Public Health Report: Draft version

Exposure to Mercury in West Virginia

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List of Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
BPH	Bureau for Public Health
EPA	US Environmental Protection Agency
FDA	Food and Drug Administration
gm/day	grams per day
kg	kilogram
kg/day	kilogram per day
km	kilometer
L/day	liter per day
lb	pounds
µg	micrograms
µg/g	micrograms per gram
µg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
mg/m^3	milligrams per cubic meter
m^3/day	cubic meter per day
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
mg/kg/day	milligrams per kilogram per day
MRL	Minimal risk level
ng/m^3	nanograms per cubic meter
NHANES	3rd national report on human exposure to environmental chemicals
oz/day	ounce per day
PCB	polychlorinated biphenyl
ppm	parts per million
RfC	chronic inhalation reference dose
RfD	Reference Dose
US	United States
USGS	United States Geological Survey
WVDEP	West Virginia Department of Environmental Protection
WVDHHR	West Virginia Department of Health and Human Resources
WVDNR	West Virginia Division of Natural Resources

Executive Summary

This public health report's purpose is to review data relevant to mercury exposures in West Virginia, determine if these exposures are harming West Virginian's health, and make appropriate recommendations to the West Virginia Department of Environmental Protection (WVDEP).

The West Virginia Legislature declared that serious health effects, known and unknown, may result from human exposure to mercury in any amount (HB4135 effective March 11, 2006). The law requires the Bureau for Public Health (BPH), a part of West Virginia Department of Health and Human Resources (WVDHHR) to report on actual and potential human health pathways. HB4135 requires BPH to report on risks from mercury consumption and, finally, make appropriate recommendations to WVDEP.

WVDHHR estimated exposure doses based on available environmental data and assumptions about how often people are exposed to mercury in the environment. Human health data relevant to these exposures are presented to put the estimates into context.

WVDHHR found:

- While mercury is a naturally occurring substance, human activities have increased mercury in our environment.
- Breathing mercury in air is not a significant source of mercury exposure for the general population.
- Mercury found in moist environments can be changed into methylmercury. Methylmercury bioaccumulates in the food chain.
- Man's primary exposure to mercury in the environment is from eating fish.
- People may consume fish in amounts that cause adverse health effects from mercury exposures. These exposures depend on consumption habits and the mercury in fish tissue. Significant data gaps regarding fish consumption and mercury in fish do not allow a determination about the potential harm to West Virginian's from eating fish.
- WVDHHR's goal is to reduce the need for mercury-based fish advisories in West Virginia and the potential for adverse health effects from mercury exposure. The precautionary public health principal is to reduce environmental mercury, thus making less mercury available to biomagnify in fish tissue.
- Eating fish is part of a well-balanced diet. Omega-3 fatty acids, found in fish tissue, are essential for good health and proper brain development.
- People who do not eat fish are exposed to less mercury than would be expected to likely cause adverse health effects.
- Vapors from elementary mercury spills are hazardous and pose a significant health hazard to people directly exposed to the vapors that result.
- Mercury-containing dental amalgams are another exposure source. Recent data confirm that exposures from dental amalgams are not likely to cause adverse health effects. Exposure estimates are as high as, or more, from fish ingestion (Appendix C). However,

inorganic mercury, found in amalgams, is harmful to the body in different ways than methylmercury, the form found in fish.

Data are inadequate to determine if:

- mercury in West Virginia fish tissue is increasing or decreasing,
- West Virginian's are exposed to more mercury than people in the United States,
- reducing mercury emissions *in West Virginia* will result in reductions in mercury residues *in fish caught West Virginia waters* and
- adverse health effects are occurring in West Virginian's due to mercury exposures from eating fish.

Major data gaps were identified.

- West Virginia and United States data are from different sources and, in several instances, are not directly comparable.
- Direct air monitoring or modeled data are not available to determine local deposition rates from West Virginia point-source mercury emitters.
- Inadequate scientific knowledge of methylation and bioaccumulation processes exists.
- West Virginia fish tissue data are not adequate to determine if mercury levels in fish tissue are increasing or decreasing.
- Fish consumption patterns in West Virginia are largely unknown.
- National data are insufficient to determine if body burden, the amount of mercury in humans, is increasing or decreasing. Body burden data specific to West Virginia are not available.

Occupational exposures or exposures to mercury in vaccines were not estimated.

It is important to recognize that this evaluation entails a qualitative approach, different from the quantitative risk assessment methodology used by environmental regulatory agencies. The end uses of these different approaches differ. Environmental agencies perform their calculations in order to determine the need for regulatory actions under their legislative authorities. BPH performs risk assessments in order to provide information to community members, medical, and public health entities, as well as our partners in the environmental agencies, about the likelihood of health effects related to particular exposures. Even if the public health evaluation concludes that actual public health effects in an exposed population are not likely or uncertain, BPH can still fully endorse precautionary actions by WVDEP to mitigate the potential for risk.

Introduction

Mercury exposures cannot be avoided or eliminated due to the ubiquitous nature of naturally occurring mercury. It is not possible to reduce the naturally occurring environmental mercury.

Human activities place more mercury in the environment than naturally occurs from soil and rock breakdown and weathering and volcanic activity. Human activities currently account for two-thirds of mercury emissions worldwide.

Most mercury added to the environment today enters through the air. One-third is from current human-produced emissions, one-third from recycling of previously released mercury, and one-third from naturally occurring sources [1]. Some studies indicate mercury in the atmosphere is three to six times higher than before the industrial era [2].

About 80% of air emissions come from burning fossil fuels, mining, smelting, and solid waste incineration. Currently, coal-fired power plants are the major source of air emissions in the United States (Figure 1). About 15% is from fertilizers, fungicides, and municipal solid waste containing mercury from discarded batteries, electrical switches, thermometers, etc. Industrial wastewater releases account for about 5% of the releases [2].

Mercury is constantly recycled through the air, soil, water, and biota. It is slowly removed from the environment through deep ocean deposition (Figure 2).

Mercury exists in several chemical forms. Each form has unique characteristics and toxicity. Methylmercury and vapors from elemental mercury are the most harmful to human health.

- Metallic or elemental mercury is a shiny metal. It is a liquid which vaporizes (gives off a gas) at room temperature. It is almost completely absorbed when inhaled.
- Mercury can combine with other elements, such as oxygen, sulfur, or chloride to form salts of mercury, or inorganic mercury. Mercuric chloride is one of the salts formed when mercury combines with chlorine. Mercury in soil is primarily inorganic.
- Methylmercury, an organic form of mercury, is the form most likely to cause human health effects in the general population. It is easily absorbed when ingested. Young children and fetuses are the most sensitive to mercury's effects because of their developing nervous systems. Methylmercury is found in much higher concentrations in fish and marine mammal tissues than in water or sediment. Humans are exposed to methylmercury by eating fish and marine mammals. Non-fish food items are not considered a source of mercury exposure because they contain so little methylmercury [3].
- Other organic forms of mercury exist. The general public is not exposed to enough of these forms to be a concern.

Methylmercury accumulates in the brain and other tissues. It is slowly removed from the body in feces, hair, and nails. Mercury in hair, nails, breast milk, and umbilical cord blood can be measured to estimate methylmercury exposures. Mercury in human blood is a measure of recent exposures to methylmercury because it is eliminated from the blood rapidly. It has a half-life in blood of 50 days. Mercury in hair records exposures over a longer period. Mercury in urine is a measure of exposure to inorganic mercury because inorganic mercury accumulates in the kidneys.

Mercury in air

The majority of mercury emissions, on a continental basis come from Asia (53%) while 9% comes from North America. West Virginia coal-fired power plants account for approximately 4% of the estimated power plant emissions within the United States (US). These plants were the source of 74% of the state's estimated mercury air emissions in 2003, which were approximately 5,370 pounds (lb), or 2.7 tons. A chlor-alkali plant in Marshall County is West Virginia's single source mercury air emitter. Nineteen percent of the state's air emissions were from this plant [1].

Deposition rates are more predictable when considering changes on a national or global basis rather than a state-wide basis. At present, there is not enough data to understand the relative contribution of global vs. localized emissions to mercury deposition patterns. This subject remains an area of scientific debate [4]. In addition, there are insufficient data to estimate the regional deposition of mercury from other states onto West Virginia soil and water bodies.

Facilities in West Virginia annually report air emissions data to EPA's Toxic Release Inventory (TRI), as well as to the Division of Air Quality's Emissions Inventory and Certificated Emissions Statement. No mercury deposition data exist for West Virginia. Significant concerns exist regarding the assumptions made by the EPA when modeling air deposition of mercury from coal-fired power plants. [5]

Exposure dose estimates show breathing mercury in air is not a significant source of mercury exposure (Appendix D). This does not mean, however, that mercury in air is of no consequence. Air emissions increase the amount of mercury cycling in the environment. This cycle increases the amount of mercury that can be converted to methylmercury and thus increases the amount of methylmercury available for bioaccumulation in fish tissue.

Researchers believe reducing air emissions will reduce methylmercury in fish tissue. However, the extent of the reductions in West Virginia fish and the time over which these reductions will occur cannot be quantified based on current data and knowledge of deposition, methylation, and bioaccumulation processes.

Methylmercury formation and bioaccumulation

Methylation is the formation of methylmercury by microbial action on mercury in moist environments. Bioaccumulation is the concentration of methylmercury in the animals. Because of bioaccumulation, fish tissue has much higher mercury concentrations (in the form of methylmercury) than can be found in water or sediments.

The concentrations in fish tissue cannot be predicted based on current knowledge because the factors affecting methylation and bioaccumulation are not well understood. [5] For instance, two adjacent waterbodies with the same mercury deposition rates can have differing concentrations of mercury in fish tissue and scientists are not able relate the mercury in fish tissue to the processes occurring in these waterbodies. Some of the factors affecting methylation and bioaccumulation are the:

- amount of wetlands near a waterbody,
- amount of mercury released from the wetlands,
- food a fish eats,
- age of the fish,
- amount of algae and other plants and animals at the low end of the food chain,
- rate at which methylmercury is converted into inorganic forms, and
- water characteristics, such as the pH as well as dissolved organic carbon and sulfate available to microorganisms. [6]

Mercury in fish

There are benefits to eating fish, but eating fish brings the potential for exposure to chemicals, such as mercury. Fish advisories are designed to balance the benefits from eating fish while limiting exposure to chemicals below levels where adverse health effects are likely. WVDHHR recommends that people follow fish advisories to avoid harmful chemical exposures while obtaining the benefits from eating fish.

Fatty fish, such as salmon, are the richest source of omega-3 fatty acids. Flax seed oil and walnuts also contain omega-3 fatty acids. Omega-3 fatty acids are needed for proper growth and neurological development. They have been shown to reduce serum cholesterol. Human beings must get omega-3 fatty acids from food. WVDHHR recommends people eat fish as part of a balanced diet.

The importance of these compounds has been determined by researchers who found children of mothers with low intake of omega-3 fatty acids during pregnancy had verbal IQ scores six points lower than average [7]. In addition, data from the Seychelles Islands, discussed below, found children whose mothers were in the *higher* mercury exposure groups scored *better* on many tests. The researchers speculate that higher omega-3 fatty acid intake was responsible for this effect.

The majority of human exposures to mercury come from eating fish. Exposures are highly variable based on quantity and species eaten as well as mercury found in fish tissue.

This report estimated mercury exposure from fish constitutes between 82 and 99.6% of West Virginian's environmental mercury exposures (Table 9). The EPA estimates that 99.99% of people's exposure to *methyl*mercury is from fish [3].

West Virginia and all states surrounding it have mercury-based fish advisories. Some advisories have been in effect since 1993. The Food and Drug Administration (FDA) and EPA revised their national fish advisory for methylmercury in the spring of 2004. WVDHHR issued the first statewide fish advisory for mercury in early 2005 based on 395 fish tissue samples collected from 56 water bodies [8]. The state-wide survey was funded through an EPA grant. The WVDEP Division of Water and Waste Management managed the grant. West Virginia Department of Natural Resources (WVDNR) collected the samples. Many previously un-sampled water bodies were included in the project. This fish advisory is due to availability of data and *does not* mean mercury in fish tissue is increasing.

WVDHHR, through an interagency agreement, partners with WVDEP and WVDNR to develop fish consumption advisories for fish caught in West Virginia. The committee reviews fish advisories and updates them as needed to protect the public health. Current state and national fish advisories are in Appendix E.

Data compiled by the WVDEP from various sources were used to estimate exposures in West Virginia. Data for edible fish species were compiled. EPA sources were used for mercury content in the US (Table 1). However, the data are limited and may not accurately reflect mercury in fish tissue from all waterbodies from which people in West Virginia eat fish.

Exposure to mercury from fish is difficult to estimate due to fish tissue variations between individuals, species, fish size (age), waterbody, and fish meal portions and how often fish is eaten. For example, sportfishermen and their families often eat fish from one waterbody, which may contain mercury higher or lower than these estimates. In addition, fish tissue data vary from

study to study. Various studies have reported the average mercury in US fresh water bass as 0.157, 0.38, and 0.41 mg/kg [9].

Not enough data are available to determine if mercury in fish tissues is increasing or decreasing. This information may be available in the future. WVDEP will sample lakes and streams where the highest levels of fish tissue mercury have been found. The majority of these sites are north of the Interstate-64 corridor.

Inadequate data on fish eating habits do not allow use of West Virginia-specific fish consumption rates. A recent survey commissioned by the WVDNR asked questions about fish-eating habits in West Virginia (Appendix B). These results and the knowledge of West Virginian's fish-eating habits indicate that state residents may eat less than the US average, 17.5 grams of fish per day (as adults). However, the estimated consumption rate cannot be used in this report due to uncertainties in the assumptions used.

Ultimately, these data gaps make mercury exposure estimates from fish uncertain.

Four studies shedding light on mercury exposures from fish are summarized below.

State of Wisconsin

The State of Wisconsin studied the relationship between mercury in human hair and fish ingestion. The average hair mercury levels of people who ate 3.0 to 4.9 meals per month was 0.53 parts per million (ppm). Values ranged from 0.03 to 6.5 ppm with 13% less than 1 ppm. Average hair mercury levels of 1 ppm were correlated with eating at least 10 fish meals per month [10].

One particular case merits mention. A woman in Wisconsin requested a blood test after she heard about mercury contamination in fish. She ate canned tuna daily as part of a high protein diet. Her blood mercury level was 25 µg/L. The report did not note any adverse health effects [11]. Her exposure dose cannot be calculated without more information, such as her weight and portion size. The US average amount of mercury in tuna is 0.206 milligrams per kilogram or parts per million (mg/kg or ppm).

Seychelles Islands

Methylmercury exposure estimates for residents of the Seychelles Islands are 10 to 20 times more than that of the typical American. Children whose mothers ate an average of 12 fish meals per week had no measurable adverse effects when tested for neurobehavioral development. The mercury in fish was less than 1 ppm (range 0.004 to 0.75 ppm).[1] The children were studied for 66 months. Mercury exposures occurred while in the womb, while breast-feeding and when eating fish. Exposure to polychlorinated biphenyls (PCBs), a common contaminant found in fish, was not a factor in the diet. Mercury levels in the mother's hair during pregnancy averaged 6.8 mg/kg or ppm (range 0.5-26.7 ppm) [2]. Incidentally, four of the six measures of neurobehavioral development showed *better* scores in the *highest mercury exposed group* for both prenatal and postnatal exposures.

1 These fish would be between West Virginia's "unlimited" and the "up to 1 meal per month" fish advisory categories.

Faroe Islands

Neurobehavioral changes were found in Faroe Islands children whose mothers ate fish and pilot whales containing mercury. While the amount of fish and pilot whale meals was similar to amounts eaten in the Seychelles Islands, several differences were noted that may or may not be significant. The pilot whales contained about 3 ppm mercury.[2] About 50% of the mercury in pilot whales is methylmercury. The rest is inorganic. Faroe Islanders were exposed to PCBs from eating fish and whales, while PCB residues were not present in the fish eaten in the Seychelles. Neurological behavior deficits were found in children when the mother's hair mercury levels exceeded 10 ppm. It is important to note that so much mercury was ingested that everyone tested has some neurological effects believed to be from methylmercury exposure.

Minamata Japan

Highly contaminated fish were eaten in Minamata Japan causing significant health effects, up to and including death. Mercury was discharged at high rates into Minamata Bay for over 30 years. Mercury in Minamata Bay's sediment was found as high as 2,000 mg/kg (or ppm). The fish and seafood contained 11 to 35 mg/kg mercury [12]. Estimated exposure doses were between 4.71E-02 and 2.0E-01 milligrams mercury per kilogram per day (mg/kg/day).[3]

Mercury spills, poisonings, and unrestricted releases

People may be exposed to hazardous amounts of mercury vapors from elemental mercury spills. Elemental mercury is a shiny, silver-colored liquid at room temperatures. People can inhale mercury vapors without realizing they are being exposed because the vapors are colorless and odorless. These vapors are heavier than air and concentrate at lower levels in rooms and enclosed spaces, where children are more likely to be.

Exposure to elemental mercury can occur in several ways. Playing with the substance or allowing spills to remain in enclosed areas exposes people to mercury vapors. Mercury poured down the drain remains in the sink trap. Also vacuuming up spills only serves to spread mercury vapors throughout the room.

Recent incidents in West Virginia illustrate the improper handling and dangerous nature of elemental mercury.

- A young child became progressively and severely ill, spending more time in the bedroom as the illness progressed. Very high levels of mercury vapor were found in the bedroom because the child had spilled mercury on the carpet in his room unbeknownst to his parents.
- Employees of a college were unaware of the hazardous nature of mercury although it was clearly visible in the science hall. Inorganic mercury from spills may have been in the facility for 40 years, with the potential for exposures to students and employees in the building.

2 Fish containing 3 ppm mercury are in West Virginia's "do not eat" fish advisory category.
3 Scientific notation is another way to write numbers with many decimal places. For instance, 0.0001 becomes 1E-04 using scientific notation. This means the decimal point is four places to the left of the whole number one. Similarly, 0.0000019 becomes 1.9E-06 using scientific notation. This means the decimal point is six places to the left of 1.9.

- A high school science teacher, cleaning out the lab, had students carry a variety of chemicals, including elemental mercury, to the boiler room and pour them down the drain. Mercury accumulates in drain traps and vapors are then emitted without detection.

Many former uses of mercury, resulting in severe adverse health effects, have been reduced or eliminated. Some are:

- grain treated with mercury-containing pesticides used to make flour or to feed livestock,
- interior latex paint,
- medications, such as calomel, and
- unrestricted industrial releases.

Exposures from these sources cannot be generalized nor estimated. However, the hazard from spills and unintentional releases remains as long as elemental mercury is found in homes, schools, and offices.

Mercury in vaccines

Thiomersol, an organic form of mercury, is a preservative added to multi-use vaccines. Thiomersol is not found in the environment. The last children's vaccine containing thiomersol was used in 2002. According to the Centers for Disease Control, there is no evidence of harm from thiomersol-containing vaccines, however some scientists believe otherwise. Children's maximum cumulative exposure to mercury from the newly formulated vaccines, in use since 1999, totals less than 3 micrograms (μg) in the first six months of life [14].

Discussion

Chemical exposures

Health effects from mercury exposure depend on many factors; amount of mercury, chemical form, duration of exposure, time of exposure (during fetal or childhood development), and route of exposure.

Mercury can enter the body in four ways.

- It can be transferred through umbilical cord blood to the developing fetus. This exposure is assessed in the studies of neurobehavioral and developmental effects considered in this report.
- It can be ingested by eating, drinking, or through normal hand-to-mouth activities. Hand-to-mouth activities (incidental ingestion) are a route for mercury to enter the body from dust, soil, sediment, and surface water. Mercury transferred through breast milk to children is considered in the epidemiological studies used in this report.
- It can be inhaled. Inhaled mercury vapors, from metallic or elemental mercury, are 80% absorbed. Note, this assessment did not distinguish between the various forms of mercury found in the air and assumed all of it (100%) was absorbed when inhaled.
- It can be absorbed through the skin, dermal exposure. However, the forms of mercury routinely found in the environment are not easily absorbed through the skin. This exposure route was not considered in this report.

Data Review

Data were gathered on mercury in the environment from the US Geological Survey (USGS), US Forest Service, WVDEP, and EPA.

West Virginia data were compared to national figures, though as noted previously national and state data are not always comparable. Data gaps exist. These issues make conclusions based on estimated exposure doses calculated from these data uncertain.

Table 1 Mercury in the environment

Media	*Amount mercury*	*Comments*
Freshwater and estuarine fish	WV: see Table 2	Edible fish species averages for fish sampled in West Virginia between April 2002 and October 2005
	US: 0.26 mg/kg	Average mercury concentration of freshwater fish [3]
Marine fish (US)	Children: 0.167 mg/kg Women of childbearing age: 0.147 mg/kg Other adults: 0.157 mg/kg	Three estimates of mercury content in marine fish were used because children, women of childbearing age, and other adults eat different species of fish [3]
Food, other than fish	US: 0.0 mg/kg	Mercury in food, other than fish (central tendency estimate [3]
	US: near a chlor-alkali plant 0.0 mg/kg	Modeled data indicate insignificant absorption in food other than fish [13]
Air	WV: 0.001623 µg/m^3 (1.623E-03 µg/m^3)	WV statewide total mean mercury ambient air concentration [15]
	US: 0.001653 µg/m^3 (1.653E-03 µg/m^3)	National total mean mercury ambient air concentration [15]
	US: 0.004 µg/ m^3 (4.0E-04µg/ m^3)	Modeled estimates 2.5 miles from a chlor-alkali plant (4 nanograms/ cubic meter) [13]
Drinking water and surface water	WV: 0.00009 milligram per liter (9E-05 mg/L)	Average mercury in WV surface water (USGS data)
	US: 0.000024 mg/L (2.4E-05 mg/L)	Calculated from US estimates of methylmercury in surface water [3]
Soil and sediment	WV: 0.13 mg/kg	Wetland soils in the Monongahela National Forest in West Virginia (average) [16]
	US: 1.06 mg/kg	Modeled data 2 km from a chlor-alkali plant [2]

Fish tissue data

Data between April 2002 and October 2005 were selected for review because 75% of these were from the recent statewide survey. This survey sampled watersheds throughout the state. The most recent samples were from October 2005.

Edible fish tissue data were classified by type and averaged (Table 2). The average concentration in *all* 418 freshwater fish composite samples in West Virginia between April 2002 and October 2005 was 0.17 mg/kg. The range was from <0.01 to 0.92 mg/kg. The average for *all edible species* sampled during this period was 0.16 mg/kg.

The chlor-alkali plant in West Virginia lies along the Ohio River in Marshall County. Fish in this area can move between the locks and dams forming the Hannibal Pool. Five fish samples were taken from that pool between April 2002 and October 2005. The average mercury content was 0.11 mg/kg. The range was 0.06 to 0.17 mg/kg.

The average mercury found in the entire WVDEP database for fish tissue samples from 1998 to Oct 2005 is 0.14 mg/kg. The data were not sufficient, however, to analyze trends in fish tissue by species or waterbody.

The average concentration of mercury for *all* freshwater and estuarine fish tissue in US is 0.26 mg/kg. The average mercury concentration of bass, nationally, is 0.38 mg/kg [3].

If these data accurately reflect average mercury content in edible fish tissue, then mercury in West Virginia fish tissue is lower than the national average.

Table 2 Mercury content in edible fish species sampled in West Virginia April 2002 - October 2005*

Fish		Average (mg/kg)	# samples	Range (mg/kg)
Trout				
	Brook trout	0.019	3	<0.008-0.049
	Brown trout	0.0638	6	<0.01-0.3725
	Rainbow trout	0.0073	10	<0.01-0.0625
	Class average for trout	*0.05*		
Catfish				
	Channel catfish	0.0043	69	0.014 – 0.2805
	Flathead catfish	0.0626	15	<0.0175-0.922
	Yellow bullhead	0.2250	1	0.225
	Black bullhead	0.0175	1	<0.0175
	Brown bullhead	0.1313	2	0.1125-0.15
	Bullhead	0.0175	1	<0.0175
	Class average for catfish	*0.12*		

Table 2 Mercury content in edible fish species sampled in West Virginia April 2002 - October 2005*				
Fish		**Average (mg/kg)**	**# samples**	**Range (mg/kg)**
Black bass				
	Largemouth bass	0.0188	48	0.0018-0.900
	Smallmouth bass	0.2412	65	0.0053-0.7475
	Spotted bass	0.2231	26	<0.0175-0.5325
	Class average for black bass	*0.25*		
Sunfish				
	Bluegill	0.0748	6	<0.0175-0.1625
	Black crappie	0.05	5	0.046-0.25
	White crappie	0.0377	6	<0.0009-0.2255
	Redbreast sunfish	0.0959	4	0.0325-0.171
	Rock bass	0.0185	21	<0.0009-0.3875
	Sunfish	0.1338	4	<0.0175-0.26
	Class average for sunfish	*0.08*		
Temperate bass				
	Hybrid striped bass	0.1126	2	0.0961-0.129
	White bass	0.2793	11	<0.0175-0.765
	Class average for temperate bass	*0.25*		
Other edible species				
	Freshwater drum	0.1871	7	0.101-0.266
	Sauger/saugeye	0.0217	16	<0.0175-0.33
	Walleye	0.3769	9	0.108-0.57
	Yellow perch	0.061	4	<0.0175-0.11
	Class average for other species	*0.21*		
	Average for all edible species	*0.16*		

** Data from various sources, database maintained by WVDEP. All samples below the detection limit were averaged as if the mercury content was equal to the detection limit.*

Fish consumption estimates

The adult freshwater fish consumption rate used in this report, 17.5 grams fish per day, or 2.3 meals per month, reflects intake for US recreational fishermen (Table 3). Although data gaps do not allow the use the fish consumption rate from the recent WVDNR survey, this rate may be 50% less than the US rate, or 1.15 meals/month. The data and assumptions for this value are discussed in Appendix B.

Fish intake by subsistence fishermen, those who get the majority of their protein from fish, was considered. Adult subsistence fishermen are assumed to eat 170 grams of fish per day.

The average US marine fish consumption rate was used for both US and West Virginia exposure dose estimates.

Adults were assumed to eat 8-ounces of fish per meal while children from 1- to 6-years-old eat 4-ounces of fish per meal and children from 7- to 14-years-old eat 6-ounces of fish per meal (Table 3). These estimates are based on grams of fish consumed per eating occasion, at the 90th percentile [17].

Table 3 Meal size and fish consumption rates

	Sportfish ingestion	Marine fish ingestion	Subsistence fishermen
Adults - assuming each fish meal is an 8-ounce portion			
grams per day (gm/day)	17.5	14	170
ounces per day (oz/day)	0.62	0.49	6.00
# meals per month	2.3	1.8	22.5
pounds per year (Lb/year)	14.1	11.3	136.8
Children 1 to 6 years old - assuming each fish meal is a 4-ounce portion			
gm/day	8.75	7	85
oz/day	0.31	0.25	3.00
# meals per month	2.3	1.8	22.5
Lb/year	7.0	5.6	68.4
Children 7 to 14 years old - assuming each fish meal is a 6-ounce portion			
gm/day	13.125	10.5	127.5
oz/day	0.46	0.37	4.50
# meals per month	2.3	1.8	22.5
Lb/year	10.6	8.5	102.6

Food, other than fish

Methylmercury exposures from food sources, other than fish, are generally a very small fraction of mercury intake [3]. The EPA estimates no methylmercury exposures are from food, other than fish, because their amounts are so minimal.

Mercury uptake by plants is insignificant. In fact, seeds can be treated with mercury to protect them from fungus and yet plants grown from these seeds absorb very little mercury. Additionally, mercury found in plants grown near chlor-alkali plants was not high enough to be a significant source of mercury exposure. Livestock raised near these facilities have a low amount of mercury in their tissues from eating mercury-containing soil. This, too, was considered an insignificant source of exposure [13].

However, very serious health effects have been observed in people who ate food contaminated by grain treated with pesticides containing mercury. People were exposed either through eating the grain directly or by eating animals who ate the treated grain. These situations are very rare and are not within the scope of this study. Note, most, if not all, mercury-containing pesticides have been banned by the EPA.

Air

Using data from 1999 information collection through its national air-toxics assessment and with various assumptions and models, EPA estimated the average amount of mercury in US ambient air at 0.001653 micrograms per cubic meter ($\mu g/m^3$), or 1.653E-03 $\mu g/m^3$. West Virginia's mean mercury ambient concentration was modeled at 0.001623 $\mu g/m^3$, or 1.623E-03 $\mu g/m^3$ [15].

Time constraints and a lack of site-specific data regarding impacts from coal-fired power plants did not allow an assessment of local or regional air exposures.

Data near a chlor-alkali plant were found in the literature. A chlor-alkali plant was selected to represent conditions near an industrial source of mercury, because the chlor-alkali plant in West Virginia emits more mercury than any single coal-fired power plant in this state [1]. EPA modeled data from a chlor-alkali plant found air concentrations were highest 2.5 kilometer (km) (about 1.5 mile) from the facility. The estimated amount is four nanograms per cubic meter (ng/m^3) or 0.004 $\mu g/m^3$.

Drinking water and surface water

People obtain drinking water from surface and ground sources. Although data for mercury in groundwater were available, they were not used to estimate exposures because using surface water data resulted in higher exposure estimates.[4]

The average mercury in surface water in West Virginia as determined by USGS was used to represent mercury in drinking water. The actual value is likely much lower than the value used because 85% of the results were below the test's detection limit.

Average total mercury from 107 West Virginia surface water samples between March 1985 and May 1993 was 0.00009 mg/L, or 9.0E-05 mg/L.[5]

4 Groundwater data is available in the WVDEP report to the West Virginia 2006 Legislature.
5 Data below the detection limit were averaged using a value of one-half of the detection limit.

The average amount of mercury in surface water in the United States is 0.000024 mg/L or 2.4E-05 mg/L. This amount was calculated using the highest rough estimate of *methyl*mercury in surface water in the US, assuming methylmercury was 7.8% of the total amount of mercury in water [3].

No National Primary Drinking Water Regulation mercury violations, which means a value higher than 0.002 mg/L (2E-03 mg/L), were reported for West Virginia public water systems.[6]

It cannot be determined if mercury in drinking water is higher or lower in West Virginia than in the US because of the data discrepancies and uncertainties.

Soil and sediment

Measured mercury in West Virginia soils was found from only one source. The data do not represent soil conditions throughout the state, as the samples were from wetland areas only on the Monongahela National Forest. The 20 sites sampled were chosen based on their relative importance in the wetland systems in the Forest. Wetland soils were chosen because much of the literature states that this is the primary location where mercury methylation occurs. The average total mercury from twenty samples in these soils was 0.13 mg/kg. The data ranged from 0.039 to 0.259 mg/kg mercury [16].

The USGS estimated 0.08 mg/kg mercury in soil in the eastern United States [18]. This is significantly less than the soil mercury estimate selected, but did not come from samples of West Virginia soil.

Modeled data near a chlor-alkali plant in Saltville, Virginia showed the highest amount of mercury in soil, 1.06 mg/kg, approximately 2 km from the plant [13].

It cannot be determined if mercury in West Virginia soils is higher or lower than in the US because of the unrepresentative nature of the West Virginia soil data.

Human Exposure Pathway Analysis

Whether or not an adverse health effect occurs depends on many factors. One of requirements for an adverse health effect to be possible is for exposures to occur through a completed pathway. A completed exposure pathway consists of five elements:

1. a source of contamination,
2. movement of one or more contaminants into and through the environment (in soil, air, groundwater or surface water) to bring them into contact with people,
3. a place where humans can be exposed to the contaminant(s),
4. a way for humans to be exposed to the contaminant(s) (such as by drinking the water or breathing the air), and
5. a receptor population, one or more people who may have been or may be in contact with the contaminant(s).

It is important to understand that the existence of a completed pathway *does not necessarily mean that a public heath hazard existed* in the past, exists currently, or is likely to exist in the future. Whether or not a public health hazard exists is largely dependent on the levels of

6 Data from the Safe Drinking Water Information System from Jan 7, 2003 to May 25, 2006

exposure. The health hazards were assessed by comparison of the estimated mercury exposures to the exposure level known to be harmful.

Each element in the exposure pathway exists in West Virginia for human inhalation and ingestion of mercury. Therefore, there are *completed* pathways for these routes of exposure. In addition, a *completed* pathway exists for people who eat fish, which contains mercury.

No *potential* pathways were found to exist. Potential pathways exist where one or more of the five pathway elements are uncertain or where information is insufficient to eliminate an element.

Exposure Analysis

Estimating Exposure Doses

Exposure doses estimate the amount of a chemical that gets into a human's body. The estimates use environmental data and assumptions about how much, how often, and how long a person might be exposed to a chemical. Conservative assumptions were used to overestimate actual exposures (Tables 1, 2, 3, and 5).

- The estimates in this report assume people come in contact with air, soil, sediment, drinking water, and surface water every day for a lifetime.
- Fish consumption estimates were averaged on a daily basis and were assumed to occur daily for a lifetime.
- All forms of mercury are assumed to be 100% absorbed, although absorption is less than this in many cases (Table 4).

Exposure doses are expressed as milligrams of chemical per kilogram body weight per day (mg/kg/day). The exposure dose calculations can be found in Appendix D.

Table 4 Human absorption ranges [3 & 19]

	Ingested	Inhaled	Exposed to skin
Methylmercury	80-100%		2-3%
Inorganic mercury	10-30%	40%	2-3%
Elemental mercury	<0.01%	80% (vapors)	

Table 5 Assumptions used to estimate exposure doses			
Data type	***Comment***		
Exposures and Time period	Everyone is exposed to food (other than fish), air, surface water, soil, and sediment every day for a lifetime. The daily average from fish ingestion is used for people who eat fish.		
Absorption	Mercury is 100% absorbed.		
Freshwater and estuarine fish ingestion	Adult: US recreational fishermen - 17.5 gm/day Adult: US subsistence fishermen – 170 gm/day	Table 3 indicates the grams per day ingested for various consumption rates. Assuming children age 1-6 eat a 4-ounce fish meal, children age 7-14 eat a 6-ounce fish meal, and adults eat an 8-ounce fish meal. Recreational fishermen intake [20] Subsistence fishermen intake. [2]	
Marine fish ingestion	General population: 14 gm/day	Average intake of marine fish from EPA's analysis of 1989-91 CSFII [17]	
Inhalation	Children: 10 cubic meters per day (m^3/day) Women of childbearing age: 11 m^3/day Other adults: 15 m^3/day		Default air intake rates (approximate mean) [2]
Drinking water	Children: 1 liter per day (L/day) Women of childbearing age: 2 L/day Other adults: 2 L/day		Default drinking water intake rates, based on 90th percentile intake rates. [2]
Surface water (incidental ingestion)	0.01 L/day		Standard incidental ingestion rate for surface water.
Soil and sediment (incidental ingestion)	Children less than 6 yrs: 0.0002 kg/day (2.0E-04 kg/day) Women of childbearing age: 0.0001 kg/day (1.0E-04 kg/day) Other adults: 0.0001 kg/day (1.0E-04 kg/day)		[2]
Body weight	Children, age 1-6 years old: 11 kilograms (kg) (approx 24 lb) mean amount for a 1-year-old Children, age 7-14 years old 25 kg (approx 55 lb) mean amount for a 7-year-old Women of childbearing age: 67 kg (approx 148 lb) Other adults: 70 kg (approx 154 lb)		[4 & 17]

Reference Doses and Minimal Risk Levels

EPA and ATSDR calculate oral and inhalation exposure doses for mercury compounds below which appreciable or measurable health effects are not expected in people exposed on a daily basis. It is important to keep in mind that estimated exposure doses over these values *do not necessarily mean* that adverse health effects will occur. It means these exposures need further evaluation. EPA and ATSDR use different comparison values to evaluate this risk. EPA reference doses (RfD) are estimates of the daily lifetime dose of substances at levels that are unlikely to cause harm in humans. ATSDR minimal risk levels (MRL) are estimates of daily human exposure to hazardous substances at or below those amounts that are unlikely to pose a measurable risk to harmful, noncancerous effects. Chronic oral MRLs are for substances ingested over 365 days or more.

Both RfDs and MRLs contain uncertainty factors. These are adjustments in the calculations to account for incomplete knowledge and are larger when there is less knowledge.

The developing nervous system is the most sensitive target organ for which data are suitable for the derivation of methylmercury RfDs and MRLs [21]. Although possible cardiovascular and immunologic effects are seen in some studies at levels at or below current RfDs and MRLs, there are not enough data to derive RfDs or MRLs based on this health effect.

ATSDR's chronic oral MRL for methylmercury, 0.0003 mg/kg/day (3E-04), is based on study of women and children who ate fish in the Seychelles Islands. An uncertainty factor of 4.5 was applied to the exposure dose. No measurable change in children's neurological function was noted in this study.

EPA's chronic oral RfD for methylmercury, 0.0001 mg/kg/day (1E-04), is based on a study of women and children who ate fish and pilot whale meat in the Faroe Islands. An uncertainty factor of 10 was applied to the methylmercury exposures. Impairment of children's neurological function was measurable. The EPA's confidence in their methylmercury RfD is high based on results of several independent studies.

Some states use their own comparison values for adults where pregnancy is not an option, due to sex, age, or inability to have children, about 3 times greater than the national figures. This is because current national RfDs and MRLs are based on adverse health effects seen from mercury exposures in the womb and during early childhood.

EPA's chronic oral RfD for mercuric chloride is 0.0003 mg/kg/day, or 3E-04 mg/kg/day. The RfD was based on autoimmune effects in rats. An uncertainty factor of 1,000 was applied. ATSDR has not established a chronic oral MRL for mercuric chloride.

ATSDR's MRL for oral exposure to inorganic mercury is 0.002 mg/kg/day, or 2E-03 mg/kg/day, for exposures occurring for 15 to 364 days. There is no MRL for chronic exposures because there was a decreased survival rate in studies of long term exposures in rats [2].

EPA chronic inhalation reference dose (RfC) for elementary mercury is 0.0003 mg/m^3, 3E-04 mg/m^3. The RfC is based on health effects, such as hand tremors, observed in people exposed to mercury vapors at work. An uncertainty factor of 30 was applied when calculating this RfC.

Possible health consequences from mercury exposures in West Virginia

Exposures to mercury were estimated for the general public, people living near an industrial source of mercury, represented by a chlor-alkali plant, people who do and do not eat fish in both amounts typical of recreational fishermen, subsistence fishermen, and their families and people who have mercury-containing dental amalgams (Appendix C and D). Each scenario used subpopulations of children from 1- to 6-years-old, 7- to 14-years-old, women of childbearing age, and other adults. Table 9 in Appendix D summarizes these results.

Estimated exposure doses were compared to appropriate oral RfD and chronic oral MRL for methylmercury. Those doses lower than the RfD or MRL were, by definition, not likely to be associated with adverse health effects. Those doses greater than the RfD or MRL were further evaluated to determine if they are associated with adverse health effects. Relevant epidemiological studies from which the RfDs and MRLs were derived were compared to the estimated mercury exposures.

The potential for subtle neurological changes from exposures during development is the potential adverse health effect that might occur from these exposures. Although some studies have found cardiovascular and immunologic effects from exposures near those estimated in this report, these health effects cannot be assessed due to data uncertainties.

Although estimates for exposures in West Virginia and the US were made, data gaps and discrepancies do not allow a determination about whether West Virginian's are exposed to more or less mercury than people elsewhere in the US. No evaluation of potential adverse health effects for people living in the US was undertaken because this was outside the scope of this report.

People living near an industrial source of mercury, represented by a chlor-alkali plant, were not exposed to significantly more mercury than the general population. This statement must be tempered, however, by the fact that mercury in fish tissue near the chlor-alkali plant in West Virginia was not found over the average for West Virginia fish. Should the industrial source of mercury result in higher than average mercury in local fish, these estimates would significantly change. The lack of air deposition modeling or ambient-air mercury measurements in West Virginia is a significant data gap for estimating exposures at mercury "hot spots."

Mercury exposures to people in West Virginia who do not eat fish

Estimates of mercury exposure for all non-fish-eating scenarios were 10 to 95 times less than the ATSDR MRL for methylmercury, 3.0E-04 mg/kg/day (Table 7 in Appendix D). Therefore, no adverse health effects are expected to people exposed to mercury in food other than fish, air, drinking water, and incidental ingestion of surface water, soil and sediment.

Mercury exposures to people in West Virginia who eat fish

Mercury exposure estimates from eating fish (Table 8) were added to the non-fish eating scenarios (Table 7). These are summarized in Table 9.[7] The conclusions based on these estimates must be interpreted in light of the uncertainties inherent in the environmental data and consumption estimates previously discussed.

7 Tables 7, 8 and 9 are in Appendix D.

First, most estimates of mercury exposure were below the RfD and MRL, therefore adverse health effects were not likely under the conditions specified.

Second, the highest estimates for mercury exposures are for those who eat fish in the bass and temperate bass category. Estimated exposure doses were above the chronic oral MRL for methylmercury (3E-04 mg/kg/day)[8] for:

- children from 1- to 6-years-old who eat 2.3 West Virginia-caught bass meals per month plus 1.8 marine fish meals per month and
- people in all subgroups who eat 22.5 West Virginia-caught bass meals per month plus 1.8 marine fish meals per month.

Comparing these exposure estimates with the oral RfD for methylmercury (1E-04 mg/kg/day)[9] indicates that children from 1- to 14- years old who eat at least four fish meals per month (i.e., 2.3 meals of West Virginia-caught fish of any species and 1.8 meals of marine fish) exceed the RfD for methylmercury.

Also, women of childbearing age and other adults eating four fish meals per month of fish, containing 0.25 mg/kg mercury, were exposed at levels equal to the RfD.

These estimates were compared to the previously mentioned Seychelle Island and Faroe Island studies to determine if subtle neurological changes may be occurring in people in West Virginia.

No neurological effects were measured in the Seychelles Islands in children whose mothers ate 48 fish meals per month, on average. Subtle neurological effects, however, were noted in mothers eating a similar number of fish meals in the Faroe Islands. Mercury content in the Seychelle fish contained less than 1 mg/kg mercury while in the Faroe Islands the pilot whales eaten contained up to 3 mg/kg mercury (50% was methylmercury and 50% was inorganic mercury.) The Faroe Island fish contained PCB residues while the Seychelle Island fish did not. It is important to note that so much mercury was ingested that everyone tested has some neurological effects believed to be from methylmercury exposure.

The estimated fish-meal frequency for West Virginian's, four times a month, is 10 times less than fish-meal frequencies in the Seychelle and Faroe Islands. The estimated mercury content of fish eaten by West Virginian's is four to six times less than that eaten in the studied populations. The estimated fish-meal frequency for some West Virginian's with the mercury content found in some West Virginia fish may be sufficient to cause subtle neurological changes in fetuses and young children who are more sensitive to mercury's effects than the studied populations. However, data are inadequate to determine if these effects might be occurring or to identify people who may be exposed to this amount of mercury from fish.

Biomonitoring Data

No health outcome data or biomonitoring data related to mercury exposures are available for West Virginia.

8 ATSDR chronic oral MRLs are estimates of daily human exposure to hazardous substances for 365 days or more at or below those that are likely to pose a measurable risk to harmful, noncancerous effects.
9 EPA oral RfDs are estimates of the daily lifetime dose of substances that that are unlikely to cause harm in humans.

National data on mercury body burden, the Center for Disease Control's third national report on human exposure to environmental chemicals reporting results from the National Health and Examination Survey (NHANES), found all women of childbearing age (between 16- and 49-years-old) had mercury in their blood below levels associated with known adverse health effects. NHANES data are insufficient to determine if mercury body burdens are increasing or decreasing [22].

Blood mercury levels have been shown to increase with greater fish ingestion and are associated with exposure to methylmercury. Blood mercury above 58 μg/L has been associated with known adverse health effects while blood mercury above 5.8 μg/L corresponds to exposures above the EPA's RfD.

Mercury in urine has been shown to increase with the number of teeth filled with mercury-containing amalgams. Normal background levels in the US are 3-4 μg of inorganic mercury per gram of creatinine. These levels are below amounts where adverse health effects would be expected.

Careful analysis of hair can be used to indicate methylmercury exposures occurring over a period of months [2]. The amount of mercury in hair associated with blood mercury level of 58 μg/L is estimated at 14 ppm, although this ratio varies significantly between individuals [2].

The Third national report on human exposure to environmental chemicals interpreted test results on mercury in human blood and urine.

- Blood mercury levels in women tested in 1999-2000 were 7.1 μg/L and 4.6 μg/L for women tested in 2001-2002. These blood mercury amounts are below levels associated with known adverse health effects. These measurements represent women in the 95th percentile of the sampled population.
- Almost 6% of the women had blood mercury levels between 5.8 and 58 μg/L. These levels are within a factor of 10 of levels where neurological effects in fetuses have been observed, 58 μg/L. This leads some researchers to state, erroneously, that all babies born to these women have experienced neurological effects.[10] However, as noted above, all women had mercury levels in blood below levels associated with adverse health effects for developing fetuses.
- Women who lived in coastal areas had average blood mercury levels 40% higher than the average of women in non-coastal areas. This result is likely because people in coastal areas eat more fish than people do in non-coastal areas.
- Blood mercury levels were higher in women whose household income exceeded $20,000 or who were non-Hispanic blacks or other non-Hispanics [23].
- Women's mercury urine levels were 3.27 micrograms mercury per gram of creatinine (μg/g) (for those tested in 1999-2000) and 3.00 μg/g (for those tested in 2001-2002). These data are 95th percentile of the studied population.

10 Many people erroneously assume that all exposures above the RfD mean that adverse health effects have occurred. Exposures above the RfD must be evaluated to determine if exposures might cause adverse health effects. Statements that babies are "at risk" of developing adverse health effects is not the same as stating that adverse health effects have occurred.

These results were used to estimate the fish ingestion of women of childbearing age involved in the NHANES survey. The report estimated they ingested 1.22 µg mercury per day from fish [23]. This is equivalent to eating 0.62 fish meals per month of fish containing 0.26 mg/kg mercury.

Community Health Concerns

Mercury exposures in substantial amounts can cause serious health effects. Some citizens are concerned these effects could occur from environmental exposures in West Virginia [24]. The following paragraphs discuss community concerns about health effects from mercury exposures not otherwise mentioned in this report.

Severe mental retardation, seizures, deafness, blindness, and death have been documented in children exposed in the womb and after birth to large amounts of mercury from grains treated with fungicide. In some cases, people were poisoned when they used these grains for flour or porridge. Infants born with blood mercury levels of 2,500 µg/L suffered severe brain damage [2]. In one case, the family ate pork fed with mercury-treated grain. People in Minamata Japan were poisoned by eating fish heavily impacted by industrial mercury releases. The concentration of mercury in sediment in these waters was as high as 2,000 mg/kg [12]. The amount of mercury in food causing death in these events ranged from 10-60 mg/kg [2]. These exposures were substantially higher than any West Virginian would be exposed to in our environment.

Further studies are needed to clarify the association, if any, between mercury exposure and cardiovascular disease. Some studies in Europe show mercury exposure may be associated with changes in cardiovascular health. These effects have not been confirmed in studies of US male health professionals [25]. Some studies have found cardiovascular and immunologic effects at or below children's developmental effects [21]. Uncertainties in data from these studies do not allow us to relate these health effects to specific exposure levels.

Many studies have looked for associations between cancer and exposure to mercury in the environment without establishing a link [2]. A recent study of breast cancer cells in a laboratory setting indicates methylmercury may affect these cells [26]. This does not indicate that mercury causes breast cancer.

A recent newspaper article stated, "…there is no evidence of a safe level given that health effects have been demonstrated at exposures below the reference dose."[24] This statement is not accurate. Although preliminary data may indicate there are other health effects at levels below amounts used to set the current RfDs and MRLs, it does not follow that adverse health effects can be demonstrated at *all* exposure levels.

Child Health Considerations

This report considered mercury's potential health effects on children. The results will assist adults who make decisions affecting them. The many differences between children and adults demand special consideration. Children can be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and often use hand-to-mouth behaviors that increase their exposure potential.

Because children are shorter than adults, they breathe dust, soil, and vapors that are close to the ground and may be exposed to more chemicals in this area than adults. The fact that children are smaller than adults means that they get a higher dose of a substance per unit of body weight. If

toxic exposure levels are high enough during critical growth stages, the developing body systems of children can be permanently damaged.

Finally, children are dependent on adults for access to housing and medical care, and for risk identification.

Women can transfer mercury to fetuses and children through umbilical-cord blood and breast milk during sensitive developmental times. In addition, children are more sensitive to the effects of mercury up to the age of six, and especially from conception up to 3-years old. Parents should be especially careful to limit mercury exposures to safe amounts by following fish advisories.

Conclusions

This report estimated exposure doses based on available environmental data and assumptions about how often people are exposed to mercury in the environment. Human health data relevant to these exposures were reviewed to put these estimates into context.

Conservative assumptions were used, such as 100% absorption of all mercury in the environment and daily exposures to fish, food, air, water, soil, and sediment. Occupational exposures to mercury and exposures from mercury-containing vaccines were not evaluated.

WVDHHR found:

- While mercury is a naturally occurring substance, human activities have increased mercury in our environment.
- Breathing mercury in air, even near a chlor-alkali plant, is not a significant source of mercury exposure for the general population. This does not mean, however, that mercury in air is of no consequence.
- Mercury found in moist environments can be changed into methylmercury. Methylmercury bioaccumulates in the food chain.
- Man's primary exposure to mercury in the environment is from eating fish. Mercury in fish constitutes between 82 and 99.6% of environmental exposures for West Virginian's who eat fish. The EPA estimates that fish ingestion is responsible for 99.99% of human methylmercury exposures.
- People may consume fish in amounts that cause adverse health effects from mercury exposures. These exposures depend on consumption habits and the mercury in fish tissue. Significant data gaps regarding fish consumption and mercury in fish do not allow a determination about the potential harm to West Virginian's from eating fish.
- People who follow West Virginia and US fish advisories obtain the benefits of eating fish without the adverse health effects from exposure to too much mercury.
- WVDHHR's goal is to reduce the need for mercury-based fish advisories in West Virginia and the potential for adverse health effects from mercury exposure. The precautionary public health principal is to reduce environmental mercury, thus making less mercury available to biomagnify in fish tissue.
- Eating fish is part of a well-balanced diet. Omega-3 fatty acids, found in fish tissue, are essential for good health and proper brain development.

- People who do not eat fish are exposed to less mercury than would be expected to likely cause adverse health effects.
- Vapors from elementary mercury spills are hazardous and pose a significant health hazard to people directly exposed to the vapors that result. The hazards are not often recognized because mercury vapors from spills are colorless and odorless. Improper cleanup methods can increase exposures.
- Mercury-containing dental amalgams are another exposure source. Recent data confirm that exposures from dental amalgams are not likely to cause adverse health effects. Exposure estimates are as high as, or more, from fish ingestion (Appendix C). However, inorganic mercury, found in amalgams, is harmful to the body in different ways than methylmercury, the form found in fish.

Data are inadequate to determine if:

- mercury in West Virginia fish tissue is increasing or decreasing,
- West Virginian's are exposed to more mercury than people in the US,
- reducing mercury emissions *in West Virginia* will result in reductions in mercury residues *in fish caught West Virginia waters* and
- adverse health effects are occurring in West Virginian's due to mercury exposures from eating fish.

Major data gaps were identified.

- West Virginia and US data are from different sources and, in several instances, are not directly comparable.
- Direct air monitoring or modeled data are not available to determine local deposition rates from West Virginia point-source mercury emitters.
- Inadequate scientific knowledge of methylation and bioaccumulation processes exists.
- West Virginia fish tissue data are not adequate to determine if mercury levels in fish tissue are increasing or decreasing.
- Fish consumption patterns in West Virginia are largely unknown.
- National data are insufficient to determine if body burden, the amount of mercury in humans, is increasing or decreasing. Body burden data specific to West Virginia are not available.

Recommendations

Based on the review of information cited in this report and the conclusions, WVDHHR recommends the following:

1. Even with this limited data, WVDEP should continue to reduce mercury emissions, due to potential adverse health effects from mercury exposure.
2. WVDEP – Water and Waste Management should re-sample fish tissue for mercury residues, as planned, in watersheds where the most restrictive fish advisories occur.

3. WVDNR and/or WVDEP should collect additional data about West Virginian's fish consumption habits.
4. WVDHHR should increase the public's awareness of fish advisories.
5. WVDHHR encourages the removal and proper disposal of mercury-containing materials from homes, schools, and workplaces.
6. West Virginian's should eat fish as part of a well-balanced diet while following fish advisories to avoid harmful amounts of chemicals. People should be especially careful to follow fish advisories during a woman's childbearing years and when infants and young children are in the household.
7. West Virginian's, particularly children, should be educated to avoid handling elemental mercury and what should be done should a spill occur.
8. People who eat a substantial amount of fish or work with mercury should mention this to their dentist or other health care provider when mercury-containing dental amalgams are recommended. This is especially recommended for children 6-years-old or younger and women who are pregnant or nursing. In all cases, the choice not to use mercury amalgam should be made in consultation with a qualified dentist (and/or physician) and weighed against the risk of alternative practices or materials.

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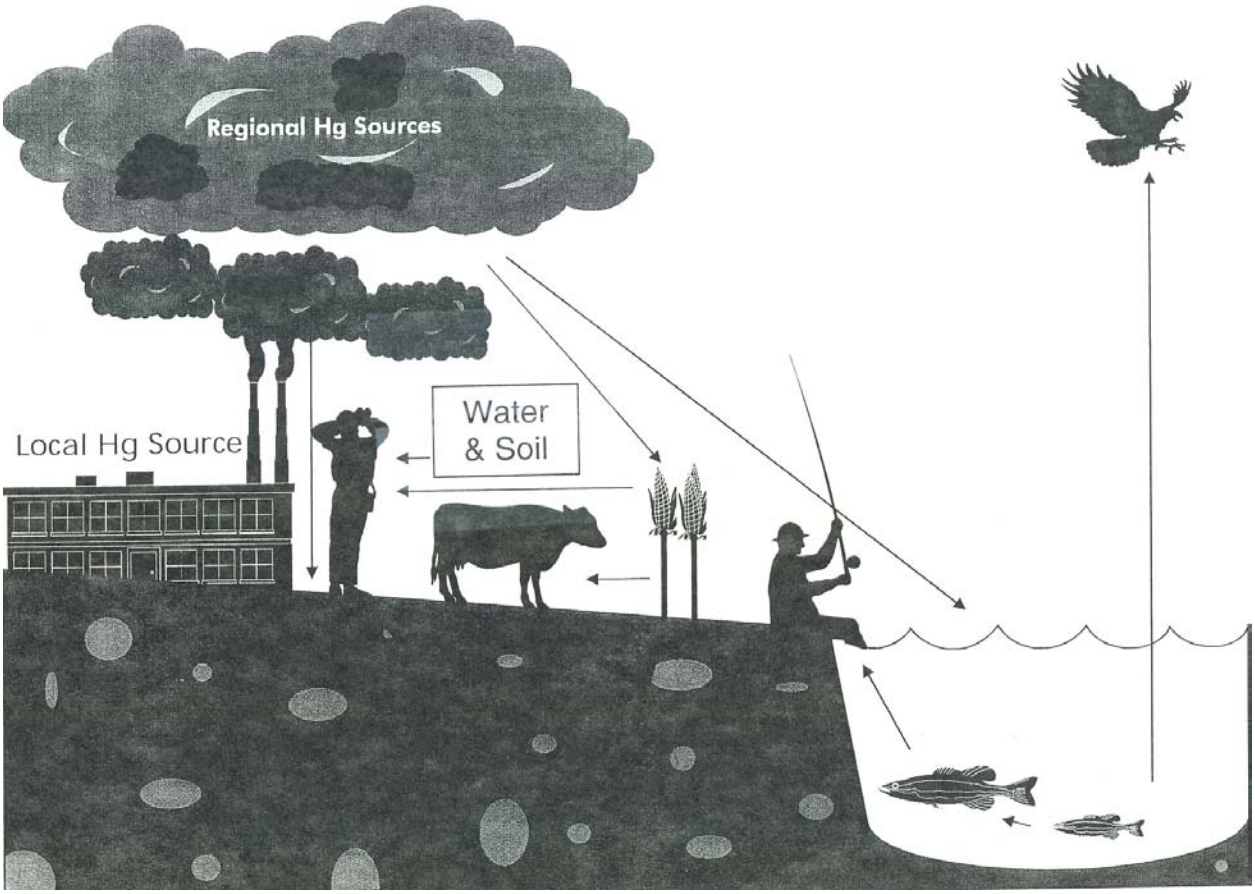
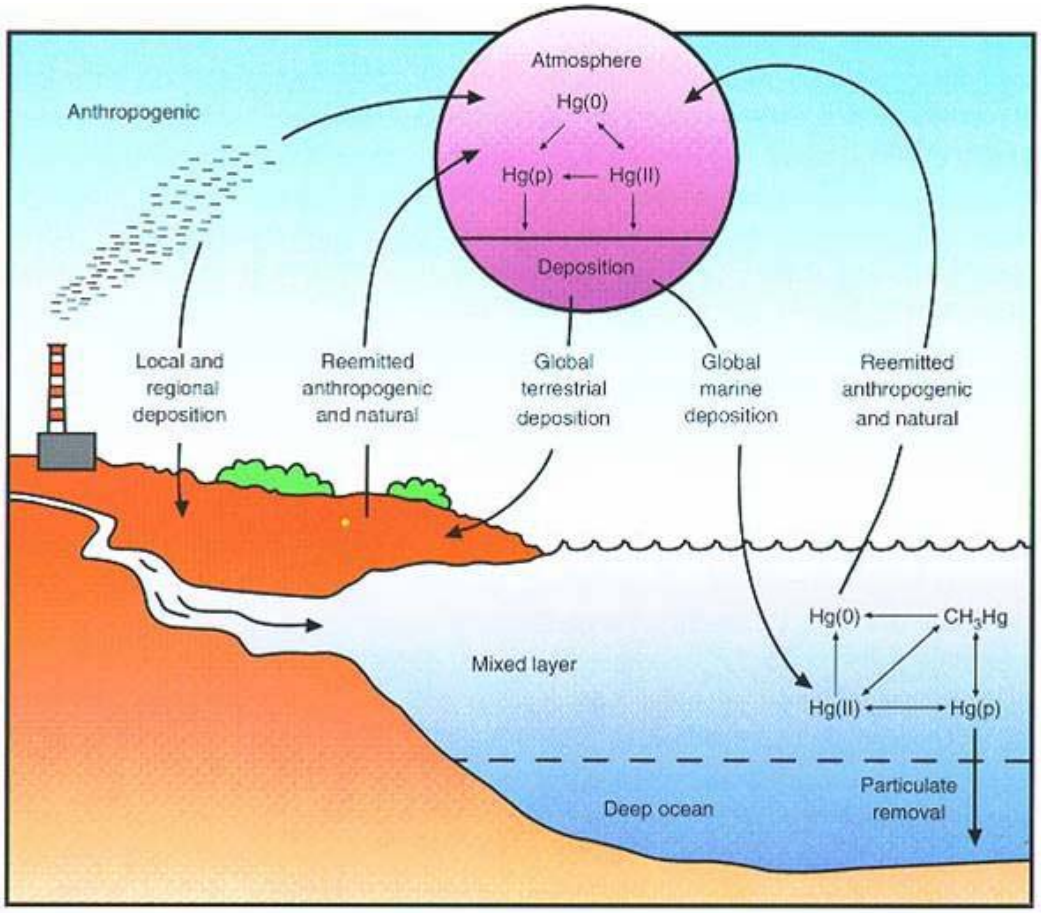
Appendix A. Figures

Figure 1. Mercury in the environment



Source of figure: US EPA ***(modified)***

Figure 2. Mercury cycle



Source of figure: Kevin A. Cavender USEPA/OAQPS

Appendix B. WV fish consumption estimate

The recent West Virginia Department of Natural Resources survey, "West Virginia resident's attitudes toward wildlife, their participation in wildlife-related recreation, and their consumption of fish caught in West Virginia (draft)" is the first time questions about West Virginian's fish-eating habits have been determined on a scientific basis [27].

There were too many uncertainties in the assumptions used to estimate an intake rate of 1.15-eight-ounce fish meals per month to allow us to use this number in this report.

The survey determined the mean *number of fish caught and eaten* in West Virginia, 15.2 per year.

The survey asked, "Which species of fish caught in West Virginia do you eat?" People could indicate more than one species of fish that they ate. We assumed this answer translated directly into the *number of fish meals eaten for that particular fish*. However, this assumption inserts an unacceptable uncertainty into the process.The additional assumptions used to determine the number of fish meals per month is in Table 3.

Table 6 Assumptions used to determine average number of 8-ounce fish meals eaten in WV

Species	# fish/year	edible ounces/fish (total ounces/fish)*	ounces fish eaten/year
Trout	7.20 (47%)	4.2 (10.5)	30.24
Catfish/bullheads	2.22 (15%)	19.2 (48)	42.62
Black bass	1.99 (13%)	6.4 (16)	12.74
Other fish	3.80 (25%)	6.4 (16)	24.32
Total	15.2 (100%)		109.92
# of 8-ounce meals/month 1.15			

** Assume 40% of the total weight of the fish is the edible portion*

Appendix C. Mercury containing dental amalgams

Exposure to mercury from dental amalgams is a *completed* pathway for those who have them.

These fillings release a small amount of mercury vapor as they are abraded and slowly dissolved in the mouth. The mercury vapor is inhaled. Exposures vary depending on mouth conditions and the number and filling placement.

Studies have found people with these fillings are exposed to about 0.00561 mg mercury per day from this source [2]. Estimates of exposure from mercury in dental amalgams were obtained by dividing 0.0056 milligrams per day by body weight.

These estimates are

- children 1 to 6 years old, 5.1E-04 mg/kg/day
- children 7 to 14 years old, 2.2E-04 mg/kg/day, and
- adults, including women of childbearing age, 0.8E-04 mg/kg/day.

No estimates of exposure to dental amalgams are greater than the oral RfC for inorganic mercury (2E-03 mg/kg/day). Therefore, no adverse health effects from these exposures are expected.

Toxicity from inorganic mercury in dental fillings is different from that found in fish (methylmercury). Inorganic toxicity is very different from methylmercury. Its effects on health may not be additive to methylmercury exposures.

Mercury from this source can be measured in urine because it accumulates in the kidneys.

The Centers for Disease Control states there is little evidence mercury-containing dental amalgams are causing neurological effects. Two recent studies found no evidence that dental fillings containing mercury can cause neurological problems [28].

Replacing existing fillings with non-mercury containing substitutes can expose people to more mercury than if they were not removed.

People who are particularly sensitive to mercury's effects, young children and pregnant women, as well as people who eat a lot of fish or work with mercury should discuss their overall risk from mercury vs. the benefits of mercury-containing dental amalgams treatment options with their health care provider when such fillings are recommended [29].

Appendix D. Exposure dose tables

Table 7. Mercury exposure estimates West Virginia and the United States from sources other than fish

		RESULT(mg/kg/day)			**CALCULATION**																			
		Estimated exposure dose (WV estimates use the WV environmental media column and US uses the US environmental media column)			**Environmental media** (amount of mercury in different media)					Drinking water intake		Fish intake		Inhalation		Surface water (incidental ingestion)		Soil (incidental ingestion)		Conversion factor *		Body weight
		WV	US		WV		US	units		L/day		gm/day		m3/day		L/day		kg/day				kg
Eating food other than fish																						
	Children 1 to 6 years-old		0.00				0.00	mg/kg													÷	11
	Children 7 to 14 years-old		0.00				0.00	mg/kg													÷	25
	Women of childbearing age		0.00				0.00	mg/kg													÷	67
	Other adults		0.00				0.00	mg/kg													÷	70
Breathing air																						
	Children 1 to 6 years-old	1.53E-06	1.56E-06	<=	1.62E-03	or	1.65E-03	$\mu g/m^3$	x					10	x					0.001	÷	11
	Children 7 to 14 years-old	6.75E-07	6.88E-07	<=	1.62E-03	or	1.65E-03	$\mu g/m^3$	x					10	x					0.001	÷	25
	Women of childbearing age	2.66E-07	2.71E-07	<=	1.62E-03	or	1.65E-03	$\mu g/m^3$	x					11	x					0.001	÷	67
	Other adults	3.48E-07	3.54E-07	<=	1.62E-03	or	1.65E-03	$\mu g/m^3$	x					15	x					0.001	÷	70
Breathing air - near a chlor-alkali plant																						
	Children 1 to 6 years-old		3.78E-06	<=			0.004	$\mu g/m^3$	x					10	x					0.001	÷	11
	Children 7 to 14 years-old		1.66E-06	<=			0.004	$\mu g/m^3$	x					10	x					0.001	÷	25
	Women of childbearing age		6.57E-07	<=			0.004	$\mu g/m^3$	x					11	x					0.001	÷	67
	Other adults		8.57E-07	<=			0.004	$\mu g/m^3$	x					15	x					0.001	÷	70
Drinking water																						
	Children 1 to 6 years-old	8.18E-06	2.18E-06	<=	9.00E-05	or	2.40E-05	mg/L	x	1											÷	11
	Children 7 to 14 years-old	3.60E-06	9.60E-07	<=	9.00E-05	or	2.40E-05	mg/L	x	1											÷	25
	Women of childbearing age	2.69E-06	7.16E-07	<=	9.00E-05	or	2.40E-05	mg/L	x	2											÷	67
	Other adults	2.57E-06	6.86E-07	<=	9.00E-05	or	2.40E-05	mg/L	x	2											÷	70

Table 7. Mercury exposure estimates West Virginia and the United States from sources other than fish

		RESULT(mg/kg/day)			**CALCULATION**																			
		Estimated exposure dose (WV estimates use the WV environmental media column and US uses the US environmental media column)			**Environmental media** (amount of mercury in different media)					Drinking water intake		Fish intake		Inhalation		Surface water (incidental ingestion)		Soil (incidental ingestion)		Conversion factor *		Body weight
		WV	US		WV		US	units		L/day		gm/day		m3/day		L/day		kg/day				kg
Incidental ingestion of surface water																								
	Children 1 to 6 years-old	8.18E-08	2.18E-08	<=	9.00E-05	or	2.40E-05	mg/L	x							0.01					÷	11
	Children 7 to 14 years-old	3.60E-08	9.60E-09	<=	9.00E-05	or	2.40E-05	mg/L	x							0.01					÷	25
	Women of childbearing age	1.34E-08	3.58E-09	<=	9.00E-05	or	2.40E-05	mg/L	x							0.01					÷	67
	Other adults	1.29E-08	3.43E-09	<=	9.00E-05	or	2.40E-05	mg/L	x							0.01					÷	70
Incidental ingestion of soil or sediment																								
	Children 1 to 6 years-old	2.36E-06	1.45E-06	<=	0.13	or	0.08	mg/kg	x									0.0002			÷	11
	Children 7 to 14 years-old	5.20E-07	3.20E-07	<=	0.13	or	0.08	mg/kg	x									0.0001			÷	25
	Women of childbearing age	1.94E-07	1.19E-07	<=	0.13	or	0.08	mg/kg	x									0.0001			÷	67
	Other adults	1.86E-07	1.14E-07	<=	0.13	or	0.08	mg/kg	x									0.0001			÷	70
Incidental ingestion of soil or sediment near a chlor-alkali plant																								
	Children 1 to 6 years-old		1.93E-05	<=		or	1.06	mg/kg	x									0.0002			÷	11
	Children 7 to 14 years-old		4.24E-06	<=		or	1.06	mg/kg	x									0.0001			÷	25
	Women of childbearing age		1.58E-06	<=		or	1.06	mg/kg	x									0.0001			÷	67
	Other adults		1.51E-06	<=		or	1.06	mg/kg	x									0.0001			÷	70
SUMMARY: Estimated exposures to food other than fish, air, drinking water, and incidental ingestion of surface water, soil, and sediment*																								
General popluation																								
	Children 1 to 6 years-old	12.2E-06	5.22E-06																					
	Children 7 to 14 years-old	4.83E-06	1.98E-06																					
	Women of childbearing age	3.16E-06	1.11E-06																					
	Other adults	3.12E-06	1.16E-06																					
People living near a chlor-alkali plant																								
	Children 1 to 6 years-old	31.3E-06	25.3E-06																					
	Children 7 to 14 years-old	9.54E-06	6.87E-06																					
	Women of childbearing age	4.94E-06	2.96E-06																					
	Other adults	4.96E-06	3.06E-06																					

**Conversion factor for fish ingestion is 0.001 kilogram per 1 gram*

** Conversion factor for breathing air is 0.001 millgrams per 1 microgram*

*** Estimates are totals of daily exposure to food, air, drinking water, surface water, soil, sediment on a daily basis. US data used where West Virginia data was not available.*

Table 8. Mercury exposure using a variety of fish ingestion assumptions																
		RESULT(mg/kg/day)			**CALCULATION**											
		Estimated exposure dose (WV estimates use the WV environmental media column and US uses the US environmental media column)			**Amount of mercury in fish tissue (mg/kg)***				Fish intake		Conversion factor		Body weight		# meals per month
		WV	US		WV		US		gm/day		kg/gm		kg		
Marine fish ingestion															
	Children 1 to 6 years-old		1.06E-04	<=			0.167		7	x	0.001	÷	11		1.8
	Children 7 to 14 years-old		7.01E-05	<=			0.167		10.5	x	0.001	÷	25		1.8
	Women of childbearing age		3.07E-05	<=			0.147		14	x	0.001	÷	67		1.8
	Other adults		3.14E-05	<=			0.157		14	x	0.001	÷	70		1.8
Recreational fisherman and family eating West Virginia trout															
	Children 1 to 6 years-old	3.98E-05	2.07E-04	<=	0.05	or	0.26	x	8.75	x	0.001	÷	11		2.3
	Children 7 to 14 years-old	2.62E-05	1.36E-04	<=	0.05	or	0.26	x	13.1	x	0.001	÷	25		2.3
	Women of childbearing age	1.31E-05	6.79E-05	<=	0.05	or	0.26	x	17.5	x	0.001	÷	67		2.3
	Other adults	1.25E-05	6.50E-05	<=	0.05	or	0.26	x	17.5	x	0.001	÷	70		2.3
Recreational fisherman and family eating West Virginia catfish															
	Children 1 to 6 years-old	9.55E-05	2.07E-04	<=	0.12	or	0.26	x	8.75	x	0.001	÷	11		2.3
	Children 7 to 14 years-old	6.29E-05	1.36E-04	<=	0.12	or	0.26	x	13.1	x	0.001	÷	25		2.3
	Women of childbearing age	3.13E-05	6.79E-05	<=	0.12	or	0.26	x	17.5	x	0.001	÷	67		2.3
	Other adults	3.00E-05	6.50E-05	<=	0.12	or	0.26	x	17.5	x	0.001	÷	70		2.3
Recreational fisherman and family eating West Virginia black bass or temperate bass															
	Children 1 to 6 years-old	1.99E-04	2.07E-04	<=	0.25	or	0.26	x	8.75	x	0.001	÷	11		2.3
	Children 7 to 14 years-old	1.31E-04	1.36E-04	<=	0.25	or	0.26	x	13.1	x	0.001	÷	25		2.3
	Women of childbearing age	6.53E-05	6.79E-05	<=	0.25	or	0.26	x	17.5	x	0.001	÷	67		2.3
	Other adults	6.25E-05	6.50E-05	<=	0.25	or	0.26	x	17.5	x	0.001	÷	70		2.3

Table 8. Mercury exposure using a variety of fish ingestion assumptions																
		RESULT(mg/kg/day)			**CALCULATION**											
		Estimated exposure dose (WV estimates use the WV environmental media column and US uses the US environmental media column)			**Amount of mercury in fish tissue (mg/kg)***				Fish intake		Conversion factor		Body weight		# meals per month
		WV	US		WV		US		gm/day		kg/gm		kg		
Recreational fisherman and family eating West Virginia sunfish															
	Children 1 to 6 years-old	6.36E-05	2.07E-04	<=	0.08	or	0.26	x	8.75	x	0.001	÷	11		2.3
	Children 7 to 14 years-old	4.19E-05	1.36E-04	<=	0.08	or	0.26	x	13.1	x	0.001	÷	25		2.3
	Women of childbearing age	2.09E-05	6.79E-05	<=	0.08	or	0.26	x	17.5	x	0.001	÷	67		2.3
	Other adults	2.00E-05	6.50E-05	<=	0.08	or	0.26	x	17.5	x	0.001	÷	70		2.3
Recreational fisherman and family eating West Virginia fish (average of all edible species)															
	Children 1 to 6 years-old	1.27E-04	2.07E-04	<=	0.16	or	0.26	x	8.75	x	0.001	÷	11		2.3
	Children 7 to 14 years-old	8.38E-05	1.36E-04	<=	0.16	or	0.26	x	13.1	x	0.001	÷	25		2.3
	Women of childbearing age	4.18E-05	6.79E-05	<=	0.16	or	0.26	x	17.5	x	0.001	÷	67		2.3
	Other adults	4.00E-05	6.50E-05	<=	0.16	or	0.26	x	17.5	x	0.001	÷	70		2.3
Subsistence fisherman and family eating West Virginia-caught black and temperate basses															
	Children 1 to 6 years-old	1.93E-03	2.01E-03	<=	0.25	or	0.26	x	85	x	0.001	÷	11		22.5
	Children 7 to 14 years-old	1.28E-03	1.33E-03	<=	0.25	or	0.26	x	128	x	0.001	÷	25		22.5
	Women of childbearing age	6.34E-04	6.60E-04	<=	0.25	or	0.26	x	170	x	0.001	÷	67		22.5
	Other adults	6.07E-04	6.31E-04	<=	0.25	or	0.26	x	170	x	0.001	÷	70		22.5

Table 9 Mercury exposures in West Virginia, summary table*												
		mg/kg/day						fishmeals per month			% Hg from fish	
		Environmental sources - general	Environmental sources - near an industrial source of mercury	marine fish	WV-caught fish	Total mercury exposures (general population)	Total mercury exposures (people living near an industrial source of mercury)	# marine meals per month	# WV-caught fishmeals per month	Total # fishmeals per month	% mercury exposures from fish (general population)	% mercury exposures from fish (near an industrial source of mercury)
Recreational fisherman and family eating West Virginia trout												
	Children 1 to 6 years-old	1.22E-05	3.13E-05	1.06E-04	3.98E-05	1.58E-04	1.77E-04	1.8	2.3	4.1	92%	82%
	Children 7 to 14 years-old	4.83E-06	9.54E-06	7.01E-05	2.62E-05	1.01E-04	1.06E-04	1.8	2.3	4.1	95%	91%
	Women of childbearing age	3.16E-06	4.94E-06	3.07E-05	1.31E-05	4.70E-05	4.87E-05	1.8	2.3	4.1	93%	90%
	Other adults	3.12E-06	4.96E-06	3.14E-05	1.25E-05	4.70E-05	4.89E-05	1.8	2.3	4.1	93%	90%
Recreational fisherman and family eating West Virginia catfish												
	Children 1 to 6 years-old	1.22E-05	3.13E-05	1.06E-04	9.55E-05	2.14E-04	2.33E-04	1.8	2.3	4.1	94%	87%
	Children 7 to 14 years-old	4.83E-06	9.54E-06	7.01E-05	6.29E-05	1.38E-04	1.43E-04	1.8	2.3	4.1	96%	93%
	Women of childbearing age	3.16E-06	4.94E-06	3.07E-05	3.13E-05	6.52E-05	6.69E-05	1.8	2.3	4.1	95%	93%
	Other adults	3.12E-06	4.96E-06	3.14E-05	3.00E-05	6.45E-05	6.64E-05	1.8	2.3	4.1	95%	93%
Recreational fisherman and family eating West Virginia black bass or temperate bass												
	Children 1 to 6 years-old	1.22E-05	3.13E-05	1.06E-04	1.99E-04	**3.17E-04**	**3.36E-04**	1.8	2.3	4.1	96%	91%
	Children 7 to 14 years-old	4.83E-06	9.54E-06	7.01E-05	1.31E-04	2.06E-04	2.11E-04	1.8	2.3	4.1	98%	95%
	Women of childbearing age	3.16E-06	4.94E-06	3.07E-05	6.53E-05	9.92E-05	1.01E-04	1.8	2.3	4.1	97%	95%
	Other adults	3.12E-06	4.96E-06	3.14E-05	6.25E-05	9.70E-05	9.89E-05	1.8	2.3	4.1	97%	95%

Table 9 Mercury exposures in West Virginia, summary table*												
		mg/kg/day						fishmeals per month			% Hg from fish	
		Environmental sources - general	Environmental sources - near an industrial source of mercury	marine fish	WV-caught fish	Total mercury exposures (general population)	Total mercury exposures (people living near an industrial source of mercury)	# marine meals per month	# WV-caught fishmeals per month	Total # fishmeals per month	% mercury exposures from fish (general population)	% mercury exposures from fish (near an industrial source of mercury)
Recreational fisherman and family eating West Virginia sunfish												
	Children 1 to 6 years-old	1.22E-05	3.13E-05	1.06E-04	6.36E-05	1.82E-04	2.01E-04	1.8	2.3	4.1	93%	84%
	Children 7 to 14 years-old	4.83E-06	9.54E-06	7.01E-05	4.19E-05	1.17E-04	1.22E-04	1.8	2.3	4.1	96%	92%
	Women of childbearing age	3.16E-06	4.94E-06	3.07E-05	2.09E-05	5.48E-05	5.65E-05	1.8	2.3	4.1	94%	91%
	Other adults	3.12E-06	4.96E-06	3.14E-05	2.00E-05	5.45E-05	5.64E-05	1.8	2.3	4.1	94%	91%
Recreational fisherman and family eating West Virginia fish (average of all edible species)												
	Children 1 to 6 years-old	1.22E-05	3.13E-05	1.06E-04	1.27E-04	2.45E-04	2.64E-04	1.8	2.3	4.1	95%	88%
	Children 7 to 14 years-old	4.83E-06	9.54E-06	7.01E-05	8.38E-05	1.59E-04	1.63E-04	1.8	2.3	4.1	97%	94%
	Women of childbearing age	3.16E-06	4.94E-06	3.07E-05	4.18E-05	7.57E-05	7.74E-05	1.8	2.3	4.1	96%	94%
	Other adults	3.12E-06	4.96E-06	3.14E-05	4.00E-05	7.45E-05	7.64E-05	1.8	2.3	4.1	96%	94%
Subsistence fisherman and family eating West Virginia-caught black and temperate bass												
	Children 1 to 6 years-old	1.22E-05	3.13E-05	1.06E-04	**1.93E-03**	**2.05E-03**	**2.07E-03**	1.8	22.5	24.3	99%	98%
	Children 7 to 14 years-old	4.83E-06	9.54E-06	7.01E-05	**1.28E-03**	**1.35E-03**	**1.36E-03**	1.8	22.5	24.3	99.6%	99%
	Women of childbearing age	3.16E-06	4.94E-06	3.07E-05	**6.34E-04**	**6.68E-04**	**6.70E-04**	1.8	22.5	24.3	99.5%	99%
	Other adults	3.12E-06	4.96E-06	3.14E-05	**6.07E-04**	**6.42E-04**	**6.43E-04**	1.8	22.5	24.3	99.5%	99%
** Estimated exposure doses above the ATSDR MRL for methylmercury (3E-04) are in bold*												

Appendix E. Fish Advisories

National Advice Concerning Mercury in Fish

In 2004, EPA and FDA issued advice for women who might become pregnant, women who are pregnant, nursing mothers, and young children. The national advice is not included in the statistics presented in this fact sheet. The following advice is still in effect:

Fish and shellfish are an important part of a healthy diet. Fish and shellfish contain high-quality protein and other essential nutrients, are low in saturated fat, and contain omega-3 fatty acids. A well-balanced diet that includes a variety of fish and shellfish can contribute to heart health and children's proper growth and development; therefore, women and young children in particular should include fish or shellfish in their diets due to the many nutritional benefits.

Nearly all fish and shellfish, however, contain traces of mercury. For most people, the risk from mercury from eating fish and shellfish is not a health concern. Yet some fish and shellfish contain higher levels of mercury that may harm an unborn baby or young child's developing nervous system. The risks from mercury in fish and shellfish depend on the amount of fish and shellfish eaten and the levels of mercury in the fish and shellfish. Therefore, the FDA and EPA are advising women who may become pregnant, pregnant women, nursing mothers, and young children to avoid some types of fish and to eat only fish and shellfish that are lower in mercury.

By following the three recommendations listed below for selecting and eating fish or shellfish, women and young children will receive the benefits of eating fish and shellfish and be confident that they have reduced their exposure to the harmful effects of mercury.

- Do not eat shark, swordfish, king mackerel, or tilefish because they contain high levels of mercury.
- Eat up to 12 ounces (2 average meals) a week of a variety of fish and shellfish that are lower in mercury.
    - Five of the most commonly consumed fish that are low in mercury are shrimp, canned light tuna, salmon, pollock, and catfish.
    - Another commonly eaten fish, albacore ("white") tuna has more mercury than canned light tuna. Eat up to 6 ounces (one average meal) of albacore tuna per week.
- Check local advisories about the safety of fish caught by family and friends in local lakes, rivers, and coastal areas. If no advice is available, eat up to 6 ounces (one average meal) per week of fish caught from local waters, but do not consume any other fish during that week.

Follow these same recommendations when including fish and shellfish in a young child's diet, but serve smaller portions. More information on the joint federal advisory is available at www.epa.gov/waterscience/fish.

West Virginia Fish Consumption Advisories for 2006

To protect the health of West Virginian's, WVDHHR offers an advisory for how often certain fish can be safely eaten. An advisory is a recommendation. Advisories should not be viewed as law or regulation. It is intended to help anglers and their families make educated choices about: where to fish, what types of fish to eat, how to limit the amount and frequency of certain fish eaten, and how to prepare and cook fish to reduce contaminants.

This advisory covers only sport fish caught in West Virginia waters. The following updated 2006 advisory recommendation is the result of reviewing new and recent fish tissue data. Data collected from lakes and rivers in West Virginia show that a general statewide advisory of sport-caught fish is appropriate. A review of this information indicates that mercury, PCBs, and dioxin are the most prevalent pollutants of concern. If you would like more detailed information about these contaminants and the levels measured, consult the DHHR Web Site at www.wvdhhr.org/fish.

Two additional species – brown trout and flathead catfish - have been added to the general advisory for all West Virginia waters. The recommendation is to eat no more than two meals of these fish per month. The brown trout addition to the general advisory is based on newly acquired PCB and mercury data and flathead catfish were added based on new PCB data. With the addition of flatfish catfish to the general advisory, the specific advisory for the Little Kanawha River is no longer necessary.

Body weight and meal size are important factors in fish advisories. Use this chart to find the size of meal that corresponds to your body weight. This advisory is designed to keep the amount of chemicals you eat at a safe level.

Table 10 Meal Sizes	
A person weighing between	Should eat no more than this amount per meal
20 or less pounds	1.0 ounces of fish (weighed before cooking)
20 - 35pounds	1.5 ounces of fish (weighed before cooking)
36 – 50 pounds	2.0 ounces of fish (weighed before cooking)
51 – 70 pounds	3.0 ounces of fish (weighed before cooking)
71 – 90 pounds	4.0 ounces of fish (weighed before cooking)
91 - 100 pounds	5.0 ounces of fish (weighed before cooking)
111 - 130 pounds	6.0 ounces of fish (weighed before cooking)
131 - 150 pounds	7.0 ounces of fish (weighed before cooking)
151 and up pounds	8.0 ounces of fish (weighed before cooking)
3.0 ounces of precooked fish is about the size of the palm of your hand or a deck of cards	
1.5 ounces of precooked fish is about one-half the size of the palm of your hand or a deck of cards	

Find the meal advice for the fish you've caught. "Do Not Eat" means you should not eat those fish because of higher contamination. The other groups ("One Meal a Week", "Two meals a Month", "One Meal a Month", and "Six Meals a Year") are recommendations about how often to eat fish.

Women of childbearing age, children, and people who regularly eat fish are particularly susceptible to contaminants that build up over time. If you fall into one of these categories, you should be especially careful to follow the meal sizes and space fish meals out according to the advisory tables.

Your body can get rid of some contaminants over time. Spacing the meals out helps prevent the contaminants from building up to harmful levels in the body. For example, if the fish you eat is in the "One Meal a Month Group", wait a month before eating another meal of fish from any restricted category. Occasionally eating fish in quantities slightly greater than the advisories recommend, such as during an annual fishing vacation, should not present a health hazard.

Follow the advice presented in this advisory, noting the differences between the General Advisories for all West Virginia waters and the more restrictive Specific Advisories.

Table 11 GENERAL ADVISORIES FOR ALL WEST VIRGINIA WATERS (except where listed in the specific advisories below)		
Species	Limit your fish meals to:	Contaminants*
Black Bass (largemouth, smallmouth, spotted) less than 12” Brown Trout Channel Catfish greater than 17” Flathead Catfish Sauger All Suckers	2 meals a month	* Mercury PCBs
Black Bass (largemouth, smallmouth, spotted) greater than 12” Walleye Saugeye White Bass Hybrid Striped Bass	1 meal a month	
Rainbow Trout	No Limit	
Channel Catfish less than 17” All other species	1 meal a week	
** meal limit determined by mercury. PCBs would have an advisory at a less restrictive level.*		

Table 12 SPECIFIC ADVISORIES – SPECIES NOT LISTED BELOW CAN BE EATEN AS INDICATED IN THE GENERAL ADVISORY			
Water Body	**Species**	**Limit your fish meals to:**	**Contaminants***
FLAT FORK CREEK	Carp Channel Catfish, all sizes Suckers	Do not eat	*PCBs
HUGHES RIVER	Sauger	1 meal a month	*Mercury
KANAWHA RIVER downstream of I-64 bridge in Dunbar including: all backwaters, Armour Creek, Heizer Creek, Manila Creek, Pocatalico River (lower two miles)	Flathead Catfish, all sizes Channel Catfish, all sizes Carp Hybrid Striped Bass Suckers	Do not eat	*Dioxin Mercury PCBs
	All other species	1 meal a month	
KANAWHA RIVER upstream of (-64 bridge at Dunbar)	Channel Catfish, less than 17”	2 meals a month	*PCBs Mercury
MEADOW RIVER	Rock Bass	2 meals a month	*Mercury

Table 12 SPECIFIC ADVISORIES – SPECIES NOT LISTED BELOW CAN BE EATEN AS INDICATED IN THE GENERAL ADVISORY			
Water Body	**Species**	**Limit your fish meals to:**	**Contaminants***
MIDDLE ISLAND CREEK	Spotted Bass less than 12”	1 meal a month	*Mercury PCBs
MONONGAHELA RIVER	Channel Catfish, all sizes	6 meals a year	*PCBs
POTOMAC RIVER main stem	All non-game fish	Do not eat	*Dioxin
NORTH BRANCH of POTOMAC RIVER	All non-game fish	Do not eat	*Dioxin
NORTH FORK of SOUTH BRANCH of POTOMAC RIVER	Rock Bass	2 meals a month	*Mercury
SOUTH FORK of SOUTH BRANCH of POTOMAC RIVER	Smallmouth Bass less than 12”	1 meal a month	*Mercury
	Sunfish	2 meals a month	
OHIO RIVER, entire WV length	Carp Channel Catfish, greater than 17”	Do not eat	*PCBs Mercury Dioxin
	Channel Catfish less than 17” Flathead Catfish, all sizes	6 meals a year	
	Drum	1 meal a month	
R.D. BAILEY LAKE	Channel Catfish greater than 17”	6 meals a year	*PCBs
SHENANDOAH RIVER	Carp Channel Catfish greater than 17”	Do not eat	*PCBs Mercury
SLEEPY CREEK LAKE	Yellow Bullhead	2 meals a month	*Mercury
WHEELING CREEK	Smallmouth Bass less than 12”	1 meal a month	*Mercury
**meal limit determined by chemical with asterisk. Other listed chemicals would have an advisory at a less restrictive level.* *PCBs: Polychlorinated biphenyls*			

For further information or the most current fish consumption advice consult the WV DHHR Web Site at www.wvdhhr.org/fish or call 304-558-2981.

Other contacts are the WV Division of Natural Resources Web Site at www.wvdnr.gov/fishing/fishing.shtm or call (304) 558-2771 and WV Department of Environmental Protection Web Site at www.wvdep.org or call (304) 926-0495.