Comments from Integrated Science & Engineering

From: Hope Larisey <hlarisey@intse.com>
Sent: Friday, April 10, 2020 12:46 PM
To: EPD Comments <EPD.Comments@dnr.ga.gov>
Subject: 305b/303d List (draft 2020) comments

Good morning Ms. Salter,

I reviewed the draft list (only for ISE clients) and found two items that appear to be typos:

Page 2
GAR030601080503
Chandler's Branch
Listed as the Chattahoochee Basin. Please double-check, As I believe this in the Savannah Basin.

Page 21
GAR031300050405
Flint River
In the Change column, it appears a typo is in the final line "Fishing Use "IS" (not "if") pending...

Kind Regards,
Hope

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INTEGRATED
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Engineering

Comments from Columbus Water Works

Columbus Water Works

Serving our Community
Protecting the Environment

June 4, 2020

Susan Salter
Watershed Protection Branch
Watershed Planning and Monitoring Program
2 Martin Luther King, Jr. Dr. SW
Suite 1152, East Tower
Atlanta, Georgia 30334

Dear Ms. Salter,

The Georgia Environmental Protection Division (GA EPD) has proposed degrading the status of the Walter F. George Reservoir (WFG) at the dam-pool and mid-lake stations based on chlorophyll *a* data. The proposed degradation changes the mid-lake station from category 3 (assessment pending) to category 5 (not supporting) and changes the dam-pool station from category 1 (supporting) to category 3 (assessment pending). Columbus Water Works is concerned that changing the status of these stations would prompt time consuming and expensive regulatory actions that would be of no benefit to enhancing the intended use of Walter F. George. Although the chlorophyll *a* standard has been occasionally exceeded, we see no evidence that water quality has degraded. We have funded two studies to review the dependence of chlorophyll *a* levels on reservoir phosphorus concentrations. Electronic copies of both of these studies are attached to this letter. A recent study we funded (*Review of the Chlorophyll a Standard for the Walter F. George Reservoir.pdf*) reviewed chlorophyll *a* and phosphorus concentrations over a 29-year interval. Key results from this study include the following:

1. The chlorophyll *a* for WFG is not trending upward. Although the data are not well characterized by linear or higher order polynomial fits, a visual review of a trend of growing season averages over a 29-year interval shows that chlorophyll *a* concentrations are not increasing but rather highly variable and not well correlated to phosphorus concentrations.
2. Further reductions in total phosphorus loads to WFG will have an insignificant impact on chlorophyll *a* concentrations in WFG. The analyses show that even if reservoir concentrations of phosphorus were consistently less than or equal to 20 µg/l, the chlorophyll *a* standard would still be periodically exceeded.
3. Further reductions to total phosphorus loads from point sources will have minimal impact on chlorophyll *a* concentrations in WFG. Nonpoint sources provide the majority of the total phosphorus load to WFG.
4. The GA EPD standard that limits chlorophyll *a* at the dam-pool and mid-lake stations is biased low. The Clean Lakes Study that was used to determine the chlorophyll *a* standard was based on data that were acquired from 1991 to 1993

when chlorophyll *a* values were lower than longer term, representative conditions. Higher chlorophyll *a* values occurred in subsequent years even though the total phosphorus concentrations were consistent with or lower than those that occurred during the Clean Lakes Study.

In 2008 we funded an additional study during which a CE-QUAL-W2 model was created and calibrated for WFG (*Assessment of Limits Being Considered on Phosphorus Discharged to Walter F. George Reservoir.pdf*). A few key results from that report are listed below:

1. Reducing point source loading of waste water treatment plants from current loads to loads that would occur with discharge concentrations of 1 mg/l produced only marginal decreases in chlorophyll *a* concentrations. Model simulations showed that even with these reductions, the standard would still be periodically exceeded.
2. The nutrient levels in WFG are relatively low, even with the addition of phosphorus by waste water treatment plants. The inflow to WFG, including the point sources from the Columbus area, has phosphorus concentrations that are among the lowest observed in the USA, with about 80% of hydropower reservoirs experiencing phosphorus concentrations greater than the concentration in the WFG inflow.
3. There are a multitude of factors, other than reservoir phosphorus concentrations, that affect the chlorophyll *a* concentration. Some of the items that were reviewed with model simulations included:

    a. Model runs with varying levels of phosphorus concentrations in algae. Algae can store phosphorus during times when it is readily available for periods when it is not available. This may be a primary reason why algal concentrations remain high even though phosphorus concentrations are low.
    b. Vertical mixing events which transport hypolimnetic phosphorus to the surface.
    c. Meteorology.
    d. Reservoir hydrology with the associated impact on residence time and nonpoint contributions from the watershed.
    e. Types of algal species and their specific requirements.

Columbus Water Works is committed to sustaining high water quality in the Chattahoochee River and WFG reservoir while maintaining affordable rates for our customers. The data show that the chlorophyll *a* levels are relatively low compared to other southeastern reservoirs. The observed fluctuations do not degrade the intended use of the reservoir. Furthermore, the phosphorus concentrations are currently extremely low and further reductions will result in negligible changes in chlorophyll *a* concentrations with an unnecessary additional expense to our customers.

The proposed status degradation for WFG is occurring because the chlorophyll a standard is biased low. Rather than degrading the status of WFG we would like to work with GA EPD to revise the chlorophyll *a* standard to create an effective standard that triggers the required regulatory actions when they are truly necessary. We would also like to work with GA EPD to come up with a better understanding of the driving forces that control the algal levels as well as other water quality concerns.

Sincerely,

Steve Davis
President
Columbus Water Works

Review of the Chlorophyll *a* Standard for the Walter F. George Reservoir

Prepared for

Columbus Water Works

Prepared by

Paul Wolff, Andy Sawyer, Jon Knight, and Jim Ruane
Reservoir Environmental Management, Inc.
Chattanooga, TN

May 2020

Introduction

The Georgia Environmental Protection Division (GA EPD) has proposed degrading the status of the Walter F. George Reservoir (WFG) at the dam-pool and mid-lake stations based on chlorophyll *a* data. The proposed degradation changes the mid-lake station from category 3 (assessment pending) to category 5 (not supporting) and changes the dam-pool station from category 1 (supporting) to category 3 (assessment pending). Changes in the status of these stations could result in regulatory actions that adversely impact CWW. GA EPD has issued a deadline to address these changes by June 5th 2020.

Columbus Water Works requested REMI's assistance in reviewing data and preparing a submittal to GA EPD. This summary report provides background on the chlorophyll *a* standard for WFG, and a review and discussion of the data associated with the chlorophyll *a* standard.

Background

The chlorophyll *a* standard for WFG requires that the growing season average for the dam-pool and mid-lake stations not exceed 15 and 18 μg/l, respectively more than once in a five-year interval (GA EPD, 2013b). The growing season average is computed with monthly photic zone composite samples. If multiple measurements are acquired for a given month, monthly averages are calculated before computing the growing season average.

This standard is based on a study conducted by GA EPD and by the Alabama Department of Environmental Management (ADEM) which is described in a three-part report (GA EPD and ADEM, 1993). The first part describes the study conducted by GA EPD which is based on data acquired in 1991. The second part describes the study conducted by ADEM which is based on data acquired from 1992 to 1993. The third part presents protection objectives and the corresponding nutrient limits and water quality criteria that are used to determine whether the water body is in compliance. Part 3 of the report specifies the chlorophyll *a* limits contained in the Ga EPD water quality standard. This document will subsequently be referred to as the Clean Lakes Study in this report.

The chlorophyll *a* standard for WFG is currently under review by GA EPD. A multi-faceted approach for determining the appropriate limits for each water body is described in *Georgia's Plan for the Adoption of Water Quality Standards* (GA EPD, 2013a). This document states that statistical methods in conjunction with models will be used to determine the numerical criteria. Two models that will be used to determine the criteria for Walter F. George include the Environmental Fluid Dynamics Code (EFDC) and the Loading Simulation Program (LSPC) both of which are maintained by Tetra Tech with EPA funding. REMI worked with Tetra Tech in 2013 to develop the EFDC model for Walter F. George.

Data and Discussion

The data used for this report include cholorophyll *a* and total phosphorus measurements collected by GA EPD and ADEM at the dam-pool and mid-lake stations. The data spans a 29 year interval from 1991 through 2019. Only growing season values from the months of April through October were used for the present analysis. Figures 1 and 2 present time series of monthly chlorophyll *a* data at the dam-pool and mid-lake stations while Figure 3 shows the growing season averages at each station. Figure 3 also shows the dam-pool and mid-lake station chlorophyll *a* standards.

Figures 1 and 2, as well as the average chlorophyll plotted in Figure 3 shows that there were no clear trends in the chlorophyll concentrations. The plot of the growing season averages contains consecutive multiyear intervals when the averages exceeded the standards and other intervals when the chlorophyll average concentrations were less than the standards. For example, from 1999 to 2003 the standards were generally exceeded while the standards were consistently met from 2008 through 2016. Although the data do not correlate well with linear or polynomial fits, a visual evaluation of the plots show that there is no consistent degradation of water quality as measured by chlorophyll *a* averages at either station.

In addition to inconsistent trends in the chlorophyll levels, total phosphorus concentrations from either lake location (Figures 4 and 5) were not in sync with the chlorophyll observations. For example, in 1999 and 2000 higher chlorophyll concentrations occurred when the total phosphorus concentrations were reduced. Conversely, 2004 and 2005 data showed an increase in total phosphorus without a corresponding increase in chlorophyll concentrations. These data suggest that the chlorophyll *a* standards resulting from the Clean Lakes Study did not take into account the long-term variability of chlorophyll concentrations or the inconsistencies of chlorophyll to phosphorus relationships.

Figures 6 and 7 show exceedance curves created using Chlorophyll *a* data collected between 1991 and 2019 at the dam-pool station (Figure 6) and between 1992 and 2019 at the mid-lake station (Figure 7) for two different levels of total phosphorus. These figures show that higher chlorophyll *a* concentrations do not correlate consistently with higher total phosphorus concentrations. For example, exceedance curves for the dam-pool station (Figure 6) show that when the dam-pool standard was exceeded, the higher chlorophyll *a* concentrations generally corresponded to lower total phosphorus levels (less than or equal to 20 µg/l). At the mid-lake station (Figure 7), when the chlorophyll *a* values exceeded the standard, the higher chlorophyll *a* concentrations corresponded to higher total phosphorus concentrations (greater than 20 µg/l).

The exceedance curves (Figures 6 and 7) also show that the chlorophyll *a* standard was exceeded with very low total phosphorus concentrations. For the dam-pool station, 28% of the values exceeded the standard when the total phosphorus concentration was less than or equal to 20 µg/l. For the mid-lake station, 21% of the values exceeded the standard when the total phosphorus concentration was less than or equal to 20 µg/l.

Figure 8 shows an exceedance curve of the mean April-October flow in the Chattahoochee River measured at the USGS Columbus gage 02341460. This curve includes each year contained in the growing season average time series (Figure 3) and shows where it lies on the flow exceedance curve.

The green labels denote years when the chlorophyll *a* standard was met at both stations while the red labels denote years when the standard was not met at one or both stations. Five out of the seven years when the standard was not met occurred during relatively low flow years with flow exceedances greater than 74%. Two of the years when the standard was not met occurred at higher flow years with flow exceedances less than 35%. The average flows for the Clean Lakes Study were greater than the median flow with exceedance values of 4%, 36%, and 44% for 1991 to 1993, respectively. Lower flow years exceeding the chlorophyll *a* standard is an expected outcome because lower flow years produce longer residence times for the water in the reservoir which provides more time for algae to grow. However, other factors are clearly involved because two of the years when the standard was exceeded occurred during higher flow years.

Figures 9 and 10 show total phosphorus exceedance curves at the mid-lake and dam-pool stations for flows less than or equal to 3600 cfs and for flows greater than 3600 cfs. A flow of 3600 cfs is the median flow for the data shown in the figures. The flows are seven day averages for measurements at the USGS Columbus Gage 02341460. Higher flows produced higher total phosphorus concentrations which is typical for reservoirs that are dominated by nonpoint source loads. The Clean Lakes Study (GA EPD and ADEM, 1993) also determined that the majority of the total phosphorus load originated from nonpoint sources with 61% originating from nonpoint sources as compared to 39% coming from point sources.

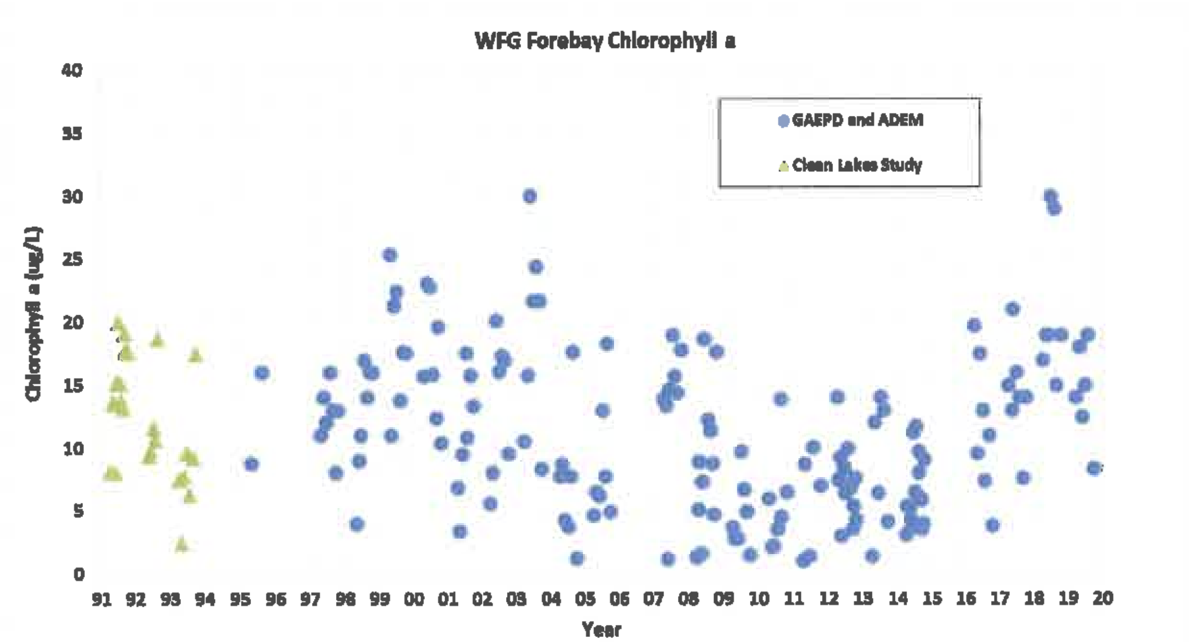

Figure 1 – Time Series of Chlorophyll *a* in the Dam-Pool Station

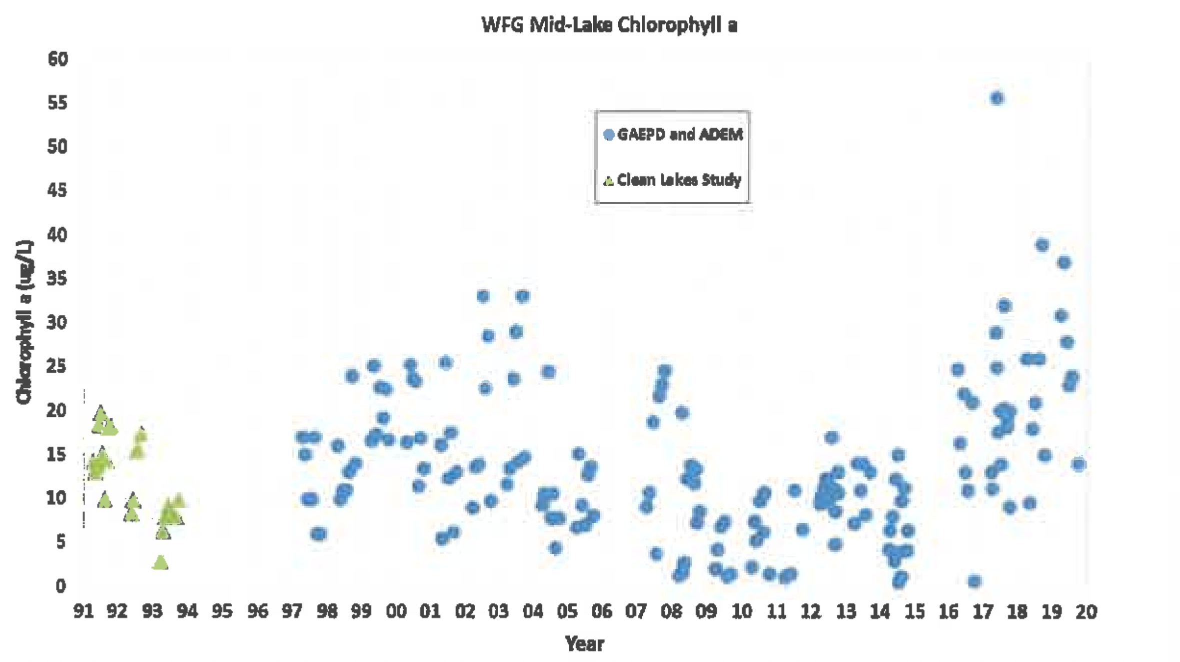

Figure 2 – Time Series of Chlorophyll *a* at the Mid-Lake Station

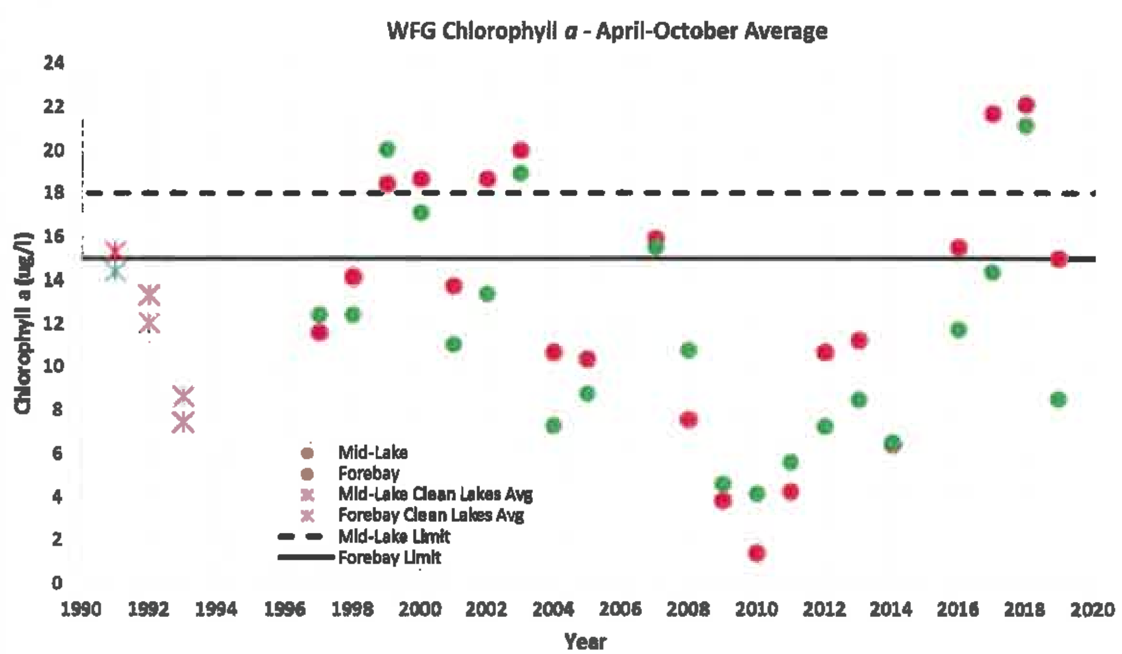

Figure 3 – Average Growing Season Chlorophyll *a* Concentrations at the Dam-Pool and Mid-Lake Stations

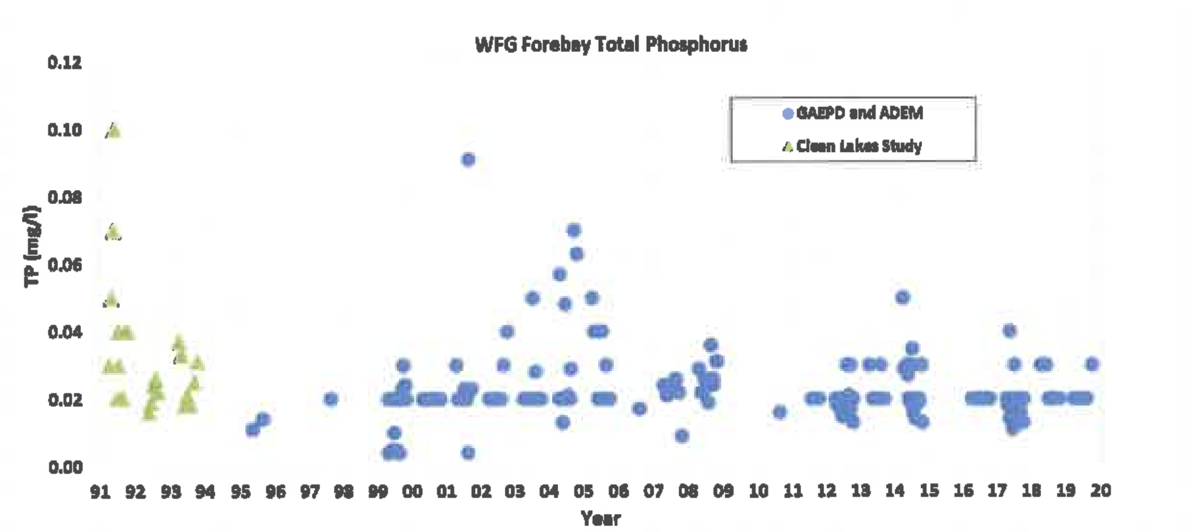

Figure 4 – Time Series of Total Phosphorus at the Dam-Pool Station

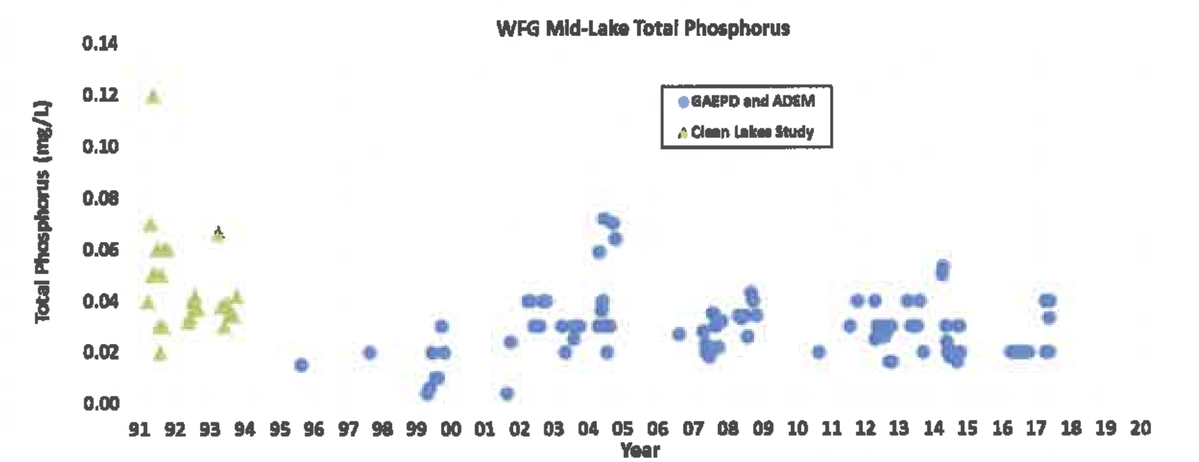

Figure 5 – Time Series of Total Phosphorus at the Mid-Lake Station

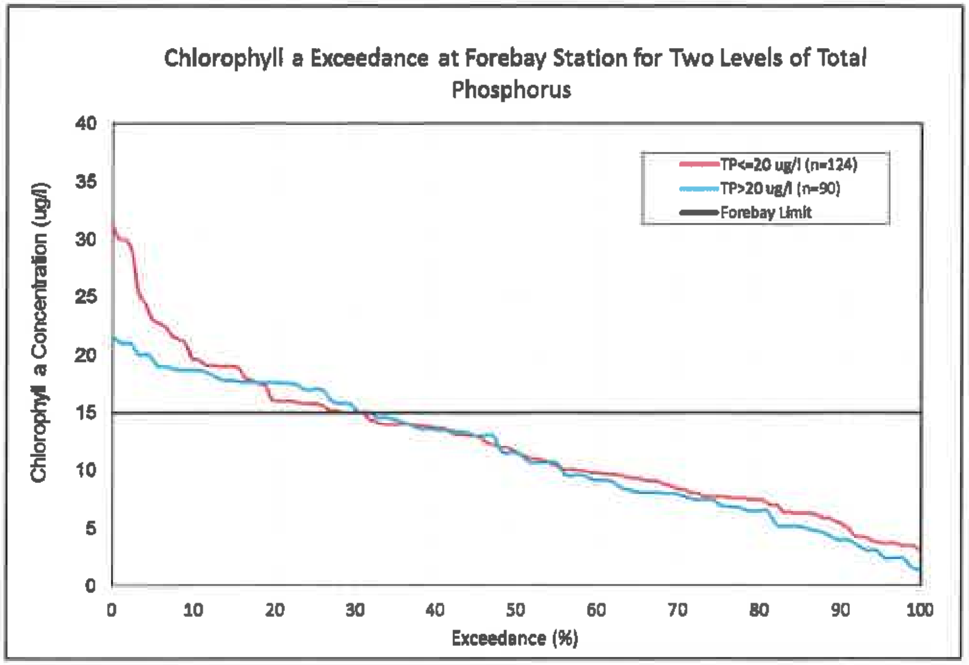

Figure 6 – Chlorophyll *a* Exceedance Curve at the Dam-Pool Station for Two Phosphorus Levels

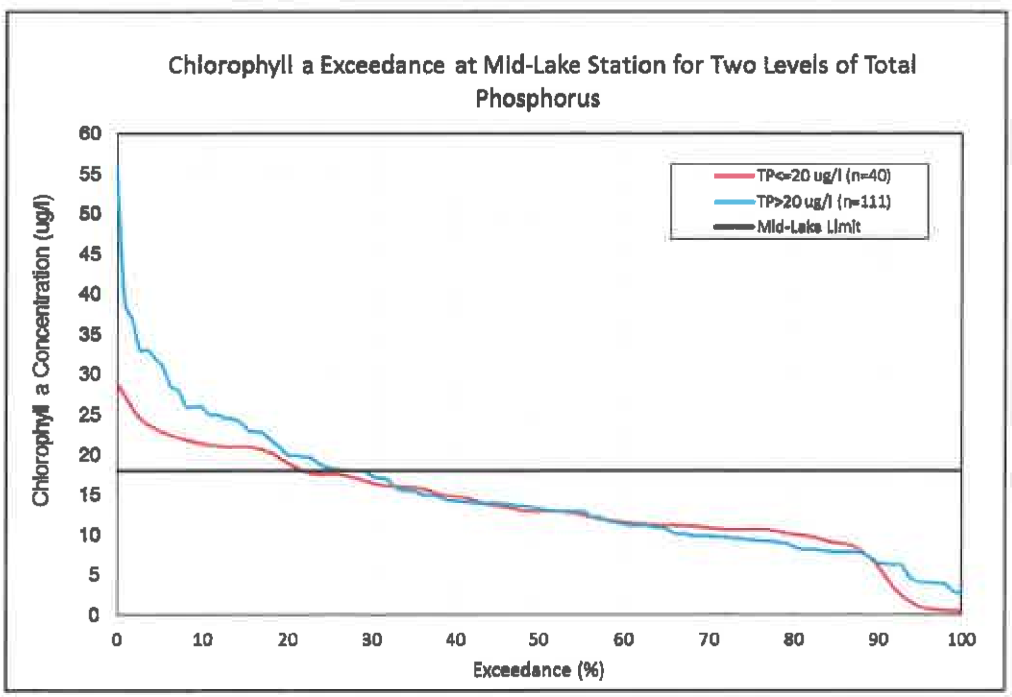

Figure 7 – Chlorophyll *a* Exceedance Curve at the Mid-Lake Station for Two Phosphorus Levels

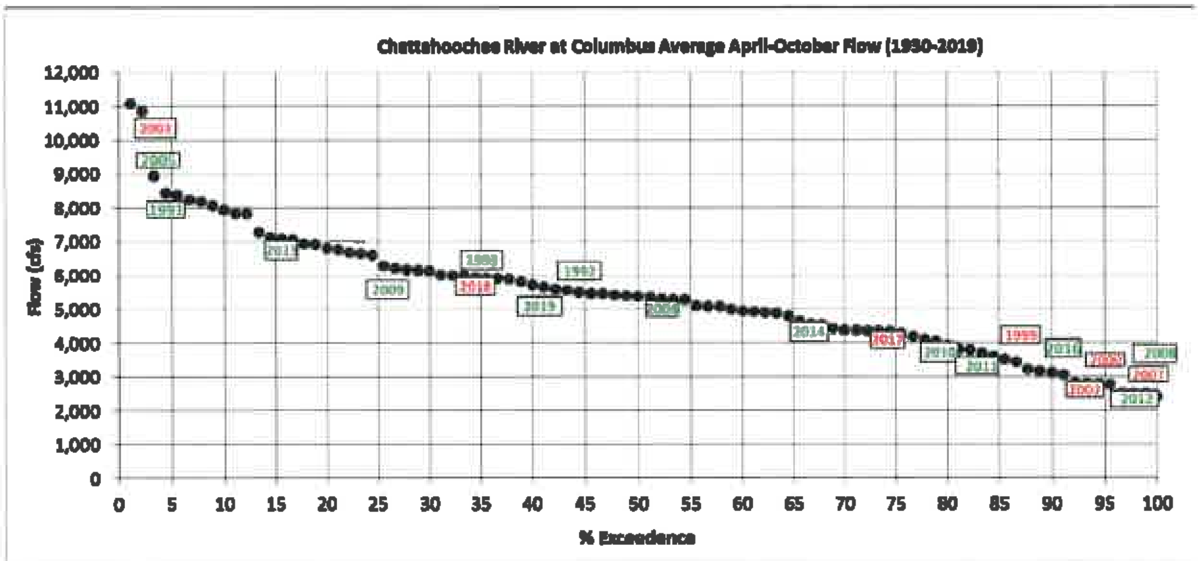

Figure 8 – Average April through October Flow Exceedance Curve (Green Labels Show Years When Chlorophyll *a* Growing Season Average Standard Was; Red Labels Show Years When One or Both Stations Exceeded the Standard)

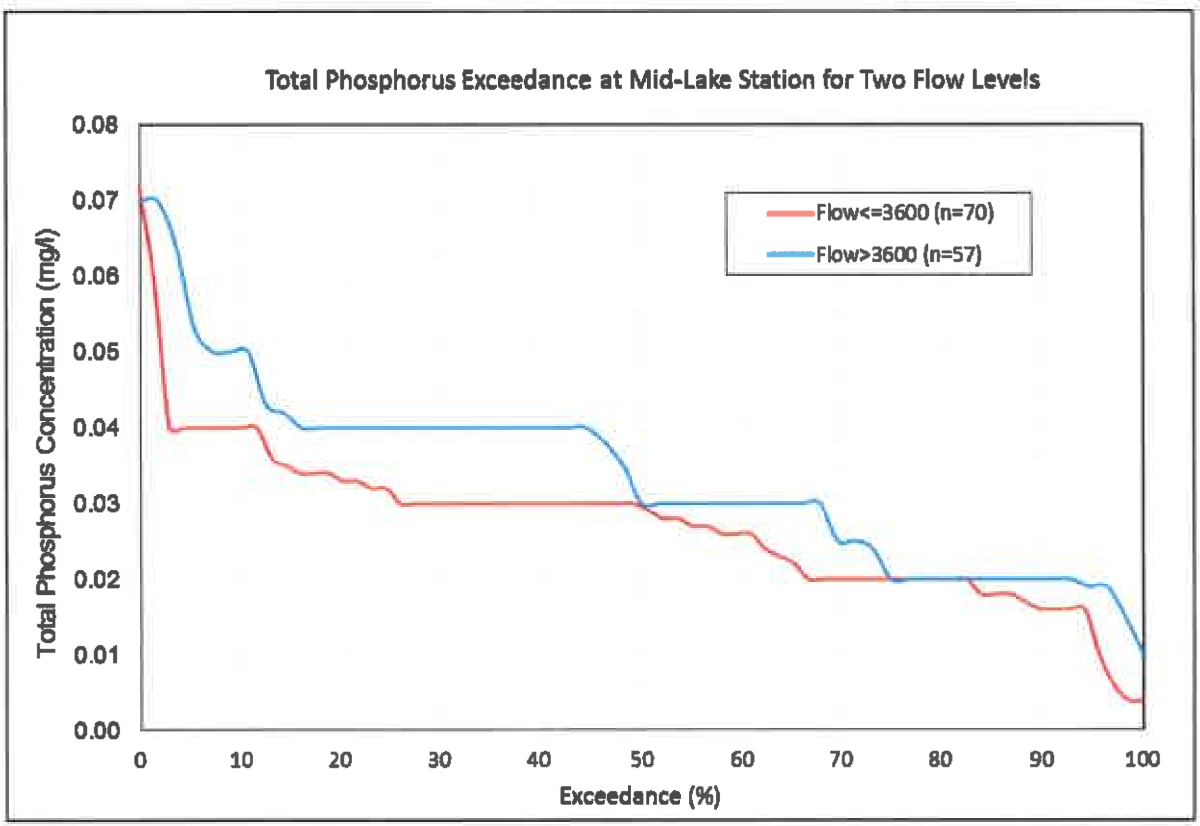

Figure 9 – Total Phosphorus Exceedance at the Mid-Lake Station for Low and High Flow Levels

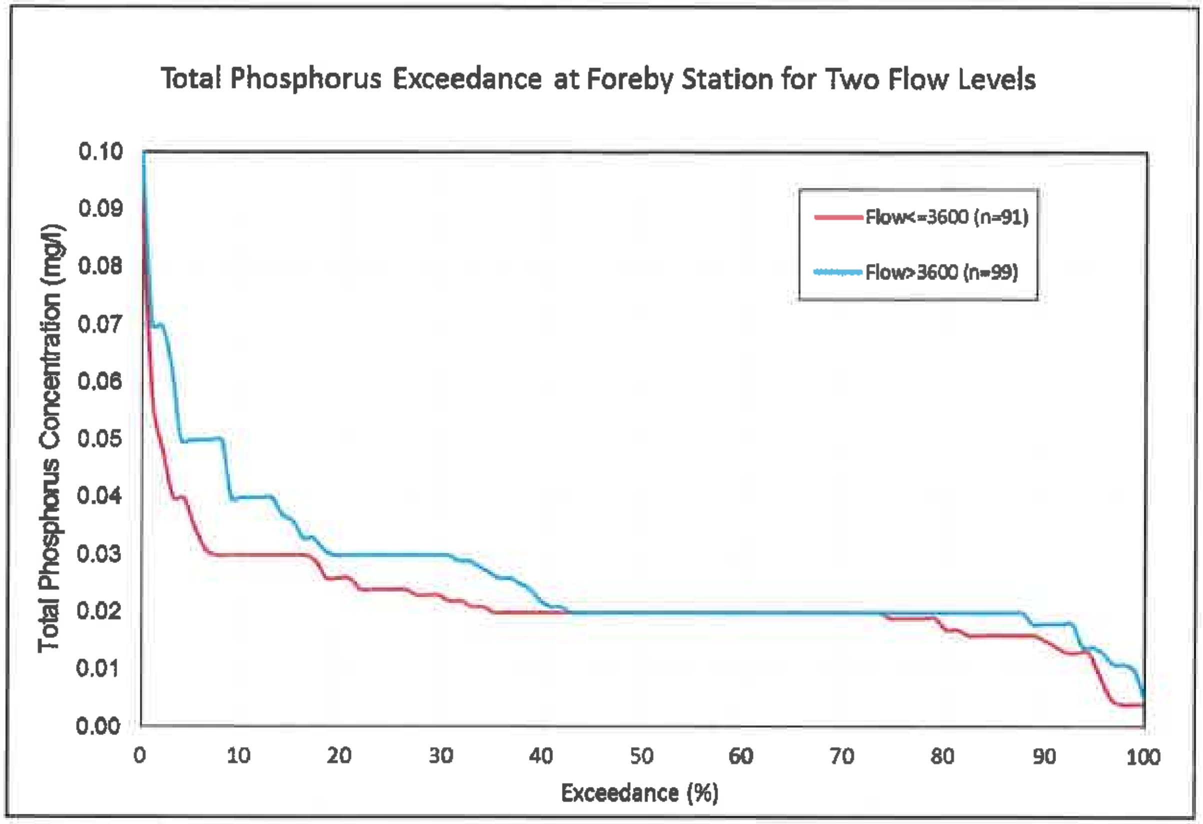

Figure 10 – Total Phosphorus Exceedance at the Dam-Pool Station for Low and High Flow Levels

Conclusions

A summary of key findings for this report include:

1. The GA EPD standard that limits chlorophyll *a* at the dam-pool and mid-lake stations is biased low. The Clean Lakes Study that was used to determine the chlorophyll *a* standard was based on data that were acquired from 1991 to 1993 when chlorophyll *a* values were lower than longer term, representative conditions. Higher chlorophyll *a* values occurred in subsequent years even though the total phosphorus concentrations were consistent with or lower than those that occurred during the Clean Lakes Study.
2. The chlorophyll *a* for WFG is not trending upward. Although the data are not well characterized by linear or higher order polynomial fits, a visual review of a trend of growing season averages over a 29 year interval shows that chlorophyll *a* concentrations are not increasing.
3. Further reductions in total phosphorus loads to WFG will have an insignificant impact on chlorophyll *a* concentrations in WFG. For the range of total phosphorus concentrations contained in this report, there is not a clear correlation between higher chlorophyll *a* and higher total phosphorus concentrations. Moreover, even if a goal of 20 µg/L total phosphorus concentration were met, 20-30% of the time the existing chlorophyll standards would be exceeded.

4. Further reductions to total phosphorus loads from point sources will not reduce chlorophyll *a* concentrations in WFG. Nonpoint sources provide the majority of the total phosphorus load to WFG.
5. The chlorophyll *a* standard for WFG is currently under review by GA EPD. It is important for CWW to be involved in the process to ensure that the standard is based on appropriate data and appropriate, well calibrated water quality and watershed models. This will help create a standard that is reasonable and includes all key causal factors contributing to the observed chlorophyll *a* concentrations.

References

GA EPD 2013a, Georgia's Plan for Adoption of Water Quality Standards for Nutrients, Georgia Environmental Protection Division, Atlanta Georgia, July 2013. (https://epd.georgia.gov/document/publication/ganutrientcriteriaplanaug2013revpdf/download)

GA EPD, *2013b 391-3-6-.03 Water Use Classifications and Water Quality Standards,* Georgia Environmental Protection Division, Atlanta Georgia, Oct 2013. (https://epd.georgia.gov/document/publication/391-3-6-03-triennial-13-final-editspdf/download)

GA EPD and ADEM, 1993, *Walter F. George Reservoir Phase I Diagnostic/Feasibility Study Final Report,* Georgia Department of Natural Resources Environmental Protection Division, Atlanta Georgia, and Alabama Department of Environmental Management, Montgomery Alabama. (http://www.adem.state.al.us/programs/water/wqsurvey/1993WFGeorge.pdf)

Assessment of Limits Being Considered on Phosphorus Discharged to Walter F. George Reservoir

Prepared for

Cliff Arnett and Billy G. Turner
Columbus Water Works

Prepared by

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Andrew F. Sawyer, REMI
Paul J. Wolff, PhD., WolffWare, Ltd

August 2008

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Assessment of Limits Being Considered on Phosphorus Discharged to Walter F. George Reservoir

The Georgia Environmental Protection Division (GAEPD) is considering limiting phosphorus concentrations in the discharges from wastewater treatment plants (WWTPs). Also, GAEPD is concerned that the water quality standard for chlorophyll a in Walter F. George (WFG) Reservoir was exceeded and that WFG was placed on the 303(d) list for GAEPD's 2006 report. However, WFG was not included in the 2008 303(d) listing.

This report provides an assessment of the effects of phosphorus on algal levels in WFG through the use of the CE-QUAL-W2 (W2) water quality model and limnological considerations. This report also addresses annual variability of algal levels observed in the lake, the level of uncertainty in predicting algal levels in the lake as a function of phosphorus concentrations in the inflows, and the risk to the successful lake fishery if phosphorus is reduced. The results of this assessment led to a recommendation that phosphorus not be decreased below current levels entering the lake. It is also recommended that the current chlorophyll a criteria be revised upward to account for the variability in chlorophyll a levels in low and high flow years even though total phosphorus (TP) in the inflow to WFG decreased 56% in 1996.

Background

Lake Standards for Chlorophyll a on WFG

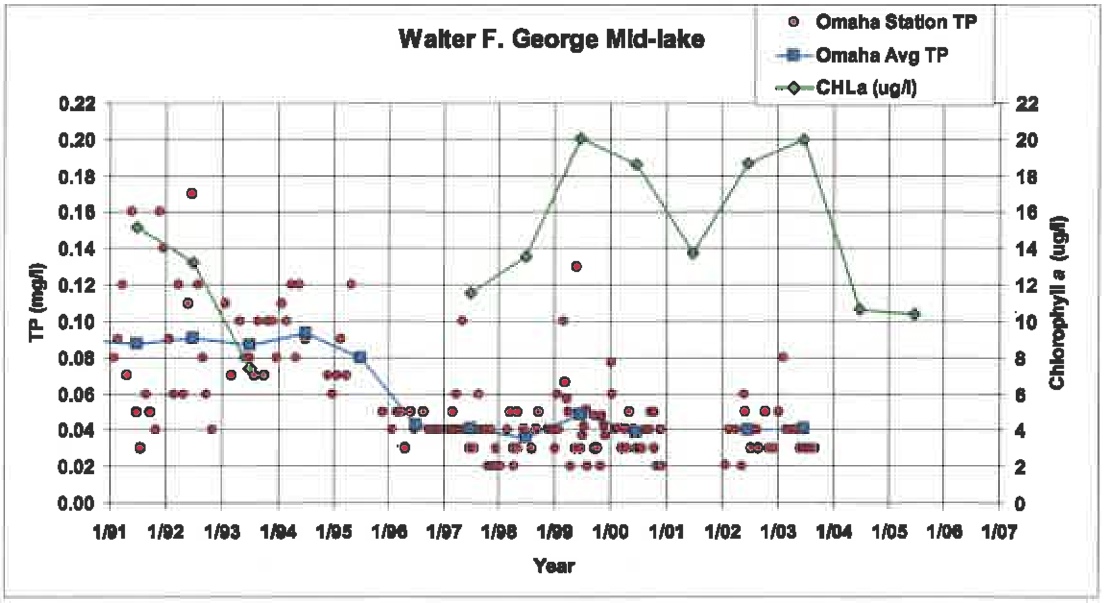
In the 1990 lake standards bill (O.C.G.A. 12-5-23.1), GAEPD was required to conduct comprehensive studies and develop water quality criteria for certain lakes like WFG. Standards were developed based on studies in 1991-1993 to establish "historical and 'current'" conditions. Monitoring for compliance began in 1997. The current chlorophyll a criteria were developed by GAEPD (and agreed to by the Alabama Department of Environment Management [ADEM]) using data from the early 1990s so that historical chlorophyll levels would not be increased by additional nutrient loads associated with anticipated future development; however, phosphorus loads from the Atlanta area and the rest of the watershed were reduced significantly in the middle 1990s due to the phosphate detergent ban. The criteria are 18 µg/L at the mid-lake station and 15 µg/L at the forebay. These criteria apply to the average of the measurements (usually monthly) during the April-October growing season. If the criteria are exceeded for more than one year over a five-year period, WFG will be listed by GAEPD under Section 303(d) of the Clean Water Act.

As GAEPD began to monitor chlorophyll a annually in 1997, the levels were at first similar to those measured in the early 1990s. As the residence times in WFG increased in 1999, 2000, 2001, and 2002 and the nutrient loads to the lake decreased due to low inflows, the chlorophyll levels increased (exceeding the chlorophyll a criteria in 1999, 2000, and 2002) even though phosphorus had been reduced in terms of concentration and load—see Figure 1. In 2003, the residence time was much lower than normal due to near-record high inflows (see Figure 2), but again, the chlorophyll a levels increased to levels exceeding the current criteria.

A closer review of the data (see Figure 3) presents the annual chlorophyll a levels together with inflow to WFG showing that chlorophyll a values were highest when flows were low and elevated compared to chlorophyll a levels during years with normal flows. Figure 4 presents the relationship between the ratio of chlorophyll a to total phosphorus (i.e., chlorophyll a/TP) and flow into WFG. Additional data review revealed that although TP in the inflow decreased about 56%, the TP at the Mid-Lake station decreased about 25%, and TP at the Dam Pool did not decrease (see Figure 5). While these results may at first appear to be counter-intuitive, they are consistent with limnological phenomena related to residence time in the lake and algal/ecosystem dynamics. An analysis using a water quality/ecosystem model provides the kind of information needed to develop understanding of the ecosystem dynamics and provide the linkages between inflows with their TP loads and the responses in the lake. This kind of information is particularly needed for evaluating the effects of point source controls for TP on lake ecosystem responses, particularly on algal dynamics and levels.

One reason for the exceedences of the current criteria is that the criteria are based on limited data collected under limited hydrologic conditions in the early 1990s. This approach may work for some reservoirs, but not reservoirs like WFG where residence time varies dramatically depending on hydrologic conditions. For example, under high flow conditions, the lake resembles a run-of-river reservoir with about 15 days residence time, compared to 45 days residence time in normal flow conditions. Under low flow conditions the lake is much more lake-like with about 90 days of residence time. These wide ranges in lake conditions significantly affect algal/ecosystem characteristics in WFG.

Another reason for this quandary is that current criteria are based on limited data with inadequate allowances for statistical variability in chlorophyll a levels. For example, in 1991 the mean chlorophyll a level over the growing season was 14.6 μg/L at the dam pool (i.e., only 0.4 μg/L less than the current criteria limit, but the standard deviation of the growing-season data is about 4 μg/L).



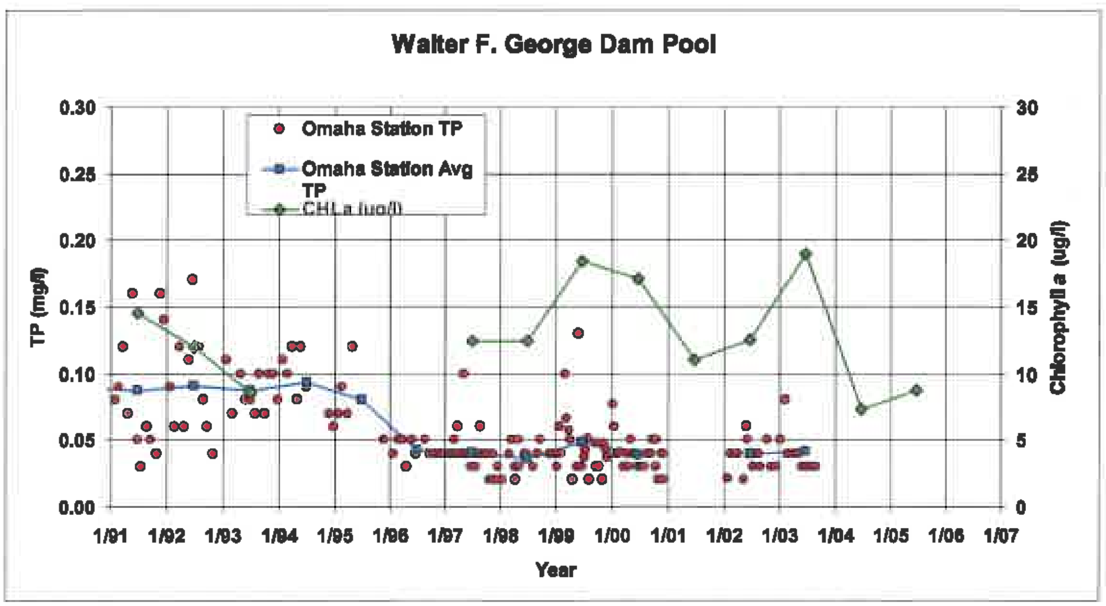


Figure 1: TP at Omaha Sampling Location (a Major Sampling Station for the Inflow to WFG) and Chlorophyll a at the Mid-Lake and Dam Pool Sampling Points Where the GAEPD Standard for Chlorophyll a is Established

Note: These figures show that even though TP decreased over 50%, Chlorophyll a is nearly the same or has increased—see the data for 1999, 2000, 2002, and 2003.

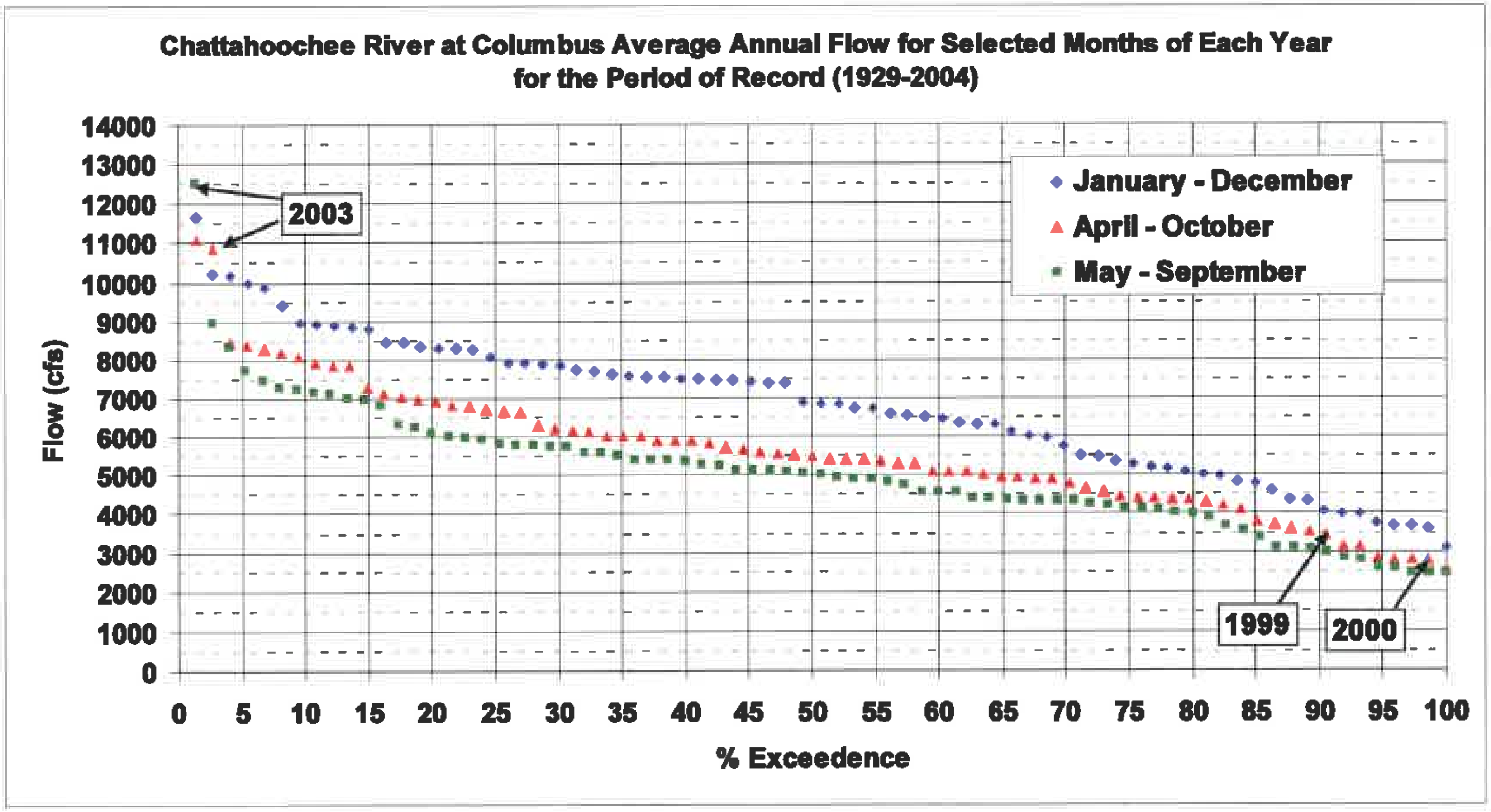
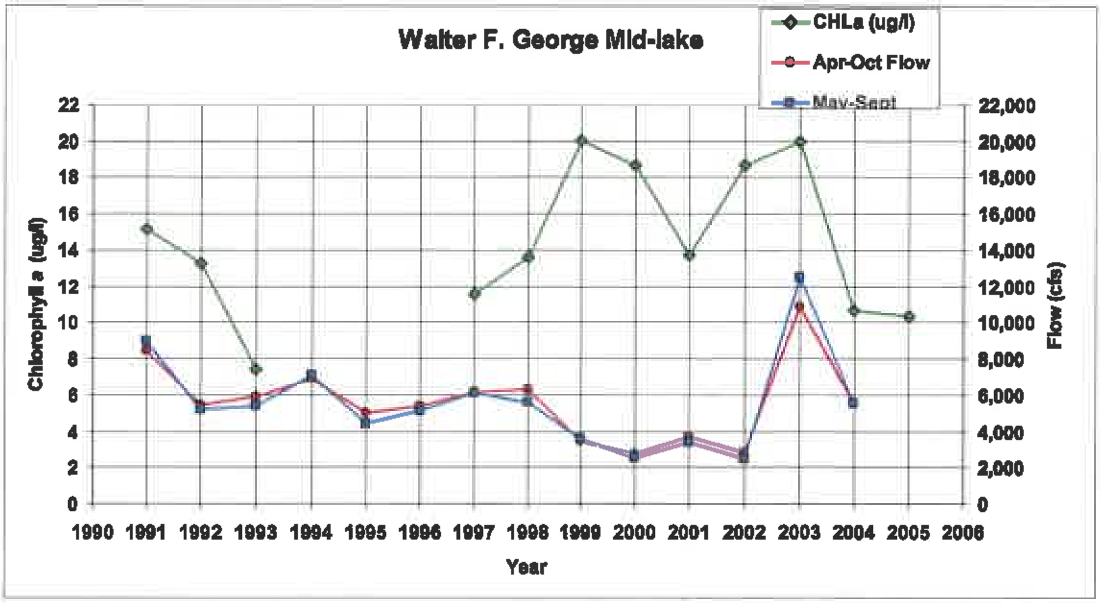


Figure 2: Frequency of Flow Exceedence at Columbus, GA for Mean Annual Flows for the Months of Jan-Dec, Apr-Oct, and May-Sept

Note: The 1999 and 2000 arrows point to the April-October mean flows, and the 2003 arrows point to the April-October and May-September mean flows.



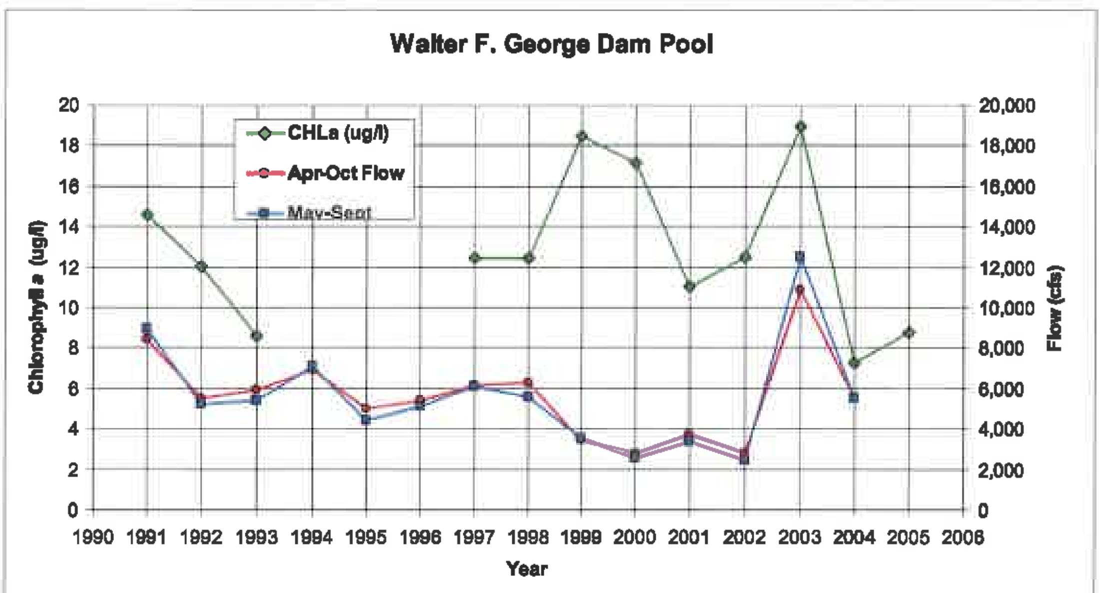
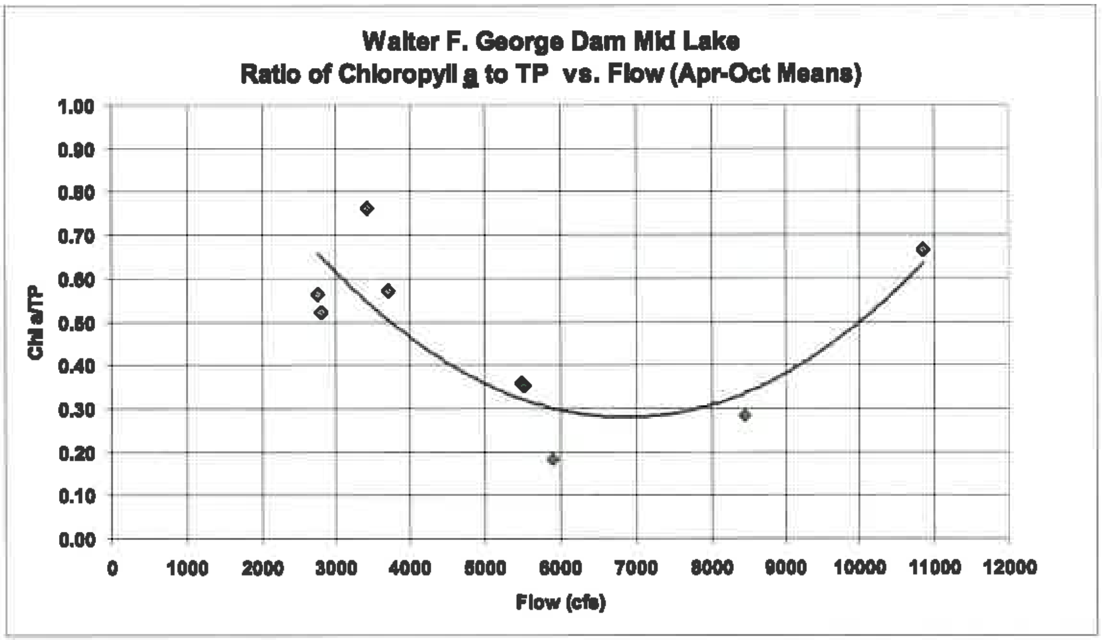


Figure 3: **Chlorophyll a** and Seasonal Flows **Plotted for the Period 1991 Through 2005**
Note: This figure shows that the higher mean levels of Chlorophyll a occurred during either low flow or a peak flow condition.



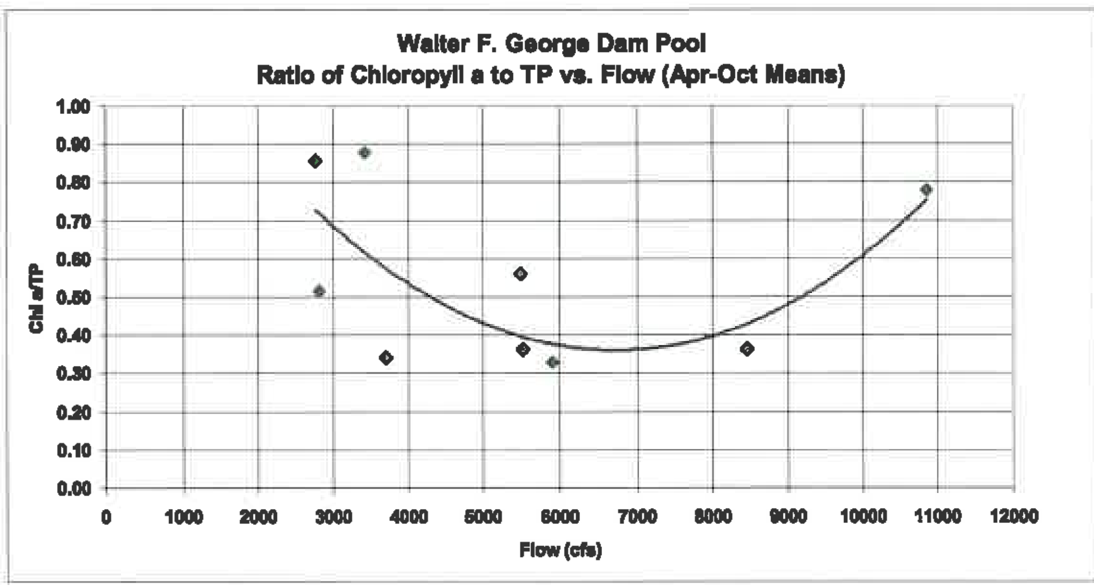
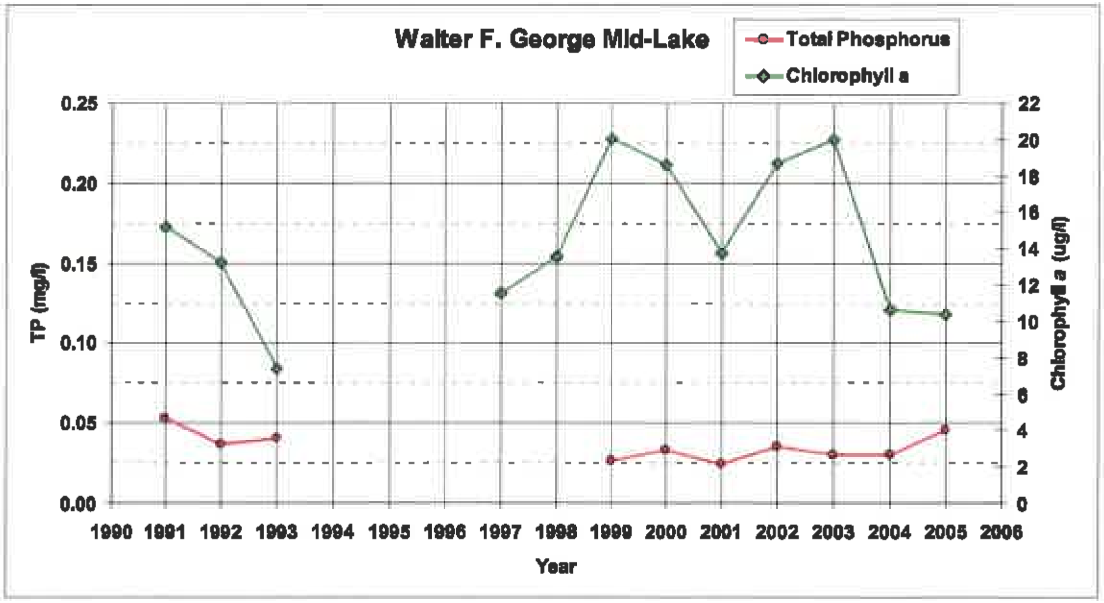


Figure 4: The Ratio of Chlorophyll a to TP at the Mid-Lake and Dam Pool Locations Plotted Versus Flow

Note: These plots show that the ratio of Chlorophyll a to TP varies significantly with flow through the reservoir system. The ratio at low and peak flows is about twice that at normal flows.



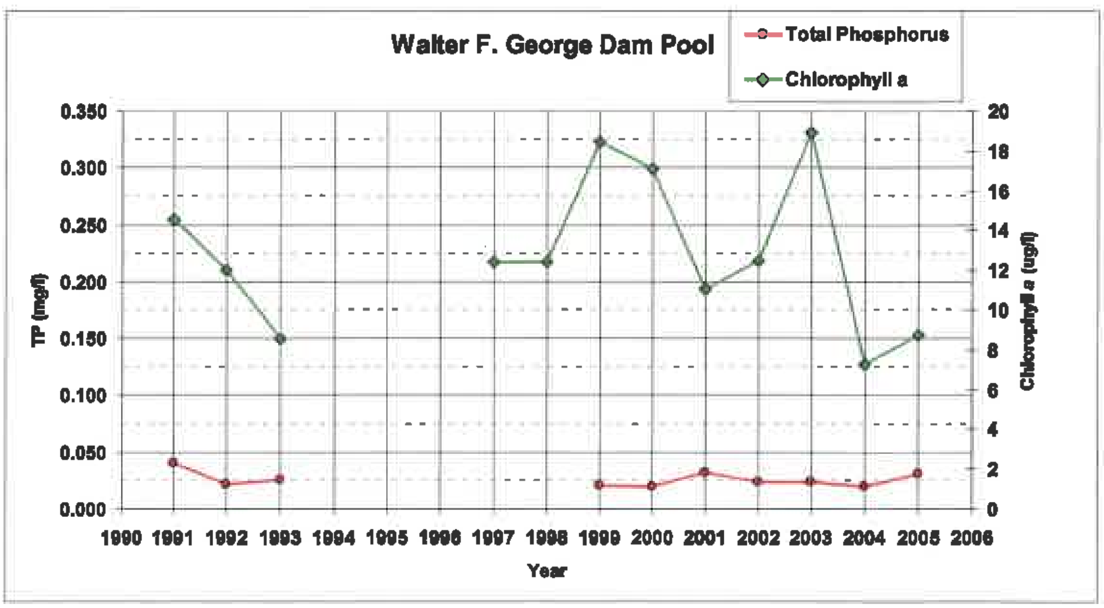


Figure 5: Chlorophyll a and TP at the Mid-Lake and Dam Pool Locations **Plotted Over Time**

Note: These plots show that TP at these locations has not decreased like TP at the Omaha location for the inflow to WFG. The plots also show that while TP does not vary significantly from year to year, Chlorophyll a does, especially in 1999, 2000, and 2003.

Phosphorus Discharges from Point Sources and Nonpoint Sources

The TP in the wastewater discharges from Columbus Water Works (CWW) averages 1.4 mg/L and on average they contribute about 23% of the TP load entering WFG (see Table 1). The main inflow from the Chattahoochee River upstream from Columbus contributes, on average, about 39% of the TP load, and local inflows between Columbus and WFG Dam contribute about 23%, for a total of 62% of the TP loading from watershed sources. The concentrations of TP in the Chattahoochee River as it enters WFG are about 0.02 mg/L, a relatively low phosphorus concentration for a large river with a highly developed watershed in the Southeast, including the Atlanta metropolitan area. The local inflows also contribute about 0.02 mg/L TP; but this is an estimate based on limited data on the tributaries as well as the processing of this TP as it passes through embayments before it reaches the mainstem of WFG. The discharges from Fort Benning contribute about 5% of the TP and Phenix City is estimated (i.e., TP data were not available on the discharges from Phenix City) to contribute about 8% of the TP to WFG. The City of Eufaula also discharges wastewater to WFG, and contributes about 2% of the TP entering WFG. This distribution of TP from the various sources is consistent with Bayne et al. (undated), who conducted an assessment based on data from the early 1990s.

The inflow to WFG, including the point sources from the Columbus area, has phosphorus concentrations that are among the lowest observed in the USA, with about 80% of hydropower reservoirs experiencing TP concentrations greater than the concentration of TP in the WFG inflow (based on project data collected for EPA Office of Water and Idaho Power).

There are very little data on nonpoint sources. This lack of data is important considering that the total drainage area above WFG Dam includes about 37% local drainage area between Columbus and the WFG Dam. The limited data that were available from recent sampling efforts were collected from Pataula and Hannahatchee Creeks. The available data on these creeks indicated that they are all low nutrient systems, although the limited 2008 data on Hannahatchee indicated that nutrients could be elevated possibly due to development in the watershed. Bayne et al. reported TP data on tributaries from Alabama for the period November 1992 through October 1993, and the mean TP for these tributaries was about 0.04 mg/L. This level of TP is twice that assumed for this report, so the assessment of the effects of point sources on eutrophication should be conservative, i.e., the predicted effects of point source reductions of TP on eutrophication should be greater than would actually occur.

It also should be noted that inorganic nitrogen was reported to be low (near 0.1 mg/L) in all of the tributaries.

Table 1. Phosphorus loads entering WFG Reservoir

Current Conditions					
	Analysis of TP Inputs for Whole Lake				
	Average Annual				
	TP, mg/L	Flow, cfs	Load, lbs/day	Percent	
Chatt. R	0.02	5,634	602	39	MDAs
Phenix	4.5	5.2	125	8	est
CWW	1.4	47	351	23	
FB	3.2	2.5	43	3	
FB	2.6	2.6	36	2	
Eufaula	2.3	2.5	31	2	
Local Inflow	0.02	3366	359	23	est
Derived Inflow	0.032	9,060	1,547	100	

Calibration of the CE-QUAL-W2 Model to Assess the Effects of a Potential Decrease in TP and to Provide Input for Developing Updated Chlorophyll a Criteria

An earlier version of W2 originally was set up for WFG by the U.S. Corps of Engineers (USCE), using data from the years 1992 and 1994. In 2000, the USCE version was modified and applied to WFG by Hauser (Loginetics, Inc.) and Ruane (Reservoir Environmental Management, Inc. [REMI]) for designing a skimmer device in front of the dam to draw water with better quality into the discharges from WFG.

For this 2008 assessment, the 2000 model was upgraded to version 3.11 that accommodates three assemblages of algae and improved water quality formulations. This allowed an evaluation of algal assemblages that have different characteristics so that natural variability in algal conditions can be simulated and related to chlorophyll a in the lake. The model was set up for two years having low flow hydrologic conditions but different water quality conditions: 1999 experienced chlorophyll a levels that exceeded the GAEPD and ADEM criteria, and 2004 experienced chlorophyll a levels that were less than the criteria. The model was calibrated to water quality data collected by GAEPD and ADEM during these two years. These calibrated models, together with published literature and interpretation of results, provide the information needed to characterize the algal and chlorophyll a dynamics in WFG. The results show that observed chlorophyll a variations in WFG are consistent with limnological phenomena related to residence time in the lake, water quality, and algal dynamics. This task provides the scientific basis for natural variations causing periodic chlorophyll a excursions beyond the current criteria. ***One dominant dynamic that occurs in WFG: long residence time in low flow years ⇨ low NO_x ⇨ blue-green algae ⇨ high chlorophyll a***

The results will include:

1. water quality analyses that show the relationship between chlorophyll a and the main factors that affect its variability.
2. an explanation as to how normal algal dynamics lead to excursions beyond current criteria.
3. an explanation as to why 1991-1993 data were not sufficiently representative of chlorophyll a conditions in WFG to be used to develop multi-year criteria.
4. an assessment of the effects of further reductions in TP loads on WFG.

Modeling Approach

CE-QUAL-W2

CE-QUAL-W2 (W2), is a two-dimensional, hydrodynamic and water quality model for reservoirs and rivers. The W2 model is deterministic (i.e., mechanistic), not stochastic. Modeled temperatures within WFG are driven by boundary conditions including inflows, outflows and their withdrawal zones, and inflow temperatures, and by other forcing functions such as heat loads and atmospheric heat exchange driven by meteorology. Modeled water quality within WFG is driven by inflow water quality (especially temperature, organic matter, nutrients, turbidity, etc), transport of water through the lake, solar radiation and wind, algal production and death, bacterial decomposition, and sediment-water interactions. Calibration and application of the model to WFG water quality required interdisciplinary knowledge of hydrodynamics, heat transfer, power plant operations, meteorology, numerical methods, computerized data assembly and analyses, physical/chemical/ biological processes and stoichiometry, limnological processes, lake sediment processes and sediment-water interactions, stream hydrologic and water quality processes, and statistics.

In planning mode (looking back and comparing effects of various operations), historical measurements are typically used as boundary conditions. In forecast mode (projecting into the future), boundary conditions are unknown so the user must take care to provide meaningful boundary condition projections. Since forecasts of future hydrologic conditions are not reliable, projecting boundary conditions often involves use of analogous historical years or sensitivity simulations covering a range of possible futures.

These studies and modeling efforts are based upon state-of-the-art approaches that are logical, sound extensions of well-founded research and studies conducted over the past half century. With any use of models it should be recognized that modeling results provide a general indicator of what is likely to occur under given sets of conditions. As is the case in all aquatic environments, natural conditions are more complex than models, so the models tend to reproduce the major patterns that are observed in the field, but will lack resolution, inputs, or formulations to reproduce all of the minor patterns that are observed. Models are internally consistent and based on rigorous governing equations, so they can often help explain apparent discrepancies in field observations. The model results contained in this report are scientifically sound and intended for regulatory decision-making purposes for determining the water quality changes attributable to reducing nutrient loads to WFG.

In the course of calibrating the W2 model for WFG, it was determined that the following modifications to version 3 would improve the performance of the model for meeting the objectives.

1. Provide for the phosphorus and nitrogen content of organic matter (i.e., ORGP and ORGN in the model control file) to be different for labile and refractory organic matter (note: labile matter decays over days and weeks; whereas refractory matter decays over months and years)—this was desired since refractory matter accounts for much of the organic matter, but has very little phosphorus and nitrogen content. This

modification allowed a more effective calibration to the data through more direct control over mass of phosphorus and nitrogen in the system. The procedure for fractionating labile and refractory organic matter and estimating the phosphorus and nitrogen content of organic matter in the lake will be presented in a later section.

2. Provide for the release of organic matter from the sediments under hypoxic conditions—this was desired since this organic matter exerts an additional dissolved oxygen (DO) demand in the water column, and it allows the modeler to include this source of organic matter in the model to allow more effective calibrations to measured data. The release of organic matter from sediments has long been recognized, but has only recently been addressed in water quality modeling (DiToro, 2001; Chapra, 1997). Version 3.11 of CE-QUAL-W2 was modified to allow labile dissolved organic matter to be released from sediments (LDOMR) when the DO over the sediments was less than O2 LIMIT, the setting used to determine when sediments release anoxic products (i.e., when anaerobic processes occur at the sediment-water interface and release ammonia, phosphorus, and iron). LDOMR was set to be a fraction of the sediment oxygen demand (SOD), in a fashion similar to how other anoxic products are handled in W2. The setting for LDOMR was consistent with the stoichiometry for DO demands associated with organic matter presented by DiToro, 2001 and Chapra, 1997.
3. Provide the option to use the Wuest wind drag coefficient—this was desired so that a higher level of mixing could be induced under low wind speed conditions. The W2 default formulation sets the drag coefficient to zero for winds less than 1 m s^{-1}. However, according to Wüest and Lorke (2003), weak winds have drag coefficients that are significant. At high wind speeds, the Wuest formulation produces lower drag coefficient than the W2 default.
4. Provide for making W2 conserve phosphorus when ALGP (the phosphorus content in algal assemblages) is not equal to ORGP (the phosphorus content in organic matter).

Documentation for the release version 3 of W2 is provided in the W2 user manual authored by Cole and Wells (2002), currently available at the following web address:

http://www.loginetics.com/w2/docs/manualv311.pdf

W2i and AGPM

W2i is a graphical user interface and pre-processor for W2 that streamlines development and checking of W2 input files, viewing of bathymetry, locating meteorological stations, executing the W2 model, and launching of the Animation and Graphics Portfolio Manager (AGPM) post-processor. The AGPM is a graphical post-processor for W2 that includes a range of plot types, including animations, vertical profiles, time-series, time-depth plots, etc. AGPM is the primary vehicle for plotting and viewing outputs from the model.

Determination of Labile and Refractory Organic Matter and Nutrient Content of Organic Matter

Organic matter and its phosphorus and nitrogen content are important components in ecosystem models like CE-QUAL-W2. In the release version of W2 all organic matter is assumed to have the same nutrient content, i.e., ORGP and ORGN are the same for both labile and refractory matter. However, in the Loginetics version of W2, labile and refractory matter has different quantities of phosphorus and nitrogen. Considering that special studies are required to fractionate organic matter into the labile and refractory components, a procedure was developed to compute these fractions from commonly measured data.

To estimate labile organic carbon (TOC_L) and refractory organic carbon (TOC_R) two equations are required:

$$TOC = TOC_L + TOC_R \quad (1)$$

$$TON = TON_L + TON_R \quad (2)$$

Where:

TOC = total organic carbon
TON = total organic nitrogen
TON_L = nitrogen content of labile organic matter
TON_R = nitrogen content of refractory organic matter.

Equation 2 is reformulated into labile and refractory nitrogen versus carbon ratios with the following transformation:

$$TON = (TON_L/TOC_L)*TOC_L + (TON_R/TOC_R)*TOC_R \quad (3)$$

Where:

$TON_L/TOC_L = 1/5.6$ (i.e., N/C = 8/45 or 7.2/40 from Wetzel, 2001; Bowie et al., 1985; Sterner and Elser, 2002); and

$TON_R/TOC_R = 1/50$ (Wetzel 2001) (also consistent with others)

Equation 3 can be solved for TOC_L, using Equation 1 to eliminate TOC_R, and using the TON/TOC ratios shown above, to produce Equation 4:

$$TOC_L = 6.31*(TON - 0.02*TOC) \quad (4)$$

Both TON and TOC are measured by GAEPD and ADEM. Once TOC_L is computed from Equation 4, TOC_R can be computed from Equation 1.

Because of luxury uptake of phosphorus by algae, it is important to compute ORGP from available data for the different years that are modeled. The determination of ORGP was based on two equations. In Equation 5, total organic phosphorus is computed from the total phosphorus (which is a measured variable) and the total inorganic phosphorus which is equivalent to the ortho-phosphate (O-P) measurement:

Total Organic Phosphorus = Total Phosphorus – Total Inorganic Phosphorus. (5)

Total organic phosphorus can also be computed by considering the total organic matter and ORGPL and ORGPR as shown in Equation 6:

Total Organic Phosphorus = $ORGP_L$ (LDOM + LPOM) + ($ORGP_R$/$ORGP_L$)*RDOM) (6)

where:

LDOM = labile dissolved organic matter. This was assumed to be 2.2 * TOC_L

RDOM = refractory dissolved organic matter. This can be determined from Equation 1 and by assuming that the ratio of refractory organic matter to refractory organic carbon is 2.2.

LPOM = labile particulate organic matter. This was estimated by assuming that the ratio of labile particulate organic matter to volatile suspended solids is 0.81. Note that the organic phosphorus supplied by the refractory particulate organic matter is negligible.

$ORGP_L$ is then determined by substituting the total organic phosphorus computed in Equation 5 into Equation 6 and then solving for $ORGP_L$. As mentioned previously, the code for the W2 model was revised to allow the use of $ORGP_L$ and $ORGN_L$ for labile organic matter and $ORGP_R$ and $ORGN_R$ for refractory organic matter. The ratios of refractory to labile ORGP and refractory to labile ORGN were both assumed to be 0.1. The quantity 0.1 is based on observations in the differences between TON_L and TON_R; the references presented above; and data from Everglade studies (Dierberg, 2003).

For the purpose of estimating ORGP, it is preferable to have data on O-P so that the phosphorus associated with organic matter can be estimated. Since GAEPD O-P data were less than detectable, estimates of O-P were developed based on experience. Using these estimates of O-P, ORGP was calculated for the mid-lake and forebay of WFG and found to be 0.0025 for 1999 and 0.0038 for 2004.

Considering that W2 allows only one value of ORGP to be used for the entire waterbody, an average of the forebay and mid-lake values was used for WFG. After selecting this value, O-P was back-calculated for all the inflows to WFG. The estimated stoichiometric values for Carbon/Phosphorus in organic matter and the values of ORGP and ORGN used in the model are consistent with those presented by Wetzel (2001) and Bowie et al. (1985).

Although 1999 and 2004 were the only years modeled for this report, ORGP values were determined for other years using the same approach. The results of the ORGP determinations were developed using median or average data for the following periods: 1992-1993: ORGP was 0.0051 for the forebay and 0.0058 for the mid-lake; 1999-2004: ORGP was 0.0045 for the forebay and 0.0052 for the mid-lake. Although the ORGP values for the latter years were lower by about 11%, all of these values are significantly greater than those determined for 1999 and 2004, especially 1999. Low ORGP values indicate that labile organic matter in the lake was produced using less phosphorus.

It is interesting to note that ORGN values were nearly the same for all years: 0.08, even though NO_x and NH_x were near zero for half of the samples from the forebay. It is also worth noting that most elevated values of chlorophyll a occurred when NO_x and NH_x were near zero, indicating the presence of blue-green algae (i.e., cyanobacteria) that are nitrogen fixers. Organisms that are nitrogen fixers can convert N_2 (i.e., nitrogen that dissolves in the lake water from the atmosphere like O_2) to organic nitrogen and grow and produce new cells without the need for NO_x and NH_x. It should be noted that high chlorophyll a values occurred in the forebay in summer and autumn months only when NO_x and NH_x were low, except in the year 2003 when residence time was low and the forebay experienced water quality through August similar to mid-lake conditions.

Model Calibration

The W2 model was calibrated for 1999 and 2004. Appendix A presents the calibration and other information regarding the development of the models for these two years. The results of the calibrations presented herein focus on the calibration for nutrients and algae and observations about water quality in the lake that are revealed by modeling these two years.

1999 Calibration

The 1999 calibration is presented in Figures 6 through 9. These figures present the results of nutrient and algae calibrations at the forebay and mid-lake monitoring points. Figures 6 and 7 present the results for calibration to NO_x, TP, chlorophyll a, and TOC at the forebay and mid-lake stations. Figures 8 and 9 present the results of algal mass simulations for three assemblages of algae.

Calibration to NO_x in the forebay (see Figure 6) is good and represents the low NO_x ecosystem that occurs in the forebay that causes nitrogen fixers (e.g., cyanobacteria) to grow. Calibration to TP is representative of data collected in the forebay. GAEPD TP data have an minimum detectable amount (MDA) of 0.02 mg/L, and "less than values" were assumed to be 0.015 mg/L. The data less than 0.015 mg/L shown in the plot were collected by ADEM. Calibration to better fit the ADEM data would have required a lower value for ORGP, that for 1999, was already lower than that determined for other years, at least for a lake-wide value for ORGP. The calibration to chlorophyll a was good except for two values in April; but attempts to calibrate to these data were unsuccessful, somewhat influenced by the lower values observed in April at the mid-lake station. Considering that ORGP and ALGP values are the same for lake-wide conditions, the model cannot be calibrated to represent diverging algal dynamics in the same timeframe. Calibration to TOC in the forebay was good.

Model-predicted algal masses in the forebay are presented in Figure 8, showing the total mass and the mass for algal assemblages 1, 2, and 3. Algae 1 is representative of diatoms as the dominate species, and Algae 3 is representative of cyanobacteria as the dominate species. Algae 2 was not a dominate algal assemblage, but would have increased significantly if Algae 3 had been limited to cyanobacteria instead of representing a broader assemblage of algae. It should be noted that a consideration for algae growth in the calibration were the results from GAEPD and EPA's AGPT study in June 2008 providing growth rates and maximum standing crop at the forebay and mid-lake station. The algal dynamics predicted for the mid-lake station are shown in Figure 9, and the assemblage patterns are similar to that shown for the forebay, but the algal mass levels are about 35% greater at the mid-lake station.

Calibration to NO_x at the mid-lake station (see Figure 7) is good, but on two occasions the model predicted near-zero levels (days 130-160 and 190-210). Examination of model predictions in adjacent model segments revealed that these drops to near-zero levels did not occur, so overall lake model predictions would not be affected substantially (note: these drops in NO_x to near-zero levels occurred during reservoir operations that moved water away from the mid-lake station to adjacent segments, but the model apparently over compensated for these events). Algal growths did not appear to be affected by these low NO_x events. The other modeled constituents are calibrated to about the same goodness of fit as those for the forebay; but, as expected, TP and chlorophyll a were at levels greater than observed in the forebay.

The algal mass and chlorophyll a levels predicted for the forebay were less than predicted for the mid-lake station. This is not unexpected considering data collected in other years over a 15-yr period; but, in 1999, the mean chlorophyll a levels over the growing season were about the same with 17 μg/L observed at the mid-lake station and 18 μg/L observed at the forebay. The predicted levels compared to the 1999 observations indicate that the model has some limitations that cannot be remedied during the timeframe and budget allocation for this study. What likely occurred in the lake was that the two locations had different assemblages of algae with different characteristics (i.e., growth rates, stoichiometry, ratio of chlorophyll a to algal mass, etc.), and the model currently is programmed to model three algal assemblages that have lake-wide settings.

2004 Calibration

The 1999 model settings for rates and coefficients that control the ecosystem processes within the W2 model were used to calibrate the model for 2004, with the exception of ORGP and one other setting (PO4S) for phosphorus sorption and settling. As discussed earlier, the stoichiometry represented by ORGP (i.e., the ratio of phosphorus to organic matter) was determined based on data to be lower for 1999 than for 2004, so this setting is different between the two years. The 1999 setting for PO4S was a relatively low value at 0.025 m/day and was used to account for sorption of phosphorus on inorganic suspended solids that settle in the lake and to improve the calibration based on observed versus predicted average TP at the forebay and mid-lake stations.

The 2004 calibration is presented in Figures 10 through 13. These figures present the results of nutrient and algae calibrations at the forebay and mid-lake monitoring points. Figures 10 and 11 present the results for calibration to NO_x, TP, chlorophyll a, and TOC at the forebay and mid-lake stations. Figures 12 and 13 present the results of algal mass simulations for three assemblages of algae.

Calibration to NO_x in the forebay (see Figure 10) is good and represents the low NO_x ecosystem that occurs in the forebay that causes nitrogen fixers (e.g., cyanobacteria) to grow. Calibration to TP is representative of data collected in the forebay except for the four relatively high values (i.e., greater than or near 0.05 mg/L) that are uncharacteristic for the forebay. These higher values of TP were not associated with elevated values of chlorophyll a, Total Kjeldahl Nitrogen (TKN), or TOC, so they were not considered to be significant to the calibration. The calibration to chlorophyll a was good and represented chlorophyll a levels very well. Calibration to TOC in the forebay was good except for two values that were greater than 5 mg/L and were uncharacteristic for the forebay. These two values were associated with very low chlorophyll a and TP levels and normal TKN values, so they were not considered to be significant to the calibration.

Model-predicted algal masses in the forebay are presented in Figure 12, showing the total mass and the mass for algal assemblages 1, 2, and 3. A dominate pattern in the algae predictions is the highly variable mass concentration that ranges from 3-4 mg/L to 0.5-1 mg/L within days over the period Julian Day (JD) 120 to 180, and these swings are inversely related to TP variations. A review of the model outputs at 6-hr intervals (see Figure 14) revealed that these variations were caused by mixing events in the forebay caused by up-reservoir winds that induced currents at the surface of the lake causing hypolimnetic water to be upwelled at the dam. This phenomenon occurred in 1999, too, between JD 230-240, and probably at other times. Such events would serve as a periodic source of TP in the surface water by elevated phosphorus levels in the hypolimnion being upwelled to the surface of the lake at the forebay. Since this could be a source of phosphorus for algae to grow, it is worth considering a study to document this process for WFG. If this was a major source of phosphorus to the epilimnion, further reduction of TP in the inflows may have limited value.

The algal dynamics predicted for the mid-lake station are shown in Figure 13. The algal assemblage patterns are similar to that shown for the forebay, and the algal mass levels are about 15% greater at the mid-lake station—considerably less difference than observed in 1999 and more consistent with average chlorophyll a differences over the last 15 years. It should be noted that for 2004, the lake-wide model settings for ORGP and ALGP were adequate in contrast to the experience with the 1999 calibration where the lake-wide settings resulted in greater differences between model-predicted chlorophyll a and observed chlorophyll a values.

Calibration to NO_x at the mid-lake station (see Figure 11) is good, but the model-predicted NO_x drops more rapidly in April and May compared to the data. This would be consistent with elevated predictions of chlorophyll a during this period compared to the observed data. However, the predicted nitrogen levels were sufficient to allow Algae 1 to dominate the algal growths during this period. The other modeled constituents are calibrated to about the same goodness of fit as those for the forebay and, as expected, TP and chlorophyll a were at levels greater than observed in the forebay.

In summary, the calibrations are good and robust. They can be used to represent years with low flow conditions with a range of ORGP values and corresponding ranges of algal mass and chlorophyll a.

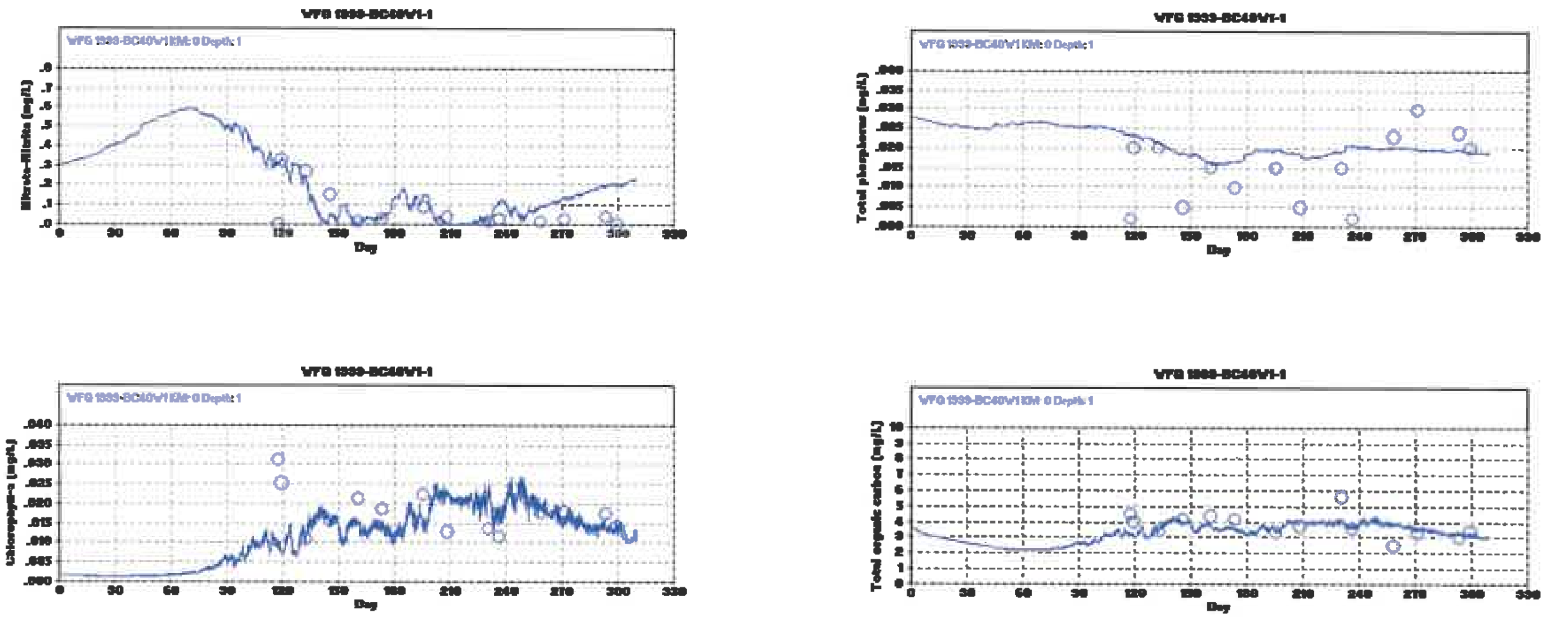


Figure 6: Model Calibration Results to 1999 Forebay Data on NO_x, TP, Chlorophyll a, and TOC
Note: Data were collected by GAEPD and ADEM [Chlorophyll a results are shown in the bottom left panel].

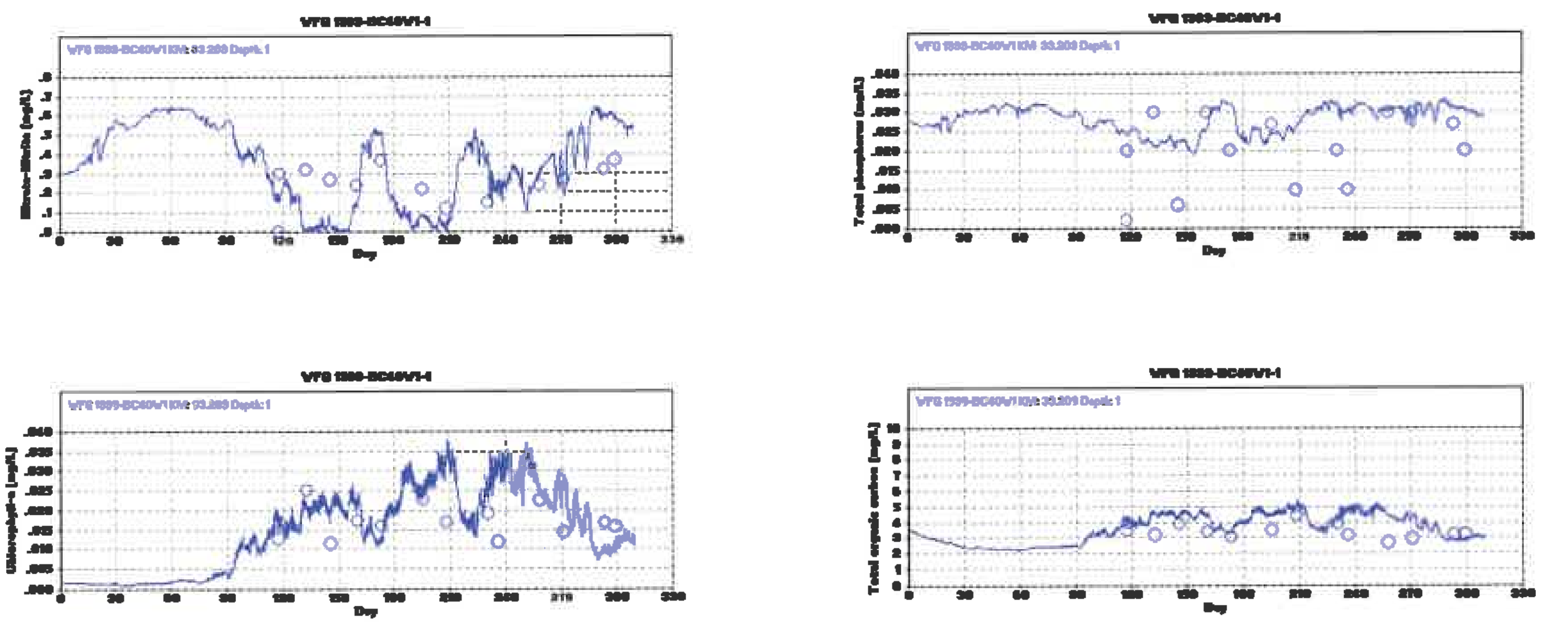


Figure 7: Model Calibration Results to 1999 Mid-Lake Data on NO_x, TP, Chlorophyll a, and TOC.
Note: Data were collected by GAEPD and ADEM [Chlorophyll a results are shown in the bottom left panel].

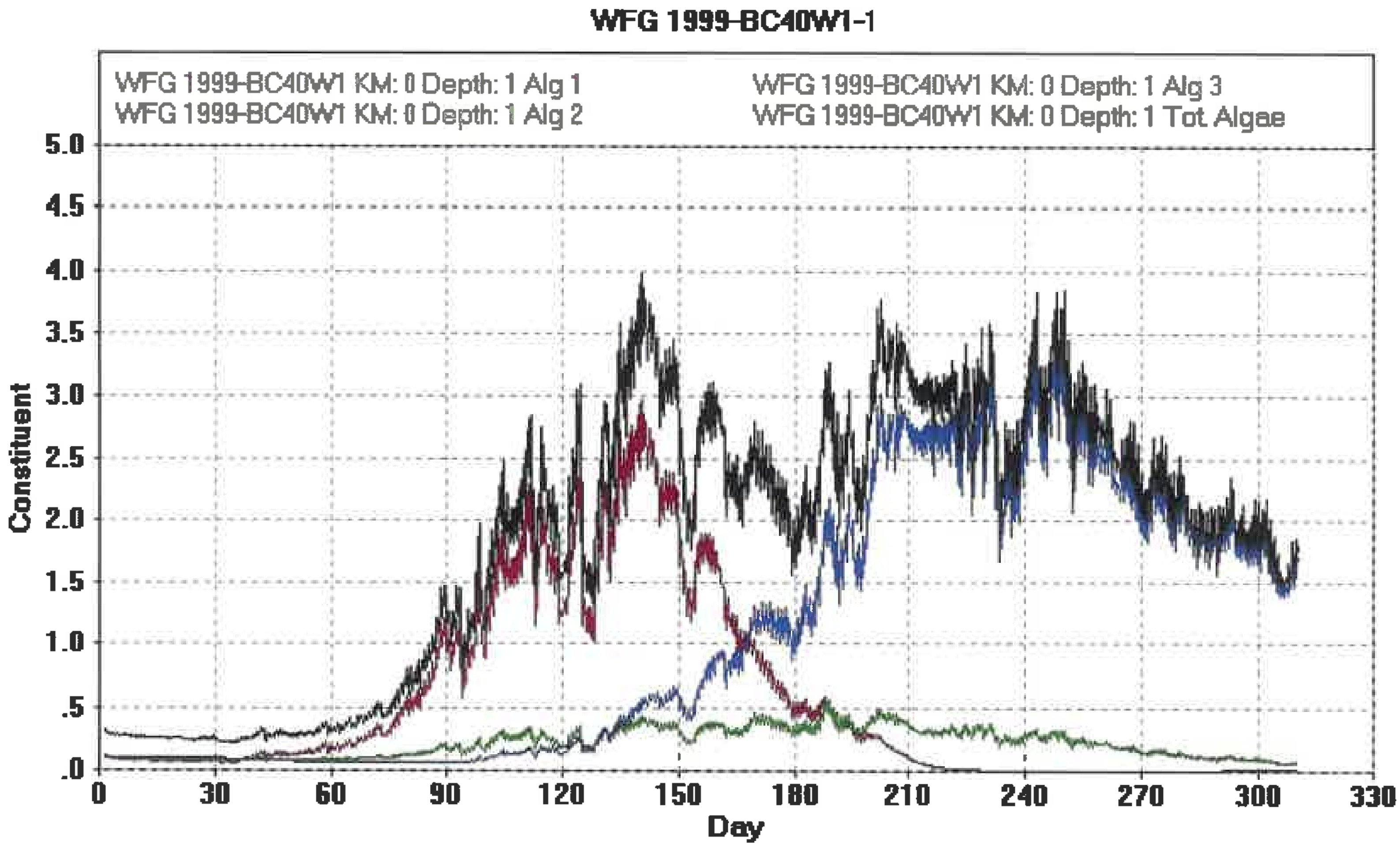


Figure 8: Model Predictions of Total Algae and Three Algal Assemblages in the Forebay for 1999

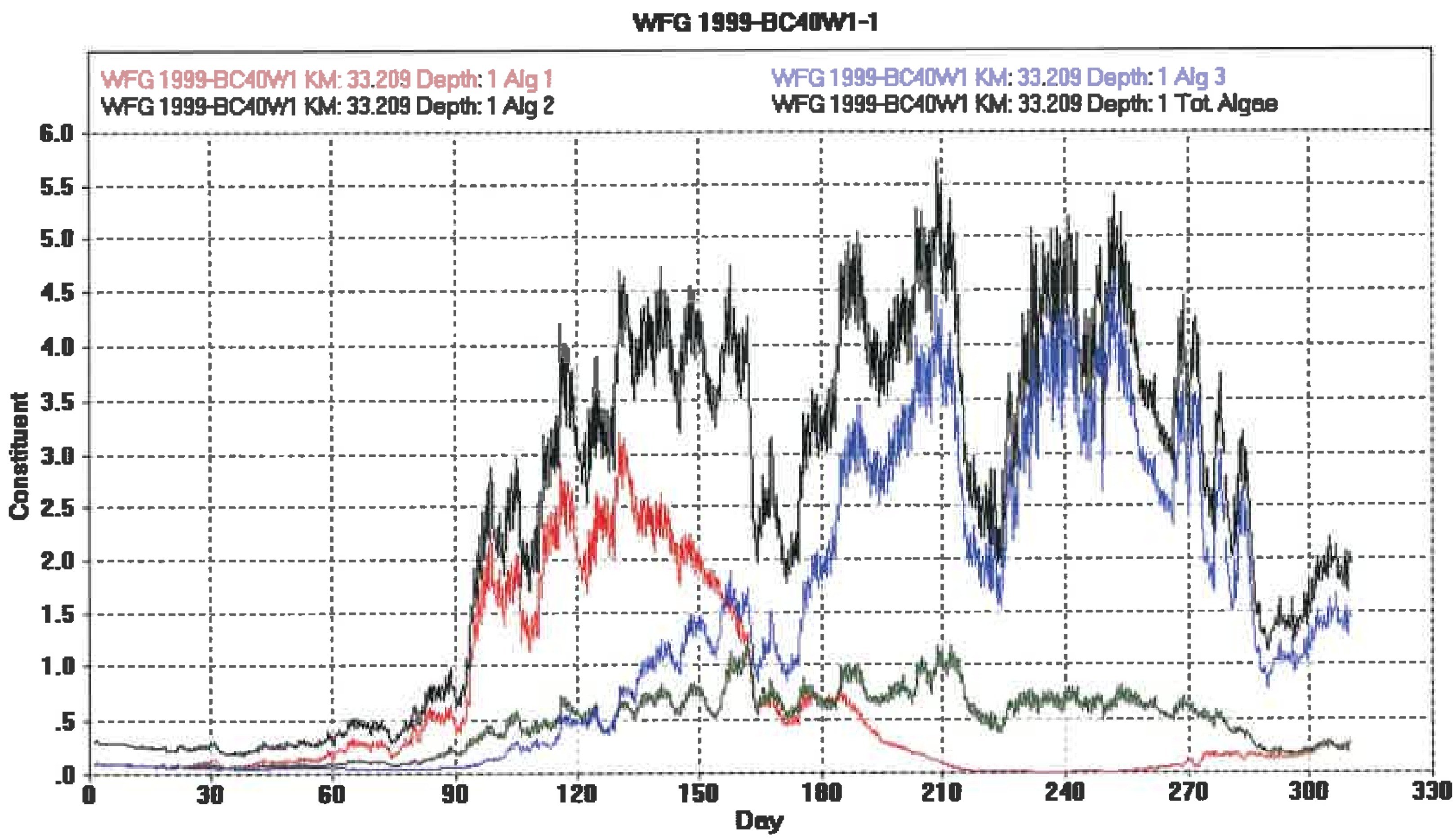


Figure 9: Model Predictions of Total Algae and Three Algal Assemblages at the Mid-Lake Location for 1999

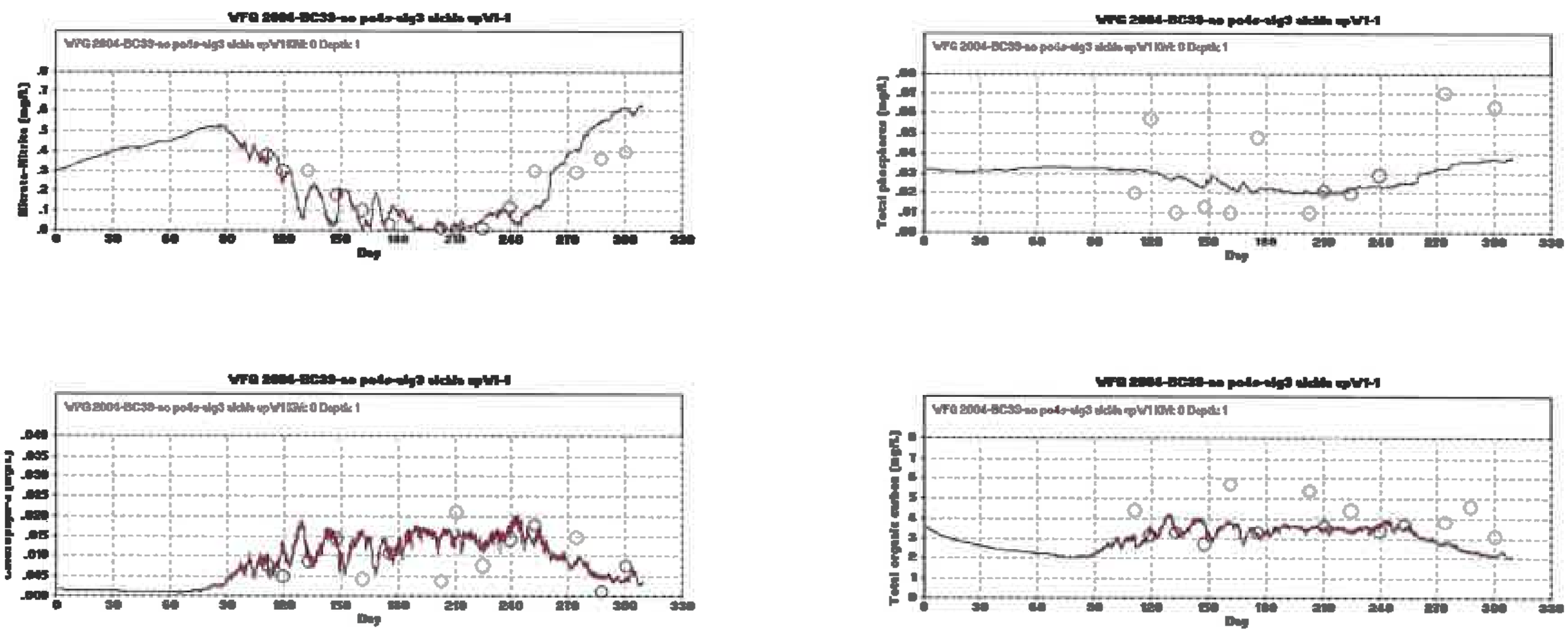


Figure 10: Model Calibration Results to 2004 Forebay Data on NO_x, TP, Chlorophyll a, and TOC
Note: Data were collected by GAEPD and ADEM [Chlorophyll a results are shown in the bottom left panel].

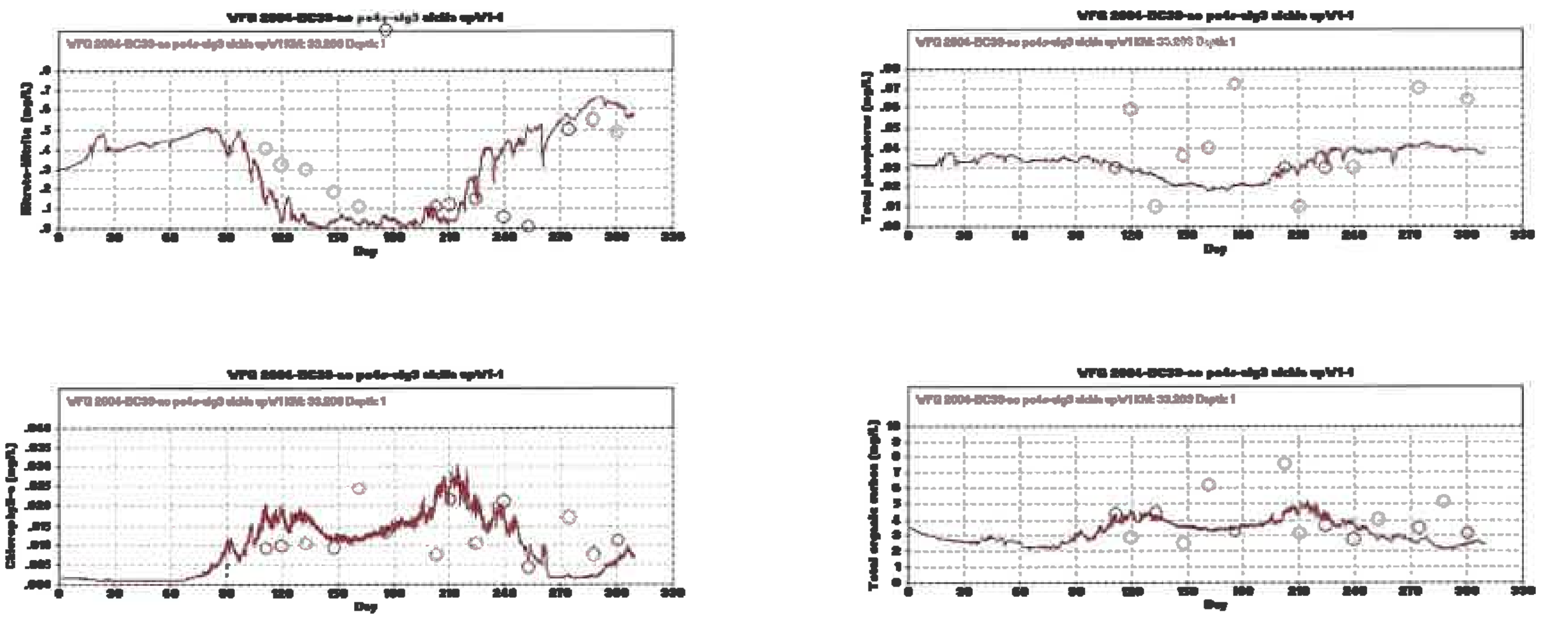


Figure 11: Model Calibration Results to 2004 Mid-Lake Data on NO_x, TP, Chlorophyll a, and TOC
Note: Data were collected by GAEPD and ADEM [Chlorophyll a results are shown in the bottom left panel].

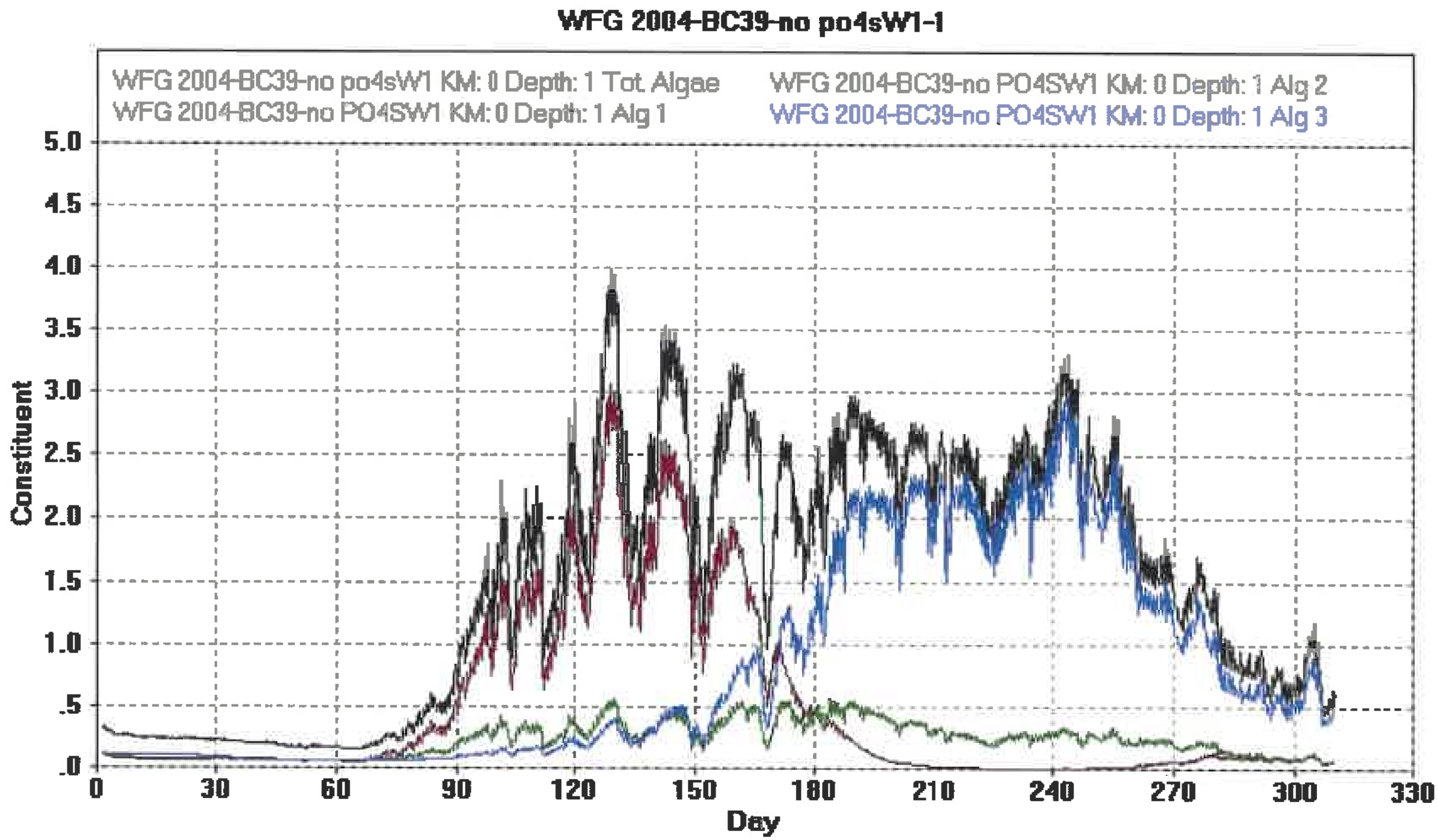


Figure 12: Model Predictions of Total Algae and Three Algal Assemblages in the Forebay for 2004

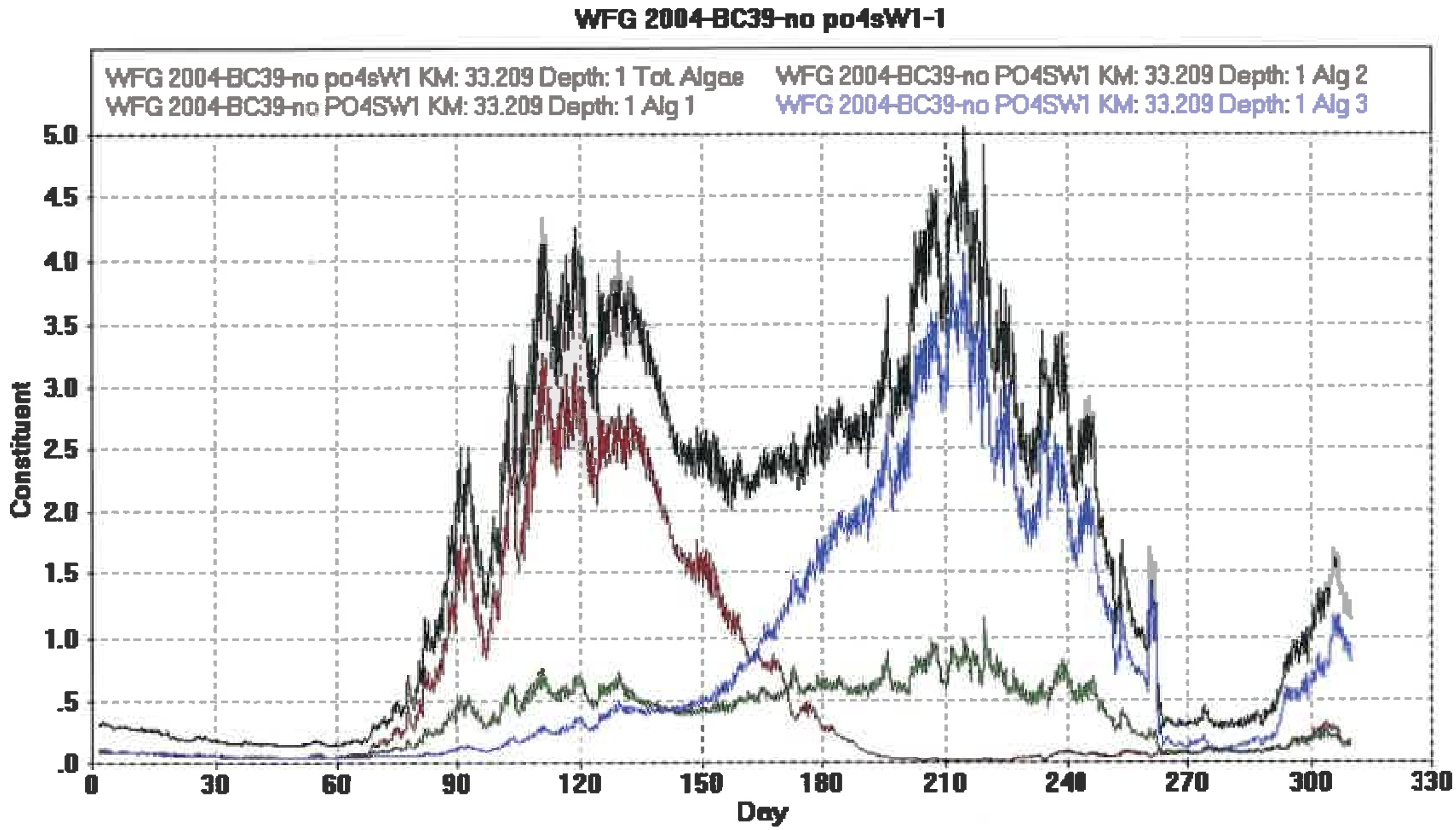


Figure 13: Model Predictions of Total Algae and Three Algal Assemblages at the Mid-Lake Location for 2004

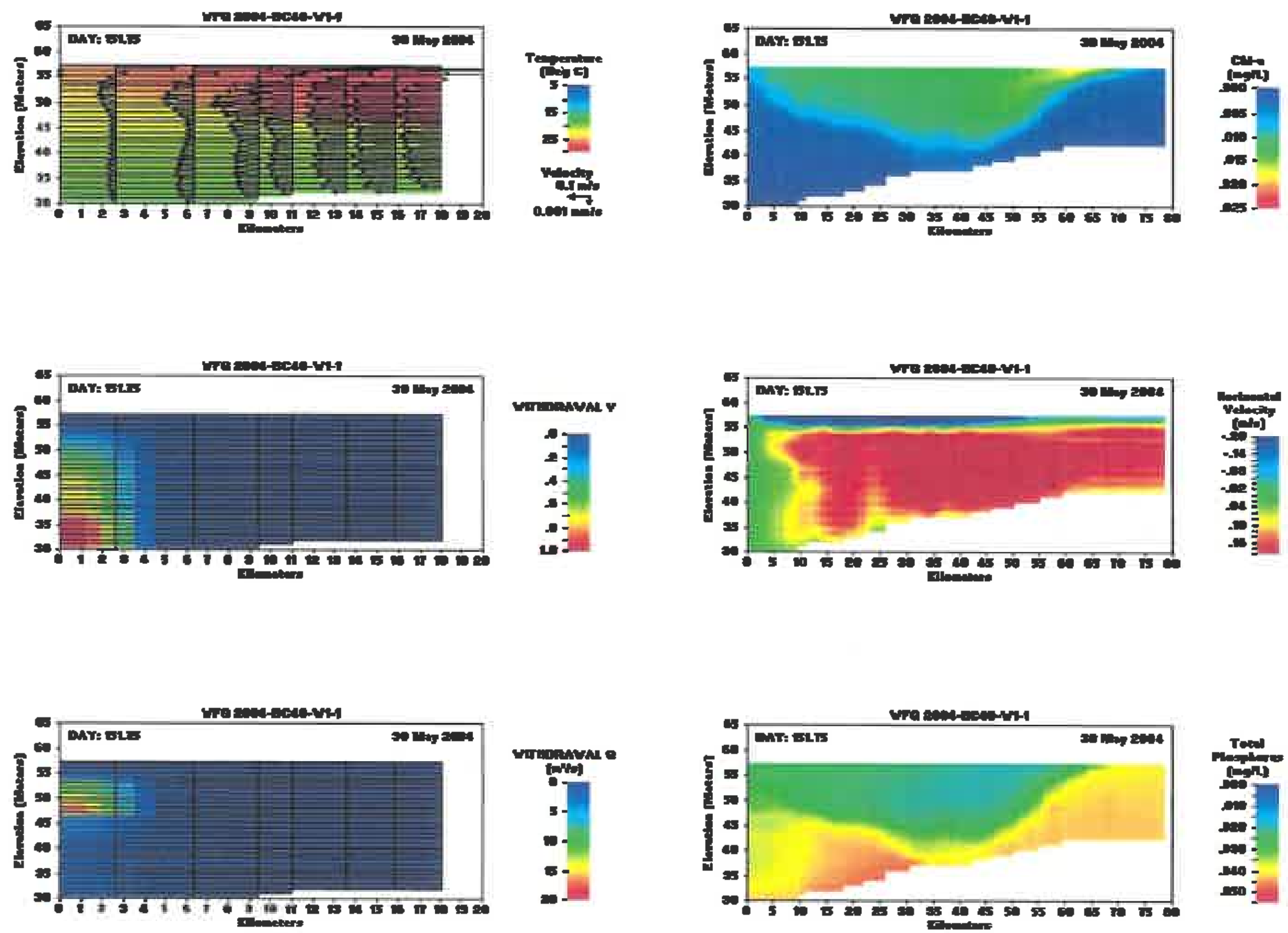


Figure 14: Forebay Upwelling Event on May 30, 2004

Note: TP was upwelled in the forebay and algae moved up reservoir from the forebay as sustained up-reservoir winds and power releases induced water currents shown by vectors in top left graph and horizontal velocities in middle right graph. The two graphs on bottom left show withdrawal zone velocities and flows (m^3/sec).

Table 2. Comparison of Growing Season Mean Values for Observed and Predicted by the Calibrated CE-QUAL-W2 Model for 1999—for the Forebay and Mid-Lake Station

	1999 Calibration--Growing Season Means				
	Forebay		Mid-Lake		
	Observed	Modeled	Observed	Modeled	
NO3 mg/l	0.08	0.14	0.24	0.28	
TP mg/l	0.015	0.020	0.020	0.028	
Chl a ug/l	18.00	15.23	17.12	20.20	
Total Labile Organic Matter (including algae) mg/l	5.10	4.3	6.2	5.3	note: W2 POM does not partly decompose to DOM
TOC mg/l	3.8	3.6	3.4	4.0	

Table 3. Comparison of Growing Season Mean Values for Observed and Predicted by the Calibrated CE-QUAL-W2 Model for 2004—for the Forebay and Mid-Lake Station

	2004 Calibration--Growing Season Means				
	Forebay		Mid-Lake		
	Observed	Modeled	Observed	Modeled	
NO3 mg/l	0.20	0.21	0.31	0.26	
TP mg/l	0.031	0.027	0.040	0.031	
Chl a ug/l	9.85	11.33	12.70	12.92	
Total Labile Organic Matter (including algae) mg/l	3.5	3.9	4.7	4.2	note: W2 POM does not partly decompose to DOM
TOC mg/l	3.9	3.1	4.0	3.4	

Model Simulations of Nutrients and Algae for Hypothetical TP Reductions from Point Sources

The estimated loads of TP entering WFG are shown in Tables 4a, 4b, and 4c for the current conditions, for the case where only GA WWTPs reduce TP to 1 mg/L, and for the case where GA and AL WWTPs reduce TP to 1 mg/L, respectively. As noted on the tables, assumptions for TP loads were necessary for the Chattahoochee River inflow since some data were less than the MDA, the Phenix City discharge since they do not report TP levels, and the local inflows since TP levels are low (sometimes less than MDA) and data are not available for much of the watershed inputs. Therefore, this assessment is based on these assumptions for TP loads. For the model runs, Case 1 refers to the case where only GA WWTPs reduce TP to 1 mg/L, and Case 2 refers to the case where GA and AL WWTPs reduce TP to 1 mg/L.

It should be noted that Tables 4b and 4c show that TP reductions would be about 10-12% for Case 1 and 17-21% for Case 2, so these reductions would be significantly lower than the 56% reduction that occurred in 1996.

The 1999 and 2004 calibrated models were used to predict the effects of reducing TP in the discharges from WWTPs to 1 mg/L on nutrients and algae at the mid-lake location and the forebay. A sensitivity analysis for the results of the assessment was also conducted considering that ORGP in WFG can change from year to year and that algae in WFG have demonstrated they can grow with lower amounts of phosphorus. For the sensitivity analysis, ORGP was decreased 0.005 for each case; i.e., ORGP for 1999 was reduced from 0.0025 to 0.0020, and ORGP for 2004 was reduced from 0.0038 to 0.0032. The sensitivity analysis was conducted on Case 2.

The results of the model predictions are presented in Figures 15 through 26 and Tables 5 and 6. The figures are time series plots of NO_x, TP, and chlorophyll a, and the tables provide growing season means from the model runs for NO_x, TP, chlorophyll a, total algae, labile organic matter, and TOC. A summary of the results is presented in the following list of observations.

1. The graphical results for Cases 1 and 2 for both 1999 and 2004 show that overall algal patterns are essentially the same and that differences between the current conditions and these cases are marginal. This is especially true considering the sensitivity run for a lower ORGP value for each year.
2. The graphical results show that nitrogen increased for Case 2 in the 2004 model predictions, but the sensitivity run showed that this increase was essentially canceled with ORGP reduced to 0.0032.
3. Phosphorus decreased in the lake at both locations in both modeled years, but algal predictions indicate that these phosphorus decreases did not significantly affect algal growths considering sensitivity to ORGP. It should be remembered, too, that phosphorus could be increased by more phosphorus transport from the hypolimnion to the epilimnion by cyanobacteria than occurred in 1999 and 2004.

4. Algal predictions for both model years and locations indicate that chlorophyll a could decrease from current levels, but not enough to comply with the existing chlorophyll a criteria, and the decrease in chlorophyll a could be nonexistent considering the results of the ORGP sensitivity model run. The decreases in chlorophyll a for Cases 1 and 2 were predicted to be about 1 and 2 µg/L, respectively; but, the criteria were exceeded by 2 to 3.5 µg/L in the years 1999 and 2000 and by 2 and 3.9 in 2003, the wet year. Considering the sensitivity runs for ORGP, the chlorophyll a decreases of 2 µg/L for Case 2 were essentially reduced to less than 1 µg/L. Considering the variability of chlorophyll a, as well as the uncertainty in predicting chlorophyll a, these decreases of 1 to 2 µg/L are within the range of error and not significant enough to render water quality management decisions.
5. Tables 5 and 6 also provide results for changes in organic matter that serves as the food base for the ecosystem including the fishery. These results show that organic matter could decrease by 10 to 20% for Case 2 using the 1999 and 2004 models, respectively. For the 1999 results, the organic matter decreased about 11%, even for the sensitivity run on Case 2.

In summary, the TP reductions being considered may or may not result in lower chlorophyll a levels in the lake, but the model predictions show that attainment of the current chlorophyll a standard is not likely. A risk of TP reductions is less organic mass that serves as the food base for the ecosystem and the fishery that is already experiencing impacts attributable to low algal production.

Table 4a. Current

Current Conditions

Analysis of TP Inputs for Whole Lake

	Average Annual				
	TP, mg/L	Flow, cfs	Load, lbs/day	Percent	
Chatt. R	0.02	5,634	602	39	MDAs
Phenix	4.5	5.2	125	8	est
CWW	1.4	47	351	23	
FB	3.2	2.5	43	3	
FB	2.6	2.6	36	2	
Eufaula	2.3	2.5	31	2	
Local Inflow	0.02	3366	359	23	est
Derived Inflow	0.032	9,060	1,547	100	

	Average Flow = 4000 at Columbus				
	TP, mg/L	Flow, cfs	Load, lbs/day	Percent	
Chatt. R	0.02	4,000	427	34	
Phenix	4.5	5.2	125	10	est
CWW	1.4	47	351	28	
FB	3.2	2.5	43	3	
FB	2.6	2.6	36	3	
Eufaula	2.3	2.5	31	2	
Local inflow	0.02	2400	256	20	est
Derived Inflow	0.037	6,460	1,269	100	

Table 4b. Case 1

Reduction of GA WWTPs to 1 mg/L of TP					
	Analysis of TP Inputs for Whole Lake				
	Average Annual				
	TP, mg/L	Flow, cfs	Load, lbs/day	Percent	
Chatt. R	0.02	5,634	602	43	MDAs
Phenix	4.5	5.2	125	9	est
CWW	1	47	251	18	
FB	1	2.5	13	1	
FB	1	2.6	14	1	
Eufaula	2.3	2.5	31	2	
Local Inflow	0.02	3366	359	26	est
Derived Inflow	0.029	9,060	1,395	100	
			10	% reduction	
	Average Flow = 4000 at Columbus				
	TP, mg/L	Flow, cfs	Load, lbs/day	Percent	
Chatt. R	0.02	4,000	427	38	
Phenix	4.5	5.2	125	11	est
CWW	1	47	251	22	
FB	1	2.5	13	1	
FB	1	2.6	14	1	
Eufaula	2.3	2.5	31	3	
Local Inflow	0.02	2400	256	23	est
Derived Inflow	0.032	6,460	1,117	100	
			12	% reduction	

Table 4c. Case 2

Reduction of GA & AL WWTPs to 1 mg/L of TP					
	Analysis of TP Inputs for Whole Lake				
	Average Annual				
	TP, mg/L	Flow, cfs	Load, lbs/day	Percent	
Chatt. R	0.02	5,634	602	47	MDAs
Phenix	1	5.2	28	2	est
CWW	1	47	251	20	
FB	1	2.5	13	1	
FB	1	2.6	14	1	
Eufaula	1	2.5	13	1	
Local Inflow	0.02	3366	359	28	est
Derived Inflow	0.026	9,060	1,281	100	
			17	% reduction	
	Average Flow = 4000 at Columbus				
	TP, mg/L	Flow, cfs	Load, lbs/day	Percent	
Chatt. R	0.02	4,000	427	43	
Phenix	1	5.2	28	3	est
CWW	1	47	251	25	
FB	1	2.5	13	1	
FB	1	2.6	14	1	
Eufaula	1	2.5	13	1	
Local Inflow	0.02	2400	256	26	est
Derived Inflow	0.029	6,460	1,003	100	
			21	% reduction	

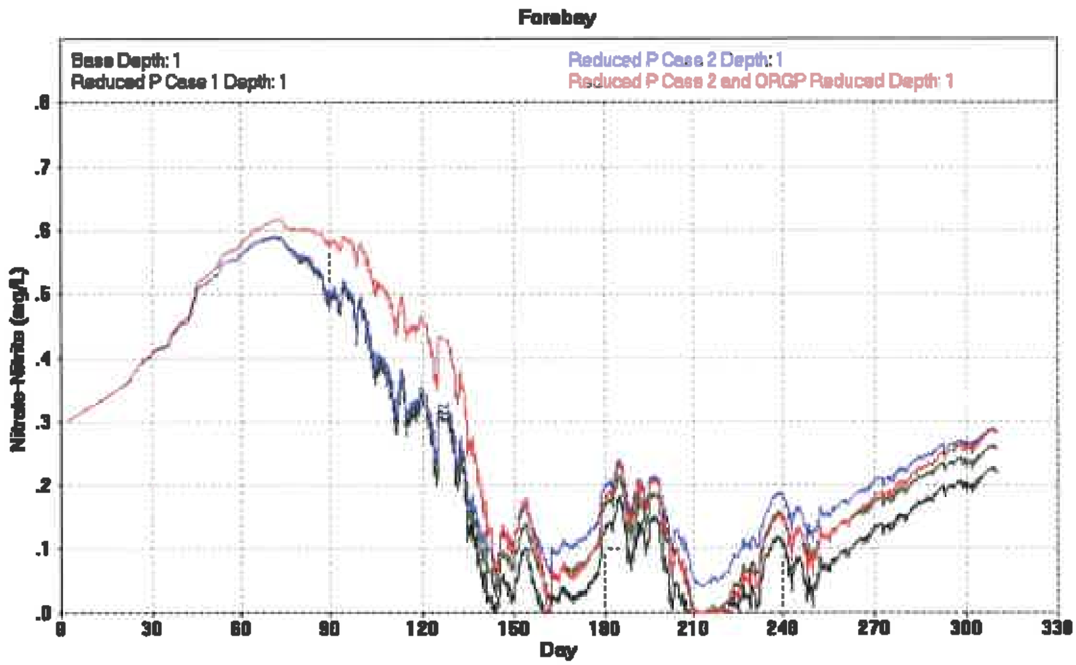


Figure 15: Nitrate Predictions at the Forebay for Cases 1 and 2 and Sensitivity to Lower ORGP Using the 1999 Model

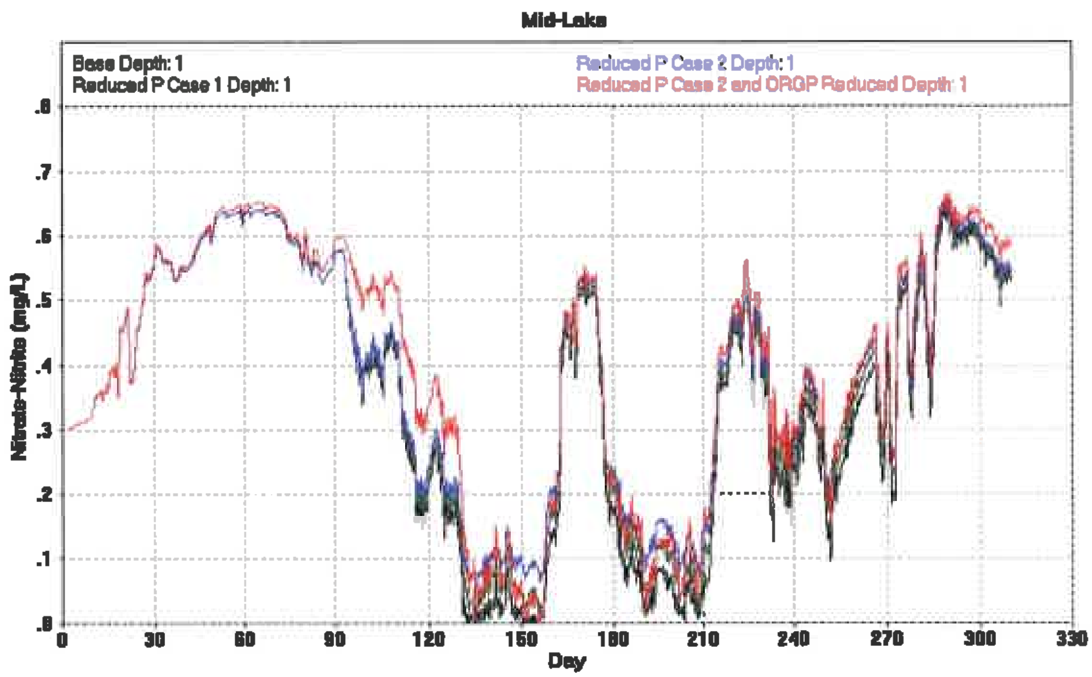


Figure 16: Nitrate Predictions at the Mid-Lake Station for Cases 1 and 2 and Sensitivity to Lower ORGP Using the 1999 Model

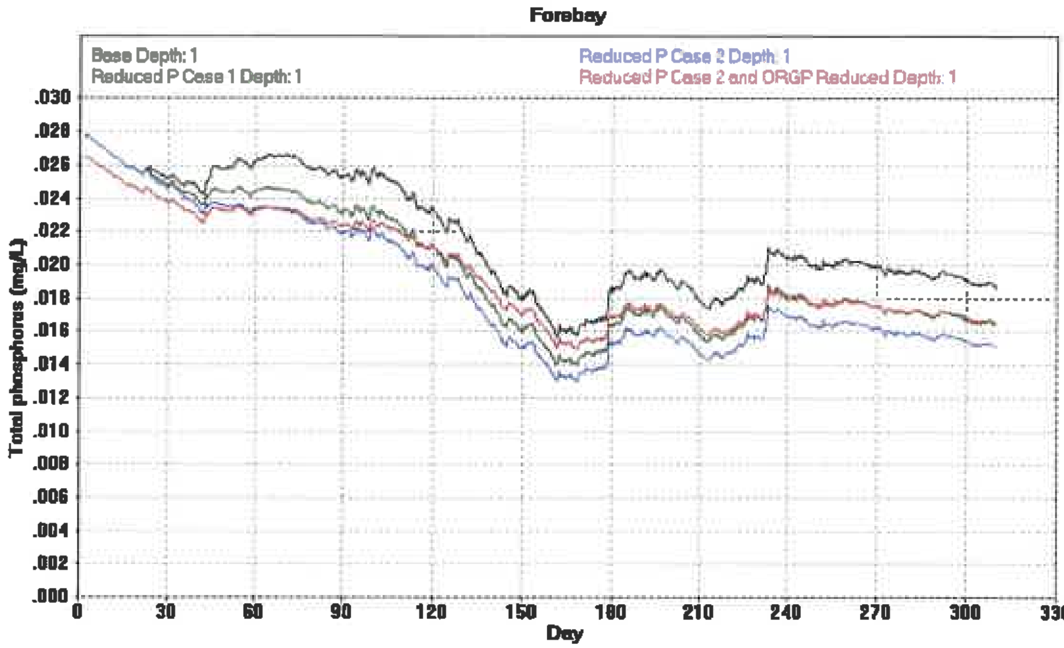


Figure 17: TP Predictions in the Forebay for Cases 1 and 2 and Sensitivity to Lower ORGP using 1999 Model (Predicted TP Would Not Include Phosphorus Added by Cyanobacteria Drawing Phosphorus from the Hypolimnion)

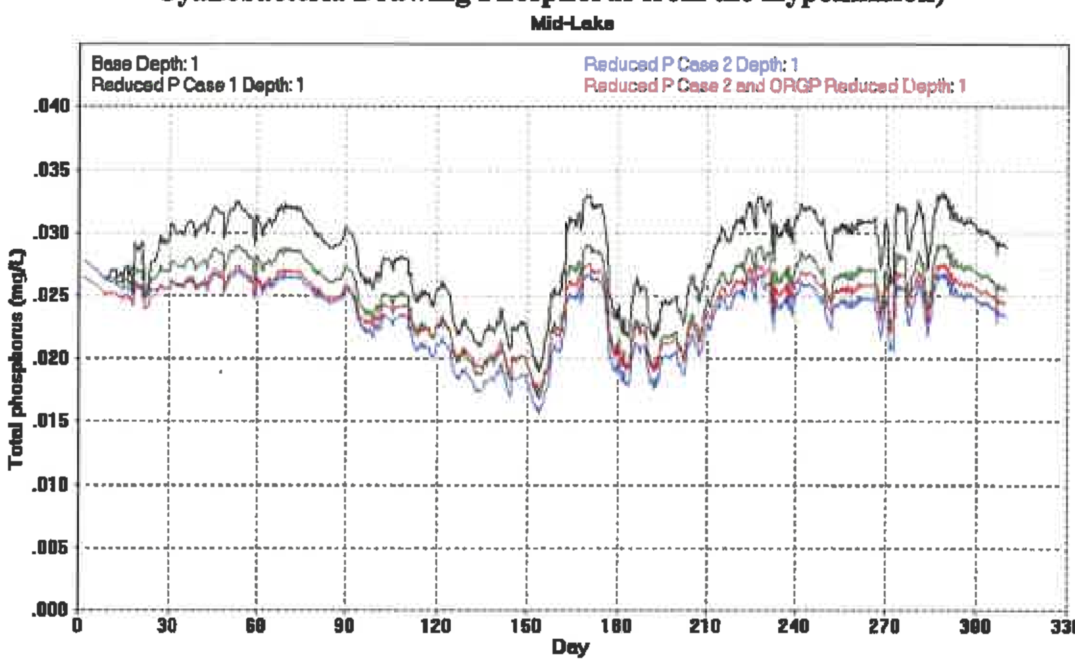


Figure 18: TP Predictions at the Mid-Lake Station for Cases 1 and 2 and Sensitivity to Lower ORGP Using the 1999 Model (Predicted TP Would Not Include Phosphorus Added by Cyanobacteria Drawing Phosphorus from the Hypolimnion)

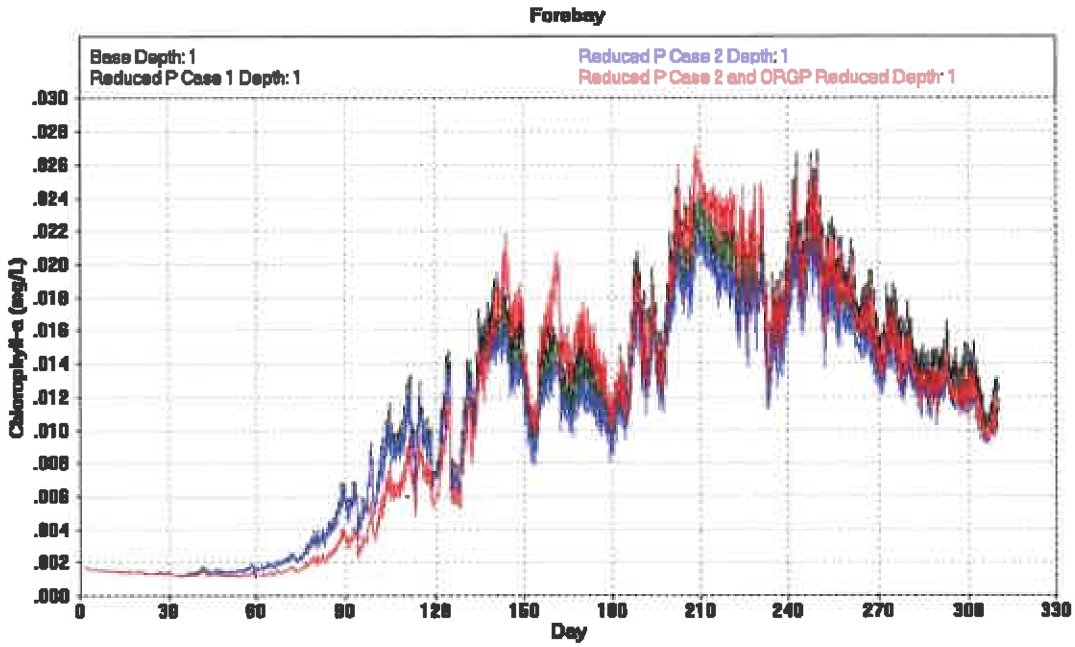


Figure 19: Chlorophyll a Predictions at the Forebay for Cases 1 and 2 and Sensitivity to Lower ORGP Using the 1999 Model

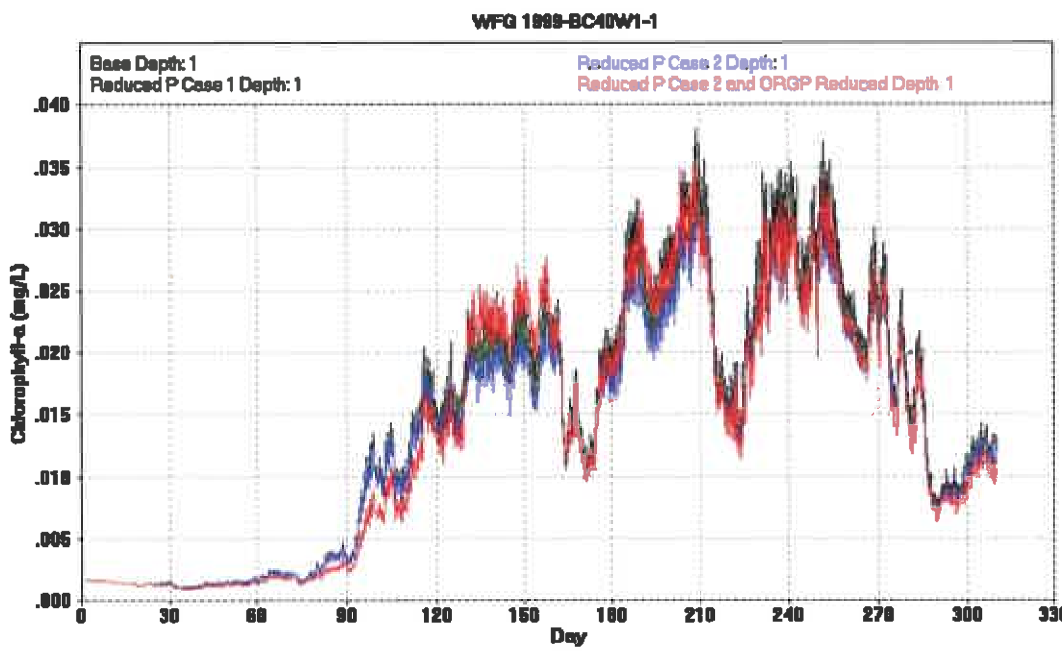


Figure 20: Chlorophyll a Predictions at the Mid-Lake Station for Cases 1 and 2 and Sensitivity to Lower ORGP Using the 1999 Model

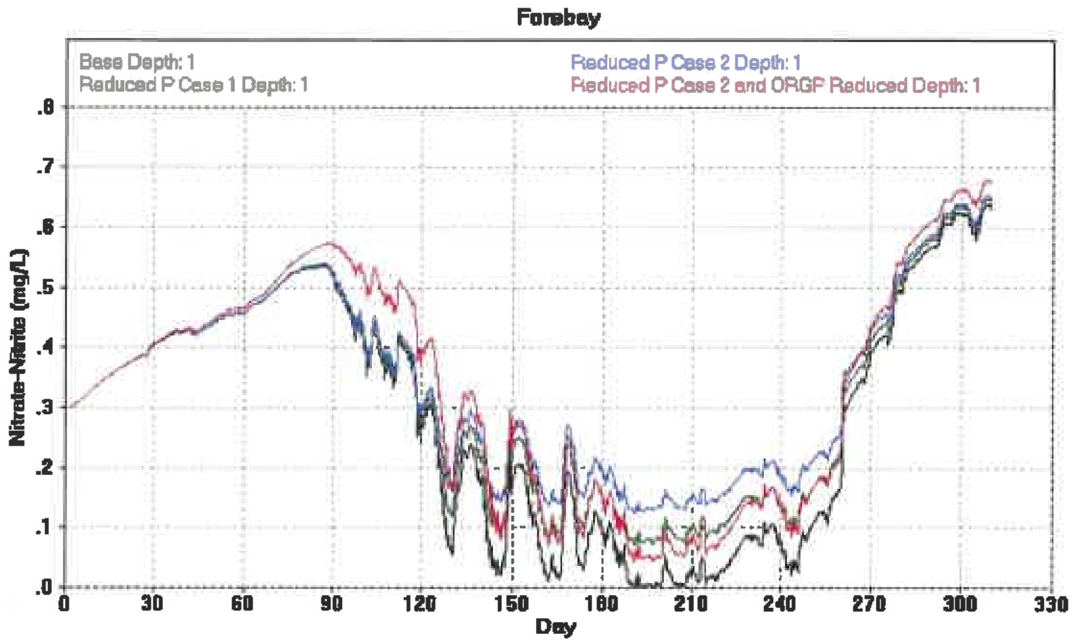


Figure 21: Nitrate Predictions at the Forebay for Cases 1 and 2 and Sensitivity to Lower ORGP Using the 2004 Model

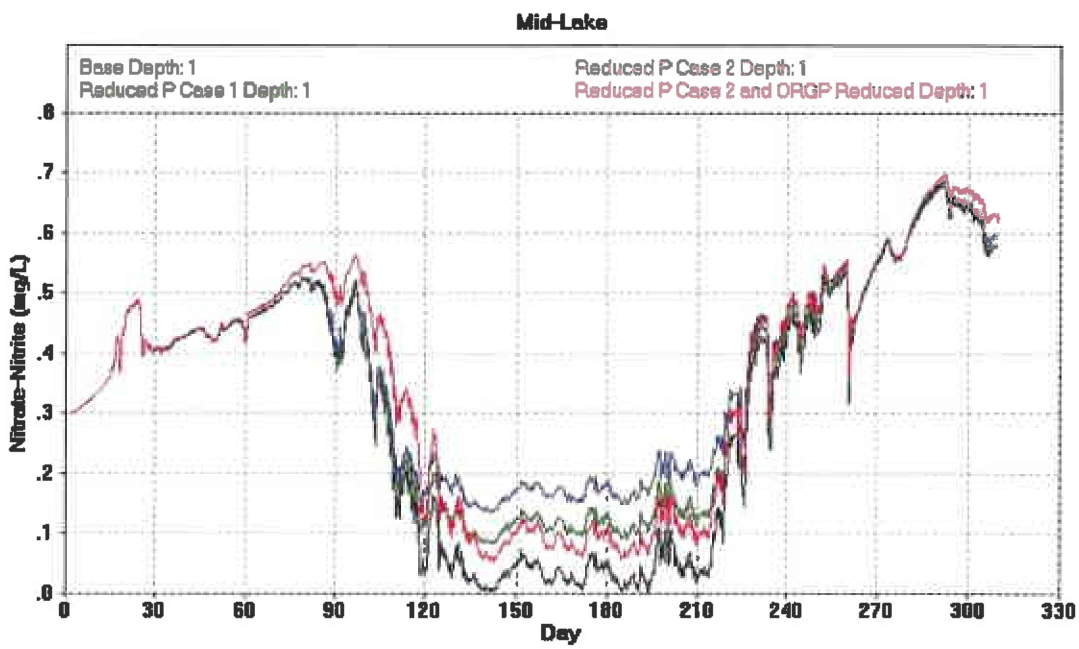


Figure 22: Nitrate Predictions at the Mid-Lake Station for Cases 1 and 2 and Sensitivity to Lower ORGP Using the 2004 Model

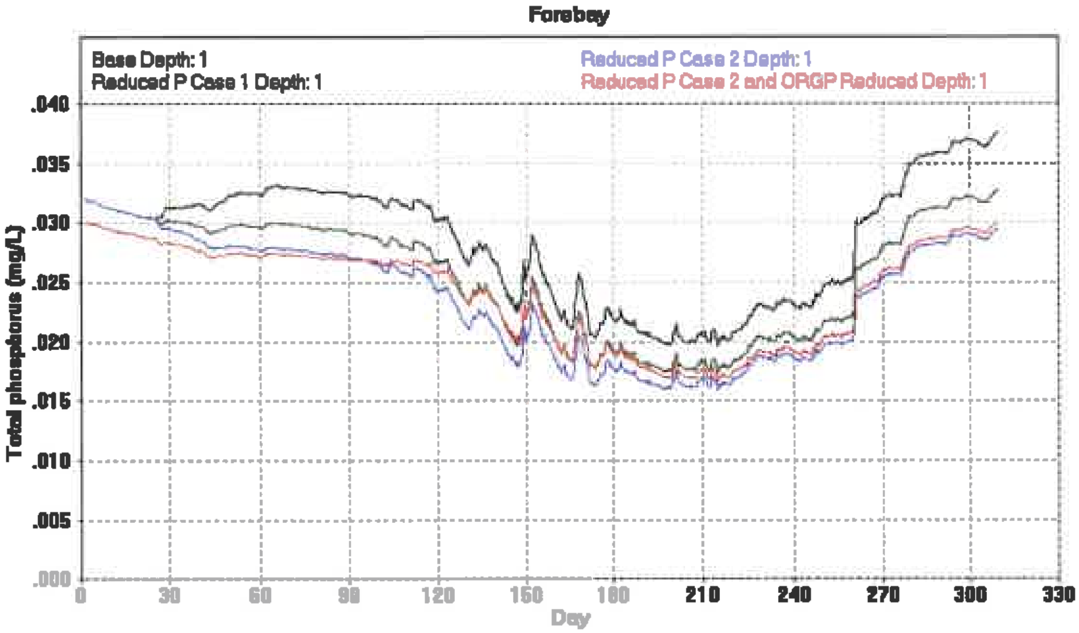


Figure 23: TP Predictions in the Forebay for Cases 1 and 2 and Sensitivity to Lower ORGP Using the 2004 Model (Predicted TP Would Not Include Phosphorus Added by Cyanobacteria Drawing Phosphorus from the Hypolimnion)

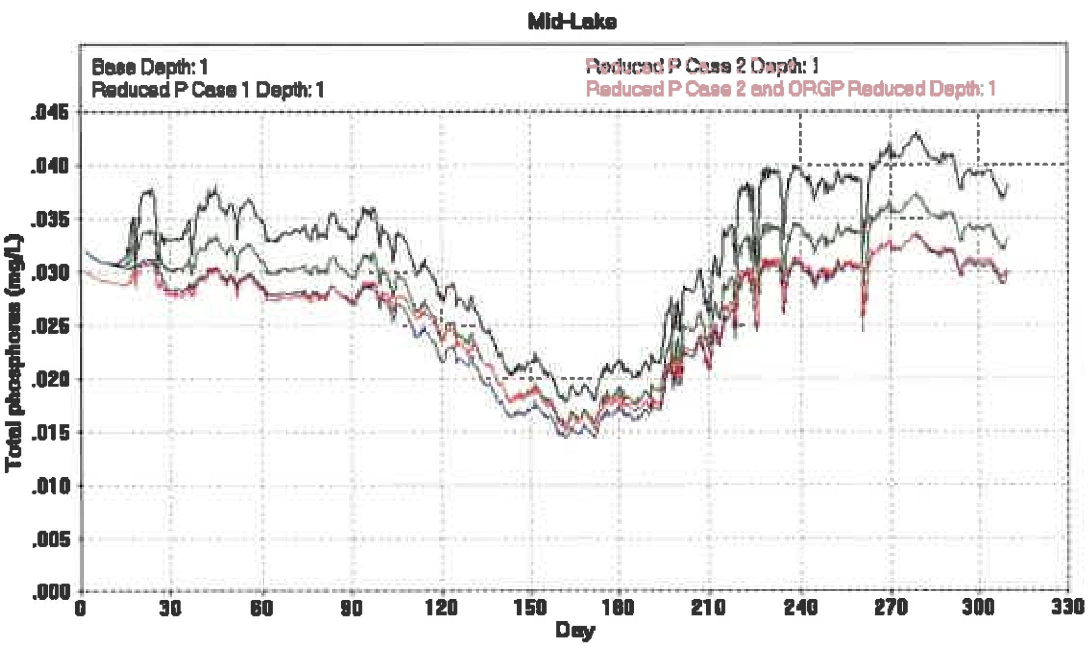


Figure 24: TP Predictions at the Mid-Lake Station for Cases 1 and 2 and Sensitivity to Lower ORGP Using the 2004 Model (Predicted TP Would Not Include Phosphorus Added by Cyanobacteria Drawing Phosphorus from the Hypolimnion)

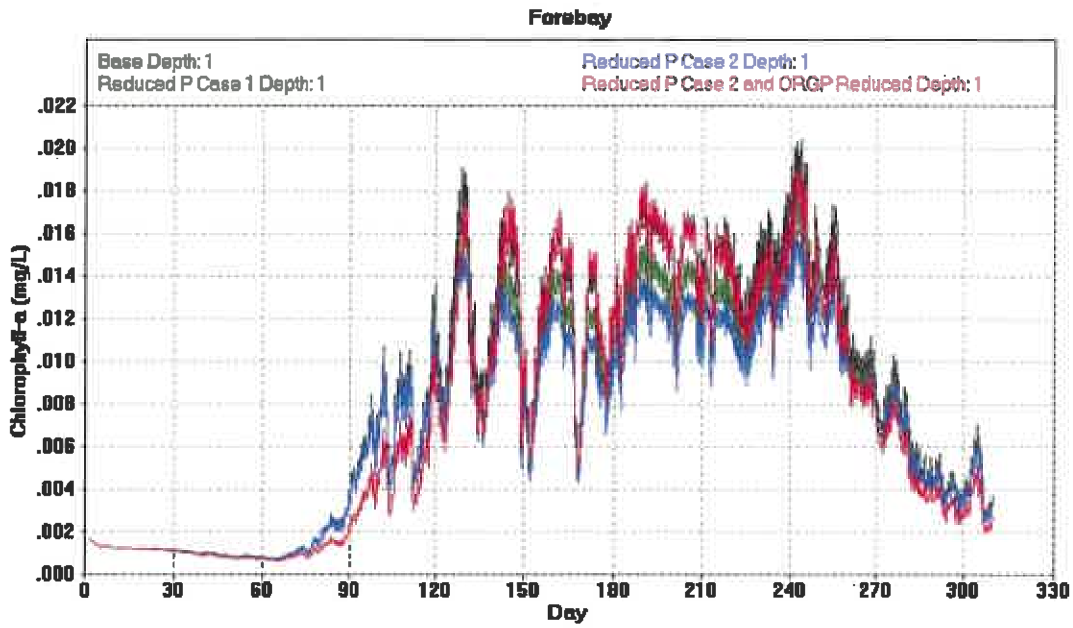


Figure 25: Chlorophyll a Predictions at the Forebay for Cases 1 and 2 and Sensitivity to Lower ORGP Using the 2004 Model

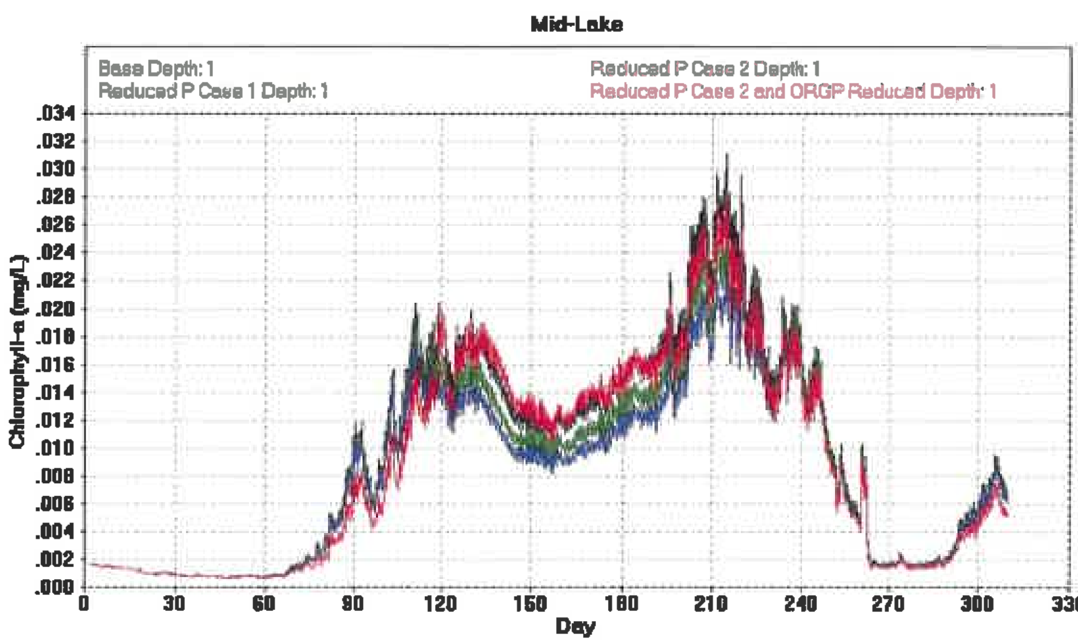


Figure 26: Chlorophyll a Predictions at the Mid-Lake Station for Cases 1 and 2 and Sensitivity to Lower ORGP Using the 2004 Model

Table 5. Model Predictions Using the 1999 Model for Current TP Loads, Case 1, Case 2, and Sensitivity to ORGP Setting

	Model predictions for current loads, Case 1, Case 2, and Sensitivity to ratio phosphorus:organic matter							
	1999--Growing Season Means							
	Forebay				Mid-Lake Station			
	Current Loads	Case 1	Case 2	Case 2 ORGP Reduced	Current Loads	Case 1	Case 2	Case 2 ORGP Reduced
NO3 mg/l	0.14	0.17	0.20	0.20	0.28	0.30	0.32	0.34
TP mg/l	0.020	0.018	0.017	0.018	0.028	0.024	0.023	0.024
Chl a ug/l	15.2	14.2	13.4	14.8	20.2	19.2	18.3	18.9
Total Algae mg/l	2.5	2.3	2.2	2.4	3.3	3.2	3.0	3.1
Labile Organic Matter mg/l	1.8	1.7	1.6	1.7	2.0	1.9	1.8	1.8
Total Labile Organic Matter (including algae) mg/l	4.3	4.0	3.8	4.1	5.3	5.0	4.8	4.9
TOC mg/l	3.6	3.4	3.3	3.5	4.0	3.9	3.8	3.9

Table 6. Model Predictions Using the 2004 Model for Current TP loads, Case 1, Case 2, and Sensitivity to ORGP Setting

	Model predictions for current loads, Case 1, Case 2, and Sensitivity to ratio phosphorus:organic matter							
	2004–Growing Season Means							
	Forebay				Mid-Lake Station			
	Current Loads	Case 1	Case 2	Case 2 ORGP Reduced	Current Loads	Case 1	Case 2	Case 2 ORGP Reduced
NO3 mg/l	0.21	0.26	0.29	0.28	0.26	0.31	0.34	0.31
TP mg/l	0.027	0.024	0.021	0.022	0.031	0.027	0.024	0.025
Chl a ug/l	11.33	10.27	9.48	10.48	12.92	11.64	10.67	12.11
Total Algae mg/l	2.1	1.9	1.7	1.9	2.4	2.2	2.0	2.2
Labile Organic Matter mg/l	1.8	1.4	1.3	1.4	1.8	1.7	1.6	1.7
Total Labile Organic Matter (including algae) mg/l	3.8	3.2	3.0	3.2	4.2	3.8	3.5	3.9
TOC mg/l	3.1	2.8	2.7	2.9	3.4	3.1	3.0	3.1

Discussion of Results

Chlorophyll a in a lake like WFG is affected by many variables: algal growth standing crop, algal species, the amount of chlorophyll a within the algal cells, levels of NO_x, levels of TP, lake vertical mixing/upwelling events, horizontal lake currents, ORGP, residence time/flushing rate, clarity of water, solar radiation, zooplankton, and forage fish. Obviously, the relationship between algae and phosphorus is not "linear" and many other factors affect the actual levels of algae: phosphorus transport processes (chemistry and sorption); types of algae; types of zooplankton; the processes that affect transformation of organic matter (rates of oxidation, settling, refractory fractions, etc.); lake mixing processes that are affected by met conditions (especially wind and solar radiation), hydrologic variation, and reservoir operations.

While many factors affect chlorophyll a, this assessment focused on those that affected chlorophyll a in two relatively low flow years—one with elevated chlorophyll a and another within the chlorophyll a standard. Low flow years were selected because GAEPD is considering TP limits on WWTPs and low flow years are more sensitive to TP loads from WWTPs. Picking two years with different levels of chlorophyll a was important to address the causes for annual variability in growing season means of chlorophyll a.

The CE-QUAL-W2 modeling identified the following dominate variables that affected chlorophyll a in WFG: ORGP, NO_x, algal species, TP, residence time, wind, and reservoir operations.

The factors that dominated mean "annual growing season" values of chlorophyll a when they were greater than the criteria were found to be low ORGP and low NO_x, especially under conditions of low flows/long residence time/low flushing rate.

The factors that were transient but important, especially for infrequent sampling intervals, were sustained wind events and short-term (peaking power) and long-term (water management) reservoir operations.

These modeling results show that observed chlorophyll a variations in WFG are consistent with limnological phenomena related to residence time in the lake, water quality, and algal dynamics. The results provide the scientific basis for natural variations causing periodic chlorophyll a excursions beyond the current criteria. ***One dominant dynamic that occurs in WFG: long residence time in low flow years ⇨ low NO_x ⇨ blue-green algae ⇨ higher*** chlorophyll a ***than for other algae species***

Data collected from WFG forebay by GAEPD and ADEM over the past 15 years show that high chlorophyll a occurred in summer only when NO_x was low, except in 2003 which had record high flows, short residence time. Data from the mid-lake station shows that chlorophyll a is high when NO_x is low, but it is also high in high flow years like 2003, in April and May (probably diatoms), and then in 1999 for no apparent reason (i.e., NO_x was normal but chlorophyll a was high). However, the CE-QUAL-W2 modeling revealed that ORGP was low in 1999 and this explained the elevated chlorophyll a levels.

Although 1999 and 2004 were the only years modeled for this report, ORGP values were determined for other years using the same approach. The results of the ORGP determinations for other years were developed using median or average data for the following periods: 1992-1993: ORGP was 0.0051 for the forebay and 0.0058 for the mid-lake; 1999-2004: ORGP was 0.0045 for the forebay and 0.0052 for the mid-lake. Although the ORGP values for the latter years were lower by about 11%, all of these values are significantly greater than those determined for 1999 and 2004, especially 1999. Low ORGP values indicate that labile organic matter in the lake was produced using less phosphorus.

Wetzel (2001) states, "…marked deviations in the sestonic C:N:P proportions occur in freshwater lakes" compared to the relatively stable conditions in the ocean. Reynolds (2006) discusses the ability of algae to grow at very low levels of phosphorus (e.g., 0.0003-0.004 mg/L) and inorganic nitrogen (e.g., 0.001-0.002 mg/L for most algae, 0.003-0.03 mg/L for some larger diatoms), "especially those algae able to migrate between the relatively resource-rich deeper water layers and the resource-depleted but isolated surface waters." Algae can store phosphorus when water concentrations of phosphorus are relatively high and use this phosphorus when needed as phosphorus becomes deficient. They can get what they need in a matter of minutes to last them through three "cycles". Dodds (2005) presents information on nutrient remineralization by organisms that supply much of the nutrient supply so that they do not need as much "new supply" from external sources. He reports that "research has shown that remineralization is an important ecosystem driver, particularly in the epilimnia of large lakes." These factors could be an explanation for the relatively level TP values measured in the forebay over the past 15 years: that cyanobacteria obtain their phosphorus from the hypolimnion and this process helps sustain TP in the epilimnion, and remineralization reduces the amount of external phosphorus required by the system.

Of course another process identified in the model calibration section for 2004 showed that phosphorus can be upwelled into the epilimnion by mixing events in the forebay caused by up-reservoir winds that induced currents at the surface of the lake causing hypolimnetic water to be upwelled at the dam. This phenomenon occurred in 1999, also. Such events would serve as a periodic source of TP in the surface water by elevated phosphorus levels in the hypolimnion being upwelled to the surface of the lake at the forebay. Since this could be a source of phosphorus for algae to grow, it is worth considering a study to document this process for WFG.

Considering that these three processes were a major source of phosphorus to the epilimnion, further reduction of TP in the inflows would probably have limited value.

Regarding the fishery in WFG, Holley et al. (2007) reported on the status of the largemouth bass and spotted bass fisheries. They reported that "growth rates are still at a record low for Lake Eufaula….The growth curve for age 1 to 5 fish…was below the statewide average, and was similar to the lower 25th percentile through age 3, lower than the 25th percentile for fish older than age 3." However, they report that "growth rates for AL reservoirs are from data through 1996 and that a statewide decrease in growth rates has been observed since that time." The drop in growth rates is attributable to the Largemouth Bass Virus Disease. But apparently the fishery is stressed.

Conclusions and Recommendations

Conclusions

1. Chlorophyll a in WFG has not decreased since 1990, even with the 56% decrease in TP in 1996—in fact, chlorophyll a has increased in some years to levels greater than measured during the period 1991-1993. Also, TP in the forebay has not decreased since 1996, and TP at the mid-lake station decreased much less than 56%. This modeling and limnological assessment found three reasons why TP and chlorophyll a have not decreased as much as would be expected in WFG: 1) algae in some years grow with less phosphorus, e.g., the amount of phosphorus used by algae to grow in 1999 was about 50% less than the normal amount used by algae for other years; 2) cyanobacteria (blue-green algae) in WFG can access phosphorus in the hypolimion and bring it up into the epilimnion, thereby not being dependent on the phosphorus level in the epilimnion; 3) nutrient remineralization by organisms supply much of the nutrients so that algae do not need as much "new supply" from external sources; and 4) periodic mixing events in the forebay induced by sustained up-reservoir winds in combination with hydropower releases from WFG causes phosphorus in the hypolimnion to be upwelled into the epilimnion. Therefore, chlorophyll a and TP in the epilimnion can persist even after TP loads to the lake are reduced.
2. The TP reductions at WWTPs being considered by GAEPD may or may not result in lower chlorophyll a levels in the lake, but the model predictions show that any change would be marginal (i.e., not measurable considering the accuracy of measuring chlorophyll a and not noticeable to lake users) and attainment of the current chlorophyll a standard is not likely. A risk of TP reductions is less organic mass that serves as the food base for the ecosystem and the fishery that is already experiencing impacts attributable to low algal production.
3. The nutrient levels in WFG are relatively low, even with the addition of TP by WWTPs. The inflow to WFG, including the point sources from the Columbus area, has phosphorus concentrations that are among the lowest observed in the USA, with about 80% of hydropower reservoirs experiencing TP concentrations greater than the concentration of TP in the WFG inflow.
4. Chlorophyll a numeric criteria for the lake should to be revised upward to account for the variability observed in the data collected over the years 1997 through 2007, possibly considering criteria linked to hydrologic conditions. The upgraded criteria would be consistent with the 1990 lake standards bill since TP has decreased significantly since 1990.

Recommendations

- A reduction in TP in the discharges from WWTPs is not recommended considering conclusion numbers 1 and 2.
- Appropriate statistical approaches should be used to develop upward revised chlorophyll a criteria. Approaches recommended by EPA, GAEPD, and ADEM as well as other approaches would be used that would lead to effective chlorophyll a monitoring that accounts for its natural variability in WFG.

Comments from Chattahoochee Riverkeeper

CHATTAHOOCHEE
RIVERKEEPER®

Keeping Watch Over Our Waters

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June 4, 2020

VIA EMAIL

Susan Salter
Environmental Protection Division
Watershed Planning and Monitoring Program
2 Martin Luther King, Jr. Drive SW, Suite 1152
Atlanta, GA 30334
Email: EPDComments@dnr.ga.gov

RE: Public Comments on the Georgia 2020 305b/303d draft list of waters

Dear Ms. Salter:

Please accept these comments from Chattahoochee Riverkeeper (CRK) regarding Georgia Environmental Protection Division's (EPD) draft 2020 305(b)/303(d) list of assessed and impaired waterways.

CRK is a non-profit environmental advocacy organization dedicated to the protection and stewardship of the Chattahoochee River, its tributaries and watershed. CRK represents approximately 10,000 members who use and enjoy the river system and depend on the Chattahoochee River and its lakes as a source of drinking water and economic prosperity. On behalf of our members and river users we submit these comments on the draft 2020 305b/303d list.

We support the removal of dissolved oxygen (DO) as a cause for impairment of Clear Creek in Fulton County.

We are thrilled that EPD proposes to remove DO as a cause of impairment of Clear Creek. Clear Creek is a tributary of Peachtree Creek located in midtown Atlanta and has been on the list of impaired streams for low dissolved oxygen levels since 1997, primarily due to combined sewer overflows in the basin.

Due to our lawsuit against the city of Atlanta in the mid-1990's and Consent Decree, the City of Atlanta has invested billions of dollars reduce combined sewer overflows to Clear Creek and other sub watersheds in Atlanta. In the approximately 12 years since the city substantially completed upgrades to its combined sewage treatment systems, CRK observed water quality improvements in the receiving tributaries. These anecdotal observations prompted the organization to quantify actual improvements in Clear Creek.

In summer 2017, CRK began monitoring under an approved Sampling Quality Assurance Plan (SQAP) to remove Clear Creek from the list of impaired streams. The data collected under CRK's SQAP showed that dissolved oxygen levels were above state water quality standards for each of the samples collected. The removal of Clear Creek from the 303(d) list is evidence that the city's efforts have resulted in real water quality improvements.

We encourage EPD to create a timely TMDL Implementation Plan for Lake Walter F. George.

In the proposed 303(d) list, the mid-lake section (Highway 83) of Lake Walter F. George moved from Category 3 (Assessment Pending) to Category 5 (Not Supporting) for chlorophyll a. This triggers the drafting of a TMDL Implementation Plan. We encourage EPD to initiate this process, and CRK formally requests to be included as a stakeholder.

CRK is not the only stakeholder to express concern about water quality in the middle and lower Chattahoochee River basin at the Walter F. George lock, dam and lake/reservoir. In the 2017 Regional Water Plan, the Middle Chattahoochee Regional Council identified a lack of "sufficient and readily available water quality monitoring data from federal, state, and local governments," and that data "has not been sufficiently compiled and analyzed critically."[1]

Model runs produced for the Council revealed that "Chlorophyll-a exceedances are projected under current conditions," and that sources of the "current total phosphorus load" and "future projected increases" are "primarily from point sources (~67%), with the main sources being municipal point sources upstream of the lake."[2]

The Council recommended EPD as the primary responsible party to "Implement protective nutrient criteria for all areas" in Management Practice WQ-7. Specifically, the Council would like to "Evaluate nutrient criteria for Lake Walter F. George with consideration of background loads at West Point Lake."[3]

When considering the upstream contributions to water quality, the Council asserted they are "concerned about nutrient loading" and the "increases in chlorophyll-a in West Point Lake and Lake Walter F. George that may result from upstream nutrient loading."[4]

Finally, the Council is not only concerned about water quality above and within the lake/reservoir at Walter F. George Lock and Dam. They have legitimate concerns about water quality immediately below the dam. In 1985, Walter F. George Dam was identified as responsible for fish kills, including the loss of 200,000 fish in a single event.[5] Georgia's EPD

[1] Middle Chattahoochee Regional Water Plan (June 2017), page 3-15, available online: https://waterplanning.georgia.gov/water-planning-regions/middle-chattahoochee-water-planning-region/middle-chattahoochee-regional.

[2] Middle Chattahoochee Regional Water Plan (June 2017), pages 3-20, 5-8 and 5-9.

[3] Middle Chattahoochee Regional Water Plan (June 2017), page 7.7.

[4] Middle Chattahoochee Regional Water Plan (June 2017), 7-18.

[5] Harold Reheis, Assistant Director, Georgia Environmental Protection Division, to Chuck Croomer, Assistant Chief of Fisheries, Georgia Game and Fish Division, "Fish Kills at Walter F. George Lock and Dam," January 8, 1985;

and the Department of Natural Resources worked with the U.S. Army Corps of Engineers to develop and institute a new lock and dam Standard Operating Procedure to mitigate for dissolved oxygen (DO) problems. Unfortunately, these new SOPs did not appear to work. TMDL's for DO in 2000 and 2001 resulted in the installation of a system of siphons to increase oxygen content during dam releases.[6]

The Regional Council's comments and recommendations parallel CRK's concerns. CRK is aware of the past, current and future projected water quality issues above, at and below Walter F. George lock, dam and lake/reservoir. Addressing water quality in the lake/reservoir can also help "ensure assimilative capacity is available in the Chattahoochee River below Walter F. George Reservoir to support economic development."[7]

Significant efforts have been made by the City of Atlanta and other Metro Atlanta utilities to address nutrient and bacteria loading into the Chattahoochee that impacted downstream water users in the Middle Chattahoochee region. It is important that EPD be proactive in addressing rising water quality issues in the Middle Chattahoochee before any impacts are felt within the region or farther downstream.

Thank you for your attention to these comments. If you have any questions, please contact Jessica Sterling, Technical Programs Director, at jsterling@chattahoochee.org or 404-352-9828.

Sincerely,

JASON ULSETH

Jason Ulseth
Riverkeeper

Memoranda For Record: Meeting with State of Georgia Officials Regarding Water Quality Downstream of Walter F. George Lock and Dam, SAMOP-R, October 7, 1985; Charles Croomer, Assistant Chief of Fisheries, Georgia Game and Fish Division, to Skeeter McClure, re: Fish Kill Reports, December 3, 1983; Harold Reheis, Assistant Director, Georgia Environmental Protection Division, to Kearney H. Windham, Natural Resources Management Branch, U.S. Army Corps of Engineers, December 13, 1985.

[6] Master Control Manual, page 7-8, available online: http://www.sam.usace.army.mil/Portals/46/docs/planning_environmental/acf/docs/ACF_MM_Final_Apr%202017.pdf?ver=2017-04-20-114651-927

[7] Middle Chattahoochee Regional Water Plan (June 2017), page 7-20.

Comments from Satilla Riverkeeper

Satilla RIVERKEEPER®

June 4, 2020

Susan Salter, Watershed Protection Branch
Watershed Planning and Monitoring Program
2 MLK, Jr. Dr. S.W., Suite 1152 East
Atlanta, GA 30334

Sent via email to EPD.Comments@dnr.ga.gov, susan.salter@dnr.ga.gov

Re: 2020 Draft 305b/303d List

Dear Ms. Salter:

Thank you for the opportunity to review and comment on the Drat 2020 Integrated 305(b)/303(d) Report. Please accept the following comments and questions in response to the public notice published on April 3, 2020.

The Satilla RiverWatch Alliance, Inc DBA Satilla Riverkeeper is a 501c3 nonprofit organization founded in 2004 to protect, restore, and educate about the Satilla River, her tributaries, and terrestrial watershed. We represent approximately 400 members throughout the watershed and across the state that care about the health of the Satilla River, regularly recreate in the river, and are invested in protecting the Satilla for future generations.

We appreciate EPD's effort to determine accurate criteria for pH and dissolved oxygen (DO) by determining naturally occurring levels for both parameters in coastal blackwater streams like those that make up the Satilla River watershed. What is the time frame to complete the study of naturally occurring levels of DO and pH in blackwater streams? When can we expect to see the updated criteria? What will be the process for stakeholder and public input?

In general, where a stream is impaired for both fecal coliform and dissolved oxygen, it is likely that the low DO is caused by pollution rather than naturally occurring. We encourage EPD to do a careful study, and not remove impairments without justification.

All the Satilla stream segments' uses are listed as Fishing. I urge EPD to *add* Recreation as a designated use on the segments where recreation regularly occurs, mainly from the Jamestown Landing in Ware County to the Woodbine Boat Ramp. (These stream segments are listed below.) I have attached our comment letter submitted to EPD on the Triennial Review Process for your reference, file name: "Satilla River Triennial Review Comment Letter 3.8.2019 signed"

Excerpt from March 8, 2019 letter to EPD requesting a change in the designated use of the Satilla River:

> This section of the Satilla River between Jamestown Landing and Woodbine includes several stream segments on Georgia's 305(b)/303(d) Integrated Report List of Waters. These segments are listed below in order of upstream to downstream.

- GAR030702010703 – Satilla River (Seventeen Mile River to US Hwy 84/Ga. Hwy. 38) Assessment Pending, Category 3 (insufficient data). Notes: EPD needs to determine the "natural DO" for the area before a use assessment is made.
- GAR030702011103- Satilla River (U.S. Highway 84/Ga. Hwy. 38 to 6 miles downstream Hwy 15/121) Not Supporting, TWR. Category 4a. Notes: TMDL completed TWR (2002).
- GAR030702011105 – Satilla River (Six miles downstream of Ga. Hwy. 15 to Buffalo Creek) Not Supporting, TWR. Category 4a. Notes: TMDL completed TWR (2002).
- GAR030702011207 – Satilla River (Buffalo Creek to Bullhead Bluff) Not Supporting, TWR. Category 4a. Notes: TMDL completed TWR (2002). EPD needs to determine the "natural DO" for the area before it can be determined whether the dissolved oxygen criteria are being met.
- GAR030702011201 – Satilla River (Rose Creek to White Oak Creek) Not Supporting, DO. Category 4a. Notes: TMDL completed DO (2001). **In the 2020 draft list, this segment is also listed as not supporting due to fecal coliform.**

<u>Comments on specific stream segments in Draft 2020 Integrated 305(b)/303(d) List:</u>

- Alabaha River (GAR030702011003) Pierce County– Hurricane Creek to Tan Trough Creek. Not supporting due to fecal coliform. Category 4a (Data indicate that at least one designated use is not being supported, but TMDL(s) have been completed for the parameter(s) that are causing a water not to meet its use(s).) TMDL completed FC 2016. EPD needs to determine the "natural DO" for the area before a use assessment is made.
    - *This stream segment is not listed as "not supporting" for DO. If it is impaired for fecal coliform and has low DO, it is likely that the low DO is a result of pollution.*
- Big Creek (GAR030702010712) Ware, Brantley – Laura S. Walker Lake to South Prong Big River. Not supporting due to fecal coliform. Category 5 (Data indicate that at least one designated use is not being supported and TMDL(s) need to be completed for one or more pollutants.) EPD needs to determine the "natural DO" for the area before it can be determined whether the dissolved oxygen criteria are being met.
    - *The description of the segment should read "Laura S. Walker Lake to South Prong Big Creek," not Big River.*
    - *It seems that if a stream is impaired for FC and has low DO, that it is likely the low DO is a cause of pollution, not natural occurrence.*
- Big Creek (GAR030702010704) Brantley County - South Prong Big Creek to Satilla River. Not supporting due to dissolved oxygen. Category 4a. TMDL completed DO 2001.
    - *This segment should be re-evaluated to determine if the levels are "natural DO" for the area before it is determined whether the DO criteria is being met. (This segment is adjacent to GAR030702010712, for which EPD needs to determine the "natural DO.")*

- Big Satilla Creek (GAR030702020101) Jeff Davis, Appling – Headwaters near Hazlehurst to Sweetwater Creek near Baxley. Not supporting due to dissolved oxygen and fecal coliform. Source: Urban Runoff
    - *This is a fairly rural agricultural area. What data does EPD have that suggests the source of the impairment is due to urban runoff?*
- Buffalo Creek (GAR030702011102) Brantley – Little Buffalo Creek to Satilla River. Not supporting due to fecal coliform and dissolved oxygen.
    - *Adopt-A-Stream volunteers have been monitoring this site for E. coli, dissolved oxygen, and other parameters since 2015. Data is available here:* https://aas.gaepd.org/EventsList.aspx?id=3717
- Colemans Creek (GAR030702020301) Appling, Wayne – Dry Branch South of Surrency to Big Satilla Creek near Screven. Not supporting due to pH and fecal coliform. Category 4a, 5. TMDLs completed DO 2001, FC 2006.
    - *Is the creek now within criteria for DO, or is it being studied to determine the natural DO of the area?*
    - *This is a blackwater stream, and could have naturally occurring low pH levels. Should this segment be listed as Category 3, while EPD studies the issue?*
- Little Satilla River (GAR030702020502) Pierce, Wayne, Brantley – Big Satilla Creek to Sixty Food Branch. Not supporting due to dissolved oxygen. Category 4a.
    - *Should this segment be moved to Category 3 while EPD determines the "natural DO" for the area?*
- Satilla River (GAR030702010204) Coffee County – Reedy Creek to Indian Creek. Assessment Pending.
    - *No cause or source is listed for this segment, but it is noted that a TMDL was completed for FC in 2011. Have the fecal coliform issues been corrected, and is the stream segment now supporting for FC, but not for DO?*
- Tributary to Seventeen Mile Creek (GAR030702010506) Coffee – 0.3 miles downstream East Baker Hwy to Seventeen Mile River. Not supporting due to fecal coliform, dissolved oxygen, and ammonia toxicity.
    - *Is the ammonia toxicity due to a municipal point source discharge? If so, can it be addressed more quickly than through a TMDL scheduled for 2030. Ten years is an exceptionally long time to wait to address a pollution issue.*

Thank you for the opportunity to comment, and please reach out with any questions regarding these comments.

Sincerely,

Laura Early

Laura Early
Executive Director and Satilla Riverkeeper

Satilla RIVERKEEPER®

March 8, 2019

Elizabeth Booth
Manager, Watershed Planning and Monitoring Program
2 Martin Luther King, Jr. Drive, Suite 1152
Atlanta, Georgia 303343
Via EPD.Comments@dnr.state.ga.us

Re: Water Quality Standards 2019 Triennial Review

Dear Ms. Booth:

Please accept these comments from Satilla Riverkeeper providing stakeholder feedback regarding Georgia Environmental Protection Division's (EPD) 2019 Triennial Review in regards to changes to the water quality rules and regulations found in 391-3-6-.03 of the Georgia Rules and Regulations for Water Quality Control in response to the public notice issued on January 7, 2019.

The Satilla RiverWatch Alliance, Inc DBA Satilla Riverkeeper is a 501c3 nonprofit organization founded in 2004 to protect, restore, and educate about the Satilla River, her tributaries, and terrestrial watershed. We represent approximately 400 members throughout the watershed and across the state that care about the health of the Satilla River, regularly recreate in the river, and are invested in protecting the Satilla for future generations.

Satilla Riverkeeper is requesting that the Designated Use of the Satilla River from Jamestown Landing (31.298385, -82.392556) in Ware County to the Woodbine Boat Ramp (30.973210,-81.723935) in Camden County be upgraded to "Recreation." This section is approximately 145 river miles. This length encompasses the Satilla River Water Trail, designated in 2016. The Satilla River Water Trail map and brochure is attached.

* PO Box 817, Nahunta, GA 31553 * Office: 9634 Main St S., Nahunta, GA 31553 *
* 912-462-5094 * Riverkeeper@SatillaRiverkeeper.org * www.satillariverkeeper.org *

Figure 1: Map of Satilla River between Jamestown Landing in Ware County and Woodbine Boat Ramp. Satilla River Water Trail landings are noted on the map.

We are requesting that the designated use for this section of the Satilla River be changed to "recreation" because local residents and visitors have been enjoying recreation year-round on the Satilla for generations, the water quality in this section of the Satilla River supports recreational uses, and local communities and businesses have invested in promoting recreation on the Satilla as an economic asset to the region. The designated use of the water body should be changed to reflect, and protect for, the actual use of the water body.

Waterbody Impairments

This section of the Satilla River between Jamestown Landing and Woodbine includes several stream segments on Georgia's 305(b)/303(d) Integrated Report List of Waters. These segments are listed below in order of upstream to downstream.

- GAR030702010703 – Satilla River (Seventeen Mile River to US Hwy 84/Ga. Hwy. 38) Assessment Pending, Category 3 (insufficient data). Notes: EPD needs to determine the "natural DO" for the area before a use assessment is made.
- GAR030702011103- Satilla River (U.S. Highway 84/Ga. Hwy. 38 to 6 miles downstream Hwy 15/121) Not Supporting, TWR. Category 4a. Notes: TMDL completed TWR (2002).
- GAR030702011105 – Satilla River (Six miles downstream of Ga. Hwy. 15 to Buffalo Creek) Not Supporting, TWR. Category 4a. Notes: TMDL completed TWR (2002).
- GAR030702011207 – Satilla River (Buffalo Creek to Bullhead Bluff) Not Supporting, TWR. Category 4a. Notes: TMDL completed TWR (2002). EPD needs to determine the "natural DO" for the area before it can be determined whether the dissolved oxygen criteria are being met.
- GAR030702011201 – Satilla River (Rose Creek to White Oak Creek) Not Supporting, DO. Category 4a. Notes: TMDL completed DO (2001).

According to the 305(b)/303(d) Integrated Report List of Waters, no segment in the Satilla River between Jamestown Landing and Woodbine Boat Ramp is impaired for fecal coliform. It is my understanding that EPD is currently revising the DO standards for coastal streams due to the fact that the ecology of coastal blackwater streams like the Satilla results in naturally occurring low DO levels.

Water Quality Data

Satilla Riverkeeper and our certified volunteers have been monitoring water quality at the public landings through Georgia's Adopt-A-Stream program since 2014. The average E. coli counts are relatively low for each of the public landings along this section of river, with the exception of U.S. 301 in Nahunta. This resulted from an outlier of 3300 cfu/100mL in July 2018. (We believe this was the result of a deer carcass that had been dumped in the river nearby.) Out of 13 sampling events at U.S. 301 in Nahunta, E. coli levels only exceeded 126 cfu/100mL once, and that was the instance noted above. As shown in Table 1 below, many of our testing locations have only exceeded safe E. coli levels set by EPA for designated swimming areas (235 cfu/100mL) once. U.S. Highway 84 in Waycross has exceeded this level twice out of 23 monitoring events, and Satilla River at Burnt Fort has never exceeded this level.

Table 1: E. coli Water Quality Data

AAS Site Id	Site Name	No. of Monitor Events	Site Average E. coli (cfu/ 100ml)	Max Recorded E. coli (cfu/ 100ml)	Date of Max recorded E. coli	Exceeds 235 cfu/ 100mL	Exceeds 126 cfu/ 100mL
S-3323	U.S. Highway 82, Nahunta	22	49.05	533	7/7/2018	Once	Twice
S-3431	Jamestown Landing	29	88.48	633	7/6/2015	Once	Seven Times
S-3655	U.S. Highway 84, Waycross	23	84.09	833	6/13/2017	Twice	Three Times
S-3767	Georgia Highway 121, Hoboken	20	59.85	567	7/18/2016	Once	Three Times
S-3769	Warners Landing	24	52.91	500	7/7/2018	Once	Twice
S-3716	Satilla River at Burnt Fort	22	36.48	167	1/27/2016	None	Once
S-4339	U.S. 301, Nahunta	13	280.5	3300	7/7/2018	Once	Once
S-3220	Woodbine Waterfront Park	33	81.82	333	11/24/2014	Once	Twice

Dissolved Oxygen (DO) levels are consistently low on this stretch of the Satilla River, as evidenced in Table 2 below. Coastal blackwater streams naturally have low dissolved oxygen levels, and it is my understanding that EPD is currently researching and revising these standards. We request that research be incorporated into the water quality standards for the designated use of recreation for blackwater rivers and streams in Georgia's coastal plain.

Table 2: Dissolved Oxygen Water Quality Data

AAS Site Id	Site Name	No. of Monitor Events	Average DO (mg/L)	Lowest DO Event (mg/L)	Date Lowest recorded DO	No. Events DO <4mg/L
S-3323	U.S. Highway 82, Nahunta	22	4.17	1.2	8/12/2018	8
S-3431	Jamestown Landing	29	4.96	3.3	8/22/2017	6
S-3655	U.S. Highway 84, Waycross	23	4.32	3.3	9/20/2016	6
S-3767	Georgia Highway 121, Hoboken	20	4.29	2.9	8/22/2017	6
S-3769	Warners Landing	24	4.43	2	8/12/2018	5
S-3716	Satilla River at Burnt Fort	22	4.23	2.2	6/21/2018	9
S-4339	U.S. 301, Nahunta	13	4.28	2.9	7/28/2018	4
S-3220	Woodbine Waterfront Park	33	4.07	1.65	6/7/2016	17

Blackwater streams and rivers in Georgia's coastal plain also have naturally lower pH with large inputs of organic matter resulting in tannic acids released to the water. In Georgia blackwater rivers, pH can reach as low as 3.5. We suggest that EPD revise these water quality standards to be reflective of the ecology of blackwater streams. Table 3 below shows the average pH measured through the Georgia Adopt-A-Stream program. Although the pH is below the state standards for many of the sites, we argue that it is not because of pollution, but it is a result of natural conditions.

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* 912-462-5094 * Riverkeeper@SatillaRiverkeeper.org * www.satillariverkeeper.org *

Table 3: pH Water Quality Data

AAS Site ID	Site Name	No. Monitor Events	Average pH	No. Events pH <6.0	Lowest Recorded pH Event	Date of Lowes t pH
S-3323	U.S. Highway 82, Nahunta	22	5.84	8	4.6	5/17/2016
S-3431	Jamestown Landing	29	5.91	7	5.5	8/31/2015
S-3655	U.S. Highway 84, Waycross	23	5.94	4	5.5	8/31/2015
S-3767	Georgia Highway 121, Hoboken	20	6.11	3	5.5	10/7/2015
S-3769	Warners Landing	24	5.96	7	5.5	8/31/2015
S-3716	Satilla River at Burnt Fort	22	5.71	12	5	9/23/2015
S-4339	U.S. 301, Nahunta	13	6.03	3	5.5	7/7/2018
S-3220	Woodbine Waterfront Park	33	6.06	7	5.5	1/31/2014

All of this data is accessible to the public through the Georgia Adopt-A-Stream database. We plan to do bacteria sampling for geometric means in Summer 2019 and Winter 2019, and will submit the results as supplemental information for this petition.

Current Users of the Waterbody

This section of the Satilla River is shared by many users. Community residents and visitors fish, kayak, canoe, swim, float, waterski, paddleboard, wade, camp, and enjoy other forms of recreation on the river year round, as is evidenced by the comments in Exhibit A and the photos in Exhibit B. One of the most popular swimming locations, nicknamed "Brantley Beach," is located at the Ava Lightsey Landing at the Highway 82 bridge in Atkinson, GA (Brantley County). The large sandbar is packed on weekends with people swimming, floating, playing in the river. The landing at GA 121 bridge between Hoboken and Blackshear is also a popular swimming and camping location.

Satilla Riverkeeper circulated a survey in which respondents noted the ways in which they recreate on the Satilla River, and which access points they use within the stretch of the Satilla River. The responses are shown below in graphical form.

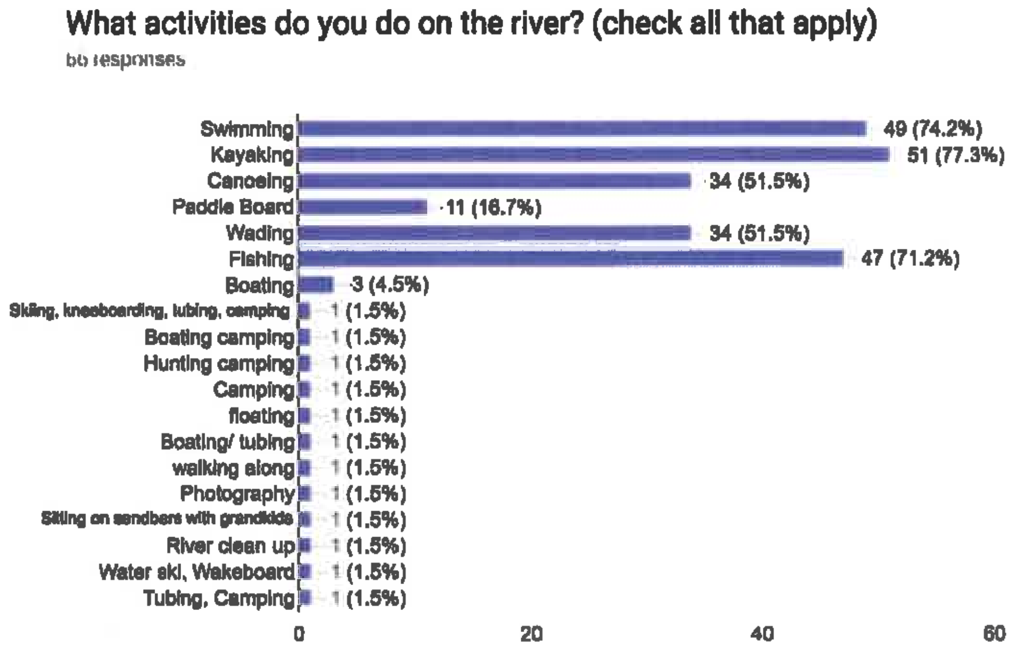


Figure 2: Survey responses, recreational activities on the Satilla River between Jamestown Landing and the Woodbine Boat Ramp.

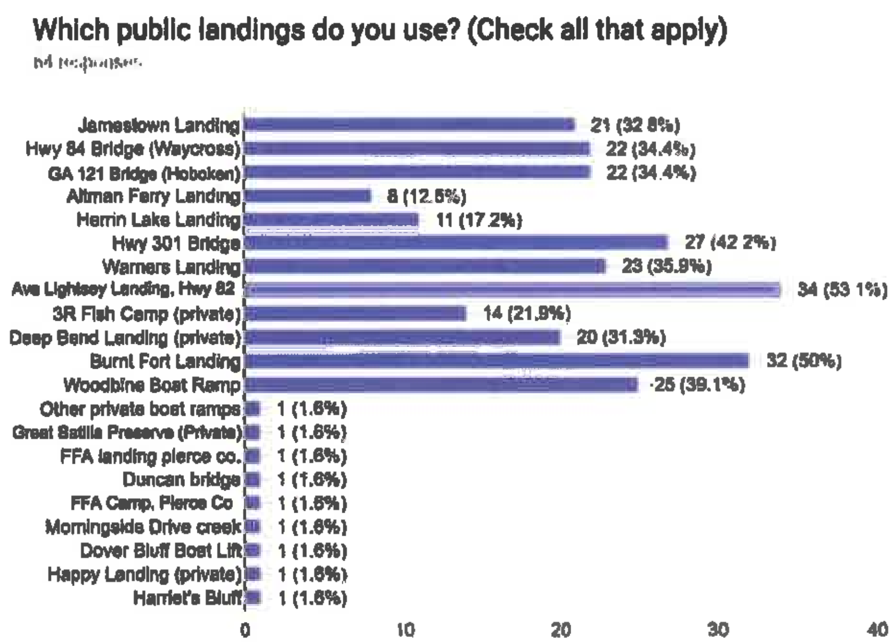


Figure 3: Survey responses, river access points used for recreation.

Satilla Riverkeeper guides paddling trips year-round on the Satilla. See Table 4 below for a list of guided trips in 2017, 2018, and 2019. Photos of select trips are also included in Exhibit B. Georgia Conservancy and Georgia River Network also guide trips on this section of the Satilla River.

Table 4: Satilla Riverkeeper Guided Paddle Trips

Date	Location	Participants
3/11/2017	Jamestown Landing to Hwy 84 Waycross	14
4/1/2017, 4/2/2017	Spring on the Satilla, 3R Fish Camp, Burnt Fort	130
10/14/2017	Hwy 301 Nahunta to Strickland's (private)	12
11/4/2017	Ava Lightsey Landing to Deep Bend Landing	7
11/5/2017	Hwy 121 to Altman's Ferry	5
1/15/2018	Warners Landing to Lightsey Landing	3
4/7/2018, 4/8/2018	Spring on the Satilla, 3R Fish Camp, Burnt Fort Landing	125
4/13/2018	Ava Lightsey to Happy Landing	3
4/28/2018	121 to Altmans Ferry	4
7/7/2018	Coffee County Club to Warners Landing	22
10/6/2018	Big Creek, highway 121	9
10/13/2018	Ava Lightsey Landing to Satilla Club	4
11/19/2018	Warner's Landing to Ava Lightsey Landing	6
3/23/2019	Scheduled, TBD	
4/6/2019, 4/7/2019	Spring on the Satilla	~100
6/22/2019	Scheduled, TBD	
10/26/2019	Scheduled, TBD	

Additionally, Satilla Riverkeeper shares water quality data with the public via SwimGuide a free, public app and web platform that easily allows users to find a popular swimming spot and check the recent water quality to ensure it is safe for swimming. Satilla Riverkeeper maintains 9 such swimming spots on SwimGuide.org. In 2017, the sites on the Satilla River got an average of 377 web views per swimming hole, with the most popular swimming site receiving 528 views, indicating that many people do swim in the Satilla River and are interested in the water quality at their swimming locations.

This section of the Satilla River is relatively rural. Surrounding land uses include some residential, timber, and forested land. The City of Waycross operates a wastewater treatment facility that is located within this stretch of the river. They hold NPDES permit GA0020966, issued in August 2015. Other sources of pollution include faulty or failing septic systems along the river and agriculture operations where runoff enters tributaries of the Satilla River.

Satilla River Water Trail

Local governments, local businesses, and community organizations have come together to designate the Satilla River Water Trail in 2016 to encourage recreation on the Satilla. This partnership invested over $10,000 in signs for public landings, informational brochures and maps, informational kiosks, and advertising the water trail. We anticipate investing another $2,000 in an informational kiosk at Burn Fort landing in 2019.

Satilla River Water Trail Partnership includes: Satilla Riverkeeper, Blackshear Main Street Program, Georgia River Network, Pierce County Chamber of Commerce, City of Waycross, GA DNR Wildlife Resources Division, Camden County PSA, Pierce County Industrial Development Authority, and Brantley County. Local governments passed resolutions in support of the Satilla River Water Trail in 2016. Resolutions from Brantley County, Pierce County, Camden County, City of Waycross, and City of Woodbine are attached.

Local businesses that benefit from recreational activities on the Satilla River include, but are not limited to: Southeast Adventure Outfitters, Kingfisher Paddleventures, Deep Bend Landing, Pony Creek Outdoor Adventures, Satilla Grocery, Jot Em Down Sporting Goods, Winges Bait and Tackle.

In summary, we request that EPD upgrade the Designated Use of the Satilla River to include Recreation between Jamestown Landing and the Woodbine Boat Ramp which coincides with the length of the established Satilla River Water Trail. Residents and visitors have used the Satilla in all months of the year for recreation activities for generations. In recent years, many local governments, businesses, and organizations have invested in improvements to public access points and invested in promoting recreation and eco-tourism on this section of the Satilla River. Satilla Riverkeeper has been monitoring water quality on the Satilla River, and results show that it is safe for swimming. Please accept this letter and attachments as our initial request as part of the 2019 Triennial Review Process. We also expect to submit supplemental information to support this request later this year. We are happy to provide any additional information needed to make an informed decision on this request.

Sincerely,

Laura Early

Laura Early
Executive Director and Riverkeeper
Satilla Riverkeeper
Riverkeeper@SatillaRiverkeeper.org

Enclosed:
Exhibit A – Survey Responses, recreational activities.
Exhibit B – Photo Evidence of recreational activities.

Attachments:
Satilla River Water Trail Brochure Map:
- **'water trail map.pdf'**
- **'WaterTrailBrochureFront.pdf'**

Letters of Support:
- **'DeepBendLanding letter Ron Easton.doc'**
- **'Satilla Designation Support Letter PC Chamber.pdf'**

Resolutions from Local Governements:
- **Brantley County – Resolution (Signed).pdf**
- **Camden County – Resolution (Signed).pdf**
- **City of Waycross – Resolution (Signed).pdf**
- **City of Woodbine – Resolution (Signed).pdf**
- **Pierce County – Resolution (Signed).pdf**

Exhibit A

Survey Comments, February 25 to March 8, 2019. (Last names left off for privacy in public comment):

First Name	Zip code	What activities do you do on the river? (check all that apply)	Comments for EPD about how you spend time on the Satilla River between Jamestown Landing and the Woodbine Boat Ramp and why it should be re-designated for Recreational Use:	Provide a short description of any photos you submitted
LORI	31553	Swimming, Kayaking, Canoeing, Wading, Fishing, SKIING, KNEEBOARDING, TUBING AND CAMPING ALSO		
Sharon	31542	Swimming, Kayaking, Wading, Fishing	We do clean up at the landings	
Tammy	31543	Swimming, Wading, Fishing, Boating camping		
Sharon	31501	Swimming, Kayaking, Canoeing, Wading	Please designate the beautiful Satilla River for recreational use. Our family of 8 loves to kayak and camp along the river. It's also great for wading, swimming, and canoeing.	Kayaking, canoeing, camping, relaxing on the Satilla.
Terry	31501	Swimming, Kayaking, Canoeing, Wading	Love to kayak and canoe on the Satilla!	
Anna	32258	Swimming, Kayaking, Canoeing, Wading	I grew up in Ware county and I enjoy returning to kayak and camp on the Satilla with my family. We often participate in river cleanups on the Satilla.	We love to kayak, camp, and even clean up the Satilla!
Carolyn	28409	Swimming, Kayaking, Wading, Fishing		
Loy	31516	Fishing	Fish only. To better protect the river that I live a 1/2 mile from and grew up on is very important to me. I would like to express my interest in keeping recreational atv's out of streams and tributaries of the Satilla River. As I fish this river year round the summer months seem to be when atv's use the river system as a playground. If you would like more details please contact me. Thanks	
Justin	31569	Swimming, Wading, Fishing, Hunting camping		

Richard	31543	Swimming, Wading, Fishing, Camping	I fish the river, swim on the river, wade in the river, we go tubing down the river, camping, hunting.	
Denny	31503	Swimming, Paddle Board, Wading		
Michael	31569	Kayaking, Canoeing, Wading, Fishing		
Katie	31522	Swimming, Kayaking, Canoeing, Paddle Board, Wading, Fishing		
Matthew	31520	Swimming, Kayaking, Fishing	I enjoy paddling with friends and family who come to visit us and want to enjoy the beautiful river we have access to. We spend time paddling, eating lunch on the shore and observing wild life.	Lunch on the river bank, paddling with family on big creek
Michelle	31568	Swimming, Kayaking, Paddle Board, Fishing	We boat, swim, Paddleboard and fish in this area regularly.	These pics are taken near Woodbine Boat Ramp and the surrounding areas on the Satilla River. These pics were all taken in the last year.
Kelie	31520	Swimming, Kayaking, Canoeing, Wading, Fishing, floating		
ANDREW	31566	Swimming, Fishing, Boating/ tubing		
Virgil	31516	Swimming, Canoeing, Wading, Fishing	Our family have used this river for over 60 years ,this is the only river left with in 40 miles that has not been,destroyed by Timber co. Misuse and abuse. Also why is it the the county don't have to control the runoff and sediment going into our river . as a privet citizen we must control runoff . but the,county gets by with all the runoff from dirt roads filling up and destroying our river.	
Steven	31523	Swimming, Kayaking, Canoeing, Paddle Board, Fishing		
James	31503	Swimming, Canoeing, Fishing		
Debbie	31501	Canoeing, Fishing	We use the river for fishing and canoeing. It was always clean and quiet until the landing was built. It is frequently trashed and polluted .	

			We also have issues with people on jet skies. Our concern is for people kayaking and canoeing. It dangerous having them on the river.	
WILLIAM	30286	Kayaking, Canoeing	paddling, fishing	
Shirley	31642	Kayaking, Canoeing		
Laurel		Swimming, Kayaking	I paddle this river every spring and look forward to kayaking on a clean river	
Ben	31525	Swimming, Kayaking, Fishing	That's what the public uses it for.	
Vicki	31522	Swimming, Kayaking, Canoeing, Wading, Fishing	Hot summers, cool water	
Jazmin	31525	Swimming, Kayaking, Canoeing, Paddle Board, Wading, Fishing		
Sands	32523	Swimming, Kayaking, Paddle Board, Wading, Fishing		
Lanny	31522	Swimming, Kayaking, Canoeing, Wading, Fishing		
Ron	31566	Swimming, Kayaking, Canoeing, Paddle Board, Wading, Fishing	Paddling and camping on sand bars	
Jason	31522	Swimming, Kayaking, Paddle Board, Fishing		
Randall and Jeanette	31525	Swimming, Kayaking	We love the river. It is beautiful and great for kayaking, swimming and fishing.	That was me on the Satilla testing out my new sun shade on my kayak.
Stacey Ann	31568	Swimming, Kayaking, Fishing	Wild and scenic river	
Jeanette	31525	Swimming, Kayaking, Fishing	I love this river. When my grown sons come for a visit, we always try to do a kayak trip on the Satilla. It is a beautiful river.	My sons and husband paddling the beautiful Satilla River. Water was a little low , but still a great trip.
Bud	31501	Kayaking, walking along		
Steve	31542	Swimming, Kayaking, Canoeing, Wading, Fishing, Photography	I've enjoyed the Satilla River all my life and there's no place like it . Some of the best fishing anywhere and the best scenery too . Some of my favorite childhood memories are of spending time with family	

			and friends at the Satilla River and every year I see lots and lots of families making memories with their children at the river . So yes this section of the Satilla River should definitely be designated for recreational use !	
Ron	31535	Swimming, Kayaking, Wading, Fishing		
Linda	31088-2020	Kayaking, Canoeing		
John	285 Dover Drive	Swimming, Kayaking, Wading, Fishing, Boating		
		Canoeing, Fishing		
David	31557	Swimming, Fishing, Boating	I use these landings to spend time with my sons because unlike some other more well off people I can not afford the more expensive theme parks and such	Me and the boys skinning a deer we caught
Karl	31548	Swimming, Kayaking, Canoeing, Wading, Fishing	My family and I enjoy our beautiful river to its fullest year round. Swimming, kayaking, canoeing, floating and fishing.	
Cheston	31525	Swimming, Kayaking, Canoeing, Paddle Board, Wading, Fishing		
Paul	30344	Kayaking, Canoeing	I kayak and swim	
Robert	31566	Swimming, Kayaking, Canoeing, Wading, Fishing, Sitting on sand bars with the grand kids	When the water levels are right the river is a great place to recreate.	
Bettina	29664	Swimming, Kayaking, Canoeing, Wading		
Benjamin	31523	Swimming, Kayaking, Wading, Fishing		
Wade	31501	Canoeing, Wading, Fishing	The wading is primarily associated with fishing during low water times. As a child I camped with my dad along the river as well. In recent years my youngest son has camped and kayaked along the river with friends.	
Charles	31523	Kayaking, Fishing		
Joan	31523	Kayaking, Fishing		
Elizabeth	31558	Swimming, Kayaking, Wading, River clean up	The Satilla River is my favorite river to paddle in Southeast Georgia. Beautiful tea colored water and white sand banks make for great	

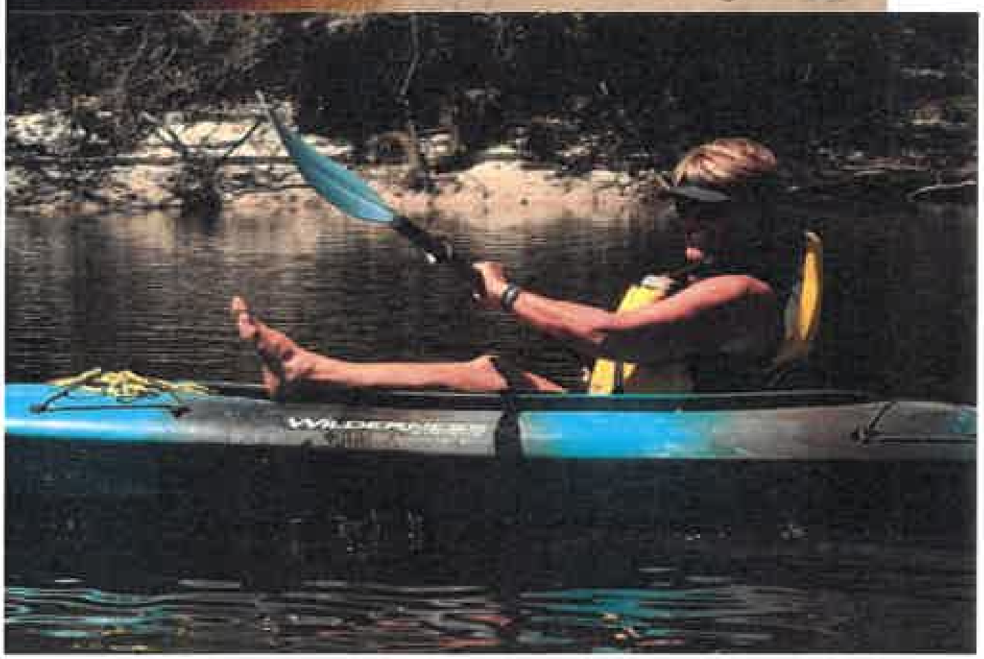
			swimming. Great location for looking for spring migrants like the prothonotary warbler. Lots of birds to observe year round , too, like belted kingfishers and snowy egrets.	
Stephen	31566	Swimming, Kayaking, Wading	This is the only remaining river in Georgia, that does not have industrial plants along the river. UNFORTUNATELY, COFFEE COUNTY HAS ON MULTIPLE OCCASIONS, DUMPED FECES AND URINE AND SHOULD SUFFER EXORBITANT FINES, WITH FEES GOING TOWARDS ADDITIONAL CLEAN UP EFFORTS, FROM THERE, SOUTHWARDS. In addition, they should take whatever steps necessary to ensure that they do not continue to violate and pollute the river with toxic waste	I do have a ton of pictures, but do not have the time to get them in on this submittal
Miranda	31525	Swimming, Wading, Fishing, Boating		
kadie	31520	Kayaking		
Christ	31569	Swimming, Paddle Board, Fishing, Water ski, Wakeboard		Paddle boarding at Woodbine boat ramp
Clay	31520	Swimming, Kayaking, Canoeing, Fishing, Tubing, Camping	The Satilla is one of our favorite recreational spots in coastal Georgia. There are lots of fun recreational activities year-round.	1) My daughter Laney George paddling Big Satilla Creek in 2015 when she was 10 years old and 2) reflection of a thunderstorm cloud in the river at our campsite upstream from Deep Bend Landing, July 4th weekend, 2017.
melissa	31548	Swimming, Canoeing, Fishing		
Jennifer	30628	Kayaking, Canoeing, Fishing		
Ashby	31305	Swimming, Kayaking, Canoeing, Fishing	camping, wildlife viewing, botanizing, etc.	

Trish	31566	Swimming, Kayaking, Canoeing, Fishing		
Paul	31305 31305	Swimming, Kayaking, Canoeing, Fishing		
anthony	30656	Kayaking		
Cathy	29369	Swimming, Kayaking, Wading	Despite living in the upstate of South Carolina, I have made multiple kayaking trips on the Satilla river, which included a little fishing, wading and swimming. In my opinion this river is more beautiful and more suited to paddling than the Edisto in South Carolina, which generates quite a bit of ecotourism. It rivals the (not very imaginatively named) Black Water River in the Florida panhandle which is popular with paddlers, swimmers and tube rental trips. If the Satilla is designated for recreational use it will be poised for garnering the necessary funds and attention to increase ecotourism on the Satilla River Water Trail.	Enjoying a picnic lunch on a sand bar about halfway through the paddle. These were taken in November 2017 somewhere between Ava Lightsey Landing and Deep Bend Landing.
Sharon	29645	Kayaking, Wading	picnicking	a November paddle between Ava and Deep Bend landings
Abby	31520	Kayaking, Canoeing	I am so excited to explore the river by kayak- such an important recreational resource for communities in the region!	
Linda Anita	31557	Kayaking, Wading	I've visited there once and it is incredibly suited for recreational use. The locals use it historically, which sets the precedence. Designate it for Recreational Use.	

Exhibit B – Photo Evidence

Satilla Riverkeeper paddle – Oct. 14, 2017. Hwy 301 landing to Strickland's landing (7 miles)

Spring on the Satilla, April 2017



Spring on the Satilla, April 2018

Satilla Riverkeeper Paddle – November 5, 2017, Hwy 121 to Altman's Ferry landing

Satilla Riverkeeper Member Paddle – July 7, 2018, Coffee County Club to Warner's Landing

Photos contributed by Satilla Riverkeeper Members:

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Paddleboarding, Woodbine

Satilla Riverkeeper Member Paddle, December 2015, Big Creek, Hwy 121 landing:
https://www.flickr.com/photos/teamgeorge/albums/72157662190330304

Comments from Douglasville

Ms. Salter,

Today I checked the new draft 2020 305(b)/303(d) list to see if there were any changes in our jurisdiction (basically all of Douglas County). The only change I noticed is to GAR031300020304, which is Anneewakee Creek from Lake Monroe to Chattahoochee River. This section was previously listed in 2018 as supporting, at Category 4a. Now it is shown as category 5, FC impaired. The note says that the EPD believes there is a possibility that EPD pH probes may be giving false low readings, and that therefore such water should be "placed in Category 3 while EPD determines" the cause of the low pH readings. I don't understand, therefore, why this segment of the creek is shown as a category 5, FC-impaired stream. Can you explain this situation?

Steve Ingle, P.E.
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