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PHASE 2 REPORT- REVIEW COPY
FURTHER SITE CHARACTERIZATION AND ANALYSIS

VOLUME 2F-A HUMAN HEALTH RISK ASSESSMENT FOR THE MID-HUDSON RIVER

HUDSON RIVER PCBs REASSESSMENT RI/FS

DECEMBER 1999

UNITED STATES • ENVIRONMENTAL PROTECTION AGENCY •

For

U.S. Environmental Protection Agency
Region II
and
U.S. Army Corps of Engineers
Kansas City District

Book 1 of 1

TAMS Consultants, Inc.
Gradient Corporation

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

December 29, 1999

To All Interested Parties:

The U.S. Environmental Protection Agency (USEPA) is pleased to release the baseline Human Health Risk Assessment for the Mid-Hudson River (Mid-Hudson HHRA), which evaluates cancer risk and non-cancer health hazards for adults, adolescents and children posed by PCBs in sediments at the Hudson River PCBs Superfund site, in the absence of remediation. The Mid-Hudson HHRA is a companion volume to USEPA's August 1999 baseline Human Health Risk Assessment for the Upper Hudson River (Upper Hudson HHRA), which evaluated cancer risks and non-cancer health hazards in the Upper Hudson River. The Mid-Hudson HHRA is posted on USEPA's website for the Hudson River PCBs Reassessment Remedial Investigation/Feasibility Study (Reassessment RI/FS) at www.epa.gov/hudson.

The Mid-Hudson HHRA is part of Phase 2 of the Reassessment RI/FS for the Hudson River PCBs Superfund site. The Mid-Hudson HHRA, together with the August 1999 Upper Hudson HHRA, will help establish acceptable exposure levels for use in developing remedial alternatives in the Feasibility Study, which is Phase 3 of the Reassessment RI/FS.

USEPA will accept comments on the Mid-Hudson HHRA until January 28, 2000. Comments should be marked with the name of the report and should include the report section and page number for each comment. Comments should be sent to:

Alison A. Hess, C.P.G.
USEPA Region 2
290 Broadway - 19th Floor
New York, NY 10007-1866
Attn: Mid-Hudson River HHRA Comments

USEPA will hold a Joint Liaison Group meeting to discuss the findings of the Mid-Hudson HHRA on January 11, 2000, at 7:30 p.m. at the Sheraton Hotel, 40 Civic Center Plaza, Poughkeepsie, New York. The meeting is open to the general public. Notification of the meeting was sent to Liaison Group members, interested parties, and the press several weeks prior to the meeting.

During the public comment period, USEPA will hold an availability session to answer questions from the public regarding the Mid-Hudson HHRA. The availability session will be held from 6:30 to 8:30 p.m. on January 18, 2000 at Sheraton Hotel, 40 Civic Center, Poughkeepsie, New York.

If you need additional information regarding the Mid-Hudson HHRA or the Reassessment RI/FS in general, please contact Ann Rychlenski, the Community Relations Coordinator for this site, at (212) 637-3672.

Sincerely yours,

William McCabe

for Richard L. Caspe, Director
Emergency and Remedial Response Division

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ACRONYMS

ATSDR	Agency for Toxic Substances and Desease Registry
CDI	Chronic Daily Intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSF	Carcinogenic Slope Factor
EPC	Exposure Point Concentration
GE	General Electric
HI	Hazard Index
HHRA	Human Health Risk Assessment
HHRASOW	Human Helath Risk Assessment Scope of Work
HQ	Hazard Quotient
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
PCB	Polychlorinated Biphenyl
RfD	References Dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RM	River Mile
RI/FS	Remedial Investigation/Feasibility Study
SARA	Superfund Amendments and Reauthorization Act of 1986
TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin
TEF	Toxicity Equivalency Factor
TSCA	Toxic Substances Control Act
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency

Executive Summary

Human Health Risk Assessment: Mid-Hudson River
Executive Summary
December 1999

This document presents the baseline Human Health Risk Assessment for the Mid-Hudson River (Mid-Hudson HHRA), which is a companion volume to the baseline Human Health Risk Assessment for the Upper Hudson River that was released by the U.S. Environmental Protection Agency (USEPA) in August 1999. Together, the two risk assessments comprise the human health risk assessment for Phase 2 of the Reassessment Remedial Investigation/Feasibility Study (Reassessment RI/FS) for the Hudson River PCBs site in New York.

The Mid-Hudson HHRA quantitatively evaluates both cancer risks and non-cancer health hazards from exposure to polychlorinated biphenyls (PCBs) in the Mid-Hudson River, which extends from the Federal Dam at Troy, New York (River Mile 154) to just south of Poughkeepsie, New York (River Mile 63). The Mid-Hudson HHRA evaluates both current and future risks to children, adolescents, and adults in the absence of any remedial action and institutional controls, such as the fish consumption advisories currently in place. The Mid-Hudson HHRA uses the most recent USEPA policy and guidance as well as additional site data and analyses to update USEPA's 1991 risk assessment.

USEPA uses risk assessment as a tool to evaluate the likelihood and degree of chemical exposure and the possible adverse health effects associated with such exposure. The basic steps of the Superfund human health risk assessment process are the following: 1) Data Collection and Analysis, to determine the nature and extent of chemical contamination in environmental media, such as sediment, water, and fish; 2) Exposure Assessment, which is an identification of possible exposed populations and an estimation of human chemical intake through exposure routes such as ingestion, inhalation, or skin contact; 3) Toxicity Assessment, which is an evaluation of chemical toxicity including cancer and non-cancer health effects from exposure to chemicals; and 4) Risk Characterization, which describes the likelihood and degree of chemical exposure at a site, the possible adverse health effects associated with such exposure, the quantification of cancer risks and non-cancer health hazards, and a discussion of the uncertainties associated with the risk assessment.

The Mid-Hudson HHRA shows that cancer risks and non-cancer health hazards to the reasonably maximally exposed (RME) individual associated with ingestion of PCBs in fish from the Mid-Hudson River are above levels of concern. Consistent with USEPA regulations, the risk managers in the Superfund program evaluate the cancer risks and non-cancer hazards to the RME individual in the decision-making process. The Mid-Hudson HHRA indicates that fish ingestion represents the primary pathway for PCB exposure and for potential adverse health effects, and that cancer risks and non-cancer health hazards from other exposure pathways are significantly below levels of concern. The results of the Mid-Hudson HHRA will help establish acceptable exposure levels for use in developing remedial alternatives for PCB-contaminated sediments in the Upper Hudson River, which is Phase 3 (Feasibility Study) of the Reassessment RI/FS.

Data Collection and Analysis

USEPA previously released reports on the nature and extent of contamination in the Hudson River as part of the Reassessment RI/FS (*e.g.*, February 1997 Data Evaluation and Interpretation Report, July 1998 Low Resolution Sediment Coring Report, August 1998 Database for the Hudson River PCBs Reassessment RI/FS [Release 4.1], and May 1999 Baseline Modeling Report) and on human health risks for the Upper Hudson River (e.g., August 1999 Volume 2F - Human Health Risk Assessment for the Upper Hudson River). The Ecological Risk Assessment for Future Risks in the Lower Hudson River (Federal Dam at Troy, New York to the Battery in New York City), which is being issued by USEPA concurrently with this report, provided the forecasted concentrations of PCBs in fish, sediments, and river water used to conduct the Mid-Hudson HHRA.

Exposure Assessment

Adults, adolescents, and children were identified as populations possibly exposed to PCBs in the Mid-Hudson River due to fishing and recreational activities (*e.g.*, swimming, wading), as well as from residential ingestion of river water. The exposure pathways identified in the Mid-Hudson HHRA are ingestion of fish, incidental ingestion of sediments, dermal contact with sediments and river water, and residential ingestion of river water. For these exposure pathways, average (central tendency) and RME estimates were calculated using point estimate analyses, whereby an individual point estimate was selected for each exposure factor used in the calculations of cancer risks and non-cancer health hazards. The RME is the maximum exposure that is reasonably expected to occur in the Mid-Hudson River under baseline conditions; the RME is not a worst-case exposure scenario.

Risks and hazards through inhalation of volatilized PCBs were not assessed in the Mid-Hudson HHRA because calculated risks for this pathway were shown to be *de minimus* (insignificant) in the Human Health Risk Assessment for the Upper Hudson River. Given that concentrations of PCBs found in the sediment and river water in the Mid-Hudson are lower than concentrations in the Upper Hudson, the risks from volatilization also would be expected to be insignificant (and lower) in the Mid-Hudson. Similarly, because the concentrations of PCBs in the Mid-Hudson River are lower than in the Upper Hudson, USEPA determined that a Monte Carlo analysis of cancer risks and non-cancer hazards for the fish ingestion pathway was not warranted for the Mid-Hudson HHRA. An assessment of the exposure and risks from dioxin-like PCBs was not performed because the findings for the Human Health Risk Assessment for the Upper Hudson River showed that the risks for dioxin-like PCBs were comparable to those calculated for total PCBs.

Ingestion of Fish

For fish ingestion, both average (central tendency) and RME estimates were developed for each of the parameters needed to calculate the cancer risks and non-cancer health hazards. Based on the 1991 New York Angler survey of fish consumption by licensed anglers (Connelly *et al.*, 1992), the central tendency fish ingestion rate was determined to be approximately six half-pound meals per year and the RME fish ingestion rate was determined to be 51 half-pound meals per year.

Both cancer risks and non-cancer health hazards to an adult angler and a child were calculated. Population mobility data from the U.S. Census Bureau for the six counties surrounding the Mid-Hudson River (*i.e.*, Albany, Columbia, Dutchess, Greene, Rensselaer, and Ulster) and fishing duration data from the 1991 New York Angler survey were used to determine the length of time an angler fishes in the Mid-Hudson River (*i.e.*, exposure duration). The exposure duration for fish ingestion was 12 years for the central tendency exposure estimate for cancer and non-cancer and 40 years for cancer (7 years for non-cancer) for the RME estimate. Standard USEPA default factors were used for angler body weight. Future concentrations of PCBs in fish were derived from forecasts presented in the Ecological Risk Assessment for Future Risks in the Lower Hudson River, which were then grouped by fish species and averaged over species for the entire Mid-Hudson River. PCB losses during cooking were assumed to be 20% for the central tendency exposure estimate and 0% (no loss) for the RME estimate, based on studies reported in the scientific literature.

Other Exposure Pathways

For the direct exposure scenarios for river water and sediment, the average (central tendency) exposure estimates for adults and young children (aged 1-6 years) were assumed to be one day every other week for the 13 weeks of summer (7 days/year) and for the RME were assumed to be one day per week for the 13 weeks of summer (13 days/year). Adolescents (aged 7-18 years) were assumed to have about three times more frequent exposure, with a central tendency exposure estimate of 20 days/year and an RME estimate of 39 days/year. The risks and hazards due to ingestion of river water for drinking water purposes were evaluated for residents living adjacent to the Mid-Hudson River. The concentrations of PCBs in water and sediment were derived from the Baseline Ecological Risk Assessment for Future Risks in the Lower Hudson River. Standard USEPA default factors were used for certain exposure parameters (*e.g.*, body weight) in the cancer risk and non-cancer hazard calculations for these pathways.

Toxicity Assessment

The toxicity assessment is an evaluation of the chronic (7 years or more) adverse health effects from exposure to PCBs (USEPA, 1989b). In the federal Superfund program, two types of adverse health effects are evaluated: 1) the incremental risk of developing cancer due to exposure to chemicals and 2) the hazards associated with non-cancer health effects, which for PCBs include reproductive impairment, developmental disorders, disruption of specific organ functions, and learning problems. The cancer risk is expressed as a probability and is based on the cancer potency of the chemical, known as a cancer slope factor, or CSF. The non-cancer hazard is expressed as the ratio of the chemical intake (dose) to a Reference Dose, or RfD. The chronic RfD represents an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure level for the human population, including sensitive populations (*e.g.*, children), that is likely to be without an appreciable risk of deleterious effects during a lifetime. Chemical exposures exceeding the RfD do not predict specific diseases. USEPA's Integrated Risk Information System, known as IRIS, provides the primary database of chemical-specific toxicity information used in Superfund risk assessments. The most current CSFs and RfDs for PCBs were used in calculating cancer risks and non-cancer hazards in the Mid-Hudson HHRA.

PCBs are a group of synthetic organic chemicals consisting of 209 individual chlorinated biphenyls called congeners. Some PCB congeners are considered to be structurally similar to dioxin and are called dioxin-like PCBs. USEPA has classified PCBs as probable human carcinogens, based on a number of studies in laboratory animals showing liver tumors. Human carcinogenicity data for PCB mixtures are limited but suggestive. USEPA (1996) described three published studies that analyzed deaths from cancer in PCB capacitor manufacturing plants (Bertazzi *et al.*, 1987; Brown, 1987; and Sinks *et al.*, 1992). Recently, Kimbrough *et al.* (1999) published the results of an epidemiological study of mortality in workers from two General Electric Company capacitor manufacturing plants in New York State. In September 1999, two Letters to the Editor regarding the Kimbrough *et al.* (1999) study and a response from Kimbrough *et al.* were published in the Journal of Occupational and Environmental Medicine. Due to the limitations of the Kimbrough *et al.* (1999) study identified by USEPA and others, USEPA expects that the findings of the Kimbrough *et al.* (1999) study will not lead to any change in its CSFs for PCBs, which were last reassessed by USEPA in 1996. The toxicity of PCBs is discussed in detail in the Human Health Risk Assessment for the Upper Hudson River.

Risk Characterization

For known or suspected carcinogens, acceptable exposure levels for Superfund are generally concentration levels that represent an incremental upper-bound lifetime cancer risk to an RME individual of 10^{-6} to 10^{-4} (USEPA, 1990). Ingestion of fish to an RME individual results in the highest cancer risks of approximately 4×10^{-4} (4 additional cancers in a population of ten thousand). Ingestion of fish for the average (central tendency) scenario results in an incremental upper-bound lifetime cancer risk to approximately 9×10^{-6} (9 additional cancers in a population of one million). If it is assumed that a child meal portion is approximately 1/3 of an adult portion, then the RME child risk for ingestion of fish is approximately 1×10^{-4}. Estimated cancer risks for all other exposure pathways are below 10^{-6} (*i.e.*, less than one in a million). The cancer risks are based on uniform exposure throughout the Mid-Hudson River (*i.e.*, that the exposure occurs throughout the Mid-Hudson study area).

Cancer Risk Summary		
Pathway	**Central Tendency Risk**	**RME Risk**
Ingestion of Fish:		
Adult	9×10^{-6} (9 in 1,000,000)	4×10^{-4} (4 in 10,000)
Child	3×10^{-6} (6 in 1,000,000)	1×10^{-4} (1 in 10,000)
Recreational Exposure to Sediment*	2×10^{-8} (2 in 100,000,000)	2×10^{-7} (2 in 10,000,000)
Recreational Dermal Exposure to Water*	9×10^{-9} (9 in 1,000,000,000)	6×10^{-8} (6 in 100,000,000)
Consumption of Drinking Water*	2×10^{-8} (2 in 100,000,000)	1×10^{-7} (1 in 10,000,000)

Total risk for child (aged 1-6), adolescent (aged 7-18), and adult (over 18).

The evaluation of non-cancer health effects involved comparing the average daily exposure levels (dose) to determine whether the estimated exposures exceed the RfD. The ratio of the site-specific calculated dose to the RfD for each exposure pathway is summed to calculate the Hazard Index (HI) for the exposed individual. An HI of one (1) is the reference level established by USEPA above which concerns about non-cancer health effects must be evaluated.

Ingestion of fish by the RME individual results in the highest value for non-cancer health hazards (HI = 30). Ingestion of fish by the average (central tendency) individual results in an HI of 3. Note that the average daily dose decreases as the exposure duration increases, so the average concentration over a 7-year exposure period used as the RME for non-cancer is greater than the average concentration over the 40-year exposure period used as the RME for the cancer assessment. Even if the average concentration of PCBs in fish over 40 years rather than the average concentration over 7 years is used to evaluate non-cancer health hazards (i.e., 0.8 ppm PCBs instead of 1.3 ppm PCBs), the HI would be 18. If it is assumed that a child meal portion is approximately 1/3 of an adult portion, then the RME child HI for ingestion of fish is 10. Total HIs for the recreational exposure pathways are all significantly less than one. The calculated HIs are based on uniform exposure throughout the Mid-Hudson River (*i.e.*, that the exposure occurs throughout the Mid-Hudson study area).

Uncertainties are inherent in the risk assessment process and may exist in PCB concentrations in environmental media, derivation of toxicity values, and estimating potential exposures. The uncertainties in risk characterization for the Mid-Hudson HHRA are expected to be similar to those found in the Human Health Risk Assessment for the Upper Hudson River.

Non-Cancer Hazard Summary		
Pathway	**Central Tendency Non-Cancer Hazard Index**	**RME Non-Cancer Hazard Index**
Ingestion of Fish:		
Adult	3	30
Child	1	10
Recreational Exposure to Sediment*	0.002	0.004
Recreational Dermal Exposure to Water*	0.005	0.007
Consumption of Drinking Water*	0.01	0.02

**Higher of value for child or adolescent, which are both higher than adult for these pathways.*

Major Findings of the Mid-Hudson HHRA

The Mid-Hudson HHRA evaluated both cancer risks and non-cancer health hazards to children, adolescents and adults posed by PCBs in the Mid-Hudson River. USEPA has classified PCBs as probable human carcinogens and known animal carcinogens. Other long-term adverse health effects of PCBs observed in laboratory animals include a reduced ability to fight infections, low birth weights, and learning problems. The major findings of the report are:

- Eating fish is the primary pathway for humans to be exposed to PCBs from the Mid-Hudson.

- Under the RME scenario for eating fish, the calculated risk is approximately four additional cases of cancer for every 10,000 people exposed. This excess cancer risk is more than 100 times higher than USEPA's goal of protection and within the upper bound of the cancer risk range generally allowed under the federal Superfund law.

- For non-cancer health effects, the RME scenario for eating fish from the Mid-Hudson results in a level of exposure to PCBs that is 30 times higher than USEPA's reference level (Hazard Index) of one.

- Under baseline conditions, the RME cancer risks and non-cancer hazards for eating fish would be above USEPA's generally acceptable levels for a 40-year exposure period beginning in 1999.

- For the fish consumption pathway, central tendency cancer risks lie within the risk range of 10^{-6} to 10^{-4}, and non-cancer hazards under central tendency assumptions fall slightly above the USEPA's reference level (Hazard Index) of one.

- Risks from being exposed to PCBs in the Mid-Hudson River through skin contact with contaminated sediments and river water, residential ingestion of river water for drinking water, incidental ingestion of sediments, and inhalation of PCBs in air are significantly below USEPA's levels of concern for cancer and non-cancer health effects.

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Chapter 1

1 Overview of Mid-Hudson River Risk Assessment

1.1 Introduction

This report presents the baseline Human Health Risk Assessment (HHRA) for the Mid-Hudson River as required under the National Oil and Hazardous Substances Pollution Contingency Plan (USEPA, 1990). This report serves as a companion report to the Human Health Risk Assessment for the Upper Hudson River (Upper Hudson HHRA) that was issued by the U.S. Environmental Protection Agency (USEPA) in August 1999. This assessment quantifies both carcinogenic and non-carcinogenic health effects from exposure to polychlorinated biphenyls (PCBs) in the Mid-Hudson River, following USEPA risk assessment policies and guidance. Both current and future risks to children, adolescents, and adults were evaluated based on the assumption of no remediation or institutional controls such as in the absence of fish consumption advisories (USEPA, 1990).

The risk assessment methodology for the Mid-Hudson River parallels the method adopted for the Upper Hudson HHRA. Therefore, much of the background and details of the risk assessment process is contained in the Upper Hudson HHRA, and the reader should refer to that report to gain a better understanding of the overall process. In addition, the 1-year move probabilities for the Mid-Hudson region is virtually the same (less than 1% difference for any age group) as that for the Upper Hudson region. Given the fact that residence duration's for the Mid-Hudson region age categories are essentially the same as those for the Upper Hudson region, the angling and residence duration distribution derived for the Upper Hudson HHRA were applied in the Mid-Hudson HHRA as well. An assessment of the exposure and risks from dioxin-like PCBs was not performed because the findings for the Human Health Risk Assessment for the Upper Hudson River showed that the risks for dioxin-like PCBs were comparable to those calculated for total PCBs.

1.2 Site Background

The Hudson River PCBs Superfund Site extends from Hudson Falls, NY to the Battery in New York City. The site covers approximately 200 river miles. The most contaminated portion of the Hudson River is between Hudson Falls, NY and the Federal Dam at Troy, NY (Upper Hudson River), and was addressed in the August 1999 Upper Hudson HHRA Report (USEPA, 1999g). This HHRA addresses the Mid-Hudson River (Plate 1), which is the area between the Federal Dam in Troy, NY (River Mile 154) and the salt water front (approximately River Mile 63) just south of Poughkeepsie, NY.

From 1957 through 1975, it is estimated that between 209,000 and 1,300,000 pounds of PCBs were discharged to the Upper Hudson River from two General Electric capacitor manufacturing facilities. The manufacture, processing, and distribution in commerce of PCBs within the U.S. was restricted in 1977 under provisions of the Toxic Substances and Control Act (USEPA, 1978). In 1973, the Fort Edward Dam was removed, which facilitated the downstream movement of PCB-contaminated sediments (USEPA, 1991a). In 1984, USEPA issued a Record of Decision (ROD) for the site (USEPA, 1984). The ROD specified: 1) an interim No Action decision concerning PCBs in Upper Hudson River sediments; 2) in-place capping, containment and monitoring of remnant deposit sediments; and 3) a treatability study to evaluate the effectiveness of removing PCBs from the Hudson River water (USEPA, 1984). This report is part of the reassessment of the No Action decision begun by USEPA Region 2 in December 1990.

Because of potential human health risks due to consumption of PCB-contaminated fish, New York State has made the following general recommendations: 1) eat no more than one meal (1/2 pound) per week of fish from the Hudson River estuary; 2) women of childbearing age, infants, and children under the age of 15 should not eat any fish species from the Hudson River; and 3) follow trimming and cooking advice (NYSDOH, 1999a). Additional health advisories made specifically for the Hudson River include: 1) Hudson Falls to Troy Dam (Upper Hudson River) -- eat no species; 2) Troy Dam south to bridge at Catskill (Mid-Hudson River) -- eat no species, except American shad (one meal/week), and alewife, blueback herring, rock bass, and yellow perch (one meal/month); 3) Bridge at Catskill south to and including the Upper Bay of New York Harbor (Mid- and Lower Hudson River) -- eat American eel, bluefish, striped bass, Atlantic needlefish, rainbow smelt, white perch, carp, goldfish, white catfish, largemouth bass, smallmouth bass, walleye, white catfish, and white perch only one meal/month, and crabs no more than six per week (NYSDOH, 1999a). In addition, health advisories are also listed for turtles and waterfowl statewide due to PCBs (NYSDOH, 1999a).

1.3 General Risk Assessment Process

The goal of the Superfund human health evaluation process is to provide a framework for developing the risk information necessary to assist in the determination of possible remedial actions at a site. The components involved in this process include: 1) Data Collection and Analysis, 2) Exposure Assessment, 3) Toxicity Assessment, and 4) Risk Characterization, as described more fully in the Upper Hudson HHRA Report (USEPA, 1999g).

1.4 Discussion of 1991 Phase 1 Risk Assessment

In 1991, USEPA issued the Phase 1 Report - Interim Characterization and Evaluation for the Hudson River PCB Reassessment Remedial Investigation/Feasibility Study, including a quantitative risk assessment for the Upper Hudson River and a qualitative risk assessment for the Lower Hudson River (USEPA, 1991a). The risks from ingestion of fish in the Lower Hudson River were qualitatively evaluated, based on the findings in the Upper Hudson River. The assessment concluded that the risks from ingestion of fish would be similar to those found in the Upper Hudson River. The PCB concentrations in fish, water, and sediment in the Lower Hudson were based on the Thomann PCB bioaccumulation model (USEPA, 1991a).

1.5 Objectives of Phase 2 Risk Assessment

In December 1990, USEPA Region 2 began a reassessment of the No-Action decision for the Upper Hudson River sediments based on, among other things, a request by New York State Department of Environmental Conservation (NYSDEC) and requirements of the Superfund Amendments and Reauthorization Act of 1986 to conduct reviews every five years of remedial decisions for sites where contamination remains on site. The reassessment consists of three phases: interim characterization and evaluation; further site characterization and analysis; and a Feasibility Study. As part of the Phase 2 Reassessment, this report presents the Human Health Risk Assessment for the Mid-Hudson River.

The objective of the Phase 2 risk assessment is to quantitatively evaluate current and potential cancer risks and non-cancer hazards from river water, sediment, and fish in the Mid-Hudson River. This Mid-Hudson HHRA provides estimates of cancer risks and non-cancer hazards both to the RME individual, or high-end risk (>90^{th} to 99^{th} percentiles), and to the average exposed individual, or central tendency risk (50^{th} percentile). Since the Phase 1 Risk Assessment, USEPA has used fate, transport, and bioaccumulation models in order to forecast PCB concentration trends in environmental media in the Mid-Hudson River region (USEPA, 1999d and USEPA, 2000). The results from these model forecasts were incorporated into this Phase 2 risk assessment. The Mid-Hudson HHRA is limited to evaluating current and potential health risks associated with PCBs, because the HHRA is being conducted as part of USEPA's Reassessment of its 1984 No-Action decision for the PCB-contaminated sediments in the Upper Hudson River.

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Chapter 2

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2 Exposure Assessment

The objective of the exposure assessment is to estimate the magnitude of human exposure to PCBs in the study area. USEPA guidance and policy call for an evaluation of the central estimate (CT) of risks and an estimate of risk for the reasonably maximum exposed (RME) individual. Consistant with USEPA regulations, the risk managers in the Superfund program evaluate the risk and hazards to the RME individual in the decision-making process. The same approach and terminology that were used in the Upper Hudson HHRA are being adopted here for the Mid-Hudson HHRA, with the exception that a Monte Carlo analysis was not performed for the fish ingestion pathway for the Mid-Hudson HHRA. Because the Mid-Hudson HHRA methods parallel those in the Upper Hudson HHRA, the reader should refer to the Upper Hudson HHRA (USEPA, 1999g) for additional details.

2.1 Exposure Pathways

For exposure and potential risks to occur, a complete exposure pathway must exist. Those pathways considered in the Upper Hudson HHRA were also considered for the Mid-Hudson HHRA. In general, during boating, fishing, and other recreational activities, members of the Mid-Hudson River study area population may be exposed to PCBs if they consume fish caught from the river, or as they come into contact with river water and river sediments. In addition, the Mid-Hudson River is a drinking water source and exposure may occur from this pathway. Potential exposure pathways considered in this HHRA are summarized in Table 2-1, identifying those pathways which are "complete" and warranted exposure and risk calculations in this study. The following sections briefly summarize the site-specific elements that make up the complete exposure pathways that are evaluated in the Mid-Hudson HHRA, while the Upper Hudson HHRA discusses the exposure pathways in more detail.

2.1.1 Potential Exposure Media

Humans may be exposed to PCBs from the site either through direct ingestion or contact with media containing PCBs. PCBs in the Hudson River have been detected, monitored and modeled extensively. The exposure media that are considered the most potentially significant source of PCB exposure at the site include fish, sediment, and river water. The relative importance of each of these potential exposure media, and those which may or may not pose a significant health risk, is determined based on the results of the quantitative exposure and risk analysis. As discussed in the Upper Hudson HHRA, PCBs in air (volatilizing from river water) were found to pose *de minimus* (*i.e.*, insignificant) risk (10^{-6} or less) in the Upper Hudson region. For the Mid-Hudson River, the total PCB concentration in river water is approximately four times lower than the Upper Hudson such that airborne PCBs from the river would exhibit a lower concentration (and risk) than determined for the Upper Hudson HHRA. Therefore, air is not quantitatively evaluated in the Mid-Hudson HHRA.

2.1.2 Potential Receptors

The population of concern in the evaluation of the Mid-Hudson River includes the inhabitants of the towns, cities, and rural areas surrounding the river who may fish or engage in activities that will bring them into contact with the river. The six counties include: Albany, Columbia, Dutchess, Greene, Rensselaer, and Ulster. From this population, anglers, recreators, and residents were defined as "receptor" groups for the purpose of quantifying the potential PCB exposures within the population as a whole. A detailed description of these receptors can be found in the Upper Hudson HHRA.

2.1.3 Potential Exposure Routes

An exposure route is the means, or mechanism, of contact with an exposure medium. Similar to the Upper Hudson River area, fish ingestion (*i.e.*, dietary intake) is the potential exposure route for anglers evaluated in this risk assessment. Routes of exposure under a recreational use scenario include: absorption of PCBs *via* dermal contact with sediments, incidental ingestion of PCBs contained in sediments during subsequent hand to mouth contact, and dermal contact with river water. Consumption of river water as a residential source of drinking water is included in the Mid-Hudson HHRA to address public concerns although it is recognized that the current and predicted PCB concentrations are well below the Maximum Contaminant Level (MCL) established under the Safe Drinking Water Act to protect public drinking water supplies.

As summarized in Table 2-1, several exposure routes are not quantitatively evaluated in this HHRA. Risks from the inhalation of air (due to PCBs volatilizing from river water) and other potable water uses such as showering were not evaluated due to low PCB concentrations present in the Mid-Hudson River and the chemical/physical properties of PCBs. In addition, other potential pathways, such as dietary intake of home-grown crops, consumption of local beef or dairy products, or consumption of snapping turtles, crabs and wild waterfowl are unlikely to be significant pathways for PCB intake, for the reasons discussed in the Upper Hudson HHRA.

2.2 Quantification of Exposure

This section of the risk assessment summarizes the basic approach for calculating human intake levels resulting from exposures to PCBs. A more detailed explanation of the quantification of exposure can be found in the Upper Hudson HHRA.

The primary source for the exposure algorithms used in the risk assessment is USEPA's Risk Assessment Guidance for Superfund, Part A (RAGS) (USEPA, 1989b). The generalized equation for calculating chemical intakes is:

$$I = \frac{C \times CR \times EF \times ED \times CF}{BW \times AT}$$

where:

I	=	*Intake* - the amount of chemical at the exchange boundary (mg/kg - day)
C	=	*Exposure Point Concentration* - the chemical concentration contacted over the exposure period at the exposure point (*e.g.*, mg/kg-fish)
CR	=	*Contact Rate* - the amount of affected medium contacted per unit time or event (*e.g.*, fish ingestion rate in g/day)
EF	=	*Exposure frequency* - describes how often exposure occurs (days/year)
ED	=	*Exposure duration* - describes how long exposure cccurs (year)
CF	=	*Conversion factor* - (kg/g)
BW	=	*Body weight* - the average body weight over the exposure period (kg)
AT	=	*Averaging time* - period over which exposure is averaged for non-carcinogenic effects (i.e., ED x 365 days/year) and 70 year lifetime for carcinogenic effects (i.e., 70 years X 365 days/year).

Exposure parameters (*e.g.*, contact rate, exposure frequency, exposure duration, body weight) describe the exposure of a receptor for a given exposure scenario (mg/kg-day). These values are the input parameters for the exposure algorithms used to estimate chemical intake. The general equation above is slightly modified for each pathway, and the specific exposure parameters for each pathway are summarized and discussed in detail in Section 2.4.

2.3 Exposure Point Concentrations

The exposure point concentrations (EPCs) for PCBs in fish, water, and sediment are based upon modeled projections of future concentrations in each medium (although the models are based upon a large monitoring record) (USEPA, 1999h). As a result, the typical approach adopted in Superfund risk assessments of calculating an upper confidence limit on a mean concentration (*i.e.*, 95% UCLM), no longer strictly applies, as discussed more fully in the Upper Hudson HHRA. In addition, as was discussed in the Upper Hudson HHRA, no screening of Contaminants of Potential Concern (COPCs) was performed for this assessment because the Mid-Hudson HHRA is being conducted as part of USEPA's Reassessment of its 1984 No Action decision for the PCB-contaminated sediments in the Hudson River. Thus, the USEPA RAGS Part D format (Tables 2-2 through 2-4) which, for a typical risk assessment, would include information necessary to determine COPCs, are not needed and are included in the Mid-Hudson HHRA only for consistency.

2.3.1 PCB Concentration in Fish

Because the Mid-Hudson HHRA examines current and future cancer health risks and non-cancer hazards, and because the concentration of PCBs in fish changes over time and location, the EPC for PCBs in fish necessarily relies upon model predictions. Three factors have an influence on the exposure point concentration in fish:

1. The concentration of PCBs for any particular fish species varies for a particular year, but overall it declines over time.

2. The concentration of PCBs within the same fish species varies with location in the Hudson River, with higher concentrations upstream compared to downstream.

3. The concentration of PCBs varies among different fish species.

Thus, even though fish are considered a single exposure medium for the Mid-Hudson HHRA, each of the above factors will influence the calculation of a single exposure point concentration.

Summary of Modeled PCB Concentration Results

The 1999 baseline Ecological Risk Assessment for Future Risks in the Lower Hudson River (USEPA, 1999h) presents a detailed discussion of the PCB bioaccumulation and transport and fate models that were used to predict future trends of PCB concentrations in fish. For this Mid-Hudson HHRA, estimated EPCs for fish were derived from forecasts using USEPA's bioaccumulation model(FISHRAND) and the Farley *et al.*(1999) fate and bioaccumulation model as presented in USEPA (1999h). The Farley *et al.*(1999) model forecasts were used for white perch (ages 1-7) because the model accounts for their migratory behavior. The Farley *et al.*(1999) model was not used to determine PCB concentrations in striped bass because it does not forecast PCB concentrations in striped bass in the Mid-Hudson HHRA study area. The FISHRAND model results were used for the brown bullhead, largemouth bass, and yellow perch. Because striped bass was not specifically modeled in the Mid-Hudson region, the FISHRAND modeled largemouth bass values, scaled by the average ratio of PCB concentration in striped bass over largemouth bass in the NYSDEC monitoring data, were used to estimate future PCB concentrations in striped bass in the Mid-Hudson River (USEPA, 1999h). The reader is referred to USEPA (1999h) for further information on the bioaccumulation and fate and transport models used to forecast concentrations of PCBs in sediment, water column, and fish in the Mid-Hudson.

Overall, forecasts of PCBs in fish were available for a total of seven fish species: brown bullhead, largemouth bass, striped bass, white perch, yellow perch, spottail shiner, and pumpkinseed. Two of these modeled species (spottail shiner and pumpkinseed) were not included in the Mid-Hudson HHRA because they are small fish and are typically not consumed by humans. However, these small fish were modeled as one component of the fish food web that contributes to PCB accumulation higher up in the food chain (*i.e.*, larger fish that are consumed by humans) (USEPA, 1999h).

Model forecasts of total PCB concentration in each species were based on PCB congeners with three or more chlorine molecules, *i.e.*, Tri+ PCB concentrations (USEPA, 1999d). For the larger fish species modeled (*i.e.*, brown bullhead, largemouth bass, striped bass, white perch, and yellow perch), the model provides estimates of PCB concentration in fish fillets, otherwise the model results are for whole fish for the smaller species (*i.e.*, spottail shiner and pumpkinseed). The fillet represents the portion of the fish most commonly consumed by humans.

Modeled predictions of future PCB concentrations in fish from the FISHRAND model are presented at three locations along the Mid-Hudson River: River Mile 152 (corresponding to River Miles 153.5 - 123.5); River Mile 113 (corresponding to River Miles 123.5 - 93.5); and River Mile 90 (corresponding to River Miles 93.5 - 63.5) (USEPA, 1999h). These three locations correspond to locations along the river where fish have been monitored by NYSDEC. Modeled predictions from the Farley *et al.*(1999) model are presented as an overall average by food web region. Food web region 1 model results (River Miles 153.5 - 73.5) were used for the Mid-Hudson HHRA (Plate 1). In general, the concentrations for all fish species decrease with River Mile and time. PCB concentrations in fish were modeled from 1999 to 2039, which covers present and future exposure to PCBs in fish. Figures 2-1 through 2-5 displays the modeled mean concentration trend over time by location for each of the five modeled species considered in the Mid-Hudson HHRA.

Concentration Averaged Over Locations

With the exception of some limited information in 1996 (NYSDOH, 1999b) and the 1991 - 1992 Hudson Angler survey (Barclay, 1993), there is insufficient information to quantify fishing preference or frequency at specific locations within the Mid-Hudson River. Consequently, projected PCB concentrations in fish were averaged over the Mid-Hudson River region. This averaging essentially presumes a uniform likelihood of fishing at any location within the Mid-Hudson River study area.

The PCB concentrations, averaged over location, for each of the modeled species are summarized in Figure 2-6. Overall, modeled PCB concentrations for striped bass are the highest, ranging from approximately 3 mg/kg to slightly less than 1 mg/kg, while the modeled PCB concentrations in yellow perch are the lowest, ranging from approximately 0.5 mg/kg to 0.25 mg/kg.

PCB Concentration Weighted by Species-Consumption Fractions

In order to take into account the fish species that individuals actually eat from the Mid-Hudson River, species-specific intake patterns, derived from the 1991 New York Angler survey (Connelly *et al.*, 1992) and (NYSDOH, 1999b) and 1991 - 1992 Hudson River angler survey (Barclay, 1993), were used to weight the concentration of PCBs in fish. That is, the overall average PCB concentration in fish that an angler consumes was based on the relative percent of different fish species consumed, and their respective modeled PCB concentrations.

A complete discussion of the 1991 New York Angler survey (Connelly *et al.*, 1992) is found in the Upper Hudson HHRA. A summary of the survey is provided in Table 2-5, and is briefly described here. A total of nine specific fish species, plus a tenth category denoted "other," were included in the Connelly *et al.* (1992) survey. Of the nine species in the survey, salmon, trout, and walleye are not commonly found in the Mid-Hudson River study area (USEPA, 1991a); therefore, these three species, along with the unidentified "other" category, were excluded when determining species ingestion weights. The six species from the 1991 New York Angler survey (Connelly *et al.*, 1992) that are potentially caught and eaten in the Mid-Hudson River were grouped such that species for which predicted PCB concentrations are unavailable were assigned the PCB concentration of a modeled species that fell within the same group.

The 1991 New York Angler survey (Connelly *et al.*, 1992) did not distinguish among species included in the "perch" and "bass" categories. Because white perch, yellow perch, largemouth bass, and striped bass are being considered separately for the Mid-Hudson region, an estimated species intake for each was based on adjusting the ingestion rates derived from the 1991 New York angler survey (Connelly *et al.*, 1992) using relative catch frequency of the four species. Table 2-6 summarizes the break down, which was based on the Mid-Hudson results of the 1996 (NYSDOH, 1999b) and the 1991 - 1992 Hudson River Angler survey (Barclay, 1993). The results from the 1996 (NYSDOH, 1999b) and 1991 - 1992 Hudson River Angler survey (Barclay, 1993) only account for the amount of each species caught, rather than the amount of each species consumed. Other surveys of the Mid-Hudson River region (Jackson, 1990) generally support the results of the NYSDOH (1999b) survey. Note that although the Jackson (1990) study revealed a higher ratio of largemouth bass to striped bass, almost 3/4 of the respondents were targeting black bass (largemouth and smallmouth bass) for a tournament. As a result, the NYSDOH (1999b) survey results were deemed more appropriate for use. In the NYSDOH (1999b) survey, the white perch catch outnumbers yellow perch about 6:1, while the striped bass catch outnumbers largemouth bass about 3:2.

Table 2-7 summarizes species-group intake percentages by summing the frequency percentage (Table 2-5) of the individual species in each group. Carp, catfish, and eel were assigned the same PCB concentration as brown bullhead, in part because like bullhead, they tend to spend much of their time at the bottom of lakes, rivers, and streams. Modeled PCB concentrations are available for each of the remaining species, in the remaining groups.

The EPCs for PCBs were derived using the species ingestion fractions shown in Table 2-7 multiplied by the PCB concentrations in each of the five modeled fish species. Thus, the weighted EPC is:

$$EPC = \sum_{X=1}^{5}\left(EPC_{GroupX} \times Species\,Ingestion\,Fraction_{GroupX}\right)$$

The species-weighted EPC value for fish in the Mid-Hudson River is summarized in Table 2-8. The EPC for each fish group (EPC_{GroupX}) is the average over all locations within the Mid-Hudson River. The central tendency EPC of 1.2 mg/kg PCBs was calculated by averaging the species-weighted concentration distribution over the 50th percentile exposure duration estimate (*i.e.*,12 years). The RME exposure EPC of 0.8 mg/kg PCBs was calculated by averaging the species-weighted concentration distribution over the 95th percentile exposure duration estimate (*i.e.*,40 years). The determination of these particular exposure durations is described in Section 2.4.1. The RME exposure duration of seven years for non-cancer hazards was 1.3 mg/kg.

It may be counter-intuitive that the RME EPC is lower than the central tendency EPC. This is a direct result of the projected decline in PCB concentrations in fish. Due to this decline over time, the average concentration over the 40-year exposure duration is less than the average concentration over the 12-year period. However, the total lifetime PCB dose, which combines concentration, exposure duration, and other intake factors, is greater for the RME point estimate.

2.3.2 PCB Concentration in Sediment

Just as is the case for fish, PCB concentrations in sediment in the Mid-Hudson generally decrease as a function of river mile and time. As described in USEPA (1999h), PCB concentrations in surficial (0 - 5 cm) sediments were modeled over time and distance. The model predictions for the Mid-Hudson study area were presented for nine different river mile segments, each approximately 10 miles long, from the Federal Dam at Troy, NY (River Mile 154) to the salt water front (approximately River Mile 63) just south of Poughkeepsie, NY (Farley *et al.*, 1999). The forecast total PCB concentrations in sediment are plotted in Figure 2-7.

The EPCs in sediment were calculated by first averaging the results for Total PCBs in sediment over the nine model segments (see Figure 2-7), then averaging these values over the central tendency (*i.e.*, 11 years) and RME (*i.e.*, 41 years) exposure durations. Note the exposure duration for this pathway is based only on residence duration, as opposed to a RME of 40 years and a central estimate of 12 years for angling duration, which is a combination of residence duration and fishing duration. The RME exposure duration is 6 years for children, 12 years for adolescents, and 23 years for adults (summing to 41 years), and the central tendency exposure duration is 3 years for children, 3 years for adolescents, and 5 years for adults (summing to 11 years). The mean of the first 1-4, 5-7, and 8-12 years of these segment averages (0.61, 0.61, and 0.59 mg/kg PCBs) was used as the central tendency point estimate EPCs for children, adolescents, and adults, respectively; the mean of the first 1-7, 8-19, and 20-42 years of these segment averages (0.58, 0.52, and 0.45 mg/kg PCBs) was used as the RME point estimates for children, adolescents, and adults, respectively (Table 2-9).

Again, it may be counter-intuitive that the RME EPCs are lower than the central tendency EPCs. This is a direct result of the declining PCB concentration in sediment over time giving rise to declining EPC estimates as the duration of exposure increases.

2.3.3 PCB Concentration in River Water

Similar to the sediment results, USEPA (1999h) provides forecast PCB concentrations in the water column over location and time. The water column model predictions for the Mid-Hudson River were presented for nine river segments, from the Federal Dam (River Mile 154) to the salt water front (approximately River Mile 63) just south of Poughkeepsie, NY (Farley *et al.*, 1999). The forecast concentrations of total PCBs in water are plotted in Figure 2-8. Note that the increase in PCB concentration in water at 2039 is a result of scour uncovering older, more highly contaminated sediments, as more fully discussed by USEPA (1999h and 2000).

The exposure point concentrations in river water were calculated by first averaging the total PCB concentrations across the nine model segments, then averaging these values over the central tendency (*i.e.*, 11 years) and RME (*i.e.*, 41 years) exposure durations. The RME exposure duration is 6 years for children, 12 years for adolescents, and 23 years for adults (summing to 41 years), and the central tendency exposure duration is 3 years for children, 3 years for adolescents, and 5 years for adults (which sum to 11 years). The mean of the first 1-4, 5-7, and 8-12 years of these segment averages (1.6×10^{-5}, 1.6×10^{-5}, and 1.5×10^{-5} mg/L PCBs) was used as the central tendency point estimate EPCs for children, adolescents, and adults, respectively; the mean of the first 1-7, 8-19, and 20-42 years of these segment averages (1.4×10^{-5}, 1.2×10^{-5}, and 9.2×10^{-6} mg/L PCBs) was used as the RME point estimates for children, adolescents, and adults, respectively (Table 2-10).

2.4 Chemical Intake Algorithms

The calculation of PCB intake for each complete exposure pathway for the Mid-Hudson HHRA follows the same procedures described in greater detail in the Upper Hudson HHRA. Complete tabulations of the exposure factors for each exposure pathway and receptor scenario are found in Tables 2-19 through 2-28.

2.4.1 Ingestion of Fish

The fish ingestion point estimate intake is calculated as:

$$\text{Intake}_{fish}(\text{mg / kg - d}) = \frac{C_{fish} \times IR \times (1 - LOSS) \times FS \times EF \times ED \times CF}{BW \times AT}$$

where:

C_{fish}	=	Concentration of PCBs in fish (mg/kg)
IR	=	Annualized fish ingestion rate (g/day)
LOSS	=	Cooking loss (g/g)
FS	=	Fraction from source (unitless fraction)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF	=	Conversion Factor (10^{-3} kg/g)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure factor values for the central tendency and RME point estimate calculations for this pathway are summarized in Table 2-19. Site-specific considerations in selecting these factors are discussed below.

Fraction from Source (FS). This HHRA examines possible exposure for the population of anglers who consume self-caught fish from the Mid-Hudson River. Thus, the exposure and risk analysis assumes the Mid-Hudson River accounts for 100% of the sportfish catch of the angler (FS=1). As noted below, the fish ingestion rate is based upon angler consumption of sportfish, such that it excludes fish that may be purchased and then consumed.

Exposure Frequency (EF). Because the fish ingestion rate is based on an annualized average ingestion over one year, an implicit exposure frequency value of 365 days/year is used in the intake calculation. This does not imply consumption of fish is 365 days per year.

Exposure Duration (ED). While Superfund risk assessments typically use the length of time that an individual remains in a single residence as an estimate for exposure duration, such an estimate is not likely to be a good predictor of angling duration, because an individual may move into a nearby residence and continue to fish in the same location, or an individual may chose to stop angling irrespective of the location of their home. Furthermore, given the large size of the Hudson River PCBs Superfund site, an individual may move from one place of residence to another, and still remain within the Mid-Hudson area and continue to fish in the Mid-Hudson River. For the purposes of defining the angler population likely to fish the Mid-Hudson River most frequently, it was assumed this population would be most likely to constitute residents from the six counties bordering the Mid-Hudson River (*i.e.*, Albany, Columbia, Dutchess, Greene, Rensselaer, and Ulster). Furthermore, the 1991 New York Angler survey (Connelly *et al.*, 1992) found that the average distance traveled by New York anglers was 34 miles, supporting the notion that the majority of the angler population for the Mid-Hudson River is likely to reside in these counties.

Given the above considerations, the exposure duration (angling, or fishing, duration) for the fish consumption pathway is not based solely upon a typical residence duration. Instead, as described more fully in the Upper Hudson HHRA, an angler is assumed to continue fishing until any of the following occur:

- the individual stops fishing;
- the individual moves out of the area, or dies.

The 1991 New York Angler survey of over 1,000 anglers (Connelly *et al.*, 1992) was used to estimate fishing duration habits within the population of New York anglers. U.S. Census data (1990) on county to county mobility provided the source of information to estimate the range of residence durations within the six counties bordering the Mid-Hudson River (Tables 2-11 through 2-18). As shown in Table 2-18, the 1-year move probabilities for the Mid-Hudson region are virtually the same (less than 1% difference for any age group) as that for the Upper Hudson region. Given the fact that residence durations for the Mid-Hudson region age categories are essentially the same as those for the Upper Hudson region, the angling and residence duration distribution derived for the Upper Hudson HHRA were applied to the Mid-Hudson HHRA as well.

The 50th percentile of the fishing duration distribution is 12 years and the 95th percentile is 40 years for the Mid-Hudson River region. These values were used as the central tendency and RME point estimates, respectively. A more complete and detailed discussion of the exposure duration derivation is provided in the Upper Hudson HHRA.

Body Weight (BW). The average adult body weight used in the intake equation was 70 kg, taken from USEPA (1989a). Note that the adult body weight found in the 1997 Exposure Factors Handbook (USEPA, 1997c) is 71.8 kg. Because USEPA's derivation of the PCB cancer toxicity factors was based upon a 70 kg adult in extrapolating the animal data to humans, this assessment uses the prior 70 kg body weight value for consistency. This difference in the body weight does not significantly change the calculated cancer risks and non-cancer hazards.

Averaging Time (AT). A 70-year lifetime averaging time of 25,550 days was used for cancer calculations (70 years × 365 day/year) (USEPA, 1989a). In order to avoid possible confusion, a 70 year life expectancy from USEPA RAGS (USEPA, 1989b) was used as the averaging time for cancer, even though the 1997 Exposure Factors Handbook (USEPA, 1997c) indicates 75 years is the most current estimate. Had a 75 year averaging time been used, this would effectively decrease the calculated intake of PCBs in fish by 7%.

Non-cancer averaging times are not averaged over a lifetime, but rather over a period of time equating to a chronic level of exposure. Chronic exposure are those exposures that exceed the subchronic exposure durations (7 years). Therefore, the averaging time for the non-cancer hazard assessment was set to 2,555 days (7 years × 365 days/year) for the RME point estimate and 4,380 days (12 years × 365 days/year) for the central tendency estimate.

Concentration of PCB in Fish (C_{fish}). As described earlier in Section 2.3.1, the PCB concentration in fish was determined based on the modeled Tri+ PCB concentration results presented in the USEPA (1999d), weighted by fish consumption patterns (Section 2.3.1). For the evaluation of cancer risks, the central tendency EPC is 1.2 mg/kg PCBs, which was calculated by averaging the species-weighted concentration distribution over the 50th percentile exposure duration estimate (i.e., 12 years). The corresponding RME value is 0.8 mg/kg PCBs, which was calculated by averaging the species-weighted concentration distribution over the 95th percentile exposure duration estimate (i.e., 40 years). It should be noted that the apparent contradiction in EPC, whereby the high-end EPC is lower than the central tendency EPC, is a direct result of the declining PCB concentration in fish over time. Due to this decline over time, the average concentration over the 40-year exposure duration is less than the average concentration over the 12-year period.

As noted above, the averaging time for the non-cancer hazard assessment was limited to a maximum of 7 years for the RME. The 7-year average EPC in fish for the RME is 1.3 mg/kg

PCBs; the central tendency point estimate EPC, which is based on a 12-year exposure duration, is 1.2 mg/kg PCBs (Table 2-19).

Fish Ingestion Rate (IR). The fish ingestion rate is based upon an estimate of the long term average consumption of self-caught fish in the angler population, expressed as an annualized daily average rate in units of grams of fish per day (g/day). It is important to note that the ingestion of fish from all sources (*e.g.*, self-caught plus purchased fish) is necessarily greater than or equal to the ingestion rate of only self-caught fish. Because the Mid-Hudson HHRA examines the risk of PCB intake from Hudson River fish only, the focus is only on self-caught fish.

A full description of the derivation of fish ingestion rates is found in the Upper Hudson HHRA. The fish ingestion rate for both the Upper and Mid-Hudson is based upon a survey of over 1,000 New York anglers (Connelly *et al.*, 1992) who catch and consume fish. For the point estimate exposure and risk calculations, the 50^{th} percentile of the empirical distribution (4.0 g/day) is used as the central tendency point estimate of fish ingestion, and the 90^{th} percentile (31.9 g/day) is the RME ingestion rate. For a one-half pound serving, these ingestion rates represent approximately 6 and 51 fish meals per year, respectively.

Cooking Loss (LOSS). Numerous studies have examined the loss of PCBs from fish during food preparation and cooking. A review of the available literature is discussed in detail in the Upper Hudson HHRA. Overall, the 12 studies reviewed support the conclusion that cooking loss may be zero to 74 percent. In addition, several studies reported net gains for PCBs (Moya *et al.*, 1998, and Armbruster *et al.*, 1987). Despite the rather wide range of cooking loss estimates, most PCB losses were between 10 and 40 percent. A value of 20% (midpoint of 0% - 40%) was selected as the central tendency point estimate for cooking loss. For the RME, no cooking loss (LOSS = 0%) was selected to include the possibility that pan drippings are consumed.

2.4.2 Ingestion of Sediment

For the sediment ingestion pathway, intake is calculated as:

$$\text{Intake}_{\text{ingestion}}(\text{mg / kg - d}) = \frac{C_{sed} \times IR \times FS \times EF \times ED \times CF}{BW \times AT}$$

where:

C_{sed}	=	Concentration of PCBs in sediment (mg/kg)
IR	=	Sediment ingestion rate (mg/day)
FS	=	Fraction from source (unitless fraction)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF	=	Conversion factor (10^{-6} kg/mg)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure factor values for the central tendency and RME point estimate calculations for this pathway are summarized in Tables 2-20 through 2-22. Site-specific considerations in selecting these factors are discussed below.

PCB Concentration in Sediment (C_{sed}). As described in Section 2.3.2, the central tendency point estimates used for PCB concentration in sediment are 0.61, 0.61, and 0.59 mg/kg for children, adolescents, and adults, respectively. The RME point estimates are 0.58, 0.52, and 0.45 mg/kg for children, adolescents, and adults, respectively (see Table 2-9).

Sediment Ingestion Rate (IR). This factor provides an estimate of incidental intake of sediment that may occur as a result of hand-to-mouth activity. In the absence of site-specific ingestion rates, USEPA recommended values for daily soil ingestion were used for this factor. The incidental ingestion rate for children is 100 mg/day, and for adults and adolescents the value is 50 mg/day. These values, reported as median estimates of soil intake, are the recommendations found in Risk Assessment Guidance for Superfund (RAGS) (USEPA, 1989b) and the Exposure Factors Handbook (USEPA, 1997c). The incidental soil (sediment) ingestion rate provides an estimate of the ingestion that may occur integrated over a variety of activities, including ingestion of indoor dust. Thus, these median ingestion rates are likely high-end estimates of incidental sediment ingestion while participating in activities along the Mid-Hudson River, because other sources (such as at home) also account for soil/sediment ingestion.

Exposure Frequency (EF). Exposure to river sediments is most likely to occur during recreational activities. However, there are no site-specific data to provide an indication of the likely frequency of recreational activities along the Mid-Hudson River, nor are there general population studies that provide usable information. Under the assumption that recreational activities are likely to be most frequent during the summer months, an estimate of one day per week during the 13 weeks of summer is considered a reasonable estimate of the RME value for adults (*i.e.*, 13 days per year). This same frequency was adopted for children (aged 1-6), assuming they would most likely be accompanied by an adult. For adolescents (aged 7-18), who are not as likely to be accompanied by an adult, it was assumed their recreational frequency was three-fold greater than the adult/child frequency (*i.e.*, 39 days per year). The RME values were reduced by 50% for the central tendency exposure calculations.

Exposure Duration (ED). The RME exposure duration for sediment ingestion in recreational scenarios is 41 years, and the central tendency value is 11 years, which correspond to the 95th and 50th percentiles, respectively, of the residence duration determined for the six Mid-Hudson counties. The RME exposure duration is 6 years for children, 12 years for adolescents, and 23 years for adults (summing to 41 years), and the central tendency exposure duration is 3 years for children, 3 years for adolescents, and 5 years for adults (which sum to 11 years). Note that these values are based on U.S. Census Bureau data for the six counties (*i.e.,* Albany, Columbia, Dutchess, Greene, Rensselaer, and Ulster) and are somewhat greater than values determined from nationwide statistics which indicate 30 years is the 95th percentile and 9 years is the 50th percentile residence duration at one location (USEPA, 1989b, and USEPA, 1997c).

Body Weight (BW). Age-specific body weights were used. The mean body weight for children aged 1 to 6 is 15 kg, the mean body weight for adolescents aged 7-18 is 43 kg, and the mean adult body weight is 70 kg (USEPA, 1989b).

Averaging Time (AT). For all recreational exposure calculations, a 70-year lifetime averaging time of 25,550 days (365 days × 70 years) was used for cancer evaluations (USEPA, 1989a). Non-cancer averaging times are equal to the exposure duration multiplied by 365 days/year (USEPA, 1989b, and USEPA, 1997c).

2.4.3 Dermal Contact with Sediment

For the sediment dermal contact, absorbed doses are used. Dermal intake (the amount absorbed into the body) is calculated as:

$$\text{Intake}_{\text{dermal}}(\text{mg / kg - d}) = \frac{C_{sed} \times DA \times AF \times SA \times EF \times ED \times CF}{BW \times AT}$$

where:

C_{sed}	=	Concentration PCBs in sediment (mg/kg)
DA	=	Dermal absorption fraction (unitless)
AF	=	Sediment/skin adherence factor (mg/cm^2)
SA	=	Skin surface area exposed (cm^2/exposure event),
EF	=	Exposure frequency (exposure events/year)
ED	=	Exposure duration (years)
CF	=	Conversion factor (10^{-6} kg/mg)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure factor values for the central tendency and RME point estimate calculations for this pathway are summarized in Tables 2-20 through 2-22. Site-specific considerations in selecting these factors are discussed below.

PCB Concentration in Sediment (C_{sed}). As described above, the central tendency point estimates used for PCB concentration in sediment are 0.61, 0.61, and 0.59 mg/kg for children, adolescents, and adults, respectively. The RME point estimates are 0.58, 0.52, and 0.45 mg/kg for children, adolescents, and adults, respectively (see Table 2-9).

Dermal Absorption Fraction (DA). The dermal absorption fraction represents the amount of a chemical in contact with skin that is absorbed through the skin and into the bloodstream. The dermal absorption rate of 14% used in this HHRA is based on the *in vivo* percutaneous absorption of PCBs from soil by rhesus monkeys (Wester *et al.*, 1993).

Soil/Skin Adherence Factor (AF). The sediment adherence values for the risk assessment were obtained from USEPA's March 1999 Draft Dermal Risk Assessment Guidance (USEPA, 1999f), which among other studies, relies upon data published by Kissel *et al.* (1998). The 50th percentile sediment/skin adherence factor for children is 0.2 mg/cm^2, and 0.3 mg/cm^2 for adults (USEPA, 1999f), as discussed in more detail in the Upper Hudson HHRA. These adherence factors are for children playing in wet soil, and adults whose soil loadings were measured for reed gathering activities. These activities, which represent active contact with soil, are appropriate surrogates for activities where Mid-Hudson River recreators may contact sediment. The soil adherence factor for adolescents was taken as the midpoint between the child and adult factors.

Skin Surface Area Exposed (SA). For children and adolescents, the mean surface area of hands, forearms, lower legs, feet, and face were calculated by multiplying the total body surface area (averaged between males and females) by the percentage of total body surface area that make up the relevant body parts (USEPA, 1997c). For children, the mean surface area of the hands, forearms, lower legs, feet, and face is 2,792 cm^2 (using data for the category 6<7 years); for adolescents, the mean surface area of the hands, forearms, lower legs, feet, and face is 4,263 cm^2 (for age 12 years); the mean surface area of adult hands, forearms, lower legs, feet, and face is 6,073 cm^2 (USEPA, 1997c).

Exposure Frequency (EF). As described above, there are no site-specific data to provide an indication of the likely frequency of recreational activities along the Mid-Hudson River, nor do general population studies exist that provide usable information. The exposure frequency factors (Tables 2-20 through 2-22) for dermal contact are the same as those for incidental ingestion described in the preceding section.

Exposure Duration (ED). As explained in the previous section, the exposure duration for sediment dermal contact in recreational scenarios is 41 years, and the central tendency value is 11 years, which correspond to the 95th and 50th percentiles, respectively, of the residence duration determined for the six Mid-Hudson counties.

Body Weight (BW). Age-specific body weights were used. The mean body weight for children aged 1 to 6 is 15 kg, the mean body weight for adolescents aged 7-18 is 43 kg, and the mean adult body weight is 70 kg (USEPA, 1989a).

Averaging Time (AT). For all recreational exposure calculations, a 70-year lifetime averaging time of 25,550 days (365 days × 70 years) was used for cancer evaluations (USEPA, 1989a). Non-cancer averaging times are equal to the exposure duration multiplied by 365 days/year (USEAP, 1989b and USEPA, 1997c).

2.4.4 Dermal Contact with River Water

For the river water dermal contact pathway, dermal intake (the amount absorbed into the body) is calculated as:

$$\text{Intake}_{\text{water}}(\text{mg / kg - d}) = \frac{C_w \times K_p \times SA \times DE \times EF \times ED \times CF}{BW \times AT}$$

where:

C_w	=	Concentration of PCBs in water (mg/l)
K_p	=	Chemical-specific dermal permeability constant (cm/hr)
SA	=	Skin surface area exposed (cm^2)
DE	=	Duration of event (hr/d)
EF	=	Exposure frequency (d/year)
ED	=	Exposure duration (years)
CF	=	Conversion factor (10^{-3} L/cm^3)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure factor values for the central tendency and RME point estimate calculations for this pathway are summarized in Tables 2-23 through 2-25. Site-specific considerations in selecting these factors are discussed below.

PCB Concentrations in River Water (C_w). As described in Section 2.3.3, the central tendency point estimates used for PCB concentration in the water column are 1.6×10^{-5}, 1.6×10^{-5}, and 1.5×10^{-5} mg/L, for children, adolescents, and adults, respectively. The RME point estimates are 1.4×10^{-5}, 1.2×10^{-5}, and 9.2×10^{-6} mg/L, for children, adolescents, and adults, respectively (Table 2-10).

Permeability Constant (K_p). In the absence of experimental measurements for the dermal permeability constant for PCBs, it was estimated to be 0.48 cm/hr based on the value for hexachlorobiphenyls reported in the 1999 Draft Dermal Risk Assessment Guidance (USEPA, 1999f).

Skin Surface Area Exposed (SA). As a conservative estimate of possible exposure, 100% of the full-body surface area was assumed to come into contact with river water. The surface areas for adults, adolescents, and children, respectively are: 18,150 cm^2, 13,100 cm^2, and 6,880 cm^2 (USEPA, 1997c).

Duration of Event (DE). For all recreator scenarios, 2.6 hours/day was used as the river water dermal exposure time, which is the national average duration for a swimming event (USEPA, 1989b).

Exposure Frequency (EF). As described above, there are no site-specific data to provide an indication of the likely frequency of recreational activities along the Mid-Hudson River, nor do general population studies exist that provide usable information. The exposure frequency factors (Tables 2-23 through 2-25) for dermal contact with water while swimming are the same as those for incidental ingestion and dermal contact with sediments described in the proceeding sections.

Exposure Duration (ED). As described in the previous sections, the exposure duration for river water dermal contact in recreational scenarios is 41 years, and the central tendency value is 11 years, which correspond to the 95^{th} and 50^{th} percentiles, respectively, of the residence duration determined for the six Mid-Hudson counties.

Body Weight (BW). Age-specific body weights were used. The mean body weight for children aged 1 to 6 is 15 kg, the mean body weight for adolescents aged 7-18 is 43 kg, and the mean adult body weight is 70 kg (USEPA, 1989a).

Averaging Time (AT). For all recreational exposure calculations, a 70-year lifetime averaging time of 25,550 days (365 days × 70 years) was used for cancer evaluations (USEPA, 1989a). Non-cancer averaging times are equal to the exposure duration multiplied by 365 days/year (USEPA, 1989b, and USEPA, 1997c).

2.4.5 Ingestion of River Water

For the river water ingestion pathway, intake is calculated as:

$$\text{Intake}_{\text{water}}(\text{mg / kg - d}) = \frac{C_w \times IR \times EF \times ED}{BW \times AT}$$

where:

C_w	=	Concentration of PCBs in water (mg/L)
IR	=	Ingestion rate (L/d)
EF	=	Exposure frequency (d/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure factor values for the central tendency and RME point estimate calculations for this pathway are summarized in Tables 2-26 through 2-28. Site-specific considerations in selecting these factors are discussed below.

PCB Concentrations in River Water (C_w). As described in Section 2.3.3, the central tendency point estimates used for PCB concentration in the water column are 1.6×10^{-5},

1.6×10^{-5}, and 1.5×10^{-5} mg/L, for children, adolescents, and adults, respectively. The RME point estimates are 1.4×10^{-5}, 1.2×10^{-5}, and 9.2×10^{-6} mg/L, for children, adolescents, and adults, respectively (Table 2-10).

Ingestion Rate (IR). For the residential scenarios, the 90th percentile and mean drinking water ingestion rates of 2.3 L/day and 1.4 L/day, respectively, were used for adults and adolescents to represent RME and central tendency exposures. Similarly the 90th percentile and mean drinking water ingestion rates of 1.5 L/day and 0.9 L/day were used to represent RME and central tendency exposures for children (USEPA, 1997c).

Exposure Frequency (EF). An exposure frequency of 350 days/year was assumed for residents of all ages (USEPA, 1991b).

Exposure Duration (ED). As described in the previous sections, the exposure duration for river water is 41 years, and the central tendency value is 11 years, which correspond to the 95th and 50th percentiles, respectively, of the residence duration determined for the six Mid-Hudson counties.

Body Weight (BW). Age-specific body weights were used. The mean body weight for children aged 1 to 6 is 15 kg, the mean body weight for adolescents aged 7-18 is 43 kg, and the mean adult body weight is 70 kg (USEPA, 1989a).

Averaging Time (AT). For all residential exposure calculations, a 70-year lifetime averaging time of 25,550 days (365 days × 70 years) was used for cancer evaluations (USEPA, 1989a,b). Non-cancer averaging times are equal to the exposure duration multiplied by 365 days/year (USEPA, 1989b and 1997c).

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Chapter 3

3 Toxicity Assessment

Potential non-cancer health hazards and cancer risks posed by exposure to PCBs are discussed using the most current USEPA toxicity values, which are summarized in Tables 3-1 and 3-2 and discussed briefly below. The reader is referred to Chapter 4 and Appendix C of the Upper Hudson HHRA for a thorough discussion of PCB toxicity and the toxicological profile.

3.1 Non-cancer Toxicity Values

The chronic RfD represents an estimate of a daily exposure level for the human population, including sensitive subpopulations, that are likely to be without an appreciable risk of deleterious effects during a lifetime. The IRIS database provides oral RfDs for two Aroclor mixtures, Aroclor 1016 (USEPA, 1999a) and Aroclor 1254 (USEPA, 1999b). The oral RfD for Aroclor 1016 is 0.00007 (7×10^{-5}) mg/kg-day, and for Aroclor 1254 is 0.00002 (2×10^{-5}) (Table 3-1).

The PCB homologue distribution of sediment and water samples is predominately dichloro- through pentachlorobiphenyls, as reported in the Hudson River Data Evaluation and Interpretation Report (USEPA, 1997a). This distribution is more similar to Aroclor 1016 than to Aroclor 1254. Therefore, for the purposes of this HHRA, the Aroclor 1016 oral RfD (7×10^{-5} mg/kg-day) was used to evaluate non-cancer toxicity for ingestion and dermal contact with Mid-Hudson River sediment and water.

The PCB homologue distribution in fish differs from the sediment and water samples due to differential bioaccumulation of PCB congeners with higher chlorination levels. Trichloro- through hexachlorobiphenyls contribute to the majority of fish tissue PCB mass as reported in the Baseline Modeling Report (USEPA, 1999d). This distribution is more similar to Aroclor 1254 than to Aroclor 1016. Therefore, for the purposes of this HHRA, the Aroclor 1254 oral RfD (2×10^{-5} mg/kg-day) was used to evaluate non-cancer toxicity for ingestion of Mid-Hudson River fish.

3.2 PCB Cancer Toxicity

The Cancer Slope Factor, or CSF, is a plausible upper bound estimate of carcinogenic potency used to calculate risk from exposure to carcinogens, by relating estimates of lifetime average chemical intake to the incremental risk of an individual developing cancer over a lifetime. In IRIS, both upper-bound and central-estimate CSFs are listed for three different tiers of PCB mixtures (USEPA, 1999c). Consistent with the recommended values in IRIS, the first tier upper-bound and central-estimate CSFs of 2.0 and 1.0 $(mg/kg\text{-}day)^{-1}$ are used to evaluate cancer risks for the upper-bound and central-estimate exposures to PCBs *via* ingestion of Mid-Hudson River fish, ingestion of Mid-Hudson River sediments, and dermal contact with Mid-Hudson River sediments (Table 3-2). The second tier upper-bound and central-estimate CSFs of 0.4 and 0.3 $(mg/kg\text{-}day)^{-1}$ are used to evaluate cancer risks for the upper-bound and central-estimate exposures to PCBs *via* ingestion and dermal contact with Mid-Hudson River water (Table 3-2). It should be noted that the PCB concentration in Hudson River water is significantly below the MCL. Recently, Kimbrough *et al.* (1999) published the results of an epidemiological study of mortality in workers from two General Electric Company capacitor manufacturing plants in New York State. In September 1999, two Letters to the Editor regarding the Kimbrough *et al.* (1999) study and a response from Kimbrough *et al.* were published in the Journal of Occupational and Environmental Medicine. Due to the limitations of the Kimbrough *et al.* (1999) study identified by USEPA and others, USEPA expects that the findings of the Kimbrough *et al.* (1999) study will not lead to any change in its CSFs for PCBs, which were last reassessed by USEPA in 1996 (USEPA, 1996).

Chapter 4

4 Risk Characterization

Risk characterization is the final step of the risk assessment process, which combines the information from the Exposure Assessment and Toxicity Assessment steps to yield estimated cancer risks and non-cancer hazards from exposure to PCBs. A detailed evaluation of the uncertainties underlying the risk assessment process is presented in Section 5.3 of the Upper Hudson HHRA. This risk characterization was prepared in accordance with USEPA guidance on risk characterization (USEPA, 1995; USEPA, 1992).

As described in the Upper Hudson HHRA, some PCB congeners are considered to be structurally similar to dioxin and have been termed "dioxin-like" congeners. A risk analysis for dioxin-like PCB congeners was not performed in the Mid-Hudson HHRA because the findings of the Upper Hudson HHRA showed that risks from the dioxin-like PCB congeners are approximately equivalent to risks from total PCBs. It is expected that a similar finding would hold for the Mid-Hudson River, and in light of the lower concentration of PCBs in the Mid-Hudson River, risks for dioxin-like PCB congeners were not evaluated in the Mid-Hudson HHRA.

4.1 Non-cancer Hazard Indices

The evaluation of non-cancer health effects involves a comparison of average daily exposure levels with established Reference Doses (RfDs) to determine whether estimated exposures exceed recommended limits to protect against chronic adverse health hazards. A more detailed explanation of non-cancer hazard indices can be found in the Upper Hudson HHRA.

The hazard quotient is calculated by dividing the estimated average daily oral dose estimates by the oral RfD as follows (USEPA, 1989b):

$$Hazard\ Quotient\ (HQ) = \frac{Average\ Daily\ Dose\ (mg\ /\ kg - day)}{RfD\ (mg\ /\ kg - day)} \qquad [4\text{-}1]$$

RME and central tendency hazard quotients calculated for each exposure pathway (fish ingestion, sediment, and water exposure pathways) are summarized in Tables 4-1 through 4-10. Hazard Quotients are summed over all COPCs (chemicals of potential concern) and all applicable exposure routes to determine the total Hazard Index (HI). In this HHRA, PCBs are the COPCs and the HQ for PCBs is equivalent to the HI. The total RME and central tendency Hazard Indices for each pathway and receptor are summarized in Tables 4-21 through 4-27.

If a Hazard Index is greater than one (*i.e.*, HI>1), unacceptable exposures may be occurring, and there may be concern for potential non-cancer effects, although the relative value of an HI above one (1) cannot be translated into an estimate of the severity of the health hazard. Ingestion of fish results in the highest Hazard Indices, with an HI of 3 for the central tendency estimate, and an HI of 30 for the high-end estimate, both representing exposures above the reference level (HI>1). Note that as discussed earlier, the average daily dose decreases as the exposure duration increases, so the average concentration over a 7-year exposure period (used as the high-end estimate in this HHRA) is greater than the average concentration over the RME duration of 40 years. Even if the average concentration over a 40-year exposure period is used (i.e., 0.8 ppm instead of 1.3 ppm), a hazard index of 18 results, which is above the reference level of 1. In addition, if it is assumed that a child's meal portion is approximately 1/3 of an adult portion, then the RME child risk for ingestion of fish would be 10. Furthermore, Total Hazard Indices for the recreational (wading and swimming) and residential exposure pathways (consuming river water) are all below one. In all cases, the Hazard Indices are based on uniform exposure throughout the Mid-Hudson River.

4.2 Cancer Risks

Cancer risks are characterized as the incremental increase in the probability that an individual will develop cancer during his or her lifetime due to site-specific exposure. The quantitative assessment of carcinogenic risks involves the evaluation of lifetime average daily dose and application of toxicity factors reflecting the carcinogenic potency of the chemical. A more detailed explanation of cancer risks can be found in the Upper Hudson HHRA.

The cancer risk is calculated by multiplying the estimated lifetime average daily oral dose estimates by the oral slope factor as follows (USEPA, 1989b):

$$Cancer\ Risk = Intake\left(\frac{mg}{kg-day}\right)\times CSF\left(\frac{mg}{kg-day}\right)^{-1} \qquad [4\text{-}2]$$

RME and central tendency cancer risk estimates calculated for each exposure pathway (fish ingestion, recreational and residential exposure pathways) are summarized in Tables 4-11 through 4-20. Total cancer risks are summed over all applicable exposure routes and exposure periods (child through adult). The total RME and central tendency cancer risks for each pathway are summarized in Tables 4-21 through 4-27.

Ingestion of fish results in the highest cancer risks, 9.3×10^{-6} (9.3 additional cancers in a population of one million) for the central tendency estimate, and 4.2×10^{-4} (4.2 additional cancers in a population of ten-thousand) for the high-end estimate. If it is assumed that a child meal portion is approximately 1/3 of an adult portion, then the RME child risk for ingestion of fish is approximately 1.4×10^{-4}.

For known or suspected carcinogens, acceptable exposure levels for Superfund are generally concentration levels that represent an incremental upper-bound lifetime cancer risk to an RME individual of 10^{-4} to 10^{-6} (USEPA, 1990). The cancer risk associated with RME fish ingestion results falls within the upper bound of the cancer risk range generally allowed under the federal Superfund law. Estimated cancer risks for all other exposure pathways are insignificant (*i.e.*, below 10^{-6}). In all cases, the cancer risks are based on uniform exposure throughout the Mid-Hudson River.

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TABLE 2-1

SELECTION OF EXPOSURE PATHWAYS -- Phase 2 Risk Assessment

MID-HUDSON RIVER

Scenario Timeframe	Source Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Fish	Fish	Mid-Hudson Fish	Angler	Adult	Ingestion	On-Site	Quant	PCBs have been widely detected in fish.
	Sediment	Sediment	Banks of Mid-Hudson	Recreator	Adult	Ingestion	On-Site	Quant	Recreators may ingest or otherwise come in contact with contaminated river sediment while engaging in recreational activities along the river.
						Dermal	On-Site	Quant	
					Adolescent	Ingestion	On-Site	Quant	
						Dermal	On-Site	Quant	
					Child	Ingestion	On-Site	Quant	
						Dermal	On-Site	Quant	
	River Water	Drinking Water	Mid-Hudson River	Resident	Adult	Ingestion	On-Site	Quant	Considered in Phase 1 Risk Assessment and determined to have *de minimus* risk. Included to address public concerns. Other potable pathways not evaluated based on risks/hazards found through ingestion being less than EPA Risk Range.
					Adolescent	Ingestion	On-Site	Quant	
					Child	Ingestion	On-Site	Quant	
		River Water	Mid-Hudson River (wading/swimming)	Recreator	Adult	Dermal	On-Site	Quant	Recreators may come in contact with contaminated river water while wading or swimmming.
					Adolescent	Dermal	On-Site	Quant	
					Child	Dermal	On-Site	Quant	
		Outdoor Air	Mid-Hudson River (River and near vicinity)	Recreator	Adult	Inhalation	On-Site	Qual	Considered in Phase 2 Upper Hudson River HHRA and determined to have insignificant risk(*i.e.de minimus*) . Concentrations in Upper Hudson River approximately four times higher than Mid-Hudson region; therefore, not evaluated further in this HHRA.
					Adolescent	Inhalation	On-Site	Qual	
					Child	Inhalation	On-Site	Qual	
				Resident	Adult	Inhalation	On-Site	Qual	Considered in Phase 2 Upper Hudson River HHRA and determined to have insignificant risk (*i.e. de minimus*). Concentrations in Upper Hudson River approximately four times higher than Mid-Hudson region; therefore, not evaluated further in this HHRA.
					Adolescent	Inhalation	On-Site	Qual	
					Child	Inhalation	On-Site	Qual	
	Home-grown Crops	Vegetables	Mid-Hudson vicinity	Resident	Adult	Ingestion	On-Site	Qual	Limited data; studies show low PCB uptake in forage crops. Qualitatively assessed in Upper Hudson River HHRA.
					Adolescent	Ingestion	On-Site	Qual	
					Child	Ingestion	On-Site	Qual	
	Beef	Beef	Mid-Hudson vicinity	Resident	Adult	Ingestion	On-Site	Qual	Limited data; studies show non-detect PCB levels in cow's milk in NY. Qualitatively assessed in Upper Hudson River HHRA.
					Adolescent	Ingestion	On-Site	Qual	
					Child	Ingestion	On-Site	Qual	
	Dairy Products	Milk, eggs	Mid-Hudson vicinity	Resident	Adult	Ingestion	On-Site	Qual	Limited data; studies show non-detect PCB levels in cow's milk in NY. Qualitatively assessed in Upper Hudson River HHRA.
					Adolescent	Ingestion	On-Site	Qual	
					Child	Ingestion	On-Site	Qual	

"Quant" = Quantitative risk analysis performed. "Qual" = Qualitative analysis performed.

TABLE 2-2

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

MID-HUDSON RIVER - Fish

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (2)
1336-36-3	PCBs (3)	0.1	N/A	2.9	N/A	mg/kg wet weight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Yes	FD, TX, ASL

(1) Minimum/maximum modeled concentration between 1999-2067 (USEPA, 1999d).

(2) Rationale Codes Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Deletion Reason: Infrequent Detection (IFD)
Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

(3) Occurrence and distribution of PCBs in fish were modeled, not measured (USEPA, 1999d).

Definitions:
N/A = Not Applicable
SQL = Sample Quantitation Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
MCL = Federal Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic

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TABLE 2-3
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
MID-HUDSON RIVER - Sediment

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (2)
1336-36-3	PCBs (3)	0.14	N/A	0.62	N/A	mg/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Yes	FD, TX, ASL

(1) Minimum/maximum segment-averaged modeled concentration between 1999-2067 (USEPA, 1999d).

(2) Rationale Codes Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Deletion Reason: Infrequent Detection (IFD)
Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

(3) Occurrence and distribution of PCBs in sediment were modeled, not measured (USEPA, 1999d).

Definitions: N/A = Not Applicable
SQL = Sample Quantitation Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
MCL = Federal Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic

TABLE 2-4

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

MID-HUDSON RIVER - River Water

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (2)
1336-36-3	PCBs (3)	3.19E-06	N/A	1.84E-05	N/A	mg/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Yes	FD, TX, ASL

(1) Minimum/maximum segment-averaged modeled concentration between 1999-2067 (USEPA, 1999d).

(2) Rationale Codes *Selection Reason:* Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Deletion Reason: Infrequent Detection (IFD)
Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

(3) Occurrence and distribution of PCBs in river water were modeled, not measured (USEPA, 1999d).

Definitions:
N/A = Not Applicable
SQL = Sample Quantitation Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
MCL = Federal Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic

Table 2-5
Summary of 1991 New York Angler Survey
Fish Consumption by Species Reported

Water Body Type/ Species Group	Number Reporting Eating Fish	Total Caught	Total Eaten	Average Number Eaten [b]	Standard Deviation [a]	Maximum Number Eaten	Percent of Hudson Species	Percent of All Fish
Flowing								
Bass	68	1,842	584	8.6	19.2	145	38%	14%
Bullhead	23	1,092	558	24.3	61.9	300	37%	14%
Carp	2	[b]	90	45.0	42.4	75	6%	2%
Catfish	11	158	113	10.3	15.5	50	7%	3%
Eel	4	38	38	9.5	10.6	25	2%	0.9%
Perch	17	833	139	8.2	12.5	51	9%	3%
Subtotal		3,963	1,522				100%	37%
Salmon	35	559	193	5.5	5.3	25		5%
Trout	130	3,099	1,230	9.5	15.7	133		30%
Walleye	36	333	134	3.7	4.2	20		3%
Other	45	2,871	1,025	22.8	50.1	200		25%
Total All Fish		10,825	4,104					100%
Not Flowing								
Bass	154	3,370	1,032	6.7	12.0	100	40%	14%
Bullhead	53	1,200	634	12.0	21.5	100	25%	8%
Carp	4	7	29	7.3	6.7	14	1.1%	0.4%
Catfish	10	46	46	4.6	6.9	20	1.8%	0.6%
Eel	2	2	3	1.5	0.7	2	0.1%	0.04%
Perch	51	2,289	816	16.0	32.4	200	32%	11%
Subtotal		6,914	2,560				100%	34%
Salmon	55	538	480	8.7	15.2	80		6%
Trout	152	2,428	1,400	9.2	18.3	150		18%
Walleye	112	2,292	1,054	9.4	14.2	75		14%
Other	94	5,976	2,125	22.6	58.1	403		28%
Total All Fish		18,148	7,619					100%
Not Reported								
Bass	128	4,006	1,110	8.7	17.0	100	45%	17%
Bullhead	55	2,374	1,099	20.0	43.2	225	44%	16%
Carp	5	16	11	2.2	1.6	5	0.4%	0.2%
Catfish	4	40	17	4.3	2.8	7	0.7%	0.3%
Eel	5	9	13	2.6	2.5	7	0.5%	0.2%
Perch	24	338	222	9.3	21.7	100	9%	3%
Subtotal		6,783	2,472				100%	37%
Salmon	14	139	120	8.6	7.3	20		2%
Trout	148	2,836	1,319	8.9	16.8	157		20%
Walleye	34	389	206	6.1	8.8	40		3%
Other	104	7,731	2,559	24.6	72.2	630		38%
Total All Fish		17,878	6,676					100%

Notes:

[a] *Mean and Standard Deviation are over number of anglers reporting they ate particular species.*
[b] *Number caught not reported.*

Modeled PCB concentration estimates are available for species in ***Bold***
Source: Connelly et al. (1992)

Table 2-6
Mid-Hudson River Perch and Bass

Species	Species Intake[1]	Mid-Hudson Species	Relative Percentage Species Caught[2]	Relative Percentage Species Intake[2]
Perch	9%	White Perch	85%	7.6%
		Yellow Perch	15%	1.4%
Bass	38%	Largemouth Bass	40%	15%
		Striped Bass	60%	23%

[1] *From 1991 New York Angler Survey (Connelly et al., 1992), see Table 2-5.*
[2] *From 1991/92 (Barclay, 1993) and 1996 NYSDOH study of Hudson River anglers (NYSDOH, 1999B).*

Table 2-7
Species-Group Intake Percentages

Group 1		Group 2		Group 3		Group 4		Group 5	
Brown bullhead	37%	White Perch	7.6%	Yellow Perch	1.4%	Largemouth Bass	15%	Striped Bass	23%
Carp	6%								
Catfish	7%								
Eel	2%								
Species Group Totals	52%		7.6%		1.4%		15%		23%

Sources:
1991 New York Angler Survey (Connelly et al, 1992).
1991/92 (Barclay, 1993) and 1996 NYSDOH study of Hudson River anglers (NYSDOH, 1999B).

TABLE 2-8
MEDIUM-SPECIFIC MODELED EXPOSURE POINT CONCENTRATION SUMMARY
MID-HUDSON RIVER FISH

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish

Chemical of Potential Concern	Units	Arithmetic Mean (3)	95% UCL of Normal Data	Maximum Concentration (3)	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
PCBs												
in Brown Bullhead	mg/kg wet weight	0.6	**	1.3	N/A	mg/kg wet weight	0.8	Mean-N	Averaged over RME ED	1.1	Mean-N	Averaged over CT ED
in Yellow Perch	mg/kg wet weight	0.2	**	0.5	N/A	mg/kg wet weight	0.3	Mean-N	Averaged over RME ED	0.4	Mean-N	Averaged over CT ED
in Largemouth Bass	mg/kg wet weight	0.8	**	1.8	N/A	mg/kg wet weight	0.9	Mean-N	Averaged over RME ED	1.4	Mean-N	Averaged over CT ED
in Striped Bass	mg/kg wet weight	1.2	**	2.9	N/A	mg/kg wet weight	1.4	Mean-N	Averaged over RME ED	2.2	Mean-N	Averaged over CT ED
in White Perch	mg/kg wet weight	0.5	**	1.4	N/A	mg/kg wet weight	0.6	Mean-N	Averaged over RME ED	1.0	Mean-N	Averaged over CT ED
Species-weighted (1)	mg/kg wet weight	0.65	**	1.5	N/A	mg/kg wet weight	0.8	Mean-N	Averaged over RME ED	1.2	Mean-N	Averaged over CT ED
Species-weighted for chronic exposure (2)	mg/kg wet weight	0.65	**	1.5	N/A	mg/kg wet weight	1.3	Mean-N	Averaged over RME ED	1.2	Mean-N	Averaged over CT ED

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

** Not applicable because fish data was modeled, not measured.

ED = Exposure Duration

CT = Central Tendency

(1) PCB concentrations for each species were weighted based on species-group intake percentages (Connelly et al., 1992; NYSDOH, 1999) and averaged over the central tendency exposure duration (12 years) to calculate the CT EPC, and over the RME exposure duration (40 years) to calculate the RME EPC for cancer risks.

(2) PCB concentrations for each species were weighted based on species-group intake percentages (Connelly et al., 1992; NYSDOH, 1999) and averaged over the central tendency exposure duration (12 years) to calculate the CT EPC, and over the RME exposure duration (7 years) to calculate the RME EPC for non-cancer hazards.

(3) Mean/maximum modeled concentration between 1999-2067 (USEPA, 1999d).

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TABLE 2-9
MEDIUM-SPECIFIC MODELED EXPOSURE POINT CONCENTRATION SUMMARY
MID-HUDSON RIVER SEDIMENT

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson

Chemical of Potential Concern	Units	Arithmetic Mean (1)	95% UCL of Normal Data	Maximum Concentration (1)	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure (2)			Central Tendency (2)		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
PCBs	mg/kg	0.3	**	0.6	N/A	mg/kg						
Adult							0.45	Mean-N	Averaged over RME ED	0.59	Mean-N	Averaged over CT ED
Adolescent							0.52	Mean-N	Averaged over RME ED	0.61	Mean-N	Averaged over CT ED
Child							0.58	Mean-N	Averaged over RME ED	0.61	Mean-N	Averaged over CT ED

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

** Not applicable because sediment data was modeled, not measured.

(1) Mean/maximum of segment-averaged modeled concentration 1999-2067 (USEPA, 1999d).

(2) EPC values were averaged over 23 yrs RME and 5 yrs CT for adults; 12 yrs RME and 3 yrs CT for adolescents; 6 yrs RME and 3 yrs CT for children; for a total of 41 yrs RME and 11 yrs CT exposure.

TABLE 2-10
MEDIUM-SPECIFIC MODELED EXPOSURE POINT CONCENTRATION SUMMARY
MID-HUDSON RIVER WATER

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water (Drinking Water Supply)
Exposure Point: Mid-Hudson River

Chemical of Potential Concern	Units	Arithmetic Mean (1)	95% UCL of Normal Data	Maximum Concentration (1)	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure (2)			Central Tendency (2)		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
PCBs	mg/L	6.1E-06	**	1.8E-05	N/A	mg/L						
Adult							9.2E-06	Mean-N	Averaged over RME ED	1.5E-05	Mean-N	Averaged over CT ED
Adolescent							1.2E-05	Mean-N	Averaged over RME ED	1.6E-05	Mean-N	Averaged over CT ED
Child							1.4E-05	Mean-N	Averaged over RME ED	1.6E-05	Mean-N	Averaged over CT ED

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

** Not applicable because river water data was modeled, not measured.

(1) Mean/maximum of segment-averaged modeled concentration 1999-2067 (USEPA, 1999d).

(2) EPC values were averaged over 23 yrs RME and 5 yrs CT for adults; 12 yrs RME and 3 yrs CT for adolescents; 6 yrs RME and 3 yrs CT for children; for a total of 41 yrs RME and 11 yrs CT exposure.

Table 2-11
County-to-County In-Migration Data for Albany County, NY

	No Move	Move In											Total from Outside Region[a]
		Total	From Abroad	Domestic									
				Total	Outside Region[a]	Inside Region							
						Total	From						
Age Group							Albany	Columbia	Dutchess	Greene	Rensselaer	Ulster	
5 to 9	8,638	9,002	228	8,774	2,318	6,456	5,795	42	14	63	536	6	2,546
10 to 14	10,128	6,482	226	6,256	1,607	4,649	4,253	28	21	36	304	7	1,833
15 to 19	11,284	9,642	236	9,406	4,983	4,423	3,713	45	133	64	428	40	5,219
20 to 24	8,012	19,788	428	19,360	11,201	8,159	6,188	83	367	311	995	215	11,629
25 to 29	5,515	18,568	640	17,928	6,882	11,046	9,111	143	94	221	1366	111	7,522
30 to 34	8,196	17,658	558	17,100	5,691	11,409	10,256	86	37	149	840	41	6,249
35 to 44	24,243	20,419	407	20,012	6,094	13,918	12,533	149	53	160	980	43	6,501
45 to 54	20,091	7,999	277	7,722	2,234	5,488	4,866	36	27	72	458	29	2,511
55 to 64	20,764	4,837	97	4,740	1,271	3,469	3,099	34	48	62	222	4	1,368
65 to 74	19,380	4,189	78	4,111	928	3,183	2,867	34	32	34	179	37	1,006
75 to 84	10,929	2,914	22	2,892	653	2,239	1,984	16	0	23	190	26	675
85+	3,670	1,746	0	1,746	367	1,379	1,227	13	0	22	117	0	367

Notes:

a. *The Mid-Hudson Region consists of Albany, Columbia, Dutchess, Greene, Rensselaer, and Ulster Counties.*

Source: 1990 U.S. Census.

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Table 2-12
County-to-County In-Migration Data for Columbia County, NY

Age Group	No Move	Move In: Total	Move In: From Abroad	Domestic: Total	Domestic: Outside Region[a]	Inside Region: Total	From: Columbia	From: Albany	From: Dutchess	From: Greene	From: Rensselaer	From: Ulster	Total from Outside Region[a]
5 to 9	2,143	2,284	91	2,193	506	1,687	1,341	48	165	47	77	9	597
10 to 14	2,399	1,583	20	1,563	433	1,130	900	28	103	35	34	30	453
15 to 19	2,644	1,587	15	1,572	539	1,033	849	31	44	48	41	20	554
20 to 24	1,591	2,024	44	1,980	415	1,565	1,314	23	86	8	118	16	459
25 to 29	1,242	3,246	52	3,194	864	2,330	1,819	97	228	38	122	26	916
30 to 34	1,663	3,144	77	3,067	922	2,145	1,678	80	217	48	91	31	999
35 to 44	6,034	3,896	84	3,812	1,332	2,480	1,859	85	165	103	230	38	1,416
45 to 54	4,979	1,932	38	1,894	622	1,272	1,060	60	80	25	24	23	660
55 to 64	4,756	1,170	4	1,166	388	778	674	34	25	19	16	10	392
65 to 74	4,650	1,075	3	1,072	370	702	613	11	30	11	29	8	373
75 to 84	2,721	823	2	821	192	629	521	10	30	8	51	9	194
85+	725	315	0	315	81	234	182	6	5	15	17	9	81

Notes:

a. The Mid-Hudson Region consists of Albany, Columbia, Dutchess, Greene, Rensselaer, and Ulster Counties.

Source: 1990 U.S. Census.

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Table 2-13
County-to-County In-Migration Data for Dutchess County, NY

Age Group	No Move	Move In: Total	Move In: From Abroad	Domestic: Total	Domestic: Outside Region[a]	Inside Region: Total	From: Dutchess	From: Albany	From: Columbia	From: Greene	From: Rensselaer	From: Ulster	Total from Outside Region[a]
5 to 9	9,052	8,557	224	8,333	3,749	4,584	4,363	0	72	0	0	149	3,973
10 to 14	9,868	5,878	135	5,743	2,249	3,494	3,367	16	33	0	0	78	2,384
15 to 19	10,981	7,671	347	7,324	4,313	3,011	2,833	24	40	9	25	80	4,660
20 to 24	7,992	12,027	461	11,566	6,472	5,094	4,675	30	61	25	31	272	6,933
25 to 29	5,622	16,195	497	15,698	7,645	8,053	7,221	166	82	12	46	526	8,142
30 to 34	8,384	15,794	409	15,385	7,156	8,229	7,578	144	90	2	13	402	7,565
35 to 44	23,706	18,091	400	17,691	7,774	9,917	9,255	41	136	8	22	455	8,174
45 to 54	21,703	7,320	180	7,140	2,865	4,275	4,049	8	32	15	4	167	3,045
55 to 64	17,443	4,503	98	4,405	1,885	2,520	2,469	0	9	5	2	35	1,983
65 to 74	13,686	3,394	74	3,320	1,496	1,824	1,727	0	20	0	0	77	1,570
75 to 84	7,236	2,331	52	2,279	984	1,295	1,220	10	33	0	0	32	1,036
85+	2,149	889	0	889	379	510	446	0	0	0	0	64	379

Notes:

a. *The Mid-Hudson Region consists of Albany, Columbia, Dutchess, Greene, Rensselaer, and Ulster Counties.*

Source: 1990 U.S. Census.

Table 2-14
County-to-County In-Migration Data for Greene County, NY

Age Group	No Move	Move In: Total	Move In: From Abroad	Domestic: Total	Domestic: Outside Region[a]	Inside Region: Total	From: Greene	From: Albany	From: Columbia	From: Duchess	From: Rensselaer	From: Ulster	Total from Outside Region[a]
5 to 9	1,491	1,496	20	1,476	593	883	712	120	1	16	0	34	613
10 to 14	1,706	1,074	2	1,072	383	689	571	79	0	21	0	18	385
15 to 19	1,713	1,145	19	1,126	495	631	525	27	19	20	5	35	514
20 to 24	1,229	1,971	57	1,914	991	923	719	81	31	33	0	59	1,048
25 to 29	967	2,594	65	2,529	1,165	1,364	1111	79	21	14	9	130	1,230
30 to 34	1,216	2,540	33	2,507	992	1,515	1169	171	49	57	12	57	1,025
35 to 44	3,742	2,816	21	2,795	1,109	1,686	1328	137	53	78	27	63	1,130
45 to 54	3,503	1,228	18	1,210	500	710	503	104	15	20	18	50	518
55 to 64	3,195	1,095	3	1,092	518	574	498	25	7	16	0	28	521
65 to 74	3,142	813	3	810	356	454	370	43	17	15	0	9	359
75 to 84	1,979	464	1	463	148	315	279	24	10	0	0	2	149
85+	480	254	0	254	127	127	120	7	0	0	0	0	127

Notes:

a. *The Mid-Hudson Region consists of Albany, Columbia, Dutchess, Greene, Rensselaer, and Ulster Counties.*

Source: 1990 U.S. Census.

303097

Table 2-15
County-to-County In-Migration Data for Rensselaer County, NY

Age Group	No Move	Move In: Total	Move In: From Abroad	Domestic: Total	Domestic: Outside Region[a]	Inside Region: Total	From: Rensselaer	From: Albany	From: Columbia	From: Duchess	From: Greene	From: Ulster	Total from Outside Region[a]
5 to 9	5,577	4,769	80	4,689	1,046	3,643	2,902	656	64	0	4	17	1,126
10 to 14	6,155	3,608	73	3,535	666	2,869	2,283	438	58	21	13	56	739
15 to 19	6,820	5,126	213	4,913	2,304	2,609	2,084	368	46	33	47	31	2,517
20 to 24	4,911	8,940	436	8,504	3,564	4,940	3,777	776	175	157	26	29	4,000
25 to 29	3,763	8,867	435	8,432	2,331	6,101	4,713	1,211	113	40	0	24	2,766
30 to 34	5,236	7,976	221	7,755	2,053	5,702	4,076	1,419	139	42	14	12	2,274
35 to 44	14,632	9,049	130	8,919	2,112	6,807	5,030	1,503	170	11	39	54	2,242
45 to 54	10,930	3,214	40	3,174	685	2,489	1,951	495	39	0	0	4	725
55 to 64	11,355	2,125	46	2,079	487	1,592	1,303	264	10	2	0	13	533
65 to 74	10,010	1,712	5	1,707	369	1,338	1,101	216	9	4	0	8	374
75 to 84	5,613	1,146	7	1,139	190	949	730	205	0	0	5	9	197
85+	1,522	520	0	520	101	419	328	75	9	0	0	7	101

Notes:

a. *The Mid-Hudson Region consists of Albany, Columbia, Dutchess, Greene, Rensselaer, and Ulster Counties.*

Source: 1990 U.S. Census.

303098

Table 2-16
County-to-County In-Migration Data for Ulster County, NY

Age Group	No Move	Move In: Total	From Abroad	Domestic: Total	Domestic: Outside Region[a]	Inside Region: Total	From Ulster	From Albany	From Columbia	From Duchess	From Greene	From Rensselaer	Total from Outside Region[a]
5 to 9	5,911	4,990	73	4,917	1,619	3,298	2,990	14	13	250	31	0	1,692
10 to 14	6,285	4,019	43	3,976	1,340	2,636	2,368	5	17	223	19	4	1,383
15 to 19	6,544	4,059	165	3,894	1,915	1,979	1,741	12	15	190	9	12	2,080
20 to 24	4,651	7,370	229	7,141	3,553	3,588	2,980	76	0	454	68	10	3,782
25 to 29	3,959	10,262	293	9,969	3,921	6,048	4,864	75	21	1004	65	19	4,214
30 to 34	5,824	9,224	226	8,998	3,238	5,760	4,916	92	18	663	56	15	3,464
35 to 44	15,066	11,368	209	11,159	3,839	7,320	6,542	45	23	629	66	15	4,048
45 to 54	13,465	4,510	65	4,445	1,602	2,843	2,504	7	18	272	31	11	1,667
55 to 64	12,045	2,774	49	2,725	832	1,893	1,722	17	9	122	23	0	881
65 to 74	10,090	2,122	28	2,094	790	1,304	1,241	0	11	37	15	0	818
75 to 84	5,884	1,307	0	1,307	350	957	890	8	0	54	5	0	350
85+	1,664	494	0	494	181	313	284	0	0	29	0	0	181

Notes:

a. The Mid-Hudson Region consists of Albany, Columbia, Dutchess, Greene, Rensselaer, and Ulster Counties.

Source: 1990 U.S. Census.

Table 2-17
County-to-County In-Migration Data for the Mid-Hudson River Region

	No Move	Move In											Total from Outside Region[a]
		Total	From Abroad	Domestic									
				Total	Outside Region[a]	Inside Region							
						Total	From						
Age Group							Albany	Renssalaer	Columbia	Dutchess	Greene	Ulster	
5 to 9	32,812	31,098	716	30,382	9,831	20,551	6,633	3,515	1,533	4,808	857	3,205	10,547
10 to 14	36,541	22,644	499	22,145	6,678	15,467	4,819	2,625	1,036	3,756	674	2,557	7,177
15 to 19	39,986	29,230	995	28,235	14,549	13,686	4,175	2,595	1,014	3,253	702	1,947	15,544
20 to 24	28,386	52,120	1,655	50,465	26,196	24,269	7,174	4,931	1,664	5,772	1,157	3,571	27,851
25 to 29	21,068	59,732	1,982	57,750	22,808	34,942	10,739	6,275	2,199	8,601	1,447	5,681	24,790
30 to 34	30,519	56,336	1,524	54,812	20,052	34,760	12,162	5,047	2,060	8,594	1,438	5,459	21,576
35 to 44	87,423	65,639	1,251	64,388	22,260	42,128	14,344	6,304	2,390	10,191	1,704	7,195	23,511
45 to 54	74,671	26,203	618	25,585	8,508	17,077	5,540	2,466	1,200	4,448	646	2,777	9,126
55 to 64	69,558	16,504	297	16,207	5,381	10,826	3,439	1,543	743	2,682	607	1,812	5,678
65 to 74	60,958	13,305	191	13,114	4,309	8,805	3,137	1,309	704	1,845	430	1,380	4,500
75 to 84	34,362	8,985	84	8,901	2,517	6,384	2,241	971	580	1,304	320	968	2,601
85+	10,210	4,218	0	4,218	1,236	2,982	1,315	462	204	480	157	364	1,236

Notes:

a. *The Mid-Hudson Region consists of Albany, Columbia, Dutchess, Greene, Rensselaer, and Ulster Counties.*

Source: 1990 U.S. Census.

Table 2-18
Computation of 1-Year Move Probabilities for the Mid-Hudson Region

Age Group (k)		$In_{1985-90,k}$ [a]	$Start_{1985-90,k}$ [b]	$Start_{1985-90,k+1}$ [c]	$Out_{1985-90,k}$ [d]	Probability of Moving in a 5-year Period[e]	$p_{k,l}$ [f] (Mid-Hudson)	$p_{k,l}$ (Upper Hudson)	Difference Mid-Hudson vs. Upper Hudson
5 to 9	(1)	10,547	32,812	36,541	6,818	15.7%	3.1%	2.5%	-0.6%
10 to 14	(2)	7,177	36,541	39,986	3,732	8.5%	1.7%	1.6%	-0.1%
15 to 19	(3)	15,544	39,986	28,386	27,144	48.9%	9.8%	9.5%	-0.3%
20 to 24	(4)	27,851	28,386	21,068	35,169	62.5%	12.5%	11.8%	-0.7%
25 to 29	(5)	24,790	21,068	30,519	15,339	33.4%	6.7%	5.9%	-0.8%
30 to 34	(6)	21,576	30,519	43,712[g]	8,383	16.1%	3.2%	3.5%	0.3%
35 to 44	(7)	23,511	87,423	74,671	36,263	32.7%	6.5%	7.5%	1.0%
45 to 54	(8)	9,126	74,671	69,558	14,239	17.0%	3.4%	2.2%	-1.2%
55 to 64	(9)	5,678	69,558	60,958	14,278	19.0%	3.8%	3.2%	-0.6%
65 to 74	(10)	4,500	60,958	34,362	31,096	47.5%	9.5%	9.5%	0.0%
75 to 84	(11)	2,601	34,362	10,210	26,753	72.4%	14.5%	14.0%	-0.5%
85+	(12)	1,236	10,210	NA[h]	11,446		100%[i]	100%[i]	0.0%

Notes:
a. *Taken from the column labeled, "Total from Outside Region" in Table 2-14.*
b. *The Mid-Hudson Region consists of Albany, Columbia, Dutchess, Greene, Rensselaer, and Ulster Counties.*
c. *Set equal to the value of* $Start_{1985-90,k}$ *in the preceding row.*
d. $Out_{1985-90,k} = (Start_{1985-90,k} - Start_{1985-90,k+1}) + In_{1985-90,k}$
e. *Set equal to* $(Out_{1985-90,k})/(Start_{1985-90,k} + In_{1985-90,k})$.
f. *Set equal to 1/5 x the probability of moving in a 5-year period.*
g. *The value in this cell is 1/2 the value listed for* $Start_{1985-90,7}$ *to make* $Start_{1985-90,6}$ *and* $Start_{1985-90,7}$ *comparable. The adjustment addresses the fact that Age Group 7 represents 10 years (ages 35 to 44), whereas Age Group 6 represents 5 years (ages 30 to 34).*
h. *Since Age Group 12 (ages 85+) is the last age group, there is no value for* $Start_{1985-90,13}$.
i. *Assumes no exposure after age 85. This assumption has no effect on the estimated risk since it is assumed that individuals stop fishing by age 80.*

TABLE 2-19

VALUES USED FOR DAILY INTAKE CALCULATIONS

MID-HUDSON RIVER FISH - Adult Angler

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish
Receptor Population: Angler
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	C_{fish}-C	PCB Concentration in Fish (Cancer)**	mg/kg wet weight	0.8	See Table 2-8	1.2	See Table 2-8	Average Daily Intake (mg/kg-day) =
	C_{fish}-NC	PCB Concentration in Fish (Non-cancer)**	mg/kg wet weight	1.3	See Table 2-8	1.2	See Table 2-8	C_{fish} x IR_{fish} x (1 - Loss) X FS x EF x ED x CF x 1/BW x 1/AT
	IR_{fish}	Ingestion Rate of Fish	grams/day	31.9	90th percentile value, based on 1991 NY Angler survey.	4.0	50th percentile value, based on 1991 NY Angler survey.	
	Loss	Cooking Loss	g/g	0	Assumes 100% PCBs remains in fish.	0.2	Assumes 20% PCBs in fish is lost through cooking.	
	FS	Fraction from Source	unitless	1	Assumes 100% fish ingested is from Mid-Hudson.	1	Assumes 100% fish ingested is from Mid-Hudson.	
	EF	Exposure Frequency	days/year	365	Fish ingestion rate already averaged over one year.	365	Fish ingestion rate already averaged over one year.	
	ED	Exposure Duration (Cancer)	years	40	95th percentile value, based on 1991 NY Angler and 1990 US Census data.	12	50th percentile valu?, based on 1991 NY Angler and 1990 US Census data.	
	ED	Exposure Duration (Noncancer)	years	7	see text	12	50th percentile value, based on 1991 NY Angler and 1990 US Census data.	
	CF	Conversion Factor	kg/g	1.00E-03	--	1.00E-03	--	
	BW	Body Weight	kg	70	Mean adult body weight, males and females (USEPA, 1989b).	70	Mean adult body weight, males and females (USEPA, 1989b).	
	AT-C	Averaging Time (Cancer)	days	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	
	AT-NC	Averaging Time (Noncancer)	days	2,555	ED (years) x 365 days/year.	4,380	ED (years) x 365 days/year.	

** Species-weighted PCB concentration averaged over river location.

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TABLE 2-20
VALUES USED FOR DAILY INTAKE CALCULATIONS
MID-HUDSON RIVER SEDIMENT - Adult Recreator

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson
Receptor Population: Recreator
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	$C_{sediment}$	Chemical Concentration in Sediment	mg/kg	0.45	See Table 2-9	0.59	See Table 2-9	Average Daily Intake (mg/kg-day) =
	$IR_{sediment}$	Ingestion Rate of Sediment	mg/day	50	Mean adult soil ingestion rate (USEPA, 1997f).	50	Mean adult soil ingestion rate (USEPA, 1997f).	$C_{sediment}$ x $IR_{sediment}$ x FS x EF x ED x CF x 1/BW x 1/AT
	FS	Fraction from Source	unitless	1	Assumes 100% sediment exposure is from Mid-Hudson.	1	Assumes 100% sediment exposure is from Mid-Hudson.	
	EF	Exposure Frequency	days/year	13	1 day/week, 3 months/yr	7	Approximately 50% of RME	
	ED	Exposure Duration	years	23	derived from 95th percentile of residence duration in 6 Mid-Hudson Counties (see text)	5	derived from 50th percentile of residence duration in 6 Mid-Hudson Counties (see text)	
	CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
	BW	Body Weight	kg	70	Mean adult body weight, males and females (USEPA, 1989b).	70	Mean adult body weight, males and females (USEPA, 1989b).	
	AT-C	Averaging Time (Cancer)	days	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	
	AT-NC	Averaging Time (Noncancer)	days	8,395	ED (years) x 365 days/year.	1,825	ED (years) x 365 days/year.	
Dermal	$C_{sediment}$	Chemical Concentration in Sediment	mg/kg	0.45	See Table 2-9	0.59	See Table 2-9	Average Daily Intake (mg/kg-day) =
	DA	Dermal Absorption	unitless	0.14	Based on absorption of PCBs from soil in monkeys (Wester, 1993).	0.14	Based on absorption of PCBs from soil in monkeys (Wester, 1993).	$C_{sediment}$ x DA x AF x SA x EF x ED x CF x 1/BW x 1/AT
	AF	Adherance Factor	mg/cm²	0.3	50% value for adult (reed gatherer): hands, lower legs, forearms, and face (USEPA, 1999f).	0.3	50% value for adult (reed gatherer): hands, lower legs, forearms, and face (USEPA, 1999f).	
	SA	Surface Area	cm²/event	6,073	Ave male/female 50th percentile: hands, lower legs, forearms, feet, and face (USEPA, 1997f).	6,073	Ave male/female 50th percentile: hands, lower legs, forearms, feet, and face (USEPA, 1997f).	
	EF	Exposure Frequency	event/year	13	1 day/week, 3 months/yr	7	Approx. 50% of RME	
	ED	Exposure Duration	years	23	derived from 95th percentile of residence duration in 6 Upper Hudson Counties (see text)	5	derived from 50th percentile of residence duration in 6 Upper Hudson Counties (see text)	
	CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
	BW	Body Weight	kg	70	Mean adult body weight, males and females (USEPA, 1989b).	70	Mean adult body weight, males and females (USEPA, 1989b).	
	AT-C	Averaging Time (Cancer)	days	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	
	AT-NC	Averaging Time (Noncancer)	days	8,395	ED (years) x 365 days/year.	1,825	ED (years) x 365 days/year.	

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TABLE 2-21

VALUES USED FOR DAILY INTAKE CALCULATIONS

MID-HUDSON RIVER SEDIMENT - Adolescent Recreator

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson
Receptor Population: Recreator
Receptor Age: Adolescent

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	$C_{sediment}$	Chemical Concentration in Sediment	mg/kg	0.52	See Table 2-9	0.61	See Table 2-9	Average Daily Intake (mg/kg-day) =
	$IR_{sediment}$	Ingestion Rate of Sediment	mg/day	50	Mean soil ingestion rate (USEPA, 1997f).	50	Mean soil ingestion rate (USEPA, 1997f).	$C_{sediment}$ x $IR_{sediment}$ x FS x EF x ED x CF x 1/BW x 1/AT
	FS	Fraction from Source	unitless	1	Assumes 100% sediment exposure is from Upper Hudson.	1	Assumes 100% sediment exposure is from Upper Hudson.	
	EF	Exposure Frequency	days/year	39	3 days/week, 3 months/yr	20	Approximately 50% of RME	
	ED	Exposure Duration	years	12	derived from 95th percentile of residence duration in 6 Mid-Hudson Counties (see text)	3	derived from 50th percentile of residence duration in 6 Mid-Hudson Counties (see text)	
	CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
	BW	Body Weight	kg	43	Mean adolescent body weight, males and females (USEPA, 1989b).	43	Mean adolescent body weight, males and females (USEPA, 1989b).	
	AT-C	Averaging Time (Cancer)	days	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	
	AT-NC	Averaging Time (Noncancer)	days	4,380	ED (years) x 365 days/year.	1,095	ED (years) x 365 days/year.	
Dermal	$C_{sediment}$	Chemical Concentration in Sediment	mg/kg	0.52	See Table 2-9	0.61	See Table 2-9	Average Daily Intake (mg/kg-day) =
	DA	Dermal Absorption	unitless	0.14	Based on absorption of PCBs from soil in monkeys (Wester, 1993).	0.14	Based on absorption of PCBs from soil in monkeys (Wester, 1993).	$C_{sediment}$ x DA x AF x SA x EF x ED x CF x 1/BW x 1/AT
	AF	Adherance Factor	mg/cm²	0.25	Midpoint of adult and child AF: Hands, lower legs, forearms, and face (USEPA, 1999f).	0.25	Midpoint of adult and child AF: Hands, lower legs, forearms, and face (USEPA, 1999f).	
	SA	Surface Area	cm²/event	4,263	Ave male/female 50th percentile age 12: hands, lower legs, forearms, feet, and face (USEPA, 1997f).	4,263	Ave male/female 50th percentile age 12: hands, lower legs, forearms, feet, and face (USEPA, 1997f).	
	EF	Exposure Frequency	event/year	39	3 days/week, 3 months/yr	20	Approximately 50% of RME	
	ED	Exposure Duration	years	12	derived from 95th percentile of residence duration in 6 Mid-Hudson Counties (see text)	3	derived from 50th percentile of residence duration in 6 Mid-Hudson Counties (see text)	
	CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
	BW	Body Weight	kg	43	Mean adolescent body weight, males and females (USEPA, 1989b).	43	Mean adolescent body weight, males and females (USEPA, 1989b).	
	AT-C	Averaging Time (Cancer)	days	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	
	AT-NC	Averaging Time (Noncancer)	days	4,380	ED (years) x 365 days/year.	1,095	ED (years) x 365 days/year.	

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TABLE 2-22

VALUES USED FOR DAILY INTAKE CALCULATIONS

MID-HUDSON RIVER SEDIMENT - Child Recreator

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson
Receptor Population: Recreator
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	$C_{sediment}$	Chemical Concentration in Sediment	mg/kg	0.58	See Table 2-9	0.61	See Table 2-9	Average Daily Intake (mg/kg-day) =
	$IR_{sediment}$	Ingestion Rate of Sediment	mg/day	100	Mean child soil ingestion rate (USEPA, 1997f).	100	Mean child soil ingestion rate (USEPA, 1997f).	$C_{sediment}$ x $IR_{sediment}$ x FS x EF x ED x CF x 1/BW x 1/AT
	FS	Fraction from Source	unitless	1	Assumes 100% sediment exposure is from Upper Hudson.	1	Assumes 100% sediment exposure is from Upper Hudson.	
	EF	Exposure Frequency	days/year	13	1 day/week, 3 months/yr	7	Approx. 50% of RME	
	ED	Exposure Duration	years	6	derived from 95th percentile of residence duration in 6 Mid-Hudson Counties (see text)	3	derived from 50th percentile of residence duration in 6 Mid-Hudson Counties (see text)	
	CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
	BW	Body Weight	kg	15	Mean child body weight, males and females (USEPA, 1989b).	15	Mean child body weight, males and females (USEPA, 1989b).	
	AT-C	Averaging Time (Cancer)	days	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	
	AT-NC	Averaging Time (Noncancer)	days	2,190	ED (years) x 365 days/year.	1,095	ED (years) x 365 days/year.	
Dermal	$C_{sediment}$	Chemical Concentration in Sediment	mg/kg	0.58	See Table 2-9	0.61	See Table 2-9	Average Daily Intake (mg/kg-day) =
	DA	Dermal Absorption	unitless	0.14	Based on absorption of PCBs from soil in monkeys (Wester, 1993).	0.14	Based on absorption of PCBs from soil in monkeys (Wester, 1993).	$C_{sediment}$ x DA x AF x SA x EF x ED x CF x 1/BW x 1/AT
	AF	Adherance Factor	mg/cm²	0.2	50% value for children (moist soil) : hands, lower legs, forearms, and face (USEPA, 1999f).	0.2	50% value for children (moist soil) : hands, lower legs, forearms, and face (USEPA, 1999f).	
	SA	Surface Area	cm²/event	2,792	50th percentile ave for male/female child age 6: hands, lower legs, forearms, feet, and face (USEPA, 1997f).	2,792	50th percentile ave for male/female child age 6: hands, lower legs, forearms, feet, and face (USEPA, 1997f).	
	EF	Exposure Frequency	event/year	13	1 day/week, 3 months/yr	7	Approx. 50% of RME	
	ED	Exposure Duration	years	6	derived from 95th percentile of residence duration in 6 Mid-Hudson Counties (see text)	3	derived from 50th percentile of residence duration in 6 Mid-Hudson Counties (see text)	
	CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
	BW	Body Weight	kg	15	Mean child body weight, males and females (USEPA, 1989b).	15	Mean child body weight, males and females (USEPA, 1989b).	
	AT-C	Averaging Time (Cancer)	days	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	
	AT-NC	Averaging Time (Noncancer)	days	2,190	ED (years) x 365 days/year.	1,095	ED (years) x 365 days/year.	

TABLE 2-23

VALUES USED FOR DAILY INTAKE CALCULATIONS

MID-HUDSON RIVER WATER - Adult Recreator

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Recreator
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Dermal	C_{water}	Chemical Concentration in River Water	mg/L	9.2E-06	See Table 2-10	1.5E-05	See Table 2-10	Average Daily Intake (mg/kg-day) =
	Kp	Dermal Permeability Constant (for PCBs)	cm/hour	0.48	Hexachlorobiphenyl (USEPA, 1999f)	0.48	Hexachlorobiphenyl (USEPA, 1999f)	C_{water} x Kp x SA x DE x EF x ED x CF x 1/BW x 1/AT
	SA	Surface Area	cm^2	18,150	Full body contact (USEPA, 1997f)	18,150	Full body contact (USEPA, 1997f)	
	DE	Dermal Exposure Time	hours/day	2.6	National average for swimming (USEPA, 1989b).	2.6	National average for swimming (USEPA, 1989b).	
	EF	Exposure Frequency	days/year	13	1 day/week, 3 months/yr	7	Approx. 50% of RME	
	ED	Exposure Duration	years	23	derived from 95th percentile of residence duration in 6 Mid-Hudson Counties (see text)	5	derived from 50th percentile of residence duration in 6 Mid-Hudson Counties (see text)	
	CF	Conversion Factor	L/cm^3	1.00E-03	--	1.00E-03	--	
	BW	Body Weight	kg	70	Mean adult body weight, males and females (USEPA, 1989b).	70	Mean adult body weight, males and females (USEPA, 1989b).	
	AT-C	Averaging Time (Cancer)	days	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	
	AT-NC	Averaging Time (Noncancer)	days	8,395	ED (years) x 365 days/year.	1,825	ED (years) x 365 days/year.	

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TABLE 2-24

VALUES USED FOR DAILY INTAKE CALCULATIONS

MID-HUDSON RIVER WATER - Adolescent Recreator

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Recreator
Receptor Age: Adolescent

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Dermal	C_{water}	Chemical Concentration in River Water	mg/L	1.2E-05	See Table 2-10	1.6E-05	See Table 2-10	Average Daily Intake (mg/kg-day) =
	Kp	Dermal Permeability Constant (for PCBs)	cm/hour	0.48	Hexachlorobiphenyl (USEPA, 1999f)	0.48	Hexachlorobiphenyl (USEPA, 1999f)	C_{water} x Kp x SA x DE x EF x ED x CF x 1/BW x 1/AT
	SA	Surface Area	cm^2	13,100	Full body contact (USEPA, 1997f)	13,100	Full body contact (USEPA, 1997f)	
	DE	Dermal Exposure Time	hours/day	2.6	National average for swimming (USEPA, 1989b).	2.6	National average for swimming (USEPA, 1989b).	
	EF	Exposure Frequency	days/year	39	3 days/week, 3 months/yr	20	Approx. 50% of RME	
	ED	Exposure Duration	years	12	derived from 95th percentile of residence duration in 6 Mid-Hudson Counties (see text)	3	derived from 50th percentile of residence duration in 6 Mid-Hudson Counties (see text)	
	CF	Conversion Factor	L/cm^3	1.00E-03	--	1.00E-03	--	
	BW	Body Weight	kg	43	Mean adolescent body weight, males and females (USEPA, 1989b).	43	Mean adolescent body weight, males and females (USEPA, 1989b).	
	AT-C	Averaging Time (Cancer)	days	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	
	AT-NC	Averaging Time (Noncancer)	days	4,380	ED (years) x 365 days/year.	1,095	ED (years) x 365 days/year.	

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TABLE 2-25

VALUES USED FOR DAILY INTAKE CALCULATIONS

MID-HUDSON RIVER WATER - Child Recreator

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Recreator
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Dermal	C_{water}	Chemical Concentration in River Water	mg/L	1.4E-05	See Table 2-10	1.6E-05	See Table 2-10	Average Daily Intake (mg/kg-day) =
	Kp	Dermal Permeability Constant (for PCBs)	cm/hour	0.48	Hexachlorobiphenyl (USEPA, 1999f)	0.48	Hexachlorobiphenyl (USEPA, 1999f)	C_{water} x Kp x SA x DE x EF x ED x CF x 1/BW x 1/AT
	SA	Surface Area	cm²	6,880	Full body contact (USEPA, 1997f)	6,880	Full body contact (USEPA, 1997f)	
	DE	Dermal Exposure Time	hours/day	2.6	National average for swimming (USEPA, 1989b).	2.6	National average for swimming (USEPA, 1989b).	
	EF	Exposure Frequency	days/year	13	1 day/week, 3 months/yr	7	Approx. 50% of RME	
	ED	Exposure Duration	years	6	derived from 95th percentile of residence duration in 6 Mid-Hudson Counties (see text)	3	derived from 50th percentile of residence duration in 6 Mid-Hudson Counties (see text)	
	CF	Conversion Factor	L/cm³	1.00E-03	--	1.00E-03	--	
	BW	Body Weight	kg	15	Mean child body weight, males and females (USEPA, 1989b).	15	Mean child body weight, males and females (USEPA, 1989b).	
	AT-C	Averaging Time (Cancer)	days	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	
	AT-NC	Averaging Time (Noncancer)	days	2,190	ED (years) x 365 days/year.	1,095	ED (years) x 365 days/year.	

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TABLE 2-26

VALUES USED FOR DAILY INTAKE CALCULATIONS

MID-HUDSON RIVER WATER - Adult Resident

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	C_{water}	Chemical Concentration in River Water	mg/L	9.2E-06	See Table 2-10	1.5E-05	See Table 2-10	Average Daily Intake (mg/kg-day) =
	IR	Ingestion Rate	L/day	2.3	90th percentile drinking water intake rate for adults (USEPA, 1997c)	1.40	Mean drinking water intake rate for adults (USEPA, 1997c)	C_{water} x IR x EF x ED x 1/BW x 1/AT
	EF	Exposure Frequency	days/year	350	(USEPA, 1991b)	350	(USEPA, 1991b)	
	ED	Exposure Duration	years	23	derived from 95th percentile of residence duration in 6 Mid-Hudson Counties (see text)	5	derived from 50th percentile of residence duration in 6 Mid-Hudson Counties (see text)	
	BW	Body Weight	kg	70	Mean adult body weight, males and females (USEPA, 1989b).	70	Mean adult body weight, males and females (USEPA, 1989b).	
	AT-C	Averaging Time (Cancer)	days	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	
	AT-NC	Averaging Time (Noncancer)	days	8,395	ED (years) x 365 days/year.	1,825	ED (years) x 365 days/year.	

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TABLE 2-27

VALUES USED FOR DAILY INTAKE CALCULATIONS

MID-HUDSON RIVER WATER - Adolescent Resident

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Resident
Receptor Age: Adolescent

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	C_{water}	Chemical Concentration in River Water	mg/L	1.2E-05	See Table 2-10	1.6E-05	See Table 2-10	Average Daily Intake (mg/kg-day) =
	IR	Ingestion Rate	L/day	2.3	90th percentile drinking water intake rate for adults (USEPA, 1997c)	1.40	Mean drinking water intake rate for adults (USEPA, 1997c)	C_{water} x IR x EF x ED x 1/BW x 1/AT
	EF	Exposure Frequency	days/year	350	(USEPA, 1991b)	350	(USEPA, 1991b)	
	ED	Exposure Duration	years	12	derived from 95th percentile of residence duration in 6 Mid-Hudson Counties (see text)	3	derived from 50th percentile of residence duration in 6 Mid-Hudson Counties (see text)	
	BW	Body Weight	kg	43	Mean adolescent body weight, males and females (USEPA, 1989b).	43	Mean adolescent body weight, males and females (USEPA, 1989b).	
	AT-C	Averaging Time (Cancer)	days	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	
	AT-NC	Averaging Time (Noncancer)	days	4,380	ED (years) x 365 days/year.	1,095	ED (years) x 365 days/year.	

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TABLE 2-28

VALUES USED FOR DAILY INTAKE CALCULATIONS

MID-HUDSON RIVER WATER - Child Resident

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	C_{water}	Chemical Concentration in River Water	mg/L	1.4E-05	See Table 2-10	1.6E-05	See Table 2-10	Average Daily Intake (mg/kg-day) =
	IR	Ingestion Rate	L/day	1.5	90th percentile drinking water intake rate for children, ages 3-5 (USEPA, 1997c)	0.87	Mean drinking water intake rate for children, ages 3-5 (USEPA, 1997c)	C_{water} x IR x EF x ED x 1/BW x 1/AT
	EF	Exposure Frequency	days/year	350	(USEPA, 1991b)	350	(USEPA, 1991b)	
	ED	Exposure Duration	years	6	derived from 95th percentile of residence duration in 6 Mid-Hudson Counties (see text)	3	derived from 50th percentile of residence duration in 6 Mid-Hudson Counties (see text)	
	BW	Body Weight	kg	15	Mean child body weight, males and females (USEPA, 1989b).	15	Mean child body weight, males and females (USEPA, 1989b).	
	AT-C	Averaging Time (Cancer)	days	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	25,550	70-year lifetime exposure x 365 d/yr (USEPA, 1989b).	
	AT-NC	Averaging Time (Noncancer)	days	2,190	ED (years) x 365 days/year.	1,095	ED (years) x 365 days/year.	

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TABLE 3-1

NON-CANCER TOXICITY DATA -- ORAL/DERMAL

MID-HUDSON RIVER

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor	Adjusted Dermal RfD	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (1) (MM/DD/YY)
Aroclor 1254	Chronic	2.00E-05 (2)	mg/kg-d	--	--	--	Immune system	300	IRIS	12/1/99
Aroclor 1016	Chronic	7.00E-05 (3)	mg/kg-d	--	--	--	Birth Weight	100	IRIS	12/1/99

N/A = Not Applicable

(1) IRIS value from most recent updated PCB file.

(2) Oral RfD for Aroclor 1254; there is no RfD available for total PCBs. PCBs in fish are considered to be most like Aroclor 1254.

(3) Oral RfD for Aroclor 1016; there is no RfD available for total PCBs. PCBs in sediment and water samples are considered to be most like Aroclor 1016.

TABLE 3-2

CANCER TOXICITY DATA -- ORAL/DERMAL

MID-HUDSON RIVER

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guideline Description	Source Target Organ	Date (1) (MM/DD/YY)
PCBs	1 (2)	--	--	$(mg/kg\text{-}d)^{-1}$	B2	IRIS	12/1/99
	2 (3)	--	--	$(mg/kg\text{-}d)^{-1}$	B2	IRIS	12/1/99
	0.3 (4)	--	--	$(mg/kg\text{-}d)^{-1}$	B2	IRIS	12/1/99
	0.4 (5)	--	--	$(mg/kg\text{-}d)^{-1}$	B2	IRIS	12/1/99

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

Weight of Evidence:

Known/Likely

Cannot be Determined

Not Likely

(1) IRIS value from most recent updated PCB file.

(2) Central estimate slope factor for exposures to PCBs via ingestion of fish, ingestion of sediments, and dermal contact (if dermal absorption fraction is applied) with sediments.

(3) Upper-bound slope factor for exposures to PCBs via ingestion of fish, ingestion of sediments, and dermal contact (if dermal absorption fraction is applied) with sediments.

(4) Central estimate slope factor for exposures to PCBs via ingestion and dermal contact (if no absorption factor is applied) with water soluble congeners in river water.

(5) Upper-bound slope factor for exposures to PCBs via ingestion and dermal contact (if no absorption factor is applied) with water soluble congeners in river water.

TABLE 4-1-RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER FISH - Adult Angler

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish
Receptor Population: Angler
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	PCBs	1.3	mg/kg wt weight	1.3	mg/kg wt weight	M	5.9E-04	mg/kg-day	2.0E-05	mg/kg-day	N/A	N/A	30
												Total Hazard Index Across All Exposure Routes/Pathways	30

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

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TABLE 4-1-CT
CALCULATION OF NON-CANCER HAZARDS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER FISH - Adult Angler

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish
Receptor Population: Angler
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	PCBs	1.2	mg/kg wt weight	1.2	mg/kg wt weight	M	5.4E-05	mg/kg-day	2.0E-05	mg/kg-day	N/A	N/A	3
Total Hazard Index Across All Exposure Routes/Pathways													3

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

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TABLE 4-2-RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER SEDIMENT- Adult Recreator

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson
Receptor Population: Recreator
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	PCBs	0.5	mg/kg	0.5	mg/kg	M	1.1E-08	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0002
Dermal	PCBs	0.5	mg/kg	0.5	mg/kg	M	5.9E-08	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0008
Total Hazard Index Across All Exposure Routes/Pathways													0.001

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

303115

TABLE 4-2-CT
CALCULATION OF NON-CANCER HAZARDS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER SEDIMENT- Adult Recreator

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson
Receptor Population: Recreator
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	PCBs	0.6	mg/kg	0.6	mg/kg	M	8.1E-09	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0001
Dermal	PCBs	0.6	mg/kg	0.6	mg/kg	M	4.1E-08	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0006
Total Hazard Index Across All Exposure Routes/Pathways													0.0007

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

303116

TABLE 4-3-RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER SEDIMENT- Adolescent Recreator

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson
Receptor Population: Recreator
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	PCBs	0.5	mg/kg	0.5	mg/kg	M	6.5E-08	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.001
Dermal	PCBs	0.5	mg/kg	0.5	mg/kg	M	1.9E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	. N/A	0.003
Total Hazard Index Across All Exposure Routes/Pathways													0.004

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

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TABLE 4-3-CT
CALCULATION OF NON-CANCER HAZARDS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER SEDIMENT- Adolescent Recreator

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson
Receptor Population: Recreator
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	PCBs	0.6	mg/kg	0.6	mg/kg	M	3.9E-08	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.001
Dermal	PCBs	0.6	mg/kg	0.6	mg/kg	M	1.2E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.002
Total Hazard Index Across All Exposure Routes/Pathways													0.003

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

303118

TABLE 4-4-RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER SEDIMENT - Child Recreator

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson
Receptor Population: Recreator
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	PCBs	0.6	mg/kg	0.6	mg/kg	M	1.4E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.002
Dermal	PCBs	0.6	mg/kg	0.6	mg/kg	M	1.1E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.002
												Total Hazard Index Across All Exposure Routes/Pathways	0.004

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

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TABLE 4-4-CT
CALCULATION OF NON-CANCER HAZARDS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER SEDIMENT - Child Recreator

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson
Receptor Population: Recreator
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	PCBs	0.6	mg/kg	0.6	mg/kg	M	7.8E-08	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.001
Dermal	PCBs	0.6	mg/kg	0.6	mg/kg	M	6.1E-08	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.001
Total Hazard Index Across All Exposure Routes/Pathways													0.002

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

303120

TABLE 4-5-RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER WATER - Adult Recreator

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Recreator
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	PCBs	9.18E-06	mg/L	9.18E-06	mg/L	M	1.1E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.002
Total Hazard Index Across All Exposure Routes/Pathways													0.002

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

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TABLE 4-5-CT
CALCULATION OF NON-CANCER HAZARDS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER WATER - Adult Recreator

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Recreator
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	PCBs	1.49E-05	mg/L	1.49E-05	mg/L	M	9.2E-08	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.001
Total Hazard Index Across All Exposure Routes/Pathways													0.001

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

303122

TABLE 4-6-RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER WATER - Adolescent Recreator

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Recreator
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	PCBs	1.16E-05	mg/L	1.16E-05	mg/L	M	4.7E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.007
Total Hazard Index Across All Exposure Routes/Pathways													0.007

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

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TABLE 4-6-CT
CALCULATION OF NON-CANCER HAZARDS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER WATER - Adolescent Recreator

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Recreator
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	PCBs	1.63E-05	mg/L	1.63E-05	mg/L	M	3.4E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.005
Total Hazard Index Across All Exposure Routes/Pathways													0.005

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

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TABLE 4-7-RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER WATER - Child Recreator

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Recreator
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	PCBs	1.40E-05	mg/L	1.40E-05	mg/L	M	2.9E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.004
Total Hazard Index Across All Exposure Routes/Pathways													0.004

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

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TABLE 4-7-CT
CALCULATION OF NON-CANCER HAZARDS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER WATER - Child Recreator

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Recreator
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	PCBs	1.63E-05	mg/L	1.63E-05	mg/L	M	1.8E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.003
Total Hazard Index Across All Exposure Routes/Pathways													0.003

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

303126

TABLE 4-8-RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER WATER - Adult Resident

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	PCBs	9.18E-06	mg/L	9.18E-06	mg/L	M	2.9E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.004
Total Hazard Index Across All Exposure Routes/Pathways													0.004

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

303127

TABLE 4-8-CT
CALCULATION OF NON-CANCER HAZARDS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER WATER - Adult Resident

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River - Drinking Water
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	PCBs	1.49E-05	mg/L	1.49E-05	mg/L	M	2.9E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.004
Total Hazard Index Across All Exposure Routes/Pathways													0.004

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

303128

TABLE 4-9-RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER WATER - Adolescent Resident

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River - Drinking Water
Receptor Population: Resident
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	PCBs	1.16E-05	mg/L	1.16E-05	mg/L	M	5.9E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0085
Total Hazard Index Across All Exposure Routes/Pathways													0.0085

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

303129

TABLE 4-9-CT
CALCULATION OF NON-CANCER HAZARDS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER WATER - Adolescent Resident

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River - Drinking Water
Receptor Population: Resident
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	PCBs	1.63E-05	mg/L	1.63E-05	mg/L	M	5.1E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0073
												Total Hazard Index Across All Exposure Routes/Pathways	0.0073

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

303130

TABLE 4-10-RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER WATER - Child Resident

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River - Drinking Water
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	PCBs	1.40E-05	mg/L	1.40E-05	mg/L	M	1.3E-06	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.019
Total Hazard Index Across All Exposure Routes/Pathways													0.0192

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

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TABLE 4-10-CT
CALCULATION OF NON-CANCER HAZARDS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER WATER - Child Resident

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River - Drinking Water
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	PCBs	1.63E-05	mg/L	1.63E-05	mg/L	M	9.1E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0130
Total Hazard Index Across All Exposure Routes/Pathways													0.0130

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

303132

TABLE 4-11-RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER FISH - Adult Angler

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish
Receptor Population: Angler
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	PCBs	0.8	mg/kg wt weight	0.8	mg/kg wt weight	M	2.1E-04	mg/kg-day	2	$(mg/kg\text{-}day)^{-1}$	4.2E-04
										Total Risk Across All Exposure Routes/Pathways	4.2E-04

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303133

TABLE 4-11-CT
CALCULATION OF CANCER RISKS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER FISH - Adult Angler

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish
Receptor Population: Angler
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	PCBs	1.2	mg/kg wt weight	1.2	mg/kg wt weight	M	9.3E-06	mg/kg-day	1	$(mg/kg\text{-}day)^{-1}$	9.3E-06
										Total Risk Across All Exposure Routes/Pathways	9.3E-06

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

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TABLE 4-12-RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER SEDIMENT- Adult Recreator

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson
Receptor Population: Recreator
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	PCBs	0.5	mg/kg	0.5	mg/kg	M	3.8E-09	mg/kg-day	2	$(mg/kg\text{-}day)^{-1}$	7.6E-09
Dermal	PCBs	0.5	mg/kg	0.5	mg/kg	M	1.9E-08	mg/kg-day	2	$(mg/kg\text{-}day)^{-1}$	3.9E-08
Total Risk Across All Exposure Routes/Pathways											4.6E-08

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303135

TABLE 4-12-CT
CALCULATION OF CANCER RISKS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER SEDIMENT- Adult Recreator

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson
Receptor Population: Recreator
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	PCBs	0.6	mg/kg	0.6	mg/kg	M	5.8E-10	mg/kg-day	1	$(mg/kg\text{-}day)^{-1}$	5.8E-10
Dermal	PCBs	0.6	mg/kg	0.6	mg/kg	M	2.9E-09	mg/kg-day	1	$(mg/kg\text{-}day)^{-1}$	2.9E-09
Total Risk Across All Exposure Routes/Pathways											3.5E-09

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303136

TABLE 4-13-RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER SEDIMENT- Adolescent Recreator

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson
Receptor Population: Recreator
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	PCBs	0.5	mg/kg	0.5	mg/kg	M	1.1E-08	mg/kg-day	2	$(mg/kg\text{-}day)^{-1}$	2.2E-08
Dermal	PCBs	0.5	mg/kg	0.5	mg/kg	M	3.3E-08	mg/kg-day	2	$(mg/kg\text{-}day)^{-1}$	6.7E-08
							Total Risk Across All Exposure Routes/Pathways				8.9E-08

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303137

TABLE 4-13-CT
CALCULATION OF CANCER RISKS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER SEDIMENT- Adolescent Recreator

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson
Receptor Population: Recreator
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	PCBs	0.6	mg/kg	0.6	mg/kg	M	1.7E-09	mg/kg-day	1	$(mg/kg\text{-}day)^{-1}$	1.7E-09
Dermal	PCBs	0.6	mg/kg	0.6	mg/kg	M	4.9E-09	mg/kg-day	1	$(mg/kg\text{-}day)^{-1}$	4.9E-09
Total Risk Across All Exposure Routes/Pathways											6.6E-09

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303138

TABLE 4-14-RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER SEDIMENT - Child Recreator

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson
Receptor Population: Recreator
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	PCBs	0.6	mg/kg	0.6	mg/kg	M	1.2E-08	mg/kg-day	2	$(mg/kg\text{-}day)^{-1}$	2.4E-08
Dermal	PCBs	0.6	mg/kg	0.6	mg/kg	M	9.2E-09	mg/kg-day	2	$(mg/kg\text{-}day)^{-1}$	1.8E-08
							Total Risk Across All Exposure Routes/Pathways				4.2E-08

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303139

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TABLE 4-14-CT
CALCULATION OF CANCER RISKS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER SEDIMENT - Child Recreator

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Banks of Mid-Hudson
Receptor Population: Recreator
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	PCBs	0.6	mg/kg	0.6	mg/kg	M	3.3E-09	mg/kg-day	1	$(mg/kg\text{-}day)^{-1}$	3.3E-09
Dermal	PCBs	0.6	mg/kg	0.6	mg/kg	M	2.6E-09	mg/kg-day	1	$(mg/kg\text{-}day)^{-1}$	2.6E-09
Total Risk Across All Exposure Routes/Pathways											5.9E-09

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303140

TABLE 4-15-RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER WATER - Adult Recreator

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Recreator
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	PCBs	9.18E-06	mg/L	9.18E-06	mg/L	M	3.5E-08	mg/kg-day	0.4	$(mg/kg\text{-}day)^{-1}$	1.4E-08
									Total Risk Across All Exposure Routes/Pathways		1.4E-08

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303141

TABLE 4-15-CT
CALCULATION OF CANCER RISKS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER WATER - Adult Recreator

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Recreator
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	PCBs	1.49E-05	mg/L	1.49E-05	mg/L	M	6.6E-09	mg/kg-day	0.3	$(mg/kg\text{-}day)^{-1}$	2.0E-09
							Total Risk Across All Exposure Routes/Pathways				2.0E-09

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303142

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TABLE 4-16-RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER WATER - Adolescent Recreator

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Recreator
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	PCBs	1.16E-05	mg/L	1.16E-05	mg/L	M	8.1E-08	mg/kg-day	0.4	$(mg/kg\text{-}day)^{-1}$	3.2E-08
									Total Risk Across All Exposure Routes/Pathways		3.2E-08

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303143

TABLE 4-16-CT
CALCULATION OF CANCER RISKS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER WATER - Adolescent Recreator

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Recreator
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	PCBs	1.63E-05	mg/L	1.63E-05	mg/L	M	1.5E-08	mg/kg-day	0.3	$(mg/kg\text{-}day)^{-1}$	4.4E-09
								Total Risk Across All Exposure Routes/Pathways			4.4E-09

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303144

TABLE 4-17-RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER WATER - Child Recreator

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Recreator
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	PCBs	1.40E-05	mg/L	1.40E-05	mg/L	M	2.4E-08	mg/kg-day	0.4	$(mg/kg\text{-}day)^{-1}$	9.8E-09
										Total Risk Across All Exposure Routes/Pathways	9.8E-09

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303145

TABLE 4-17-CT
CALCULATION OF CANCER RISKS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER WATER - Child Recreator

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Recreator
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	PCBs	1.63E-05	mg/L	1.63E-05	mg/L	M	7.7E-09	mg/kg-day	0.3	$(mg/kg\text{-}day)^{-1}$	2.3E-09
							Total Risk Across All Exposure Routes/Pathways				2.3E-09

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303146

TABLE 4-18-RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER WATER - Adult Resident

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water (Drinking Water)
Exposure Point: Mid-Hudson River
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	PCBs	9.18E-06	mg/L	9.18E-06	mg/L	M	9.5E-08	mg/kg-day	0.4	$(mg/kg\text{-}day)^{-1}$	3.8E-08
Total Risk Across All Exposure Routes/Pathways											3.8E-08

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303147

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TABLE 4-18-CT
CALCULATION OF CANCER RISKS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER WATER - Adult Resident

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water (Drinking Water)
Exposure Point: Mid-Hudson River
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	PCBs	1.49E-05	mg/L	1.49E-05	mg/L	M	2.0E-08	mg/kg-day	0.3	$(mg/kg\text{-}day)^{-1}$	6.1E-09
										Total Risk Across All Exposure Routes/Pathways	6.1E-09

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303148

TABLE 4-19-RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER WATER - Adolescent Resident

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Resident
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	PCBs	1.16E-05	mg/L	1.16E-05	mg/L	M	1.0E-07	mg/kg-day	0.4	$(mg/kg\text{-}day)^{-1}$	4.1E-08
								Total Risk Across All Exposure Routes/Pathways			4.1E-08

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303149

TABLE 4-19-CT
CALCULATION OF CANCER RISKS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER WATER - Adolescent Resident

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water (Drinking Water)
Exposure Point: Mid-Hudson River
Receptor Population: Resident
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	PCBs	1.63E-05	mg/L	1.63E-05	mg/L	M	2.2E-08	mg/kg-day	0.3	$(mg/kg\text{-}day)^{-1}$	6.5E-09
									Total Risk Across All Exposure Routes/Pathways		6.5E-09

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303150

TABLE 4-20-RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
MID-HUDSON RIVER WATER - Child Resident

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	PCBs	1.40E-05	mg/L	1.40E-05	mg/L	M	1.15E-07	mg/kg-day	0.4	$(mg/kg\text{-}day)^{-1}$	4.6E-08
										Total Risk Across All Exposure Routes/Pathways	4.6E-08

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

303151

TABLE 4-20-CT
CALCULATION OF CANCER RISKS
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER WATER - *Child Resident*

Scenario Timeframe: Current/Future
Medium: River Water
Exposure Medium: River Water
Exposure Point: Mid-Hudson River
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	PCBs	1.63E-05	mg/L	1.63E-05	mg/L	M	3.9E-08	mg/kg-day	0.3	$(mg/kg\text{-}day)^{-1}$	1.2E-08
							Total Risk Across All Exposure Routes/Pathways				1.2E-08

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

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TABLE 4-21-RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

MID-HUDSON RIVER - Adult Angler

Scenario Timeframe: Current/Future
Receptor Population: Angler
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Fish	Fish	Mid-Hudson Fish	PCBs	4.2E-04	--	--	4.2E-04	PCBs	Immune System	30	--	--	30
						Total Risk Across Fish	4.2E-04					Total Hazard Index Across All Media and All Exposure Routes	30
						Total Risk Across All Media and All Exposure Routes	4.2E-04						
												Total Immune System HI =	30

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TABLE 4-21-CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY EXPOSURE

MID-HUDSON RIVER - Adult Angler

Scenario Timeframe: Current/Future
Receptor Population: Angler
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Fish	Fish	Mid-Hudson Fish	PCBs	9.3E-06	--	--	9.3E-06	PCBs	Immune System	3	--	--	3

Total Risk Across Fish	9.3E-06
Total Risk Across All Media and All Exposure Routes	9.3E-06
Total Hazard Index Across All Media and All Exposure Routes	3
Total Immune System HI =	3

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TABLE 4-22-RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

MID-HUDSON RIVER - Adult Recreator

Scenario Timeframe: Current/Future
Receptor Population: Recreator
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Banks of Mid-Hudson	PCBs	7.6E-09	--	3.9E-08	4.6E-08	PCBs	Low Birth Weight	0.000	--	0.001	0.001
River Water	River Water	Mid-Hudson River	PCBs	--	--	1.4E-08	1.4E-08	PCBs	Low Birth Weight	--	--	0.0015	0.0015

Total Risk Across Sediment	4.6E-08
Total Risk Across River Water	1.4E-08
Total Risk Across All Media and All Exposure Routes	6.0E-08

Total Hazard Index Across All Media and All Exposure Routes	0.003
Total Low Birth Weight HI =	0.003

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TABLE 4-22-CT
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
MID-HUDSON RIVER - Adult Recreator

Scenario Timeframe: Current/Future
Receptor Population: Recreator
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Banks of Mid-Hudson	PCBs	5.8E-10	--	2.9E-09	3.5E-09	PCBs	Low Birth Weight	0.000	--	0.001	0.001
River Water	River Water	Mid-Hudson River	PCBs	--	--	2.0E-09	2.0E-09	PCBs	Low Birth Weight	--	--	0.0013	0.0013

Total Risk Across Sediment	3.5E-09
Total Risk Across River Water	2.0E-09
Total Risk Across All Media and All Exposure Routes	5.5E-09
Total Hazard Index Across All Media and All Exposure Routes	0.002
Total Low Birth Weight HI =	0.002

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TABLE 4-23-RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

MID-HUDSON RIVER - Adolescent Recreator

Scenario Timeframe: Current/Future
Receptor Population: Recreator
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Banks of Mid-Hudson	PCBs	2.2E-08	--	6.7E-08	8.9E-08	PCBs	Low Birth Weight	0.001	--	0.003	0.004
River Water	River Water	Mid-Hudson River	PCBs	--	--	3.2E-08	3.2E-08	PCBs	Low Birth Weight	--	--	0.007	0.0067
						Total Risk Across Sediment	8.9E-08			Total Hazard Index Across All Media and All Exposure Routes			0.010
						Total Risk Across River Water	3.2E-08						
						Total Risk Across All Media and All Exposure Routes	1.2E-07			Total Low Birth Weight HI =			0.010

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TABLE 4-23-CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY EXPOSURE

MID-HUDSON RIVER - Adolescent Recreator

Scenario Timeframe: Current/Future
Receptor Population: Recreator
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Banks of Mid-Hudson	PCBs	1.7E-09	--	4.9E-09	6.6E-09	PCBs	Low Birth Weight	0.001	--	0.002	0.002
River Water	River Water	Mid-Hudson River	PCBs	--	--	4.4E-09	4.4E-09	PCBs	Low Birth Weight	--	--	0.0049	0.0049

Total Risk Across Sediment	6.6E-09
Total Risk Across River Water	4.4E-09
Total Risk Across All Media and All Exposure Routes	1.1E-08
Total Hazard Index Across All Media and All Exposure Routes	0.007
Total Low Birth Weight HI =	0.007

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TABLE 4-24-RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

MID-HUDSON RIVER - Child Recreator

Scenario Timeframe: Current/Future
Receptor Population: Recreator
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Banks of Mid-Hudson	PCBs	2.4E-08	--	1.8E-08	4.2E-08	PCBs	Low Birth Weight	0.002	--	0.002	0.003
River Water	River Water	Mid-Hudson River	PCBs	--	--	9.8E-09	9.8E-09	PCBs	Low Birth Weight	--	--	0.0041	0.0041

Total Risk Across Sediment	4.2E-08
Total Risk Across River Water	9.8E-09
Total Risk Across All Media and All Exposure Routes	5.2E-08
Total Hazard Index Across All Media and All Exposure Routes	0.008
Total Low Birth Weight HI =	0.008

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TABLE 4-24-CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY EXPOSURE

MID-HUDSON RIVER - Child Recreator

Scenario Timeframe: Current/Future
Receptor Population: Recreator
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Banks of Mid-Hudson	PCBs	3.3E-09	--	2.6E-09	5.9E-09	PCBs	Low Birth Weight	0.001	--	0.001	0.002
River Water	River Water	Mid-Hudson River	PCBs	--	--	2.3E-09	2.3E-09	PCBs	Low Birth Weight	--	--	0.0026	0.0026

Total Risk Across Sediment	5.9E-09
Total Risk Across River Water	2.3E-09
Total Risk Across All Media and All Exposure Routes	8.2E-09
Total Hazard Index Across All Media and All Exposure Routes	0.005
Total Low Birth Weight HI =	0.005

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TABLE 4-25-RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

MID-HUDSON RIVER - Adult Resident

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
River Water	River Water	Mid-Hudson River	PCBs	3.8E-08	--	--	3.8E-08	PCBs	Low Birth Weight	0.0041	--	--	0.0041
						Total Risk Across All Media and All Exposure Routes	3.8E-08					Total Hazard Index Across All Media and All Exposure Routes	0.004

Total Low Birth Weight HI = 0.004

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TABLE 4-25-CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY EXPOSURE

MID-HUDSON RIVER - Adult Resident

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
River Water	River Water	Mid-Hudson River	PCBs	6.1E-09	--	--	6.1E-09	PCBs	Low Birth Weight	0.0041	--	--	0.0041
						Total Risk Across All Media and All Exposure Routes	6.1E-09					Total Hazard Index Across All Media and All Exposure Routes	0.004
												Total Low Birth Weight HI =	0.004

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TABLE 4-26-RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

MID-HUDSON RIVER - Adolescent Resident

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
River Water	River Water	Mid-Hudson River	PCBs	4.1E-08	--	--	4.1E-08	PCBs	ow Birth Weig	0.0085	--	--	0.0085
			Total Risk Across All Media and All Exposure Routes				4.1E-08		Total Hazard Index Across All Media and All Exposure Routes				0.008

Total Low Birth Weight HI = 0.008

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TABLE 4-26-CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY EXPOSURE

MID-HUDSON RIVER - Adolescent Resident

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
River Water	River Water	Mid-Hudson River	PCBs	6.5E-09	--	--	6.5E-09	PCBs	Low Birth Weight	0.0073	--	--	0.0073
						Total Risk Across All Media and All Exposure Routes	6.5E-09			Total Hazard Index Across All Media and All Exposure Routes			0.007

Total Low Birth Weight HI = 0.007

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TABLE 4-27-RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

MID-HUDSON RIVER - Child Resident

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
River Water	River Water	Mid-Hudson River	PCBs	4.6E-08	--	--	4.6E-08	PCBs	Low Birth Weight	0.0192	--	--	0.0192
						Total Risk Across All Media and All Exposure Routes	4.6E-08					Total Hazard Index Across All Media and All Exposure Routes	0.019

Total Low Birth Weight HI = 0.019

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TABLE 4-27-CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY EXPOSURE

MID-HUDSON RIVER - Child Resident

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	*Inhalation*	*Dermal*	Exposure Routes Total		*Primary* Target Organ	*Ingestion*	*Inhalation*	*Dermal*	Exposure Routes Total
River Water	River Water	Mid-Hudson River	PCBs	1.2E-08	--	--	1.2E-08	PCBs	Low Birth Weight	0.0130	--	--	0.0130
				Total Risk Across All Media and All Exposure Routes			1.2E-08	Total Hazard Index Across All Media and All Exposure Routes					0.013

Total Low Birth Weight HI = 0.013

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Figures

Figure 2-1
Average PCB Concentration in Brown Bullhead
Mid-Hudson River

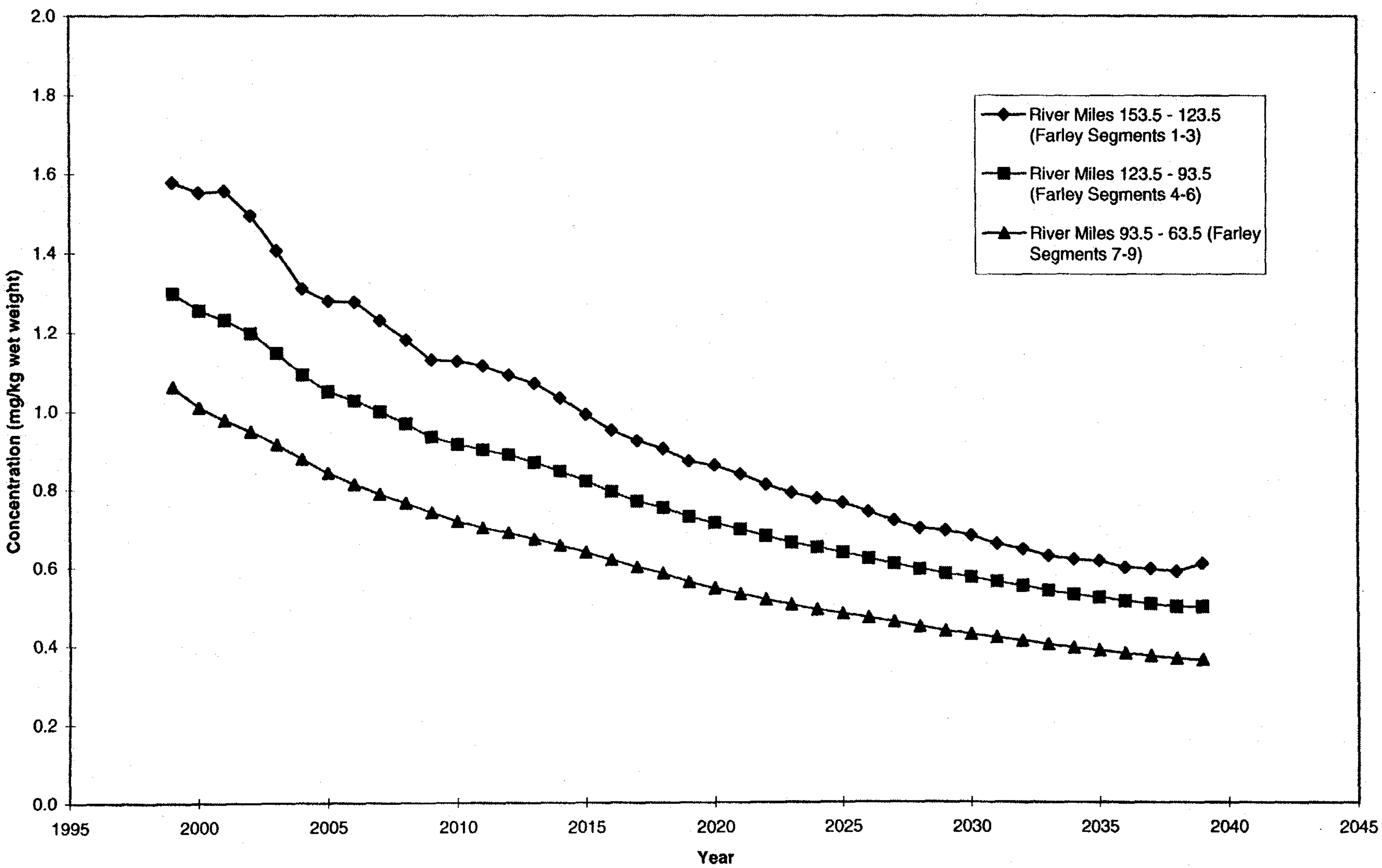

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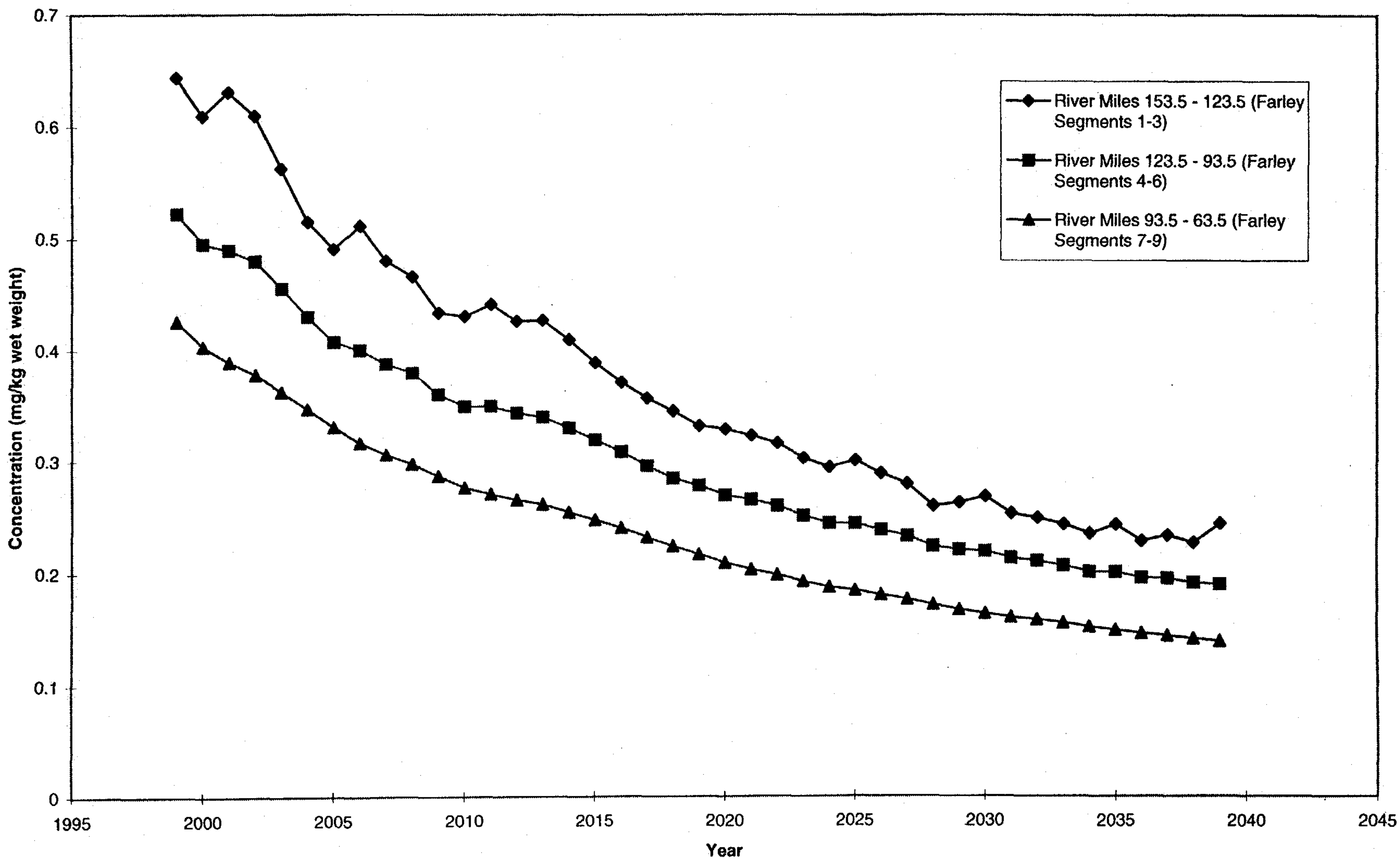
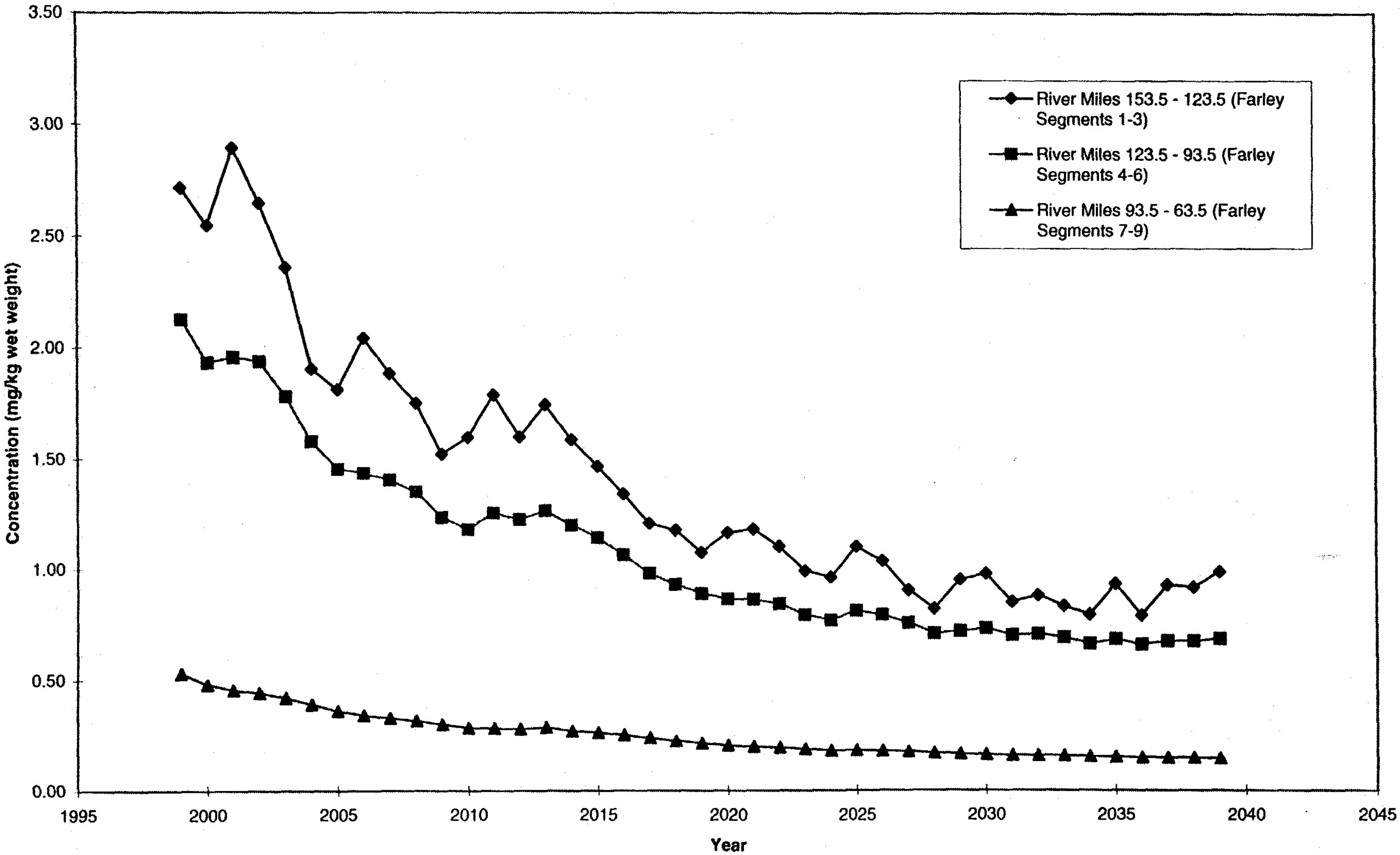
Figure 2-2
Average PCB Concentration in Yellow Perch
Mid-Hudson River



303169

Figure 2-3
Average PCB Concentration in Largemouth Bass
Mid-Hudson River



303170

Figure 2-4
Average PCB Concentration in Striped Bass
Mid-Hudson River

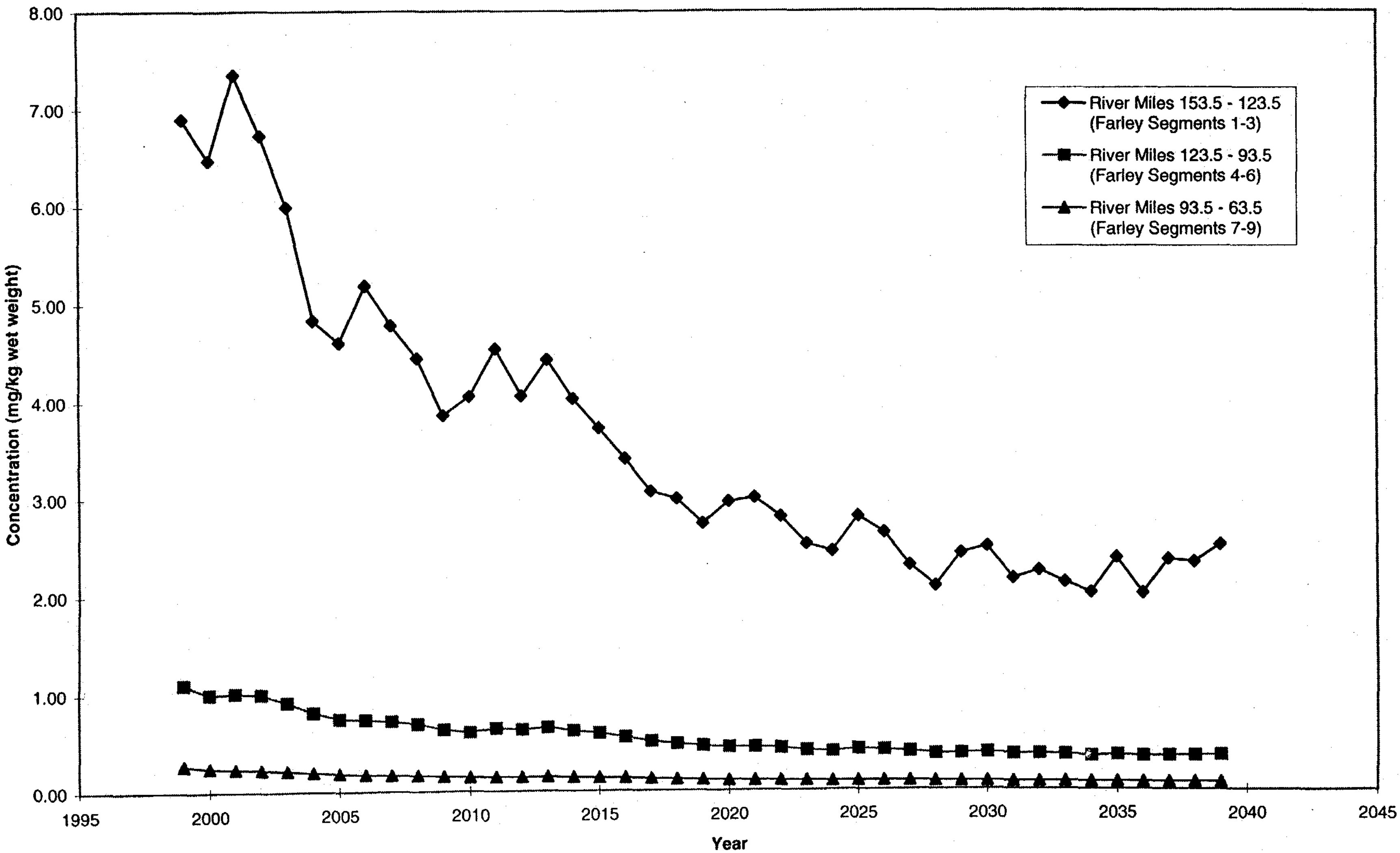


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Figure 2-5
Average PCB Concentration in White Perch
Mid-Hudson River

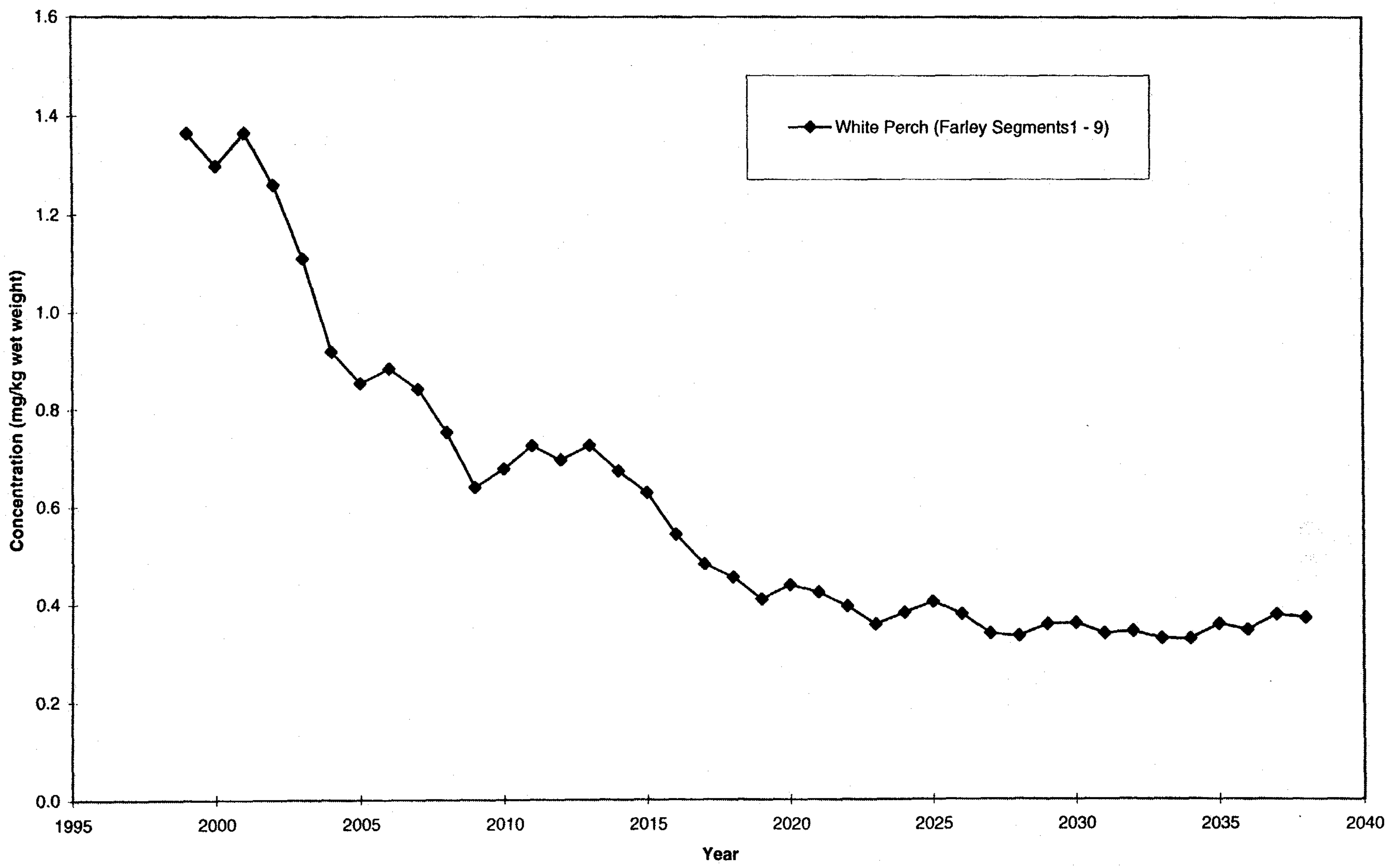

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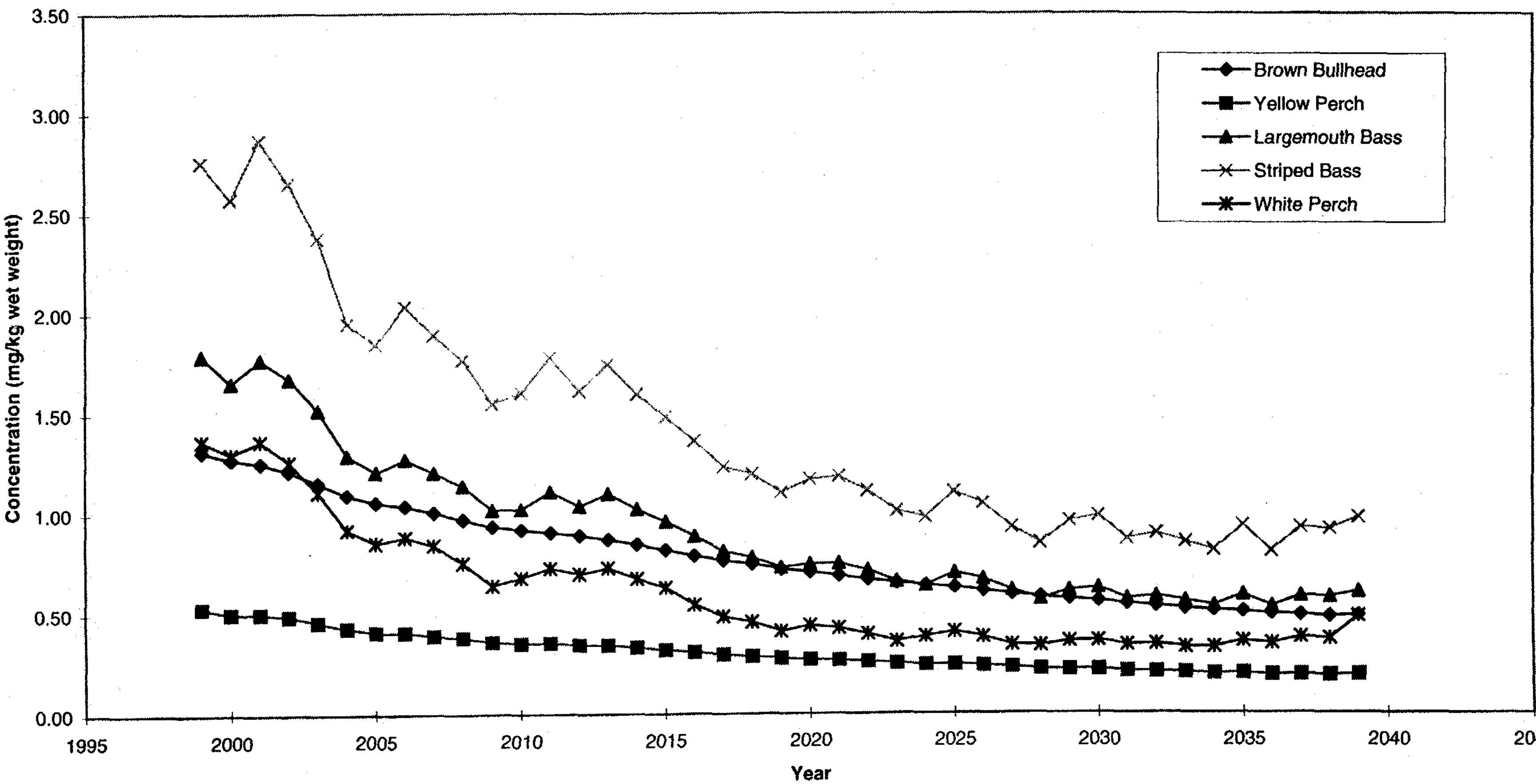
Figure 2-6
Average PCB Concentration by Species (averaged over location)
Mid-Hudson River



303173

Figure 2-7
Average Total PCB Concentration in Sediment
Mid-Hudson River

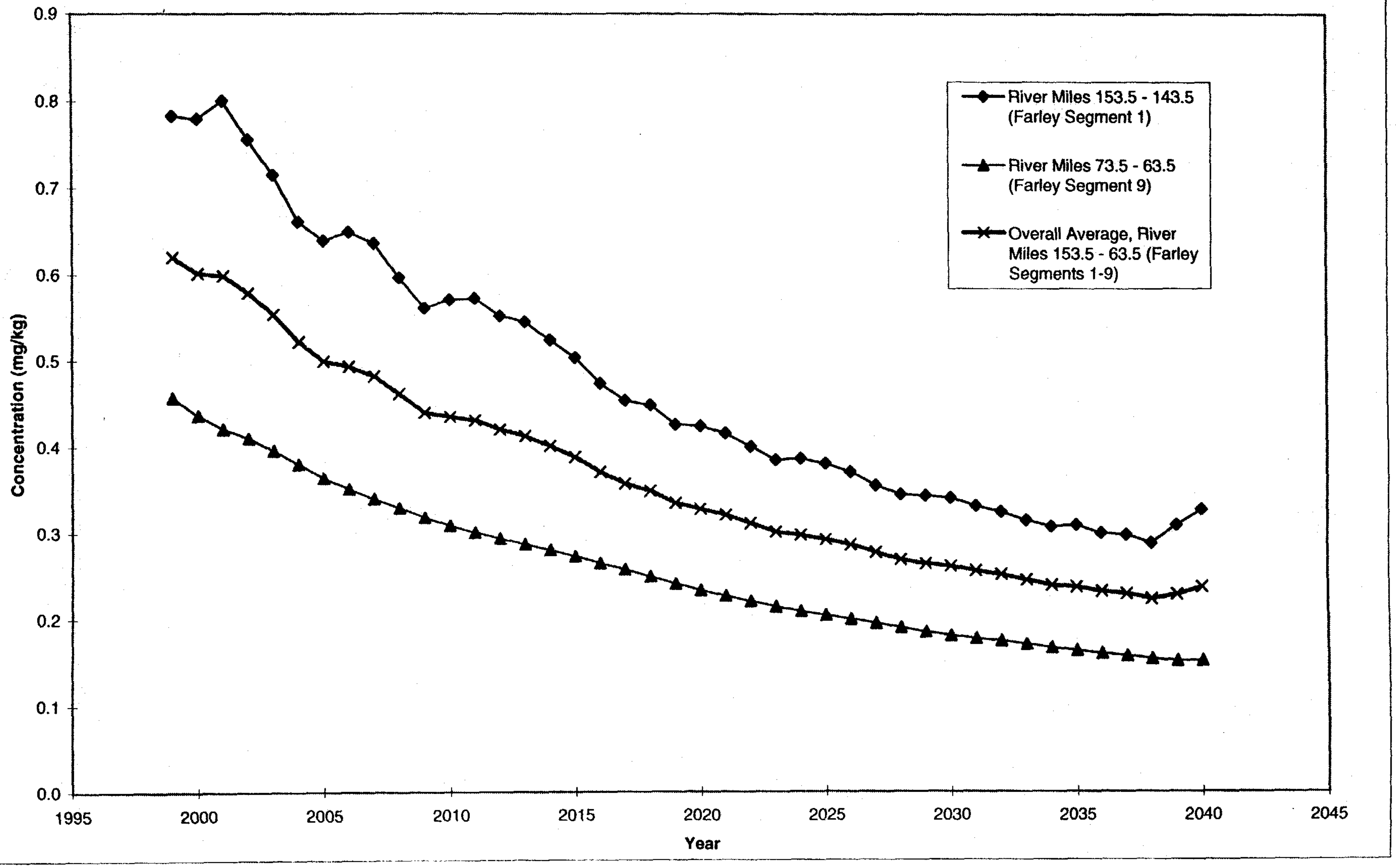


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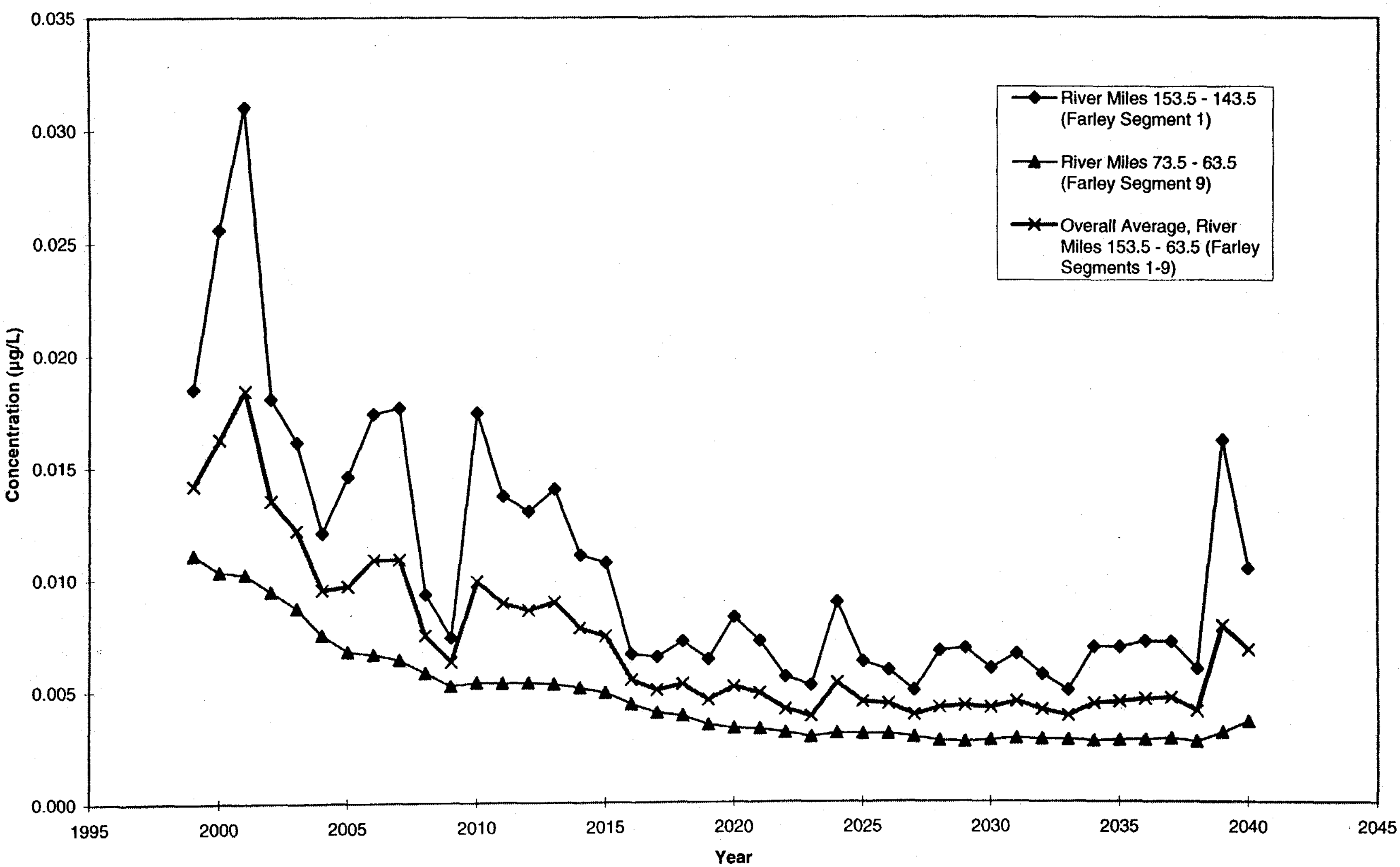
Figure 2-8
Average Total PCB Concentration in River Water
Mid-Hudson River



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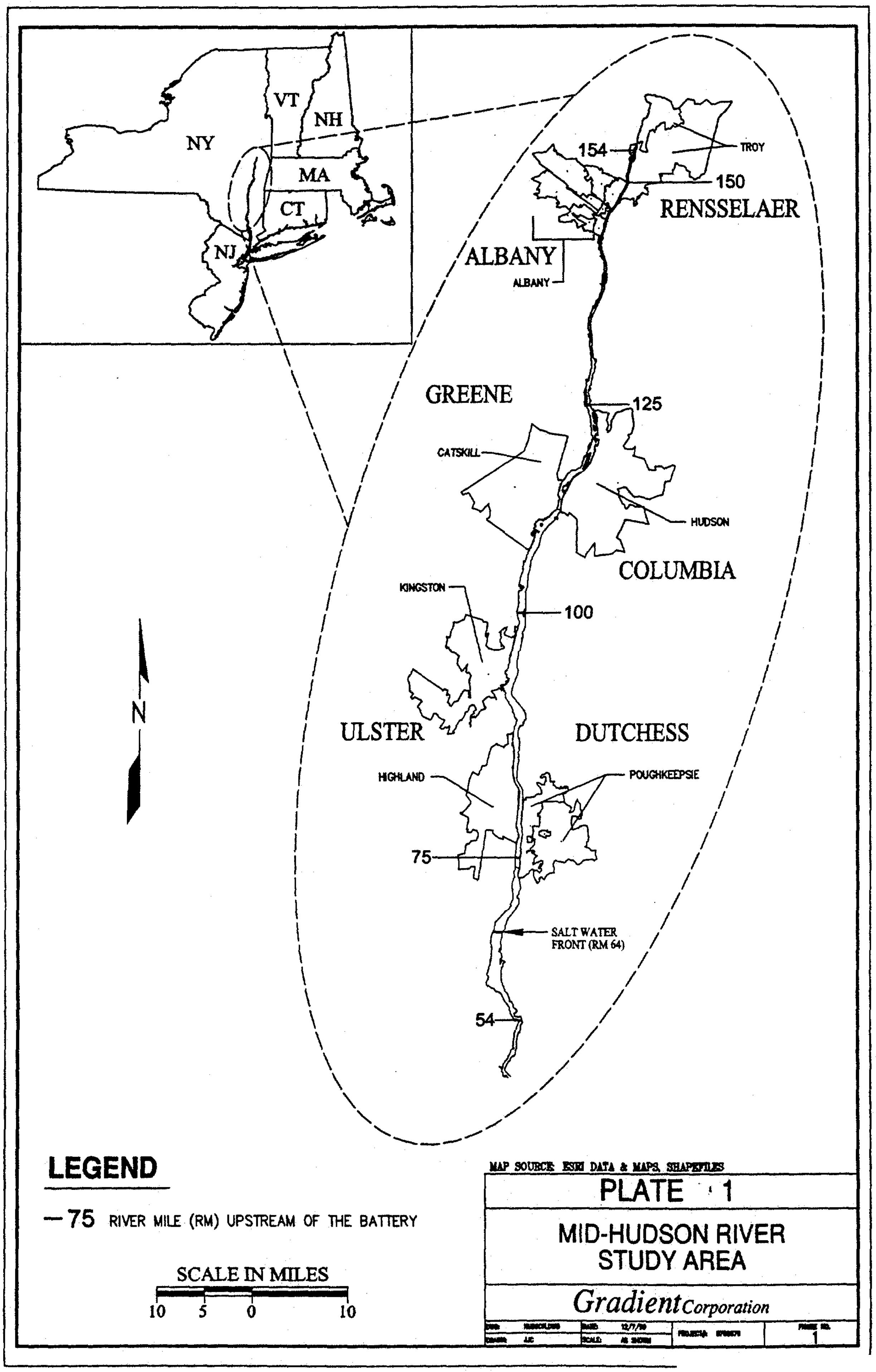
Convert to ng/L by dividing by 1000 for comparison to Table 2-10.


NY
VT
NH
MA
CT
NJ
154
150
TROY
RENSSELAER
ALBANY
ALBANY
GREENE
125
CATSKILL
HUDSON
COLUMBIA
KINGSTON
100
ULSTER
DUTCHESS
N
HIGHLAND
POUGHKEEPSIE
75
SALT WATER FRONT (RM 64)
54
LEGEND
—75 RIVER MILE (RM) UPSTREAM OF THE BATTERY
SCALE IN MILES
10 5 0 10
MAP SOURCE: ESRI DATA & MAPS, SHAPEFILES
PLATE 1
MID-HUDSON RIVER STUDY AREA
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