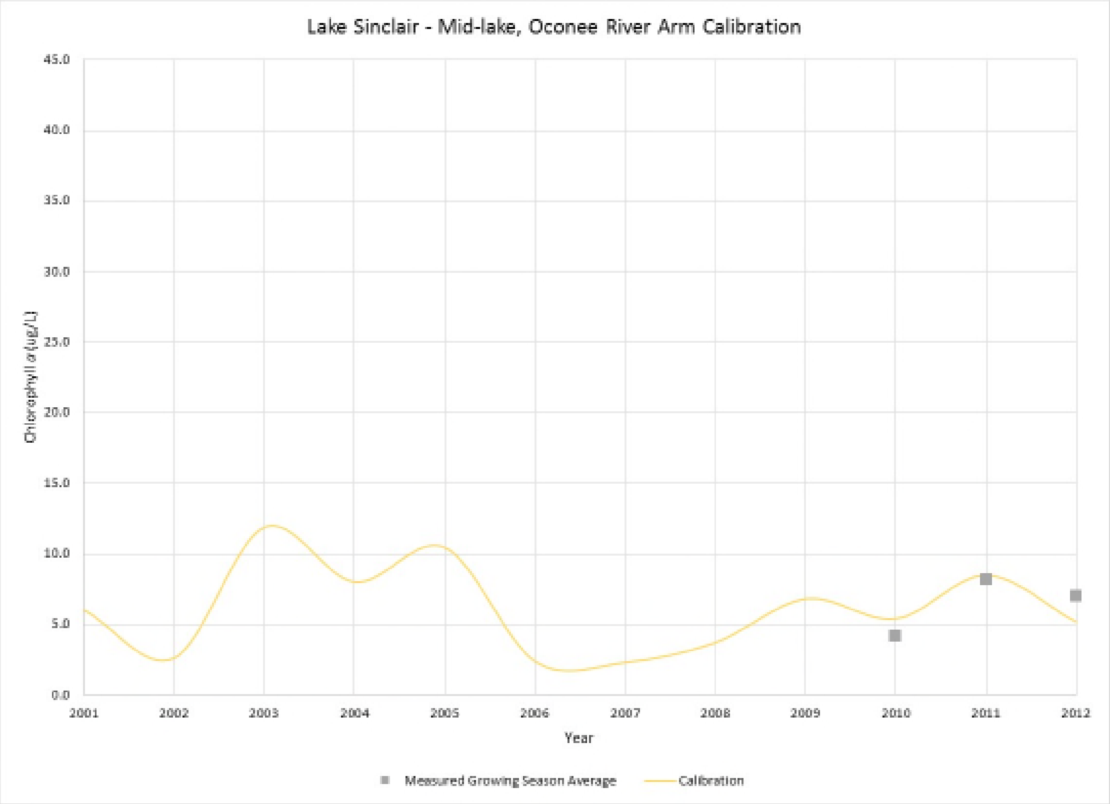

Figure 4-69 Lake Sinclair – Mid-lake, Oconee River Arm Calibration

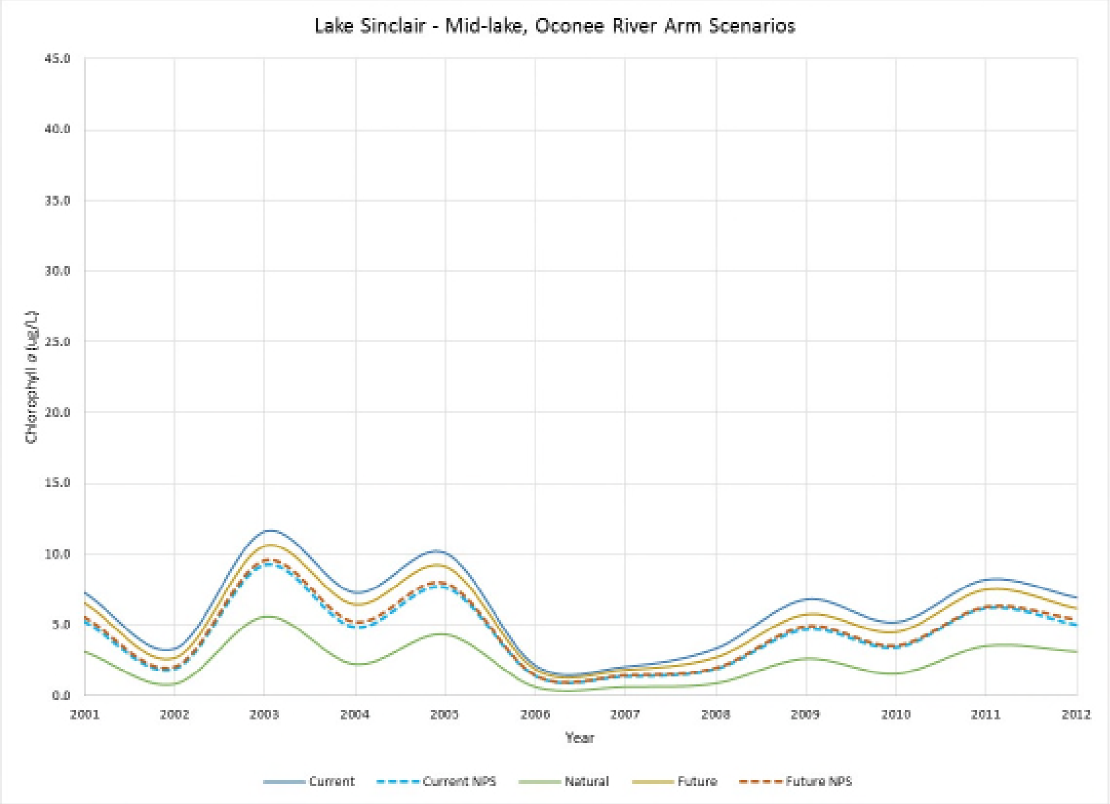

Figure 4-70 Lake Sinclair – Mid-lake, Oconee River Arm Scenarios

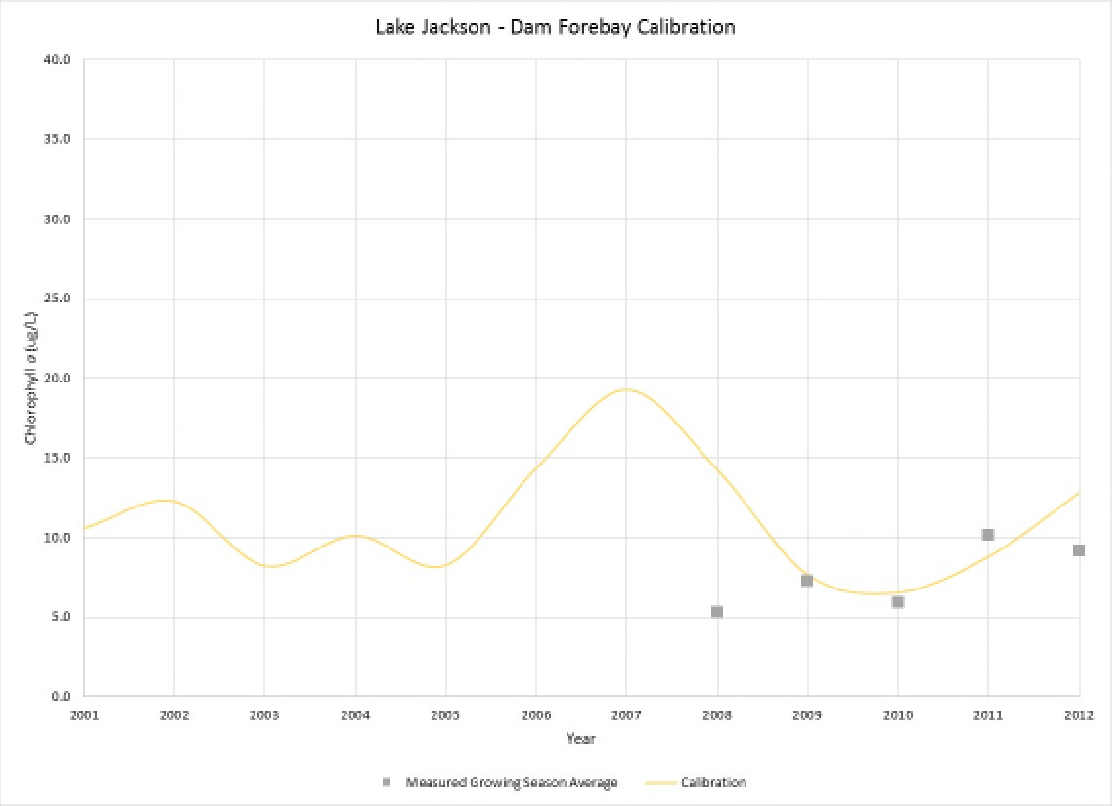

Figure 4-71 Lake Jackson - Dam Forebay Calibration

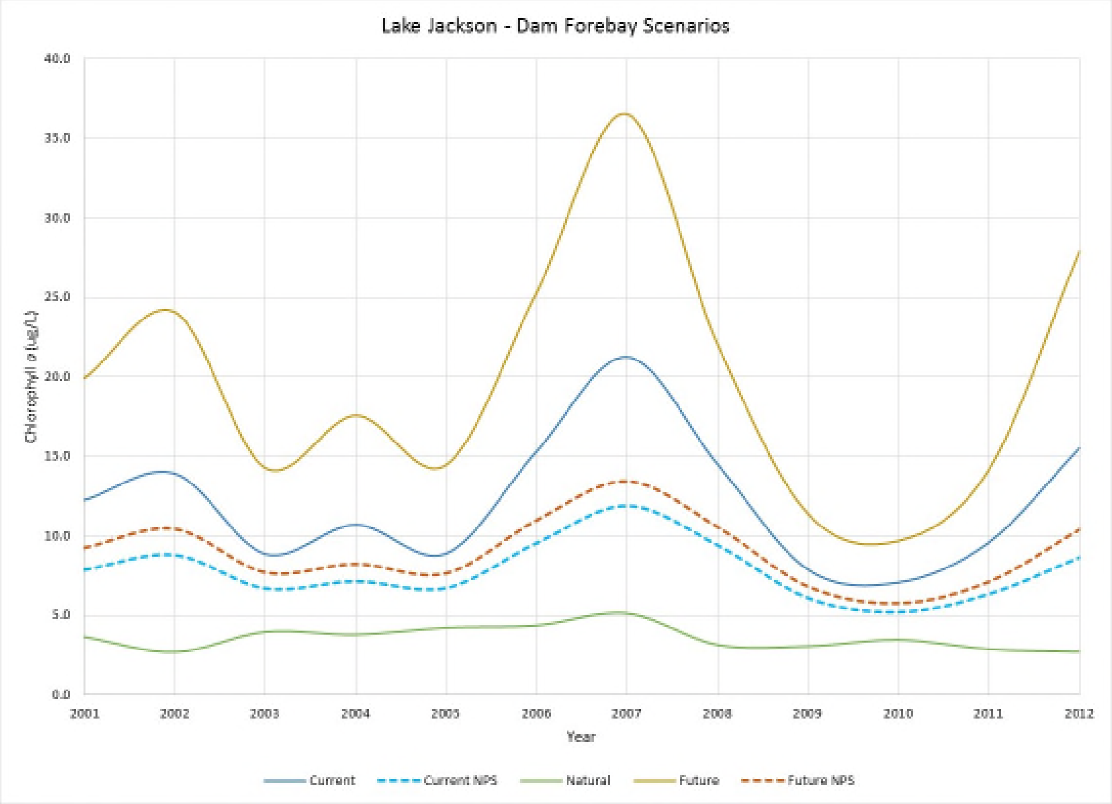

Figure 4-72 Lake Jackson - Dam Forebay Scenarios

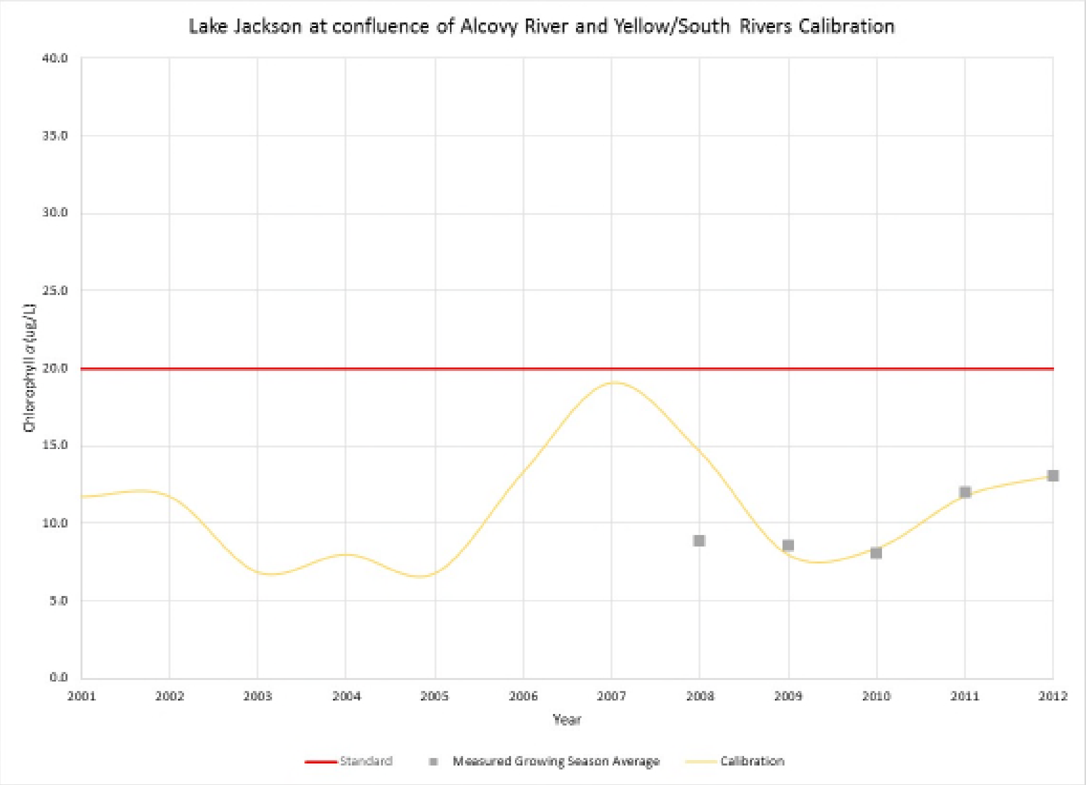

Figure 4-73 Lake Jackson – Mid-lake, at confluence of Alcovy River and Yellow/South Rivers Calibration

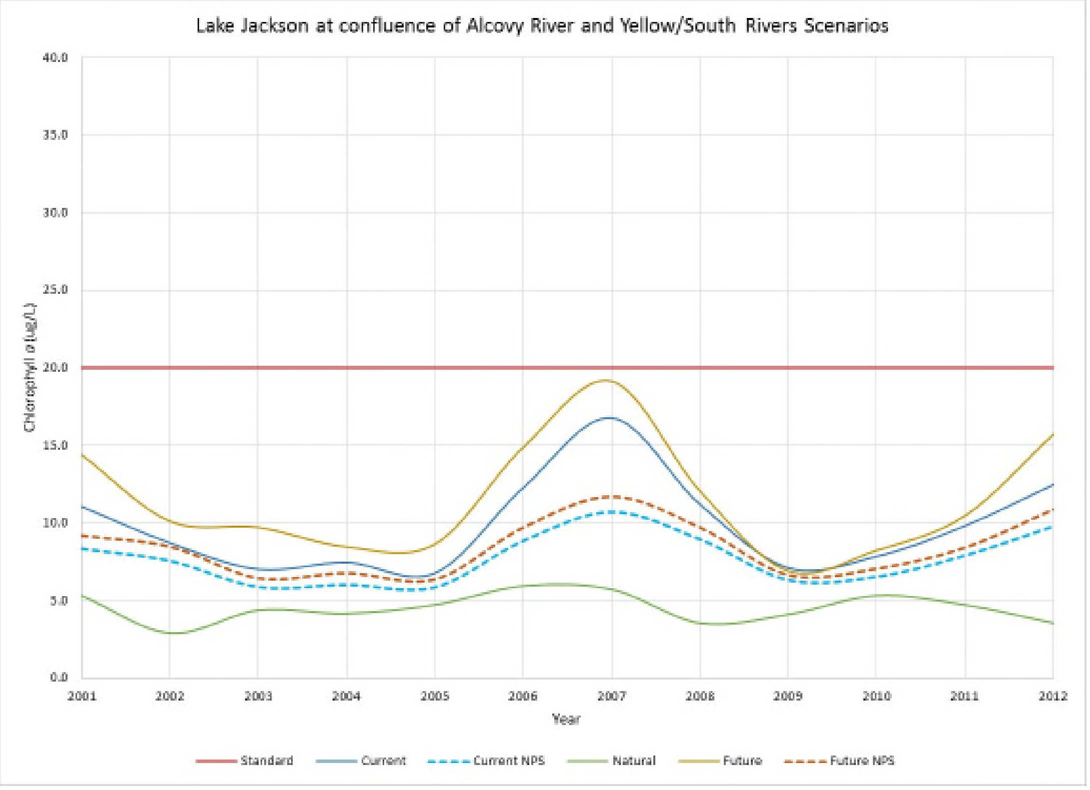

Figure 4-74 Lake Jackson – Mid-lake, at confluence of Alcovy River and Yellow/South Rivers Scenarios

4.4. Watershed Results

The sections to follow illustrate the current and future total phosphorus (TP) and total nitrogen (TN) loads by subwatershed during representative wet and dry weather conditions. Dry weather conditions typically illustrate the effects of point source loads while wet weather conditions are more representative of loads from nonpoint sources.

4.4.1. Chattahoochee River Watershed

Watershed models were used to represent the current and future nutrient loads by subwatersheds throughout the Chattahoochee River Watershed for representative dry and wet weather conditions. Figure 4-75 through Figure 4-90 illustrate current and future TP and TN loads by subwatershed. Appendices D, E, F, and G present the nutrient loads by subwatershed (Lake Lanier, Upper Chattahoochee River, Middle Chattahoochee River, and Lower Chattahoochee River, respectively) for TP, TN, and BOD for each year for each modeled scenario.

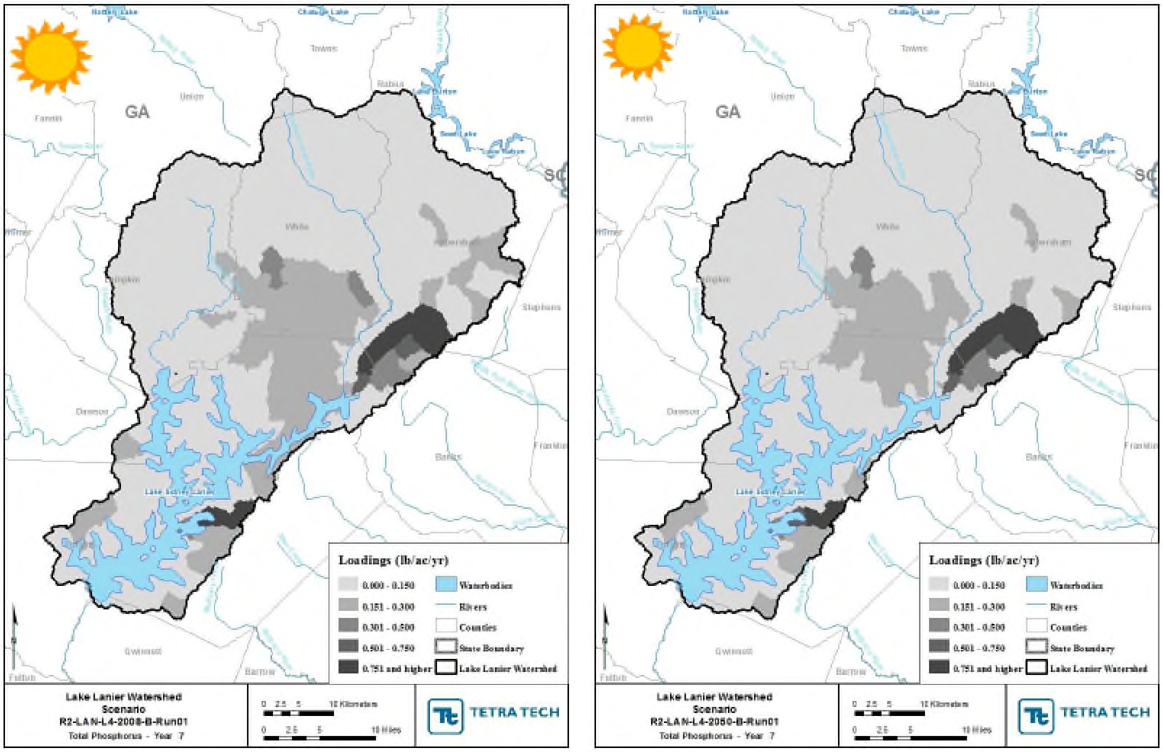

Figure 4-75 Current (left) and Future (right) Lake Lanier Watershed Total Phosphorus loads during representative dry weather conditions

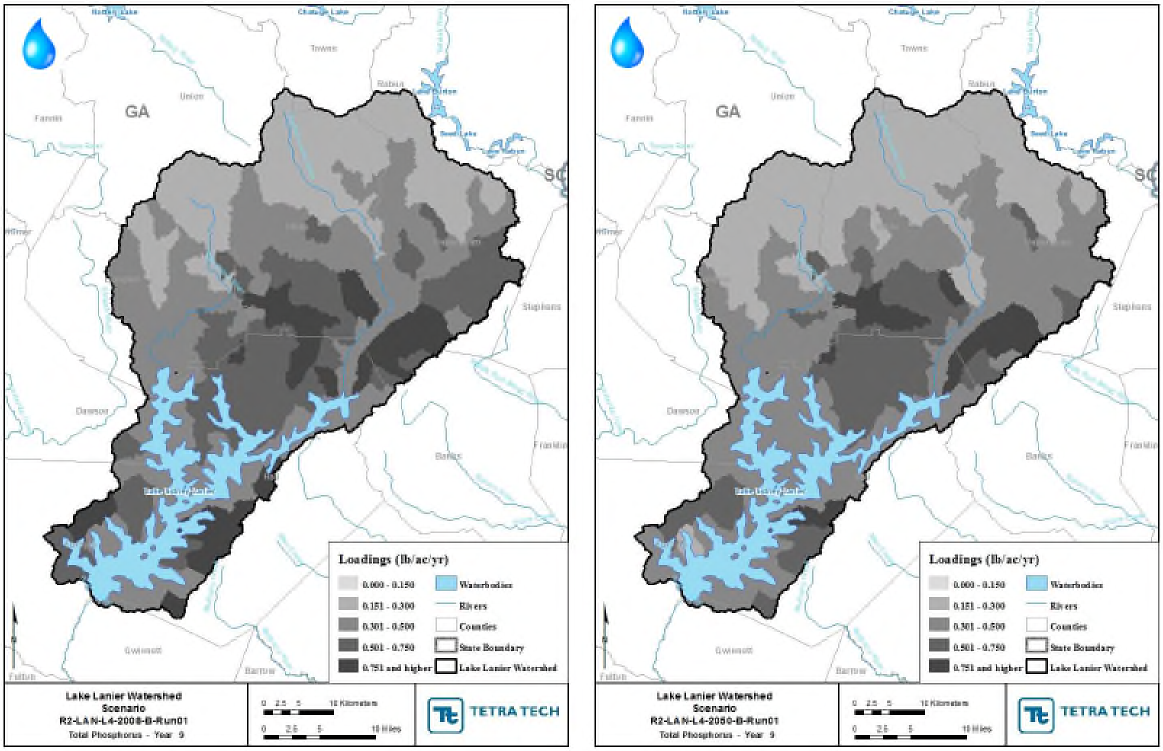

Figure 4-76 Current (left) and Future (right) Lake Lanier Watershed Total Phosphorus loads during representative wet weather conditions

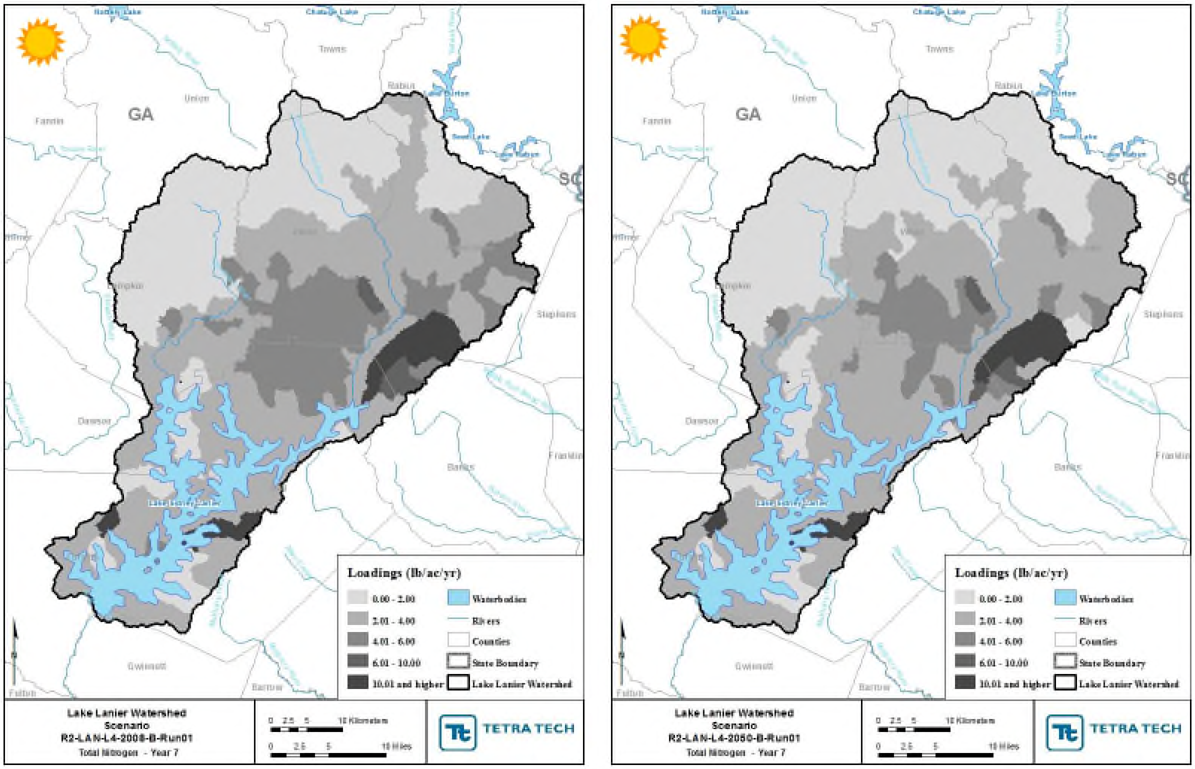

Figure 4-77 Current (left) and Future (right) Lake Lanier Watershed Total Nitrogen loads during representative dry weather conditions

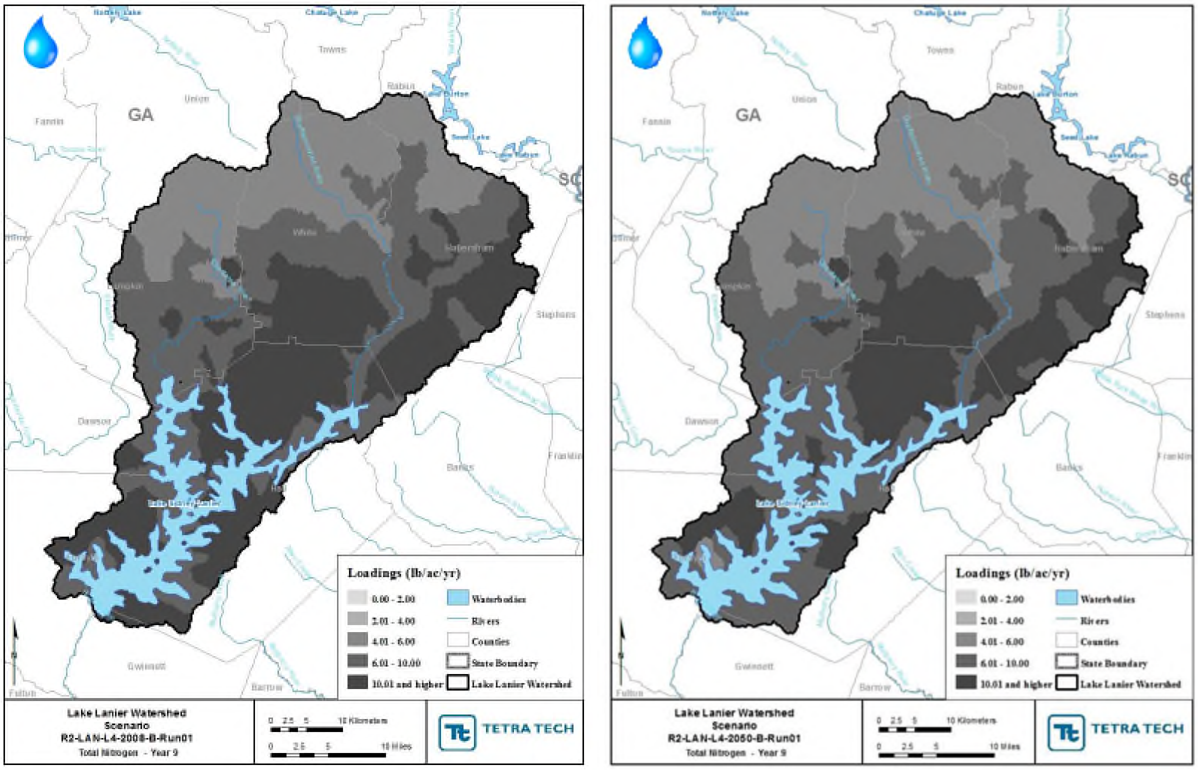

Figure 4-78 Current (left) and Future (right) Lake Lanier Watershed Total Nitrogen loads during representative wet weather conditions

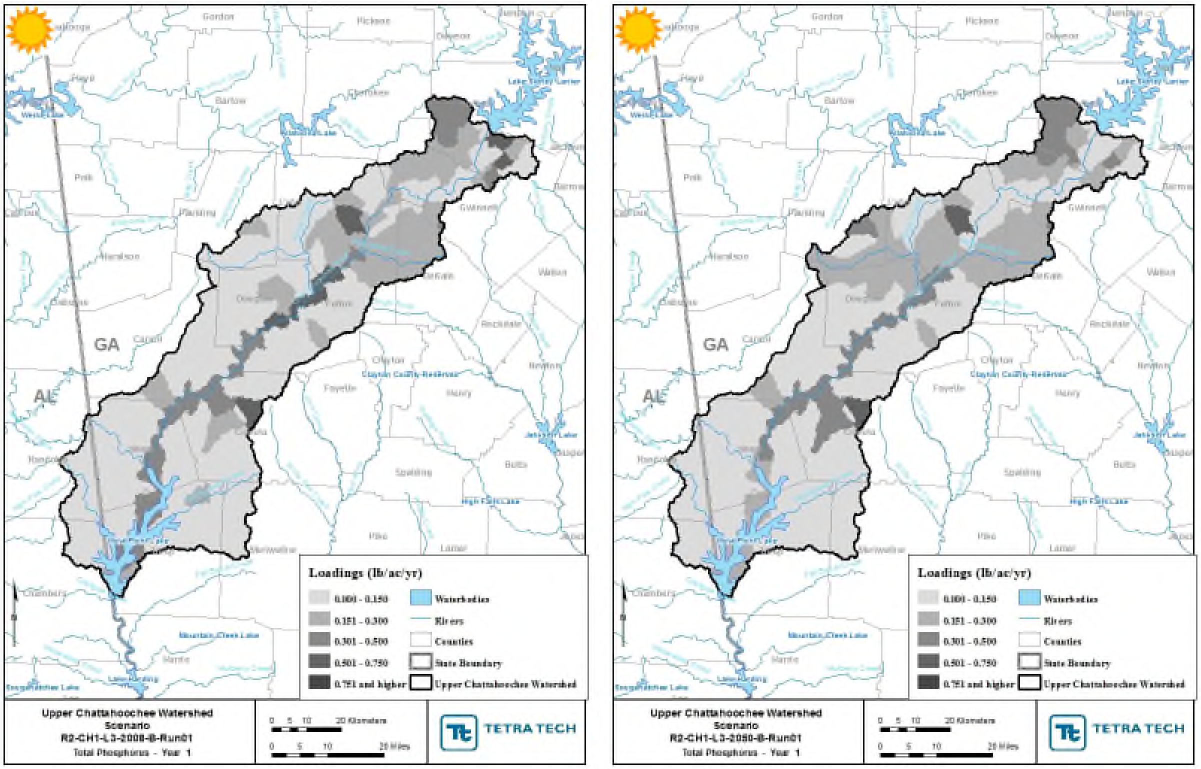

Figure 4-79 Current (left) and Future (right) Upper Chattahoochee River Watershed Total Phosphorus loads during representative dry weather conditions

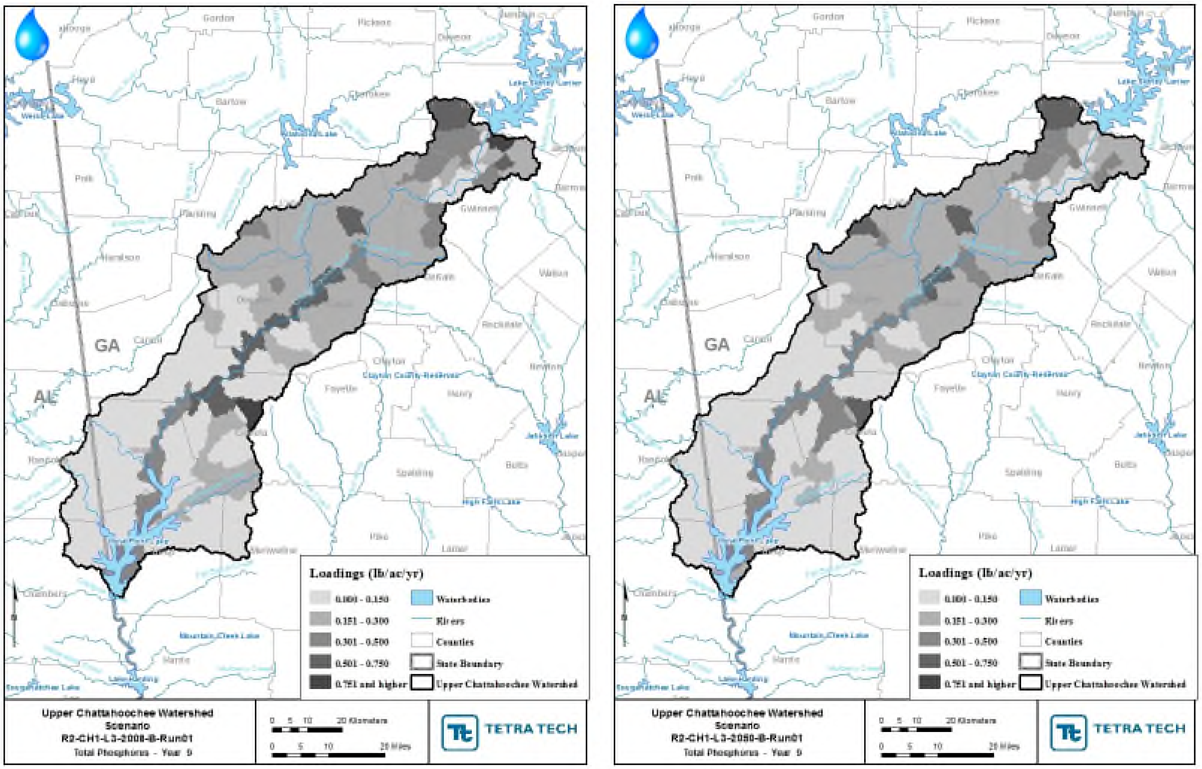

Figure 4-80 Current (left) and Future (right) Upper Chattahoochee River Watershed Total Phosphorus loads during representative wet weather conditions

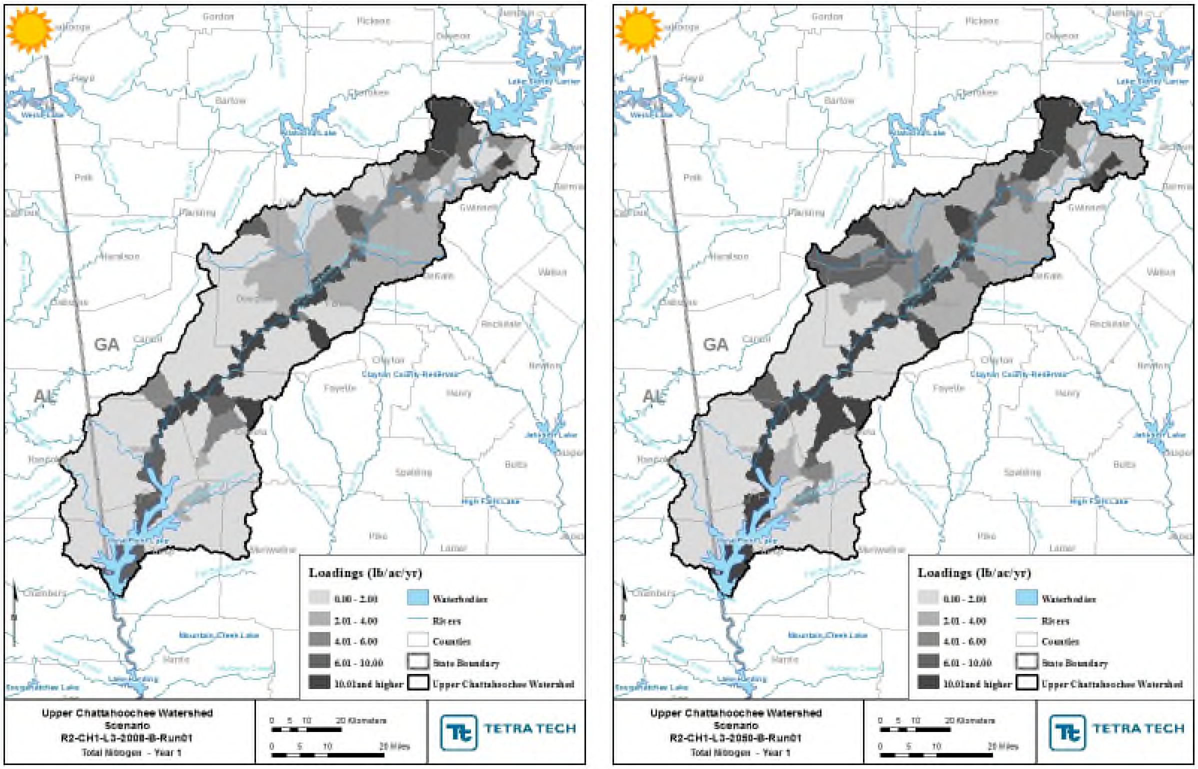

Figure 4-81 Current (left) and Future (right) Upper Chattahoochee River Watershed Total Nitrogen loads during representative dry weather conditions

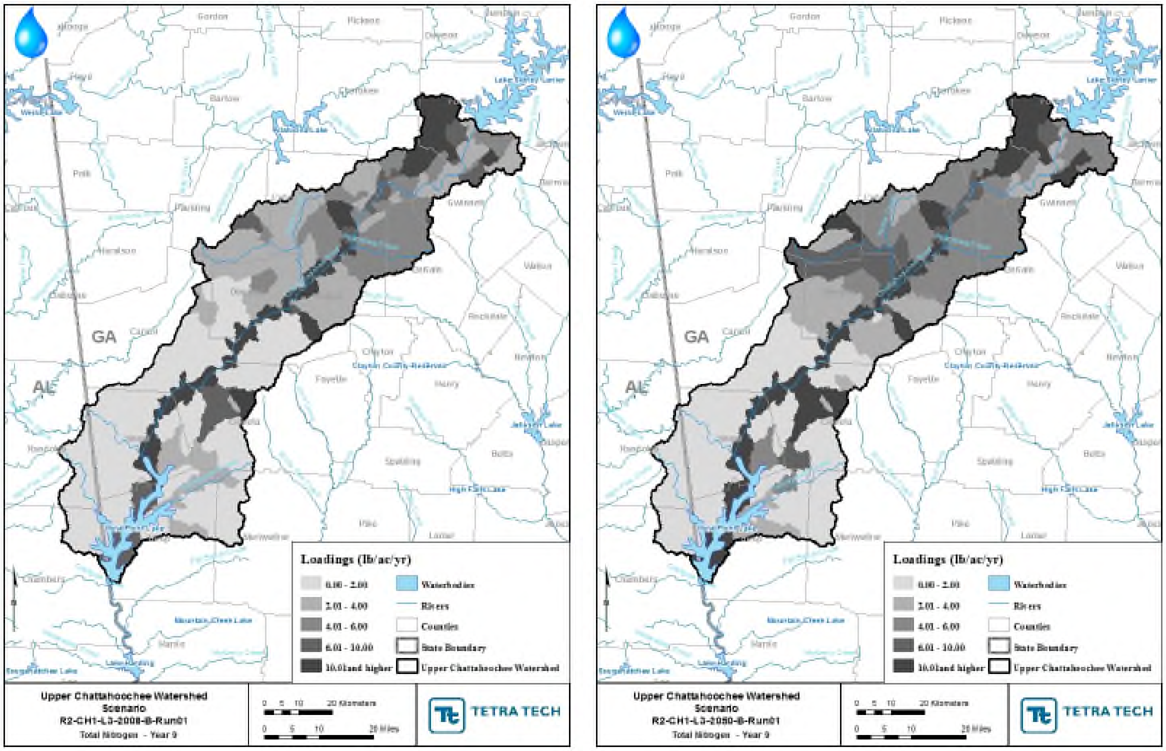

Figure 4-82 Current (left) and Future (right) Upper Chattahoochee River Watershed Total Nitrogen loads during representative wet weather conditions

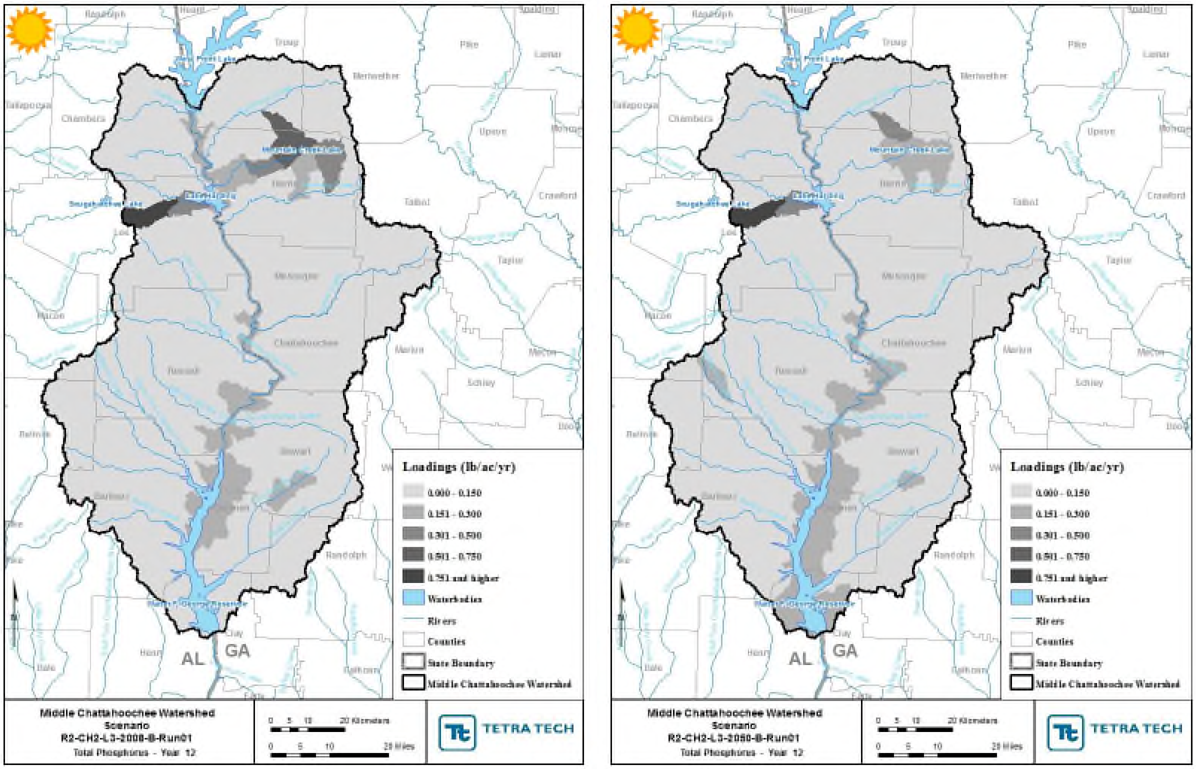

Figure 4-83 Current (left) and Future (right) Middle Chattahoochee River Watershed Total Phosphorus loads during representative dry weather conditions

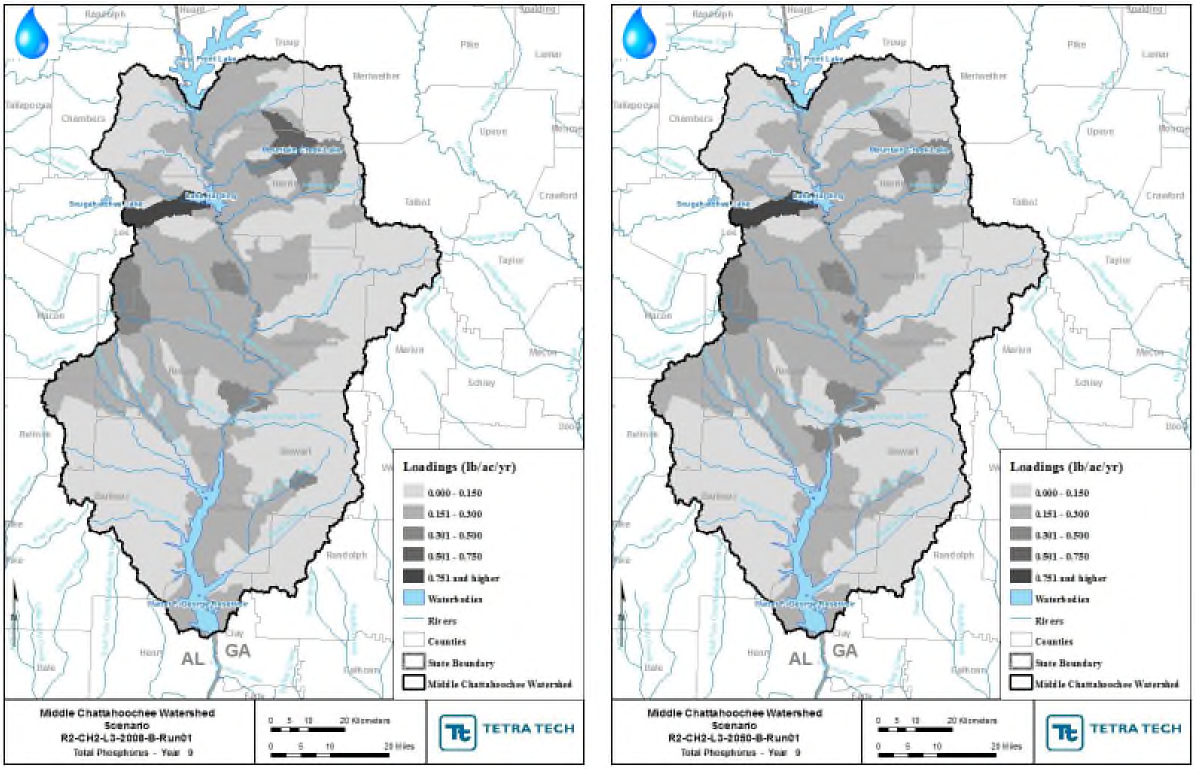

Figure 4-84 Current (left) and Future (right) Middle Chattahoochee River Watershed Total Phosphorus loads during representative wet weather conditions

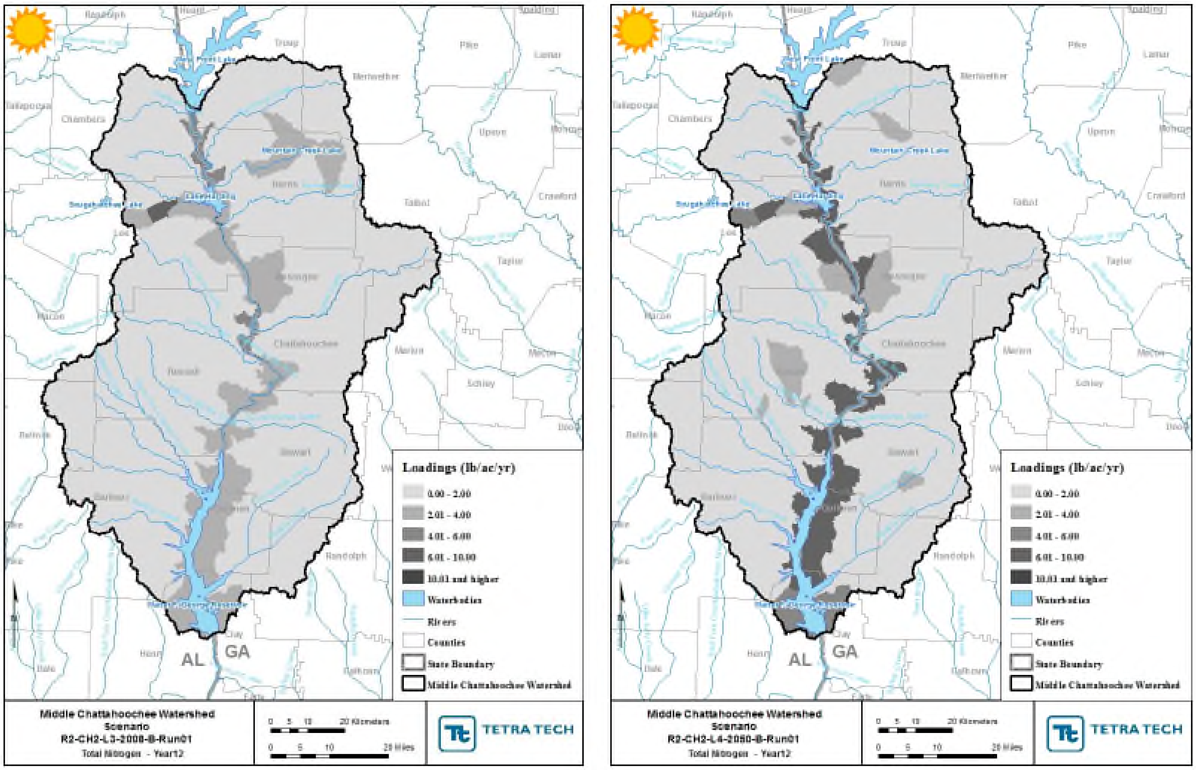

Figure 4-85 Current (left) and Future (right) Middle Chattahoochee River Watershed Total Nitrogen loads during representative dry weather conditions

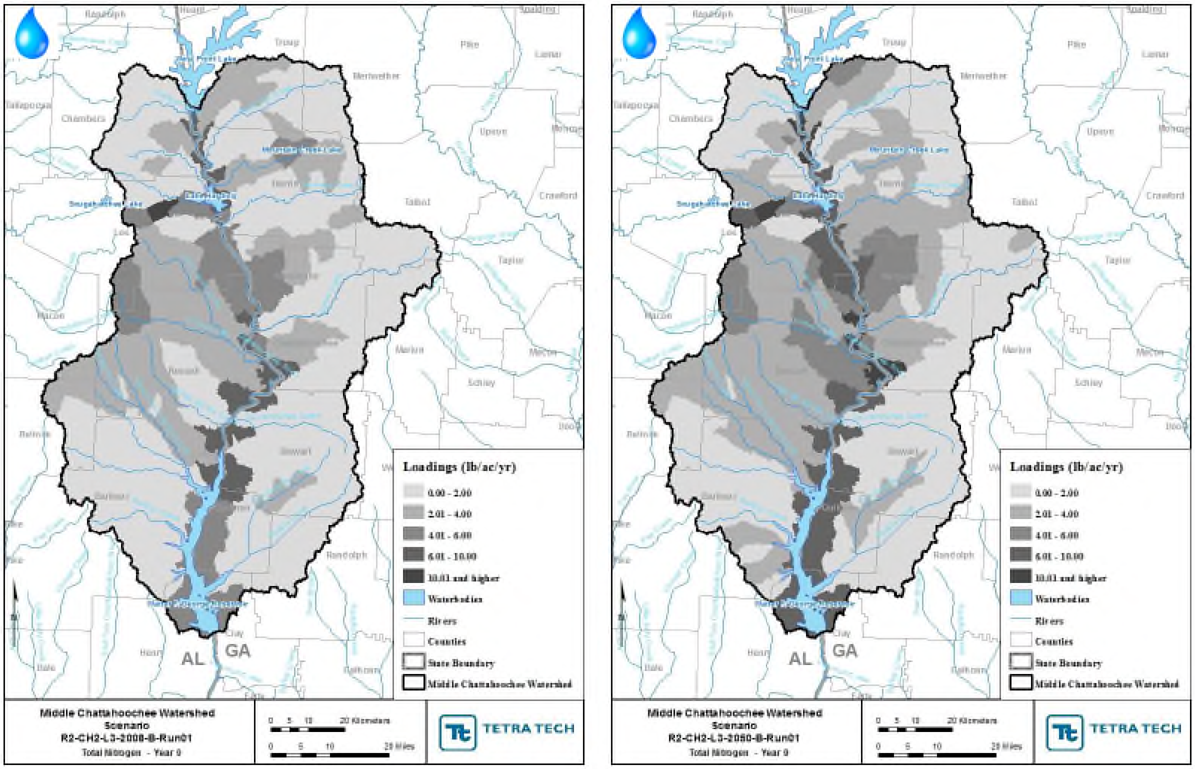

Figure 4-86 Current (left) and Future (right) Middle Chattahoochee River Watershed Total Nitrogen loads during representative wet weather conditions

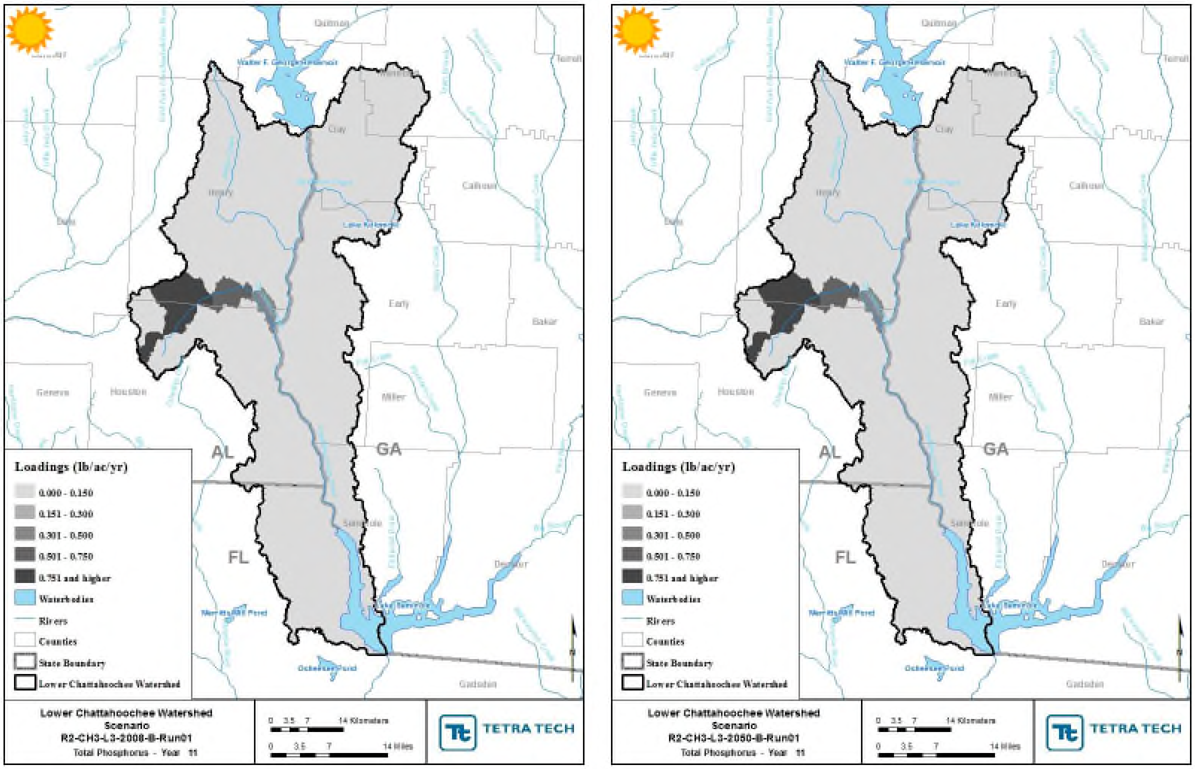

Figure 4-87 Current (left) and Future (right) Lower Chattahoochee River Watershed Total Phosphorus loads during representative dry weather conditions

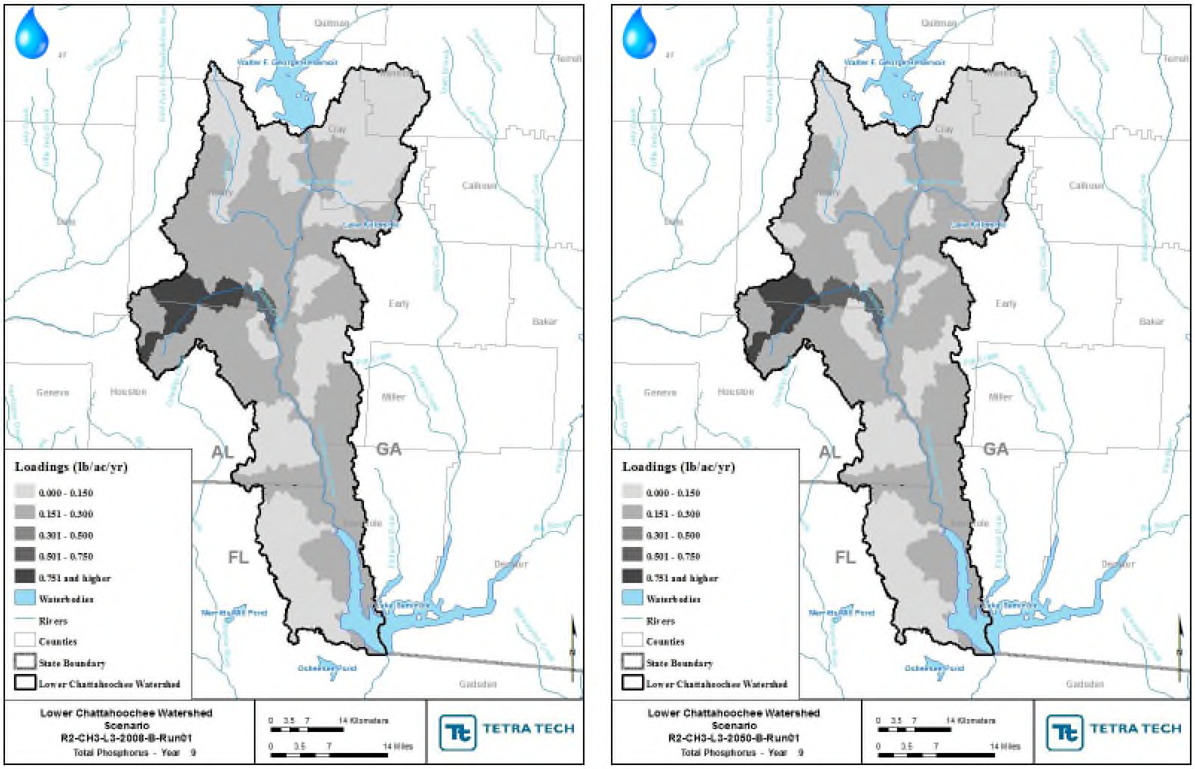

Figure 4-88 Current (left) and Future (right) Lower Chattahoochee River Watershed Total Phosphorus loads during representative wet weather conditions

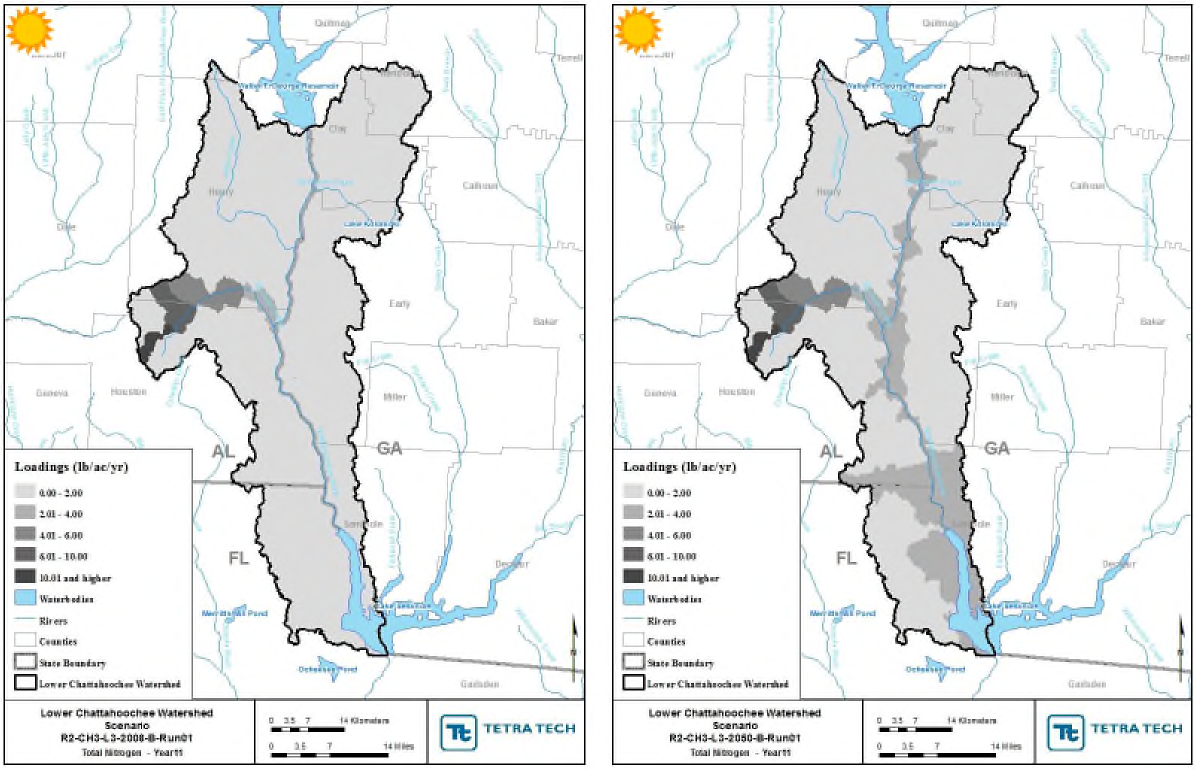

Figure 4-89 Current (left) and Future (right) Lower Chattahoochee River Watershed Total Nitrogen loads during representative dry weather conditions

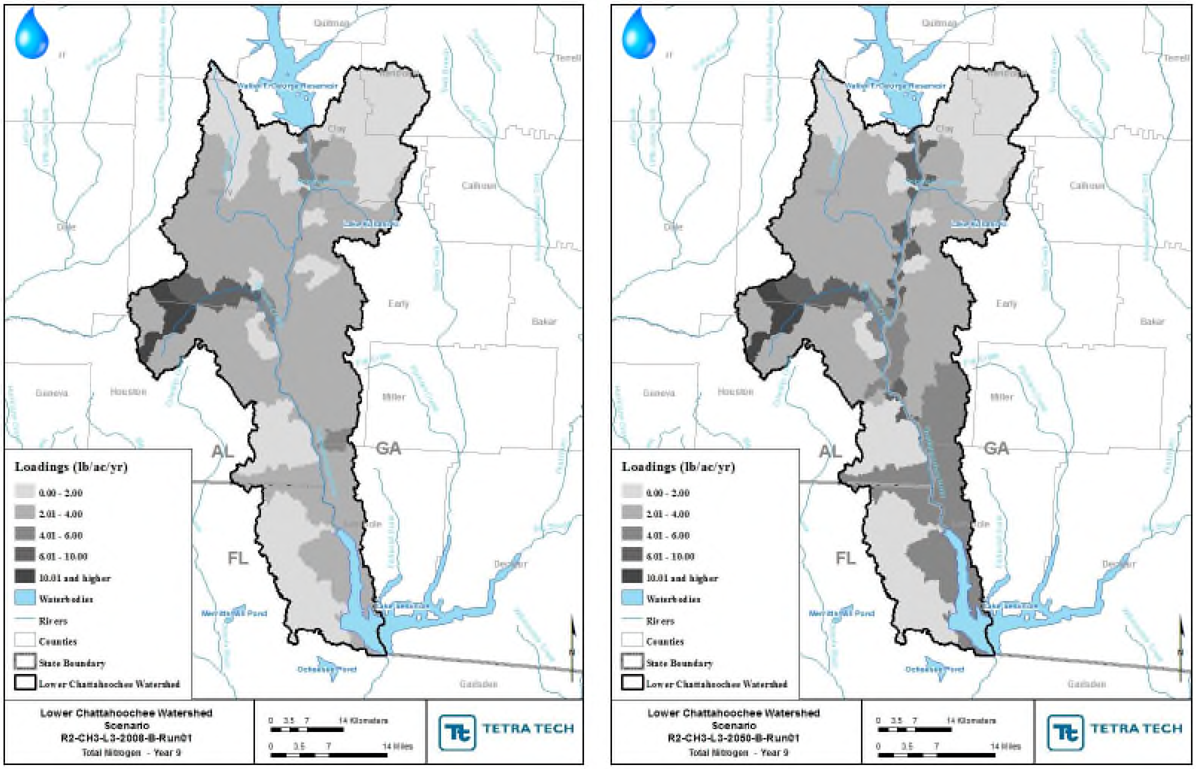

Figure 4-90 Current (left) and Future (right) Lower Chattahoochee River Watershed Total Nitrogen loads during representative wet weather conditions

4.4.2. Flint and Ochlockonee River Watersheds

The current and future nutrient loads represented by watershed models for subwatersheds throughout the Flint and Ochlockonee River Watersheds for representative dry and wet weather conditions are illustrated in Figure 4-91 through Figure 4-98 for TP and TN. Appendices H and I present the nutrient loads by subwatershed (Flint River and Ochlockonee River, respectively) for TP, TN, and BOD for each year for each modeled scenario.

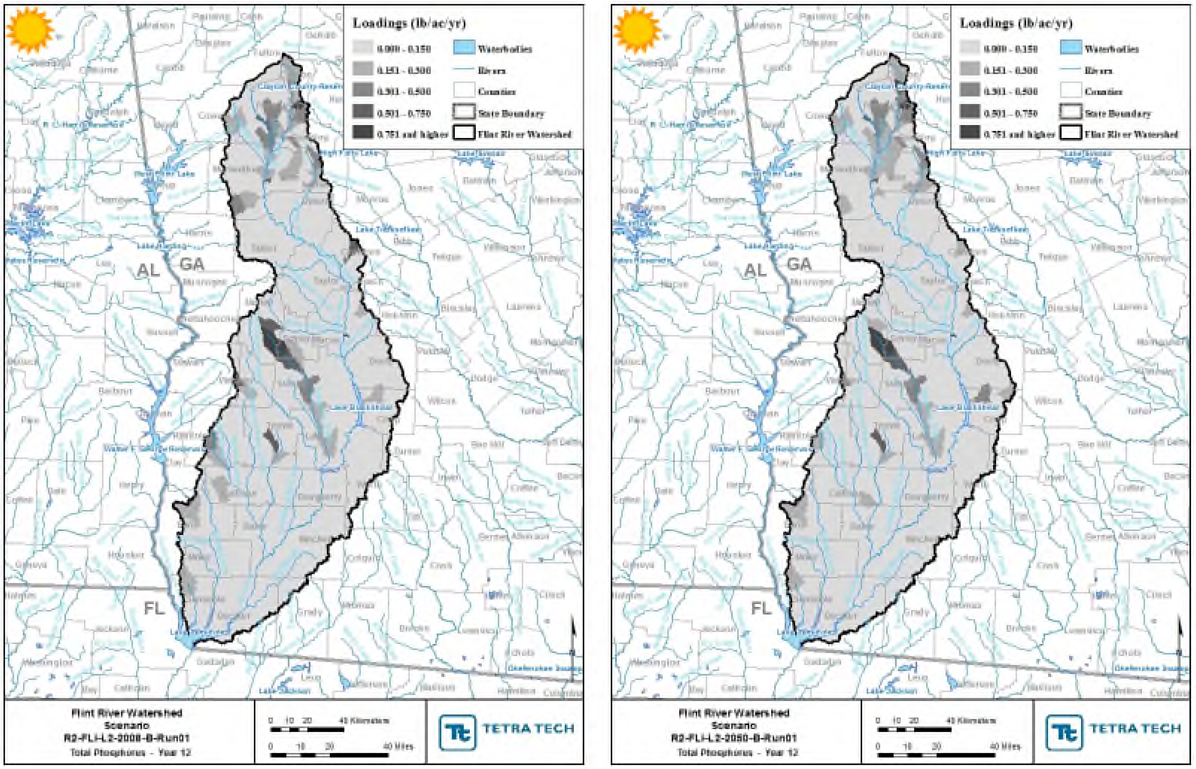

Figure 4-91 Current (left) and Future (right) Flint River Watershed Total Phosphorus loads during representative dry weather conditions

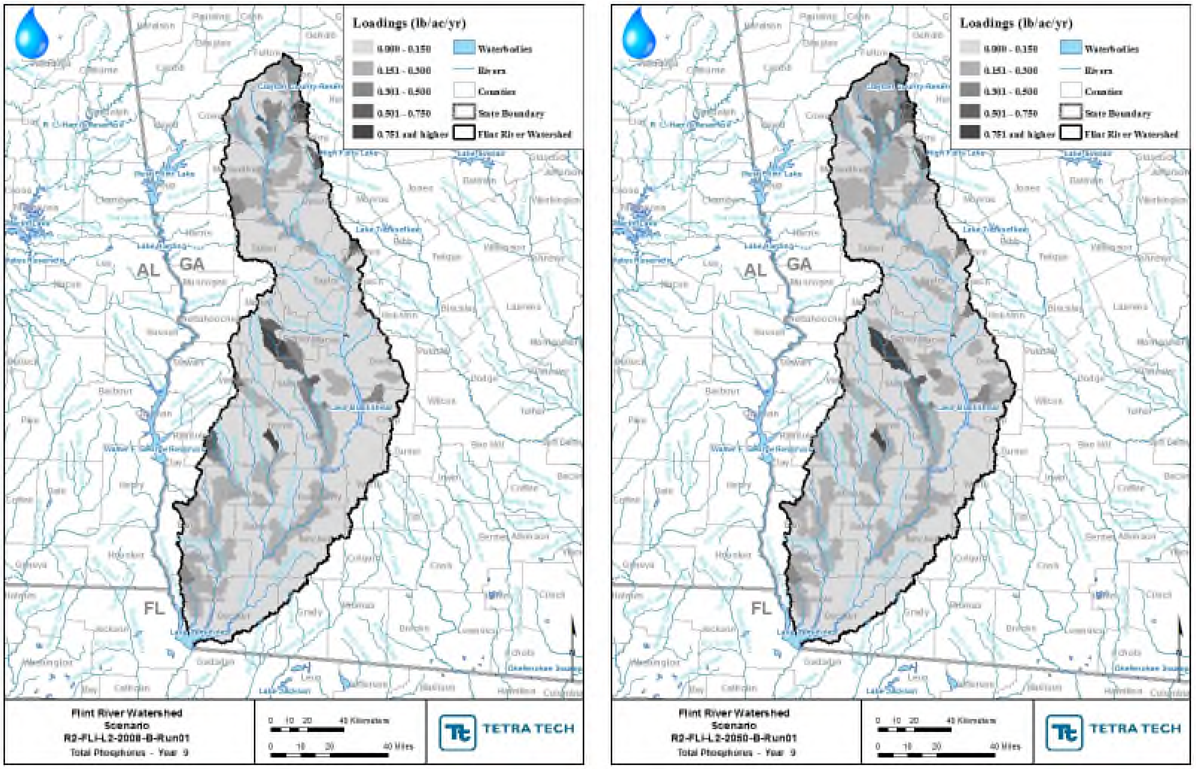

Figure 4-92 Current (left) and Future (right) Flint River Watershed Total Phosphorus loads during representative wet weather conditions

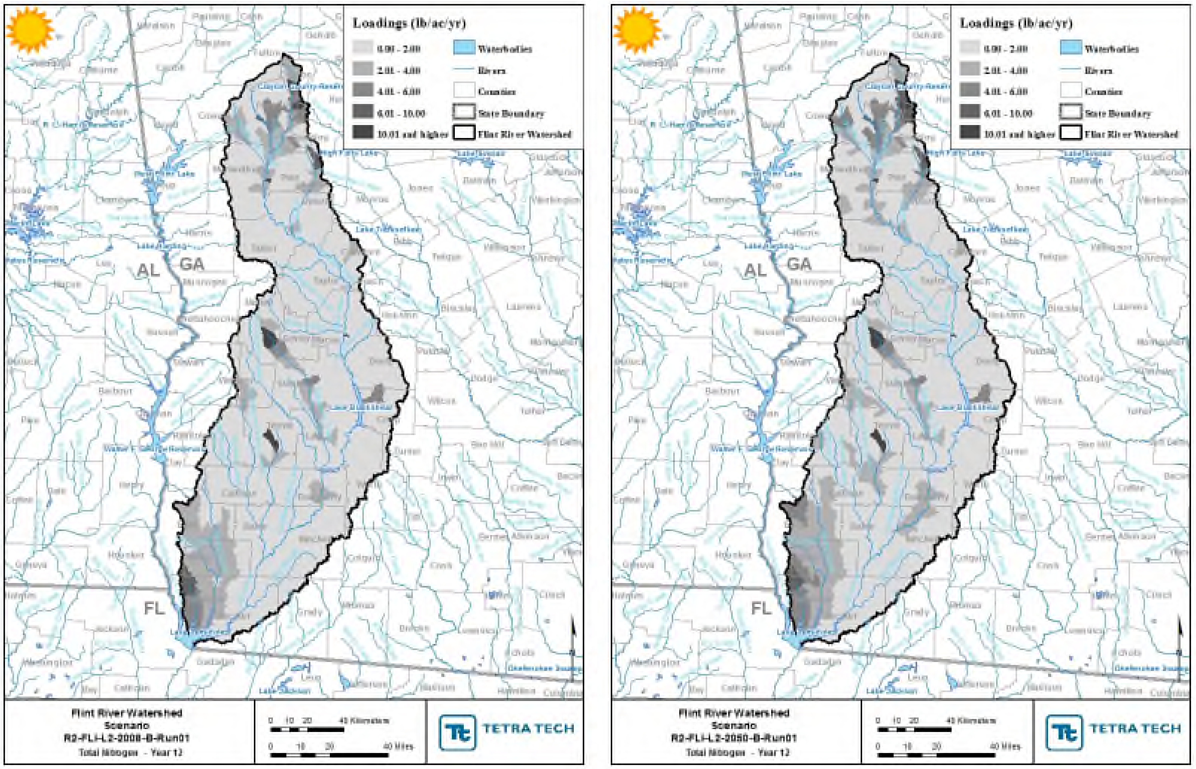

Figure 4-93 Current (left) and Future (right) Flint River Watershed Total Nitrogen loads during representative dry weather conditions

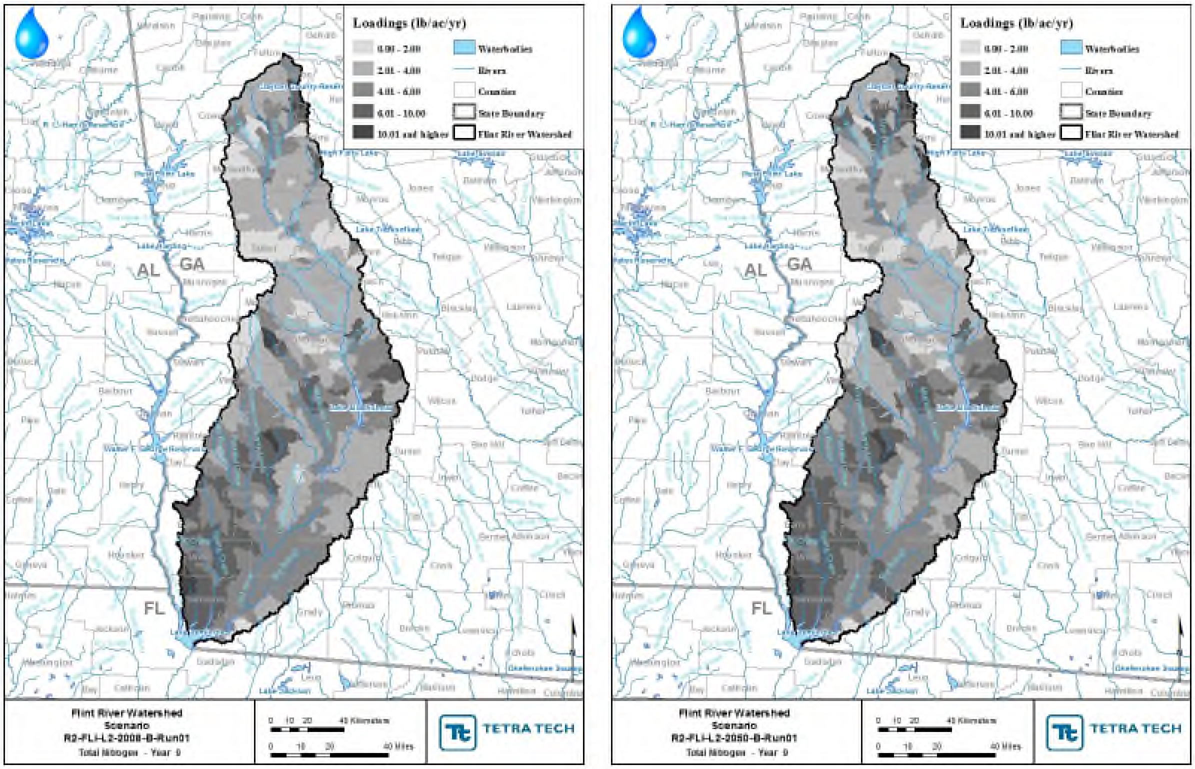

Figure 4-94 Current (left) and Future (right) Flint River Watershed Total Nitrogen loads during representative wet weather conditions

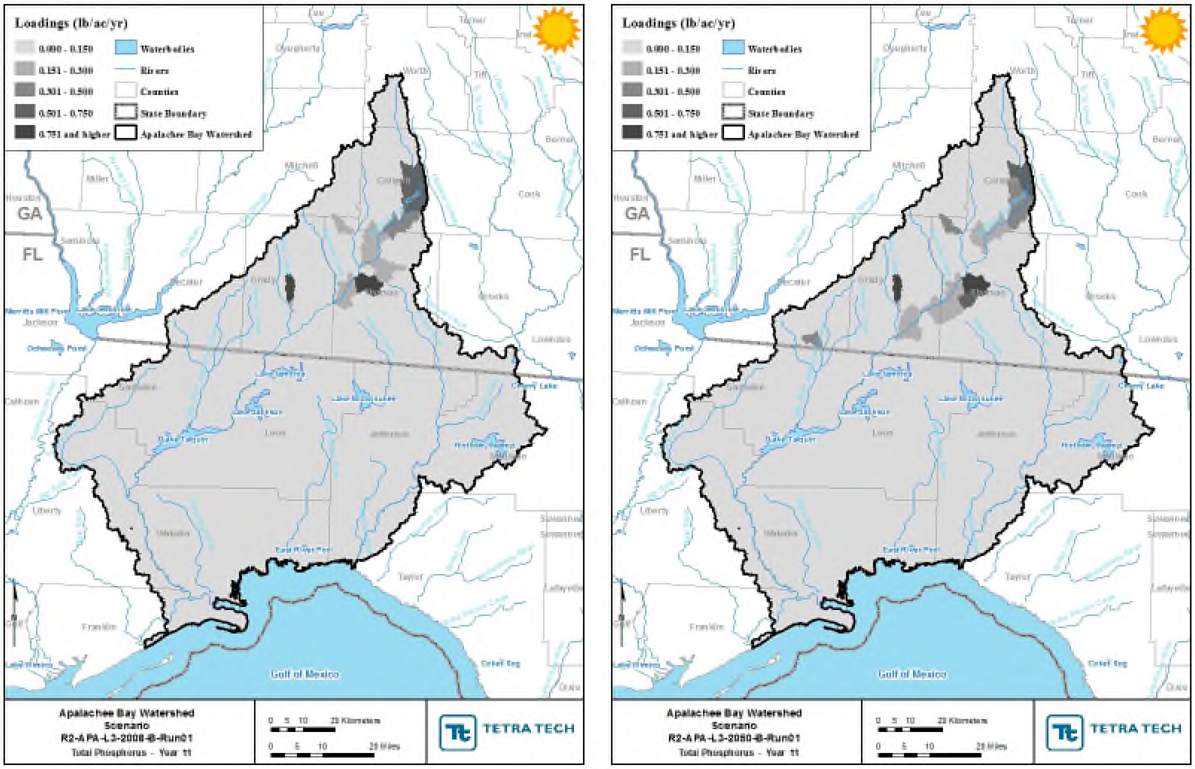

Figure 4-95 Current (left) and Future (right) Ochlockonee River Watershed Total Phosphorus loads during representative dry weather conditions

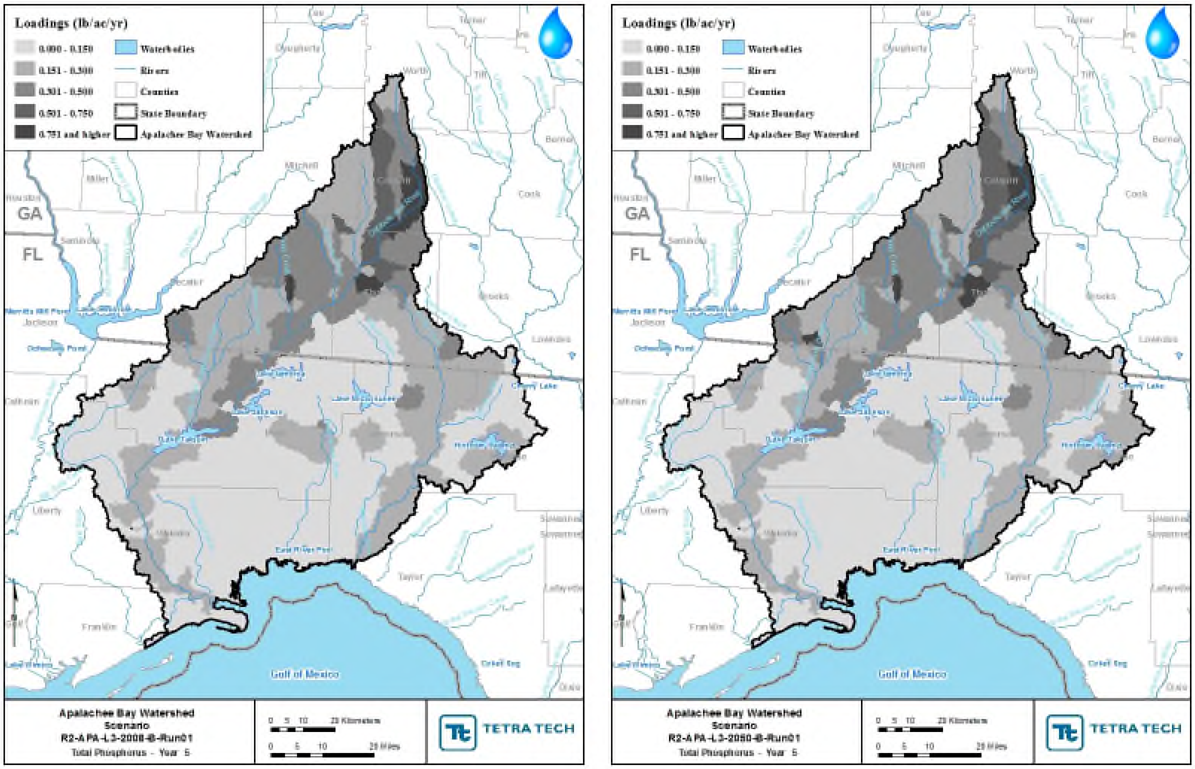

Figure 4-96 Current (left) and Future (right) Ochlockonee River Watershed Total Phosphorus loads during representative wet weather conditions

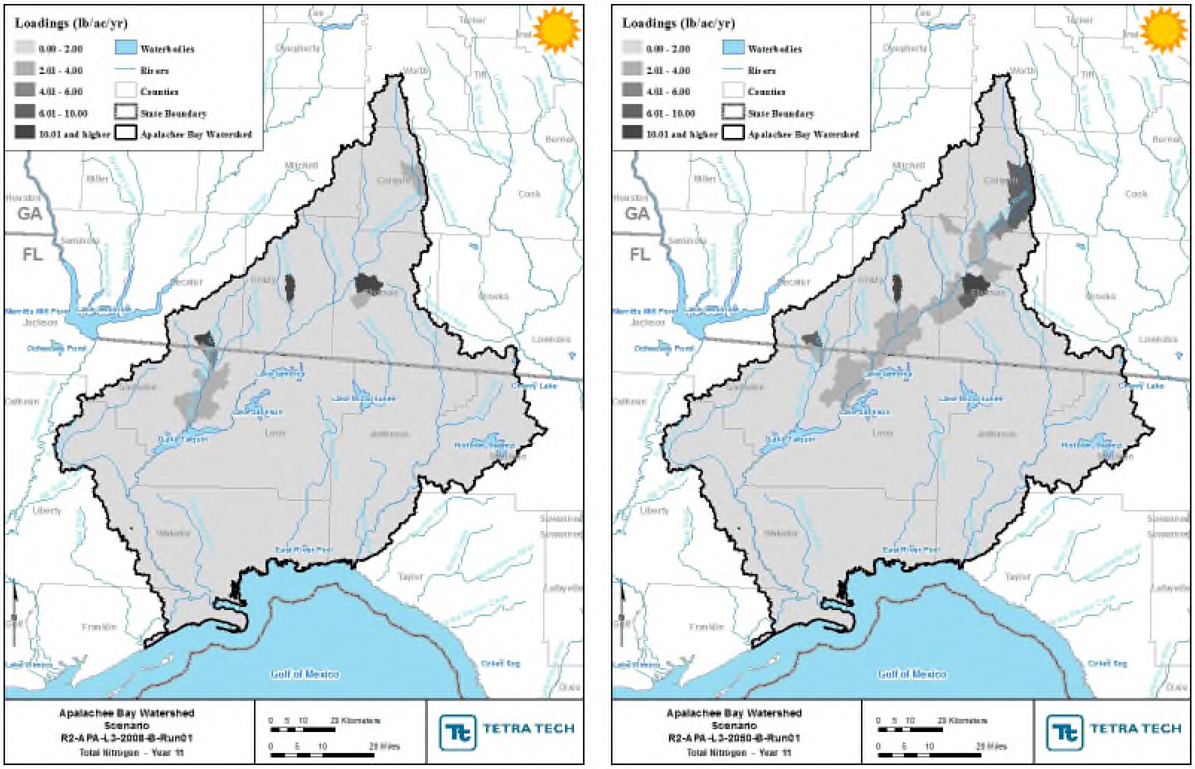

Figure 4-97 Current (left) and Future (right) Ochlockonee River Watershed Total Nitrogen loads during representative dry weather conditions

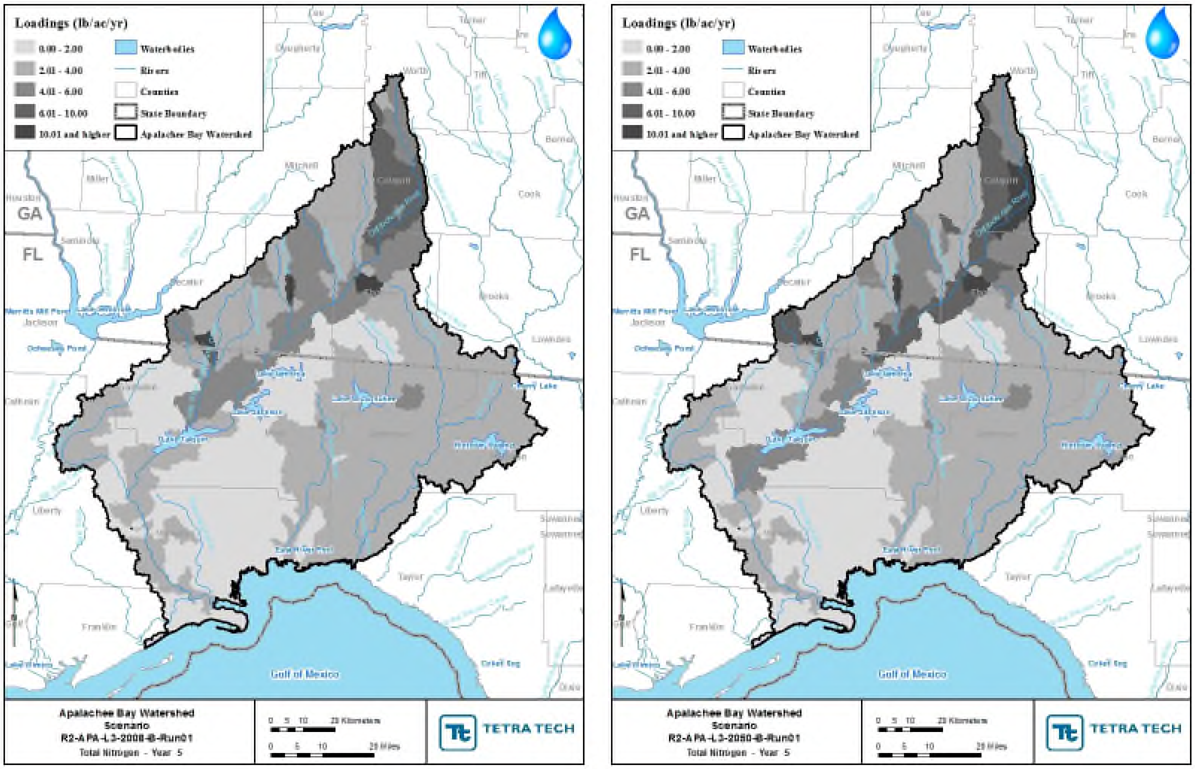

Figure 4-98 Current (left) and Future (right) Ochlockonee River Watershed Total Nitrogen loads during representative wet weather conditions

4.4.3. Coosa, Tallapoosa, and Tennessee River Watersheds

Results from the watershed models for the Coosa, Tallapoosa, and Tennessee River Watersheds were used to represent the current and future nutrient loads by subwatersheds for representative dry and wet weather conditions. Figure 4-99 through Figure 4-122 illustrate current and future TP and TN loads by subwatershed. Appendices J, K, L, M, N, and O present the nutrient loads by subwatershed (Carters Lake, Lake Allatoona, Coosa River, Tallapoosa River, Little Tallapoosa River, and Tennessee River, respectively) for TP, TN, and BOD for each year for each modeled scenario.

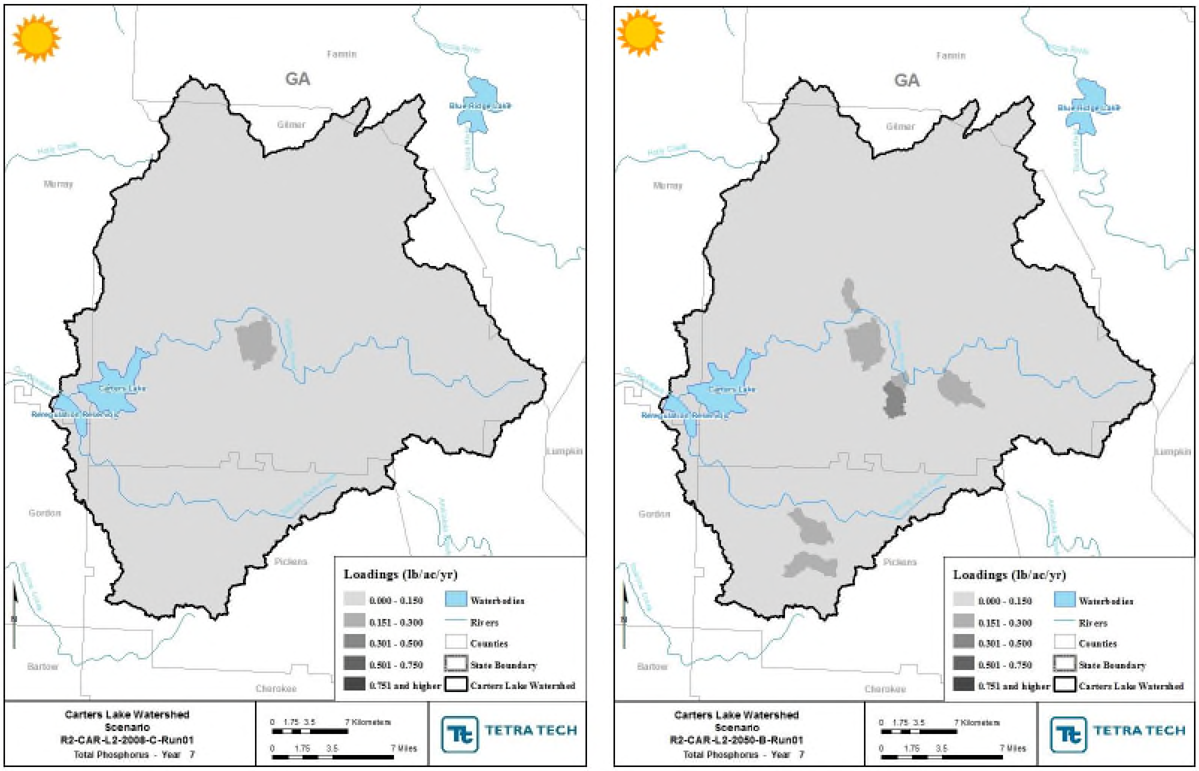

Figure 4-99 Current (left) and Future (right) Carters Lake Watershed Total Phosphorus loads during representative dry weather conditions

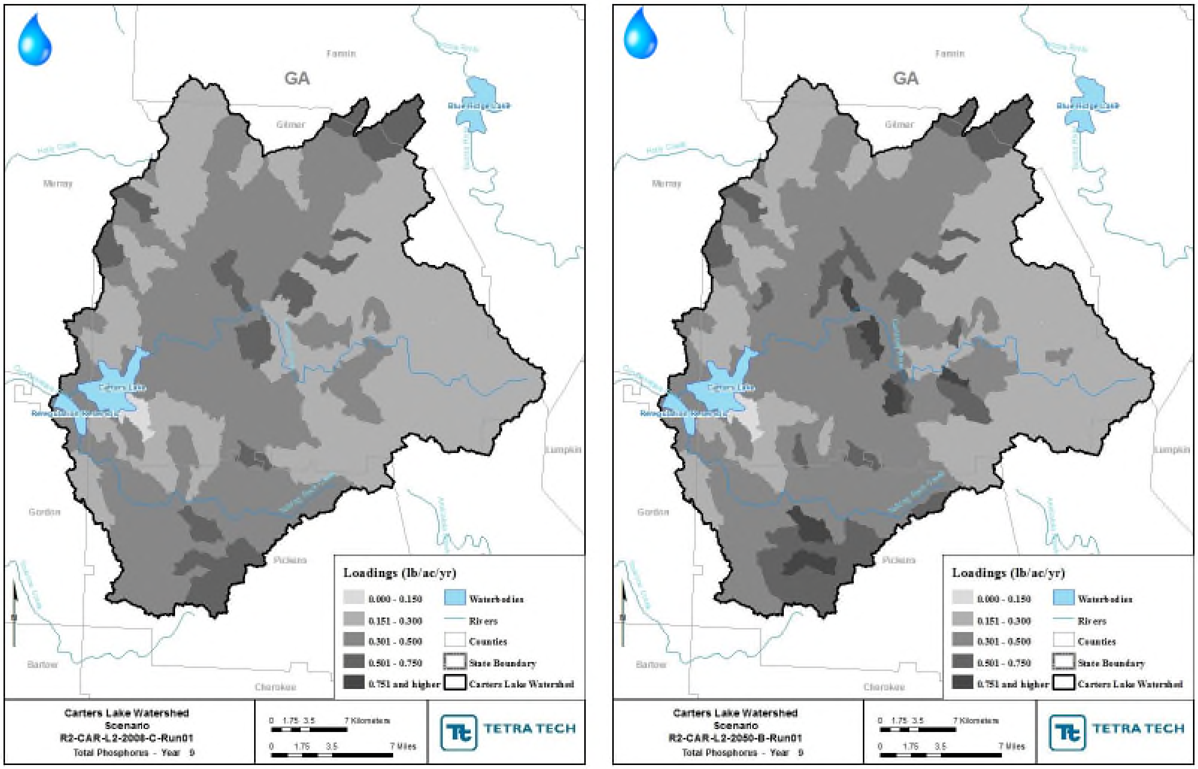

Figure 4-100 Current (left) and Future (right) Carters Lake Watershed Total Phosphorus loads during representative wet weather conditions

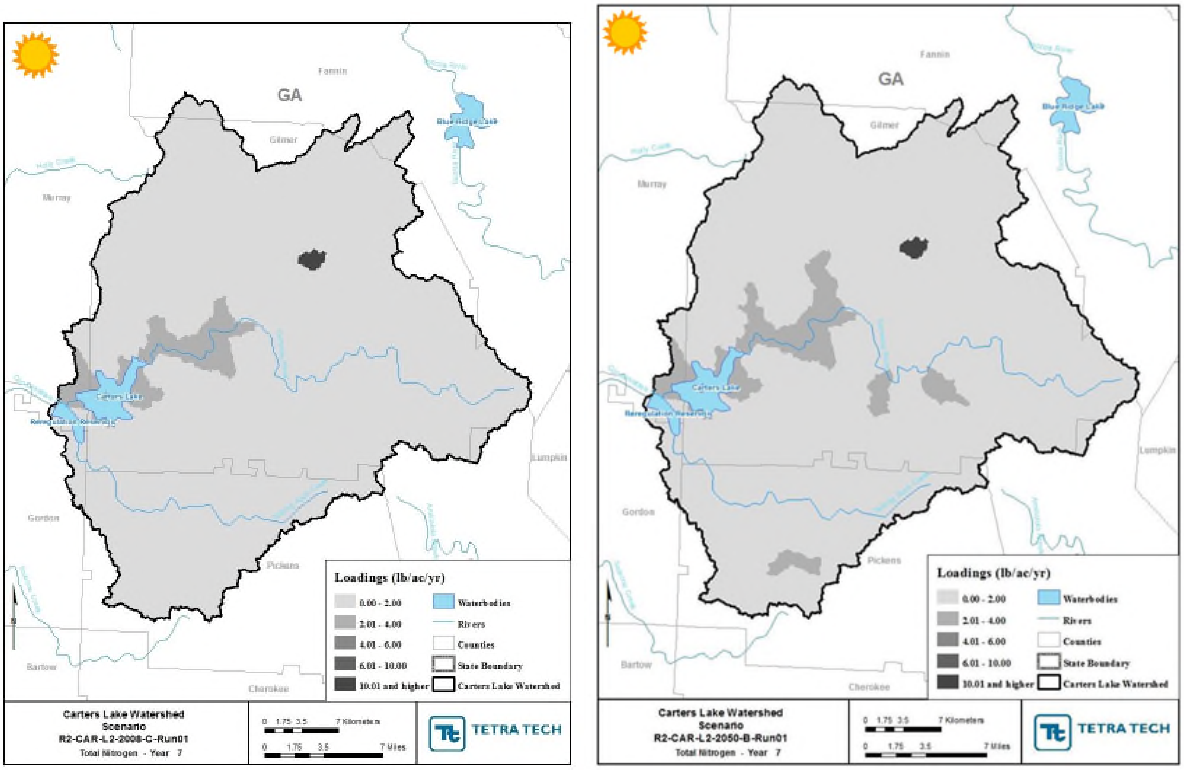

Figure 4-101 Current (left) and Future (right) Carters Lake Watershed Total Nitrogen loads during representative dry weather conditions

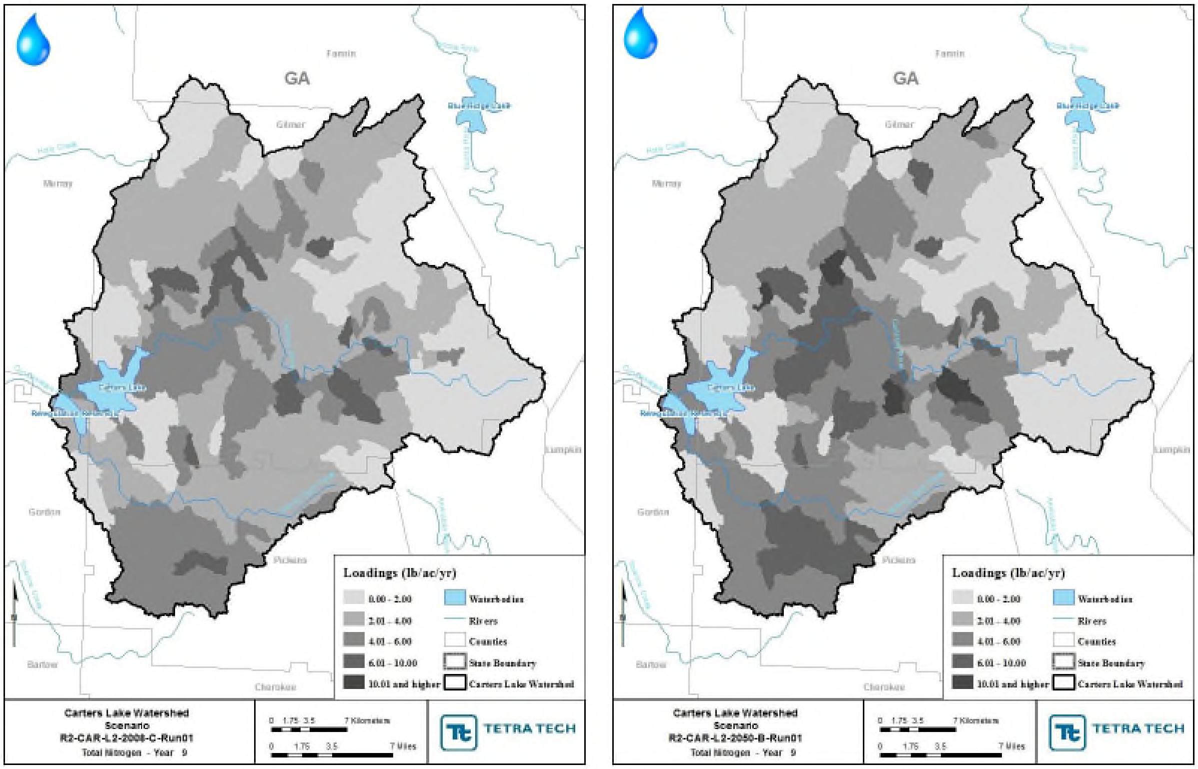

Figure 4-102 Current (left) and Future (right) Carters Lake Watershed Total Nitrogen loads during representative wet weather conditions

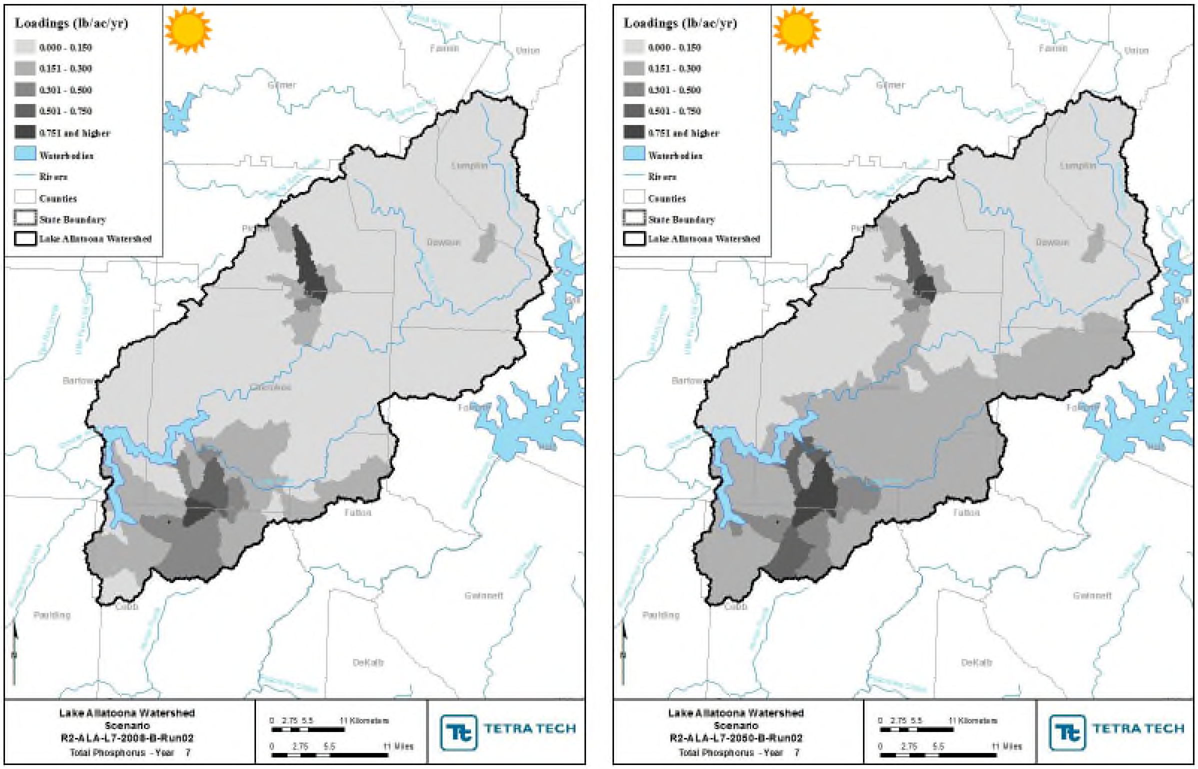

Figure 4-103 Current (left) and Future (right) Lake Allatoona Watershed Total Phosphorus loads during representative dry weather conditions

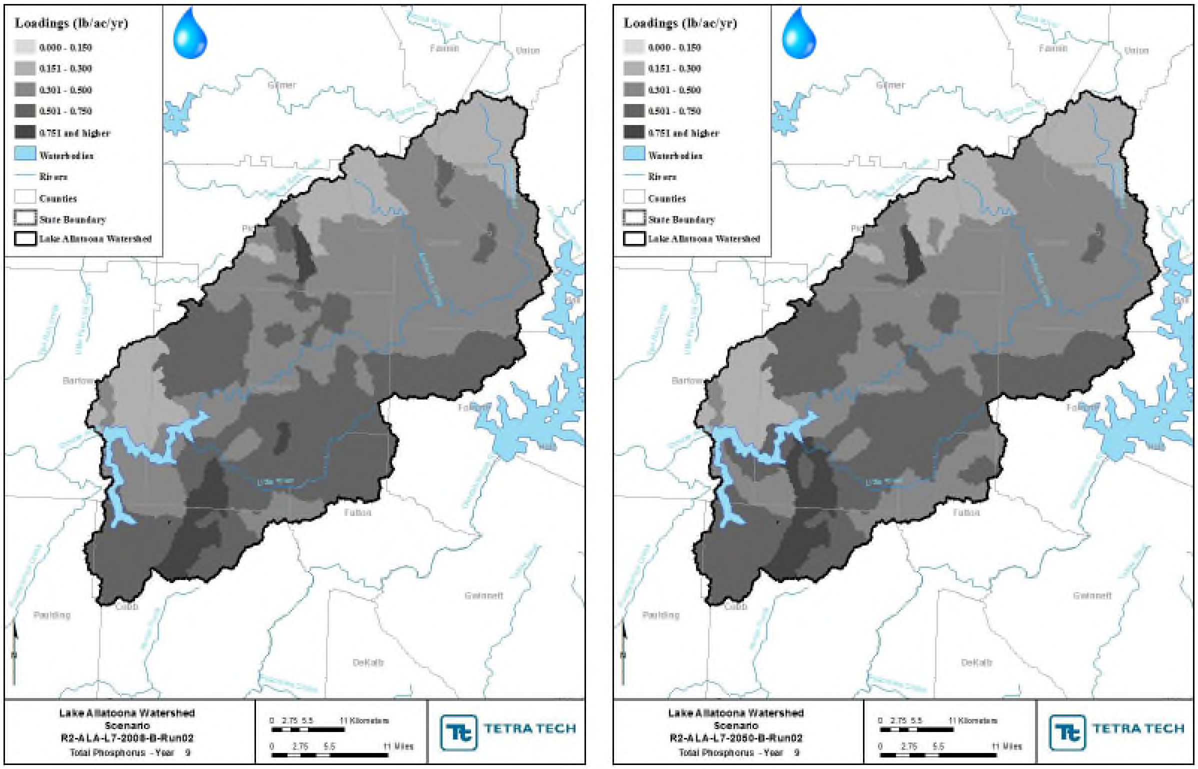

Figure 4-104 Current (left) and Future (right) Lake Allatoona Watershed Total Phosphorus loads during representative wet weather conditions

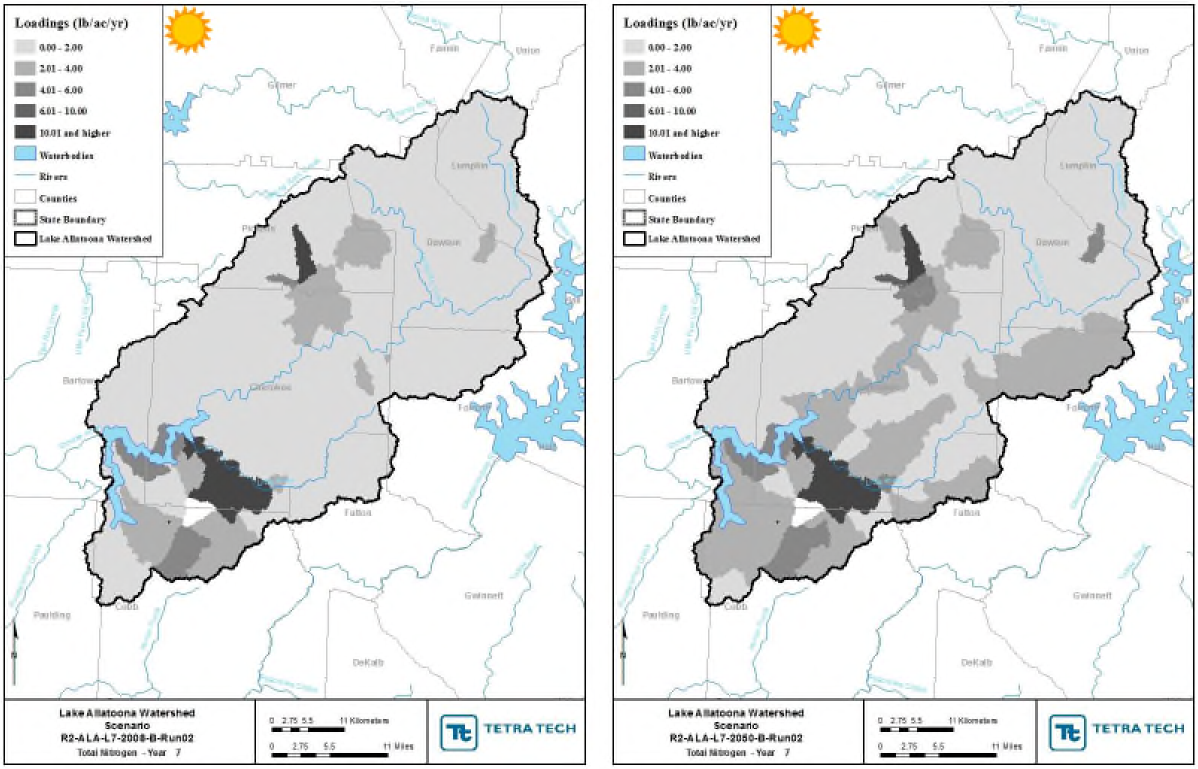

Figure 4-105 Current (left) and Future (right) Lake Allatoona Watershed Total Nitrogen loads during representative dry weather conditions

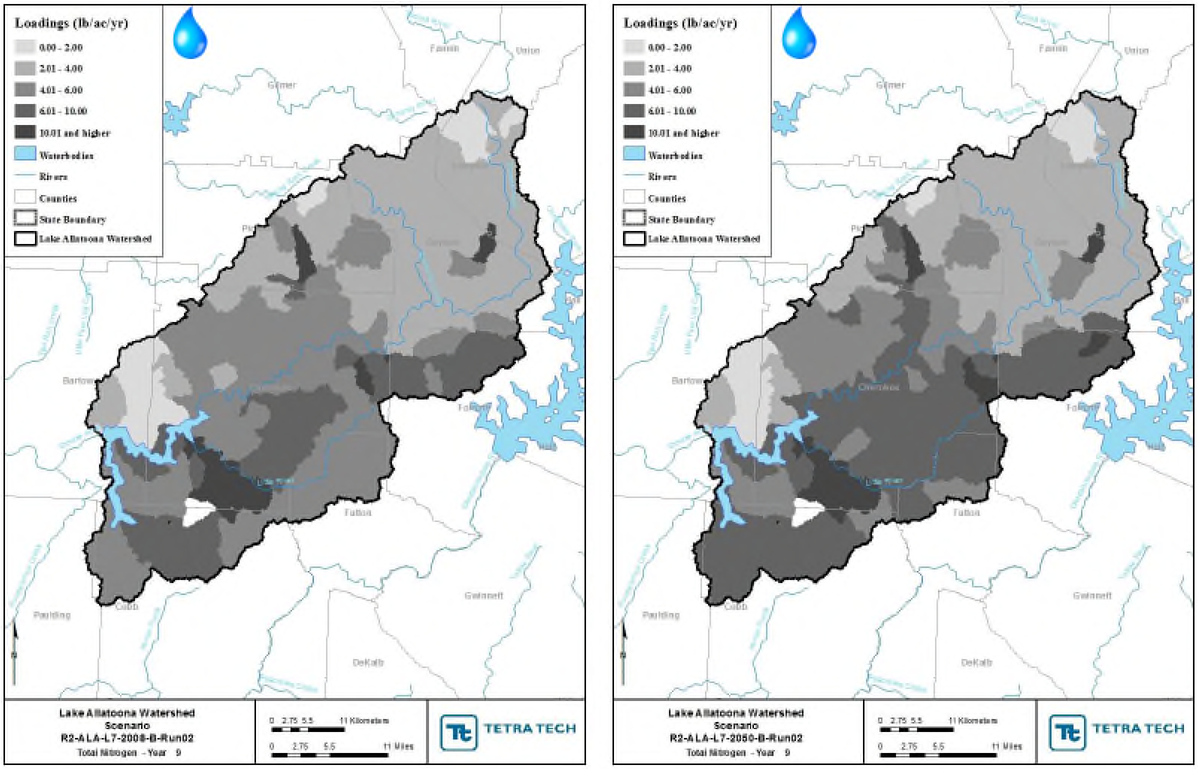

Figure 4-106 Current (left) and Future (right) Lake Allatoona Watershed Total Nitrogen loads during representative wet weather conditions

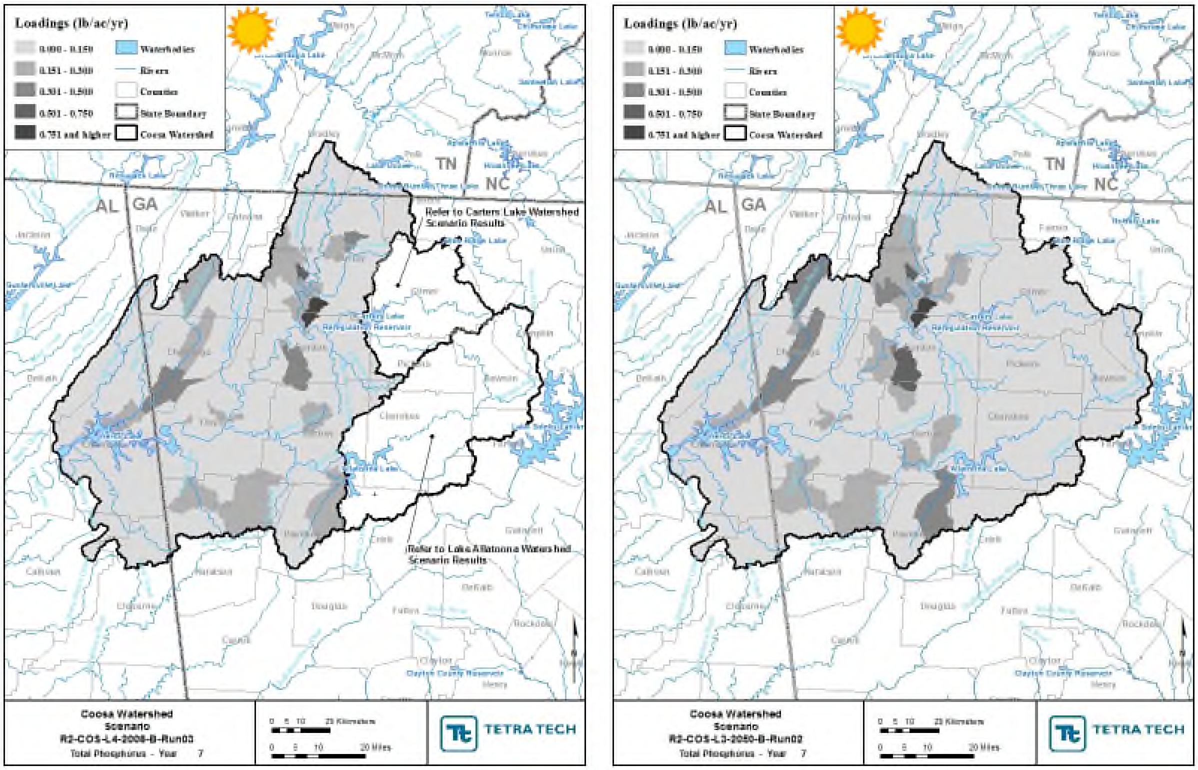

Figure 4-107 Current (left) and Future (right) Coosa River Watershed Total Phosphorus loads during representative dry weather conditions

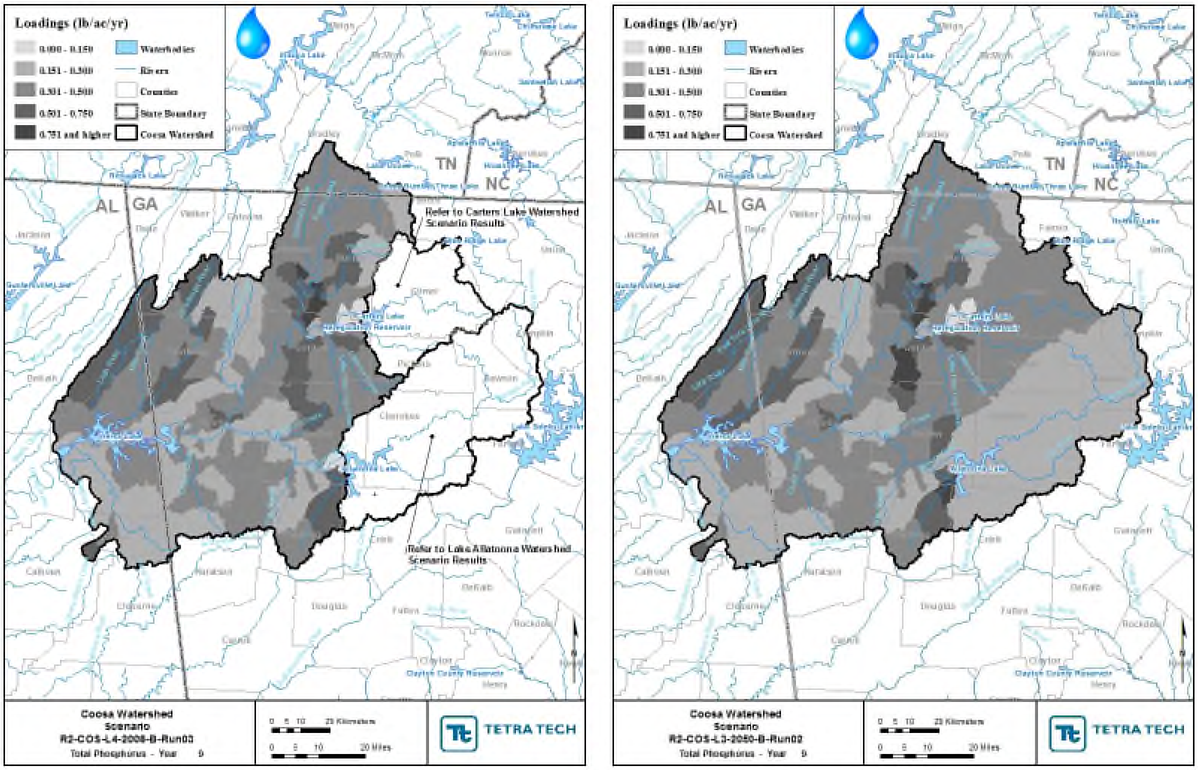

Figure 4-108 Current (left) and Future (right) Coosa River Watershed Total Phosphorus loads during representative wet weather conditions

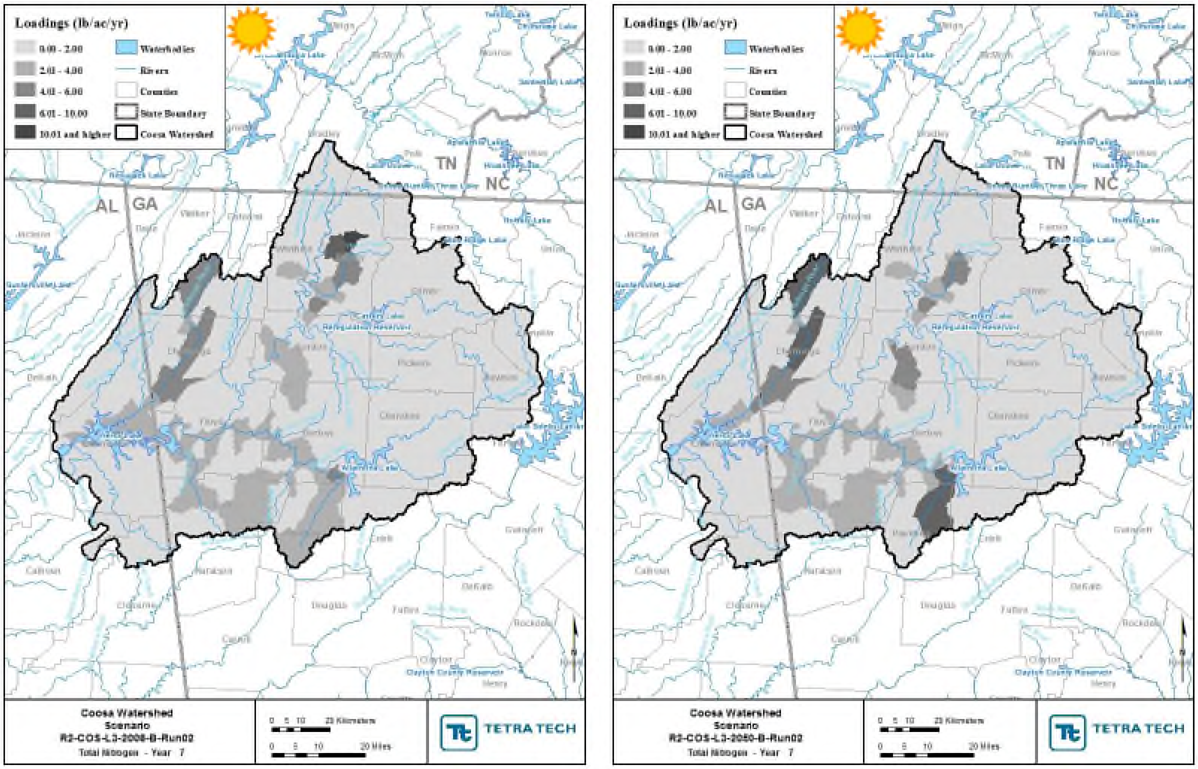

Figure 4-109 Current (left) and Future (right) Coosa River Watershed Total Nitrogen loads during representative dry weather conditions

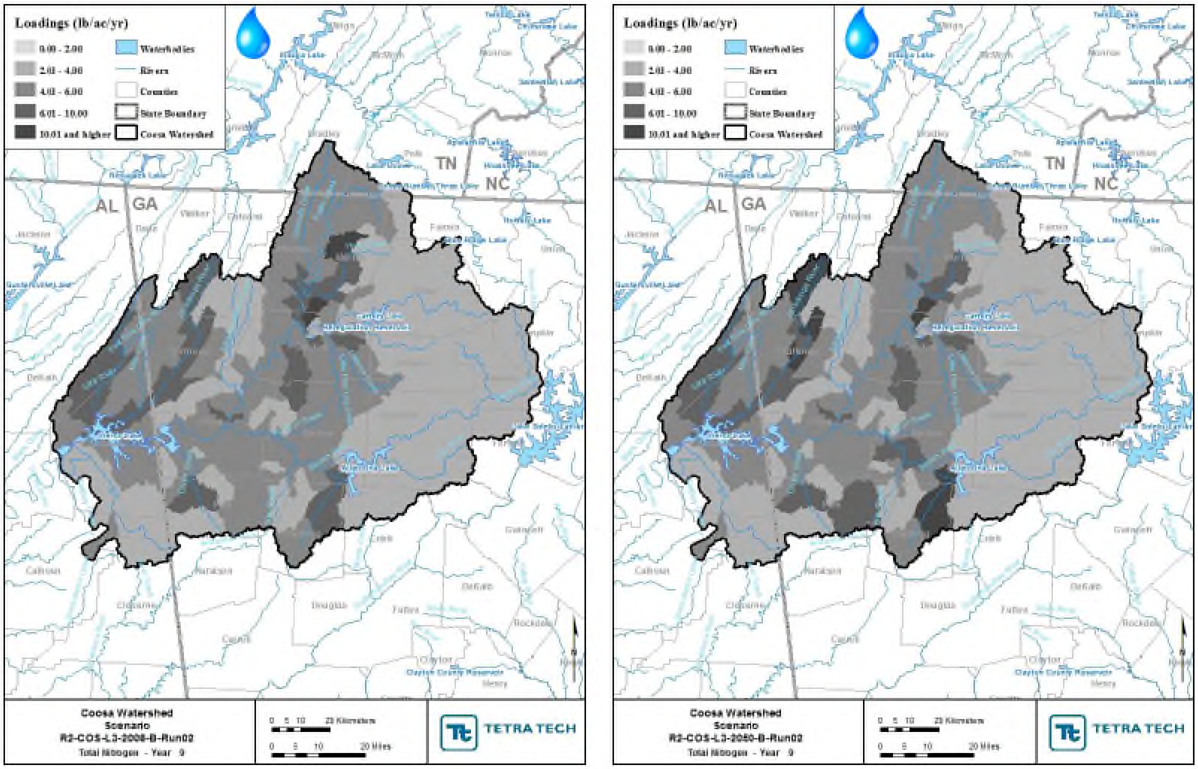

Figure 4-110 Current (left) and Future (right) Coosa River Watershed Total Nitrogen loads during representative wet weather conditions

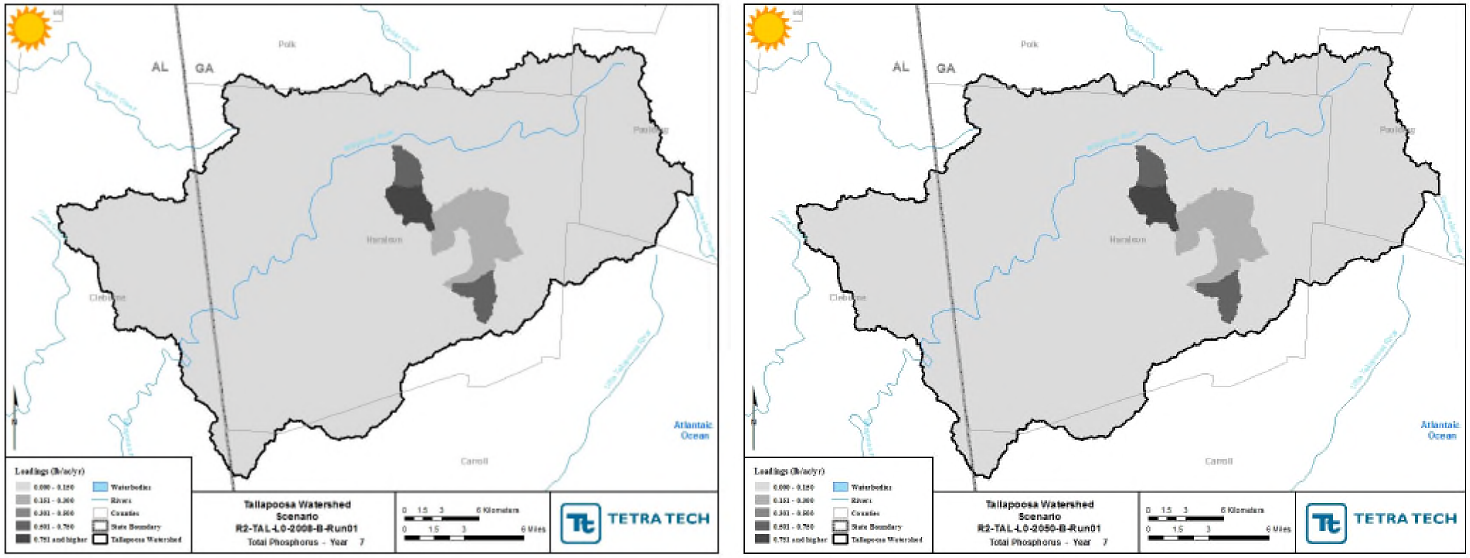

Figure 4-111 Current (left) and Future (right) Tallapoosa River Watershed Total Phosphorus loads during representative dry weather conditions

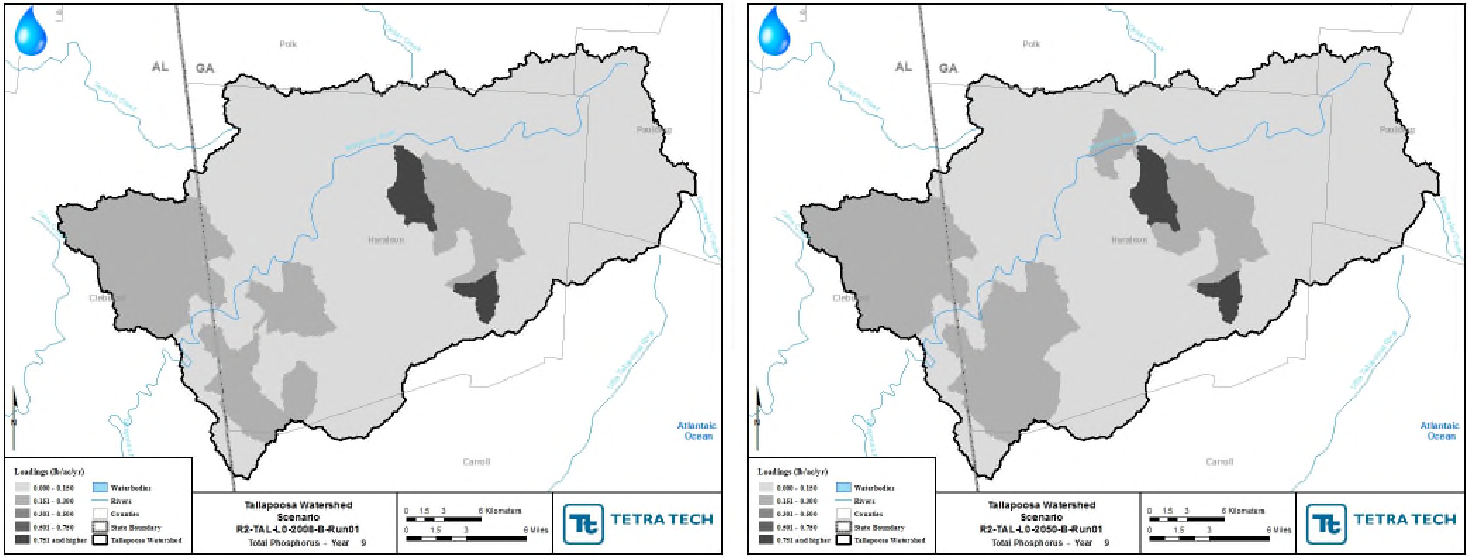

Figure 4-112 Current (left) and Future (right) Tallapoosa River Watershed Total Phosphorus loads during representative wet weather conditions

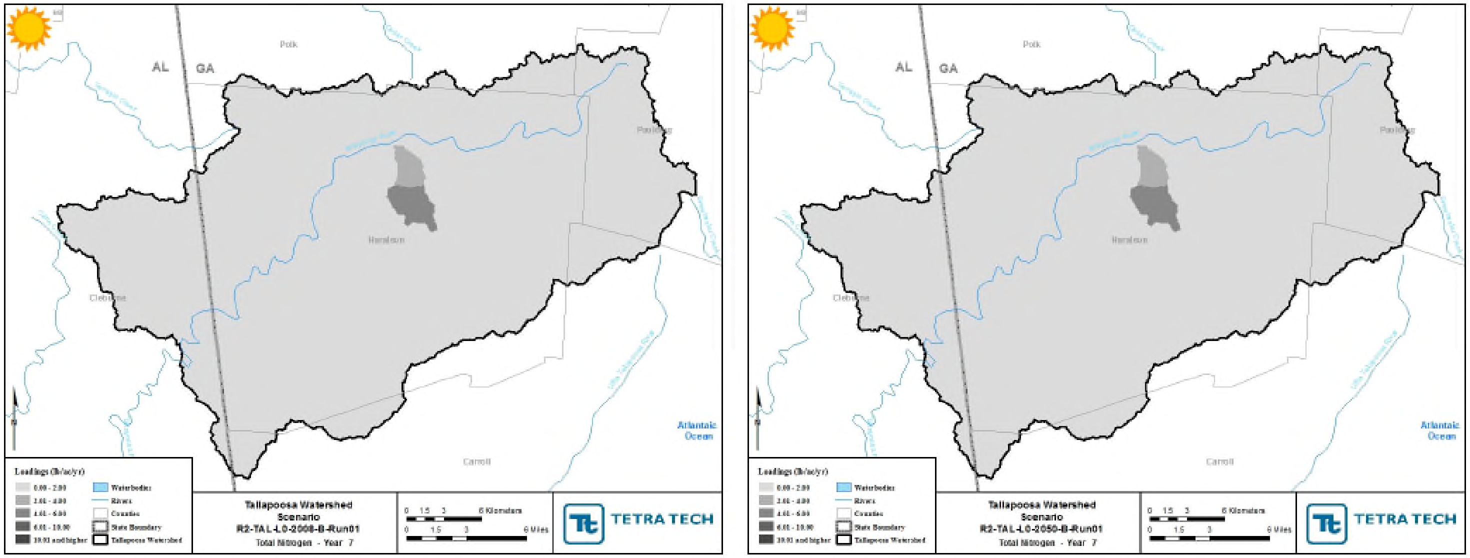

Figure 4-113 Current (left) and Future (right) Tallapoosa River Watershed Total Nitrogen loads during representative dry weather conditions

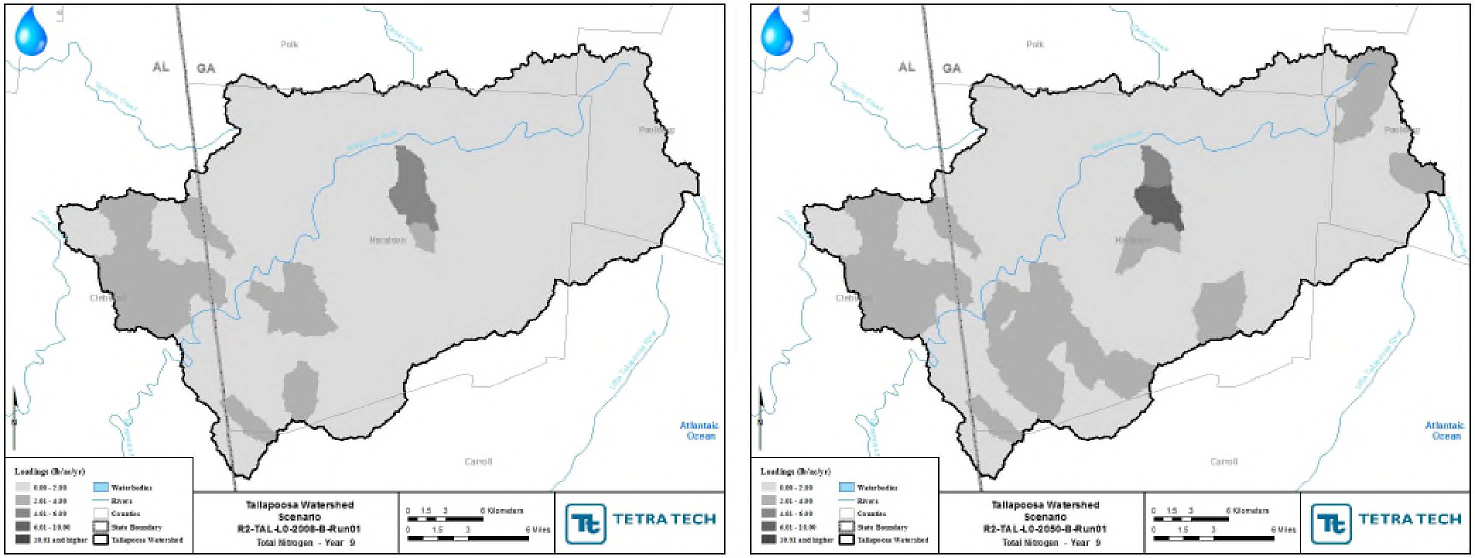

Figure 4-114 Current (left) and Future (right) Tallapoosa River Watershed Total Nitrogen loads during representative wet weather conditions

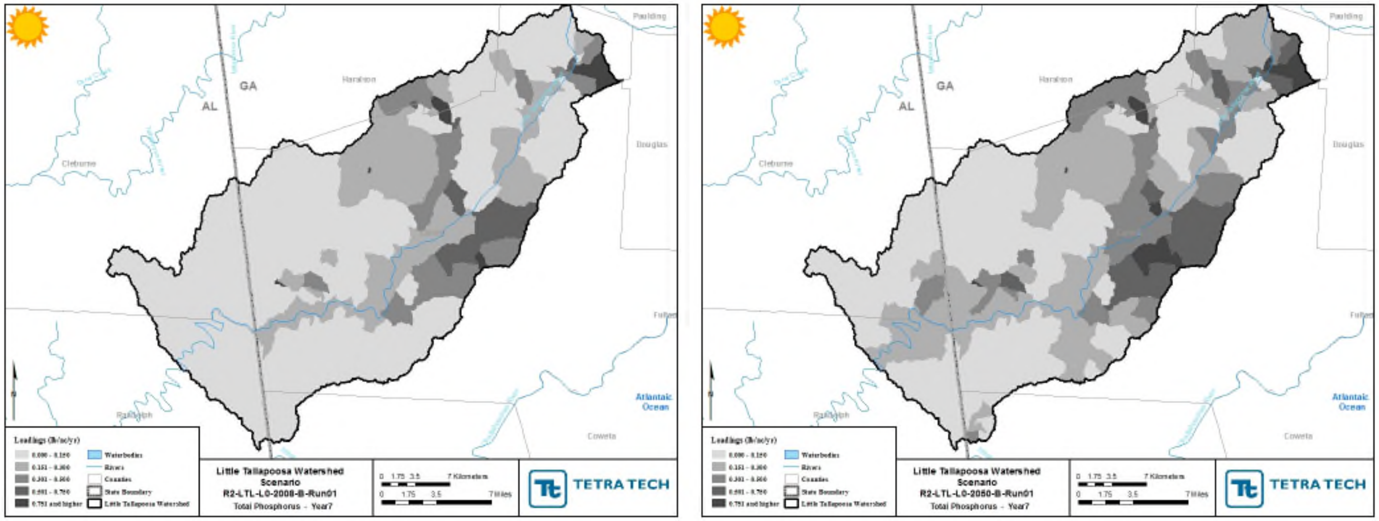

Figure 4-115 Current (left) and Future (right) Little Tallapoosa River Watershed Total Phosphorus loads during representative dry weather conditions

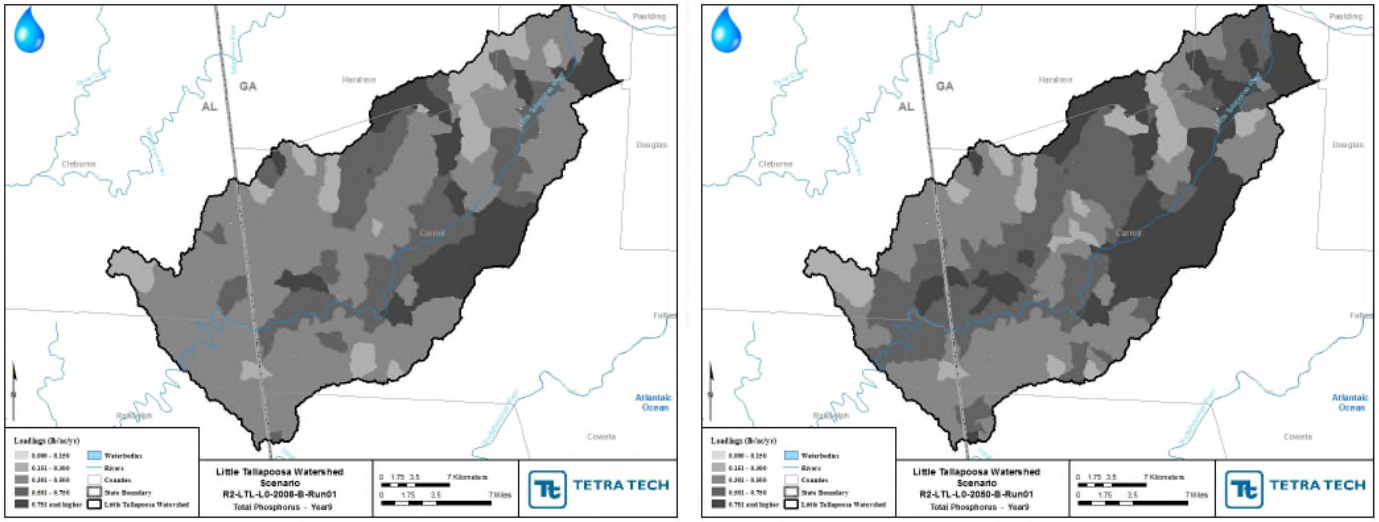

Figure 4-116 Current (left) and Future (right) Little Tallapoosa River Watershed Total Phosphorus loads during representative wet weather conditions

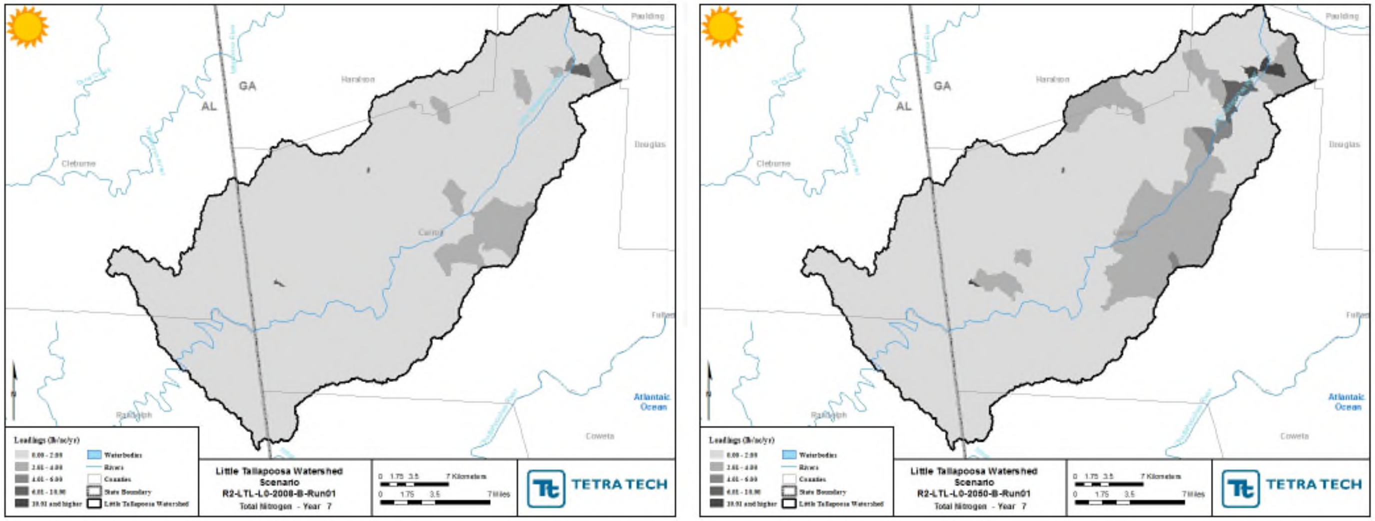

Figure 4-117 Current (left) and Future (right) Little Tallapoosa River Watershed Total Nitrogen loads during representative dry weather conditions

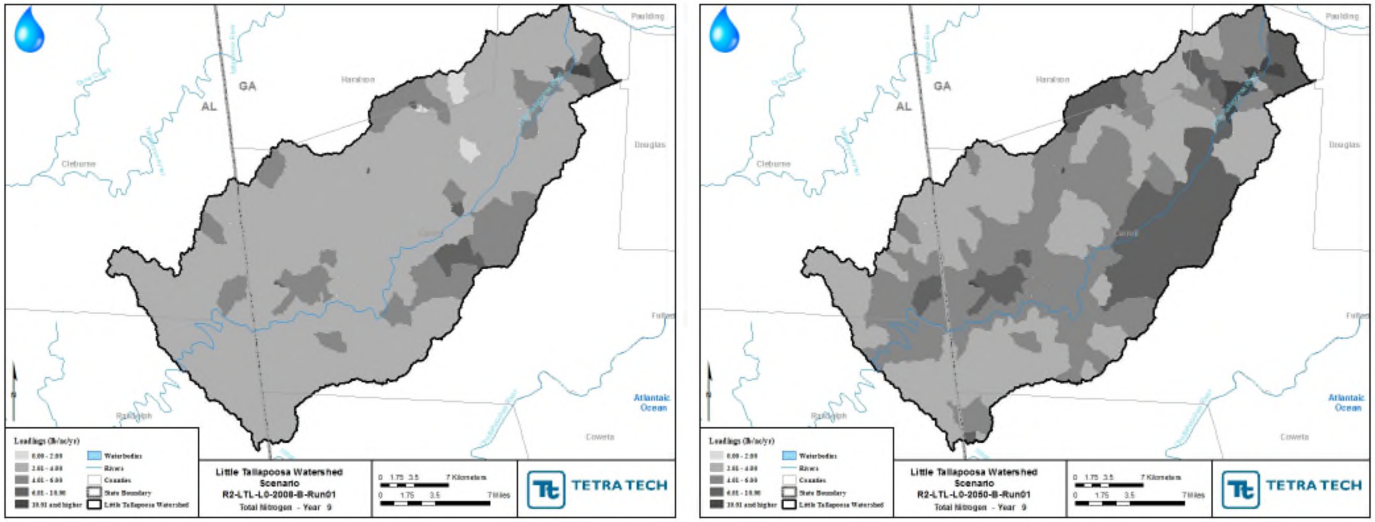

Figure 4-118 Current (left) and Future (right) Little Tallapoosa River Watershed Total Nitrogen loads during representative wet weather conditions

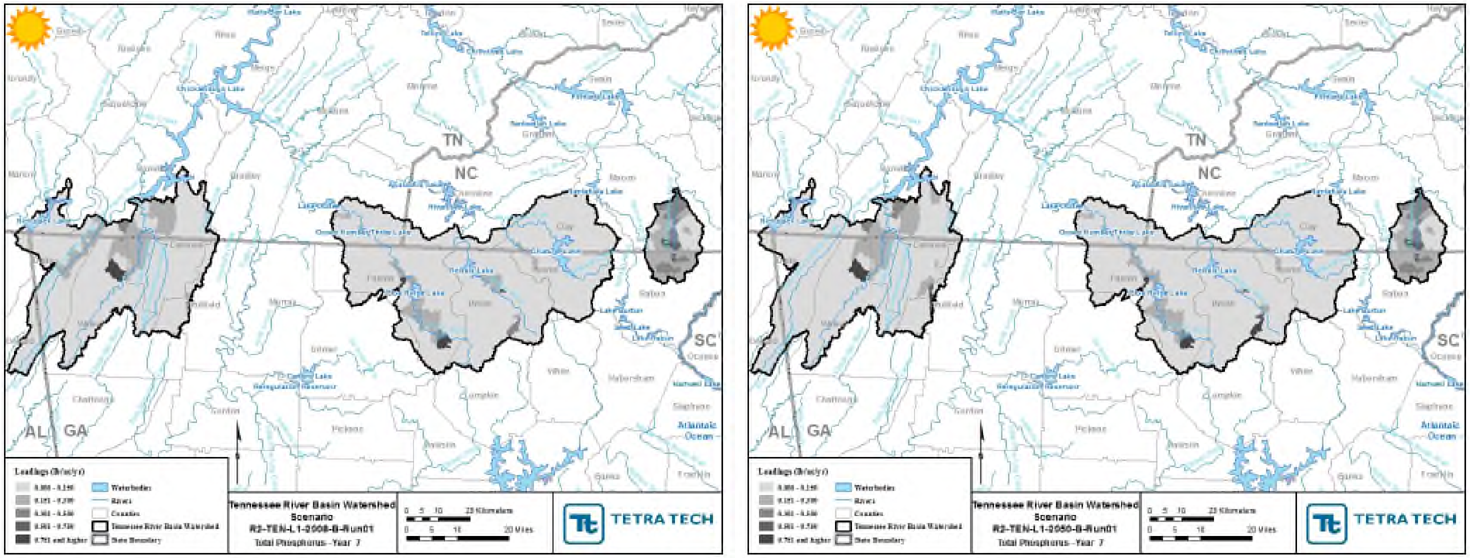

Figure 4-119 Current (left) and Future (right) Tennessee River Watershed Total Phosphorus loads during representative dry weather conditions

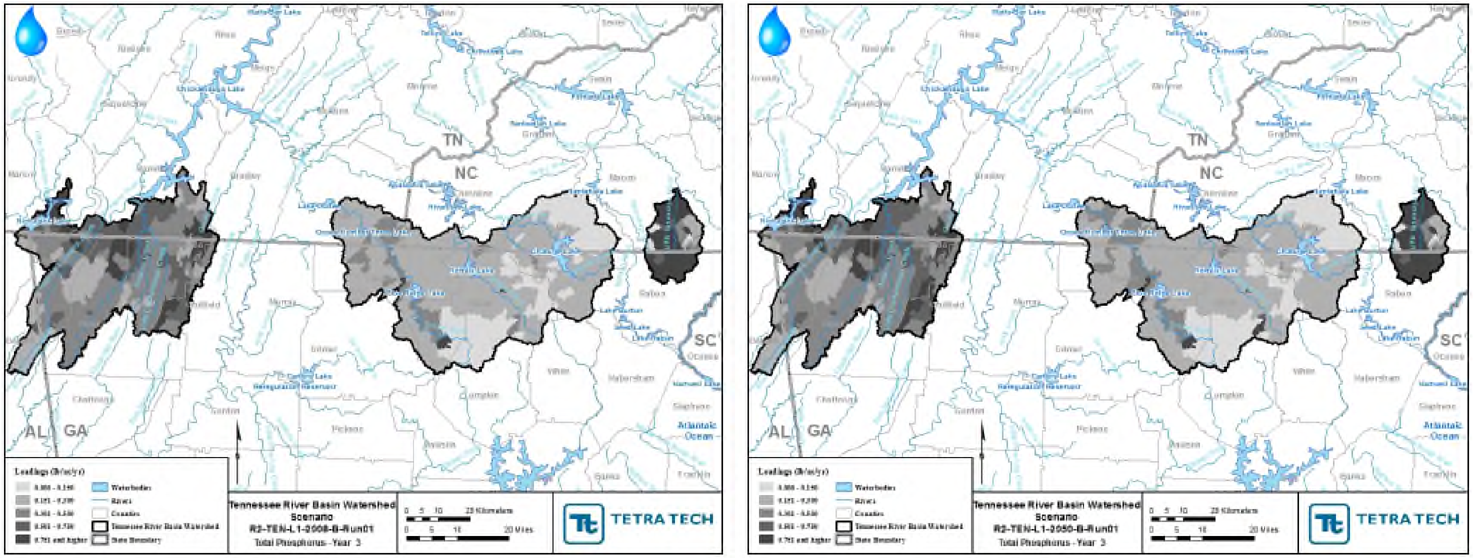

Figure 4-120 Current (left) and Future (right) Tennessee River Watershed Total Phosphorus loads during representative wet weather conditions

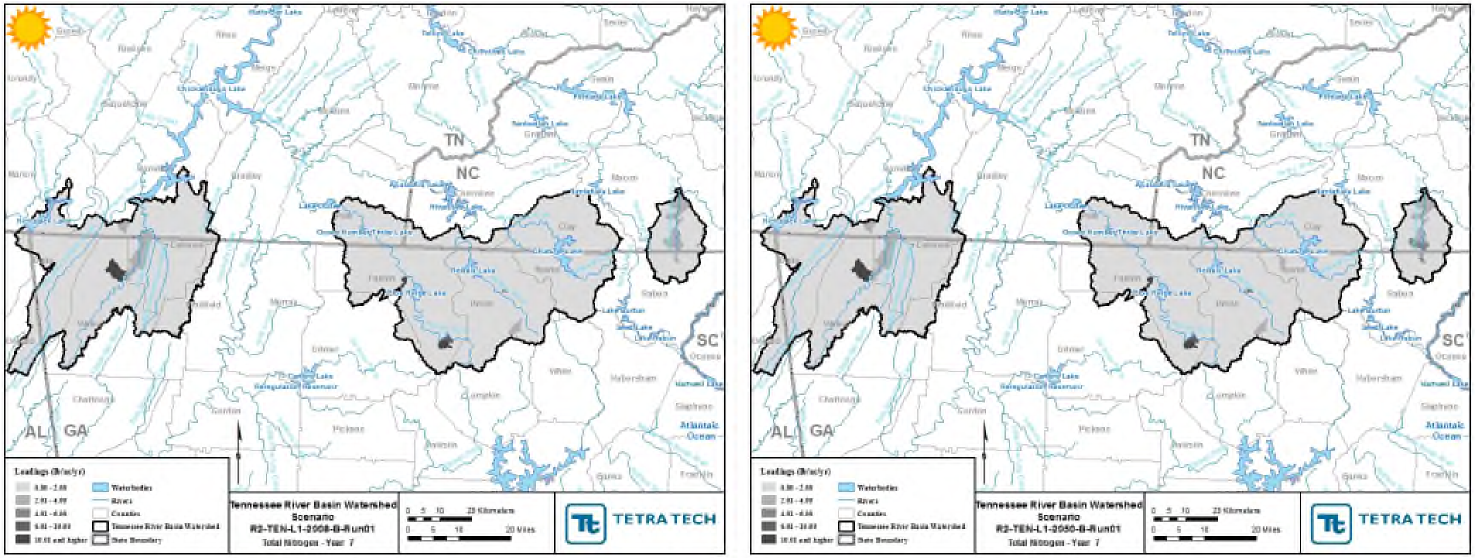

Figure 4-121 Current (left) and Future (right) Tennessee River Watershed Total Nitrogen loads during representative dry weather conditions

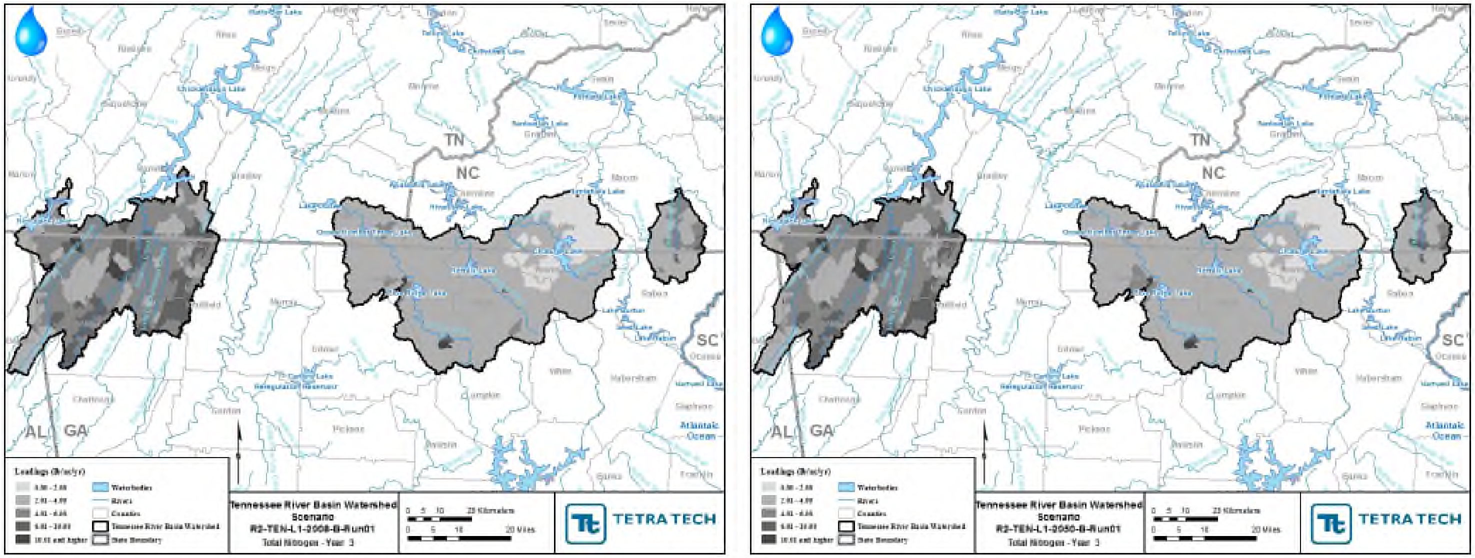

Figure 4-122 Current (left) and Future (right) Tennessee River Watershed Total Nitrogen loads during representative wet weather conditions

4.4.4. Savannah and Ogeechee River Watersheds

Watershed models were used to represent the current and future nutrient loads by subwatershed in the Lower Savannah and Ogeechee River Watersheds for representative dry and wet weather conditions. Figure 4-123 through Figure 4-130 illustrate current and future TP and TN loads by subwatershed. Appendices S and T present the nutrient loads by subwatershed (Lower Savannah River and Ogeechee River, respectively) for TP, TN, and BOD for each year for each modeled scenario.

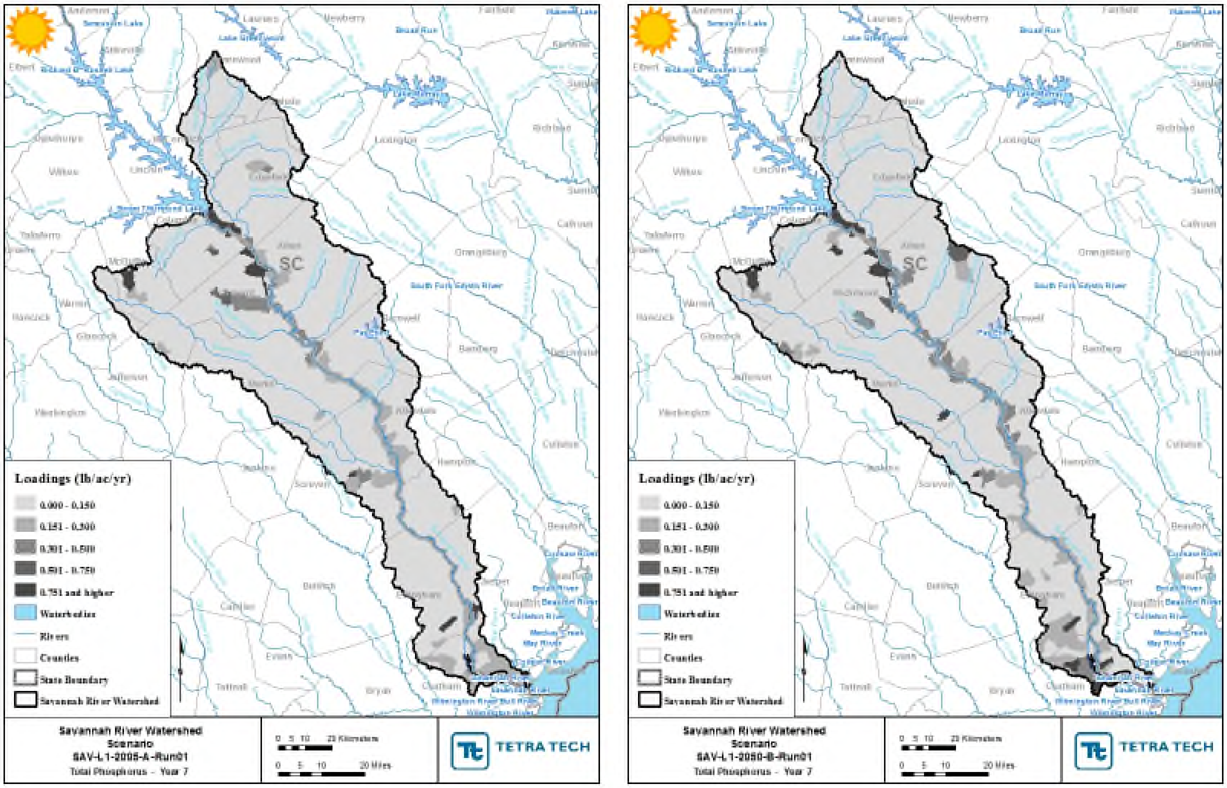

Figure 4-123 Current (left) and Future (right) Lower Savannah River Watershed Total Phosphorus loads during representative dry weather conditions

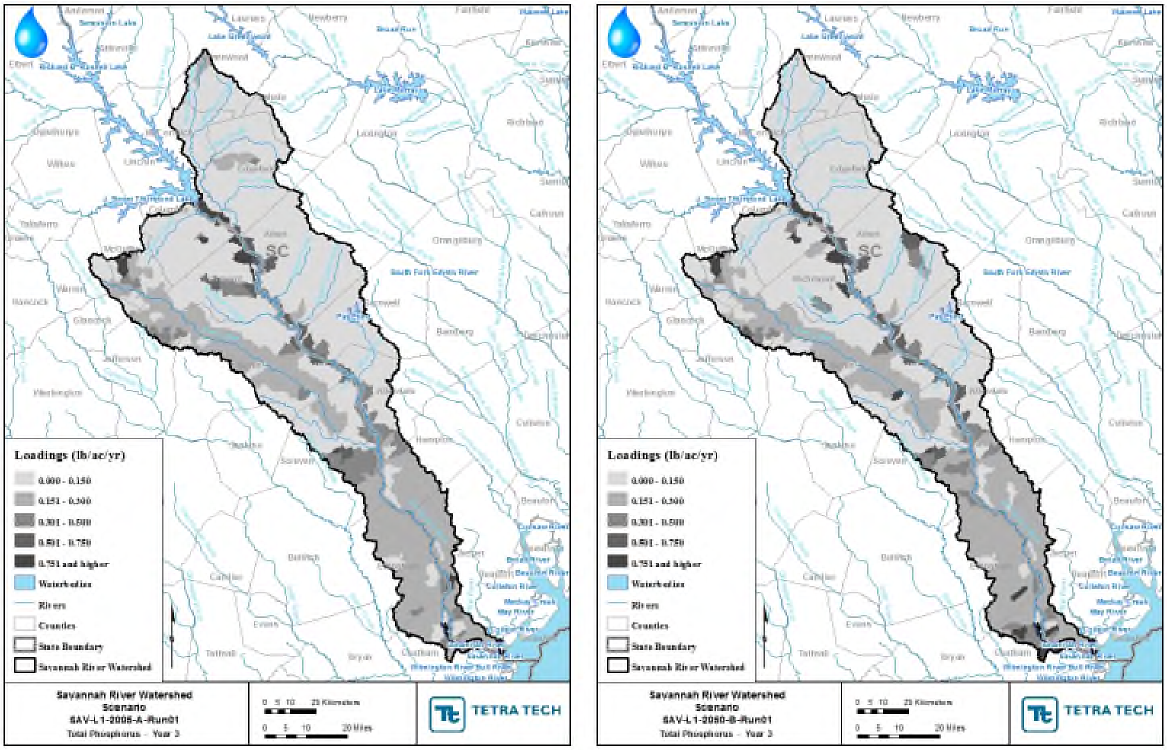

Figure 4-124 Current (left) and Future (right) Lower Savannah River Watershed Total Phosphorus loads during representative wet weather conditions

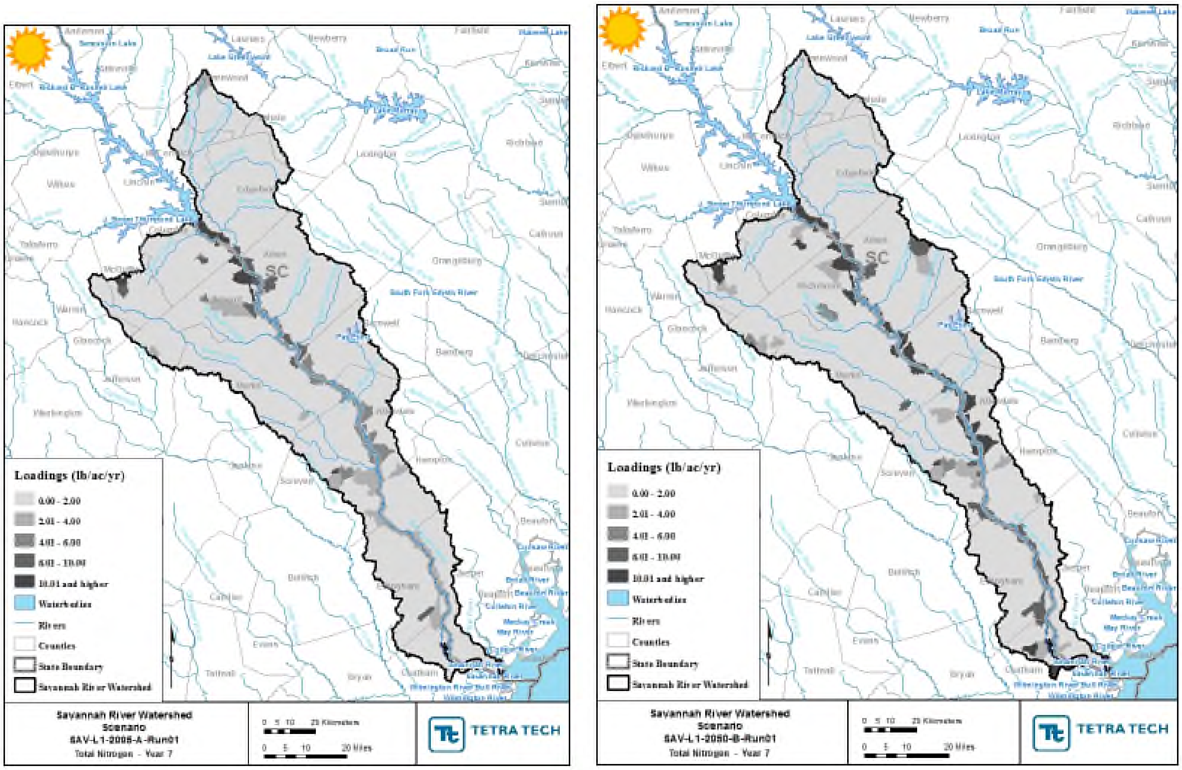

Figure 4-125 Current (left) and Future (right) Lower Savannah River Watershed Total Nitrogen loads during representative dry weather conditions

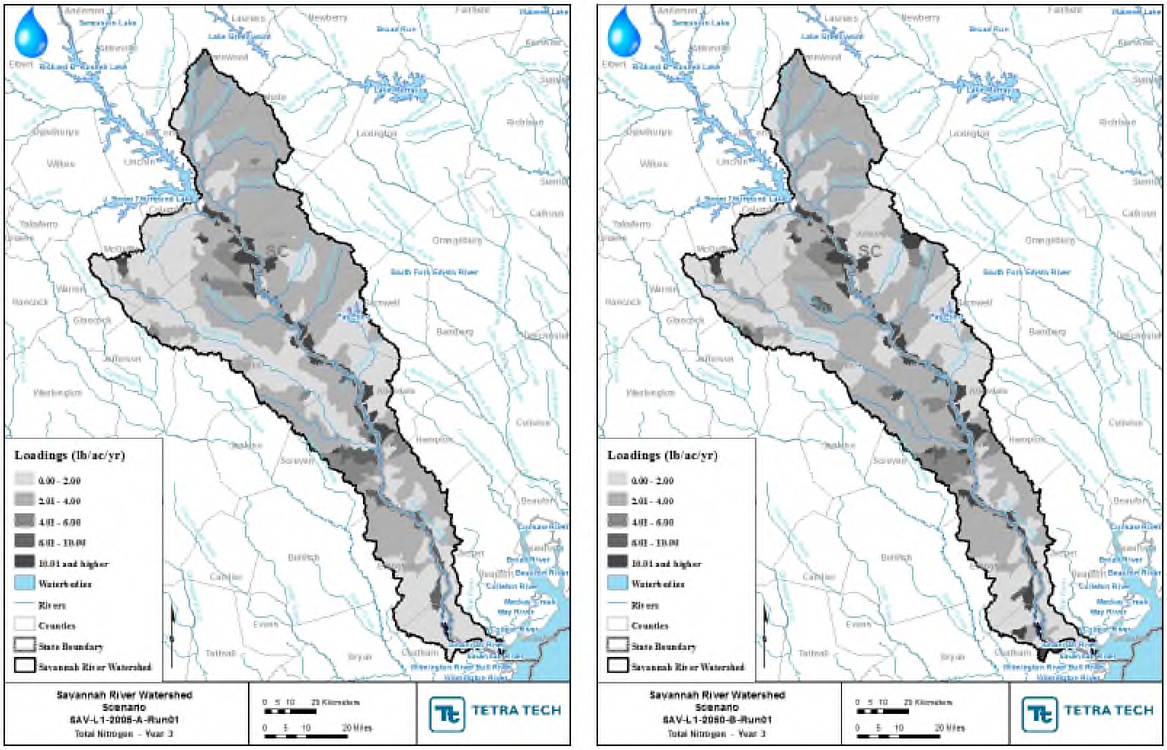

Figure 4-126 Current (left) and Future (right) Lower Savannah River Watershed Total Nitrogen loads during representative wet weather conditions

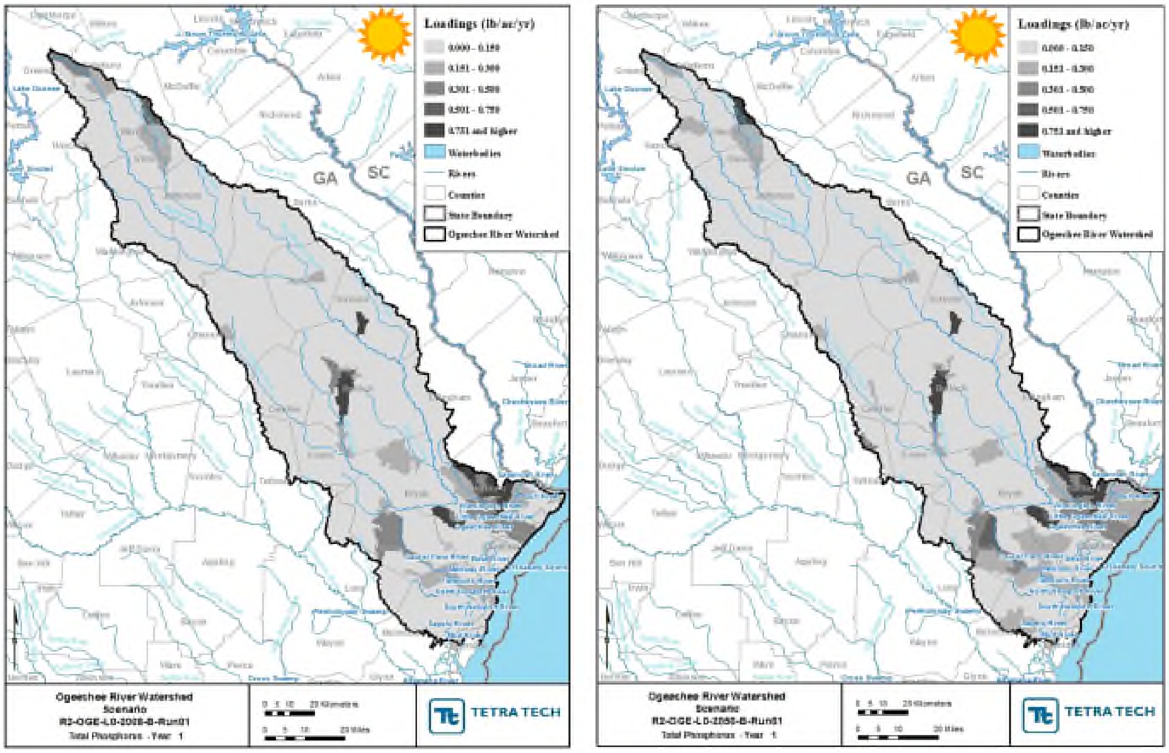

Figure 4-127 Current (left) and Future (right) Ogeechee River Watershed Total Phosphorus loads during representative dry weather conditions

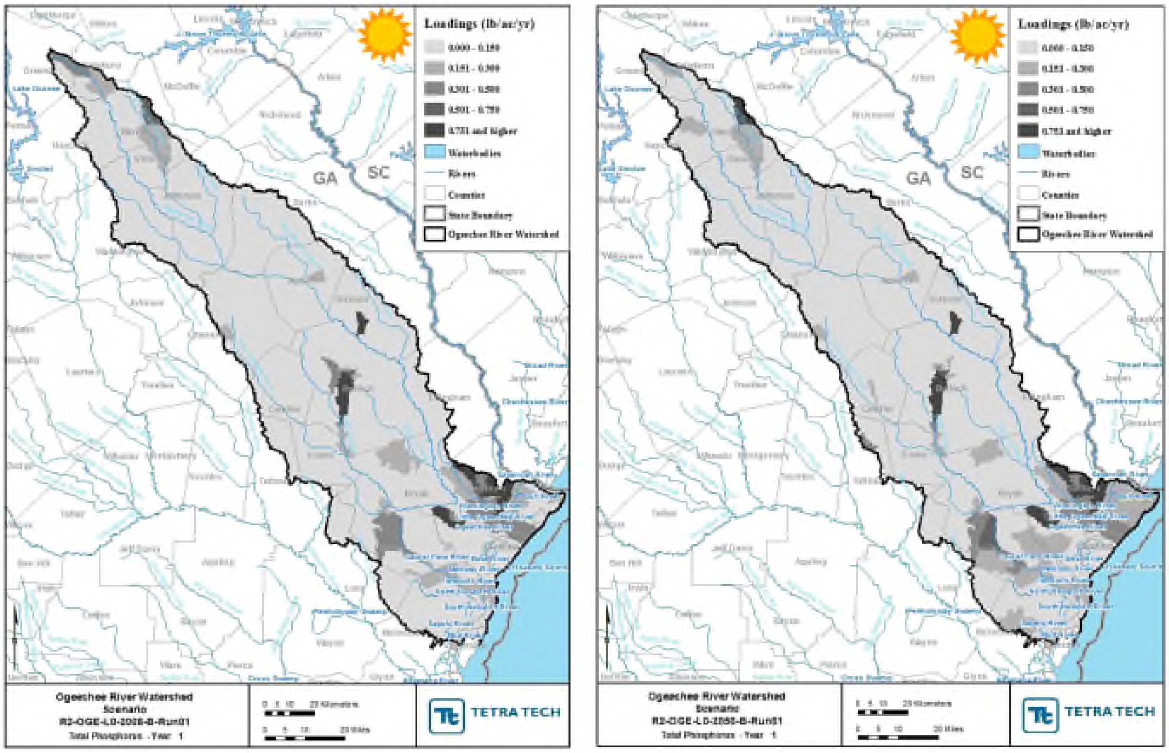

Figure 4-128 Current (left) and Future (right) Ogeechee River Watershed Total Phosphorus loads during representative wet weather conditions

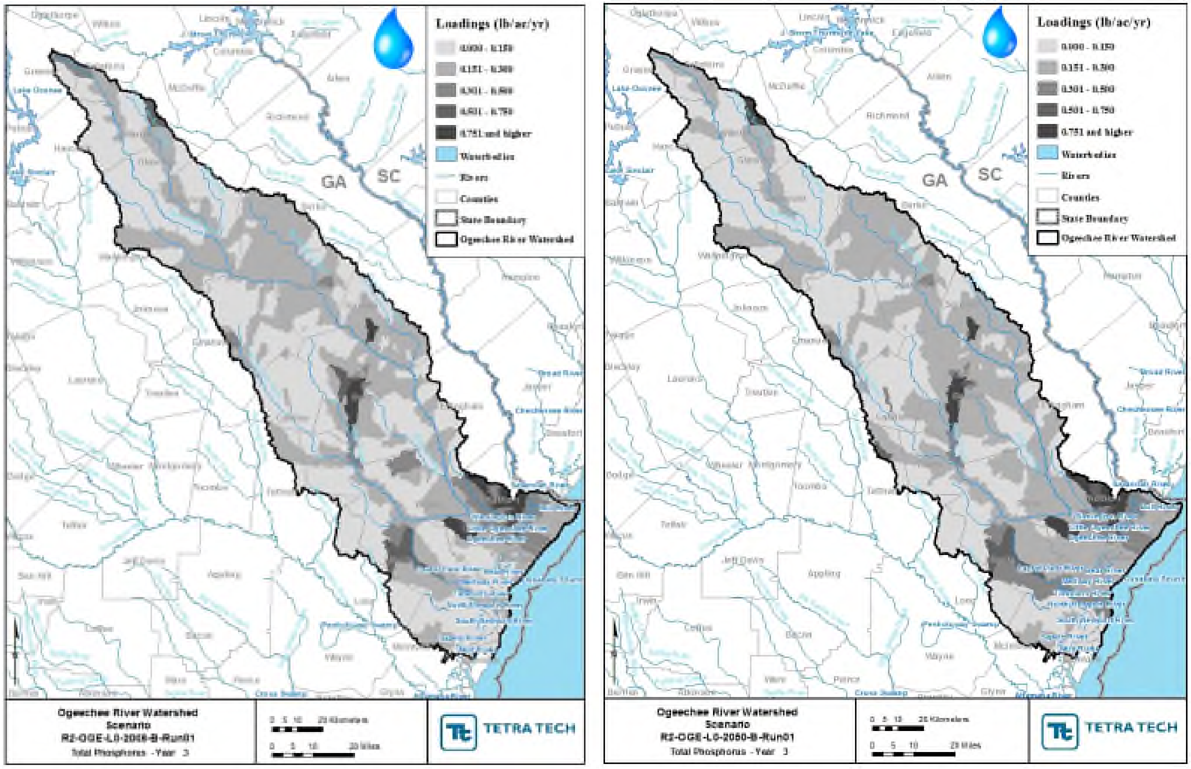

Figure 4-129 Current (left) and Future (right) Ogeechee River Watershed Total Nitrogen loads during representative dry weather conditions

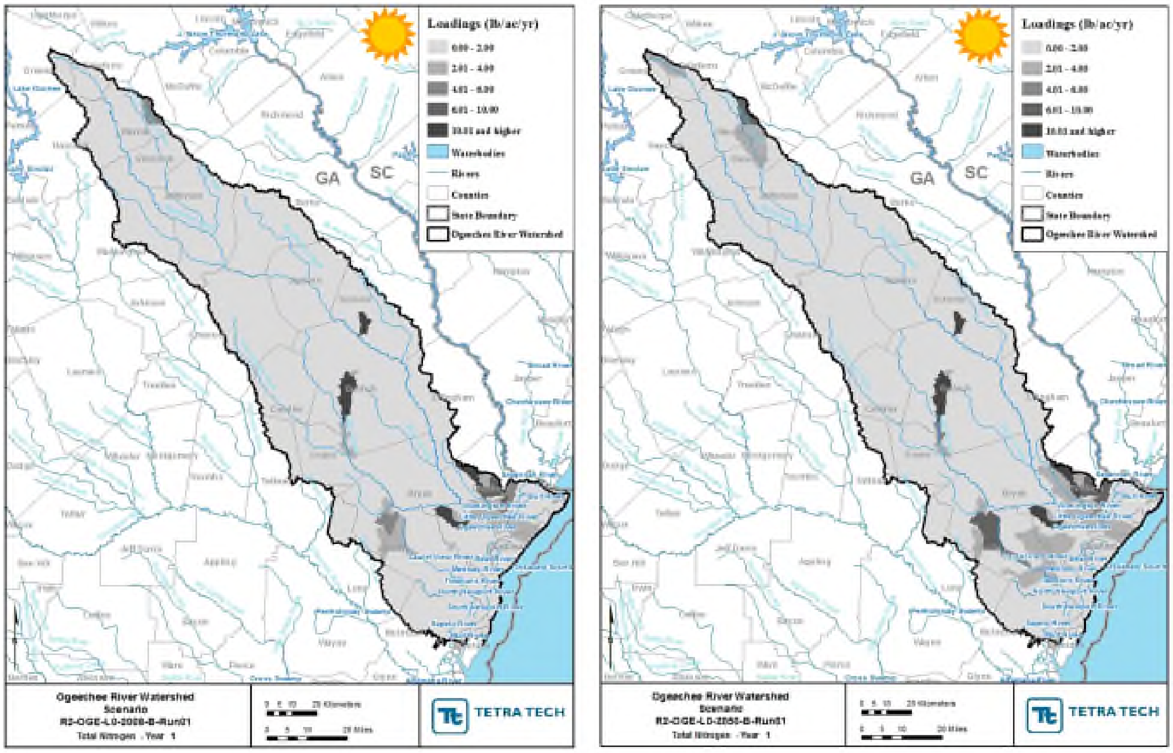

Figure 4-130 Current (left) and Future (right) Ogeechee River Watershed Total Nitrogen loads during representative wet weather conditions

4.4.5. Oconee, Ocmulgee, and Altamaha River Watersheds

Results from the watershed models for the Oconee, Ocmulgee, and Altamaha River Watersheds were used to represent the current and future nutrient loads by subwatersheds for representative dry and wet weather conditions. Figure 4-131 through Figure 4-142 illustrate current and future TP and TN loads by subwatershed. Appendices P, Q, and R present the nutrient loads by subwatershed (Upper Oconee River, Upper Ocmulgee River, and Altamaha River, respectively) for TP, TN, and BOD for each year for each modeled scenario.

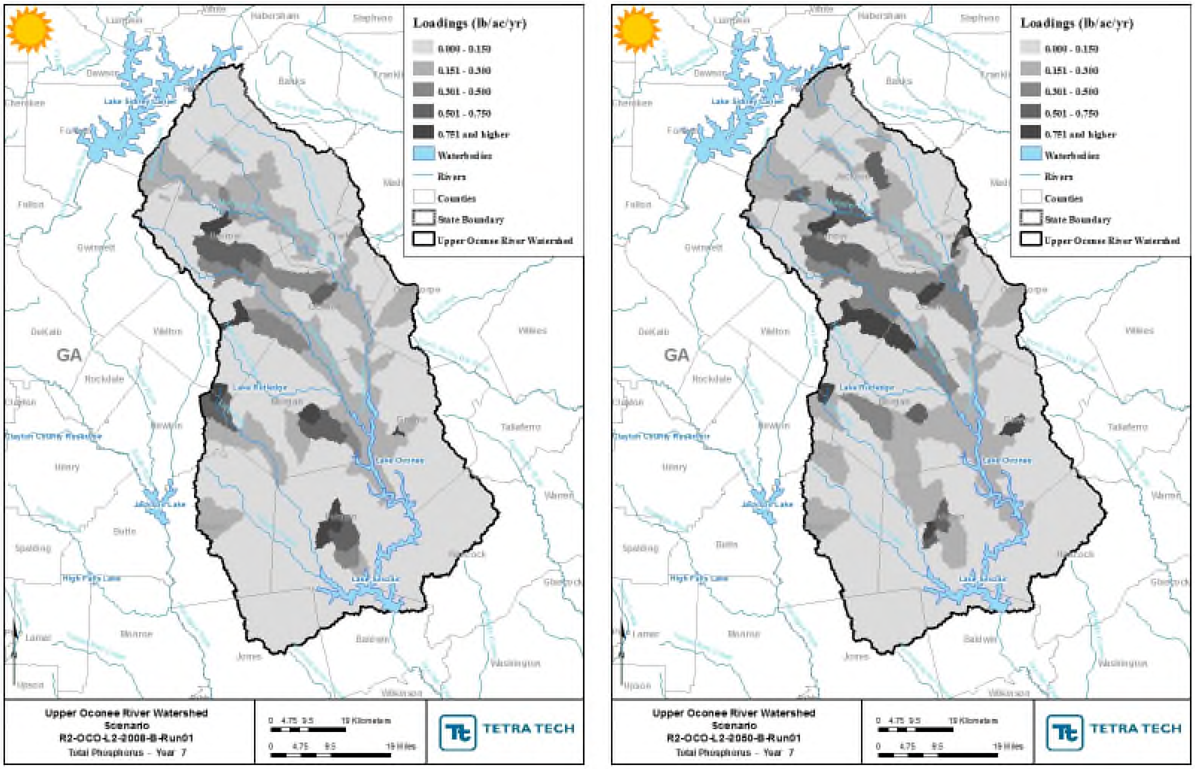

Figure 4-131 Current (left) and Future (right) Upper Oconee River Watershed Total Phosphorus loads during representative dry weather conditions

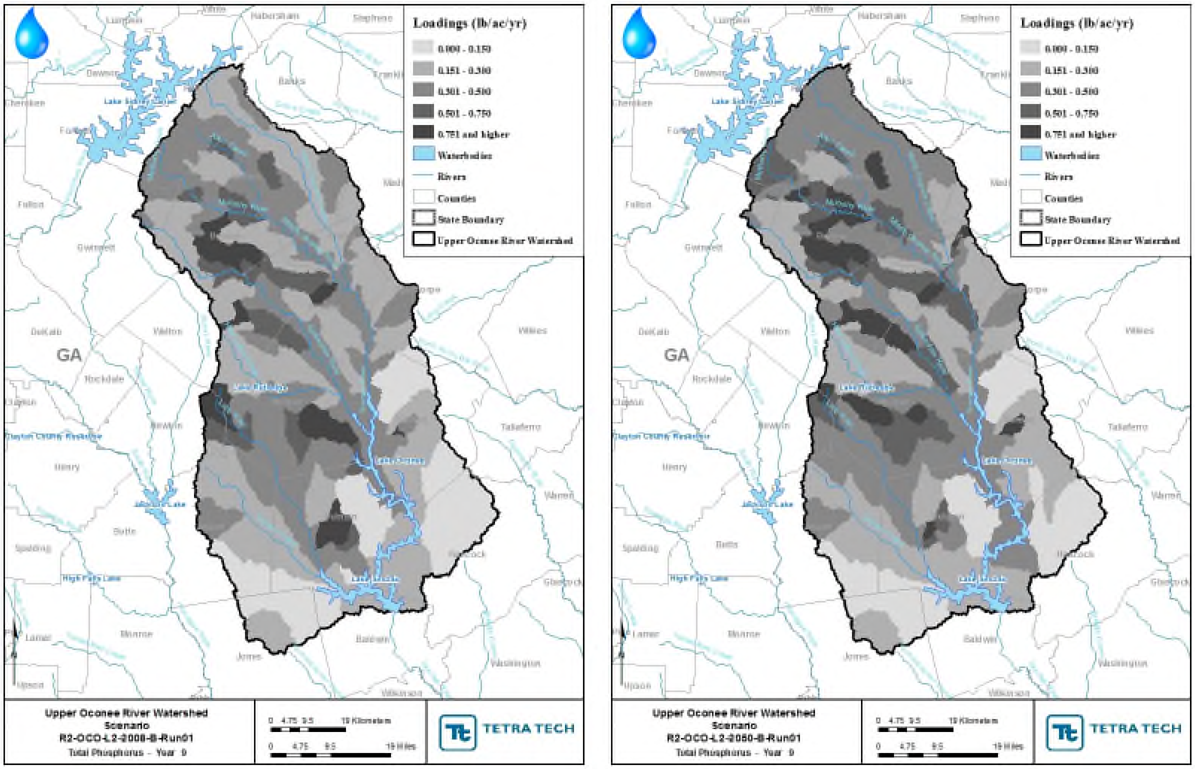

Figure 4-132 Current (left) and Future (right) Upper Oconee River Watershed Total Phosphorus loads during representative wet weather conditions

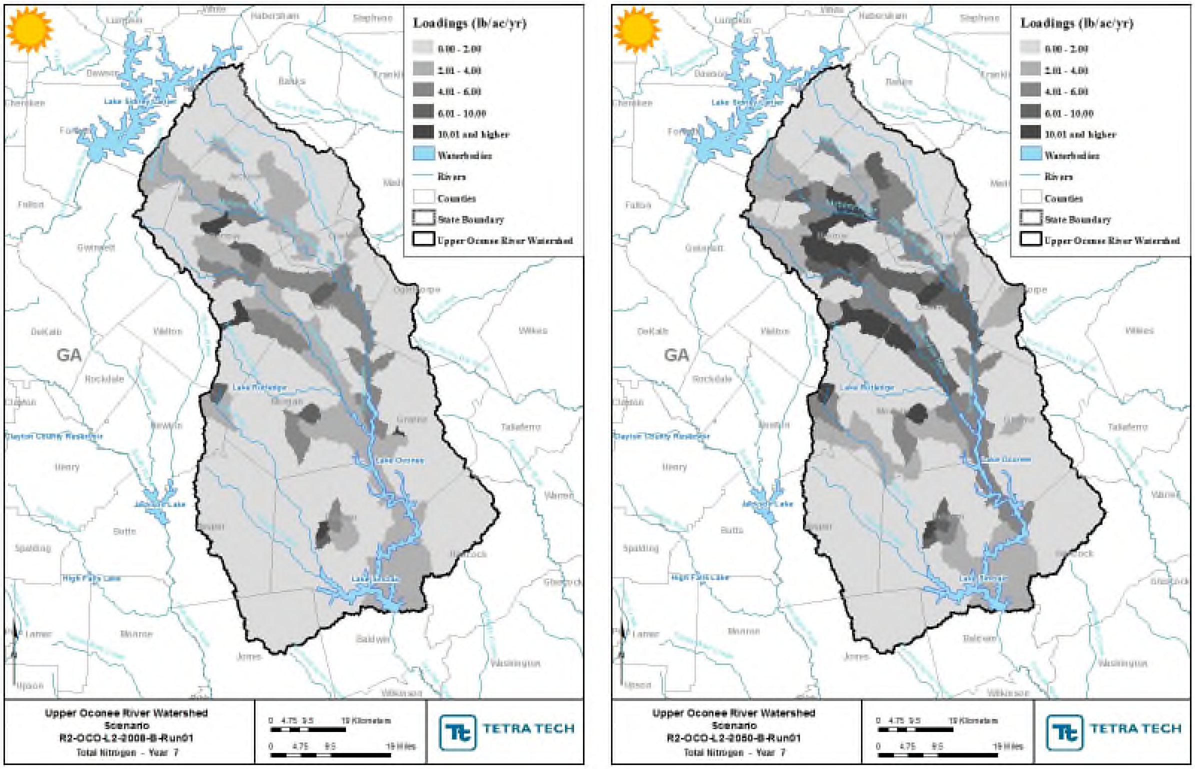

Figure 4-133 Current (left) and Future (right) Upper Oconee River Watershed Total Nitrogen loads during representative dry weather conditions

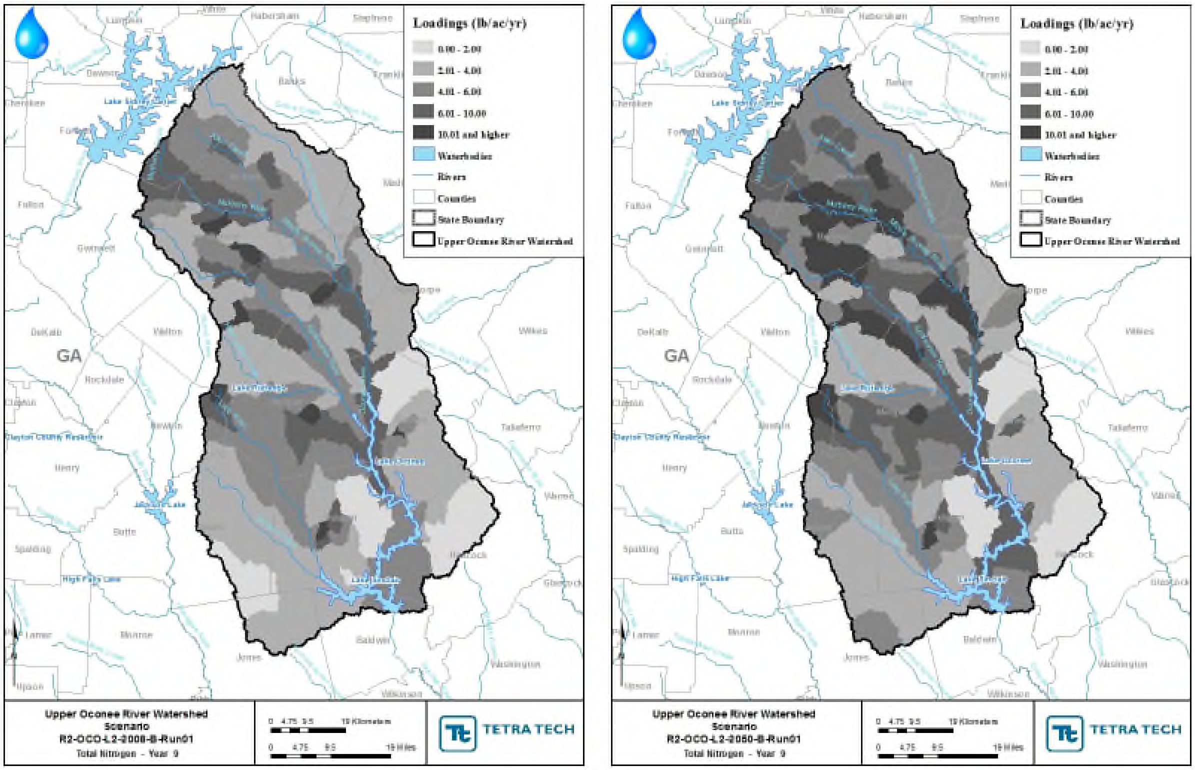

Figure 4-134 Current (left) and Future (right) Upper Oconee River Watershed Total Nitrogen loads during representative wet weather conditions

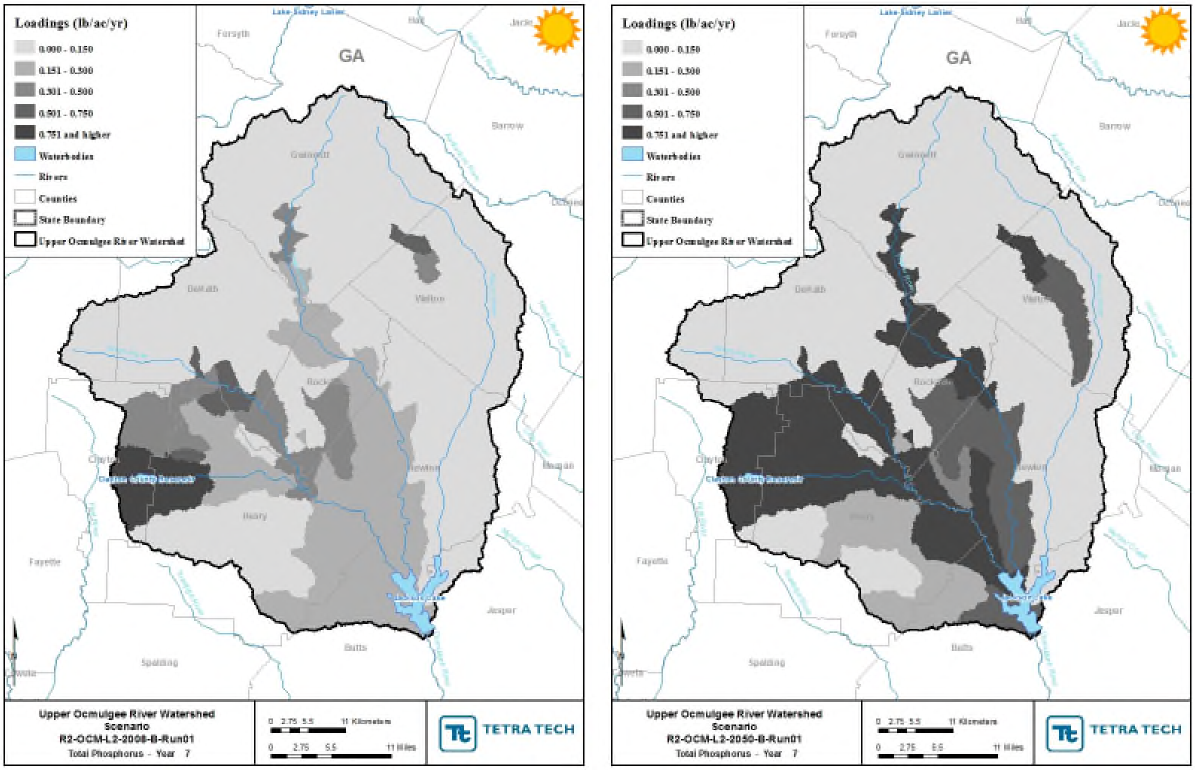

Figure 4-135 Current (left) and Future (right) Upper Ocmulgee River Watershed Total Phosphorus loads during representative dry weather conditions

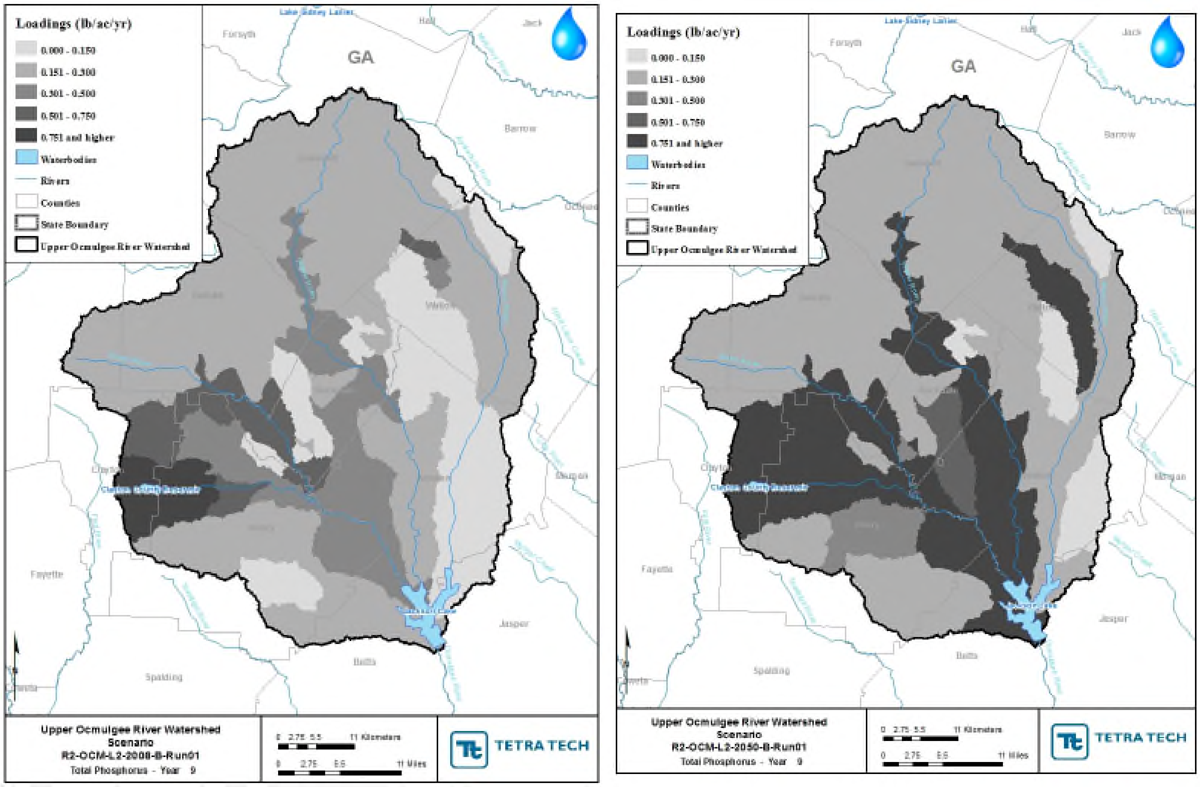

Figure 4-136 Current (left) and Future (right) Upper Ocmulgee River Watershed Total Phosphorus loads during representative wet weather conditions

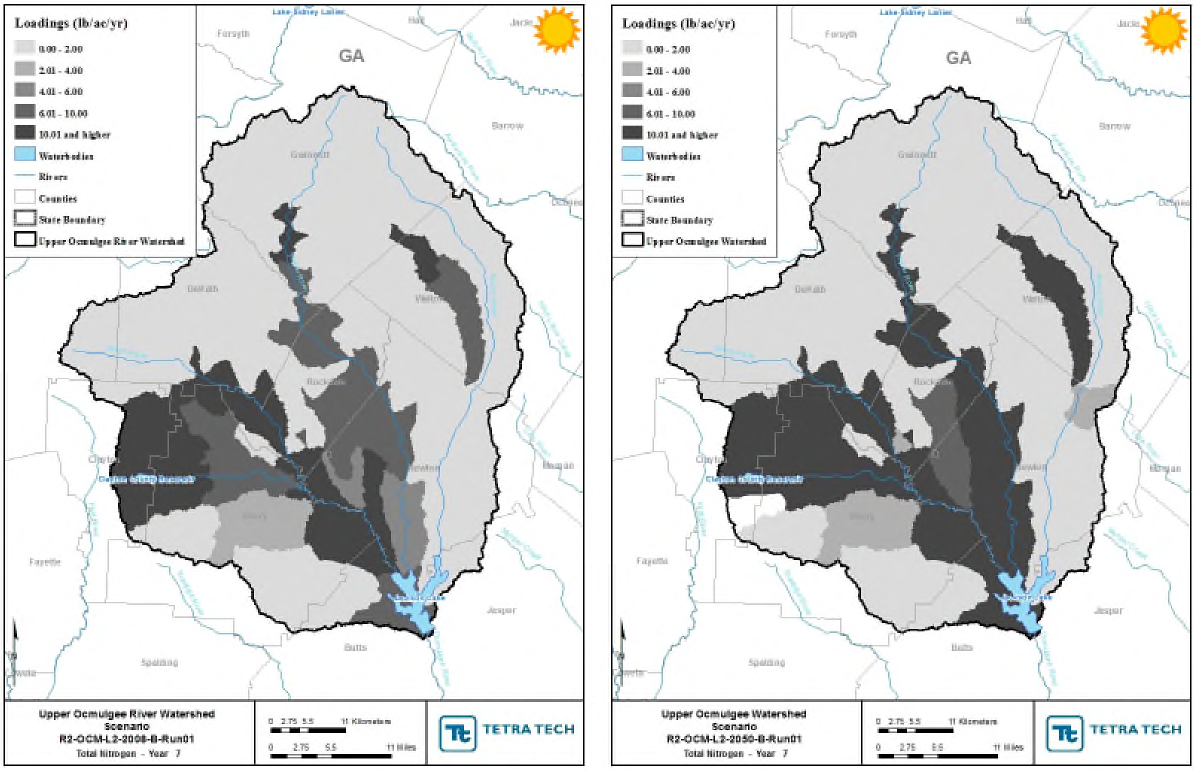

Figure 4-137 Current (left) and Future (right) Upper Ocmulgee River Watershed Total Nitrogen loads during representative dry weather conditions

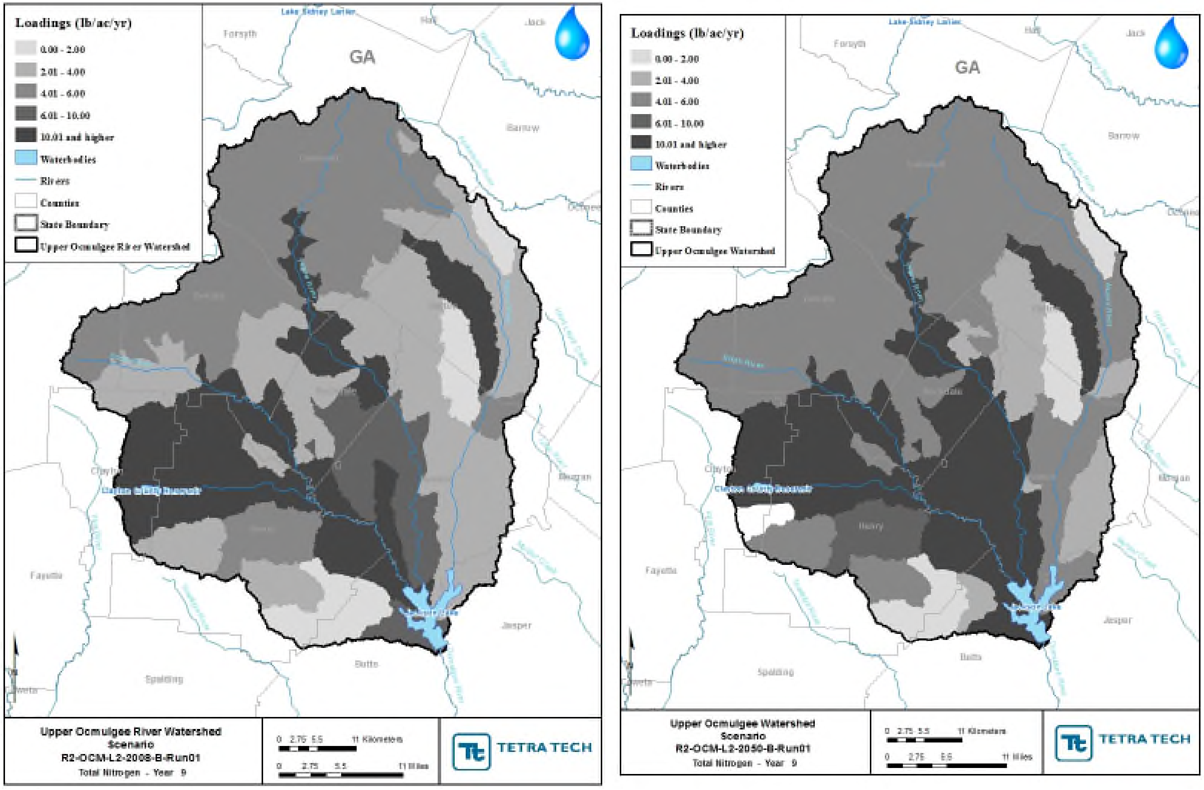

Figure 4-138 Current (left) and Future (right) Upper Ocmulgee River Watershed Total Nitrogen loads during representative wet weather conditions

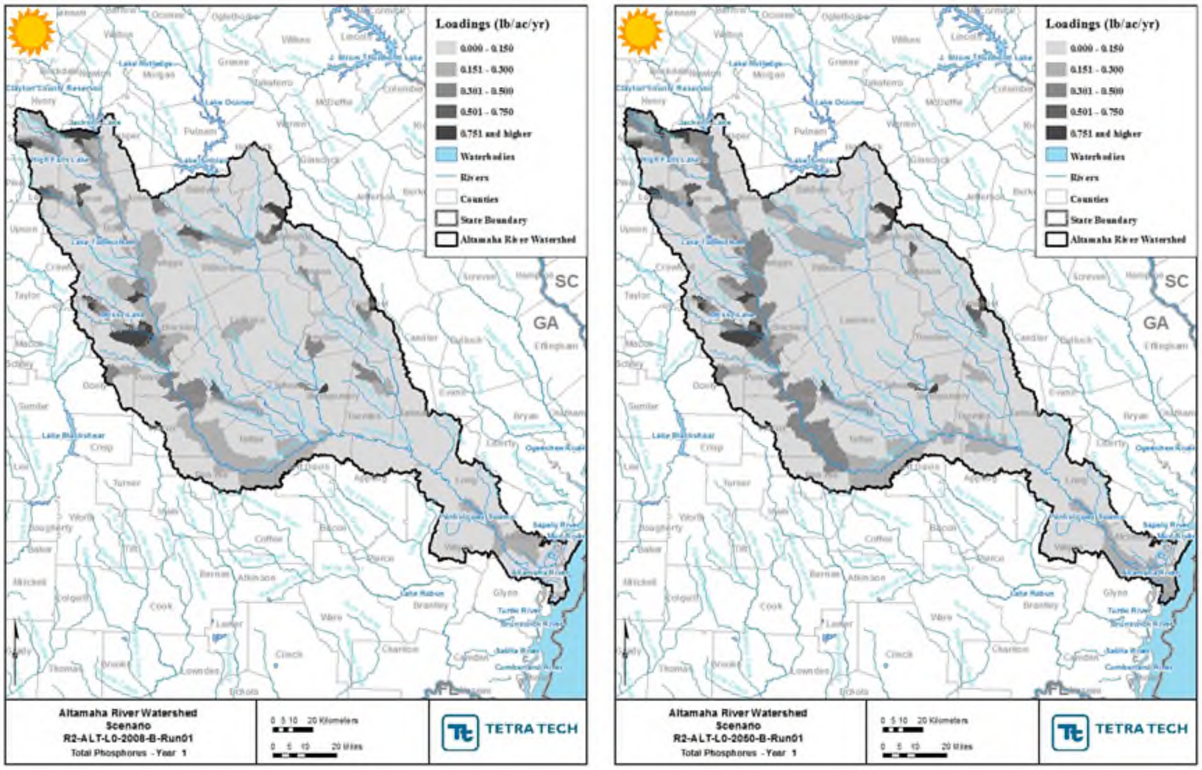

Figure 4-139 Current (left) and Future (right) Altamaha River Watershed Total Phosphorus loads during representative dry weather conditions

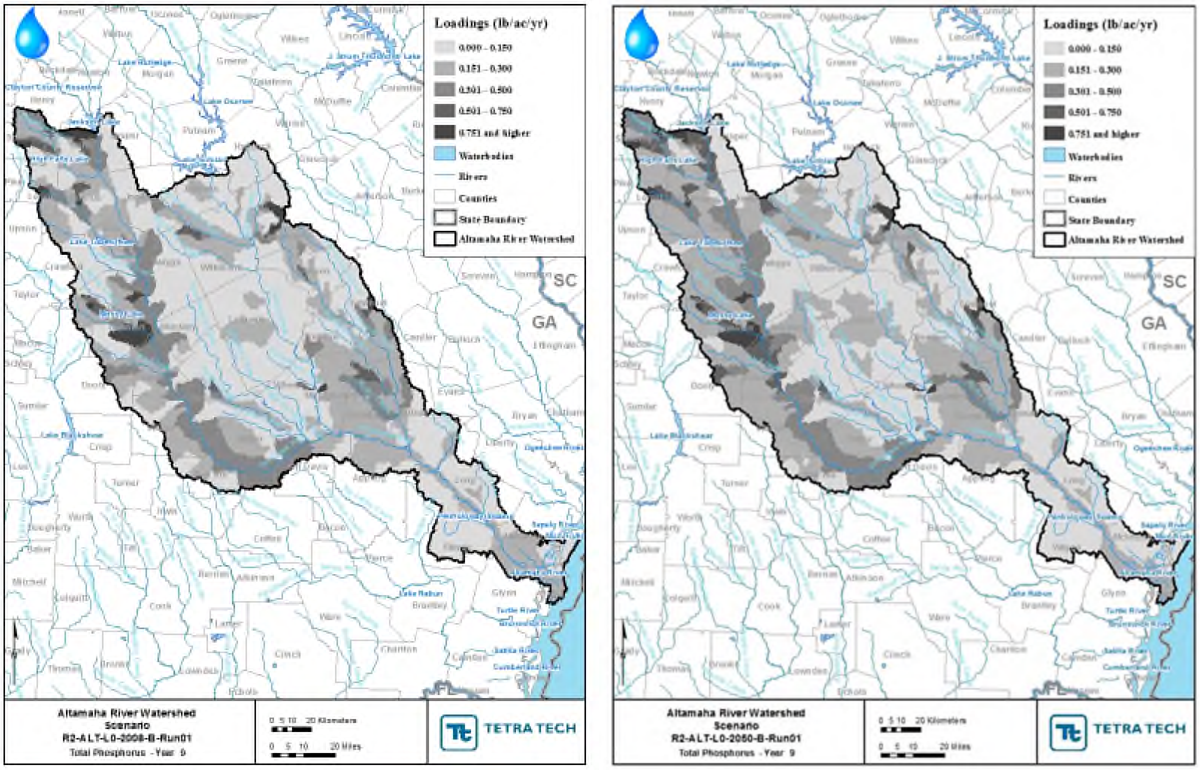

Figure 4-140 Current (left) and Future (right) Altamaha River Watershed Total Phosphorus loads during representative wet weather conditions

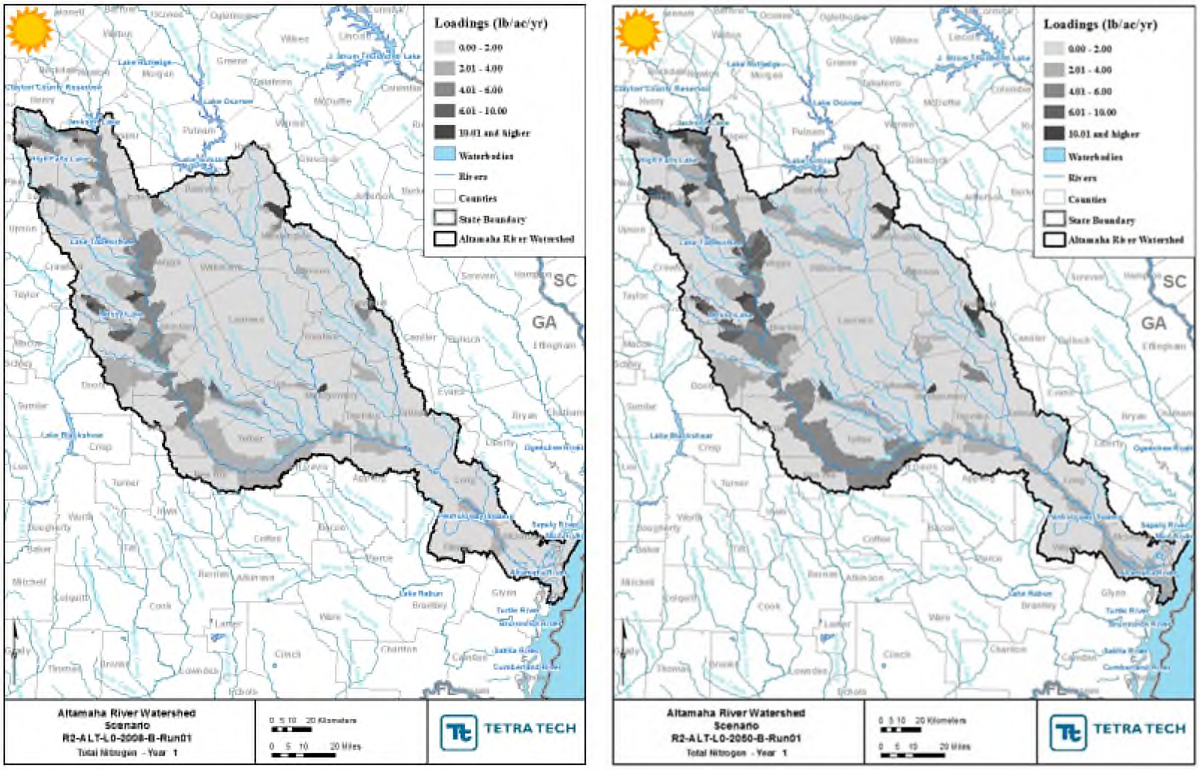

Figure 4-141 Current (left) and Future (right) Altamaha River Watershed Total Nitrogen loads during representative dry weather conditions

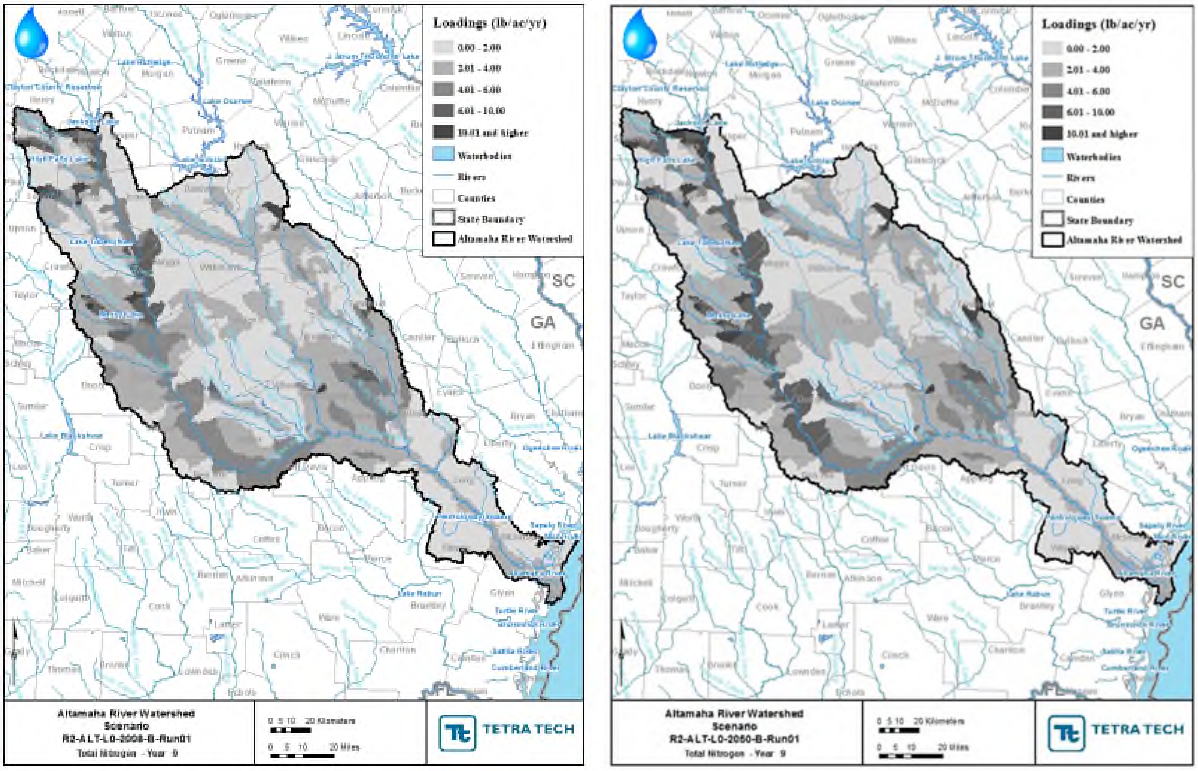

Figure 4-142 Current (left) and Future (right) Altamaha River Watershed Total Nitrogen loads during representative wet weather conditions

4.4.6. Suwannee, Satilla, and St. Mary's River Watersheds

Watershed models were used to represent the current and future nutrient loads by subwatershed in the Suwannee, Satilla, and St. Mary's River Watersheds for representative dry and wet weather conditions. Figure 4-143 through Figure 4-154 illustrate current and future TP and TN loads by subwatershed. Appendices U, V and W present the nutrient loads by subwatershed (Suwannee, Satilla, and St. Mary's, respectively) for TP, TN, and BOD for each year for each modeled scenario.

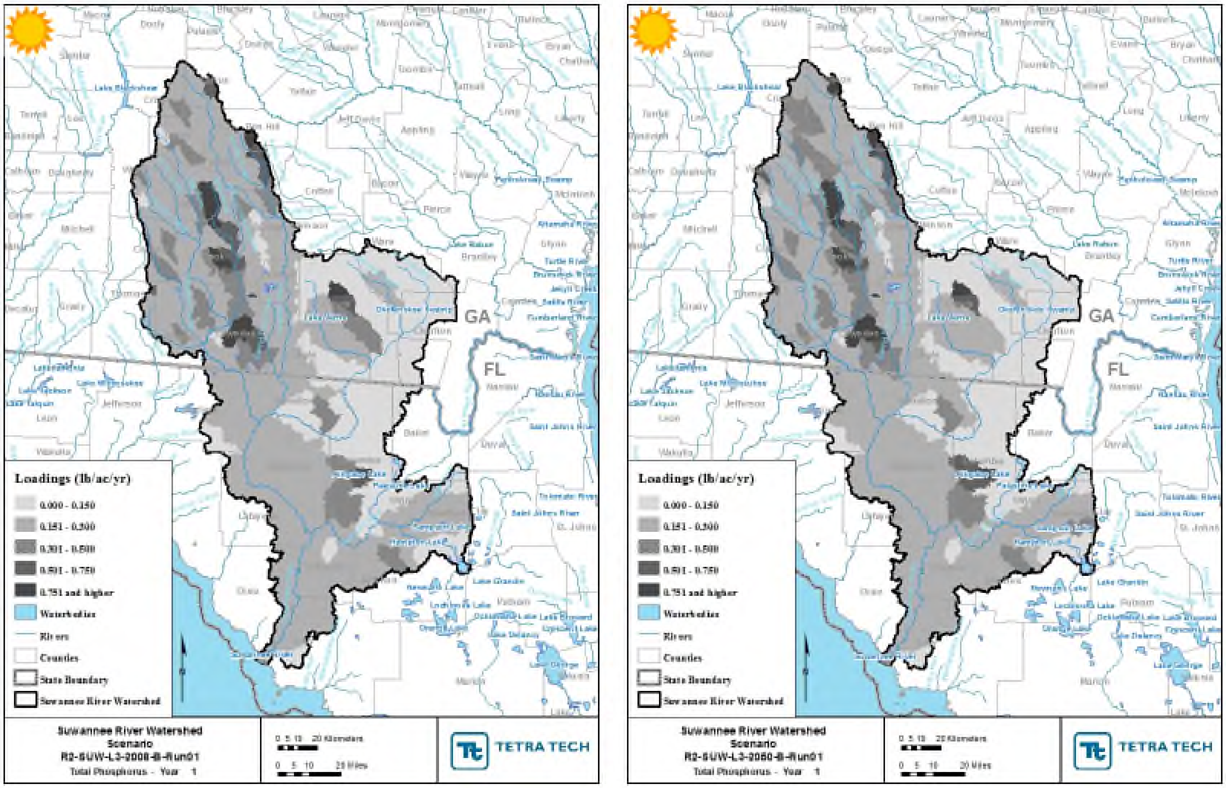

Figure 4-143 Current (left) and Future (right) Suwannee River Watershed Total Phosphorus loads during representative dry weather conditions

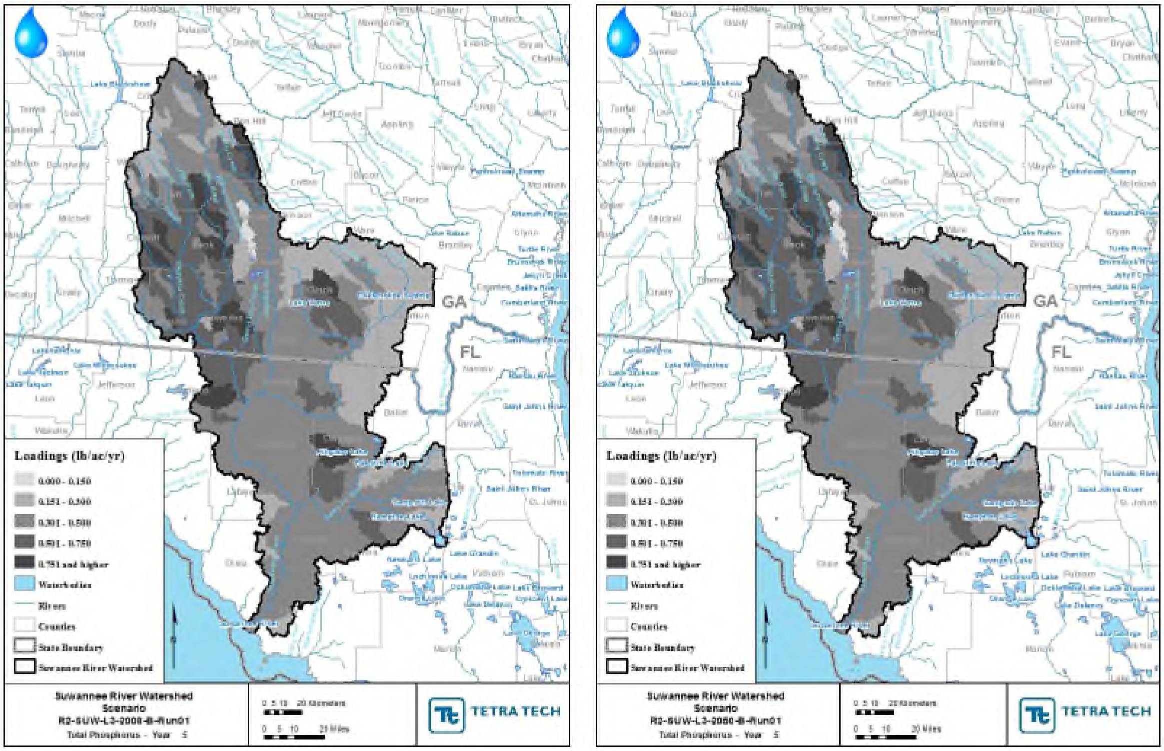

Figure 4-144 Current (left) and Future (right) Suwannee River Watershed Total Phosphorus loads during representative wet weather conditions

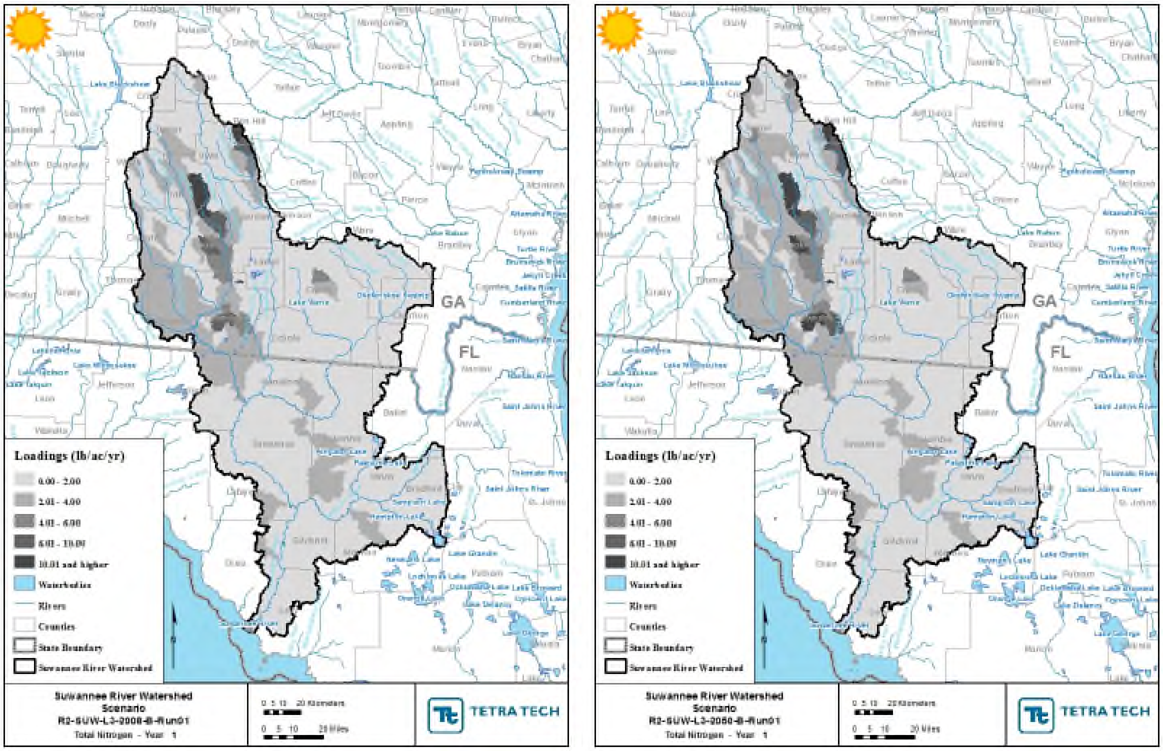

Figure 4-145 Current (left) and Future (right) Suwannee River Watershed Total Nitrogen loads during representative dry weather conditions

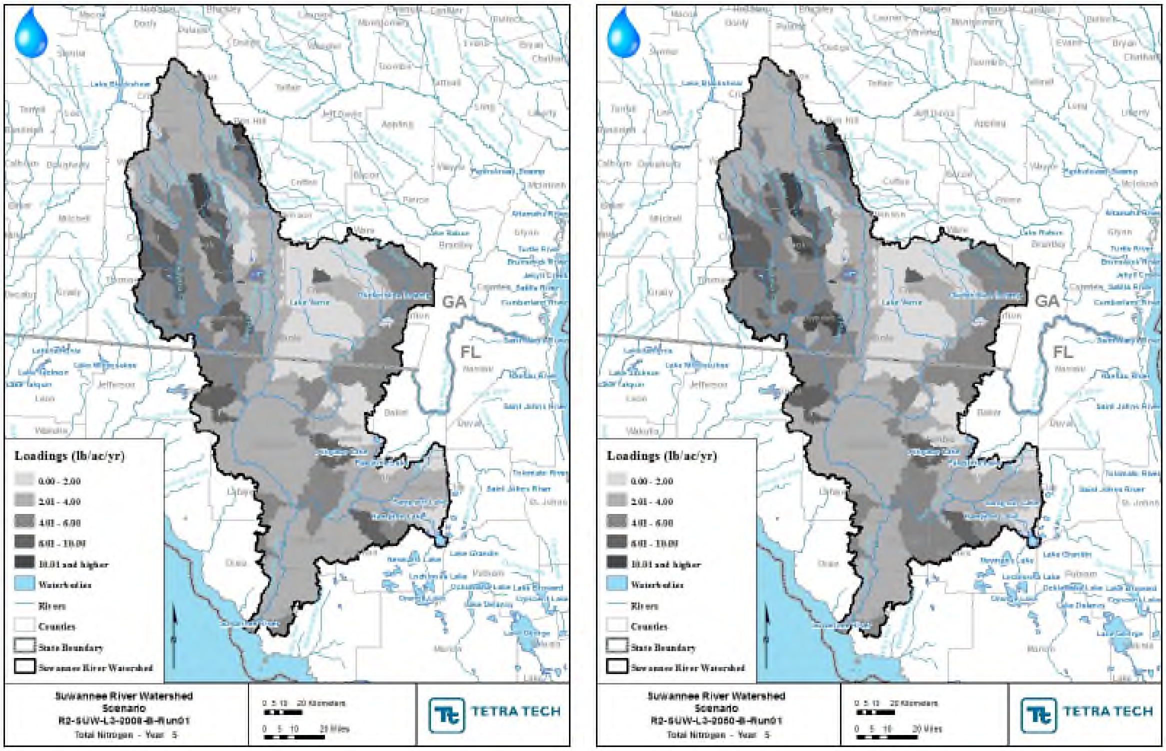

Figure 4-146 Current (left) and Future (right) Suwannee River Watershed Total Nitrogen loads during representative wet weather conditions

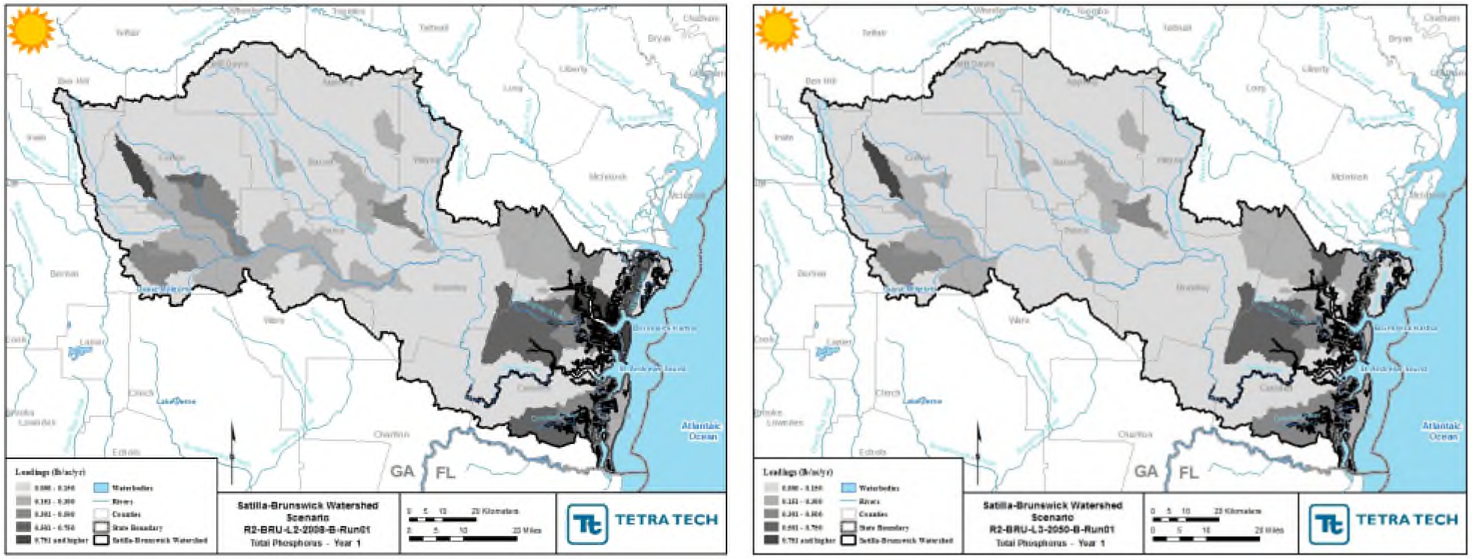

Figure 4-147 Current (left) and Future (right) Satilla River Watershed Total Phosphorus loads during representative dry weather conditions

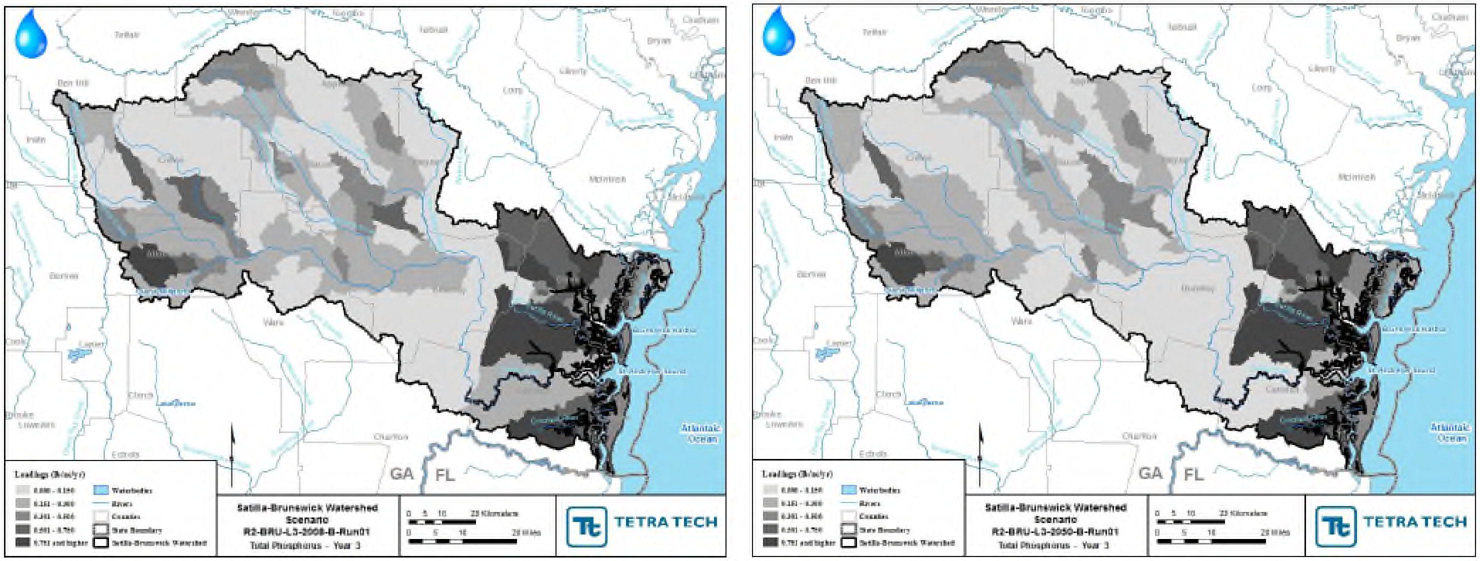

Figure 4-148 Current (left) and Future (right) Satilla River Watershed Total Phosphorus loads during representative wet weather conditions

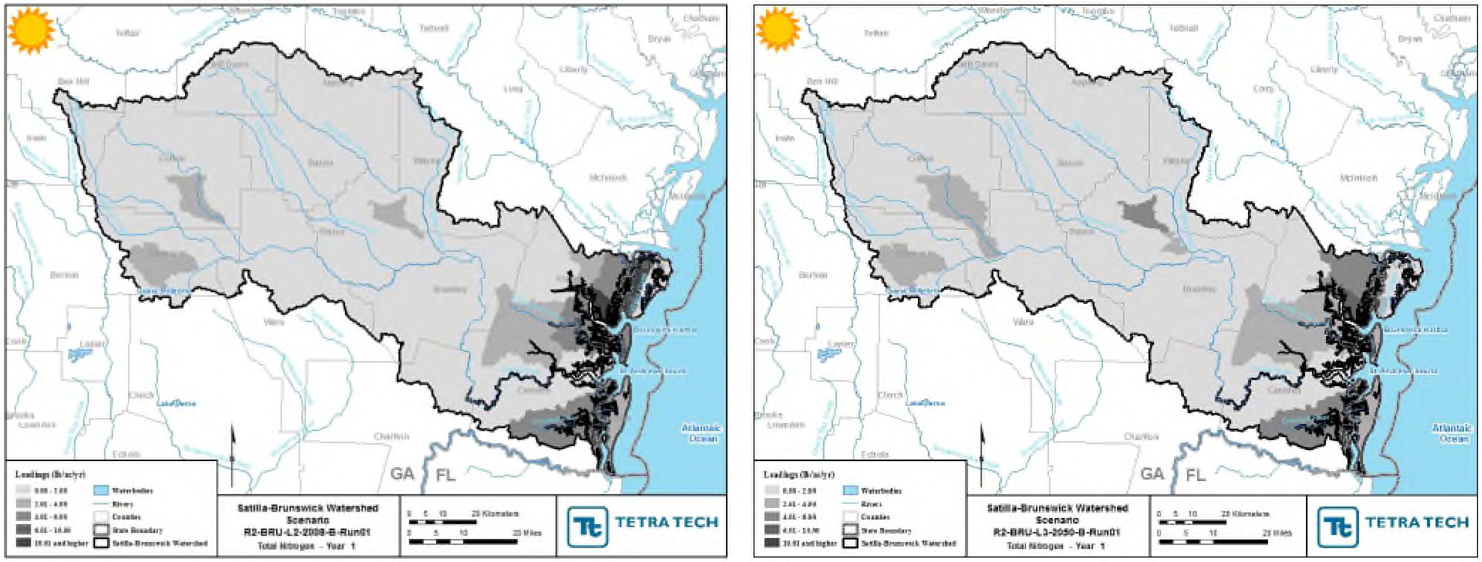

Figure 4-149 Current (left) and Future (right) Satilla River Watershed Total Nitrogen loads during representative dry weather conditions

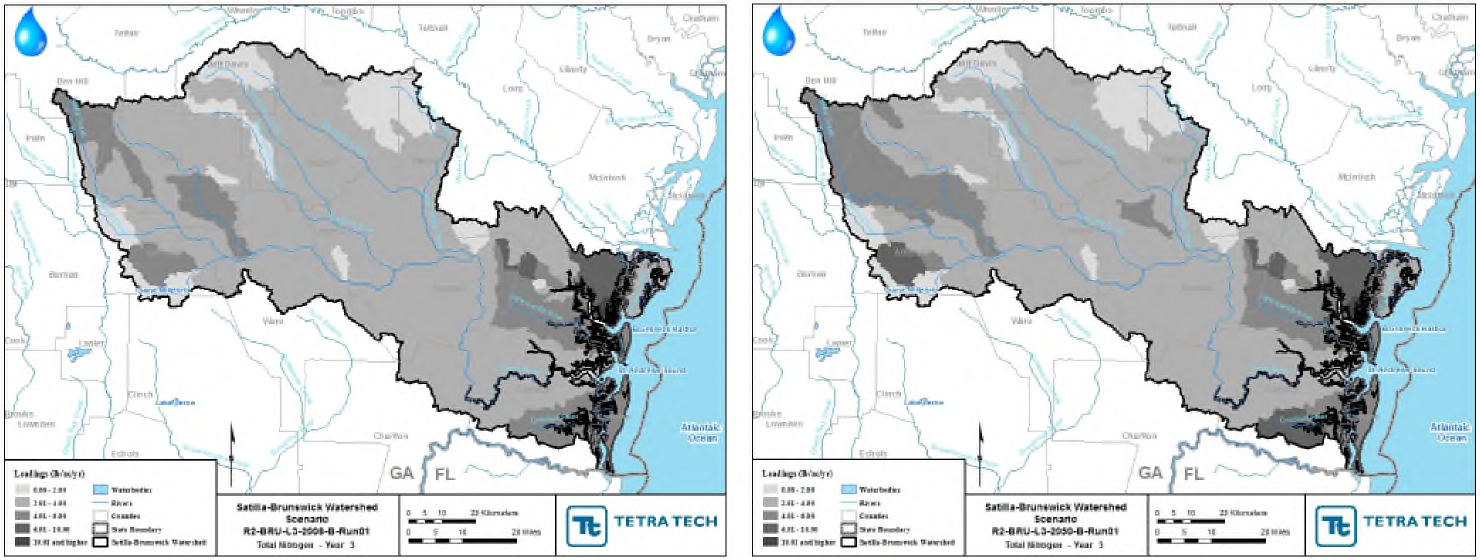

Figure 4-150 Current (left) and Future (right) Satilla River Watershed Total Nitrogen loads during representative wet weather conditions

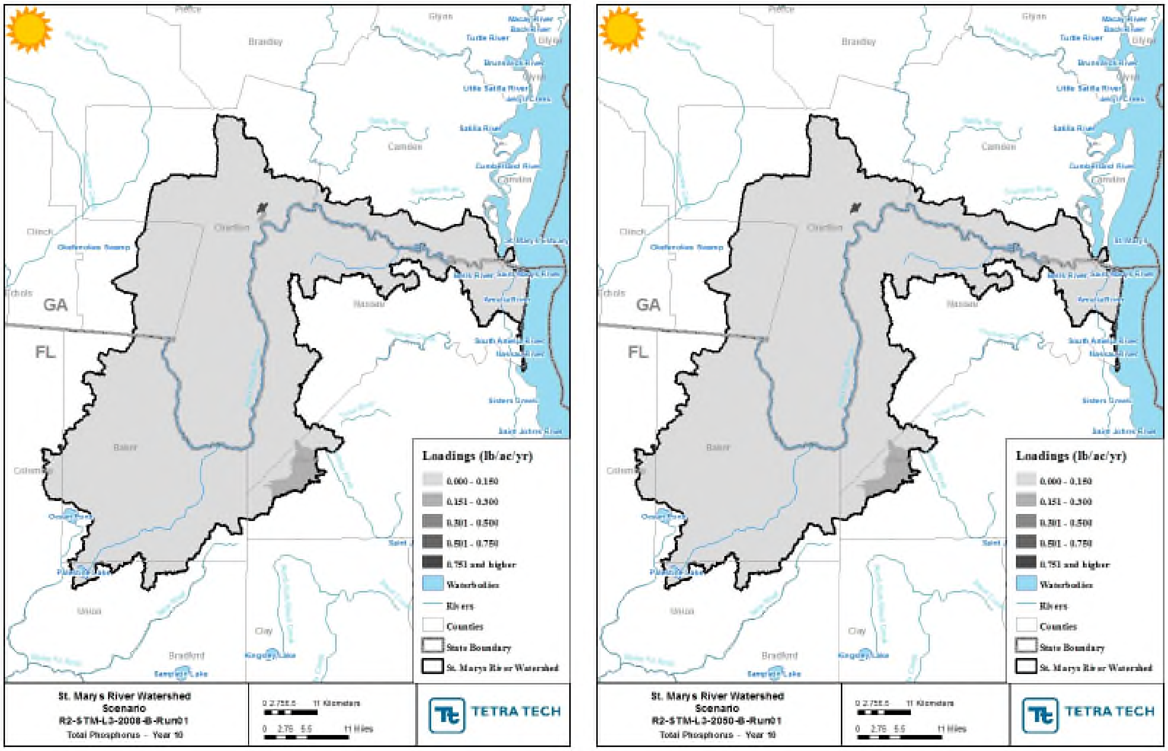

Figure 4-151 Current (left) and Future (right) St. Mary's River Watershed Total Phosphorus loads during representative dry weather conditions

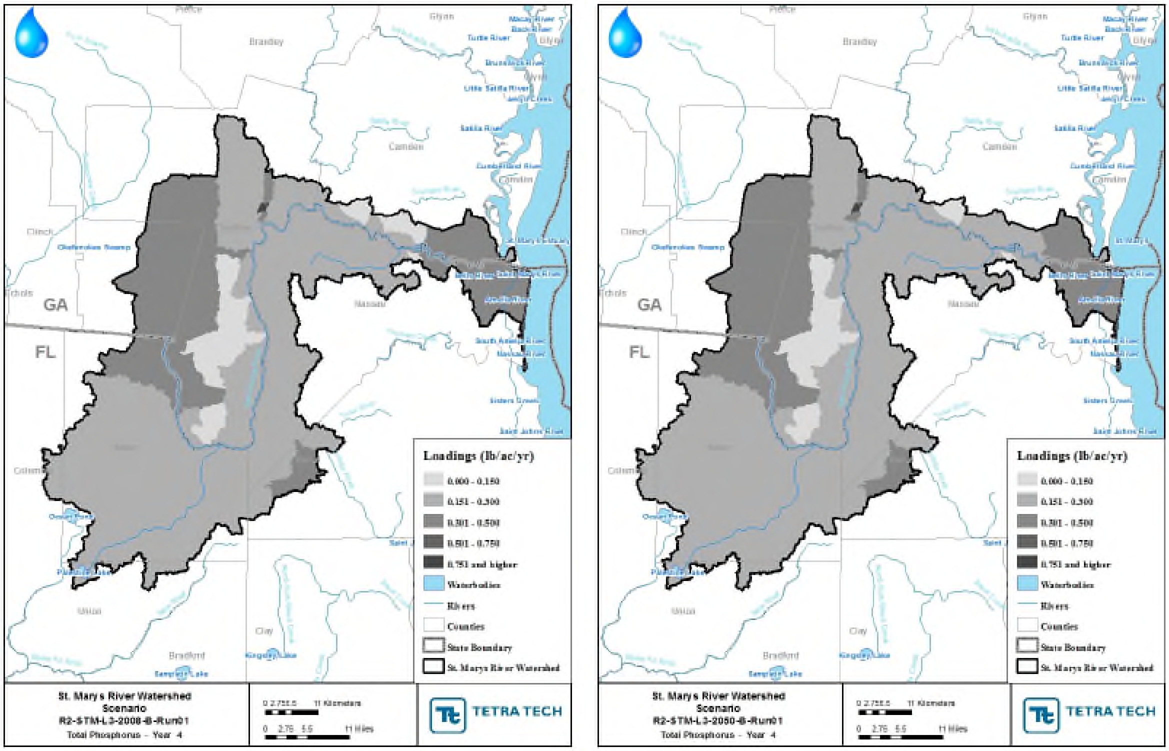

Figure 4-152 Current (left) and Future (right) St. Mary's River Watershed Total Phosphorus loads during representative wet weather conditions

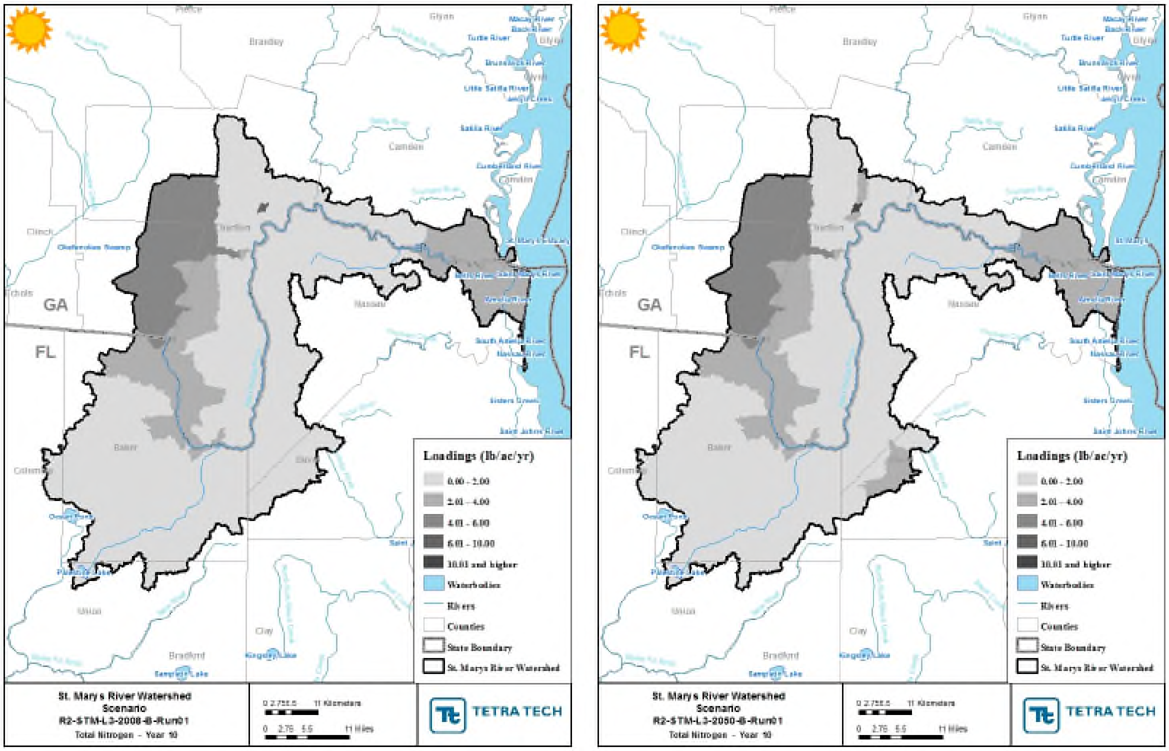

Figure 4-153 Current (left) and Future (right) St. Mary's River Watershed Total Nitrogen loads during representative dry weather conditions

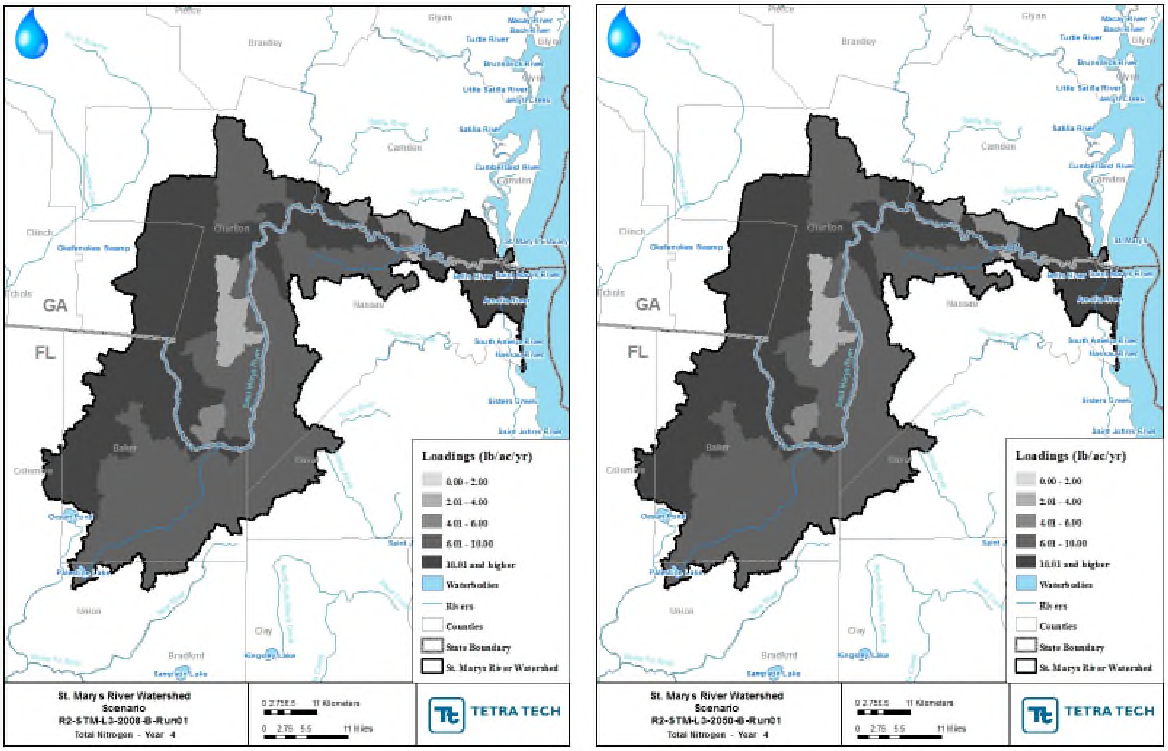

Figure 4-154 Current (left) and Future (right) St. Mary's River Watershed Total Nitrogen loads during representative wet weather conditions

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