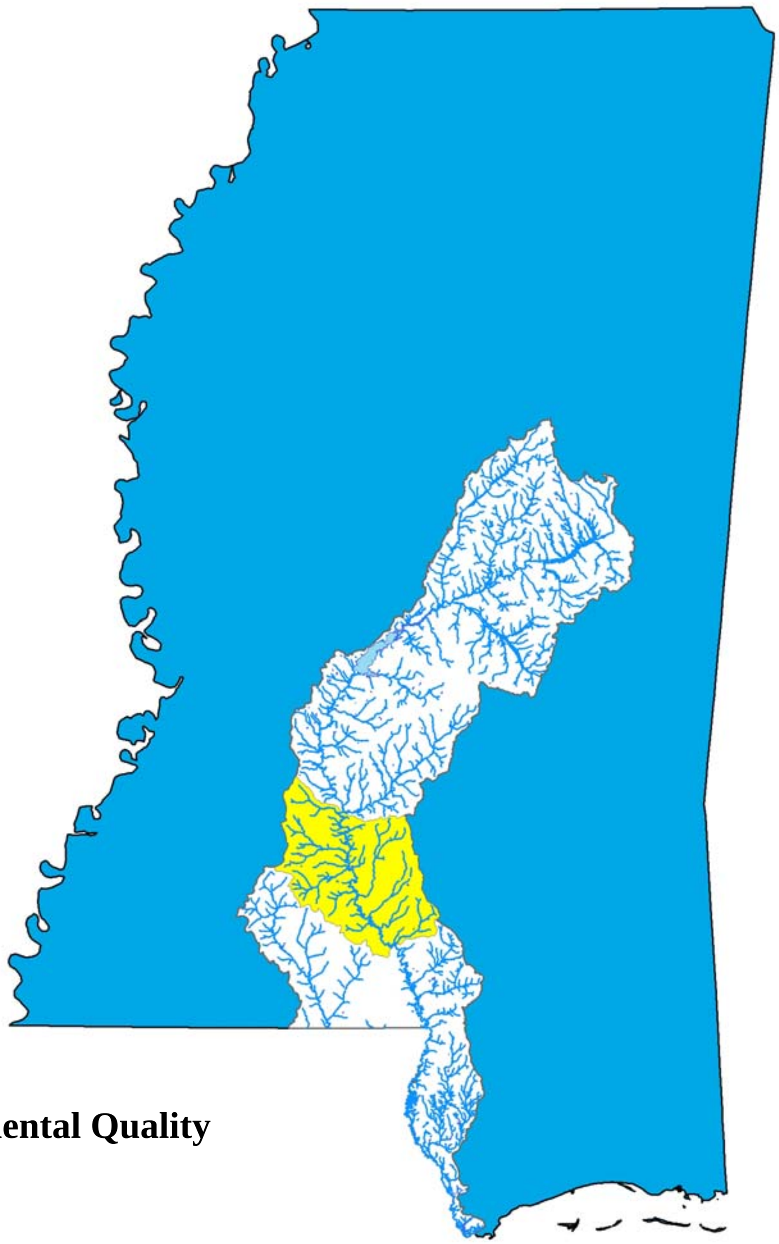
FINAL REPORT
June 2004
ID: 504062802

Pearl River (HUC 03180003) Phase One Total Maximum Daily Load for Mercury

80
Hg
Mercury
200.59



Pearl River Basin

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FOREWORD

This report has been prepared in accordance with the schedule contained within the federal consent decree dated December 22, 1998. (*Sierra Club v. Hankinson, No. 97-CV-3683 (N.D. Ga.)*) The report contains one or more Total Maximum Daily Loads (TMDLs) for water body segments found on Mississippi's 1996 Section 303(d) List of Impaired Waterbodies. Because of the accelerated schedule required by the consent decree, many of these TMDLs have been prepared out of sequence with the State's rotating basin approach. The segments addressed are comprised of monitored segments that have data indicating impairment. The implementation of the TMDLs contained herein will be prioritized within Mississippi's rotating basin approach.

The amount and quality of the data on which this report is based are limited. As additional information becomes available, the TMDLs may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, modification to state water quality criteria, or changes in landuse within the watershed. In some cases, additional water quality data may indicate that no impairment exists.

Prefixes for fractions and multiples of SI units

Fraction	Prefix	Symbol	Multiple	Prefix	Symbol
10^{-1}	**deci**	**d**	**10**	**deka**	**da**
10^{-2}	**centi**	**c**	10^{2}	**hecto**	**h**
10^{-3}	**milli**	**m**	10^{3}	**kilo**	**k**
10^{-6}	**micro**	μ	10^{6}	**mega**	**M**
10^{-9}	**nano**	**n**	10^{9}	**giga**	**G**
10^{-12}	**pico**	**p**	10^{12}	**tera**	**T**
10^{-15}	**femto**	**f**	10^{15}	**peta**	**P**
10^{-18}	**atto**	**a**	10^{18}	**exa**	**E**

Conversion Factors

To convert from	To	Multiply by	To Convert from	To	Multiply by
acres	**sq. miles**	**0.001562**	**days**	**seconds**	**86400.00**
cubic feet	**cu. Meter**	**0.028316**	**feet**	**meters**	**0.304800**
cubic feet	**gallons**	**7.480519**	**gallons**	**cu. feet**	**0.133680**
cubic feet	**liters**	**28.31684**	**hectares**	**acres**	**2.471053**
cfs	**gal/min**	**448.8311**	**miles**	**meters**	**1609.344**
cfs	**MGD**	**0.646316**	**mg/l**	**ppm**	**1**
cubic meters	**gallons**	**264.1720**	**μg/l * cfs**	**gm/day**	**2.45**
cubic meters	**liters**	**1000**	**μg/l * MGD**	**gm/day**	**3.79**

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Table i. Listing Information

Name	ID	County	HUC	Cause	Mon/Eval
Pearl River	MSLMPRLRM	Lawrence Marion	03180003	Mercury	Evaluated
At Monticello: From confluence with Bahala Creek to confluence with Holiday Creek					

Table ii. Water Quality Standard

Parameter	Beneficial use	Water Quality Criteria
Mercury (II) total dissolved Hg(II) expressed as total recoverable	Aquatic Life Support	*Fresh Water* Acute: instantaneous concentration may not exceed 2.1 μg/l Chronic: average concentration may not exceed 0.012 μg/l expressed as total recoverable

Table iii. NPDES Facilities

NPDES ID	Facility Name	County	Receiving Water	Flow (MGD)
MS0022462	Copiah Educational Foundation, Inc.(Copiah Academy)	Copiah	Unnamed Creek to Copiah Creek	0.03000
MS0023922	Hazlehurst POTW	Copiah	Bahala Creek	0.95000
MS0032921	Copiah County Industrial Park	Copiah	Copiah Creek	0.14500
MS0034894	Timberlanes Camp and Dude Ranch	Copiah	Unnamed Tributary of Little Beaverdam Creek	0.01200
MS0036552	Kitchens Brothers Manufacturing Company	Copiah	Unnamed Tributary of Bahala Creek	0.04700
MS0036986	Georgia Gulf Chemicals and Vinyls, LLC., Gallman	Copiah	Copiah Creek	0.03590
MS0041874	Crystal Springs POTW	Copiah	Little Copiah Creek	0.99000
MS0044725	Sanderson Farms, Inc. Hazlehurst Processing Division	Copiah	Copiah Creek	0.90000
MS0049476	Hazlehurst Lumber Company	Copiah	Unnamed Tributary of Long Creek	0.01700
MS0050971	Family Fish House	Copiah	Unnamed Tributary of Copiah Creek	0.00300
MS0024848	Bassfield POTW	Jefferson Davis	Holiday Creek	0.06500

Table iii. NPDES Facilities Cont'd

NPDES ID	Facility Name	County	Receiving Water	Flow (MGD)
MS0029033	Prentiss POTW	Jefferson Davis	Big White Sand Creek	0.60400
MS0035009	Jefferson Davis Vocational Technical Center	Jefferson Davis	Choctaw Creek	0.01000
MS0037109	Polks Meat Products, Inc., Prentiss Plant	Jefferson Davis	White Sand Creek	0.01500
MS0037222	Emmett Smith Slaughterhouse	Jefferson Davis	Unnamed Tributary to White Sand Creek	0.00075
MS0038989	Lily Rose Water Association	Jefferson Davis	Dry Creek	0.05100
MS0043290	Mallard Trailer Park	Jefferson Davis	Unnamed Tributary to Dry Creek	0.00400
MS0044334	Thurman Trailer Park	Jefferson Davis	Holiday Creek	0.00600
MS0002941	Georgia Pacific Corporation, Monticello Mill	Lawrence	Pearl River	31.53000
MS0020729	New Hebron POTW	Lawrence	West Silver Creek	0.06000
MS0024643	Monticello POTW	Lawrence	Halls Creek	0.22500
MS0025453	Silver Creek POTW	Lawrence	Silver Creek	0.04500
MS0028240	Topeka Tilton Attendance Center	Lawrence	Unnamed Creek to East Topishaw Creek	0.01875
MS0047953	Monticello Forest Products Corporation	Lawrence	Unnamed Tributary to Pearl River	0.00100
MS0048143	Monticello Head Start Centers	Lawrence	Unnamed Creek to Pearl River	0.00500
MS0049336	Joe N. Miles and Sons, Inc.	Lawrence	Unnamed Tributary to Silver Creek	0.02600
MS0055263	Little Angels Day Care	Lawrence	Tributary of Magees Creek	0.00050
MS0055743	Monticello Hardwood, Inc.	Lawrence	Unnamed Tributary of Pearl River	0.14400
MS0056821	Town of New Hebron WWTP	Lawrence	West Prong of Silver Creek	0.00840
MS0036871	Lake Lincoln State Park	Lincoln	Ford's Creek	0.00850
MS0002208	Georgia Pacific Corporation, Columbia	Marion	Unnamed Tributary to Holiday Creek	0.10000

Table iv. Total Maximum Daily Load

Type	Load	MOS Type
WLA	1.64 gm/day	
LA	9.46 gm/day	
MOS (50%)	11.10 gm/day	Explicit and Implicit
TMDL	22.20 gm/day	

EXECUTIVE SUMMARY

According to Mississippi's 2002 List of Water Bodies, one segment of the Pearl River is impaired by mercury. The listed segment is located within Hydrologic Unit Code (HUC) 03180003 in Lawrence and Marion Counties in south central Mississippi. Flathead catfish, largemouth bass, bowfin, white crappie, bluegill, freshwater drum, channel catfish, and spotted gar caught in this water body have been sampled and the data indicate a possible impairment due to levels of mercury in the fish flesh. The bioaccumulation of methylmercury in fish flesh is the basis for the impairment in the water body.

A fish consumption advisory has not been issued for this segment of the Pearl River. In samples collected in 1994 and 1995, only one out of 6 samples exceeded the current levels derived using the 1997 Fish Advisory Guidance published by EPA. In November 2003, MDEQ completed additional mercury sampling in this segment. The results show no fish consumption advisory is needed today. However, EPA, along with the support of the FDA, is now recommending a new reference dose for mercury. If MDEQ adopts EPA's new reference dose, the mercury fish consumption advisory level will change from 1.0 ppm to 0.3 ppm. Adoption of EPA's new reference dose would result in a fish consumption advisory for this water body segment based on the most recent data. This TMDL is being completed based on consideration of this change in the fish consumption advisory level.

This Phase One Mercury TMDL for the Pearl River (HUC 03180003) has been developed prior to a complete understanding of the linkage between mercury in the water and mercury in the fish. Additionally, this Phase One Mercury TMDL is only concerned with point source contributions to the water body. Atmospheric deposition, nonpoint source contributions, and natural background will be considered in Phase Two. It is anticipated that the mercury data generated from the point source contributors during the next few years will enhance the knowledge base on this issue.

The endpoints selected for this Phase One Mercury TMDL are based on MDEQ regulations. There are several mercury criteria to evaluate. The human health criterion is currently 153 ng/l of total mercury. The aquatic life support criteria are 12 ng/l fresh water and 25 ng/l salt water of total mercury II expressed as total recoverable. Recent EPA criteria guidance has suggested that each of these numbers need to be revised. This guidance recommends that the 153 ng/l total mercury criterion be replaced with a methylmercury criterion of 0.3 mg/kg measured in fish tissue. The guidance also recommends that the aquatic life support numbers increase to a more representative value of 770 ng/l and 940 ng/l total mercury, respectively. However, these new numbers have not been adopted by the Mississippi Commission on Environmental Quality. MDEQ is therefore proposing the most protective of the currently adopted criteria, 12 ng/l. To further account for the unknowns, an additional explicit margin of safety is included in this TMDL. This explicit margin of safety is set at 50%.

The implementation plan in this Phase One TMDL calls for a moratorium on any future increase in mercury discharges in the Pearl River watershed (HUC 03180003). Increased monitoring in the Pearl River watershed (HUC 03180003) is recommended. This TMDL also recommends pollution prevention alternatives and activities.

1.0 INTRODUCTION

1.1 BACKGROUND

The identification of water bodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those water bodies are required by Section 303(d) of the Clean Water Act. This is also a requirement of the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR Part 130). The TMDL process is designed to restore and maintain the quality of those impaired water bodies through the establishment of pollutant specific allowable loads. The pollutant of concern for this TMDL is mercury. The purpose of this TMDL is to establish water quality objectives and best management practices to reduce the mercury levels currently found in fish flesh taken from this segment of the Pearl River.

Human exposure to inorganic mercury in large amounts can cause a variety of health effects. The two organ systems most likely affected are the central nervous system and the kidney. However, the most significant concerns regarding chronic exposure to low concentrations of methylmercury in fish are for neurological effects on the developing fetus and children.[1]

1.2 PHASED TMDL APPROACH

This document is phase one of a multi-phase TMDL being developed for mercury in the Pearl River (HUC 03180003). This Phase One Mercury TMDL will determine the maximum load of mercury that should be introduced into the impaired segment based on Mississippi's water quality criteria. Phase Two of this TMDL project, to be completed at a later date, will quantify the mercury load to this water body that is directly related to atmospheric sources and other nonpoint sources. Phase Two will also attempt to include a fate and transport model for the water body that will better characterize aquatic mercury cycling.

1.3 WATER BODY SEGMENT LOCATION

As summarized in Table 1, segment MSLMPRLRM of the Pearl River is located near Monticello, Mississippi and begins at the confluence with Bahala Creek and ends at the confluence with Holiday Creek. The location of the Pearl River watershed (HUC 03180003) is provided in Figure 1. The location of the 303(d) listed segment of the Pearl River is shown in Figure 2. Figure 3 and Table 2 provide landuse information for the watershed.

Table 1. Water Body Identification for the Pearl River (HUC 03180003) Phase One Mercury TMDL

Water Body Name	Water Body ID	Assessment Type	County	Impaired Use	Cause
Pearl River	MSLMPRLRM	Evaluated	Lawrence Marion	Aquatic Life Support	Mercury
Location – At Monticello: From confluence with Bahala Creek to confluence with Holiday Creek					

Figure 1. Area Location Map

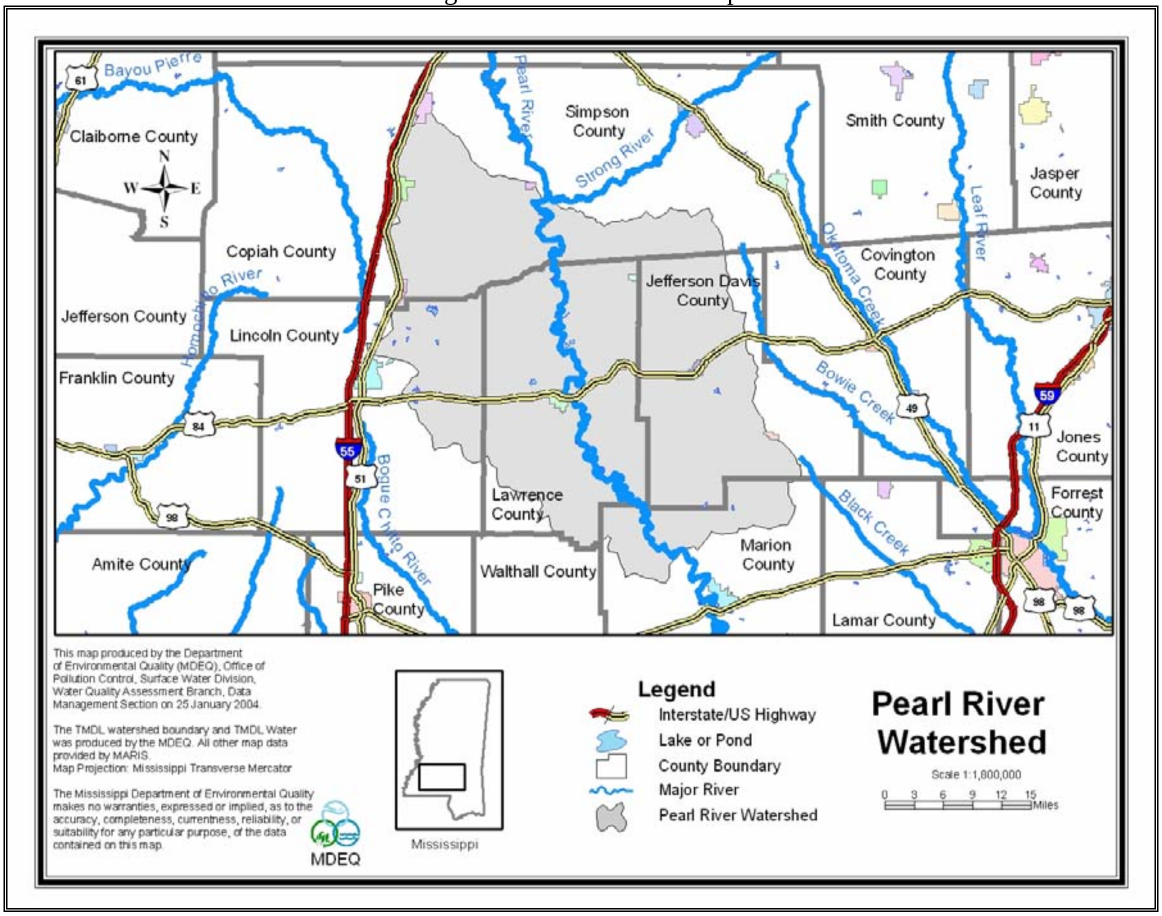

Figure 2. The Pearl River Watershed (HUC 03180003) – 303(d) Segment Location

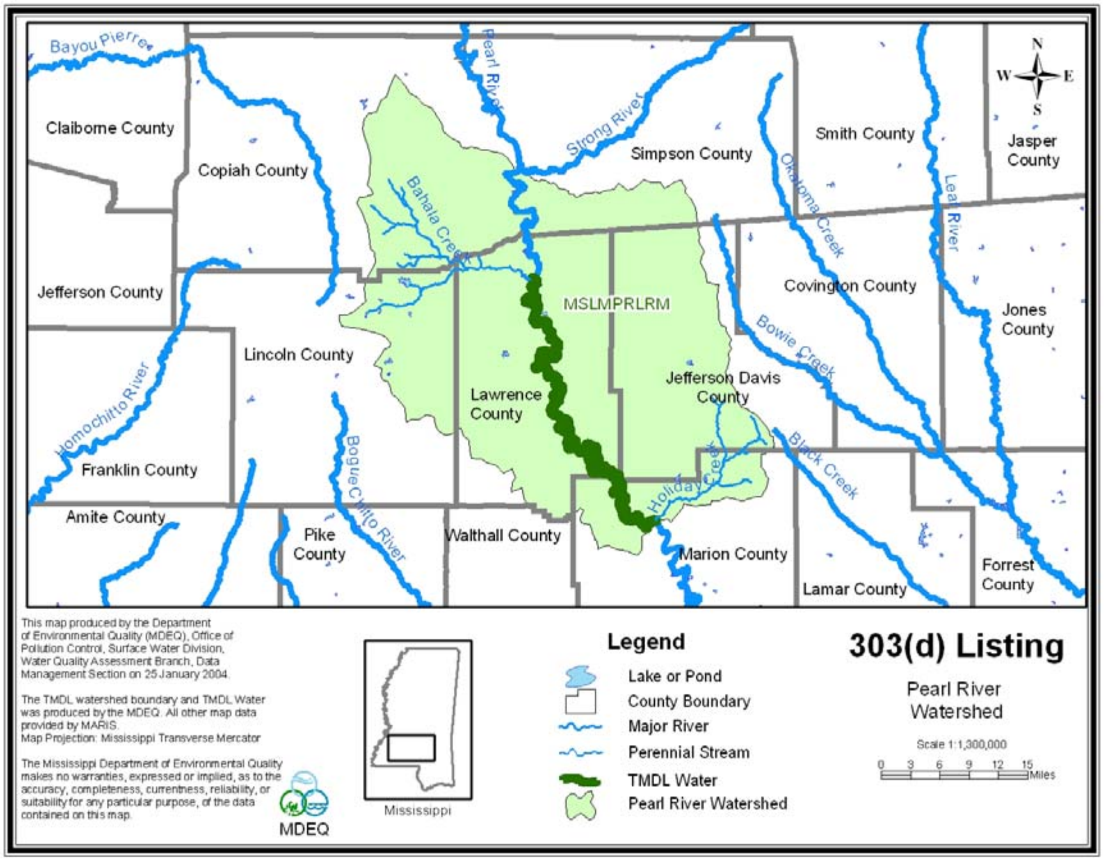

Figure 3. Landuse Distribution within the Pearl River Watershed (HUC 03180003)

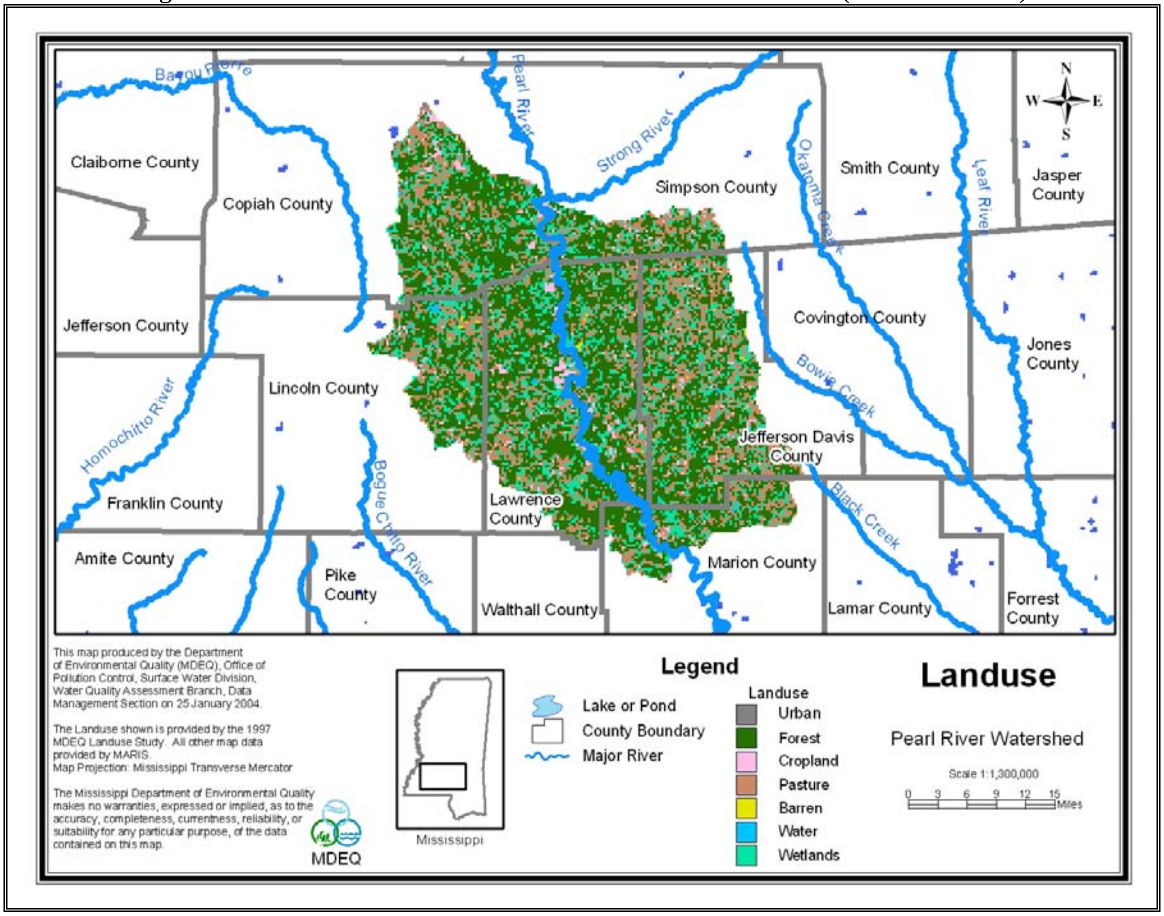

Table 2. Landuse Distribution within the Pearl River Watershed (HUC 03180003) (acres)

Forest	Agriculture	Urban	Wetland	Barren	Water	Total
404087.16	220662.76	1563.88	145419.32	3680.18	8048.59	783461.89
51.6%	**28.1%**	**0.2%**	**18.6%**	**0.5%**	**1.0%**	**100.0%**

1.4 WATER BODY DESIGNATED USE

Designated beneficial uses and water quality standards are established by the State of Mississippi in the *Water Quality Criteria for Intrastate, Interstate and Coastal Waters* regulations. These regulations set the criteria concentrations for pollutants and methods for calculating loads based on the standards. MDEQ regulations require the use of these standards for establishing loads for Mississippi waters. The standards for the listed segment of the Pearl River (HUC 03180003) have been established based on a designated use of Fish and Wildlife.

1.5 APPLICABLE WATER QUALITY STANDARDS

Mercury is included within MDEQ regulations as a toxic substance. The standards specifically set the numeric criteria and calculation methods for determining the loading from sources for this pollutant.

The water quality standards applicable to the uses of the water body segment and the pollutant of concern are listed in Table 3 as defined by the current *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* regulations.

Table 3. State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters

Parameter	Beneficial use	Water Quality Criteria
Total Mercury	Public Water Supply	Concentration may not exceed 0.151 µg/l
Total Mercury	Fish Consumption	Concentration may not exceed 0.153 µg/l
Mercury (II) total dissolved Hg(II) expressed as total recoverable	Aquatic Life Support	*Fresh Water* <u>Acute:</u> instantaneous concentration may not exceed 2.1 µg/l <u>Chronic:</u> average concentration may not exceed 0.012 µg/l expressed as total recoverable

2.0 TMDL ENDPOINT AND WATER QUALITY ASSESSMENT

2.1 SELECTION OF A TMDL ENDPOINT AND CRITICAL CONDITION

One of the major components of a TMDL is the establishment of instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints, therefore, represent the water quality goals specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are needed to restore designated uses. However, due to the many unknowns within the mercury cycle, there is no clearly defined linkage between water column mercury loading and bioaccumulation rates within the fish. In the Executive Summary (Vol. I, Page O-2) of its Mercury Study report to Congress, EPA states that

> "*given the current scientific understanding of the environmental fate and transport of this element, it is not possible to quantify how much of the methylmercury in fish consumed by the U.S. population is contributed by U.S. emissions relative to other sources of mercury (such as natural sources and re-emissions from the global pool). As a result, it cannot be assumed that a change in total mercury emissions will be linearly related to any resulting change in methylmercury in fish, nor over what time period these changes would occur.*"[12]

2.1.1 Mercury Speciation and Chemistry

It has long been recognized that the chemical form of mercury (Hg) in air, water, and soil include elemental mercury Hg(0), inorganic ionic mercury (HgII) as soluble (HgIIs) or particulate mercury forms (HgIIp), and the organic form called monomethylmercury (MMHg or $HgCh3^{+}$). Each form has different behaviors that depend on its chemical and physical properties.[4]

The predominant source of mercury is atmospheric deposition. The atmospheric burden of mercury arises from both natural and anthropogenic sources accumulated over large periods. Both land and water environments release background mercury in the form Hg(0), except when combustion (forest and other terrestrial fires, fossil fuel combustion, waste combustion, etc.) produces the oxidized form – HgII. Hg(0) dissolves in water according to Henry's Law, and is only weakly soluble in water (about 0.006 ng/l at equilibrium with present-day air concentrations).[3] Thus, Hg(0) must oxidize to HgII, which then is the predominant form of mercury in wet or dry deposition. Hg(0) has a half-life of about 1 year in the atmosphere, while that of HgII varies between hours to months.

Only a fraction of mercury entering watersheds from deposition actually is transported into waterbodies. Values ranging from 5 to 50 percent have been reported, and a common value of 25 percent has often been quoted.[17] Most of the mercury entering the watershed remains in the soil or terrestrial biota, or is reduced to Hg(0) and transfers back to the atmosphere by evasion. Thus, direct deposition on the water body frequently overshadows delivery from the watershed in many aquatic systems studied in the northern U.S.[4]

2.1.2 Mercury Transport and Transformations

Mercury that makes its way into aquatic environments is essentially all inorganic ionic HgII. Hg(0) is only weakly soluble in water, while organic forms are usually present in trace amounts with MMHg in the typical range of 0.1 to 5 percent of the total mercury. However, higher amounts of MMHg can enter from wetland drainage.[17] Measurements of MMHg in rainwater seem to be associated with marine production of dimethylmercury, which hydrolyzes to form MMHg. Dimethylmercury does not seem to occur in fresh-water environments but only in the marine environment.[5] The ionized forms of mercury (HgII, MMHg) react rapidly and strongly with particulates. Furthermore, ionized forms react strongly with sulfide ions and somewhat strongly with organic complexes.

The production of MMHg by microorganisms and its subsequent accumulation in fish is by far the greatest concern. Part of that concern arises from MMHg's long biological half-lives in fish (1-2 years) as opposed to humans and other warm-blooded creatures that have half-lives of 1-3 months. Thus fish can accumulate MMHg to high levels, and the consumed fish – especially long-lived predatory fish – provide exposure of sensitive fish-eating organisms to MMHg.

Two competing processes affect the concentrations of MMHg, methylation produces MMHg while demethylation cleaves the methyl group and then reduces HgII to Hg(0) in a two-step process. The net MMHg produced is what scientists measure and organisms accumulate.

Microorganisms perform most of the methylation and demethylation, and sulfate reducing bacteria produce almost all of the MMHg.[2] The concentration of sulfate necessary to support production has an optimum because at higher concentrations, the produced sulfide binds HgII and can make it less available for uptake by sulfate reducing bacteria. Thus, many factors control the production of MMHg: the availability of HgII controlled largely by particulate material and dissolved organic carbon compounds; sulfide and sulfate concentrations; the presence of active sulfate reducing bacteria, and zones of sulfate production. MMHg production is often associated with sediments because most of the HgII is there and anaerobic conditions associated with reductive processes like sulfate reduction also occur there. The presence of sediments along with a ready source of biodegradable organic carbon resulting from plant production, may explain why wetlands are a major locale for production of MMHg. Circulation with surface waters may make wetland MMHg available for uptake. Emerging insects may substantially increase transfer of MMHg produced in wetlands to predatory fish.[11]

The food web has an important role in distributing MMHg into fish populations where fish consumers can then become part of the food web. The wide variability in mercury concentrations in similar sized fishes arise from the variety of local conditions of mercury bio-availability, MMHg production, and MMHg transfer among food web components.[4]

2.1.3 Mississippi Mercury Criteria (Fresh Water)

The beneficial use listed in Table 3 applicable to the listed segment of the Pearl River in HUC 03180003 is Aquatic Life Support. The aquatic life criterion in fresh water, 0.012 μg/l of total Hg(II) is an appropriate endpoint for Phase One of this TMDL study. This criterion is currently the most restrictive criterion for mercury concentration in the water column. We believe the toxicity criteria are overprotective of toxicity to aquatic life. According to *Ambient Water Quality Criteria for Mercury – 1984*, the 0.012 μg/l criterion for aquatic life was calculated based on a FDA action level of 1.0 mg/kg. This is a concentration of mercury in fish tissue of edible fish. The criterion was also based on a bioconcentration factor (BCF) of 81,700, which was the laboratory-determined ratio of the concentration of mercury in the tissue of the fathead minnow to the concentration of dissolved HgII in the lab water. The BCF of 81,700 is based on the transfer of mercury from the water to the tissue of the fathead minnow, and not directly to any species of edible fish.

In the “unused data” section of the same criteria document, BCF’s ranging from 373 to 2400 were calculated for Bluegill, although the footnotes report that each BCF was not dependent on the concentration in the water. This means that there was no direct correlation between successive samples of mercury in the water and in the Bluegill fish tissue. However, a BCF was calculated in each case anyway, and they were much lower than the fathead minnow BCF. Although the criteria document states that the high BCF of the fathead minnow “might be more representative of commonly consumed warm-water fishes”; the Bluegill (which is a freshwater fish common in Mississippi) contradicts that assumption. To infer that the BCF of mercury in fathead minnows “might” be representative in light of the stated Bluegill results is an over-protective conclusion. Therefore, the use of the 0.012 μg/l of total mercury as the endpoint target for this TMDL incorporates an implicit margin of safety.

Additionally, we believe the 0.153 μg/l human health criterion is also protective of aquatic life. In *EPA’s National Recommended Water Quality Criteria-Correction*, April 1999, EPA published 0.770 μg/l as the proposed freshwater aquatic life criterion. In effect, EPA has said that 0.153 μg/l is five times more protective of aquatic life than the proposed criterion. We believe 0.153 μg/l is protective of aquatic life while 0.012 μg/l is overprotective of aquatic toxicity, (a conclusion that EPA has supported by virtue of the latest proposed aquatic life criteria publication of 0.770 μg/l). If Mississippi’s water quality criteria regarding mercury change, this Phase One TMDL will be revised to reflect those changes.

However, fish flesh sampling data indicate a possible impairment of the water body’s designated use. Therefore, to account for the uncertainty inherent with mercury fate and transport, this TMDL calls for a moratorium on future mercury discharges in the Pearl River watershed (HUC 03180003). This is to ensure the overall mercury load from point source contributors to the system does not increase. In addition, the TMDL includes an explicit MOS set at 50% for this TMDL.

2.2 MISSISSIPPI REGULATIONS ON FLOW DETERMINATION

In addition to the endpoint, the flow rate must be determined in order to calculate the TMDL. According to Section II.9.D(2) of the *State of Mississippi Water Quality Criteria for Intrastate, Interstate and Coastal Waters* regulations, the 7Q10 flow shall be used when applying chronic toxicity criteria concentrations to calculations determining the load to a stream. The 7Q10 flow is estimated to be 756 cfs at the most downstream point of the listed segment of the Pearl River. This estimate was provided by the MDEQ Office of Land and Water and is based on flow data from USGS Gage Stations 02488850 (Holiday Creek at Goss, Mississippi) and 02489000 (Pearl River near Columbia, Mississippi).

2.3 DISCUSSION OF INSTREAM WATER QUALITY

This segment of the Pearl River is listed based on fish tissue data collected from the Pearl River at Monticello, Mississippi. Data collected at this site is summarized and analyzed in the following sections. No fish advisory has been issued for this segment of the Pearl River.

2.3.1 Inventory of Water Quality Monitoring Data

Fish tissue samples were collected by MDEQ from the Pearl River at Monticello, Mississippi. Samples of various fish were collected in 1994, 1995, and 2003. These data are provided in Appendix A.

2.3.2 Analysis of Fish Tissue Data

Fish tissue data have been analyzed to identify violations requiring fish consumption advisories. Statistical summaries of methylmercury levels in fish tissue (wet weight filets) collected from the Pearl River at Monticello, Mississippi are presented in Table 4. These summaries are based on available data from 1994 to 2003, which is listed in Appendix A.

A single sampling event could have more than one fish, so the number of samples are listed along with the number of fish collected at that site. The percent exceedance value references the number of sampling events that averaged above the 1.0 ppm FDA action level. This percentage does not represent the number of individual fish that were found to exceed the action level. The table also gives the minimum, maximum, and average methylmercury levels found for all of the samples collected at the site. The fish tissue data collected from these water bodies are listed in Appendix A. No fish advisory has been issued for this segment of the Pearl River.

Table 4. Water Quality Station Data Analysis

Station	Sample Events	Number of Fish	Percent Exceedance*	Min ppm	Max ppm	Average ppm
Pearl River @ Monticello, MS	14	45	7%	0.21	1.37	0.59

* Percent exceedance is based on sampling events not individual fish.

3.0 SOURCE ASSESSMENT

A TMDL evaluation must examine all known potential sources of the pollutant in the subject watershed, including point sources, nonpoint sources, and background levels. The source assessment is used as the basis of development of the model and ultimate analysis of the TMDL allocation options. However, in this Phase One Mercury TMDL, only point source contributions are considered for evaluation. Phase Two of the TMDL will further study contributions from nonpoint sources and background levels in the analysis.

3.1 POTENTIAL SOURCES OF MERCURY

Mercury emissions can occur from both natural and man-made sources. The man-made sources are estimated to account for the majority of all emissions. Appendix C contains a thorough outline of mercury sources. The following are examples of mercury sources in the environment that can be controlled.[7]

- Cement and Lime Kilns
- Coal and Oil Burning
- Copper Smelting
- Crematories
- Dental Amalgam Preparation/Disposal
- Dwelling Demolition (thermostats and switches)
- Electrical Product Manufacturing and Disposal (switches, fluorescent lights, some headlights and batteries)
- Evaporation of Mercury from Landfills
- Garbage Incinerators
- Hazardous Waste Incinerators
- Industrial Waste Discharge
- Laboratories Use and Waste
- Medical Waste Incinerators
- Petroleum Refining
- Residential Boilers
- Wastewater Treatment Plants and Sewage
- Wood Burning

Many items that we are in contact with everyday contain mercury. When these items are no longer useful, care should be taken to ensure that they are kept out of the trash or drain. When products containing mercury are placed in the trash, the mercury doesn't disappear. It finds its way into the environment from waste incinerators, landfills, or wastewater treatment facilities.

Items that may contain mercury include:

- Fluorescent Lamps
- Mercury Switches
- Mercury Vapor Lamps
- Thermostat Probes
- Metal Halide Lamps
- Relays
- High Pressure Sodium Lamps
- Thermometers
- Neon Lamps
- Thermostats
- Dental Amalgam
- Manometers
- Gauges
- Laboratory Solutions

3.1.1 Fluorescent and High-Intensity Discharge Lamps

Fluorescent and high-intensity discharge (HID) lamps are used because they can use up to 50% less electricity than incandescent lighting. However, these lamps must be managed and disposed of properly because they contain mercury.[8]

3.1.2 Mercury Switches and Relays

Mercury switches are found in a variety of items ranging from chest freezers to sump pumps. Mercury containing tilt switches are found under the lids of clothes washers and chest freezers. They stop the spin cycle or turn on a light. They are also found in motion-sensitive and position-sensitive safety switches in clothes irons and space heaters. Float switches are commonly used in sump pumps and bilge pumps to turn the equipment on and off when the water is at a certain level. Automobile trunk and hood light switches often contain mercury. A variety of manufacturing processes use relays to control power to heaters or pumps. Relays that contain mercury switches activate airbags, anti-lock brakes, some seat belt systems, and some automatically adjusting suspension systems. Some agricultural equipment, military vehicles, mass transit vehicles, and fire hook and ladder equipment also contain mercury switches.[8]

3.1.3 Mercury-Containing Thermostats and Thermostat Probes

Mercury-containing tilt switches have been used in thermostats for more than 40 years. They provide accurate and reliable temperature control, require little or no maintenance, and do not require a power source. However, each switch contains approximately 3 grams of mercury. Mercury-free thermostats are available. Electronic thermostats now provide many of the same features as mercury thermostats.[8]

Mercury-containing thermostat probes may be found in several types of gas-fired appliances that have pilot lights, such as ranges, ovens, clothes dryers, water heaters, furnaces, or space heaters.

3.1.4 Mercury Thermometers

Some fever and laboratory thermometers contain mercury and should not be thrown in the trash. A typical fever thermometer contains about 0.5 grams of mercury. Larger laboratory thermometers can contain up to 3 grams of mercury. Many thermometers used to measure air and water temperature also contain mercury. They are used by homeowners, businesses, institutions, and recreational anglers. When the thermometers break outdoors, the mercury is difficult to capture. Mercury free thermometers such as digital thermometers are as accurate as mercury thermometers for most applications.[8]

3.1.5 Gauges, Manometers, Barometers, and Vacuum Gauges

Many barometers and vacuum gauges found in machinery contain mercury. Liquid mercury in the gauges responds to air pressure in a precise way that can be read on a calibrated scale. Several mercury-free alternatives are available. Some operate on the same principle as mercury gauges but use mercury-free liquids in the tube.[8]

Needle or bourdon gauges operate under a vacuum with a needle indicator. Electronic gauges can be used to measure pressure, but they must be calibrated with a mercury manometer. Equipment manufacturers recommend that service technicians use a needle or digital gauge to test the systems they are servicing, but that they calibrate the gauges they use in the field with a mercury manometer kept at their shop.[8]

3.2 POINT SOURCE ASSESSMENT

The point sources within the Pearl River watershed (HUC 03180003) are listed in Table 5. Point sources that are possible contributors of mercury or that have flows greater than 0.05 MGD will be recommended by this TMDL to monitor their wastewater effluent for mercury. In an attempt to control mercury levels in the water body, this Phase One TMDL will call for a moratorium on any future increase in mercury discharges into the Pearl River watershed (HUC 03180003).

Table 5. Permitted Facilities in the Pearl River Watershed (HUC 03180003)

NPDES ID	Facility Name	County	Receiving Water	Permitted Flow (MGD)
MS0022462	Copiah Educational Foundation, Inc. (Copiah Academy)	Copiah	Unnamed Creek to Copiah Creek	0.03000
MS0023922	Hazlehurst POTW	Copiah	Bahala Creek	0.95000
MS0032921	Copiah County Industrial Park	Copiah	Copiah Creek	0.14500*
MS0034894	Timberlanes Camp and Dude Ranch	Copiah	Unnamed Tributary of Little Beaverdam Creek	0.01200

Table 5 Cont'd. Permitted Facilities in the Pearl River Watershed (HUC 03180003)

NPDES ID	Facility Name	County	Receiving Water	Permitted Flow (MGD)
MS0036552	Kitchens Brothers Manufacturing Company	Copiah	Unnamed Tributary of Bahala Creek	0.04700*
MS0036986	Georgia Gulf Chemicals and Vinyls, LLC., Gallman	Copiah	Copiah Creek	0.03590
MS0041874	Crystal Springs POTW	Copiah	Little Copiah Creek	0.99000
MS0044725	Sanderson Farms, Inc. Hazlehurst Processing	Copiah	Copiah Creek	0.90000
MS0049476	Hazlehurst Lumber Company	Copiah	Unnamed Tributary of Long Creek	0.01700*
MS0050971	Family Fish House	Copiah	Unnamed Tributary of Copiah Creek	0.00300
MS0024848	Bassfield POTW	Jefferson Davis	Holiday Creek	0.06500
MS0029033	Prentiss POTW	Jefferson Davis	Big White Sand Creek	0.60400
MS0035009	Jefferson Davis Vocational Technical Center	Jefferson Davis	Choctaw Creek	0.01000
MS0037109	Polks Meat Products, Inc., Prentiss Plant	Jefferson Davis	White Sand Creek	0.01500
MS0037222	Emmett Smith Slaughterhouse	Jefferson Davis	Unnamed Tributary to White Sand Creek	0.00075
MS0038989	Lily Rose Water Association	Jefferson Davis	Dry Creek	0.05100
MS0043290	Mallard Trailer Park	Jefferson Davis	Unnamed Tributary to Dry Creek	0.00400
MS0044334	Thurman Trailer Park	Jefferson Davis	Holiday Creek	0.00600
MS0002941	Georgia Pacific Corporation, Monticello Mill	Lawrence	Pearl River	31.53000*
MS0020729	New Hebron POTW	Lawrence	West Silver Creek	0.06000
MS0024643	Monticello POTW	Lawrence	Halls Creek	0.22500
MS0025453	Silver Creek POTW	Lawrence	Silver Creek	0.04500
MS0028240	Topeka Tilton Attendance Center	Lawrence	Unnamed Creek to East Topishaw Creek	0.01875
MS0047953	Monticello Forest Products Corporation	Lawrence	Unnamed Tributary to Pearl River	0.00100
MS0048143	Monticello Head Start Centers	Lawrence	Unnamed Creek to Pearl River	0.00500
MS0049336	Joe N. Miles and Sons, Inc.	Lawrence	Unnamed Tributary to Silver Creek	0.02600
MS0055263	Little Angels Day Care	Lawrence	Tributary of Magees Creek	0.00050
MS0055743	Monticello Hardwood, Inc.	Lawrence	Unnamed Tributary of Pearl River	0.14400

Table 5 Cont'd. Permitted Facilities in the Pearl River Watershed (HUC 03180003)

NPDES ID	Facility Name	County	Receiving Water	Permitted Flow (MGD)
MS0056821	Town of New Hebron WWTP	Lawrence	West Prong of Silver Creek	0.00840
MS0036871	Lake Lincoln State Park	Lincoln	Ford's Creek	0.00850
MS0002208	Georgia Pacific Corporation, Columbia	Marion	Unnamed Tributary to Holiday Creek	0.10000

* This NPDES facility does not have a permit limit for flow. The facility is required to report flow information in each discharge monitoring report. The flow value given above is an average of the facility's historical flow data.

4.0 MODELING PROCEDURE

Establishing the relationship between the instream water quality target and the source loadings is a critical component of TMDL development. It allows for the evaluation of alternatives for possible wasteload reductions. The link for mercury in the water column and mercury in fish flesh has not been established. The discussion of mercury TMDL calculations is included in this section.

4.1 MODELING CALCULATIONS

Mass balance equations have been used to determine the mercury TMDL in the Pearl River watershed (HUC 03180003). A more complicated model is not warranted for Phase One of the TMDL analyzed because: (1) only contributions from point sources are considered, but none are known; (2) the mercury cycling processes will not be represented until Phase Two; (3) and water quality data for ambient mercury concentrations are not available to correspond to the levels of mercury found in the fish flesh for the Pearl River.

4.2 CALCULATION SETUP

The watershed for the listed segment of the Pearl River contains all of HUC 03180003. The delineation of the watershed is based primarily on an analysis of the National Hydrography Dataset (NHD) stream network in the watershed. As a conservative assumption, the 7Q10 low flow condition is the flow used to calculate this TMDL. The 7Q10 was calculated at most downstream point of the listed segment. All upstream tributaries and point source loads located within HUC 03180003 are included in this TMDL.

4.3 SOURCE REPRESENTATION

Only point sources are considered in this Phase One Mercury TMDL. Point sources that are possible contributors of mercury or that have flows greater than 0.05 MGD will be recommended by this TMDL to monitor their wastewater effluent for mercury. Table 6 lists the facilities that are recommended for mercury monitoring in the Pearl River watershed (HUC 03180003).

Table 6. Facilities in the Pearl River Watershed (HUC 03180003) Recommended for Mercury Monitoring

Facility Name	NPDES ID
MS0022462	Copiah Educational Foundation, Inc.(Copiah Academy)
MS0023922	Hazlehurst POTW
MS0032921	Copiah County Industrial Park
MS0036552	Kitchens Brothers Manufacturing Company
MS0036986	Georgia Gulf Chemicals and Vinyls, LLC., Gallman*
MS0041874	Crystal Springs POTW
MS0044725	Sanderson Farms, Inc. Hazlehurst Processing Division

Table 6 Cont'd. Facilities in the Pearl River Watershed (HUC 03180003) Recommended for Mercury Monitoring

Facility Name	NPDES ID
MS0049476	Hazlehurst Lumber Company
MS0024848	Bassfield POTW
MS0029033	Prentiss POTW
MS0035009	Jefferson Davis Vocational Technical Center
MS0038989	Lily Rose Water Association
MS0002941	Georgia Pacific Corporation, Monticello Mill
MS0020729	New Hebron POTW
MS0024643	Monticello POTW
MS0025453	Silver Creek POTW
MS0028240	Topeka Tilton Attendance Center
MS0047953	Monticello Forest Products Corporation
MS0055743	Monticello Hardwood, Inc.
MS0056821	Town of New Hebron WWTP
MS0002208	Georgia Pacific Corporation, Columbia

* This facility has conducted some mercury monitoring prior to development of the TMDL. However, additional monitoring needs to be conducted using the sampling methods recommended in this TMDL.

A significant amount of mercury water quality sampling data from the Pearl River is needed to adequately explain the relationship between mercury concentration in the water column with the concentration in fish tissue. As ambient mercury data and tools for analyzing mercury cycling become available, Phase Two of this TMDL project will be completed to accurately represent mercury sources, atmospheric deposition, and stream response.

5.0 ALLOCATION

TMDLs are composed of the sum of individual waste load allocations (ΣWLAs) for point sources, the sum of load allocations (ΣLAs) for nonpoint sources, and a margin of safety (MOS). This definition is mathematically expressed by the equation:

$$TMDL = \Sigma WLA + \Sigma LA + MOS$$

The TMDL is the amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. This TMDL represents the maximum load of mercury that can be introduced into the water body by point source discharge based on Mississippi's mercury criterion.

5.1 TMDL CALCULATION

The TMDL Calculation is based upon the conservation of mass principle, where the load can be calculated by using the following relationship:

$$Concentration = Load / Flow$$

Rearranging this equation, the load can be calculated as follows:

$$Load = Concentration * Flow$$

Load gm/day = 0.012 µg/l * 756 cfs * 2.45 (unit conversion factor) = 22.2 gm/day

The overall TMDL load for total mercury in the water body system is 22.2 grams per day. The total mercury II target of 0.012 µg/l is expressed as Total Recoverable Mercury.

Table 7. TMDL for Total Mercury II

Segment ID	Flow (cfs)	Total Hg(II) Target (µg/l)	TMDL (gm/day)
MSLMPRLRM	756	0.012	22.2

Once the total TMDL has been calculated, the components of the equation can then be allocated.

5.2 TMDL ALLOCATIONS

The allocation for this TMDL involves a wasteload allocation for point sources and a load allocation for nonpoint sources necessary for attainment of water quality standards in the Pearl River watershed (HUC 03180003). The Wasteload Allocation (WLA) for this TMDL was determined by multiplying the permitted flow of the dischargers within the Pearl River watershed (HUC 03180003) by the mercury criterion. Since this TMDL calls for a moratorium on any future increase in mercury discharges into the Pearl River watershed (HUC 03180003), the WLA component should not increase. The Load Allocation (LA) accounts for atmospheric deposition and background.

5.2.1 Wasteload Allocations

The sum of the loads allocated to the point sources, (ΣWLAs) is determined by multiplying the permitted flow from the facility by the mercury criterion. Appendix B provides a list of permitted facilities within the watershed. Each facility's flow is multiplied by the mercury criterion and a conversion factor to give a daily load. This TMDL recommends that possible contributors of mercury or facilities with flows greater than 0.05 MGD monitor wastewater effluent for mercury.

All municipalities must complete the NPDES Form 2A Application. According to this application, supplemental information regarding effluent testing and toxicity testing must be included if one or more of the following is true: (1) the facility has a design flow rate greater than or equal to 1.0 MGD, (2) the facility is required to have a pretreatment program, or (3) the facility is otherwise required by the permitting authority to provide additional effluent information or submit the results of toxicity testing. Some facilities listed below will be required to monitor for mercury in order to meet their 2A application requirements. Minor municipal facilities not meeting any of the above requirements are not required to complete all of the 2A application are not required to monitor for mercury. In addition, the 2A application does not apply to commercial and industrial facilities. However, due to the mercury impairment in this watershed, this TMDL recommends that mercury monitoring similar to that required by a complete 2A application be required for all facilities listed in Table 8. This TMDL recommends that all facilities listed below have mercury monitoring required as part of their permitting process. If mercury is found in the facility's discharge, permit limits could be developed and a mercury minimization program would be needed.

Table 8. Facilities Recommended to Perform Mercury Effluent Monitoring

Facility Name	NPDES ID
MS0022462	Copiah Educational Foundation, Inc.(Copiah Academy)
MS0023922	Hazlehurst POTW
MS0032921	Copiah County Industrial Park
MS0036552	Kitchens Brothers Manufacturing Company
MS0036986	Georgia Gulf Chemicals and Vinyls, LLC., Gallman
MS0041874	Crystal Springs POTW

Table 8 Cont'd. Facilities Recommended to Perform Mercury Effluent Monitoring

Facility Name	NPDES ID
MS0044725	Sanderson Farms, Inc. Hazlehurst Processing Division
MS0049476	Hazlehurst Lumber Company
MS0024848	Bassfield POTW
MS0029033	Prentiss POTW
MS0035009	Jefferson Davis Vocational Technical Center
MS0038989	Lily Rose Water Association
MS0002941	Georgia Pacific Corporation, Monticello Mill
MS0020729	New Hebron POTW
MS0024643	Monticello POTW
MS0025453	Silver Creek POTW
MS0028240	Topeka Tilton Attendance Center
MS0047953	Monticello Forest Products Corporation
MS0055743	Monticello Hardwood, Inc.
MS0056821	Town of New Hebron WWTP
MS0002208	Georgia Pacific Corporation, Columbia

* This facility has conducted some mercury monitoring prior to development of the TMDL. However, additional monitoring needs to be conducted using the sampling methods recommended in this TMDL.

5.2.2 Load Allocations

The Load Allocations (LA) for this TMDL account for mercury due to atmospheric deposition and background. Since atmospheric deposition is believed to be the primary source of mercury, a large portion of the TMDL has been set aside for this component. Phase Two of this TMDL project will explore atmospheric deposition along with local and national air-emission reduction goals.

5.3 INCORPORATION OF A MARGIN OF SAFETY

The two options for MOS development are either to implicitly incorporate the MOS using conservative assumptions or to explicitly specify a portion of the total TMDL as the MOS. A dual MOS method has been selected for this Phase One TMDL. It is implicit, based on the conservative assumptions inherent in the selection of the TMDL endpoint of 0.012 μg/l. In addition, it is explicit to account for uncertainty in the mercury linkage between fish flesh mercury levels and water-column mercury levels. The explicit MOS has been set at 50%.

Additional conservative assumptions for TMDL calculation are inherent in the development of the 0.153 μg/l human health standard. The criterion is based on the following equation:

$$C = \frac{\text{reference dose} * \text{human body weight}}{\text{fish consumption rate} * \text{bio-concentration factor}}$$

The criterion was based on a combination of fish consumption rates and bio-concentration factors for fresh water fishes, coastal organisms, and salt-water fishes. If the coastal organisms and salt-water fishes are omitted from the calculation, the criterion would be 2.22 μg/l. The fish tissue data collected from the Pearl River at Monticello, Mississippi show elevated mercury levels in Flathead Catfish, Channel Catfish, Largemouth Bass, Spotted Bass, Bass sp., Freshwater Drum, and Bowfin. However, the BCF used in the criteria development considers four species of freshwater fish resulting in an average BCF of 5500, which is higher than that of either the bass or the catfish. Using the higher combined value in the denominator of the above equation, another conservative assumption is introduced into the calculations.

Additionally, the fresh water fish consumption rate established in the *Ambient Water Quality Criteria for Mercury* is 1.72 gm/day per person. Our regulations, however, require the use of 6.5 gm/day per person. This calculation would set the criterion at 0.587 μg/l as compared to the 0.153 μg/l in Mississippi's water quality standards. The use of a fish consumption rate of almost 3.8 times that for freshwater species alone introduces yet another conservative assumption which is already a part of the current human health standard for Mississippi.

However, there is enough uncertainty inherent to this entire process to justify the inclusion of an explicit MOS. As previously mentioned, this explicit MOS has been set at 50%.

TMDL = WLA + LA + MOS

22.2 gm/day = 1.64 gm/day WLA + 9.46 gm/day LA + 11.10 gm/day MOS

5.4 SEASONALITY

Wet deposition is greatest in the winter and spring seasons. Mercury will be expected to fluctuate based on the amount and distribution of rainfall, and variability of localized and distant atmospheric sources. While a maximum daily load is established in this TMDL, the average annual load is of greatest significance since mercury bioaccumulation and the resulting risk to human health that results from mercury consumption is a long term phenomenon. Thus, daily or weekly inputs are less meaningful than total annual loads over many years. The use of annual load allows for integration of short-term or seasonal variability. Inputs will continue to be estimated through monitoring and modeling.

Methylation of mercury is expected to be highest during the summer. High temperatures and static conditions result in hypoxic and/or conditions that promote methylation. Based on this enhanced methylation and high predator feeding activity during the summer, mercury bioaccumulation is expected to be greatest during the summer. However, based on the refractory nature of mercury, seasonal changes in body burden would be expected to be slight. Inherent variability of mercury concentrations between individual fish of the same and/or different size categories is expected to be greater than seasonal variability.[15]

5.5 IMPLEMENTATION PLAN

Implementation of this Phase One Mercury TMDL will differ from other types of TMDLs since atmospheric deposition is believed to be the primary pollutant source. This will involve MDEQ working with stakeholders to identify the most appropriate mechanisms to implement this TMDL project. MDEQ will cooperate with EPA concerning national initiatives and strategies, which will be important to implement regulatory controls on a national and international basis. Much monitoring, research, and regulation is in progress on the national level. MDEQ will consider these ongoing activities in implementing this and future phases of this TMDL project.

The ultimate reduction of mercury in the environment will take numerous years and is in line with the Bi-national Toxics Strategy, which sets a national challenge of 50% reduction of mercury releases to the air by 2006. Phase Two of this TMDL project will explore atmospheric deposition along with local and national air-emission reduction goals. Long-term monitoring of wet deposition rates and fish tissue in the water body segment will serve as environmental indicators to evaluate the effectiveness of the TMDLs and other parallel control measures.[15]

MDEQ also supports and encourages Pollution Prevention activities (P2 activities) as part of this implementation plan. P2 activities help alleviate costs and resources associated with controlling, removing, and managing mercury contamination in the environment. These activities include: (1) separating mercury-containing waste from the trash and save it for local household hazardous waste collection days, (2) taking mercury-containing items such as thermometers to a household hazardous waste collection facility, (3) removing mercury-containing items from households and schools (including student laboratories), and (4) conserving electricity (burning less coal and oil, which naturally contains mercury, for electricity will emit less mercury into the environment). Table 9 gives some examples of possible P2 alternatives for products containing mercury.

Table 9. Pollution Prevention (P2) Alternatives for Products Containing Mercury

Discards Known to Contain Mercury	P2 Alternatives
Thermometers	Red Bulb (Alcohol) Thermometers Digital Thermometers
Thermostats (non-electric models)	Electric Models
Batteries (old alkaline type prior to 1996)	Recharge Alkaline Batteries Mercury Free Batteries
Button Batteries	Mercury Free Button Batteries (Zinc air type)
Silver Amalgam Waste	Ask Your Dentist
Quicksilver Maze Toy	Mercury-Free Toys
Old Latex Paints (since 1990, mercury has been banned in latex paints)	New Latex Paint
Some Shoes that Light Up (L.A. Gear’s My Lil’ Lights if bought before June 1994)	Mercury-Free Shoes
Switches (some light and appliance switches)	Mechanical or Electrical Switches
Contact Lens Solution Containing Thimerosol	Mercury-Free Solution
Lights (fluorescent, high intensity discharge, and mercury vapor lamps)	Energy Efficient Fluorescent Lights (These lights still contain mercury. However, energy will be conserved thereby reducing mercury emissions from coal and oil combustion)

6.0 CONCLUSION

MDEQ will not approve any NPDES Permit application for the Pearl River drainage area (HUC 03180003) that does not comply with the moratorium for additional mercury discharges into this segment. In addition, this TMDL recommends all dischargers that are possible contributors of mercury or that have flows greater than 0.05 MGD to monitor for mercury using clean techniques and accurate testing methods. This TMDL also recommends and encourages Pollution Prevention Alternatives/Activities that address possible sources of mercury within the Pearl River watershed (HUC 03180003).

Phase Two of this TMDL will include nonpoint sources of mercury, atmospheric deposition, and will consider the effects of mercury cycling in the water body. The TMDL calculations from Phase One may be revised in Phase Two of this TMDL since more will be known about the percentage of mercury contributions from point and nonpoint sources.

6.1 FOLLOW-UP MONITORING

Additional ambient mercury monitoring for all species of mercury will be needed for development of Phase Two. Additional information is required to facilitate the understanding of the methylmercury process and the linkage between mercury in the water column and mercury in fish flesh. Specialized monitoring approaches will also be needed to determine the atmospheric deposition contribution to mercury in the watershed.

MDEQ has adopted the Basin Approach to Water Quality Management, a plan that divides Mississippi's major drainage basins into five groups. During each yearlong cycle, MDEQ resources for water quality monitoring are focused on one of the basin groups. During the next monitoring phase in the Pearl River Basin, the Pearl River (HUC 03180003) may receive additional monitoring to identify the improvements in water quality gained from the implementation of the Phase One strategy included in this TMDL. MDEQ plans to continue monitoring mercury concentrations in fish tissue within this segment of the Pearl River in order to protect human health.

6.2 PUBLIC PARTICIPATION

This Phase One TMDL project will be published for a 30-day public notice. During this time, the public will be notified by publication in both a statewide and local newspaper. The public will be given an opportunity to review the TMDL and submit comments. MDEQ also distributes all TMDLs at the beginning of the public notice to those members of the public who have requested to be included on a TMDL mailing list. TMDL mailing list members may request to receive the TMDL reports through either, email or the postal service. Anyone wishing to become a member of the TMDL mailing list should contact Greg Jackson at (601) 961-5098 or Greg_Jackson@deq.state.ms.us.

All comments received during the public notice period and at any public hearings become a part of the record of this TMDL. All comments will be considered in the ultimate approval of this TMDL and for submission of this TMDL to EPA Region 4 for final approval.

DEFINITIONS

Ambient Stations: Network of fixed monitoring stations established for systematic water quality sampling at regular intervals, and for uniform parametric coverage over a long-term period.

Assimilative Capacity: The amount of contaminant load that can be discharged to a specific stream or river without violating the provisions of the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters and Water Quality* regulations. Assimilative capacity is the extent to which a body of water can receive wastes without significant deterioration of beneficial uses.

Atmospheric Deposition: Input of chemical components from the atmosphere into natural waters through the processes of wet deposition (rain, snow) and dry deposition (particle fallout, gas-water exchange). Components can include nutrients, acidity, trace elements, and anthropogenic organics.

Background: Ambient pollutant concentrations due to natural sources, nearby sources other than the one currently under consideration, and unidentified anthropogenic sources.

Best Management Practices: (1) The methods, measures, or practices selected by an agency to meet its nonpoint source control needs. BMPs include but are not limited to structural and nonstructural controls and operation and maintenance procedures. BMPs can be applied before, during, or after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters. (2) Methods have been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.

Bioaccumulation (Bioretention): (1) The uptake and, at least temporary, storage of a chemical by an exposed animal. The chemical can be retained in its original form and/or as modified by enzymatic and non-enzymatic reactions in the body. (2) The retention and concentration of a substance by an organism. Accumulation of a large amount of a substance in the body by ingesting small amounts of the substance over an extended time. (3) The process by which a compound is taken up by an aquatic organism, both from water and through food.

Bioaccumulation Factor (BAF): The ratio of a substance's concentration in tissue versus its concentration in ambient water, in situations where the organism and the food chain are exposed.

Bioconcentration: (1) The accumulation of a chemical in tissues of an organism (such as fish) to levels greater then in the surrounding medium (such as water) in which the organism resides. (2) The net accumulation of a substance directly from water in to and onto aquatic organisms. (3) The process by which a compound is absorbed from water through the gills or epithelial tissues and is concentrated in the body.

Bioconcentration Factor (BCF): (1) The ratio of the concentration of a chemical in aquatic organisms to the amount in water at equilibrium. (2) The measure of the tendency for a substance to accumulate in the tissue of an aquatic organism. BCF is determined by the extent of partitioning of a substance, at equilibrium, between the tissue of an aquatic organism and water. As the ratio of concentration of a substance in the organism divided by the concentration in water, higher BCF values reflect a tendency for substances to accumulate in the tissue of aquatic organisms.

Calibration: Testing and tuning of a model to a set of field data. Also includes minimization of deviations between measured field conditions and output of a model by selecting appropriate model coefficients.

Critical Condition: Hydrologic and atmospheric conditions in which the pollutants causing impairment of a water body have their greatest potential for adverse effects.

Daily Discharge: The "discharge of a pollutant" measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the "daily average" is calculated as the average.

Designated Use: (1) Those uses specified in water quality standards for each water body or segment whether or not they are being attained. (2) Those water uses identified in state water quality standards which must be achieved and maintained as required under the Clean Water Act.

Discharge Monitoring Report: Report of effluent characteristics submitted by a facility that has been granted an NPDES Permit.

Effluent: (1) Any solid, liquid, or gas which enters the environment as a by-product of a man-oriented process. The substances that flow out of a designated source. Effluent, effluence, and efflux have the same meaning. (2) Wastewater – treated or untreated – that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters.

Effluent Standards and Limitations: All State or Federal effluent standards and limitations on quantities, rates, and concentrations of chemical, physical, biological, and other constituents to which a waste or wastewater discharge may be subject under the Federal Act or the State law. This includes, but is not limited to, effluent limitations, standards of performance, toxic effluent standards and prohibitions, pretreatment standards, and schedules of compliance.

Geometric Mean: The *n*th root of the product of *n* numbers. A 30-day geometric mean is the 30^{th} root of the product of 30 numbers.

Impairment: Conditions in which the applicable state water quality standards are not met for a water body and the designated use is impaired.

Load Allocation (LA): The portion of a receiving water's loading capacity attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources. Load allocations are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Wherever possible, natural and nonpoint source loads should be distinguished.

Loading: (1) An amount of matter or thermal energy that is introduced into a receiving water. Loading may be either man caused (pollutant loading) or natural (background loading). (2) The concentration of a pollutant, usually expressed in grains of pollutant per cubic foot of contaminated gas stream.

Margin of Safety (MOS): A required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant load and the quality of the receiving water body.

Mercury (Hg): A silver-white metal, atomic weight 200.59, which is a slightly volatile liquid at room temperature. Mercury is a naturally occurring element that is found in air, water and soil. It ranks about 67th in natural abundance among the elements in crustal rocks. Most of the mercury in the atmosphere is elemental mercury vapor (which circulates in the atmosphere for up to a year, and hence can be widely dispersed and transported thousands of miles from likely sources of emission). Most of the mercury in water, soil, sediments, or plants and animals is in the form of inorganic water-soluble salts (most commonly mercuric chloride) and organic forms of mercury (commonly methylmercury). Among the commercially important compounds of mercury are mercuric sulfide, a common antiseptic also used as the pigment vermilion; mercurous chloride, or calomel, used for electrodes, and formerly used as a cathartic; mercuric chloride, or corrosive sublimate; and medicinals such as Mercurochrome.

Mercury (elemental): Mercury in a zero (0) oxidation state - referred to as mercury vapor when present in the atmosphere and as metallic mercury when present in its liquid form.

Mercury II (inorganic mercury): Mercury which has been naturally oxidized to a divalent oxidation state and exhibits a wide range of acute toxicity to aquatic life. Inorganic mercury occurs in numerous forms/compounds; the most common include mercuric chloride ($HgCl_2$), mercurous chloride (Hg_2Cl_2), and mercuric oxide (Hg[O]).

Methylmercury (organic mercury): Mercury II which has been methylated in surface waters by naturally occurring bacteria and which can substantially accumulate in the food chain. Nearly all of the mercury that accumulates in fish tissue is methylmercury.

Nonpoint Source Pollution: The pollution from sources which generally are not controlled by establishing effluent limitations under sections 301, 302, and 402. Nonpoint source pollutants are not traceable to a discrete identifiable origin, but generally result from land runoff, precipitation, drainage, or seepage. This water may contain pollutants that come from land use activities such as agriculture, construction, silviculture, surface mining, disposal of wastewater, hydrologic modifications, and urban development.

NPDES Permit: An individual or general permit issued by the MDEQ Permit Board pursuant to regulations adopted by the Commission under Mississippi Code Annotated (as amended) § 49-17-17 and § 49-17-29 for discharges into State waters.

Part Per Million: One millionth of a measurement. This nomenclature also applies to part per billion and part per trillion. 1 mg/kg mercury in fish flesh is one part per million. 1 μg/l liquid concentration is equivalent to one part per billion. 1 nanogram liquid concentration is equivalent to one part per trillion.

Phased TMDL Project: Under the phased approach, the TMDL has load allocations and wasteload allocations calculated with margins of safety to meet water quality standards. The allocations are based on estimates that use available data and information, but monitoring for collection of new data is required. The phased approach provides for further pollution reduction without waiting for new data collection and analysis.

Point Source Pollution: Pollution from a stationary location or fixed facility from which pollutants are discharged or emitted. Pollution from any single identifiable source, e.g., a pipe, ditch, ship, ore pit, or factory smokestack.

Pollution Prevention (P2) Activities: (1) The use of materials, processes, or practices that reduce or eliminate the creation of pollutants or wastes. It includes practices that reduce the use of hazardous materials, energy, water, or other resources, and practices that protect natural resources through conservation or more efficient uses. (2) A preventative action or a measure taken to minimize waste generation or waste toxicity, if waste generation is inevitable. In a broad sense, it incorporates clean technology, low-waste technology, non-waste technology, prevention, quantity reduction, recycling, reduction, resource conservation, resource recovery, source reduction, toxicity reduction, waste minimization, etc.

Pollution: Generally, the presence of matter or energy whose nature, location, or quantity produces undesired environmental effects. Under the Clean Water Act, for example, the term is defined as man-made or man-induced alteration of the physical, biological, and radiological integrity of water. Other pollution related terms include: agricultural pollution, air pollution, indoor air pollution, industrial waste pollution, manmade air pollution, natural pollution, noise pollution, oil pollution, sewage pollution, soil pollution, thermal pollution, water pollution, and wood burning stove pollution.

Practical Bioaccumulation Factor (PBCF): A practical approximation used in lieu of a BCF in the derivation of the human health criteria for mercury in Ambient Water Quality Criteria for Mercury. The PCBF's were calculated as the ratio of the average concentration of mercury in muscle in one species of fish to the average concentration of mercury in the body of water in which the species normally lives.

Publicly Owned Treatment Works (POTW): The treatment works treating domestic sewage that is owned by a municipality or State.

Scientific Notation (exponential notation): Mathematical method in which very large numbers or very small numbers are expressed in a more concise form. The notation is based on powers of ten. Numbers in scientific notation are expressed as the following: *4.16 x 10^(+b)* and *4.16 x 10^(-b) [same as 4.16E4 or4.16E-4]*. In this case, *b* is always a positive, real number. The *10^(+b)* tells us that the decimal point is *b* places to the right of where it is shown. The *10^(-b)* tells us that the decimal point is *b* places to the left of where it is shown.
For example: $2.7X10^4 = 2.7E+4 = 27000$ and $2.7X10^{-4} = 2.7E-4 = 0.00027$.

Sigma (Σ): Shorthand way to express taking the sum of a series of numbers. For example, the sum or total of three amounts 24, 123, 16, ($\mathbf{d}_1$, $\mathbf{d}_2$, $\mathbf{d}_3$) respectively could be shown as:

$$\sum_{i=1}^{3} d_i = d_1+d_2+d_3 = 24+123+16 = 163$$

STORET: EPA's computerized water quality data base that includes physical, chemical, and biological data measured in water bodies throughout the United States.

Storm Water: (1) The storm water runoff, snow melt runoff, and surface runoff and drainage. (2) Rainfall that does not evaporate or infiltrate the ground because of impervious land surfaces or a soil infiltration rate than rainfall intensity, but instead flows into adjacent land or water bodies or is routed into a drain or sewer system.

Total Maximum Daily Load (TMDL): (1) The total allowable pollutant load to a receiving water such that any additional loading will produce a violation of water quality standards. (2) The sum of the individual waste load allocations and load allocations. A margin of safety is included with the two types of allocations so that any additional loading, regardless of source, would not produce a violation of water quality standards.

Waste: Useless, unwanted, or discarded material resulting from (agricultural, commercial, community, and industrial) activities. Wastes include solids, liquids, and gases.

Wasteload Allocation (WLA): (1) The portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality based effluent limitation. (2) The portion of a receiving water's total maximum daily load that is allocated to one of its existing or future point sources of pollution. (3) The maximum load of pollutants each discharger of waste is allowed to release into a particular waterway. Discharge limits are usually required for each specific water quality criterion being, or expected to be, violated. The portion of a stream's total assimilative capacity assigned to an individual discharge.

Water Quality Criteria: Specific levels of water quality which, if reached, are expected to render a body of water suitable for its designated use. The criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, fish production, or industrial processes. Water quality criteria are comprised of numeric and narrative criteria. Numeric criteria are scientifically derived ambient concentrations developed by EPA or States for various pollutants of concern to protect human health and aquatic life. Narrative criteria are statements that describe the desired water quality goal.

Water Quality Standards: (1) Provisions of State or Federal law which consist of a designated use or uses for the water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water, and serve the purposes of the Clean Water Act. (2) A law or regulation that consists of the beneficial designated use or uses of a water body, the numeric and narrative water quality criteria that are necessary to protect the use or uses of that particular water body, and an antidegradation statement. (3) State-adopted and EPA-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.

Waters of the State: All waters within the jurisdiction of this State, including all streams, lakes, ponds, wetlands, impounding reservoirs, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, situated wholly or partly within or bordering upon the State, and such coastal waters as are within the jurisdiction of the State, except lakes, ponds, or other surface waters which are wholly landlocked and privately owned, and which are not regulated under the Federal Clean Water Act (33 U.S.C.1251 et seq.).

Watershed: (1) The land area that drains (contributes runoff) into a stream. (2) The land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common delivery point.

ABBREVIATIONS

7Q10	Seven-Day Average Low Stream Flow with a Ten-Year Occurrence Period
BASINS	Better Assessment Science Integrating Point and Nonpoint Sources
BMP	Best Management Practice
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
GIS	Geographic Information System
HCR	Hydrograph Controlled Release Facility
HUC	Hydrologic Unit Code
LA	Load Allocation
MARIS	State of Mississippi Automated Resource Information System
MDEQ	Mississippi Department of Environmental Quality
MOS	Margin of Safety
NHD	National Hydrography Dataset
NRCS	National Resource Conservation Service
NPDES	National Pollution Discharge Elimination System
NPSM	Nonpoint Source Model
P2	Pollution Prevention
PCS	Permit Compliance System
PPB	Part per Billion (1×10^{-9}) (µg/l)
PPM	Part per Million (1×10^{-6}) (mg/l)
PPT	Part per Trillion (1×10^{-12}) (ng/l)
USGS	United States Geological Survey
WLA	Waste Load Allocation

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APPENDIX A

Fish Flesh Mercury Data in the Pearl River at Monticello, MS

County	Year	Site	Hg (ppm)		Species	# Fish	Min. Wt.	Max. Wt.	Mean Wt.
Lawrence	1994	Pearl River @ Monticello, MS	0.34		Flathead Catfish	4	3.0	5.2	4.0
Lawrence	1994	Pearl River @ Monticello, MS	0.86		Largemouth Bass	1	4.6	4.6	4.6
Lawrence	1994	Pearl River @ Monticello, MS	0.72		Largemouth Bass	4	1.6	2.8	2.2
Lawrence	1995	Pearl River @ Monticello, MS	0.68		Largemouth Bass	3	2.5	3.7	3.0
Lawrence	1995	Pearl River @ Monticello, MS	0.42		Largemouth Bass	4	1.1	1.6	1.4
Lawrence	1995	Pearl River @ Monticello, MS	1.37	**	Bowfin	2	6.6	7.8	7.2
Lawrence	2003	Pearl River @ Monticello, MS	0.90		Largemouth Bass	3	3.2	4.1	3.7
Lawrence	2003	Pearl River @ Monticello, MS	0.76		Largemouth Bass	4	1.5	1.9	1.6
Lawrence	2003	Pearl River @ Monticello, MS	0.62		Largemouth Bass	4	0.8	1.2	1.0
Lawrence	2003	Pearl River @ Monticello, MS	0.41		White Crappie	3	1.0	1.1	1.0
Lawrence	2003	Pearl River @ Monticello, MS	0.21		Bluegill	2	0.4	0.5	0.4
Lawrence	2003	Pearl River @ Monticello, MS	0.27		Freshwater Drum	3	1.4	1.7	1.5
Lawrence	2003	Pearl River @ Monticello, MS	0.26		Channel Catfish	5	1.7	2.2	1.8
Lawrence	2003	Pearl River @ Monticello, MS	0.49		Spotted Gar	3	1.4	1.6	1.5

*** Above 1.0 (ppm)*

APPENDIX B: Daily Load from NPDES Permitted Facilities

NPDES ID	Facility Name	Permitted Flow (MGD)	Mercury Criterion (μg/l)	Conversion Factor	Daily Load (g/day)
MS0022462	Copiah Educational Foundation, Inc.(Copiah Academy)	0.03000	0.012	3.79	1.36E-03
MS0023922	Hazlehurst POTW	0.95000	0.012	3.79	4.32E-02
MS0032921	Copiah County Industrial Park	0.14500*	0.012	3.79	6.59E-03
MS0034894	Timberlanes Camp and Dude Ranch	0.01200	0.012	3.79	5.46E-04
MS0036552	Kitchens Brothers Manufacturing Company	0.04700*	0.012	3.79	2.14E-03
MS0036986	Georgia Gulf Chemicals and Vinyls, LLC., Gallman	0.03590	0.012	3.79	1.63E-03
MS0041874	Crystal Springs POTW	0.99000	0.012	3.79	4.50E-02
MS0044725	Sanderson Farms, Inc. Hazlehurst Processing Division	0.90000	0.012	3.79	4.09E-02
MS0049476	Hazlehurst Lumber Company	0.01700*	0.012	3.79	7.73E-04
MS0050971	Family Fish House	0.00300	0.012	3.79	1.36E-04
MS0024848	Bassfield POTW	0.06500	0.012	3.79	2.96E-03
MS0029033	Prentiss POTW	0.60400	0.012	3.79	2.75E-02
MS0035009	Jefferson Davis Vocational Technical Center	0.01000	0.012	3.79	4.55E-04
MS0037109	Polks Meat Products, Inc., Prentiss Plant	0.01500	0.012	3.79	6.82E-04
MS0037222	Emmett Smith Slaughterhouse	0.00075	0.012	3.79	3.41E-05
MS0038989	Lily Rose Water Association	0.05100	0.012	3.79	2.32E-03
MS0043290	Mallard Trailer Park	0.00400	0.012	3.79	1.82E-04
MS0044334	Thurman Trailer Park	0.00600	0.012	3.79	2.73E-04
MS0002941	Georgia Pacific Corporation, Monticello Mill	31.53000*	0.012	3.79	1.43E+00
MS0020729	New Hebron POTW	0.06000	0.012	3.79	2.73E-03
MS0024643	Monticello POTW	0.22500	0.012	3.79	1.02E-02
MS0025453	Silver Creek POTW	0.04500	0.012	3.79	2.05E-03
MS0028240	Topeka Tilton Attendance Center	0.01875	0.012	3.79	8.53E-04
MS0047953	Monticello Forest Products Corporation	0.00100	0.012	3.79	4.55E-05

NPDES ID	Facility Name	Permitted Flow (MGD)	Mercury Criterion (μg/l)	Conversion Factor	Daily Load (g/day)
MS0048143	Monticello Head Start Centers	0.00500	0.012	3.79	2.27E-04
MS0049336	Joe N. Miles and Sons, Inc.	0.02600	0.012	3.79	1.18E-03
MS0055263	Little Angels Day Care	0.00050	0.012	3.79	2.27E-05
MS0055743	Monticello Hardwood, Inc.	0.14400	0.012	3.79	6.55E-03
MS0056821	Town of New Hebron WWTP	0.00840	0.012	3.79	3.82E-04
MS0036871	Lake Lincoln State Park	0.00850	0.012	3.79	3.87E-04
MS0002208	Georgia Pacific Corporation, Columbia	0.10000	0.012	3.79	4.55E-03
				ΣWLAs	**1.64E+00**

* This NPDES facility does not have a permit limit for flow. The facility is required to report flow information in each discharge monitoring report. The flow value given above is an average of the facility's historical flow data.

APPENDIX C: Mercury Use Outline

Sources of Mercury

I. Deliberate Use of Mercury

A. Use of Mercury for its Physical and Electrical Properties

1. Instruments
    - *a. Barometers*
    - *b. Hydrometers*
    - *c. Manometers*
    - *d. Pyrometers*
    - *e. Sphymonometers*
    - *f. Thermometers*
2. Lamps
    - *a. Fluorescent*
    - *b. High Pressure Sodium*
    - *c. Mercury Arc*
    - *d. Metal Halide*
    - *e. Neon*
    - *f. UV disinfectant*
3. Pivots
    - *a. WWTP Trickling Filter System*
    - *b. Lighthouses*
4. Switches
    - *a. Household Switches*
    - *b. Industrial Switches*
    - *c. Mercury Thermocouple*
    - *d. Tilt (Motion) Switches*
5. Electrical Equipment
    - *a. Rectifiers*
    - *b. Batteries {Including alkaline, button (Hg – Zn) and (Hg – Cd)}*
6. Toys and Games

B. Medical, Dental, and Veterinary Use

1. Pharmaceuticals
    - *a. Anesthetic*
    - *b. Antiseptic*
    - *c. Antineoplastic Agent*
    - *d. Antisyphilitic*
    - *e. Cathartic*
    - *f. Diuretic*
    - *g. Purgative*
2. Dental Amalgam
3. Disinfectant
    - *a. Phenyl Mercuric Acetate (PMA)*
    - *b. Thimerisol*
4. Diagnostic Reagents (see laboratory use)

C. Spiritist Use
1. Ingested, Dusted, Added to Bathing Solutions and Candles
    a. *Asogue (Hg)*
    b. *Precipitado Rojo (HgO)*
    c. *Precipitado Amarillo (HgO)*
    d. *Precipitado Blanco* (Hg_2Cl_2)

D. Laboratory Use
1. Slide Preparation
    a. *Stain*
2. Electroanalysis
    a. *Cathode*
3. Algae Sample Preservative
4. Reagents (used to analyze other chemicals)
    a. *Acetic Acid*
    b. *Acetone*
    c. *Aldehyde*
    d. *Ammonia*
    e. *Arsenic*
    f. *Barbital*
    g. *Chloride*
    h. *Chlorine*
    i. *Citric Acid*
    j. *CO in gas*
    k. *Cystine*
    l. *Glucose*
    m. *HCN*
    n. *Iron*
    o. *Kjeldahl Nitrogen*
    p. *Manganese*
    q. *Mercury*
    r. *Triophene*
    s. *Vanadium*
    t. *Wine Coloring*
    u. *Zinc*

E. Mining/Metals Industry
1. Electrolysis
    a. *Cathode*
2. Extracting Au and Ag from Ore
3. Extracting Au from Pb
4. Electroplating Al
5. Other Processes
    a. *Etching Steel/Iron*
    b. *Fire Gilding*
    c. *Blackening Brass*

F. Chlor-Alkali Industry
1. Mercury Cell Process
    a. *Production of Chlorine, Caustic Soda, Sodium Hydroxide and Products Manufactured with These Raw Materials*

G. Fungicide/Pesticide

1. Seed Protectant
2. Golf Courses
    a. *Snow Mold Control*
3. Root Maggot Control
4. Imported Gray Goods (undyed textiles)
5. Paint and Glues
    a. *Latex Paint**
    b. *Marine Paint**
    c. *Gold Porcelain Paint*
    d. *Corrugated Cardboard Glue*

H. Preservative

1. Kyanizing Wood*
2. Anatomical Specimens
3. Embalming*
4. Tanning

I. Coloring

1. Pigment
    a. *Colored Papers*
    b. *Horn*
    c. *Inks*
    d. *Linen*
    e. *Plastics*
    f. *Rubber*
    g. *Sealing Wax*
2. Stain for Wood*
3. Mordant for Dye
    a. *Beaver and Rabbit Pelts*

J. Other Deliberate Uses

1. Plastics
    a. *Catalyst for Curing*
2. Fireworks
    a. *Pharoah's Serpents and Bengal Green Lights*
3. Photography*
    a. *Intensifier*
    b. *Magic Photograms*

II. Production/Storage

A. Mining

1. Mines with Mercury as the Primary Product
2. Mines with Secondary Production of Mercury

B. U.S. Federal Supply

C. Recycling

1. Facilities Include Fluorescent Lamp Recycling and Thermostat Recycling

III. By-Product/Contaminant

A. Combustion
1. Incineration
   a. *Municipal Solid Waste*
   b. *Medical Waste*
   c. *Sewage Sludge*
   d. *Cremation*
2. Fuel Combustion
   a. *Coal*
   b. *Oil*
   c. *Natural Gas*
   d. *Wood*

B. Vaporization
1. Landfill Gas
2. Petroleum Refining
3. Wastewater Treatment Plants
4. Mining
   a. *Smelting*
   b. *Roasting*

C. Product Contaminant
1. Chloralkali Products

IV. Natural

A. Volcanoes
B. Mineralized Bedrock
1. Cinnabar

Source: Michigan Mercury Pollution Prevention Task Force. April 1996. *Mercury Pollution Prevention in Michigan: Summary of Current Efforts and Recommendations for Future Activities.*