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# Limnological Conditions in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August to September 2005, May 2006, and October 2006

Open-File Report 2008–1268

U.S. Department of the Interior
U.S. Geological Survey

**Cover photograph.** Northern shoreline of Lake William C. Bowen below Interstate-26 bridge.

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DIRK KEMPTHORNE, Secretary

**U.S. Geological Survey**
Mark D. Myers, Director

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# Conversion Factors

| Multiply | By | To obtain |
|---|---|---|
| | Length | |
| inch (in.) | 25.4 | millimeter (mm) |
| foot (ft) | 0.3048 | meter (m) |
| mile (mi) | 1.609 | kilometer (km) |
| | Area | |
| acre | 4,047 | square meter ($m^2$) |
| square foot ($ft^2$) | 0.09290 | square meter ($m^2$) |
| square mile ($mi^2$) | 2.590 | square kilometer ($km^2$) |
| | Volume | |
| gallon (gal) | 3.785 | liter (L) |
| cubic foot ($ft^3$) | 0.02832 | cubic meter ($m^3$) |
| | Flow rate | |
| cubic foot per second ($ft^3/s$) | 0.02832 | cubic meter per second ($m^3/s$) |
| inch per hour (in/h) | 0.0254 | meter per hour (m/h) |
| | Mass | |
| ounce, avoirdupois (oz) | 28.35 | gram (g) |
| pound, avoirdupois (lb) | 0.4536 | kilogram (kg) |

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = (1.8 \times °C) + 32$$

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$°C = (°F - 32)/1.8$$

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Concentrations of chemical consituents are in milligrams per liter (mg/L), micrograms per liter (µg/L), and nanograms per liter (ng/L).

Concentrations of algal constituents are in cells per 100 milliliters (cells/100 mL).

Spartanburg Water System is referenced as SWS.

# Limnological Conditions in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August to September 2005, May 2006, and October 2006

By Celeste A. Journey and Thomas A. Abrahamsen

## Abstract

The U.S. Geological Survey, in cooperation with the Spartanburg Water System, conducted three spatial surveys of the limnological conditions in Lake William C. Bowen (Lake Bowen) and Municipal Reservoir #1 (Reservoir #1), Spartanburg County, South Carolina, during August to September 2005, May 2006, and October 2006. The surveys were conducted to identify spatial distribution and concentrations of geosmin and 2-methylisoborneol, common trophic state indicators (nutrients, transparency, and chlorophyll *a*), algal community structure, and stratification of the water column at the time of sampling. Screening tools such as the Carlson trophic state index, total nitrogen to total phosphorus ratios, and relative thermal resistance to mixing were used to help compare data among sites and among seasons. Water-column samples were collected at two depths at each selected site: a near-surface sample collected above a 1-meter depth and a lake-bottom sample collected at a depth of 2.5 to 7 meters, depending on the depth at the site.

The degree of stratification of the water column was demonstrated by temperature-depth profiles and computed relative thermal resistance to mixing. Seasonal occurrence of thermal stratification (August to September 2005; May 2006) and de-stratification (October 2006) was evident in the depth profiles of water temperature in Lake Bowen. The most stable water-column (highest relative thermal resistance to mixing) conditions occurred in Lake Bowen during the August to September 2005 survey. The least stable water-column (destratified) conditions occurred in Lake Bowen during the October 2006 survey and Reservoir #1 during all three surveys. Changes with depth in dissolved oxygen (decreased with depth to near anoxic conditions in the hypolimnion), pH (decreased with depth), and specific conductance (increased with depth) along with thermal stratification indicated Lake Bowen was exhibiting characteristics common to both mesotrophic and eutrophic conditions.

Nutrient dynamics were different in Lake Bowen during the May 2006 survey from those during the August to September 2005 and October 2006 surveys. Total organic nitrogen concentrations (total Kjeldahl nitrogen minus ammonia) remained relatively constant within the surveys and ranged from 0.15 to 0.36 milligram per liter during the period of study. Nitrate was the dominant inorganic species of nitrogen during May 2006. Ammonia was the dominant species during the August to September 2005 and October 2006 surveys. During the August and September 2005 survey, ammonia was detected only in bottom samples collected in the near anoxic hypolimnion, but during the October 2006 survey, ammonia was detected under destratified conditions in surface and bottom samples. In Lake Bowen, total phosphorus concentrations in bottom samples did not exhibit the dramatic, high values during the May 2006 and October 2006 surveys (0.009 to 0.014 milligram per liter) that were identified for the August to September 2005 survey (0.022 to 0.034 milligram per liter). Chlorophyll *a* concentrations appeared to vary with the species of inorganic nitrogen. Greater chlorophyll *a* concentrations were identified in samples from the May 2006 survey (6.8 to 15 micrograms per liter) than in the August to September 2005 (1.2 to 6.4 micrograms per liter) and October surveys (5.6 to 8.2 micrograms per liter) at all sites in Lake Bowen and Reservoir #1. For the three limnological surveys, surface concentrations of chlorophyll *a* and total phosphorus were well below established numerical criteria for South Carolina.

In general, the computed trophic state indices indicated that mesotrophic conditions were present in Lake Bowen and Reservoir #1. The total nitrogen to total phosphorus ratios in Lake Bowen and Reservoir #1 were below 22:1 for the August to September 2005 survey, indicating a high probability of dominance by nitrogen-fixing cyanobacteria. Ratios during the May and October 2006 surveys at some sites in Lake Bowen were above 22:1, indicating a lower probability of cyanobacterial dominance. Total nitrogen to total phosphorus ratios were consistently below 22:1 for a site in Reservoir #1 (MR1-14).

For all three surveys, 2-methylisoborneol concentrations were below the laboratory reporting limit of 0.005 microgram per liter. Of the three surveys, the highest concentrations of geosmin were measured during the August to September 2005 survey in samples collected near the bottom of Lake Bowen when stratified conditions existed. Elevated geosmin concentrations ranged from 0.016 to 0.039 microgram per liter at sites and depths that had elevated ammonia and total phosphorus concentrations in Lake Bowen. Geosmin levels were lower in samples from sites in Reservoir #1 than those from Lake Bowen. The lowest geosmin concentrations for Lake Bowen were measured during the October 2006 survey (less than 0.005 to 0.007 microgram per liter) when destratified conditions existed.

Members of the division Cyanophyta (also known as cyanobacteria or blue-green algae) were present in the greatest abundance of all the phytoplankton divisions in Lake Bowen and Reservoir #1 at every site and sampling depth during all three surveys. For the three surveys, phytoplankton cells in the division Cyanophyta composed 91 to 99 percent of the total phytoplankton community among all sites and depths. During the August to September 2005 survey, several potentially geosmin-producing genera were identified in Lake Bowen and Reservoir #1 samples. The most abundant genera were *Lyngbya* and *Synechococcus*. During the May and October 2006 surveys, fewer potentially geosmin-producing genera were identified in Lake Bowen and Reservoir #1 samples; the most abundant genera were *Synechococcus*. Overall, the cyanobacterial communities in these samples were dominated by the picoplankton, *Synechococcus sp.1*, and other unidentified members of Chroococaceae, *Cyanogranis ferruginea*, and periodically, *Lyngbya limnetica*. No pattern between the algal cell density of the potentially geosmin-producing genera of cyanobacteria and geosmin occurrence was identified during the three surveys.

## Introduction

The Spartanburg Water System (SWS) uses surface water from two reservoirs within Spartanburg County, South Carolina: Lake William C. Bowen (Lake Bowen) and Municipal Reservoir #1 (Reservoir #1). Lake Bowen and Reservoir #1 were created by the impoundment of the South Pacolet River. Water flows from Lake Bowen immediately downstream into Reservoir #1 (fig. 1). Water from Lake Bowen and Reservoir #1 is treated at the R.B. Simms Water Treatment Plant (WTP) located near Reservoir #1. Outflow from Reservoir #1 is near the confluence of the South and North Pacolet Rivers that forms the Pacolet River.

Previous monitoring by SWS identified geosmin (trans-1, 10 dimethyl-trans-9-decalol) in the source water as the most frequent cause of taste-and-odor problems in their finished drinking water. Another taste-and-odor compound, 2-methylisoborneol (MIB), also occurs but less frequently. A one-time event in May 2005 produced geosmin concentrations that exceeded 100 ng/L (nanograms per liter or parts per trillion) in the source water, which was more than ten times the human taste-and-odor threshold level of 10 ng/L (Wnorowski, 1992). At these high levels, the activated carbon filter system at the R.B. Simms WTP was unable to remove or reduce geosmin effectively below the threshold level to prevent taste-and-odor problems in the finished water. Prior to May 2005, SWS had measured elevated geosmin concentrations but never as early as May or at these high concentrations. Subsequent monitoring by SWS identified recurring periods of elevated geosmin concentrations and sporadic elevations in MIB concentrations.

Throughout the United States, occasional taste-and-odor episodes in public water systems that use surface-water supplies are common (Weete and others, 1977; Izaguirre and others, 1982; Mueller and Ruddy, 1992; Paerl and others, 2001; Smith and others, 2002; Havens and others, 2003; Graham and others, 2004; Westerhoff and others, 2005; Zaitlin and Watson, 2005; Taylor and others, 2006; Christiansen and others, 2006). Algal-derived compounds that produce taste and odor in drinking water are not harmful; therefore, taste-and-odor problems are a palatability, rather than health, issue for drinking-water systems. Second to chlorine, earthy, musty odors produced by the compounds geosmin and MIB are responsible for repeated taste-and-odor problems in drinking water (Suffet and others, 1996). Geosmin and MIB are produced by certain algae and bacteria. Human sensitivity for these compounds is extremely

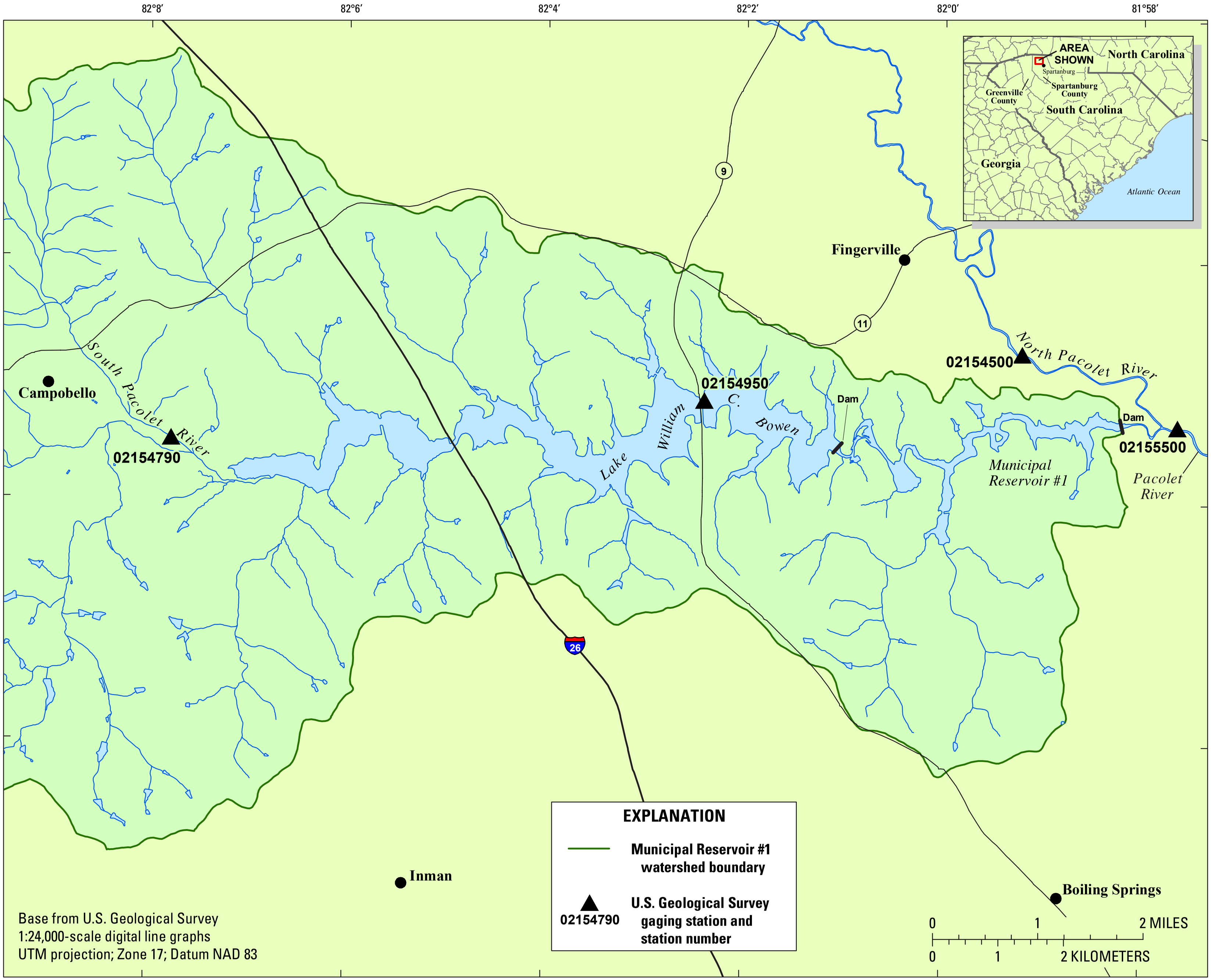


**Figure 1.** Location of Lake William C. Bowen and Municipal Reservoir #1 in Spartanburg County, South Carolina.

low. Human taste-and-odor threshold is from 2 to 15 parts per trillion (nanograms per liter) for geosmin and MIB (Wnorowski, 1992; Young and others, 1996).

Surface-water taste-and-odor episodes can be related to algal blooms that are triggered by environmental conditions. Cyanophyta (blue-green algae), Chlorophyta (green algae), Bacillariophyta (diatoms), and dinoflagellates are the four algal divisions responsible for the most common odor complaints; however, only certain genera of Cyanophyta are known to be important sources of geosmin and MIB (Izaguirre and others, 1988; Rashash and others, 1996). Additionally, three genera of Actinomycetes, a type of bacteria that is found ubiquitously in soils but also in the aquatic environment, is an important source of geosmin and MIB (Zaitlin and Watson, 2005). Genera of cyanobacteria reported to produce geosmin and MIB include *Anabaena, Planktothrix, Oscillatoria, Aphanizomenon, Lyngba, Symploca* (Izaguirre and others, 1988; Rashash and others, 1996), and *Synechococcus* (Taylor and others, 2006). Genera of Actinomycetes that produce geosmin and MIB are *Microbispora*, *Nocardia*, and *Streptomycetes* (Zaitlin and Watson, 2005).

Some effects on human and aquatic health are related to cyanobacterial blooms (Carmichael, 1994; Pilotto and others, 1999; Paerl and others, 2001; Smith and others, 2002; Graham and others, 2004). Fish deaths during cyanobacteria blooms may be caused directly by toxins produced by certain species of cyanobacteria or indirectly from depletion of oxygen in the water, by the release of hydrogen sulfide and ammonia from cell decay, or by algae clogging the gills.

Cyanobacterial blooms can be stimulated by human activity that introduces excessive nutrients or modifies the water residence time in a lake or reservoir (Burkholder, 1992; Mueller and Ruddy, 1992; Smith and others, 1995; Downing and others, 2001; Paerl and others, 2001; Havens and others, 2003; Graham and others, 2004; Christensen and others, 2006). Changes in release patterns from existing reservoirs may reduce the flow and mixing of water, leading to stronger temperature stratification during the hotter months of the year. Human activity that contributes phosphorus and nitrogen can fuel the growth of algae and the development of blooms. The nutrients may come from a variety of sources in a watershed, including soil erosion, urban runoff, irrigation drainage, failing septic or sewer systems, or point sources such as wastewater-treatment-plant outfalls or animal feedlots.

The U.S. Geological Survey (USGS), in cooperation with the Spartanburg Water System, conducted three spatial surveys of geosmin and MIB levels in Lake Bowen and Reservoir #1 during August to September 2005, May 2006, and October 2006. The surveys provided snapshots of the spatial distribution of geosmin, MIB, nutrient concentrations, nitrogen-to-phosphorus ratios, chlorophyll *a*, and algal community structure.

## Purpose and Scope

The purpose of this report is to describe the findings from the three surveys of limnological conditions related to geosmin and MIB occurrence in Lake Bowen and Reservoir #1. Specifically, this report includes the following:

1. description of the limnological characteristics of the lakes at the time of sampling, including stratification and trophic state;
2. identification of areas of the lakes where nutrients, chlorophyll *a*, phytoplankton ash-free dry mass (algal biomass), and wastewater compounds were elevated at the time of sampling;
3. identify areas of the lakes where geosmin and MIB were elevated at the time of sampling;
4. characterization of the dominant algal community structure in the lakes at the time of sampling; and
5. an evaluation of the algal community to determine the density of algal species that are known geosmin producers in the lakes at the time of sampling.

## Description of Study Area

Lake Bowen is a manmade lake (reservoir) created in 1960 by the impoundment of the South Pacolet River (fig. 1). At full pool elevation of 815 feet (ft) National Geodectic Vertical Datum of 1929 (NGVD 29), Lake Bowen has a surface area of 1,534 acres and has 33.0 miles (mi) of shoreline (table 1; Janet Cann, Spartanburg Water System, oral commun., 2007).

Water flows from Lake Bowen immediately downstream into a second reservoir, Municipal Reservoir #1, which was created in 1926 (table 1; accessed on February 12, 2008, at *http://www.spartanburgwater.org/history.html)*. Water from these lakes is treated at the R.B. Simms WTP, located on Reservoir #1. Reservoir #1 is substantially smaller than Lake Bowen. At full pool elevation of 777 ft (NGVD 29), the lake surface of Reservoir #1 covers an area of 272 acres and has 13.1 mi of shoreline (table 1; Janet Cann, Spartanburg Water System, oral commun., 2007). Recreational activities are allowed on Lake Bowen, but are restricted on Reservoir #1 (accessed on February 13, 2008, at *http://www.spartanburgwater.org/history.html*). Outflow from Reservoir #1 is about 2,600 ft upstream from the confluence of the South and North Pacolet Rivers.

The South Pacolet River watershed, which encompasses these lakes, drains 91.4 square miles ($mi^2$) and is located in Spartanburg and eastern Greenville Counties, South Carolina. Flow in the South Pacolet River is measured at USGS gaging station 02154790 (South Pacolet River near Campobello, S.C.). Station 02154790 is located 1.1 mi upstream from Lake Bowen and monitors a drainage area of 55.4 $mi^2$. During 1989–2006, the average annual flow measured at Station 02154790 was 97.7 cubic feet per second ($ft^3/s$) (U.S. Geological Survey, 2007).

Land use within the South Pacolet River basin was determined for 1982, 1992, and 2001 from public domain Geospatial Information System (GIS) coverages (Appendix A; table 2; fig. 2). The 1992 and 2001 land use was computed from the National Land Cover Data (NLCD) that was derived from the early to mid-1990s Landsat Thematic Mapper satellite data. The NLCD is a 21-class land-cover classification scheme applied consistently over the United States (Appendix A; Price and others, 2006). The 1982 land use was compiled from a larger resolution coverage that used a different land cover classification scheme derived from the Geographic Information Retrieval and Analysis System (GIRAS). The GIRAS software system was developed by the USGS and is used to digitize, edit, and produce cartographic and statistical output from the mapped information (Mitchell and others, 1977; Price and others, 2006).

In general, land use within the South Pacolet River basin can be classified as rural. Forested land (cumulative total of mixed, deciduous, and evergreen) dominated the land use from 1992 to 2001 at 62 and 49 percent of the basin, respectively, indicating a decrease in forestation during that period. In 1982, the acreage of land covered by forested land was almost equal to the acreage covered by agricultural land (46.2 percent). The percentage of the basin covered by agricultural land use dropped from 46.2 percent in 1982 to 30.5 percent in 1992. In 1992, 12 percent of the agricultural land was covered by pasture and hay fields, and 18 percent was covered by row crops. A further reduction in agricultural land use was indicated by the 2001 coverage to only 24.1 percent, and only 0.1 percent of that land use was row crops. Residential and developed (urban) land use covered a much smaller part of the South Pacolet River basin, ranging from 4.4 percent (cumulative total of all urban categories) in 1982 to 3.0 percent (cumulative total of all developed categories) in 1992. At this small margin of difference in developed land use change from

**Table 1.** Physical characteristics of Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina.

[NGVD 29, National Geodectic Vertical Datum of 1929; --, no data]

| Reservoir Characteristic | Lake William C. Bowen | Municipal Reservoir #1 |
|---|---|---|
| Full pool elevation (feet NGVD 29) | 815 | 777 |
| Storage capacity (billion gallons) | [a]7.4 | -- |
| Reservoir size (acres) | [b]1,534 | [b]272 |
| Watershed area (square miles) | [c]82 | [c]90 |
| Shoreline miles | [b]33 | [b]13.1 |
| Spillway crest (feet NGVD 29) | [a]815 | [b]777 |
| Date formed | [a]1960 | [d]1926 |
| Maximum depth (feet) | [c]41 | -- |
| Average depth (feet) | [c]15 | -- |

[a] Cooney and others, 2005

[b] Janet Cann, Spartanburg Water System, oral commun., 2007

[c] South Carolina Department of Health and Environmental Control, 2001

[d] Spartanburg Water System, accessed Feburary 12, 2008, at *http://www.spartanburg.org/history.html*

**Table 2.** Land use in the South Pacolet River basin in 1982, 1992, and 2001, Spartanburg County, South Carolina.

[GIRAS, Geographic Information Retrieval and Analysis System; NLCD, National Land Cover Data]

| Code | Category | Acreage | Percentage |
|---|---|---|---|
| | 1982 Land Use (GIRAS) | | |
| 53 | Water - reservoir | 7,752 | 3.0 |
| 17 | Urban - other urban or built-up land | 762 | 0.3 |
| 11 | Urban - residential | 8,123 | 3.1 |
| 12 | Urban - commercial and services | 226 | 0.1 |
| 13 | Urban - industrial | 439 | 0.2 |
| 14 | Urban - transportation, communication, and utilities | 1,868 | 0.7 |
| 76 | Barren - transitional | 710 | 0.3 |
| 41 | Forest - deciduous | 92,785 | 35 |
| 42 | Forest - evergreen | 9,362 | 3.6 |
| 43 | Forest - mixed | 19,765 | 7.5 |
| 21 | Agricultural - cropland and pasture | 106,658 | 41 |
| 22 | Agricultural - orchards, groves, vineyards, and nurseries | 13,518 | 5.2 |
| | 1992 Land Use (NLCD) | | |
| 11 | Open water | 8,102 | 3.1 |
| 21 | Developed - low-intensity residential | 5,676 | 2.2 |
| 22 | Developed - high-intensity residential | 317 | 0.1 |
| 23 | Developed - commercial/industrial/transportation | 1,944 | 0.7 |
| 24 | Developed - high-intensity | 0 | 0 |
| 31 | Barren - bare rock/sand/clay | 138 | 0.1 |
| 33 | Barren - transitional | 1,495 | 0.6 |
| 41 | Forested upland - deciduous | 77,926 | 30 |
| 42 | Forested upland - evergreen | 50,208 | 19 |
| 43 | Forested upland - mixed | 35,142 | 13 |
| 52 | Shrub/scrub | 0 | 0 |
| 71 | Grassland/herbaceous | 0 | 0 |
| 81 | Herbaceous planted/cultivated - pasture/hay | 31,707 | 12 |
| 82 | Herbaceous planted/cultivated - row crops | 46,065 | 18 |
| 85 | Herbaceous planted/cultivated - urban/recreational grasses | 1,289 | 0.5 |
| 91 | Wetlands - woody wetlands | 1,652 | 0.6 |
| 92 | Wetlands - emergent herbaceous wetlands | 156 | 0.1 |
| | 2001 Land Use (NLCD) | | |
| 11 | Open water | 9,824 | 3.8 |
| 21 | Developed - open space | 26,545 | 10 |
| 22 | Developed - low-intensity | 4,756 | 1.8 |
| 23 | Developed - medium-intensity | 914 | 0.3 |
| 24 | Developed - high-intensity | 193 | 0.1 |
| 31 | Barren - bare rock/sand/clay | 1,294 | 0.5 |
| 33 | Barren - transitional | 0 | 0 |
| 41 | Forested upland - deciduous | 92,665 | 35 |
| 42 | Forested upland - evergreen | 33,604 | 13 |
| 43 | Forested upland - mixed | 1,896 | 0.7 |
| 52 | Shrub/scrub | 2,403 | 0.9 |
| 71 | Grassland/herbaceous | 18,325 | 7.0 |
| 81 | Pasture/hay | 63,679 | 24 |
| 82 | Cultivated crops | 156 | 0.1 |
| 85 | Herbaceous planted/cultivated - urban/recreational grasses | 0 | 0 |
| 90 | Woody wetlands | 5,563 | 2.1 |
| 92 | Wetlands - emergent herbaceous wetlands | 0 | 0 |

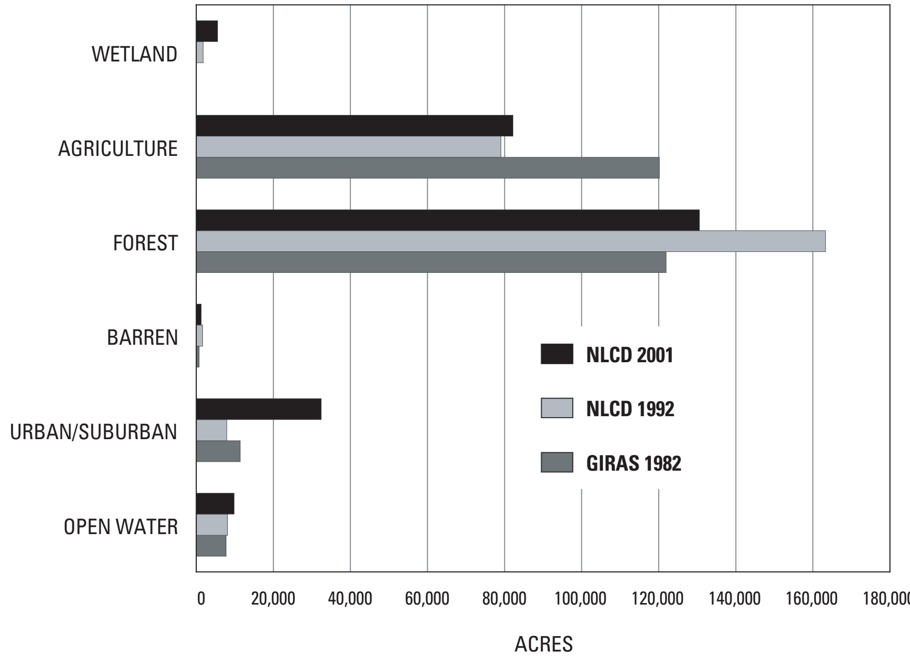


**Figure 2.** Land-use change in the South Pacolet River basin, Spartanburg County, South Carolina, from 1982 to 2001. Data from National Land Cover Database (NLCD) and Geographic Information Retrieval and Analysis System (GIRAS) Geospatial Information System coverages (Price and others, 2007).

1982 to 1992, the degree of change cannot be determined from the available data because of resolution differences in the coverage; however, an increase in developed land use to 12.2 percent in 2001 was evident. Low-intensity residential development was the dominant category within the developed land use in 1992 but was replaced in its ranking by open land development (including parks and golf courses) in 2001.

The entire watershed for Lake Bowen and Reservoir #1 lies within the Piedmont Physiographic Province, which is aggregated into the U.S. Environmental Protection Agency (USEPA) nutrient ecoregion IX. The USEPA aggregated nutrient ecoregion IX combines the Piedmont and Southeastern Plains level III ecoregions (U.S. Environmental Protection Agency, 2000; Omernik, 2005). An ecoregion is defined as a region that has similar biological, chemical, and geographic characteristics within the terrestrial and aquatic compartments of its ecological systems (Omernik, 2005).

## Previous Investigations

Lake Bowen was assessed as part of a watershed-wide investigation conducted in the South Pacolet River basin in 1976 by the USEPA National Eutrophication Survey (U.S. Environmental Protection Agency, 1976). The survey ranked Lake Bowen 7th out of 13 lakes in South Carolina in overall trophic quality and reported that the reservoir was characterized by phosphorus-limited and nutrient-enriched conditions with macrophytes present in shallow areas. The estimated total phosphorous and nitrogen loads to Lake Bowen were 2,533 and 80,250 kilograms per year (kg/yr), respectively, in 1976 (table 3).

The 1976 USEPA study classified Lake Bowen as predominantly phosphorus limited on the basis of a primary productivity test and ratios of mean inorganic nitrogen to orthophosphate concentrations that were greater than 26:1 (U.S. Environmental Protection Agency, 1976). The mean concentration of chlorophyll *a* was 3.9 micrograms per liter (µg/L); total phosphorus, 0.022 milligram per liter (mg/L); and total inorganic nitrogen, 0.36 mg/L (U.S. Environmental Protection Agency, 1976). South Pacolet River delivered 1,780 kg/yr of total phosphorus (about 70 percent of total) to Lake Bowen. The combined delivery of the total phosphorus load from minor tributaries and immediate shoreline drainage was an order of magnitude less than the South Pacolet (398 kg/yr or about 16 percent of the total load of 2,533 kg/yr). A municipal sewage-treatment plant (STP) contributed another 10 percent.

**Table 3.** Summary of nutrient loads to Lake William C. Bowen, Spartanburg County, South Carolina, in 1976. Reported by the U.S. Environmental Protection Agency (1976).

[$km^2$, square kilometers; $mi^2$, square miles; kg/yr, kilograms per year; TP, total phosphorus; TN, total nitrogen; ($kg/km^2$)/yr, kilograms per square kilometer per year; NA, not applicable]

| Source | Drainage area ($km^2$ [$mi^2$]) | Total phosphorus load (kg/yr) | Total nitrogen load (kg/yr) | Mean annual TP export [($kg/km^2$)/yr] | Mean annual TN export [($kg/km^2$)/yr] |
|---|---|---|---|---|---|
| South Pacolet River | 145 [56] | 1,780 | 60,985 | 12.3 | 421 |
| Minor tributaries and immediate shoreline drainage | 61 [23.6] | 398 | 12,100 | 6.5 | 198 |
| Municipal Sewage Treatment Plant | NA | 245 | 310 | NA | NA |
| Direct precipitation | 206 [79.5] | 110 | 6,855 | 0.5 | 33 |
| Total loading to Lake Bowen | NA | 2,533 | 80,250 | NA | NA |

Annual load of total nitrogen to Lake Bowen was 80,250 kg/yr. South Pacolet River delivered 60,985 kg/yr (about 76 percent of total). The combined delivery from minor tributaries and immediate shoreline drainage was 5 times less than that of the South Pacolet River (12,100 kg/yr or about 15 percent of the total load). The municipal STP contributed less than 1 percent.

In 1991, best management practices (BMPs) were implemented by the Natural Resources Conservation Service, in cooperation with the South Carolina Department of Health and Environmental Control (SCDHEC), in the Lake Bowen watershed to reduce nutrient loadings. Public outreach and education efforts were the main forms of BMPs. Improvement in water quality of Lake Bowen was reported by SCDHEC in 1998, when Lake Bowen was ranked as one of the least eutrophic large lakes in South Carolina. The water quality was characterized by low nutrient concentrations (South Carolina Department of Health and Environmental Control, 2001). However, monitoring data were not adequate to quantify any reduction in nutrient loadings from the watershed. The assessment was based on in-lake nutrient and chlorophyll *a* measurements. During 2001 to 2006, Lake Bowen and Reservoir #1 continued to be assessed as having good water quality with respect to low nutrient and chlorophyll *a* concentrations relative to established numerical criteria (South Carolina Department of Health and Environmental Control, 2006).

Regionally, cyanobacterial blooms and associated taste-and-odor occurrence have been reported in reservoir systems similar to that of Lake Bowen and Municipal Reservoir #1. North Carolina Department of Environmental and Natural Resources (NCDENR) Environmental Management Commission evaluated the trophic status of reservoirs in North Carolina that served as drinking-water supplies in 2006 (North Carolina Department of Environment and Natural Resources, 2006). A survey of chlorophyll *a* levels and phytoplankton communities was used to evaluate the reservoirs. Although about 70 percent or more of the chlorophyll *a* levels were below the 40 µg/L numeric criteria established by NCDENR, cyanobacterial blooms were reported to occur during the summer months (June–August 2000, 2002, and 2005). Six lakes in the Piedmont ecoregion of the Broad and Catawba River basins had taste-and-odor problems sufficient to require additional treatment. Cyanobacteria species *Lyngbya wollei, Lyngbya* sp.*, Aphanizomenon flos-aquae, Anabaena* sp.*,* and *Anabaenopsis* sp.*,* and *Oscillatoria* sp. were identified in these lake systems.

The cyanobacterium*, Anabaena* sp., was indicated as the source of geosmin in Lake Ogletree near Auburn, Alabama (Saadoun and others, 2000). Lake Ogletree also was located in the Piedmont ecoregion. In Lake Ogletree, geosmin production was correlated with increasing concentrations of ammonia and low nitrogen-to-phosphorus ratios. Actinomycetes bacteria were indicated as the source of taste-and-odor problems for the Broad River in Columbia, South Carolina (Raschke and others, 1975).

Suspended-sediment dynamics were found to affect the phytoplankton community in a lake in the Piedmont ecoregion of North Carolina (Cuker and others, 1990; Burkholder, 1992). Specifically, suspended sediment composed of montmorillonite clays and periods of high sediment loads preferentially favored cyanobacteria as a result of phosphorus sorption and light attenuation processes.

# Approach and Methods

The focus of the surveys was to identify the spatial distribution and occurrence of geosmin and MIB, common trophic-state indicator characteristics (nutrients, transparency, and chlorophyll *a*), and algal community structure. Limnological characterization focused on determining the water-quality conditions and degree of stratification at the time of sampling. Screening tools such as the Carlson trophic state index (TSI) (Carlson, 1977) and relative thermal resistance to mixing (RTRM) were applied to the data to facilitate comparison among sites and among seasons.

## Data Collection

Eight of 16 potential sites in Lake Bowen and Reservoir #1 were selected on the basis of an initial field evaluation conducted August 15–16, 2005, prior to the August 30–September 15, 2005, sampling. Accessibility and variations in depth and degree of stratification were the primary selection criteria for the sites. Global positioning system (GPS) and GIS data on the sampling sites were collected during the initial field work. The seven sampling transects for the initial survey provided good coverage of Lake Bowen, but only one sampling transect was located on Reservoir #1 (fig. 3, table 4). Site selection on Reservoir #1 was limited to bridge access during the initial survey because no public boat ramp existed for Reservoir #1. Boat access was provided by SWS at the R.B. Simms WTP in subsequent surveys when the number of sites on Lake Bowen was reduced to two and an extra site on Reservoir #1 was added in May 2006. Prefixes of "LWB" for sites in Lake Bowen and "MR1" for sites in Reservoir #1 were assigned as identifiers (table 4).

**Table 4.** Description of sites and number of samples taken in Lake William C. Bowen and Municipal Reservoir #1 (South Pacolet Reservoir), August 2005 to October 2006.

[USGS, U.S. Geological Survey; ID, identifier; mi$^2$, square miles; ft, feet; --, no data]

| USGS station number | Station name | Site ID | Drainage area (mi$^2$) | Maximum depth (ft) | Samples collected | | |
|---|---|---|---|---|---|---|---|
| | | | | | August to September 2005 | May 2006 | October 2006 |
| 350636082054600 | Lake William C. Bowen at S.C. Road 37 (Site 3), below Campbello, S.C. | LWB-3 | -- | 10 | 1 | 0 | 0 |
| 350625082051800 | Lake William C. Bowen above I-26 (Site 4), below Campbello, S.C. | LWB-4 | -- | 11 | 1 | 0 | 0 |
| 350624082035200 | Lake William C. Bowen below I-26 (Site 5), near Inman, S.C. | LWB-5 | -- | 18 | 2 | 0 | 0 |
| 350628082025200 | Lake William C. Bowen above S.C. Highway 9 (Site 7), near New Prospect, S.C. | LWB-7 | -- | 26 | 2 | 0 | 0 |
| 02154950 | Lake William C. Bowen at S.C. Highway 9 bridge (Site 8) near Fingerville, S.C. | LWB-8 | 79.4 | 26 | 2 | 2 | 2 |
| 350641082014700 | Lake Willam C. Bowen below S.C. Highway 9 (Site 10), near Fingerville, S.C. | LWB-10 | -- | 30 | 2 | 2 | 2 |
| 350627082012800 | Lake William C. Bowen Dam (Site 11), near Fingerville, S.C. | LWB-11 | -- | 35 | 2 | 0 | 0 |
| 3506420820154 | Municipal Reservoir #1 below Lake William C. Bowen Dam, near Fingerville, S.C. | MR1-12 | -- | 7 | 0 | 1 | 0 |
| 02155000 | Municipal Reservoir #1 (South Pacolet Reservoir) near Fingerville, S.C. | MR1-14 | 92 | 20 | 2 | 2 | 2 |

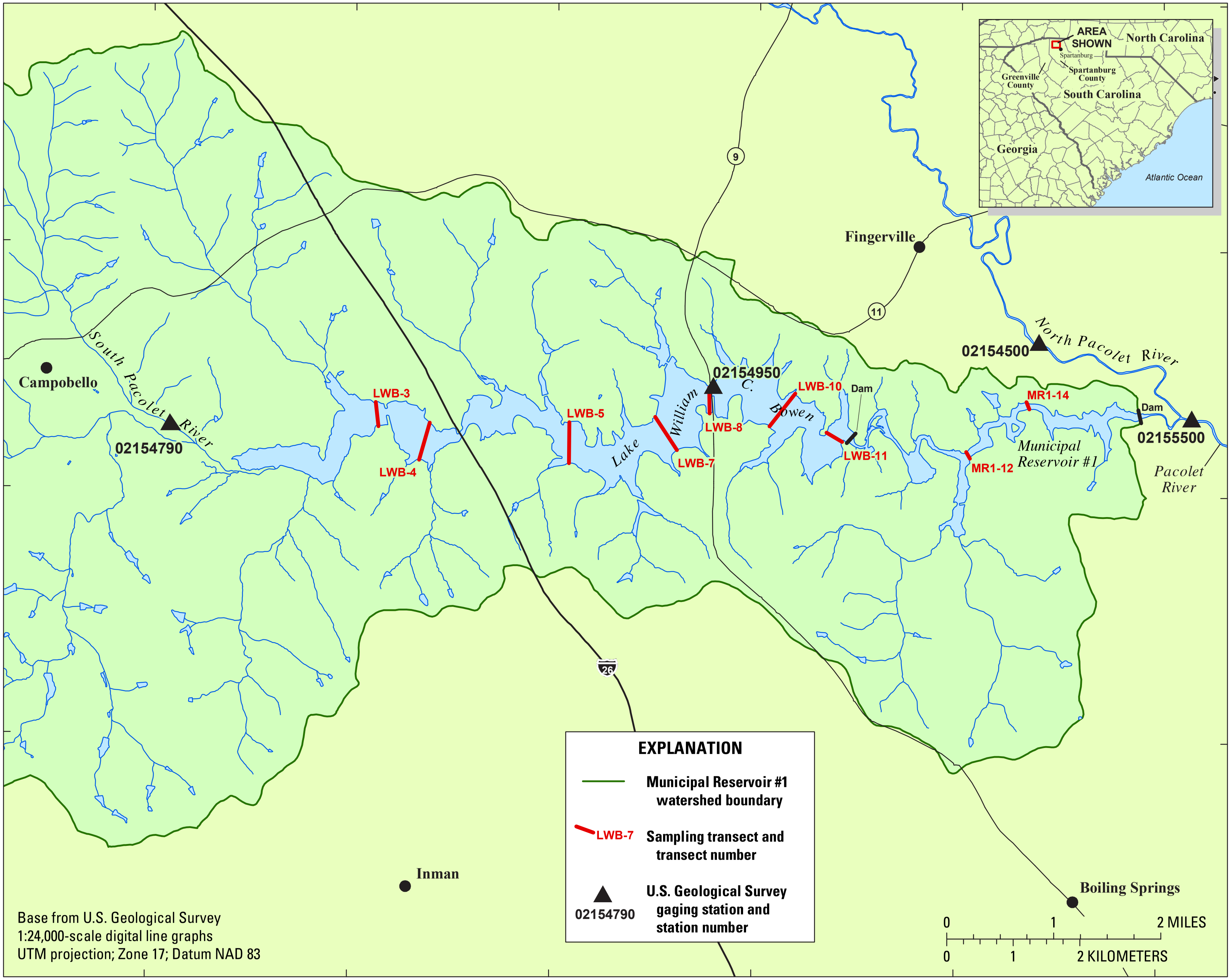


**Figure 3.** Transect locations in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, 2005–2006.

The degree of stratification at the time of sampling was evaluated by the measurement of depth profiles of specific conductance, water temperature, dissolved oxygen concentration, and *in vivo* fluorescence as total chlorophyll. These characteristics were measured at the time of sampling in 1-meter (m) depth intervals at three to five points (25, 50, and 75 percent or 10, 25, 50, 75, and 90 percent width increments, respectively) along the transect at each site.

For the first spatial survey, sample collection activities were conducted over a 2-week interval (August 30, 2005 to September 15, 2005); sample collection activities for May 2006 and October 2006 were conducted over a 2- to 3-day period. Water-column samples were collected at two depths at each selected transect—a near-surface sample at 1-m depth and a bottom sample that ranged from 2.5 to 7 m in depth depending on depth at the transect site. A point sampler (pre-cleaned acrylic Kemmerer) was used to collect three subsamples at the 25, 50, and 75 percent width increments or five subsamples at the 10, 25, 50, 75, and 90 percent increments (depending on width of the transect) along each transect at each depth. For each depth, the collected subsamples were composited to ensure the sample was representative of the entire transect at the targeted depth, and aliquots from the composited sample were continually mixed in a pre-cleaned plastic churn to ensure adequate sampling of the particulate material. Samples were processed in the field, placed on ice, and shipped overnight to the appropriate laboratories. Preparation, cleaning, collection, and processing methods followed established protocols described in the USGS National Field Manual for the Collection of Water-Quality Data (U.S. Geological Survey, variously dated). All shipped samples were received by the laboratory adequately preserved and within designated holding times.

In 2005, water samples were analyzed for total nitrogen, dissolved nitrate plus nitrite, ammonia, total Kjeldahl nitrogen (ammonia plus organic nitrogen), dissolved orthophosphate, total phosphorus, dissolved organic carbon, ultraviolet absorbance at 254 and 280 nanometers (estimate of the humic content or reactive fraction of organic carbon), phytoplankton pigments chlorophyll *a* and *b*, and phytoplankton ash-free dry mass (as estimate of algal biomass) by the USGS National Water Quality Laboratory (NWQL) in Denver, Colorado. Descriptions of the methods and laboratory reporting limits are provided in Appendix B. In 2006, water samples were analyzed by NWQL for the above parameters and the additional parameters of turbidity, total suspended solids, pheophytin *a* (degradation pigment of chlorophyll *a*), iron, manganese, silica, hardness, and wastewater indicator compounds.

Throughout the period of study, samples used to enumerate and identify phytoplankton were collected simultaneously with water samples for the other constituents. Prior to processing, the samples were agitated to resuspend any phytoplankton, and a 250-milliliter (mL) aliquot was removed and preserved in the field by the addition of a preservative that contained 25-percent glutaraldehyde. In general, one milliliter of the 25-percent glutaraldehyde preservative was added for every 100 mL of sample. Taxonomic characterization and enumeration of phytoplankton in samples were conducted by the contract laboratory, Phycotech, Inc. (St. Joseph, Michigan). Counts were conducted at multiple magnifications to include organism sizes spanning several orders of magnitude. A minimum of 400 natural units (single cells, colonies, or filaments) per sample were counted for each sample in order to ensure a robust statistical enumeration of the phytoplankton community. Phytoplankton samples were classified at the species level, when possible, to identify blue-green algae that were potential geosmin producers. Phytoplankton data were analyzed to determine if the algal community structure corresponded to the indicated trophic status based on nutrient and chlorophyll *a* levels at the time of sampling.

In all three surveys, water samples were collected and analyzed for taste-and-odor compounds (geosmin and MIB). The USGS Organic Geochemistry Research Laboratory in Lawrence, Kansas, determined geosmin and MIB concentrations using a gas chromatography and mass spectrometry method with a reporting limit of 0.005 µg/L (Appendix B; Zimmerman and others, 2002). In 2006, samples also were analyzed for an algal toxin, microcystin, by the USGS Organic Geochemistry Research Laboratory using an Enzyme-Linked Immunoabsorbent Assay (ELISA) method with a reporting limit of 0.1 µg/L (Appendix B).

An innovative screening procedure was used to determine whether human activities could be a potential source of nutrients in Lake Bowen and Reservoir #1. The approach incorporated an analytical technique that determines the presence of compounds commonly associated with human wastewater (Appendix B). For this approach, it was assumed that human contributions of nutrients to the reservoirs was probable if wastewater compounds co-occurred with elevated nutrient concentrations. Wastewater compounds included more than 20 organic compounds frequently found in runoff and storm-drain systems in urbanized areas as a result of the use of products such as solvents, gasoline, oil, and coal tar; disinfectants, surfactants, flame retardants, and other detergent agents found in household wastewater; fragrances and additives found in personal care products such as perfumes, soaps, and lotions; chemicals from ingested food and drugs (pharmaceuticals) and their metabolites; and pesticides commonly used for domestic, rather than agricultural, purposes.

## Data Analysis

Nutrient enrichment, particularly the nutrients nitrogen and phosphorus, in aquatic ecosystems leads to increased primary productivity (phytoplankton, periphyton, aquatic macrophytes). Eutrophication is a natural process in all aquatic systems, including freshwater reservoirs, where an aquatic system eventually becomes increasingly nutrient-rich and biologically productive over time. Human activity (fertilizer application, septic-tank leakage, release of wastewater-treatment-plant effluent) in the watersheds of lakes and reservoirs often accelerates this process. Nitrogen and phosphorus are the two nutrients of most concern in the accelerated eutrophication of reservoirs systems. Nutrient enrichment in a lake or reservoir may lead to nuisance cyanobacterial blooms that result in taste-and-odor problems or production of algal toxins that potentially could generate fish kills and impair human health. Ecosystem effects of eutrophication often include decreased species diversity in aquatic foodwebs, increased plant and animal biomass, and increased turbidity (Wetzel, 1983).

Algae require nutrients, especially nitrogen and phosphorus, for growth. Phosphorus commonly is the limiting nutrient because concentrations of bioavailable phosphorus often are much lower than concentrations of nitrogen in lakes and reservoirs (Harris, 1986; Downing and McCauley, 1992). Traditionally, total nitrogen to total phosphorus (TN:TP) ratios commonly are used to gain insight into potential nutrient limitation. An empirically derived mass ratio of TN:TP of 29:1 was originally reported in order to differentiate between lakes with dominance of nitrogen-fixing cyanobacteria and lakes without this dominance (Smith, 1983); however, on further evaluation it was concluded that a mass ratio of 22:1 provided a better differentiation (Smith and others, 1995; Havens and others, 2003). Lower TN:TP ratios favor cyanobacteria because all species of cyanobacteria are better able to compete for nitrogen than other phytoplankton when the pool of available nitrogen is scarce (Downing and others, 2001; Havens and others, 2003).

Nutrient concentrations, chlorophyll *a* concentrations, and transparency are interrelated. Increases in nutrient concentrations (enrichment) tend to decrease the transparency of the water and increase the chlorophyll *a* concentrations. Empirically derived trophic state indices (TSIs) developed by Carlson (1977) use log transformations of Secchi disk depths, chlorophyll *a* concentrations, and TP concentrations as estimates of algal biomass on a scale of 0 to 110. The TSI equations are:

$$TSI_{SD} = 60 - 14.41\,(\text{Ln}\,[SD]), \tag{1}$$

$$TSI_{CHL} = 9.81\,(\text{Ln}\,[CHL]) + 30.6, \text{ and} \tag{2}$$

$$TSI_{TP} = 14.42\,(\text{Ln}\,[TP]) + 4.15, \tag{3}$$

where $TSI_{SD}$ is the Carlson TSI for Secchi disk depth; Ln is the natural logarithm; SD is the Secchi disk depth, in meters; $TSI_{CHL}$ is the Carlson TSI for chlorophyll *a*; CHL is the near-surface chlorophyll *a* concentration, in µg/L; $TSI_{TP}$ is the Carlson TSI for total phosphorus; and TP is the near-surface total phosphorus concentration, in µg/L. Each increase of ten units on the scale represents a doubling of algal biomass (Carlson and Simpson, 1996; table 5). The empirical nature of the Carlson TSI does not define the trophic state but is useful as an indicator or screening tool for comparing lakes within a region and for assessing changes in trophic status over time.

Because past research identified water-column stability as a possible factor related to the occurrence of cyanobacterial blooms (Paerl, 1988; Paerl and others, 2001; Havens and others, 2003), the depth profiles of water temperature, specific conductance, dissolved oxygen, and pH were used to evaluate degree of stratification at the time of sampling. During the summer months when the surface water of the lake is warmer than the underlying lake water, a physically distinct, warmer, upper layer of water, the epilimnion, is maintained over a deeper, cooler, more dense layer, the hypolimnion. The region of sharp temperature changes between these two layers is called the thermocline or metalimnion. Stratification is the establishment of these distinct layers and is of major importance in the chemical cycling within lakes and consequently for the biota.

The relative thermal resistance to mixing (RTRM) is an index that is used to compute thermal stratification based on the intensity of thermally induced density differences of adjacent water layers (Welch, 1992; Wetzel and Likens, 2000; Wetzel, 2001). The density of water varies as a function of water temperature, such that the maximum density of water occurs at about 4 degrees Celsius (ºC). The RTRM is the amount of work needed to completely mix a column of water. The higher the RTRM, the greater the density difference, and therefore, the more difficult it is for mixing to occur.

$$\text{RTRM} = \frac{\rho_{z2} - \rho_{z1}}{\rho_4 - \rho_5}, \quad (4)$$

where RTRM is the relative thermal resistance to mixing (dimensionless); $\rho_{z1}$ and $\rho_{z2}$ are water densities at shallower water depth z1 and deeper water depth z2, respectively, in kilograms per cubic meter (kg/m$^3$); and $\rho_4$ and $\rho_5$ are water densities (kg/m$^3$) at 4 and 5 ºC, respectively. The difference in density of water at 4 ºC and 5 ºC is constant at 0.008 kg/m$^3$.

The USEPA has recommended numerical criteria for ecoregion IX for lakes and reservoirs to ensure the protection of the lake and reservoir quality (U.S. Environmental Protection Agency, 2000). The USEPA numerical criteria that represent reference conditions are as follows: TP concentrations less than 0.02 mg/L, TN concentrations less than 0.36 mg/L, chlorophyll *a* concentrations less than 4.93 µg/L, and transparency (Secchi disk depth) greater than 1.53 m. Nutrient and chlorophyll levels in a reservoir that did not meet these recommended conditions indicated a potential for the reservoir to be nutrient enriched or eutrophic.

The SCDHEC also has established numerical nutrient criteria to evaluate the water quality in lakes and reservoirs: TP concentrations less than 0.06 mg/L, TN concentrations less than 1.50 mg/L, chlorophyll *a* concentrations less than 40 µg/L, and turbidity less than 25 nephelometric turbidity units (NTUs) (South Carolina Department of Health and Environmental Control, 2004). Lakes and reservoirs that have nutrient and chlorophyll concentrations that exceed these criteria are considered to be impaired due to nutrient enrichment.

Previous studies concluded that the connection between geosmin production by cyanobacteria and variations in water quality and climate is complex (Reynolds, 1999; Smith and Bennett, 1999; Downing and others, 2001; Graham and others, 2004). Specifically, because cyanobacteria are known to be important sources of geosmin, the assumption that a correlation between geosmin levels in a water supply and cyanobacteria cell densities exists may seem logical; that is, the greater the cyanobacterial density, the greater the geosmin levels. However, the relation between cyanobacterial density and geosmin levels often is absent or poor because (1) geosmin production is strain and species specific and (2) low or even undetectable cyanobacterial densities may be sufficient to produce taste-and-odor threshold concentrations of geosmin (Graham and others, 2008). Additionally, the relation between cyanobacteria blooms and limnological factors is not straightforward. Cyanobacteria blooms are affected by the inter-relation of several factors, such as elevated TP content, high water temperature, high water-column stability (limited mixing), low grazing pressure by zooplankton, and low TN:TP ratios (Paerl, 1988; Paerl and others, 2001; Havens and others, 2003). The spatial distribution of algal species, TP concentrations, and low TN:TP ratios in two reservoirs were evaluated in relation to geosmin and MIB concentrations to determine whether observable patterns were present at the time of sampling.

**Table 5.** Carlson trophic state indices and associated trophic state conditions, generalized limnological characteristics, and potential effects on water-supply systems. (Modified from Carlson and Simpson, 1996.)

[<, less than]

| Carlson trophic state index (unitless) | Trophic state condition | Generalized limnological characteristics | Potential effects on water supply |
|---|---|---|---|
| <30 | Oligotrophic | Nutrient-poor conditions; clear water; dissolved oxygen present in hypolimnion. | Water may be suitable for an unfiltered water supply. |
| 30–40 | | Hypolimnion of shallower lakes may become anoxic (dissolved oxygen near or at zero). | |
| 40–50 | Mesotrophic | Nutrient-balanced conditions; increased algal growth; increasing probability of anoxic hypolimnion. | Iron and manganese levels increase; taste-and-odor problems; increased turbidity from increased algal growth requires filtration. |
| 50–60 | Eutrophic | Nutrient-enriched conditions; anoxic hypolimnion; excessive macrophyte plant growth a problem. | |
| 60–70 | | Cyanobacteria (blue-green algae) often dominate; algal scums may become a problem. | Episodes of severe taste and odor. |

## Quality Assurance

Appropriate quality-control and -assurance procedures were applied throughout the investigation. Field-data collection was conducted by teams experienced in water-quality sampling and biological assessment protocols. A width-integrated sample was collected at three to five points along the selected transect at the targeted depth to ensure a representative sample. Because of the expected low-level concentrations of geosmin and wastewater indicators and the sensitivity of the analytical methods used to measure those concentrations, field blanks were collected during each sampling trip to ensure cross contamination did not affect the analytical results. The analytical results were compiled and reviewed for precision and accuracy prior to data analysis.

Analytical results for the field blanks indicated no microcystin, geosmin, or MIB contamination of the samples was introduced by the sampling or processing equipment. Dissolved calcium, dissolved silica, dissolved nitrite, and total phosphorus were detected at least once in the field blank but at estimated levels below the laboratory reporting level (LRL). Actual concentrations of these constituents in the environmental samples generally were greater than the contamination level (exception for phosphorus and nitrite).

Selection of an appropriate method for handling censored data is necessary when laboratories report quantitative, estimated, and censored results. The NWQL used this information-rich type of reporting where (1) results above a “quantitation limit” (equivalent to the NWQL’s LRL) are reported as quantitative, (2) results between the “quantitation limit” and the “detection limit” (equivalent to the NWQL’s long-term method detection level, or LT-MDL) are reported as estimated (E) because the values are considered semi-quantitative, and (3) results below the LT-MDL are reported as censored (< LRL) (Childress and others, 1999) (Appendix B). In this report, results are listed in tables as follows: quantitative values as the value with no remark code; estimated values as the reported values with a remark code of E, and censored values as less than the LRL values. For graphical purposes, estimated and censored values were not replaced with other values, but were plotted as the reported estimated and LRL values.

# Limnological Conditions

As part of reconnaissance efforts and the three surveys on Lake Bowen and Reservoir #1, specific conductance, pH, dissolved oxygen, and water temperature were measured in the field with a calibrated multiparameter sonde to obtain 1-meter depth profiles. Profile data were used to assess the degree of stratification during the sampling event. Transparency also was measured in the field by Secchi disk depth. Nutrient, organic carbon, chlorophyll *a*, algal biomass, geosmin, and MIB levels were analyzed for in composited water samples collected near the surface (at or above 1 m) and below the hypolimnion (at or below 6 m). These water-quality data were used to compute the TSI, were compared to established SCDHEC and USEPA numerical criteria, and were used to identify areas in Lake Bowen and Reservoir #1 where these consituents and characteristics were elevated. Water samples also were analyzed for wastewater compounds to identify areas where human activity could have contributed to nutrient concentrations. Phytoplankton identification and enumeration conducted for all water samples to determine if the algal community structure corresponded to the indicated trophic status on the basis of nutrient and chlorophyll *a* concentrations at the time of sampling.

## Stratification

During the August to September 2005 survey, the temperature-depth profiles and the computed RTRMs at LWB-5, LWB-8, and LWB-10 indicated that highly stratified conditions were present in Lake Bowen (fig. 4*A*–*C*; table 6). A distinct thermocline between the 4- and 5-m depths was observed at all sites, with the exception of LWB-5 at which the thermocline was located between the 3- and 4-m depths (fig. 4*A*, table 6). Dissolved oxygen concentrations decreased rapidly from about 8.0 mg/L near the surface to less than 1 mg/L in the hypolimnion at site LWB-10. Because of a malfunctioning dissolved oxygen probe, dissolved oxygen concentrations were not measured for other sites on Lake Bowen during this survey. That decrease in dissolved oxygen concentrations corresponded to an increase in specific conductance from 40 to 68 microsiemens per centimeter (µS/cm) at site LWB-10 (fig. 4*C*). Increased specific conductance in the anoxic hypoliminion could be related to remobilization of certain constituents, such as phosphorus, metals, and ammonia, from the sediment or loss of consituents from the epilimnion. The change in pH with depth was less dramatic than the change in specific conductance from about 6.2 in the epilimnion to 5.9 below the thermocline. Specific conductance and pH values at sites LWB-5 and LWB-8 produced distinct profiles during August 2005 (fig. 4*A*, *B*; table 6). However, temperature-depth profiles and computed RTRMs in Reservoir #1 at MR1-14 did not indicate a stratified condition (fig. 4*D*; table 6). Minimal changes in dissolved oxygen concentration, pH, and specific conductance with depth were observed at MR1-14 (fig. 4*D*).

During the May 2006 survey, the degree of stratification that was demonstrated by temperature-depth profiles and computed RTRMs was less pronounced than during the August to September 2005 survey in Lake Bowen at sites LWB-8 and LWB-10 and was negligible at LWB-5 (fig. 5*A–C*; table 7). In stratified areas of the lake, the thermocline was located between 5 and 6 m. A similar response occurred for dissolved oxygen concentrations with depth at LWB-10 during May 2006 and August to September 2005 surveys (tables 6 and 7; figs. 5*C* and fig. 4*C*, respectively). In contrast, a more distinct change in pH with depth occurred at LWB-8 and LWB-10 during May 2006 than during August to September 2005; pH values ranged from 7.5 to 8.0 in the epilimnion and decreased to 6.2 in the hypolimnion. The pH values in the hypolimnion during May 2006 are similar to those during August to September 2005. The temperature-depth profiles and computed RTRMs in Reservoir #1 at MR1-14 did not indicate a stratified condition during the May 2006 survey (fig. 5*D*).

During the October 2006 survey, temperature-depth profiles and RTRMs at all sites in both reservoirs exhibited destratified conditions (fig. 6*A–D*; table 8). Profiles of water temperature, dissolved oxygen concentrations, specific conductance, and pH exhibited negligible change with depth during this survey at sites LWB-8, LWB-10, and MR1-14 (fig. 6*A*, *B*, *D*). Site MR1-12 had negligible stratification (fig. 6*C*).

In summary, the seasonal occurrence of thermal stratification and destratification was evident in the depth profiles of water temperature collected during all three surveys in Lake Bowen (figs. 4–6). The degree of stratification based on RTRM for water temperatures between the epilimnion (1-m depth) and hypolimnion (5- to 7-m depth) varied among the three surveys (table 9). The most stable (stratified) water-column conditions occurred in Lake Bowen during the August to September 2005 survey, and the least stable (destratified) water-column conditions occurred in Lake Bowen and Reservoir #1 in the October 2006 survey (table 9). Profiles show that dissolved oxygen, specific conductance, and pH varied with depth. Additionally, the position of the thermocline varied with depth depending on the degree of stratification as measured by the RTRM. In contrast, Reservoir #1 did not exhibit stratified conditions during the surveys.

Changes with depth in dissolved oxygen, pH, and specific conductance with thermal stratification indicated Lake Bowen was exhibiting characteristics common to mesotrophic and eutrophic state conditions (table 5). During periods of stratification, increases in pH near the surface can be explained by increased photosynthetic activity in the epilimnion. Decreased pH and dissolved oxygen in the hypolimnion often are related to increased activity of the respiration and decomposition processes. During the August to September 2005 and May 2006 surveys when stratified conditions existed, the hypolimnion in Lake Bowen exhibited near-anoxic conditions.

## Nutrient and Chlorophyll *a* Levels

Samples were analyzed for several species of nitrogen that tend to be present in surface-water systems. Dissolved nitrate, nitrite, and ammonia concentrations are the inorganic species of nitrogen that were readily available for uptake by algae. Nitrate is the inorganic species of nitrogen that commonly occurs in oxygen-rich environments. Nitrite is the nitrogen species that tends to occur in oxygen-poor, reducing environments. Ammonia is the most reduced species of nitrogen that can be formed in oxygen-depleted environments and generally was derived from degradation of organic nitrogen compounds. Total Kjeldahl nitrogen (TKN) concentrations are the cumulative measure of total organic nitrogen (total concentrations include particulate and dissolved forms) and ammonia. Organic nitrogen is the measure of all nitrogen-containing organic compounds. Total nitrogen concentrations (TN) were computed as the sum of dissolved nitrate plus nitrite and TKN.

Samples were analyzed for dissolved orthophosphate and TP concentrations. Orthophosphate concentration is a measure of the inorganic species of phosphorus that is readily available for uptake by algae. Total phosphorus concentration is a measure of the sum of inorganic and organic species of phosphorus in both dissolved and particulate forms.

**Table 6.** Summary of dissolved oxygen, water temperature, specific conductance, pH, water density, and relative thermal resistance to mixing (RTRM) values at various depths at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August to September 2005.

[mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; kg/m$^3$, kilograms per cubic meter; --, no data; NA, not applicable]

| Site | Date | Depth (meters) | Dissolved oxygen (mg/L) | Water temperature (degrees Celsius) | Specific conductance (µS/cm) | pH (standard units) | Water density (kg/m$^3$) | RTRM (unitless) |
|---|---|---|---|---|---|---|---|---|
| LWB-5 | 08/31/05 | 0.1 | -- | 28.0 | 41.0 | 6.9 | 996.25 | NA |
| LWB-5 | 08/31/05 | 1 | -- | 28.0 | 41.0 | 6.9 | 996.27 | 1.8 |
| LWB-5 | 08/31/05 | 2 | -- | 27.9 | 41.0 | 6.9 | 996.28 | 1.8 |
| LWB-5 | 08/31/05 | 3 | -- | 29.8 | 41.0 | 6.8 | 995.73 | –69.0 |
| LWB-5 | 08/31/05 | 4 | -- | 24.6 | 59.0 | 6.5 | 997.18 | 180.9 |
| LWB-5 | 08/31/05 | 5 | -- | 21.2 | 77.0 | 6.4 | 997.98 | 100.2 |
| LWB-7 | 09/01/05 | 0.1 | -- | 28.2 | 41.0 | 7.1 | 996.20 | NA |
| LWB-7 | 09/01/05 | 1 | -- | 28.2 | 41.0 | 7.1 | 996.20 | 0.4 |
| LWB-7 | 09/01/05 | 2 | -- | 28.2 | 41.0 | 7.1 | 996.21 | 1.1 |
| LWB-7 | 09/01/05 | 3 | -- | 27.7 | 39.0 | 7.0 | 996.35 | 17.0 |
| LWB-7 | 09/01/05 | 4 | -- | 26.5 | 40.0 | 6.8 | 996.68 | 41.7 |
| LWB-7 | 09/01/05 | 5 | -- | 22.8 | 55.0 | 6.5 | 997.62 | 116.6 |
| LWB-7 | 09/01/05 | 6 | -- | 20.7 | 67.0 | 6.3 | 998.09 | 59.4 |
| LWB-7 | 09/01/05 | 7 | -- | 18.8 | 92.0 | 6.5 | -- | -- |
| LWB-8 | 08/31/05 | 0.1 | -- | 29.0 | 40.0 | 6.9 | 995.99 | NA |
| LWB-8 | 08/31/05 | 1 | -- | 28.7 | 40.0 | 6.9 | 996.08 | 11.3 |
| LWB-8 | 08/31/05 | 2 | -- | 28.2 | 40.0 | 7.0 | 996.22 | 18.0 |
| LWB-8 | 08/31/05 | 3 | -- | 27.7 | 39.0 | 7.0 | 996.34 | 14.5 |
| LWB-8 | 08/31/05 | 4 | -- | 26.7 | 38.0 | 6.6 | 996.63 | 37.0 |
| LWB-8 | 08/31/05 | 5 | -- | 21.5 | 54.0 | 6.3 | 997.92 | 160.4 |
| LWB-8 | 08/31/05 | 6 | -- | 19.7 | 67.0 | 6.3 | 998.31 | 48.5 |
| LWB-10 | 09/06/05 | 0.1 | -- | -- | -- | -- | -- | -- |
| LWB-10 | 09/06/05 | 1 | 8.0 | 26.9 | 39.8 | 6.2 | 999.88 | NA |
| LWB-10 | 09/06/05 | 2 | 8.2 | 26.8 | 39.7 | 6.2 | 999.87 | –1.5 |
| LWB-10 | 09/06/05 | 3 | 8.1 | 26.7 | 39.5 | 6.2 | 999.87 | 0.5 |
| LWB-10 | 09/06/05 | 4 | 6.5 | 26.3 | 40.6 | 6.2 | 999.95 | 10.1 |
| LWB-10 | 09/06/05 | 5 | 2.6 | 23.4 | 45.1 | 6.0 | 999.98 | 4.1 |
| LWB-10 | 09/06/05 | 6 | 1.1 | 20.0 | 61.4 | 5.9 | 999.93 | –6.6 |
| LWB-10 | 09/06/05 | 7 | 0.8 | 18.1 | 68.2 | 5.9 | 999.92 | –2.0 |
| MR1-14 | 09/07/05 | 0.1 | -- | -- | -- | -- | -- | -- |
| MR1-14 | 09/07/05 | 1 | 8.0 | 26.5 | 38.5 | 6.1 | 996.68 | NA |
| MR1-14 | 09/07/05 | 2 | 6.8 | 26.4 | 38.5 | 6.2 | 996.71 | 3.4 |
| MR1-14 | 09/07/05 | 3 | 6.7 | 26.3 | 38.6 | 6.2 | 996.73 | 2.4 |
| MR1-14 | 09/07/05 | 4 | 6.9 | 26.2 | 38.7 | 6.2 | 996.75 | 2.7 |
| MR1-14 | 09/07/05 | 5 | 6.6 | 26.2 | 38.7 | 6.2 | 996.77 | 2.0 |
| MR1-14 | 09/07/05 | 6 | 6.4 | 26.0 | 39.1 | 6.2 | 996.82 | 7.3 |
| MR1-14 | 09/07/05 | 7 | 5.7 | 25.3 | 40.2 | 6.1 | 996.99 | 20.3 |
| MR1-14 | 09/07/05 | 8 | 5.2 | 25.1 | 41.1 | -- | 997.06 | 9.0 |
| LWB-8 | 09/15/05 | 0.1 | 8.0 | 28.4 | 39.6 | 7.0 | 996.15 | NA |
| LWB-8 | 09/15/05 | 1 | 8.0 | 27.2 | 39.3 | 7.1 | 996.50 | 43.7 |
| LWB-8 | 09/15/05 | 2 | 8.0 | 26.1 | 38.7 | 7.0 | 996.79 | 36.3 |
| LWB-8 | 09/15/05 | 3 | 7.4 | 25.7 | 38.2 | 6.9 | 996.89 | 12.2 |
| LWB-8 | 09/15/05 | 4 | 4.8 | 25.1 | 37.9 | 6.9 | 997.05 | 19.5 |
| LWB-8 | 09/15/05 | 5 | 2.5 | 24.0 | 37.4 | 6.7 | 997.32 | 34.0 |
| LWB-8 | 09/15/05 | 6 | 0.7 | 20.8 | 79.3 | 6.5 | 998.07 | 94.1 |

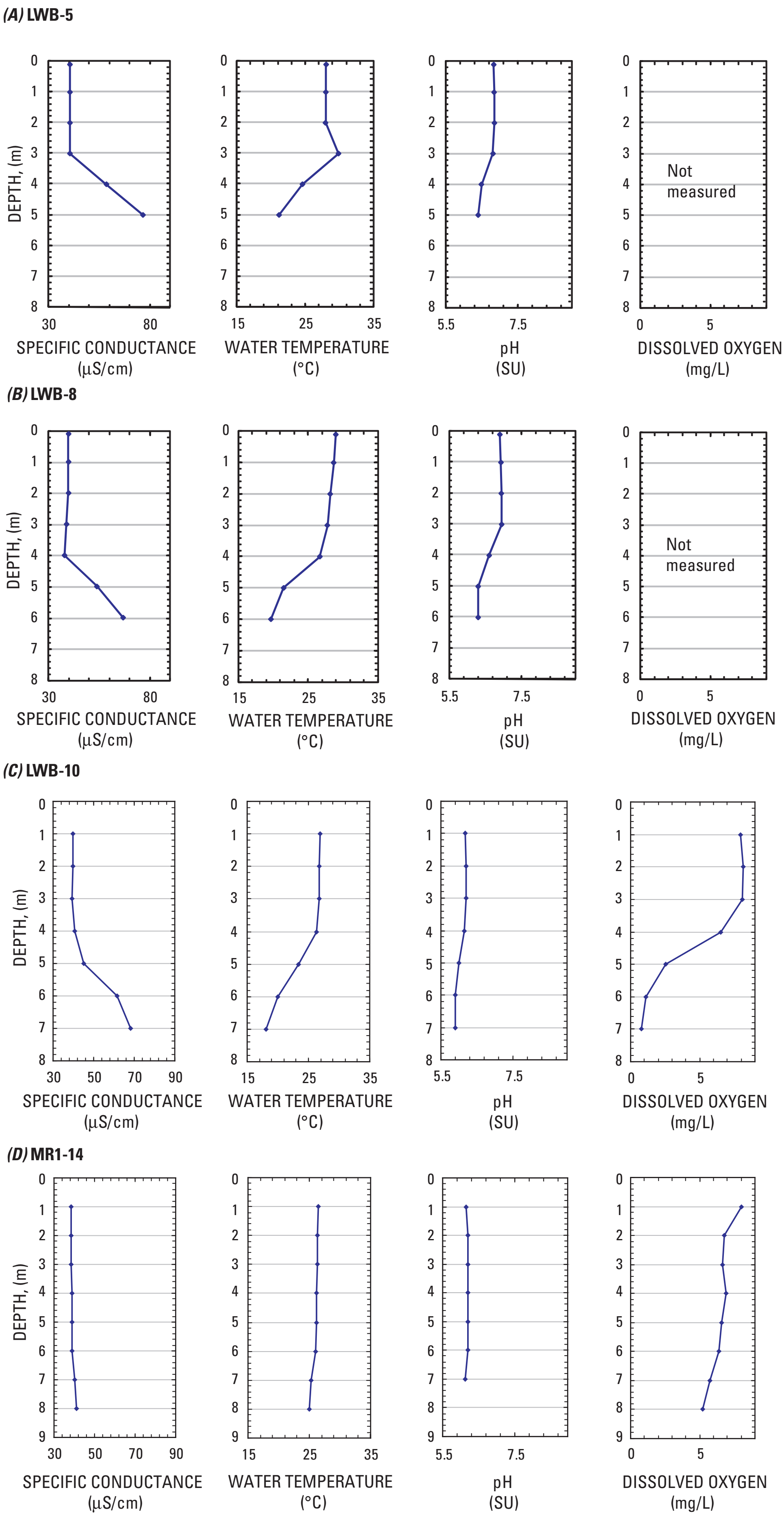


**Figure 4.** Depth profiles of temperature, pH, specific conductance, and dissolved oxygen at the mid-point of sites (*A*) LWB-5, (*B*) LWB-8, (*C*) LWB-10, and (*D*) MR1-14 in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August–September 2005.
[m, meters; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; °C, degrees Celsius; SU, standard pH units]

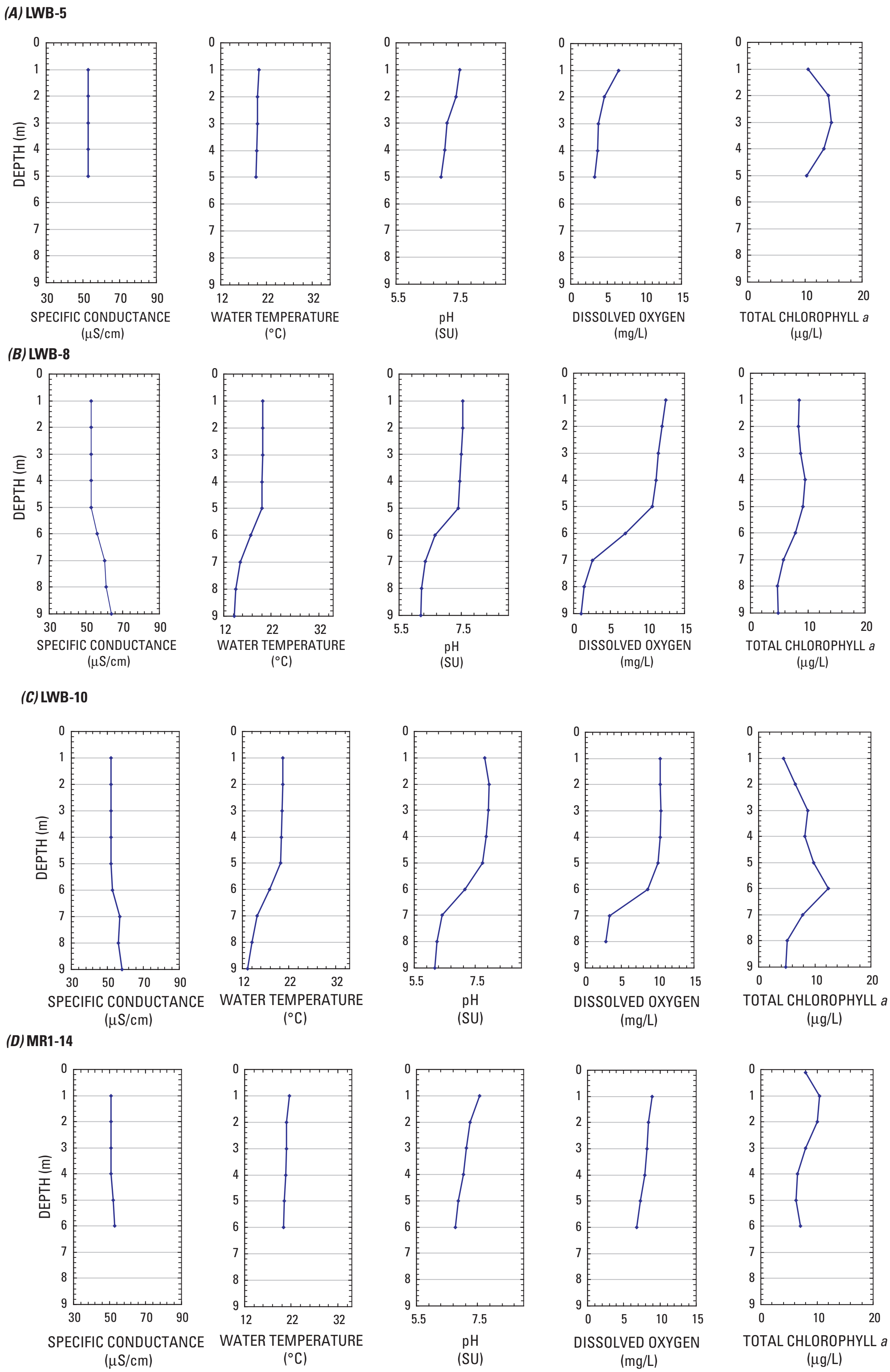


**Figure 5.** Depth profiles of temperature, pH, specific conductance, dissolved oxygen, and chlorophyll *a* at the mid-points of sites (*A*) LWB-5, (*B*) LWB-8, (*C*) LWB-10, and (*D*) MR1-14 in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, May 2006. [m, meters; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; °C, degrees Celsius; SU, standard pH units; µg/L, micrograms per liter]

**Table 7.** Summary of dissolved oxygen, water temperature, specific conductance, pH, total chlorophyll *a*, water density, and relative thermal resistance to mixing (RTRM) values at various depths at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, May 2006.

[mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; kg/m$^3$, kilograms per cubic meter; µg/L, micrograms per liter; --, no data; NA, not applicable]

| Site | Date | Depth (meters) | Dissolved oxygen (mg/L) | Water temperature (degrees Celsius) | Specific conductance (µS/cm) | pH (standard units) | Total chlorophyll *a* (µg/L) | Water density (kg/m$^3$) | RTRM (unitless) |
|---|---|---|---|---|---|---|---|---|---|
| LWB-5 | 05/15/06 | 0.1 | -- | -- | -- | -- | -- | -- | NA |
| LWB-5 | 05/15/06 | 1 | 6.4 | 20.4 | 53.0 | 7.5 | 10.60 | 998.14 | NA |
| LWB-5 | 05/15/06 | 2 | 4.6 | 20.1 | 53.0 | 7.4 | 14.10 | 998.21 | 7.8 |
| LWB-5 | 05/15/06 | 3 | 3.7 | 20.0 | 53.0 | 7.1 | 14.60 | 998.23 | 3.4 |
| LWB-5 | 05/15/06 | 4 | 3.7 | 19.9 | 53.0 | 7.1 | 13.30 | 998.25 | 1.5 |
| LWB-5 | 05/15/06 | 5 | 3.2 | 19.7 | 53.0 | 7.0 | 10.30 | 998.29 | 5.6 |
| LWB-7 | 05/15/06 | 0.1 | -- | -- | -- | -- | -- | -- | -- |
| LWB-7 | 05/15/06 | 1 | 5.6 | 20.6 | 52.0 | 7.7 | 11.70 | 998.10 | NA |
| LWB-7 | 05/15/06 | 2 | 5.2 | 20.3 | 52.0 | 7.5 | 11.90 | 998.18 | 9.8 |
| LWB-7 | 05/15/06 | 3 | 4.7 | 20.1 | 52.0 | 7.4 | 12.10 | 998.22 | 4.2 |
| LWB-7 | 05/15/06 | 4 | 4.5 | 20.0 | 52.0 | 7.3 | 11.20 | 998.23 | 1.3 |
| LWB-7 | 05/15/06 | 5 | 4.1 | 19.9 | 52.0 | 7.2 | 9.30 | 998.25 | 3.1 |
| LWB-7 | 05/15/06 | 6 | 2.7 | 18.6 | 54.0 | 6.6 | 7.70 | 998.51 | 32.5 |
| LWB-7 | 05/15/06 | 7 | 1.4 | 15.5 | 61.0 | 6.0 | 7.70 | 999.05 | 67.1 |
| LWB-8 | 05/16/06 | 0.1 | -- | -- | -- | -- | -- | -- | -- |
| LWB-8 | 05/16/06 | 1 | 12.4 | 20.2 | 53.0 | 7.5 | 8.50 | 998.20 | NA |
| LWB-8 | 05/16/06 | 2 | 12.0 | 20.2 | 53.0 | 7.5 | 8.40 | 998.20 | 0.0 |
| LWB-8 | 05/16/06 | 3 | 11.5 | 20.1 | 53.0 | 7.5 | 8.80 | 998.21 | 0.5 |
| LWB-8 | 05/16/06 | 4 | 11.1 | 20.1 | 53.0 | 7.5 | 9.50 | 998.21 | 0.5 |
| LWB-8 | 05/16/06 | 5 | 10.7 | 20.0 | 53.0 | 7.4 | 9.20 | 998.23 | 1.8 |
| LWB-8 | 05/16/06 | 6 | 7.0 | 17.7 | 56.0 | 6.7 | 7.80 | 998.68 | 56.3 |
| LWB-8 | 05/16/06 | 7 | 2.6 | 15.5 | 60.0 | 6.3 | 5.70 | 999.06 | 47.5 |
| LWB-8 | 05/16/06 | 8 | 1.4 | 14.5 | 61.0 | 6.2 | 4.70 | 999.21 | 18.6 |
| LWB-8 | 05/16/06 | 9 | 1.1 | 14.2 | 64.0 | 6.2 | 4.80 | 999.25 | 5.2 |
| LWB-10 | 05/15/06 | 0.1 | -- | -- | -- | -- | -- | -- | -- |
| LWB-10 | 05/15/06 | 1 | 10.4 | 20.7 | 52.0 | 7.8 | 4.40 | 998.08 | NA |
| LWB-10 | 05/15/06 | 2 | 10.4 | 20.6 | 52.0 | 8.0 | 6.60 | 998.11 | 2.7 |
| LWB-10 | 05/15/06 | 3 | 10.4 | 20.5 | 52.0 | 7.9 | 8.70 | 998.14 | 3.7 |
| LWB-10 | 05/15/06 | 4 | 10.3 | 20.3 | 52.0 | 7.9 | 8.30 | 998.16 | 3.4 |
| LWB-10 | 05/15/06 | 5 | 10.1 | 20.2 | 52.0 | 7.7 | 9.80 | 998.19 | 2.9 |
| LWB-10 | 05/15/06 | 6 | 8.6 | 17.9 | 53.0 | 7.2 | 12.40 | 998.65 | 57.4 |
| LWB-10 | 05/15/06 | 7 | 3.4 | 15.1 | 57.0 | 6.4 | 7.80 | 999.11 | 57.8 |
| LWB-10 | 05/15/06 | 8 | 2.8 | 14.0 | 56.0 | 6.3 | 5.10 | 999.27 | 20.6 |
| LWB-10 | 05/15/06 | 9 | 1.7 | 13.2 | 58.0 | 6.2 | 4.80 | 999.38 | 14.0 |
| MR1-14 | 05/17/06 | 0.1 | -- | -- | -- | -- | -- | -- | -- |
| MR1-14 | 05/17/06 | 1 | 8.9 | 21.6 | 51.0 | 7.6 | 8.00 | 997.90 | NA |
| MR1-14 | 05/17/06 | 2 | 8.5 | 21.0 | 51.0 | 7.3 | 10.40 | 998.01 | 14.0 |
| MR1-14 | 05/17/06 | 3 | 8.2 | 21.0 | 51.0 | 7.1 | 10.00 | 998.03 | 2.2 |
| MR1-14 | 05/17/06 | 4 | 7.9 | 20.8 | 51.0 | 7.0 | 8.00 | 998.06 | 3.2 |
| MR1-14 | 05/17/06 | 5 | 7.3 | 20.6 | 52.0 | 6.9 | 6.50 | 998.11 | 6.9 |
| MR1-14 | 05/17/06 | 6 | 6.8 | 20.4 | 53.0 | 6.8 | 6.30 | 998.15 | 4.5 |

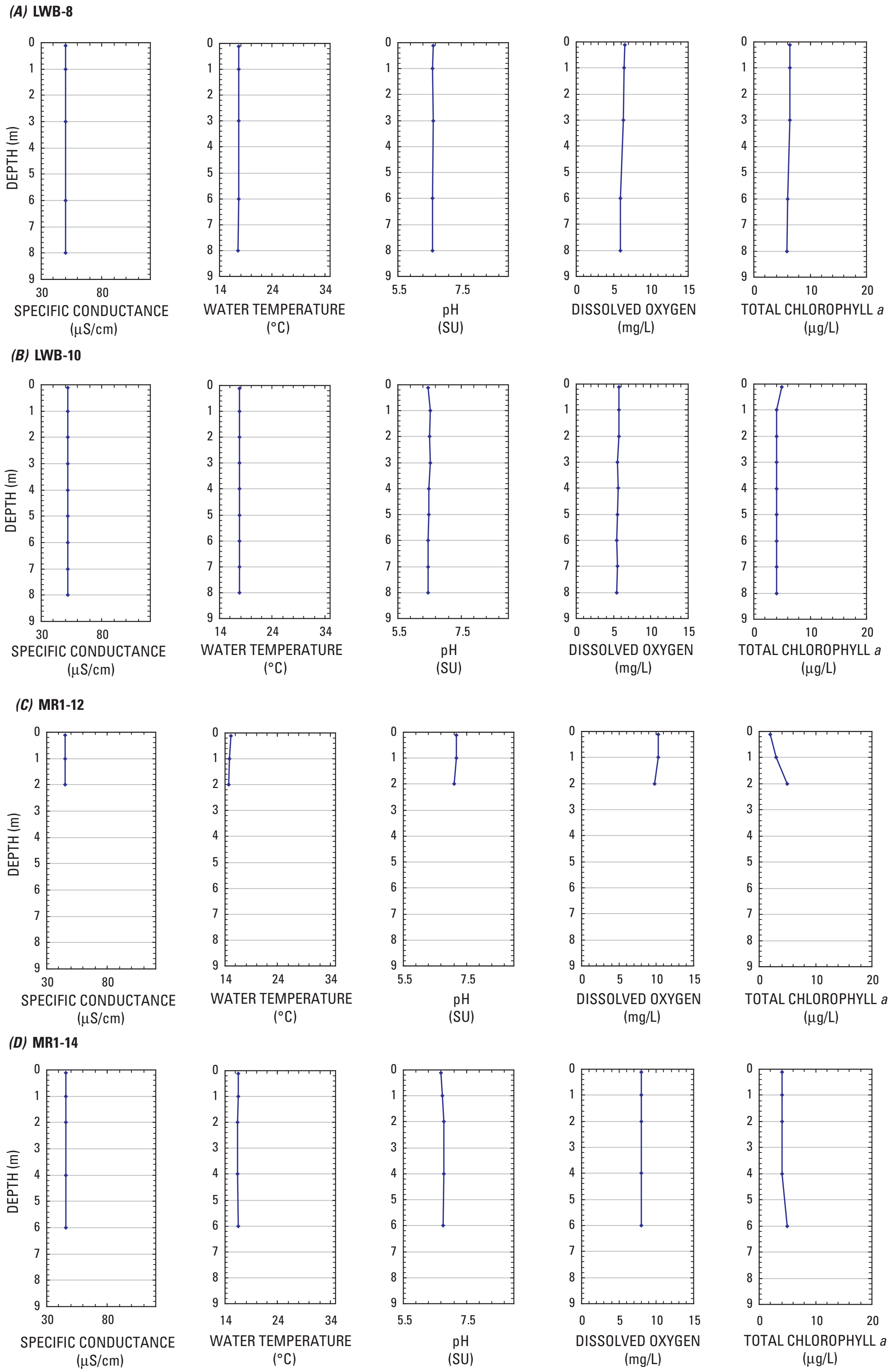


**Figure 6.** Depth profiles of temperature, pH, specific conductance, dissolved oxygen, and chlorophyll *a* at the mid-points of sites (*A*) LWB-8, (*B*) LWB-10, (*C*) MR1-12, and (*D*) MR1-14 in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, October 2006. [m, meters; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; °C, degrees Celsius; SU, standard pH units; µg/L, micrograms per liter]

**Table 8.** Summary of dissolved oxygen, water temperature, specific conductance, pH, total chlorophyll *a*, water density, and relative thermal resistance to mixing (RTRM) values at various depths at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, October 2006.

[mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; kg/m³, kilograms per cubic meter; µg/L, micrograms per liter; NA, not applicable; --, no data]

| Site | Date | Depth (meters) | Dissolved oxygen (mg/L) | Water temperature (degrees Celsius) | Specific conductance (µS/cm) | pH (standard units) | Total chlorophyll *a* (µg/L) | Water density (kg/m³) | RTRM (unitless) |
|---|---|---|---|---|---|---|---|---|---|
| LWB-8 | 10/03/06 | 0.1 | 8.1 | 25.1 | 46.0 | 7.4 | 8 | 997.04 | NA |
| LWB-8 | 10/03/06 | 1 | 8.0 | 24.4 | 46.0 | 7.4 | 9 | 997.23 | 23.5 |
| LWB-8 | 10/03/06 | 2 | 7.3 | 23.1 | 46.0 | 7.2 | 11 | 997.55 | 40.3 |
| LWB-8 | 10/03/06 | 3 | 7.0 | 22.8 | 46.0 | 7.1 | 12 | 997.61 | 7.4 |
| LWB-8 | 10/03/06 | 4 | 6.4 | 22.7 | 46.0 | 7.0 | 8 | 997.65 | 4.7 |
| LWB-8 | 10/03/06 | 5 | 5.6 | 22.5 | 46.0 | 6.8 | 6 | 997.68 | 4.1 |
| LWB-8 | 10/03/06 | 6 | 4.8 | 22.3 | 47.0 | 6.7 | 6 | 997.72 | 5.2 |
| LWB-8 | 10/03/06 | 7 | 0.2 | 21.0 | 96.0 | 6.5 | 8 | 998.02 | 37.4 |
| LWB-8 | 10/03/06 | 7.5 | 0.0 | 20.0 | 120.0 | 6.7 | 11 | 998.23 | 26.4 |
| LWB-9 | 10/03/06 | 0.1 | 7.6 | 24.5 | 46.0 | 7.2 | 5 | 997.20 | NA |
| LWB-9 | 10/03/06 | 1 | 7.5 | 24.1 | 46.0 | 7.2 | 8 | 997.30 | 11.9 |
| LWB-9 | 10/03/06 | 2 | 7.2 | 23.0 | 46.0 | 7.2 | 10 | 997.56 | 33.0 |
| LWB-9 | 10/03/06 | 3 | 6.5 | 22.8 | 45.0 | 7.0 | 11 | 997.62 | 6.8 |
| LWB-9 | 10/03/06 | 4 | 6.2 | 22.7 | 46.0 | 6.9 | 10 | 997.63 | 2.3 |
| LWB-9 | 10/03/06 | 5 | 5.8 | 22.7 | 46.0 | 6.8 | 7 | 997.65 | 2.0 |
| LWB-9 | 10/03/06 | 6 | 5.2 | 22.5 | 46.0 | 6.7 | 5 | 997.69 | 5.2 |
| LWB-9 | 10/03/06 | 7 | 0.0 | 21.4 | 70.0 | 6.4 | 6 | 997.95 | 31.6 |
| LWB-9 | 10/03/06 | 7.5 | 0.0 | 19.2 | 130.0 | 6.7 | 11 | 998.40 | 56.9 |
| LWB-10 | 10/03/06 | 0.1 | 7.9 | 25.2 | 46.0 | 6.9 | 4 | 997.02 | NA |
| LWB-10 | 10/03/06 | 1 | 7.7 | 24.4 | 46.0 | 7.0 | 9 | 997.23 | 25.4 |
| LWB-10 | 10/03/06 | 2 | 7.8 | 23.1 | 46.0 | 7.1 | 12 | 997.54 | 39.4 |
| LWB-10 | 10/03/06 | 3 | 7.2 | 22.9 | 45.0 | 7.0 | 10 | 997.59 | 6.2 |
| LWB-10 | 10/03/06 | 4 | 6.6 | 22.8 | 46.0 | 6.8 | 8 | 997.62 | 3.8 |
| LWB-10 | 10/03/06 | 5 | 5.1 | 22.6 | 46.0 | 6.2 | 4 | 997.67 | 6.4 |
| LWB-10 | 10/03/06 | 6 | 4.5 | 22.3 | 48.0 | 6.6 | 4 | 997.72 | 6.1 |
| LWB-10 | 10/03/06 | 7 | 0.4 | 21.9 | 58.0 | 6.3 | 7 | 997.83 | 14.0 |
| LWB-10 | 10/03/06 | 7.5 | 0.2 | 19.8 | 110.0 | 6.6 | 13 | -- | -- |
| LWB-10 | 10/03/06 | 8 | 0.1 | 18.5 | 117.0 | 6.7 | 13 | 998.53 | 87.1 |
| LWB-8 | 10/24/06 | 0.1 | 6.5 | 17.7 | 50.0 | 6.6 | 5 | 998.68 | NA |
| LWB-8 | 10/24/06 | 1 | 6.4 | 17.7 | 50.0 | 6.6 | 6 | 998.68 | –0.2 |
| LWB-8 | 10/24/06 | 3 | 6.3 | 17.7 | 50.0 | 6.6 | 5 | 998.68 | 0.2 |
| LWB-8 | 10/24/06 | 6 | 6.0 | 17.6 | 50.0 | 6.6 | 4 | 998.69 | 0.9 |
| LWB-8 | 10/24/06 | 8 | 5.9 | 17.6 | 50.0 | 6.6 | 4 | 998.71 | 2.0 |
| LWB-10 | 10/24/06 | 0.1 | 5.7 | 17.8 | 52.0 | 6.5 | 5 | 998.67 | NA |
| LWB-10 | 10/24/06 | 1 | 5.7 | 17.8 | 52.0 | 6.5 | 4 | 998.67 | –0.2 |
| LWB-10 | 10/24/06 | 2 | 5.7 | 17.8 | 52.0 | 6.5 | 4 | 998.67 | 0.0 |
| LWB-10 | 10/24/06 | 3 | 5.6 | 17.8 | 52.0 | 6.5 | 4 | 998.67 | 0.2 |
| LWB-10 | 10/24/06 | 4 | 5.6 | 17.8 | 52.0 | 6.5 | 4 | 998.67 | 0.0 |
| LWB-10 | 10/24/06 | 5 | 5.5 | 17.8 | 52.0 | 6.5 | 4 | 998.67 | 0.0 |
| LWB-10 | 10/24/06 | 6 | 5.5 | 17.8 | 52.0 | 6.5 | 4 | 998.67 | 0.0 |
| LWB-10 | 10/24/06 | 7 | 5.5 | 17.7 | 52.0 | 6.5 | 4 | 998.67 | 0.2 |
| LWB-10 | 10/24/06 | 8 | 5.5 | 17.7 | 52.0 | 6.5 | 4 | 998.67 | 0.0 |
| MR1-12 | 10/25/06 | 0.1 | 10.3 | 15.1 | 45.0 | 7.2 | 2 | 999.11 | NA |
| MR1-12 | 10/25/06 | 1 | 10.3 | 14.8 | 45.0 | 7.2 | 3 | 999.15 | 5.6 |
| MR1-12 | 10/25/06 | 2 | 9.8 | 14.7 | 45.0 | 7.1 | 5 | 999.18 | 3.3 |
| MR1-14 | 10/25/06 | 0.1 | 8.0 | 16.5 | 46.0 | 6.7 | 4 | 998.90 | NA |
| MR1-14 | 10/25/06 | 1 | 8.0 | 16.5 | 46.0 | 6.7 | 4 | 998.89 | –0.2 |
| MR1-14 | 10/25/06 | 2 | 8.0 | 16.5 | 46.0 | 6.8 | 4 | 998.90 | 0.4 |
| MR1-14 | 10/25/06 | 4 | 8.0 | 16.4 | 46.0 | 6.8 | 4 | 998.90 | 0.2 |
| MR1-14 | 10/25/06 | 6 | 8.0 | 16.5 | 46.0 | 6.8 | 5 | 998.89 | –0.6 |

**Table 9.** Computed values of relative thermal resistance to mixing (RTRM) between the epilimnion (1-meter depth) and the hypolimnion (5- to 7-meter depth) at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.

[ID, identification; --, no data]

| Site ID | Relative thermal resistance to mixing between the epilimnion and hypolimnion | | | |
|---|---|---|---|---|
| | August 30–September 7, 2005 | September 15, 2005 | May 15–17, 2006 | October 24–25, 2006 |
| LWB-5 | 214 | -- | 18 | -- |
| LWB-7 | 236 | -- | 118 | -- |
| LWB-8 | 278 | 196 | 108 | 3.2 |
| LWB-10 | 252 | -- | 128 | 0.5 |
| MR1-14 | 47 | -- | 31 | 0 |

## Spatial and Temporal Variation

TKN, TP, ammonia, and chlorophyll *a* concentrations were determined for seven sites in Lake Bowen and one site in Reservoir #1 in samples collected near the surface (about 1-m depth) and bottom (between 2.5- and 7-m depth) during the August to September 2005 survey (table 4; fig. 7*A–D*; table 10). Samples of bottom water were collected at sites LWB-3 and LWB-4 from depths of less than 3 m. Bottom samples from sites LWB-5, LWB-7, LWB-8, LWB-10, LWB-11, and MR1-14 were collected at depths of 5 to 7 m.

The nitrate plus nitrite concentrations at all sites were less than the LRL of 0.06 mg/L during the August to September 2005 survey; therefore, TKN concentrations were equivalent to the TN concentrations (Appendix B, table 10). Concentrations of TKN in samples collected near the surface of Lake Bowen ranged from 0.20 mg/L (LWB-5) to 0.29 mg/L (LWB-10) and was 0.33 mg/L in the surface sample from Reservoir #1 (MR1-14) (table 10, fig. 7*A*). TKN concentrations in the bottom samples were almost double the TKN concentrations in the surface samples at sites LWB-5, LWB-7, LWB-8, and LWB-10 but similar at sites LWB-3, LWB-4, LWB-11, and MR1-14 (table 10; fig. 7*A*). Ammonia concentrations were at or less than the LRL (ranged from 0.01 to 0.04 mg/L) in the surface samples at all site, but ranged from 0.034 (LWB-11) to 0.267 mg/L (LWB-10) in bottom samples collected at depths greater than 5 m (sites LWB-5, LWB-7, LWB-8, LWB-10, and LWB-11) in Lake Bowen during the August to September 2005 survey (fig. 7*C*). These elevated ammonia concentrations probably account for the greater TKN concentrations with depth because the total organic nitrogen concentrations remained relatively constant. Stratification in Lake Bowen during the survey created near-anoxic conditions in the hypolimnion at these sites that probably was favorable to the production and preservation of ammonia through denitrification (table 6; fig. 4*D*).

During the August to September 2005 survey, dissolved orthophosphate concentrations at all sites were less than the LRL (ranged from < 0.02 to < 0.09 mg/L) (table 10). For Lake Bowen, TP concentrations exhibited a pattern similar to that of TKN concentrations, such that the bottom samples at sites LWB-5, LWB-7, LWB-8, and LWB-10 had higher TP concentrations than the surface samples (table 10, fig. 7*B*). TP concentrations in surface samples from Lake Bowen ranged from 0.013 mg/L (LWB-5) to 0.020 mg/L (LWB-3) and was 0.021 mg/L in a sample from Reservoir #1 (MR1-14) (fig. 7*B*; table 10). Bottom samples from Lake Bowen contained TP concentrations ranging from 0.019 mg/L (LWB-4) to 0.034 mg/L (LWB-8), and the concentration in a bottom sample from Reservoir #1 (MR1-14) was 0.025 mg/L.

Ash-free dry mass, an estimate of phytoplankton biomass, was less than the LRLs (ranged from <7.5 to <15 mg/L). Another estimate of algal biomass for the survey, concentrations of chlorophyll *a*, also indicated relatively low algal biomass. Chlorophyll *a* concentrations in the surface samples from Lake Bowen ranged from 1.3 (LWB-10) to 6.4 µg/L (LWB-3) and the concentration in a sample from Reservoir #1 (MR1-14) was 1.3 µg/L (table 10, fig. 7*D*). Chlorophyll *a* concentrations in the bottom samples from Lake Bowen ranged from 1.2 (LWB-10) to 5.7 µg/L (LWB-3), and the concentration in a sample from Reservoir #1 (MR1-14) was 3.0 µg/L (table 10, fig. 7*D*).

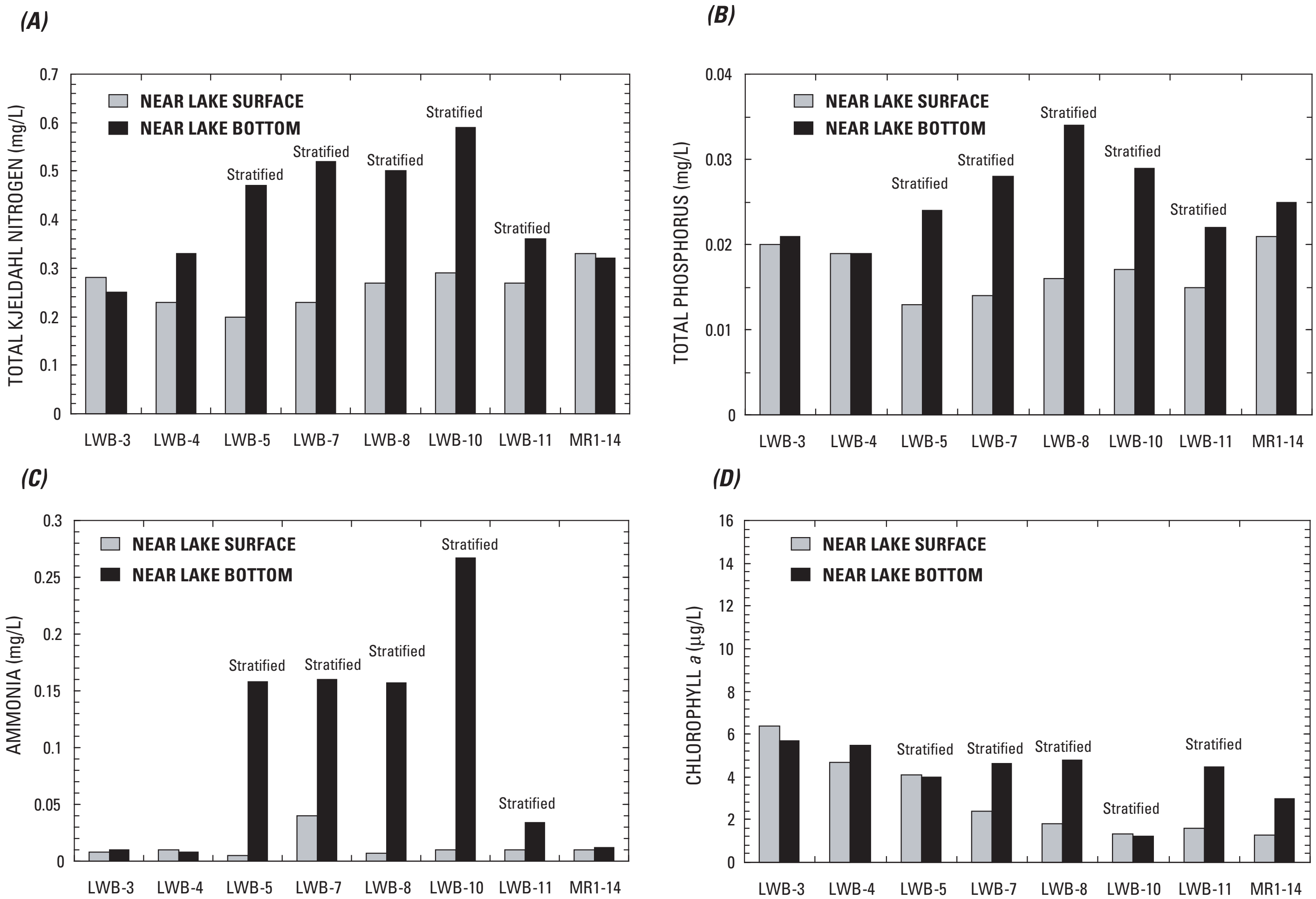


**Figure 7.** Concentrations of (*A*) total Kjeldahl nitrogen, (*B*) total phosphorus, (*C*) ammonia, and (*D*) chlorophyll *a* in samples from near the surface (1-meter depth) and near the bottom (between 2.5 and 7 meters) at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 30–September 15, 2005. [mg/L, milligrams per liter; µg/L, micrograms per liter]

In the May 2006 survey, two of the original seven sites in Lake Bowen (LWB-8 and LWB-10) and one site in Reservoir #1 (MR1-14) were sampled at near-surface (1 m) and near-bottom depths (6 m) (table 4; table 11); one site in Reservoir #1 (MR1-12) was sampled as near-surface only. Ammonia and nitrite concentrations were less than the LRL of 0.04 and 0.008 mg/L, respectively, at all sites during the time of sampling. Therefore, nitrate plus nitrite concentrations were representative mainly of nitrate concentrations. Nitrate concentration (as measured by nitrate plus nitrite) of 0.10 mg/L in Lake Bowen (surface and bottom samples at all sites) was slightly higher than the concentration of 0.07 mg/L in Reservoir #1 (MR1-12 and MR1-14 bottom) (table 11, fig. 8*C*). Concentrations of TKN ranged from 0.25 (LWB-8 surface) to 0.31 mg/L (MR1-14 surface and LWB-10 bottom) (table 11; fig. 8*A*). Unlike concentrations in the August to September 2005 survey, TKN concentrations in May 2006 were relatively constant among the sites and between the surface and bottom samples. Orthophosphate concentrations were less than the LRL (ranged from <0.02 to <0.04 mg/L) at all sites and depths, except for the bottom sample from LWB-8 which had a concentration of 0.04 mg/L during the May 2006 survey (table 11). Concentrations of TP in surface samples ranged from 0.012 to 0.014 mg/L at sites LWB-10 and LWB-8, respectively, in Lake Bowen and from 0.014 to 0.018 mg/L at sites MR1-12 and MR1-14, respectively, in Reservoir #1 (table 11, fig. 8*B*). Concentrations of TP in bottom samples were equivalent to, or slightly less than, concentrations in surface samples from Lake Bowen, but slightly higher than concentrations in surface samples from MR1-14 in Reservoir #1 (table 11, fig. 8*B*).

**Table 10.** Concentrations of selected water-quality constituents in samples collected near the lake surface and near the lake bottom at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August to September 2005.

[Highlighted columns indicate samples from near the lake surface; E, estimated; <, less than the laboratory reporting limit; --, no data; NA, not applicable]

| Constituent | Units | LWB-3 | | | | LWB-4 | | | |
|---|---|---|---|---|---|---|---|---|---|
| Site description | NA | Lake Bowen at Road 37 below Campbello, S.C. | | | | Lake Bowen above Interstate 26 below Campbello, S.C. | | | |
| Date of sample | NA | 08/30/05 | 09/15/05 | 08/30/05 | 09/15/05 | 08/30/05 | 09/15/05 | 08/30/05 | 09/15/05 |
| Time of sample | hours-minutes | 0840 | 1000 | 0850 | 1010 | 1340 | 1045 | 1350 | 1050 |
| Sample depth | meters | 1 | 1 | 2.5 | 2.5 | 1 | 1 | 2.5 | 2.5 |
| Transparency | meters | 0.96 | -- | -- | -- | 0.99 | -- | -- | -- |
| Barometric pressure | millimeters mercury | 750 | -- | -- | -- | 739 | -- | -- | -- |
| Dissolved oxygen | milligrams per liter | 7.9 | -- | -- | -- | 10.3 | -- | -- | -- |
| Dissolved oxygen | percent saturation | 100 | -- | -- | -- | 134 | -- | -- | -- |
| Field pH | standard units | 7.1 | 7.4 | -- | 7.4 | 7.6 | 7.5 | -- | 7.5 |
| Field specific conductance | microsiemens per centimeter at 25 degrees Celsius | 43 | 41 | -- | 41 | 43 | 41 | -- | 41 |
| Air temperature | degrees Celsius | 26.9 | -- | -- | -- | -- | -- | 29.6 | -- |
| Water temperature | degrees Celsius | 28.6 | -- | -- | -- | -- | -- | -- | -- |
| Total Kjeldahl nitrogen | milligrams per liter | 0.28 | -- | 0.25 | -- | 0.23 | -- | 0.33 | -- |
| Ammonia, dissolved | milligrams per liter | E 0.008 | -- | 0.010 | -- | < 0.01 | -- | E 0.008 | -- |
| Nitrite plus nitrate, dissolved | milligrams per liter | < 0.06 | -- | E 0.03 | -- | < 0.06 | -- | < 0.06 | -- |
| Nitrite, dissolved | milligrams per liter | < 0.008 | -- | < 0.008 | -- | < 0.008 | -- | < 0.008 | -- |
| Total organic nitrogen | milligrams per liter | 0.28 | -- | 0.24 | -- | 0.23 | -- | 0.33 | -- |
| Total nitrogen | milligrams per liter | 0.28 | -- | 0.25 | -- | 0.23 | -- | 0.33 | -- |
| Orthophosphate, dissolved | milligrams per liter | < 0.02 | -- | < 0.02 | -- | < 0.02 | -- | < 0.02 | -- |
| Total phosphorus | milligrams per liter | 0.020 | -- | 0.021 | -- | 0.019 | -- | 0.019 | -- |
| Total nitrogen/total phosphorus ratio | unitless | 14 | -- | 12 | -- | 12 | -- | 17 | -- |
| Dissolved organic carbon | milligrams per liter | 2.5 | -- | 2.3 | -- | 2.5 | -- | 2.8 | -- |
| Ultraviolet absorbance at 254 nanometers | per centimeter | 0.060 | -- | 0.062 | -- | 0.060 | -- | 0.057 | -- |
| Ultraviolet absorbance at 280 nanometers | per centimeter | 0.045 | -- | 0.047 | -- | 0.046 | -- | 0.043 | -- |
| Ash-free dry mass phytoplankton biomass | milligrams per liter | -- | < 10 | -- | < 10 | -- | < 10 | -- | < 7.5 |
| Ash weight biomass | milligrams per liter | -- | 426 | -- | 432 | -- | 417 | -- | 314 |
| Dry weight biomass | milligrams per liter | -- | 435 | -- | 440 | -- | 425 | -- | 321 |
| Chlorophyll *a* | micrograms per liter | -- | E 6.4 | -- | E 5.7 | -- | E 4.7 | -- | E 5.5 |
| Chlorophyll *b* | micrograms per liter | -- | <0.1 | -- | E 0.5 | -- | <0.1 | -- | E 0.6 |
| 2-methyisoborneol, dissolved | micrograms per liter | < 0.005 | -- | < 0.005 | -- | < 0.005 | -- | < 0.005 | -- |
| Geosmin, dissolved | micrograms per liter | < 0.005 | -- | 0.005 | -- | 0.005 | -- | < 0.005 | -- |

**Table 10.** Concentrations of selected water-quality constituents in samples collected near the lake surface and near the lake bottom at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August to September 2005.—Continued

[Highlighted columns indicate samples from near the lake surface; E, estimated; <, less than the laboratory reporting limit; --, no data; NA, not applicable]

| Constituent | Units | LWB-5 | | | | LWB-7 | | | |
|---|---|---|---|---|---|---|---|---|---|
| Site description | NA | Lake Bowen below Interstate 26, near Inman, S.C. | | | | Lake Bowen above S.C. Highway 9 near New Prospect, S.C. | | | |
| Date of sample | NA | 08/31/05 | 09/15/05 | 08/31/05 | 09/15/05 | 09/01/05 | 09/15/05 | 09/01/05 | 09/15/05 |
| Time of sample | hours-minutes | 0840 | 1130 | 0850 | 1140 | 0840 | 1215 | 0850 | 1220 |
| Sample depth | meters | 1 | 1 | 5 | 5 | 1 | 1 | 6 | -- |
| Transparency | meters | 1.40 | -- | -- | -- | 1.55 | -- | -- | -- |
| Barometric pressure | millimeters mercury | 740 | -- | -- | -- | -- | -- | -- | -- |
| Dissolved oxygen | milligrams per liter | 6.5 | -- | -- | -- | 8 | -- | -- | -- |
| Dissolved oxygen | percent saturation | 86 | -- | -- | -- | 103 | -- | -- | -- |
| Field pH | standard units | 7.1 | 7.1 | -- | 6.7 | 7.2 | 7.1 | -- | 6.7 |
| Field specific conductance | microsiemens per centimeter at 25 degrees Celsius | 41 | 40 | -- | 42 | 40 | 39 | -- | 83 |
| Air temperature | degrees Celsius | 27.2 | -- | -- | -- | 24.8 | -- | -- | -- |
| Water temperature | degrees Celsius | 28.1 | -- | -- | -- | 28.2 | -- | -- | -- |
| Total Kjeldahl nitrogen | milligrams per liter | 0.20 | -- | 0.47 | -- | 0.23 | -- | 0.52 | -- |
| Ammonia, dissolved | milligrams per liter | E 0.005 | -- | 0.158 | -- | < 0.04 | -- | 0.160 | -- |
| Nitrite plus nitrate, dissolved | milligrams per liter | < 0.06 | -- | < 0.06 | -- | < 0.06 | -- | < 0.06 | -- |
| Nitrite, dissolved | milligrams per liter | < 0.008 | -- | < 0.008 | -- | < 0.008 | -- | < 0.008 | -- |
| Total organic nitrogen | milligrams per liter | 0.20 | -- | 0.31 | -- | 0.23 | -- | 0.36 | -- |
| Total nitrogen | milligrams per liter | 0.20 | -- | 0.47 | -- | 0.23 | -- | 0.52 | -- |
| Orthophosphate, dissolved | milligrams per liter | < 0.02 | -- | < 0.02 | -- | < 0.02 | -- | < 0.02 | -- |
| Total phosphorus | milligrams per liter | 0.013 | -- | 0.024 | -- | 0.014 | -- | 0.028 | -- |
| Total nitrogen/total phosphorus ratio | unitless | 15 | -- | 20 | -- | 16 | -- | 19 | -- |
| Dissolved organic carbon | milligrams per liter | 3.0 | -- | 2.9 | -- | 2.7 | -- | 4.7 | -- |
| Ultraviolet absorbance at 254 nanometers | per centimeter | 0.058 | -- | 0.133 | -- | 0.058 | -- | 0.266 | -- |
| Ultraviolet absorbance at 280 nanometers | per centimeter | 0.043 | -- | 0.106 | -- | 0.043 | -- | 0.216 | -- |
| Ash-free dry mass phytoplankton biomass | milligrams per liter | -- | < 10 | -- | < 7.5 | -- | < 7.5 | -- | < 7.5 |
| Ash weight biomass | milligrams per liter | -- | 425 | -- | 319 | -- | 312 | -- | 321 |
| Dry weight biomass | milligrams per liter | -- | 432 | -- | 326 | -- | 318 | -- | 327 |
| Chlorophyll *a* | micrograms per liter | -- | E 4.1 | -- | E 4.0 | -- | E 2.4 | -- | E 4.6 |
| Chlorophyll *b* | micrograms per liter | -- | E 0.6 | -- | E 0.5 | -- | E 0.3 | -- | E 0.7 |
| 2-methyisoborneol, dissolved | micrograms per liter | < 0.005 | -- | < 0.005 | -- | < 0.005 | -- | < 0.005 | -- |
| Geosmin, dissolved | micrograms per liter | < 0.005 | -- | < 0.005 | -- | 0.005 | -- | 0.016 | -- |

**Table 10.** Concentrations of selected water-quality constituents in samples collected near the lake surface and near the lake bottom at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August to September 2005.—Continued

[Highlighted columns indicate samples from near the lake surface; E, estimated; <, less than the laboratory reporting limit; --, no data; NA, not applicable]

| Constituent | Units | LWB-8 | | | | LWB-10 | |
|---|---|---|---|---|---|---|---|
| Site description | NA | Lake Bowen at S.C. Highway 9 Bridge near Fingerville, S.C. | | | | Lake Bowen below Highway S.C. 9 near Fingerville, S.C. | |
| Date of sample | NA | 08/31/05 | 09/15/05 | 08/31/05 | 09/15/05 | 09/06/05 | 09/06/05 |
| Time of sample | hours-minutes | 1340 | 1315 | 1350 | 1320 | 1340 | 1350 |
| Sample depth | meters | 1 | 1 | 6 | 6 | 1 | 7 |
| Transparency | meters | 1.30 | -- | -- | -- | 1.32 | 1.32 |
| Barometric pressure | millimeters mercury | 739 | -- | 739 | -- | 752 | 752 |
| Dissolved oxygen | milligrams per liter | 7.3 | -- | -- | -- | 8 | 0.8 |
| Dissolved oxygen | percent saturation | 98 | -- | -- | -- | 101 | 8 |
| Field pH | standard units | 7.3 | 7.0 | -- | 6.5 | 6.2 | 5.9 |
| Field specific conductance | microsiemens per centimeter at 25 degrees Celsius | 40 | 39 | -- | 77 | 40 | 68 |
| Air temperature | degrees Celsius | 31.9 | -- | 31.9 | -- | 28.8 | 28.4 |
| Water temperature | degrees Celsius | 29.2 | -- | -- | -- | 26.9 | 18.1 |
| Total Kjeldahl nitrogen | milligrams per liter | 0.27 | -- | 0.50 | -- | 0.29 | 0.59 |
| Ammonia, dissolved | milligrams per liter | E 0.007 | -- | 0.157 | -- | < 0.01 | 0.267 |
| Nitrite plus nitrate, dissolved | milligrams per liter | < 0.06 | -- | < 0.06 | -- | < 0.06 | < 0.06 |
| Nitrite, dissolved | milligrams per liter | < 0.008 | -- | < 0.008 | -- | < 0.008 | < 0.008 |
| Total organic nitrogen | milligrams per liter | 0.27 | -- | 0.34 | -- | 0.29 | 0.32 |
| Total nitrogen | milligrams per liter | 0.27 | -- | 0.50 | -- | 0.29 | 0.59 |
| Orthophosphate, dissolved | milligrams per liter | < 0.02 | -- | < 0.02 | -- | < 0.02 | < 0.02 |
| Total phosphorus | milligrams per liter | 0.016 | -- | 0.034 | -- | 0.017 | 0.029 |
| Total nitrogen/total phosphorus ratio | unitless | 17 | -- | 15 | -- | 17 | 20 |
| Dissolved organic carbon | milligrams per liter | 3.5 | -- | 4.2 | -- | 3.3 | 4.2 |
| Ultraviolet absorbance at 254 nanometers | per centimeter | 0.059 | -- | 0.280 | -- | 0.064 | 0.397 |
| Ultraviolet absorbance at 280 nanometers | per centimeter | 0.042 | -- | 0.227 | -- | 0.047 | 0.328 |
| Ash-free dry mass phytoplankton biomass | milligrams per liter | -- | < 7.5 | -- | < 7.5 | < 15 | < 15 |
| Ash weight biomass | milligrams per liter | -- | 314 | -- | 315 | 644 | 644 |
| Dry weight biomass | milligrams per liter | -- | 320 | -- | 321 | 654 | 655 |
| Chlorophyll *a* | micrograms per liter | -- | E 1.8 | -- | E 4.8 | E 1.3 | E 1.2 |
| Chlorophyll *b* | micrograms per liter | -- | E 0.2 | -- | E 0.7 | <0.1 | <0.1 |
| 2-methyisoborneol, dissolved | micrograms per liter | < 0.005 | -- | < 0.005 | -- | < 0.005 | < 0.005 |
| Geosmin, dissolved | micrograms per liter | < 0.005 | -- | 0.024 | -- | < 0.005 | 0.039 |

**Table 10.** Concentrations of selected water-quality constituents in samples collected near the lake surface and near the lake bottom at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August to September 2005.—Continued

[Highlighted columns indicate samples from near the lake surface; E, estimated; <, less than the laboratory reporting limit; --, no data; NA, not applicable]

| Constituent | Units | LWB-11 | | MR1-14 | |
|---|---|---|---|---|---|
| Site description | NA | Lake Bowen Dam near Fingerville, S.C. | | Municipal Reservoir #1 near Fingerville, S.C. | |
| Date of sample | NA | 09/07/05 | 09/07/05 | 09/07/05 | 09/07/05 |
| Time of sample | hours-minutes | 0740 | 0750 | 1140 | 1150 |
| Sample depth | meters | 1 | 7 | 1 | 6 |
| Transparency | meters | 1.14 | 1.32 | -- | -- |
| Barometric pressure | millimeters mercury | 752 | 752 | 752 | 752 |
| Dissolved oxygen | milligrams per liter | 7 | 0.9 | 8 | 6.4 |
| Dissolved oxygen | percent saturation | 87 | 10 | 101 | 80 |
| Field pH | standard units | 6.0 | 5.9 | 6.1 | 6.2 |
| Field specific conductance | microsiemens per centimeter at 25 degrees Celsius | 39 | 58 | 38 | 39 |
| Air temperature | degrees Celsius | 22.0 | 22.0 | -- | -- |
| Water temperature | degrees Celsius | 25.8 | 19.3 | 26.5 | 26.0 |
| Total Kjeldahl nitrogen | milligrams per liter | 0.27 | 0.36 | 0.33 | 0.32 |
| Ammonia, dissolved | milligrams per liter | < 0.01 | 0.034 | < 0.01 | 0.012 |
| Nitrite plus nitrate, dissolved | milligrams per liter | < 0.06 | < 0.06 | < 0.06 | < 0.06 |
| Nitrite, dissolved | milligrams per liter | < 0.008 | < 0.008 | < 0.008 | < 0.008 |
| Total organic nitrogen | milligrams per liter | 0.27 | 0.32 | 0.33 | 0.31 |
| Total nitrogen | milligrams per liter | 0.27 | 0.36 | 0.33 | 0.32 |
| Orthophosphate, dissolved | milligrams per liter | < 0.09 | < 0.02 | < 0.09 | < 0.09 |
| Total phosphorus | milligrams per liter | 0.015 | 0.022 | 0.021 | 0.025 |
| Total nitrogen/total phosphorus ratio | unitless | 18 | 16 | 16 | 13 |
| Dissolved organic carbon | milligrams per liter | 3.3 | 3.6 | 3.2 | 3.3 |
| Ultraviolet absorbance at 254 nanometers | per centimeter | 0.068 | 0.164 | 0.076 | 0.077 |
| Ultraviolet absorbance at 280 nanometers | per centimeter | 0.049 | 0.13 | 0.058 | 0.055 |
| Ash-free dry mass phytoplankton biomass | milligrams per liter | < 15 | < 15 | < 15 | < 15 |
| Ash weight biomass | milligrams per liter | 640 | 644 | 639 | 636 |
| Dry weight biomass | milligrams per liter | 650 | 654 | 649 | 647 |
| Chlorophyll *a* | micrograms per liter | E 1.6 | E 4.5 | E 1.3 | E 3.0 |
| Chlorophyll *b* | micrograms per liter | E 0.4 | <0.1 | <0.1 | <0.1 |
| 2-methyisoborneol, dissolved | micrograms per liter | < 0.005 | < 0.005 | < 0.005 | < 0.005 |
| Geosmin, dissolved | micrograms per liter | < 0.005 | 0.017 | < 0.005 | < 0.005 |

**Table 11.** Concentrations of selected water-quality constituents in samples collected near the lake surface and near the lake bottom at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, May 2006.

[Highlighted columns indicate the sample is from near the lake surface; E, estimated; <, less than the laboratory reporting limit; --, no data; NTRU, nephelometric turbidity ratio units; NA, not applicable]

| Constituent | Units | LWB-8 | | LWB-10 | | MR1-12 | MRI-14 | |
|---|---|---|---|---|---|---|---|---|
| Site description | NA | Lake Bowen at S.C. Highway 9 bridge near Fingerville, S.C. | | Lake Bowen below S.C. Highway 9 near Fingerville, S.C. | | Municipal Reservoir #1 below Lake Bowen Dam, near Fingerville, S.C. | Municipal Reservoir #1 near Fingerville, S.C. | |
| Date of sample | NA | 05/16/06 | 05/16/06 | 05/15/06 | 05/15/06 | 05/17/06 | 05/17/06 | 05/17/06 |
| Time of sample | hours-minutes | 0900 | 0905 | 1145 | 1155 | 0700 | 0930 | 0935 |
| Sample depth | meters | 1 | 6 | 1 | 6 | 1 | 1 | 6 |
| Transparency | meters | 2.00 | -- | 2.01 | -- | 1.00 | 1.04 | -- |
| Turbidity | NTRU | 3.3 | 2.5 | 2.9 | 2.6 | 6.9 | 3.0 | 7.2 |
| Barometric pressure | millimeters mercury | -- | -- | -- | -- | -- | -- | -- |
| Dissolved oxygen | milligrams per liter | 12.4 | 7.0 | 10.4 | 8.6 | 7.4 | 8.9 | 6.8 |
| Dissolved oxygen | percent saturation | -- | -- | -- | -- | -- | -- | -- |
| Field pH | standard units | 7.5 | 6.7 | 8.0 | 7.2 | 7.0 | 7.5 | 6.8 |
| Field specific conductance | microsiemens per centimeter at 25 degrees Celsius | 53 | 56 | 52 | 53 | 51 | 51 | 53 |
| Air Temperature | degrees Celsius | -- | -- | -- | -- | -- | -- | -- |
| Water Temperature | degrees Celsius | 20.1 | 17.7 | 20.7 | 17.9 | 20.7 | 21.6 | 20.4 |
| Hardness | milligrams per liter | 12 | 12 | 12 | 12 | 11 | 12 | 12 |
| Calcium, dissolved | milligrams per liter | 2.8 | 2.76 | 2.75 | 2.72 | 2.56 | 2.72 | 2.67 |
| Magnesium, dissolved | milligrams per liter | 1.26 | 1.25 | 1.25 | 1.23 | 1.18 | 1.24 | 1.22 |
| Sodium, dissolved | milligrams per liter | 3.23 | 3.19 | 3.18 | 3.13 | 3.13 | 3.08 | 3.09 |
| Silica, dissolved | milligrams per liter | 11.1 | 11.2 | 11.2 | 11.1 | 10.7 | 10.4 | 10.5 |
| Total suspended solids | milligrams per liter | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| Total Kjeldahl nitrogen | milligrams per liter | 0.25 | 0.26 | 0.27 | 0.31 | 0.29 | 0.31 | 0.30 |
| Ammonia, dissolved | milligrams per liter | < 0.04 | < 0.04 | < 0.04 | < 0.04 | < 0.04 | < 0.04 | E 0.03 |
| Nitrite plus nitrate, dissolved | milligrams per liter | 0.10 | 0.10 | 0.10 | 0.10 | 0.07 | E 0.05 | 0.07 |
| Nitrite, dissolved | milligrams per liter | < 0.008 | < 0.008 | < 0.008 | < 0.008 | < 0.008 | < 0.008 | < 0.008 |
| Total organic nitrogen | milligrams per liter | 0.25 | 0.26 | 0.27 | 0.31 | 0.29 | 0.31 | 0.30 |
| Total nitrogen | milligrams per liter | 0.35 | 0.26 | 0.37 | 0.41 | 0.36 | 0.31 | 0.37 |
| Orthophosphate, dissolved | milligrams per liter | < 0.02 | 0.04 | < 0.02 | < 0.04 | < 0.02 | < 0.02 | < 0.02 |
| Total phosphorus | milligrams per liter | 0.014 | 0.014 | 0.012 | 0.011 | 0.014 | 0.018 | 0.022 |
| Total nitrogen/total phosphorus ratio | unitless | 25 | 19 | 31 | 37 | 26 | 17 | 17 |
| Dissolved organic carbon | milligrams per liter | 2.0 | 2.0 | 2.4 | 2.4 | 2.4 | 2.3 | 2.3 |
| Ultraviolet absorbance at 254 nanometers | per centimeter | 0.031 | 0.032 | 0.034 | 0.033 | 0.033 | 0.034 | 0.033 |
| Ultraviolet absorbance at 280 nanometers | per centimeter | 0.022 | 0.024 | 0.025 | 0.024 | 0.025 | 0.026 | 0.024 |
| Ash-free dry mass phytoplankton biomass | milligrams per liter | < 15 | < 15 | -- | < 15 | < 15 | < 15 | < 15 |
| Ash weight biomass | milligrams per liter | 654 | 638 | -- | 648 | 646 | 632 | 639 |
| Dry weight biomass | milligrams per liter | 665 | 649 | -- | 658 | 657 | 642 | 650 |
| Biomass/chlorophyll ratio | unitless | 696 | 892 | -- | 1,550 | 1,280 | 901 | 1,300 |
| Chlorophyll *a* | micrograms per liter | 15.1 | 11.8 | 6.8 | 6.8 | 8.6 | 11.1 | 8.5 |
| Total chlorophyll *a* | micrograms per liter | 8.5 | 7.8 | 4.4 | 12.4 | -- | 8 | 6.3 |
| Pheophytin *a* | micrograms per liter | < 0.1 | 5.8 | 3.7 | 3.8 | 4 | 5.2 | 5.2 |
| Iron, dissolved | micrograms per liter | 11 | 9 | 11 | 12 | 24 | 12 | 22 |
| Manganese, dissolved | micrograms per liter | E 0.5 | 0.7 | 1.2 | 1.0 | 2.1 | E 0.6 | 17.1 |
| 2-methylisoborneol, dissolved | micrograms per liter | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.005 |
| Geosmin, dissolved | micrograms per liter | 0.013 | 0.016 | 0.012 | 0.024 | 0.005 | 0.007 | 0.008 |
| Microcystin, dissolved | micrograms per liter | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |

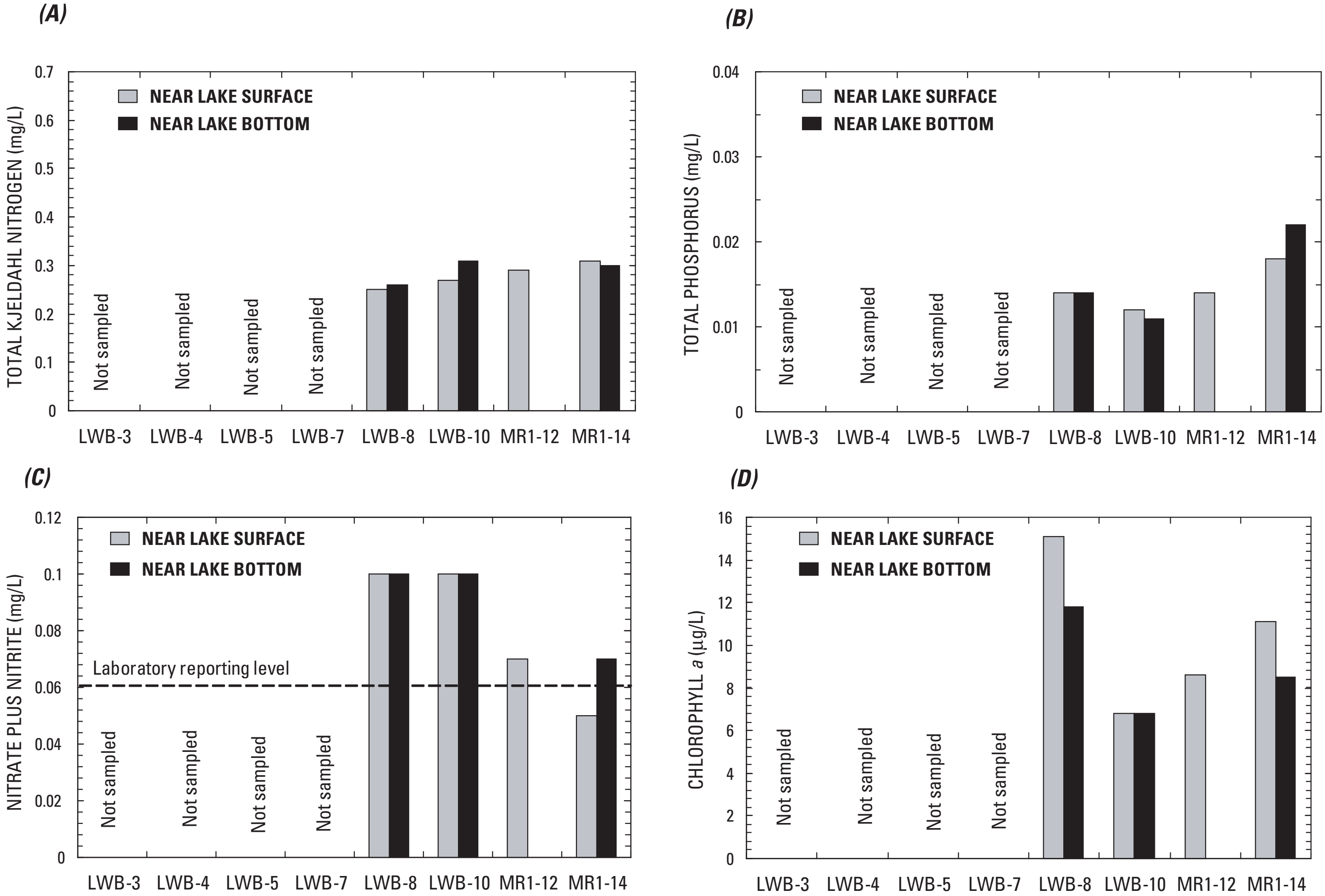


**Figure 8.** Concentrations of (*A*) total Kjeldahl nitrogen, (*B*) total phosphorus, (*C*) nitrate plus nitrite, and (*D*) chlorophyll *a* in samples from near the surface (1-meter depth) and near the bottom (6-meter depth) at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, May 16–17, 2006. [mg/L, milligrams per liter; µg/L, micrograms per liter]

Phytoplankton biomass (as ash-free dry mass) was less than the LRL of 15 mg/L at all sites in the May 2006 survey (table 11). Chlorophyll *a* concentrations in samples from near the lake surface were 6.8 and 15.1 µg/L at sites LWB-10 and LWB-8, respectively, in Lake Bowen and were 8.6 and 11.1 µg/L at sites MR1-12 and MR1-14, respectively, in Reservoir #1 (table 11, fig. 8*D*). Bottom samples from these sites contained equal or slightly lower chlorophyll *a* concentrations than the surface samples (table 11, fig. 8*D*).

In the October 2006 survey, two sites in Lake Bowen (LWB-8 and LWB-10) and one site in Reservoir #1 (MR1-14) were sampled at near-surface (1 m) and near-bottom depths (6 m) (tables 4 and 12). Nitrate plus nitrite concentrations were less than the LRL of 0.06 mg/L at all sites during the time of sampling (table 12). However, estimated (not quantitative) nitrate plus nitrite concentrations of 0.03 mg/L were detected in the surface sample from LWB-8 and in both surface and bottom samples from MR1-14 (table 12). Surface and bottom concentrations of TKN were similar at all sites ranging from 0.46 to 0.48 mg/L in samples from Lake Bowen and 0.21 to 0.24 mg/L in samples from Reservoir #1 (table 12, fig. 9*A*). The greater TKN concentrations in Lake Bowen can be accounted for by ammonia concentrations that ranged from 0.217 to 0.232 mg/L; the ammonia concentration in the sample from Reservoir #1 was 0.056 mg/L (table 12, fig. 9*C*).

Orthophosphate concentrations were less than the LRL of 0.008 mg/L at all sites during the time of sampling; however, estimated orthophosphate concentrations of 0.003 and 0.004 mg/L were detected at all sites (table 12). In the surface samples, TP concentrations ranged from an estimated 0.008 mg/L to 0.012 mg/L at sites LWB-10 and LWB-8, respectively, in Lake Bowen and was 0.010 mg/L at site MR1-14 in Reservoir #1 (table 12, fig. 9*B*). In Lake Bowen, bottom samples contained TP concentrations similar to those in surface samples. The bottom sample

**Table 12.** Concentrations of selected water-quality constituents in samples collected near the lake surface and near the lake bottom at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, October 2006.

[Highlighted columns indicate the sample is from near the lake surface; -- no data; <, less than the laboratory reporting limit; E, estimated; NA, not applicable; NTRU, nephelometric turbidity ratio units]

| Constituents | Units | LWB-8 | | LWB-10 | | MR1-14 | |
|---|---|---|---|---|---|---|---|
| Site description | NA | Lake William C. Bowen at S.C. Highway 9 bridge near Fingerville, S.C. | | Lake Bowen below S.C. Highway 9 near Fingerville, S.C. | | Municipal Reservoir #1 (South Pacolet River Reservoir) near Fingerville, S.C. | |
| Date of sample | NA | 10/24/06 | 10/24/06 | 10/24/06 | 10/24/06 | 10/25/06 | 10/25/06 |
| Time of sample | hours-minutes | 1500 | 1510 | 1145 | 1150 | 0900 | 0910 |
| Sample depth | meters | 1 | 6 | 1 | 6 | 1 | 6 |
| Transparency | meters | 0.90 | -- | 1.12 | -- | 1.10 | -- |
| Turbidity | NTRU | 9.1 | 7.9 | 8.5 | 6.9 | 5.5 | 5.1 |
| Barometric Pressure | millimeters mercury | 747 | 747 | 747 | 747 | 752 | 752 |
| Dissolved Oxygen | milligrams per liter | 6.1 | 5.7 | 5.4 | 5.1 | 9.0 | 8.7 |
| Dissolved Oxygen | percent saturation | 64 | 60 | 56 | 53 | 92 | 89 |
| Field pH | standard units | 6.7 | 6.7 | 6.7 | 6.6 | 6.9 | 7.0 |
| Field specific conductance | microsiemens per centimeter at 25 degrees Celsius | 50 | 49 | 51 | 51 | 45 | 45 |
| Air temperature | degrees Celsius | 12.3 | 12.3 | 10.7 | 10.7 | 6.5 | 6.5 |
| Water temperature | degrees Celsius | 17.6 | 17.6 | 17.7 | 17.7 | 16.4 | 16.4 |
| Hardness | milligrams per liter | 14 | 13 | 14 | 14 | 13 | 13 |
| Calcium, dissolved | milligrams per liter | 3.24 | 3.14 | 3.33 | 3.23 | 3.11 | 3.04 |
| Magnesium, dissolved | milligrams per liter | 1.38 | 1.33 | 1.4 | 1.35 | 1.34 | 1.32 |
| Sodium, dissolved | milligrams per liter | 3.11 | 3.05 | 3.07 | 3.01 | 3.06 | 2.92 |
| Silica, dissolved | milligrams per liter | 11.3 | 11.1 | 11.1 | 11 | 10.5 | 10.4 |
| Total suspended solids | milligrams per liter | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| Total Kjeldahl nitrogen | milligrams per liter | 0.46 | 0.47 | 0.47 | 0.48 | 0.24 | 0.21 |
| Ammonia, dissolved | milligrams per liter | 0.220 | 0.217 | 0.225 | 0.232 | 0.056 | 0.056 |
| Nitrite plus nitrate, dissolved | milligrams per liter | E 0.03 | < 0.06 | < 0.06 | < 0.06 | E 0.03 | E 0.03 |
| Nitrite, dissolved | milligrams per liter | E 0.001 | < 0.002 | < 0.002 | < 0.002 | < 0.002 | < 0.002 |
| Total organic nitrogen | milligrams per liter | 0.24 | 0.25 | 0.24 | 0.25 | 0.18 | 0.15 |
| Total nitrogen | milligrams per liter | 0.46 | 0.47 | 0.47 | 0.48 | 0.24 | 0.21 |
| Orthophosphate, dissolved | milligrams per liter | E 0.004 | E 0.003 | E 0.003 | E 0.003 | E 0.003 | E 0.003 |
| Total phosphorus | milligrams per liter | 0.012 | 0.012 | E 0.008 | 0.009 | 0.01 | 0.014 |
| Total nitrogen/total phosphorus ratio | Unitless | 38 | 39 | 59 | 53 | 24 | 15 |
| Dissolved organic carbon | milligrams per liter | 2.0 | 2.1 | 2.0 | 2.1 | 2.1 | 2.0 |
| Ultraviolet absorbance at 254 nanometers | per centimeter | 0.091 | 0.087 | -- | 0.097 | 0.042 | 0.042 |
| Ultraviolet absorbance at 280 nanometers | per centimeter | 0.074 | 0.068 | -- | 0.077 | 0.029 | 0.029 |
| Ash-free dry mass phytoplankton Biomass | milligrams per liter | < 10 | < 10 | < 10 | < 12 | < 7.5 | < 7.5 |
| Ash weight biomass | milligrams per liter | 429 | 425 | 428 | 511 | 320 | 320 |
| Dry weight biomass | milligrams per liter | 437 | 433 | 436 | 520 | 326 | 326 |
| Biomass/chlorophyll ratio | unitless | 973 | 1100 | 1230 | 1270 | 1030 | 1140 |
| Chlorophyll *a* | micrograms per liter | 8.2 | 7.3 | 6.5 | 7.2 | 5.6 | 5 |
| Total chlorophyll *a* | micrograms per liter | 5.5 | 4.5 | 4.9 | 3.9 | 4.4 | 3.9 |
| Pheophytin *a* | micrograms per liter | 3.9 | 3.9 | 3.5 | 3.3 | 3.6 | 3.5 |
| Iron, dissolved | micrograms per liter | 681 | 634 | 718 | 725 | 34 | 39 |
| Manganese, dissolved | micrograms per liter | 351 | 323 | 467 | 456 | 1 | 1.3 |
| MIB, dissolved | micrograms per liter | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.005 |
| Geosmin, dissolved | micrograms per liter | 0.006 | 0.006 | 0.007 | 0.006 | < 0.005 | < 0.005 |
| Microcystin, dissolved | micrograms per liter | < 0.1 | < 0.1 | 0.3 | < 0.1 | < 0.1 | < 0.1 |

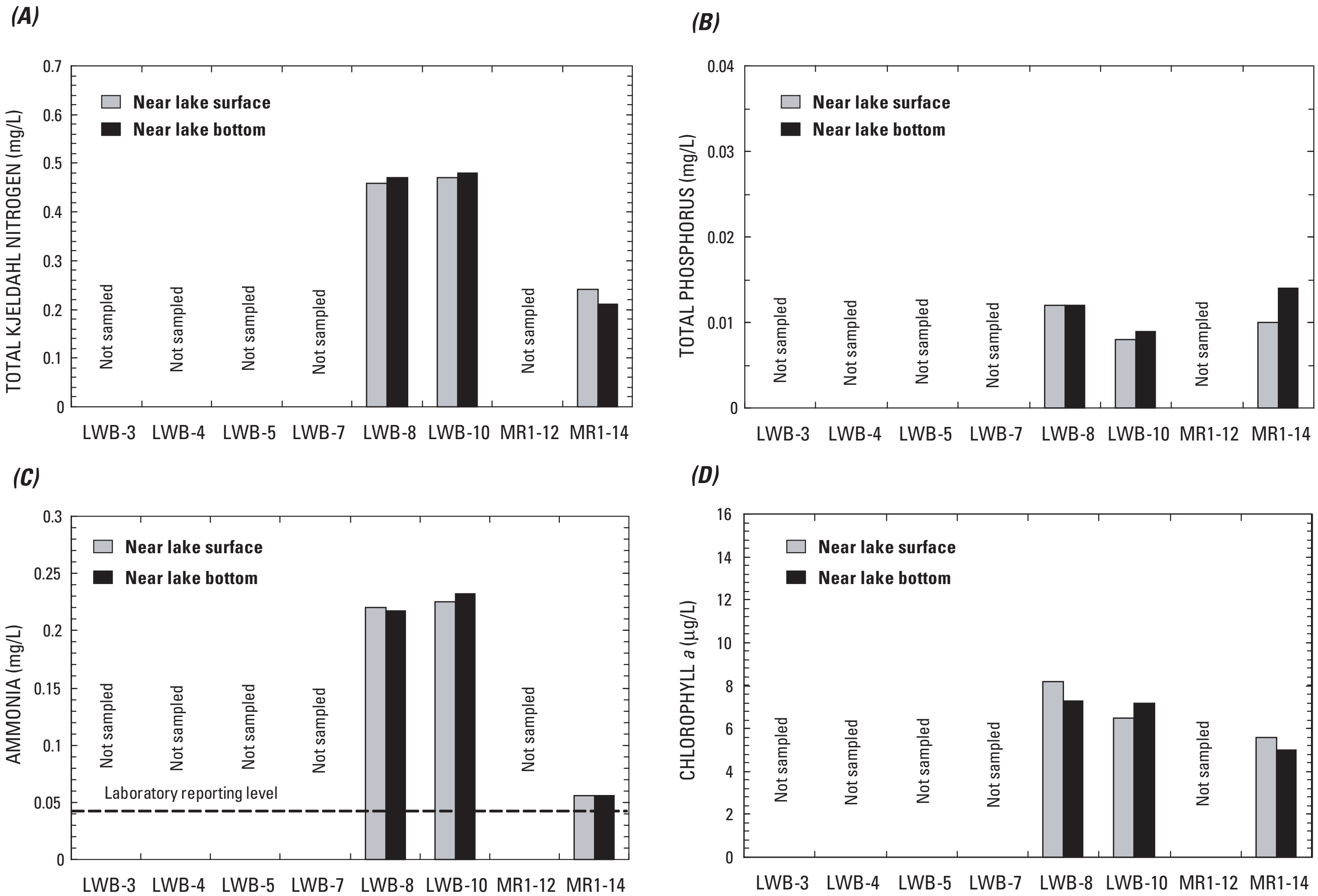


**Figure 9.** Concentrations of (*A*) total Kjeldahl nitrogen, (*B*) total phosphorus, (*C*) ammonia, and (*D*) chlorophyll *a* in samples from near the surface (1-meter depth) and near the bottom (6-meter depth) at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, October 24–25, 2006. [mg/L, milligrams per liter; µg/L, micrograms per liter]

from MR1-14 in Reservoir #1 contained a slightly higher TP concentration (0.014 mg/L) than the surface sample (table 12; fig. 9*B*).

Phytoplankton biomass (as ash-free dry mass) was less than the LRL (ranged from 7.5 to 12 mg/L) at all sites during the October 2006 survey (table 12). Chlorophyll *a* concentrations near the lake surface were 8.2 and 6.5 µg/L at sites LWB-8 and LWB-10, respectively, in Lake Bowen and 5.6 µg/L at site MR1-14 in Reservoir #1 (table 12, fig. 9*D*). Bottom samples at these sites contained chlorophyll *a* concentrations of 7.3 and 7.2 µg/L at sites LWB-8 and LWB-10, respectively, and 5.0 µg/L at site MR1-14 (table 12, fig. 9*D*).

In summary, nutrient dynamics were different in Lake Bowen during the May 2006 survey than during the August to September 2005 and October 2006 surveys. Total organic nitrogen concentrations (TKN minus ammonia) remained relatively constant among the three surveys (tables 10–12). Nitrate was the dominant inorganic species of nitrogen during the May 2006 survey (fig. 8*C*, table 11) but not during the August to September 2005 and October 2006 surveys (figs. 7*C*, 8*C*, and 9*C*; tables 10–12) when ammonia was the dominant form. In the August to September 2005 survey, ammonia was detected only in bottom samples collected in the near-anoxic conditions of the hypolimnion (fig. 7*C*, table 10), but in the October 2006 survey, ammonia was detected under destratified conditions in both surface and bottom samples (fig. 9*C*, table 12). Total phosphorus concentrations were present in lower concentrations in bottom samples in the May 2006 and October 2006 surveys than were identified in the August to September 2005 survey (figs. 8*B*, 7*B*; tables 10, 11). Chlorophyll *a* concentrations appeared to vary with the species of inorganic nitrogen. Much greater chlorophyll *a* concentrations were identified during the May 2006 survey than during the August to September 2005 and October 2006 surveys at most sites in Lake Bowen and Reservoir #1; exceptions are the concentrations for LWB-10 in Lake Bowen during October 2006 (figs. 7*D*, 8*D*, and 9*D*; tables 10–12). In Lake Bowen, site LWB-10 tended to have equal or slightly higher nitrogen concentrations than LWB-8, but site LWB-8 tended to have slightly higher total phosphorus and chlorophyll *a* concentrations than LWB-10 (figs. 7*B*,*D*; 8*B*,*D*; and 9*B*,*D*; tables 10–12).

## Comparison to Numerical Criteria and Guidelines

Nitrogen and phosphorus concentrations and ratios are commonly linked to the primary productivity of lakes and reservoirs because all aquatic plants (phytoplankton, macrophytes, periphyton) require these nutrients for growth. Because phosphorus tends to be the limiting nutrient and chlorophyll *a* tends to provide an estimate of the algal biomass, numerical criteria for total phosphorus, transparency, and chlorophyll *a* concentrations near the lake surface are established to evaluate the degree of nutrient enrichment in a lake or reservoir (U.S. Environmental Protection Agency, 2000; South Carolina Department of Health and Environmental Control, 2004).

For the three limnological surveys, near-surface concentrations of chlorophyll *a* and total phosphorus were well below the established SCDHEC numerical criteria of 40 µg/L and 0.06 mg/L, respectively, at all sites (fig. 10*A*,*B*; tables 10–12). Surface turbidity levels that ranged from 2.9 to 6.9 nephelometric turbidity ratio units (NTRU) during

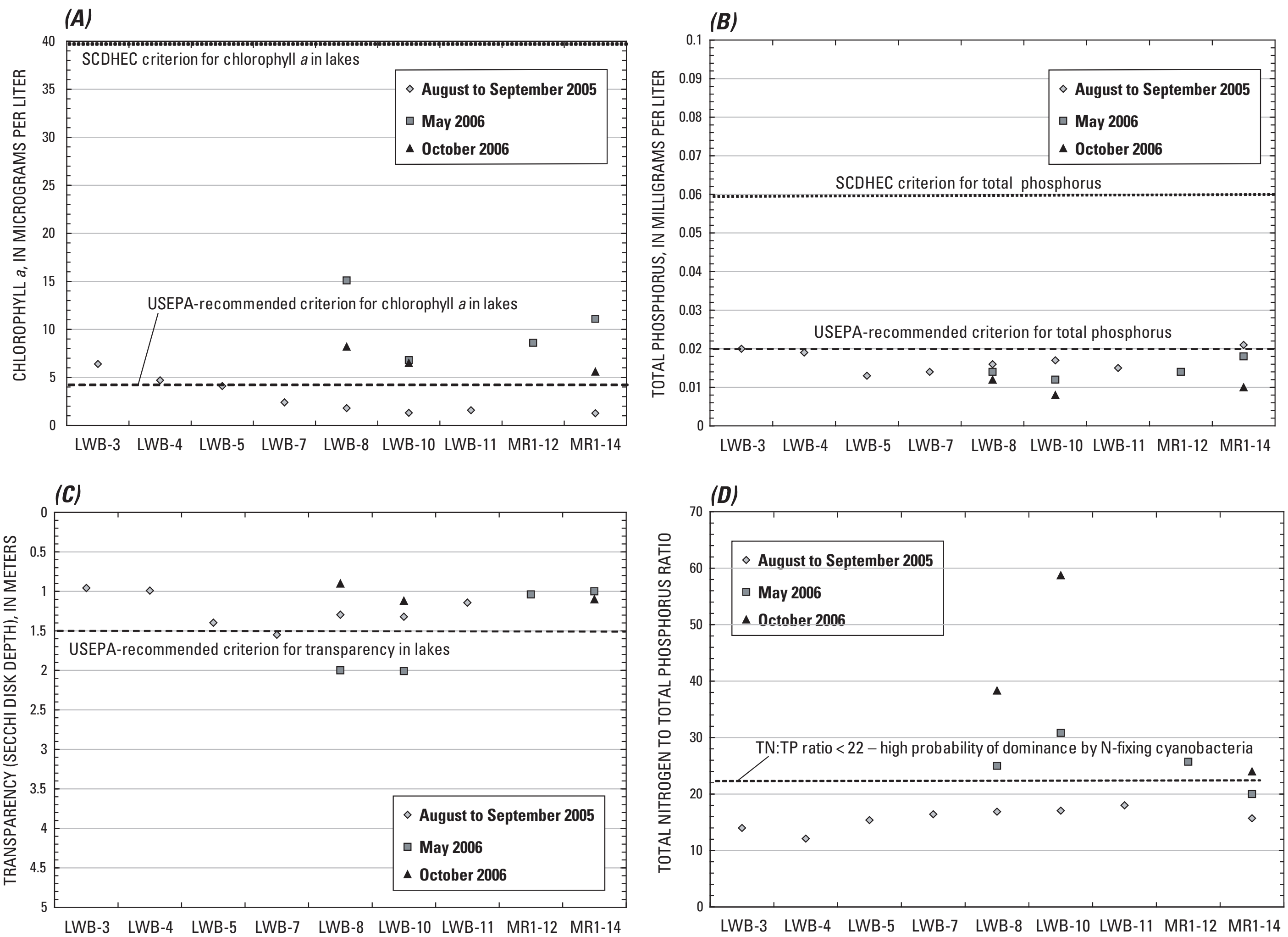


**Figure 10.** Concentrations of (*A*) chlorophyll *a*, (*B*) total phosphorus, (*C*) values of transparency, and (*D*) ratios of total nitrogen to total phosphorus in samples collected near the lake surface along with established criteria and guidelines at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August–September 2005, May 2006, and October 2006. [SCDHEC, South Carolina Department of Health and Environmental Control; USEPA, U.S. Environmental Protection Agency; TN, total nitrogen; TP, total phosphorus]

the May 2006 survey and from 5.5 to 9.1 NTRU during the October 2006 survey also were much lower than the SCDHEC numerical criterion of 25 NTRU (tables 11, 12).

The more restrictive USEPA recommended criterion of 4.93 µg/L for chlorophyll *a* was not met at sites LWB-8, LWB-10, MR1-12, and MR1-14 during the May and October 2006 surveys (fig. 10*A*; tables 10–12). The TP concentration of 0.021 mg/L in a surface sample from MR1-14 during the August to September 2005 survey barely exceeded the USEPA recommended criterion of 0.020 mg/L (fig. 10*B*, table 10). However, values for transparency of the water column frequently were less than recommended by the USEPA numerical criterion of 1.5 m (fig. 10*C*). The only exceptions were Secchi disk depths of about 2 m at sites LWB-8 and LWB-10 during the May 2006 survey.

Guidelines provided by Smith and others (1995) state that a TN to TP ratio of 22:1 can be used as a screening tool to identify environmental conditions where there is a high probability of dominance by nitrogen-fixing cyanobacteria. Ratios of TN to TP below 22:1 were considered more conducive for cyanobacterial dominance in most systems.

During the August to September 2005 survey, all sites had TN to TP ratios below the guideline of 22:1 (22) indicating a high probability of dominance by nitrogen-fixing cyanobacteria (Smith and others, 1995) (fig. 10*D*, table 10). During this period, TN to TP ratios for water near the lake surface ranged from 12 (LWB-4) to 18 (LWB-11) in Lake Bowen and was 16 at site MR1-14 in Reservoir #1 (fig. 10*D*, table 10). In fact, an apparent trend of increasing ratios from headwaters to dam was demonstrated among the sites in Lake Bowen (fig. 10*D*). During the May 2006 survey, three of the four sites sampled had TN to TP ratios greater than the guideline of 22:1 (Smith and others, 1995). During this survey, the TN to TP ratios for the near-surface samples were 25 and 31 at sites LWB-8 and LWB-10, respectively, in Lake Bowen and 26 and 17 at sites MR1-12 and MR1-14, respectively, in Reservoir #1 (fig. 10*D*, table 11). The highest TN to TP ratios for near-surface samples of 38, 59, and 24 at sites LWB-8 and LWB-10 in Lake Bowen and at MR1-14 in Reservoir #1, respectively, were observed during the October 2006 survey (fig. 10*D*, table 12).

In summary, seven sites in Lake Bowen and one site (MR1-14) in Reservoir #1 had TN to TP ratios below 22:1 for the August to September 2005 survey (fig. 10*D*, tables 10–12), indicating a high probability of dominance by nitrogen-fixing cyanobacteria. During the May and October 2006 surveys, sites LWB-8 and LWB-10 in Lake Bowen and MR1-12 in Reservoir #1 had TN to TP ratios greater than 22:1, indicating a lower probability of cyanobacterial dominance. Site MR1-14 in Reservoir #1 had TN to TP ratios that were below 22:1 for the August to September 2005 and May 2006 surveys, and the TN to TP ratios slightly exceeded 22:1 during the October 2006 survey.

## Trophic Status

Determination of the trophic status of lakes and reservoirs used for drinking-water supplies can be beneficial to water-supply systems, especially those that experience severe or frequent taste-and-odor episodes. The trophic status serves as a measure of the physical, chemical, and biological conditions of a lake or reservoir (table 5). Data commonly used to estimate the trophic state are transparency of the water column (as measured by Secchi disk depth) and near-surface nutrient and chlorophyll *a* concentrations. These data serve as an indirect measure of phytoplankton biomass and community structure.

TSIs for chlorophyll *a*, total phosphorus, and transparency were computed with empirically derived equations from Carlson (1977). During the August to September 2005 survey, the chlorophyll *a* TSI ranged from 33 (LWB-10 and MR1-14) to 49 (LWB-3) indicating a range from mesotrophic (headwaters to mid-lake) to oligotrophic (mid-lake to dam) conditions in Lake Bowen and oligotrophic conditons at site MR1-14 in Reservoir #1 (tables 5 and 13; fig. 11*A*). Total phosphorus TSIs were more consistent among sites than the chlorophyll *a* TSIs, ranging from 41 to 48, indicating a mesotrophic condition (tables 5 and 13; fig. 11*B*). Transparency was collected only at sites in Lake Bowen during the August to September 2005 survey. Transparency TSIs ranged from 54 to 61, indicating eutrophic conditions (tables 5 and 13; fig. 11*C*).

Chlorophyll *a* TSIs were higher at sites LWB-8, LWB-10, and MR1-14 during the May and October 2006 surveys than during the August to September 2005 survey, indicating mesotrophic to near-eutrophic conditions, whereas total phosphorus TSIs were lower at these sites, indicating oligotrophic to mesotrophic conditions (tables 5 and 13; fig. 11*A*,*B*). Transparency TSIs during the October 2006 survey were similar to those during the August to September 2005 survey, and transparency TSIs in the May 2006 survey were slightly lower than those during the August to September 2005 survey (table 13; fig. 11*C*).

**Table 13.** Individual and average Carlson trophic state indices computed from surface chlorophyll *a* and total phosphorus concentrations and from transparency (Secchi disk depth) at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August to September 2005, May 2006, and October 2006.

[--, no data]

| Trophic state index | Survey period | Lake William C. Bowen Sites | | | | | | | Municipal Reservoir #1 sites | | Average of all sites |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | LWB-3 | LWB-4 | LWB-5 | LWB-7 | LWB-8 | LWB-10 | LWB-11 | MR1-12 | MR1-14 | |
| Chlorophyll *a* | August–September 2005 | 49 | 46 | 44 | 39 | 36 | 33 | 35 | -- | 33 | 39 |
| | May 2006 | -- | -- | -- | -- | 57 | 49 | -- | 52 | 54 | 53 |
| | October 2006 | -- | -- | -- | -- | 51 | 49 | -- | -- | 48 | 49 |
| Total phosphorus | August–September 2005 | 47 | 47 | 41 | 42 | 44 | 45 | 43 | -- | 48 | 45 |
| | May 2006 | -- | -- | -- | -- | 42 | 40 | -- | 42 | 46 | 43 |
| | October 2006 | -- | -- | -- | -- | 40 | 34 | -- | -- | 37 | 37 |
| Secchi disk depth (transparency) | August–September 2005 | 61 | 60 | 55 | 54 | 56 | 56 | 58 | -- | -- | 57 |
| | May 2006 | -- | -- | -- | -- | 50 | 50 | -- | 59 | 60 | 55 |
| | October 2006 | -- | -- | -- | -- | 62 | 58 | -- | -- | 59 | 60 |

In summary, computed TSIs for Lake Bowen and Reservoir #1 sites varied by a high degree both spatially and temporally during the three surveys. In addition, differences were observed among the three TSIs (total phosphorus, chlorophyll *a*, and transparency) for individual samples that can be explained by the inherent variability within the empirically derived equations or by the interrelationships among the three variables (Carlson and Simpson, 1996). For example, phosphorus may have been limiting algal biomass in May 2006 when the TSI for total phosphorus was less than the TSIs for chlorophyll *a* and transparency (Carlson and Simpson, 1996). Additionally, during the August to September 2005 survey, non-algal suspended sediment could have limited algal mass when the TSI for transparency was greater than the other two TSIs. In general, the TSIs indicated that the trophic status of Lake Bowen and Reservoir #1 represented mesotrophic conditions (table 5).

## Wastewater Indicator Compound Occurrence

During the May and October 2006 surveys, water samples from sites in Lake Bowen and Reservoir #1 also were analyzed for dissolved concentrations of compounds commonly found in human wastewater (Appendix B). Identification of a large group of these compounds at relatively high concentrations would indicate the potential contribution of these compounds from wastewater systems to Lake Bowen. Naphthalene, phenol, and DEET were detected in the field blank at concentrations below their LRL (reported as estimated [E]), so these results were removed from the reported environmental data. Surrogate percent recovery values for bisphenol *a* were extremely low for all sites, so those results also were removed from the reported environmental data.

During the May 2006 survey, samples from all sites and depths contained no measurable levels of pesticides, polycyclic aromatic hydrocarbons (commonly found in fuels), and flame retardants (table 14). One indication of potential wastewater contribution was identified in a sample from site LWB-10 near the lake bottom; the greatest number of wastewater compounds, including four fecal-related sterol compounds (cholesterol, coprostanol, beta-sisterol, and beta-stigmastanol) and two detergent agents (nonylphenol and its metabolite diethyloxynonylphenol), were detected at estimated (semi-quantitative) levels (table 14). The same two detergent agents were detected in the surface samples from LWB-8 and LWB-10 but not in any samples from Reservoir #1 (table 14).

Compounds less indicative of wastewater also were detected during the May 2006 survey. A compound commonly found in sunscreen (methyl salicylate) was detected at extremely low estimated levels at all sites and all

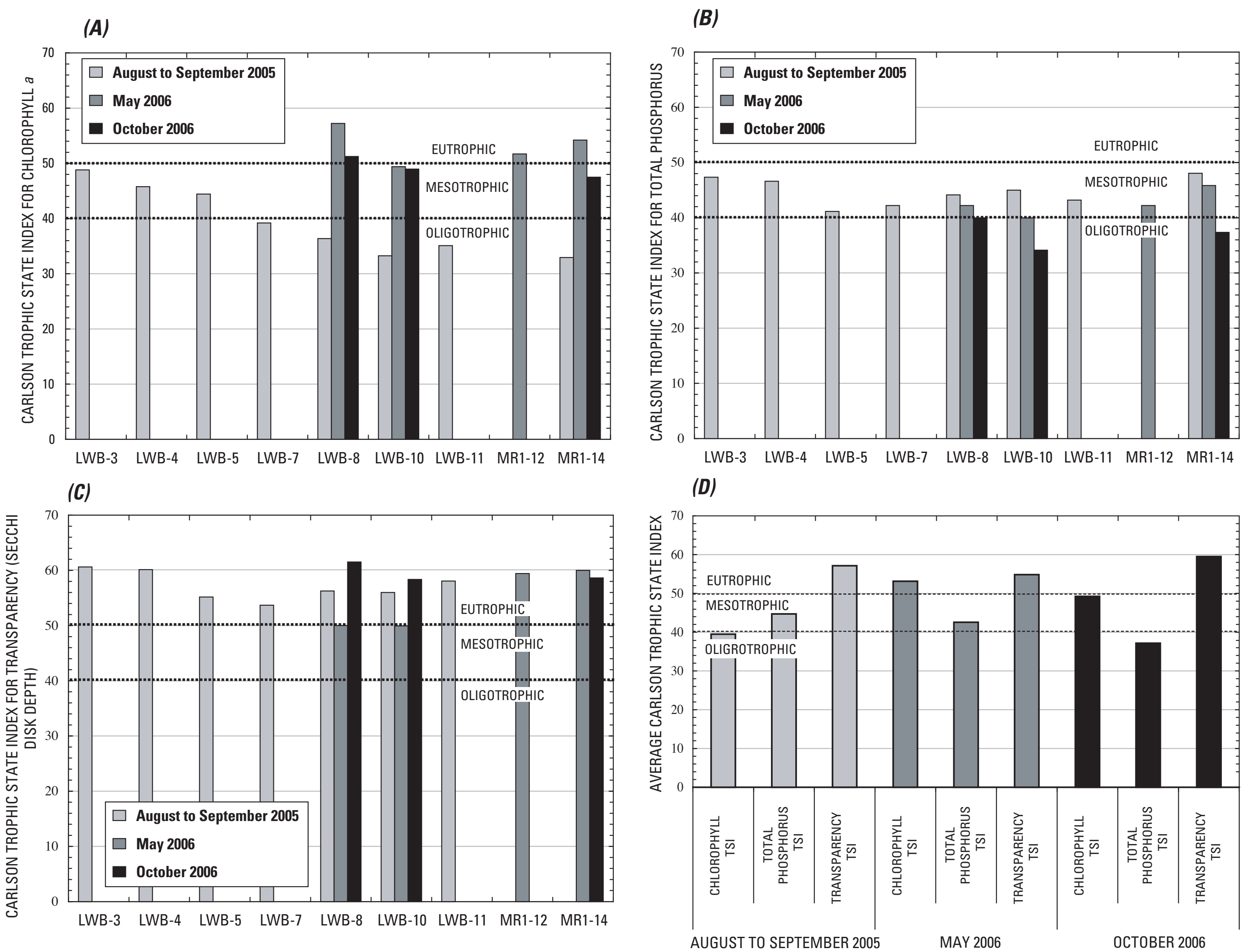


**Figure 11.** Computed Carlson trophic state indices (TSI) for (*A*) chlorophyll *a*, (*B*) total phosphorus, and (*C*) transparency for selected sites and (*D*) average of all sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August–September 2005, May 2006, and October 2006.

depths (table 14) and often was accompanied by similarly low detections of compounds associated with ointment-related compounds (camphor) at sites LWB-8, MR1-12, and MR1-14 and fragrance-related compounds (isophorone, benzophenone) at sites LWB-8 and LWB-10.

During the October 2006 survey, samples from all sites and depths had no measurable levels of pesticides or flame retardants, but polycyclic aromatic hydrocarbons, 1- and 2-methylnaphthalene, were present at estimated (semi-quantitative) concentrations (table 15). A potential indicator of wastewater contribution, the detergent agent nonylphenol, was detected at estimated concentrations at sites LWB-10 and MR1-14 (table 15).

Similar compounds that are less indicative of wastewater were detected during the May 2006 and October 2006 surveys. A sunscreen-related compound (methyl salicylate) was detected at all sites and all depths (table 15) and often was accompanied by detections of two or more fragrance-related compounds (isophorone, benzophenone, acetyl-hexamethyl-tetrahydro-naphthalene [AHTN], and hexahdyrohexamethylcyclopentabenzopyran [HHCB]).

**Table 14.** Concentrations of wastewater compounds in samples collected near the lake surface and near the lake bottom at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, May 2006.

[Highlighted columns indicate sample is collected near the lake surface; <, less than the laboratory reporting limit; E, estimated; HHMM, hours and minutes; µg/L, micrograms per liter]

| Wastewater compound (dissolved) | Compound uses or sources | Units | LWB-8 | | LWB-10 | | MR1-12 | MR1-14 | |
|---|---|---|---|---|---|---|---|---|---|
| Site description | | | Lake Bowen at S.C. Highway 9 bridge near Fingerville, S.C. | | Lake Bowen below S.C. Highway 9 near Fingerville, S.C. | | Municipal Reservoir #1 below Lake Bowen Dam, near Fingerville, S.C. | Municipal Reservoir #1 near Fingerville, S.C. | |
| Date of sample | | | 05/16/06 | | 05/15/06 | | 05/17/06 | 05/17/06 | |
| Time of sample | | HHMM | 0900 | 0905 | 1145 | 1155 | 0700 | 0930 | 0935 |
| Depth of sample | | meters | 1 | 6 | 1 | 6 | 1 | 1 | 6 |
| Carbazole | Pesticide (insecticide); dyes, explosives, lubricants | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Bromacil | Pesticide (herbicide) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Carbaryl | Pesticide (insecticide) | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Metolachlor | Pesticide (herbicide) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Metalaxyl | Pesticide (herbicide) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chlorpyrifos | Pesticide (insecticide) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Diazinon | Pesticide (insecticide) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Prometon | Pesticide (herbicide) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 9,10-Anthraquinone | Seed treatment; bird repellant | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,4-Dichlorobenzene | Moth repellant, fumigant, deodorant | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Tetrachloroethene | Solvent, degreaser | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Tribromomethane | Trihalomethane | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Isophorone | Solvent | µg/L | E 0.179 | E 0.0282 | E 0.0347 | E 0.0277 | < 0.5 | < 0.5 | < 0.5 |
| 5-Methyl-1H-benzotriazole | Antifreeze and deicers | µg/L | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Isopropylbenzene (cumene) | Phenol, fuels, paint thinners | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| p-Cresol | Wood preservative | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Phenol | Disinfectant, leachate, chemical manufacturing | µg/L | | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Anthracene | PAH: tar, diesel, crude oil; wood preservative | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Benzo[a]pyrene | PAH: regulated | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Fluoranthene | PAH: tar, asphalt | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Phenanthrene | PAH: tar, diesel, crude oil | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Pyrene | PAH: tar, asphalt | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |

**Table 14.** Concentrations of wastewater compounds in samples collected near the lake surface and near the lake bottom at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, May 2006.—Continued

[Highlighted columns indicate sample is collected near the lake surface; <, less than the laboratory reporting limit; E, estimated; HHMM, hours and minutes; µg/L, micrograms per liter]

| Wastewater compound (dissolved) | Compound uses or sources | Units | LWB-8 | | LWB-10 | | MR1-12 | MR1-14 | |
|---|---|---|---|---|---|---|---|---|---|
| Site description | | | Lake Bowen at S.C. Highway 9 bridge near Fingerville, S.C. | | Lake Bowen below S.C. Highway 9 near Fingerville, S.C. | | Municipal Reservoir #1 below Lake Bowen Dam, near Fingerville, S.C. | Municipal Reservoir #1 near Fingerville, S.C. | |
| Date of sample | | | 05/16/06 | | 05/15/06 | | 05/17/06 | 05/17/06 | |
| Time of sample | | HHMM | 0900 | 0905 | 1145 | 1155 | 0700 | 0930 | 0935 |
| Depth of sample | | meters | 1 | 6 | 1 | 6 | 1 | 1 | 6 |
| Naphthalene | PAH: Gasoline, moth repellant, fumigant | µg/L | | | | | | | |
| 1-Methylnaphthalene | Gasoline, diesel, crude oil | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 2,6-Dimethylnaphthalene | Diesel and kerosene | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 2-Methylnaphthalene | Gasoline, diesel, crude oil | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 3-Methyl-1H-indole (skatol) | Fragrance (stench in feces, coal tar) | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Acetyl hexamethyl tetrahydro naphthalene (AHTN) | Fragrance (musk) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Hexahydrohexamethyl cyclopent-abenzopyran (HHCB) | Fragrance (musk) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Indole | Pesticides (inert ingredient); fragrance (coffee) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Isoborneol | Fragrance (perfumes) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| D-Limonene | Fragrance (aerosols); antimicrobial | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Camphor | Flavor, odorant, ointment | µg/L | E 0.0211 | < 0.5 | < 0.5 | < 0.5 | E 0.0095 | < 0.5 | E 0.0148 |
| Methyl salicylate | Food, beverage, liniment, sunscreen | µg/L | E 0.0234 | E 0.0253 | E 0.0278 | E 0.0394 | E 0.0126 | E 0.0153 | E 0.0266 |
| Triethyl citrate | Cosmetics, pharmaceuticals | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Acetophenone | Fragrance (detergent, tobacco); flavor in beverages | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Benzophenone | Fragrance (fixative for perfumes and soap) | µg/L | E 0.0314 | < 0.5 | E 0.0244 | E 0.0302 | < 0.5 | < 0.5 | < 0.5 |
| 3-tert-Butyl-4-hydroxyanisole (BHA) | Preservative; antioxidant | µg/L | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 |
| Cholesterol | Sterol (plant and animal) | µg/L | < 2 | < 2 | < 2 | E 0.386 | < 2 | < 2 | < 2 |
| 3-beta-Coprostanol | Sterol (animal); primary carnivore indicator | µg/L | < 2 | < 2 | < 2 | E 0.126 | < 2 | < 2 | < 2 |
| beta-Sitosterol | Sterol (plant) | µg/L | < 2 | < 2 | < 2 | E 0.461 | E 0.196 | < 2 | E 0.2 |

**Table 14.** Concentrations of wastewater compounds in samples collected near the lake surface and near the lake bottom at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, May 2006.—Continued

[Highlighted columns indicate sample is collected near the lake surface; <, less than the laboratory reporting limit; E, estimated; HHMM, hours and minutes; µg/L, micrograms per liter]

| Wastewater compound (dissolved) | Compound uses or sources | Units | LWB-8 | | LWB-10 | | MR1-12 | MR1-14 | |
|---|---|---|---|---|---|---|---|---|---|
| Site description | | | Lake Bowen at S.C. Highway 9 bridge near Fingerville, S.C. | | Lake Bowen below S.C. Highway 9 near Fingerville, S.C. | | Municipal Reservoir #1 below Lake Bowen Dam, near Fingerville, S.C. | Municipal Reservoir #1 near Fingerville, S.C. | |
| Date of sample | | | 05/16/06 | | 05/15/06 | | 05/17/06 | 05/17/06 | |
| Time of sample | | HHMM | 0900 | 0905 | 1145 | 1155 | 0700 | 0930 | 0935 |
| Depth of sample | | meters | 1 | 6 | 1 | 6 | 1 | 1 | 6 |
| beta-Stigmastanol | Sterol (plant) | µg/L | < 2 | < 2 | < 2 | E 0.429 | < 2 | < 2 | < 2 |
| Menthol | Cigarettes, cough drops, liniment, mouthwash | µg/L | E 0.0508 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cotinine | Primary nicotine metabolite | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Caffeine | Beverage; diuretic | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Isoquinoline | Fragrance, flavor | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 4-Cumylphenol | Nonionic detergent metabolite | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 4-Octylphenol | Nonionic detergent metabolite | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 4-Nonylphenol | Nonionic detergent metabolite | µg/L | E 1.42 | < 5 | E 1.12 | E 0.599 | < 5 | < 5 | < 5 |
| 4-tert-Octylphenol | Nonionic detergent metabolite | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Diethoxynonylphenol | Nonionic detergent metabolite | µg/L | E 1.08 | < 5 | E 0.905 | E 0.856 | < 5 | < 5 | < 5 |
| Diethoxyoctylphenol | Nonionic detergent metabolite | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Monoethoxyoctylphenol | Nonionic detergent metabolite | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Triclosan | Disinfectant; antimicrobial | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Tributyl phosphate | Flame retardant; antifoaming agent | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Triphenyl phosphate | Flame retardant; plasticizer, wax, resin, finish | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Tris(2-butoxyethyl) phosphate | Flame retardant | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Tris(2-chloroethyl) phosphate | Flame retardant; plasticizer | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Tris(dichloroisopropyl) phosphate | Flame retardant | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |

**Table 15.** Concentrations of wastewater compounds in samples collected near the lake surface and near the lake bottom at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, October 2006.

[Highlighted columns indicate sample is collected near the lake surface; <, less than the laboratory reporting limit; E, estimated; HHMM, hours and minutes; µg/L, micrograms per liter]

| Wastewater compound (dissolved) | Compound uses or sources | Units | LWB-8 | | LWB-10 | | MR1-14 | |
|---|---|---|---|---|---|---|---|---|
| Site description | | | Lake Bowen at S.C. Highway 9 Bridge near Fingerville, S.C. | | Lake Bowen below S.C. Highway 9 near Fingerville, S.C. | | Municipal Reservoir #1 near Fingerville, S.C. | |
| Date of sample | | | 10/24/06 | | 10/24/06 | | 10/25/06 | |
| Time of sample | | HHMM | 1500 | 1510 | 1145 | 1150 | 0900 | 0910 |
| Depth of sample | | meters | 1 | 6 | 1 | 6 | 1 | 6 |
| Carbazole | Pesticide (insecticide); dyes, explosives, lubricants | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Bromacil | Pesticide (herbicide) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Carbaryl | Pesticide (insecticide) | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Metolachlor | Pesticide (herbicide) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Metalaxyl | Pesticide (herbicide) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chlorpyrifos | Pesticide (insecticide) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Diazinon | Pesticide (insecticide) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Prometon | Pesticide (herbicide) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 9,10-Anthraquinone | Seed treatment; bird repellant | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,4-Dichlorobenzene | Moth repellant, fumigant, deodorant | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Tetrachloroethene | Solvent, degreaser | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Tribromomethane | Trihalomethane | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Isophorone | Solvent | µg/L | < 0.5 | E 0.0093 | E 0.0206 | E 0.0234 | E 0.0136 | E 0.0169 |
| 5-Methyl-1H-benzotriazole | Antifreeze and deicers | µg/L | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Isopropylbenzene (cumene) | Phenol, fuels, paint thinners | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| p-Cresol | Wood preservative | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Phenol | Disinfectant, leachate, chemical manufacturing | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Anthracene | PAH: tar, diesel, crude oil; wood preservative | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Benzo[a]pyrene | PAH: regulated | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Fluoranthene | PAH: tar, asphalt | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Phenanthrene | PAH: tar, diesel, crude oil | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Pyrene | PAH: tar, asphalt | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Naphthalene | PAH: Gasoline, moth repellant, fumigant | µg/L | | | | | | |
| 1-Methylnaphthalene | Gasoline, diesel, crude oil | µg/L | < 0.5 | E 0.0056 | E 0.0037 | E 0.0061 | < 0.5 | < 0.5 |
| 2,6-Dimethylnaphthalene | Diesel and kerosene | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 2-Methylnaphthalene | Gasoline, diesel, crude oil | µg/L | < 0.5 | < 0.5 | < 0.5 | E 0.011 | < 0.5 | < 0.5 |
| 3-Methyl-1H-indole (skatol) | Fragrance (stench in feces, coal tar) | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |

**Table 15.** Concentrations of wastewater compounds in samples collected near the lake surface and near the lake bottom at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, October 2006.—Continued

[Highlighted columns indicate sample is collected near the lake surface; <, less than the laboratory reporting limit; E, estimated; HHMM, hours and minutes; µg/L, micrograms per liter]

| Wastewater compound (dissolved) | Compound uses or sources | Units | LWB-8 | | LWB-10 | | MR1-14 | |
|---|---|---|---|---|---|---|---|---|
| Site description | | | Lake Bowen at S.C. Highway 9 Bridge near Fingerville, S.C. | | Lake Bowen below S.C. Highway 9 near Fingerville, S.C. | | Municipal Reservoir #1 near Fingerville, S.C. | |
| Date of sample | | | 10/24/06 | | 10/24/06 | | 10/25/06 | |
| Time of sample | | HHMM | 1500 | 1510 | 1145 | 1150 | 0900 | 0910 |
| Depth of sample | | meters | 1 | 6 | 1 | 6 | 1 | 6 |
| Acetyl hexamethyl tetrahydro naphthalene (AHTN) | Fragrance (musk) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | E 0.0112 |
| Hexahydrohexamethyl cyclopentabenzopyran (HHCB) | Fragrance (musk) | µg/L | < 0.5 | < 0.5 | E 0.0296 | < 0.5 | < 0.5 | E 0.0373 |
| Indole | Pesticides (inert ingredient); fragrance (coffee) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Isoborneol | Fragrance (perfumes) | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| D-Limonene | Fragrance (aerosols); antimicrobial | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Camphor | Flavor, odorant, ointment | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Methyl salicylate | Food, beverage, liniment, sunscreen | µg/L | E 0.0122 | E 0.0123 | E 0.0273 | E 0.028 | E 0.009 | E 0.0176 |
| Triethyl citrate | Cosmetics, pharmaceuticals | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Acetophenone | Fragrance (detergent, tobacco); flavor in beverages | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Benzophenone | Fragrance (fixative for perfumes and soap) | µg/L | < 0.5 | E 0.0409 | < 0.5 | < 0.5 | E 0.0284 | E 0.0654 |
| 3-tert-Butyl-4-hydroxyanisole (BHA) | Preservative; antioxidant | µg/L | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 |
| Cholesterol | Sterol (plant and animal) | µg/L | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 3-beta-Coprostanol | Sterol (animal); primary carnivore indicator | µg/L | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 |
| beta-Sitosterol | Sterol (plant) | µg/L | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 |
| beta-Stigmastanol | Sterol (plant) | µg/L | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Menthol | Cigarettes, cough drops, liniment, mouthwash | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cotinine | Primary nicotine metabolite | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Caffeine | Beverage; diuretic | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Isoquinoline | Frangrance, flavor | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 4-Cumylphenol | Nonionic detergent metabolite | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 4-Octylphenol | Nonionic detergent metabolite | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 4-Nonylphenol | Nonionic detergent metabolite | µg/L | < 5 | < 5 | < 5 | E 0.748 | E 0.494 | E 0.753 |
| 4-tert-Octylphenol | Nonionic detergent metabolite | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |

**Table 15.** Concentrations of wastewater compounds in samples collected near the lake surface and near the lake bottom at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, October 2006.—Continued

[Highlighted columns indicate sample is collected near the lake surface; <, less than the laboratory reporting limit; E, estimated; HHMM, hours and minutes; µg/L, micrograms per liter]

| Wastewater compound (dissolved) | Compound uses or sources | Units | LWB-8 | | LWB-10 | | MR1-14 | |
|---|---|---|---|---|---|---|---|---|
| Site description | | | Lake Bowen at S.C. Highway 9 Bridge near Fingerville, S.C. | | Lake Bowen below S.C. Highway 9 near Fingerville, S.C. | | Municipal Reservoir #1 near Fingerville, S.C. | |
| Date of sample | | | 10/24/06 | | 10/24/06 | | 10/25/06 | |
| Time of sample | | HHMM | 1500 | 1510 | 1145 | 1150 | 0900 | 0910 |
| Depth of sample | | meters | 1 | 6 | 1 | 6 | 1 | 6 |
| Diethoxynonylphenol | Nonionic detergent metabolite | µg/L | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 |
| Diethoxyoctylphenol | Nonionic detergent metabolite | µg/L | < 1 | < 1 | E 0.0385 | < 1 | < 1 | < 1 |
| Monoethoxyoctylphenol | Nonionic detergent metabolite | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Triclosan | Disinfectant; antimicrobial | µg/L | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Tributyl phosphate | Flame retardant; antifoaming agent | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Triphenyl phosphate | Flame retardant; plasticizer, wax, resin, finish | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Tris(2-butoxyethyl) phosphate | Flame retardant | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Tris(2-chloroethyl) phosphate | Flame retardant; plasticizer | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Tris(dichloroisopropyl) phosphate | Flame retardant | µg/L | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |

## Geosmin and MIB Occurrence

The computed TN:TP ratios, which implied the potential dominance of cyanobacteria, and TSIs, which indicated mesotrophic conditions in Lake Bowen and Reservoir #1, further indicated the potential for taste-and-odor problems associated with cyanobacteria (Carlson and Simpson, 1996; Smith and others, 2002). Eutrophic lake conditions often promote the development of blooms of nuisance algae, primarily cyanobacteria (Carlson and Simpson, 1996; Downing and others, 2001; Smith and others, 2002). Cyanobacteria-dominated phytoplankton communities can severely affect water quality by the release of algal toxins or, at least, influence the perception of water quality as a result of taste-and-odor problems. Taste-and-odor compounds, especially geosmin and MIB, can be generated in the absence of conspicuous blooms. These episodes in particular are difficult to anticipate, trace, and control. No conspicuous blooms were observed during any of the surveys in Lake Bowen and Reservoir #1.

Surface and bottom samples were collected from seven sites in Lake Bowen and one site in Reservoir #1 during the August to September 2005 survey and analyzed for geosmin and MIB concentrations (table 4). The SWS also monitored geosmin concentrations weekly in raw water at the R.B. Simms WTP during the same period (fig. 10*D*). Concentrations of MIB were less than the LRL of 0.005 µg/L at all sites in Lake Bowen and Reservoir #1 during the August to September 2005 survey (table 10). Surface samples from sites in Lake Bowen contained geosmin concentrations at or less than the LRL of 0.005 µg/L (table 10, fig. 12*A*). Geosmin concentrations were less than the LRL in the bottom samples at sites LWB-7, LWB-8, LWB-10, and LWB-11 and ranged from 0.016 to 0.039 µg/L (fig. 12*A*). Samples of surface and bottom water from site MR1-14 in Reservoir #1 had geosmin concentrations less than the LRL; these concentrations corresponded to the geosmin concentrations in the raw water at R.B. Simms WTP (fig. 12*D*).

Near-surface and near-bottom samples were collected at two sites in Lake Bowen and two sites in Reservoir #1 during the May 2006 survey and were analyzed for geosmin (fig. 12*B*), MIB, and microcystin concentrations (table 11). Concentrations of MIB and microcystin were below their LRLs of 0.005 and 0.10 µg/L, respectively, at all sites in Lake Bowen and Reservoir #1 (table 11). Surface concentrations of geosmin were 0.013 and 0.012 µg/L at sites LWB-8 and LWB-10, respectively, in Lake Bowen and 0.005 and 0.007 µg/L at sites MR1-12 and MR1-14, respectively, in Reservoir #1 (table 11; fig. 12*B*). As observed during the August to September 2005 survey, geosmin concentrations were higher in the bottom samples than in the surface samples from Lake Bowen. Samples from the bottom depths at sites LWB-8 and LWB-10 in Lake Bowen contained higher geosmin concentrations of 0.016 and 0.024 µg/L, respectively, than samples from the surface. The bottom samples from MR1-14 in Reservoir #1 contained a geosmin concentration of 0.008 µg/L. Much higher geosmin concentrations were measured (above 0.020 µg/L) in the raw water at R.B. Simms WTP during the May 2006 survey (fig. 12*D*).

During the October 2006 survey, concentrations of MIB were less than the LRL of 0.005 µg/L at all sites in Lake Bowen and Reservoir #1 (table 12). However, at LWB-10 only, microcystin was detected in a sample from the lake surface at a concentration of 0.03 µg/L. The geosmin concentrations in samples from near the surface and bottom at sites in Lake Bowen were lower than during the previous two surveys, ranging from 0.006 to 0.007 µg/L (fig. 12*C*; table 12). Samples from site MR1-14 in Reservoir #1 during the October 2006 survey contained geosmin concentrations less than the LRL of 0.005 µg/L (fig. 12*C*; table 12), which correspond to the geosmin levels (below 0.010 µg/L) in the raw water at R.B. Simms WTP (fig. 12*D*).

In summary, MIB concentrations for all three surveys were less than the LRL of 0.005 µg/L. Of the three surveys, the highest concentrations of geosmin were measured in bottom samples from sites LWB-8 (0.024 µg/L) and LWB-10 (0.039 µg/L) in Lake Bowen during the August to September 2005 survey when stratified conditions existed. These elevated geosmin concentrations in Lake Bowen were present at sites and depths that had elevated ammonia and TP concentrations. However, surface samples from all sites in Lake Bowen and from both depths at site MR1-14 in Reservoir #1 contained geosmin concentrations less than the LRL of 0.005 µg/L during the same survey. During the May 2006 survey, geosmin concentrations again were highest at sites LWB-8 and LWB-10 in Lake Bowen and were more evenly distributed throughout the water column. Geosmin concentrations were lower in samples from sites in Reservoir #1 than in samples from sites in Lake Bowen. The lowest geosmin concentrations for sites LWB-8 and LWB-10 were measured during the October 2006 survey when destratified conditions existed.

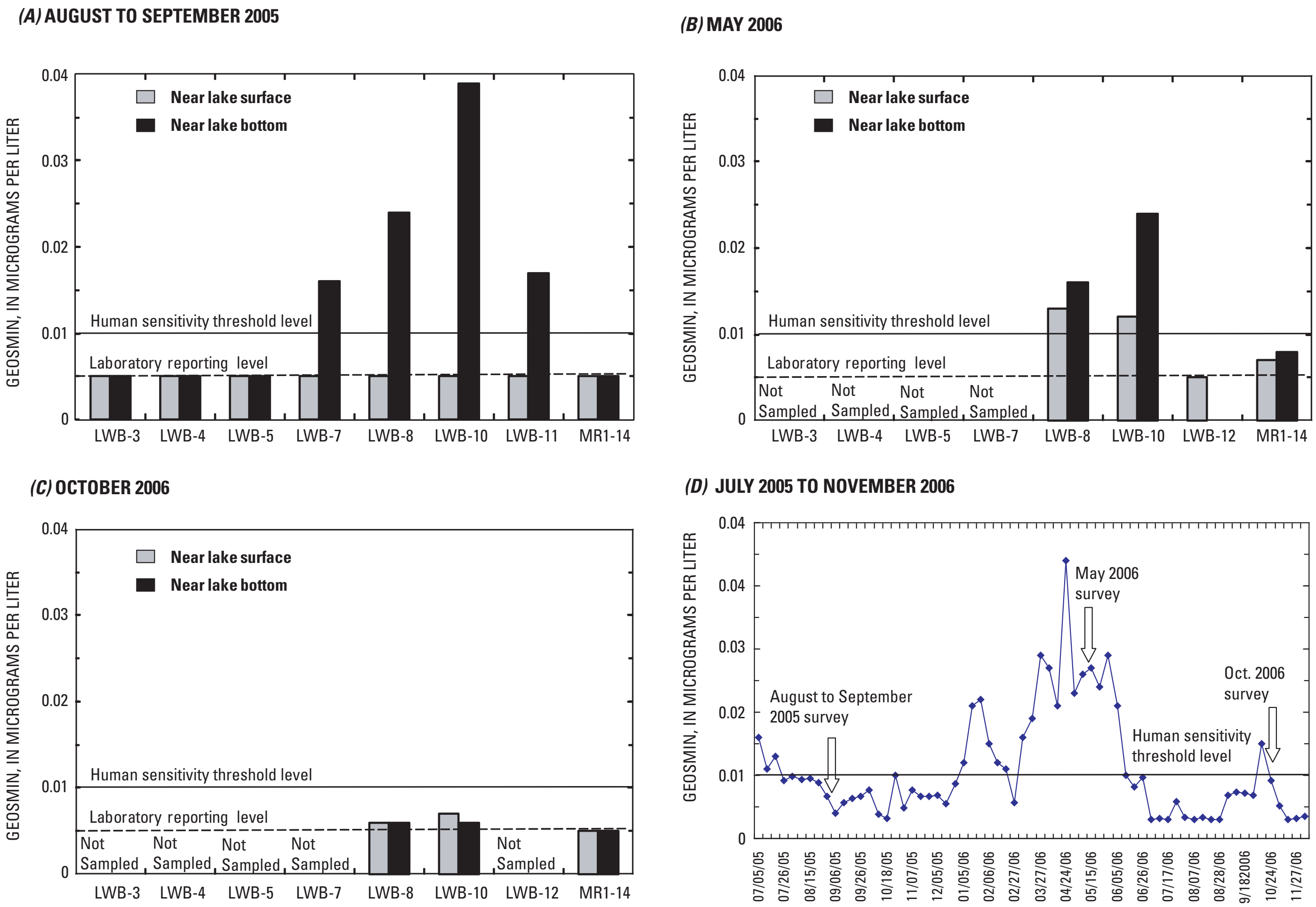


**Figure 12.** Concentrations of geosmin near the surface (1-meter depth) and near the bottom (2.5 to 7 meters depth) at selected sites in Lake William C. Bowen and Municipal Reservoir #1 in (*A*) August to September 2005, (*B*) May 2006, and (*C*) October 2006 and (*D*) in raw and finished water at R.B. Simms water treatment plant in Spartanburg County, South Carolina.

## Phytoplankton Community Structure

The effects of eutrophic conditions on the aquatic ecosystem often include decreased diversity in aquatic plant species, especially the replacement of more sensitive species with more opportunistic taxa like cyanobacteria (Wetzel, 1983; Reynolds, 2007). Identification of phytoplankton community structure provides a better indication of the trophic conditions in a reservoir than just physical and chemical data alone. Samples were collected during the three surveys and analyzed for phytoplankton enumeration and identification to compare the algal response in the two reservoirs to the trophic conditions.

Total phytoplankton densities ranged from 200,513 to 384,154 cells per milliliter (cells/mL) in samples collected near the surface at LWB-11 and LWB-3, respectively, in Lake Bowen during the August to September 2005 survey (table 16). Total phytoplankton densities of 312,792 and 183,150 cells/mL in samples from the bottom depths at sites LWB-10 and LWB-11, respectively, appeared to be similar to the densities at surface depths (table 16). A sample from site MR1-14 in Reservoir #1 at the surface depth contained the highest total phytoplankton density of 414,314 cells/mL (table 16).

During the May 2006 survey, total phytoplankton densities appeared to be slightly lower than densities measured in the August to September 2006 survey at two of the three sites sampled (table 16). Total phytoplankton densities were 212,640 and 142,415 cells/mL in samples collected near the surface at sites LWB-8 and LWB-10, respectively, in Lake Bowen and 274,708 cells/mL in samples collected near the surface at site MR1-14 in Reservoir #1

**Table 16.** Cell densities by major divisions of the phytoplankton community in samples collected at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August to September 2005, May 2006, and October 2006.

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site ID | Date of sample | Depth (m) | Phytoplankton density by division (cells/mL) | | | | | | | | | | Total phytoplankton density (cells/mL) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cyanobacteria | Chlorophyta | Bacillariophyta | Chrysophyta | Cryptophyta | Euglenophyta | Miscellaneous | Pyrrhophyta | Rhodophyta | Xanthophyta | |
| August to September 2005 | | | | | | | | | | | | | |
| LWB-03 | 8/30/2005 | 1 | 350,833 | 31,957 | 909 | 32 | 162 | 54 | 0 | 206 | 0 | 0 | 384,154 |
| LWB-04 | 8/30/2005 | 1 | 358,522 | 13,350 | 746 | 97 | 130 | 65 | 0 | 97 | 0 | 0 | 373,008 |
| LWB-05 | 8/31/2005 | 1 | 303,411 | 13,781 | 969 | 212 | 273 | 91 | 0 | 176 | 0 | 30 | 318,943 |
| LWB-07 | 9/1/2005 | 1 | 287,861 | 5,713 | 619 | 204 | 23 | 159 | 0 | 102 | 0 | 0 | 294,681 |
| LWB-08 | 8/31/2005 | 1 | 235,775 | 10,550 | 636 | 114 | 23 | 136 | 0 | 91 | 0 | 0 | 247,324 |
| LWB-10 | 9/6/2005 | 1 | 268,876 | 2,399 | 772 | 79 | 147 | 79 | 68 | 45 | 0 | 0 | 272,466 |
| | | 7 | 310,206 | 1,771 | 29 | 0 | 78 | 702 | 0 | 5 | 0 | 0 | 312,792 |
| LWB-11 | 9/7/2005 | 1 | 197,037 | 1,552 | 924 | 810 | 30 | 45 | 30 | 67 | 0 | 15 | 200,513 |
| | | 7 | 176,206 | 5,009 | 712 | 697 | 379 | 136 | 0 | 11 | 0 | 0 | 183,150 |
| MR1-14 | 9/7/2005 | 1 | 408,504 | 3,592 | 811 | 714 | 389 | 32 | 0 | 238 | 0 | 32 | 414,314 |
| | | 6 | 352,526 | 3,458 | 953 | 848 | 182 | 61 | 0 | 81 | 0 | 0 | 358,108 |
| May 2006 | | | | | | | | | | | | | |
| LWB-08 | 5/16/2006 | 1 | 206,953 | 1,620 | 1,200 | 1,757 | 404 | 10 | 616 | 81 | 0 | 0 | 212,640 |
| | | 6 | 182,964 | 2,852 | 1,281 | 5,786 | 1,363 | 61 | 182 | 91 | 0 | 0 | 194,580 |
| LWB-10 | 5/15/2006 | 1 | 138,120 | 1,197 | 493 | 1,272 | 182 | 10 | 1,091 | 50 | 0 | 0 | 142,415 |
| | | 6 | 150,385 | 1,202 | 1,076 | 242 | 128 | 10 | 1,818 | 71 | 0 | 0 | 154,932 |
| MR1-14 | 5/17/2006 | 1 | 260,936 | 2,808 | 1,877 | 7,232 | 379 | 38 | 1,363 | 76 | 0 | 0 | 274,708 |
| | | 6 | 259,284 | 3,245 | 1,838 | 4,714 | 256 | 0 | 511 | 106 | 0 | 0 | 269,953 |
| October 2006 | | | | | | | | | | | | | |
| LWB-08 | 10/24/2006 | 1 | 166,062 | 2,416 | 545 | 874 | 364 | 151 | 954 | 15 | 0 | 0 | 171,382 |
| | | 6 | 171,414 | 3,710 | 340 | 1,045 | 545 | 181 | 273 | 34 | 0 | 0 | 177,541 |
| LWB-10 | 10/24/2006 | 1 | 189,422 | 2,690 | 288 | 636 | 348 | 140 | 318 | 102 | 23 | 0 | 193,966 |
| | | 6 | 231,036 | 3,280 | 333 | 318 | 409 | 89 | 545 | 15 | 15 | 0 | 236,040 |
| MR1-14 | 10/25/2006 | 1 | 153,851 | 2,985 | 477 | 4,385 | 841 | 23 | 0 | 68 | 0 | 0 | 162,629 |
| | | 6 | 177,039 | 3,088 | 500 | 3,305 | 386 | 33 | 0 | 10 | 0 | 0 | 184,361 |

(table 16). As observed during the August to September 2005 survey, total phytoplankton densities were similar in samples from the surface and bottom depths at each site (table 16).

Total phytoplankton densities in samples collected near the surface were 171,382 and 193,966 cells/mL at sites LWB-8 and LWB-10, respectively, in Lake Bowen and 162,629 cells/mL at site MR1-14 in Reservoir #1 during the October 2006 survey (table 16). As observed in the previous two surveys, total phytoplankton densities were similar in samples from the 1-m and 6-m depths at each site (table 16). Members of the division Cyanophyta (also known as cyanobacteria or blue-green algae) had the greatest abundance of all the phytoplankton communities in Lake Bowen and Reservoir #1 at all sites and sampling depths during all three surveys (August to September 2005, May 2006, and October 2006) (tables 16 and 17).

In Lake Bowen, the abundance of cyanobacterial cells in the division Cyanophyta as part of the total phytoplankton community ranged from 91 to 99 percent at sites LWB-3 and LWB-10, respectively, during the August to September 2005 survey; from 94 to 97 percent at sites LWB-8 and LWB-10, respectively, during the May 2006 survey; and from 97 to 98 percent at sites LWB-8 and LWB-10, respectively, during the October 2006 survey (table 17). Samples from site MR1-14 in Reservoir #1 had constituent percentages similar to those from Lake Bowen sites during the three surveys (table 17). For all sites, the mean cyanobacterial abundances, based on cells per unit volume, accounted for 97 percent of all algal divisions during August to September 2005, 96 percent during May 2006, and 97 percent during October 2006.

During the three surveys, the next most abundant algal divisions were the green algae (Chlorophyta), the diatoms (Bacillariophyta), and the golden-brown algae (Chrysophyta). The relative abundances of these divisions varied among sites and surveys (tables 16 and 17). In general, the greatest densities of green algae were identified at sites on the upper end of Lake Bowen (from site LWB-3 to site LWB-8; fig. 3) and ranged from 5,713 to 31,957 cells/mL, accounting for about 2 to 8 percent of the phytoplankton community during the August to September 2005 survey (table 16). In contrast, at site MR1-14 in Reservoir #1, the density of green algae was about 3,500 cells/mL, or less than 1 percent of the phytoplankton community, during this survey. Some temporal changes in green algae densities were observed at sites LWB-10 and MR1-14 during the three surveys; however, site LWB-8 appeared to have a greater temporal change (tables 16 and 17). Golden-brown algal densities were about equal to diatom densities during the August to September 2005 survey but were slightly higher than diatom densities during the May and October 2006 surveys in both reservoirs (tables 16, 17). Site MR1-14 in Reservoir #1 had the highest golden-brown algal densities of 7,232 and 4,385 cells/mL in surface samples collected during the May and October 2006 surveys, respectively. Densities were highest for green and golden-brown algal divisions and had their highest densities at most sites and depths sampled during the May 2006 survey. Except for Cryptophyta (LWB-8 at 6-m depth), no other phytoplankton division exceeded 1,000 cells/mL or 0.7 percent representation (tables 16 and 17).

Dominance of cyanobacteria relative to the other algal divisions cannot be described adequately because the cell densities were based on cells per unit volume and because the species within the different algal groups have a wide range of algal cell sizes. Overall, the members of the division Cyanophyta identified in these samples were dominated by the picoplankton members of the algal family Chroococaceae, especially species within the genus *Synechococcus.* Because of the extremely small size of picoplankton (less than one micron), members of the Chroococaceae family often were undefined in the taxonomic classification. Together the genus *Synechococcus* and its family Chroococaceae composed from 58 to 96 percent of the cyanobacterial community during the three surveys.

In order to compare algal groups of more equal cell size, phytoplankton densities by algal divisions were tabulated without the Chroococaceae family (picoplankton-sized species) of the division Cyanophyta (tables 18 and 19). Even with the removal of the picoplankton species, cyanobacteria were the most abundant of the algal divisions (table 18). Green algae, golden brown algae, and diatoms generally composed less than 20 percent of the total phytoplankton community (the exception was golden-brown algae at site LWB-8 at the 6-m depth in the May 2006 survey; table 19). In Lake Bowen, the abundance of cyanobacterial cells in the division Cyanophyta (without the family Chroococaceae) as part of the total phytoplankton community ranged from 84 to 97 percent at sites LWB-3 and LWB-10, respectively, during the August to September 2005 survey; from 45 to 90 percent at sites LWB-8 and LWB-10, respectively, in the May 2006 survey; and from 93 to 96 percent at sites LWB-8 and LWB-10, respectively, in the October 2006 survey (table 19). In Reservoir #1 at site MR1-14, cyanobacterial cells accounted for 86 to 97 percent of the total phytoplankton community during the three surveys.

During the August to September 2005 survey, several potential geosmin-producing genera were identified in Lake Bowen and Reservoir #1; the most abundant were *Lyngbya* and *Synechococcus* (table 20). Cell density of

**Table 17.** Percentages of cell densities by major divisions of the phytoplankton community in samples collected at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August to September 2005, May 2006, and October 2006.

[ID, identifier; m, meters; %, percent of total cells]

| Site ID | Date of sample | Depth (m) | Phytoplankton density by division (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cyanobacteria | Chlorophyta | Bacillariophyta | Chrysophyta | Cryptophyta | Euglenophyta | Miscellaneous | Pyrrhophyta | Rhodophyta | Xanthophyta |
| | | | August to September 2005 | | | | | | | | | |
| LWB-03 | 8/30/2005 | 1 | 91 | 8.3 | 0.24 | 0.01 | 0.04 | 0.01 | 0 | 0.05 | 0 | 0 |
| LWB-04 | 8/30/2005 | 1 | 96 | 3.6 | 0.20 | 0.03 | 0.03 | 0.02 | 0 | 0.03 | 0 | 0 |
| LWB-05 | 8/31/2005 | 1 | 95 | 4.3 | 0.30 | 0.07 | 0.09 | 0.03 | 0 | 0.06 | 0 | 0.01 |
| LWB-07 | 9/1/2005 | 1 | 98 | 1.9 | 0.21 | 0.07 | 0.01 | 0.05 | 0 | 0.03 | 0 | 0 |
| LWB-08 | 8/31/2005 | 1 | 95 | 4.3 | 0.26 | 0.05 | 0.01 | 0.06 | 0 | 0.04 | 0 | 0 |
| LWB-10 | 9/6/2005 | 1 | 99 | 0.88 | 0.28 | 0.03 | 0.05 | 0.03 | 0.03 | 0.02 | 0 | 0 |
| | | 7 | 99 | 0.57 | 0.01 | 0.00 | 0.02 | 0.22 | 0 | 0.00 | 0 | 0 |
| LWB-11 | 9/7/2005 | 1 | 98 | 0.77 | 0.46 | 0.40 | 0.02 | 0.02 | 0.02 | 0.03 | 0 | 0.01 |
| | | 7 | 96 | 2.7 | 0.39 | 0.38 | 0.21 | 0.07 | 0 | 0.01 | 0 | 0 |
| MR1-14 | 9/7/2005 | 1 | 99 | 0.87 | 0.20 | 0.17 | 0.09 | 0.01 | 0 | 0.06 | 0 | 0.01 |
| | | 6 | 98 | 0.97 | 0.27 | 0.24 | 0.05 | 0.02 | 0 | 0.02 | 0 | 0 |
| | | | May 2006 | | | | | | | | | |
| LWB-08 | 5/16/2006 | 1 | 97 | 0.76 | 0.56 | 0.83 | 0.19 | 0.00 | 0.29 | 0.04 | 0 | 0 |
| | | 6 | 94 | 1.5 | 0.66 | 3.0 | 0.70 | 0.03 | 0.09 | 0.05 | 0 | 0 |
| LWB-10 | 5/15/2006 | 1 | 97 | 0.84 | 0.35 | 0.89 | 0.13 | 0.01 | 0.77 | 0.04 | 0 | 0 |
| | | 6 | 97 | 0.78 | 0.69 | 0.16 | 0.08 | 0.01 | 1.17 | 0.05 | 0 | 0 |
| MR1-14 | 5/17/2006 | 1 | 95 | 1.0 | 0.68 | 2.6 | 0.14 | 0.01 | 0.50 | 0.03 | 0 | 0 |
| | | 6 | 96 | 1.2 | 0.68 | 1.7 | 0.09 | 0 | 0.19 | 0.04 | 0 | 0 |
| | | | October 2006 | | | | | | | | | |
| LWB-08 | 10/24/2006 | 1 | 97 | 1.4 | 0.32 | 0.51 | 0.21 | 0.09 | 0.56 | 0.01 | 0 | 0 |
| | | 6 | 97 | 2.1 | 0.19 | 0.59 | 0.31 | 0.10 | 0.15 | 0.02 | 0 | 0 |
| LWB-10 | 10/24/2006 | 1 | 98 | 1.4 | 0.15 | 0.33 | 0.18 | 0.07 | 0.16 | 0.05 | 0.01 | 0 |
| | | 6 | 98 | 1.4 | 0.14 | 0.13 | 0.17 | 0.04 | 0.23 | 0.01 | 0.01 | 0 |
| MR1-14 | 10/25/2006 | 1 | 95 | 1.8 | 0.29 | 2.7 | 0.52 | 0.01 | 0 | 0.04 | 0 | 0 |
| | | 6 | 96 | 1.7 | 0.27 | 1.8 | 0.21 | 0.02 | 0 | 0.01 | 0 | 0 |

**Table 18.** Cell densities by major divisions of the phytoplankton community, without the picoplankton in the Family Chrococcaeceae, in samples collected at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August to September 2005, May 2006, and October 2006.

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site ID | Date of sample | Depth (m) | Phytoplankton density by division (cells/mL) | | | | | | | | | | Total phytoplankton density (cells/mL) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cyanobacteria (no Chroococcaceae) | Chlorophyta | Bacillariophyta | Chrysophyta | Cryptophyta | Euglenophyta | Miscellaneous | Pyrrhophyta | Rhodophyta | Xanthophyta | |
| August to September 2005 | | | | | | | | | | | | | |
| LWB-03 | 8/30/2005 | 1 | 174,256 | 31,957 | 909 | 32 | 162 | 54 | 0 | 206 | 0 | 0 | 207,577 |
| LWB-04 | 8/30/2005 | 1 | 194,233 | 13,350 | 746 | 97 | 130 | 65 | 0 | 97 | 0 | 0 | 208,719 |
| LWB-05 | 8/31/2005 | 1 | 125,881 | 13,781 | 969 | 212 | 273 | 91 | 0 | 176 | 0 | 30 | 141,413 |
| LWB-07 | 9/1/2005 | 1 | 93,997 | 5,713 | 619 | 204 | 23 | 159 | 0 | 102 | 0 | 0 | 100,817 |
| LWB-08 | 8/31/2005 | 1 | 90,814 | 10,550 | 636 | 114 | 23 | 136 | 0 | 91 | 0 | 0 | 102,363 |
| LWB-10 | 9/6/2005 | 1 | 106,378 | 2,399 | 772 | 79 | 147 | 79 | 68 | 45 | 0 | 0 | 109,968 |
| | | 7 | 73,329 | 1,771 | 29 | 0 | 78 | 702 | 0 | 5 | 0 | 0 | 75,914 |
| LWB-11 | 9/7/2005 | 1 | 67,558 | 1,552 | 924 | 810 | 30 | 45 | 30 | 67 | 0 | 15 | 71,033 |
| | | 7 | 65,541 | 5,009 | 712 | 697 | 379 | 136 | 0 | 11 | 0 | 0 | 72,485 |
| MR1-14 | 9/7/2005 | 1 | 213,038 | 3,592 | 811 | 714 | 389 | 32 | 0 | 238 | 0 | 32 | 218,848 |
| | | 6 | 167,296 | 3,458 | 953 | 848 | 182 | 61 | 0 | 81 | 0 | 0 | 172,878 |
| May 2006 | | | | | | | | | | | | | |
| LWB-08 | 5/16/2006 | 1 | 4,745 | 1,620 | 1,200 | 1,757 | 404 | 10 | 616 | 81 | 0 | 0 | 10,432 |
| | | 6 | 13,141 | 2,852 | 1,281 | 5,786 | 1,363 | 61 | 182 | 91 | 0 | 0 | 24,757 |
| LWB-10 | 5/15/2006 | 1 | 36,786 | 1,197 | 493 | 1,272 | 182 | 10 | 1,091 | 50 | 0 | 0 | 41,081 |
| | | 6 | 29,657 | 1,202 | 1,076 | 242 | 128 | 10 | 1,818 | 71 | 0 | 0 | 34,203 |
| MR1-14 | 5/17/2006 | 1 | 83,602 | 2,808 | 1,877 | 7,232 | 379 | 38 | 1,363 | 76 | 0 | 0 | 97,375 |
| | | 6 | 114,981 | 3,245 | 1,838 | 4,714 | 256 | 0 | 511 | 106 | 0 | 0 | 125,650 |
| October 2006 | | | | | | | | | | | | | |
| LWB-08 | 10/24/2006 | 1 | 100,739 | 2,416 | 545 | 874 | 364 | 151 | 954 | 15 | 0 | 0 | 106,059 |
| | | 6 | 82,765 | 3,710 | 340 | 1,045 | 545 | 181 | 273 | 34 | 0 | 0 | 88,892 |
| LWB-10 | 10/24/2006 | 1 | 56,242 | 2,690 | 288 | 636 | 348 | 140 | 318 | 102 | 23 | 0 | 60,786 |
| | | 6 | 114,811 | 3,280 | 333 | 318 | 409 | 89 | 545 | 15 | 15 | 0 | 119,816 |
| MR1-14 | 10/25/2006 | 1 | 77,687 | 2,985 | 477 | 4,385 | 841 | 23 | 0 | 68 | 0 | 0 | 86,466 |
| | | 6 | 94,927 | 3,088 | 500 | 3,305 | 386 | 33 | 0 | 10 | 0 | 0 | 102,249 |

**Table 19.** Percentages of cell densities by major divisions of the phytoplankton community, without the picoplankton in the Family Chrococcaceae, in samples collected at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August to September 2005, May 2006, and October 2006.

[ID, identifier; m, meters; %, percent of total cells]

| Site ID | Date of sample | Depth (m) | Phytoplankton density by division (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cyanobacteria (no Chroococcaceae) | Chlorophyta | Bacillariophyta | Chrysophyta | Cryptophyta | Euglenophyta | Miscellaneous | Pyrrhophyta | Rhodophyta | Xanthophyta |
| August to September 2005 | | | | | | | | | | | | |
| LWB-03 | 8/30/2005 | 1 | 84 | 15 | 0.44 | 0.02 | 0.08 | 0.03 | 0 | 0.10 | 0 | 0 |
| LWB-04 | 8/30/2005 | 1 | 93 | 6.4 | 0.36 | 0.05 | 0.06 | 0.03 | 0 | 0.05 | 0 | 0 |
| LWB-05 | 8/31/2005 | 1 | 89 | 9.7 | 0.69 | 0.15 | 0.19 | 0.06 | 0 | 0.12 | 0 | 0 |
| LWB-07 | 9/1/2005 | 1 | 93 | 5.7 | 0.61 | 0.20 | 0.02 | 0.16 | 0 | 0.10 | 0 | 0 |
| LWB-08 | 8/31/2005 | 1 | 89 | 10 | 0.62 | 0.11 | 0.02 | 0.13 | 0 | 0.09 | 0 | 0 |
| LWB-10 | 9/6/2005 | 1 | 97 | 2.2 | 0.70 | 0.07 | 0.13 | 0.07 | 0 | 0.04 | 0 | 0 |
| | | 7 | 97 | 2.3 | 0.04 | 0.00 | 0.10 | 0.93 | 0 | 0.01 | 0 | 0 |
| LWB-11 | 9/7/2005 | 1 | 95 | 2.2 | 1.30 | 1.14 | 0.04 | 0.06 | 0 | 0.09 | 0 | 0 |
| | | 7 | 90 | 6.9 | 0.98 | 0.96 | 0.52 | 0.19 | 0 | 0.02 | 0 | 0 |
| MR1-14 | 9/7/2005 | 1 | 97 | 1.6 | 0.37 | 0.33 | 0.18 | 0.01 | 0 | 0.11 | 0 | 0 |
| | | 6 | 97 | 2.0 | 0.55 | 0.49 | 0.11 | 0.04 | 0 | 0.05 | 0 | 0 |
| May 2006 | | | | | | | | | | | | |
| LWB-08 | 5/16/2006 | 1 | 45 | 16 | 12 | 17 | 3.9 | 0.10 | 5.90 | 0.77 | 0 | 0 |
| | | 6 | 53 | 12 | 5.2 | 23 | 5.5 | 0.24 | 0.73 | 0.37 | 0 | 0 |
| LWB-10 | 5/15/2006 | 1 | 90 | 2.9 | 1.2 | 3.1 | 0.44 | 0.02 | 2.65 | 0.12 | 0 | 0 |
| | | 6 | 87 | 3.5 | 3.1 | 0.71 | 0.37 | 0.03 | 5.31 | 0.21 | 0 | 0 |
| MR1-14 | 5/17/2006 | 1 | 86 | 2.9 | 1.9 | 7.4 | 0.39 | 0.04 | 1.40 | 0.08 | 0 | 0 |
| | | 6 | 92 | 2.6 | 1.5 | 3.8 | 0.20 | | 0.41 | 0.08 | 0 | 0 |
| October 2006 | | | | | | | | | | | | |
| LWB-08 | 10/24/2006 | 1 | 95 | 2.3 | 0.51 | 0.82 | 0.34 | 0.14 | 0.90 | 0.01 | 0 | 0 |
| | | 6 | 93 | 4.2 | 0.38 | 1.18 | 0.61 | 0.20 | 0.31 | 0.04 | 0 | 0 |
| LWB-10 | 10/24/2006 | 1 | 93 | 4.4 | 0.47 | 1.05 | 0.57 | 0.23 | 0.52 | 0.17 | 0.04 | 0 |
| | | 6 | 96 | 2.7 | 0.28 | 0.27 | 0.34 | 0.07 | 0.46 | 0.01 | 0.01 | 0 |
| MR1-14 | 10/25/2006 | 1 | 90 | 3.5 | 0.55 | 5.07 | 0.97 | 0.03 | 0.00 | 0.08 | 0 | 0 |
| | | 6 | 93 | 3.0 | 0.49 | 3.23 | 0.38 | 0.03 | 0.00 | 0.01 | 0 | 0 |

**Table 20.** Phytoplankton cell densities of potentially geosmin-producing genera of cyanobacteria in samples collected at selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August to September 2005, May 2006, and October 2006.

[cells/mL, cells per milliliter; NS, site not sampled]

| Genus | Species | Phytoplankton cell density (cells/mL) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | August to September 2005 at 1-meter depth | | | | | | | | May 2006 at 1-meter depth | | | October 2006 at 1-meter depth | | |
| | | LWB-3 | LWB-4 | LWB-5 | LWB-7 | LWB-8 | LWB-10 | LWB-11 | MR1-14 | LWB-8 | LWB-10 | MR1-14 | LWB-8 | LWB-10 | MR1-14 |
| | | Potentially Geosmin-Producing Cyanobacteria | | | | | | | | | | | | | |
| *Anabaena* | *planctonica* | 0 | 0 | 0 | 0 | 274 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *aphanizomenoides* | 0 | 0 | 0 | 0 | 394 | 2,190 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *macrospora* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Oscillatoria* | *limnetica* | 0 | 974 | 303 | 0 | 0 | 0 | 325 | 0 | 73 | 0 | 0 | 454 | 0 | 0 |
| | *amphibia* | 0 | 0 | 364 | 303 | 0 | 0 | 909 | 0 | 303 | 0 | 0 | 0 | 0 | 0 |
| | *agardhii* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *tenuis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Aphanizomenon* | *issatschenkoi* | 1,558 | 0 | 0 | 114 | 151 | 0 | 0 | 293 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *gracile* | 400 | 0 | 0 | 682 | 0 | 0 | 3,458 | 3,750 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lyngbya* | *limnetica* | 86,073 | 64,139 | 39,356 | 37,037 | 41,667 | 32,116 | 12,729 | 48,606 | 0 | 0 | 379 | 2,629 | 1,670 | 1,136 |
| *Microcystis* | *wesenbergii* | 0 | 0 | 2,743 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Synechecococcus* | sp.1 | 61,596 | 139,619 | 106,767 | 90,341 | 69,809 | 69,809 | 102,661 | 127,299 | 104,030 | 54,752 | 82,129 | 41,064 | 57,490 | 32,851 |
| | *leopoliensis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *elongatus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4,106 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Other Cyanobacteria of Interest | | | | | | | | | | | | | |
| *Cylindrospermopsis* | *raciborskii* | | 671 | 1,539 | 3,401 | 2,234 | 1,677 | 1,419 | 406 | | | | 744 | 598 | 759 |
| *Cyanogranis* | *ferruginea* | 85,414 | 128,449 | 84,319 | 49,277 | 49,277 | 70,395 | 49,043 | 159,658 | 36,410 | 4,745 | 83,223 | 96,912 | 53,906 | 75,792 |
| **Genus** | **Species** | **August to September 2005 at 6-meter depth** | | | | | | | | **May 2006 at 6-meter depth** | | | **October 2006 at 6-meter depth** | | |
| | | **LWB-3** | **LWB-4** | **LWB-5** | **LWB-7** | **LWB-8** | **LWB-10** | **LWB-11** | **MR1-14** | **LWB-8** | **LWB-10** | **MR1-14** | **LWB-8** | **LWB-10** | **MR1-14** |
| | | Potentially Geosmin-Producing Cyanobacteria | | | | | | | | | | | | | |
| *Anabaena* | *planctonica* | NS | NS | NS | NS | NS | 283 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *aphanizomenoides* | NS | NS | NS | NS | NS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *macrospora* | NS | NS | NS | NS | NS | 0 | 61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Oscillatoria* | *limnetica* | NS | NS | NS | NS | NS | 0 | 227 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *amphibia* | NS | NS | NS | NS | NS | 293 | 606 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *agardhii* | NS | NS | NS | NS | NS | 488 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *tenuis* | NS | NS | NS | NS | NS | 325 | 2,048 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | sp. | NS | NS | NS | NS | NS | 0 | 1,363 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Aphanizomenon* | *issatschenkoi* | NS | NS | NS | NS | NS | 98 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *gracile* | NS | NS | NS | NS | NS | 0 | 2,019 | 2,757 | 0 | 0 | 0 | 151 | 0 | 0 |
| *Lyngbya* | *limnetica* | NS | NS | NS | NS | NS | 644 | 12,268 | 34,933 | 0 | 0 | 0 | 250 | 2,590 | 1,590 |
| *Microcystis* | *wesenbergii* | NS | NS | NS | NS | NS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *aeruginosa* | NS | NS | NS | NS | NS | 0 | 0 | 0 | 0 | 0 | 123 | 0 | 0 | 0 |
| *Synechecococcus* | sp.1 | NS | NS | NS | NS | NS | 32,851 | 57,490 | 180,683 | 90,341 | 60,228 | 98,554 | 32,851 | 69,809 | 16,426 |
| | *leopoliensis* | NS | NS | NS | NS | NS | 9,034 | 5,133 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *elongatus* | NS | NS | NS | NS | NS | 12,593 | 2,053 | 5,475 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Other Cyanobacteria of Interest | | | | | | | | | | | | | |
| *Cylindrospermopsis* | *raciborskii* | NS | NS | NS | NS | NS | 98 | 1,414 | 937 | 0 | 0 | 0 | 0 | 525 | 942 |
| *Cyanogranis* | *ferruginea* | NS | NS | NS | NS | NS | 19,711 | 45,171 | 0 | 29,566 | 13,141 | 114,981 | 82,364 | 11,696 | 92,395 |

*Synechococcus sp.1* in samples collected from the surface ranged from 61,596 to 139,619 cells/mL at sites LWB-3 and LWB-4, respectively, in Lake Bowen and was 127,299 cells/mL at site MR1-14 in Reservoir #1 (table 20). *Synechococcus sp.1* demonstrated about a 50-percent reduction with depth sites LWB-10 and LWB-11, whereas MR1-14 demonstrated an increase of about 20 percent with depth (table 20). Cell density of *Lyngbya limetica* ranged from 12,729 to 86,073 cells/mL in samples collected near the surface at sites LWB-11 and LWB-3, respectively, in Lake Bowen and was 48,606 cells/mL at site MR1-14 in Reservoir #1 (table 20). *Lyngbya limetica* demonstrated large reduction in cell densities with depth (98 percent) at site LWB-10; densities at sites LWB-11 and MR1-14 were relatively stable (table 20).

During the May and October 2006 surveys, fewer potentially geosmin-producing genera were identified in Lake Bowen and Reservoir #1; the most abundant genera were *Synechococcus* (table 20). In Lake Bowen, no distinct pattern in variability in the abundance of geosmin-producing genera was identified among the three surveys at each site. However, at site MR1-14 in Reservoir #1, cell densities of *Synechococcus sp.1* were lower during the October 2006 survey than during the other two surveys (table 20).

No pattern for algal cell density of the potentially geosmin-producing genera of cyanobacteria in relation to geosmin occurrence was identified during the three surveys. Although sites MR1-14 in Reservoir #1 and sites LWB-03, LWB-04, and LWB-05 in the upper end of Lake Bowen contained low geosmin concentrations (near the LRL of 0.005 µg/L), these sites also had cyanobacterial phytoplankton communities that had relatively high densities of *Synechococcus* and other geosmin-producing genera at the time of sampling (table 20).

## Summary

The U.S. Geological Survey, in cooperation with the Spartanburg Water System, conducted three spatial surveys of limnological conditions, which included sampling and analysis for geosmin and 2-methylisoborneol, in Lake William C. Bowen (Lake Bowen) and Municipal Reservoir #1 (Reservoir #1), Spartanburg County, South Carolina, during August to September 2005, May 2006, and October 2006. The focus of the surveys was to identify spatial distribution and occurrence of geosmin and MIB, common trophic state indicator constituents (nutrients, transparency, and chlorophyll *a*), and algal community structure and to determine the degree of stratification at the time of sampling.

Water samples were analyzed for total nitrogen, dissolved nitrate plus nitrite, ammonia, total Kjeldahl nitrogen (ammonia plus organic nitrogen), dissolved orthophosphate, total phosphorus, dissolved organic carbon, ultraviolet absorbance at 254 and 280 nanometers (estimate of the humic content or reactive fraction of organic carbon), phytoplankton pigments of chlorophyll *a* and *b*, and phytoplankton biomass by the U.S. Geological Survey National Water Quality Laboratory (NWQL) in Denver, Colorado. In 2006, water samples were analyzed by the NWQL for the above constituents and properties of turbidity, total suspended solids, pheophyton *a* (degradation pigment of chlorophyll *a*), iron, manganese, silica, hardness, and wastewater indicator compounds. Samples were analyzed for algal taxonomy by a contract laboratory.

The degree of stratification was demonstrated by temperature-depth profiles and computed relative thermal resistance to mixing. Seasonal occurrence of thermal stratification (August to Septmber 2005; May 2006) and destratification (October 2006) was evident in the depth profiles of water temperature in Lake Bowen. The most stable water-column conditions (highest relative thermal resistance to mixing) occurred in Lake Bowen during the August to September 2005 survey. The least stable water-column conditions (destratified) occurred in Lake Bowen during the October 2006 survey and in Reservoir #1 during all three surveys. In stratified areas of the lake, the thermocline was located at a lower depth (between 5 and 6 meters) during the May 2006 survey than during the August to September 2005 survey (between 4 and 5 meters).

Changes with depth in dissolved oxygen (decreased to near anoxic conditions in the hypolimnion), pH (decreased), and specific conductance (increased) with thermal stratification indicate that Lake Bowen was exhibiting characteristics common to the mesotrophic and eutrophic states. During stratified periods, increases in pH near the surface can be explained by increased photosynthetic activity in the epilimnion. Decreased pH and dissolved oxygen in the hypolimnion often are related to increased activity of respiration and decomposition processes. Increased specific conductance could be related to remobilization of phosphorus, trace elements, and ammonia in the anoxic hypoliminion.

Nutrient dynamics were different in Lake Bowen during the May 2006 survey from those during the August to September 2005 and October 2006 surveys. Total organic nitrogen concentrations (total Kjeldahl nitrogen minus ammonia) remained relatively constant among sites during the three surveys. Nitrate was the dominant inorganic species of nitrogen in the May 2006 survey; ammonia was the dominant form during the August to September 2005 and October 2006 surveys. During the August to September 2005 survey, ammonia was detected only in bottom samples collected in the near-anoxic conditions of the hypolimnion, but during the October 2006 survey, ammonia was detected under destratified conditions in both surface and bottom samples. Total phosphorus concentrations in bottom samples were substantially greater than in surface samples during the August to September 2005 survey but not during the May 2006 and October 2006 surveys. Chlorophyll *a* concentrations appeared to vary with the species of inorganic nitrogen. Much greater chlorophyll *a* concentrations were identified during the May 2006 survey when nitrate was the dominant species than during the August to September 2006 and October 2006 surveys at all sites in Lake Bowen and Reservoir #1.

For the three limnological surveys, concentrations of chlorophyll *a* and total phosphorus in surface samples were well below the established South Carolina numerical criteria of 40 micrograms per liter and 0.06 milligram per liter, respectively, at all sites. The more restrictive criterion recommended by U.S. Environmental Protection Agency (USEPA) of 4.93 micrograms per liter for chlorophyll *a* was not met at sites LWB-8, LWB-10, MR1-12, and MR1-14 during the May and October 2006 surveys. The total phosphorus concentration of 0.021 milligram per liter in a sample from MR1-14 in the August to September 2005 survey slightly exceeded the USEPA recommended criterion of 0.020 milligram per liter. However, transparency of the water column frequently was less than 1.5 meter, the recommended numerical criterion.

The total nitrogen to total phosphorus ratios at seven sites in Lake Bowen and one site (MR1-14) in Reservoir #1 were below 22:1 for the August to September 2005 survey, indicating a high probability of dominance by nitrogen-fixing cyanobacteria. During the May and October 2006 survey, TN to TP ratios were above 22:1 at sites LWB-8 and LWB-10 in Lake Bowen and MR1-12 in Reservoir #1, indicating a smaller probability of cyanobacterial dominance. At site MR1-14 in Reservoir #1, TN to TP ratios were below 22:1 during the August to September 2005 and May 2006 surveys and slightly above 22:1 during the October 2006 survey.

Trophic state indices (TSIs) for Lake Bowen and Reservoir #1 varied both spatially and temporally during the three surveys. In addition, variation in the three TSIs (total phosphorus, chlorophyll *a*, and transparency) for individual samples can be explained by the inherent variability within the empirically derived equations or by the interrelationships among the three variables. In general, the TSIs indicated that the trophic status of Lake Bowen and Reservoir #1 represented mesotrophic conditions.

For all three surveys, 2-methylisoborneol concentrations were below the laboratory reporting level of 0.005 microgram per liter. Of the three surveys, the highest concentrations of geosmin were measured in samples from sites LWB-8 (0.024 microgram per liter) and LWB-10 (0.039 microgram per liter) collected near the lake bottom in Lake Bowen during the August to September 2005 survey when stratified conditions existed. These elevated concentrations of geosmin were present at sites and depths in Lake Bowen that had elevated ammonia and total phosphorus concentrations. But surface samples from all sites in Lake Bowen and from samples at both depths for site MR1-14 in Reservoir #1 contained geosmin concentrations at or below 0.005 microgram per liter during the August to September 2005 survey.

During the May 2006 survey, geosmin concentrations again were highest at sites LWB-8 and LWB-10 and were more evenly distributed throughout the water column in Lake Bowen. Geosmin concentrations were lower in samples from sites in Reservoir #1 than in samples from Lake Bowen. During the May 2006 survey, elevated geosmin concentrations (0.012–0.024 microgram per liter) appeared to correspond to nitrate concentrations at the same sites. The lowest geosmin concentrations (0.006 to 0.007 microgram per liter) for sites LWB-8 and LWB-10 were measured during the October 2006 survey when destratified conditions existed.

Total phytoplankton densities ranged from 200,513 to 384,154 cells per milliliter in samples collected from the surface from Lake Bowen during the August to September 2005 survey. Total phytoplankton densities appeared to be similar in samples collected near the bottom and near the surface during this survey. The sample collected near the surface at site MR1-14 in Reservoir #1 had the highest total phytoplankton density of 414,314 cells per milliliter. During the May 2006 survey, total phytoplankton densities appeared to be slightly reduced from densities measured during the August to September 2006 survey at two of the three sites sampled. As observed during the August to

September 2005 survey, total phytoplankton densities were similar in samples collected near the surface and bottom depths at each site.

Total phytoplankton densities in samples collected near the surface were 171,382 and 193,966 cells per milliliter at sites LWB-8 and LWB-10, respectively, in Lake Bowen and 162,629 cells per milliliter at site MR1-14 in Reservoir #1 during the October 2006 survey. As observed during the previous two surveys, total phytoplankton densities were similar in samples collected from surface and bottom depths at each site.

Members of the division Cyanophyta (also known as cyanobacteria or blue-green algae) were present in the greatest abundance of all the phytoplankton communities in Lake Bowen and Reservoir #1 at all sites and sampling depths during all three surveys. For the three surveys, the abundance of cyanobacterial cells in the Cyanophyta division as part of the total phytoplankton community ranged from 91 to 99 percent among all sites and depths. Even with the removal of the picoplankton species (species that have extremely small cell sizes) from consideration, the percentage of cyanobacterial cells in the Cyanophyta division as part of the total phytoplankton community was greater (45 to 97 percent) than the percentage of other algal divisions.

Several potentially geosmin-producing genera were identified in Lake Bowen and Reservoir #1, with the most abundant being *Lyngbya* and *Synechococcus*, during the August to September 2005 survey. During the May and October 2006 survey, fewer potentially geosmin-producing genera were identified in Lake Bowen and Reservoir #1, with the most abundant genera being *Synechococcus*. Overall, the members of the division Cyanophyta identified in these samples were dominated by the picoplankton members of the algal family Chroococaceae (especially species within the genus *Synechococcus)*, *Cyanogranis ferruginea*, and *Lyngbya limnetica*. No pattern was identified between algal cell density of potentially geosmin-producing genera of cyanobacteria and the geosmin occurrence during the three surveys.

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# Appendix A. National Land Cover Database (NLCD) Land Cover Classification System Key and Definitions

## NLCD Land Cover Classification System Key

**Water**
- 11 Open Water
- 12 Perennial Ice/Snow

**Developed**
- 21 Low Intensity Residential
- 22 High Intensity Residential
- 23 Commercial/Industrial/Transportation

**Barren**
- 31 Bare Rock/Sand/Clay
- 32 Quarries/Strip Mines/Gravel Pits
- 33 Transitional

**Forested Upland**
- 41 Deciduous Forest
- 42 Evergreen Forest
- 43 Mixed Forest

**Shrubland**
- 51 Shrubland

**Non-natural Woody**
- 61 Orchards/Vineyards/Other

**Herbaceous Upland**
- 71 Grasslands/Herbaceous

**Herbaceous Planted/Cultivated**
- 81 Pasture/Hay
- 82 Row Crops
- 83 Small Grains
- 84 Fallow
- 85 Urban/Recreational Grasses

**Wetlands**
- 91 Woody Wetlands
- 92 Emergent Herbaceous Wetlands

## NLCD Land Cover Classification System Land Cover Class Definitions

**Water—**All areas of open water or permanent ice/snow cover.

11. Open Water—All areas of open water; typically 25 percent or greater cover of water (per pixel).
12. Perennial Ice/Snow—All areas characterized by year-long cover of ice, snow, or both.

**Developed**—Areas characterized by a high percentage (30 percent or greater) of constructed materials (for example, asphalt, concrete, and buildings).

21. Low Intensity Residential—Includes areas with a mixture of constructed materials and vegetation. Constructed materials account for 30 to 80 percent of the cover. Vegetation may account for 20 to 70 percent of the cover. These areas most commonly include single-family housing units. Population densities will be lower than in high intensity residential areas.
22. High Intensity Residential—Includes highly developed areas where people reside in high numbers. Examples include apartment complexes and row houses. Vegetation accounts for less than 20 percent of the cover. Constructed materials account for 80 to 100 percent of the cover.
23. Commercial/Industrial/Transportation—Includes infrastructure (for example roads and railroads) and all highly developed areas not classified as High Intensity Residential.

**Barren—**Areas characterized by bare rock, gravel, sand, silt, clay, or other earthen material, with little or no "green" vegetation present regardless of its inherent ability to support life. Vegetation, if present, is more widely spaced and scrubby than that in the "green" vegetated categories; lichen cover may be extensive.

31. Bare Rock/Sand/Clay—Perennially barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, beaches, and other accumulations of earthen material.
32. Quarries/Strip Mines/Gravel Pits—Areas of extractive mining activities with significant surface expression.
33. Transitional—Areas of sparse vegetative cover (less than 25 percent of cover) that are dynamically changing from one land cover to another, often because of land-use activities. Examples include forest clearcuts, a transition phase between forest and agricultural land, the temporary clearing of vegetation, and changes due to natural causes (for example, fire and flood).

**Forested Upland**—Areas characterized by tree cover (natural or semi-natural woody vegetation, generally greater than 6 meters tall); tree canopy accounts for 25 to 100 percent of the cover.

41. Deciduous Forest—Areas dominated by trees where 75 percent or more of the tree species shed foliage simultaneously in response to seasonal change.
42. Evergreen Forest—Areas dominated by trees where 75 percent or more of the tree species maintain their leaves all year. Canopy is never without green foliage.
43. Mixed Forest—Areas dominated by trees where neither deciduous nor evergreen species represent more than 75 percent of the cover present.

**Shrubland**—Areas characterized by natural or semi-natural woody vegetation with aerial stems, generally less than 6 meters tall, with individuals or clumps not touching to interlocking. Both evergreen and deciduous species of true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions are included.

51. Shrubland—Areas dominated by shrubs; shrub canopy accounts for 25 to 100 percent of the cover. Shrub cover is generally greater than 25 percent when tree cover is less than 25 percent. Shrub cover may be less than 25 percent in cases when the cover of other life forms (for example, herbaceous or tree) is less than 25 percent and shrub cover exceeds the cover of the other life forms.

**Non-natural Woody**—Areas dominated by non-natural woody vegetation; non-natural woody vegetative canopy accounts for 25 to 100 percent of the cover. The non-natural woody classification is subject to the availability of sufficient ancillary data to differentiate non-natural woody vegetation from natural woody vegetation.

61. Orchards/Vineyards/Other—Orchards, vineyards, and other areas planted or maintained for the production of fruits, nuts, berries, or ornamentals.

**Herbaceous Upland**—Upland areas characterized by natural or semi-natural herbaceous vegetation; herbaceous vegetation accounts for 75 to 100 percent of the cover.

71. Grasslands/Herbaceous—Areas dominated by upland grasses and forbs. In rare cases, herbaceous cover is less than 25 percent but exceeds the combined cover of the woody species present. These areas are not subject to intensive management, but they are often utilized for grazing.

**Planted/Cultivated**—Areas characterized by herbaceous vegetation that has been planted or is intensively managed for the production of food, feed, or fiber, or is maintained in developed settings for specific purposes. Herbaceous vegetation accounts for 75 to 100 percent of the cover.

81. Pasture/Hay—Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops.
82. Row Crops—Areas used for the production of crops, such as corn, soybeans, vegetables, tobacco, and cotton.
83. Small Grains—Areas used for the production of graminoid crops such as wheat, barley, oats, and rice.
84. Fallow—Areas used for the production of crops that are temporarily barren or with sparse vegetative cover as a result of being tilled in a management practice that incorporates prescribed alternation between cropping and tillage.
85. Urban/Recreational Grasses—Vegetation (primarily grasses) planted in developed settings for recreation, erosion control, or aesthetic purposes. Examples include parks, lawns, golf courses, airport grasses, and industrial site grasses.

**Wetlands**—Areas where the soil or substrate is periodically saturated with or covered with water.

91. Woody Wetlands—Areas where forest or shrubland vegetation accounts for 25 to 100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.
92. Emergent Herbaceous Wetlands—Areas where perennial herbaceous vegetation accounts for 75 to 100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.

# Appendix B. Laboratory Reporting Levels and Method Descriptions for Selected Analytes in Water Samples Collected from Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina

**Schedule 1509**

**Description:** Chlorophyll a, Pheophytin a, Biomass (AFDM) in Phytoplankton
**Analyzing Laboratory(s):** USGS-National Water Quality Lab, Denver, CO

| Analyte | Lab Code | Parameter Code | M | CAS Number | RL | Unit | RL Type | Container |
|---|---|---|---|---|---|---|---|---|
| Biomass, phytoplankton, ash-free dry weight | 2190 | 49953 | 00093 | | 0.1 | mg/L | mrl | CHL |
| chlorophyll a | 3152 | 70953 | 00050 | 479-61-8 | 0.1 | ug/L | mrl | CHL |
| Pheophytin A, phytoplankton | 3152 | 62360 | 00050 | 603-17-8 | 0.1 | ug/L | mrl | CHL |
| Phytoplankton, biomass, ash weight | 2189 | 81353 | GRV05 | | 0.1 | mg/L | mrl | CHL |
| Phytoplankton, biomass, dry weight | 2190 | 81354 | GRV06 | | 0.1 | mg/L | mrl | CHL |

*CAS Registry Number® is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CASRNs through CAS Client Services.*

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**Method ID:** 10200 I

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Rapi-Note 05-025
Changes to NWQL Chlorophyll Analyses, September 9, 2005, NWQL Rapi-Note 05-025

Chlorophyll memo
NWQL Memo: Changes to NWQL Chlorophyll Analysis

## Schedule 1865

**Description:** Low Level Dissolved Nutrients + Persulfate Total Nitrogen & Phosphorus
**Analyzing Laboratory(s):** USGS-National Water Quality Lab, Denver, CO

| Analyte | Lab Code | Parameter Code | M | CAS Number | RL | Unit | RL Type | Container |
|---|---|---|---|---|---|---|---|---|
| Nitrogen, ammonia as N | 3116 | 00608 | 00048 | 7664-41-7 | 0.02 | mg/L | irl | FCC |
| nitrogen, nitrite | 3117 | 00613 | 00049 | 14797-65-0 | 0.002 | mg/L | irl | FCC |
| nitrogen, nitrite + nitrate | 1979 | 00631 | CL050 | | 0.016 | mg/L | lrl | FCC |
| Total nitrogen (NH3+NO2+NO3+Organic), filtered | 2754 | 62854 | CL063 | 17778-88-0 | 0.06 | mg/L | lrl | FCC |
| Total nitrogen (NH3+NO2+NO3+Organic), unfiltered | 2756 | 62855 | AKP01 | 17778-88-0 | 0.06 | mg/L | lrl | WCA |
| Phosphorus | 2331 | 00666 | CL020 | 7723-14-0 | 0.006 | mg/L | lrl | FCC |
| phosphorus, phosphate, ortho | 3118 | 00671 | 00048 | 14265-44-2 | 0.006 | mg/L | irl | FCC |
| Phosphorus | 2333 | 00665 | CL021 | 7723-14-0 | 0.008 | mg/L | lrl | WCA |



### References

WRIR 03-4174
Patton, C.J., Kryskalla. J.R., Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory ? Evaluation of Alkaline Persulfate Digestion as an Alternative to Kjeldahl Digestion for Determination of Total and Dissolved Nitrogen and Phosphorus in Water, Water-Resources Investigations Report 03-4174, 33p.
**Method ID:** I-2650-03 , I-4650-03

**OFR 93-125**
Fishman, M.J., ed., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory--Determination of inorganic and organic constituents in water and fluvial sediments: U.S. Geological Survey Open-File Report 93-125, 217 p.
**Method ID:** I-2540-90 , I-2525-89 , I-2601-90 , I-2542-89 , I-2546-91 , I-2522-90 , I-2606-89

**EPA 365.1**
Determination of Phosphorus by Semi-Automated Colorimetry Revision 2.0, Methods for the Determination of Inorganic Substances in Environmental Samples

Memo -- USEPA Approval for nationwide use of ATP method
Telliard, W.A., USEPA, Director of Analytical Methods, Engineering and Anlysis Division

Memo - method approval announcement (July 2, 2003)
Approval of a Water Quality Analytical Method for the Determination of Nitrogen and Phosphorus in Whole and Filtered Water by the National Water Quality Laboratory
**Method ID:** I-2650-03

**Schedule 591**

**Description:** S591 NWQL, Major Ions + Trace + Physical Property
**Analyzing Laboratory(s):** USGS-National Water Quality Lab, Denver, CO

| Analyte | Lab Code | Parameter Code | M | CAS Number | RL | Unit | RL Type | Container |
|---|---|---|---|---|---|---|---|---|
| Calcium | 659 | 00915 | PLA11 | 7440-70-2 | 0.04 | mg/L | lrl | FA |
| Chloride | 1571 | 00940 | IC022 | 16887-00-6 | 0.12 | mg/L | lrl | FU |
| Fluoride | 31 | 00950 | ISE05 | 16984-48-8 | 0.12 | mg/L | lrl | FU |
| Inductively coupled plasma (ICP) setup | 2002 | L2002 | | | | unsp | lrl | FA |
| Iron | 645 | 01046 | PLA11 | 7439-89-6 | 8 | ug/L | lrl | FA |
| Magnesium | 663 | 00925 | PLA11 | 7439-95-4 | 0.02 | mg/L | lrl | FA |
| Manganese | 648 | 01056 | PLA11 | 7439-96-5 | 0.4 | ug/L | lrl | FA |
| pH, laboratory | 68 | 00403 | EL006 | | 0.1 | pH | mrl | RU |
| Potassium | 2773 | 00935 | PLO03 | 7440-09-7 | 0.02 | mg/L | lrl | FA |
| Residue, 180 degrees Celsius (TDS) | 27 | 70300 | ROE10 | | 10 | mg/L | mrl | FU |
| Silica | 56 | 00955 | CL064 | 7631-86-9 | 0.20 | mg/L | lrl | FU |
| Sodium | 675 | 00930 | PLA11 | 7440-23-5 | 0.12 | mg/L | lrl | FA |
| specific conductance, laboratory | 69 | 90095 | WHT03 | | 2.6 | uS/cm | mrl | RU |
| Sulfate | 1572 | 00945 | IC022 | 14808-79-8 | 0.18 | mg/L | lrl | FU |

*Lab Code 69 may only be deleted when the field conductivity value is provided.*



**References**

**Std Meth 20th Edition - 3120**
American Public Health Association, 1998, Standard methods for the examination of water and wastewater (20th ed.); Washington, D.C., American Public Health Association, American Water Works Association, and Water Environment Federation, p.3-37 - 3-43.
**Method ID:** 3120-ICP

**TWRI B5-A1/89**
Fishman, M.J., and Friedman, L.C., 1989, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 545 p.
**Method ID:** I-2587-89 , I-2057-85 , I-2700-89 , I-2327-89 , I-2781-89 , I-1750-89

**OFR 93-125**
Fishman, M.J., ed., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory--Determination of inorganic and organic constituents in water and fluvial sediments: U.S. Geological Survey Open-File Report 93-125, 217 p.
**Method ID:** I-1472-87

TWRI B5-A1/89
Fishman, M.J., and Friedman, L.C., 1989, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 545 p.
**Method ID:** I-2587-89 , I-2057-85 , I-2700-89 , I-2327-89 , I-2781-89 , I-1750-89

**Lab Code 49**

**Description:** Solids, Volatile on Ignition (VOI), suspended, gravimetric
**Analyzing Laboratory:** USGS-National Water Quality Lab, Denver, CO

| Parameter Name | Lab Code | Parameter Code | M | CAS Number | RL | Unit | RL Code |
|---|---|---|---|---|---|---|---|
| residue, volatile | 49 | 00535 | SLD05 | | 10 | mg/L | mrl |

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**Callins**

| Parameter Name | Lab Code | Parameter Code | M | CAS Number | RL | Unit | RL Code |
|---|---|---|---|---|---|---|---|
| Residue | 169 | 00530 | SLD04 | | 10 | mg/L | mrl |

**References**

**TWRI B5-A1/89**
Fishman, M.J., and Friedman, L.C., 1989, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 545 p.
**Method ID:** I-3767-89

**Lab Code 2614**

**Description:** UV Absorbing Organic Constituents - 254 nm, Filtered, Glass Fiber Filter
**Analyzing Laboratory:** USGS-National Water Quality Lab, Denver, CO

| Parameter Name | Lab Code | Parameter Code | M | CAS Number | RL | Unit | RL Code |
|---|---|---|---|---|---|---|---|
| Ultraviolet absorbing organic constituents - 254 nm | 2614 | 50624 | UV005 | | 0.018 | u/cm | lrl |

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| Parameter Name | Lab Code | Parameter Code | M | CAS Number | RL | Unit | RL Code |
|---|---|---|---|---|---|---|---|
| Ultraviolet absorbing organic constituents - 280nm | 2615 | 61726 | UV007 | | 0.016 | u/cm | lrl |

**References**

**Std Meth, 19th Ed. 1995**
UV-Absorbing organic constituents, Nineteenth Edition of Standard Methods for the Examination of Water and Wastewater (American Public Health Association, 1995), p. 5-60 to 5-62
**Method ID:** 5910

## Lab Code 2612

**Description:** Organic Carbon, Dissolved, (DOC), Water, Filtered, SUPOR, Sulfuric Acid Preserved
**Analyzing Laboratory:** "USGS-National Water Quality Lab, Denver, CO "

| Parameter Name | Lab Code | Parameter Code | M | CAS Number | RL | Unit | RL Code |
|---|---|---|---|---|---|---|---|
| Organic carbon | 2612 | 00681 | OX006 | | 0.4 | mg/L | lrl |

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**References**

**OFR 92-480**
Brenton, R.W., and Arnett, T.L., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory--Determination of dissolved organic carbon by uv-promoted persulfate oxidation and infrared spectrometry: U.S. Geological Survey Open-File Report 92-480, 12 p.
**Method ID:** O-1120-92

## Schedule 1433

**Description:** Waste Water Compounds, Filtered , SPE, GCMS
**Analyzing Laboratory(s):**
"USGS-National Water Quality Lab, Denver, CO "

| Analyte | Parameter Code | M | CAS Number | RL | Unit | RL Type | CA | Container |
|---|---|---|---|---|---|---|---|---|
| Cotinine | 62005 | GCM37 | 486-56-6 | 0.4 | ug/L | lrl | | GCC |
| 5-Methyl-1H-benzotriazole | 62063 | GCM37 | 136-85-6 | 0.08 | ug/L | lrl | | GCC |
| Anthraquinone | 62066 | GCM37 | 84-65-1 | 0.16 | ug/L | lrl | | GCC |
| Acetophenone | 62064 | GCM37 | 98-86-2 | 0.4 | ug/L | lrl | | GCC |
| Acetyl hexamethyl tetrahydronaphthalene (AHTN) | 62065 | GCM37 | 21145-77-7 | 0.5 | ug/L | irl | | GCC |
| Anthracene | 34221 | GCM37 | 120-12-7 | 0.08 | ug/L | lrl | | GCC |
| 1,4-Dichlorobenzene | 34572 | GCM37 | 106-46-7 | 0.08 | ug/L | lrl | | GCC |
| Benzo[a]pyrene | 34248 | GCM37 | 50-32-8 | 0.12 | ug/L | lrl | | GCC |
| Benzophenone | 62067 | GCM37 | 119-61-9 | 0.12 | ug/L | lrl | | GCC |
| Bromacil | 04029 | GCM37 | 314-40-9 | 0.4 | ug/L | lrl | | GCC |
| Bromoform | 34288 | GCM37 | 75-25-2 | 0.08 | ug/L | irl | | GCC |
| 3-tert-Butyl-4-hydroxy anisole (BHA) | 62059 | GCM37 | 25013-16-5 | 0.6 | ug/L | lrl | | GCC |
| Caffeine | 50305 | GCM37 | 58-08-2 | 0.1 | ug/L | lrl | | GCC |
| Caffeine-C13 | 99584 | GCM37 | | | pct | | | GCC |
| Camphor | 62070 | GCM37 | 76-22-2 | 0.10 | ug/L | lrl | | GCC |
| Carbaryl | 82680 | GCM37 | 63-25-2 | 1.0 | ug/L | lrl | | GCC |
| Carbazole | 62071 | GCM37 | 86-74-8 | 0.08 | ug/L | lrl | | GCC |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Chlorpyrifos | 38933 | GCM37 | 2921-88-2 | 0.12 | ug/L | lrl | | GCC |
| Cholesterol | 62072 | GCM37 | 57-88-5 | 1.4 | ug/L | lrl | | GCC |
| 3-beta-Coprostanol | 62057 | GCM37 | 360-68-9 | 1 | ug/L | lrl | | GCC |
| Isopropylbenzene | 62078 | GCM37 | 98-82-8 | 0.10 | ug/L | lrl | | GCC |
| Fluoranthene-d10 | 99586 | GCM37 | 93951-69-0 | | pct | | | GCC |
| Bisphenol A-d3 | 99583 | GCM37 | | | pct | | | GCC |
| Decafluorobiphenyl | 99585 | GCM37 | 434-90-2 | | pct | | | GCC |
| N,N-diethyl-meta-toluamide (DEET) | 62082 | GCM37 | 134-62-3 | 0.1 | ug/L | lrl | | GCC |
| Diazinon | 39572 | GCM37 | 333-41-5 | 0.08 | ug/L | lrl | | GCC |
| Bisphenol A | 62069 | GCM37 | 80-05-7 | 0.4 | ug/L | lrl | | GCC |
| Triethyl citrate (ethyl citrate) | 62091 | GCM37 | 77-93-0 | 0.2 | ug/L | lrl | | GCC |
| Tetrachloroethylene | 34476 | GCM37 | 127-18-4 | 0.08 | ug/L | lrl | | GCC |
| Fluoranthene | 34377 | GCM37 | 206-44-0 | 0.08 | ug/L | irl | | GCC |
| Hexahydrohexamethylcyclopentabenzopyran (HHCB) | 62075 | GCM37 | 1222-05-5 | 0.5 | ug/L | irl | | GCC |
| Indole | 62076 | GCM37 | 120-72-9 | 0.14 | ug/L | lrl | | GCC |
| Isoborneol | 62077 | GCM37 | 124-76-5 | 0.06 | ug/L | lrl | | GCC |
| Isophorone | 34409 | GCM37 | 78-59-1 | 0.08 | ug/L | lrl | | GCC |
| Isoquinoline | 62079 | GCM37 | 119-65-3 | 0.2 | ug/L | lrl | | GCC |
| d-Limonene | 62073 | GCM37 | 5989-27-5 | 0.04 | ug/L | lrl | | GCC |
| Menthol | 62080 | GCM37 | 89-78-1 | 0.2 | ug/L | lrl | | GCC |
| Metalaxyl | 50359 | GCM37 | 57837-19-1 | 0.08 | ug/L | lrl | | GCC |
| Metolachlor | 39415 | GCM37 | 51218-45-2 | 0.08 | ug/L | lrl | | GCC |
| Naphthalene | 34443 | GCM37 | 91-20-3 | 0.10 | ug/L | lrl | | GCC |
| 1-Methylnaphthalene | 62054 | GCM37 | 90-12-0 | 0.10 | ug/L | lrl | | GCC |
| 2,6-Dimethylnaphthalene | 62055 | GCM37 | 581-42-0 | 0.12 | ug/L | lrl | | GCC |
| 2-Methylnaphthalene | 62056 | GCM37 | 91-57-6 | 0.08 | ug/L | lrl | | GCC |
| 4-Nonylphenol diethoxylate, (sum of all isomers) aka NP2EO | 62083 | GCM37 | | 5 | ug/L | irl | | GCC |
| 4-Octylphenol diethoxylate, (sum of all isomers) aka OP2EO | 61705 | GCM37 | | 1 | ug/L | irl | | GCC |
| 4-Octylphenol monoethoxylate, (sum of all isomers) aka OP1EO | 61706 | GCM37 | | 1 | ug/L | irl | | GCC |
| p-Cresol | 62084 | GCM37 | 106-44-5 | 0.18 | ug/L | lrl | | GCC |
| 4-Cumylphenol | 62060 | GCM37 | 599-64-4 | 0.1 | ug/L | lrl | | GCC |
| para-Nonylphenol (total) (branched) | 62085 | GCM37 | 84852-15-3 | 1 | ug/L | lrl | | GCC |
| 4-n-Octylphenol | 62061 | GCM37 | 1806-26-4 | 0.16 | ug/L | lrl | | GCC |
| 4-tert-Octylphenol | 62062 | GCM37 | 140-66-9 | 1 | ug/L | lrl | | GCC |
| Phenanthrene | 34462 | GCM37 | 85-01-8 | 0.08 | ug/L | irl | | GCC |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Phenol | 34466 | GCM37 | 108-95-2 | 0.2 | ug/L | lrl | | GCC |
| Pentachlorophenol | 34459 | GCM37 | 87-86-5 | 2 | ug/L | irl | | GCC |
| Tributyl phosphate | 62089 | GCM37 | 126-73-8 | 0.2 | ug/L | lrl | | GCC |
| Triphenyl phosphate | 62092 | GCM37 | 115-86-6 | 0.1 | ug/L | lrl | | GCC |
| Tris(2-butoxyethyl)phosphate | 62093 | GCM37 | 78-51-3 | 0.4 | ug/L | lrl | | GCC |
| Tris(2-chloroethyl)phosphate | 62087 | GCM37 | 115-96-8 | 0.1 | ug/L | lrl | | GCC |
| Prometon | 04037 | GCM37 | 1610-18-0 | 0.18 | ug/L | lrl | | GCC |
| Pyrene | 34470 | GCM37 | 129-00-0 | 0.08 | ug/L | lrl | | GCC |
| Methyl salicylate | 62081 | GCM37 | 119-36-8 | 0.1 | ug/L | lrl | | GCC |
| Sample volume | 99587 | GCM37 | | | mL | | | GCC |
| set number, schedule 1433 | 99588 | GCM37 | | | no. | | | GCC |
| 3-Methyl-1(H)-indole (Skatole) | 62058 | GCM37 | 83-34-1 | 0.08 | ug/L | irl | | GCC |
| beta-Sitosterol | 62068 | GCM37 | 83-46-5 | 1.6 | ug/L | lrl | | GCC |
| beta-Stigmastanol | 62086 | GCM37 | 19466-47-8 | 1.2 | ug/L | lrl | | GCC |
| Triclosan | 62090 | GCM37 | 3380-34-5 | 0.2 | ug/L | lrl | | GCC |
| Tris(dichlorisopropyl)phosphate | 62088 | GCM37 | 13674-87-8 | 0.12 | ug/L | lrl | | GCC |

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*Values of "C" in the C A column denote NELAP Certified analytes*

## Container Requirements

| Quantity | Bottle |
|---|---|
| 1 | **1L** GCC - This schedule consumes the entire container.<br>**Description:**<br>**Treatment and Preservation:** 1L; 500mL; 125mL; or 60mL (see schedule for size) Glass amber bottle baked at 450 deg C<br>by laboratory - **SOME** GCCs should be filtered CHECK METHOD REFERENCE OR EMAIL LABHELP@USGS.GOV<br>FOR FILTERING REQUIREMENTS? DO NOT RINSE BOTTLE. Do not fill bottle beyond shoulder. reagents must<br>be added to the sample at the NWQL before analyses. Chill sample and maintain at 4 deg C. ship immediately. |

## References

WRIR 01-4186
Zaugg, S.D., Smith, S.G., Schroeder, M.P., Barber, L.B., and Burkhardt, M.R., 2002, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory---Determination of wastewater compounds by polystyrene-divinylbenzene solid-phase extraction and capillary-column gas chromatography/mass spectrometry: U.S. Geological Survey Water-Resources Investigations Report 01-4186, 37 p.
**Method ID:** O-1433-01

NWQL Tech Memo 06.01
Review of method performance and improvements for determining wastewater compounds (Schedule 1433), May 3, 2006

OWQ Information note 2007.04
Office of Water Quality Information Note 2007.04, Field methods- Dechlorination reagent for organic compounds tested resulting in new preservative requirements for water samples containing residual chlorine

## NON-NWQL ANALYSES FOR WATER SAMPLES

**Lab Schedule GCG**

**Description:** Geosmin and Methyisoborneol Analysis

**Analyzing Laboraotry:** USGS, Kansas Organic Geochemistry Laboratory

**Method:** Gas chromatography/mass spectrometry

**Laboratory Reporting Level:** 0.005 micrograms per liter

**References:**
Zimmerman, A.C. Ziegler, and E.M. Thurman, 2002, Method of Analysis and Quality-Assurance Practices by U.S. Geological Survey Organic Geochemistry Research Group--Determination of Geosmin and 2-methylisoborneol in Water Using Solid-Phase Microextraction and Gas Chromatography/Mass Spectrometry: U.S. Geological Survey Open-File Report 02-337, 12 p.

**Lab Schedule IMN**

**Description:** Microcystin

**Analyzing Laboraotry:** USGS, Kansas Organic Geochemistry Laboratory

**Method:** Enzyme-Linked Immunoabsorbent Assay (ELISA)

**Laboratory Reporting Level:** 0.010 microgram per liter

Other background information

# Appendix C. Phytoplankton Taxonomy at Selected Sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| LWB-03 | 30-Aug-05 | 1 | Bacillariophyta | Achnanthaceae | *Achnanthes minutissima* | 6 | 260 |
| | | | | Fragilariaceae | *Fragilaria construens* | | 65 |
| | | | | | *Synedra nana* | | 162 |
| | | | | | *Synedra tenera* | | 260 |
| | | | | Naviculaceae | *Navicula* | | 65 |
| | | | | Stephanodiscaceae | *Cyclotella pseudostelligera* | | 97 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 15 | 195 |
| | | | | | *Chlamydomonas globosa* | | 65 |
| | | | | | *Chlorogonium* | | 32 |
| | | | | Chlorococcaceae | | | 682 |
| | | | | | *Nautococcus pyriformis* | | 16,289 |
| | | | | | *Tetraedron minimum* | | 32 |
| | | | | Desmidiaceae | *Closterium* | | 32 |
| | | | | | *Cosmarium tenue* | | 32 |
| | | | | | *Staurastrum hexacerum* | | 32 |
| | | | | | *Xanthidium* | | 97 |
| | | | | Micractinaceae | *Golenkeniopsis parvula* | | 9,582 |
| | | | | | *Golenkinia paucispina* | | 162 |
| | | | | Oocystaceae | *Closteriopsis longissima* | | 519 |
| | | | | | *Franceia droescheri* | | 32 |
| | | | | | *Monoraphidium capricornutum* | | 4,106 |
| | | | | Scenedesmaceae | *Scenedesmus bicaudatus* | | 65 |
| | | | Chrysophyta | Synuraceae | *Mallomonas* | 1 | 32 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 2 | 130 |
| | | | | | *Rhodomonas minuta* | | 32 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 8 | 98,554 |
| | | | | | *Aphanocapsa delicatissima* | | 9,855 |
| | | | | | *Merismopedia warmingiana* | | 6,570 |
| | | | | | *Synechococcus sp.1* | | 61,596 |
| | | | | Nostocaceae | *Aphanizomenon gracile* | | 400 |
| | | | | | *Aphanizomenon issatschenkoi* | | 1,558 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 86,073 |
| | | | | | *Oscillatoria amphibia* | | 811 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 85,414 |
| | | | Euglenophyta | Euglenaceae | *Euglena* | 3 | 32 |
| | | | | | *Trachelomonas* | | 11 |
| | | | | | *Trachelomonas volvocina* | | 11 |
| | | | Pyrrhophyta | Glenodiniaceae | *Glenodinium* | 4 | 11 |
| | | | | | *Gymnodinium sp.1* | | 32 |
| | | | | | *Gymnodinium sp.2* | | 32 |
| | | | | Peridinaceae | *Peridinium umbonatum* | | 130 |
| LWB-04 | 30-Aug-05 | 1 | Bacillariophyta | Achnanthaceae | *Achnanthes minutissima* | 6 | 389 |
| | | | | Fragilariaceae | *Synedra nana* | | 97 |
| | | | | | *Synedra tenera* | | 130 |
| | | | | Naviculaceae | *Navicula* | | 32 |
| | | | | Stephanodiscaceae | *Cyclostephanos tholiformis* | | 32 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | | *Cyclotella pseudostelligera* | | 65 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 18 | 292 |
| | | | | | *Chlorogonium* | | 32 |
| | | | | Chlorococcaceae | Unknown | | 162 |
| | | | | | *Nautococcus pyriformis* | | 9,034 |
| | | | | Desmidiaceae | *Staurastrum hexacerum* | | 32 |
| | | | | | *Staurastrum iotanum* | | 32 |
| | | | | | *Xanthidium* | | 195 |
| | | | | Micractinaceae | *Golenkeniopsis parvula* | | 1,643 |
| | | | | | *Golenkinia paucispina* | | 227 |
| | | | | Oocystaceae | *Ankistrodesmus falcatus* | | 97 |
| | | | | | *Closteriopsis longissima* | | 584 |
| | | | | | *Monoraphidium capricornutum* | | 411 |
| | | | | | *Oocystis parva* | | 32 |
| | | | | Scenedesmaceae | *Crucigenia crucifera* | | 88 |
| | | | | | *Scenedesmus bijuga* | | 32 |
| | | | | | *Scenedesmus serratus* | | 65 |
| | | | | | *Selenastrum minutum* | | 32 |
| | | | | Zygnemataceae | *Mougeotia* | | 162 |
| | | | | | *Teilingia granulata* | | 195 |
| | | | Chrysophyta | Chrysocapsaceae | Unknown | 3 | |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | |
| | | | | Synuraceae | *Mallomonas* | | |
| | | | | Cryptomonadaceae | *Cryptomonas erosa* | | |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 7 | 16,426 |
| | | | | | *Aphanocapsa delicatissima* | | 8,213 |
| | | | | | *Synechococcus sp.1* | | 139,619 |
| | | | | | *Synechocystis* | | 32 |
| | | | | Nostocaceae | *Cylindrospermopsis raciborskii* | | 671 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 64,139 |
| | | | | | *Oscillatoria limnetica* | | 974 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 128,449 |
| | | | Euglenophyta | Euglenaceae | *Euglena* | 2 | 32 |
| | | | | | *Trachelomonas* | | 32 |
| | | | Pyrrhophyta | Gymnodiniaceae | *Gymnodinium sp.3* | 2 | 32 |
| | | | | Peridinaceae | *Peridinium umbonatum* | | 65 |
| LWB-05 | 31-Aug-05 | 1 | Bacillariophyta | Achnanthaceae | *Achnanthes minutissima* | 7 | 61 |
| | | | | Bacillariaceae | *Nitzschia palea* | | 121 |
| | | | | Fragilariaceae | *Fragilaria construens* | | 30 |
| | | | | | *Synedra nana* | | 303 |
| | | | | | *Synedra tenera* | | 151 |
| | | | | Naviculaceae | *Navicula* | | 30 |
| | | | | Stephanodiscaceae | *Cyclotella pseudostelligera* | | 273 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 9 | 151 |
| | | | | Chlorococcaceae | Unknown | | 91 |
| | | | | | *Nautococcus pyriformis* | | 11,146 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | | *Schroederia judayi* | | 30 |
| | | | | | *Tetraedron gracile* | | 30 |
| | | | | | *Tetraedron minimum* | | 30 |
| | | | | Desmidiaceae | *Staurastrum hexacerum* | | 61 |
| | | | | | *Staurastrum iotanum* | | 121 |
| | | | | | *Xanthidium* | | 242 |
| | | | | Dictyosphaeriaceae | *Dictyosphaerium pulchellum* | | 121 |
| | | | Chlorophyta | Hydrodictyaceae | *Pediastrum tetras* | 12 | 242 |
| | | | | Micractinaceae | *Golenkeniopsis parvula* | | 91 |
| | | | | | *Golenkinia paucispina* | | 61 |
| | | | | Oocystaceae | *Ankistrodesmus falcatus* | | 30 |
| | | | | | *Closteriopsis longissima* | | 242 |
| | | | | Oocystaceae | *Monoraphidium capricornutum* | | 182 |
| | | | | Scenedesmaceae | *Scenedesmus abundans* | | 30 |
| | | | | | *Scenedesmus bijuga* | | 61 |
| | | | | | *Scenedesmus opoliensis* | | 61 |
| | | | | | *Scenedesmus serratus* | | 303 |
| | | | | Zygnemataceae | *Mougeotia* | | 61 |
| | | | | | *Teilingia granulata* | | 394 |
| | | | Chrysophyta | Chloromonadinaceae | *Gonyostomum ovatum* | 3 | 61 |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | 61 |
| | | | | Synuraceae | *Mallomonas* | | 91 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 1 | 273 |
| | | | Cyanophtyta | Chroococcaceae | Unknown | 9 | 65,703 |
| | | | | | *Aphanocapsa delicatissima* | | 2,196 |
| | | | | | *Merismopedia warmingiana* | | 121 |
| | | | | | *Microcystis wesenbergii* | | 2,743 |
| | | | | | *Synechococcus sp.1* | | 106,767 |
| | | | | Nostocaceae | *Cylindrospermopsis raciborskii* | | 1,539 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 39,356 |
| | | | | | *Oscillatoria amphibia* | | 364 |
| | | | | | *Oscillatoria limnetica* | | 303 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 84,319 |
| | | | Euglenophyta | Euglenaceae | *Euglena* | 2 | 61 |
| | | | | | *Phacus horridus* | | 30 |
| | | | Pyrrhophyta | Gymnodiniaceae | *Gymnodinium sp.3* | 2 | 22 |
| | | | | Peridinaceae | *Peridinium umbonatum* | | 154 |
| | | | Xanthophyta | Centratractaceae | *Centratractus belonophorus* | 1 | 30 |
| | | | | | | | |
| LWB-07 | 1-Sep-05 | 1 | Bacillariophyta | Achnanthaceae | *Achnanthes minutissima* | 4 | 204 |
| | | | | Fragilariaceae | *Synedra nana* | | 114 |
| | | | | | *Synedra tenera* | | 256 |
| | | | | Stephanodiscaceae | *Cyclotella pseudostelligera* | | 45 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 18 | 91 |
| | | | | Chlorococcaceae | Unknown | | 682 |
| | | | | | *Nautococcus pyriformis* | | 2,464 |
| | | | | Desmidiaceae | *Staurastrum hexacerum* | | 136 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | | *Staurastrum iotanum* | | 68 |
| | | | | | *Xanthidium* | | 273 |
| | | | | Hydrodictyaceae | *Pediastrum tetras* | | 182 |
| | | | | Micractinaceae | *Golenkeniopsis parvula* | | 204 |
| | | | | | *Golenkinia paucispina* | | 23 |
| | | | | Oocystaceae | *Ankistrodesmus falcatus* | | 45 |
| | | | | | *Closteriopsis longissima* | | 182 |
| | | | | | *Kirchneriella* | | 68 |
| | | | | | *Monoraphidium capricornutum* | | 477 |
| | | | | Scenedesmaceae | *Crucigenia tetrapedia* | | 91 |
| | | | | | *Scenedesmus bijuga* | | 45 |
| | | | | | *Scenedesmus serratus* | | 273 |
| | | | | | *Tetrastrum staurogeniaeforme* | | 91 |
| | | | | Zygnemataceae | *Mougeotia* | | 23 |
| | | | | | *Teilingia granulata* | | 295 |
| | | | Chrysophyta | Dinobryaceae | *Dinobryon bavaricum* | 3 | 68 |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | 114 |
| | | | | Synuraceae | *Mallomonas* | | 23 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 1 | 23 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 9 | 98,554 |
| | | | | | *Aphanocapsa delicatissima* | | 8,084 |
| | | | | | *Dactylococcopsis irregularis* | | 68 |
| | | | | | *Synechococcus sp.1* | | 90,341 |
| | | | | Nostocaceae | *Aphanizomenon gracile* | | 682 |
| | | | | | *Aphanizomenon issatschenkoi* | | 114 |
| | | | | | *Cylindrospermopsis raciborskii* | | 3,401 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 37,037 |
| | | | | | *Oscillatoria amphibia* | | 303 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 49,277 |
| | | | Euglenophyta | Euglenaceae | *Euglena* | 1 | 159 |
| | | | Pyrrhophyta | Glenodiniaceae | *Glenodinium* | 3 | 11 |
| | | | | | *Gymnodinium sp.3* | | 23 |
| | | | | Peridinaceae | *Peridinium umbonatum* | | 68 |
| LWB-08 | 31-Aug-05 | 1 | Bacillariophyta | Achnanthaceae | *Achnanthes minutissima* | 8 | 68 |
| | | | | Bacillariaceae | *Nitzschia palea* | | 45 |
| | | | | Fragilariaceae | *Fragilaria capucina* | | 23 |
| | | | | | *Synedra nana* | | 136 |
| | | | | | *Synedra tenera* | | 136 |
| | | | | | *Synedra ulna* | | 23 |
| | | | | Rhizosoleniaceae | *Rhizosolenia longiseta* | | 23 |
| | | | | Stephanodiscaceae | *Cyclotella pseudostelligera* | | 182 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 20 | 91 |
| | | | | Chlorococcaceae | Unknown | | 227 |
| | | | | | *Nautococcus pyriformis* | | 5,749 |
| | | | | | *Tetraedron muticum* | | 23 |
| | | | | Desmidiaceae | *Staurastrum hexacerum* | | 45 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | | *Staurastrum iotanum* | | 182 |
| | | | | | *Xanthidium* | | 182 |
| | | | | Dictyosphaeriaceae | *Dictyosphaerium pulchellum* | | 2,464 |
| | | | | Hydrodictyaceae | *Pediastrum* | | 88 |
| | | | | Micractinaceae | *Golenkeniopsis parvula* | | 114 |
| | | | | | *Golenkinia paucispina* | | 45 |
| | | | | Oocystaceae | *Ankistrodesmus falcatus* | | 23 |
| | | | | | *Closteriopsis longissima* | | 136 |
| | | | | | *Monoraphidium capricornutum* | | 114 |
| | | | | | *Oocystis pusilla* | | 91 |
| | | | | | *Treubaria setigerum* | | 23 |
| | | | | Scenedesmaceae | *Crucigenia crucifera* | | 182 |
| | | | | | *Scenedesmus opoliensis* | | 45 |
| | | | | | *Scenedesmus serratus* | | 454 |
| | | | | Zygnemataceae | *Mougeotia* | | 45 |
| | | | | | *Teilingia granulata* | | 227 |
| | | | Chrysophyta | Dinobryaceae | *Dinobryon bavaricum* | 3 | 23 |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | 68 |
| | | | | Synuraceae | *Mallomonas* | | 23 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 1 | 23 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 11 | 69,809 |
| | | | | | *Aphanocapsa delicatissima* | | 1,545 |
| | | | | | *Chroococcus minutus* | | 45 |
| | | | | | *Dactylococcopsis irregularis* | | 23 |
| | | | | | *Merismopedia tenuissima* | | 545 |
| | | | | | *Synechococcus sp.1* | | 69,809 |
| | | | | Nostocaceae | *Anabaena aphanizomenoides* | | 394 |
| | | | | | *Anabaena planctonica* | | 274 |
| | | | | | *Aphanizomenon issatschenkoi* | | 151 |
| | | | | | *Cylindrospermopsis raciborskii* | | 2,234 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 41,667 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 49,277 |
| | | | Euglenophyta | Euglenaceae | *Euglena* | 2 | 114 |
| | | | | | *Trachelomonas* | | 23 |
| | | | Pyrrhophyta | Gymnodiniaceae | *Gymnodinium sp.3* | 2 | 45 |
| | | | | Peridinaceae | *Peridinium umbonatum* | | 45 |
| | | | | | | | |
| LWB-08 | 16-May-06 | 1 | Bacillariophyta | Achnanthaceae | *Achnanthes minutissima* | 9 | 20 |
| | | | | | *Aulacoseira ambigua* | | 49 |
| | | | | | *Aulacoseira distans* | | 444 |
| | | | | Bacillariaceae | *Nitzschia acicularis* | | 20 |
| | | | | | *Nitzschia palea* | | 10 |
| | | | | Fragilariaceae | *Synedra tenera* | | 263 |
| | | | | | *Synedra ulna* | | 10 |
| | | | | Rhizosoleniaceae | *Rhizosolenia longiseta* | | 212 |
| | | | | Stephanodiscaceae | *Cyclotella stelligera* | | 172 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 18 | 242 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | | *Chlamydomonas globosa* | | 10 |
| | | | | Chlorococcaceae | Unknown | | 30 |
| | | | | | *Tetraedron caudatum* | | 10 |
| | | | | Desmidiaceae | *Closterium* | | 30 |
| | | | | | *Cosmarium* | | 10 |
| | | | | Dictyosphaeriaceae | *Dictyosphaerium pulchellum* | | 40 |
| | | | | Micractinaceae | *Micractinium pusillum* | | 206 |
| | | | | Oocystaceae | *Ankistrodesmus convolutus* | | 20 |
| | | | | | *Ankistrodesmus falcatus* | | 565 |
| | | | | | *Monoraphidium capricornutum* | | 10 |
| | | | | | *Oocystis parva* | | 61 |
| | | | | | *Quadrigula lacustris* | | 20 |
| | | | | Phacotaceae | *Phacotus lendneri* | | 10 |
| | | | | Polyblepharidaceae | *Nephroselmis* | | 10 |
| | | | | Scenedesmaceae | *Scenedesmus abundans* | | 20 |
| | | | | | *Scenedesmus verrucosus* | | 40 |
| | | | | | *Selenastrum gracile* | | 121 |
| | | | | Volvocaceae | *Eudorina elegans* | | 162 |
| | | | Chrysophyta | Chrysococcaceae | *Kephyrion gracilis* | 8 | 111 |
| | | | | | *Kephyrion skujae* | | 10 |
| | | | | Dinobryaceae | *Dinobryon* | | 1,303 |
| | | | | | *Dinobryon sociale* | | 20 |
| | | | | | *Dinobryon sp.4* | | 30 |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | 121 |
| | | | | Paraliaceae | *Ellipsoidion pachydermum* | | 111 |
| | | | | Synuraceae | *Mallomonas* | | 50 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 3 | 293 |
| | | | | Cryptomonadaceae | *Cryptomonas ovata* | | 10 |
| | | | | Cryptomonadaceae | *Rhodomonas minuta* | | 101 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 8 | 65,703 |
| | | | | | *Aphanothece nidulans* | | 404 |
| | | | | | *Chroococcus minimus* | | 20 |
| | | | | | *Synechococcus sp.1* | | 104,030 |
| | | | | | *Synechocystis* | | 10 |
| | | | | Oscillatoriaceae | *Oscillatoria amphibia* | | 303 |
| | | | | | *Oscillatoria limnetica* | | 73 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 36,410 |
| | | | Euglenophyta | Euglenaceae | *Trachelomonas volvocina* | 1 | 10 |
| | | | Miscellaneous | . | Unknown | | 616 |
| | | | Pyrrhophyta | Gymnodiniaceae | *Gymnodinium sp.2* | 3 | 30 |
| | | | | Gymnodiniaceae | *Gymnodinium sp.3* | | 30 |
| | | | | Peridinaceae | *Peridinium umbonatum* | | 20 |
| LWB-08 | 16-May-06 | 6 | Bacillariophyta | Aulacoseriaceae | *Aulacoseira ambigua* | 7 | 161 |
| | | | | | *Aulacoseira distans* | | 485 |
| | | | | Fragilariaceae | *Fragilaria construens* | | 91 |
| | | | | | *Synedra tenera* | | 242 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | | *Synedra ulna* | | 30 |
| | | | | Rhizosoleniaceae | *Rhizosolenia longiseta* | | 61 |
| | | | | Stephanodiscaceae | *Cyclotella stelligera* | | 212 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 7 | 394 |
| | | | | | *Chlamydomonas globosa* | | 61 |
| | | | | Chlorococcaceae | Unknown | | 91 |
| | | | Chlorophyta | Desmidiaceae | *Closterium* | | 61 |
| | | | | Micractinaceae | *Micractinium pusillum* | | 212 |
| | | | | Oocystaceae | *Ankistrodesmus falcatus* | | 727 |
| | | | | Oocystaceae | *Oocystis parva* | | 212 |
| | | | | Scenedesmaceae | *Scenedesmus serratus* | | 1,095 |
| | | | Chrysophyta | Chrysococcaceae | *Kephyrion* | 5 | 30 |
| | | | | Dinobryaceae | *Dinobryon* | | 1,000 |
| | | | | Dinobryaceae | *Dinobryon sp.4* | | 30 |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | 4,544 |
| | | | | Paraliaceae | *Ellipsoidion pachydermum* | | 182 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 2 | 757 |
| | | | | Cryptomonadaceae | *Rhodomonas minuta* | | 606 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 3 | 62,965 |
| | | | | | *Synechococcus sp.1* | | 90,341 |
| | | | | Nostocaceae | *Pseudanabaena* | | 91 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 29,566 |
| | | | Euglenophyta | Euglenaceae | *Strombomonas* | 2 | 30 |
| | | | | | *Trachelomonas* | | 30 |
| | | | Miscellaneous | . | Unknown | | 182 |
| | | | Pyrrhophyta | Peridinaceae | *Peridinium umbonatum* | 1 | 91 |
| LWB-08 | 24-Oct-06 | 1 | Bacillariophyta | Aulacoseriaceae | *Aulacoseira granulata* | 7 | 91 |
| | | | | Bacillariaceae | *Nitzschia acicularis* | | 15 |
| | | | | | *Nitzschia gracilis* | | 30 |
| | | | | Fragilariaceae | *Synedra tenera* | | 333 |
| | | | | | *Synedra ulna* | | 30 |
| | | | | Rhizosoleniaceae | *Rhizosolenia longiseta* | | 15 |
| | | | | Stephanodiscaceae | *Cyclostephanos tholiformis* | | 30 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 25 | 76 |
| | | | | | *Chlamydomonas globosa* | | 15 |
| | | | | | *Pyramichlamys cordiformis* | | 11 |
| | | | | Chlorococcaceae | Unknown | | 212 |
| | | | | | *Tetraedron minimum* | | 30 |
| | | | | Desmidiaceae | *Closterium* | | 48 |
| | | | | | *Cosmarium* | | 61 |
| | | | | | *Staurastrum hexacerum* | | 106 |
| | | | | | *Staurastrum iotanum* | | 30 |
| | | | | | *Staurastrum natator* | | 11 |
| | | | | Hydrodictyaceae | *Pediastrum tetras* | | 44 |
| | | | | Micractinaceae | *Golenkinia paucispina* | | 30 |
| | | | | | *Micractinium pusillum* | | 151 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | Oocystaceae | *Ankistrodesmus braunii* | | 30 |
| | | | | | *Ankistrodesmus falcatus* | | 1,091 |
| | | | | | *Franceia droescheri* | | 15 |
| | | | | | *Monoraphidium capricornutum* | | 15 |
| | | | | | *Quadrigula lacustris* | | 76 |
| | | | | | *Treubaria setigera* | | 15 |
| | | | | Scenedesmaceae | *Crucigenia crucifera* | | 15 |
| | | | | | *Scenedesmus abundans* | | 30 |
| | | | | | *Scenedesmus denticulatus* | | 61 |
| | | | | | *Scenedesmus opoliensis* | | 61 |
| | | | | | *Scenedesmus serratus* | | 91 |
| | | | | | *Selenastrum minutum* | | 30 |
| | | | | Zygnemataceae | *Teilingia granulata* | | 61 |
| | | | Chrysophyta | Chloromonadinaceae | *Gonyostomum ovatum* | 2 | 11 |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | 863 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 3 | 136 |
| | | | | | *Cryptomonas lucens* | | 121 |
| | | | | | *Rhodomonas minuta* | | 106 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 10 | 20,532 |
| | | | | | *Aphanocapsa delicatissima* | | 1,696 |
| | | | | | *Aphanocapsa elachista* | | 61 |
| | | | | | *Chroococcus minimus* | | 91 |
| | | | | | *Dactylococcopsis irregularis* | | 1,818 |
| | | | | | *Merismopedia tenuissima* | | 61 |
| | | | | | *Synechococcus sp.1* | | 41,064 |
| | | | | Nostocaceae | *Cylindrospermopsis raciborskii* | | 744 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 2,629 |
| | | | | | *Oscillatoria limnetica* | | 454 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 96,912 |
| | | | Euglenophyta | Euglenaceae | *Euglena* | 3 | 30 |
| | | | | | *Trachelomonas* | | 15 |
| | | | | | *Trachelomonas volvocina* | | 106 |
| | | | Miscellaneous | . | Unknown | 1 | 954 |
| | | | Pyrrhophyta | Peridinaceae | *Peridinium umbonatum* | 1 | 15 |
| | | | | | | | |
| LWB-08 | 24-Oct-06 | 6 | Bacillariophyta | Aulacoseriaceae | *Aulacoseira ambigua* | 2 | 135 |
| | | | | Fragilariaceae | *Synedra tenera* | | 204 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 25 | 159 |
| | | | | | *Pyramichlamys cordiformis* | | 23 |
| | | | | Chlorococcaceae | Unknown | | 250 |
| | | | | | *Tetraedron caudatum* | | 23 |
| | | | | | *Tetraedron minimum* | | 23 |
| | | | | Desmidiaceae | *Closterium* | | 45 |
| | | | | | *Cosmarium* | | 23 |
| | | | | | *Staurastrum* | | 23 |
| | | | | | *Staurastrum dejectum* | | 23 |
| | | | | | *Staurastrum hexacerum* | | 68 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | | *Staurastrum natator* | | 11 |
| | | | | Dictyosphaeriaceae | *Dictyosphaerium pulchellum* | | 91 |
| | | | | Hydrodictyaceae | *Pediastrum* | | 364 |
| | | | | | *Pediastrum tetras* | | 114 |
| | | | | Micractinaceae | *Golenkinia paucispina* | | 114 |
| | | | | | *Micractinium pusillum* | | 45 |
| | | | | Oocystaceae | *Ankistrodesmus braunii* | | 11 |
| | | | | | *Ankistrodesmus convolutus* | | 91 |
| | | | | | *Ankistrodesmus falcatus* | | 1,440 |
| | | | | | *Kirchneriella lunaris* | | 182 |
| | | | | | *Oocystis parva* | | 114 |
| | | | | Scenedesmaceae | *Scenedesmus acutus* | | 44 |
| | | | | | *Scenedesmus opoliensis* | | 45 |
| | | | | | *Scenedesmus serratus* | | 227 |
| | | | | | *Selenastrum minutum* | | 23 |
| | | | | Zygnemataceae | *Teilingia granulata* | | 136 |
| | | | Chrysophyta | Chloromonadinaceae | *Gonyostomum ovatum* | 3 | 45 |
| | | | | Chrysocapsaceae | Unknown | | 136 |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | 818 |
| | | | | Synuraceae | *Mallomonas* | | 45 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 4 | 364 |
| | | | | | *Cryptomonas lucens* | | 114 |
| | | | | | *Cryptomonas rostratiformis* | | 23 |
| | | | | | *Rhodomonas minuta* | | 45 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 8 | 49,277 |
| | | | | | *Aphanocapsa delicatissima* | | 1,159 |
| | | | | | *Aphanocapsa elachista* | | 1,545 |
| | | | | | *Dactylococcopsis irregularis* | | 1,772 |
| | | | | | *Synechococcus sp.1* | | 32,851 |
| | | | | | *Synechocystis* | | 2,045 |
| | | | | Nostocaceae | *Aphanizomenon gracile* | | 151 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 250 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 82,364 |
| | | | Euglenophyta | Euglenaceae | *Euglena acus* | 3 | 22 |
| | | | | | *Strombomonas* | | 23 |
| | | | | | *Trachelomonas volvocina* | | 136 |
| | | | Miscellaneous | . | Unknown | | 273 |
| | | | Pyrrhophyta | Gymnodiniaceae | *Gymnodinium sp.3* | 2 | 23 |
| | | | | Peridinaceae | *Peridinium umbonatum* | | 11 |
| LWB-10 | 6-Sep-05 | 1 | Bacillariophyta | Achnanthaceae | *Achnanthes minutissima* | 8 | 91 |
| | | | | Bacillariaceae | *Nitzschia acicularis* | | 23 |
| | | | | | *Nitzschia palea* | | 23 |
| | | | | Fragilariaceae | *Fragilaria construens* | | 23 |
| | | | | | *Synedra nana* | | 227 |
| | | | | | *Synedra tenera* | | 295 |
| | | | | | *Synedra ulna* | | 23 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | Stephanodiscaceae | *Cyclotella pseudostelligera* | | 68 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 22 | 136 |
| | | | | | Unknown | | 159 |
| | | | | | *Nautococcus pyriformis* | | 513 |
| | | | | | *Tetraedron caudatum* | | 23 |
| | | | | | *Tetraedron minimum* | | 45 |
| | | | | | *Tetraedron regulare* | | 23 |
| | | | | Desmidiaceae | *Staurastrum dejectum* | | 23 |
| | | | | | *Staurastrum hexacerum* | | 114 |
| | | | | | *Staurastrum iotanum* | | 182 |
| | | | Chlorophyta | Desmidiaceae | *Staurastrum natator* | | 68 |
| | | | | | *Xanthidium* | | 68 |
| | | | | Micractinaceae | *Golenkeniopsis parvula* | | 136 |
| | | | | | *Golenkinia paucispina* | | 23 |
| | | | | Oocystaceae | *Ankistrodesmus braunii* | | 23 |
| | | | | | *Ankistrodesmus falcatus* | | 45 |
| | | | | | *Closteriopsis longissima* | | 68 |
| | | | | | *Franceia droescheri* | | 23 |
| | | | | | *Kirchneriella* | | 45 |
| | | | | | *Monoraphidium capricornutum* | | 45 |
| | | | | Scenedesmaceae | *Scenedesmus opoliensis* | | 45 |
| | | | | | *Scenedesmus serratus* | | 227 |
| | | | | | *Selenastrum gracile* | | 91 |
| | | | | Zygnemataceae | *Teilingia granulata* | | 273 |
| | | | Chrysophyta | Chloromonadinaceae | *Gonyostomum ovatum* | 2 | 11 |
| | | | | Synuraceae | *Mallomonas* | | 68 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 2 | 136 |
| | | | | | *Cryptomonas rostratiformis* | | 11 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 8 | 90,341 |
| | | | | | *Aphanocapsa delicatissima* | | 1,643 |
| | | | | | *Dactylococcopsis irregularis* | | 432 |
| | | | | | *Merismopedia tenuissima* | | 273 |
| | | | | | *Synechococcus sp.1* | | 69,809 |
| | | | | Nostocaceae | *Aphanizomenon gracile* | | 2,190 |
| | | | | Nostocaceae | *Cylindrospermopsis raciborskii* | | 1,677 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 32,116 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 70,395 |
| | | | Euglenophyta | Euglenaceae | *Euglena* | 2 | 68 |
| | | | | | *Trachelomonas volvocina* | | 11 |
| | | | Miscellaneous | . | Unknown | | 68 |
| | | | Pyrrhophyta | Gymnodiniaceae | *Gymnodinium sp.3* | 3 | 23 |
| | | | | Peridinaceae | *Peridinium polonicum* | | 11 |
| | | | | | *Peridinium umbonatum* | | 11 |
| LWB-10 | 6-Sep-05 | 7 | Bacillariophyta | Bacillariaceae | *Nitzschia gracilis* | 4 | 5 |
| | | | | | *Nitzschia palea* | | 5 |
| | | | | Fragilariaceae | *Synedra tenera* | | 15 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | Gomphonemataceae | *Gomphonema parvulum* | | 5 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 8 | 10 |
| | | | | Chlorococcaceae | Unknown | | 548 |
| | | | | Desmidiaceae | *Xanthidium* | | 5 |
| | | | | Hydrodictyaceae | *Pediastrum* | | 20 |
| | | | | Oocystaceae | *Ankistrodesmus falcatus* | | 5 |
| | | | | | *Kirchneriella* | | 65 |
| | | | | Scenedesmaceae | *Crucigenia tetrapedia* | | 20 |
| | | | | | *Didymogenes anomala* | | 5 |
| | | | | | *Scenedesmus serratus* | | 1,095 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 3 | 59 |
| | | | | | *Cryptomonas rostratiformis* | | 10 |
| | | | | | *Rhodomonas minuta* | | 10 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 16 | 147,832 |
| | | | | | *Aphanocapsa delicatissima* | | 1,170 |
| | | | | | *Aphanothece nidulans* | | 32,851 |
| | | | | | *Synechococcus elongatus* | | 12,593 |
| | | | | | *Synechococcus leopoliensis* | | 9,034 |
| | | | | | *Synechococcus sp.1* | | 32,851 |
| | | | | | *Synechocystis* | | 548 |
| | | | | Nostocaceae | *Anabaena planctonica* | | 283 |
| | | | | | *Aphanizomenon issatschenkoi* | | 98 |
| | | | | | *Cylindrospermopsis raciborskii* | | 137 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 644 |
| | | | | | *Oscillatoria agardhii* | | 488 |
| | | | | | *Oscillatoria amphibia* | | 293 |
| | | | | | *Oscillatoria tenuis* | | 325 |
| | | | | | *Romeria* | | 50,962 |
| | | | | | *Spirulina* | | 388 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 19,711 |
| | | | Euglenophyta | Euglenaceae | *Euglena* | 1 | 702 |
| | | | Pyrrhophyta | Peridinaceae | *Peridinium umbonatum* | 1 | 5 |
| | | | | | | | |
| LWB-10 | 15-May-06 | 1 | Bacillariophyta | Aulacoseriaceae | *Aulacoseira ambigua* | 9 | 59 |
| | | | | | *Aulacoseira distans* | | 121 |
| | | | | Bacillariaceae | *Nitzschia palea* | | 10 |
| | | | | Fragilariaceae | *Synedra tenera* | | 162 |
| | | | | | *Synedra ulna* | | 30 |
| | | | | Rhizosoleniaceae | *Rhizosolenia longiseta* | | 20 |
| | | | | Stephanodiscaceae | *Cyclostephanos tholiformis* | | 10 |
| | | | | | *Cyclotella ocellata* | | 20 |
| | | | | | *Cyclotella stelligera* | | 61 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 12 | 303 |
| | | | | | *Chlamydomonas globosa* | | 131 |
| | | | | Chlorococcaceae | Unknown | | 30 |
| | | | | Desmidiaceae | *Closterium* | | 10 |
| | | | | | *Cosmarium* | | 10 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | Dictyosphaeriaceae | *Dictyosphaerium pulchellum* | | 121 |
| | | | | Oocystaceae | *Ankistrodesmus convolutus* | | 10 |
| | | | | | *Ankistrodesmus falcatus* | | 394 |
| | | | | | *Monoraphidium capricornutum* | | 10 |
| | | | | | *Oocystis parva* | | 20 |
| | | | | Polyblepharidaceae | *Nephroselmis* | | 10 |
| | | | | Scenedesmaceae | *Scenedesmus serratus* | | 30 |
| | | | | Volvocaceae | *Eudorina elegans* | | 117 |
| | | | Chrysophyta | Chrysococcaceae | *Kephyrion gracilis* | 8 | 61 |
| | | | | Dinobryaceae | *Chrysolykos planctonicus* | | 10 |
| | | | | | *Dinobryon* | | 1,030 |
| | | | | | *Dinobryon sociale* | | 20 |
| | | | | | *Dinobryon sp.4* | | 20 |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | 81 |
| | | | | Paraliaceae | *Ellipsoidion pachydermum* | | 30 |
| | | | | Stichiogloeaceae | *Stichogloea olivacea* | | 20 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | | 131 |
| | | | | | *Rhodomonas minuta* | | 50 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 6 | 76,653 |
| | | | | | *Aphanocapsa delicatissima* | | 1,010 |
| | | | | | *Aphanothece nidulans* | | 727 |
| | | | | | *Chroococcus minimus* | | 20 |
| | | | | | *Synechococcus sp.1* | | 54,752 |
| | | | | | *Synechocystis* | | 212 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 4,745 |
| | | | Euglenophyta | Euglenaceae | *Euglena* | 1 | 10 |
| | | | Miscellaneous | . | Unknown | | 1,091 |
| | | | Pyrrhophyta | Gymnodiniaceae | *Gymnodinium sp.2* | 4 | 10 |
| | | | | | *Gymnodinium sp.3* | | 10 |
| | | | | Peridinaceae | *Peridinium polonicum* | | 10 |
| | | | | | *Peridinium umbonatum* | | 20 |
| LWB-10 | 15-May-06 | 6 | Bacillariophyta | Aulacoseriaceae | *Aulacoseira ambigua* | | 110 |
| | | | | | *Aulacoseira distans* | | 626 |
| | | | | Fragilariaceae | *Asterionella formosa* | | 27 |
| | | | | | *Synedra tenera* | | 111 |
| | | | | | *Synedra ulna* | | 61 |
| | | | | Gomphonemataceae | *Gomphonema olivaceum* | | 10 |
| | | | | Rhizosoleniaceae | *Rhizosolenia longiseta* | | 30 |
| | | | | Stephanodiscaceae | *Cyclotella stelligera* | | 101 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 11 | 202 |
| | | | | | *Chlamydomonas globosa* | | 10 |
| | | | | Chlorococcaceae | Unknown | | 182 |
| | | | | | *Tetraedron minimum* | | 10 |
| | | | | | *Tetraedron muticum* | | 10 |
| | | | | Desmidiaceae | *Closterium* | | 50 |
| | | | | Micractinaceae | *Golenkinia radiata* | | 10 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | | *Micractinium pusillum* | | 61 |
| | | | | Oocystaceae | *Ankistrodesmus falcatus* | | 454 |
| | | | | | *Oocystis parva* | | 50 |
| | | | | Scenedesmaceae | *Tetrastrum heteracanthum* | | 40 |
| | | | | Volvocaceae | *Eudorina elegans* | | 121 |
| | | | Chrysophyta | Chrysococcaceae | *Kephyrion* | 7 | 10 |
| | | | | | *Kephyrion gracilis* | | 30 |
| | | | | Dinobryaceae | *Dinobryon* | | 101 |
| | | | | | *Dinobryon sociale* | | 10 |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | 20 |
| | | | | Paraliaceae | *Ellipsoidion pachydermum* | | 61 |
| | | | | Synuraceae | *Mallomonas* | | 10 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 2 | 121 |
| | | | | | *Cryptomonas rostratiformis* | | 7 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 4 | 76,653 |
| | | | | | *Chroococcus minimus* | | 40 |
| | | | | | *Merismopedia tenuissima* | | 323 |
| | | | | | *Synechococcus sp.1* | | 60,228 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 13,141 |
| | | | Euglenophyta | Euglenaceae | *Trachelomonas* | 1 | 10 |
| | | | Miscellaneous | . | Unknown | | 1,818 |
| | | | Pyrrhophyta | Gymnodiniaceae | *Gymnodinium sp.2* | 3 | 20 |
| | | | | | *Gymnodinium sp.3* | | 40 |
| | | | | Peridinaceae | *Peridinium umbonatum* | | 10 |
| LWB-10 | 24-Oct-06 | 1 | Bacillariophyta | Bacillariaceae | *Nitzschia palea* | 2 | 15 |
| | | | | Fragilariaceae | *Synedra tenera* | | 273 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 24 | 151 |
| | | | | Chlorococcaceae | Unknown | | 136 |
| | | | | | *Tetraedron minimum* | | 45 |
| | | | | Desmidiaceae | *Closterium* | | 91 |
| | | | | | *Cosmarium* | | 45 |
| | | | | | *Staurastrum cingulum* | | 23 |
| | | | | | *Staurastrum dejectum* | | 61 |
| | | | | | *Staurastrum hexacerum* | | 45 |
| | | | | Hydrodictyaceae | *Pediastrum tetras* | | 88 |
| | | | | Micractinaceae | *Micractinium pusillum* | | 91 |
| | | | | Oocystaceae | *Ankistrodesmus braunii* | | 45 |
| | | | | | *Ankistrodesmus convolutus* | | 91 |
| | | | | | *Ankistrodesmus falcatus* | | 872 |
| | | | | | *Kirchneriella lunaris* | | 68 |
| | | | | | *Monoraphidium capricornutum* | | 45 |
| | | | | | *Oocystis parva* | | 167 |
| | | | | | *Quadrigula lacustris* | | 45 |
| | | | | Scenedesmaceae | *Scenedesmus abundans* | | 45 |
| | | | | | *Scenedesmus bijuga* | | 45 |
| | | | | | *Scenedesmus denticulatus* | | 23 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | | *Scenedesmus opoliensis* | | 68 |
| | | | | | *Scenedesmus serratus* | | 245 |
| | | | | | *Selenastrum minutum* | | 106 |
| | | | | Zygnemataceae | *Teilingia granulata* | | 45 |
| | | | Chrysophyta | Chloromonadinaceae | *Gonyostomum ovatum* | 4 | 45 |
| | | | | Chrysocapsaceae | Unknown | | 182 |
| | | | | Dinobryaceae | *Dinobryon* | | 68 |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | 295 |
| | | | | Synuraceae | *Mallomonas* | | 45 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 3 | 121 |
| | | | | | *Cryptomonas lucens* | | 167 |
| | | | | | *Cryptomonas rostratiformis* | | 61 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 11 | 69,809 |
| | | | | | *Aphanocapsa delicatissima* | | 1,979 |
| | | | | | *Aphanocapsa elachista* | | 2,499 |
| | | | | | *Dactylococcopsis irregularis* | | 1,022 |
| | | | | | *Merismopedia tenuissima* | | 176 |
| | | | | | *Merismopedia warmingiana* | | 182 |
| | | | | | *Synechococcus sp.1* | | 57,490 |
| | | | | | *Synechocystis* | | 23 |
| | | | | Nostocaceae | *Cylindrospermopsis raciborskii* | | 598 |
| | | | | | *Pseudanabaena galeata* | | 68 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 1,670 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 53,906 |
| | | | Euglenophyta | Euglenaceae | *Euglena* | 3 | 61 |
| | | | | | *Euglena acus* | | 11 |
| | | | | | *Trachelomonas volvocina* | | 68 |
| | | | Miscellaneous | . | Unknown | | 318 |
| | | | Pyrrhophyta | Gymnodiniaceae | *Gymnodinium sp.2* | 3 | 45 |
| | | | | | *Gymnodinium sp.3* | | 45 |
| | | | | Peridinaceae | *Peridinium umbonatum* | | 11 |
| | | | Rhodophyta | Batrachospermaceae | *Bitrichia ochridana* | 1 | 23 |
| | | | | | | | |
| LWB-10 | 24-Oct-06 | 6 | Bacillariophyta | Achnanthaceae | *Achnanthes minutissima* | 4 | 15 |
| | | | | Fragilariaceae | *Synedra tenera* | | 288 |
| | | | | | *Synedra ulna* | | 15 |
| | | | | Stephanodiscaceae | *Cyclostephanos tholiformis* | | 15 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 25 | 136 |
| | | | | Chlorococcaceae | Unknown | | 121 |
| | | | | | *Tetraedron caudatum* | | 15 |
| | | | | | *Tetraedron minimum* | | 30 |
| | | | | Coelastraceae | *Coelastrum pseudomicroporum* | | 121 |
| | | | | Desmidiaceae | *Closterium* | | 76 |
| | | | | | *Cosmarium* | | 15 |
| | | | | | *Staurastrum dejectum* | | 11 |
| | | | | | *Staurastrum hexacerum* | | 45 |
| | | | | | *Xanthidium* | | 45 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | Dictyosphaeriaceae | *Dictyosphaerium chlorelloides* | | 61 |
| | | | | Hydrodictyaceae | *Pediastrum tetras* | | 121 |
| | | | | Micractinaceae | *Micractinium pusillum* | | 76 |
| | | | | Oocystaceae | *Ankistrodesmus braunii* | | 45 |
| | | | | | *Ankistrodesmus convolutus* | | 30 |
| | | | | | *Ankistrodesmus falcatus* | | 1,654 |
| | | | | | *Kirchneriella lunaris* | | 61 |
| | | | | | *Monoraphidium capricornutum* | | 15 |
| | | | | | *Oocystis parva* | | 30 |
| | | | | | *Quadrigula lacustris* | | 30 |
| | | | | | *Treubaria setigera* | | 15 |
| | | | | Scenedesmaceae | *Scenedesmus abundans* | | 30 |
| | | | | | *Scenedesmus opoliensis* | | 151 |
| | | | | | *Scenedesmus serratus* | | 191 |
| | | | | | *Selenastrum minutum* | | 76 |
| | | | | Zygnemataceae | *Teilingia granulata* | | 76 |
| | | | Chrysophyta | Chloromonadinaceae | *Gonyostomum ovatum* | 6 | 61 |
| | | | | Chrysococcaceae | *Chrysococcus minutus* | | 15 |
| | | | | Dinobryaceae | *Dinobryon* | | 15 |
| | | | | | *Dinobryon bavaricum* | | 15 |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | 197 |
| | | | | Synuraceae | *Mallomonas* | | 15 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 4 | 227 |
| | | | | | *Cryptomonas lucens* | | 91 |
| | | | | | *Cryptomonas rostratiformis* | | 15 |
| | | | | | *Rhodomonas minuta* | | 76 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 11 | 41,064 |
| | | | | | *Aphanocapsa delicatissima* | | 2,050 |
| | | | | | *Aphanocapsa elachista* | | 1,545 |
| | | | | | *Aphanothece nidulans* | | 303 |
| | | | | | *Chroococcus minimus* | | 182 |
| | | | | | *Dactylococcopsis irregularis* | | 1,091 |
| | | | | | *Merismopedia punctata* | | 61 |
| | | | | | *Merismopedia warmingiana* | | 121 |
| | | | | | *Synechococcus sp.1* | | 69,809 |
| | | | | Nostocaceae | *Cylindrospermopsis raciborskii* | | 525 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 2,590 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 111,696 |
| | | | Euglenophyta | Euglenaceae | *Euglena* | 3 | 44 |
| | | | | | *Phacus longicauda* | | 15 |
| | | | | | *Trachelomonas volvocina* | | 30 |
| | | | Miscellaneous | . | Unknown | | 545 |
| | | | Pyrrhophyta | Glenodiniaceae | *Glenodinium quadridens* | 1 | 15 |
| | | | Rhodophyta | Batrachospermaceae | *Bitrichia ochridana* | 1 | 15 |
| LWB-11 | 07-Sep-05 | 1 | Bacillariophyta | Achnanthaceae | *Achnanthes minutissima* | 4 | 76 |
| | | | | Fragilariaceae | *Synedra nana* | | 530 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | | *Synedra tenera* | | 182 |
| | | | | Stephanodiscaceae | *Cyclotella pseudostelligera* | | 136 |
| | | | Chlorophyta | Characiaceae | *Characium ambiguum* | 22 | 15 |
| | | | | Chlamydomonadaceae | *Chlamydomonas* | | 61 |
| | | | | Chlorococcaceae | Unknown | | 45 |
| | | | | Desmidiaceae | *Staurastrum dejectum* | | 30 |
| | | | | | *Staurastrum hexacerum* | | 61 |
| | | | | | *Staurastrum iotanum* | | 182 |
| | | | | | *Staurastrum natator* | | 61 |
| | | | | | *Xanthidium* | | 45 |
| | | | | Micractinaceae | *Golenkeniopsis parvula* | | 91 |
| | | | | | *Golenkinia paucispina* | | 15 |
| | | | | Oocystaceae | *Ankistrodesmus convolutus* | | 15 |
| | | | | | *Ankistrodesmus falcatus* | | 159 |
| | | | | | *Closteriopsis longissima* | | 182 |
| | | | | | *Kirchneriella* | | 91 |
| | | | Chlorophyta | Oocystaceae | *Monoraphidium capricornutum* | | 15 |
| | | | | | *Oocystis parva* | | 30 |
| | | | | | *Quadrigula lacustris* | | 15 |
| | | | | | *Treubaria setigerum* | | 15 |
| | | | | Palmellopsidaceae | *Asterococcus limnecticus* | | 15 |
| | | | | Scenedesmaceae | *Lagerheimia ciliata* | | 15 |
| | | | | | *Scenedesmus opoliensis* | | 30 |
| | | | | | *Scenedesmus serratus* | | 136 |
| | | | | Zygnemataceae | *Teilingia granulata* | | 227 |
| | | | Chrysophyta | Dinobryaceae | *Dinobryon bavaricum* | 7 | 15 |
| | | | | | *Dinobryon sociale* | | 15 |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | 159 |
| | | | | | *Ochromonas* | | 576 |
| | | | | Synuraceae | *Mallomonas* | | 45 |
| | | | | Cryptomonadaceae | *Cryptomonas erosa* | | 15 |
| | | | | | *Cryptomonas rostratiformis* | | 15 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 9 | 24,639 |
| | | | | | *Aphanocapsa delicatissima* | | 1,454 |
| | | | | | *Dactylococcopsis irregularis* | | 545 |
| | | | | | *Merismopedia warmingiana* | | 182 |
| | | | | | *Synechococcus sp.1* | | 102,661 |
| | | | | Nostocaceae | *Aphanizomenon gracile* | | 3,458 |
| | | | | | *Cylindrospermopsis raciborskii* | | 1,419 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 12,729 |
| | | | | | *Oscillatoria amphibia* | | 909 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 49,043 |
| | | | Euglenophyta | Euglenaceae | *Euglena* | 2 | 30 |
| | | | | | *Trachelomonas volvocina* | | 15 |
| | | | Miscellaneous | . | Unknown | | 30 |
| | | | Pyrrhophyta | Gymnodiniaceae | *Gymnodinium sp.1* | 4 | 11 |
| | | | | | *Gymnodinium sp.3* | | 15 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | Peridinaceae | *Peridinium cinctum* | | 11 |
| | | | | | *Peridinium umbonatum* | | 30 |
| | | | Xanthophyta | Centratractaceae | *Centratractus belonophorus* | 1 | 15 |
| LWB-11 | 07-Sep-05 | 7 | Bacillariophyta | Achnanthaceae | *Achnanthes minutissima* | 6 | 76 |
| | | | | Bacillariaceae | *Nitzschia acicularis* | | 15 |
| | | | | Fragilariaceae | *Asterionella formosa* | | 15 |
| | | | | | *Synedra nana* | | 439 |
| | | | | | *Synedra tenera* | | 76 |
| | | | | Stephanodiscaceae | *Cyclotella pseudostelligera* | | 91 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 20 | 61 |
| | | | | Chlorococcaceae | Unknown | | 45 |
| | | | | | *Nautococcus pyriformis* | | 4,106 |
| | | | | | *Tetraedron muticum* | | 15 |
| | | | | Desmidiaceae | *Staurastrum dejectum* | | 11 |
| | | | | | *Staurastrum hexacerum* | | 15 |
| | | | | | *Staurastrum iotanum* | | 45 |
| | | | | | *Staurastrum natator* | | 15 |
| | | | | | *Xanthidium* | | 91 |
| | | | | Hydrodictyaceae | *Pediastrum tetras* | | 44 |
| | | | | Micractinaceae | *Golenkeniopsis parvula* | | 30 |
| | | | | | *Golenkinia paucispina* | | 15 |
| | | | | Oocystaceae | *Ankistrodesmus falcatus* | | 106 |
| | | | | | *Closteriopsis longissima* | | 15 |
| | | | | | *Kirchneriella* | | 91 |
| | | | | | *Oocystis parva* | | 15 |
| | | | | Phacotaceae | *Phacotus lendneri* | | 15 |
| | | | | Scenedesmaceae | *Crucigenia tetrapedia* | | 121 |
| | | | | | *Scenedesmus opoliensis* | | 15 |
| | | | | | *Scenedesmus serratus* | | 91 |
| | | | | Zygnemataceae | *Teilingia granulata* | | 45 |
| | | | Chrysophyta | Chloromonadinaceae | *Gonyostomum ovatum* | 4 | 15 |
| | | | | | *Gonyostomum semen* | | 15 |
| | | | | Chrysocapsaceae | Unknown | | 15 |
| | | | | Ochromonadaceae | *Ochromonas* | | 636 |
| | | | | Synuraceae | *Mallomonas* | | 15 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 2 | 364 |
| | | | | | *Cryptomonas rostratiformis* | | 15 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 16 | 45,171 |
| | | | | | *Aphanocapsa delicatissima* | | 394 |
| | | | | | *Chroococcus minutus* | | 61 |
| | | | | | *Dactylococcopsis irregularis* | | 364 |
| | | | | | *Synechococcus elongatus* | | 2,053 |
| | | | | | *Synechococcus leopoliensis* | | 5,133 |
| | | | | | *Synechococcus sp.1* | | 57,490 |
| | | | | Nostocaceae | *Anabaena macrospora* | | 61 |
| | | | | | *Aphanizomenon gracile* | | 2,019 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | | *Cylindrospermopsis raciborskii* | | 1,414 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 12,268 |
| | | | | | *Oscillatoria* | | 1,363 |
| | | | | | *Oscillatoria amphibia* | | 606 |
| | | | | | *Oscillatoria limnetica* | | 227 |
| | | | | | *Oscillatoria tenuis* | | 2,048 |
| | | | | | *Romeria* | | 364 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 45,171 |
| | | | Euglenophyta | Euglenaceae | *Euglena* | | 106 |
| | | | | | *Trachelomonas volvocina* | | 30 |
| | | | Pyrrhophyta | Peridinaceae | *Peridinium umbonatum* | 1 | 11 |
| MR1-14 | 07-Sep-05 | 1 | Bacillariophyta | Bacillariaceae | *Nitzschia acicularis* | 6 | 32 |
| | | | | | *Nitzschia gracilis* | | 32 |
| | | | | | *Nitzschia palea* | | 32 |
| | | | | Fragilariaceae | *Synedra nana* | | 454 |
| | | | | | *Synedra tenera* | | 97 |
| | | | | Stephanodiscaceae | *Cyclotella pseudostelligera* | | 162 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 17 | 130 |
| | | | | Chlorococcaceae | Unknown | | 130 |
| | | | | | *Nautococcus pyriformis* | | 1,232 |
| | | | | | *Tetraedron minimum* | | 65 |
| | | | | | *Tetraedron muticum* | | 32 |
| | | | | Desmidiaceae | *Staurastrum hexacerum* | | 32 |
| | | | | | *Staurastrum iotanum* | | 265 |
| | | | | | *Staurastrum natator* | | 32 |
| | | | | | *Staurastrum paradoxum* | | 32 |
| | | | | | *Xanthidium* | | 162 |
| | | | | Hydrodictyaceae | *Pediastrum tetras* | | 44 |
| | | | | Micractinaceae | *Golenkeniopsis parvula* | | 234 |
| | | | | Oocystaceae | *Closteriopsis longissima* | | 97 |
| | | | | | *Monoraphidium capricornutum* | | 130 |
| | | | | | *Treubaria setigerum* | | 65 |
| | | | | Scenedesmaceae | *Scenedesmus opoliensis* | | 130 |
| | | | | | *Scenedesmus serratus* | | 454 |
| | | | | Zygnemataceae | *Teilingia granulata* | | 325 |
| | | | Chrysophyta | Chrysocapsaceae | Unknown | 5 | 195 |
| | | | | | *Chrysococcus minutus* | | 32 |
| | | | | Dinobryaceae | *Dinobryon sociale* | | 32 |
| | | | | Ochromonadaceae | *Ochromonas* | | 325 |
| | | | | Synuraceae | *Mallomonas* | | 130 |
| | | | | Cryptomonadaceae | *Cryptomonas erosa* | | 389 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 10 | 45,171 |
| | | | | | *Aphanocapsa delicatissima* | | 18,013 |
| | | | | | *Dactylococcopsis irregularis* | | 876 |
| | | | | | *Synechococcus elongatus* | | 4,106 |
| | | | | | *Synechococcus sp.1* | | 127,299 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | Nostocaceae | *Aphanizomenon gracile* | | 3,750 |
| | | | | | *Aphanizomenon issatschenkoi* | | 293 |
| | | | | | *Cylindrospermopsis raciborskii* | | 406 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 48,606 |
| | | | | | *Oscillatoria limnetica* | | 325 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 159,658 |
| | | | Euglenophyta | Euglenaceae | *Euglena* | 1 | 32 |
| | | | Pyrrhophyta | Gymnodiniaceae | *Gymnodinium sp.1* | 2 | 11 |
| | | | | Peridinaceae | *Peridinium umbonatum* | | 227 |
| | | | Xanthophyta | Centratractaceae | *Centratractus belonophorus* | 1 | 32 |
| MR1-14 | 07-Sep-05 | 6 | Bacillariophyta | Achnanthaceae | *Achnanthes minutissima* | 10 | 141 |
| | | | | | *Aulacoseira granulata* | | 29 |
| | | | | Bacillariaceae | *Nitzschia dissipata* | | 20 |
| | | | | | *Nitzschia palea* | | 40 |
| | | | | Fragilariaceae | *Synedra nana* | | 404 |
| | | | | | *Synedra tenera* | | 242 |
| | | | | | *Synedra ulna* | | 20 |
| | | | | Naviculaceae | *Navicula* | | 20 |
| | | | Bacillariophyta | Rhizosoleniaceae | *Rhizosolenia longiseta* | | 15 |
| | | | | Stephanodiscaceae | *Cyclotella pseudostelligera* | | 20 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 24 | 20 |
| | | | | Chlorococcaceae | Unknown | | 364 |
| | | | | | *Diacanthos belanophorus* | | 20 |
| | | | | | *Nautococcus pyriformis* | | 1,095 |
| | | | | | *Tetraedron caudatum* | | 20 |
| | | | | | *Tetraedron minimum* | | 20 |
| | | | | Desmidiaceae | *Staurastrum dejectum* | | 81 |
| | | | | | *Staurastrum hexacerum* | | 101 |
| | | | | | *Staurastrum iotanum* | | 40 |
| | | | | | *Staurastrum natator* | | 81 |
| | | | | | *Xanthidium* | | 20 |
| | | | | Micractinaceae | *Golenkeniopsis parvula* | | 182 |
| | | | | | *Golenkinia paucispina* | | 61 |
| | | | | Oocystaceae | *Ankistrodesmus falcatus* | | 263 |
| | | | | | *Closteriopsis longissima* | | 40 |
| | | | | | *Franceia droescheri* | | 20 |
| | | | | | *Kirchneriella* | | 81 |
| | | | | | *Monoraphidium capricornutum* | | 121 |
| | | | | | *Treubaria setigerum* | | 20 |
| | | | | Phacotaceae | *Phacotus lendneri* | | 20 |
| | | | | Scenedesmaceae | *Scenedesmus abundans* | | 81 |
| | | | | | *Scenedesmus opoliensis* | | 162 |
| | | | | | *Scenedesmus serratus* | | 444 |
| | | | | | *Selenastrum minutum* | | 61 |
| | | | | Zygnemataceae | *Teilingia granulata* | | 40 |
| | | | Chrysophyta | Chloromonadinaceae | *Gonyostomum semen* | 5 | 20 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | Dinobryaceae | *Dinobryon bavaricum* | | 40 |
| | | | | | *Dinobryon sociale* | | 20 |
| | | | | Ochromonadaceae | *Ochromonas* | | 727 |
| | | | | Synuraceae | *Mallomonas* | | 40 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 1 | 182 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 8 | 109,505 |
| | | | | | *Aphanocapsa delicatissima* | | 17,448 |
| | | | | | *Dactylococcopsis irregularis* | | 788 |
| | | | | | *Synechococcus elongatus* | | 5,475 |
| | | | | | *Synechococcus sp.1* | | 180,683 |
| | | | | Nostocaceae | *Aphanizomenon gracile* | | 2,757 |
| | | | | | *Cylindrospermopsis raciborskii* | | 937 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 34,933 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 128,669 |
| | | | Euglenophyta | Euglenaceae | *Euglena* | 2 | 40 |
| | | | | | *Trachelomonas* | | 20 |
| | | | Pyrrhophyta | Gymnodiniaceae | *Gymnodinium sp.3* | 2 | 61 |
| | | | | Peridinaceae | *Peridinium umbonatum* | | 20 |
| | | | | | | | |
| MR1-14 | 17-May-06 | 1 | Bacillariophyta | Aulacoseriaceae | *Aulacoseira ambigua* | 7 | 227 |
| | | | | | *Aulacoseira distans* | | 682 |
| | | | | Fragilariaceae | *Asterionella formosa* | | 22 |
| | | | | | *Synedra tenera* | | 682 |
| | | | | | *Synedra ulna* | | 38 |
| | | | | Rhizosoleniaceae | *Rhizosolenia longiseta* | | 76 |
| | | | | Stephanodiscaceae | *Cyclotella stelligera* | | 151 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 12 | 492 |
| | | | | Chlorococcaceae | Unknown | | 114 |
| | | | | | *Tetraedron minimum* | | 38 |
| | | | | Micractinaceae | *Micractinium pusillum* | | 505 |
| | | | | Oocystaceae | *Ankistrodesmus convolutus* | | 38 |
| | | | | | *Ankistrodesmus falcatus* | | 826 |
| | | | | | *Franceia droescheri* | | 38 |
| | | | | | *Monoraphidium capricornutum* | | 76 |
| | | | | | *Oocystis parva* | | 76 |
| | | | | Scenedesmaceae | *Crucigenia tetrapedia* | | 151 |
| | | | | | *Scenedesmus opoliensis* | | 227 |
| | | | | | *Scenedesmus quadricauda* | | 76 |
| | | | | | *Scenedesmus serratus* | | 151 |
| | | | Chrysophyta | Chrysocapsaceae | Unknown | 10 | 114 |
| | | | | | *Kephyrion* | | 76 |
| | | | | | *Kephyrion gracilis* | | 76 |
| | | | | Dinobryaceae | *Dinobryon* | | 2,613 |
| | | | | | *Dinobryon bavaricum* | | 303 |
| | | | | | *Dinobryon sp.4* | | 151 |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | 3,181 |
| | | | | Paraliaceae | *Ellipsoidion pachydermum* | | 682 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | Synuraceae | *Mallomonas* | | 38 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | | 341 |
| | | | | | *Rhodomonas minuta* | | 38 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 4 | 94,448 |
| | | | | | *Aphanothece nidulans* | | 757 |
| | | | | | *Synechococcus sp.1* | | 82,129 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 379 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 83,223 |
| | | | Euglenophyta | Euglenaceae | *Trachelomonas* | 1 | 38 |
| | | | Miscellaneous | . | Unknown | Unknown | 1,363 |
| | | | Pyrrhophyta | Gymnodiniaceae | *Gymnodinium sp.3* | 2 | 38 |
| | | | | Peridinaceae | *Peridinium umbonatum* | | 38 |
| MR1-14 | 17-May-06 | 6 | Bacillariophyta | Achnanthaceae | *Achnanthes minutissima* | 8 | 114 |
| | | | | | *Aulacoseira ambigua* | | 341 |
| | | | | | *Aulacoseira distans* | | 909 |
| | | | | | *Aulacoseira granulata* | | 21 |
| | | | | Bacillariaceae | *Nitzschia acicularis* | | 28 |
| | | | | Fragilariaceae | *Synedra tenera* | | 312 |
| | | | | Naviculaceae | *Navicula viridula* | | 28 |
| | | | | Stephanodiscaceae | *Cyclotella stelligera* | | 85 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 15 | 227 |
| | | | | | *Chlamydomonas globosa* | | 28 |
| | | | | Chlorococcaceae | Unknown | | 199 |
| | | | | | *Tetraedron caudatum* | | 28 |
| | | | | Hydrodictyaceae | *Pediastrum tetras* | | 28 |
| | | | | Micractinaceae | *Micractinium pusillum* | | 319 |
| | | | | Oocystaceae | *Ankistrodesmus convolutus* | | 28 |
| | | | | | *Ankistrodesmus falcatus* | | 1,590 |
| | | | | | *Franceia droescheri* | | 28 |
| | | | | | *Kirchneriella* | | 57 |
| | | | | | *Monoraphidium capricornutum* | | 142 |
| | | | | | *Oocystis parva* | | 28 |
| | | | | Scenedesmaceae | *Scenedesmus abundans* | | 114 |
| | | | | | *Scenedesmus opoliensis* | | 28 |
| | | | | | *Scenedesmus serratus* | | 284 |
| | | | | | *Tetrastrum heteracanthum* | | 114 |
| | | | Chrysophyta | Chrysococcaceae | *Chrysococcus minutus* | 7 | 28 |
| | | | | | *Kephyrion skujae* | | 28 |
| | | | | Dinobryaceae | *Dinobryon* | | 1,789 |
| | | | | | *Dinobryon bavaricum* | | 28 |
| | | | | | *Dinobryon sp.4* | | 114 |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | 1,704 |
| | | | | Paraliaceae | *Ellipsoidion pachydermum* | | 1,022 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 2 | 199 |
| | | | | Cryptomonadaceae | *Rhodomonas minuta* | | 57 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 4 | 45,171 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | | | *Merismopedia tenuissima* | | 454 |
| | | | | | *Microcystis aeruginosa* | | 123 |
| | | | | | *Synechococcus sp.1* | | 98,554 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 114,981 |
| | | | Miscellaneous | . | Unknown | Unknown | 511 |
| | | | Pyrrhophyta | Gymnodiniaceae | *Gymnodinium sp.2* | 3 | 10 |
| | | | | | *Gymnodinium sp.3* | | 85 |
| | | | | Peridinaceae | *Peridinium polonicum* | | 10 |
| MR1-14 | 25-Oct-06 | 1 | Bacillariophyta | Bacillariaceae | *Nitzschia gracilis* | 4 | 23 |
| | | | | Fragilariaceae | *Synedra tenera* | | 409 |
| | | | | Fragilariaceae | *Synedra ulna* | | 23 |
| | | | | Stephanodiscaceae | *Cyclostephanos tholiformis* | | 23 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 17 | 68 |
| | | | | Chlorococcaceae | Unknown | | 136 |
| | | | | | *Tetraedron minimum* | | 23 |
| | | | | Desmidiaceae | *Cosmarium* | | 23 |
| | | | | | *Staurastrum dejectum* | | 23 |
| | | | | | *Staurastrum hexacerum* | | 91 |
| | | | | Micractinaceae | *Golenkinia radiata* | | 23 |
| | | | | | *Micractinium pusillum* | | 119 |
| | | | | Oocystaceae | *Ankistrodesmus braunii* | | 23 |
| | | | | | *Ankistrodesmus convolutus* | | 23 |
| | | | | | *Ankistrodesmus falcatus* | | 1,253 |
| | | | | | *Monoraphidium capricornutum* | | 23 |
| | | | | | *Oocystis parva* | | 284 |
| | | | | Scenedesmaceae | *Crucigenia tetrapedia* | | 91 |
| | | | | | *Scenedesmus opoliensis* | | 45 |
| | | | | | *Scenedesmus serratus* | | 409 |
| | | | | | *Selenastrum minutum* | | 307 |
| | | | | Zygnemataceae | *Teilingia granulata* | | 23 |
| | | | Chrysophyta | Chrysocapsaceae | Unknown | 3 | 23 |
| | | | | Dinobryaceae | *Dinobryon bavaricum* | | 91 |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | 4,226 |
| | | | | Synuraceae | *Mallomonas* | | 45 |
| | | | Cryptophyta | Cryptomonadaceae | *Cryptomonas erosa* | 3 | 477 |
| | | | | | *Cryptomonas rostratiformis* | | 23 |
| | | | | | *Rhodomonas minuta* | | 341 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 8 | 36,958 |
| | | | | | *Aphanocapsa delicatissima* | | 4,468 |
| | | | | | *Chroococcus minutus* | | 91 |
| | | | | | *Dactylococcopsis irregularis* | | 568 |
| | | | | | *Synechococcus sp.1* | | 32,851 |
| | | | | | *Synechocystis* | | 1,227 |
| | | | | Nostocaceae | *Cylindrospermopsis raciborskii* | | 759 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 1,136 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 75,792 |

**Appendix C-1.** Algal taxa from all phytoplankton divisions in samples collected from selected sites in Lake William C. Bowen and Municipal Reservoir #1, Spartanburg County, South Carolina, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site | Sample date | Depth (m) | Division | Family | Scientific name | Known species by division count | Taxon cell density (cells/mL) |
|---|---|---|---|---|---|---|---|
| | | | Euglenophyta | Euglenaceae | *Trachelomonas* | 1 | 23 |
| | | | Pyrrhophyta | Gymnodiniaceae | *Gymnodinium sp.3* | 1 | 68 |
| MR1-14 | 25-Oct-06 | 6 | Bacillariophyta | Achnanthaceae | *Achnanthes minutissima* | 6 | 23 |
| | | | | | *Aulacoseira ambigua* | | 45 |
| | | | | Bacillariaceae | *Nitzschia acicularis* | | 45 |
| | | | | Fragilariaceae | *Fragilaria construens* | | 114 |
| | | | | | *Synedra tenera* | | 250 |
| | | | | Naviculaceae | *Navicula cryptocephala* | | 23 |
| | | | Chlorophyta | Chlamydomonadaceae | *Chlamydomonas* | 17 | 45 |
| | | | | Chlorococcaceae | Unknown | | 68 |
| | | | | | *Tetraedron caudatum* | | 23 |
| | | | | | *Tetraedron minimum* | | 68 |
| | | | | Desmidiaceae | *Closterium* | | 45 |
| | | | | | *Staurastrum hexacerum* | | 91 |
| | | | | Micractinaceae | *Micractinium pusillum* | | 68 |
| | | | | Oocystaceae | *Ankistrodesmus braunii* | | 45 |
| | | | | | *Ankistrodesmus convolutus* | | 45 |
| | | | | | *Ankistrodesmus falcatus* | | 2,045 |
| | | | | | *Franceia droescheri* | | 23 |
| | | | | | *Kirchneriella lunaris* | | 91 |
| | | | | | *Oocystis parva* | | 68 |
| | | | | Palmellopsidaceae | *Sphaerocystis schroeteri* | | 21 |
| | | | | Scenedesmaceae | *Scenedesmus opoliensis* | | 204 |
| | | | | | *Scenedesmus serratus* | | 68 |
| | | | | | *Selenastrum minutum* | | 45 |
| | | | | Zygnemataceae | *Teilingia granulata* | | 23 |
| | | | Chrysophyta | Chloromonadinaceae | *Gonyostomum ovatum* | 8 | 10 |
| | | | | Dinobryaceae | *Dinobryon* | | 91 |
| | | | | | *Dinobryon bavaricum* | | 68 |
| | | | | Ochromonadaceae | *Erkenia subaequiciliata* | | 3,135 |
| | | | | Cryptomonadaceae | *Cryptomonas erosa* | | 136 |
| | | | | | *Cryptomonas lucens* | | 23 |
| | | | | | *Cryptomonas rostratiformis* | | 23 |
| | | | | | *Rhodomonas minuta* | | 204 |
| | | | Cyanobacteria | Chroococcaceae | Unknown | 7 | 61,596 |
| | | | | | *Aphanocapsa delicatissima* | | 1,704 |
| | | | | | *Dactylococcopsis irregularis* | | 1,022 |
| | | | | | *Synechococcus sp.1* | | 16,426 |
| | | | | | *Synechocystis* | | 1,363 |
| | | | | Nostocaceae | *Cylindrospermopsis raciborskii* | | 942 |
| | | | | Oscillatoriaceae | *Lyngbya limnetica* | | 1,590 |
| | | | | Synechococcaceae | *Cyanogranis ferruginea* | | 92,395 |
| | | | Euglenophyta | Euglenaceae | *Euglena* | 2 | 10 |
| | | | | | *Trachelomonas* | | 23 |
| | | | Pyrrhophyta | Gymnodiniaceae | *Gymnodinium sp.3* | 1 | 10 |

**Appendix C-2.** Cyanobacterial cell densities, by species, in samples collected at selected sites in Lake William C. Bowen and Municipal Reservoir #1, August 2005 to October 2006.

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site ID_Sample Depth (m) | Sample date | Division | Family | Taxon | Density (cell/mL) |
|---|---|---|---|---|---|
| LWB-03_1 | 8/30/2005 | Cyanobacteria | Nostocaceae | *Aphanizomenon gracile* | 400 |
| LWB-03_1 | 8/30/2005 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria amphibia* | 811 |
| LWB-03_1 | 8/30/2005 | Cyanobacteria | Nostocaceae | *Aphanizomenon issatschenkoi* | 1,558 |
| LWB-03_1 | 8/30/2005 | Cyanobacteria | Chroococcaceae | *Merismopedia warmingiana* | 6,570 |
| LWB-03_1 | 8/30/2005 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 9,855 |
| LWB-03_1 | 8/30/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 61,596 |
| LWB-03_1 | 8/30/2005 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 85,414 |
| LWB-03_1 | 8/30/2005 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 86,073 |
| LWB-03_1 | 8/30/2005 | Cyanobacteria | Chroococcaceae | *Chroococcaceae* | 98,554 |
| LWB-04_1 | 8/30/2005 | Cyanobacteria | Chroococcaceae | *Synechocystis* | 32 |
| LWB-04_1 | 8/30/2005 | Cyanobacteria | Nostocaceae | *Cylindrospermopsis raciborskii* | 671 |
| LWB-04_1 | 8/30/2005 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria limnetica* | 974 |
| LWB-04_1 | 8/30/2005 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 8,213 |
| LWB-04_1 | 8/30/2005 | Cyanobacteria | Chroococcaceae | *Chroococcaceae* | 16,426 |
| LWB-04_1 | 8/30/2005 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 64,139 |
| LWB-04_1 | 8/30/2005 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 128,449 |
| LWB-04_1 | 8/30/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 139,619 |
| LWB-05_1 | 8/31/2005 | Cyanobacteria | Chroococcaceae | *Merismopedia warmingiana* | 121 |
| LWB-05_1 | 8/31/2005 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria limnetica* | 303 |
| LWB-05_1 | 8/31/2005 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria amphibia* | 364 |
| LWB-05_1 | 8/31/2005 | Cyanobacteria | Nostocaceae | *Cylindrospermopsis raciborskii* | 1,539 |
| LWB-05_1 | 8/31/2005 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 2,196 |
| LWB-05_1 | 8/31/2005 | Cyanobacteria | Chroococcaceae | *Microcystis wesenbergii* | 2,743 |
| LWB-05_1 | 8/31/2005 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 39,356 |
| LWB-05_1 | 8/31/2005 | Cyanobacteria | Chroococcaceae | *Chroococcaceae* | 65,703 |
| LWB-05_1 | 8/31/2005 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 84,319 |
| LWB-05_1 | 8/31/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 106,767 |
| LWB-07_1 | 9/1/2005 | Cyanobacteria | Chroococcaceae | *Dactylococcopsis irregularis* | 68 |
| LWB-07_1 | 9/1/2005 | Cyanobacteria | Nostocaceae | *Aphanizomenon issatschenkoi* | 114 |
| LWB-07_1 | 9/1/2005 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria amphibia* | 303 |
| LWB-07_1 | 9/1/2005 | Cyanobacteria | Nostocaceae | *Aphanizomenon gracile* | 682 |
| LWB-07_1 | 9/1/2005 | Cyanobacteria | Nostocaceae | *Cylindrospermopsis raciborskii* | 3,401 |
| LWB-07_1 | 9/1/2005 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 8,084 |
| LWB-07_1 | 9/1/2005 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 37,037 |
| LWB-07_1 | 9/1/2005 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 49,277 |
| LWB-07_1 | 9/1/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 90,341 |
| LWB-07_1 | 9/1/2005 | Cyanobacteria | Chroococcaceae | *Chroococcaceae* | 98,554 |
| LWB-08_1 | 8/31/2005 | Cyanobacteria | Chroococcaceae | *Dactylococcopsis irregularis* | 23 |
| LWB-08_1 | 8/31/2005 | Cyanobacteria | Chroococcaceae | *Chroococcus minutus* | 45 |
| LWB-08_1 | 8/31/2005 | Cyanobacteria | Nostocaceae | *Aphanizomenon issatschenkoi* | 151 |
| LWB-08_1 | 8/31/2005 | Cyanobacteria | Nostocaceae | *Anabaena planctonica* | 274 |
| LWB-08_1 | 8/31/2005 | Cyanobacteria | Nostocaceae | *Anabaena aphanizomenoides* | 394 |
| LWB-08_1 | 8/31/2005 | Cyanobacteria | Chroococcaceae | *Merismopedia tenuissima* | 545 |
| LWB-08_1 | 8/31/2005 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 1,545 |
| LWB-08_1 | 8/31/2005 | Cyanobacteria | Nostocaceae | *Cylindrospermopsis raciborskii* | 2,234 |
| LWB-08_1 | 8/31/2005 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 41,667 |
| LWB-08_1 | 8/31/2005 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 49,277 |
| LWB-08_1 | 8/31/2005 | Cyanobacteria | Chroococcaceae | *Chroococcaceae* | 69,809 |
| LWB-08_1 | 8/31/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 69,809 |

**Appendix C-2.** Cyanobacterial cell densities, by species, in samples collected at selected sites in Lake William C. Bowen and Municipal Reservoir #1, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site ID_Sample Depth (m) | Sample date | Division | Family | Taxon | Density (cell/mL) |
|---|---|---|---|---|---|
| LWB-08_1 | 5/16/2006 | Cyanobacteria | Chroococcaceae | *Chroococcaceae* | 65,703 |
| LWB-08_1 | 5/16/2006 | Cyanobacteria | Chroococcaceae | *Aphanothece nidulans* | 404 |
| LWB-08_1 | 5/16/2006 | Cyanobacteria | Chroococcaceae | *Chroococcus minimus* | 20 |
| LWB-08_1 | 5/16/2006 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 104,030 |
| LWB-08_1 | 5/16/2006 | Cyanobacteria | Chroococcaceae | *Synechocystis* | 10 |
| LWB-08_1 | 5/16/2006 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria amphibia* | 303 |
| LWB-08_1 | 5/16/2006 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria limnetica* | 73 |
| LWB-08_1 | 5/16/2006 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 36,410 |
| LWB-08_6 | 5/16/2006 | Cyanobacteria | Chroococcaceae | *Chroococcaceae* | 62,965 |
| LWB-08_6 | 5/16/2006 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 90,341 |
| LWB-08_6 | 5/16/2006 | Cyanobacteria | Nostocaceae | *Pseudanabaena* | 91 |
| LWB-08_6 | 5/16/2006 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 29,566 |
| LWB-08_1 | 10/24/2006 | Cyanobacteria | Chroococcaceae | undefined | 20,532 |
| LWB-08_1 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 1,696 |
| LWB-08_1 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Aphanocapsa elachista* | 61 |
| LWB-08_1 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Chroococcus minimus* | 91 |
| LWB-08_1 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Dactylococcopsis irregularis* | 1,818 |
| LWB-08_1 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Merismopedia tenuissima* | 61 |
| LWB-08_1 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 41,064 |
| LWB-08_1 | 10/24/2006 | Cyanobacteria | Nostocaceae | *Cylindrospermopsis raciborskii* | 744 |
| LWB-08_1 | 10/24/2006 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 2,629 |
| LWB-08_1 | 10/24/2006 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria limnetica* | 454 |
| LWB-08_1 | 10/24/2006 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 96,912 |
| LWB-08_6 | 10/24/2006 | Cyanobacteria | Chroococcaceae | undefined | 49,277 |
| LWB-08_6 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 1,159 |
| LWB-08_6 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Aphanocapsa elachista* | 1,545 |
| LWB-08_6 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Dactylococcopsis irregularis* | 1,772 |
| LWB-08_6 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 32,851 |
| LWB-08_6 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Synechocystis* | 2,045 |
| LWB-08_6 | 10/24/2006 | Cyanobacteria | Nostocaceae | *Aphanizomenon gracile* | 151 |
| LWB-08_6 | 10/24/2006 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 250 |
| LWB-08_6 | 10/24/2006 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 82,364 |
| LWB-10_1 | 9/6/2005 | Cyanobacteria | Chroococcaceae | *Merismopedia tenuissima* | 273 |
| LWB-10_1 | 9/6/2005 | Cyanobacteria | Chroococcaceae | *Dactylococcopsis irregularis* | 432 |
| LWB-10_1 | 9/6/2005 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 1,643 |
| LWB-10_1 | 9/6/2005 | Cyanobacteria | Nostocaceae | *Cylindrospermopsis raciborskii* | 1,677 |
| LWB-10_1 | 9/6/2005 | Cyanobacteria | Nostocaceae | *Aphanizomenon gracile* | 2,190 |
| | | | | Others | 6,214 |
| LWB-10_1 | 9/6/2005 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 32,116 |
| LWB-10_1 | 9/6/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 69,809 |
| LWB-10_1 | 9/6/2005 | Cyanobacteria | Chroococcaceae | *Chroococcaceae* | 90,341 |
| LWB-10_1 | 9/6/2005 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 70,395 |
| LWB-10_1 | 5/15/2006 | Cyanobacteria | Chroococcaceae | undefined | 76,653 |
| LWB-10_1 | 5/15/2006 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 1,010 |
| LWB-10_1 | 5/15/2006 | Cyanobacteria | Chroococcaceae | *Aphanothece nidulans* | 727 |
| LWB-10_1 | 5/15/2006 | Cyanobacteria | Chroococcaceae | *Chroococcus minimus* | 20 |
| LWB-10_1 | 5/15/2006 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 54,752 |
| LWB-10_1 | 5/15/2006 | Cyanobacteria | Chroococcaceae | *Synechocystis* | 212 |
| LWB-10_1 | 5/15/2006 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 4,745 |

**Appendix C-2.** Cyanobacterial cell densities, by species, in samples collected at selected sites in Lake William C. Bowen and Municipal Reservoir #1, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site ID_Sample Depth (m) | Sample date | Division | Family | Taxon | Density (cell/mL) |
|---|---|---|---|---|---|
| LWB-10_1 | 10/24/2006 | Cyanobacteria | Chroococcaceae | undefined | 69,809 |
| LWB-10_1 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 1,979 |
| LWB-10_1 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Aphanocapsa elachista* | 2,499 |
| LWB-10_1 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Dactylococcopsis irregularis* | 1,022 |
| LWB-10_1 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Merismopedia tenuissima* | 176 |
| LWB-10_1 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Merismopedia warmingiana* | 182 |
| LWB-10_1 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 57,490 |
| LWB-10_1 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Synechocystis* | 23 |
| LWB-10_1 | 10/24/2006 | Cyanobacteria | Nostocaceae | *Cylindrospermopsis raciborskii* | 598 |
| LWB-10_1 | 10/24/2006 | Cyanobacteria | Nostocaceae | *Pseudanabaena galeata* | 68 |
| LWB-10_1 | 10/24/2006 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 1,670 |
| LWB-10_1 | 10/24/2006 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 53,906 |
| LWB-10_6 | 5/15/2006 | Cyanobacteria | Chroococcaceae | undefined | 76,653 |
| LWB-10_6 | 5/15/2006 | Cyanobacteria | Chroococcaceae | *Chroococcus minimus* | 40 |
| LWB-10_6 | 5/15/2006 | Cyanobacteria | Chroococcaceae | *Merismopedia tenuissima* | 323 |
| LWB-10_6 | 5/15/2006 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 60,228 |
| LWB-10_6 | 5/15/2006 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 13,141 |
| LWB-10_6 | 10/24/2006 | Cyanobacteria | Chroococcaceae | undefined | 41,064 |
| LWB-10_6 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 2,050 |
| LWB-10_6 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Aphanocapsa elachista* | 1,545 |
| LWB-10_6 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Aphanothece nidulans* | 303 |
| LWB-10_6 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Chroococcus minimus* | 182 |
| LWB-10_6 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Dactylococcopsis irregularis* | 1,091 |
| LWB-10_6 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Merismopedia punctata* | 61 |
| LWB-10_6 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Merismopedia warmingiana* | 121 |
| LWB-10_6 | 10/24/2006 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 69,809 |
| LWB-10_6 | 10/24/2006 | Cyanobacteria | Nostocaceae | *Cylindrospermopsis raciborskii* | 525 |
| LWB-10_6 | 10/24/2006 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 2,590 |
| LWB-10_6 | 10/24/2006 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 111,696 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Nostocaceae | *Cylindrospermopsis raciborskii* | 39 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Nostocaceae | *Aphanizomenon issatschenkoi* | 98 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Nostocaceae | *Cylindrospermopsis raciborskii* | 98 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Nostocaceae | *Anabaena planctonica* | 283 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria amphibia* | 293 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria tenuis* | 325 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Oscillatoriaceae | *Spirulina* | 388 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria agardhii* | 488 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Chroococcaceae | *Synechocystis* | 548 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 644 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 1,170 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus leopoliensis* | 9,034 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus elongatus* | 12,593 |
| | | | | Others | 25,999 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 19,711 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Chroococcaceae | *Aphanothece nidulans* | 32,851 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 32,851 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | Oscillatoriaceae | *Romeria* | 50,962 |
| LWB-10_7 | 9/6/2005 | Cyanobacteria | | *Chroococcaceae* | 147,832 |

**Appendix C-2.** Cyanobacterial cell densities, by species, in samples collected at selected sites in Lake William C. Bowen and Municipal Reservoir #1, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site ID_Sample Depth (m) | Sample date | Division | Family | Taxon | Density (cell/mL) |
|---|---|---|---|---|---|
| LWB-11_1 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Merismopedia warmingiana* | 182 |
| LWB-11_1 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Dactylococcopsis irregularis* | 545 |
| LWB-11_1 | 9/7/2005 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria amphibia* | 909 |
| LWB-11_1 | 9/7/2005 | Cyanobacteria | Nostocaceae | *Cylindrospermopsis raciborskii* | 1,419 |
| LWB-11_1 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 1,454 |
| LWB-11_1 | 9/7/2005 | Cyanobacteria | Nostocaceae | *Aphanizomenon gracile* | 3,458 |
| | | | | Others | 7,966 |
| LWB-11_1 | 9/7/2005 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 12,729 |
| LWB-11_1 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Chroococcaceae* | 24,639 |
| LWB-11_1 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 102,661 |
| LWB-11_1 | 9/7/2005 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 49,043 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Chroococcus minutus* | 61 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Nostocaceae | *Anabaena macrospora* | 61 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria limnetica* | 227 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Dactylococcopsis irregularis* | 364 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Oscillatoriaceae | *Romeria* | 364 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 394 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria amphibia* | 606 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria* | 1,363 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Nostocaceae | *Cylindrospermopsis raciborskii* | 1,414 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Nostocaceae | *Aphanizomenon gracile* | 2,019 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria tenuis* | 2,048 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus elongatus* | 2,053 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus leopoliensis* | 5,133 |
| | | | | Others | 16,106 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 12,268 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Chroococcaceae* | 45,171 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 45,171 |
| LWB-11_7 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 57,490 |
| MR1-14_1 | 9/7/2005 | Cyanobacteria | Chroococcaceae | undefined | 45,171 |
| MR1-14_1 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 18,013 |
| MR1-14_1 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Dactylococcopsis irregularis* | 876 |
| MR1-14_1 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus elongatus* | 4,106 |
| MR1-14_1 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 127,299 |
| MR1-14_1 | 9/7/2005 | Cyanobacteria | Nostocaceae | *Aphanizomenon gracile* | 3,750 |
| MR1-14_1 | 9/7/2005 | Cyanobacteria | Nostocaceae | *Aphanizomenon issatschenkoi* | 293 |
| MR1-14_1 | 9/7/2005 | Cyanobacteria | Nostocaceae | *Cylindrospermopsis raciborskii* | 406 |
| MR1-14_1 | 9/7/2005 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 48,606 |
| MR1-14_1 | 9/7/2005 | Cyanobacteria | Oscillatoriaceae | *Oscillatoria limnetica* | 325 |
| MR1-14_1 | 9/7/2005 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 159,658 |
| MR1-14_1 | 5/17/2006 | Cyanobacteria | Chroococcaceae | undefined | 94,448 |
| MR1-14_1 | 5/17/2006 | Cyanobacteria | Chroococcaceae | *Aphanothece nidulans* | 757 |
| MR1-14_1 | 5/17/2006 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 82,129 |
| MR1-14_1 | 5/17/2006 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 379 |
| MR1-14_1 | 5/17/2006 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 83,223 |
| MR1-14_1 | 10/25/2006 | Cyanobacteria | Chroococcaceae | undefined | 36,958 |
| MR1-14_1 | 10/25/2006 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 4,468 |
| MR1-14_1 | 10/25/2006 | Cyanobacteria | Chroococcaceae | *Chroococcus minutus* | 91 |
| MR1-14_1 | 10/25/2006 | Cyanobacteria | Chroococcaceae | *Dactylococcopsis irregularis* | 568 |

**Appendix C-2.** Cyanobacterial cell densities, by species, in samples collected at selected sites in Lake William C. Bowen and Municipal Reservoir #1, August 2005 to October 2006.—Continued

[ID, identifier; m, meters; cells/mL, cells per milliliter]

| Site ID_Sample Depth (m) | Sample date | Division | Family | Taxon | Density (cell/mL) |
|---|---|---|---|---|---|
| MR1-14_1 | 10/25/2006 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 32,851 |
| MR1-14_1 | 10/25/2006 | Cyanobacteria | Chroococcaceae | *Synechocystis* | 1,227 |
| MR1-14_1 | 10/25/2006 | Cyanobacteria | Nostocaceae | *Cylindrospermopsis raciborskii* | 759 |
| MR1-14_1 | 10/25/2006 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 1,136 |
| MR1-14_1 | 10/25/2006 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 75,792 |
| MR1-14_6 | 9/7/2005 | Cyanobacteria | Chroococcaceae | undefined | 109,505 |
| MR1-14_6 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 17,448 |
| MR1-14_6 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Dactylococcopsis irregularis* | 788 |
| MR1-14_6 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus elongatus* | 5,475 |
| MR1-14_6 | 9/7/2005 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 180,683 |
| MR1-14_6 | 9/7/2005 | Cyanobacteria | Nostocaceae | *Aphanizomenon gracile* | 2,757 |
| MR1-14_6 | 9/7/2005 | Cyanobacteria | Nostocaceae | *Cylindrospermopsis raciborskii* | 937 |
| MR1-14_6 | 9/7/2005 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 34,933 |
| MR1-14_6 | 9/7/2005 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | |
| MR1-14_6 | 5/17/2006 | Cyanobacteria | Chroococcaceae | undefined | 45,171 |
| MR1-14_6 | 5/17/2006 | Cyanobacteria | Chroococcaceae | *Merismopedia tenuissima* | 454 |
| MR1-14_6 | 5/17/2006 | Cyanobacteria | Chroococcaceae | *Microcystis aeruginosa* | 123 |
| MR1-14_6 | 5/17/2006 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 98,554 |
| MR1-14_6 | 5/17/2006 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 114,981 |
| MR1-14_6 | 10/25/2006 | Cyanobacteria | Chroococcaceae | undefined | 61,596 |
| MR1-14_6 | 10/25/2006 | Cyanobacteria | Chroococcaceae | *Aphanocapsa delicatissima* | 1,704 |
| MR1-14_6 | 10/25/2006 | Cyanobacteria | Chroococcaceae | *Dactylococcopsis irregularis* | 1,022 |
| MR1-14_6 | 10/25/2006 | Cyanobacteria | Chroococcaceae | *Synechococcus sp.1* | 16,426 |
| MR1-14_6 | 10/25/2006 | Cyanobacteria | Chroococcaceae | *Synechocystis* | 1,363 |
| MR1-14_6 | 10/25/2006 | Cyanobacteria | Nostocaceae | *Cylindrospermopsis raciborskii* | 942 |
| MR1-14_6 | 10/25/2006 | Cyanobacteria | Oscillatoriaceae | *Lyngbya limnetica* | 1,590 |
| MR1-14_6 | 10/25/2006 | Cyanobacteria | Synechococcaceae | *Cyanogranis ferruginea* | 92,395 |

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