TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Total Mercury in Fish Tissue Residue

In

Lake Yonah (HUC 03060102)

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 a Total Maximum Daily Load (TMDL) for total mercury in fish tissue for Lake Yonah in the Savannah River Basin. Subsequent actions must be consistent with this TMDL.

James D. Giattina, Director
Water Management Division

Date

Table of Contents

Table of Figures

Table of Tables

TOTAL MAXIMUM DAILY LOAD (TMDL)

Total Mercury in Fish Tissue Residue

In the

In the Lake Yonah Watershed

Under the authority of Section 303(d) of the Clean Water Act, 33 U.S.C. 1251 et seq., as amended by the Water Quality Act of 1987, P.L. 100-4, the U.S. Environmental Protection Agency is hereby establishing a TMDL for total mercury for the protection of public health associated with the consumption of fish taken from Lake Yonah in Georgia.

The calculated allowable load of mercury that may come into Lake Yonah without exceeding the applicable water quality standard is 1.3 ng/l and **Error! Not a valid link.** kilograms per year. The applicable water quality standard is the State of Georgia's numeric interpretation of their narrative water quality standard for protection of human health from toxic substances. This interpretation provides that total mercury in Lake Yonah shall not exceed the level that will result in bioaccumulation of more than 0.3 mg/kg mercury in fish tissue residue.

1. Introduction

The U.S. Environmental Protection Agency (EPA) Region 4 is establishing this Total Maximum Daily Load (TMDL) for total mercury in Lake Yonah, Georgia from the confluence of Tugaloo and Tallulah Rivers in Habersham County. This segment was included on the State of Georgia's 2004 Section 303(d) list of impaired waters because mercury in fish tissue exceeded the numeric interpretation of the Georgia narrative water quality standard of 0.3 mg mercury/kg fish tissue (GAEPD, 2001).

The State of Georgia provided EPA with a numeric interpretation of the Georgia narrative water quality standard for mercury (GADNR-EPD, 2001). The numeric interpretation, which provides that methylmercury in fish tissue is not to exceed 0.3 mg/kg, is consistent with EPA's recently adopted guidance value for methylmercury (USEPA, 2000; USEPA, 2001). The State also provided EPA with a methodology for determining when a waterbody is impaired and is to be listed on the State's Section 303(d) lists, as well as a methodology for calculating the site-specific allowable water column concentration to protect the general population from the accumulation of mercury in fish tissue. Using EPA's recently collected site-specific data for mercury and the State's methodology for calculating allowable mercury concentrations, Lake Yonah is attaining the applicable water quality standard for mercury. However, the Consent Decree in the case of Sierra Club v. EPA, 1:94-cv-2501-MHS (N.D. Ga.) requires the State or EPA to develop TMDLs for all waterbodies on the State of Georgia's current 303(d) list. Although Lake Yonah appears to be attaining the applicable water quality standard for mercury, EPA is establishing this TMDL because the listed segment remains on the State's current 303(d) list.

TMDLs are required for waters on a state's Section 303(d) list by Section 303(d) of the Clean Water Act (CWA) and the associated regulations at 40 CFR Part 130. A TMDL establishes the maximum amount of a pollutant a waterbody can assimilate without exceeding the applicable water quality standard. The TMDL allocates the total allowable pollutant load to wasteload allocations (WLAs) for point sources regulated by the National Pollutant Discharge Elimination System (NPDES) program and to load allocations (LAs) for all other sources. The WLAs and LAs in the TMDL provide a basis for states to limit the amount of pollution from both point and nonpoint sources to restore or protect a waterbody from exceeding the applicable water quality standard. This TMDL will provide the maximum average annual load of mercury that can enter Lake Yonah without exceeding the applicable water quality standard. An allocation of the maximum annual load will be provided for both point sources and nonpoint sources. Because of the significant uncertainties associated with attaining reduction in the nonpoint source loading of mercury, which is primarily from atmospheric deposition, and due to the persistent bioaccumlative nature of mercury, this TMDL will propose that current NPDES permitted discharges be held at their current loading of mercury.

2. Problem Definition

The listed segment of the Lake Yonah is on the State of Georgia's 2004 Section 303(d) list. Lake Yonah was listed because mercury in the tissue of largemouth bass and catfish exceeded Fish Consumption Guidelines (FCG) established by the State of Georgia (GADNR, 2000). The Fish Consumption Guidelines establish limits on the amount of fish that should be consumed over a given time frame (a week or a month) in order to protect human health.

The Georgia Department of Natural Resources (GADNR) uses a risk-based approach to determine how often contaminated fish may be consumed at different levels of fish tissue contamination assuming a consumption rate of approximately 32.5 grams of fish per day. Table 1 provides the recommended frequency of fish consumption for three different levels of contamination with mercury.

Table 1 Georgia Department of Natural Resources Fish Consumption Guidelines.

Mercury Fish Tissue Threshold (mg/kg)	Frequency of Consumption
0.23	Once a Week
0.70	Once a Month
2.3	Do Not Eat

If fish tissue contains 0.23 mg/kg (parts per million) or more of mercury, the State's FCG indicates that the fish should not be consumed more than once a week. If fish tissue contains 0.70 mg/kg (parts per million) or more of mercury, the State's FCG indicates the fish should not be consumed more than once per month, and if the fish tissue contains 2.30 mg/kg (parts per million) or greater of mercury, the State issues a "Do Not Eat" guideline. The FCG in place for Lake Yonah is that largemouth bass and catfish should not be consumed more than once a week.

The methodology used by the State of Georgia in the development of the fish consumption guidelines targets specific species and size of fish, and uses a conservative risked-based approach in determining whether consumption guidance is warranted for a particular waterbody. EPA supports the State of Georgia's approach to establishing consumption guidelines as an appropriate way to inform the public of the potential risks in eating certain size and species of fish.

3. Applicable Water Quality Standard

TMDLs are established at levels necessary to attain and maintain the applicable narrative and numerical water quality standards (See 40 CFR Section 130.7(c)(1)). In December 2002, Georgia adopted a numeric human health standard for total mercury in fish tissue in the Rules and Regulations for Water Quality Control Chapter 391-3-6. The numeric standard is as follows:

> **Rule 391-3-6.03**, (5)(e)(vii) Mercury: For the protection of human health, total mercury concentrations bioaccumulating in a waterbody, in a representative population of fish, shellfish and/or other seafood representing different trophic levels, shall not exceed a total mercury concentration in edible tissues of 0.3 mg/kg wet weight. This standard is in accord with the USEPA Water Quality Criterion for the Protection of Human Health: Methylmercury, (January 2001, EPA-823-R-01-001), and because nearly 100% of the mercury in fish tissue is methylmercury, adoption of the standard as total mercury is an additional conservative measure. The representative fish tissue total mercury concentration for a waterbody is determined by calculating a Trophic-Weighted Residue Value, as described by the Georgia EPD Protocol (October 19, 2001).

Using this methodology, a waterbody is determined to be impaired when, when the weighted fish consumption concentration is greater than 0.30 mg/kg. This is based on the assumption that the general population is consuming greater than 17.5 grams of fish per day. The methodology uses a "weighted consumption" approach that assumes that **Error! Not a valid link.** grams per day (58.4%) of the total fish consumption is trophic level 3 fish (e.g., catfish and sunfish), and **Error! Not a valid link.** grams per day (41.6%) are trophic level 4 fish (e.g., largemouth bass). See Equation 3-1 below.

Equation 3-1 Calculation of Weighted Fish Tissue Concentration to Determine Impairment

$$Weighted\ Fish\ Tissue\ Concentration = (Avg\ Trophic\ 4\ Conc.* 41.6\%) + (Avg\ Trophic\ 3 * 58.4\%)$$

where:

Geometric Mean Trophic Level 4 Concentration (mercury in fish tissue) = **Error! Not a valid link.** mg/kg

Geometric Mean Trophic Level 3 Concentration (mercury in fish tissue) =**Error! Not a valid link.** mg/kg

In July 2002, EPA sampled 2 locations in Lake Yonah to collect site-specific data on ambient mercury in fish tissue and in the water. Using Equation 3-1, the site-specific fish tissue concentration data collected in the Lake Yonah yields a weighted fish tissue concentration of **Error! Not a valid link.** mg/kg which is less than the State's current, applicable water quality criterion of 0.3 mg/kg.

4. TMDL Target

In order to establish the TMDL, the maximum allowable concentration of total mercury in the ambient water that will prevent accumulation of methylmercury in fish tissue greater than the applicable water quality standard of 0.3 mg/kg level must be determined. To determine this allowable ambient water concentration, EPA referred to the "Revisions to the Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health" (also referred to as the "Human Health Methodology"; USEPA, 2000).

The methodology is expressed below (Equation 4-1):

Equation 4-1 Calculation of the Water Quality Target

$$WQT = \frac{((ReferenceDose - RSC) * BodyWeight * UnitsConversion)}{(ConsumptionRate * Weighted\ BAF * FractionMeHg)}$$

where:

WQT = target water quality concentration of total Mercury in ng/l
Reference Dose = 0.0001 mg/kg/day Methylmercury (MeHg)
RSC = 0.000027mg/kg/day MeHg (Relative Source Contribution from Saltwater Species)
Body Weight = 70 kg
Units Conversion = 1.0E6
Consumption Rate = 0.0175 kg/day Fish
Weighted Bioaccumulation Factor = **Error! Not a valid link.**
Fraction of the Total Mercury as Methylmercury = **Error! Not a valid link.** as measured

In the determination of the allowable ambient water concentration, EPA used the recommended national values from the Human Health Methodology, including the reference dose of 0.0001-mg/k/day methylmercury; a standard average adult body weight of 70 kg; and the consumption rate for the general population of 17.5 grams of fish per day. (Note that a recent report by the National Academy of Sciences confirms that methylmercury is a potent toxin, and concludes that EPA's reference dose of 0.0001 mg/kg/day is appropriate (National Research Council, 2000)). For the other factors in the calculation, bioaccumulation and fraction methylmercury, EPA used site-specific data from Lake Yonah collected in August 2003. (See Section 5.2.) From this site-specific data, EPA determined a representative "weighted" bioaccumulation factor (BAF). This BAF was calculated by taking the average calculated BAF from each of the two trophic levels to determine a "weighted" BAF based upon the different consumption rates for trophic levels, and the measured fraction methylmercury of **Error! Not a valid link.**. **Using this approach, an allowable concentration of total mercury in the ambient water (WQT) in the listed segment of the Lake Yonah for the protection of human health is Error! Not a valid link. nanograms per liter (parts per trillion)**. This concentration or less in the ambient water will prevent the bioaccumulation of mercury in fish tissue above 0.3 mg/kg. The site-specific data for total mercury in the water column collected in August 2003 was **Error! Not a valid link.** and **Error! Not a valid link.** ng/l.

5. Background

The Lake Yonah is located in north/central Georgia (USGS Hydrologic Unit Code (HUC) 03060102). The Lake Yonah basin is presented in Figure 1.

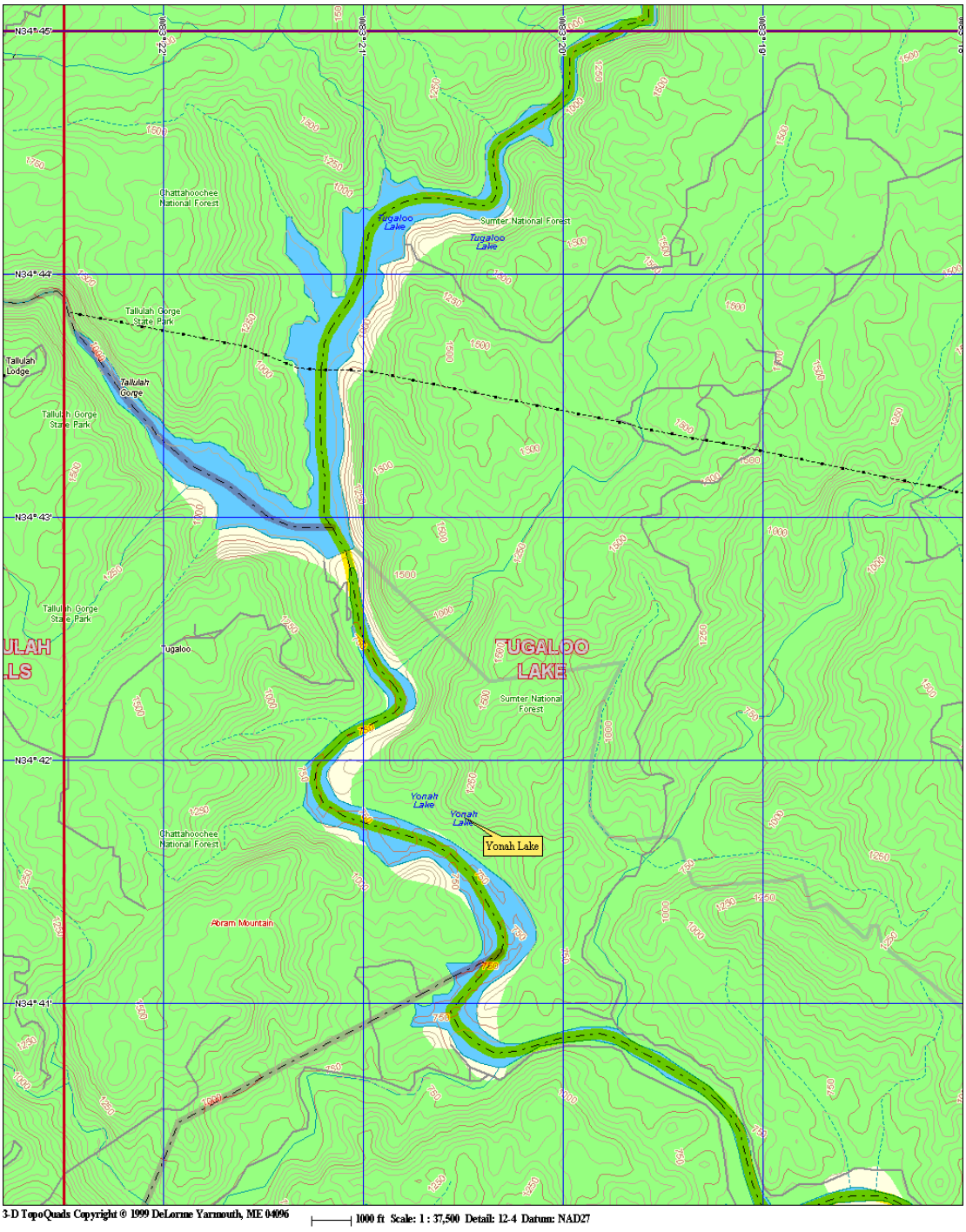

Figure 1 Map of the Lake Yonah basin in north/central Georgia.

5.1. Source Assessment

A TMDL evaluation examines the known potential sources of the pollutant in the watershed, including point sources, nonpoint sources, and background levels. There are

no NPDES permitted facilities that discharge to Lake Yonah. The primary nonpoint source of mercury is atmospheric deposition.

5.2. Available Monitoring Data

EPA Region 4 sampled two locations in Lake Yonah in August of 2003. Since even low concentrations of mercury in water can lead to significant accumulation of mercury in fish tissue, EPA sampled the Lake Yonah using the most sensitive sampling and analytical techniques. The samples were collected using the "clean hands" method (USEPA, 2000 and 1996), and analyzed using the ultra-trace level analytical technique, EPA Methods 1630/1631 (USEPA, 1998 and 1999). EPA adopted this method in June of 1999 for mercury in water for data gathering and compliance monitoring under the Clean Water Act and Safe Drinking Water Act. This method can reliably measure mercury to 0.5 ng/l (parts per trillion).

The purpose of this data collection effort was to collect data needed for the development of this mercury TMDL. The locations for the water column samples are at the headwaters and dam pool of Lake Yonah. Water column, fish, sediment and soil samples (taken adjacent to the water column samples outside the flood plain) were collected from 2 locations within Lake Yonah.

The fish collection consisted of approximately 10 fish per sampling location, of which 5 were trophic level 3 fish (sunfish) and 5 were considered trophic level 4 (largemouth bass, spotted bass).

The following sections provide the results of the field sampling for mercury.

5.2.1. Water Column Data

Water column samples were collected to determine the ambient concentration of mercury in the water column using Method 1631, an ultra-trace level clean sampling and analytical technique with a quantification level of 0.5 ng/l. The water column samples were analyzed for both total mercury and methylmercury. Because methylmercury is the primary form of mercury taken up in the food chain, it was important to quantify the fraction of the total mercury present in the methyl form. Table 2 provides the measured total and methyl mercury concentrations in the water column of Lake Yonah.

Table 2 Water Column Mercury Concentrations, August 2003.

Station	Waterbody	Mercury, Total (THg, ng/L)	Mercury, Methyl (MeHg, ng/L)	Fraction MeHg
Yonah 1	Lake Yonah	1.3	0.049	0.04
Yonah 2	Lake Yonah	0.88	0.023	0.03

5.2.2. Fish Tissue Data

Samples of fish were taken from the listed segment of the Lake Yonah within the same area as the water column and sediment samples. Trophic level three (sunfish, catfish) and trophic level four fish (bass) were targeted in the collection because they represent the fish that are caught and kept by anglers and consumed as a source of food. The fish filets obtained during EPA's sampling effort were analyzed for total mercury (THg). Table 3 provides the individual fish data.

Table 3 Fish Tissue Mercury Data for the Lake Yonah, Georgia, July 2002.

Station	Waterbody	Trophic Level	Species	Total Length (mm)	Whole Wt (gm)	Filet Wt (gm)	THg, (mg/kg) Wet Weight
1	Lake Yonah	4	spotted bass	325	517	192	0.59
1	Lake Yonah	4	largemouth bass	405	912	317	0.63
1	Lake Yonah	4	largemouth bass	390	768	276	0.37
1	Lake Yonah	4	largemouth bass	345	519	169	0.19
1	Lake Yonah	4	largemouth bass	310	376	140	0.18
1	Lake Yonah	3	redbreast sunfish	160	74	23	0.085
1	Lake Yonah	3	redbreast sunfish	155	62	21	0.092
1	Lake Yonah	3	redbreast sunfish	145	55	20	0.12
1	Lake Yonah	3	redbreast sunfish	140	48	15	0.15
1	Lake Yonah	3	redbreast sunfish	135	43	14	0.057
1	Lake Yonah	3	redear sunfish	322	700	224	0.48
1	Lake Yonah	3	redear sunfish	317	643	193	0.41
2	Lake Yonah	4	largemouth bass	415	917	305	0.60
2	Lake Yonah	4	largemouth bass	395	820	285	0.68
2	Lake Yonah	4	largemouth bass	355	559	192	0.36
2	Lake Yonah	4	largemouth bass	305	341	122	0.17
2	Lake Yonah	4	largemouth bass	300	351	130	0.29
2	Lake Yonah	3	redear sunfish	330	706	184	0.52
2	Lake Yonah	3	redear sunfish	185	100	37	0.095
2	Lake Yonah	3	redbreast sunfish	170	87	31	0.079
2	Lake Yonah	3	bluegill sunfish	170	90	32	0.069
2	Lake Yonah	3	bluegill sunfish	160	72	28	0.40

Weighted fish tissue concentration calculated by applying Equation 3-1 to the July 2002 data. A weighted fish tissue concentration exceeding 0.3 mg/kg would indicate impairment.

Table 4 Geometric Mean Fish Tissue Concentration in the Lake Yonah, Georgia, July 2002.

Trophic Level	Avg. Conc. Total Hg mg/kg	Max. Conc. Total Hg mg/kg	Min. Conc. Total Hg mg/kg	Count	Length	Total Hg mg/kg Geomean
4	**Error! Not a valid link.**	**Error! Not a valid link.**	**Error! Not a valid link.**	**Error! Not a valid link.**	**Error! Not a valid link.**	**Error! Not a valid link.**
3	**Error! Not a valid link.**	**Error! Not a valid link.**	**Error! Not a valid link.**	**Error! Not a valid link.**	**Error! Not a valid link.**	**Error! Not a valid link.**

Applying Equation 3-1 to the trophic level geometric mean concentrations yields a weighted average fish tissue concentration of **Error! Not a valid link.** mg/kg.

6. Total Maximum Daily Load (TMDL)

The TMDL is the total amount of a pollutant that can be assimilated by the receiving waterbody without exceeding the applicable water quality standard (as calculated in Section 3). The TMDL for the Lake Yonah is **Error! Not a valid link.** kg/year to protect against significant accumulation of mercury in fish tissue. This TMDL determines the maximum load of total mercury that can enter Lake Yonah within a year without exceeding 0.3 mg/kg in fish tissue residue as calculated in Section 3.

6.1. Critical Condition Determination

The annual average flow and annual average loading represent the critical conditions for this TMDL. Annual average flow and annual average loading are appropriate for several reasons. First, EPA's Human Health methodology, which has been used to derive an appropriate numeric interpretation of Georgia's narrative water quality standard for toxic substances for this TMDL, assumes that health effects due to mercury occur as a result of long-term exposure to mercury in fish tissue through consumption of contaminated fish. The bioaccumulation of methylmercury in fish tissue is a long-term, multi-year, process. The State applies their human health criteria at a flow equivalent to the annual average flow (Georgia Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(5)(e)(iv) which requires the application of annual average load in the TMDL.

6.2. Seasonal Variation

Mercury is expected to fluctuate based on the amount and distribution of rainfall, and on variable emissions from local and distant atmospheric sources. Since wet deposition is greatest in the spring and winter seasons, loadings of mercury are highest during these times of the year. However, these seasonal impacts or other short-term variability in loadings are damped out by the biotic response of bioaccumulation, which as discussed above, is a long-term process. Therefore, seasonal variations are not important in this TMDL, since the load is expressed on an average annual basis.

6.3. Margin of Safety

A Margin of Safety (MOS) is a required component of a TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving waterbody. The MOS may be expressed in conservative assumptions used to develop the TMDL. A MOS is incorporated into this TMDL in that the maximum load is based upon a conservative representation of mercury entering Lake Yonah and the TMDL calculation does not take into account reduction/volatilization. In addition, that increment of mercury loading between the current annual loading and the total amount of mercury the Lake can receive without exceeding the water quality standard is reserved as an additional MOS. This MOS reflects EPA's recognition that mercury is a persistent, bioaccumulative pollutant that appears on EPA's list of priority toxic pollutants.

6.4. TMDL Determination

To determine the total maximum load of total mercury to Lake Yonah, a conservative mass balance calculation is used. The annual average flow and the water quality standard calculated from Equation 4-1 is used to determine the maximum load of mercury to the waterbody that will not exceed a water column concentration of **Error! Not a valid link.** ng/l.

Equation 6-1 TMDL Determination

$$TMDL = \frac{WQT(ng/l) * Annual\ Average\ Flow * Number\ of\ Seconds/Year * 1000}{Number\ of\ ng/g}$$

where:

Water Quality Target= **Error! Not a valid link.** ng/l
Annual Average Flow in Waterbody = 30.1 cubic meters/second
Number of Seconds/Year = 31536000
Number of ng per gram = 1E9
The TMDL load is calculated as Error! Not a valid link. kg/year total mercury.

7. Allocation of Loads

In a TMDL assessment, the total allowable load is divided and allocated to the various pollutant sources. This allocation is provided as a Load Allocation (LA) to the nonpoint sources and as a Wasteload Allocation (WLA) to the point-source facilities in Georgia with an NPDES permit.

The calculated allowable load of mercury that can come into Lake Yonah without exceeding the applicable water quality standard of Error! Not a valid link. ng/l is 0.5 kg/year. Because this assessment indicates that the allowable load can be maintained without reducing the current loads received by the lake, both point and nonpoint sources will be assigned allocations equal to current loads. Presently, there are no discharges to Lake Yonah. Future discharges to Lake Yonah, that have reasonable potential to

discharge mercury, would need to meet the water quality target at the end of the pipe. The remainder of the loading capacity is assigned to the MOS.

8. References

Georgia Department of Natural Resources (GADNR). 2000. Guidelines for Eating Fish from Georgia Waters. Atlanta, Georgia.

Georgia Environmental Protection Division (GADNR-EPD). July 30, 2001 letter to USEPA Region 4 RE: Interim Mercury Criterion, interpreting Georgia's water quality narrative for mercury in fish tissue.

National Research Council. 2000. Toxicological Effects of Methylmercury. Committee on the Toxicological Effects of Methylmercury, Board on Environmental Studies and Toxicology. National Academy Press. Washington, D.C., 368 pp.

United States Environmental Protection Agency (USEPA). 1996. Method 1669. Sampling ambient water for trace metals at EPA water quality criteria levels. USEPA, Office of Water, Washington, D.C. (821/R-96-008).

United States Environmental Protection Agency (USEPA). 1998. Method 1630. Methylmercury in water by distillation, aqueous methylation, purge and trap, and cold vapor atomic fluorescence spectrometry. USEPA, Office of Water, Office of Science and Technology, Washington, D.C

United States Environmental Protection Agency (USEPA). 1999. Method 1631. Mercury in water by oxidation, purge and trap, and cold vapor atomic fluorescence spectrometry. USEPA, Office of Water, Office of Science and Technology, Washington, D.C.

United States Environmental Protection Agency (USEPA). 2000. EPA's 2000 Revisions to the Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (11/3/2000; 65 FR 66444-66482).

United States Environmental Protection Agency (USEPA). 2001. Water Quality Criteria for the Protection of Human Health: Methylmercury. Washington, D.C. (EPA-823-R-01-001).