

**TOTAL MAXIMUM DAILY LOAD (TMDL)**

**For**

**Total Mercury in Fish Tissue Residue**

**In**

**Big Haynes Reservoir**



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**TOTAL MAXIMUM DAILY LOAD (TMDL)**  
**Total Mercury in Fish Tissue Residue**  
**In the**  
**In the Big Haynes Reservoir**

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 Big Haynes Reservoir in Georgia.

The calculated allowable load of mercury that may come into the identified segments of the Big Haynes Reservoir without exceeding the applicable water quality standard is 0.30 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 indicates that the consumption of fish by the general population is not to exceed 0.3 mg/kg mercury in fish tissue.

This TMDL shall become effective immediately, and is incorporated into the Continuing Planning Process for the State of Georgia under Sections 303(d)(2) and 303(e) of the Clean Water Act.

Signed this \_\_\_\_\_ day of \_\_\_\_\_, 2002.

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Beverly H. Banister, Director  
Water Management Division

## 1. Introduction

The U.S. Environmental Protection Agency (EPA) Region 4 is establishing this Total Maximum Daily Load (TMDL) for total mercury for the Big Haynes Reservoir in Rockdale, County, Georgia. Big Haynes Reservoir is included on the State of Georgia's 2000 Section 303(d) list of impaired waters because mercury in certain species of fish tissue exceeds the Georgia Department of Natural Resources (GDNR) Fish Consumption Guidelines. GDNR's Fish Consumption Guidelines are established using a "risk-based" approach based on conservative assumptions to determine whether an advisory is issued for a particular fish species in a particular waterbody. For the current Section 303(d) list, the State included waters where the fish consumption guideline value was exceeded.

The State of Georgia recently provided a letter to EPA in July 2001, which provides a numeric interpretation of the Georgia narrative water quality standard for mercury (GAEPD, 2001). That numeric interpretation states that fish tissue is not to exceed 0.3 mg/kg, is consistent with EPA's recently adopted guidance value for Methylmercury (USEPA, 2000). The same letter also provides a State methodology for determining when a waterbody is impaired and is to be listed on the State's future 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 the State's methodology provided in the July 2001 letter and EPA's recently collected site-specific data for mercury for the Big Haynes Reservoir, it has been determined that the Big Haynes Reservoir is attaining the applicable water quality standard for mercury and a TMDL is not needed. 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. Since the Big Haynes Reservoir is on the current Section 303(d) list, EPA is establishing this TMDL.

As described above, the State of Georgia has recently interpreted its narrative water quality standard for mercury in a manner that is consistent with EPA's recently adopted criterion document for residual mercury in fish tissue. Using the State's methodology and the data recently collected by Region 4, it appears that Big Haynes Reservoir is attaining the applicable water quality standard for mercury.

Georgia submitted a supplement to its 2000 303(d) List to EPA for review on June 8, 2001. This supplement, approved by EPA in June 2001, was meant to update the State's List for the Oconee, Ocmulgee and Altamaha Basins based on the State's most recent water quality monitoring data. However, the EPA data and the State's recent interpretation of its narrative standard for mercury were not available for consideration before the State's supplemental list was submitted and approved. Therefore, the Big Haynes Reservoir remains on the Section 303(d) list despite evidence that it is attaining the applicable water quality standard for mercury.

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. Since the Big Haynes Reservoir remains on the State's current 303(d) List, EPA is establishing this TMDL despite the recent data and information demonstrating that the water is currently attaining the applicable water quality standard for mercury. In the absence of the Consent Decree, EPA would not establish this TMDL because the water no longer needs the TMDL.

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) permit 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 the waterbody from exceeding the applicable water quality standard. This TMDL will provide the maximum annual average load of mercury that can enter the Big Haynes Reservoir without exceeding the applicable water quality standard. An allocation of the maximum annual average load will be provided to both point sources and to nonpoint sources that are primarily air deposition. Because of the significant uncertainties associated with the attainable reduction of the nonpoint source loading of mercury (i.e., atmospheric deposition) and the persistent bioaccumulative nature of mercury, this TMDL will establish that current NPDES permitted discharges be held at their current loading of mercury.

## 2. Problem Definition

Big Haynes Reservoir is on the State of Georgia's 2000 Section 303(d) list. Big Haynes Reservoir was listed because mercury in the tissue of largemouth bass and catfish exceeded the Fish Consumption Guidelines (FCG) established by the State of Georgia. (See Georgia Department of Natural Resources, 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 (DNR) 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 per day. Table 1 provides the frequency of consumption for three different levels of fish tissue contaminated with mercury.

**Table 1 Georgia Department of Natural Resources Fish Consumption Guideline**

<b>Mercury Fish Tissue Threshold (mg/kg)</b>	<b>Frequency of Consumption</b>
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 a 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 following FCGs are in place for the Big Haynes Reservoir: largemouth bass and catfish— no more than one meal per 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 risk-based approach in determining whether consumption guidelines are 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 numeric water quality standards. (See 40 CFR Section 130.7(c)(1)). The State of Georgia's Rules and Regulations for Water Quality Control do not include a numeric criterion for the protection of human health from methylmercury. The State's regulations provide a narrative water quality standard in which waters are to be free from toxics. Since mercury may cause toxicity in humans, a numeric "interpretation" of the narrative water quality standard is necessary to assure that a TMDL will protect human health. EPA defers to the State water quality standard or criterion as the applicable water quality standard for development of the TMDL. States may establish (or interpret) their applicable water quality standards for protection of human health at a numeric concentration different from their fish consumption guidelines. The State of Georgia has made a numeric interpretation of their narrative water quality standard for toxic substances at a numeric concentration of no more than 0.3 mg/kg methylmercury in fish tissue. (See the July 2001 letter from the State to EPA.) This numeric interpretation protects the "general population" which is the population that consumes 17.5 grams per day or less of freshwater fish. This approach is consistent with EPA's recently adopted guidance value for the protection of human health from methylmercury described in the document entitled, "Water Quality Criterion for the Protection of Human Health: Methylmercury". (EPA 2001) Using this methodology, it is determined that the general population is consuming greater than 17.5 grams of fish per day, the waterbody is determined to be impaired and will be included on future State Section 303(d) lists when the weighted fish consumption concentration is greater than 0.3 mg/kg. The methodology uses a "weighted consumption" approach that assumes that 9.9 grams per day (58.4%) of the total fish consumption is trophic level 3 fish (e.g., catfish and sunfish), and 7.6 grams per day (41.6%) are trophic level 4 fish (e.g., largemouth bass). See Equation 3-1 below.

#### Equation 3-1 Weighted Fish Tissue Calculation to Determine Impairment

$$\text{Weighted Fish Tissue Concentration} = (\text{Avg Trophic 4 Conc.} * 43.4\%) + (\text{Avg Trophic 3} * 56.6\%)$$



where:

Avg. Trophic 4 Concentration = 0.4 mg/kg

Avg. Trophic Level 3 Concentration = 0.1 mg/kg

EPA collected site-specific data from the Big Haynes Reservoir on ambient mercury in fish tissue and in the water column in March/April 2001 at 2 locations. Using Equation 3-1, site-specific fish tissue concentration data collected in the Big Haynes Reservoir yields a weighted fish tissue concentration of 0.2 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 must be determined that will prevent accumulation of methylmercury in fish tissue above the applicable water quality standard of 0.3 mg/kg. To determine this allowable ambient water concentration, EPA referred to the "Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health" (EPA 2000). The methodology is expressed below (Equation 4-1):

##### Equation 4-1 Water Quality Standard Calculation

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

where:

WQS = 4.1 ng/l

Reference Dose = 0.0001 mg/kg/day 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 = 5,626,243

Fraction of the Total Mercury as Methylmercury = 0.01 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 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. (See NAS, Toxicological Effects of Methylmercury, July 2000)). For the other factors in the calculation, bioaccumulation and fraction methylmercury, EPA used site-specific data from

the Big Haynes Reservoir collected in March/April of 2001. (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 a median measured percentage methylmercury of 1.0%. Using this approach, an allowable concentration of total mercury in the ambient water of Big Haynes Reservoir for the protection of human health is 4.1 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 March/April 2001 were 2.8 ng/l.

## **5. Background**

The Big Haynes Reservoir is located in north/central Georgia (USGS Hydrologic Unit Code (HUC) 3070103). Big Haynes Reservoir basin is located in northwestern Rockdale County. Because of the recent construction of the reservoir a locational map of the reservoir is not available for this report.

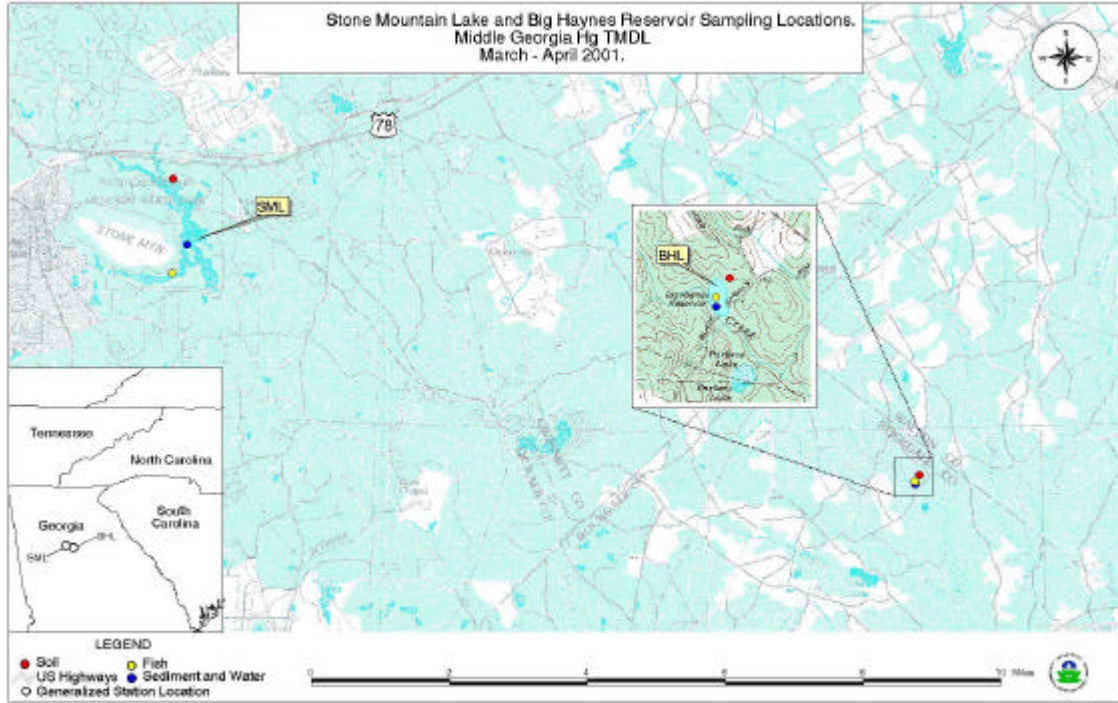
### **5.1. Source Assessment**

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 the listed segments of the Big Haynes Reservoir.

### **5.2. Available Monitoring Data**

EPA Region 4 sampled the Big Haynes Reservoir in April and May of 2001. Since even low concentrations of mercury in water can lead to significant accumulation of mercury in fish tissue, EPA sampled Big Haynes Reservoir using the most sensitive sampling and analytical techniques. The samples were collected using the “clean hands” method (EPA, November 2000), and analyzed using the ultra-trace level analytical technique, EPA Method 1631 (USEPA, 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 sample locations for the water column are illustrated in Figure 1. Water column, sediment and soil samples were taken adjacent to the water column samples outside the flood plain in the Big Haynes Reservoir.



**Figure 1 Big Haynes Reservoir Sampling Station Locations**

Sample locations for the fish collection are illustrated in Figure 1. The fish collection consisted of approximately 10 fish per sampling location, 5 - trophic level 3 fish (sunfish, catfish, etc.) and 5 - trophic level 4 (largemouth bass).

The following sections provide the results of the March/April 2001 field sampling for mercury.

**5.2.1. Water Column Data**

Water column samples were taken 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 in the methyl form. Table 2 provides the measured mercury concentrations in the water column of the Big Haynes Reservoir.

**Table 2 Water Column Mercury Concentrations**

Station	Waterbody	Mercury, Total (THg, ng/L)	Mercury, Methyl (MeHg, ng/L)	Fraction MeHg
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BHL-1	Big Haynes Reservoir	2.81	0.04	0.01
BHL-2	Big Haynes Reservoir	NA	0.03	

### 5.2.2. *Sediment/Soil Data*

Samples of river sediments were gathered at the same locations as the water samples to determine the amount of mercury associated with the sediments and porewater. This data provides important information that can be used to parameterize the water quality model by providing evidence of the effects of mercury in the sediments on the total mercury water column concentration. Soil samples were collected from the surrounding watershed where the other samples were taken. EPA collected the soil samples to be used in the calibration of the watershed model. Table 3 provides the mercury concentrations associated with soils collected during the summer of 2001.

**Table 3 Sediment/Soil Mercury Concentrations**

Station	Waterbody	Total Mercury		Methylmercury	
		Sediment	Surface Soil	Sediment	Surface Soil
BHL-1	Big Haynes Reservoir	0.0481	0.0119	0.798	0.23
BHL-2	Big Haynes Reservoir	0.0468	NA	NA	0.31

### 5.2.3. *Fish Tissue Data*

Samples of fish were taken from the Big Haynes Reservoir (from the upper and lower sections of the listed segment) within the same area as the water column and sediment samples. Trophic level three (sunfish, catfish) and four fish (largemouth 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. Table 4 provides the individual fish data.

**Table 4 Fish Tissue Mercury Data**

Station	Waterbody	Trophic Level	Species	Total Length (mm)	Whole Wt (gm)	Filet Wt (gm)	THg, (mg/kg) Wet Weight
BHL	Big Haynes Reservoir	4	Largemouth Bass	335	523	223	0.57
BHL	Big Haynes Reservoir	4	Largemouth Bass	350	527	209	0.55
BHL	Big Haynes Reservoir	4	Largemouth Bass	315	384	143	0.63
BHL	Big Haynes Reservoir	4	Largemouth Bass	310	326	129	0.19
BHL	Big Haynes	4	Largemouth Bass	288	286	108	0.14

	Reservoir						
BHL	Big Haynes Reservoir	3	Brown Bullhead	349	581	141	0.079
BHL	Big Haynes Reservoir	3	Brown Bullhead	361	673	148	0.088
BHL	Big Haynes Reservoir	3	Bluegill	168	87	33	0.14
BHL	Big Haynes Reservoir	3	Bluegill	168	85	33	0.094
BHL	Big Haynes Reservoir	3	Redear Sunfish	191	121	48	0.062
BHL	Big Haynes Reservoir	3	Longnose Gar	149	55	21	

Table 5 shows the calculated weighted fish tissue concentration using the data from March/April 2001 sampling and applying Equation 3-1. A weighted fish tissue concentration exceeding 0.3 mg/kg would indicate impairment.

**Table 5 Weighted Average Fish Tissue Concentration**

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	0.42	0.63	0.14	5	319.6	0.35
3	0.09	0.14	0.06	5	231	0.09

Applying Equation 3-1 to the trophic level geometric mean concentrations yields a weighted average fish tissue concentration of 0.20 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). For the Big Haynes Reservoir, the water quality standard is 4.1 ng/l to protect the accumulation of mercury in fish tissue. This TMDL determines the maximum load of total mercury that can enter the Big Haynes Reservoir within a year without exceeding 4.1 ng/l total mercury in the water column.

### 6.1. Critical Condition Determination

The average annual flow and average annual loading represents the critical conditions for this TMDL. Average annual flow and average annual 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 criterion 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 average annual load in the TMDL.

## **6.2. Seasonal Variation**

Mercury is expected to fluctuate based on the amount and distribution of rainfall, and 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 seasons. 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, since this TMDL is expressed as an average annual load, seasonal variations are not considered a significant factor.

## **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 is typically incorporated into the 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 the Big Haynes Reservoir, the TMDL calculation does not take into account reduction/volatilization.

Because the Big Haynes Reservoir is currently not impaired due to the accumulation of mercury in fish tissue, an additional margin of safety will be assigned to the background load allocation (LA) using an explicit 10%.

## **6.4. TMDL Determination**

To determine the potential total maximum load of total mercury to the Big Haynes Reservoir, a conservative mass balance calculation is used. The annual average flow and the water quality standard as calculated in Equation 4-1 will be used to be used to determine the maximum load of mercury to the waterbody not to exceed a water column concentration of 4.1 ng/l. (See Equation 6-1.)

**Equation 6-1 TMDL Determination**

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

where:

Water Quality Standard= 4.1 ng/l

Annual Average Flow in Waterbody = 2.1 cubic meters/second

Number of Seconds/Year = 31536000

Number of ng per gram = 1E9

**The potential TMDL Load is calculated as 0.30 kg/year total mercury.**

## 7. Allocation of Loads

In a TMDL assessment, the total allowable load is allocated to the various point and nonpoint pollutant sources. Since there is no point source facilities discharging to the listed segment the WLA is zero. Since it is clear that the predominant source of mercury loading to the waterbody is air deposition, the LA will set their allocation to air deposition. Therefore, as shown in Table 6, the total allowable load is provided as a wasteload allocation (zero allocation to NPDES permitted facilities) and load allocation (LA) to the nonpoint source air deposition sources.

**Table 6 TMDL Allocation**

<b>TMDL (kg/yr)</b>	<b>Wasteload Allocation (kg/yr)</b>	<b>Load Allocation (kg/yr)</b>	<b>MOS (kg/yr)</b>
0.30	0.0	0.27	0.03

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