

# LAKE & RESERVOIR ASSESSMENTS CHOWAN RIVER BASIN



**Merchants Millpond**

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Environmental Sciences Section  
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May 31, 2011

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## **GLOSSARY**

<b>Algae</b>	Small aquatic plants that occur as single cells, colonies, or filaments. May also be referred to as phytoplankton, although phytoplankton are a subset of algae.
<b>Algal biovolume</b>	The volume of all living algae in a unit area at a given point in time. To determine biovolume, individual cells in a known amount of sample are counted. Cells are measured to obtain their cell volume, which is used in calculating biovolume.
<b>Algal density</b>	The density of algae based on the number of units (single cells, filaments and/or colonies) present in a milliliter of water. The severity of an algae bloom is determined by the algal density as follows: Mild bloom = 10,000 to 20,000 units/ml Moderate bloom = 20,000 to 30,000 units/ml Severe bloom = 30,000 to 100,000 units/ml Extreme bloom = Greater than 100,000 units/ml
<b>Algal Growth Potential Test (AGPT)</b>	A test to determine the nutrient that is the most limiting to the growth of algae in a body of water. The sample water is split such that one sub-sample is given additional nitrogen, another is given phosphorus, a third may be given a combination of nitrogen and phosphorus, and one sub-sample is not treated and acts as the control. A specific species of algae is added to each sub-sample and is allowed to grow for a given period of time. The dry weights of algae in each sub-sample and the control are then measured to determine the rate of productivity in each treatment. The treatment (nitrogen or phosphorus) with the greatest algal productivity is said to be the limiting nutrient of the sample source. If the control sample has an algal dry weight greater than 5 mg/L, the source water is considered to be unlimited for either nitrogen or phosphorus.
<b>Centric diatom</b>	Diatoms are photosynthetic algae that have a siliceous skeleton (frustule) and are found in almost every aquatic environment including fresh and marine waters, soils, in fact almost anywhere moist. Centric diatoms are circular in shape and are often found in the water column.
<b>Chlorophyll a</b>	Chlorophyll <i>a</i> is an algal pigment that is used as an approximate measure of algal biomass. The concentration of chlorophyll <i>a</i> is used in the calculation of the NCTSI, and the value listed is a lake-wide average from all sampling locations.
<b>Clinograde</b>	In productive lakes where oxygen levels drop to zero in the lower waters near the bottom, the graphed changes in oxygen concentration from the surface to the lake bottom produces a curve known as clinograde curve.
<b>Cocoid</b>	Round or spherical shaped cell.
<b>Conductivity</b>	This is a measure of the ability of water to conduct an electrical current. This measure increases as water becomes more mineralized.
<b>Dissolved oxygen</b>	The range of surface concentrations found at the sampling locations.
<b>Dissolved oxygen saturation</b>	The capacity of water to absorb oxygen gas. Often expressed as a percentage, the amount of oxygen that can dissolve into water will change depending on a number of parameters, the most important being temperature. Dissolved oxygen saturation is inversely proportion to temperature, that is, as temperature increases, water's capacity for oxygen will decrease, and vice versa.
<b>Eutrophic</b>	Describes a lake with elevated biological productivity and low water transparency.

<b>Eutrophication</b>	The process of physical, chemical, and biological changes in a lake associated with the presence of one or more of the following: excessive nutrients, organic matter, silt enrichment and sedimentation.
<b>Limiting nutrient</b>	The plant nutrient present in lowest concentration relative to need limits growth such that addition of the limiting nutrient will stimulate additional growth. In north temperate lakes, phosphorus (P) is commonly the limiting nutrient for algal growth.
<b>Manganese</b>	A naturally occurring metal commonly found in soils and organic matter. As a trace nutrient, manganese is essential to all forms of biological life. Manganese in lakes is released from bottom sediments and enters the water column when the oxygen concentration in the water near the lake bottom is extremely low or absent. Manganese in lake water may cause taste and odor problems in drinking water and require additional treatment of the raw water at water treatment facilities to alleviate this problem.
<b>Mesotrophic</b>	Describes a lake with moderate biological productivity and water transparency.
<b>NCTSI</b>	North Carolina Trophic State Index was specifically developed for North Carolina lakes as part of the state's original Clean Lakes Classification Survey (NRCD 1982). Values for total organic nitrogen, total phosphorus, chlorophyll <i>a</i> and Secchi depth are used to calculate a numeric score representing the lake's degree of biological productivity.
<b>Oligotrophic</b>	Describes a lake with low biological productivity and high water transparency.
<b>pH</b>	The range of surface pH readings found at the sampling locations. This value is used to express the relative acidity or alkalinity of water.
<b>Photic zone</b>	The portion of the water column in which there is sufficient light for algal growth. DWQ considers 2 times the Secchi depth as depicting the photic zone.
<b>Secchi depth</b>	This is a measure of water transparency expressed in meters. This parameter is used in the calculation of the NCTSI value for the lake. The depth listed is an average value from all sampling locations in the lake.
<b>Temperature</b>	The range of surface temperatures found at the sampling locations.
<b>Total Kjeldahl nitrogen</b>	The sum of organic nitrogen and ammonia in a water body. High measurements of TKN typically results from sewage and manure discharges in water bodies.
<b>Total organic Nitrogen (TON)</b>	Total Organic Nitrogen (TON) can represent a major reservoir of nitrogen in aquatic systems during summer months. Similar to phosphorus, this concentration can be related to lake productivity and is used in the calculation of the NCTSI. The concentration listed is a lake-wide average from all sampling stations and is calculated by subtracting Ammonia concentrations from TKN concentrations.
<b>Total phosphorus (TP)</b>	Total phosphorus (TP) includes all forms of phosphorus that occur in water. This nutrient is essential for the growth of aquatic plants and is often the nutrient that limits the growth of phytoplankton. It is used to calculate the NCTSI. The concentration listed is a lake-wide average from all sampling stations.
<b>Trophic state</b>	This is a relative description of the biological productivity of a lake based on the calculated NCTSI value. Trophic states may range from extremely productive (Hypereutrophic) to very low productivity (Oligotrophic).
<b>Turbidity</b>	A measure of the ability of light to pass through a volume of water. Turbidity may be influenced by suspended sediment and/or algae in the water.
<b>Watershed</b>	A drainage area in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

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## **Overview**

The Chowan River basin is located in the northeastern coastal plain of North Carolina and includes all or parts of Northampton, Hertford, Gates, Bertie and Chowan Counties. The Chowan River is formed at the border of Virginia and North Carolina by the confluence of the Nottoway and Blackwater Rivers and flows southeastward into Albemarle Sound. The region in which the Chowan River flows has slow natural drainage, is heavy in clays and sand, and contains many man-made ditches to accommodate drainage for agriculture.

Mercury has been identified as a widespread contaminant in fish from all North Carolina coastal river basins. In the Chowan River basin, elevated mercury levels have been measured in long-lived piscivores such as largemouth bass and bowfin. Research indicates that atmospheric mercury deposition is a significant source for the observed mercury levels. A fish consumption advisory has been placed on largemouth bass, black crappie, catfish, chain pickerel, warmouth, Yellow perch and bowfin (or blackfish) caught east of I-85 and black crappie caught south and east of I-95 for mercury contamination was issued by the NC Department of Health and Human Services, Division of Public Health. This advisory includes lakes that support these fish in the Chowan River Basin (<http://www.epi.state.nc.us/epi/fish/current.html>).

Following the description of the assessment methodology used for the Chowan River Basin, there are individual summaries for each of the lakes and a two-paged matrix that distills the information used to make the lakes use support assessments. For additional information on a particular lake (including sampling data), please go to <http://www.esb.enr.state.nc.us/>.

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## **Assessment Methodology**

For this report, data from January 1, 2006 through September 30, 2010 were reviewed. All lakes were sampled during the summer from May through September of 2009. Data were assessed for deviations of the state's class C water quality standards for chlorophyll *a*, pH, dissolved oxygen, water temperature, turbidity, and surface metals. Other parameters discussed in this report include Secchi depth and percent dissolved oxygen saturation. Secchi depth provides a measure of water clarity and is used in calculating the trophic or nutrient enriched status of a lake. Percent dissolved oxygen saturation gives information on the amount of dissolved oxygen in the water column and may be increased by photosynthesis or depressed by oxygen-consuming decomposition.

Additional data considered as part of the use support assessment include historic DWQ water quality data, documented algal blooms and/or fish kills, problematic aquatic macrophytes, or listing on the EPA's 303(d) List of Impaired Waters.

For a more complete discussion of lake ecology and assessment, please go to <http://www.esb.enr.state.nc.us/>. The 1990 North Carolina Lake Assessment Report (downloadable from this website) contains a detailed chapter on ecological concepts that clarifies how the parameters discussed in this review relate to water quality and reservoir health.

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## LAKE & RESERVOIR ASSESSMENTS

HUC 03010203

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### Merchants Millpond

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<i>Ambient Lakes Program Name</i>	Merchants Millpond	
<i>Trophic Status (NC TSI)</i>	Hypereutrophic	
<i>Mean Depth (meters)</i>	1.2	
<i>Volume (10<sup>6</sup> m<sup>3</sup>)</i>	0.22	
<i>Watershed Area (mi<sup>2</sup>)</i>	79.0	
<i>Classification</i>	C NSW	
<i>Station</i>	CHO0153A	CHO0154A
<i>Number of Times Sampled</i>	5	5

Merchants Millpond, located in Gates County in the coastal plain region of North Carolina, has a rich and varied history. Originally called Norfleets Millpond, it was constructed in 1811 and contained a grist mill, a wheat mill and a saw mill. By the turn of the century, the mill was the largest in Gates County and became its chief trade center. A new mercantile business established at the pond enabled local farmers to shop while their whole grain corn and wheat were transformed into meal and flour. Thus, the millpond was given the name "merchants".

The mill was in operation until shortly after World War II. In 1973, the millpond and some adjacent lands were donated to the North Carolina Division of Parks and Recreation by Mr. A. B. Coleman and Merchants Millpond State Park was established. In December of that year, the Nature Conservancy conveyed the title of 925 acres of woodlands on the north side of the millpond to the state of North Carolina, and this area comprises the current boundaries of the park (NRCD 1978).

Merchants Millpond is a shallow lake with a maximum depth of five feet (1.5 meters), with major inflow coming from Lassiter Swamp Creek. The millpond drainage area is characterized by flat or gently rolling terrain with the majority being forested or wetlands, approximately one quarter is urbanized, and some also some agriculture. The millpond is used for recreational paddling and fishing.

ISU staff monitored Merchants Millpond five times in 2010. The millpond is shallow and very dry conditions in early summer reduced the water level. By July, the depth of the millpond at the upper sampling site (CHO153A) became too shallow to negotiate by boat and this site was dropped. In its place, a new sampling site near the dam (CHO155A) was established.

Because of the swamp-like nature of the Merchants Millpond, surface dissolved oxygen is naturally low. In 2010, surface dissolved oxygen values ranged from 2.3 mg/L in June at the upper end of the millpond (CHO153A) and 6.0 mg/L at the mid-lake sampling site (CHO154A) in July (Appendix A). Surface water temperatures ranged from 22.4°C in May to 29.6°C in July. Surface pH values ranged from 6.1 to 6.4 s.u. and conductivity ranged from 74 to 86 µmhos/cm. Secchi depths ranged from 0.3 to 1.1 meters. These physical measurements are similar to those previously recorded by DWQ staff for this millpond since 1981 when it was first monitored.

Total phosphorus concentrations ranged from 0.06 to 0.20 mg/L (Appendix A). Values for and nitrite plus nitrate were frequently less than the DWQ Laboratory detection level while total Kjeldahl nitrogen concentrations were at levels indicative of organic nitrogen loading. In the case of Merchant's Millpond, a portion of this nitrogen is from decaying organic material in the form of aquatic weeds, tree leaves and algae which release organic nitrogen compounds into the lake water. Total phosphorus concentrations ranged from 0.06 to 0.20 mg/L. Chlorophyll a values, an indicator of algae growth, were greater than the state water quality standard of 40 ug/L, at one or both lake sampling sites from May through August.

Based on the calculated NCTSI scores in 2010, Merchants Millpond was determined to be hypereutrophic (demonstrating exceptionally elevated biological productivity) in May and June and August and eutrophic (demonstrating elevated biological productivity) in July and September. The trophic state of Merchants Millpond has previously been determined to be eutrophic since it was first monitored by DWQ in 1981. The exceptionally dry conditions in the northeastern region of the state during the summer of 2010 may have contributed to the hypereutrophic conditions observed.

## Appendix A-Chowan River Basin Lake Data October 1, 2006 through September 31, 2010

SURFACE PHYSICAL DATA								
Lake	Date m/d/yr	Sampling Station	DO mg/L	Temp Water C	pH s.u.	Cond. µmhos/cm	Depth Secchi meters	DO Percent SAT
<b>MERCHANTS MILLPOND</b>	September 23, 2010	CHO154A	3.3	24.4	6.1	84	0.8	39.5%
	September 23, 2010	CHO155A	5.1	24.1	6.2	84	1.3	60.7%
	August 9, 2010	CHO154A	4.2	29.4	6.2	78	0.6	55.0%
	August 9, 2010	CHO155A	3.6	28.8	6.2	79	0.9	46.7%
	July 12, 2010	CHO154A	6.0	29.6	6.4	80	1.0	78.9%
	July 12, 2010	CHO155A	4.2	28.1	6.3	82	1.1	53.8%
	June 7, 2010	CHO0153A	2.3	27.0	6.2	83	0.3	28.9%
	June 7, 2010	CHO0154A	4.9	27.9	6.1	74	0.4	62.5%
	May 10, 2010	CHO0153A	5.2	22.4	6.3	86	0.6	59.9%
	May 10, 2010	CHO0154A	4.5	23.2	6.3	82	0.3	52.7%

PHOTIC ZONE DATA														
Lake	Date m/d/yr	Sampling Station	TP mg/L	TKN mg/L	NH3 mg/L	NOx mg/L	TN mg/L	TON mg/L	TIN mg/L	Chla µg/L	Solids Total mg/L	Total Solids Suspended mg/L	Turbidity NTU	COMMENTS
<b>MERCHANTS MILLPOND</b>	September 23, 2010	CHO154A	0.12	1.10	<0.02	<0.02	1.11	1.09	0.02	9.8	105	12.0	15.0	
	September 23, 2010	CHO155A	0.06	0.84	<0.02	<0.02	0.85	0.83	0.02	7.2	92	<6.2	2.1	
	August 9, 2010	CHO154A	0.14	1.20	<0.02			1.19		82	130	38.0	25.0	NO2 + NO3 (<0.04 mg/L) had lab code P.
	August 9, 2010	CHO155A	0.12	1.30	<0.02	<0.02	1.31	1.29	0.02	73	94	8.5	5.1	
	July 12, 2010	CHO154A	0.10	0.96	<0.02	<0.02	0.97	0.95	0.02	77	110	20.0	20.0	
	July 12, 2010	CHO155A	0.10	0.95	0.030	<0.02	0.96	0.92	0.04	43	97	<12.0	11.0	
	June 7, 2010	CHO0153A	0.18	1.40	<0.02	<0.02	1.41	1.39	0.02	62	120	8.5	6.8	
	June 7, 2010	CHO0154A	0.19	1.50	0.020	<0.02	1.51	1.48	0.03	36	140	42.0	25.0	
	May 10, 2010	CHO0153A	0.17	1.30	<0.02	<0.02	1.31	1.29	0.02	46	120	15.0	7.1	
	May 10, 2010	CHO0154A	0.20	1.20	<0.02	<0.02	1.21	1.19	0.02	56	140	24.0	15.0	