TMDL Report

Dissolved Oxygen and Nutrient TMDLs for Lake Hancock and Lower Saddle Creek

(WBID 1623L & 1623K)

U.S. Environmental Protection Agency
Region 4

March 2006

United States Environmental Protection Agency

Region 4 serving the southeast

In compliance with the provisions of the Federal Clean Water Act, 33 U.S.C §1251 et. seq., as amended by the Water Quality Act of 1987, P.L. 400-4, the U.S Environmental Protection Agency is hereby establishing the Total Maximum Daily Load (TMDL) for nutrients in the Peace River Basin (WBIDs 1623L and 1623K). Subsequent actions must be consistent with this TMDL.

/s/ March 31, 2006

James D. Giattina, Director Date
Water Management Division

Acknowledgments

EPA would like to acknowledge that the contents of this report and the total maximum daily load (TMDL) contained herein were developed by the Florida Department of Environmental Protection (FDEP). Many of the text and figures may not read as though EPA is the primary author for this reason, but EPA is officially establishing the TMDL for dissolved oxygen and nutrients for Lake Hancock and Lower Saddle Creek, (WBID 1623L & 1623K). EPA is establishing this TMDL in order to meet consent decree requirements pursuant to the Consent Decree entered in the case of Florida Wildlife Federation, et al. v. Carol Browner, et al., Case No. 98-356-CIV-Stafford.

This study could not have been accomplished without significant contributions from staff in the Florida Department of Environmental Protection's (the Department) Watershed Assessment Section. Douglas Gilbert provided technical assistance in model development and calibration. The Department also recognizes the substantial support and assistance from FDEPs Tampa District Office, the Southwest Florida Water Management District (SWFWMD), the Polk County Natural Resource Division, Soil and Water Engineering Technology, Inc. (SWET), and Quantitative Environmental Analysis (QEA), LLC, and their contributions towards understanding the issues, history, and processes at work in the Banana Lake watershed.

Editorial assistance provided by Jan Mandrup-Poulsen and Kevin Petrus.
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Identification of Impaired Surface Waters Rule

http://www.dep.state.fl.us/water/tmdl/docs/AmendedIWR.pdf

STORET Program

http://www.dep.state.fl.us/water/storet/index.htm

2000 305(b) Report

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Criteria for Surface Water Quality Classifications

http://www/dep.state.fl.us/legal/legaldocuments/rules/ruleslistnum.htm

Basin Status Report for the Lake Hunter Basin

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Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the TMDL for nutrients and dissolved oxygen (DO) for Lake Hancock and Lower Saddle Creek located in the Lake Hancock basin. Lake Hancock and Lower Saddle Creek are essentially the headwaters of the Peace River and have a direct impact on water quantity and quality of the downstream river reaches. The lake and creek were verified as impaired for nutrients and low DO using the methodology in the Identification of Impaired Surface Waters Rule (IWR, Rule 62-303, Florida Administrative Code). The lake and creek were included on the Verified List of impaired waters that was adopted by Secretarial Order on June 17, 2005. The TMDLs establish the allowable loadings to the lake and canal that would restore the waterbodies so that they meet their applicable water quality criteria for nutrients and DO.

1.2 Identification of Waterbody

Lake Hancock is located southeast of the City of Lakeland, north of Bartow and west of Winter Haven in Polk County, Florida, at Latitude 27^{o} 58" 30' and Longitude 81^{o} 50" 25'. The estimated surface area of the lake is 4,533 acres. The approximate total volume of the lake is 19,795,031.5 m^3 (16,048 acre-feet) with an average depth of 5 ft (1.5 m). The surface water drainage area of the lake is approximately 140 square miles. The surface water drainage area of Lake Hancock and Lower Saddle Creek is approximately 157 square miles. Lake Hancock and Lower Saddle Creek watersheds are illustrated in **Figure 1.1** which also shows the eight major subbasins which make up the Lake Hancock watershed. The watershed's land use designations are primarily urban, citrus, and abandoned phosphate mine lands. The normal pool topographic elevation of the water surface is approximately 97.7 feet National Geodetic Vertical Datum (NGVD) (BCI Engineers and Scientists, Inc., 2005). Primary tributaries flowing into Lake Hancock include Banana Lake Canal, Lake Lena Run, and Saddle Creek Above Lake Hancock (here after referred to as Middle and Upper Saddle Creek).

Significant sub-basins draining to Lake Hancock and Lower Saddle Creek include Middle and Upper Saddle Creek, the Lake Parker subbasin (which includes Lakes Bonny, Gibson, Crago, and Parker); the Banana Lake subbasin (which includes Lakes Bentley, Hollingsworth, Banana, and Banana Lake Canal); the Lake Lena subbasin (which includes Lakes Areitta, Ariana, Lena, and Lake Lena Run); and the Eagle Lake sub-basin (which includes Lakes Thomas, Sears, Spirit, Eagle, and Millsite).

Lower Saddle Creek is the outlet channel for Lake Hancock. The creek's confluence with the Peace Creek Drainage Canal forms the headwaters of the Peace River which travels approximately 105 miles to Charlotte Harbor. In 1963, the Outfall Control Structure P-11 was constructed approximately 3,500 feet south of Lake Hancock in Lower Saddle Creek to regulate discharge from the lake. Structure P-11 was constructed to replace a structure that consisted of concrete, timber piles, and removable boards. This current structure is operated and maintained by the Southwest Florida Water Management District (District). Two 7-foot high by 20-foot wide radial gates with an invert of 91.7 feet NGVD are used to regulate the flows until an elevation of 98.7 feet is attained. When the level of the Lake attains this elevation, surface water will begin to flow around the structure.

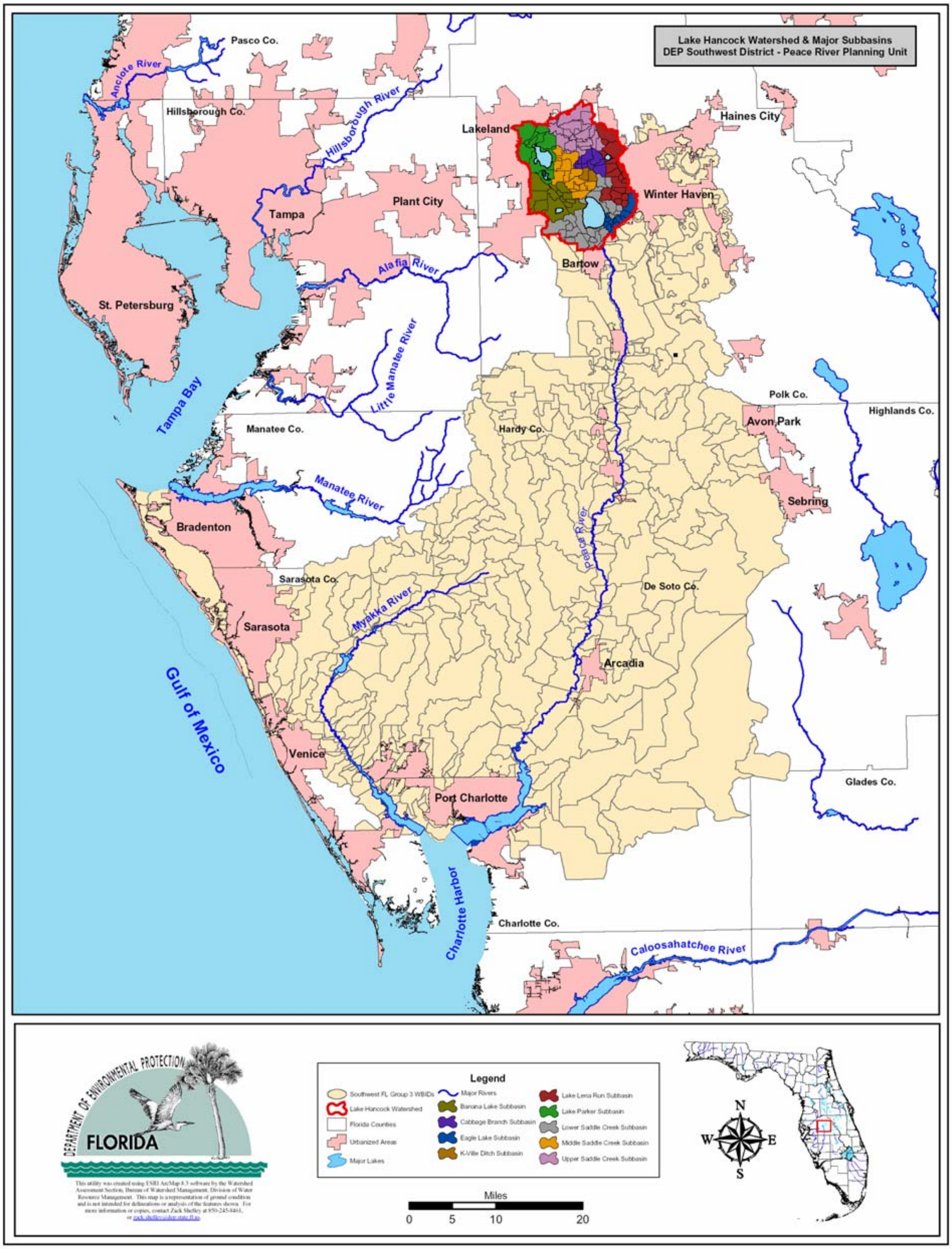


Figure 1.1 Southwest Florida Group 3 WBIDs and Major Metropolitan Areas Surrounding the Lake Hancock Watershed and its Major Subbasins

For assessment purposes, the Department has divided the Lake Hancock Basin into water assessment polygons with a unique waterbody identification (WBID) number for each watershed or stream reach. The lake has been given the WBID number of 1623L and Lower Saddle Creek the WBID number 1623K. The Lake Hancock WBID and its sampling/monitoring stations are illustrated in **Figure 1.2.** The Lower Saddle Creek WBID and its sampling/monitoring stations are illustrated in **Figure 1.3.**

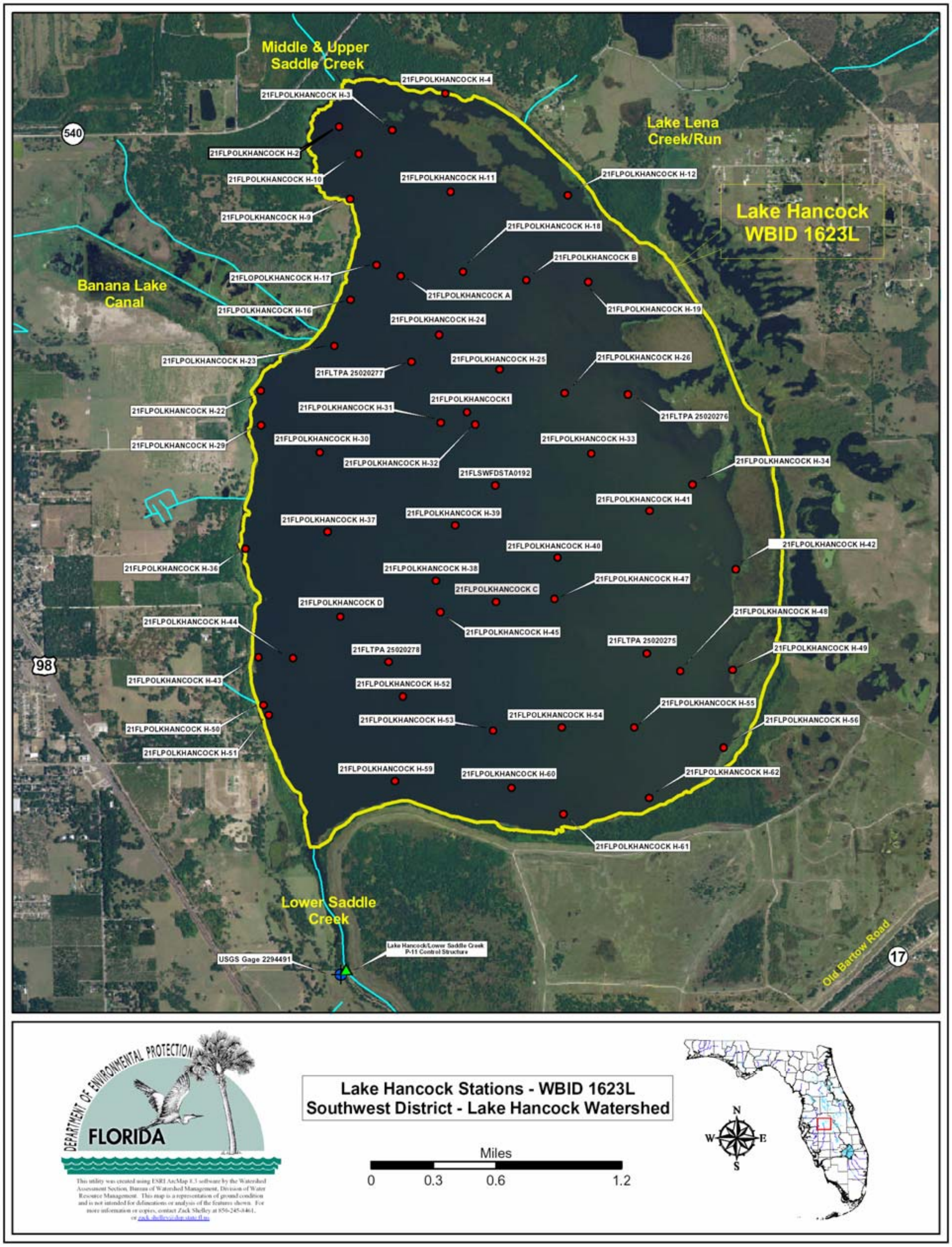


Figure 1.2 Lake Hancock (WBID 1623L) and Monitoring Stations

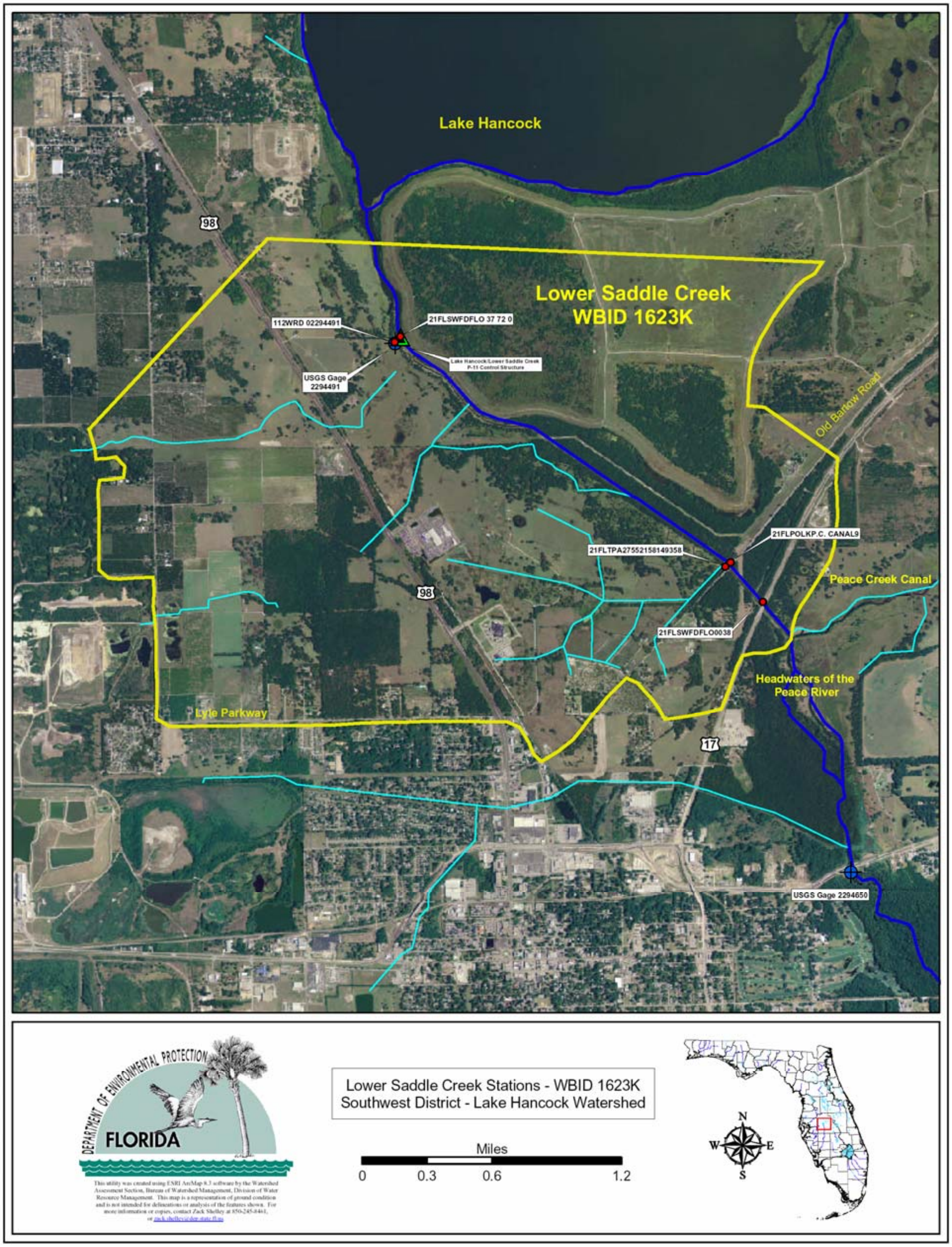


Figure 1.3 Lower Saddle Creek (WBID 1623K) and Monitoring Stations

1.3 Lake Hancock Basin Background Information

Lake Hancock is part of the headwaters of the Peace River, along with Lake Hamilton and the Winter Haven Chain of Lakes which flow into the Peace Creek Drainage Canal. Lake Hancock generates the greater input via Lower Saddle Creek. The Lake Hancock watershed is located within west-central Polk County near the geographic center of peninsular Florida. Polk County is part of the highland area that trends along the north-south axis of peninsular Florida. Within the county are three ridges separated by relatively flat lowland areas. The Lake Hancock watershed occupies the area between the Lakeland Ridge on the western boundary and Winter Haven Ridge along the eastern boundary (BCI Engineers and Scientists, Inc., 2005). Significant portions of the watershed have been mined for phosphate ore creating numerous spoil piles, clay settling area embankments, and water filled depressions and lakes.

In 1963, a weir/gate control structure (designated P-11) was constructed in Lower Saddle Creek, approximately 3,500 feet south of Lake Hancock, to regulate discharges from the lake into the Peace River and reduce flooding in downstream reaches during high rainfall/water events (Environmental Research and Design, Inc., 1999). Since construction of the P-11 structure, the water level in the lake has averaged between elevations of 97 and 98.5 feet NGVD (BCI Engineers and Scientists, Inc., 2005).

The tributary watershed to Structure P-11, which regulates flow from Lake Hancock, is approximately 143 sq miles. Lake Hancock receives inflow from primarily three major tributaries. Middle and Upper Saddle Creek originate east of the City of Lakeland and generally flow south through a swampy area before entering into the north shore of the lake. Lake Lena Run originates in Auburndale and enters Lake Hancock on the northeast side. Banana Lake, located about 1-mile northwest of Highland City, discharges into the Banana Lake Overflow Canal that enters the west side of the Lake. These three tributaries account for approximately 81% of the Lake Hancock watershed. The Eagle Lake system located below Lake Lena Run is a minor tributary that originates in the Eagle Lake area and enters Lake Hancock on the southeast side. Remaining areas of the watershed are contiguous to the Lake.

Climate in the Lake Hancock basin is subtropical with humid, rainy summers, and dry mild winters. Average monthly temperatures range from 61°F in January to 82°F in July and August. About half of the annual rainfall occurs during the summer months of June through September. There has been an extended period of below normal rainfall in the Lake Hancock area and in central Florida generally since 1960. The Lake Hancock Watershed is underlain by a layer of sand, clay, and limestone, ranging in thickness from about 100 to 400 feet. Under the surficial layer is several thousand feet of limestone and dolomite. The formations comprising the watershed (Hammett, Snell, Joyner; USGS 1981) can be divided into three hydrogeologic units: (1) the surficial aquifer, (2) secondary artesian aquifers and confining beds, and (3) the Floridan aquifer. The surficial aquifer is composed of sand, sandy clay, and pebble phosphate deposits, which in Polk County have been strip mined extensively. The thickness of this unit varies between 20 and 130 feet. The secondary artesian aquifers and confining beds are composed of clay, dolomite, and limestone of the Hawthorn Formation and Tampa Limestone. The thickness of this unit varies between 50 and 150 feet.

The Floridan aquifer consists of limestone and dolomite of the Suwannee Limestone, Ocala Limestone, and Avon Park Limestone. Drilling logs indicate that zones within the limestone and dolomite contain numerous cavities and honeycomb features that have resulted from dissolution of the carbonate rock by circulating ground water. Weaknesses in the geologic structure caused by dissolution are responsible for sinkhole collapses. Ardaman and Associates, Inc. in 1976 reported that between the years 1956 and 1975 more than 20 sinkhole collapses had occurred within two miles of Lake Hancock. Ground water in the surficial and the secondary artesian aquifers typically flow from the ridge areas to the streams and lakes of the lowland areas. However, the lowering of the Florida aquifer due to ground water withdrawals has created a downward movement of the surficial water into the secondary artesian in the area of Lake Hancock and the upper Peace River. A muck layer ranging in thickness from 1 to 4 feet covers the bottom of the lake. Underlying the muck are surficial deposits ranging from 9 to 17 feet in thickness which reside on top of the Bone Valley Formation containing phosphatic sands, gravels, and clays (Patton, 1980). Below the Bone Valley formation are Hawthorne limestones which have been dissolutioned by lateral movement of water to form the lake (BCI Engineers and Scientists, Inc., 2005).

Mining for phosphate in the vicinity of Lake Hancock began between 1941 and 1952. No mining in the vicinity of Lake Hancock is evident in a 1941 aerial photograph of the Lake. By 1952, aerial photographs indicate some areas approximately one mile to the northeast of the lake were being mined. Areas to the south of the lake showed mining activity by 1958. These areas were ultimately converted to clay settling areas. The 1968 aerials show active mining along the majority of the east side of the lake. Most of these mined areas have been reclaimed (BCI Engineers and Scientists, Inc., 2005).

1.4 TMDL Background Information

The TMDL Report for Lake Hancock and Lower Saddle Creek is part of the implementation of the Florida Department of Environmental Protection’s (Department) watershed management approach for restoring and protecting water resources and addressing Total Maximum Daily Load (TMDL) Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state’s fifty-two river basins over a five-year cycle, provides a framework for implementing the requirements of the 1972 federal Clean Water Act and the 1999 Florida Watershed Restoration Act (Chapter 99-223, Laws of Florida).

A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet the waterbody’s designated uses. A waterbody that does not meet its designated uses is defined as impaired. TMDLs must be developed and implemented for each of the state’s impaired waters, unless the impairment is documented to be a naturally occurring condition that cannot be abated by a TMDL or unless a management plan already in place is expected to correct the problem.

The development and implementation of a Basin Management Action Plan, or BMAP, to reduce the amount of pollutants that caused the impairment will follow this TMDL Report. These activities will depend heavily on the active participation of the Southwest Florida Water Management District (SWFWMD), Polk County, local governments, local businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for Lake Hancock and Lower Saddle Creek.

Chapter 2: STATEMENT OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rule Making History

Section 303(d) of the federal Clean Water Act requires states to submit to the EPA a list of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing the impairment of the listed waters on a schedule. The Department has developed such lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin, referred to as the Verified List, is also required by the Florid Watershed Restoration Act (Subsection 403.067[4)] Florida Statutes [F.S.]), and the state's 303(d) list is amended annually to include basin updates.

Florida's 1998 303(d) list included 52 waterbodies in the Peace River Planning Unit with 11 of those waterbodies in the Lake Hancock basin. However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rule-making process, the Environmental Regulation Commission adopted the new methodology as Chapter 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001.

2.2 Information on Verified Impairment

The Department used the IWR methodology to assess water quality in Lake Hancock and Lower Saddle Creek. The lake and the creek were both verified impaired for nutrients and dissolved oxygen (DO). The IWR methodology uses the water quality variables total nitrogen (TN), total phosphorus (TP), and chlorophyll *a* (a measure of algal mass, corrected and uncorrected) in calculating annual TSI values for lakes used in interpreting Florida's narrative nutrient criteria. The IWR uses the number of freshwater DO criterion exceedances to assess for DO impairment. The DO freshwater criterion in the State of Florida is 5 milligrams per liter (mg/L).

Lake Hancock was verified as impaired for nutrients based on an annual average Trophic State Index (TSI) value of 83.5 which exceeded the IWR threshold value of 60 during the verification period (the Verified Period for the Group 3 basins is from January 1, 1997 to June 30, 2004). The Planning Period for Group 3 basins is from January 1, 1992 to December 31, 2001. For the verified period, the lake was impaired for elevated seasonal and annual chlorophyll *a* values that exceeded the state freshwater threshold of 20 micrograms per liter (μg/L). The TN, TP, and biochemical oxygen demand (BOD) medians for the lake for the verified period were 4.46, 0.49, and 9.9 mg/L, respectively. The State of Florida's threshold screening values for TN, TP, and BOD are 1.7, 0.11 mg/L, and 2.9 mg/L, respectively (Friedemann, M. and Hand, J., 1989).

The TSI is calculated based on concentrations of TP, TN, and chlorophyll a as follows:

TSI Formula

$CHLA_{TSI} = 16.8 + 14.4 * LN(Chl\ a)$ — Chlorophyll a in µg/L
$TN_{TSI} = 56 + 19.8 * LN(N)$ — Nitrogen in mg/L
$TN2_{TSI} = 10 * [5.96 + 2.15 * LN(N + 0.0001)]$ — Phosphorus in mg/L
$TPTSI = 18.6 * LN(P * 1000) – 18.4$
$TP2_{TSI} = 10 * [2.36 * LN(P * 1000) – 2.38]$

If N/P > 30, *then* $NUTR_{TSI} = TP2_{TSI}$
If N/P < 10, *then* $NUTR_{TSI} = TN2_{TSI}$
if 10< N/P < 30, *then* $NUTR_{TSI} = (TP_{TSI} + TN_{TSI})/2$

$TSI = (CHLA_{TSI} + NUTR_{TSI})/2$ — Note: TSI has no units

The lake is listed as impaired for DO because, from 1997 to 2004, more than 10 percent of the DO results did not meet the freshwater DO criterion of 5 mg/L. Following the IWR methodology, there were 27 DO exceedances out of 140 samples (19.3 percent exceedance rate).

Lower Saddle Creek was verified as impaired for nutrients based on elevated seasonal and annual average chlorophyll a values that exceeded the threshold of 20 µg/L for freshwater streams. Annual average chlorophyll a values for the Verified Period (years 1997 to 2003) were 107, 89.1, 141.1, 73.5, 102.6, 93.2, and 163.5 µ/g/L, respectively. The TN, TP, and BOD medians for the creek for the verified period were 2.40, 0.40, and 6.5 mg/L, respectively. The creek is impaired for DO because, from 1997 to 2004, more than 10 percent of the DO results did not meet the freshwater DO criterion of 5 mg/L. Following the IWR methodology, there were 46 DO exceedances out of 130 samples (35.4 percent exceedance rate).

For modeling purposes, the following analysis of the eutrophication-related data for Lake Hancock used “all” of the available data from 1984 – 2004 for which records of TP, TN, and Chlorophyll a were sufficient to calculate seasonal annual average conditions. To calculate the TSI for a given year, there must be at least one sample of TN, TP, and Chlorophyll a taken at the same time period in each season of the year. Based on the IWR methodology, numerous data could not be used in the verified period thus limiting the amount of data to calculate annual average TSI values. The absence of data from all four seasons for many years in the planning and verified periods resulted in 2003 as the only year with sufficient data to calculate a TSI for Lake Hancock for assessing impairment following the IWR methodology.

Figure 2.1 displays annual average TSI values for all data from 1984 to 2004 (includes Lakewatch data) and the IWR verified period TSI value from 2003 (does not include Lakewatch data). Additionally, as the verified period ends in June of 2004, annual averages were not calculated for 2004 but are displayed in **Figure 2.1** for review. In 2003, the seasonal annual average TSI value of 83.5 exceeded the IWR threshold value of 60. Exceeding 60 in any one year of the verified period is sufficient in identifying a lake as being impaired for nutrients. In addition, if the mean color value is less than 40 platinum cobalt units (PCUs) and the annual mean TSI value exceeds 40 (instead of 60), the lake may be verified as impaired (IWR, Chapter 62-303.352).

Monthly and annual average TN results for Lake Hancock from 1992 to 2004 are displayed in **Figures 2.2** and **2.3,** respectively. Monthly and annual average TP results from 1992 to 2004 are displayed in **Figures 2.4** and **2.5.** Monthly and annual average chlorophyll a results from 1992 to 2004 are displayed in **Figures 2.6** and **2.7.** Monthly and annual average DO results from 1992 to 2004 are displayed in **Figures 2.8** and **2.9.** Monthly and annual average TN results for Lower Saddle Creek from 1992 to 2004 are displayed in **Figures 2.10** and **2.11,** respectively. Individual station and annual average TP results from 1992 to 2004 are displayed in **Figures 2.12** and **2.13.** Monthly and annual average chlorophyll a results from 1992 to 2004 are displayed in **Figures 2.14** and **2.15.** Monthly and annual average DO results for Lower Saddle Creek from 1992 to 2004 are displayed in **Figures 2.16** and **2.17.**

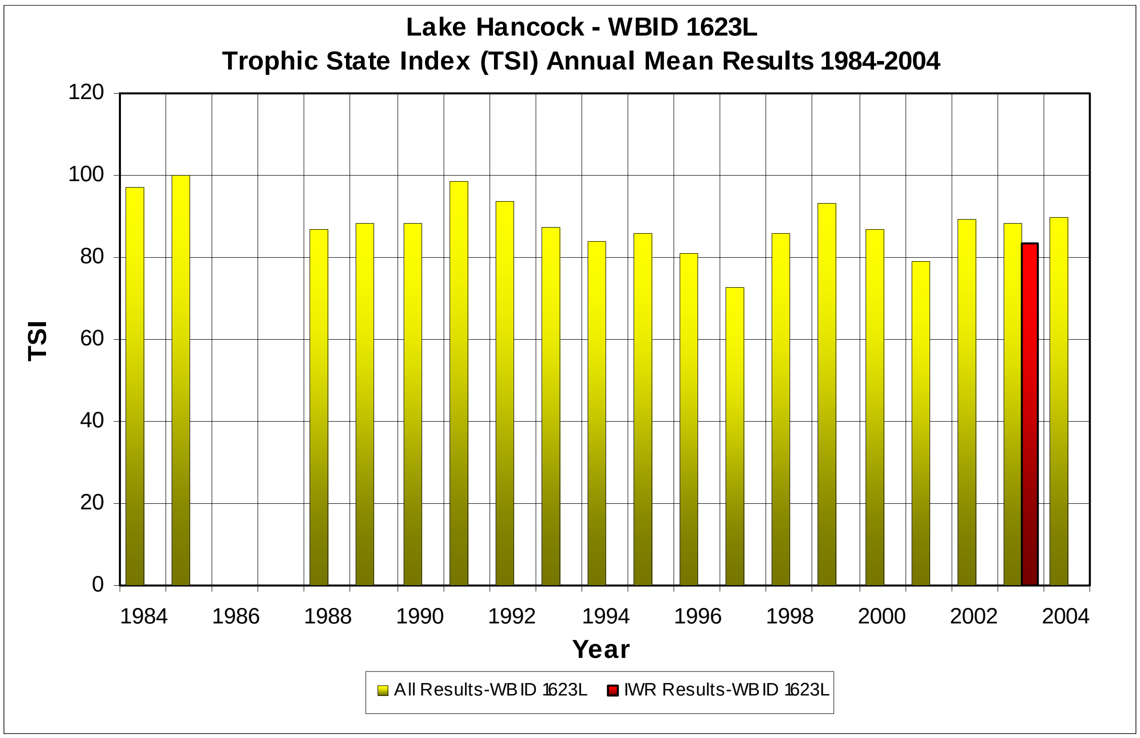


Figure 2.1 TSI Results for Lake Hancock Calculated from Annual Average Concentrations of TP, TN, and Chlorophyll a from 1984 to 2004

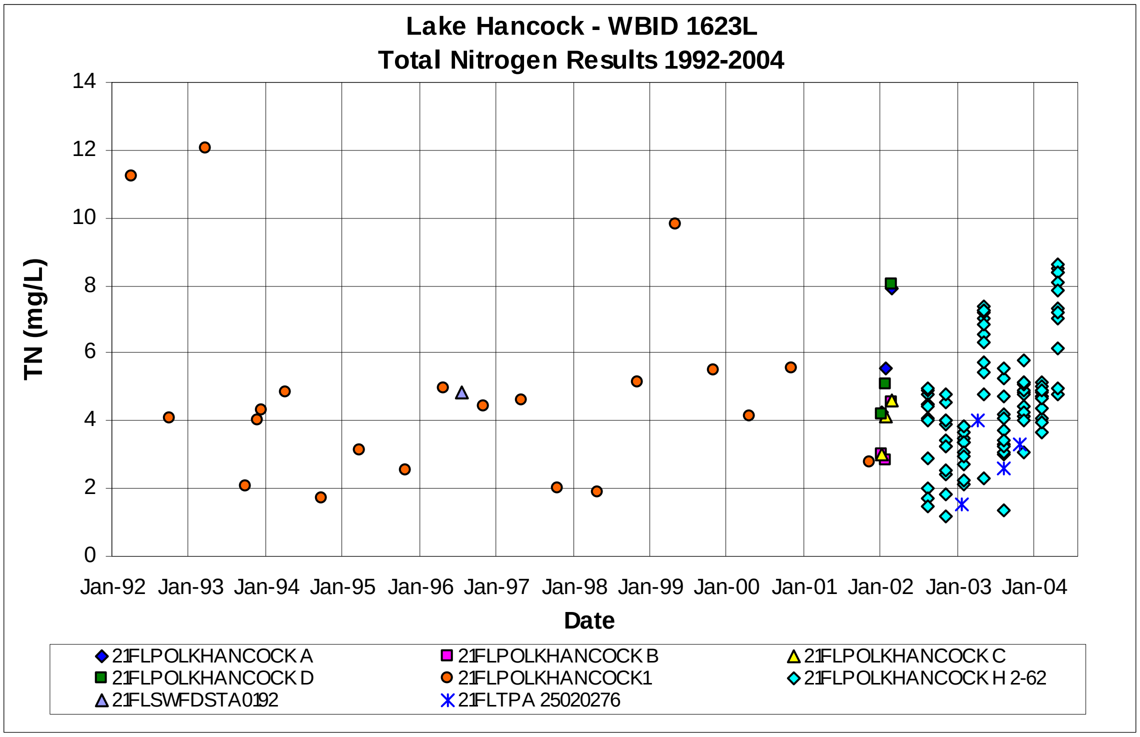


Figure 2.2 Total Nitrogen Monthly Results for Lake Hancock from 1992 to 2004

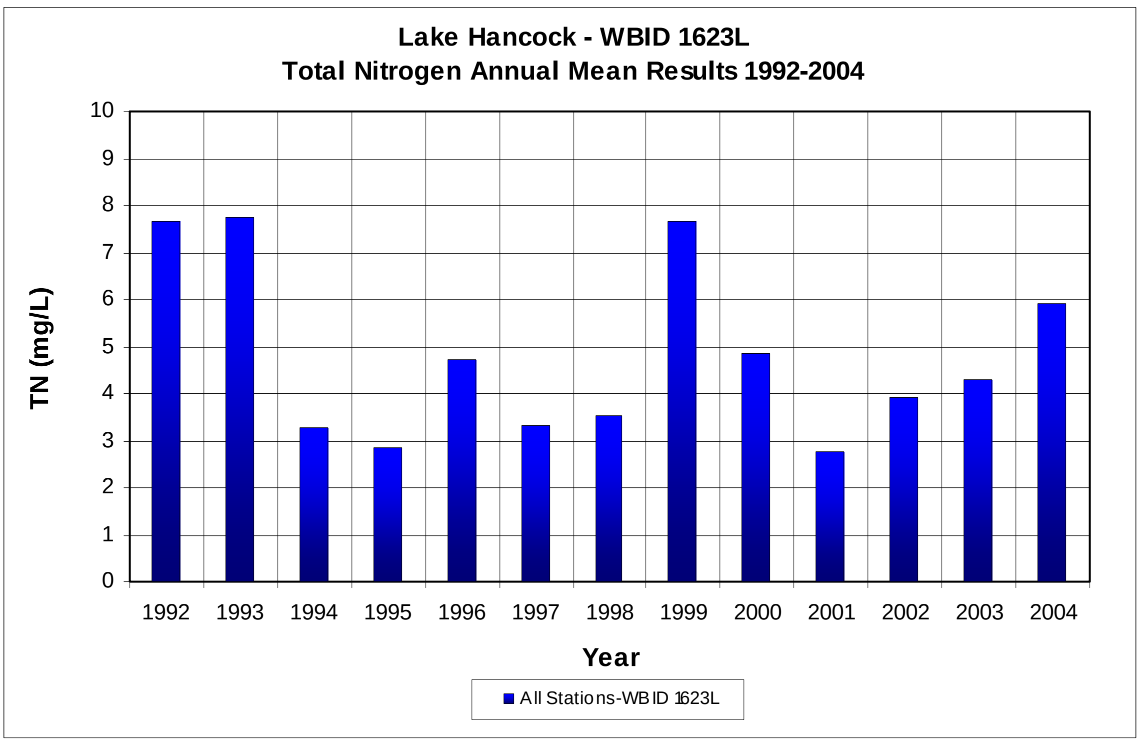


Figure 2.3 Total Nitrogen Annual Mean Results for Lake Hancock from 1992 to 2004

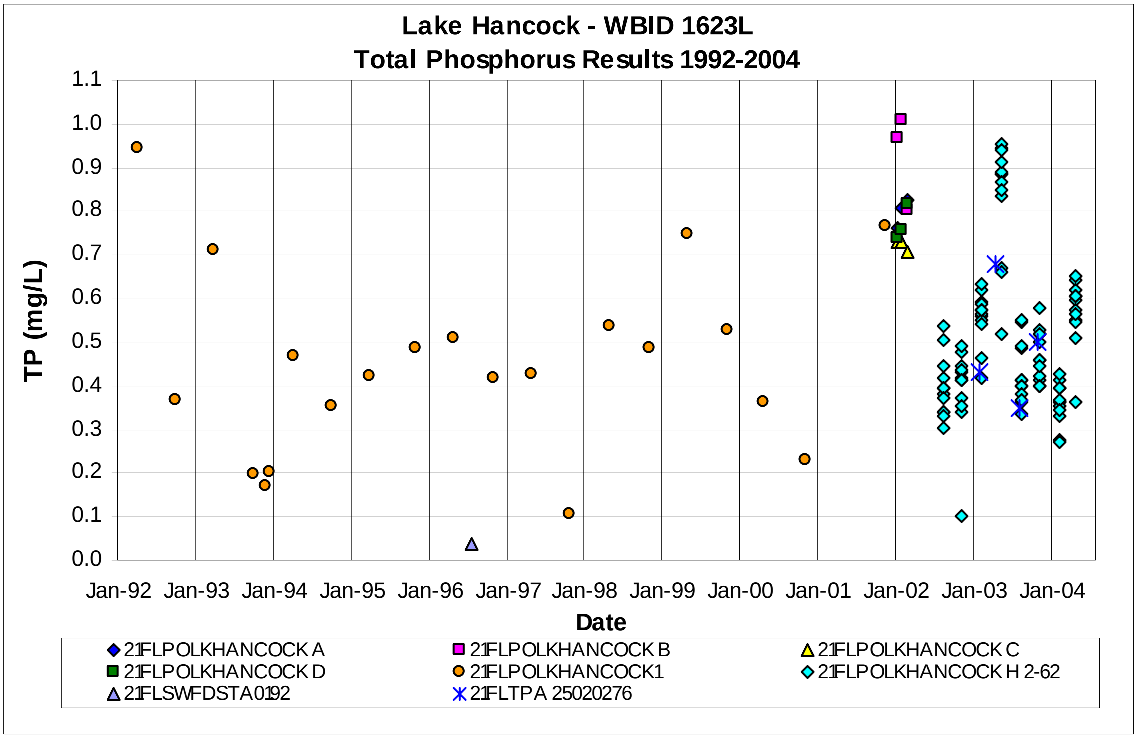


Figure 2.4 Total Phosphorus Monthly Results for Lake Hancock from 1992 to 2004

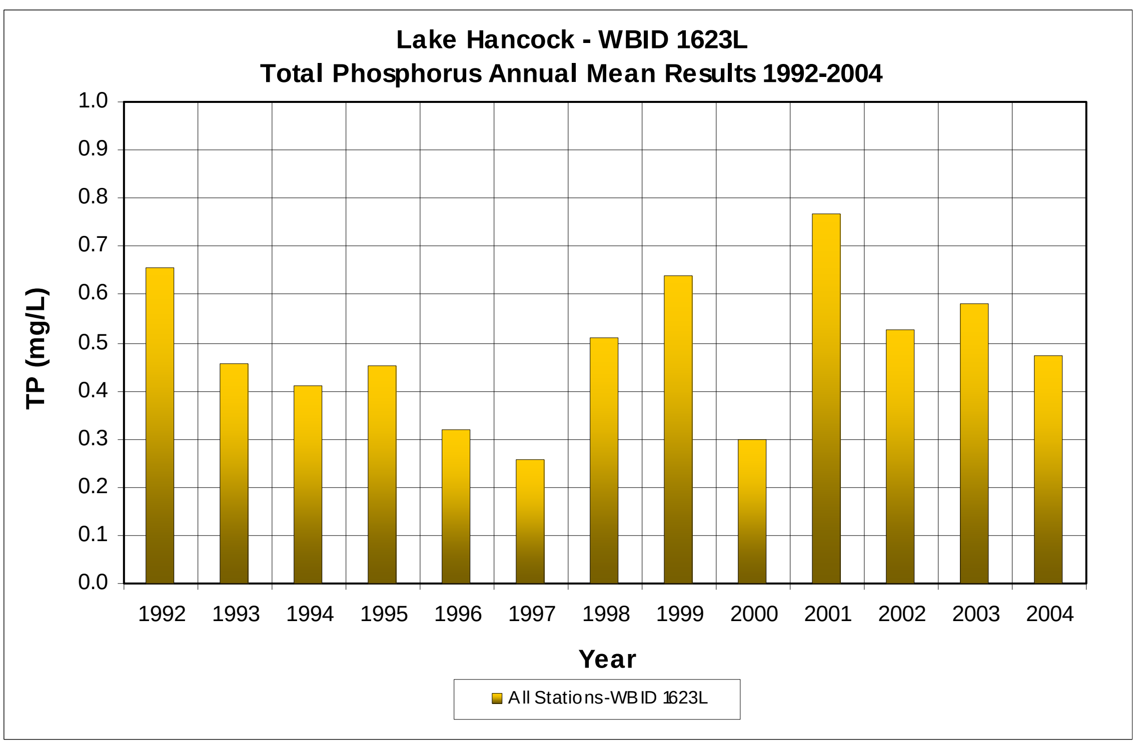


Figure 2.5 Total Phosphorus Annual Mean Results for Lake Hancock from 1992 to 2004

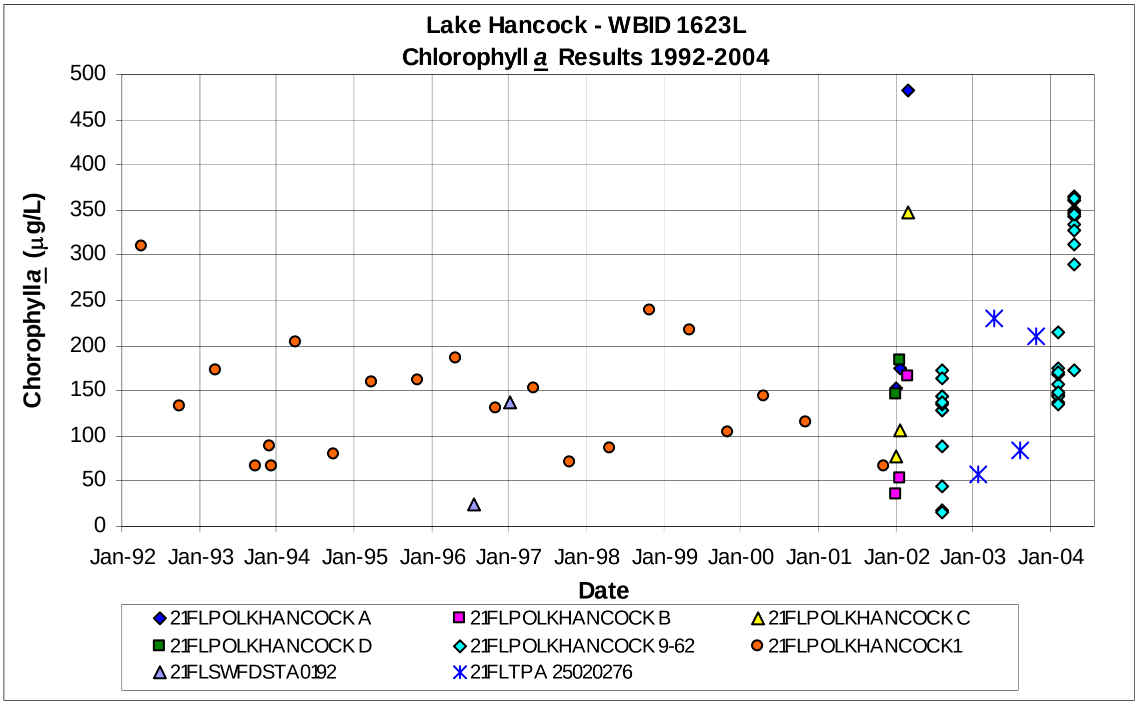


Figure 2.6 Chlorophyll a Monthly Results for Lake Hancock from 1992 to 2004

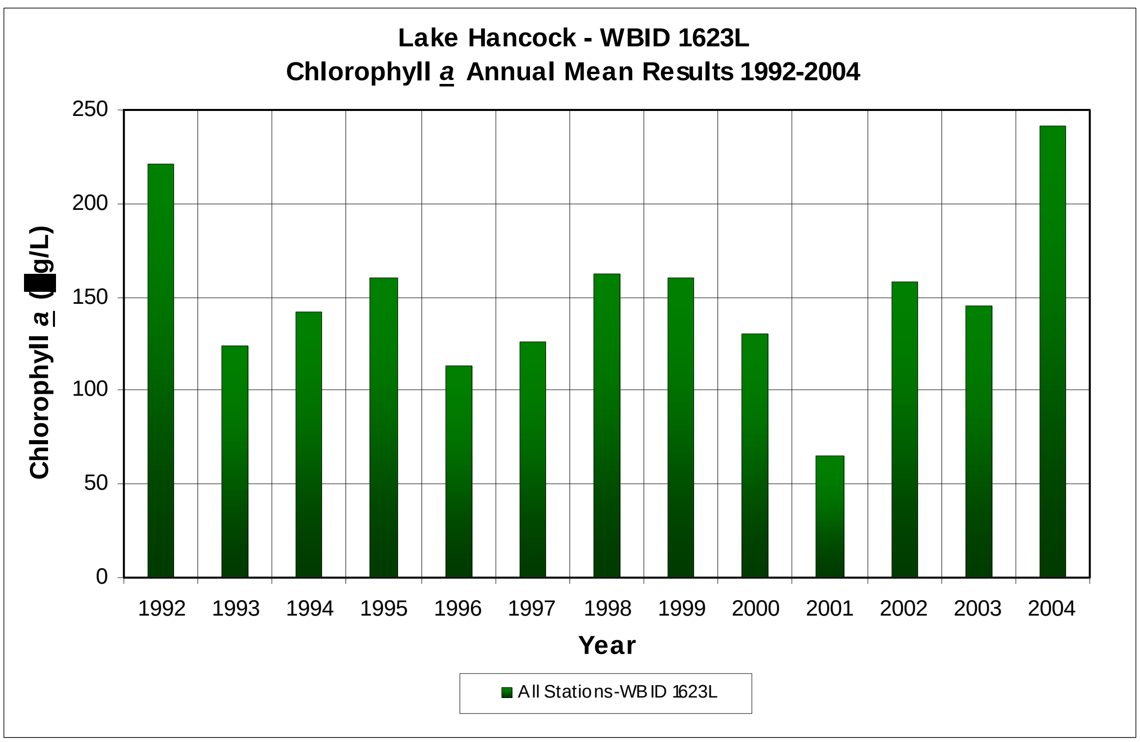


Figure 2.7 Chlorophyll a Annual Mean Results for Lake Hancock from 1992 to 2004

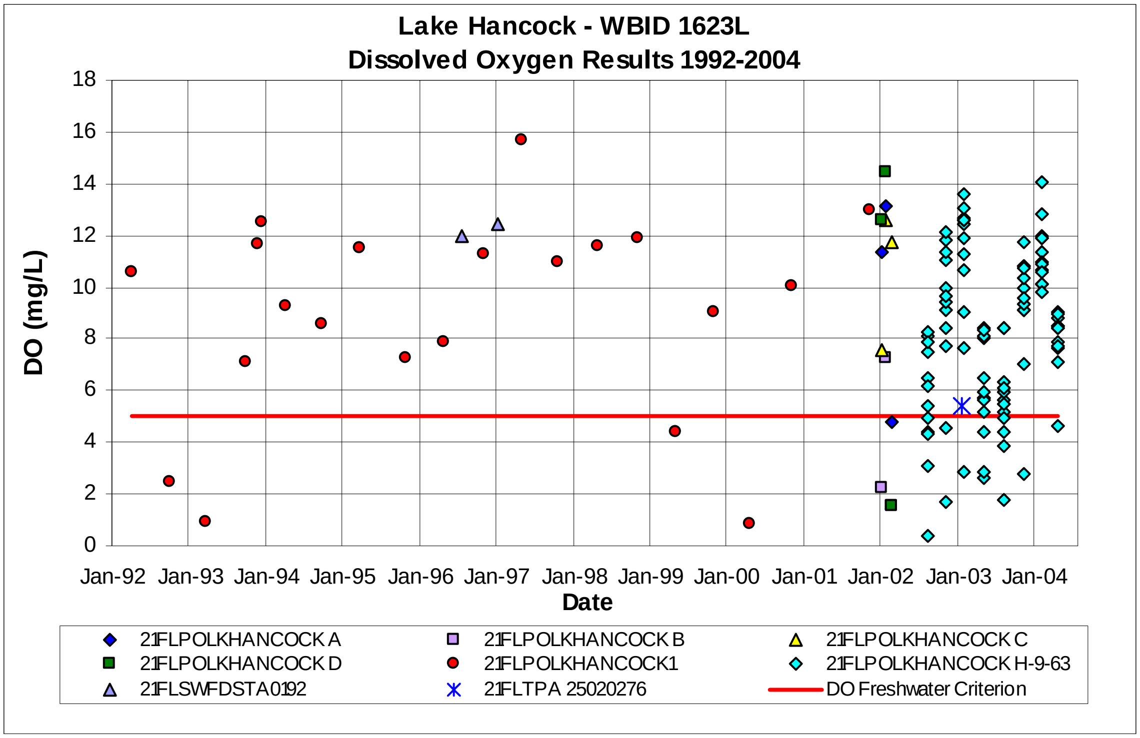


Figure 2.8 Dissolved Oxygen Monthly Results for Lake Hancock from 1992 to 2004

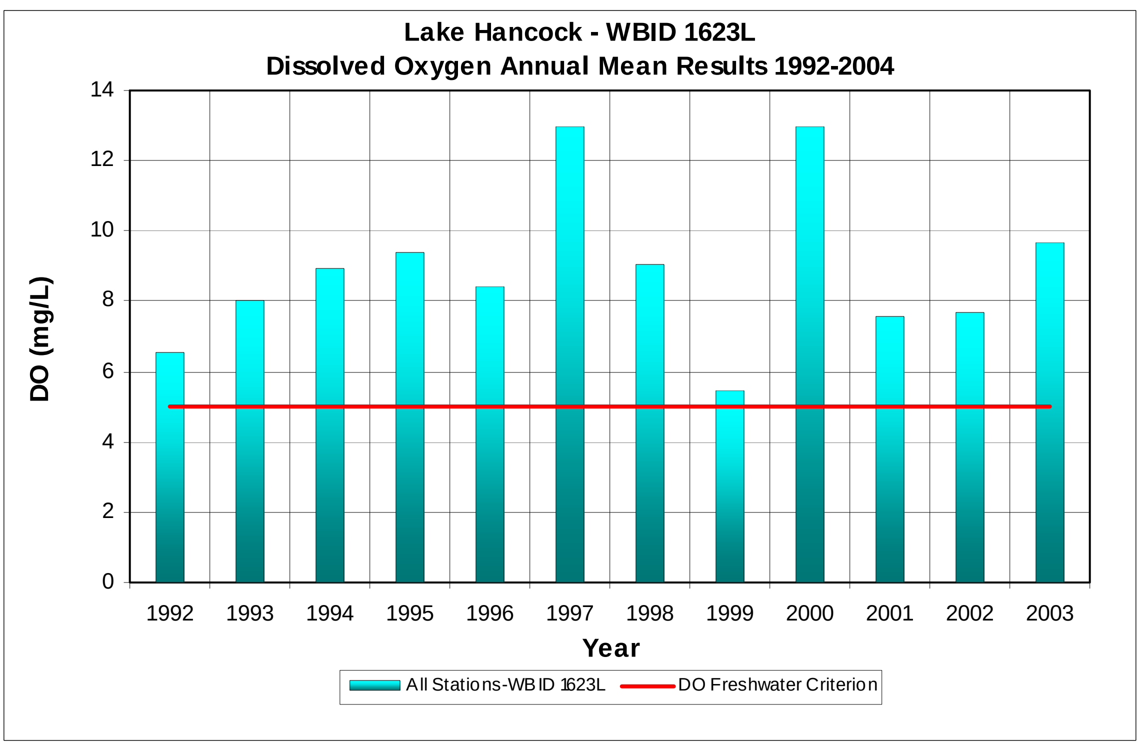


Figure 2.9 Dissolved Oxygen Annual Mean Results for Lake Hancock from 1992 to 2004

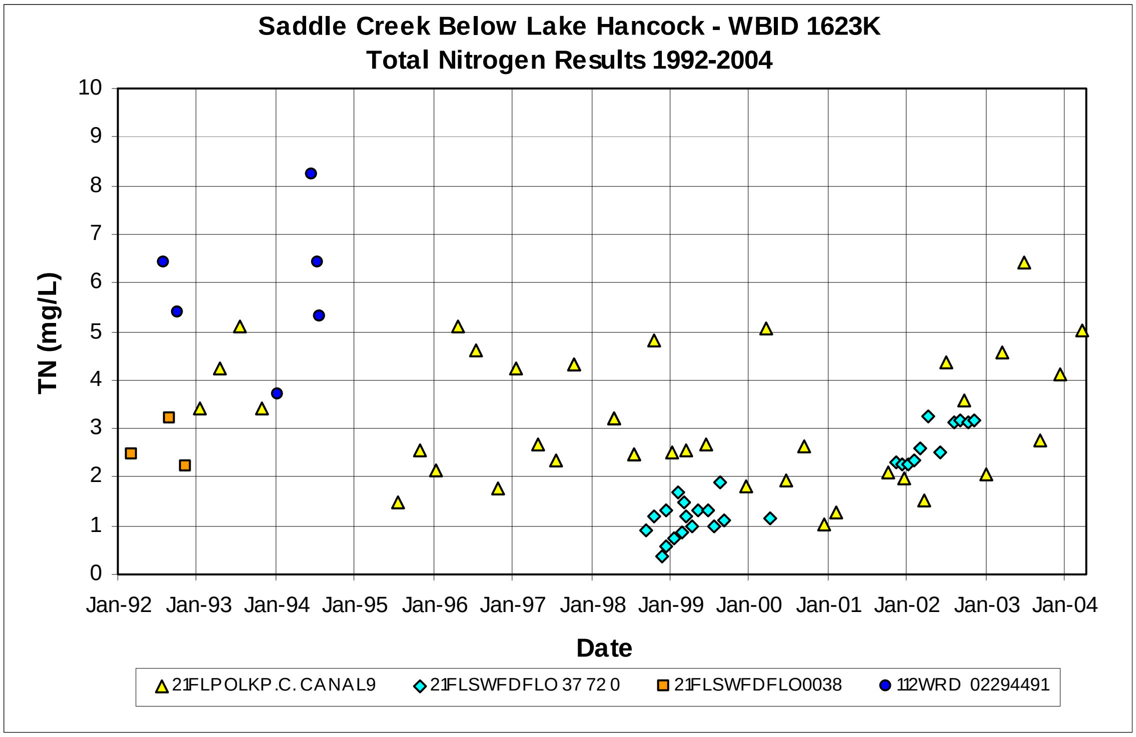


Figure 2.10 Total Nitrogen Monthly Results for Lower Saddle Creek from 1992 to 2004

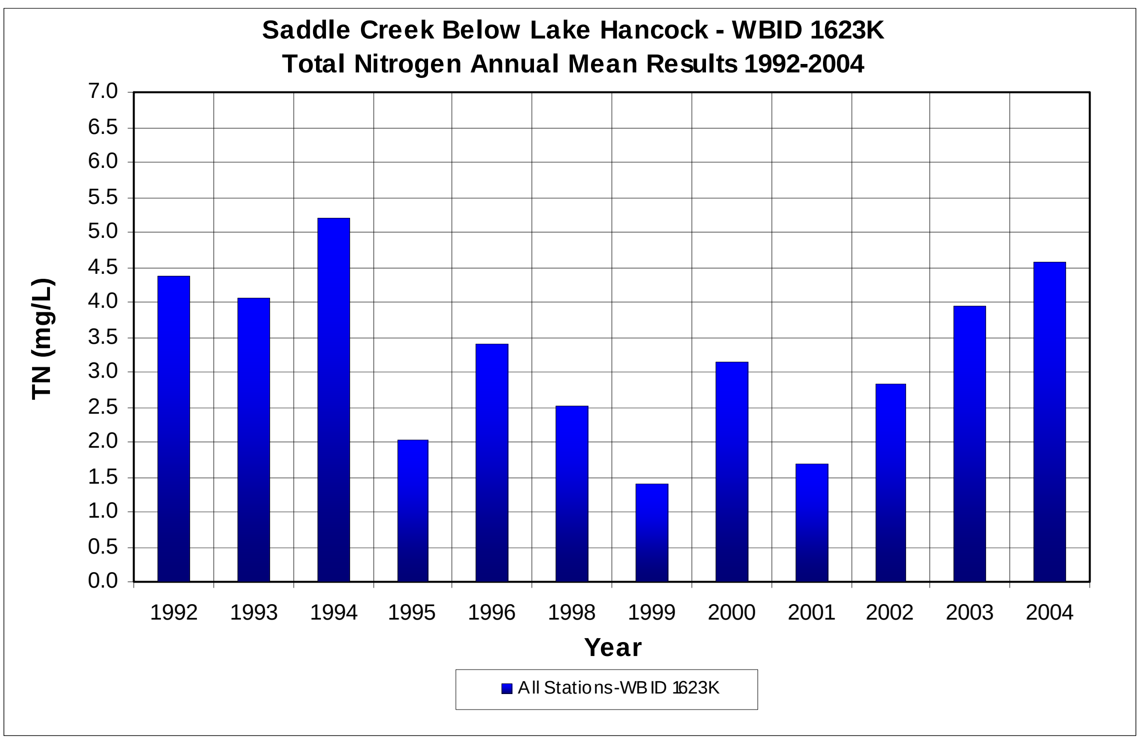


Figure 2.11 Total Nitrogen Annual Mean Results for Lower Saddle Creek from 1992 to 2004

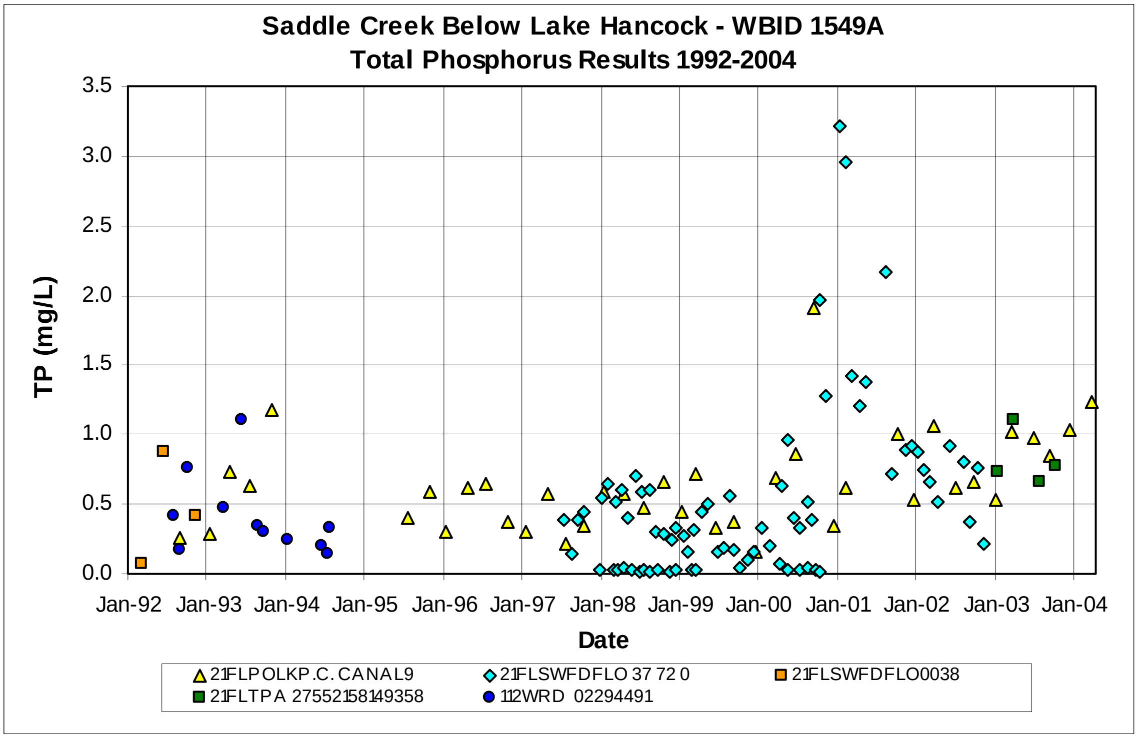


Figure 2.12 Total Phosphorus Monthly Results for Lower Saddle Creek from 1992 to 2004

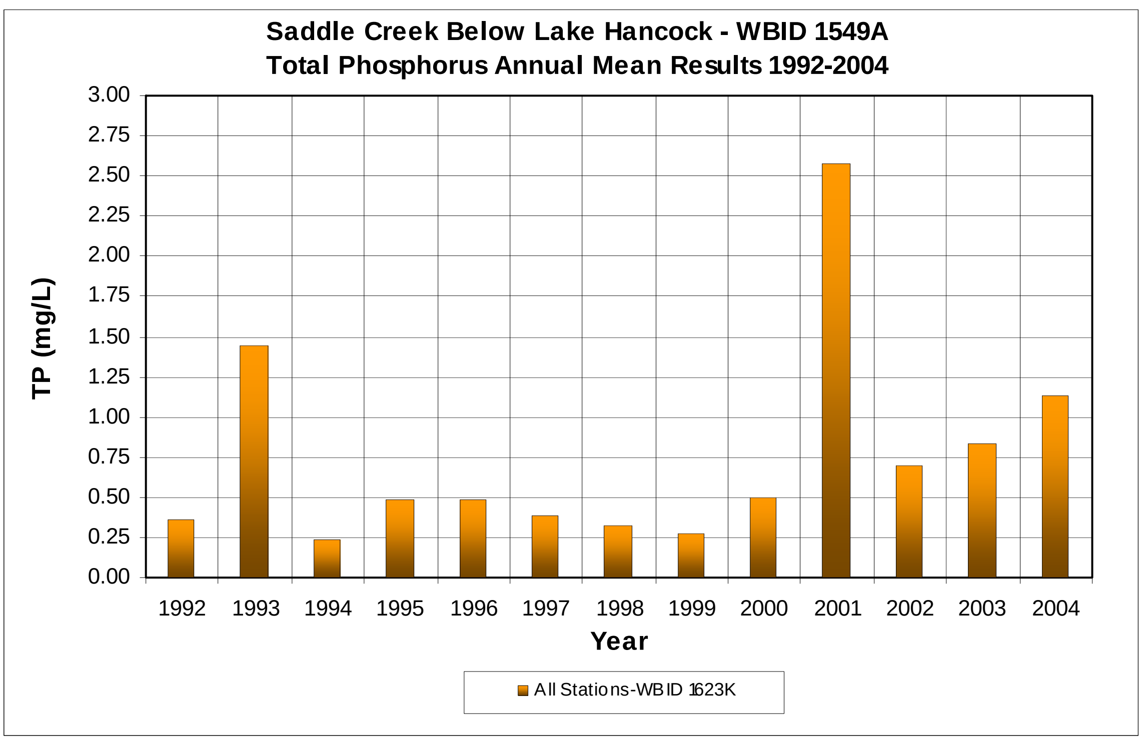


Figure 2.13 Total Phosphorus Annual Mean Results for Lower Saddle Creek from 1992 to 2004

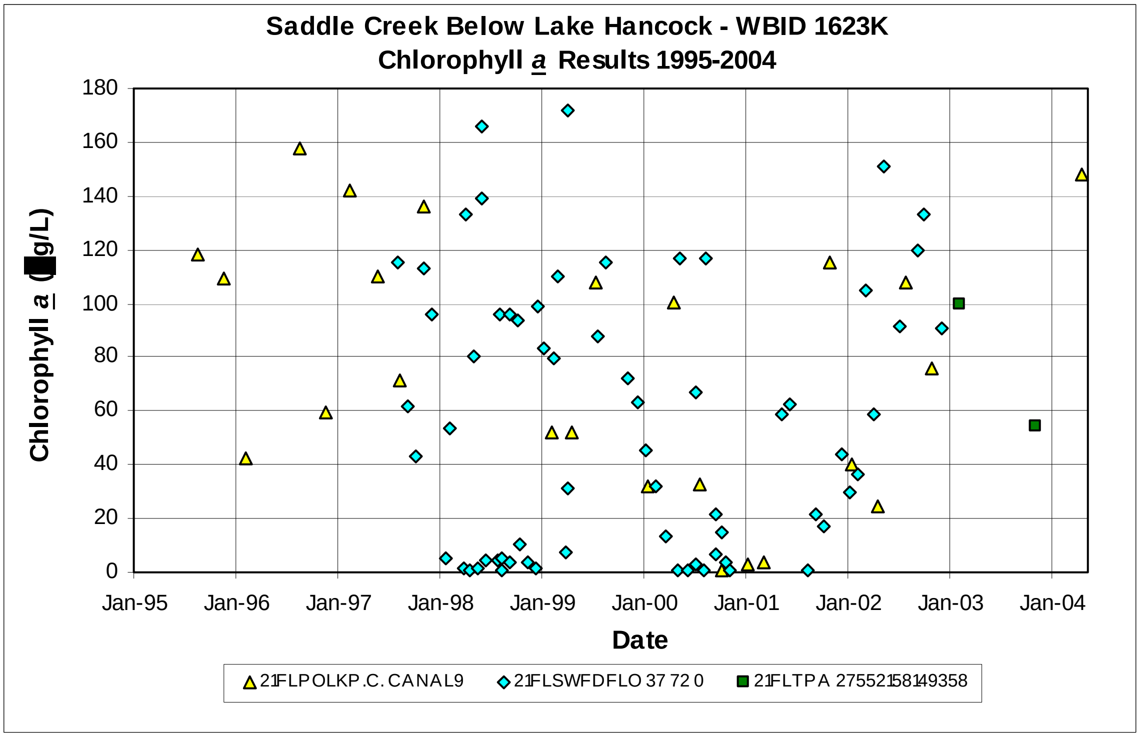


Figure 2.14 Chlorophyll a Monthly Results for Lower Saddle Creek from 1995 to 2004

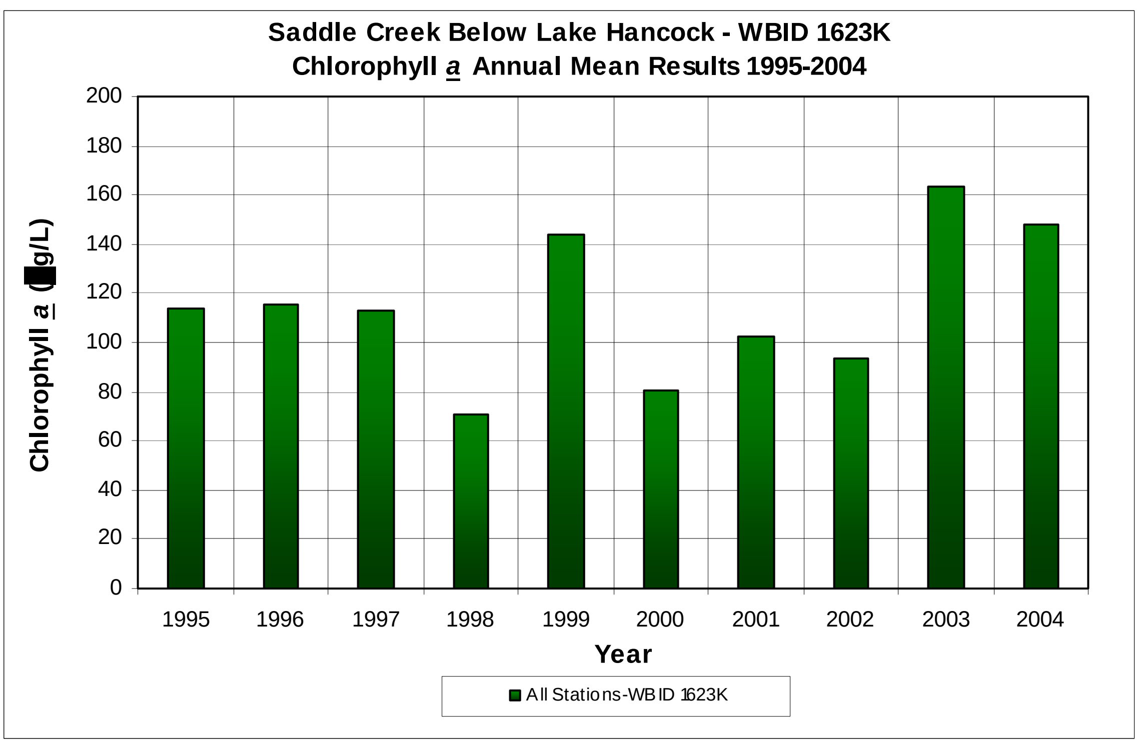


Figure 2.15 Chlorophyll a Annual Mean Results for Lower Saddle Creek from 1995 to 2004

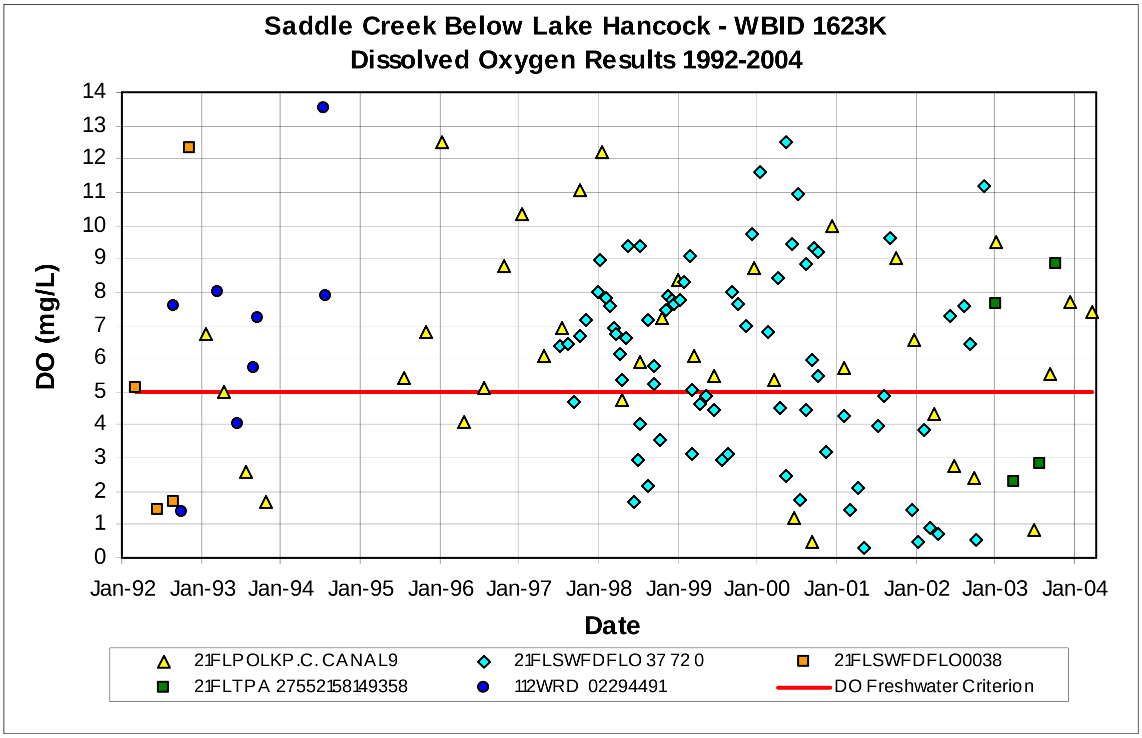


Figure 2.16 Dissolved Oxygen Monthly Results for Lower Saddle Creek from 1992 to 2004

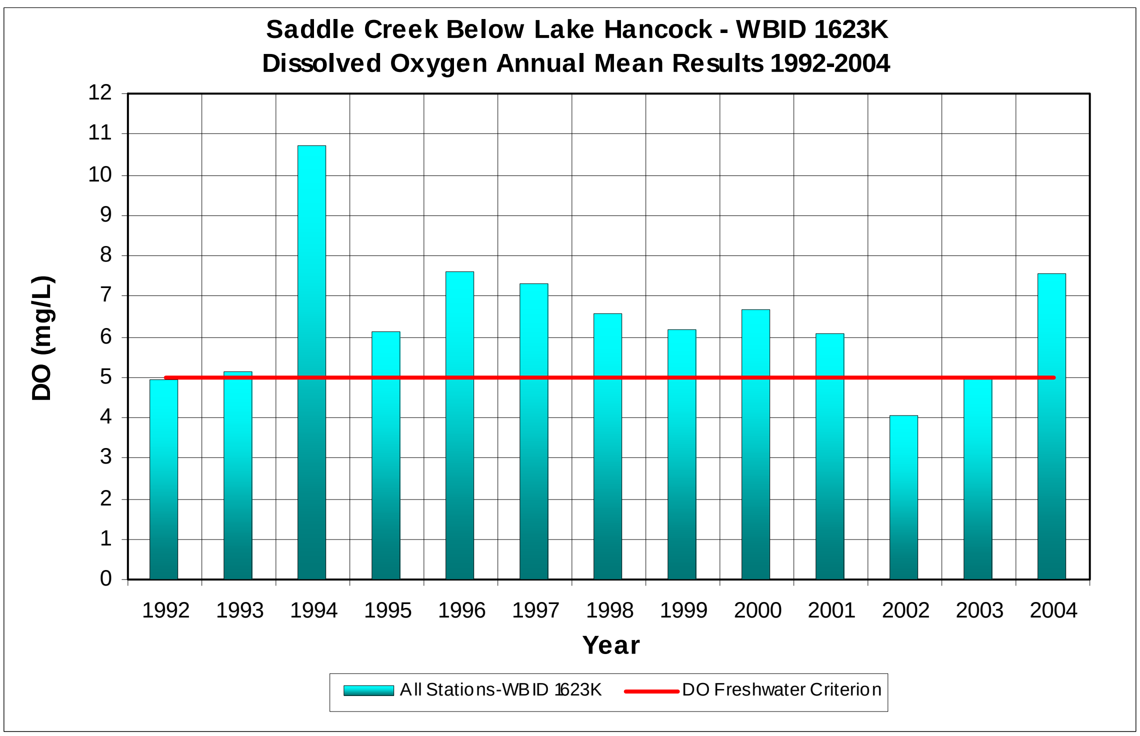


Figure 2.17 Dissolved Oxygen Annual Mean Results for Lower Saddle Creek from 1992 to 2004

Table 2.1 provides summary statistics for the lake and creek for TN, TP, chlorophyll a, and DO from 1992 to 2004. Individual water quality measurements for TN, TP, chlorophyll a, and DO used in the assessment are provided in **Appendix B**

Table 2.1 Water quality summary statistics for TN, TP, Chlorophyll a, and DO from 1992 to 2004 for Lake Hancock (WBID 1623L) and Lower Saddle Creek (WBID 1623K)

Waterbody	Water Variable	# of Samples	Minimum	Mean	Median	Maximum
Lake Hancock	Total Nitrogen	134	1.19	4.57	4.40	12.03
Lake Hancock	Total Phosphorus	135	0.04	0.52	0.49	1.01
Lake Hancock	Chlorophyll a	77	16.02	175.15	148	558.00
Lake Hancock	Dissolved Oxygen	140	0.38	8.26	8.43	15.70
Lower Saddle Cr.	Total Nitrogen	75	0.39	2.95	2.50	11.02
Lower Saddle Cr.	Total Phosphorus	134	0.01	0.63	0.45	10.50
Lower Saddle Cr.	Chlorophyll a	111	1.00	101.18	79.30	612.00
Lower Saddle Cr.	Dissolved Oxygen	130	0.31	6.08	6.26	15.56

As part of the listing process, the Department attempts to identify the limiting nutrient or nutrients for the impaired waterbody. The limiting nutrient, generally nitrogen or phosphorus, is defined as the nutrient that limits plant growth when it is not available in sufficient quantities. A limiting nutrient is a chemical that is necessary for plant growth, but available in quantities smaller than those needed for algae, represented by chlorophyll a, and macrophytes to grow. Once the limiting nutrient in a waterbody is exhausted, algae stop growing. If more of the limiting nutrient is added, larger algal populations will result until nutrients or other environmental factors again limit their growth. In Florida waterbodies, nitrogen and phosphorus are most often the limiting nutrients.

In addition to causing excessive growth of algae, nutrient enrichment of a waterbody can lead to widely varying DO levels and low DO concentrations in bottom waters. Algal populations produce oxygen as a result of photosynthesis during daylight hours and consume oxygen due to respiration at night and at water depths where light does not penetrate. Additionally, a portion of the dead algal population will become part of the organic material that will be broken down by microbes and in the process will consume DO in the water column and sediments. The low DO values in the lake and canal is linked to the excessive algal growth that led to waters being impaired for nutrients.

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criteria Applicable to the TMDL

Florida's surface water is protected for five designated use classifications, as follows:

Class I	**Potable water supplies**
Class II	**Shellfish propagation or harvesting**
Class III	**Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife**
Class IV	**Agricultural water supplies**
Class V	**Navigation, utility, and industrial use (there are no state waters currently in this class)**

Lake Hancock and Lower Saddle Creek are classified as Class III freshwater waterbodies, with a designated use of recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criterion applicable to the observed impairments for Lake Hancock and Lower Saddle Creek are the state of Florida's narrative nutrient criterion [Rule 62-302.530(48)(b), FAC] and dissolved oxygen criterion [Rule 62-302.530(31), F.A.C].

3.2 Dissolved Oxygen Criterion for Lakes and Streams

The Class III freshwater criterion for dissolved oxygen (DO) for lakes and streams, established by Subsection 62-302.530(31), F.A.C., states that DO shall not be less than 5.0 mg/L and that normal daily and seasonal fluctuations above these levels shall be maintained.

As required by the IWR, the Department must identify the pollutants causing or contributing to DO impairment. If a waterbody segment has a sufficient number of DO exceedances for placement on the Verified List and nutrients is on the Verified List, based on exceedances of the IWR TSI or chlorophyll *a* thresholds, then "nutrients" is identified as a pollutant contributing to DO exceedances. The Department also applies the following analysis to identify the pollutant(s) contributing to DO exceedances:

• The waterbody segment median values for biological oxygen demand (BOD), total nitrogen (TN), and total phosphorus (TP) are determined for the verified period (i.e., January 1997 to June 2004).

• The median values are then compared with the screening levels for the appropriate waterbody type. The screening levels represent the 70th percentile value of data collected from streams, lakes, or estuaries in Florida **(Table 3.1)**.

• If a waterbody segment BOD median value exceeds the screening level, BOD is identified as a pollutant contributing to DO exceedances.

• If a waterbody segment TN or TP median values exceed the appropriate screening levels, and there are insufficient data to assess nutrients using the IWR TSI or chlorophyll *a* thresholds, the nutrient exceeding the screening level may be identified as a pollutant contributing to the exceedances.

Depressed DO concentrations may be caused by several factors including the decay of oxygen demanding waste from point and non-point sources, conversion of ammonia to nitrate by bacteria, algal and macrophyte respiration, excessive epiphyte or floating macrophyte growth blocking light to submerged aquatic vegetation, and sediment oxygen demand. Nutrients may also influence DO levels indirectly. Algal populations can increase rapidly if nutrients are available and the production of oxygen as a result of photosynthesis during daylight hours and algal respiration or consumption of oxygen from the water column at night can result in large diurnal fluctuations of DO in the water column. A fraction of any increased algal biomass may also become part of the organic material that will be broken down by microbes or settle to the bottom. Processes that consume oxygen from the water column such as microbial breakdown of organic material and sediment oxygen demand are fairly constant over the short term.

For Lake Hancock and Lower Saddle Creek, DO concentrations may be related to organic enrichment which exerts a biochemical oxygen demand in the water column. Ammonia concentrations may also affect DO due to the conversion of ammonia to nitrate in the nitrification process, where oxygen is consumed by aerobic nitrifying bacteria. During the verified period, monthly and annual average chlorophyll *a* concentrations for the lake and the creek were well above the IWR's threshold for nutrient impairment (20 μg/L) for freshwater.

Table 3.1 Screening Level Values (70th percentile) Based on STORET Data from 1979 to 1987

Waterbody Type	BOD 5 Day (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Stream	2.0	1.6	.22
Lake	2.9	1.7	.11
Estuary	2.1	1.0	.19

Source: Friedemann, F., and Hand, J., July 1989.

3.3 Interpretation of the Narrative Nutrient Criteria for Lakes and Streams

To place a waterbody segment on the Verified List for nutrients, the Department checks against the appropriate impairment threshold identified in the IWR. In addition, the limiting nutrient or nutrients causing impairment must also be identified. The following method is used to identify the limiting nutrient(s) in streams and lakes:

• The ratios of TN to TP are calculated for each paired value of TN and TP (per sampling event) collected during the verified period. If a waterbody segment TN or TP median values exceed the appropriate screening levels, the nutrient exceeding the screening level may be identified as a potential pollutant causing impairment. The median values are then compared with the screening levels for the appropriate waterbody type. The screening levels represent the 70th percentile value of data collected from streams, lakes, or estuaries in Florida (see **Table 3.1**).

• The individual ratios over the entire verified period (i.e., January 1997 to June 2004) are evaluated to determine the limiting nutrient(s). If all the sampling event ratios are less than 10, nitrogen is identified as the limiting nutrient, and if all the ratios are greater than 30, phosphorus is identified as the limiting nutrient. Both nitrogen and phosphorus are identified as limiting nutrients if the ratios are between 10 and 30. For Lake Hancock and Lower Saddle Creek the median TN/TP ratios are 9.49 and 7.22, respectively, for the verified period, suggesting that nitrogen is the limiting nutrient in both waters.

Florida's nutrient criterion is narrative only — nutrient concentrations of a body of water shall not be altered so as to cause an imbalance in natural populations of aquatic flora or fauna. Accordingly, a nutrient-related target was needed to represent levels at which an imbalance in flora or fauna is expected to occur. While the IWR provides a threshold for nutrient impairment for lakes based on annual average TSI levels, these thresholds are not standards and are not required to be used as the nutrient-related water quality target for TMDLs. In recognition that the IWR thresholds were developed using statewide average conditions, the IWR (Subsection 62-303.450, F.A.C.) specifically allows the use of alternative, site-specific thresholds that more accurately reflect conditions beyond which an imbalance in flora or fauna occurs in the waterbody.

The TSI originally developed by **R. E. Carlson (1977)** was calculated based on Secchi depth, chlorophyll concentration, and total phosphorus concentration and was used to describe a lake's trophic state. Carlson's TSI was developed based on the assumption that the lakes were all phosphorus limited. In Florida, because the local geology produced a phosphorus rich soil, nitrogen can be the sole or co-limiting factor for phytoplankton in some lakes. In addition, because of the existence of dark-water lakes in the state, using Secchi depth as an index to represent lake trophic state can produce misleading results. Therefore, the TSI was revised to be based on total nitrogen, total phosphorus, and chlorophyll *a* concentrations.

The Florida-specific TSI for Lake Hancock was determined based on the analysis of data from 313 Florida lakes. The index was adjusted so that a chlorophyll *a* concentration of 20 μg/L was equal to a TSI value of 60. A TSI of 60 was then set as the threshold for nutrient impairment for most lakes (for those with a color higher than 40 platinum cobalt units) because, generally, the phytoplankton may switch to communities dominated by blue-green algae at chlorophyll *a* levels above 20 μg/L. These blue-green algae are often an unfavorable food source to zooplankton and many other aquatic animals. Some blue-green algae may even produce toxins, which could be harmful to fish and other animals. In addition, excessive growth of phytoplankton and the subsequent death of these algae may consume large quantities of dissolved oxygen and result in anaerobic condition in lakes, which makes conditions in the impacted lake unfavorable for fish and other wildlife. All of these processes may negatively impact the health and balance of native fauna and flora.

Because of the amazing diversity and productivity of Florida lakes, some lakes have a natural background TSI that is different from 60. In recognition of this natural variation, the IWR allows for the use of a lower TSI (40) in very clear lakes, a higher TSI if paleolimnological data indicate the lake was naturally above 60, and the development of site-specific thresholds that better represent the levels at which nutrient impairment occurs. For the Lake Hancock and Lower Saddle Creek TMDLs, the Department applied the Watershed Assessment Model (WAM) (Soil and Water Engineering Technology, Inc., 2005) and the BATHTUB model (Quantitative Environmental Analysis, LLC, 2005) to simulate water quality discharges and eutrophication processes to determine the appropriate nutrient loadings. The WAM model was used to estimate the natural background TSI by setting land uses to a mixture of natural land cover. The loadings were then input to the BATHTUB lake model to calculate a natural background TSI value. Once the natural background TSI was determined, then an increase of 5 TSI units above natural background was used as the water quality target for the TMDL.

Water quality in Lower Saddle Creek is directly influenced by the water quality in Lake Hancock. As a result of this direct influence, an alternative chlorophyll a threshold was established for the creek based on the annual average chlorophyll a of the lake needed to meet the TSI target for the TMDL.

3.3.1 Nutrient Criteria Definitions

Chlorophyll *a*

Chlorophyll is a green pigment found in plants and is an essential component in the process of converting light energy into chemical energy. Chlorophyll is capable of channeling the energy of sunlight into chemical energy through the process of photosynthesis. In photosynthesis, the energy absorbed by chlorophyll transforms carbon dioxide and water in carbohydrates and oxygen. The chemical energy stored by photosynthesis in carbohydrates drives biochemical reactions in nearly all living organisms. Thus, chlorophyll is at the center of the photosynthetic oxidation-reduction reaction between carbon dioxide and water.

There are several types of chlorophyll; however, the predominant form is chlorophyll *a*. The measurement of chlorophyll *a* in a water sample is a useful indicator of phytoplankton biomass, especially when used in conjunction with analysis concerning algal growth potential and species abundance. The greater the abundance of chlorophyll *a*, typically the greater the abundance of algae. Algae are the primary producers in the aquatic web, and thus are very important in characterizing the productivity of lakes and streams. As noted earlier, chlorophyll *a* measurements are also used to estimate the trophic conditions of lakes and lentic waters.

Nitrogen Total as N (TN)

Total nitrogen is the combined measurement of nitrate (NO3), nitrite (NO2), ammonia, and organic nitrogen found in water. Nitrogen compounds function as important nutrients to many aquatic organisms and are essential to the chemical processes that exist between land, air, and water. The most readily bioavailable forms of nitrogen are ammonia and nitrate. These compounds, in conjunction with other nutrients, serve as an important base for primary productivity.

The major source of excessive amounts of nitrogen in surface water are the effluent from municipal treatment plants and runoff from agricultural sites. When nutrient concentrations consistently exceed natural levels, the resulting nutrient imbalance can cause undesirable changes in a waterbody's biological community and drive an aquatic system into an accelerated rate of eutrophication. Usually, the eutrophication process is observed as a change in the structure of the algal community and includes severe algal blooms that may cover large areas for extended periods. Large algal blooms are generally followed by a depletion in dissolved oxygen concentrations as a result of algal decomposition.

Phosphorus Total as P (TP)

Phosphorus is one of the primary nutrients that regulates algal and macrophyte growth in natural waters, particularly in fresh water. Phosphate, the form in which almost all phosphorus is found in the water column, can enter the aquatic environment in a number of ways. Natural processes transport phosphate to water through atmospheric deposition, ground water percolation, and terrestrial runoff. Municipal treatment plants, industries, agriculture, and domestic activities also contribute to phosphate loading through direct discharge and natural transport mechanisms. The very high levels of phosphorus in some of Florida's streams and estuaries are usually caused by phosphate mining and fertilizer processing activities.

High phosphorus concentrations are frequently responsible for accelerating the process of eutrophication, or accelerated aging, of a waterbody. Once phosphorus and other important nutrients enter the ecosystem, they are extremely difficult to remove. They become tied up in biomass or deposited in sediments. Nutrients, particularly phosphates, deposited in sediments generally are redistributed to the water column. This type of cycling compounds the difficulty of halting the eutrophication process.

3.4 Paleolimnological Conditions in the Lake Hancock Basin

Lake Hancock

Paleolimnological methods can be used to identify baseline limnological conditions and to assess anthropogenic changes in lakes that lack historical limnological data. The lack of historical water quality data makes it difficult to document past changes in the trophic status of numerous Florida lakes. The absence of long-term limnological data makes it difficult to document the timing and magnitude of anthropenic changes in most of Florida's lakes. Thus, paleolimnological studies are very important in yielding information on historical trophic conditions.

In 2002, a paleolimnological study of Lake Hancock was performed by the University of Florida (Brenner, Whitmore, Curtis, and Hodell). Two sediment cores were collected from the lake to evaluate historical trophic state changes in the basin. Sediment diatom assemblages and variables (density, carbon, nitrogen, phosphorus, and organic matter) were measured. The trophic state was inferred by using models that relate diatom assemblages to water quality variables in Florida lakes. Although age-depth relations for the cores could not be established using radiometric methods, unsupported $Lead^{210}$ activities in the cores suggested that the upper deposits in the cores accumulated within the last 100 years (Brenner, Whitmore, Curtis, and Hodell, 2002).

Diatom data from one of the core samples suggest that the lake has been hypereutrophic and there has been no directional change in trophic status over time represented by the top 60 centimeters (cm) of the core (<100 years). Limnetic total phosphorus and chlorophyll a from the other core sample indicates a shift from eutrophic to hypereutrophic conditions above 28 cm. This suggests that the lake has been hypereutrophic for the last 100 years or less and less productive (eutrophic) beyond that time period, as inferred from sediments that are greater than 100 years old (Brenner, Whitmore, Curtis, and Hodell, 2002). Thus, the results indicate that the trophic state of the lake was historically mesotrophic to eutrophic prior to becoming hypereutrophic. The diatom assemblages and $Lead^{210}$ dating suggest that this shift probably occurred within the last 100 years which would temporally correspond with anthropogenic disturbances in the watershed and surrounding airshed.

However, the authors note that the thin sediment accumulation on the bottom of Lake Hancock makes it a less than ideal archive of paleolimnological information and that diatom assemblages be used only to discern general trends rather than identify specific inference values (i.e., used with caution for this specific lake).

Lake Parker (Lake Parker Subbasin)

Results from a case study conducted by Brenner, Whitmore, Flannery, and Binford (1993) show that Lake Parker has displayed statistically significant increases in limnetic total phosphorus and chlorophyll a concentrations since the 1920's. The study evaluated sediment diatom assemblages to infer former water quality. Sediment diatoms are powerful bio-indicators of historic and current nutrient concentrations. They are ubiquitous, well preserved, and sensitive to even subtle environmental shifts (Dixit, et al., 1992)

Although Lake Parker overlies phosphatic deposits, the paleolimnological record from the study indicates that the lake was naturally meso-trophic. Several lines of quantitative evidence (diatom transfer rates and nutrient accumulation rates) suggest progressive increases in total phosphorus and chlorophyll a in the lake between 1920 and 1980. Net accumulation rates of phosphorus have increased more than 10-fold in this century. In addition, there is no evidence of substantial macrophyte presence in the lake (Brenner, Whitmore, Flannery, and Binford, 1993). As a result of human disturbances that affected both the watershed and surrounding airshed, the authors estimate that the lake underwent substantial cultural eutrophication during this time period.

Lake Hollingsworth (Banana Lake Subbasin)

Similar to most of the lakes located in the Lake Hancock and Saddle Creek basin, Lake Hollingsworth lies in phosphate rich central Florida. In 1899, it was reported that the states largest strawberry farm was operating near the lake. In the early 1900s, residential development began on the northwest portion of the lake. The 1920s marked additional changes in land use with the groundbreaking for Florida Southern College and more residents. In the 1950s citrus groves were prominent in the area but were steadily being replaced for phosphate mining activities. By the mid-1970s, citrus groves had been replaced by residential and extractive land uses. Today, nearly the entire lake watershed is developed. The earliest limnological investigations on Lake Hollingsworth suggest that hypereutrophic conditions already existed by the late 1960s (Chew, 1974; Huber et al., 1982). According Brenner et al., (1995), historical total phosphorus inferences based on diatom analyses from lake core samples indicated that Lake Hollingsworth was naturally eutrophic. The limnetic phosphorus concentrations increased in the middle of the 20th century with very high phosphorus levels occurring between the 1950s and 1970s. The historical perspective provided by the paleolimnological data demonstrates that Lake Hollingsworth was naturally eutrophic, but became hypereutrophic as a consequence of anthropogenic disturbances.

Chapter 4: ASSESSMENT OF SOURCES

4.1 Overview

Stormwater runoff drains to a network of lakes and streams to Lake Hancock, which discharges to Lower Saddle Creek, the Peace River and, ultimately, Charlotte Harbor and the Gulf of Mexico. Lake Hancock is the most downstream lake in the Saddle Creek drainage basin. A primary basin setup was used to create an ArcView project file for the primary basin, Lake Hancock. The term "primary basin" in WAM refers to a collection of subbasins or basins that discharge to a single receiving water body. In this study, the Lake Hancock basin is the primary basin. The primary basin setup procedure used to model Lake Hancock is described in detail in the WAM Draft Watershed Assessment Report of the Lake Hancock Basin **(see Appendix H).** The WAM model was then linked to the BATHTUB model. The BATHTUB model simulates nutrients in reservoirs and lakes based on annual average inputs. The BATHTUB model is described in detail in the BATHTUB Framework for the Lake Hancock Basin, Florida, Final Report **(see Appendix F.**

The external load assessment conducted by the Watershed Assessment Model (WAM) and BATHTUB models was intended to determine the loading characteristics of the various sources of pollutants in the Lake Hancock Basin including the Lake Hancock and Lower Saddle Creek watersheds (**see Figure 4.1).** Assessing the external load entailed assessing land use patterns, soils, topography, hydrography, point sources, sewer service area coverages, climate, and rainfall to determine the volume, concentration, timing, location, and underlying nature of the point and nonpoint sources of nutrients to the lake.

WAM is a tool that has been shown to be useful in the assessment of watershed-related properties. WAM was developed to allow engineers and planners to assess the water quality of both surface water and groundwater. The model simulates the primary physical processes important for watershed hydrologic and pollutant transport. The model assesses the hydrology of the watershed using imbedded models including "Groundwater Loading Effects of Agricultural Management Systems" (GLEAMS; Knisel, 1993), "Everglades Agricultural Area Model" (EAAMod; Botcher et al., 1998; SWET, 1999), and two submodels written specifically for WAM to handle wetland and urban landscapes. Dynamic routing of flows is accomplished through the use of an algorithm that uses a Manning's flow equation based technique (Jacobson et al., 1998). BATHTUB is a U. S. Army Corps of Engineers steady-state model. The model incorporates several empirical equations of nutrient settling and algal growth to predict steady-state nutrient and chlorophyll *a* concentrations based on waterbody characteristics, hydraulic characteristics, and nutrient loadings. BATHTUB is capable of predicting concentrations of chlorophyll *a*, total nitrogen (TN), total phosphorus (TP) and transparency in a waterbody under different loading conditions (QEA, LLC, 2005).

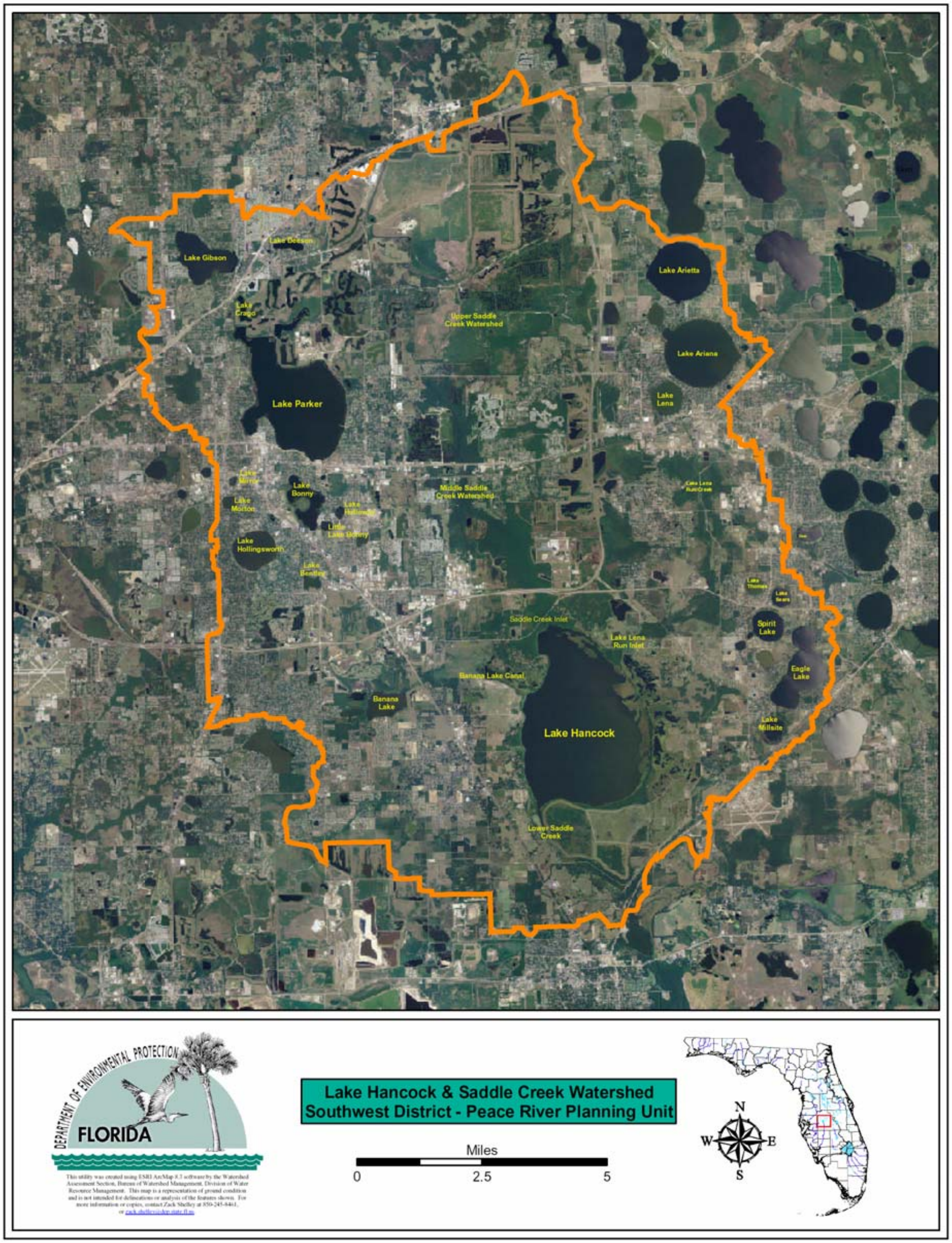


Figure 4.1 Aerial View of the Lake Hancock and Saddle Creek Watershed, Polk County, Florida, 2004

4.2 Potential Sources of Nutrients in the Lake Hancock and Lower Saddle Creek Watersheds

An important part of the TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of the pollutant of concern in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either "point sources" or "nonpoint sources." Historically, the term point sources has meant discharges to surface waters that typically have a continuous flow via a discernable, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. In contrast, the term "nonpoint sources" was used to describe intermittent, rainfall driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land uses, agriculture, silviculture, and mining; discharges from failing septic systems; and atmospheric deposition.

However, the 1987 amendments to the Clean Water Act redefined certain nonpoint sources of pollution as point sources subject to regulation under the EPA's National Pollutant Discharge Elimination Program (NPDES). These nonpoint sources included certain urban stormwater discharges, including those from local government master drainage systems, construction sites over five acres, and a wide variety of industries (see **Appendix A** for background information on the federal and state stormwater programs).

To be consistent with Clean Water Act definitions, the term "point source" will be used to describe traditional point sources (such as domestic and industrial wastewater discharges) and stormwater systems requiring an NPDES stormwater permit when allocating pollutant load reductions required by a TMDL **(see Section 6.1).** However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES stormwater discharges and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

4.2.1 Point Sources

Point sources generally contribute small amounts of pollutants to the lake-stream network on a continual or recurring basis regardless of climate conditions. These sources are important when summing pollutant loads over a long period of time. There is one active permitted wastewater treatment facility and three active permitted industrial facilities located in the Lake Hancock and Lower Saddle Creek watershed. However, only two sites had treated effluent discharged to streams that were considered significant enough, in terms of volumes and concentrations, to affect modeling results. As a note for the Banana Lake subbasin, in 1926, the City of Lakeland's WWTP began to discharge effluent into Stahl Creek/Canal which flows downstream to Banana Lake. Between January 1975 and April 1987, the plant discharged on average 6.4 mgd. In 1987, effluent discharge was diverted away from Stahl Canal and Banana Lake.

Lake Lena Subbasin

There are two active National Pollutant Discharge Elimination System (NPDES) permitted facilities located within the Lake Lena Subbasin; the City of Auburndale Alfred Waste Water Treatment Facility (WWTF) (NPDES FL0021466) and the Florida Distillers Company – Auburndale (NPDES FL0003051).

The Auburndale WWTF is an existing 1.4 million gallon a day (MGD) annual average daily flow complete mix extended oxidation ditch domestic wastewater treatment facility. The facility is operated to achieve secondary treatment with basic disinfection for land application of effluent and/or advanced secondary treatment with basic disinfection and dechlorination prior to discharging to Lake Lena Run, the outflow tributary from Lake Lena. Effluent disposal consists of a 0.65 MGD monthly average daily flow permitted surface water discharge (D001) to Lake Lena Run.

The Florida Distillers facility is a citrus and cane molasses fermentation and bottling plant with a 2.6 MGD design capicity. The facility is involved in the manufacture of brandy, rum, and grain whiskey from cane, citrus, and grains. The materials are mashed with water, pasteurized, fermented, concentrated, and subsequently distilled, blended, and bottled. The liquid waste stream is evaporation condensate, cleaning water, cooling water and sanitary wastewater. The wastewater undergoes neutralization, flow equalization and biological treatment through an activated sludge plant. The effluent is chlorinated, aerated and discharged through Outfall D002. Effluent disposal consists of a 0.5 MGD monthly average daily flow permitted surface water discharge to Lake Lena Run, the outflow tributary from Lake Lena

The discharges from the Auburndale WWTP and Florida Distillers facility were considered significant enough, in terms of volumes and concentrations, to affect modeling results and as a result, were incorporated into the WAM model and in determining TMDL point source loads **(see Figure 4.2).**

Lake Parker Subbasin

Two active permitted fossil fuel power generation facilities are located on the banks of Lake Parker; the Lakeland Larson Memorial Plant (NPDES FL0026298) and the Lakeland Electric Mcintosh Plant (NPDES FL0026301).

The Larsen facility has a design capacity of 115 MGD for unit #001 and 115 MGD for unit #002. The McIntosh facility has a design capacity of 115.2 MGD for unit #1. Unit #2 ceased operations in 1988. The plants withdraw water from Lake Parker to use as once through cooling water and cooling tower make up water and returns the water to the lake. In essence, water is removed from the lake, used for cooling and then returned to the lake with an insignificant volumetric loss or pollutant contribution. The Larsen and McIntosh facility discharges were not considered significant enough, in terms of volumes and concentrations, to affect modeling results and as a result, were not incorporated into the WAM model and in determining TMDL point source loads (**see Figure 4.2).**

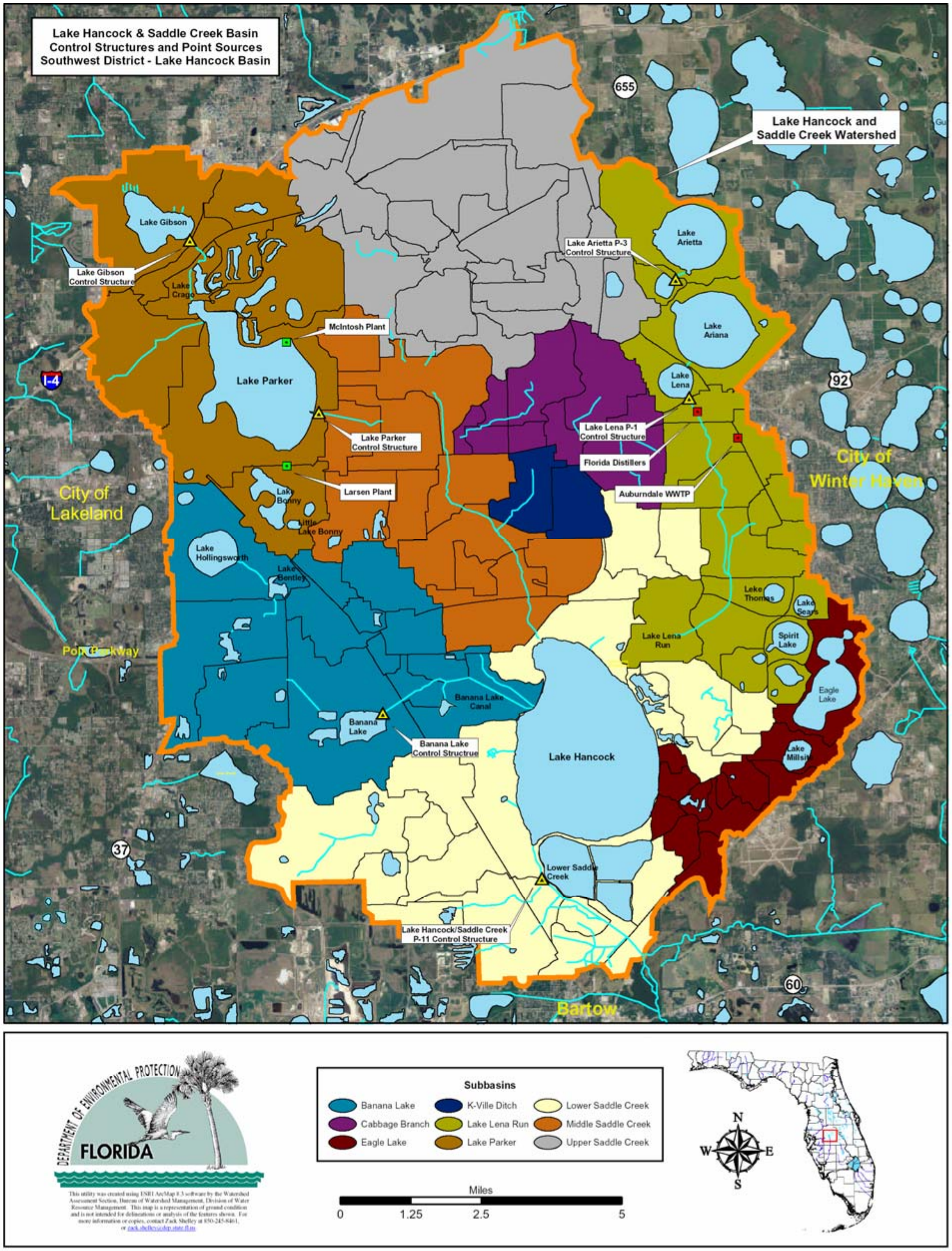


Figure 4.2 Lake Hancock and Lower Saddle Creek Watershed Lake Control Structures and Active NPDES Facilities

Municipal Separate Storm Sewer System Permittees

Municipal separate storm sewer systems (MS4s) may discharge nutrients to waterbodies in response to storm events. To address stormwater discharges, the EPA developed the National Pollutant Discharge Elimination System (NPDES) stormwater permitting program in two phases. Phase I, promulgated in 1990, addresses large and medium MS4s located in incorporated places and counties with populations of 100,000 or more. Phase II permitting began in 2003. Regulated Phase II MS4s, which are defined in Section 62-624.800, F.A.C., typically cover urbanized areas serving jurisdictions with a population of at least 10,000 or discharge into Class I or Class II waters, or Outstanding Florida Waters.

The stormwater collection systems in the Lake Hancock Basin, which are owned and operated by Polk County in conjunction with the Florida Department of Transportation, are covered by a NPDES Phase I MS4 permit. The Lake Hancock and Lower Saddle Creek watersheds are situated between the cities of Lakeland, Winterhaven, Auburndale, and Bartow. The City of Lakeland has areas in it’s jurisdiction located within the Lake Hancock Basin (**Figure 4.1**). At this time, it is unknown if local governments located in the lake and creek watersheds have applied for coverage under the Phase II NPDES MS4 permit.

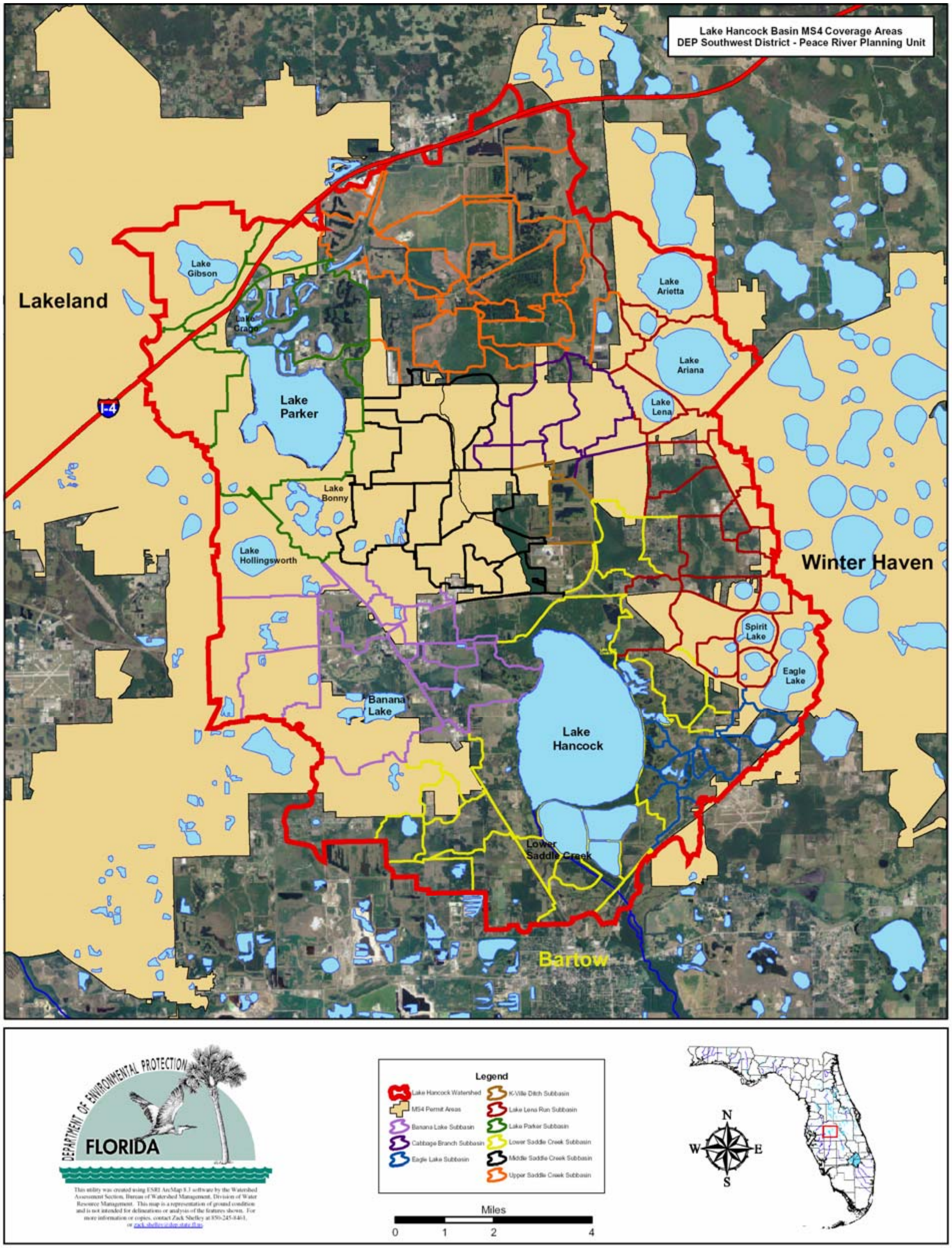


Figure 4.3 Phase I MS4 Coverage Area for the Lake Hancock Basin

Capital Improvement Projects in The Banana Lake and Banana Lake Canal Subbasin

Lake John *(June 2004 to Present)*

Shoreline erosion at Peterson Park along the peninsula is being caused by boat wakes from boaters using the ramp at the park and by residents accessing the narrow waterway east of the park. To address this issue, the City has developed a shoreline stabilization project to repair and stabilize shoreline near the bridge crossing and shoreline adjacent to the bridge. Construction is scheduled for FY 2005. (City of Lakeland Public Works Department, 2005).

Lake Morton *(July 2003 to Present)*

The City of Lakeland initiated Master Plan for Lake Morton in 2003 to preserve and enhance the aesthetic qualities of the lake for continued public use and lake water quality. The Plan involves future renovation and continuing maintenance concerns for the lake. Phase 1 of the Master Plan addresses the shoreline erosion and lack of wildlife habitat by using a combination of methods for repairing and stabilizing the shoreline that will include the use of seawalls, rock, sloping banks and aquatic vegetation to reclaim lost shore, stabilize the bank and provide enhanced habitat(City of Lakeland Public Works Department, 2005).

Lake Hollingsworth

Southern Landing Treatment Wetland Project *(September 2004 to Present)*
Lake Hollingsworth is a eutrophic to hypereutrophic water body in a highly urbanized portion of the City of Lakeland. Studies have demonstrated that stormwater runoff contributes a significant nutrient and sediment load to the lake. The City has completed a dredging project and whole lake alum treatment on the lake, but stormwater retrofit projects were considered necessary to further reduce pollutant loads. The 1995 Lake Hollingsworth Watershed Management Plan identified potential locations for the creation of stormwater treatment facilities. Southern Landing was included as a potential area for such a facility.

The recently completed Southern Landing project is located directly across from Florida Southern College on the shore of Lake Hollingsworth. The 1.3-acre treatment wetland was designed to provide treatment to a 66-acre sub-basin on the northwest side of lake. In addition to the treatment of stormwater, the wetland will include boardwalks for public access and serve as an outdoor laboratory for the college (City of Lakeland Public Works Department, 2005).

Buckingham Avenue Wetland Project *(August 2001 to Present)*
A drained wetland on the south side of Lake Hollingsworth is being evaluated for storing and treating runoff from surrounding neighborhoods. The wetland was previously drained by a canal, and is in poor condition. The canal, which parallels Buckingham Avenue, collects a portion of the stormwater runoff from a 92-acre drainage basin on the south side of Lake Hollingsworth. An existing forested wetland was partially intersected by the canal is being evaluated to reduce flooding and filter stormwater. The City plans to install a water level control structure and pump station along the canal bank to pump water into the wetland thereby reducing flooding that occurs in the residential neighborhood along Buckingham Avenue and providing treatment of stormwater prior to its discharge into Lake Hollingsworth (City of Lakeland Public Works Department, 2005).

West Side Stormwater Treatment Project *(September 2002 to Present)*

In addition to the other capital improvement projects to reduce pollutant loadings into Lake Hollingsworth, the City has developed a conceptual plan to construct a stormwater treatment wetland on the west side of the lake. The plan consists of constructing linear wetland strands along the lakeshore. The strands will be approximately 30' wide and will be vegetated with wetland plants. The strands will intercept stormwater runoff from 13 existing outfall pipes that currently discharge untreated stormwater into the lake from a 217 acre sub-basin. Locating the strands near the lakeshore will also serve to preserve the open space and recreational nature of the remaining upland areas between the lake and road. The City is currently working on permitting, easement acquisition, construction, and final design plans (City of Lakeland Public Works Department, 2005).

Capital Improvement Projects in the Lake Parker Subbasin

Lake Gibson *(September 2004 to Present)*

Due to extensive development in the past decade, the City of Lakeland began ecological and engineering analysis of the Lake Gibson watershed and hydrology of the basin. The southwest basin retrofit project analysis for Lake Gibson includes stormwater runoff monitoring, flow monitoring, characterization of the hydrology, modeling of the drainage system, and estimation of pollutant loadings to the lake. The evaluation phase is anticipated to be complete by FY 2005 (City of Lakeland Public Works Department, 2005).

Lake Mirror *(2005 and Beyond)*

Due to the large amount of untreated stormwater that drains from a portion of downtown Lakeland, the City of Lakeland has developed design plans to re-align Main Street away from Lake Mirror's shoreline. The new design will include the construction of an interceptor drainage system near Iowa Street that will re-direct stormwater to a basin to be constructed on the northeast side of the lake. This basin will be equipped to provide stormwater storage and subsequent alum treatment. Treated water will then be discharged back into Lake Mirror. There are also plans to install a pump system on the northwest corner of the lake that will pump lake water into the interceptor system so that captured lake water will also undergo alum treatment prior to being re-circulated back into the lake. Anticipated start of funding began in 2005 (City of Lakeland Public Works Department, 2005).

Lake Parker

Griffen Road Stormwater Treatment Wetland *(September 2004 to present)*
In 1993, a recommendation to provide stormwater treatment to this system was listed as the number one priority in the Lake Parker Diagnostic/Feasibility Study conducted by the Southwest Florida Water Management District. According the City, the drainage basin that flows through the canal system adjacent to the project site contributes a large pollutant load to Lake Parker. The basin includes portions of US 98 North and areas north of Griffin Road. Under the proposed plan, water flowing through the canal system would be diverted into the wetland for treatment prior to discharge back into the canal and eventual discharge into Lake Parker.

Southwest Basin Stormwater Retrofit *(August 2001 to Present)*
The southwest sub-basin of Lake Parker drains a highly urbanized landscape which has been extensively developed and includes many acres of pavement, roofs, and roads, which result in the stormwater runoff into Lake Parker. A feasibility study led to the design and permitting of two wet-detention stormwater treatment ponds that are under construction on the southwest

shoreline. The design includes diversion structures to route low flows from the existing drainage network to the wetland ponds, with higher flows bypassed directly to the lake (City of Lakeland Public Works Department, 2005).

Tributary Swamp Restoration *(April 2001 to Present)*
The subject forested wetland receives surface water runoff from surrounding urban areas prior to its discharge to Lake Parker. Historically, the wetland area attenuated stormwater flow volumes and provided water quality treatment functions such as sediment deposition and nutrient removal. However, the system was channelized and drained many years ago. As a result of the channelization, the wetland system apparently reduced historic storage time characteristics and resulted in significantly degrading desirable wetland attributes. The soils in the wetland have receded and the vegetation, including large trees have been impacted. The project will restore the hydrology of the wetland through the backfilling of ditches and the installation of a control structure at the outfall. Stormwater runoff entering the wetland from the surrounding lands will be stored and treated by the wetland prior to being discharged to the lake (City of Lakeland Public Works Department, 2005).

Robson Street Neighborhood *(February 2003 to Present)*
After the City annexed the Robson Street neighborhood in October of 2001, the City began to receive numerous complaints of flooding in the streets and private properties in the north Lakeland area. As a result, the creek running south of I-4 that crosses Robson Street and travels towards the Robson Street neighborhood is currently being studied. A project is being planned to retrofit this drainage system to allow for more flood storage as well as water quality treatment. In addition, the neighborhood surrounding Robson Street is being studied to alleviate flooding in the region (City of Lakeland Public Works Department, 2005).

4.2.2 Nonpoint Sources and Land Uses

Unlike traditional point source effluent loads, nonpoint source loads enter at so many locations and exhibit such large temporal variation that a direct monitoring approach is often infeasible. For the Lake Hancock and Lower Saddle Creek TMDLs, all nonpoint sources were evaluated by use of a watershed and lake modeling approach. **Table 4.1** shows the existing area of the various land use categories examined and modeled for the Lake Hancock and Saddle Creek watersheds. **Figure 4.4** shows the drainage basin area for the lake and creek and the spatial distribution of the existing land uses shown in **Table 4.1. Figure 4.5** shows the spatial distribution of land use coverages for the Lake Hancock Basin when converted to “natural background” land cover.

The predominate existing land coverages for the Lake Hancock Basin (which includes all nine subbsins) are low, medium, and high density residential (20.2%); followed by extractive-post phosphorus mining (16.2%); agriculture (14.2%); and commercial, industrial, transportation, and utilities (8.1%). These coverages account for 58.6 percent of the land use in the Lake Hancock basin. Lakes and interconnected waterways/streams/wetlands etc. account for 23.2 percent of the watershed. The areas occupied by anthropogenic land uses account for 63.5 percent of the watershed.

Land use coverages for the entire basin were aggregated using the Florida Land Use, Cover and Forms Classification System (FLUCCS, 1999). The spatial distribution and acreage of different land use categories for WAM were identified using the 1999 land use coverage (scale 1:24,000) provided by the Southwest Florida Water Management District (SWFWMD) contained in the Lake Hancock Basin WAM model developed by Soil and Water Engineering Technology, Inc. (2005).

Table 4.1 Lake Hancock Basin Existing Land Use Descriptions

FLUCCS ID	Lake Hancock Basin Existing Land Use Coverage	Acres	Sq Miles	Percent

1600	Extractive-Phosphorus Mining	16,210.0	25.33	16.15%
1200	Medium Density Residential, Fixed Single Family Units	13,155.8	20.56	13.11%
5201	Interconnected Lakes	12,179.8	19.03	12.13%
2100	Pastures and Fields	8,942.7	13.97	8.91%
6150	Stream and Lake Swamps (Bottomland)	6,138.1	9.59	6.11%
1800	Recreation	4,989.0	7.80	4.97%
2210	Citrus Groves	4,875.4	7.62	4.86%
1100	Low Density Residential, Fixed Single Family Units	4,304.6	6.73	4.29%
1400	Commercial and Services	3,679.4	5.75	3.67%
4340	Hardwood - Conifer Mixed	2,908.4	4.54	2.90%
1300	High Density Residential	2,834.3	4.43	2.82%
5300	Reservoirs	2,619.3	4.09	2.61%
1900	Undeveloped Land	2,043.6	3.19	2.04%
1500	Industrial	1,991.7	3.11	1.98%
6410	Freshwater Marshes	1,692.7	2.64	1.69%
8100	Transportation	1,556.8	2.43	1.55%
6210	Cypress	1,349.2	2.11	1.34%
2600	Old Field	1,346.7	2.10	1.34%
1700	Educational Facilities	1,238.0	1.93	1.23%
4110	Pine Flatwoods	1,215.8	1.90	1.21%
8300	Utilities	859.9	1.34	0.86%
7400	Barren Land	761.1	1.19	0.76%
3200	Prairies	600.5	0.94	0.60%
6300	Wetland Forested Mixed	575.8	0.90	0.57%
4200	Upland Hardwood Forest	437.4	0.68	0.44%
6440	Emergent Aquatic Vegetation	378.1	0.59	0.38%
5200	Lakes	355.8	0.56	0.35%
6430	Wet Prairies	274.3	0.43	0.27%
2410	Tree Nurseries	165.6	0.26	0.16%
3100	Herbaceous	135.9	0.21	0.14%
2140	Row Crops	126.0	0.20	0.13%
6200	Wetland Coniferous Forest	98.8	0.15	0.10%
4100	Upland Coniferous Forests	93.9	0.15	0.09%
3290	Other Shrubs and Brush	66.7	0.10	0.07%
2520	Dairies	61.8	0.10	0.06%
2550	Tropical Fish Farms	29.7	0.05	0.03%
6530	Inland Shores/Ephemeral Ponds	29.7	0.05	0.03%
8200	Communications	22.2	0.03	0.02%
2310	Cattle Feeding Operation	19.8	0.03	0.02%
6100	Mixed Wetland Hardwoods	12.4	0.02	0.01%
4400	Coniferous Plantations	7.4	0.01	0.01%
Total		**100,383.5**	**156.85**	**100**

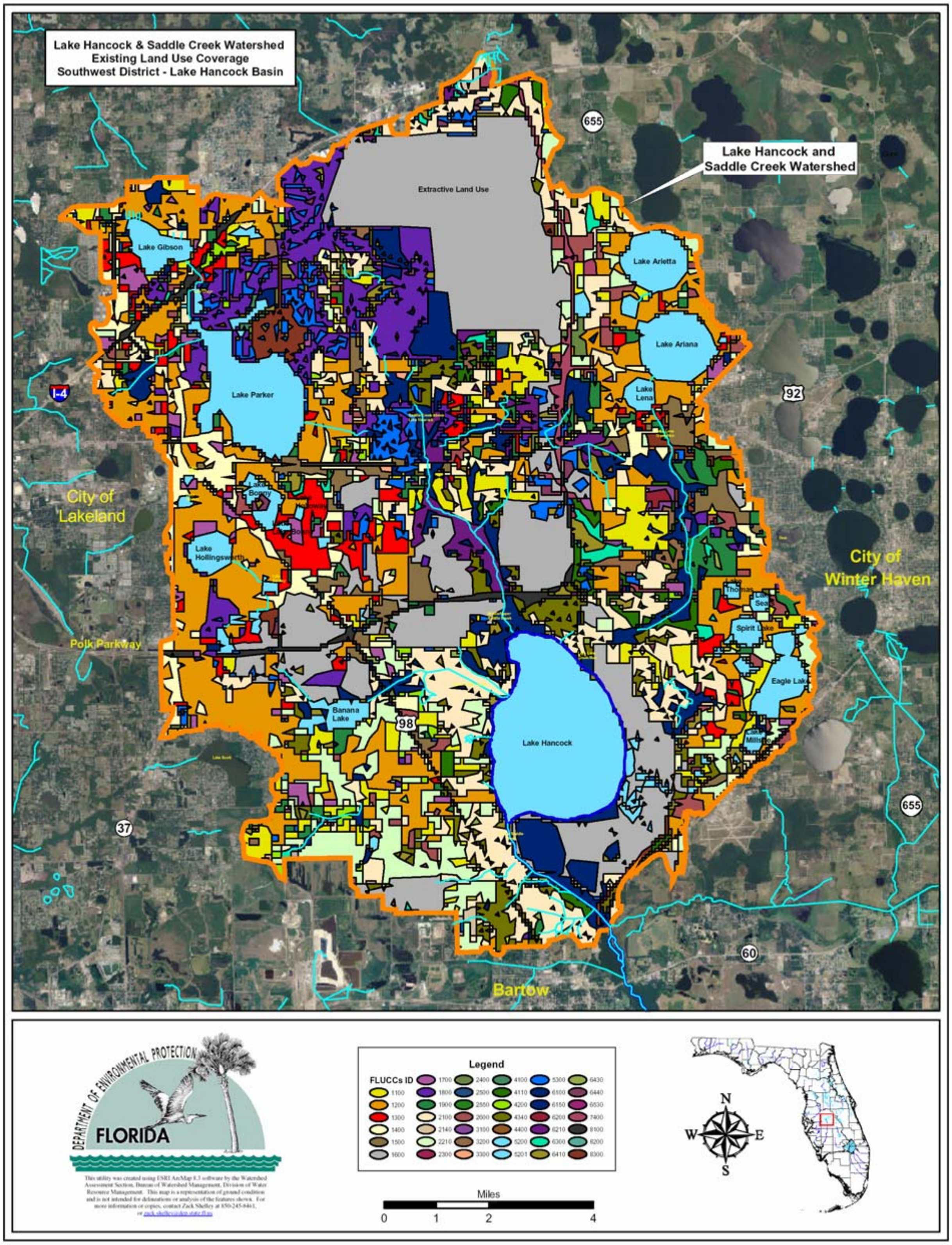


Figure 4.4 Lake Hancock and Saddle Creek Existing Land Use Coverage

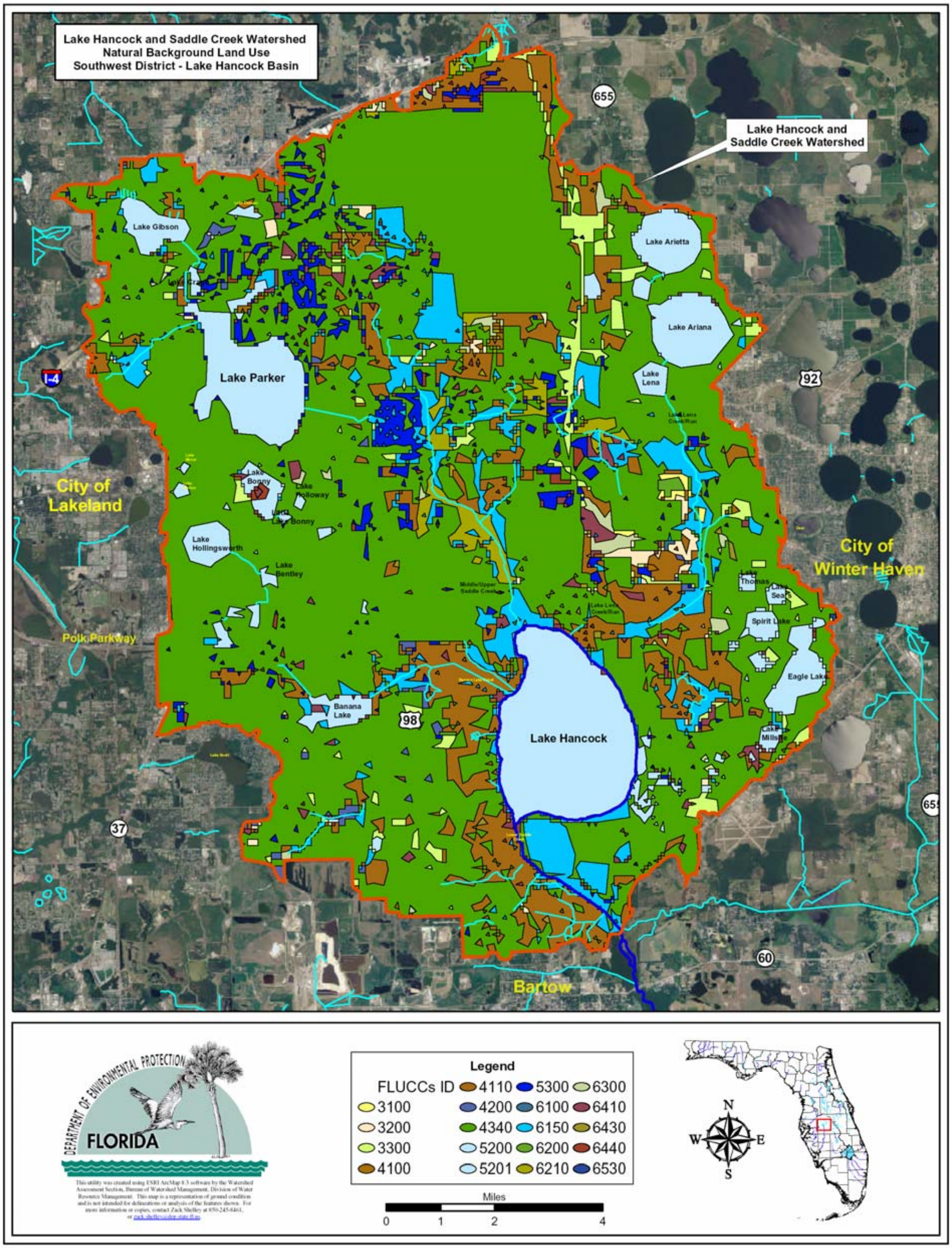


Figure 4.5 Lake Hancock and Saddle Creek Natural Background Land Use Coverage Polk County Population

According to the U.S Census Bureau, the population density in Polk County, in the year 2000, was at or less than 258.2 people per square mile (10 person/mi^2 is the minimum used by the Census Bureau). The Bureau reports that the total population in 2000 for Polk County, which includes (but is not exclusive to) the Lake Hancock and Lower Saddle Creek watersheds, was 483,924, with 226,376 housing units. Polk County occupies an area of approximately 2,009 square miles. For all of Polk County, the Bureau reported a housing density of 120.8 houses per square mile. Polk County is just below the average housing density for Florida counties with 134.3 housing units per square mile (U.S. Census Bureau Web site, 2004).

Polk County Septic Tanks

Onsite sewage treatment and disposal systems (OSTDSs), including septic tanks, are commonly used where providing central sewer is not cost-effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDSs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTDS is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, however, OSTDSs can be a source of nutrients (nitrogen and phosphorus), pathogens, and other pollutants to both ground water and surface water.

As of 2001, Polk County had a cumulative registry of 112,848 septic systems. Data for septic tanks are based on 1970 – 2001 census results, with year-by-year additions based on new septic tank construction. The data do not reflect septic tanks that have been removed going back to 1970. From fiscal years 1993–2004, 1,151 permits for repairs were issued in Polk County (Florida Department of Health, 2004). Based on the number of permitted septic tanks and housing units (226, 376) located in the county, approximately 50 percent of the housing units are connected to a central sewer line (i.e., wastewater treatment facility), with the remaining 50 percent utilizing septic tank systems.

4.3 Estimating Point and Nonpoint Source Loadings

Model Approach

WAM was utilized to estimate the nutrient loads within and discharged from the Lake Hancock basin. WAM is a Geographic Information System (GIS) based model that allows users to interactively simulate and assess the environmental effects of various land use changes and associated land use practices.

WAM utilizes ESRI™ ArcView 3.2 with Spatial Analyst 2.0 to analyze and display model input and output using grids. Grid datasets, as opposed to polygon datasets, spatially represent geographic data as a collection of raster cells. Each cell contains attributes of the dataset, e.g. land use code numbers, that can be overlaid with cells of other grids. The benefits of using grids over polygons include computational speed and output resolution. Output can be displayed by grid cell as opposed to by subbasin polygon. The cell size is dependant on the desired resolution. A grid cell size of one hectare was chosen with the intent that this would adequately characterize the land use and capture linear features such as highways (SWET, 2005).

The WAM model water quality parameters (impact parameters) simulated for Lake Hancock and the Saddle Creek watershed include: Water quantity, soluble nitrogen (N) forms (ammonia, soluble organic, nitrate), particular N, groundwater N, soluble phosphorus (P), particulate P, groundwater P, sediment, 5-day biological oxygen demand (BOD_5), and land sourced dissolved oxygen. GIS datasets of land use, soils and rainfall are used to calculate the combined impact of the watershed characteristics for a given grid cell. Once the combined impact for each unique cell within a watershed is determined, the cumulative impact for the entire watershed is determined by attenuating the constituent to the sub-basin outlets. Constituents are attenuated based upon the flow distances (overland to nearest water body, through wetlands or depressions and within streams to the sub-basin outlet), flow rates in each related flow path and the type of wetland or depression encountered. **Figure 4.6** shows the conceptual routing schemes and flow distances that are calculated for each cell (SWET, 2005).

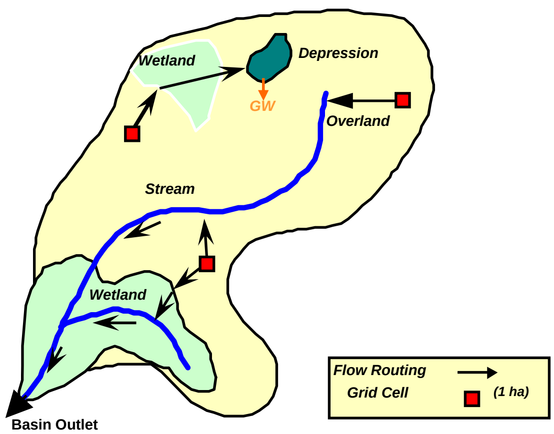


Figure 4.6 WAM Conceptual Routing Diagram (SWET, 2005)

A portion of the flow in each cell is converted to groundwater based on the soil type and the amount of imperviousness estimated for each land use. Surface flow that enters depressions is also converted to groundwater. Groundwater is routed to the nearest stream unless directed otherwise.

The hydrologic contaminant transport modeling is accomplished by first simulating all of the unique grid cell combinations of land use, soils, and rainfall by using one of several source cell models including GLEAMS (Knisel, 1993), EAAMOD (Bottcher et al., 1998; SWET, 1999), a wetland module, and an urban module. The time series outputs for each grid cell is then routed and attenuated to the nearest stream and then through the entire stream network of the watershed. Dynamic routing of flows is accomplished through the use of an algorithm, BLASROUTE.exe, that uses a non-linear reservoir technique (Jacobson et al., 1998). **Figure 4.7** below shows a flow diagram of the hydrologic contaminant transport modeling component of the overall WAM model.

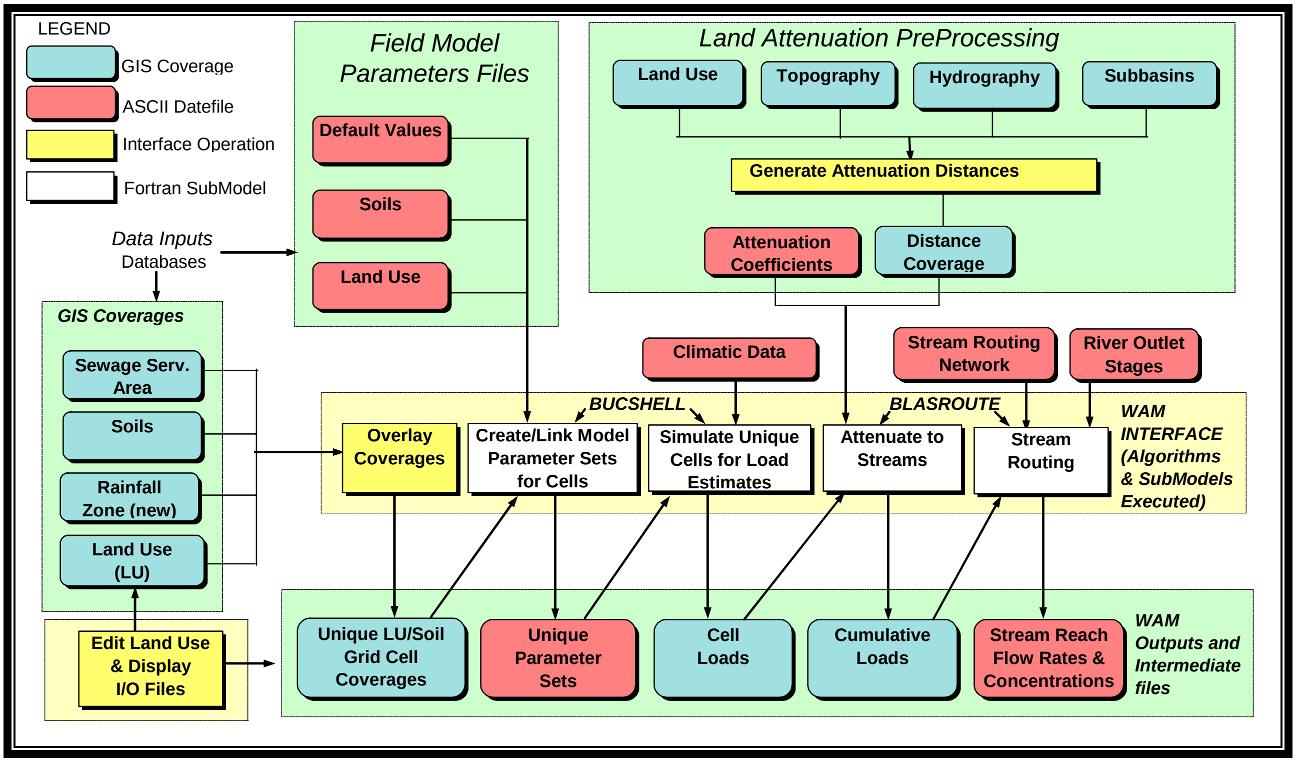


Figure 4.7 WAM Dynamic Modeling Approach (SWET, 2005)

While BATHTUB has the capability to simulate large, sinuous reservoirs and lakes using multiple model cells, the size and nature of the eleven lakes evaluated supported the designation of one BATHTUB segment for each lake. However, because of the interconnectedness of the eleven lakes, including Lake Hancock, all eleven lakes were incorporated into a single BATHTUB model framework containing eleven linked segments. The outflow from each lake enters the next lake downstream. Surface water and groundwater inputs are designated as tributaries in the model (one set to each lake). These inputs are provided by WAM which was explicitly set up to output the incremental surface water and groundwater quantity and quality flowing into each of the BATHTUB-simulated lakes. That is, the tributaries designated in the BATHTUB model have flows and concentrations that reflect their local upstream (between lakes) sources only. Groundwater seepage from each lake is simulated using BATHTUB's channels. A schematic of the model framework is shown in **Figure 4.8.** All flows that do not point to a lake represent flows that are lost to the system. Dailey WAM results were computed for the time period 1994 to 2003. The WAM results were averaged on an annual basis to develop eleven separate BATHTUB model scenarios, one for each year (QEA, LLC, 2005).

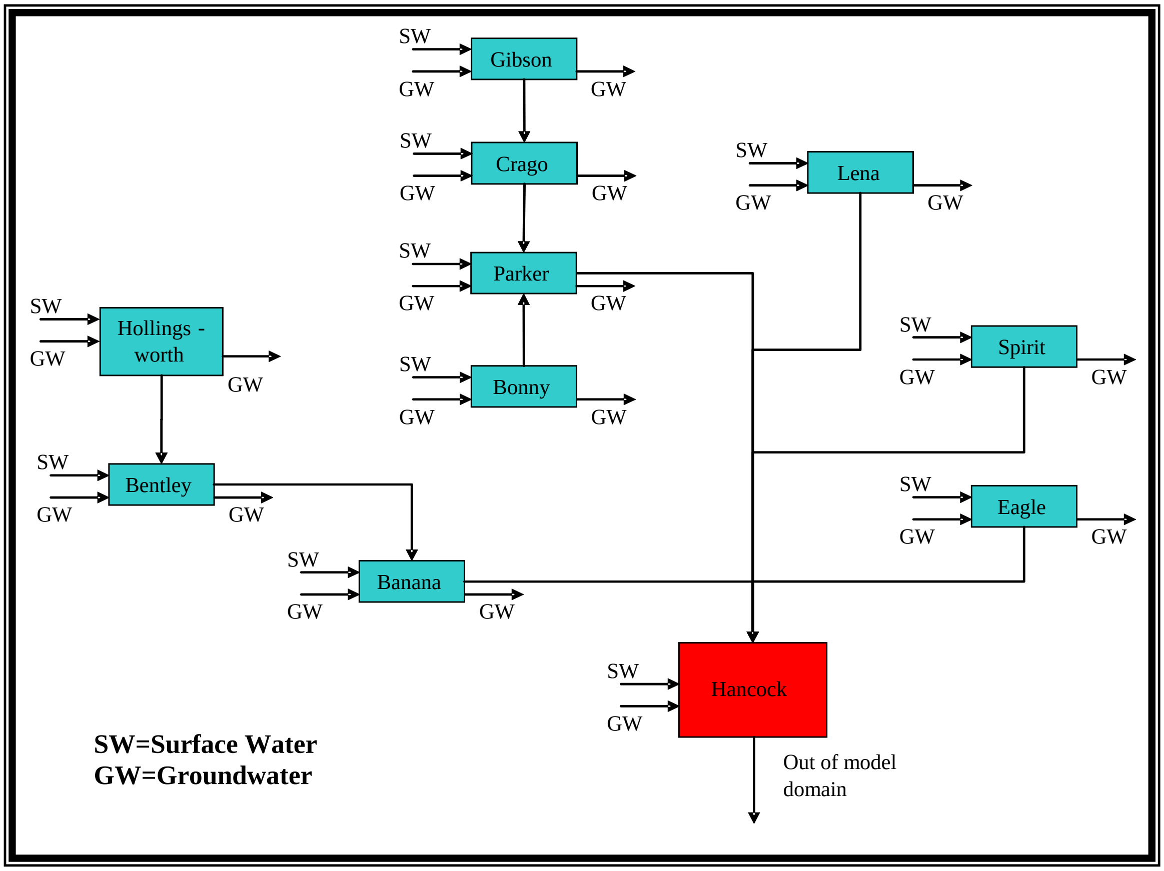


Figure 4.8 Model schematic depicting the interconnected eleven lakes modeled for Lake Hancock watershed (QEA, 2005)

Land Use and Soils

All of the GIS spatial datasets necessary to set up WAM were provided by the Department in custom Albers projection in the HPGN (metric) datum. Most of the datasets are from other sources including Southwest Florida Water Management District (land use), Natural Resource Conservation Service (soils) and United States Geographical Survey (topography and hydrography). The SURGO soils datasets were modified to include abbreviated soil designations in order that these attributes would match WAM soils database established for the State. The land use dataset utilizes the Florida Land Use Cover Classification System (FLUCCS), which is also utilized by WAM (**as noted in Chapter 4 Section 4.2.2**).

Hydrologic Data

National Hydrologic Datasets (NHDs) were reviewed but were not used because of the lack of information and ability to define the hydrologic stream network within the Lake Hancock Basin. Instead, a detailed water management modeling assessment performed by Keith and Schnars, P. A. (2003) for the Polk County Board of County Commissioners and SWFWMD was utilized.

The Primary Basin Setup procedure available in WAM was utilized to layout and code the stream network. The line segments of the Keith and Schnars reach coverage were coded with numbers in descending order from upstream to downstream. Not all of the segments were utilized. For modeling purposes, it is possible to represent clusters of segments as one reach. Line segments were added along the boundaries of the lakes to form shorelines. These shorelines were needed to properly calculate overland distances to the lakes (used for attenuation). In total, 98 hydrologic model reaches were assigned. A profile of these reaches is shown in **Figure 4.9** (SWET, 2005).

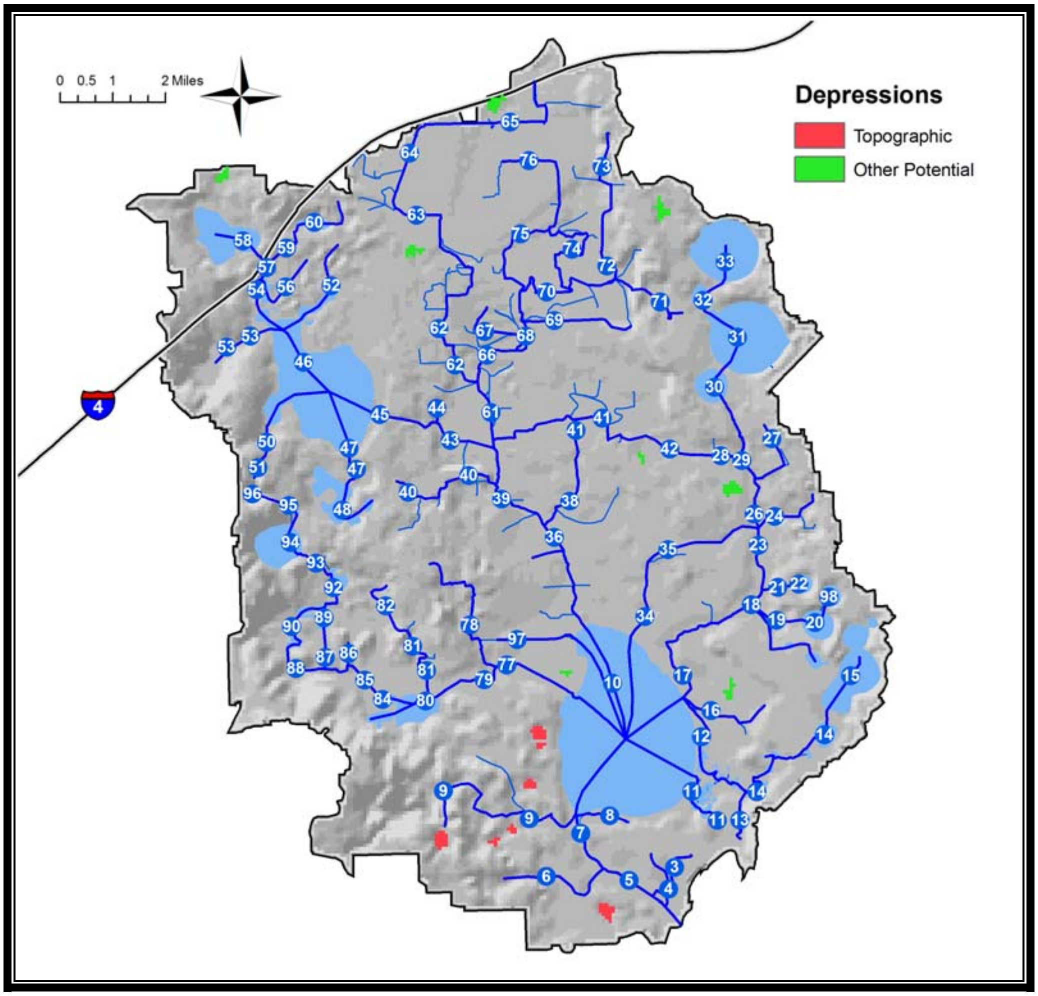


Figure 4.9 Model Reaches and Estimated Depressions Attenuation Distances

Depressions

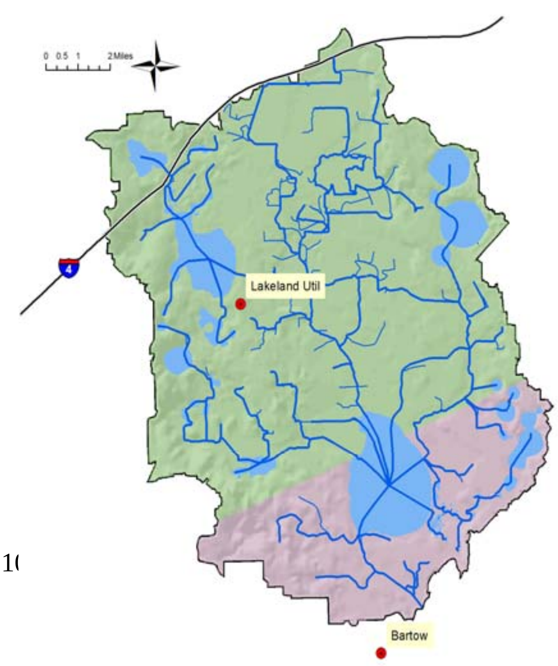
Depressions are one of the three geographic features (wetlands, streams and depressions) that WAM routes runoff to and attenuates. Areas that drain to depressions are attenuated differently than areas that drain via surface water to the streams. Runoff entering depressions converts to groundwater with very little phosphorus re-emerging in the streams. A grid of topographical and potential isolated depressional areas were created by an algorithm in the WAM Primary Basin Setup. This algorithm utilizes wetlands from the land use dataset, depressional soils such as surrency of the soils dataset, hydrography and topography. A grid of topographical depressed areas is produced based on the topography grid, which was created from the USGS DEMs. Grid functions available in ArcView™ Spatial Analyst were

then used to locate depressions and determine their minimum elevation and depth at which runoff overflow would occur. The depth is added to the minimum elevation to determine the overflow elevation. All elevations equal to or less than this elevation in the region of the sink are identified and converted to a new grid of topographic depressions. A wetland and depressional soil grid was then created by selecting and merging those features from their respective source grids. These areas represent potentially depressional areas as opposed to topographic depressions. Both grids are then converted to polygon shapefiles.
Potential depressions that lie in areas where land slopes are sufficient to generate runoff discharge are removed. The topography grid is then used to create a grid of slope values. Polygons of potential depressional areas that lie over an area with an average slope that is above a set minimum slope are then removed.

The hydrography dataset is used in the algorithm to eliminate areas that are on or near "connected" hydrologic features. Connected features represent those line segments of the hydrography that form a contiguous drainage network including boundaries of lakes and wetlands. Any such boundaries that are isolated away from the connected system are not utilized in the analysis. Polygons that are within a set distance from the connected system are removed in both the topographic and potential depression shapefiles. This is based on the assumption that if the depression is close enough to the stream network, it is most likely connected to the network somehow.

A new screening process, however, was added specifically for the Lake Hancock watershed study when it was discovered that several small topographic depressions were appearing in heavily urbanized areas. Considering the nature of urban drainage, it is likely that drainage from these areas is captured and conveyed by local culverts. The algorithm was modified to exclude depressions in areas dominated with urban land use. **Figure 4.9** shows the results of the analysis for depressions and stream reaches (SWET, 2005).

WAM attenuates water quality parameters in the runoff based on distances and the type of geographic feature the runoff passes through (upland, wetland, depression and stream. The WAM Primary Basin Setup includes an algorithm to develop a series of grids for this purpose. ArcView™ Spatial Analyst cost distance functions are employed to both determine distance and attributes of the feature that is found. For example, when the closest wetland is found, the wetland FLUCCS number can also be returned. In addition, a grid of wetland distances to streams can be accessed to return the distance to the next feature (SWET, 2005).



Rainfall

Rainfall datasets were created from monitoring information obtained from the National Weather Service (NWS). The stations were initially chosen based on their locations for adequate spatial coverage of the study area and for the appropriate period of record. For flexibility in modeling, it is important to have an adequate period of record. A 13 year period between January 1992 and December 2004 was chosen, though it was expected that the model would not utilize this entire period. The model uses the first two years of data to reach equilibrium with antecedent conditions. The model output reflects any remaining years of input data. Only years 1994 to 2003 were used for generating files for the BATHTUB model.

Figure 4.10 Rainfall Stations and Zones

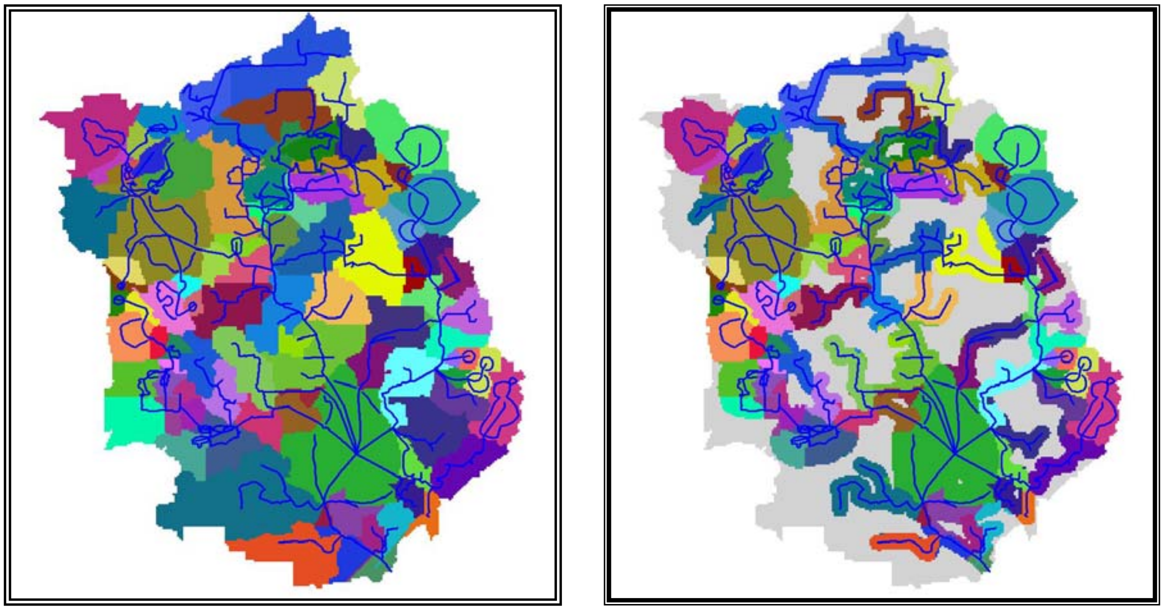
The rainfall records were then reviewed for completeness. Some stations were rejected because of abnormal annual rainfall compared to surrounding stations. The three USGS stations shown were first considered, but upon data review the Winter Haven station appeared to be quite different from the other two stations. When it was found that this station's data had not been verified after 1999, it was decided to use only the Bartow (COOP: 080478) and Lakeland (COOP: 084797 and COOP: 084802) National Weather Service stations. These data were retrieved from the Climate Interactive Rapid Retrieval User System (CIRRUS) hosted by the Southeast Regional Climate Center, 2005. The data from the selected rainfall stations was formatted and converted to centimeters for use by WAM. Theissen's polygon method was applied to create rainfall zones for the stations noted above and shown in **Figure 4.10**.

Control Structures

Six major water control structures located within the Lake Hancock and Saddle Creek watershed were incorporated into the WAM model. These structures are located at lakes Arietta (P-3), Banana, Gibson, Hancock/Lower Saddle Creek (P-11), Lena (P-1), and Parker. Most of the structures in this basin consist of weirs that are operated to maintain optimum lake elevations. The major control structures as shown in **Figure 4.2** are operated and maintained by the Southwest Florida Water Management District. Several other smaller structures were added to the model to simulate culvert connections and other water control features. The elevation controls were adjusted to reflect observed water levels throughout the basin (SWET, 2005).

Groundwater

An option in WAM allows groundwater to be routed to specified locations as opposed to the closest downstream waterbody, which is how surface water is routed. This option is particularly useful for dealing with springsheds or with deep surficial systems where groundwater emerges further downstream as opposed to the nearest stream. It is also possible to send groundwater out of the system to an offsite spring or as recharge to underlying aquifer system by designating the groundwater zone as discharging to reach number 1, which by default is an offsite reach. In Lake Hancock Basin, it was assumed that some groundwater discharges to nearby streams/lakes, while the majority percolates to the deeper Upper Floridan Aquifer (UFA). To reflect this, buffers were created around the streams and lakes (200 meters for streams and 500 meters for lakes) that included groundwater zones equal to the nearest reach number. Reach number 1 was assigned to any areas outside of these buffers. **Figure 4.11** shows the zones of surface water (Stream Node) and groundwater (GW Node) distribution. Areas shaded in gray discharge to the UFA (SWET, 2005).



Stream Node **GW Node**

Figure 4.11 Surface Water and Groundwater Distribution Zones

Several previous studies in the Lake Hancock basin found that significant leakage to the UFA is occurring from most of its lakes and streams. For example, Environmental Research and Design (1999) estimated by in-situ leakage studies and USGS data that Lake Hancock receives about 4-6 inches of groundwater inflow per year, but leaks between 25 to 35 inches to the UFA per year. To better handle this leakage component in the basin, WAM was modified so that leakage rates for each stream and lake reach could be assigned. These leakage rates are the primary calibration factors for this basin. This leakage rate is calculated by the following equation:

Reach leakage rate (m^3/y) = Area x K_{leak} x Relative Head

Where, Area = reach's water surface area (m^2)
K_{leak} = leakage coefficient (m/y)
Relative Head = (water surface elevation – impeding layer elevation)/ unit thickness – dimensionless (SWET, 2005)

WAM Model Linkage to the BATHTUB Model

GIS and model data set inputs for the WAM model included land use, soils, topography & depressions, hydrogaphy, USGS gage and flow volume, septic tanks, water use pumpage, point sources, rainfall, groundwater, atmospheric deposition, solar radiation, control structures, and attenuation distances/stream reaches.

The BATHTUB model simulates lakes based on annual average inputs. The inputs required for BATHTUB are the following annual data: rain (amount and TN and TP concentrations), evaporation, surface water inflow volumes and TN and TP loads, groundwater inflow volumes and TN and TP loads, and leakage volume. Because BATHTUB is unable to vary the rainfall rate between lakes, it was decided that WAM would include rain inputs as part of its surface reach loads, so that the rainzones could be represented. Therefore, BATHTUB inputs show no rainfall. BATHTUB has been set up to simulate Lake Hancock and its ten major contributing lakes. The flow routing to and between lakes is build into both WAM and BATHTUB. BATHTUB routes flow and constituents between lakes, but requires WAM to provide all flow and constituents generated above and between the lakes.

Using the BATHTUB input decks, WAM produced a nonpoint source file for each lake reach which contained all of the inflow and constituent loads data needed by BATHTUB. These files and the normal WAM reach files were used by an Access database which processed and formatted the input data necessary for BATHTUB (SWET, 2005).

WAM and BATHTUB Calibration

The data used for calibration is included in the Department's IWR database and the Polk County Water Atlas database. The WAM model was initially set up based on parameters presented in the modeling report just completed by BCI Engineers & Scientists, Inc. (2005). This report was extremely helpful, however, upon data review and discussion with local experts it was found that some of the structures, particularly their control elevations had to be updated. Also, in the western basin near Lake John, the hydrography was verified to be quite different than what was shown in the report, i.e., Lake John was found to flow north and east through Summerset Lake instead of south. Also, a major culvert into the southeast end of Lake Crago from a series of old mining pits was also not represented. All of the flow and structure setting were verified against available lake stage data, which deemed the best hydrology data available to calibrate against because it was available throughout the basin. There were three flow stations located with the basin that were also used to verify net flow volumes.

The parameters varied to obtain the best fit were the weir crest elevations for the lake structures and the leakage rates for each reach. The nearly closed lakes, such as Eagle, Spirit, Thomas, and Arietta, where the most difficult because getting the leakage rates correct required numerous trial and error runs. Also, the balance of leakage between connected lakes like Parker, Crago, and Bonny required special attention so that significant backflow between the lakes was not generated, though some backflow is probably real. Another calibration issue was the 3-foot culvert from the upper end of Lake Crago to the connected mine pits located to the northeast. The reasonable leakage rates in these pits created the situation that there was a net positive flow from Lake Crago to these pits than the other inflows and outflows. WAM was able to handle this net negative reach inflow, but BATHTUB was not. Therefore, since the flows throw this culvert were quite low compared to the other inflow to the lake, the culvert was raised to prevent flow except during major events. This solved the BATHTUB problem. Water quality calibration was limited by the fact that only in-lake data were available and WAM currently does not have a lake submodel to properly represent the nutrient dynamics, particularly internal loadings from bottom sediments, algal populations, and macrophytes. These limitations were the reason WAM was linked to BATHTUB, which is capable of handling the in-lake dynamics much better and on a long term basis. WAM performed fairly well in matching the general nutrient levels in several of the lakes, which gives confidence that the simulated nutrient loading rates to the lakes are reasonable (SWET, 2005).

Lake Hancock Basin Existing Land Use Loadings

The total loadings of nitrogen and phosphorus generated in the Lake Hancock Basin were estimated using the WAM and BATHTUB models. Modeling frameworks were designed to simulate the period 1994 through 2003. This time period had the best available seasonal data for the contributing subbasins and also included the verified period for Group 3 waterbodies located in the Lake Hancock watershed.

Based on the hydrology, and lake and stream interconnected reaches, nine major subbasins were delineated in making up the Lake Hancock watershed. The nine subbasins include Banana Lake and Banana Lake Canal, Cabbage Branch, Eagle Lake, K-Ville Branch, Lake Lena and Lake Lena Run/Creek, Lake Parker, Lower Saddle Creek, Middle Saddle Creek, and Upper Saddle Creek. Within the nine subbasins making up the Lake Hancock watershed, eleven lakes were targeted and modeled based on nutrient impairment and the interconnected nature of the waterbodies contributing runoff and loadings to Lake Hancock and Lower Saddle Creek. The eleven lakes are Lake Gibson, Lake Crago, Lake Bonny, Lake Parker, Lake Lena, Lake Hollingsworth, Lake Bentley, Banana Lake, Spirit Lake, Eagle Lake, and Lake Hancock. All of these lakes are impaired for nutrients based on the Department's Impaired Waters Rule methodology. Each lake was modeled separately to determine individual contributions to Lake Hancock and Lower Saddle Creek. **Tables 4.2** through **4.7** illustrate the total water volume and loadings for TN and TP going into each of the eleven lakes from 1994 to 2003 based on the WAM and BATHTUB model results under current land use conditions. Loads were estimated based on lake surface rainfall, surface water inflow, groundwater inflow and septic inflow. Groundwater loss/leakage from each lake was also calculated and subtracted from the total inflow volume.

Table 4.2 Lakes Gibson and Crago Water Volume and Loadings for TN and TP from 1994 to 2003

Lake Gibson						Lake Crago				
Year	Water (hm^3)	TN (kg)	TN (lbs)	TP (kg)	TP (lbs)	Water (hm^3)	TN (kg)	TN (lbs)	TP (kg)	TP (lbs)
1994	6.7	10,815.4	23,843.9	836.9	1,845.1	1.8	1,532.0	3,377.6	206.5	455.2
1995	7.0	13,422.2	29,590.9	864.3	1,905.5	1.3	975.5	2,150.7	124.9	275.4
1996	5.5	8,323.0	18,349.1	714.1	1,574.4	1.4	1,050.1	2,315.0	173.4	382.3
1997	8.4	16,079.5	35,449.3	1,182.1	2,606.2	1.4	1,249.8	2,755.3	153.9	339.2
1998	6.9	12,176.4	26,844.4	870.4	1,918.8	1.3	986.6	2,175.0	122.8	270.7

1999	4.7	8,676.8	19,129.0	642.2	1,415.8	1.2	1,117.2	2,463.1	156.0	343.8
2000	3.7	8,950.2	19,731.8	516.1	1,137.9	0.9	1,025.8	2,261.4	118.7	261.8
2001	4.7	10,787.6	23,782.6	710.6	1,566.6	0.9	806.1	1,777.1	96.4	212.5
2002	8.3	12,066.5	26,602.1	1,061.1	2,339.3	1.8	1,479.6	3,262.1	197.8	436.0
2003	6.9	13,944.7	30,742.9	829.8	1,829.4	1.0	713.7	1,573.3	78.7	173.4
94-03 Mean	6.3	11,524.2	25,406.6	822.8	1,813.9	1.3	1,093.6	2,411.1	142.9	315.0
94-03 Totals	62.7	115,242.4	254,066.1	8,227.7	18,138.9	12.9	10,936.4	24,110.6	1,429.0	3,150.3

hm^3: Cubic Hectometers; kg: Kilograms; lbs: Pound

Table 4.3 Lakes Bonny and Parker Water Volume and Loadings for TN and TP from 1994 to 2003

	Lake Bonny					Lake Parker				
Year	Water (hm^3)	TN (kg)	TN (lbs)	TP (kg)	TP (lbs)	Water (hm^3)	TN (kg)	TN (lbs)	TP (kg)	TP (lbs)
1994	3.9	3,832.2	8,448.6	448.5	988.8	28.5	23,624.2	52,082.4	3,330.8	7,343.2
1995	4.1	5,263.8	11,604.8	472.2	1,041.0	29.6	30,685.8	67,650.7	3,408.7	7,514.9
1996	3.0	2,429.4	5,356.0	359.1	791.6	22.5	16,120.8	35,540.4	2,649.8	5,841.8
1997	4.9	6,951.3	15,324.9	629.3	1,387.4	35.3	39,650.4	87,414.2	4,436.6	9,780.9
1998	4.0	4,340.0	9,568.0	467.7	1,031.0	28.4	27,585.3	60,815.1	3,253.2	7,172.2
1999	2.6	2,514.3	5,543.0	308.2	679.5	19.5	16,428.3	36,218.1	2,343.8	5,167.3
2000	2.0	2,468.3	5,441.7	238.0	524.8	15.0	15,148.7	33,397.1	1,790.9	3,948.2
2001	2.6	3,400.4	7,496.6	333.5	735.1	19.7	22,304.7	49,173.5	2,485.4	5,479.4
2002	4.8	4,674.1	10,304.6	579.2	1,276.9	34.8	29,299.0	64,593.3	4,136.2	9,118.8
2003	4.1	5,095.4	11,233.4	447.8	987.1	28.6	32,376.8	71,378.6	3,201.5	7,058.0
94-03 Mean	3.6	4,096.9	9,032.2	428.3	944.3	26.2	25,322.4	55,826.3	3,103.7	6,842.5
94-03 Totals	36.0	40,969.3	90,321.8	4,283.4	9,443.2	261.8	253,224.0	558,263.4	31,036.9	68,424.6

hm^3: Cubic Hectometers; kg: Kilograms; lbs: Pounds

Table 4.4 Lakes Lena and Banana Water Volume and Loadings for TN and TP from 1994 to 2003

	Lake Lena					Banana Lake				
Year	Water (hm^3)	TN (kg)	TN (lbs)	TP (kg)	TP (lbs)	Water (hm^3)	TN (kg)	TN (lbs)	TP (kg)	TP (lbs)
1994	3.1	4,862.6	10,720.3	380.5	838.8	11.8	19,178.6	42,281.6	1,846.3	4,070.4
1995	4.7	9,690.2	21,363.2	637.0	1,404.4	13.1	21,642.2	47,713.0	2,048.2	4,515.4
1996	1.9	1,550.2	3,417.7	229.3	505.4	9.0	13,498.4	29,759.0	1,459.6	3,217.9
1997	4.6	10,021.9	22,094.6	732.4	1,614.6	16.8	29,160.4	64,287.7	3,015.3	6,647.7
1998	5.6	9,849.3	21,714.1	794.6	1,751.8	14.4	17,896.8	39,455.8	2,342.6	5,164.6
1999	1.4	1,861.0	4,102.8	163.6	360.7	7.5	12,011.8	26,481.5	1,261.5	2,781.2

2000	1.1	2,326.6	5,129.2	126.9	279.8	5.8	12,030.6	26,522.8	1,003.4	2,212.1
2001	1.4	2,823.9	6,225.6	204.5	450.9	8.4	16,435.4	36,234.0	1,553.9	3,425.7
2002	2.8	3,903.2	8,605.1	374.8	826.3	15.5	25,754.7	56,779.4	2,566.8	5,658.7
2003	6.1	11,516.0	25,388.3	887.8	1,957.3	14.5	19,000.5	41,889.0	2,247.6	4,955.2
94-03 Mean	3.3	5,840.5	12,876.1	453.1	999.0	11.7	18,661.0	41,140.4	1,934.5	4,264.9
94-03 Totals	32.7	58,404.9	128,760.8	4,531.4	9,990.0	116.8	186,609.6	411,403.7	19,345.2	42,649.0

hm^3: Cubic Hectometers; kg: Kilograms; lbs: Pounds

Table 4.5 Lakes Hancock and Hollingsworth Water Volume and Loadings for TN and TP from 1994 to 2003

	Lake Hancock					Lake Hollingsworth				
Year	Water (hm^3)	TN (kg)	TN (lbs)	TP (kg)	TP (lbs)	Water (hm^3)	TN (kg)	TN (lbs)	TP (kg)	TP (lbs)
1994	84.3	95,809.9	211,224.8	12,901.6	28,443.2	4.9	12,135.9	26,755.1	560.5	1,235.6
1995	92.7	104,720.5	230,869.2	15,015.7	33,104.0	5.2	16,619.0	36,638.7	578.3	1,274.9
1996	67.0	70,727.9	155,928.3	11,013.8	24,281.4	3.9	3,107.1	6,850.0	438.6	966.9
1997	127.8	134,996.1	297,615.5	23,884.2	52,655.7	6.3	21,147.9	46,623.1	703.9	1,551.9
1998	108.4	109,122.0	240,572.9	19,501.5	42,993.5	5.2	14,557.2	32,093.2	525.4	1,158.4
1999	56.5	62,991.0	138,871.5	9,798.8	21,602.7	3.4	8,036.1	17,716.6	387.7	854.7
2000	45.9	59,478.1	131,126.9	8,443.0	18,613.5	2.6	9,500.9	20,946.0	290.4	640.2
2001	66.7	78,445.6	172,943.0	12,962.3	28,576.9	3.4	11,431.4	25,201.9	393.6	867.7
2002	115.5	116,668.0	257,208.9	19,492.5	42,973.6	6.1	13,817.9	30,463.3	685.9	1,512.2
2003	106.6	109,343.0	241,060.2	18,321.6	40,392.2	5.2	15,868.4	34,983.8	532.0	1,172.9
94-03 Mean	87.1	94,230.2	207,742.1	15,133.5	33,363.7	4.6	12,622.2	27,827.2	509.6	1,123.5
94-03 Totals	871.4	942,302.2	2,077,421.2	151,335.0	333,636.7	46.3	126,221.9	278,271.6	5,096.3	11,235.4

hm^3: Cubic Hectometers; kg: Kilograms; lbs: Pounds

Table 4.6 Lakes Bentley and Spirit Water Volume and Loadings for TN and TP from 1994 to 2003

	Lake Bentley					Spirit Lake				
Year	Water (hm^3)	TN (kg)	TN (lbs)	TP (kg)	TP (lbs)	Water (hm^3)	TN (kg)	TN (lbs)	TP (kg)	TP (lbs)
1994	1.3	4,284.4	9,445.5	152.1	335.3	1.5	4,763.4	10,501.5	159.7	352.1
1995	1.4	6,427.2	14,169.5	161.9	356.8	1.7	5,624.3	12,399.5	190.6	420.1
1996	1.0	766.5	1,689.9	122.6	270.4	1.5	3,569.4	7,869.2	151.5	334.0
1997	1.7	8,138.6	17,942.5	213.8	471.4	2.0	7,601.4	16,758.3	261.3	576.1
1998	1.5	5,158.4	11,372.2	159.9	352.6	1.8	5,268.1	11,614.1	240.6	530.3
1999	0.9	2,538.9	5,597.4	110.5	243.6	1.5	3,384.1	7,460.7	144.0	317.5

2000	0.7	3,372.4	7,434.9	85.7	188.9	1.4	3,087.4	6,806.6	120.6	265.9
2001	0.9	4,548.1	10,026.9	119.4	263.3	1.4	4,070.3	8,973.6	127.7	281.5
2002	1.6	4,396.0	9,691.4	191.7	422.7	2.0	7,608.7	16,774.2	265.3	585.0
2003	1.5	6,054.5	13,347.9	156.2	344.3	1.8	5,790.5	12,765.9	232.0	511.6
94-03 Mean	1.3	4,568.5	10,071.8	147.4	324.9	1.7	5,076.8	11,192.4	189.3	417.4
94-03 Totals	12.6	45,685.0	100,718.1	1,473.8	3,249.2	16.5	50,767.7	111,923.6	1,893.3	4,174.0

hm^3: Cubic Hectometers; kg: Kilograms; lbs: Pounds

Table 4.7 Eagle Lake Water Volume and Loadings for TN and TP from 1994 to 2003

Eagle Lake					
Year	**Water** (hm^3)	**TN** (kg)	**TN** (lbs)	**TP** (kg)	**TP** (lbs)
1994	5.7	21,801.6	48,064.3	624.6	1,377.1
1995	5.9	22,129.8	48,788.0	647.2	1,426.9
1996	4.6	15,462.0	34,087.9	560.3	1,235.2
1997	7.2	28,597.2	63,046.1	811.8	1,789.6
1998	5.9	19,421.4	42,816.8	649.4	1,431.8
1999	4.0	15,395.9	33,942.2	510.2	1,124.8
2000	3.5	17,420.4	38,405.5	489.6	1,079.5
2001	4.1	21,855.3	48,182.8	543.6	1,198.4
2002	7.1	25,974.2	57,263.3	753.4	1,661.0
2003	5.8	19,534.5	43,066.1	613.5	1,352.6
94-03 Mean	5.4	20,759.2	45,766.3	620.4	1,367.7
94-03 Totals	53.7	207,592.3	457,662.9	6,203.7	13,676.9

hm^3: Cubic Hectometers; kg: Kilograms; lbs: Pounds

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

Nutrient enrichment and the resulting problems related to eutrophication tend to be widespread and are frequently manifested far (in both time and space) from their source. Addressing eutrophication involves relating water quality and biological effects (such as photosynthesis, decomposition, and nutrient recycling), as acted upon by hydrodynamic factors (including flow, wind, tide, and salinity) to the timing and magnitude of constituent loads supplied from various categories of pollution sources. The assimilative capacity should be related to some specific hydro-meteorological condition such as an 'average' during a selected time span or to cover some range of expected variation in these conditions. Lake

Hancock was modeled as part of an eleven lake series over a ten year period of record (1994 – 2003). Additional lakes modeled include Gibson, Crago, Parker, Banana, Bentley, Lena, Hollingsworth, Spirit, and Eagle. Lakes Banana, Bonny, Hancock, Lena, and Parker are Group 3 waterbodies impaired for nutrients scheduled for TMDL development in 2005.

As discussed in Chapter 4, the WAM model was selected as the watershed model. It was run dynamically through the ten-year period of record with all the lakes linked together in their current configuration. BATHTUB was selected as the lake model. It was set up with all the lakes linked together and the model calibrated based on the annual average output from WAM and run year by year (1994 – 2003) for all eleven lakes.

5.1.1 Rainfall

The long-term average for the two rainfall gages used in the model [Bartow (COOP: 080478) and Lakeland (COOP: 084797 and COOP: 084802) National Weather Service stations] was 52.01 inches/year. The 10-year average rainfall for the study period (1994 – 2003) is 55.23 for Lakeland (60th percentile) and 51.2 inches at Bartow (71st percentile) (see **Table 5.1**). Therefore, the study period represented a wetter than average period containing a very dry year. The year 2000 was the driest year with 38.3 inches of rain recorded in Lakeland (10th percentile of the long-term record) and with 35.9 inches recorded at Bartow (~ the 1st percentile of the long-term record). For the year 2000, evaporation exceeded rainfall. This created a year with very high in-lake concentrations in both the current condition and natural land use background scenario.

Table 5.1 Bartow and Lakeland, Florida, Rainfall Stations Used for Model Loading and Calibration

Rainfall from Bartow and Lakeland		
Bartow	1900-2004 average = 53.7"	
Lakeland	1949-2004 average = 50.33"	
Year	**Lakeland**	**Bartow**
1994	67.13	60
1995	48.47	60.31
1996	52.85	46.1
1997	58.14	60.2
1998	54.41	62.33
1999	48.66	42.29
2000	38.26	35.87
2001	57.67	49.56
2002	66.58	71.44
2003	60.13	63.83
94-03 Average	55.23	55.19

Note: Lakeland stations missing data from September and October 1995.

5.1.2 Model Calibration

Watershed Assessment Model (WAM)

WAM was calibrated by consultants to conditions for the years 1994 – 2003. Calibration consisted of a water balance approach to match the measured in-lake stages and flows at flow measuring points. An Access database tool was created to aggregate the daily predictions for surface water and groundwater (flows and TN, TP concentrations) up to annual average conditions in a format compatible with the requirements of the BATHTUB model. For details on the WAM model see "WAM Watershed Assessment Model, Model Documentation and Users Manual", Soil and Water Engineering Technology, Inc., 2005 (**Appendix J**). For details on model calibration see Final Report, September, 2005 (**Appendix H**).

BATHTUB Model

The consultant provided the Department with copies of ten BATHTUB input decks (one for each year 1994 – 2003) set up for current conditions but not calibrated. The Department calibrated the BATHTUB model which consisted of running each model year through all of the model options in BATHTUB to determine which set of models provided the best un-calibrated fit to the measured data. As a result of running through these models it became apparent that for many of the lake/year combinations the watershed model was not delivering enough mass to match the measured data for either TN or TP. In other lake/year combinations there was too much mass. Once a set of models was selected the primary calibration for TN and TP was achieved by invoking BATHTUBs internal loading rate functions for both TN and TP to match the measured in-lake mass. This Internal Loading (IL) rate integrates all the missing mass. It is not proposed that the IL rate represents only those in-lake processes that either recycle mass within the lake or fix nitrogen from the atmosphere; it also includes all other missing mass. As such, it will be referred to as the 'missing mass.' Chlorophyll a was calibrated using the BATHTUB calibration coefficient. Each lake/year combination was calibrated individually, but once the chlorophyll a calibration was set, it remained unchanged for all other BATHTUB simulations (background and TMDL development)

The phosphorous model that best fit Lake Hancock was Model 1, Second-Order, Available P model. The nitrogen model selected was Model 1, the Second-Order, Available N model. The chlorophyll a model selected was Model 1, for P, N, Light and Flushing. Details regarding the selected models can be found in the BATHTUB Users Manual (U.S. Army Corps of Engineers, 1999; Walker, W.W., 2004). **Figures 5.1** – **5.4** illustrate the measured, un-calibrated, and calibrated data for TN, TP, Chlorophyll a, and TSI for the ten-year modeled period (1994 – 2003) for Lake Hancock.

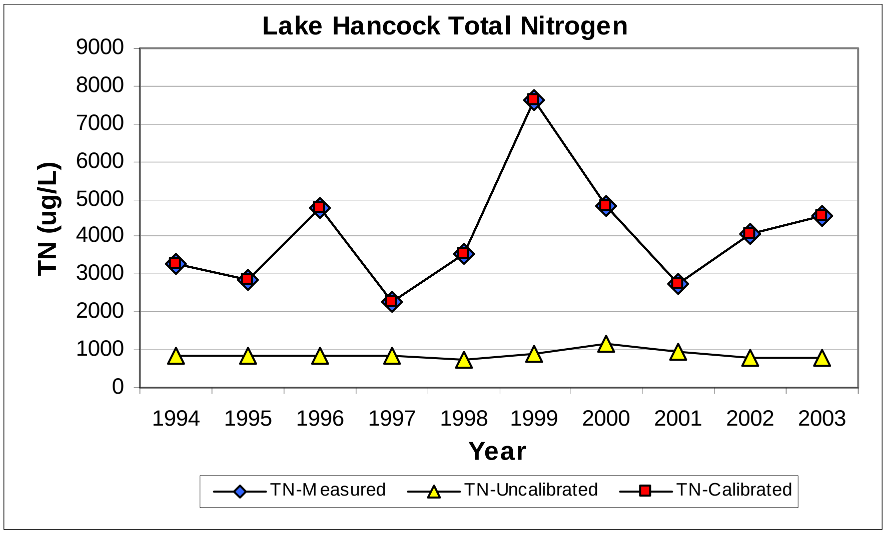


Figure 5.1 Lake Hancock Total Nitrogen Measured, Un-Calibrated, and Calibrated Data from 1994 to 2003

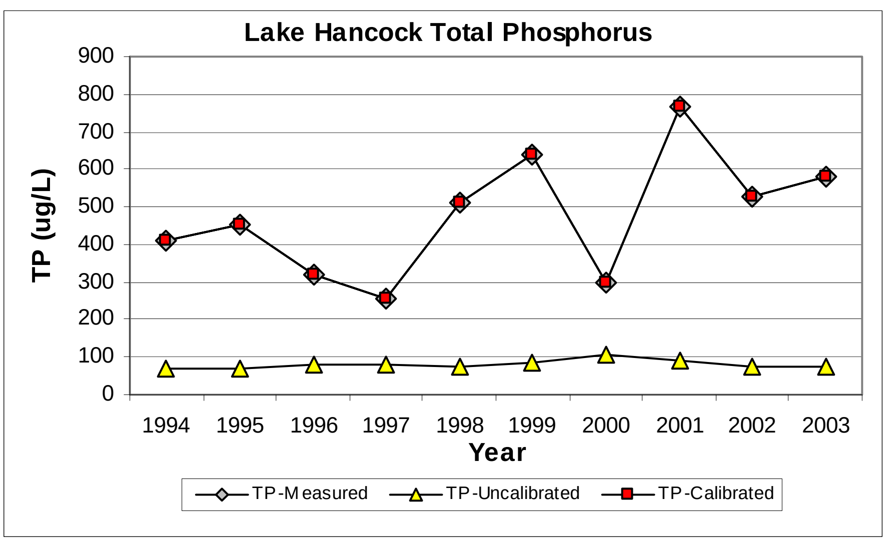


Figure 5.2 Lake Hancock Total Phosphorus Measured, Un-Calibrated, and Calibrated Data from 1994 to 2003

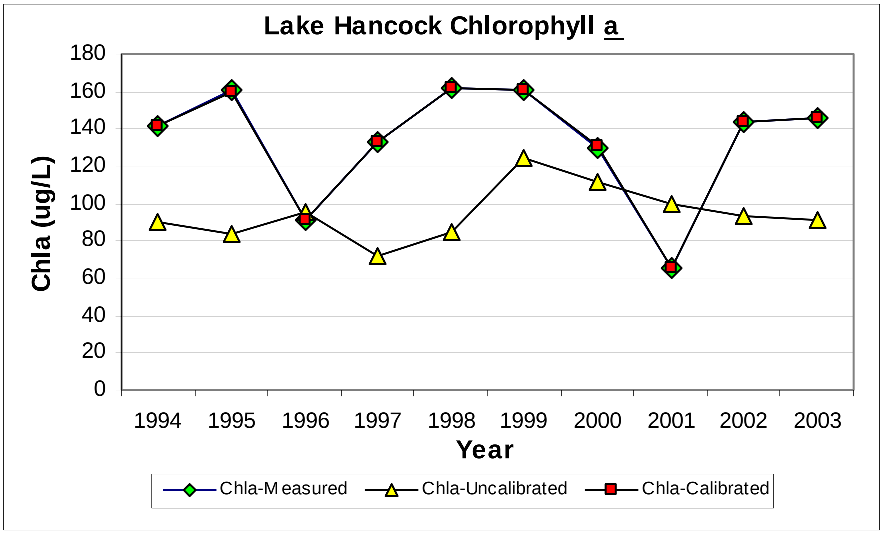


Figure 5.3 Lake Hancock Chlorophyll *a* Measured, Un-Calibrated, and Calibrated Data from 1994 to 2003

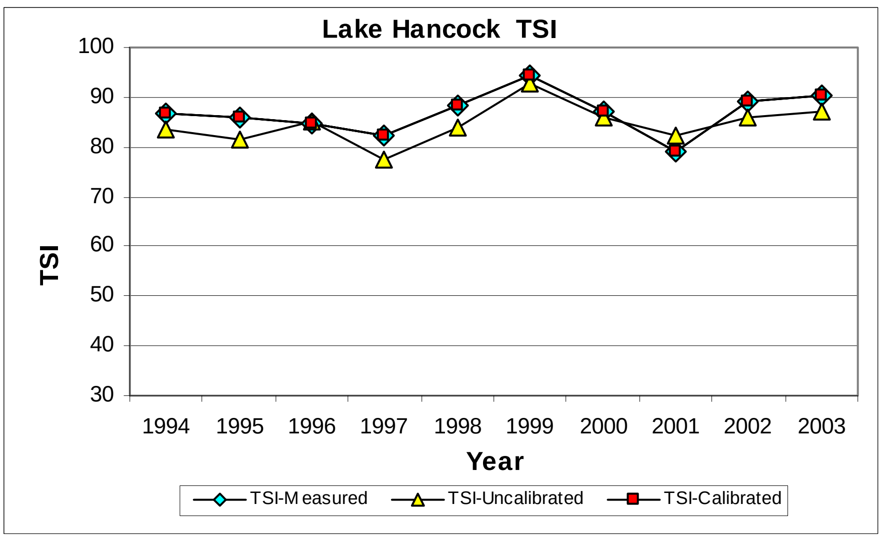


Figure 5.4 Lake Hancock TSI Measured, Un-Calibrated, and Calibrated Data from 1994 to 2003

5.1.3 Background Conditions

WAM Model

WAM was used to describe and evaluate the "natural land use background condition" for the entire Lake Hancock watershed, including Lower Saddle Creek. For this simulation all current land uses were 'reassigned' to a mixture of Herbaceous, Prairies, Other Shrubs and Brush, Upland Coniferous Forest, Pine Flatwoods, Upland Hardwoods Forest, Hardwood Conifer Mix (the majority), Lakes, Interconnected Lakes, Reservoirs, Mixed Wetland Hardwoods, Streams and Lakes Swamps (bottomlands), Wetland Coniferous Forest, Cypress, Wetland Forested Mix, Freshwater Marshes, Wet Prairies, Emergent Aquatic Vegetation, Inland Shores and Ephemeral Ponds. The current condition was maintained for all waterbody physical characteristics. From this point forward, the natural land use background will be referred to as "background."

At first, the WAM was run with current rates of seepage around waterbodies and leakance from inside waterbodies. This resulted in such a large reduction in the total water flowing into the lakes that even with the significant reduction in external watershed loading, several lake/year combinations had higher concentrations of TN, TP, and chlorophyll a than under current conditions as the evaporation of 1.32 m nearly exceeded inflow and the lakes dried up. To account for this water loss in the background condition, seepage around the lakes was adjusted back to background conditions in the model and leakance was adjusted down (50 percent of current rate) until the lake stages and surface areas approximated current conditions. Even under this scenario the total water inflowing to the lakes under the background scenario was less than current conditions, particularly in the drier years (1996 and 2000). Again this resulted in concentrations for some lake/year combinations being as great as they are under current conditions. In other words, the watershed model is indicating that under 'natural land use' dry conditions the lakes would have a trophic state similar to that of today. Conversely, under average or wet conditions the natural land use trophic states were significantly less than current conditions.

BATHTUB Model

After achieving acceptable WAM background results, the BATHTUB model was run with no reduction in the total amount of missing mass (internal loading rate). As expected with the reduction in total flow for the background condition and with no attenuation of the missing mass, many of the lake/year combinations did not improve. In fact, for the dry years the background condition was still worst than the current condition. In an effort to find the natural background, reductions in the missing mass were made. First, the BATHTUB model was used to identify the total external load of TN and TP under both the current condition and the background condition. Then the ratio of the change in external load between the background condition and the current condition (background/current) was applied to the missing mass (internal loading rate). This was called the attenuated case (A). This brought the in-lake trophic states down in the average and wet years, but many of the dry year lake trophic states remained higher in the background condition than in the current condition. As a result, the remaining missing mass was reduced until the worst case dry year trophic state was below the current conditions. This required an additional 75 percent reduction in the missing mass remaining after attenuation.

Understanding abbreviations

L 100 = leakance at current conditions (calibrated model)
L50 = leakance reduced from current conditions by 50 percent
L0 = leakance reduced to near zero (0.01 m)
PC = results from calibrated BATHTUB model
IL = missing mass (used internal loading rate to achieve mass balance in model calibration)
ILA = missing mass changed by the ratio of the change in external mass of background/current condition.
IL50 = ILA plus an additional 50 percent reduction in missing mass
IL75 = ILA plus an additional 75 percent reduction in missing mass
ILNIL = all missing mass eliminated (loading rate = 0.0)
M = Measured data

5.2 Selection of the TMDL Threshold

It should be recognized that the direct application of natural background as the target TSI would not allow for any assimilative capacity. The IWR uses as one measure of impairment in lakes, a 10 unit change in TSI from "historical" levels. This 10 unit increase is assumed to represent the transition of a lake from one trophic state (say mesotrophic) to another nutrient enriched condition (eutrophic). The Department has assumed that allowing a 5 unit increase in TSI over the natural background condition would prevent a lake from becoming impaired (changing trophic states) and reserve 5 TSI units to allow for future changes in the basin and as part of the implicit margin of safety in establishing the assimilative capacity.

After examining the background runs for Lake Hancock, it was decided that the scenario with leakance set at 50 percent of the current condition and the attenuated missing mass reduced by an additional 75 percent represented the natural land use background condition. As has been Department practice, when acceptable background conditions can be established the target for TMDL development becomes the background TSI plus 5 TSI units. This raises the target TSI for Lake Hancock to 74.4 (69.4 + 5 TSI units).

In order to complete the TMDL for Lake Hancock and Lower Saddle Creek, load reductions had to be proposed for the ten upstream lakes contributing to Lake Hancock. Based on achieving the TMDL targets for each year of the ten year period of record, a long-term annual average TMDL for TSI was set at 74.3. The 0.1 TSI difference between the target and the established TMDL may be considered as additional margin of safety (MOS). The range in TSI TMDL targets was between 66.2 and 83.1.

Water quality in Lower Saddle Creek is directly influenced by the water quality in Lake Hancock. As a result of this direct influence, the chlorophyll a target for the creek is 82.4 μg/L **(Table 5.4)**, which is the annual average chlorophyll a of the lake needed to meet the TSI target for the TMDL.

The required annual average percent reduction for TN coming into Lake Hancock was 75.2 percent with an allowable long-term annual average loading of 318,497.6 kg/year (702,167.1 lbs/year). The required annual average percent reduction for TP coming into the lake was 75.5 with an allowable long-term annual average loading of 101,749.6 kg/year (224,319.5 lbs/year).

The annual percent reductions ranged between 64.3 and 81.6 for TN and between 64.9 and 81.6 for TP. These reductions correspond to a range in loadings of 134,421.9 kg/year (296,349.6 lbs/year) to 476,505.4 kg/year (105,0514.8 lbs/year) for TN and between 14,430.8 kg/year (31,814.5 lbs/year) to 166,848.9 kg/year (367,838.9 lbs/year) for TP. Maintaining the long-term annual average loadings for TN and TP established in this TMDL should result in attaining the target long-term annual average TSI of 74.3 (the model TMDL target is 74.4).

Table 5.2 shows the TSI for the calibrated model (PC), the background model (IL75), the TMDL Target TSI, TMDL-TSI, and the percent reduction for Lake Hancock. The TSI for the calibrated model (PC), the background model (IL75), the TMDL Target TSI, TMDL-TSI, and the percent reduction for the ten lakes modeled for the Lake Hancock Basin are displayed in **Appendix C**.

Table 5.3 shows the mass for TN and TP for the calibrated model, TMDL, and percent reductions for Lake Hancock. The mass for TN and TP for the ten lakes modeled for the Lake Hancock Basin are displayed in **Appendix D**.

Table 5.4 shows the annual average concentrations for TN, TP, and chlorophyll a for Lake Hancock. Annual average concentrations for the ten lakes modeled for the Lake Hancock Basin are displayed in **Appendix E**.

Figures 5.5 – **5.8** show the TMDL target, calibrated data, and L50-IL75 for TN, TP, Chlorophyll a, and TSI for the ten-year modeled period (1994 – 2003) for Lake Hancock.

Table 5.2 Lake Hancock TSI for PC, Background, TMDL Target, and TSI-Unit Percent Reduction

Lake Hancock TSI for Measured, PC, Background, TMDL Target, TMDL, and TSI-unit Percent Reduction Based on Background L50-IL75							
Year	Color (PCU)	Measured	Calibrated	Background IL75	Target IL75+5	TMDL	Percent Reduction
1994	72.5	86.7	86.7	72.4	77.4	77.4	66.6
1995	87.5	86.0	86.0	68.1	73.1	73.1	75.0
1996	66.7	84.8	84.8	69.7	74.7	74.7	74.6
1997	53.3	82.2	82.2	61.9	66.9	66.7	75.0
1998	73.3	88.4	88.3	68.9	73.9	73.8	80.5
1999	240.0	94.4	94.5	78.1	83.1	83.1	82.0
2000		87.1	87.2	71.0	76.0	76.0	76.2
2001		79.2	79.2	61.2	66.2	66.2	74.0
2002	108.3	89.0	89.0	70.5	75.5	75.3	79.5
2003	100.3	90.4	90.4	72.1	77.1	77.1	80.6
Minimum	53.3	79.2	79.2	61.2	66.2	66.2	66.6
Maximum	240.0	94.4	94.5	78.1	83.1	83.1	82.0
Mean	100.2	86.8	86.8	69.4	74.4	74.3	76.4

Table 5.3 Lake Hancock Mass for TN and TP for Calibrated Model, TMDL, and Percent Reduction

Lake Hancock Mass for TN and TP for Calibrated Model and TMDL, with Mass Percent Reductions (kg/year)						
Year	TN-MASS Calibrated	TN-MASS TMDL	TN-MASS % Reduction	TP-MASS Calibrated	TP-MASS TMDL	TP-MASS % Reduction
1994	1,020,579.1	363,921.6	64.3	323,799.6	113,600.8	64.9
1995	905,831.2	242,404.3	73.2	445,186.1	116,198.5	73.9
1996	1,454,898.7	383,852.0	73.6	147,439.7	39,513.2	73.2
1997	791,641.4	206,396.3	73.9	195,723.7	50,881.9	74.0
1998	1,510,080.9	307,309.1	79.6	663,968.6	133,367.0	79.9
1999	2,575,794.6	475,038.2	81.6	390,675.9	71,704.5	81.6
2000	698,685.9	171,653.8	75.4	55,875.5	14,430.8	74.2
2001	479,896.6	134,421.9	72.0	637,466.0	166,848.9	73.8
2002	1,948,595.8	423,473.2	78.3	699,984.0	146,013.7	79.1
2003	2,358,247.0	476,505.4	79.8	839,590.6	164,936.8	80.4
Minimum	479,896.6	134,421.9	64.3	55,875.5	14,430.8	64.9
Maximum	2,575,794.6	476,505.4	81.6	839,590.6	166,848.9	81.6
Mean	1,374,425.1	318,497.6	75.2	439,971.0	101,749.6	75.5

Table 5.4 Lake Hancock Annual Average Concentrations for TN, TP, and Chlorophyll *a*

Lake Hancock Annual Average Concentrations for TN, TP, and Chlorophyll *a* (µg/L)												
Year	Measured TN	Calibrated TN	TMDL TN	Background TN	Measured TP	Calibrated TP	TMDL TP	Background TP	Measured Chl *a*	Calibrated Chl *a*	TMDL Chl *a*	Background Chl *a*
1994	3,290.5	3,290.7	1,748.3	1,479.3	411.5	412.0	233.8	107.5	141.6	141.8	100.3	73.6
1995	2,845.5	2,845.7	1,229.9	963.4	453.5	452.7	219.2	114.2	160.4	159.4	93.1	67.6
1996	4,742.3	4,741.4	2,190.3	1,678.6	320.3	319.8	154.8	103.8	91.0	91.1	61.0	47.2
1997	2,257.8	2,257.2	888.7	684.7	256.7	256.1	117.2	62.7	133.1	133.3	62.8	40.8
1998	3,521.0	3,521.7	1,306.8	1,025.4	511.0	511.1	215.7	117.8	162.2	161.6	93.5	68.4
1999	7,644.5	7,643.9	2,975.7	2,212.3	637.0	636.9	258.9	172.2	160.2	160.4	113.9	90.4
2000	4,840.0	4,839.4	2,139.1	1,570.9	297.5	297.1	139.1	102.5	130.2	130.5	79.4	59.4
2001	2,760.0	2,760.0	1,225.4	938.9	767.0	767.7	379.3	211.0	65.7	64.9	36.2	26.8
2002	4,050.5	4,050.9	1,561.9	1,211.4	525.7	524.7	224.5	131.4	143.6	143.2	88.3	66.2
2003	4,573.6	4,573.8	1,754.1	1,340.7	581.6	581.3	244.0	138.8	145.5	145.6	95.6	71.7
Minimum	2,257.8	2,257.2	888.7	684.7	256.7	256.1	117.2	62.7	65.7	64.9	36.2	26.8
Maximum	7,644.5	7,643.9	2,975.7	2,212.3	767.0	767.7	379.3	211.0	162.2	161.6	113.9	90.4
Mean	4,052.6	4,052.5	1,702.0	1,310.6	476.2	475.9	218.7	126.2	133.4	133.2	82.4	61.2

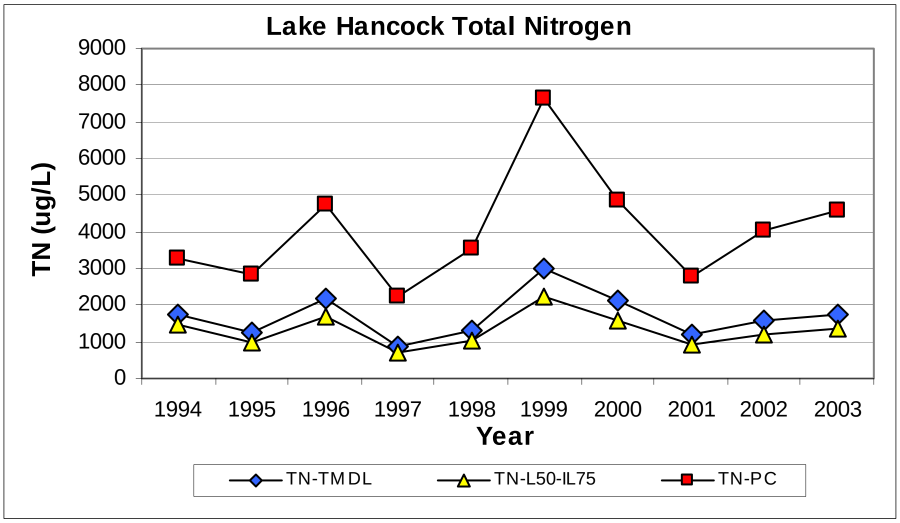


Figure 5.5 **Lake Hancock Total Nitrogen Target TMDL, L50-IL75, and Background Calibration from 1994 to 2003**

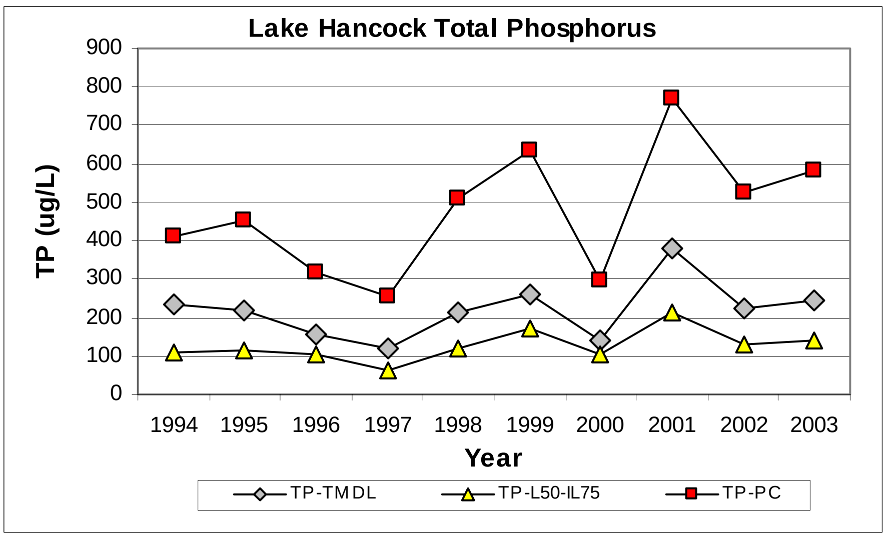


Figure 5.6 **Lake Hancock Total Phosphorus Target TMDL, L50-IL75, and Background Calibration from 1994 to 2003**

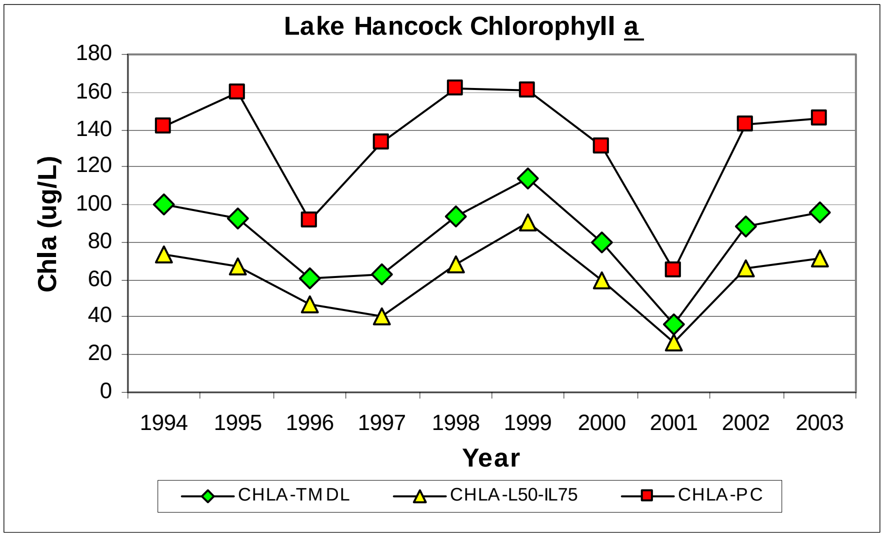


Figure 5.7 **Lake Hancock Chlorophyll *a* Target TMDL, L50-IL75, and Background Calibration from 1994 to 2003**

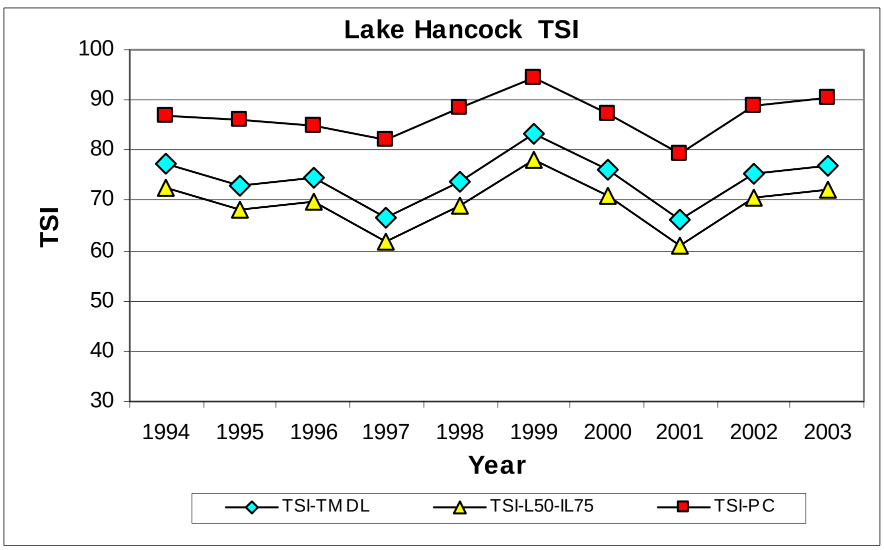


Figure 5.8 **Lake Hancock TSI Target TMDL, L50-IL75, and Background Calibration from 1994 to 2003**

5.3 Critical Conditions

To evaluate nutrient impairment in a lake, a reference condition is needed. For lakes in Florida, the reference condition is represented by the TSI. Lake Hancock was included on the list of impaired waters because at least one annual mean TSI (in the year 2003) exceeded the IWR threshold during the verified period. The estimated assimilative capacity was based on annual average conditions (i.e., values from all four seasons in a calendar year) rather than critical/seasonal conditions because (a) the methodology used to determine the assimilative capacity does not lend itself very well to short-term assessments, (b) the Department is generally more concerned with the net change in overall primary productivity in the segment, which is better addressed on an annual basis, and (c) the methodology used to determine impairment is based on an annual average and requires data from all four quarters of a calendar year.

5.4 Wasteload Allocation

There are two NPDES facilities that discharge into Lake Lena Run, a tributary to Lake Hancock. The City of Auburndale Allred WWTF (FL0021466-004-DW1P/RA) operates a 1.4 MGD annual average daily flow (AADF) that must provide advanced secondary treatment for any discharge into Lake Lena Run. The facility is permitted to discharge 0.65 mgd on a monthly average basis to Lake Lena Run. The facility has a permit limit for total nitrogen of 6.0 mg/L as a monthly average and a report only limit for total phosphorus.

The second facility is Florida Distillers Company-Auburndale, (FL0003051-003-IWB). The facility is permitted to discharge up to 0.5 mgd (monthly average) to Lake Lena Run through outfall D002. They have a daily maximum total nitrogen limit of 4.4 mg/L and a report only limit for total phosphorus.

Several different scenarios were examined to evaluate the contribution of the two facilities to the flow and loadings coming into Lake Hancock. The first scenario was for the current condition used for calibration. This case is referred to as Point Sources Predicted Calibration (PSPC). The flows and concentrations used were based on the monthly average data contained in the EPA NPDES database referred to as the Permit Compliance System (PCS). This set of information was used to calibrate the WAM model and is the base case against which the other two scenarios will be evaluated. The second case was for the two facilities at their respective permit limits for flows and concentrations. This set of data was provided by staff from EPA Region IV. This case is referred to as Point Sources Maximum (PSMAX). The last scenario was with both point sources completely removed. This case is referred to as No Point Sources (NoPS).

Table 5.5 contains the flow in cubic hectometers per year (CHMY) for each source. Sources include tributary inflow and advective inflow. The tributary inflow is generated within the WAM model and the advective terms are generated within the BATHTUB model. The advective terms reflect the net discharge from one BATHTUB segment into another and are derived from water-balance calculations. The water balances in BATHTUB are expressed as a system of simultaneous linear equations that are solved via matrix inversion to estimate the advective out-flow from each model segment. The advective inflow to Lake Hancock represents the sum of all the advective outflows from the upstream lakes.

Table 5.5 Flow in Cubic Hectometers Per Year for Each Source

Year	PSPC TRIB-Flow (hm3/yr)	PSPC ADV-Flow (hm3/yr)	PSPC TOT-Flow (hm3/yr)	PSMAX TRIB-Flow (hm3/yr)	PSMAX ADV-Flow (hm3/yr)	PSMAX TOT-Flow (hm3/yr)	NoPS TRIB-Flow (hm3/yr)	NoPS ADV-Flow (hm3/yr)	NoPS TOT-Flow (hm3/yr)
1994	84.3192	30.9393	115.2585	83.6379	30.9393	114.5772	82.0881	30.9393	113.0274
1995	92.7466	34.9953	127.7419	92.5607	34.9954	127.5561	91.0104	34.9954	126.0058
1996	66.9599	17.9993	84.9593	67.3612	17.9994	85.3606	65.818	17.9994	83.8174
1997	127.8228	50.2292	178.0521	127.8971	50.2293	178.1264	126.3497	50.2293	176.5791
1998	108.4174	35.7243	144.1416	108.556	35.7243	144.2803	107.0008	35.7242	142.725
1999	56.474	12.4693	68.9433	56.8721	12.4693	69.3413	55.3333	12.4693	67.8026
2000	45.8525	5.5804	51.4329	46.377	5.5804	51.9573	44.8298	5.5804	50.4102
2001	66.6592	13.9542	80.6135	67.2088	13.9542	81.163	65.6655	13.9542	79.6197
2002	115.5383	46.7394	162.2776	115.8947	46.7394	162.634	114.3425	46.7395	161.0819
2003	106.6242	36.4613	143.0855	106.8131	36.4613	143.2744	105.2606	36.4613	141.7219
Minimum	45.8525	5.5804	51.4329	46.377	5.5804	51.9573	44.8298	5.5804	50.4102
Maximum	127.8228	50.2292	178.0521	127.8971	50.2293	178.1264	126.3497	50.2293	176.5791
Mean	87.1414	28.5092	115.6506	87.3178	28.5092	115.8271	85.7699	28.5092	114.2791

Point Sources at Current Conditions (PSPC)
Point Sources at Permit Limits (PSMAX)
No Point Sources (NoPS)

Table 5.6 contains the difference between the calibrated model total flows into the lake and the PSMAX and NoPS scenarios. From the Table it can be seen that on average, the current condition has slightly less overall flow than with the two facilities operating at the monthly average flows specified in the permits. At the permitted monthly average flow, the annual average inflow to the lake increased by only 0.25 percent over the current condition. The elimination of both facilities would reduce the annual average flow into the lake by 1.30 percent (1.37 CHMY).

Table 5.6 Difference between PSPC and PSMAX and PSPC and NoPS Flow (hm3/yr)

Year	PSPC-PSMAX Flow Total (hm3/yr)	PSPC-NoPS Flow Total (hm3/yr)	PSPC-PSMAX Flow Total (hm3/yr)	PSPC-NoPS Flow Total (hm3/yr)
			%change	%change
1994	0.68	2.23	0.59	1.94
1995	0.19	1.74	0.15	1.36
1996	-0.4	1.14	-0.47	1.34
1997	-0.07	1.47	-0.04	0.83
1998	-0.14	1.42	-0.1	0.98
1999	-0.4	1.14	-0.58	1.65
2000	-0.52	1.02	-1.02	1.99
2001	-0.55	0.99	-0.68	1.23
2002	-0.36	1.2	-0.22	0.74
2003	-0.19	1.36	-0.13	0.95
Minimum	-0.55	0.99	-1.02	0.74
Maximum	0.68	2.23	0.59	1.99
Mean	-0.18	1.37	-0.25	1.3

Table 5.7 contains the results for TP for each of the scenarios described for flow. The various sources of TP include tributary inflow, advective inflow, and internal loading. The mass attributed to internal loading is described in the section on model calibration. Recall, it is not just mass from internal recycling, but is actually the sum of all the TP mass not otherwise accounted for in the mass balance, (i.e. the missing TP mass).

Table 5.7 Total Phosphorus Mass (kg/year)

Year	PSPC TP-TRIB	PSPC TP-ADV	PSPC TP-IL	PSPC TP-TOT	PSMAX TP-TRIB	PSMAX TP-ADV	PSMAX TP-IL	PSMAX TP-TOT	NoPS TP-TRIB	NoPS TP-ADV	NoPS TP-IL	NoPS TP-TOT
1994	12,901.6	13,017.8	298,084.1	324,003.6	12,845.1	13,017.8	297,866.9	323,729.8	12,513.5	13,017.8	297,455.4	322,986.7
1995	15,015.7	14,260.5	416,194.8	445,471.0	15,053.8	14,260.5	416,129.9	445,444.2	14,722.0	14,260.5	415,842.7	444,825.1
1996	11,013.8	7,923.4	128,590.5	147,527.8	11,191.6	7,923.5	128,610.0	147,725.1	10,860.9	7,923.5	128,534.8	147,319.2
1997	23,884.2	19,930.5	152,013.0	195,827.7	23,928.7	19,930.5	152,044.3	195,903.5	23,596.7	19,930.5	151,819.6	195,346.8
1998	19,501.5	20,041.7	624,853.1	664,396.3	19,546.7	20,041.7	624,877.3	664,465.8	19,215.2	20,041.7	624,631.9	663,888.8
1999	9,798.8	6,161.3	374,972.4	390,932.5	9,883.8	6,161.3	375,111.8	391,156.9	9,553.9	6,161.3	374,571.6	390,286.8
2000	8,443.0	5,335.3	42,126.1	55,904.3	8,543.6	5,335.3	42,150.5	56,029.3	8,211.5	5,335.3	42,061.2	55,608.0
2001	12,962.3	9,387.4	615,537.7	637,887.4	13,084.5	9,387.4	616,012.3	638,484.2	12,753.5	9,387.4	614,734.9	636,875.8
2002	19,492.5	19,122.8	661,821.8	700,437.0	19,579.5	19,122.8	662,076.4	700,778.7	19,247.8	19,122.8	661,432.9	699,803.4
2003	18,321.6	11,908.5	809,914.9	840,145.0	18,350.1	11,908.5	809,967.5	840,226.1	18,019.2	11,908.5	809,608.1	839,535.9
Minimum	8,443.0	5,335.3	42,126.1	55,904.3	8,543.6	5,335.3	42,150.5	56,029.3	8,211.5	5,335.3	42,061.2	55,608.0
Maximum	23,884.2	20,041.7	809,914.9	840,145.0	23,928.7	20,041.7	809,967.5	840,226.1	23,596.7	20,041.7	809,608.1	839,535.9
Mean	15,133.5	12,708.9	412,410.8	440,253.2	15,200.7	12,708.9	412,484.7	440,394.4	14,869.4	12,708.9	412,069.3	439,647.6

Point Sources at Current Conditions (PSPC)
Point Sources at Permit Limits (PSMAX)
No Point Sources (NoPS)

Table 5.8 contains the differences between the calibrated model total TP mass (kg/y) input into the Lake and both the PSMAX and NoPS scenarios. From the Table it can be seen that on average, the current condition has slightly less overall TP mass than with the two facilities operating at the monthly average concentrations derived from the PCS data. At the permitted monthly average flow, the annual average TP mass inflowing to the Lake increased by only 0.05 percent (141.1 kg/y). The elimination of both facilities would reduce the annual average TP mass into the Lake by 0.19 percent (605.6 kg/y).

Table 5.8 Total Phosphorus Mass (kg/year) Difference between PSPC and PSMAX and PSPC and NoPS

Year	PSPC-PSMAX Difference in TP as kg/year	PSPC-NoPS Difference in TP as kg/year	PSPC-PSMAX Difference in TP as percent	PSPC-NoPS Difference in TP as percent
1994	273.7	1016.8	0.08	0.31
1995	26.8	645.8	0.01	0.14
1996	-197.3	208.6	-0.13	0.14
1997	-75.8	480.9	-0.04	0.25
1998	-69.5	507.5	-0.01	0.08
1999	-224.4	645.7	-0.06	0.17
2000	-125	296.4	-0.22	0.53
2001	-596.8	1011.6	-0.09	0.16
2002	-341.7	633.6	-0.05	0.09
2003	-81.1	609.1	-0.01	0.07
Minimum	-596.8	208.6	-0.22	0.07
Maximum	273.7	1016.8	0.08	0.53
Average	-141.1	605.6	-0.05	0.19

Table 5.9 contains the results for TN for each of the scenarios described for flow. The various sources of TN include tributary inflow, advective inflow, and internal loading. The mass attributed to internal loading is described in the section on model calibration. Recall, it is not just mass from internal recycling, but is actually the sum of all the TN mass not otherwise accounted for in the mass balance, (i.e. the missing TN mass).

Table 5.9 Total Nitrogen Mass (kg/year)

Year	PSPC TN-TRIB	PSPC TN-ADV	PSPC TN-IL	PSPC TN-TOT	PSMAX TN-TRIB	PSMAX TN-ADV	PSMAX TN-IL	PSMAX TN-TOT	NoPS TN-TRIB	NoPS TN-ADV	NoPS TN-IL	NoPS TN-TOT
1994	95,809.9	75,027.0	850,324.1	1,021,161.0	99,941.4	75,026.9	849,704.5	1,024,672.9	90,738.9	75,026.9	848,530.6	1,014,296.3
1995	104,720.5	61,645.1	739,972.1	906,337.7	108,193.2	61,645.1	739,856.8	909,695.1	98,999.9	61,645.1	739,346.2	899,991.3
1996	70,727.9	39,596.6	1,345,495.3	1,455,819.8	77,139.8	39,596.6	1,345,699.8	1,462,436.3	68,159.9	39,596.7	1,344,913.1	1,452,669.8
1997	134,996.1	122,453.1	534,558.1	792,007.3	141,163.9	122,453.2	534,668.1	798,285.3	132,002.4	122,453.3	533,878.1	788,333.7
1998	109,122.0	83,581.5	1,318,279.8	1,510,983.3	114,354.6	83,581.5	1,318,330.9	1,516,267.0	105,156.2	83,581.4	1,317,813.1	1,506,550.8
1999	62,991.0	39,803.0	2,474,694.5	2,577,488.5	70,235.5	39,802.9	2,475,614.5	2,585,653.0	61,372.4	39,803.0	2,472,049.0	2,573,224.3
2000	59,478.1	24,454.2	615,174.7	699,107.0	66,778.6	24,454.1	615,530.6	706,763.3	58,011.6	24,454.2	614,226.9	696,692.7
2001	78,445.6	64,208.1	337,473.9	480,127.6	85,764.2	64,208.0	337,734.1	487,706.3	76,920.5	64,207.9	337,033.8	478,162.1
2002	116,668.0	162,759.0	1,670,312.0	1,949,739.0	123,696.4	162,759.0	1,670,954.9	1,957,410.3	114,567.2	162,759.3	1,669,330.6	1,946,657.1
2003	109,343.0	88,903.1	2,161,480.5	2,359,726.5	114,456.2	88,903.0	2,161,620.8	2,364,980.0	105,257.8	88,903.0	2,160,661.8	2,354,822.5
Minimum	59,478.1	24,454.2	337,473.9	480,127.6	66,778.6	24,454.1	337,734.1	487,706.3	58,011.6	24,454.2	337,033.8	478,162.1
Maximum	134,996.1	162,759.0	2,474,694.5	2,577,488.5	141,163.9	162,759.0	2,475,614.5	2,585,653.0	132,002.4	162,759.3	2,472,049.0	2,573,224.3
Average	94,230.2	76,243.1	1,204,776.5	1,375,249.8	100,172.4	76,243.0	1,204,971.5	1,381,386.9	91,118.7	76,243.1	1,203,778.3	1,371,140.0

Point Sources at Current Conditions (PSPC)
Point Sources at Permit Limits (PSMAX)
No Point Sources (NoPS)

Table 5.10 contains the differences between the calibrated model total TN mass (kg/y) input into the Lake and both the PSMAX and NoPS scenarios. From the Table, it can be seen that on average, the current condition has slightly less overall TN mass than with the two facilities operating at the monthly average concentrations derived from the PCS data. At the permitted monthly average flow, the annual average TN mass inflowing to the Lake increased by only 0.59 percent (6137.2 kg/y). The elimination of both facilities would reduce the annual average TN mass into the lake by 0.36 percent (4109.7 kg/y).

Table 5.10 Total Nitrogen Mass (kg/year) Difference between PSPC and PSMAX and PSPC and NoPS

Year	**PSPC-PSMAX** Difference in TN as kg/year	**PSPC-NoPS** Difference in TN as kg/year	**PSPC-PSMAX** Difference in TN as percent	**PSPC-NoPS** Difference in TN as percent
1994	-3511.9	6864.7	-0.34	0.67
1995	-3357.4	6346.4	-0.37	0.7
1996	-6616.5	3150	-0.45	0.22
1997	-6278	3673.6	-0.79	0.46
1998	-5283.8	4432.5	-0.35	0.29
1999	-8164.5	4264.3	-0.32	0.17
2000	-7656.3	2414.3	-1.1	0.35
2001	-7578.7	1965.5	-1.58	0.41
2002	-7671.3	3081.9	-0.39	0.16
2003	-5253.5	4904	-0.22	0.21
Minimum	-8164.5	1965.5	-1.58	0.16
Maximum	-3357.4	6864.7	-0.22	0.7
Average	-6137.2	4109.7	-0.59	0.36

To summarize, the annual average difference between operating the facilities at current conditions and at their respective permit limits was a 0.25 percent increase in total flow coming into the lake in combination with a 0.05 percent increase in TP mass and a 0.59 percent increase in TN mass. The annual average difference between the current condition and elimination of the two facilities was a 1.3 percent reduction in total flow coming into the lake in combination with a 0.19 percent reduction in TP mass and a 0.36 percent reduction in TN mass. Preliminary modeling with Bathtub indicates that the reduction in flow resulting from elimination of the two facilities had an adverse effect on the Lake that more than countered the impact of the mass reductions. At this time, our preliminary results indicate that the annual average TSI of the Lake would increase by 0.2 TSI units if the two facilities were eliminated. Therefore, it is the recommendation of the DEP, that at this time the two NPDES facilities be permitted such that there are no increases in TP or TN loadings to the lake.

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

A TMDL can be expressed as the sum of all point source loads (wasteload allocations or WLAs), nonpoint source loads (load allocations or LAs), and an appropriate margin of safety (MOS) that takes into account any uncertainty about the relationship between effluent limitations and water quality:

As mentioned previously, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

$$\textbf{TMDL} \cong \sum \textbf{WLAs}_{\textbf{wastewater}} + \sum \textbf{WLAs}_{\textbf{NPDES Stormwater}} + \sum \textbf{LAs} + \textbf{MOS}$$

It should be noted that the various components of the TMDL equation may not sum up to the value of the TMDL because a) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is accounted for within the LA, and b) TMDL components can be expressed in different terms [for example, the WLA for stormwater is typically expressed as a percent reduction and the WLA for wastewater is typically expressed as a mass per day].

WLAs for stormwater discharges are typically expressed as "percent reduction" because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges is also different than the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored and treated, they are not subject to the same types of effluent limitations as wastewater facilities, and instead are required to meet a performance standard of providing treatment to the "maximum extent practical" through the implementation of Best Management Practices.

This approach is consistent with federal regulations [40 CFR § 130.2(I)], which state that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or **other appropriate measure**. The TMDL for Lake Hancock is expressed in terms of pounds (lbs) per year (converted from kilograms per year as shown in Chapter 5) and percent reductions, and represent the maximum annual average load of TN and TP Lake Hancock can assimilate and maintain the Class III narrative nutrient criterion (see **Table 6.1**).

Table 6.1 Lake Hancock and Lower Saddle Creek TMDL Load Allocations

WBID	Parameter	WLA		LA (lbs/year)	MOS	TMDL (lbs/year)	Percent Reduction
		Wastewater (lbs/year)	Stormwater (% reduction)				
1623L, 1623K	TN	(*1)	75.2	702,167.1	Implicit	702,167.1	75.2
1623L, 1623K	TP	(*1)	75.5	224,319.5	Implicit	224,319.5	75.5

(*1) Note: permits for the two facilities should be modified to include monthly average limits for flow, TN, and TP used in the scenario PSMAX.

6.2 Load Allocation (LA)

The required long-term annual average allowable LA is 702,167.1lbs/year for TN and 224,319.5lbs/year for TP. This corresponds to reductions from the existing loadings of 75.2 percent for TN and 75.5 percent for TP. Maintaining the long-term annual average loadings for TP and TN established as this TMDL should result in attaining the target lake annual average TSI of 74.4 and the creek annual average chlorophyll *a* target of 82.4 μg/L. It should be noted that the LA may include loading from stormwater discharges regulated by the Department and the Water Management District that are not part of the NPDES Stormwater Program **(see Appendix A).**

6.3 Wasteload Allocation (WLA)

NPDES Wastewater Discharges

As noted in Chapter 4, Section 4.2.1, there are two active National Pollutant Discharge Elimination System (NPDES) permitted facilities located within the Lake Lena Run/Creek watershed. Lake Lena Run is a part of the Lake Lena and Lake Lena Run Subbasin modeled for the Lake Hancock Basin. Based on the results discussed in Section 5.4, the annual average difference between operating the facilities at current conditions and at their respective permit limits was a 0.25 percent increase in total flow coming into the Lake in combination with a 0.05 percent increase in TP mass and a 0.59 percent increase in TN mass. The annual average difference between the current condition and elimination of the two facilities was a 1.3 percent reduction in total flow coming into the Lake in combination with a 0.19 percent reduction in TP mass and a 0.36 percent reduction in TN mass. Preliminary modeling with Bathtub indicates that the reduction in flow resulting from elimination of the two facilities had an adverse effect on the Lake that more than countered the impact of the mass reductions. At this time, our preliminary results indicate that the annual average TSI of the Lake would increase by 0.2 TSI units if the two facilities were eliminated. Therefore, it is the recommendation of the DEP, that at this time the two NPDES facilities be permitted such that there are no increases in TP or TN loadings to the Lake over those modeled in the scenario PSMAX discussed in Section 5.4.

NPDES Stormwater Discharges

The wasteload allocation for stormwater discharges is a 75.2 percent reduction in loading for TN and 75.5 percent for TP, which is the required percent reduction in nonpoint sources. It should be noted that the LA may include loading from stormwater discharges regulated by the Department and the Water Management District that are not part of the NPDES Stormwater Program.

6.4 Margin of Safety (MOS)

TMDLs must address uncertainty issues by incorporating a MOS into the analysis. The MOS is a required component of a TMDL and accounts for the uncertainty about the relationship between pollutant loads and the quality of the receiving waterbody [Clean Water Act, Section 303(d)(1)(c)]. Considerable uncertainty is usually inherent in estimating nutrient loading from nonpoint sources, as well as predicting water quality response. The effectiveness of management activities (e.g., stormwater management plans) in reducing loading is also subject to uncertainty.

The MOS can either be implicitly accounted for by choosing conservative assumptions about loading or water quality response, or explicitly accounted for during the allocation of loadings.

Consistent with the recommendations of the Allocation Technical Advisory Committee (Florida Department of Environmental Protection, February 2001), an implicit margin of safety (MOS) was used in the development of the Lake Hancock and Lower Saddle Creek TMDLs. An implicit MOS was used because the TMDL was based on the conservative decisions associated with a number of the modeling assumptions in determining assimilative capacity (i.e., loading and water quality response) for Lake Hancock.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

Following adoption of this TMDL by rule, the next step in the TMDL process is to develop an implementation plan for the TMDL, which will be a component of the Basin Management Action Plan for Lake Hancock and Lower Saddle Creek (and the Lake Hancock Basin). This document will be developed in cooperation with local stakeholders and will attempt to reach consensus on more detailed allocations and on how load reductions will be accomplished.

The Basin Management Action Plan (BMAP) will include:

- Appropriate allocations among the affected parties.
- A description of the load reduction activities to be undertaken.
- Timetables for project implementation and completion.
- Funding mechanisms that may be utilized.
- Any applicable signed agreements.
- Local ordinances defining actions to be taken or prohibited.
- Local water quality standards, permits, or load limitation agreements.
- Monitoring and follow-up measures.

It should be noted that TMDL development and implementation is an iterative process, and this TMDL will be re-evaluated during the BMAP development process and subsequent Watershed Management cycles. The Department acknowledges the uncertainty associated with TMDL development and allocation, particularly in estimates of nonpoint source loads and allocations for NPDES stormwater discharges, and fully expects that it may be further refined or revised over time. If any changes in the estimate of the assimilative capacity AND/OR allocation between point and nonpoint sources are required, the rule adopting this TMDL will be revised, thereby providing a point of entry for interested parties.

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Appendices

Appendix A: Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C.

The rule requires the state's water management districts (WMDs) to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a SWIM plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, stormwater PLRGs have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka. No PLRG has been developed for Newnans Lake at the time this study was conducted.

In 1987, the U.S. Congress established Section 402(p) as part of the federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES permitting program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began implementation of the Phase I NPDES stormwater program in 1990. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific Standard Industrial Classification (SIC) codes, construction sites disturbing five or more acres of land, and master drainage systems of local governments with a population above 100,000, which are better known as municipal separate storm sewer systems (MS4s). However, because the master drainage systems of most local governments in Florida are interconnected, the EPA implemented Phase I of the MS4 permitting program on a countywide basis, which brought in all cities (incorporated areas), Chapter 298 urban water control districts, and the Florida Department of Transportation throughout the fifteen counties meeting the population criteria. The Department received authorization to implement the NPDES stormwater program in 2000.

An important difference between the NPDES and other state stormwater permitting programs is that the NPDES program covers both new and existing discharges, while the other state programs focus on new discharges. Additionally, Phase II of the NPDES Program, implemented in 2003, expands the need for these permits to construction sites between one and five acres, and to local governments with as few as 1,000 people. While these urban stormwater discharges are now technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility similar to other point sources of pollution, such as domestic and industrial wastewater discharges. It should be noted that all MS4 permits issued in Florida include a re-opener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.

Appendix B: TN, TP, Chlorophyll a, DO Monitoring Data Used in the TMDL Analysis for Lake Hancock and Lower Saddle Creek

Lake Hancock TN Data

WBID	Station	Date	Time	Depth	Storet Code	TN (mg/L)	R-Code
1623L	21FLPOLKHANCOCK1	4/9/1992	1141	0.50	600	11.22	
1623L	21FLPOLKHANCOCK1	10/7/1992	1527	0.70	600	4.07	
1623L	21FLPOLKHANCOCK1	3/31/1993	1530	0.70	600	12.03	
1623L	21FLPOLKHANCOCK1	10/7/1993	1107	0.70	600	2.04	
1623L	21FLPOLKHANCOCK1	12/6/1993	1053	0.70	600	4.02	
1623L	21FLPOLKHANCOCK1	12/20/1993	1043	0.70	600	4.30	
1623L	21FLPOLKHANCOCK1	4/12/1994	1210	0.60	600	4.87	
1623L	21FLPOLKHANCOCK1	10/5/1994	1205	0.90	600	1.71	
1623L	21FLPOLKHANCOCK1	4/5/1995	1230	0.80	600	3.13	
1623L	21FLPOLKHANCOCK1	11/8/1995	844	0.80	600	2.56	
1623L	21FLPOLKHANCOCK1	5/8/1996	1200	0.80	600	4.99	
1623L	21FLSWFDSTA0192	8/1/1996	1535	0.50	600	4.82	
1623L	21FLPOLKHANCOCK1	11/13/1996	1248	2.62	600	4.42	
1623L	21FLPOLKHANCOCK1	5/7/1997	1150	0.10	600	4.63	
1623L	21FLPOLKHANCOCK1	10/30/1997	1145	0.70	600	1.98	
1623L	21FLPOLKHANCOCK1	5/7/1998	1245	0.80	600	1.89	
1623L	21FLPOLKHANCOCK1	11/9/1998	1015	0.60	600	5.15	
1623L	21FLPOLKHANCOCK1	5/11/1999	900	0.50	600	9.80	
1623L	21FLPOLKHANCOCK1	11/9/1999	830	0.49	600	5.49	
1623L	21FLPOLKHANCOCK1	5/3/2000	815	0.30	600	4.11	
1623L	21FLPOLKHANCOCK1	11/16/2000	1200	0.40	600	5.57	
1623L	21FLPOLKHANCOCK1	11/20/2001	1400	0.50	600	2.76	
1623L	21FLPOLKHANCOCK A	1/16/2002	845	0.50	600	4.24	
1623L	21FLPOLKHANCOCK B	1/16/2002	915	0.50	600	3.00	
1623L	21FLPOLKHANCOCK C	1/16/2002	945	0.50	600	3.00	
1623L	21FLPOLKHANCOCK D	1/16/2002	1005	0.50	600	4.19	
1623L	21FLPOLKHANCOCK A	2/5/2002	1345	0.50	600	5.58	
1623L	21FLPOLKHANCOCK B	2/5/2002	1410	0.50	600	2.86	
1623L	21FLPOLKHANCOCK C	2/5/2002	1435	0.50	600	4.15	
1623L	21FLPOLKHANCOCK D	2/5/2002	1500	0.50	600	5.11	
1623L	21FLPOLKHANCOCK A	3/7/2002	1355	0.50	600	7.93	
1623L	21FLPOLKHANCOCK B	3/7/2002	1400	0.50	600	4.54	
1623L	21FLPOLKHANCOCK C	3/7/2002	1416	0.50	600	4.60	
1623L	21FLPOLKHANCOCK D	3/7/2002	1430	0.50	600	8.06	
1623L	21FLPOLKHANCOCK H-10	8/22/2002	810	0.50	600	2.03	
1623L	21FLPOLKHANCOCK H-16	8/22/2002	840	0.50	600	4.06	
1623L	21FLPOLKHANCOCK H-17	8/22/2002	820	0.50	600	4.46	
1623L	21FLPOLKHANCOCK H-18	8/22/2002	830	0.50	600	4.78	
1623L	21FLPOLKHANCOCK H-2	8/22/2002	805	0.50	600	1.69	
1623L	21FLPOLKHANCOCK H-23	8/22/2002	845	0.50	600	2.88	
1623L	21FLPOLKHANCOCK H-26	8/22/2002	920	0.50	600	3.99	

WBID	Station	Date	Time	Depth	Storet Code	TN (mg/L)	R-Code
1623L	21FLPOLKHANCOCK H-37	8/22/2002	855	0.50	600	4.92	
1623L	21FLPOLKHANCOCK H-4	8/22/2002	750	0.50	600	1.48	
1623L	21FLPOLKHANCOCK H-52	8/22/2002	930	0.50	600	4.94	
1623L	21FLPOLKHANCOCK H-59	8/22/2002	945	0.50	600	4.47	
1623L	21FLPOLKHANCOCK H-62	8/22/2002	1000	0.50	600	4.41	
1623L	21FLPOLKHANCOCK H-12	11/18/2002	1305	0.50	600	2.43	
1623L	21FLPOLKHANCOCK H-16	11/18/2002	945	0.20	600	3.25	
1623L	21FLPOLKHANCOCK H-19	11/18/2002	1255	0.50	600	2.55	
1623L	21FLPOLKHANCOCK H-2	11/18/2002	925	0.40	600	1.19	
1623L	21FLPOLKHANCOCK H-23	11/18/2002	1005	0.50	600	3.90	
1623L	21FLPOLKHANCOCK H-25	11/18/2002	1240	0.40	600	3.44	
1623L	21FLPOLKHANCOCK H-30	11/18/2002	1020	0.50	600	4.57	
1623L	21FLPOLKHANCOCK H-33	11/18/2002	1150	0.50	600	3.26	
1623L	21FLPOLKHANCOCK H-36	11/18/2002	1035	0.40	600	4.81	
1623L	21FLPOLKHANCOCK H-40	11/18/2002	1130	0.40	600	1.83	
1623L	21FLPOLKHANCOCK H-53	11/18/2002	1225	0.50	600	4.01	
1623L	21FLPOLKHANCOCK H-55	11/18/2002	1210	0.40	600	3.99	
1623L	21FLTPA 25020276	2/4/2003	940	0.20	600	1.51	+
1623L	21FLPOLKHANCOCK H-16	2/13/2003	825	0.50	600	2.73	
1623L	21FLPOLKHANCOCK H-17	2/13/2003	840	0.50	600	3.38	
1623L	21FLPOLKHANCOCK H-22	2/13/2003	915	0.45	600	3.38	
1623L	21FLPOLKHANCOCK H-25	2/13/2003	900	0.50	600	3.48	
1623L	21FLPOLKHANCOCK H-29	2/13/2003	920	0.50	600	3.82	
1623L	21FLPOLKHANCOCK H-30	2/13/2003	945	0.50	600	3.64	
1623L	21FLPOLKHANCOCK H-36	2/13/2003	935	0.45	600	3.83	
1623L	21FLPOLKHANCOCK H-41	2/13/2003	1040	0.50	600	2.13	
1623L	21FLPOLKHANCOCK H-45	2/13/2003	1110	0.50	600	3.39	
1623L	21FLPOLKHANCOCK H-47	2/13/2003	1055	0.50	600	2.26	
1623L	21FLPOLKHANCOCK H-59	2/13/2003	1120	0.50	600	3.05	
1623L	21FLPOLKHANCOCK H-62	2/13/2003	1140	0.50	600	2.95	
1623L	21FLTPA 25020276	4/22/2003	1110	0.20	600	4.00	+
1623L	21FLPOLKHANCOCK H-24	5/20/2003	1150	0.50	600	7.04	
1623L	21FLPOLKHANCOCK H-25	5/20/2003	1140	0.50	600	6.56	
1623L	21FLPOLKHANCOCK H-31	5/20/2003	1200	0.50	600	7.38	
1623L	21FLPOLKHANCOCK H-32	5/20/2003	1210	0.50	600	5.45	
1623L	21FLPOLKHANCOCK H-37	5/20/2003	1010	0.50	600	7.20	
1623L	21FLPOLKHANCOCK H-38	5/20/2003	1000	0.50	600	6.30	
1623L	21FLPOLKHANCOCK H-4	5/20/2003	1115	0.50	600	2.31	
1623L	21FLPOLKHANCOCK H-40	5/20/2003	845	0.50	600	7.27	
1623L	21FLPOLKHANCOCK H-47	5/20/2003	900	0.50	600	5.72	
1623L	21FLPOLKHANCOCK H-52	5/20/2003	950	0.50	600	7.28	
1623L	21FLPOLKHANCOCK H-53	5/20/2003	940	0.50	600	6.83	
1623L	21FLPOLKHANCOCK H-56	5/20/2003	920	0.40	600	4.81	
1623L	21FLTPA 25020276	8/18/2003	900	0.20	600	2.60	+
1623L	21FLPOLKHANCOCK H-18	8/20/2003	840	0.50	600	4.19	
1623L	21FLPOLKHANCOCK H-23	8/20/2003	855	0.50	600	3.01	
1623L	21FLPOLKHANCOCK H-24	8/20/2003	850	0.50	600	5.26	

WBID	Station	Date	Time	Depth	Storet Code	TN (mg/L)	R-Code
1623L	21FLPOLKHANCOCK H-37	8/20/2003	910	0.50	600	3.69	
1623L	21FLPOLKHANCOCK H-38	8/20/2003	920	0.50	600	3.34	
1623L	21FLPOLKHANCOCK H-39	8/20/2003	930	0.50	600	5.54	
1623L	21FLPOLKHANCOCK H-4	8/20/2003	820	0.50	600	1.37	
1623L	21FLPOLKHANCOCK H-47	8/20/2003	1050	0.50	600	4.09	
1623L	21FLPOLKHANCOCK H-48	8/20/2003	1040	0.50	600	3.09	
1623L	21FLPOLKHANCOCK H-51	8/20/2003	1000	0.50	600	3.26	
1623L	21FLPOLKHANCOCK H-59	8/20/2003	1015	0.50	600	3.42	
1623L	21FLPOLKHANCOCK H-61	8/20/2003	1025	0.50	600	4.72	
1623L	21FLTPA 25020276	11/3/2003	1040	0.20	600	3.30	+
1623L	21FLPOLKHANCOCK H-11	11/18/2003	1150	0.50	600	4.13	
1623L	21FLPOLKHANCOCK H-16	11/18/2003	1130	0.50	600	5.76	
1623L	21FLPOLKHANCOCK H-22	11/18/2003	1120	0.50	600	4.42	
1623L	21FLPOLKHANCOCK H-3	11/18/2003	1140	0.50	600	4.87	
1623L	21FLPOLKHANCOCK H-30	11/18/2003	1110	0.50	600	4.79	
1623L	21FLPOLKHANCOCK H-31	11/18/2003	1100	0.50	600	4.89	
1623L	21FLPOLKHANCOCK H-34	11/18/2003	945	0.50	600	4.26	
1623L	21FLPOLKHANCOCK H-40	11/18/2003	955	0.50	600	5.13	
1623L	21FLPOLKHANCOCK H-43	11/18/2003	1010	0.50	600	5.07	
1623L	21FLPOLKHANCOCK H-48	11/18/2003	905	0.50	600	5.13	
1623L	21FLPOLKHANCOCK H-49	11/18/2003	920	0.50	600	3.09	
1623L	21FLPOLKHANCOCK H-54	11/18/2003	850	0.50	600	4.01	
1623L	21FLPOLKHANCOCK H-11	2/19/2004	1120	0.50	600	4.06	+
1623L	21FLPOLKHANCOCK H-22	2/19/2004	1055	0.50	600	4.70	+
1623L	21FLPOLKHANCOCK H-24	2/19/2004	1110	0.50	600	3.64	+
1623L	21FLPOLKHANCOCK H-30	2/19/2004	1045	0.50	600	4.86	+
1623L	21FLPOLKHANCOCK H-33	2/19/2004	950	0.50	600	4.89	+
1623L	21FLPOLKHANCOCK H-34	2/19/2004	1000	0.50	600	4.70	+
1623L	21FLPOLKHANCOCK H-36	2/19/2004	920	0.50	600	5.13	+
1623L	21FLPOLKHANCOCK H-37	2/19/2004	935	0.50	600	4.39	+
1623L	21FLPOLKHANCOCK H-44	2/19/2004	905	0.50	600	5.01	+
1623L	21FLPOLKHANCOCK H-59	2/19/2004	850	0.50	600	3.95	+
1623L	21FLPOLKHANCOCK H-62	2/19/2004	830	0.50	600	4.65	+
1623L	21FLPOLKHANCOCK H-9	2/19/2004	1130	0.50	600	4.91	+
1623L	21FLPOLKHANCOCK H-12	5/5/2004	950	0.50	600	4.79	+
1623L	21FLPOLKHANCOCK H-22	5/5/2004	925	0.40	600	8.53	+
1623L	21FLPOLKHANCOCK H-3	5/5/2004	940	0.40	600	7.30	+
1623L	21FLPOLKHANCOCK H-31	5/5/2004	835	0.50	600	8.40	+
1623L	21FLPOLKHANCOCK H-33	5/5/2004	825	0.50	600	6.15	+
1623L	21FLPOLKHANCOCK H-36	5/5/2004	915	0.50	600	8.64	+
1623L	21FLPOLKHANCOCK H-40	5/5/2004	815	0.50	600	7.06	+
1623L	21FLPOLKHANCOCK H-43	5/5/2004	910	0.50	600	8.40	+
1623L	21FLPOLKHANCOCK H-47	5/5/2004	805	0.50	600	8.11	+
1623L	21FLPOLKHANCOCK H-50	5/5/2004	900	0.50	600	4.98	+
1623L	21FLPOLKHANCOCK H-54	5/5/2004	755	0.50	600	7.85	+
1623L	21FLPOLKHANCOCK H-62	5/5/2004	745	0.50	600	7.20	+

+ : Calculated value.

Lake Hancock TP Data

WBID	Station	Date	Time	Depth	Storet Code	TP (mg/L)	R-Code
1623L	21FLPOLKHANCOCK1	4/9/1992	1141	0.50	665	0.94	
1623L	21FLPOLKHANCOCK1	10/7/1992	1527	0.70	665	0.37	
1623L	21FLPOLKHANCOCK1	3/31/1993	1530	0.70	665	0.71	
1623L	21FLPOLKHANCOCK1	10/7/1993	1107	0.70	665	0.20	
1623L	21FLPOLKHANCOCK1	12/6/1993	1053	0.70	665	0.17	
1623L	21FLPOLKHANCOCK1	12/20/1993	1043	0.70	665	0.20	
1623L	21FLPOLKHANCOCK1	4/12/1994	1210	0.60	665	0.47	
1623L	21FLPOLKHANCOCK1	10/5/1994	1205	0.90	665	0.36	
1623L	21FLPOLKHANCOCK1	4/5/1995	1230	0.80	665	0.42	
1623L	21FLPOLKHANCOCK1	11/8/1995	844	0.80	665	0.49	
1623L	21FLPOLKHANCOCK1	5/8/1996	1200	0.80	665	0.51	
1623L	21FLSWFDSTA0192	8/1/1996	1535	0.50	665	0.04	
1623L	21FLPOLKHANCOCK1	11/13/1996	1248	2.62	665	0.42	
1623L	21FLPOLKHANCOCK1	5/7/1997	1150	0.10	665	0.43	
1623L	21FLPOLKHANCOCK1	10/30/1997	1145	0.70	665	0.11	
1623L	21FLPOLKHANCOCK1	5/7/1998	1245	0.80	665	0.54	
1623L	21FLPOLKHANCOCK1	11/9/1998	1015	0.60	665	0.49	
1623L	21FLPOLKHANCOCK1	5/11/1999	900	0.50	665	0.75	
1623L	21FLPOLKHANCOCK1	11/9/1999	830	0.49	665	0.53	
1623L	21FLPOLKHANCOCK1	5/3/2000	815	0.30	665	0.36	
1623L	21FLPOLKHANCOCK1	11/16/2000	1200	0.40	665	0.23	
1623L	21FLPOLKHANCOCK1	11/20/2001	1400	0.50	665	0.77	
1623L	21FLPOLKHANCOCK A	1/16/2002	845	0.50	665	0.76	
1623L	21FLPOLKHANCOCK B	1/16/2002	915	0.50	665	0.97	
1623L	21FLPOLKHANCOCK C	1/16/2002	945	0.50	665	0.73	
1623L	21FLPOLKHANCOCK D	1/16/2002	1005	0.50	665	0.74	
1623L	21FLPOLKHANCOCK A	2/5/2002	1345	0.50	665	0.81	
1623L	21FLPOLKHANCOCK B	2/5/2002	1410	0.50	665	1.01	
1623L	21FLPOLKHANCOCK C	2/5/2002	1435	0.50	665	0.73	
1623L	21FLPOLKHANCOCK D	2/5/2002	1500	0.50	665	0.76	
1623L	21FLPOLKHANCOCK A	3/7/2002	1355	0.50	665	0.82	
1623L	21FLPOLKHANCOCK B	3/7/2002	1400	0.50	665	0.80	
1623L	21FLPOLKHANCOCK C	3/7/2002	1416	0.50	665	0.71	
1623L	21FLPOLKHANCOCK D	3/7/2002	1430	0.50	665	0.82	
1623L	21FLPOLKHANCOCK H-10	8/22/2002	810	0.50	665	0.44	
1623L	21FLPOLKHANCOCK H-16	8/22/2002	840	0.50	665	0.39	
1623L	21FLPOLKHANCOCK H-17	8/22/2002	820	0.50	665	0.34	
1623L	21FLPOLKHANCOCK H-18	8/22/2002	830	0.50	665	0.42	
1623L	21FLPOLKHANCOCK H-2	8/22/2002	805	0.50	665	0.50	
1623L	21FLPOLKHANCOCK H-23	8/22/2002	845	0.50	665	0.38	
1623L	21FLPOLKHANCOCK H-26	8/22/2002	920	0.50	665	0.34	
1623L	21FLPOLKHANCOCK H-37	8/22/2002	855	0.50	665	0.39	
1623L	21FLPOLKHANCOCK H-4	8/22/2002	750	0.50	665	0.54	
1623L	21FLPOLKHANCOCK H-52	8/22/2002	930	0.50	665	0.37	
1623L	21FLPOLKHANCOCK H-59	8/22/2002	945	0.50	665	0.30	A

WBID	Station	Date	Time	Depth	Storet Code	TP (mg/L)	R-Code
1623L	21FLPOLKHANCOCK H-62	8/22/2002	1000	0.50	665	0.33	
1623L	21FLPOLKHANCOCK H-12	11/18/2002	1305	0.50	665	0.34	
1623L	21FLPOLKHANCOCK H-16	11/18/2002	945	0.20	665	0.43	
1623L	21FLPOLKHANCOCK H-19	11/18/2002	1255	0.50	665	0.42	
1623L	21FLPOLKHANCOCK H-2	11/18/2002	925	0.40	665	0.45	
1623L	21FLPOLKHANCOCK H-23	11/18/2002	1005	0.50	665	0.41	
1623L	21FLPOLKHANCOCK H-25	11/18/2002	1240	0.40	665	0.43	
1623L	21FLPOLKHANCOCK H-30	11/18/2002	1020	0.50	665	0.48	
1623L	21FLPOLKHANCOCK H-33	11/18/2002	1150	0.50	665	0.37	
1623L	21FLPOLKHANCOCK H-36	11/18/2002	1035	0.40	665	0.49	
1623L	21FLPOLKHANCOCK H-40	11/18/2002	1130	0.40	665	0.10	
1623L	21FLPOLKHANCOCK H-53	11/18/2002	1225	0.50	665	0.41	
1623L	21FLPOLKHANCOCK H-55	11/18/2002	1210	0.40	665	0.35	
1623L	21FLTPA 25020276	2/4/2003	940	0.20	665	0.43	
1623L	21FLPOLKHANCOCK H-16	2/13/2003	825	0.50	665	0.56	
1623L	21FLPOLKHANCOCK H-17	2/13/2003	840	0.50	665	0.56	
1623L	21FLPOLKHANCOCK H-22	2/13/2003	915	0.45	665	0.59	
1623L	21FLPOLKHANCOCK H-25	2/13/2003	900	0.50	665	0.55	
1623L	21FLPOLKHANCOCK H-29	2/13/2003	920	0.50	665	0.62	
1623L	21FLPOLKHANCOCK H-30	2/13/2003	945	0.50	665	0.59	
1623L	21FLPOLKHANCOCK H-36	2/13/2003	935	0.45	665	0.63	
1623L	21FLPOLKHANCOCK H-41	2/13/2003	1040	0.50	665	0.42	
1623L	21FLPOLKHANCOCK H-45	2/13/2003	1110	0.50	665	0.58	
1623L	21FLPOLKHANCOCK H-47	2/13/2003	1055	0.50	665	0.46	
1623L	21FLPOLKHANCOCK H-59	2/13/2003	1120	0.50	665	0.57	
1623L	21FLPOLKHANCOCK H-62	2/13/2003	1140	0.50	665	0.54	
1623L	21FLTPA 25020276	4/22/2003	1110	0.20	665	0.68	
1623L	21FLPOLKHANCOCK H-24	5/20/2003	1150	0.50	665	0.95	
1623L	21FLPOLKHANCOCK H-25	5/20/2003	1140	0.50	665	0.83	
1623L	21FLPOLKHANCOCK H-31	5/20/2003	1200	0.50	665	0.95	
1623L	21FLPOLKHANCOCK H-32	5/20/2003	1210	0.50	665	0.89	
1623L	21FLPOLKHANCOCK H-37	5/20/2003	1010	0.50	665	0.88	
1623L	21FLPOLKHANCOCK H-37	5/20/2003	1015	0.50	665	0.89	
1623L	21FLPOLKHANCOCK H-38	5/20/2003	1000	0.50	665	0.87	
1623L	21FLPOLKHANCOCK H-4	5/20/2003	1115	0.50	665	0.52	
1623L	21FLPOLKHANCOCK H-40	5/20/2003	845	0.50	665	0.94	
1623L	21FLPOLKHANCOCK H-47	5/20/2003	900	0.50	665	0.67	
1623L	21FLPOLKHANCOCK H-52	5/20/2003	950	0.50	665	0.91	
1623L	21FLPOLKHANCOCK H-53	5/20/2003	940	0.50	665	0.85	
1623L	21FLPOLKHANCOCK H-56	5/20/2003	920	0.40	665	0.66	
1623L	21FLTPA 25020276	8/18/2003	900	0.20	665	0.35	
1623L	21FLPOLKHANCOCK H-18	8/20/2003	840	0.50	665	0.41	
1623L	21FLPOLKHANCOCK H-23	8/20/2003	855	0.50	665	0.49	
1623L	21FLPOLKHANCOCK H-24	8/20/2003	850	0.50	665	0.54	
1623L	21FLPOLKHANCOCK H-37	8/20/2003	910	0.50	665	0.41	
1623L	21FLPOLKHANCOCK H-38	8/20/2003	920	0.50	665	0.40	
1623L	21FLPOLKHANCOCK H-39	8/20/2003	930	0.50	665	0.55	

WBID	Station	Date	Time	Depth	Storet Code	TP (mg/L)	R-Code
1623L	21FLPOLKHANCOCK H-4	8/20/2003	820	0.50	665	0.40	
1623L	21FLPOLKHANCOCK H-47	8/20/2003	1050	0.50	665	0.38	
1623L	21FLPOLKHANCOCK H-48	8/20/2003	1040	0.50	665	0.33	
1623L	21FLPOLKHANCOCK H-51	8/20/2003	1000	0.50	665	0.36	
1623L	21FLPOLKHANCOCK H-59	8/20/2003	1015	0.50	665	0.37	
1623L	21FLPOLKHANCOCK H-61	8/20/2003	1025	0.50	665	0.49	
1623L	21FLTPA 25020276	11/3/2003	1040	0.20	665	0.50	
1623L	21FLPOLKHANCOCK H-11	11/18/2003	1150	0.50	665	0.46	
1623L	21FLPOLKHANCOCK H-16	11/18/2003	1130	0.50	665	0.58	
1623L	21FLPOLKHANCOCK H-22	11/18/2003	1120	0.50	665	0.52	
1623L	21FLPOLKHANCOCK H-3	11/18/2003	1140	0.50	665	0.50	
1623L	21FLPOLKHANCOCK H-30	11/18/2003	1110	0.50	665	0.41	
1623L	21FLPOLKHANCOCK H-31	11/18/2003	1100	0.50	665	0.46	
1623L	21FLPOLKHANCOCK H-34	11/18/2003	945	0.50	665	0.42	
1623L	21FLPOLKHANCOCK H-40	11/18/2003	955	0.50	665	0.53	
1623L	21FLPOLKHANCOCK H-43	11/18/2003	1010	0.50	665	0.45	
1623L	21FLPOLKHANCOCK H-48	11/18/2003	905	0.50	665	0.52	
1623L	21FLPOLKHANCOCK H-49	11/18/2003	920	0.50	665	0.40	
1623L	21FLPOLKHANCOCK H-54	11/18/2003	850	0.50	665	0.40	
1623L	21FLPOLKHANCOCK H-11	2/19/2004	1120	0.50	665	0.27	
1623L	21FLPOLKHANCOCK H-22	2/19/2004	1055	0.50	665	0.36	
1623L	21FLPOLKHANCOCK H-24	2/19/2004	1110	0.50	665	0.27	
1623L	21FLPOLKHANCOCK H-30	2/19/2004	1045	0.50	665	0.41	
1623L	21FLPOLKHANCOCK H-33	2/19/2004	950	0.50	665	0.33	
1623L	21FLPOLKHANCOCK H-34	2/19/2004	1000	0.50	665	0.36	
1623L	21FLPOLKHANCOCK H-36	2/19/2004	920	0.50	665	0.43	
1623L	21FLPOLKHANCOCK H-37	2/19/2004	935	0.50	665	0.35	
1623L	21FLPOLKHANCOCK H-44	2/19/2004	905	0.50	665	0.37	
1623L	21FLPOLKHANCOCK H-59	2/19/2004	850	0.50	665	0.40	
1623L	21FLPOLKHANCOCK H-62	2/19/2004	830	0.50	665	0.34	
1623L	21FLPOLKHANCOCK H-9	2/19/2004	1130	0.50	665	0.39	
1623L	21FLPOLKHANCOCK H-12	5/5/2004	950	0.50	665	0.36	
1623L	21FLPOLKHANCOCK H-22	5/5/2004	925	0.40	665	0.64	
1623L	21FLPOLKHANCOCK H-3	5/5/2004	940	0.40	665	0.62	
1623L	21FLPOLKHANCOCK H-31	5/5/2004	835	0.50	665	0.55	
1623L	21FLPOLKHANCOCK H-33	5/5/2004	825	0.50	665	0.60	
1623L	21FLPOLKHANCOCK H-36	5/5/2004	915	0.50	665	0.57	
1623L	21FLPOLKHANCOCK H-40	5/5/2004	815	0.50	665	0.61	
1623L	21FLPOLKHANCOCK H-43	5/5/2004	910	0.50	665	0.61	
1623L	21FLPOLKHANCOCK H-47	5/5/2004	805	0.50	665	0.65	
1623L	21FLPOLKHANCOCK H-50	5/5/2004	900	0.50	665	0.55	
1623L	21FLPOLKHANCOCK H-54	5/5/2004	755	0.50	665	0.51	
1623L	21FLPOLKHANCOCK H-62	5/5/2004	745	0.50	665	0.56	

A: Value reported is the mean of two or more determinations.

Lake Hancock Chlorophyll a Data

WBID	Station	Date	Time	Depth	Storet Code	Chla (μg/L)	R-Code
1623L	21FLPOLKHANCOCK1	4/9/1992	1141	1.64	32210	310.5	
1623L	21FLPOLKHANCOCK1	10/7/1992	1527	4.59	32210	131.8	
1623L	21FLPOLKHANCOCK1	3/31/1993	1530	2.30	32210	173.1	
1623L	21FLPOLKHANCOCK1	10/7/1993	1107	2.30	32210	66.4	
1623L	21FLPOLKHANCOCK1	12/6/1993	1053	2.30	32210	87.8	
1623L	21FLPOLKHANCOCK1	12/20/1993	1043	2.30	32210	67.3	
1623L	21FLPOLKHANCOCK1	4/12/1994	1210	1.97	32210	204.5	
1623L	21FLPOLKHANCOCK1	10/5/1994	1205	2.95	32210	78.8	
1623L	21FLPOLKHANCOCK1	4/5/1995	1230	2.62	32210	158.9	
1623L	21FLPOLKHANCOCK1	11/8/1995	844	2.62	32210	161.8	
1623L	21FLPOLKHANCOCK1	5/8/1996	1200	2.62	32210	186.6	
1623L	21FLSWFDSTA0192	8/1/1996	1535	0.50	32210	24.1	
1623L	21FLSWFDSTA0192	8/1/1996	1535	0.50	32211	23.3	
1623L	21FLPOLKHANCOCK1	11/13/1996	1248	2.62	32210	130.1	
1623L	21FLSWFDSTA0192	1/13/1997	2500	0.50	32210	171.3	
1623L	21FLSWFDSTA0192	1/13/1997	2500	0.50	32211	137.8	
1623L	21FLPOLKHANCOCK1	5/7/1997	1150	0.33	32210	152.0	
1623L	21FLPOLKHANCOCK1	10/30/1997	1145	2.30	32210	71.5	
1623L	21FLPOLKHANCOCK1	5/7/1998	1245	0.80	32210	86.5	
1623L	21FLPOLKHANCOCK1	11/9/1998	1015	1.97	32210	237.9	
1623L	21FLPOLKHANCOCK1	5/11/1999	900	0.50	32223	216.3	
1623L	21FLPOLKHANCOCK1	11/9/1999	830	0.49	32223	104.1	
1623L	21FLPOLKHANCOCK1	5/3/2000	815	0.30	32223	144.2	
1623L	21FLPOLKHANCOCK1	11/16/2000	1200	0.40	32223	116.2	
1623L	21FLPOLKHANCOCK1	11/20/2001	1400	0.50	32223	65.7	
1623L	21FLPOLKHANCOCK A	1/16/2002	845	0.50	32223	152.2	E
1623L	21FLPOLKHANCOCK B	1/16/2002	915	0.50	32223	34.4	E
1623L	21FLPOLKHANCOCK C	1/16/2002	945	0.50	32223	76.9	E
1623L	21FLPOLKHANCOCK D	1/16/2002	1005	0.50	32223	146.9	
1623L	21FLPOLKHANCOCK A	2/5/2002	1345	0.50	32223	175.2	E
1623L	21FLPOLKHANCOCK B	2/5/2002	1410	0.50	32223	53.7	E
1623L	21FLPOLKHANCOCK C	2/5/2002	1435	0.50	32223	106.1	E
1623L	21FLPOLKHANCOCK D	2/5/2002	1500	0.50	32223	184.2	E
1623L	21FLPOLKHANCOCK A	3/7/2002	1355	0.50	32223	483.0	
1623L	21FLPOLKHANCOCK B	3/7/2002	1400	0.50	32223	166.0	
1623L	21FLPOLKHANCOCK C	3/7/2002	1416	0.50	32223	348.0	
1623L	21FLPOLKHANCOCK D	3/7/2002	1430	0.50	32223	558.0	
1623L	21FLPOLKHANCOCK H-10	8/22/2002	810	0.50	32223	43.3	
1623L	21FLPOLKHANCOCK H-16	8/22/2002	840	0.50	32223	128.2	
1623L	21FLPOLKHANCOCK H-17	8/22/2002	820	0.50	32223	172.2	
1623L	21FLPOLKHANCOCK H-18	8/22/2002	830	0.50	32223	164.2	
1623L	21FLPOLKHANCOCK H-2	8/22/2002	805	0.50	32223	17.6	
1623L	21FLPOLKHANCOCK H-23	8/22/2002	845	0.50	32223	88.1	
1623L	21FLPOLKHANCOCK H-26	8/22/2002	920	0.50	32223	128.2	
1623L	21FLPOLKHANCOCK H-37	8/22/2002	855	0.50	32223	144.2	

WBID	Station	Date	Time	Depth	Storet Code	Chla (μg/L)	R-Code
1623L	21FLPOLKHANCOCK H-4	8/22/2002	750	0.50	32223	16.0	
1623L	21FLPOLKHANCOCK H-52	8/22/2002	930	0.50	32223	134.2	
1623L	21FLPOLKHANCOCK H-59	8/22/2002	945	0.50	32223	144.2	
1623L	21FLPOLKHANCOCK H-62	8/22/2002	1000	0.50	32223	136.8	A
1623L	21FLTPA 25020276	2/4/2003	940	0.20	32209	57.0	Q
1623L	21FLTPA 25020276	4/22/2003	1110	0.20	32209	230.0	
1623L	21FLTPA 25020276	8/18/2003	900	0.20	32209	85.0	
1623L	21FLTPA 25020276	11/3/2003	1040	0.20	32209	210.0	
1623L	21FLPOLKHANCOCK H-11	2/19/2004	1120	0.50	32210	146.4	
1623L	21FLPOLKHANCOCK H-22	2/19/2004	1055	0.50	32210	143.7	
1623L	21FLPOLKHANCOCK H-24	2/19/2004	1110	0.50	32210	137.8	
1623L	21FLPOLKHANCOCK H-30	2/19/2004	1045	0.50	32210	156.6	
1623L	21FLPOLKHANCOCK H-33	2/19/2004	950	0.50	32210	175.5	
1623L	21FLPOLKHANCOCK H-34	2/19/2004	1000	0.50	32210	143.1	
1623L	21FLPOLKHANCOCK H-36	2/19/2004	920	0.50	32210	148.0	
1623L	21FLPOLKHANCOCK H-37	2/19/2004	935	0.50	32210	168.6	
1623L	21FLPOLKHANCOCK H-44	2/19/2004	905	0.50	32210	148.0	
1623L	21FLPOLKHANCOCK H-59	2/19/2004	850	0.50	32210	170.1	
1623L	21FLPOLKHANCOCK H-62	2/19/2004	830	0.50	32210	134.3	
1623L	21FLPOLKHANCOCK H-9	2/19/2004	1130	0.50	32210	213.7	
1623L	21FLPOLKHANCOCK H-12	5/5/2004	950	0.50	32210	171.5	
1623L	21FLPOLKHANCOCK H-22	5/5/2004	925	0.40	32210	364.5	
1623L	21FLPOLKHANCOCK H-3	5/5/2004	940	0.40	32210	349.7	
1623L	21FLPOLKHANCOCK H-31	5/5/2004	835	0.50	32210	343.4	
1623L	21FLPOLKHANCOCK H-33	5/5/2004	825	0.50	32210	289.8	
1623L	21FLPOLKHANCOCK H-36	5/5/2004	915	0.50	32210	360.7	
1623L	21FLPOLKHANCOCK H-40	5/5/2004	815	0.50	32210	333.7	
1623L	21FLPOLKHANCOCK H-43	5/5/2004	910	0.50	32210	346.9	
1623L	21FLPOLKHANCOCK H-47	5/5/2004	805	0.50	32210	346.2	
1623L	21FLPOLKHANCOCK H-50	5/5/2004	900	0.50	32210	362.3	
1623L	21FLPOLKHANCOCK H-54	5/5/2004	755	0.50	32210	312.8	
1623L	21FLPOLKHANCOCK H-62	5/5/2004	745	0.50	32210	327.3	

A: Value reported is the mean of two or more determinations.

E: Extra sample taken in compositing process.

Q: Sample held beyond normal holding time.

Lake Hancock Dissolved Oxygen Data

WBID	Station	Date	Time	Depth	Storet Code	DO (mg/L)	R-Code
1623L	21FLPOLKHANCOCK1	4/9/1992	1141	0.50	299	10.60	
1623L	21FLPOLKHANCOCK1	10/7/1992	1527	0.70	299	2.50	
1623L	21FLPOLKHANCOCK1	3/31/1993	1530	0.70	299	0.90	
1623L	21FLPOLKHANCOCK1	10/7/1993	1107	0.70	299	7.10	
1623L	21FLPOLKHANCOCK1	12/6/1993	1053	0.70	299	11.70	
1623L	21FLPOLKHANCOCK1	12/20/1993	1043	0.70	299	12.50	
1623L	21FLPOLKHANCOCK1	4/12/1994	1210	0.60	299	9.30	
1623L	21FLPOLKHANCOCK1	10/5/1994	1205	0.90	299	8.60	
1623L	21FLPOLKHANCOCK1	4/5/1995	1230	0.80	299	11.50	
1623L	21FLPOLKHANCOCK1	11/8/1995	844	0.80	299	7.30	
1623L	21FLPOLKHANCOCK1	5/8/1996	1200	0.80	299	7.90	
1623L	21FLSWFDSTA0192	8/1/1996	1535	0.50	299	6.10	
1623L	21FLPOLKHANCOCK1	11/13/1996	1248	0.80	299	11.30	
1623L	21FLSWFDSTA0192	1/13/1997	1500	0.50	299	12.23	
1623L	21FLPOLKHANCOCK1	5/7/1997	1150	0.10	299	15.70	
1623L	21FLPOLKHANCOCK1	10/30/1997	1145	0.70	299	10.95	
1623L	21FLPOLKHANCOCK1	5/7/1998	1245	0.80	299	11.56	
1623L	21FLPOLKHANCOCK1	11/9/1998	1015	0.60	299	11.92	
1623L	21FLPOLKHANCOCK1	5/11/1999	900	0.50	299	4.39	
1623L	21FLTPA 25020275	9/7/1999	1110	0.30	299	7.98	
1623L	21FLTPA 25020276	9/7/1999	145	0.30	299	9.25	
1623L	21FLTPA 25020278	9/8/1999	1115	0.60	299	7.98	
1623L	21FLTPA 25020277	9/8/1999	140	0.60	299	10.30	
1623L	21FLPOLKHANCOCK1	11/9/1999	830	0.49	299	9.05	
1623L	21FLPOLKHANCOCK1	5/3/2000	815	0.30	299	0.84	
1623L	21FLPOLKHANCOCK1	11/16/2000	1200	0.40	299	10.08	
1623L	21FLPOLKHANCOCK1	11/20/2001	1400	0.50	299	12.95	
1623L	21FLPOLKHANCOCK B	1/16/2002	915	0.50	299	2.21	
1623L	21FLPOLKHANCOCK C	1/16/2002	945	0.50	299	7.56	
1623L	21FLPOLKHANCOCK A	1/16/2002	845	0.50	299	11.32	
1623L	21FLPOLKHANCOCK D	1/16/2002	1005	0.50	299	12.57	
1623L	21FLPOLKHANCOCK B	2/5/2002	1410	0.50	299	7.29	
1623L	21FLPOLKHANCOCK C	2/5/2002	1435	0.50	299	12.60	
1623L	21FLPOLKHANCOCK A	2/5/2002	1345	0.50	299	13.17	
1623L	21FLPOLKHANCOCK D	2/5/2002	1500	0.50	299	14.45	
1623L	21FLPOLKHANCOCK B	3/7/2002	1400	0.50	299	1.51	
1623L	21FLPOLKHANCOCK D	3/7/2002	1430	0.50	299	1.52	
1623L	21FLPOLKHANCOCK A	3/7/2002	1355	0.50	299	4.79	
1623L	21FLPOLKHANCOCK C	3/7/2002	1416	0.50	299	11.77	
1623L	21FLPOLKHANCOCK H-4	8/22/2002	750	0.50	299	0.38	
1623L	21FLPOLKHANCOCK H-2	8/22/2002	805	0.50	299	3.08	
1623L	21FLPOLKHANCOCK H-23	8/22/2002	845	0.50	299	4.36	
1623L	21FLPOLKHANCOCK H-10	8/22/2002	810	0.50	299	4.43	
1623L	21FLPOLKHANCOCK H-62	8/22/2002	1000	0.50	299	4.94	
1623L	21FLPOLKHANCOCK H-52	8/22/2002	930	0.50	299	5.42	

WBID	Station	Date	Time	Depth	Storet Code	DO (mg/L)	R-Code
1623L	21FLPOLKHANCOCK H-52	8/22/2002	935	0.50	299	5.42	
1623L	21FLPOLKHANCOCK H-37	8/22/2002	855	0.50	299	6.19	
1623L	21FLPOLKHANCOCK H-16	8/22/2002	840	0.50	299	6.51	
1623L	21FLPOLKHANCOCK H-17	8/22/2002	820	0.50	299	7.47	
1623L	21FLPOLKHANCOCK H-59	8/22/2002	945	0.50	299	7.86	
1623L	21FLPOLKHANCOCK H-18	8/22/2002	830	0.50	299	8.14	
1623L	21FLPOLKHANCOCK H-26	8/22/2002	920	0.50	299	8.28	
1623L	21FLPOLKHANCOCK H-40	11/18/2002	1130	0.40	299	1.67	
1623L	21FLPOLKHANCOCK H-2	11/18/2002	925	0.40	299	4.54	
1623L	21FLPOLKHANCOCK H-16	11/18/2002	945	0.20	299	7.69	
1623L	21FLPOLKHANCOCK H-12	11/18/2002	1305	0.50	299	8.41	
1623L	21FLPOLKHANCOCK H-23	11/18/2002	1005	0.50	299	9.12	
1623L	21FLPOLKHANCOCK H-30	11/18/2002	1020	0.50	299	9.44	
1623L	21FLPOLKHANCOCK H-55	11/18/2002	1210	0.40	299	9.64	
1623L	21FLPOLKHANCOCK H-36	11/18/2002	1035	0.40	299	9.98	
1623L	21FLPOLKHANCOCK H-19	11/18/2002	1255	0.50	299	11.04	
1623L	21FLPOLKHANCOCK H-25	11/18/2002	1240	0.40	299	11.38	
1623L	21FLPOLKHANCOCK H-33	11/18/2002	1150	0.50	299	11.84	
1623L	21FLPOLKHANCOCK H-53	11/18/2002	1225	0.50	299	12.11	
1623L	21FLTPA 25020276	2/4/2003	940	0.20	299	5.44	D
1623L	21FLPOLKHANCOCK H-41	2/13/2003	1040	0.50	299	2.88	
1623L	21FLPOLKHANCOCK H-16	2/13/2003	825	0.50	299	7.63	
1623L	21FLPOLKHANCOCK H-47	2/13/2003	1055	0.50	299	9.01	
1623L	21FLPOLKHANCOCK H-36	2/13/2003	935	0.45	299	10.68	
1623L	21FLPOLKHANCOCK H-22	2/13/2003	915	0.45	299	11.31	
1623L	21FLPOLKHANCOCK H-25	2/13/2003	900	0.50	299	11.93	
1623L	21FLPOLKHANCOCK H-17	2/13/2003	840	0.50	299	12.44	
1623L	21FLPOLKHANCOCK H-29	2/13/2003	920	0.50	299	12.60	
1623L	21FLPOLKHANCOCK H-62	2/13/2003	1140	0.50	299	12.63	
1623L	21FLPOLKHANCOCK H-30	2/13/2003	945	0.50	299	12.69	
1623L	21FLPOLKHANCOCK H-59	2/13/2003	1120	0.50	299	13.09	
1623L	21FLPOLKHANCOCK H-45	2/13/2003	1110	0.50	299	13.58	
1623L	21FLTPA 25020276	4/22/2003	1110	0.20	299	3.94	D
1623L	21FLPOLKHANCOCK H-4	5/20/2003	1115	0.50	299	2.59	
1623L	21FLPOLKHANCOCK H-56	5/20/2003	920	0.40	299	2.86	
1623L	21FLPOLKHANCOCK H-47	5/20/2003	900	0.50	299	4.37	
1623L	21FLPOLKHANCOCK H-52	5/20/2003	950	0.50	299	5.21	
1623L	21FLPOLKHANCOCK H-38	5/20/2003	1000	0.50	299	5.65	
1623L	21FLPOLKHANCOCK H-37	5/20/2003	1010	0.50	299	5.68	
1623L	21FLPOLKHANCOCK H-40	5/20/2003	845	0.50	299	5.98	
1623L	21FLPOLKHANCOCK H-53	5/20/2003	940	0.50	299	6.46	
1623L	21FLPOLKHANCOCK H-24	5/20/2003	1150	0.50	299	8.07	
1623L	21FLPOLKHANCOCK H-25	5/20/2003	1140	0.50	299	8.12	
1623L	21FLPOLKHANCOCK H-32	5/20/2003	1210	0.50	299	8.37	
1623L	21FLPOLKHANCOCK H-31	5/20/2003	1200	0.50	299	8.43	
1623L	21FLTPA 25020276	8/18/2003	900	0.20	299	6.40	
1623L	21FLPOLKHANCOCK H-4	8/20/2003	820	0.50	299	1.77	

WBID	Station	Date	Time	Depth	Storet Code	DO (mg/L)	R-Code
1623L	21FLPOLKHANCOCK H-23	8/20/2003	855	0.50	299	3.89	
1623L	21FLPOLKHANCOCK H-24	8/20/2003	850	0.50	299	4.38	
1623L	21FLPOLKHANCOCK H-37	8/20/2003	910	0.50	299	4.96	
1623L	21FLPOLKHANCOCK H-18	8/20/2003	840	0.50	299	5.19	
1623L	21FLPOLKHANCOCK H-39	8/20/2003	930	0.50	299	5.46	
1623L	21FLPOLKHANCOCK H-38	8/20/2003	920	0.50	299	5.61	
1623L	21FLPOLKHANCOCK H-47	8/20/2003	1050	0.50	299	5.92	
1623L	21FLPOLKHANCOCK H-61	8/20/2003	1025	0.50	299	6.07	
1623L	21FLPOLKHANCOCK H-51	8/20/2003	1000	0.50	299	6.36	
1623L	21FLPOLKHANCOCK H-59	8/20/2003	1015	0.50	299	8.42	
1623L	21FLPOLKHANCOCK H-48	8/20/2003	1040	0.50	299	8.45	
1623L	21FLTPA 25020276	11/3/2003	1040	0.20	299	4.76	
1623L	21FLPOLKHANCOCK H-49	11/18/2003	920	0.50	299	2.77	
1623L	21FLPOLKHANCOCK H-16	11/18/2003	1130	0.50	299	7.04	
1623L	21FLPOLKHANCOCK H-22	11/18/2003	1120	0.50	299	9.12	
1623L	21FLPOLKHANCOCK H-30	11/18/2003	1110	0.50	299	9.12	
1623L	21FLPOLKHANCOCK H-34	11/18/2003	945	0.50	299	9.38	
1623L	21FLPOLKHANCOCK H-40	11/18/2003	955	0.50	299	9.59	
1623L	21FLPOLKHANCOCK H-31	11/18/2003	1100	0.50	299	10.00	
1623L	21FLPOLKHANCOCK H-48	11/18/2003	905	0.50	299	10.36	
1623L	21FLPOLKHANCOCK H-54	11/18/2003	850	0.50	299	10.74	
1623L	21FLPOLKHANCOCK H-43	11/18/2003	1010	0.50	299	10.81	
1623L	21FLPOLKHANCOCK H-3	11/18/2003	1140	0.50	299	10.85	
1623L	21FLPOLKHANCOCK H-11	11/18/2003	1150	0.50	299	11.78	
1623L	21FLPOLKHANCOCK H-36	2/19/2004	920	0.50	299	9.84	
1623L	21FLPOLKHANCOCK H-22	2/19/2004	1055	0.50	299	10.14	
1623L	21FLPOLKHANCOCK H-62	2/19/2004	830	0.50	299	10.57	
1623L	21FLPOLKHANCOCK H-44	2/19/2004	905	0.50	299	10.67	
1623L	21FLPOLKHANCOCK H-59	2/19/2004	850	0.50	299	10.93	
1623L	21FLPOLKHANCOCK H-37	2/19/2004	935	0.50	299	10.95	
1623L	21FLPOLKHANCOCK H-34	2/19/2004	1000	0.50	299	11.34	
1623L	21FLPOLKHANCOCK H-24	2/19/2004	1110	0.50	299	11.87	
1623L	21FLPOLKHANCOCK H-9	2/19/2004	1130	0.50	299	11.89	
1623L	21FLPOLKHANCOCK H-33	2/19/2004	950	0.50	299	11.94	
1623L	21FLPOLKHANCOCK H-30	2/19/2004	1045	0.50	299	12.83	
1623L	21FLPOLKHANCOCK H-11	2/19/2004	1120	0.50	299	14.06	
1623L	21FLPOLKHANCOCK H-12	5/5/2004	950	0.50	299	4.65	
1623L	21FLPOLKHANCOCK H-36	5/5/2004	915	0.50	299	7.12	
1623L	21FLPOLKHANCOCK H-47	5/5/2004	805	0.50	299	7.66	
1623L	21FLPOLKHANCOCK H-50	5/5/2004	900	0.50	299	7.69	
1623L	21FLPOLKHANCOCK H-43	5/5/2004	910	0.50	299	7.90	
1623L	21FLPOLKHANCOCK H-40	5/5/2004	815	0.50	299	8.39	
1623L	21FLPOLKHANCOCK H-62	5/5/2004	745	0.50	299	8.43	
1623L	21FLPOLKHANCOCK H-3	5/5/2004	940	0.40	299	8.49	
1623L	21FLPOLKHANCOCK H-33	5/5/2004	825	0.50	299	8.49	
1623L	21FLPOLKHANCOCK H-31	5/5/2004	835	0.50	299	8.79	
1623L	21FLPOLKHANCOCK H-54	5/5/2004	755	0.50	299	8.99	

WBID	Station	Date	Time	Depth	Storet Code	DO (mg/L)	R-Code
1623L	21FLPOLKHANCOCK H-22	5/5/2004	925	0.40	299	9.03	

D: Field measurement.

Lower Saddle Creek TN Data

WBID	Station	Date	Time	Depth	Storet Code	TN (mg/L)	R-Code
1623K	21FLSWFDFLO0038	3/26/1992	1200	8.00	600	2.46	
1623K	21FLSWFDFLO0038	7/8/1992	1005	2.00	600	11.02	
1623K	112WRD 02294491	8/21/1992	1035	0.50	600	6.42	
1623K	21FLSWFDFLO0038	9/22/1992	1420	4.10	600	3.22	
1623K	112WRD 02294491	10/29/1992	1645	0.50	600	5.40	
1623K	21FLSWFDFLO0038	12/7/1992	1500	2.00	600	2.22	
1623K	21FLPOLKP.C. CANAL9	2/11/1993	1250	0.50	600	3.43	
1623K	21FLPOLKP.C. CANAL9	5/13/1993	910	0.20	600	4.24	
1623K	21FLPOLKP.C. CANAL9	8/17/1993	1320	0.30	600	5.11	
1623K	21FLPOLKP.C. CANAL9	11/23/1993	910	0.40	600	3.42	
1623K	112WRD 02294491	2/9/1994	1015	0.50	600	3.72	
1623K	112WRD 02294491	7/14/1994	1000	0.50	600	8.22	
1623K	112WRD 02294491	8/9/1994	1610	0.50	600	6.42	
1623K	112WRD 02294491	8/23/1994	1020	0.50	600	5.32	
1623K	21FLPOLKP.C. CANAL9	8/16/1995	1153	0.60	600	1.49	
1623K	21FLPOLKP.C. CANAL9	11/21/1995	915	0.50	600	2.55	
1623K	21FLPOLKP.C. CANAL9	2/7/1996	928	0.50	600	2.15	
1623K	21FLPOLKP.C. CANAL9	5/21/1996	815	0.50	600	5.10	
1623K	21FLPOLKP.C. CANAL9	8/14/1996	835	0.50	600	4.59	
1623K	21FLPOLKP.C. CANAL9	11/20/1996	825	0.50	600	1.78	
1623K	21FLPOLKP.C. CANAL9	2/12/1997	825	0.50	600	4.22	
1623K	21FLPOLKP.C. CANAL9	5/20/1997	830	0.50	600	2.67	
1623K	21FLPOLKP.C. CANAL9	8/12/1997	925	0.80	600	2.33	
1623K	21FLPOLKP.C. CANAL9	11/5/1997	1112	0.70	600	4.31	
1623K	21FLPOLKP.C. CANAL9	5/13/1998	1040	0.80	600	3.23	
1623K	21FLPOLKP.C. CANAL9	8/10/1998	1100	0.70	600	2.45	
1623K	21FLSWFDFLO 37 72 0	10/7/1998	900	0.30	600	0.89	
1623K	21FLSWFDFLO 37 72 0	11/9/1998	1115	0.30	600	1.20	
1623K	21FLPOLKP.C. CANAL9	11/12/1998	1050	0.50	600	4.83	
1623K	21FLSWFDFLO 37 72 0	12/17/1998	1130	0.30	600	0.39	
1623K	21FLSWFDFLO 37 72 0	1/5/1999	1615	0.30	600	1.30	
1623K	21FLSWFDFLO 37 72 0	1/7/1999	1355	0.50	600	0.59	
1623K	21FLPOLKP.C. CANAL9	2/1/1999	1030	0.25	600	2.49	
1623K	21FLSWFDFLO 37 72 0	2/9/1999	1200	0.80	600	0.73	
1623K	21FLSWFDFLO 37 72 0	3/1/1999	1650	0.50	600	1.70	
1623K	21FLSWFDFLO 37 72 0	3/24/1999	1135	0.50	600	0.88	
1623K	21FLSWFDFLO 37 72 0	4/5/1999	1030	0.80	600	1.50	
1623K	21FLSWFDFLO 37 72 0	4/6/1999	1245	0.50	600	1.20	
1623K	21FLPOLKP.C. CANAL9	4/14/1999	851	0.50	600	2.54	
1623K	21FLSWFDFLO 37 72 0	5/10/1999	1445	0.65	600	1.00	

WBID	Station	Date	Time	Depth	Storet Code	TN (mg/L)	R-Code
1623K	21FLSWFDFLO 37 72 0	6/9/1999	1000	0.75	600	1.30	
1623K	21FLPOLKP.C. CANAL9	7/14/1999	940	0.50	600	2.66	
1623K	21FLSWFDFLO 37 72 0	7/17/1999	925	0.30	600	1.30	
1623K	21FLSWFDFLO 37 72 0	8/16/1999	1030	0.50	600	1.00	
1623K	21FLSWFDFLO 37 72 0	9/16/1999	1040	0.50	600	1.90	
1623K	21FLSWFDFLO 37 72 0	10/4/1999	1410	0.50	600	1.10	
1623K	21FLPOLKP.C. CANAL9	1/13/2000	950	0.50	600	1.82	
1623K	21FLPOLKP.C. CANAL9	4/17/2000	900	0.50	600	5.05	
1623K	21FLSWFDFLO 37 72 0	5/3/2000	1100	0.50	600	1.15	
1623K	21FLPOLKP.C. CANAL9	7/18/2000	710	0.30	600	1.92	
1623K	21FLPOLKP.C. CANAL9	10/5/2000	1000	0.50	600	2.65	
1623K	21FLPOLKP.C. CANAL9	1/9/2001	1245	0.20	600	1.04	
1623K	21FLPOLKP.C. CANAL9	3/6/2001	1100	0.30	600	1.26	
1623K	21FLPOLKP.C. CANAL9	10/29/2001	1330	0.50	600	2.11	
1623K	21FLSWFDFLO 37 72 0	12/10/2001	1020	0.50	600	2.31	
1623K	21FLSWFDFLO 37 72 0	1/8/2002	1035	0.50	600	2.26	
1623K	21FLPOLKP.C. CANAL9	1/15/2002	1145	0.33	600	1.99	
1623K	21FLSWFDFLO 37 72 0	2/6/2002	915	0.50	600	2.27	
1623K	21FLSWFDFLO 37 72 0	3/4/2002	1110	0.50	600	2.34	
1623K	21FLSWFDFLO 37 72 0	4/2/2002	1115	0.50	600	2.59	
1623K	21FLPOLKP.C. CANAL9	4/17/2002	1055	0.15	600	1.54	
1623K	21FLSWFDFLO 37 72 0	5/6/2002	1050	0.50	600	3.24	
1623K	21FLSWFDFLO 37 72 0	7/4/2002	1530	0.50	600	2.50	
1623K	21FLPOLKP.C. CANAL9	7/24/2002	930	0.50	600	4.36	
1623K	21FLSWFDFLO 37 72 0	9/5/2002	1700	0.50	600	3.13	
1623K	21FLSWFDFLO 37 72 0	10/1/2002	1200	0.50	600	3.19	
1623K	21FLPOLKP.C. CANAL9	10/23/2002	930	0.30	600	3.60	
1623K	21FLSWFDFLO 37 72 0	11/4/2002	1040	0.50	600	3.11	
1623K	21FLSWFDFLO 37 72 0	12/4/2002	1050	0.50	600	3.16	
1623K	21FLPOLKP.C. CANAL9	1/28/2003	1005	0.50	600	2.07	
1623K	21FLPOLKP.C. CANAL9	4/16/2003	930	0.50	600	4.58	
1623K	21FLPOLKP.C. CANAL9	7/23/2003	915	0.50	600	6.42	
1623K	21FLPOLKP.C. CANAL9	10/8/2003	1020	0.50	600	2.74	
1623K	21FLPOLKP.C. CANAL9	1/7/2004	940	0.40	600	4.11	
1623K	21FLPOLKP.C. CANAL9	4/15/2004	955	0.25	600	5.03	

Lower Saddle Creek TP Data

WBID	Station	Date	Time	Depth	Storet Code	TP (mg/L)	R-Code
1623K	21FLSWFDFLO0038	3/26/1992	1200	8.00	665	0.07	
1623K	21FLSWFDFLO0038	7/8/1992	1005	2.00	665	0.88	
1623K	112WRD 02294491	8/21/1992	1035	0.50	665	0.42	
1623K	21FLSWFDFLO0038	9/22/1992	1420	4.10	665	0.26	
1623K	112WRD 02294491	9/25/1992	1130	0.50	665	0.17	
1623K	112WRD 02294491	10/29/1992	1645	0.50	665	0.76	
1623K	21FLSWFDFLO0038	12/7/1992	1500	2.00	665	0.42	
1623K	21FLPOLKP.C. CANAL9	2/11/1993	1250	0.50	665	0.28	
1623K	112WRD 02294491	4/16/1993	1150	0.50	665	0.47	
1623K	21FLPOLKP.C. CANAL9	5/13/1993	910	0.20	665	0.73	
1623K	112WRD 02294491	7/9/1993	1300	0.50	665	1.10	
1623K	21FLPOLKP.C. CANAL9	8/17/1993	1320	0.30	665	0.63	
1623K	112WRD 02294491	9/23/1993	1130	0.50	665	0.35	
1623K	112WRD 02294491	10/13/1993	1300	0.50	665	0.30	
1623K	21FLPOLKP.C. CANAL9	11/23/1993	910	0.40	665	1.17	
1623K	112WRD 02294491	2/9/1994	1015	0.50	665	0.24	
1623K	112WRD 02294491	7/14/1994	1000	0.50	665	0.20	
1623K	112WRD 02294491	8/9/1994	1610	0.50	665	0.15	
1623K	112WRD 02294491	8/23/1994	1020	0.50	665	0.33	
1623K	21FLPOLKP.C. CANAL9	8/16/1995	1153	0.60	665	0.40	
1623K	21FLPOLKP.C. CANAL9	11/21/1995	915	0.50	665	0.58	
1623K	21FLPOLKP.C. CANAL9	2/7/1996	928	0.33	665	0.30	
1623K	21FLPOLKP.C. CANAL9	5/21/1996	815	0.33	665	0.62	
1623K	21FLPOLKP.C. CANAL9	8/14/1996	835	0.33	665	0.65	
1623K	21FLPOLKP.C. CANAL9	11/20/1996	825	0.33	665	0.38	
1623K	21FLPOLKP.C. CANAL9	2/12/1997	825	0.50	665	0.30	
1623K	21FLPOLKP.C. CANAL9	5/20/1997	830	0.50	665	0.58	
1623K	21FLSWFDFLO 37 72 0	8/4/1997	1200	1.00	665	0.39	
1623K	21FLPOLKP.C. CANAL9	8/12/1997	925	0.80	665	0.21	
1623K	21FLSWFDFLO 37 72 0	9/10/1997	1030	1.00	665	0.15	
1623K	21FLSWFDFLO 37 72 0	10/6/1997	1130	1.00	665	0.39	
1623K	21FLSWFDFLO 37 72 0	11/3/1997	1040	0.30	665	0.45	
1623K	21FLPOLKP.C. CANAL9	11/5/1997	1112	0.70	665	0.35	
1623K	21FLSWFDFLO 37 72 0	1/22/1998	1330	0.50	665	0.03	
1623K	21FLSWFDFLO 37 72 0	2/2/1998	1040	0.70	665	0.55	
1623K	21FLPOLKP.C. CANAL9	2/10/1998	1130	1.40	665	0.60	
1623K	21FLSWFDFLO 37 72 0	3/2/1998	1015	0.30	665	0.65	
1623K	21FLSWFDFLO 37 72 0	3/26/1998	1030	0.50	665	0.02	
1623K	21FLSWFDFLO 37 72 0	4/6/1998	1010	0.30	665	0.51	
1623K	21FLSWFDFLO 37 72 0	4/15/1998	1125	0.50	665	0.03	
1623K	21FLSWFDFLO 37 72 0	5/4/1998	1215	0.30	665	0.60	
1623K	21FLPOLKP.C. CANAL9	5/13/1998	1040	0.80	665	0.57	
1623K	21FLSWFDFLO 37 72 0	5/15/1998	1100	0.50	665	0.04	
1623K	21FLSWFDFLO 37 72 0	6/1/1998	1045	0.30	665	0.40	
1623K	21FLSWFDFLO 37 72 0	6/16/1998	1345	0.50	665	0.02	

WBID	Station	Date	Time	Depth	Storet Code	TP (mg/L)	R-Code
1623K	21FLSWFDFLO 37 72 0	7/6/1998	1100	0.30	665	0.71	
1623K	21FLSWFDFLO 37 72 0	7/28/1998	1230	0.50	665	0.02	
1623K	21FLSWFDFLO 37 72 0	8/3/1998	1130	0.60	665	0.58	
1623K	21FLPOLKP.C. CANAL9	8/10/1998	1100	0.70	665	0.47	
1623K	21FLSWFDFLO 37 72 0	8/11/1998	1230	0.50	665	0.03	
1623K	21FLSWFDFLO 37 72 0	9/8/1998	1015	0.30	665	0.60	
1623K	21FLSWFDFLO 37 72 0	9/10/1998	1245	0.50	665	0.01	
1623K	21FLSWFDFLO 37 72 0	10/7/1998	900	0.30	665	0.31	
1623K	21FLSWFDFLO 37 72 0	10/12/1998	1545	0.50	665	0.03	
1623K	21FLSWFDFLO 37 72 0	11/9/1998	1115	0.30	665	0.29	
1623K	21FLPOLKP.C. CANAL9	11/12/1998	1050	0.50	665	0.66	
1623K	21FLSWFDFLO 37 72 0	12/9/1998	1355	0.50	665	0.02	
1623K	21FLSWFDFLO 37 72 0	12/17/1998	1130	0.30	665	0.24	
1623K	21FLSWFDFLO 37 72 0	1/5/1999	1615	0.30	665	0.33	
1623K	21FLSWFDFLO 37 72 0	1/7/1999	1355	.	665	0.03	
1623K	21FLPOLKP.C. CANAL9	2/1/1999	1030	0.25	665	0.44	
1623K	21FLSWFDFLO 37 72 0	2/9/1999	1200	0.80	665	0.28	
1623K	21FLSWFDFLO 37 72 0	3/1/1999	1650	0.50	665	0.15	
1623K	21FLSWFDFLO 37 72 0	3/24/1999	1135	0.50	665	0.03	
1623K	21FLSWFDFLO 37 72 0	4/5/1999	1030	0.80	665	0.31	
1623K	21FLSWFDFLO 37 72 0	4/6/1999	1245	0.50	665	0.02	
1623K	21FLPOLKP.C. CANAL9	4/14/1999	851	0.50	665	0.72	
1623K	21FLSWFDFLO 37 72 0	5/10/1999	1445	0.65	665	0.44	
1623K	21FLSWFDFLO 37 72 0	6/9/1999	1000	0.75	665	0.50	
1623K	21FLPOLKP.C. CANAL9	7/14/1999	940	0.50	665	0.33	
1623K	21FLSWFDFLO 37 72 0	7/17/1999	925	0.30	665	0.16	
1623K	21FLSWFDFLO 37 72 0	8/16/1999	1030	0.50	665	0.18	
1623K	21FLSWFDFLO 37 72 0	9/16/1999	1040	0.50	665	0.56	
1623K	21FLSWFDFLO 37 72 0	10/4/1999	1410	0.50	665	0.18	
1623K	21FLPOLKP.C. CANAL9	10/5/1999	950	1.63	665	0.37	
1623K	21FLSWFDFLO 37 72 0	11/1/1999	930	0.50	665	0.05	
1623K	21FLSWFDFLO 37 72 0	12/8/1999	1000	0.50	665	0.10	
1623K	21FLSWFDFLO 37 72 0	1/5/2000	1030	0.50	665	0.16	
1623K	21FLPOLKP.C. CANAL9	1/13/2000	950	0.50	665	0.15	
1623K	21FLSWFDFLO 37 72 0	2/8/2000	1130	0.50	665	0.33	
1623K	21FLSWFDFLO 37 72 0	3/15/2000	1100	0.50	665	0.21	
1623K	21FLPOLKP.C. CANAL9	4/17/2000	900	0.50	665	0.69	
1623K	21FLSWFDFLO 37 72 0	5/3/2000	1100	0.50	665	0.07	
1623K	21FLSWFDFLO 37 72 0	5/11/2000	1000	0.50	665	0.64	
1623K	21FLSWFDFLO 37 72 0	6/6/2000	1155	0.50	665	0.03	
1623K	21FLSWFDFLO 37 72 0	6/8/2000	1100	0.50	665	0.96	
1623K	21FLSWFDFLO 37 72 0	7/6/2000	1445	0.50	665	0.40	
1623K	21FLPOLKP.C. CANAL9	7/18/2000	710	0.30	665	0.86	
1623K	21FLSWFDFLO 37 72 0	8/1/2000	1145	0.50	665	0.03	
1623K	21FLSWFDFLO 37 72 0	8/8/2000	1500	0.50	665	0.33	
1623K	21FLSWFDFLO 37 72 0	9/12/2000	1000	0.50	665	0.52	
1623K	21FLSWFDFLO 37 72 0	9/13/2000	1145	0.50	665	0.04	

WBID	Station	Date	Time	Depth	Storet Code	TP (mg/L)	R-Code
1623K	21FLSWFDFLO 37 72 0	10/3/2000	1510	0.50	665	0.39	
1623K	21FLPOLKP.C. CANAL9	10/5/2000	1000	0.50	665	1.90	
1623K	21FLSWFDFLO 37 72 0	10/17/2000	1530	0.50	665	0.03	
1623K	21FLSWFDFLO 37 72 0	11/1/2000	1120	0.50	665	0.02	
1623K	21FLSWFDFLO 37 72 0	11/6/2000	1430	0.50	665	1.96	
1623K	21FLSWFDFLO 37 72 0	12/6/2000	1330	0.50	665	1.27	
1623K	21FLPOLKP.C. CANAL9	1/9/2001	1245	0.20	665	0.35	
1623K	21FLSWFDFLO 37 72 0	2/7/2001	1545	0.55	665	3.21	
1623K	21FLPOLKP.C. CANAL9	3/6/2001	1100	0.30	665	0.62	
1623K	21FLSWFDFLO 37 72 0	3/7/2001	945	0.50	665	2.95	
1623K	21FLSWFDFLO 37 72 0	4/3/2001	1015	0.50	665	1.42	
1623K	21FLSWFDFLO 37 72 0	5/9/2001	1040	0.50	665	1.20	
1623K	21FLSWFDFLO 37 72 0	6/5/2001	940	0.32	665	1.38	
1623K	21FLSWFDFLO 37 72 0	8/9/2001	1330	0.50	665	10.50	
1623K	21FLSWFDFLO 37 72 0	9/4/2001	1050	0.50	665	2.17	
1623K	21FLSWFDFLO 37 72 0	10/2/2001	1050	0.50	665	0.72	
1623K	21FLPOLKP.C. CANAL9	10/29/2001	1330	0.50	665	1.01	
1623K	21FLSWFDFLO 37 72 0	12/10/2001	1020	0.50	665	0.88	
1623K	21FLSWFDFLO 37 72 0	1/8/2002	1035	0.50	665	0.92	
1623K	21FLPOLKP.C. CANAL9	1/15/2002	1145	0.33	665	0.53	
1623K	21FLSWFDFLO 37 72 0	2/6/2002	915	0.50	665	0.88	
1623K	21FLSWFDFLO 37 72 0	3/4/2002	1110	0.50	665	0.75	
1623K	21FLSWFDFLO 37 72 0	4/2/2002	1115	0.50	665	0.66	
1623K	21FLPOLKP.C. CANAL9	4/17/2002	1055	0.15	665	1.06	
1623K	21FLSWFDFLO 37 72 0	5/6/2002	1050	0.50	665	0.51	
1623K	21FLSWFDFLO 37 72 0	7/4/2002	1530	0.50	665	0.92	
1623K	21FLPOLKP.C. CANAL9	7/24/2002	930	0.50	665	0.61	
1623K	21FLSWFDFLO 37 72 0	9/5/2002	1700	0.50	665	0.80	
1623K	21FLSWFDFLO 37 72 0	10/1/2002	1200	0.50	665	0.38	
1623K	21FLPOLKP.C. CANAL9	10/23/2002	930	0.30	665	0.67	
1623K	21FLSWFDFLO 37 72 0	11/4/2002	1040	0.50	665	0.76	
1623K	21FLSWFDFLO 37 72 0	12/4/2002	1050	0.50	665	0.21	
1623K	21FLPOLKP.C. CANAL9	1/28/2003	1005	0.50	665	0.53	
1623K	21FLTPA 27552158149358	2/5/2003	1345	0.20	665	0.73	
1623K	21FLPOLKP.C. CANAL9	4/16/2003	930	0.50	665	1.01	
1623K	21FLTPA 27552158149358	4/22/2003	1000	0.20	665	1.10	
1623K	21FLPOLKP.C. CANAL9	7/23/2003	915	0.50	665	0.97	
1623K	21FLTPA 27552158149358	8/19/2003	950	0.20	665	0.66	
1623K	21FLPOLKP.C. CANAL9	10/8/2003	1020	0.50	665	0.85	
1623K	21FLTPA 27552158149358	11/4/2003	1145	0.20	665	0.78	
1623K	21FLPOLKP.C. CANAL9	1/7/2004	940	0.40	665	1.04	
1623K	21FLPOLKP.C. CANAL9	4/15/2004	955	0.25	665	1.23	

Lower Saddle Creek Chlorophyll a Data

WBID	Station	Date	Time	Depth	Storet Code	Chla (µg/L)	R-Code
1623K	21FLPOLKP.C. CANAL9	8/16/1995	1153	1.97	32210	118.2	
1623K	21FLPOLKP.C. CANAL9	11/21/1995	915	0.33	32210	109.2	
1623K	21FLPOLKP.C. CANAL9	2/7/1996	928	0.33	32210	42.8	
1623K	21FLPOLKP.C. CANAL9	5/21/1996	815	0.33	32210	201.9	
1623K	21FLPOLKP.C. CANAL9	8/14/1996	835	0.33	32210	157.7	
1623K	21FLPOLKP.C. CANAL9	11/20/1996	825	0.33	32210	59.5	
1623K	21FLPOLKP.C. CANAL9	2/12/1997	825	2.95	32210	141.8	
1623K	21FLPOLKP.C. CANAL9	5/20/1997	830	1.31	32210	110.1	
1623K	21FLSWFDFLO 37 72 0	8/4/1997	1200	1.00	32209	114.9	
1623K	21FLPOLKP.C. CANAL9	8/12/1997	925	2.62	32210	71.7	
1623K	21FLSWFDFLO 37 72 0	9/10/1997	1030	1.00	32209	61.4	
1623K	21FLSWFDFLO 37 72 0	10/6/1997	1130	1.00	32209	43.0	
1623K	21FLSWFDFLO 37 72 0	11/3/1997	1040	0.30	32209	112.9	
1623K	21FLPOLKP.C. CANAL9	11/5/1997	1112	2.30	32210	136.0	
1623K	21FLSWFDFLO 37 72 0	12/1/1997	1035	1.40	32210	195.0	
1623K	21FLSWFDFLO 37 72 0	12/1/1997	1035	1.40	32209	96.1	
1623K	21FLSWFDFLO 37 72 0	1/22/1998	1330	0.50	32209	5.3	
1623K	21FLSWFDFLO 37 72 0	2/2/1998	1040	0.70	32209	53.4	
1623K	21FLSWFDFLO 37 72 0	3/2/1998	1015	0.30	32209	229.6	
1623K	21FLSWFDFLO 37 72 0	3/26/1998	1030	0.50	32209	1.6	
1623K	21FLSWFDFLO 37 72 0	4/6/1998	1010	0.30	32209	133.5	
1623K	21FLSWFDFLO 37 72 0	4/15/1998	1125	0.50	32209	1.0	
1623K	21FLSWFDFLO 37 72 0	5/4/1998	1215	0.30	32209	80.1	
1623K	21FLSWFDFLO 37 72 0	5/15/1998	1100	0.50	32209	1.6	
1623K	21FLSWFDFLO 37 72 0	6/1/1998	1045	0.30	32210	166.0	
1623K	21FLSWFDFLO 37 72 0	6/1/1998	1045	0.30	32209	138.8	
1623K	21FLSWFDFLO 37 72 0	6/16/1998	1345	0.50	32209	4.8	
1623K	21FLSWFDFLO 37 72 0	7/6/1998	1100	0.30	32209	267.0	
1623K	21FLSWFDFLO 37 72 0	7/28/1998	1230	0.50	32209	4.3	
1623K	21FLSWFDFLO 37 72 0	8/3/1998	1130	0.60	32209	96.1	
1623K	21FLSWFDFLO 37 72 0	8/11/1998	1230	0.50	32210	5.0	
1623K	21FLSWFDFLO 37 72 0	8/11/1998	1230	0.50	32209	1.0	
1623K	21FLSWFDFLO 37 72 0	9/8/1998	1015	0.30	32209	96.1	
1623K	21FLSWFDFLO 37 72 0	9/10/1998	1245	0.50	32209	3.7	
1623K	21FLSWFDFLO 37 72 0	10/7/1998	900	0.30	32209	93.5	
1623K	21FLSWFDFLO 37 72 0	10/12/1998	1545	0.50	32209	10.7	
1623K	21FLSWFDFLO 37 72 0	11/9/1998	1115	0.30	32209	203.0	
1623K	21FLSWFDFLO 37 72 0	11/9/1998	1320	0.50	32209	3.7	
1623K	21FLSWFDFLO 37 72 0	12/9/1998	1355	0.50	32209	1.6	
1623K	21FLSWFDFLO 37 72 0	12/17/1998	1130	0.30	32209	98.6	
1623K	21FLSWFDFLO 37 72 0	1/5/1999	1615	0.30	32209	223.0	
1623K	21FLSWFDFLO 37 72 0	1/7/1999	1355	0.50	32209	83.5	
1623K	21FLPOLKP.C. CANAL9	2/1/1999	1030	0.25	32223	52.1	
1623K	21FLSWFDFLO 37 72 0	2/9/1999	1200	0.80	32209	79.3	
1623K	21FLSWFDFLO 37 72 0	3/1/1999	1650	0.50	32209	110.0	

WBID	Station	Date	Time	Depth	Storet Code	Chl*a* (μg/L)	R-Code
1623K	21FLSWFDFLO 37 72 0	3/24/1999	1135	0.50	32209	7.4	
1623K	21FLSWFDFLO 37 72 0	4/5/1999	1030	0.80	32209	172.1	
1623K	21FLSWFDFLO 37 72 0	4/6/1999	1245	0.50	32209	31.3	
1623K	21FLPOLKP.C. CANAL9	4/14/1999	851	0.50	32223	52.1	
1623K	21FLSWFDFLO 37 72 0	5/10/1999	1445	0.65	32209	229.0	
1623K	21FLSWFDFLO 37 72 0	6/9/1999	1000	0.75	32209	310.0	
1623K	21FLPOLKP.C. CANAL9	7/14/1999	940	0.50	32223	108.1	
1623K	21FLSWFDFLO 37 72 0	7/17/1999	925	0.30	32209	88.1	
1623K	21FLSWFDFLO 37 72 0	8/16/1999	1030	0.50	32209	115.0	
1623K	21FLSWFDFLO 37 72 0	9/16/1999	1040	0.50	32209	333.0	
1623K	21FLSWFDFLO 37 72 0	10/4/1999	1410	0.50	32209	350.0	
1623K	21FLSWFDFLO 37 72 0	11/1/1999	930	0.50	32209	71.8	
1623K	21FLSWFDFLO 37 72 0	12/8/1999	1000	0.50	32209	63.1	
1623K	21FLSWFDFLO 37 72 0	1/5/2000	1030	0.50	32209	45.4	
1623K	21FLPOLKP.C. CANAL9	1/13/2000	950	0.50	32223	32.0	
1623K	21FLSWFDFLO 37 72 0	2/8/2000	1130	0.50	32209	32.0	
1623K	21FLSWFDFLO 37 72 0	3/15/2000	1100	0.50	32209	13.4	
1623K	21FLPOLKP.C. CANAL9	4/17/2000	900	0.50	32223	100.2	
1623K	21FLSWFDFLO 37 72 0	5/3/2000	1100	0.50	32209	1.0	
1623K	21FLSWFDFLO 37 72 0	5/11/2000	1000	0.50	32209	117.0	
1623K	21FLSWFDFLO 37 72 0	6/6/2000	1155	0.50	32209	1.0	
1623K	21FLSWFDFLO 37 72 0	6/8/2000	1100	0.50	32209	512.0	
1623K	21FLSWFDFLO 37 72 0	7/6/2000	1340	0.50	32209	3.2	
1623K	21FLSWFDFLO 37 72 0	7/6/2000	1445	0.50	32209	66.8	
1623K	21FLPOLKP.C. CANAL9	7/18/2000	710	0.30	32223	32.4	
1623K	21FLSWFDFLO 37 72 0	8/1/2000	1145	0.50	32209	1.1	
1623K	21FLSWFDFLO 37 72 0	8/8/2000	1500	0.50	32209	117.0	
1623K	21FLSWFDFLO 37 72 0	9/12/2000	1000	0.50	32209	21.4	
1623K	21FLSWFDFLO 37 72 0	9/13/2000	1145	0.50	32209	6.4	
1623K	21FLSWFDFLO 37 72 0	10/3/2000	1510	0.50	32209	14.7	
1623K	21FLPOLKP.C. CANAL9	10/5/2000	1000	0.50	32223	1.0	
1623K	21FLSWFDFLO 37 72 0	10/17/2000	1530	0.50	32209	3.6	
1623K	21FLSWFDFLO 37 72 0	11/1/2000	1120	0.50	32209	1.0	
1623K	21FLSWFDFLO 37 72 0	11/6/2000	1430	0.50	32209	363.0	
1623K	21FLSWFDFLO 37 72 0	12/6/2000	1330	0.50	32209	246.0	
1623K	21FLPOLKP.C. CANAL9	1/9/2001	1245	0.20	32223	3.2	
1623K	21FLSWFDFLO 37 72 0	2/7/2001	1545	0.55	32209	612.0	
1623K	21FLPOLKP.C. CANAL9	3/6/2001	1100	0.30	32223	4.0	
1623K	21FLSWFDFLO 37 72 0	3/7/2001	945	0.50	32209	260.0	
1623K	21FLSWFDFLO 37 72 0	4/3/2001	1015	0.50	32209	240.0	
1623K	21FLSWFDFLO 37 72 0	5/9/2001	1040	0.50	32209	58.7	
1623K	21FLSWFDFLO 37 72 0	6/5/2001	940	0.32	32209	62.7	
1623K	21FLSWFDFLO 37 72 0	8/9/2001	1330	0.50	32209	1.0	
1623K	21FLSWFDFLO 37 72 0	9/4/2001	1050	0.50	32209	21.4	
1623K	21FLSWFDFLO 37 72 0	10/2/2001	1050	0.50	32209	17.4	
1623K	21FLPOLKP.C. CANAL9	10/29/2001	1330	0.50	32223	115.3	
1623K	21FLSWFDFLO 37 72 0	12/10/2001	1020	0.50	32209	44.1	

WBID	Station	Date	Time	Depth	Storet Code	Chla (µg/L)	R-Code
1623K	21FLSWFDFLO 37 72 0	1/8/2002	1035	0.50	32209	29.7	
1623K	21FLPOLKP.C. CANAL9	1/15/2002	1145	0.33	32223	40.1	
1623K	21FLSWFDFLO 37 72 0	2/6/2002	915	0.50	32209	36.3	
1623K	21FLSWFDFLO 37 72 0	3/4/2002	1110	0.50	32209	104.7	
1623K	21FLSWFDFLO 37 72 0	4/2/2002	1115	0.50	32209	59.1	
1623K	21FLPOLKP.C. CANAL9	4/17/2002	1055	0.15	32223	24.8	
1623K	21FLSWFDFLO 37 72 0	5/6/2002	1050	0.50	32209	151.0	
1623K	21FLSWFDFLO 37 72 0	7/4/2002	1530	0.50	32209	91.8	
1623K	21FLPOLKP.C. CANAL9	7/24/2002	930	0.50	32223	108.1	
1623K	21FLSWFDFLO 37 72 0	9/5/2002	1700	0.50	32209	120.0	
1623K	21FLSWFDFLO 37 72 0	10/1/2002	1200	0.50	32209	133.0	
1623K	21FLPOLKP.C. CANAL9	10/23/2002	930	0.30	32223	76.1	
1623K	21FLSWFDFLO 37 72 0	11/4/2002	1040	0.50	32209	241.0	
1623K	21FLSWFDFLO 37 72 0	12/4/2002	1050	0.50	32209	90.6	
1623K	21FLTPA 27552158149358	2/5/2003	1345	0.20	32209	100.0	
1623K	21FLTPA 27552158149358	4/22/2003	1000	0.20	32209	240.0	
1623K	21FLTPA 27552158149358	8/19/2003	950	0.20	32209	260.0	
1623K	21FLTPA 27552158149358	11/4/2003	1145	0.20	32209	54.0	
1623K	21FLPOLKP.C. CANAL9	4/15/2004	955	0.25	32210	148.0	

Lower Saddle Creek Dissolved Oxygen Data

WBID	Station	Date	Time	Depth	Storet Code	DO (mg/L)	R-Code
1623K	21FLSWFDFLO0038	3/26/1992	1200	0.80	299	5.12	
1623K	21FLSWFDFLO0038	7/8/1992	1045	2.00	299	1.43	
1623K	21FLSWFDFLO0038	9/22/1992	1420	4.59	299	1.67	
1623K	112WRD 02294491	9/25/1992	1130	0.50	300	7.60	
1623K	112WRD 02294491	10/29/1992	1645	0.50	300	1.40	
1623K	21FLSWFDFLO0038	12/7/1992	1500	1.64	299	12.29	
1623K	21FLPOLKP.C. CANAL9	2/11/1993	1250	0.50	299	6.70	
1623K	112WRD 02294491	4/16/1993	1150	0.50	300	8.00	
1623K	21FLPOLKP.C. CANAL9	5/13/1993	910	0.20	299	5.00	
1623K	112WRD 02294491	7/9/1993	1300	0.50	300	4.00	
1623K	21FLPOLKP.C. CANAL9	8/17/1993	1320	0.30	299	2.60	
1623K	112WRD 02294491	9/23/1993	1130	0.50	300	5.70	
1623K	112WRD 02294491	10/13/1993	1300	0.50	300	7.20	
1623K	21FLPOLKP.C. CANAL9	11/23/1993	910	0.40	299	1.70	
1623K	112WRD 02294491	8/9/1994	1610	0.50	300	13.50	
1623K	112WRD 02294491	8/23/1994	1020	0.50	300	7.90	
1623K	21FLPOLKP.C. CANAL9	8/16/1995	1153	0.60	299	5.40	
1623K	21FLPOLKP.C. CANAL9	11/21/1995	915	0.33	299	6.80	
1623K	21FLPOLKP.C. CANAL9	2/7/1996	928	0.33	299	12.50	
1623K	21FLPOLKP.C. CANAL9	5/21/1996	815	0.33	299	4.10	
1623K	21FLPOLKP.C. CANAL9	8/14/1996	835	0.33	299	5.10	
1623K	21FLPOLKP.C. CANAL9	11/20/1996	825	0.33	299	8.80	
1623K	21FLPOLKP.C. CANAL9	2/12/1997	825	0.00	299	10.34	

WBID	Station	Date	Time	Depth	Storet Code	DO (mg/L)	R-Code
1623K	21FLPOLKP.C. CANAL9	5/20/1997	830	0.00	299	6.04	
1623K	21FLSWFDFLO 37 72 0	8/4/1997	1200	1.00	299	6.39	
1623K	21FLPOLKP.C. CANAL9	8/12/1997	925	0.80	299	6.88	
1623K	21FLSWFDFLO 37 72 0	9/10/1997	1030	1.00	299	6.44	
1623K	21FLSWFDFLO 37 72 0	10/6/1997	1130	1.00	299	4.71	
1623K	21FLSWFDFLO 37 72 0	11/3/1997	1040	0.30	299	6.68	
1623K	21FLPOLKP.C. CANAL9	11/5/1997	1112	0.70	299	11.03	
1623K	21FLSWFDFLO 37 72 0	12/1/1997	1035	1.40	299	7.18	
1623K	21FLSWFDFLO 37 72 0	1/22/1998	1330	S	299	7.98	
1623K	21FLSWFDFLO 37 72 0	2/2/1998	1040	0.70	299	8.94	
1623K	21FLPOLKP.C. CANAL9	2/10/1998	1130	1.40	299	12.18	
1623K	21FLSWFDFLO 37 72 0	3/2/1998	1015	0.30	299	7.83	
1623K	21FLSWFDFLO 37 72 0	3/26/1998	1030	B	299	7.57	
1623K	21FLSWFDFLO 37 72 0	4/6/1998	1010	0.30	299	6.89	
1623K	21FLSWFDFLO 37 72 0	4/15/1998	1125	B	299	6.70	
1623K	21FLSWFDFLO 37 72 0	5/4/1998	1215	0.30	299	6.13	
1623K	21FLPOLKP.C. CANAL9	5/13/1998	1040	0.80	299	4.76	
1623K	21FLSWFDFLO 37 72 0	5/15/1998	1100	S	299	5.32	
1623K	21FLSWFDFLO 37 72 0	6/1/1998	1045	0.30	299	6.60	
1623K	21FLSWFDFLO 37 72 0	6/16/1998	1345	S	299	9.35	
1623K	21FLSWFDFLO 37 72 0	7/6/1998	1100	0.30	299	1.70	
1623K	21FLSWFDFLO 37 72 0	7/28/1998	1230	S	299	2.95	
1623K	21FLSWFDFLO 37 72 0	8/3/1998	1130	0.60	299	4.00	
1623K	21FLPOLKP.C. CANAL9	8/10/1998	1100	0.70	299	5.91	
1623K	21FLSWFDFLO 37 72 0	8/11/1998	1230	S	299	9.36	
1623K	21FLSWFDFLO 37 72 0	9/8/1998	1015	0.30	299	2.19	
1623K	21FLSWFDFLO 37 72 0	9/10/1998	1245	S	299	7.17	
1623K	21FLSWFDFLO 37 72 0	10/7/1998	900	0.30	299	5.77	
1623K	21FLSWFDFLO 37 72 0	10/12/1998	1545	B	299	5.22	
1623K	21FLSWFDFLO 37 72 0	11/9/1998	1320	S	299	3.54	
1623K	21FLPOLKP.C. CANAL9	11/12/1998	1050	0.50	299	7.20	
1623K	21FLSWFDFLO 37 72 0	12/9/1998	1355	S	299	7.44	
1623K	21FLSWFDFLO 37 72 0	12/17/1998	1130	0.30	299	7.89	
1623K	21FLSWFDFLO 37 72 0	1/5/1999	1615	0.30	299	7.74	
1623K	21FLSWFDFLO 37 72 0	1/7/1999	1355	S	299	7.61	
1623K	21FLPOLKP.C. CANAL9	2/1/1999	1030	0.25	299	8.36	
1623K	21FLSWFDFLO 37 72 0	2/9/1999	1200	0.80	299	7.75	
1623K	21FLSWFDFLO 37 72 0	3/1/1999	1650	0.50	299	8.31	
1623K	21FLSWFDFLO 37 72 0	3/24/1999	1135	S	299	9.06	
1623K	21FLSWFDFLO 37 72 0	4/5/1999	1030	0.80	299	5.05	
1623K	21FLSWFDFLO 37 72 0	4/6/1999	1245	S	299	3.14	
1623K	21FLPOLKP.C. CANAL9	4/14/1999	851	0.50	299	6.07	
1623K	21FLSWFDFLO 37 72 0	5/10/1999	1445	0.65	299	4.61	
1623K	21FLSWFDFLO 37 72 0	6/9/1999	1000	0.75	299	4.89	
1623K	21FLPOLKP.C. CANAL9	7/14/1999	940	0.50	299	5.49	
1623K	21FLSWFDFLO 37 72 0	7/17/1999	925	0.30	299	4.42	
1623K	21FLSWFDFLO 37 72 0	8/16/1999	1030	0.50	299	2.92	

WBID	Station	Date	Time	Depth	Storet Code	DO (mg/L)	R-Code
1623K	21FLSWFDFLO 37 72 0	9/16/1999	1040	0.50	299	3.15	
1623K	21FLSWFDFLO 37 72 0	10/4/1999	1410	0.50	299	7.97	
1623K	21FLSWFDFLO 37 72 0	11/1/1999	930	0.50	299	7.61	
1623K	21FLSWFDFLO 37 72 0	12/8/1999	1000	0.50	299	7.00	
1623K	21FLSWFDFLO 37 72 0	1/5/2000	1030	0.50	299	9.73	
1623K	21FLPOLKP.C. CANAL9	1/13/2000	950	0.50	299	8.72	
1623K	21FLSWFDFLO 37 72 0	2/8/2000	1130	0.50	299	11.61	
1623K	21FLSWFDFLO 37 72 0	3/15/2000	1100	0.50	299	6.81	
1623K	21FLPOLKP.C. CANAL9	4/17/2000	900	0.50	299	5.35	
1623K	21FLSWFDFLO 37 72 0	5/3/2000	1100	0.50	299	8.42	
1623K	21FLSWFDFLO 37 72 0	5/11/2000	1000	0.50	299	4.51	
1623K	21FLSWFDFLO 37 72 0	6/6/2000	1155	S	299	12.49	
1623K	21FLSWFDFLO 37 72 0	6/8/2000	1100	0.50	299	2.44	
1623K	21FLSWFDFLO 37 72 0	7/6/2000	1340	S	299	9.45	
1623K	21FLPOLKP.C. CANAL9	7/18/2000	710	0.30	299	1.21	
1623K	21FLSWFDFLO 37 72 0	8/1/2000	1145	S	299	10.91	
1623K	21FLSWFDFLO 37 72 0	8/8/2000	1500	0.50	299	1.75	
1623K	21FLSWFDFLO 37 72 0	9/12/2000	1000	0.50	299	4.44	
1623K	21FLSWFDFLO 37 72 0	9/13/2000	1145	S	299	8.83	
1623K	21FLSWFDFLO 37 72 0	10/3/2000	1510	0.50	299	5.97	
1623K	21FLPOLKP.C. CANAL9	10/5/2000	1000	0.50	299	0.47	
1623K	21FLSWFDFLO 37 72 0	10/17/2000	1530	S	299	9.34	
1623K	21FLSWFDFLO 37 72 0	11/1/2000	1120	S	299	9.17	
1623K	21FLSWFDFLO 37 72 0	11/6/2000	1430	0.50	299	5.49	
1623K	21FLSWFDFLO 37 72 0	12/6/2000	1330	0.50	299	3.18	
1623K	21FLPOLKP.C. CANAL9	1/9/2001	1245	0.20	299	9.99	
1623K	21FLSWFDFLO 37 72 0	2/7/2001	1545	0.55	299	15.56	
1623K	21FLPOLKP.C. CANAL9	3/6/2001	1100	0.30	299	5.70	
1623K	21FLSWFDFLO 37 72 0	3/7/2001	945	0.50	299	4.27	
1623K	21FLSWFDFLO 37 72 0	4/3/2001	1015	0.50	299	1.45	
1623K	21FLSWFDFLO 37 72 0	5/9/2001	1040	0.50	299	2.12	
1623K	21FLSWFDFLO 37 72 0	6/5/2001	940	0.32	299	0.31	
1623K	21FLSWFDFLO 37 72 0	8/9/2001	1330	0.50	299	3.97	
1623K	21FLSWFDFLO 37 72 0	9/4/2001	1050	0.50	299	4.87	
1623K	21FLSWFDFLO 37 72 0	10/2/2001	1050	0.50	299	9.60	
1623K	21FLPOLKP.C. CANAL9	10/29/2001	1330	0.50	299	9.01	
1623K	21FLSWFDFLO 37 72 0	1/8/2002	1035	0.50	299	1.45	
1623K	21FLPOLKP.C. CANAL9	1/15/2002	1145	0.33	299	6.55	
1623K	21FLSWFDFLO 37 72 0	2/6/2002	915	0.50	299	0.49	
1623K	21FLSWFDFLO 37 72 0	3/4/2002	1110	0.50	299	3.87	
1623K	21FLSWFDFLO 37 72 0	4/2/2002	1115	0.50	299	0.88	
1623K	21FLPOLKP.C. CANAL9	4/17/2002	1055	0.15	299	4.30	
1623K	21FLSWFDFLO 37 72 0	5/6/2002	1050	0.50	299	0.72	
1623K	21FLSWFDFLO 37 72 0	7/4/2002	1530	0.50	299	7.30	
1623K	21FLPOLKP.C. CANAL9	7/24/2002	930	0.50	299	2.78	
1623K	21FLSWFDFLO 37 72 0	9/5/2002	1700	0.50	299	7.60	
1623K	21FLSWFDFLO 37 72 0	10/1/2002	1200	0.50	299	6.45	

WBID	Station	Date	Time	Depth	Storet Code	DO (mg/L)	R-Code
1623K	21FLPOLKP.C. CANAL9	10/23/2002	930	0.30	299	2.42	
1623K	21FLSWFDFLO 37 72 0	11/4/2002	1040	0.50	299	0.52	
1623K	21FLSWFDFLO 37 72 0	12/4/2002	1050	0.50	299	11.16	
1623K	21FLPOLKP.C. CANAL9	1/28/2003	1005	0.50	299	9.52	
1623K	21FLTPA 27552158149358	2/5/2003	1345	0.20	299	7.65	
1623K	21FLPOLKP.C. CANAL9	4/16/2003	930	0.50	299	2.22	
1623K	21FLTPA 27552158149358	4/22/2003	1000	0.20	299	2.31	
1623K	21FLPOLKP.C. CANAL9	7/23/2003	915	0.50	299	0.84	
1623K	21FLTPA 27552158149358	8/19/2003	950	0.20	299	2.82	
1623K	21FLPOLKP.C. CANAL9	10/8/2003	1020	0.50	299	5.54	
1623K	21FLTPA 27552158149358	11/4/2003	1145	0.20	299	8.85	
1623K	21FLPOLKP.C. CANAL9	1/7/2004	940	0.40	299	7.69	
1623K	21FLPOLKP.C. CANAL9	4/15/2004	955	0.25	299	7.38	

Appendix F: SWET Watershed Assessment Model (WAM) Final Report for the Lake Hancock and Saddle Creek Basin (available upon request)

Appendix G: QEA, LLC, BATHTUB Model Final Report for the Lake Hancock and Saddle Creek Basin (available upon request)

Appendix H: WAM Watershed Assessment Model, Model Documentation and Users Manual, Soil and Water Engineering Technology, Inc., May, 2005 (available upon request)