Carters Lake Model Scenarios

Description and Results for Nutrient Criteria Revisions

Georgia Environmental Protection Division
Atlanta, Georgia

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INTRODUCTION

Carters Lake lies in the Coosawattee Watershed (HUC# 03150102) in Northwest Georgia (Figure 1-2) approximately 70 miles north northwest of the city of Atlanta. Carters Lake is a US Army Corps of Engineers Lake (USACE), and has been complete and operational since 1977. Carters Lake was formed by the Carters Dam and Reregulation Dam project, from the bed of the Coosawattee River, between Ellijay and Carters. It is the deepest manmade reservoir east of the Mississippi River and has 62 miles of shoreline with no development or private docks. The reservoir was developed as a multipurpose project for flood control, hydropower, navigation, water quality, fish and wildlife enhancement, recreation, and spans an area of about 3,220 acres. Carters Dam has a drainage area of 372 square miles and the Carters Reregulation Reservoir has a drainage area of 148 square miles for a total drainage area at the Reregulation Dam of 520 square miles (Figure 1-3). Five counties are located either completely or partially in the Carters Lake Watershed, therefore making the watershed very important to a wide-range of communities. There will be an ever-increasing need to balance water resources protection while allowing for smart economic development in these local communities.

The Georgia Environmental Protection Division (GAEPD) proposed water quality standards for Carters Lake in 2001, as those waters impounded by Carters Dam and upstream on the Coosawattee River as well as other impounded tributaries to an elevation of 1072 feet mean sea level corresponding to the normal pool elevation of Carters Lake. The Board of Natural Resources adopted water quality standards for Carters Lake and its major tributaries in 2002 with its designated uses of Recreation and Drinking Water. Lake wide standards for pH, total nitrogen, phosphorus, fecal coliform bacteria, dissolved oxygen, and temperature were established. Also, site-specific growing season average (April-October) chlorophyll *a* standards and annual total phosphorus loading standards for major lake tributaries were established. Below are the current standards related to nutrients and chlorophyll *a*:

> 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 | 5 µg/L |
> | 2 | Carters Lake at Coosawattee River embayment mouth | 10 µg/L |
>
> Phosphorous: Total lake loading shall not exceed 172,500 pounds or 0.46 pounds per acre-foot of lake volume per year.
>
> 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 pounds |
> | 2 | Mountaintown Creek at U.S. Highway 76 | 8,000 pounds |

In 2006, the GAEPD listed both segments of Carters Lake, Woodring Branch and Coosawattee River Embayment, on the State's 303(d) list for not meeting the chlorophyll *a* water quality standard. The GAEPD has recently completed TMDL modeling to address these exceedances. When the preliminary TMDL reductions were modeled in the watershed, the growing season average chlorophyll *a* levels at the Woodring Branch site were still above 5 µg/L. Therefore, EPD is reevaluating the chlorophyll *a* criteria at this location, as well as revisiting the nitrogen and phosphorus standards as part of the model analysis, to ensure the current standards are scientifically sound and protective.

Two computer models were developed for Carters and its watershed. The models included a watershed model, and an in-lake hydrodynamic and water quality model. The watershed model of Carters Lake was developed using the Loading Simulation Program in C++ (LSPC). This model includes all point sources that have a permitted discharge of 0.1 MGD or greater within the watershed. The watershed model simulates the effects of surface runoff on both water quality and flow and was calibrated to data collected from 2001 through 2009. The results of this model were used as tributary flow inputs in the hydrodynamic model, Environmental Fluid Dynamics Code (EFDC) (Figure 1-1).

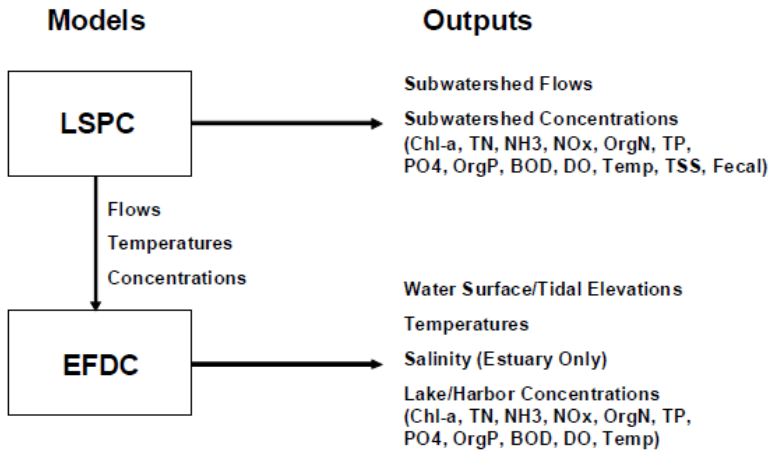

Figure 1-1 Linkage between LSPC and EFDC model

EFDC was used to simulate the transport and flow of water within the lake, the fate and transport of nutrients within the lake, and the uptake by phytoplankton. The growth and death of phytoplankton was measured through a surrogate parameter called chlorophyll *a*. The EFDC model was calibrated to nutrient and chlorophyll *a* concentrations measured in the lake during the 2001 through 2009 growing seasons. The setup, calibration and validation of these computer models are documented in the following two reports:

- *Watershed Hydrology and Water Quality Modeling Report for Carters Lake, Georgia – REV1 (Tetra Tech 2011)*
- *Hydrodynamic and Water Quality Modeling Report for Carters Lake, Georgia – REV1 (Tetra Tech 2012)*

Once the models were calibrated for Carters Lake and its watershed, various scenarios were run and analyzed to evaluate the nutrient sources. The following section describes these scenarios.

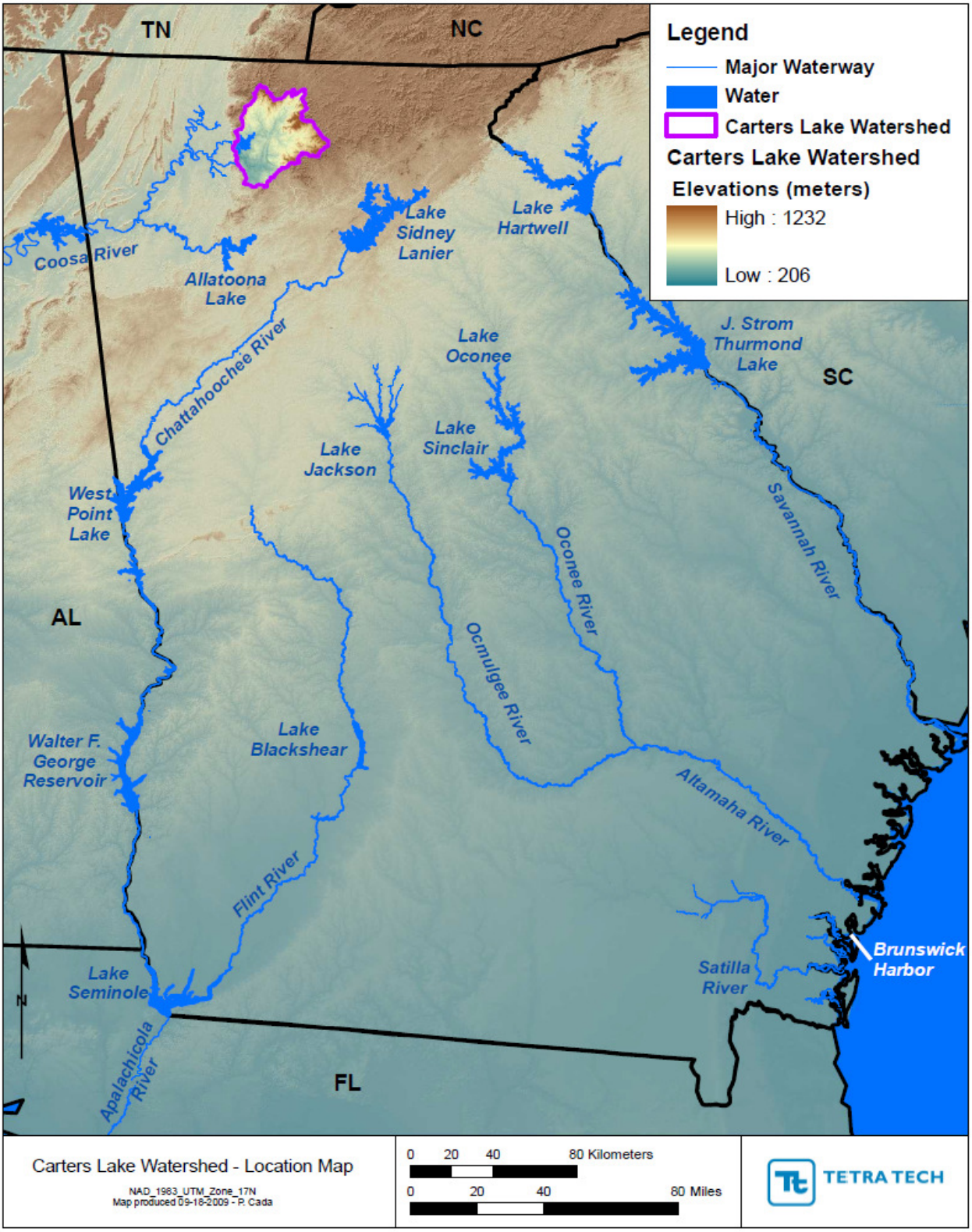

Figure 1-2 Location of Carters Lake

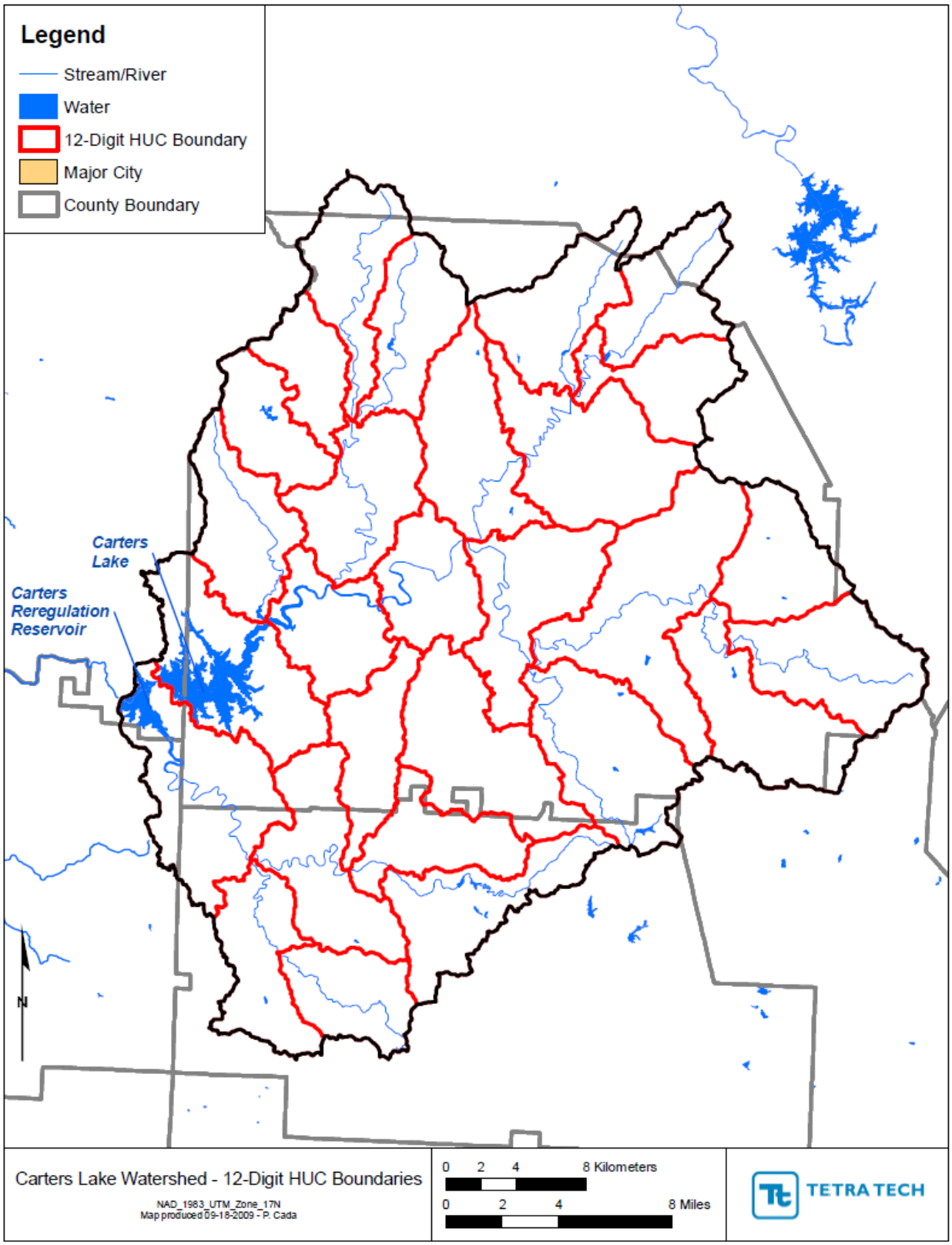

Figure 1-3 Carters Lake Watershed

2.0 DESCRIPTION OF SCENARIOS

Seven scenarios were run using the models developed for the Carters Lake to explain the sources and contributions of chlorophyll *a* levels observed, and for use in establishing new or revised chlorophyll *a* criteria. For each scenario, both hydrology (Figure 2-1) and water quality (Figure 2-2) was calibrated and validated at locations within the watershed from the LSPC model. However, only three tributary locations were evaluated for purposes of assessment in the Carters Lake watershed (Table 2-1). The outputs were examined from January 1, 2001 through December 31, 2009. Watershed flows were evaluated based on monthly and annual average flows and percentiles of daily average flows. Watershed water quality was evaluated based on annual and monthly loading, annual and monthly concentrations, and percentiles of daily average concentrations. Watershed flows and water quality were input into the EFDC model. The hydrodynamic and water quality outputs (Figure 2-3) from the EFDC model were evaluated at two locations (Table 2-2) in Carters Lake from 2001 through 2009. Results were evaluated based on growing season averages (April 1 through October 31). A short description of each scenario is presented below.

2.1 Scenario 1A (Calibration Baseline)

Scenario 1A was performed using the calibrated Carters Lake Watershed hydrology and water quality model (LSPC) and the calibrated Carters Lake model (EFDC). The calibrated LSPC model was run using monthly flow data for watershed water withdrawals, as well as daily and/or monthly flow and water quality data from point source discharges. If no data were available for the point source discharges, values were input at the permitted limits, or in some cases values were assumed if no permit limit existed.

2.2 Scenario 1B (Full Permit)

Scenario 1B was performed using the calibrated (Scenario 1A) Carters Lake Watershed hydrology and water quality model (LSPC) and the calibrated Carters Lake model (EFDC) as a starting point. Point source discharges and water withdrawals were then input at their full current permitted limits.

2.3 Scenario 1C (TMDL)

Scenario 1C was performed by taking Scenario 1B and reducing the agricultural nutrient surface loading by 40%. For the TMDL scenario, it was assumed that a 40% reduction in surface loading had a corresponding 10% reduction in subsurface loading. The combination of a 40% surface load reduction and a 10% subsurface load reduction equated to a total land use reduction of 25% for Pasture, 21% for Cropland and 27% for Chicken Land. However, the Woodring Branch site was still not in compliance, which will be discussed later.

2.4 Scenario 1D (All Forest)

Scenario 1D was an all forested scenario. This scenario was performed using the calibrated (Scenario 1A) Carters Lake Watershed hydrology and water quality model (LSPC) and the calibrated Carters Lake model (EFDC) as a starting point. Point source discharges, water withdrawals, and septic tanks were then removed and all landuse was converted to forest.

2.5 Scenario 1E (No Point Source)

Scenario 1E was a No Point Source scenario. This scenario was performed using the calibrated (Scenario 1A) Carters Lake Watershed hydrology and water quality model (LSPC) and the calibrated Carters Lake model (EFDC) as a starting point. Point source discharges and water withdrawals were removed, and current landuse was contained in this scenario.

2.6 Scenario 1F (2040)

Scenario 1F was a 2040 landuse scenario. This scenario was performed by taking Scenario 1C as a starting point and changing the landuse to the 2040 projected GLUT. The 2040 Georgia Landuse Trends (GLUT) dataset was obtained from the University of Georgia. Septic tanks were included at their projected 2040 numbers and point sources and water withdrawals were unchanged from the Full Permit scenario

2.7 Scenario 1G (Mountaintown Creek Total P Load of 16,000 lbs/year)

Scenario 1G was a Mountaintown Creek 16,000 lb/yr Total Phosphorus Load scenario. This scenario was performed using the models employed in the TMDL scenario (Scenario 1C) as a starting point. Scenario 1C was chosen as a starting point because the simulated results for the critical year of 2009 had the greatest deviation from 16,000 pounds. An additional load (1,900 lbs/yr) was added to Mountaintown Creek so that the annual Total Phosphorus load for Mountaintown Creek for the critical year of 2009 was 16,000 lbs.

2.8 Scenario IH (Total Nitrogen Increase to 4 mg/L)

Scenario 1H was performed using Scenario 1C (TMDL) and increasing the nitrogen load to the lake to 4 mg/L.

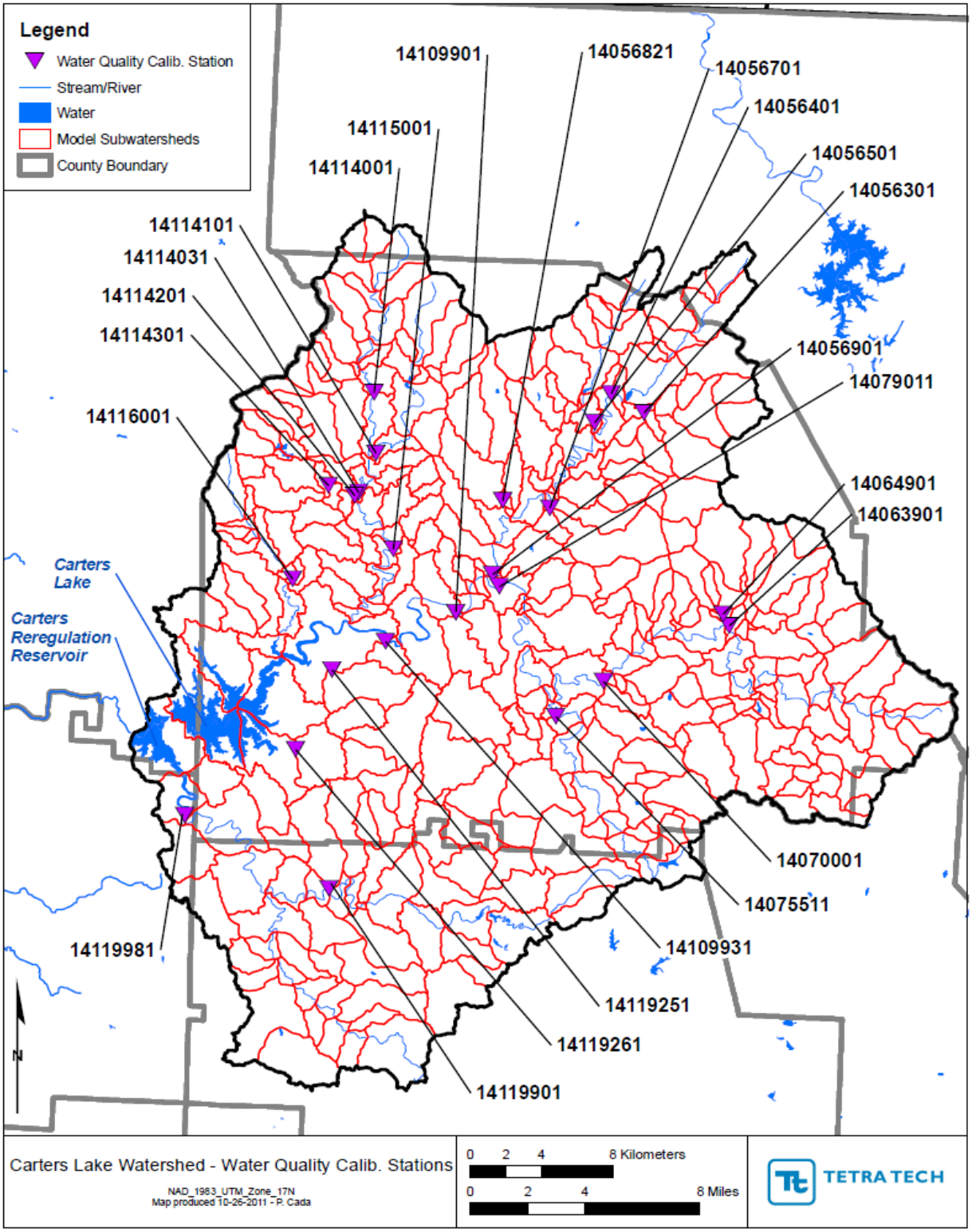

Figure 2-1 Carters Lake Watershed Water Quality Calibration and Validation Sites

Table 2-1 Summary of Carters Lake Watershed Assessment Sites

Station Name	Station Number	Drainage Area (Acres)	LSPC Subbasin
Coosawattee River @ Old Hwy 5	14109901	150,944	1001
Mountaintown Creek @ US Hwy 76	14115001	39,570	37
Talking Rock Creek in Resort Community	14119981	76,603	1004

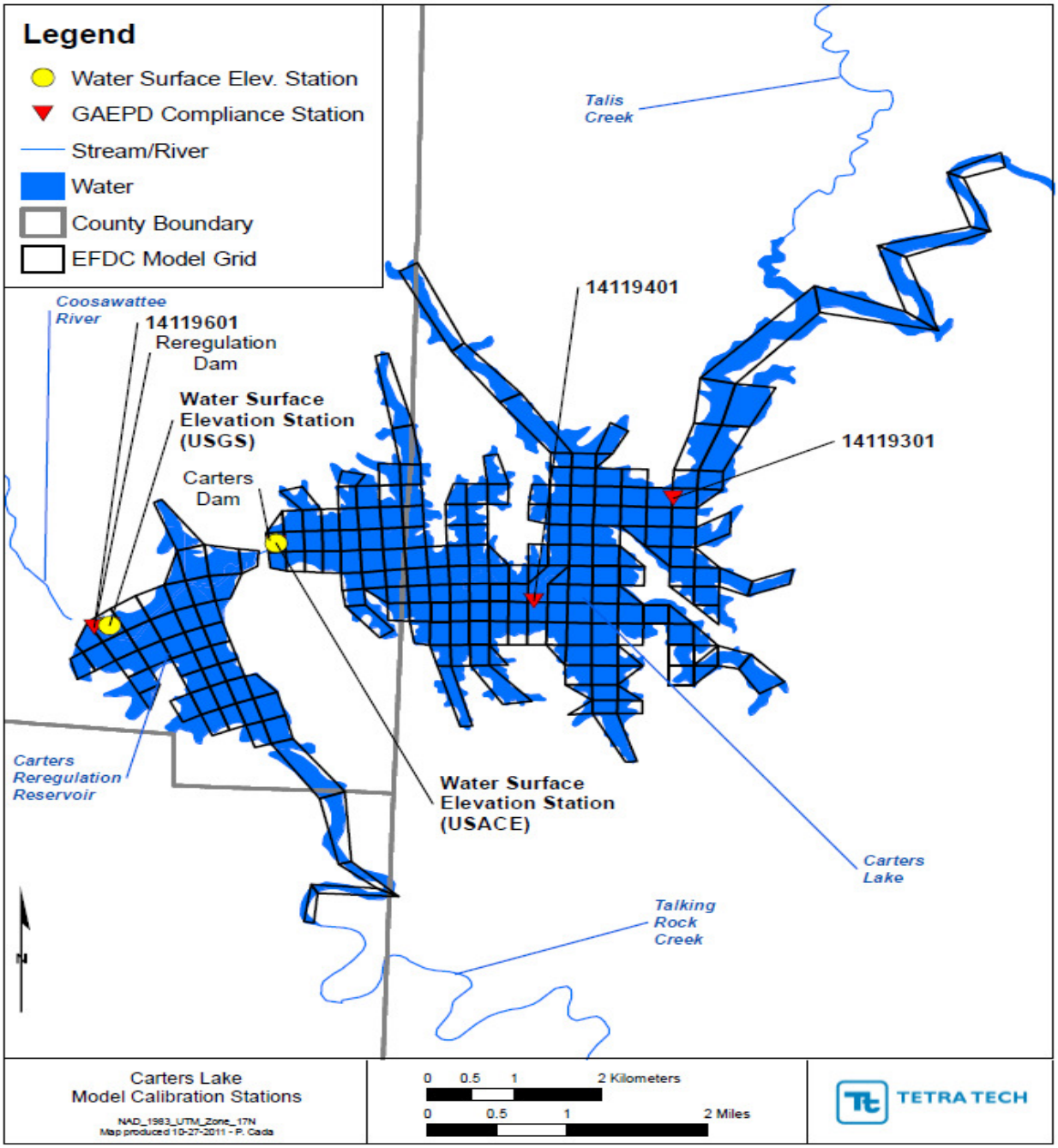

Figure 2-2 Carters Lake Hydrodynamic and Water Quality Calibration Stations

Table 2-2 Summary of Carters Lake Evaluation Sites

Station Name	Station Number	EFDC Cell		Segment	Layers
		I-Value	J-Value		
Carters Lake at Coosawattee River embayment	14119301	33	14	199	9
Carters Lake upstream from Woodring Branch	14119401	27	8	59	16

3.0 ANALYSIS OF SCENARIOS

3.1 Phosphorus Loading Standards

The TMDL for Carters Lake was based on reducing the agricultural nutrient surface loading by 40% and the subsurface loading by 10% for a total land loading reduction of 25% for Pasture, 21% for Cropland, and 27% for Chicken Land. Table 3-1 provides the Total Nitrogen and Total Phosphorus export loads for each landuse for the existing (Scenario 1A) and TMDL (Scenario 1C) conditions for Critical Year 2009.

Table 3-1 Nutrient Landuse Export Rate (lbs/year) for Scenario 1A (Calibration) and Scenario 1C (TMDL) for Critical Year 2009

		Barren	Forest	Wetland	Pasture	Chicken Land	Cropland	Urban	Golf	Failing Septic Tanks
Existing Condition	TP	11,018	90,533	117	8,906	28,276	1,623	18,671	72	272
	TN	64,597	715,252	1,239	98,456	539,218	19,025	122,456	537	2,425
TMDL	TP	11,018	90,533	117	6,675	20,720	1,286	18,671	72	272
	TN	64,597	715,252	1,239	73,793	395,139	15,070	122,456	537	2,425
% Reduction		0%	0%	0%	25%	27%	21%	0%	0%	0%

These values are only landuse associated and ignore in-stream biochemical cycling. Therefore, they are not comparable to the annual Total Phosphorus load delivered to the major tributary compliance points. To evaluate compliance with the major tributary Total Phosphorus loading standards at each compliance station, calculations are based on daily flow and monthly Total Phosphorus concentrations measured. Although the flow varies daily, the Total Phosphorus concentrations are held constant until the date of the next monthly measurement.

Table 3-2 compares the modeled calibration annual Total Phosphorus load for Scenario 1A to the actual calculated loads used for compliance for the major tributary annual Total Phosphorus loading standards. In average to above average precipitation years, the calculated annual load is often higher than the modeled load. This may be due to the method of holding Total Phosphorus concentration constant as described above when calculating the annual major tributary load.

Table 3-2 Summary of Annual Total Phosphorus Loads (lbs/year) for Scenario 1A (Calibration) and Actual Calculated Loads

Station	Current Standard		2001	2002	2003	2004	2005	2006	2007	2008	2009
Coosawattee River @ Old Hwy 5	151,500	Modeled	119,600	96,500	126,800	126,900	109,400	94,900	104,900	105,300	**177,600**
		Calculated	N/A	93,000	106,600	**156,400**	**277,00**	85,400	127,580	127,600	**266,00**
Mountaintown Creek @ US Hwy 76	8,000	Modeled	5,000	5,500	**12,100**	**10,500**	7,900	3,100	1,600	2,700	**14,600**
		Calculated	N/A	2,700	5,000	6,800	**15,900**	5,700	2,710	4,700	**19,700**

Table 3-3 provides the modeled annual Total Phosphorus load for the major tributary compliance points for the TMDL scenario (1C). After the agricultural reductions are applied to the Carters Lake watershed, the phosphorus loading at Mountaintown Creek is still higher than the current Total Phosphorus loading standard of 8,000 lbs/year in several years.

Table 3-3 Summary of Annual Total Phosphorus Loads for Scenario 1C (TMDL)

Station	Current Standard	2001	2002	2003	2004	2005	2006	2007	2008	2009
Coosawattee River @ Old Hwy 5	151,500	33,900	29,500	57,400	50,500	44,400	23,600	16,300	22,700	63,000
Mountaintown Creek @ US Hwy 76	8,000	4,800	5,200	**11,600**	**10,100**	7,600	2,900	1,500	2,600	**14,100**

The effects of various landuses on the annual Total Phosphorus load were determined by converting all landuses in the Carters Lake watershed to forest (Scenario 1D). Table 3-4 provides the modeled annual Total Phosphorus loads for each of the major tributaries for the all forested scenario. The all forested load for Mountaintown Creek in 2009 is approximately 16% lower than the TMDL load for Mountaintown Creek. These results indicate that the original annual Total Phosphorus loading standard for Mountaintown Creek may be too low and needs to be revised.

Table 3-4 Summary of Annual Total Phosphorus Loads for Scenario 1D (All Forested)

Station	Current Standard	2001	2002	2003	2004	2005	2006	2007	2008	2009
Coosawattee River @ Old Hwy 5	151,500	15,500	12,600	36,000	31,700	24,000	8,200	3,800	7,300	40,400
Mountaintown Creek @ US Hwy 76	8,000	3,700	4,100	**9,800**	**8,700**	6,300	2,200	1,100	1,800	**12,100**
Talking Rock Creek @ Reregulation Reservoir inlet	N/A	10,100	9,300	30,700	20,400	10,300	7,500	2,300	4,900	33,700

Table 3-5 shows that based on 2005 landuse, the Mountaintown Creek watershed is approximately 92% forested. The next major landuse is agricultural making up approximately 4%. Agricultural lands have higher nutrient loading rates than forested lands, and urbanized lands have increased impervious surfaces that result in higher flows during storm events. Both of these, singularly or in combination, will result in a higher annual nutrient load than an all forested scenario.

Table 3-5 Mountaintown Creek Watershed Landuse (GLUT 2005)

Stream	Landuse Categories - Acres (Percent)													
	Beach	Water	Low Intensity Development	Medium Intensity Development	High Intensity Development	Barren	Forest	Golf	Pasture	Crop	Wetland	Failing Septic	Chicken Land	Total
Mountaintown Creek	0 (0)	111 (0.3)	1,112 (2.8)	12 (0)	3 (0)	137 (0.3)	36,485 (92.2)	0 (0)	556 (1.4)	90 (0.2)	19 (0)	45 (0)	999 (2.5)	43,337 (100)

Increasing the annual Total Phosphorus load at Mountaintown Creek to 16,000 lbs/year is necessary because in wet years the criteria is currrently un-obtainable given the current landuse, and also under an all forested scenario. Setting the standard to 16,000 lbs/year allows for a 10% margin of safety compared to the baseline calibration scenario. This new standard will be protective of the growing season average chlorophyll *a* concentrations for each assessment site in the lake (results from Model Scenario 1G) as shown in Table 3-6.

Table 3-6 Summary of Chlorophyll *a* Data (µg/L) as a result of Increasing Total P Load at Mountaintown Creek to 16,000 lbs/year (Scenario 1G)

Station Name	Standard	2001	2002	2003	2004	2005	2006	2007	2008	2009
Carters Lake at Coosawattee River embayment	10 (Current)	7.38	7.86	8.25	5.12	6.32	3.68	8.32	4.58	3.88
Carters Lake upstream from Woodring Branch	10 (Proposed)	4.81	8.28	7.98	7.91	6.89	4.11	6.09	2.99	3.79

Since Carters Lake also has a phosphorus total lake loading of 172,500 pounds or 0.46 pounds per acre-foot of lake volume per year, we also examined whether this standard is appropriate based on an analysis of the modeling. The modeled annual load of phosphorus for Carters Lake are presented in Table 3-7 for the Calibration, Full Permit, and TMDL scenarios.

Table 3-7 Summary of Annual Total Phosphorus Lake Loads for Scenario 1A (Calibration), 1B (Full Permit), and 1C (TMDL)

Standard			2001	2002	2003	2004	2005	2006	2007	2008	2009
Annual Load of Phosphorus (lbs)	172,500	Calibration (1A)	155,502	133,102	**190,356**	**180,395**	163,072	125,430	119,451	129,145	**242,877**
		Full Permit (1B)	77,362	72,215	130,492	110,093	105,993	59,793	36,039	53,280	137,586
		TMDL (1C)	74,430	69,493	125,710	106,225	102,044	57,798	35,134	51,470	132,196
Specific Loading (lbs/Acre-Ft)	0.46	Calibration (1A)	0.41	0.36	**0.50**	**0.48**	0.43	0.35	0.35	0.37	**0.64**
		Full Permit (1B)	0.21	0.19	0.35	0.29	0.28	0.17	0.11	0.15	0.36
		TMDL (1C)	0.20	0.19	0.33	0.28	0.27	0.16	0.10	0.15	0.35

While the calibration scenario shows exceedances of the total lake loading, the full permit and TMDL scenarios show the phosphorus loading for the lake below the current standards. This is due to the reduction in phosphorus in permits and the 40% reduction in agricultural phosphorus loading, respectively. Thus, the current standards are appropriate and protective of the lake.

3.2 Chlorophyll *a* Standards

The watershed and lake models were used to predict the effect of various nutrient loads and sources on the lake chlorophyll *a* levels. The data indicate there were chlorophyll *a* violations at Woodring Branch and the Coosawattee River embayment at baseline calibration conditions. The models were then run at full permitted loads to predict the chlorophyll *a* levels in the lake, and again there were chlorophyll *a* violations at the Woodring Branch site in the middle lake, with the Coosawattee River embayment station in the upper lake meeting its standard (see Figures 3-1 and 3-4). When the preliminary TMDL reduction of 40% in the agricultural nutrient load was applied, the growing season average chlorophyll *a* levels at this middle station were still above 5 µg/L in most years (Figure 3-4). The results of the all forest model scenario also indicate that the Woodring Branch site can still exceed the current chlorophyll *a* criteria (Figure 3-4), further demonstrating that this compliance station needs to be adjusted.

Figures 3-1 through 3-5 show the level of chlorophyll *a* due to the various sources, as well as the model results for most of the scenarios. It is important to note that the TMDL model results were negligible compared to the full permit results. In addition, the 2040 landuse at full permit scenario also had a negligible effect of chlorophyll a levels. By amending the Woodring Branch site to 10 µg/L, this allows for a safety margin of approximately 17% from both increased landuse changes and permit loading. This proposed criterion is still protective of the Recreation and Drinking Water designated uses.

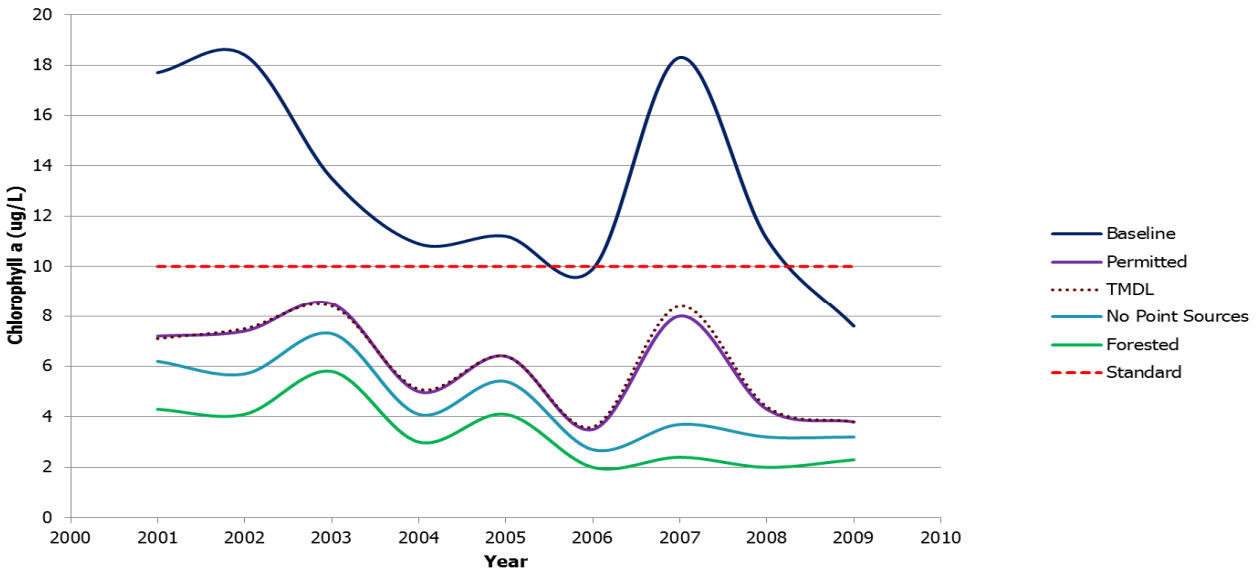

Figure 3-1 Coosawattee River Embayment Scenario Results in Relation to Current Standard

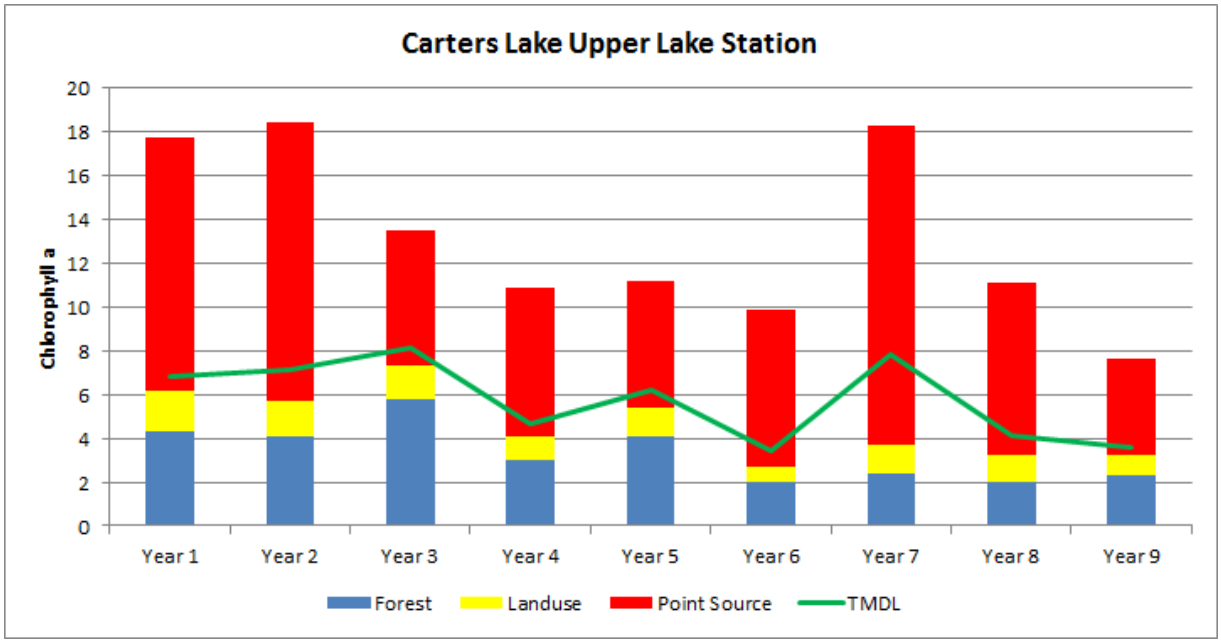

Figure 3-2 Coosawattee River Embayment Chlorophyll a Contributions for Baseline Calibration Scenario

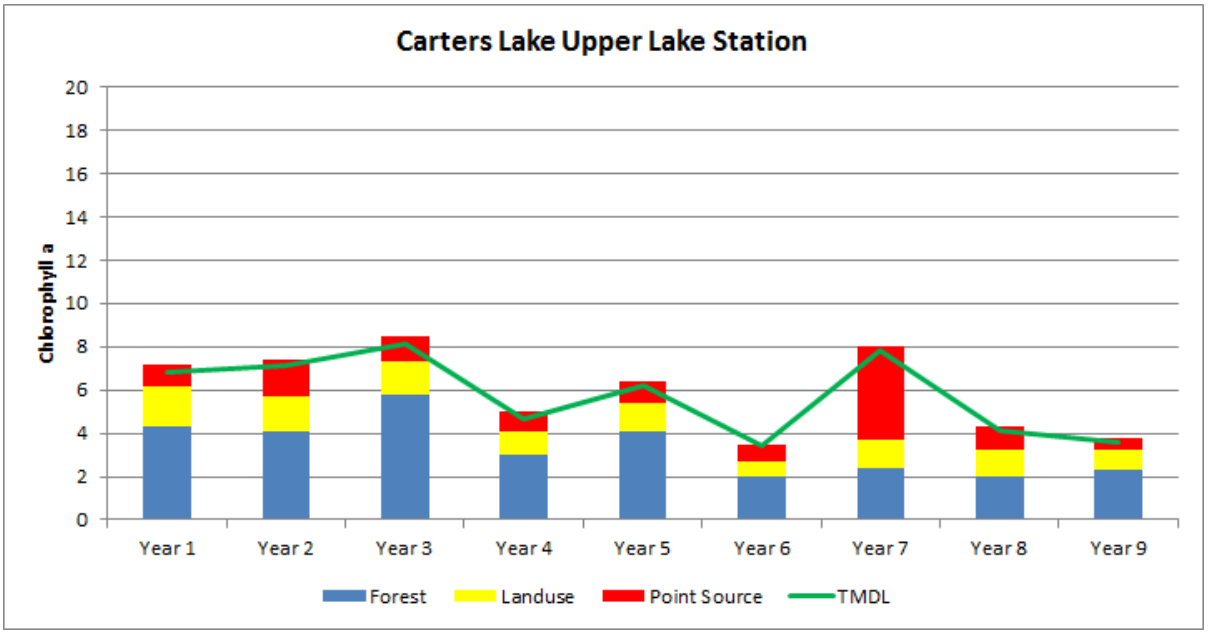

Figure 3-3 Coosawattee River Embayment Chlorophyll a Contributions for Full Permit Scenario

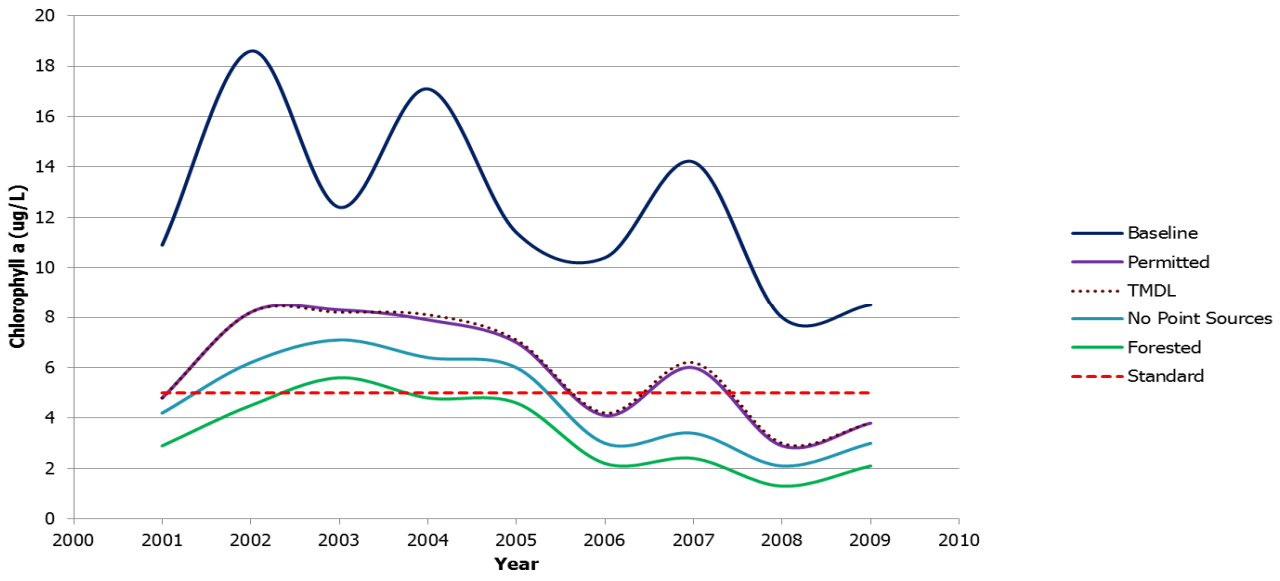

Figure 3-4 Woodring Branch Scenario Results in Relation to Current Standard

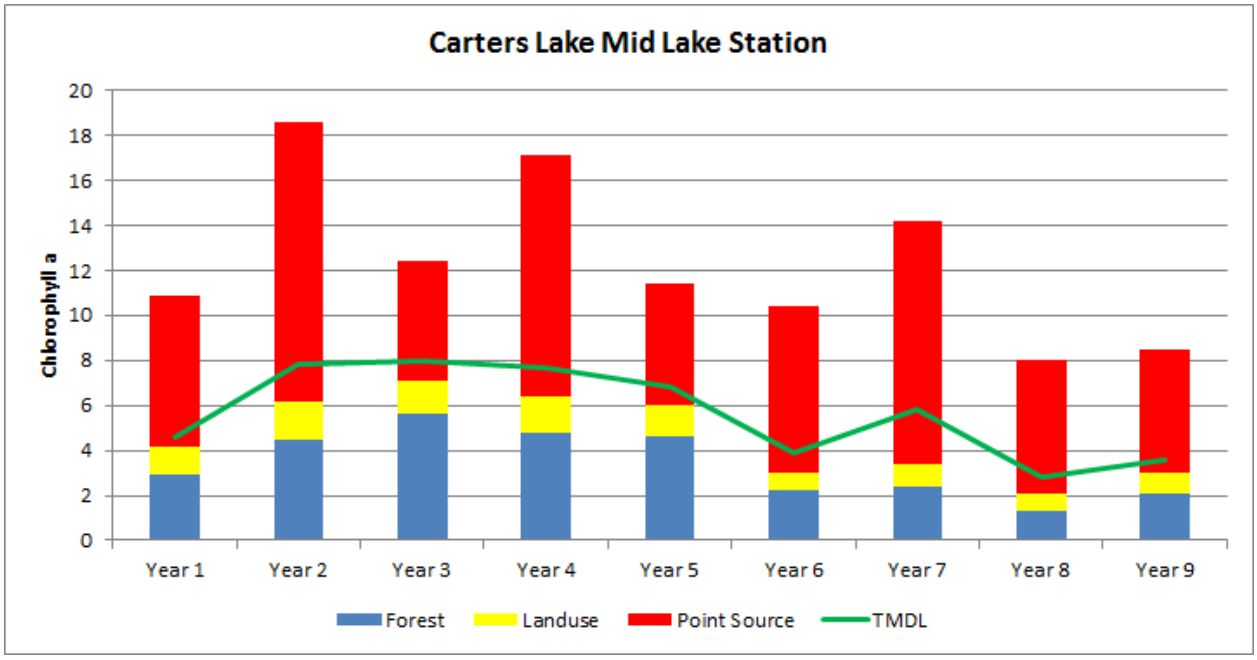

Figure 3-5 Woodring Branch Chlorophyll a Contributions for Baseline Scenario

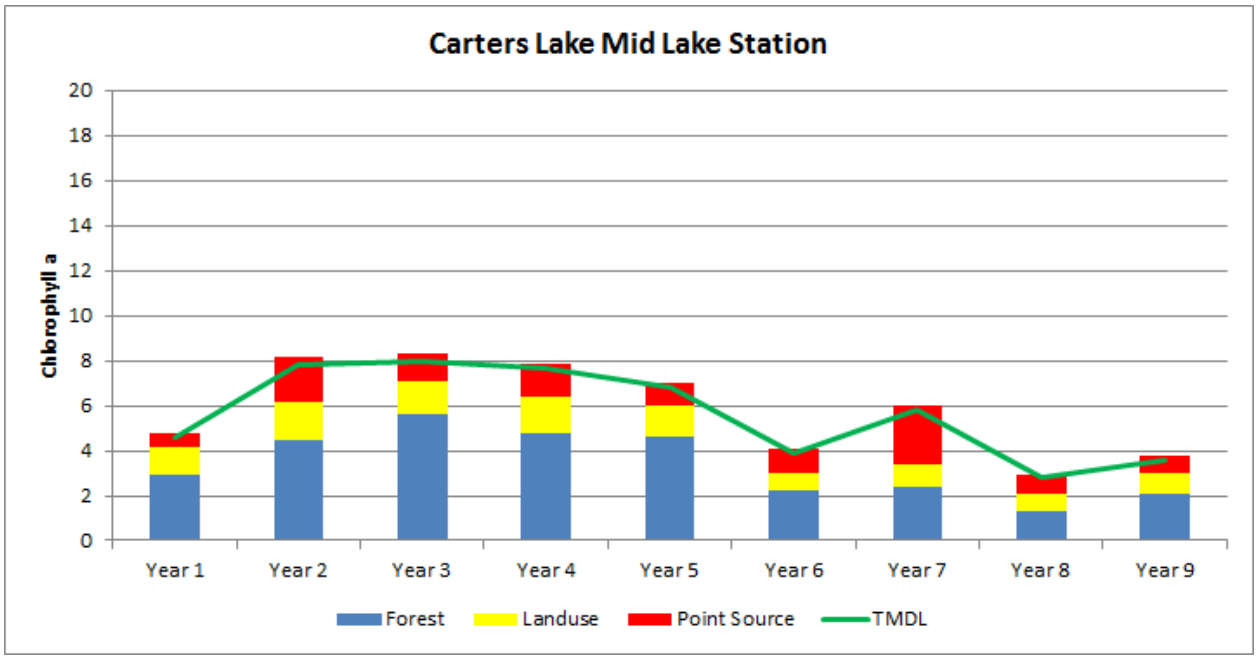

Figure 3-6 Woodring Branch Chlorophyll a Contributions for Full Permit Scenario

3.3 Total Nitrogen Standard

The modeling results were also evaluated to examine whether the current 'anytime, anyplace' nitrogen standard of not to exceed 4.0 mg/L is protective of the lake. For each model scenario, the total nitrogen growing season average was evaluated from 2001 to 2009. The preliminary analyses indicated that the total nitrogen standard could be revised to a 'not to exceed a growing season average of 1 mg/L as nitrogen in the photic zone'. This proposed criterion, however, does not take into consideration an accurate model that will indicate if this is protective downstream in Lake Weiss. Until an accurate calibrated model is complete for the Coosa Basin and Lake Weiss to allow for a complete understanding of the nitrogen dynamics, the current total nitrogen standard (4.0 mg/L) will remain. A protective and scientifically, defensible total nitrogen standard will be proposed when this modeling effort is complete.

This criterion is still protective of the Recreation and Drinking Water designated uses in Carters Lake. Modeling (Scenario 1H) indicated that increasing the total nitrogen concentration in the lake to a 4 mg/L level did not affect the chlorophyll *a* levels as indicated in Figures 3-7 through 3-9.

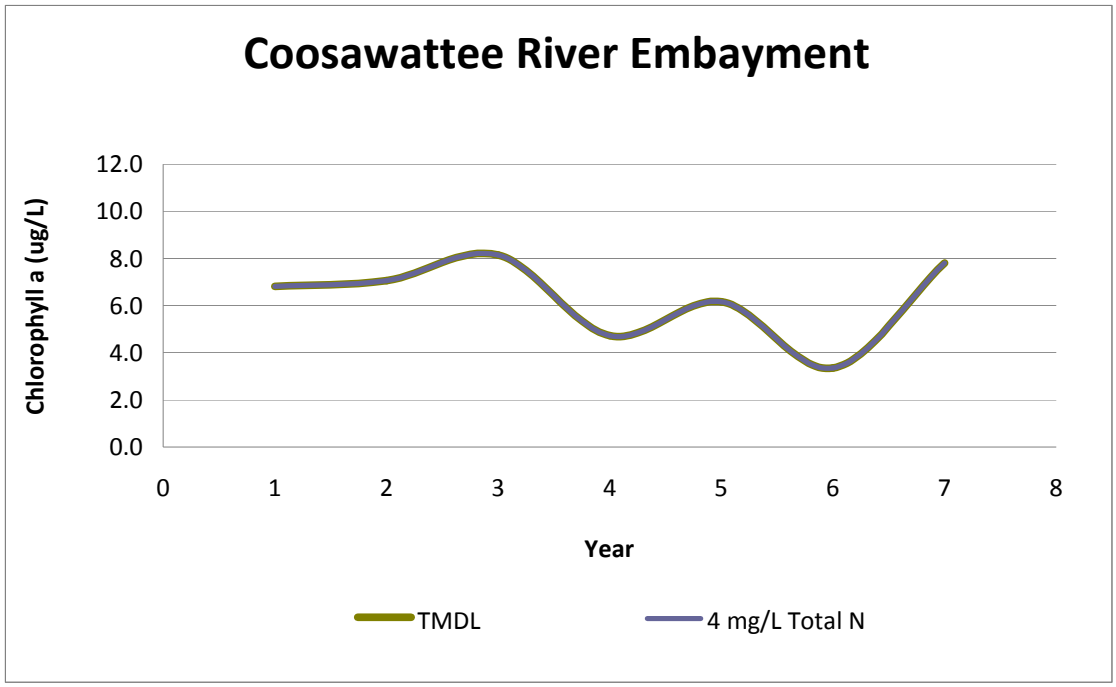

Figure 3-7 Chlorophyll Levels in the Upper Lake from the TMDL (Scenario 1C) and Increasing the Total Nitrogen Load to the Current Standard (Scenario 1H)

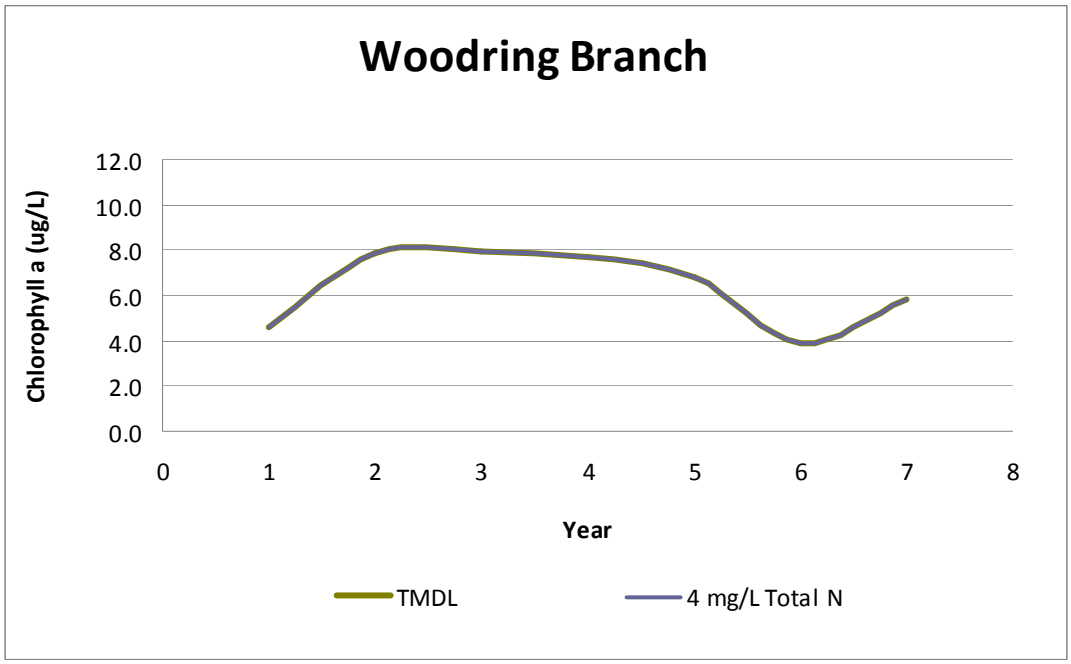

Figure 3-8 Chlorophyll Levels in the Middle Lake from the TMDL (Scenario 1C) and Increasing the Total Nitrogen Load to the Current Standard (Scenario 1H)

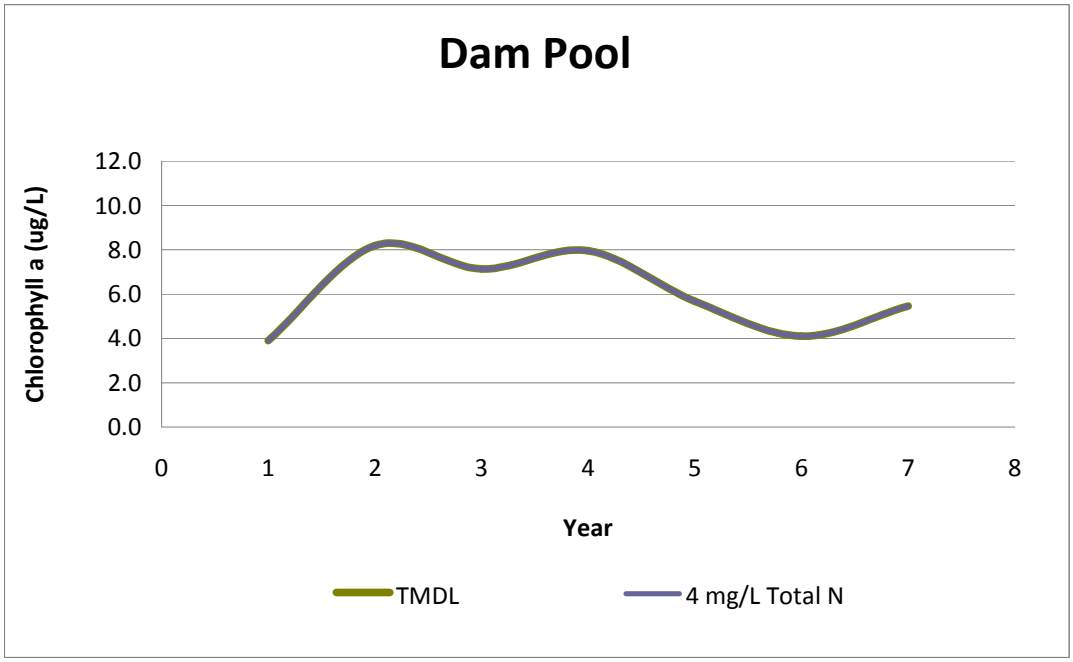

Figure 3-9 Chlorophyll Levels in the Dam Pool from the TMDL (Scenario 1C) and Increasing the Total Nitrogen Load to the Current Standard (Scenario 1H)

4.0 DESIGNATED USE SUPPORT

4.1 Recreational Use Support

There have been no recreational closures due to algal blooms at any of the U.S. Army Corps of Engineers beaches on Carters Lake (personal communication, COE).

4.2 Fisheries Use Support

There have been no fish kills in Carters Lake due to dissolved oxygen deficiency since nutrient standards were adopted. This lake has both a warm water and cool water fishery. The black bass fishery is excellent, with spotted bass representing 90% of the population. Spotted bass prefer clear, cool water and utilize deeper water than largemouth bass. Largemouth bass comprise a much smaller portion of the black bass fishery at Carters. This is likely attributed to the physical habitat at Carters being more suited to spotted bass in this deep, steep-sided impoundment.

The Carters cool water fishery is supported through WRD stocking of striped bass, walleye and since 2003, hybrid bass (striped and white bass cross). Hybrid bass will tolerate warmer water temperatures than striped bass. Hybrid bass growth is good, but the Carters hybrid fishery is still developing. The Carters walleye population is good. Their growth is excellent given the robust forage base. Striped bass require at a minimum critical habitat having temperatures of less than 25 °C and with greater than 3 mg/L of dissolved oxygen. Water temperatures of 22 °C or less with dissolved oxygen concentrations of 5 mg/L or more are optimal for this species. Following the spring spawn the larger striped bass spend the remainder of the summer in cool water refuges within Carters Lake. WRD research of the Carters striped bass fishery indicates that it has likely suffered from high summer water temperatures and low dissolved oxygen (e.g. insufficient habitat with cool temperatures and higher dissolved oxygen). Table 4-1 below is WRD tabulations of their mid-August striped bass habitat ratings and depth thickness (where water temperature was less than 25 °C and dissolved oxygen was greater than 3 mg/L), and the number of stations exceeding the chlorophyll *a* standard for those years (as shown in Figure 4-1). These qualitative results infer no connection with chlorophyll a levels and striped bass habitat quality.

Table 4-1 WRD Fisheries August Striped Bass Habitat Rating For Carters Lake

Table 4-1a: Dam Area (Not Proximal to Standard Station)				
Mid-August; Year	Habitat Rating *	Critical Habitat Depth [T<25 and DO > 3]	Optimal Habitat Depth [T<22 and DO > 5]	Number of Stations With Chlorophyll *a* Exceedances
2001	Fair	> 10 meters	0 meters	Standards Not Adopted
2002	Fair	> 10 meters	0 meters	Two (Midlake and Upper Coosawattee Arm)
2003	No data	No data	No Data	Two (Midlake and Upper Coosawattee Arm)
2004	Fair	> 12 meters	0 meters	One ((Midlake)
2005	Fair	> 12 meters	0 meters	Two (Midlake and Upper Coosawattee Arm)
2006	Fair	> 11 meters	0 meters	One ((Midlake)
2007	Fair	8 meters	0 meters	Two (Midlake and Upper Coosawattee Arm)

2008	Fair	18 meters	0 meters	Two (Midlake and Upper Coosawattee Arm)
2009	Fair	13 meters	0 meters	One (Midlake)
2010	Fair	6 meters	0 meters	One (Midlake)
2011	Fair	11 meters	0 meters	Two (Midlake and Upper Coosawattee Arm)
2012	Fair	15 meters	0 meters	One (Midlake)

Table 4-1b: Midlake at Woodring Recreational Area (Proximal to Standard Station)

Mid-August; Year	Habitat Rating *	Critical Habitat Depth [T<25 and DO > 3]	Optimal Habitat Depth [T<22 and DO > 5]	Number of Stations With Chlorophyll *a* Exceedances
2001	Fair	> 9 meters	0 meters	As in 4-1a
2002	Poor	2 meters	0 meters	
2003	No Data	No Data	No Data	
2004	Fair	11meters	0 meters	
2005	Fair	13meters	0 meters	
2006	Fair	12 meters	0 meters	
2007	Fair	8 meters	0 meters	
2008	Fair	17 meters	0 meters	
2009	Fair	9 meters	0 meters	
2010	Poor	0 meters	0 meters	
2011	Poor	2 meters	0 meters	
2012	Fair	13 meters	0 meters	

* Habitat rating is based on a qualitative matrix. "Good" habitat is that which has critical habitat depth greater than three meters and any level of optimal habitat depth present. "Fair" habitat is that which has three or more meters of critical habitat depth but no optimal habitat depth. "Poor" habitat is that which has less than three meters of critical habitat depth.

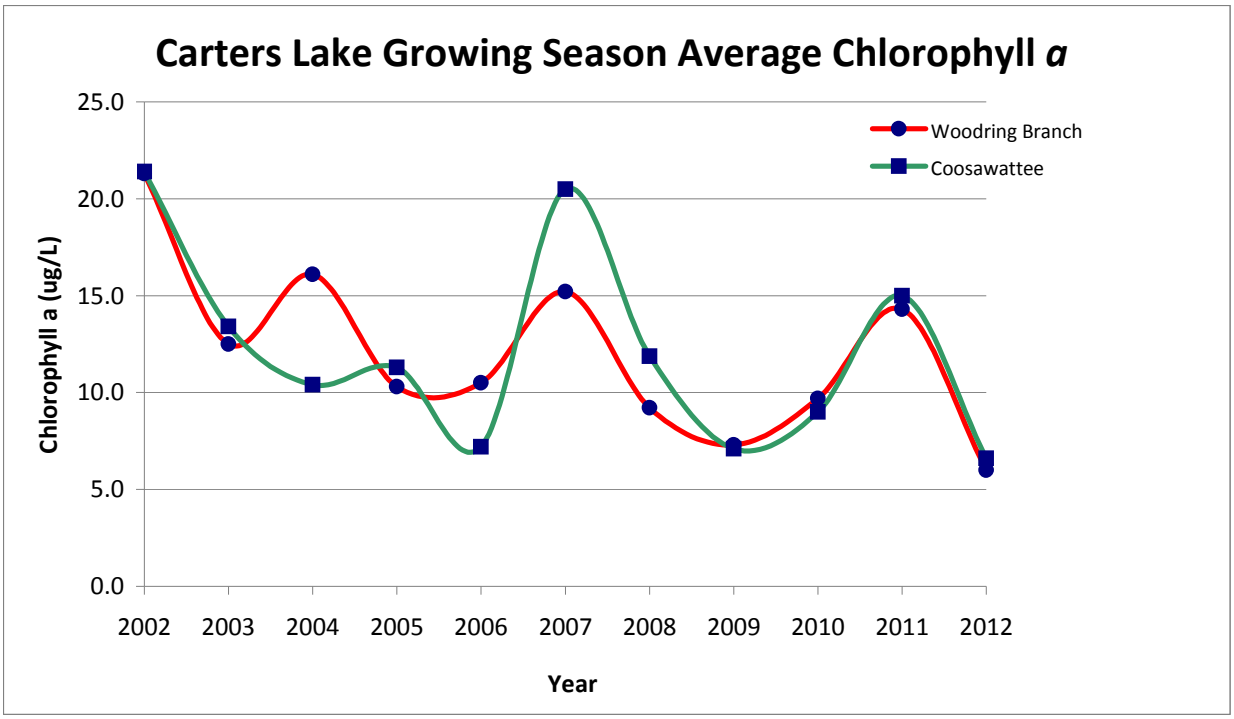

Figure 4-1 Historic Carters Lake Growing Season Average Chlorophyll a

4.3 Drinking Water Source Use Support

The City of Chatsworth has a water supply intake at the very upper end of the Wurley Creek arm of Carters Lake, where nutrient loadings are usually highest. The location of the drinking water withdrawal is shallower and not proximal to either of the current chlorophyll a standard monitoring locations in the main, deeper portions of the lake. The City has had difficulty on many occasions treating this water source due to algal concentrations during the early part of the growing season. These events start in April, right after the turnover of the lake, and usually last a couple of weeks to at worst a few months (see Figure 4.2).

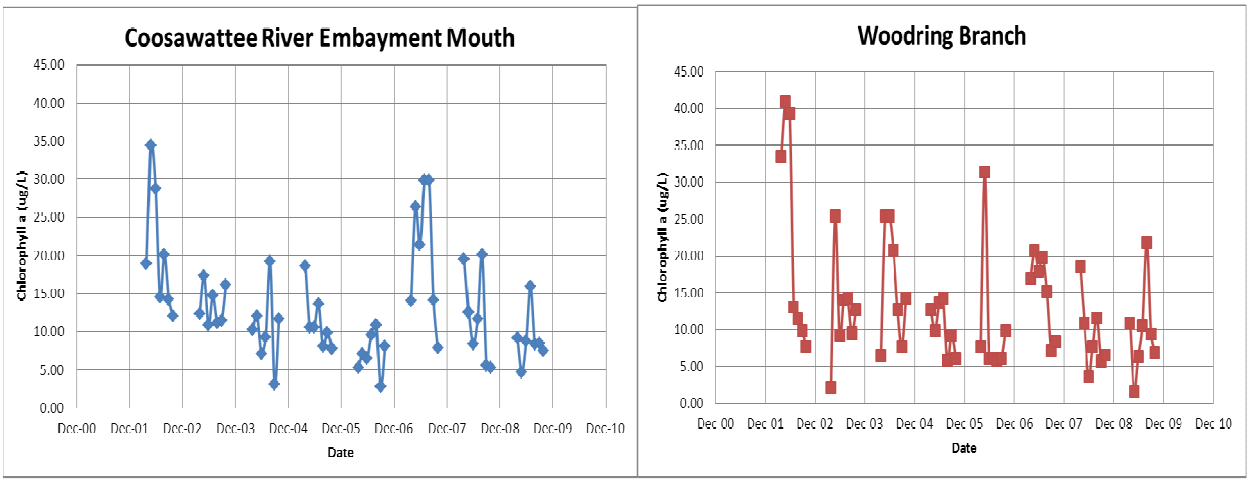

Figure 4.2 Monthly Chlorophyll a at the Carters Lake Monitoring Stations

While the algal presence is a nuisance, the issue is typically manageable with an estimated $10,000 to $15,000 per year in treatment costs. During these events, the City of Chatsworth feeds powdered activated carbon (PAC) in an effort to adsorb the taste and odor causing compounds, such Geosmin and MIB, produced by algae. The City of Chatsworth's Carters Lake Plant is a package plant without conventional sedimentation. There is a very short detention time for the PAC to adsorb the taste and odor causing compounds. In recent years, the City of Chatsworth has reduced the amount of water they are withdrawing from Carters Lake for drinking water. In the last couple of years, they are typically withdrawing in the 0.3 to 0.5 MGD range on average, although they are permitted to withdraw up to 2.3 MGD. Economically, it has been more advantageous to buy water from nearby water suppliers than to produce it themselves.

The extent of the algal problem increases during drought conditions when lake levels are low. The worst years the City has had regarding taste and odor complaints were in 2007 and the beginning of 2008, resulting in elevated treatment costs (approximately $65,000 per year). In 2007, the growing season average chlorophyll a levels at both the Coosawattee River embayment mouth station and Woodring Branch station were above 10 ug/L and in early 2008 (April and May), the chlorophyll a levels at both stations were well above the proposed criteria of 10 ug/L. The lake levels have returned to near normal pools since this time, with no other significant algal related drinking water issues. Chlorophyll levels in the lake should continue to decrease with the implementation of the City of Ellijay Total Phosphorus permit limit and the proposed reduction in agricultural non-point sources as a result of the future TMDL.

The City of Calhoun withdraws water from their intake located approximately 25 miles downstream from the Carters Re-regulation Reservoir dam, on the Coosawattee River. Calhoun has experienced problems with treating this source water due to elevated algal concentrations. These events generally occur in the spring from April to June and last approximately 2 to 6 weeks. During these events, the City of Calhoun feeds powdered activated carbon (PAC) to adsorb the taste and odor causing compounds at a cost of approximately $20,000 to $40,000 per year in added treatment costs. Although some of the nutrient loading to the Coosawatttee below Carters is contributed by other sources such as from the high agricultural landuse along this segment, outflow from Carters is a contributor.