Appendix A

Excerpts From Revised Baseline Modeling Report

EXECUTIVE SUMMARY
Revised Baseline Modeling Report
JANUARY 2000

This report presents results and findings from the application of mathematical models for PCB physical/chemical transport and fate, as well as PCB bioaccumulation in the Upper Hudson River. The modeling effort for the Hudson River PCBs site Reassessment has been designed to predict future levels of PCBs in Upper Hudson River sediment, water and fish. This report provides predictions under baseline conditions, that is, without remediation of PCB-contaminated sediment in the Upper Hudson River (equivalent to a No Action scenario). The predicted sediment, water and fish PCB concentrations from the models are used as inputs in the Human Health and Ecological Risk Assessments. Subsequently, the models will be used in the Feasibility Study (the Phase 3 Report) to help evaluate and compare the effectiveness of various remedial scenarios.

The Revised Baseline Modeling Report (RBMR or Revised BMR) incorporates changes to the May 1999 Baseline Modeling Report (BMR) based on public comments and additional analyses, and supercedes the May 1999 report. The Revised BMR consists of four books. Books 1 and 2 are on the transport and fate models, with Book 1 containing the report text and Book 2 containing the corresponding tables, figures and plates. Similarly, Books 3 and 4 are on the bioaccumulation models, with Book 3 containing the report text and Book 4 containing the corresponding tables, figures and plates. Predictions of future PCB concentrations in sediment and water from the transport and fate models are used as input values for the bioaccumulation models. The bioaccumulation models forecast PCB concentrations in various fish species based on these inputs.

MODELING OBJECTIVES

The overall goal of the modeling is to develop scientifically credible models capable of answering the following principal questions:

- When will PCB levels in fish populations recover to levels meeting human health and ecological risk criteria under continued No Action?
- Can remedies other than No Action significantly shorten the time required to achieve acceptable risk levels?
- Are there contaminated sediments now buried that are likely to become “reactivated” following a major flood, possibly resulting in an increase in contamination of the fish population?

The work presented in this Revised BMR provides information relevant to the first and third questions. Forecasts regarding the potential impacts of various remedial scenarios, thus addressing the second question, will be presented in the Feasibility Study (the Phase 3 Report)

MODEL DEVELOPMENT

A large body of information from site-specific field measurements (documented in Hudson River Database Release 4.1), laboratory experiments and the scientific literature was synthesized within the models to develop the PCB transport and fate and the PCB bioaccumulation models. Data from numerous sources were utilized including USEPA, the New York State Department of Environmental Conservation, the National Oceanic and Atmospheric Administration, the US Geological Survey and the General Electric Company.

The proposed modeling approach and preliminary demonstrations of model outputs were made available for public review in the Preliminary Model Calibration Report (PMCR), which was issued in October 1996. The modeling framework of the PMCR was revised based on a peer review and public comment, as well as the incorporation of additional data. The baseline modeling effort and results were documented in the Baseline Modeling Report (BMR) issued in May 1999. USEPA decided to revise the BMR to reflect changes to the models based on public comment and additional analyses that were conducted. The Revised BMR includes model refinements, additional years of data, longer model forecasts, validation to an independent dataset, and additional model sensitivity analyses. This Revised BMR supercedes the May 1999 BMR.

Transport and Fate Models

HUDTOX - The backbone of the modeling effort is the Upper Hudson River Toxic Chemical Model (HUDTOX). HUDTOX was developed to simulate PCB transport and fate for 40 miles of the Upper Hudson River from Fort Edward to Troy, New York. HUDTOX is a transport and fate model, which is based on the principle of conservation of mass. The fate and transport model simulates PCBs in the water column and sediment bed, but not in fish. It balances inputs, outputs and internal sources and sinks for the Upper Hudson River. Mass balances are constructed first for water, then solids and bottom sediment, and finally PCBs. External inputs of water, solids loads and PCB loads, plus values for many internal model coefficients, were specified from field observations. Once inputs are specified, the remaining internal model parameters are calibrated so that concentrations computed by the model agree with field observations. Model calculations of forecasted PCB concentrations in water and sediment from HUDTOX are used as inputs for the forecasts of the bioaccumulation models (as described in Books 3 and 4).

Depth of Scour Model (DOSM) - The Depth of Scour Model was principally developed to provide spatially-refined information on sediment erosion depths in response to high-flow events such as a 100-year peak flow. The DOSM is a two-dimensional, sediment erosion model that was applied to the Thompson Island Pool. The Thompson Island Pool is characterized by high levels of PCBs in the cohesive sediments. DOSM is linked with a hydrodynamic model that predicts the velocity and shear stress (force of the water acting on the sediment surface) during high flows. There is also a linkage between the DOSM and HUDTOX. Relationships between river flow and cohesive sediment resuspension were developed using the DOSM for a range of flows below the 100-year peak flow. These relationships were used in the HUDTOX model for representing flow-dependent resuspension.

Bioaccumulation Models

Three separate bioaccumulation models were developed in a sequential manner, beginning with a simple, data-driven empirical approach (Bivariate BAF Analysis), followed by a probabilistic food chain model, and ending with a time-varying, mechanistic approach (FISHRAND). The three approaches are complementary, with each progressively more complex model building on the results of the preceding, simpler effort. All three bioaccumulation models are presented in the Revised BMR; however, the FISHRAND model is the final bioaccumulation model that is used to predict future fish PCB body burdens.

Bivariate BAF Analysis - The Bivariate BAF (Bioaccumulation Factor) Analysis is a simple empirical approach that draws on the wealth of historical PCB data for the Hudson River to relate PCB levels in water and sediments (two variables, or "bivariate") to observed PCB levels in fish. This analysis is useful in understanding the relative importance of water and sediment sources on particular species of fish. As this empirical approach does not describe causal relationships, the analysis has limited predictive capabilities and accordingly was not used for forecasts.

Empirical Probabilistic Food Chain Model - The Empirical Probabilistic Food Chain Model is a more sophisticated representation of the steady-state relationships between fish body burdens and PCB exposure concentrations in water and sediments. The model combines information from available PCB exposure measurements with knowledge about the ecology of different fish species and the food chain relationships among larger fish, smaller fish, and invertebrates in the water column and sediments. The Probabilistic Model provides information on the expected range of uncertainty and variability associated with the estimates of average fish body burdens.

(FISHRAND) Mechanistic Time-Varying Model - The FISHRAND model is based on the peer-reviewed uptake model developed by Gobas (1993 and 1995) and provides a mechanistic, process-based, time-varying representation of PCB bioaccumulation. This is the same form of the model that was used to develop criteria under the Great Lakes Initiative (USEPA, 1995). The FISHRAND model incorporates distributions instead of point estimates for input parameters, and calculates distributions of fish body burdens from which particular point estimates can be obtained, for example, the median, average, or 95th percentile. FISHRAND was used to predict the future fish PCB body burdens for the Human Health and Ecological Risk Assessments.

MODEL CALIBRATION

The principal HUDTOX application was a long-term historical calibration for a 21-year period from 1977 through 1997. Consistent with the Reassessment principal questions, emphasis was placed on calibration of the model to long-term trends in sediment and water column PCB concentrations. However, a short-term hindcast calibration test was also conducted from 1991 to 1997 to establish model performance for certain individual PCB congeners. Model applications included mass balances for seven different PCB forms: total PCBs, Tri+, and five individual PCB congeners (BZ#4, BZ#28, BZ#52, BZ#[90+101] and BZ#138). Total PCBs represents the sum of all measured PCB congeners and represents the entire PCB mass. Tri+ represents the sum of the trichloro- through decachlorobiphenyl homologue groups. Use of Tri+ as the historical calibration parameter allows for the comparison of data that were analyzed by congener-specific methods with data analyzed by packed-column methods (that did not separate the various PCBs as well and did not measure many of the mono- and dichlorobiphenyls). Therefore, use of the operationally defined Tri+ term allows for a consistent basis for comparison over the entire period for which historical data were available. Tri+ is also a good representation of the PCBs that bioaccumulate in fish.

The five PCB congeners were selected for model calibration based primarily on their physical-chemical properties and frequencies of detection in environmental samples across different media. These individual congener simulations help provide a better understanding of the environmental processes controlling PCB dynamics in the river by testing the model with PCBs with widely varying properties. BZ#4 is a dichloro congener that represents a final product of PCB dechlorination in the sediments. BZ#28 is a trichloro congener that has similar physical-chemical properties to Tri+. BZ#52 is a tetrachloro congener that was selected because of its resistance to degradation and based on its presence in Aroclor 1242, the main Aroclor used by General Electric at the Hudson River capacitor plants. BZ#[90+101] (a pentachloro congener) and BZ#138 (a hexachloro congener) represent higher-chlorinated congeners that strongly partition to solids in the river and bioaccumulate in fish.

The HUDTOX model calibration strategy can be considered minimal and conservative. It is minimal in that external inputs and internal model parameters were determined independently to the fullest extent possible from site-specific data and only a minimal number of parameters were adjusted during model calibration. It is conservative in that parameters determined through model calibration were held spatially and temporally constant unless there was supporting information to the contrary. Consistent with the Reassessment principal questions, emphasis was placed on calibration to long-term trends in sediment and water column PCB concentrations, not short transient changes or localized variations.

The 21-year historical calibration for Tri+ served as the main development vehicle for the PCB fate and transport model used in the Reassessment. This calibration was successful in reproducing observed long-term trends in water and sediment PCB concentrations over the 21-year period. This was primarily demonstrated through comparisons between model results and available data for long-term Tri+ surface sediment concentrations, in-river solids and Tri+ mass transport at low and high flows, and water column solids and Tri+ concentrations. Many different metrics were used collectively in a “weight of evidence” approach to demonstrate model reliability.

The calibration of the FISHRAND model was conducted by a process known as Bayesian updating. This approach optimizes the agreement between predicted distributions of fish concentrations from the FISHRAND model as compared to empirical distributions based on the data by adjusting three input distributions (percent lipid in fish, total organic carbon in sediment, and the octanol-water partition coefficient or K_{ow}). Initial input distributions (referred to as prior distributions) are specified based on site-specific data and values from the published scientific literature. The model is run and calculates the likelihood of obtaining an output distribution that matches observed measurements given the input distribution. The prior input distributions are then adjusted (within constraints of the data) and these adjusted distributions are referred to as posterior distributions. The focus of the calibration was on the wet weight concentrations (as opposed to the lipid-normalized concentrations) because the wet weight concentrations are generally of primary interest to USEPA and other regulators, the lipid content of any given fish is difficult to predict, and the model predicts fish body burdens on a wet weight basis and then lipid-normalizes. It was determined that, overall, the FISHRAND model predicts wet weight Tri+ PCB fish body burdens to within a factor of two, and typically significantly less than that.

MODEL VALIDATION

Model validation is the comparison of model output to observed data for a dataset that was not included in the calibration of the model. A HUDTOX model validation was conducted to compare predicted and observed water column concentrations for Tri+ using a dataset acquired in 1998 for the Upper Hudson River by General Electric. Results indicated good agreement at both Thompson Island Dam and Schuylerville over an entire year, spanning a range of environmental conditions in the river. The validation was judged successful and it enhances the credibility of the model as a predictive tool.

Several approaches were used to validate the FISHRAND model. One method was to calibrate FISHRAND for one river mile, and then to run the model for a different river mile. Satisfactory agreement for both river miles implied model validity across locations in the Hudson River. In addition, a calibration was conducted using only part of the available dataset, and then the model results were compared with the remaining portion of the dataset. The posterior distributions obtained using only the partial dataset were compared to the posterior distributions obtained using the full dataset. Finally, the partial-data calibrated model was run for the forecast period and these results compared to the full-data calibrated model results. Good agreement across all three metrics implied confidence in the performance of the model.

MODEL FORECAST

In the Revised BMR, the HUDTOX model was run for a 70-year forecast period from 1998 through 2067 for Tri+. The forecast period was lengthened from the 21-year forecast in the May 1999 BMR for two reasons. First, the fish body burdens attained for the 21-year forecast presented risks and hazards above levels of concern as documented in the risk assessments (*i.e.,* the 21-year forecast was too short to predict when PCB concentrations in fish would decrease below levels of concern). Second, the 70-year forecast period was selected in order to provide exposure concentrations that can be used directly in the Monte Carlo analysis in the Human Health Risk Assessment. Tri+ was simulated because it reflects PCB congeners that bioaccumulate in fish and hence are key to the risk assessment.

In order to conduct forecast simulations with the HUDTOX model, it was necessary to specify future conditions in the Upper Hudson River for flows, solids loads, and upstream Tri+ loads. These model inputs are not easily predicted (similar to predicting the future weather), but reasonable estimates were made based on historical observations and current information regarding PCB loading trends.

The baseline forecast simulation was run for an assumed constant Tri+ concentration of 10 ng/L at the model's upstream boundary at Fort Edward. This level represented the annual average Tri+ concentration that was observed in 1997 and assumes that there will be no future load increases or reductions from upstream sources. In particular, it also assumes that the PCB migration from the GE Hudson Falls Plant site would not increase or decrease and that there would not be any type of event similar to the releases that occurred with the partial failure of the Allen Mill gate structure in 1991. Recognizing the uncertainty in this upstream load, model sensitivity runs were conducted for an assumed Tri+ concentration of zero (0 ng/L) to represent a lower bound on future loads due to the implementation of remedial measures upstream, and for an assumed concentration of 30 ng/L to reflect increased loads similar to observations in 1998.

Results from 70-year forecast simulations contain inherent uncertainty due to uncertainties in estimating future flow and solids loading conditions. Furthermore, various model input assumptions, while less influential in 21-year simulations, can become more important in 70-year forecast simulations. This uncertainty can be assessed and accounted for in USEPA's decision making by evaluating predictions across a range of alternate scenarios for these inputs. For this reason, model sensitivity runs were also conducted for three additional hydrologic conditions: plus/minus 50 percent changes in future tributary solids loads, a different assumption for the depth of particle mixing in the surface sediments, and different starting concentrations for Tri+ in the sediments.

Risk-based target levels for fish PCB body burdens have not yet been established. In the Feasibility Study, site-specific target levels to be protective of human health and the environment will be developed from the risk assessments. However, it is beneficial at this time to compare forecasted fish PCB levels against example target levels as a matter of perspective. The target levels used for this analysis provide several concentrations spanning two orders-of-magnitude. Again, these are not endorsements of these values for decision making. Appropriate values will be developed in the Feasibility Study for the site.

MAJOR FINDINGS

The primary objective of the modeling effort is to construct a scientifically credible tool to help in the understanding of PCB transport and fate and bioaccumulation in the Upper Hudson River, and to use that tool for making forecasts of what will happen in the future. As such, one of the major findings was that it was possible to construct models that simulate conditions that match the observed data reasonably well. Consequently, the model predictions can be reliably used to evaluate future ecological and human health risks and to assess the relative time it takes for the river to recover under various remedial scenarios.

There are numerous general observations about the river that are apparent from the mass balance exercises. Some important observations that impact the understanding of the system include:

- The river is net depositional for solids in Thompson Island Pool, and apparently also in downstream reaches;

- Solids loads are dominated by tributary inputs;

- PCB (Tri+) loads to the water column are dominated by sediment to water mass transfer under non-scouring flow conditions; and,

- Water column and PCB (Tri+) surface sediment concentrations are gradually declining due to reduced input loads and natural attenuation.

Beyond the general observations above, the model forecasts provide the following findings regarding PCBs in the Upper Hudson River. It should be noted that the findings below are made based on the evaluation of Tri+, and that some of the findings may differ for other mixtures of PCBs, such as total PCBs or individual congeners.

1. PCB (Tri+) concentrations in the surface sediment are forecasted to decline at annual rates of approximately 7 to 9 percent over the next two decades, consistent with long-term historical trends.

2. PCB (Tri+) loads from upstream of the model boundary at Fort Edward control the long-term responses of PCB (Tri+) concentrations in the water column and surface sediments, and accordingly, body burdens in fish.

- For the first two to three decades of the model forecast, depending on location, the in-place PCB (Tri+) reservoir in the sediments and sediment-water transfer processes control responses of surface sediment concentrations.

- Water column PCB (Tri+) concentrations are increasingly controlled by the upstream boundary at Fort Edward over the long term. The rate at which water column concentrations approach an asymptote depends upon the assumed magnitude of the upstream boundary load and location within the river.

3. Forecasted surface sediment PCB (Tri+) concentrations in several localized areas in the Stillwater reach and the Thompson Island Pool increase after 40 to 50 years, despite exponential-type decreases up to that time. These computed increases are due to relatively small annual erosion rates that eventually, over an extended length of time, expose PCB concentrations that were previously at depth.

    - The relative magnitudes of computed increases in surface sediment PCB (Tri+) concentrations are small within the context of long-term trends in historical concentrations.

    - The occurrence, magnitude and timing of these computed increases are dependent on forecast assumption. It is reasonable to assume that localized erosion occurs within the river, but at scales smaller than the spatial scale of the model. Therefore, the model may not accurately reflect the areal extent of such erosion or its timing.

4. Results of the 100-year peak flow show that a flood of this magnitude would result in only a small additional increase in sediment erosion beyond what might be expected for a reasonable range of annual peak flows.

    - The small sediment scour depths produced by the 100-year peak flow result in only very small increases in surface sediment PCB (Tri+) concentrations. These increases decline to values in the base forecast simulation (without the 100-year peak flow) in approximately four years.

- Increases in water column PCB (Tri+) concentrations in response to a 100-year peak flow are very short-lived (on the order of weeks) and decline rapidly after occurrence of the event.

- The 100-year event causes an increase of less than 30 kg (70 lbs) in cumulative PCB (Tri+) mass loading across the Thompson Island Dam by the end of the first year of the forecast. This increase represents approximately 13 percent of the average annual PCB (Tri+) mass loading across Thompson Island Dam during the 1990's.

5. The FISHRAND model results for the 70-year forecasts show that predicted wet weight PCB (Tri+) fish body burdens asymptotically approach steady-state concentrations. These concentrations are species-specific, depending on the relative influence of sediment versus water sources, and reflect the upstream boundary assumption. That is, the asymptotic value is lowest for the 0 ng/L upstream boundary condition and approximately an order of magnitude higher for the 10 ng/L upstream boundary condition. Under the 30 ng/L upstream boundary condition, the asymptotic value is approximately a factor of five higher than the 10 ng/L result.

6. FISHRAND model results show that PCB (Tri+) uptake in fish is predominantly attributable to dietary sources, with a smaller contribution from direct water uptake. Analysis of relative sediment and water contributions within the food chain yielded the following results. Brown bullhead are most sensitive to changes in sediment concentration and not very sensitive to changes in water concentration; largemouth bass are more sensitive to sediment concentrations than to water concentrations, but water plays a larger role than for brown bullhead; yellow perch are driven primarily by the water; white perch show greater sensitivity to sediment; and pumpkinseed and spottail shiner are sensitive to small changes in water concentration.

7. The time it takes to attain acceptable target levels in fish tissue is greatly dependent upon the target level selected. Target levels will be selected as part of the Feasibility Study for the site.

Summation

The modeling effort for the Reassessment has provided USEPA with valuable insights regarding factors that control transport and fate and bioaccumulation of PCBs in the Upper Hudson River. Forecasted responses of water column and surface sediment PCB (Tri+) concentrations in the Upper Hudson River, as calculated by HUDTOX, are sensitive to changes in hydrology, solids loadings, sediment particle mixing depth and sediment initial conditions. Forecasted responses of fish body burdens using the FISHRAND model are sensitive to changes in lipid content of fish, total organic carbon in sediment, and the octanol-water partitioning coefficient (K_{ow}).

The models are useful tools for forecasting future sediment, water and fish PCB concentrations. The forecasts can be reliably used to evaluate future ecological and human health risks and to assess the relative time it takes for the river to recover under various remedial scenarios.

Figure 6-6: Comparison of FISHRAND Model Results Before and After Calibration Procedure for Largemouth Bass

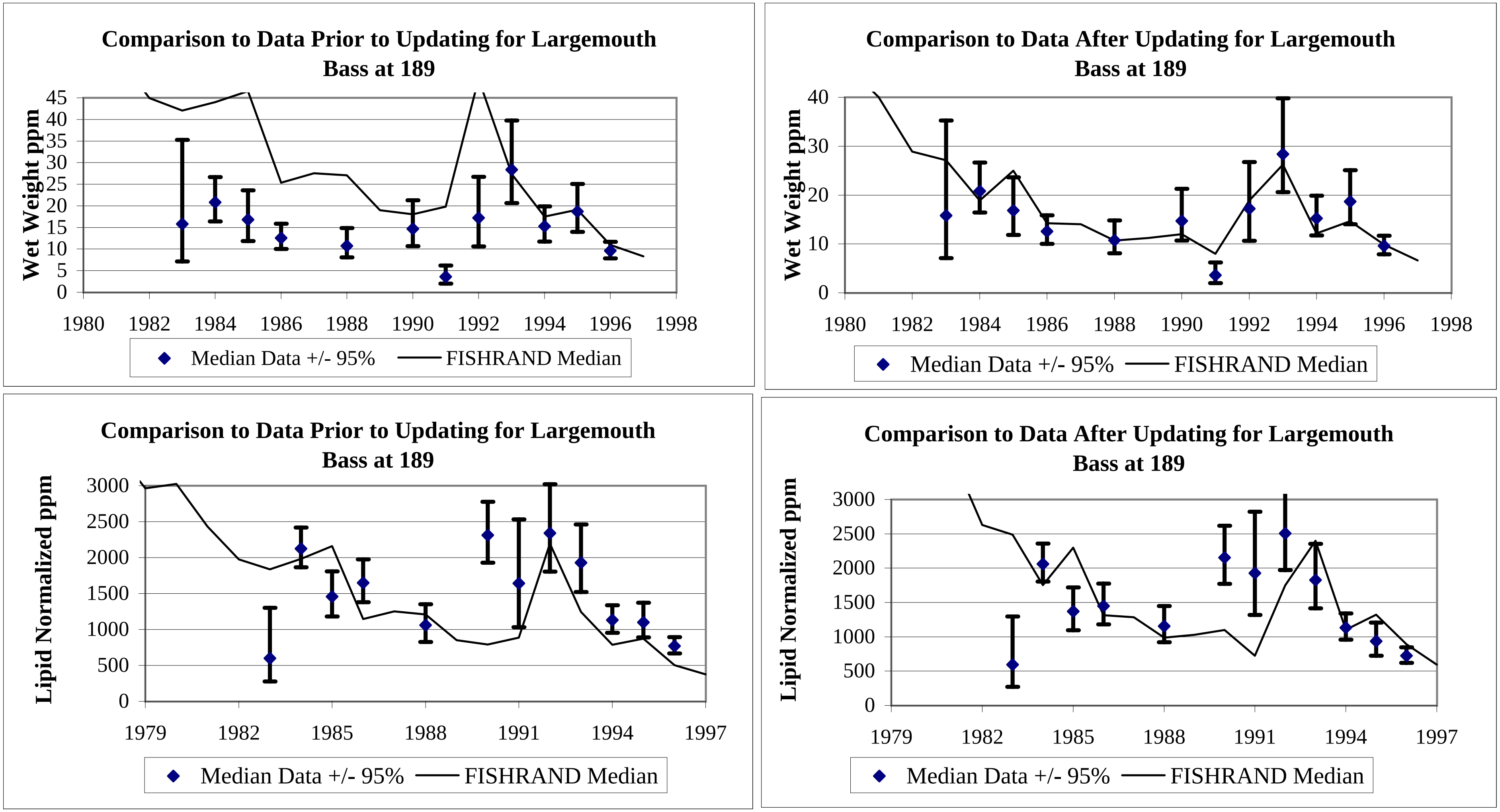


Figure 6-6: Comparison of FISHRAND Model Results Before and After Calibration Procedure for Largemouth Bass, continued

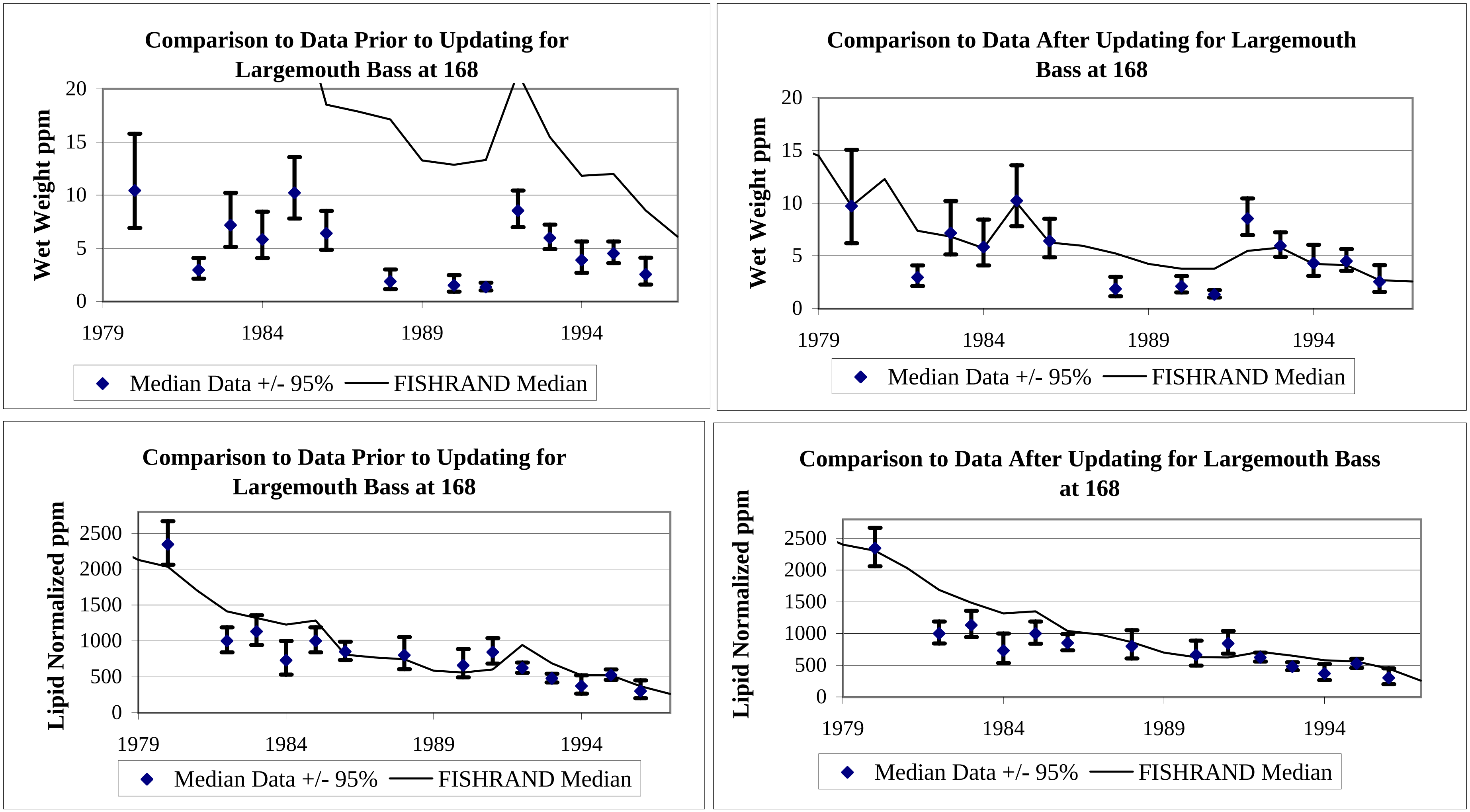


Figure 6-6: Comparison of FISHRAND Model Results Before and After Calibration Procedure for Largemouth Bass, continued

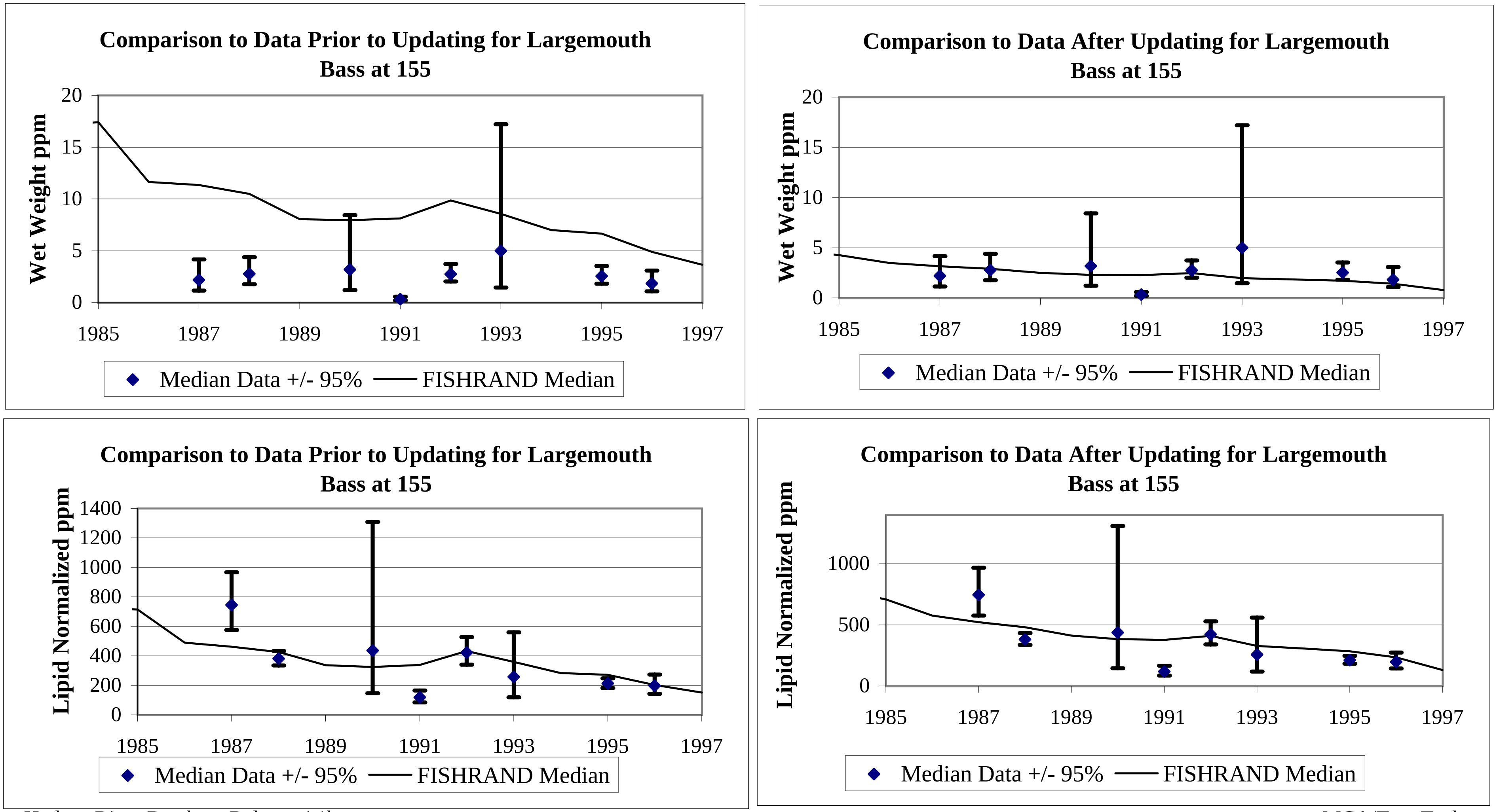
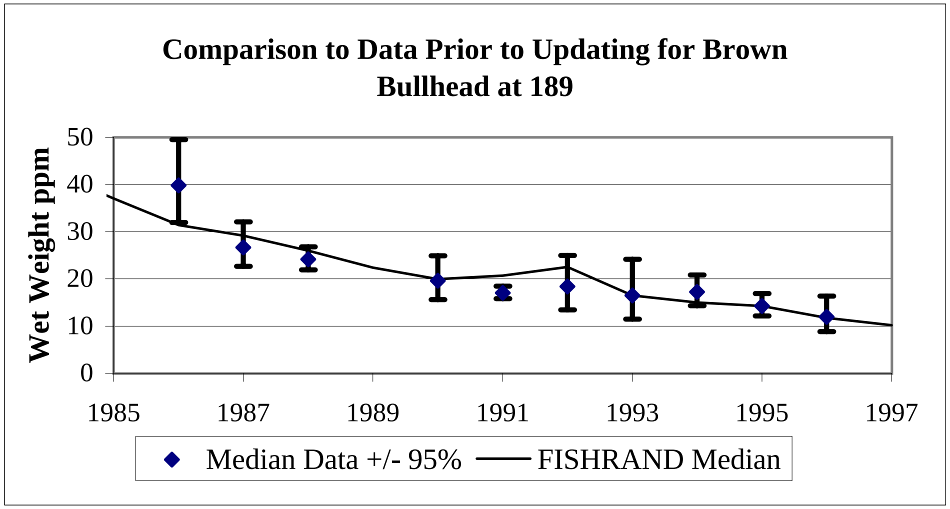
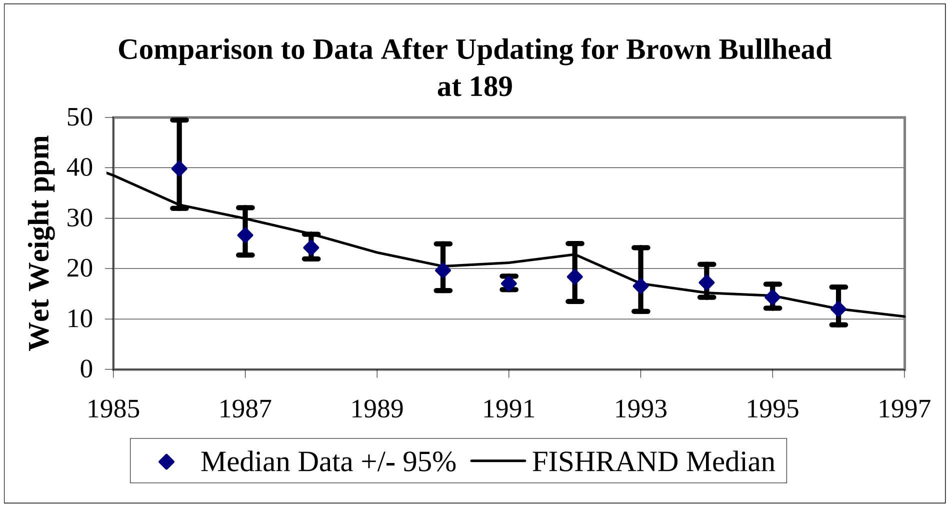
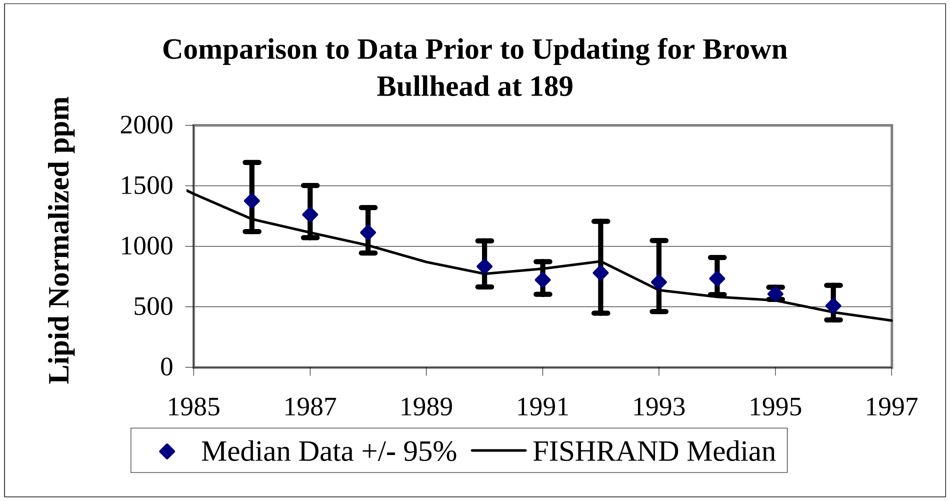


Figure 6-7: Comparison of FISHRAND Model Results Before and After Calibration Procedure, continued for Brown Bullhead







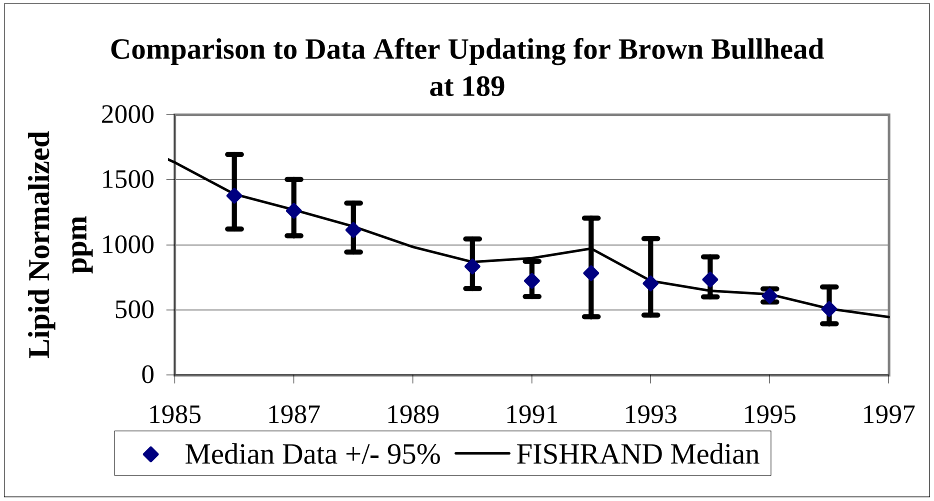


Figure 6-7: Comparison of FISHRAND Model Results Before and After Calibration Procedure for Brown Bullhead, continued

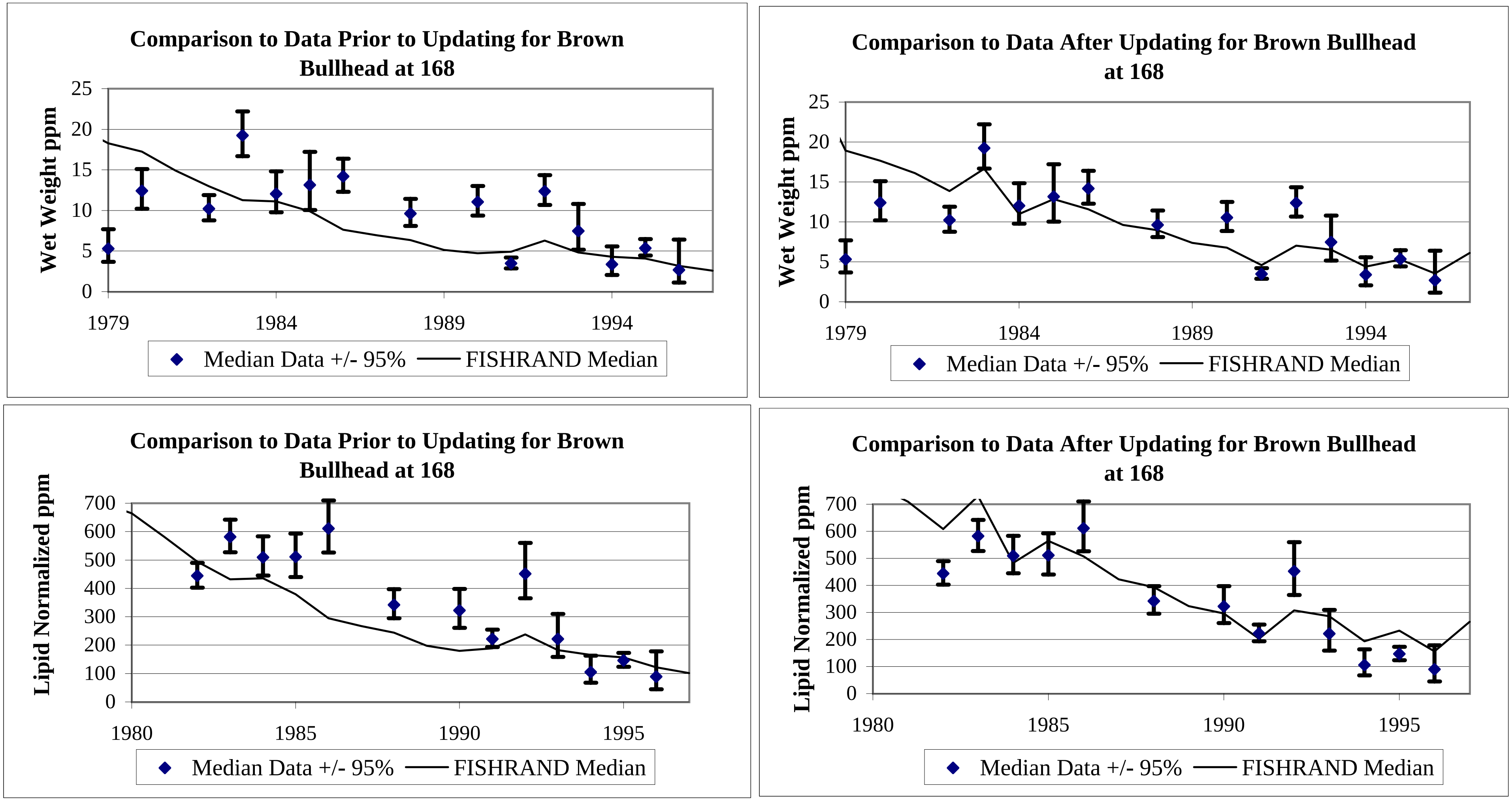


Figure 6-8: Comparison of FISHRAND Model Results Before and After Calibration Procedure for Yellow Perch and White Perch

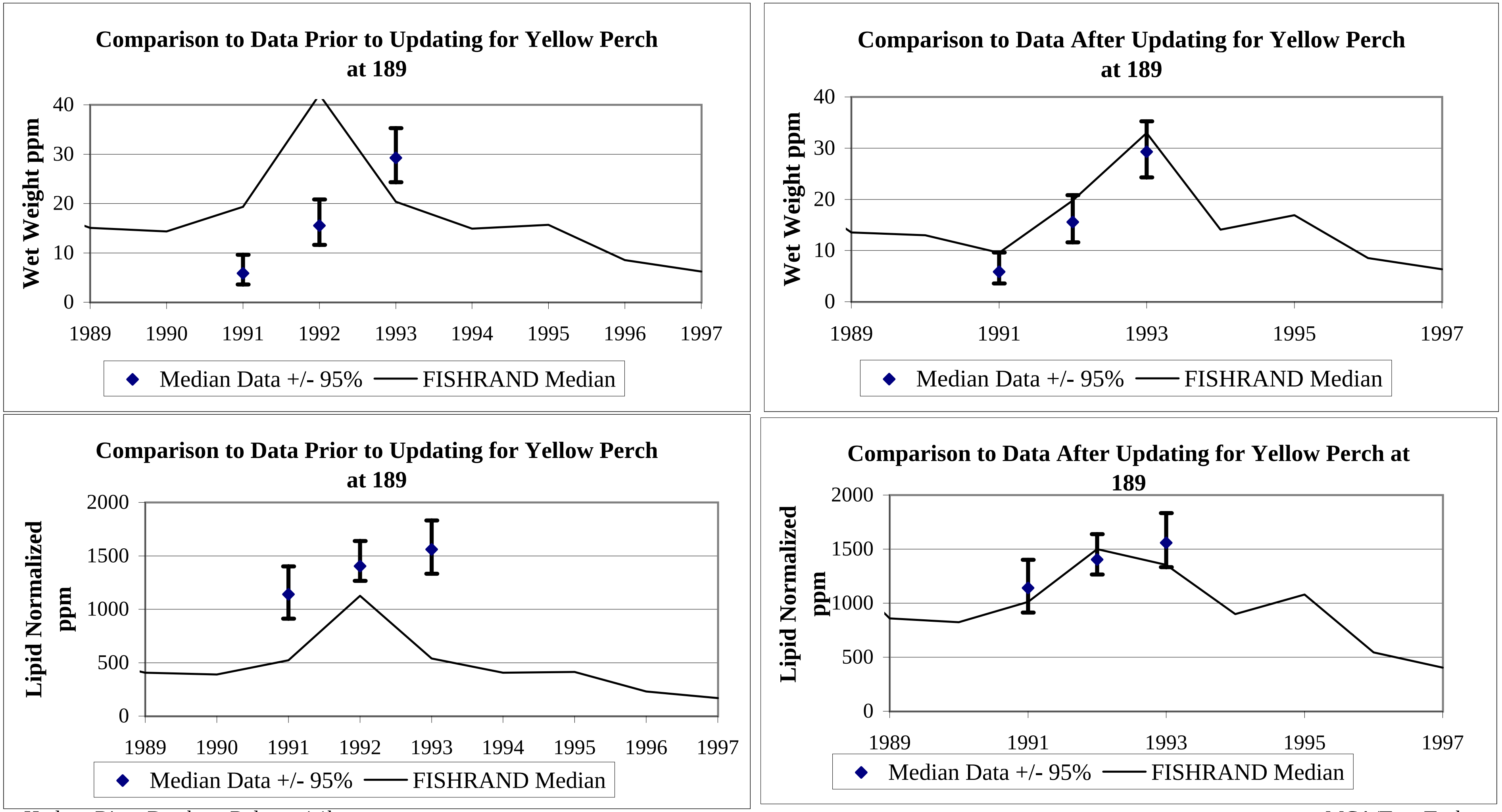


Figure 6-8: Comparison of FISHRAND Model Results Before and After Calibration Procedure, continued for Yellow Perch and White Perch, continued

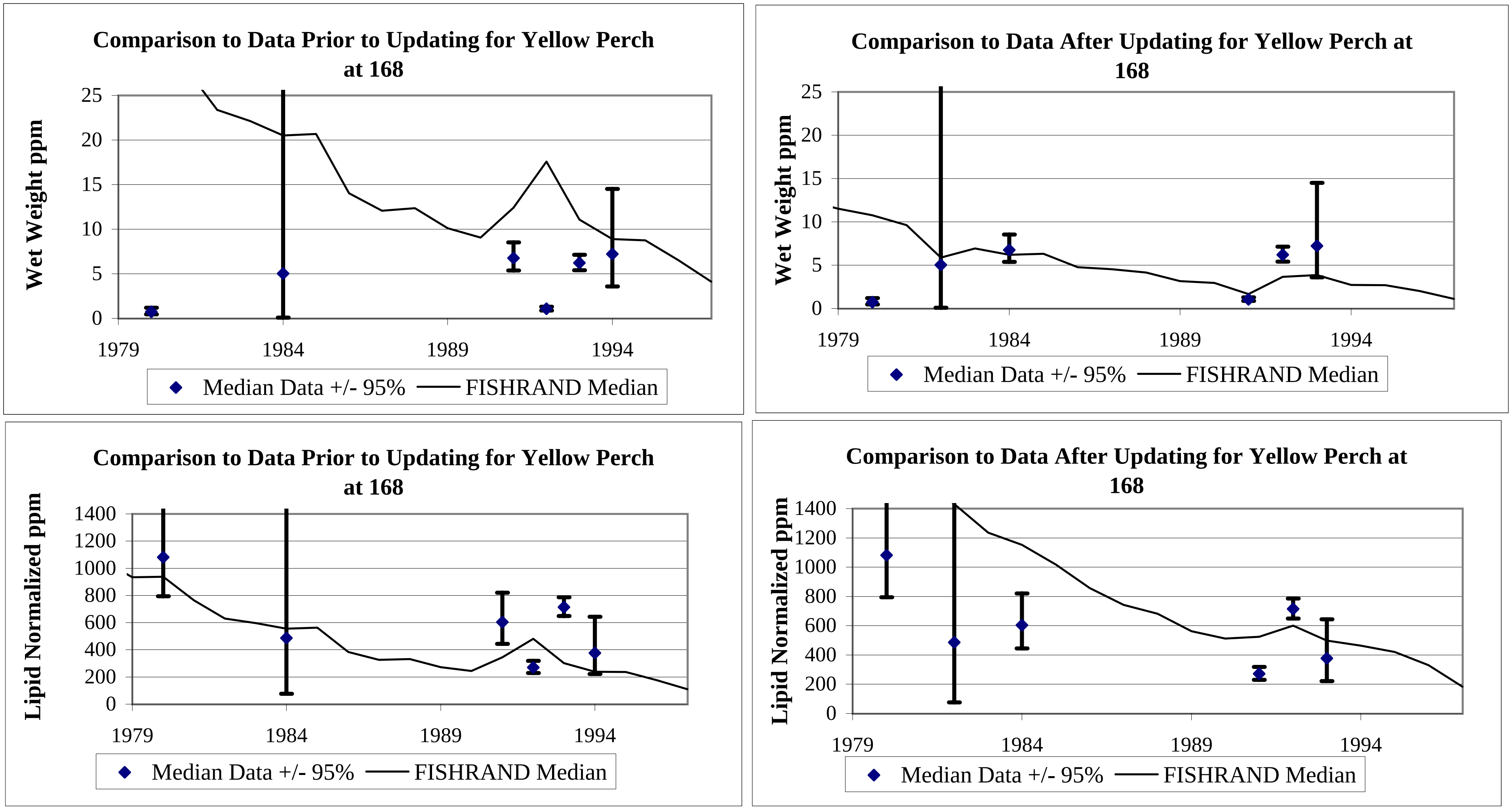


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Figure 6-8: Comparison of FISHRAND Model Results Before and After Calibration Procedure for Yellow Perch and White Perch, continued

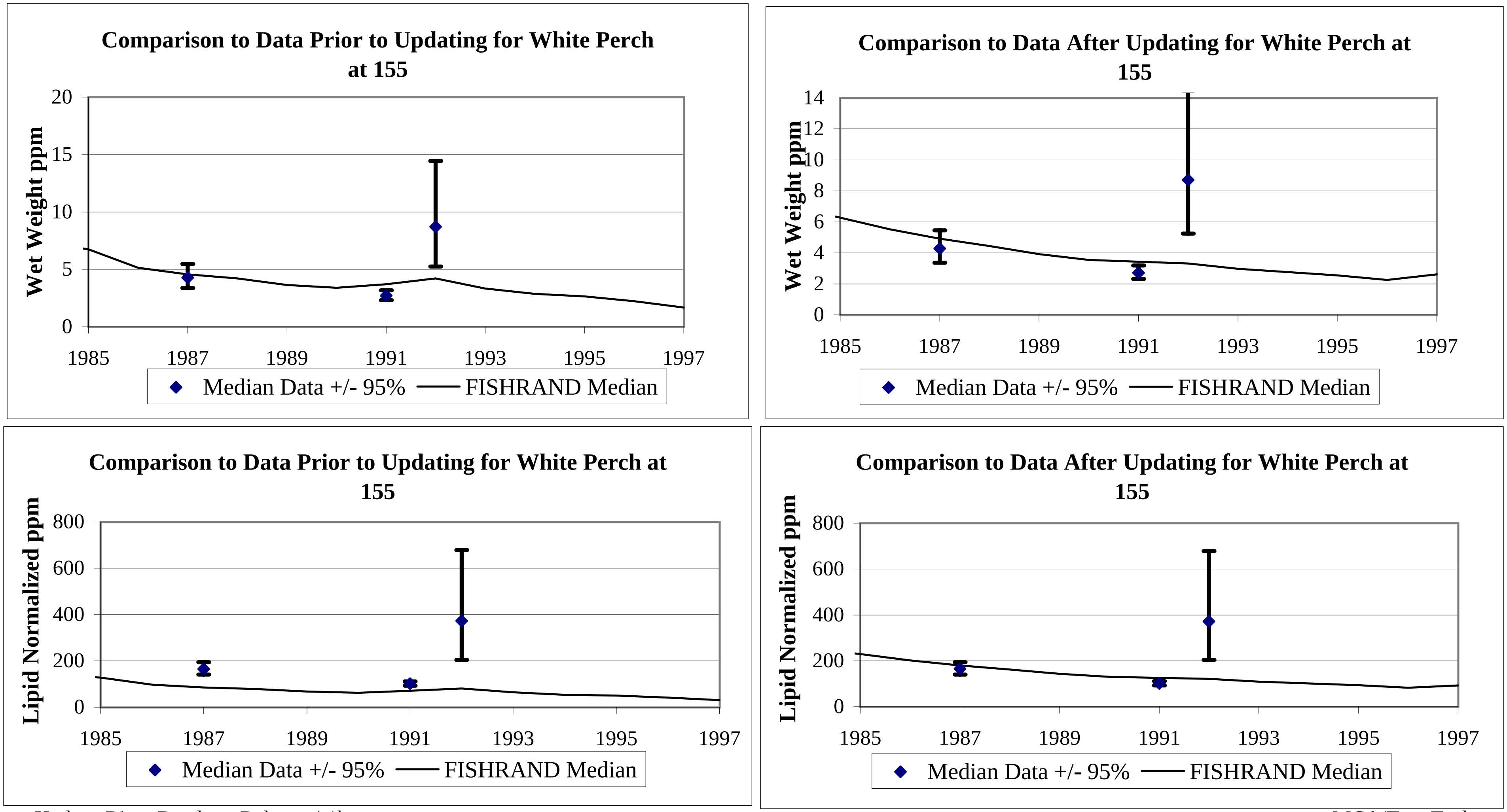


Figure 6-9: Comparison of FISHRAND Model Results Before and After Calibration Procedure for Pumpkinseed

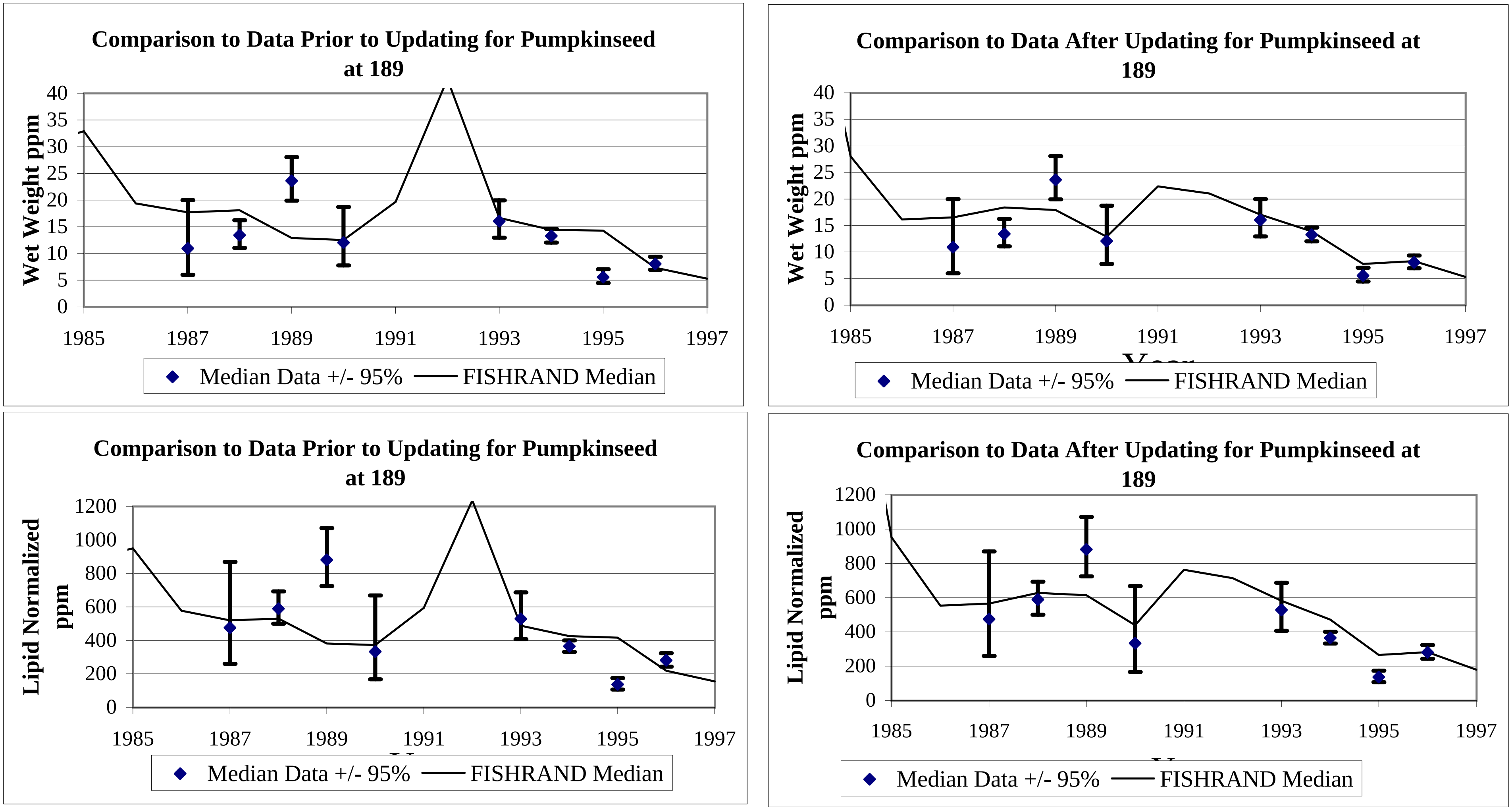
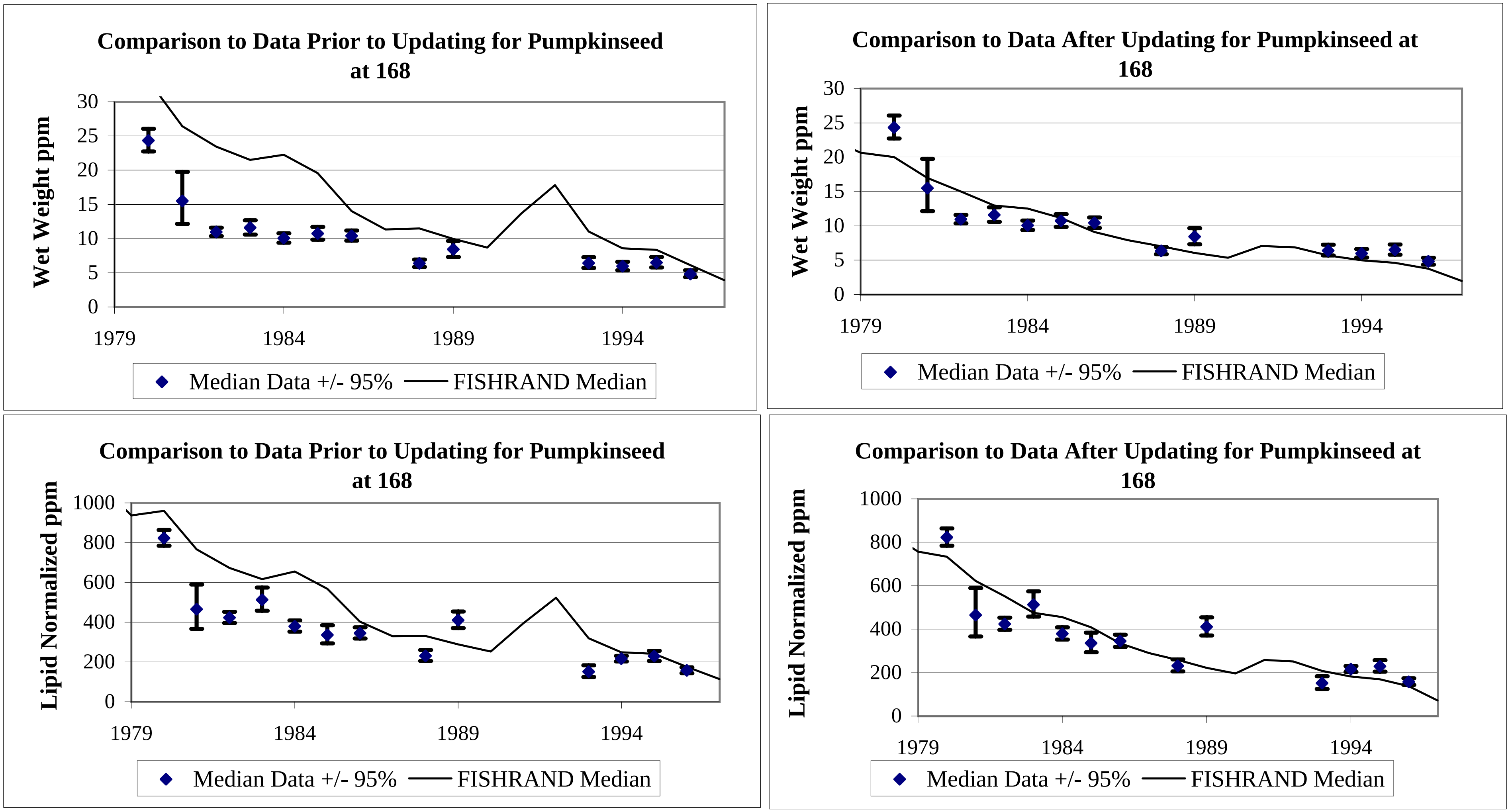


Figure 6-9: Comparison of FISHRAND Model Results Before and After Calibration Procedure for Pumpkinseed, continued



Appendix B

Modeled Estimates of PCBs in Air

B.1 Introduction

In order to assess the impact of volatilization of PCBs from the Upper Hudson, PCB emission estimates were coupled with air dispersion modeling using the Industrial Source Complex (ISC) model. The ISC model is recommended as a preferred model by the U.S. Environmental Protection Agency (USEPA) for use in regulatory and permitting applications. The ISC model was developed by USEPA for determining atmospheric pollutant concentrations associated with point, line, area and volume sources of emission. The model has undergone several revisions to incorporate new features (*e.g.*, Schulman and Hanna 1986; Schulman and Scire 1980) since first being issued by Bowers *et al*. (1979).

The ISC model, based on an advanced steady-state Gaussian plume equation, calculates chemical concentrations at specific downwind locations as a function of wind speed, atmospheric stability, temperature gradient, mixing height and downwind distance. It can account for plume rise, building downwash effect, settling and dry deposition of particulates, receptor elevation and complex terrain adjustment. At each receptor location, the computed concentrations are weighted and averaged according to the joint frequency of occurrence of wind-speed and wind-direction categories, classified by the Pasquill-Gifford atmospheric stability categories.

Two separate versions of the ISC model are available to permit both long-term and short-term air quality impact analysis. The primary difference between the two models is the type of weather data needed as input. The short-term version, ISCST, was designed to calculate contaminant concentrations over time periods as short as one hour. The ISCST model can be used to calculate ambient concentrations over longer time periods (for example one year), simply by averaging the hourly predictions over the appropriate averaging period. Because the ISCST predictions are based upon more detailed meteorologic inputs, the predictions from the ISCST model are more accurate than those estimated using the ISCLT model. The ISCST model requires more detailed weather input data than does the long-term version, ISCLT, which was designed to determine the monthly, seasonal, or annual average concentrations. For this assessment, the current ISC Short Term model, ISCST3 Version 97363, was used to estimate the concentration of PCBs in air in the immediate vicinity of the river.

B.2 Features of the ISC Model

The ISC model[1] provides a range of user-specified and USEPA-recommended default options. The “simple terrain” algorithm of the ISC model, which was adopted here, is appropriate when the topography within the model domain can be described as reasonably flat terrain with elevation variation of less than approximately 30 feet, or when the chemical release point is reasonably close to the ground, which is the case for the current analysis.

The model assumes that pollutants from an emission source disperse in a Gaussian manner, with dispersion coefficients that vary as a function of atmospheric stability. Six atmospheric stability classes (A-F) are used in the model, with A representing the most unstable atmospheric class and F representing the most stable class. For each of these six stability classes, dispersion coefficients are calculated, as a function of distance, to define the spread of the plume from the source in the horizontal and vertical directions.

A set of standard rural or urban dispersion coefficients are used by the ISCST3 model, depending on the location of the source and the surrounding land use. The EPA guidance on the distinction between urban and rural is based on land use within a 3-km radius of the site in question. If over 50% of the land use within a 3 km radius is rural (single-family residential is considered rural), then rural dispersion coefficients are appropriate. Rural dispersion coefficients were adopted for the current assessment. It should be noted that rural atmospheric dispersion coefficients lead to predictions of lower chemical dispersion and mixing than do the urban dispersion coefficients which account for the increased mixing induced by the higher heat fluxes in urban settings and greater mixing induced by air flow around large buildings. Thus, the rural dispersion coefficients used lead to predictions of higher chemical concentrations in the atmosphere.

The standard EPA default regulatory options were used in the ISCST3 modeling. Default vertical wind profile exponents were used for each stability class (A:0.07, B:0.07, C:0.10, D:0.15, E:0.35, F:0.55 for the rural mode). These wind profile exponents define the increase in wind velocity with height. Also, default vertical potential temperature gradients were used for each stability class (A:0.0, B:0.0, C:0.0, D:0.0, E:0.02, F:0.035 ^{o}K/m); these define the strength of the temperature inversion during stable (E and F) atmospheric conditions.

B.3 Meteorological Data

The principal meteorological input required by the ISCST model is hourly meteorological data including the joint frequency of occurrence of wind-speed and wind-direction categories, and mixing heights classified according to the Pasquill stability categories. The meteorologic data was

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[1] “ISC" is used to describe common features possessed by both ISCST3 and ISCLT3 models. "ISCST3" or "ISCLT3" is used if a distinction between the two models exists.

obtained from the National Climatic Data Center for the National Weather Service (NWS) station at Albany New York Airport from EPA's electronic bulletin board service (USEPA, 1998). The most recent full-year (8760 hours) of NWS data from the Albany station was used for the ISCST modeling.

B.4 Source Characterization

Volatile emissions of PCBs from the Upper Hudson River water surface provide the source term for the air modeling performed for this assessment. The PCB flux (μg/sec) from the river surface depends on chemical factors (*e.g.*, the volatility of PCBs and their affinity to partition into air, water, *etc.*); atmospheric conditions, including wind speed, ambient temperature; and the diffusion of PCBs at the water-air interface.

A model incorporating a two-layer film resistance approach is commonly applied to the estimation of chemical volatilization at the air-water interface (Achman *et al.*, 1993; Bopp 1983). The two-layer model accounts for diffusion through a water boundary layer on the water side of the interface, then diffusion through an air boundary layer on the air side of the air-water boundary. Given the complexity and uncertainty of modeling this chemical release, PCB releases were estimated using two approaches. The first approach uses the two-layer model, and the physical-chemical parameters for PCBs determined by Bopp (1983) to estimate the flux of PCBs from the water column into the air. This estimate was compared with an empirical calculation based on actual PCB flux measurements from Green Bay, Lake Michigan (Achman *et al.*, 1993).

According to the two-layer film resistance model, the flux of chemical across the air-water interface is given by (Bopp, 1983):

$$F = K_l (C_w - C_g/H) \qquad [1]$$

and

$$\frac{1}{K_l} = \frac{m_l}{D_l} + \frac{m_g}{HD_g} \qquad [2]$$

where:

F	=	flux (g/cm^2-sec)
C_w	=	chemical concentration in water (g/cm^3)
C_g	=	chemical concentration in bulk gas phase (g/cm^3)

H	=	dimensionless Henry's law constant
K_l	=	mass transfer coefficient (cm/sec)
μ_l, μ_g	=	liquid and gaseous boundary layer thickness (cm)
D_l	=	liquid diffusion coefficient (cm^2/sec)
D_g	=	liquid diffusion coefficient (cm^2/sec)

The mass transfer coefficient is a function of chemical-specific Henry's law constant and chemical diffusion coefficients. Values for tri- and tetrachlorobiphenyl published by Bopp (1983) were used to estimate the PCB mass transfer coefficient. The parameter values, and the mass transfer coefficients calculated using equation [2] are summarized below. The calculated mass transfer coefficients compare favorably with the empirical coefficients determined by Achman *et al*. (1993) based on *in-situ* measurements for total PCBs in Lake Michigan. Achman *et al.* (1993) determined mass transfer coefficients ranging from 0.02 to 0.31 m/day (0.2×10^{-4} to 3.6×10^{-4} cm/sec).

Chemical-Specific Input Parameters for Flux Estimate[a]

Parameter (units)	Trichlorobiphenyl	Tetrachlorobiphenyl
H (dimensionless)	3.3×10^{-2}	1.4×10^{-2}
D_l (cm^2/sec)	0.58×10^{-5}	0.58×10^{-5}
D_g (cm^2/sec)	5.4×10^{-2}	5.2×10^{-2}
K_l (cm/sec) [b]	2.7×10^{-4}	2.2×10^{-4}

Notes:

[a] *Source: Bopp (1983)*

[b] *Calculated using equation [2] with m_l = 0.018 cm and m_g = 1 cm (Bopp, 1983)*

It is typically observed, as suggested by Bopp (1983), that the gas phase term (C_g/H) in Equation [1] is small with respect to the chemical concentration in water (C_w). Under these conditions, the flux of chemical from the water reduces to:

$$F \approx K_l \times C_w \qquad [3]$$

Equation [3] indicates that the flux is linearly proportional to the concentration in water. For a unit concentration in water (1 ng/L ≡ 10^{-12} g/cm^3), the flux of PCBs into the air based on Equation [3] is:

trichlorobiphenyl:	2.7×10^{-7} (ng/cm^2-sec per ng/L)
tetrachlorobiphenyl:	2.2×10^{-7} (ng/cm^2-sec per ng/L)

Given the only slight differences in the flux estimates, the higher flux rate (2.7×10^{-7} ng/cm^2-sec per ng/L) was used as the source term to the ISCST model to estimate the PCB concentration in air.

The flux calculated according to the two-film theory model, was compared with the PCB flux from water estimated based on the field studies performed by Achman *et al*. (1993), who measured PCB volatilization from Lake Michigan on 14 separate days from June to October, 1989. The total PCB concentration in water measured during the study period ranged from 0.35 ng/L to 7.8 ng/L. The measured PCB flux rates ranged from 13 to 1,300 ng/m^2-day. The highest flux rate (1,300 ng/m^2-day) corresponded to a PCB concentration in water of 6.67 ng/L and was measured on a day with a wind speed of 6.5 m/sec (the day with the highest observed wind speed during the study when PCB measurements were taken).

Using the 14 measurements from the Achman *et al*. study, the ordinary least squares linear regression fit to the data gives:

$$\text{Flux (ng/m}^2\text{-day)} = 0.087\ C_l\ \text{(ng/m}^3\text{)} + 47.5 \qquad (R^2=0.31)$$

The data exhibited a significant degree of variability, as evidenced by the low R^2 value. Using this empirical regression equation, the flux of PCBs from water per unit concentration is 134.5 ng/m^2-day per ng/L, or 1.6×10^{-7} ng/cm^2-sec per ng/L. The average normalized flux (average of 14 measurements) measured by Achman *et al*. was 104 ng/m^2-day, or 1.2×10^{-7} ng/cm^2-sec per ng/L. These experimental results are very close to the flux estimate calculated above using the two-layer film resistance theory.

B.5 Scaling Unit Emission Rate to Actual Source Strength

The ISC model yields a predicted chemical concentration (*e.g.*, pg/m^3) at a particular point in space averaged over a particular time period that is linearly proportional to the emission source (in µg/sec). This linear property is common to the Gaussian "advection dispersion" type models widely used for chemical fate and transport not only in air but in soil, groundwater and surface water. Because of the linear relationship between the source emission rate and the predicted ambient chemical concentration in air, the ISC model can be run for a "unit emission source" (*i.e.*, 1 μg/sec), and the results then scaled based on the actual source strength of any particular constituent modeled. This greatly reduces the number of modeling iterations required. The ISC model results for the unit source are converted to the chemical-specific concentration predictions by a simple arithmetic conversion using the chemical-specific emission rates for the source(s) under consideration:

$$C_i(x,y) = C^*(x,y) \times J_i \qquad [1]$$

where:

$C_i(x,y)$	=	chemical concentration of the i^{th} chemical at a particular (x,y) location (pg/m^3)
$C^*(x,y)$	=	normalized chemical concentration in air at a particular (x,y) location per unit emission rate (pg/m^3 per μg/sec emissions)
J_i	=	emission rate for the i^{th} chemical (μg/sec)

For this assessment, a unit source (1 μg/sec) was apportioned to a representative reach of the river, taken as a one kilometer long, by approximately 200 meter wide, which is a representative width of the Upper Hudson in the vicinity of the Thompson Island Pool area.

As described above, the flux rate ($\mu g/cm^2$-sec) is linearly proportional to the concentration of PCBs dissolved in water. Therefore, the ISCST model results can be scaled linearly to the PCB concentration in water.

B.6 Summary of Modeling Results

The average normalized chemical concentration predictions, $C^*(x,y)$, were calculated for receptor points covering a uniform grid (50 m × 50 m) up to 200 meters on either side of this representative stretch of river. The complete ISCST output file is provided in Attachment B-1. A plot of the annual average normalized PCB concentration in air is provided in Figure B-1.

Not surprisingly, the maximum average concentrations are predicted to occur immediately along either side of the river, with slightly higher ambient concentrations predicted along the eastern, or predominantly downwind, bank of the river. The typical concentration along the eastern river bank is on the order of 70 picograms per cubic meter per 1 μg/sec emission source strength (*e.g.*, 70 pg/m^3 per μg/sec). The concentration drops approximately 10-fold as the distance downwind increases to approximately 200 meters. The downwind average normalized concentration within a 200 meter wide zone is approximately 22 pg/m^3 per μg/sec of PCB emissions.

B.7 References

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Table B-1
Airborne PCB Concentrations (ng/m³)

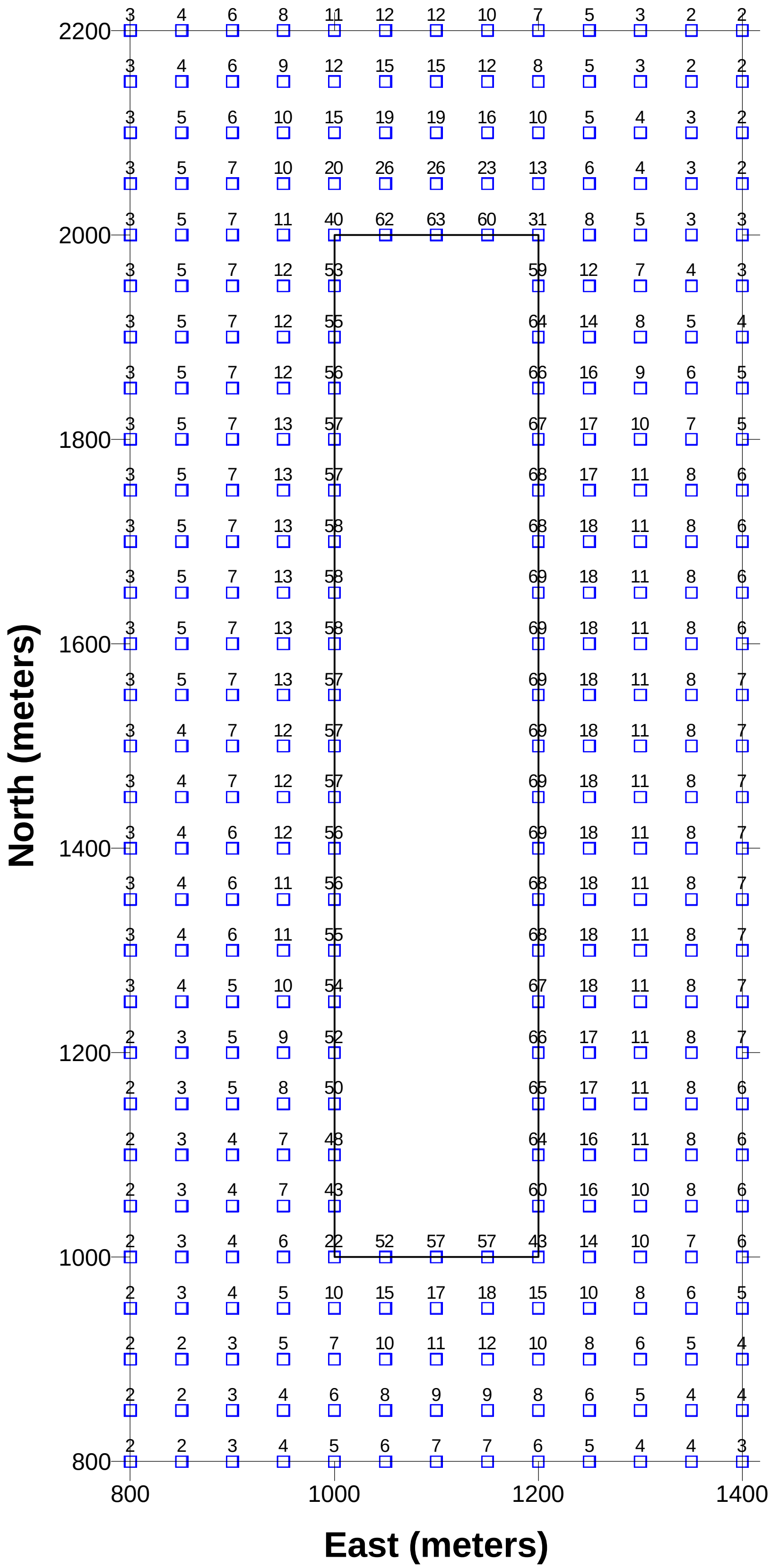
Monitor Height	Date	Location	Aroclor 1221	Aroclor 1242	Aroclor 1254	Total PCBs (a)
1 m	8/25-27/80	A	<10	110	<10	120
1 m	9/5-7/80	A	<10	520	<10	530
1 m	8/19-26/81	A	<0.3	46	1.3	47
1 m	9/2-9/81	A	<0.3	50	1.1	51
1 m	9/16-26/81	A	<0.3	32	0.6	33
1 m	9/10/81	A	<3	60	<2	63
1 m	9/10/81	B	<3	58	<2	61
4.5m	9/10/81	A	<3	39	<2	42
4.5m	9/10/81	B	<3	31	<2	34

Notes:
(a) Total PCB based on summing Aroclor concentrations, including 1/2 the detection limit for non-detected results.
Source: Buckley and Tofflemire (1983)

Table B-2
Summary of PCBs Detected in Air and Corresponding Water Sampling Results
Remnant Deposit Monitoring Program (Harza, 1992)

AIR			WATER		Transfer Coefficient
Site	**Date**	**PCB Conc ($\mu g/m^3$)**	**Associated Water Sample Locations**	**Total PCB ($\mu g/L$)**	**Ratio PCB_{air}/PCB_{h2o}**
A2	9/18/91	0.03	RS2-W1	1.8 (9/19/91)	0.02
			RS2-W2	NS	
			E1	1.1 (9/19/91)	0.03
A3	9/18/91	0.03	RS3-W1	1.5 (9/19/91)	0.02
			RS3-W2	1.8 (9/19/91)	0.02
A4	6/8/91	0.03	RS4-W1	NS	
			E3	0.14 (6/7/91)	0.2
			RS4-W2	NS	
			E4	ND (6/7/91)	
	9/18/91	0.13	RS4-W1	NS	
			E3	1.4 (9/19/91)	0.09
			RS4-W2	NS	
			E4	1.5 (9/19/91)	0.09
	9/18/91	0.11	RS4-W1		
			E3		
			RS4-W2		
			E4		
B3	5/15/91	0.08	RS3-W1	ND	
			RS3-W2	ND	
	5/15/91	0.06	RS3-W1		
			RS3-W2		
	5/21/91	0.04	RS3-W1	0.14	0.3
			RS3-W2	ND	
	5/21/91	0.03	RS3-W1		
			RS3-W2		
	5/24/91	0.06	RS3-W1	NS	
			RS3-W2	NS	
	5/24/91	0.04	RS3-W1		
			RS3-W2		
	5/27/91	0.03	RS3-W1	NS	
			RS3-W2	NS	
	6/8/91	0.05	RS3-W1	0.2	0.3
			RS3-W2	0.14	0.4

ISCST Model Results
Normalized PCB Concentration
(pg/m³ per 1 µg/s)



TAMS/Gradient Corporation

Attachment B-1

ISCST3 Modeling Results

```
**BEE-Line Software: BEEST for Windows data input file
**                   Date: 3/18/99  Time: 10:41:10 AM
NO ECHO


 BEE-Line ISCST3 "BEEST" Version 6.61

 Input File - C:\Beework\hudson.DTA
Output File - C:\Beework\hudson.LST
   Met File - C:\Beework\METDATA\ALBAN91.MET


***********************************
*** SETUP Finishes Successfully ***
***********************************
```

```
**MODELOPTs: CONC                         RURAL  FLAT          DFAULT

                                           ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses NO DRY DEPLETION.  DDPLETE =  F
**Model Uses NO WET DEPLETION.  WDPLETE =  F
**NO WET SCAVENGING Data Provided.
**Model Does NOT Use GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
           1. Final Plume Rise.
           2. Stack-tip Downwash.
           3. Buoyancy-induced Dispersion.
           4. Use Calms Processing Routine.
           5. Not Use Missing Data Processing Routine.
           6. Default Wind Profile Exponents.
           7. Default Vertical Potential Temperature Gradients.
           8. "Upper Bound" Values for Supersquat Buildings.
           9. No Exponential Decay for RURAL Mode

**Model Assumes Receptors on FLAT Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Calculates ANNUAL Averages Only

**This Run Includes:     1 Source(s);      1 Source Group(s); and     320 Receptor(s)

**The Model Assumes A Pollutant Type of:  OTHER

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
         Model Outputs Tables of ANNUAL Averages by Receptor
         Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    10.00 ;    Decay Coef. =    0.000     ;    Rot. Angle =     0.0
                 Emission Units = UG/S                                     ;  Emission Rate Unit Factor =   0.10000E+07
                 Output Units   = PG/M

**Approximate Storage Requirements of Model =     1.2 MB of RAM.

**Input Runstream File:          C:\Beework\hudson.DTA
**Output Print File:             C:\Beework\hudson.LST
```

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** AREA SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC /METER**2)	COORD (SW CORNER) X (METERS)	COORD (SW CORNER) Y (METERS)	BASE ELEV. (METERS)	RELEASE HEIGHT (METERS)	X-DIM OF AREA (METERS)	Y-DIM OF AREA (METERS)	ORIENT. OF AREA (DEG.)	INIT. SZ (METERS)	EMISSION RATE SCALAR VARY BY
RIVER	0	0.50000E-05	1000.0	1000.0	0.0	0.00	200.00	1000.00	0.00	0.00	

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID	SOURCE IDs
ALL	RIVER ,

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(   1000.0,    1400.0,       0.0,       0.0);
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(   1000.0,    1600.0,       0.0,       0.0);
(   1000.0,    1700.0,       0.0,       0.0);
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(   1000.0,    1900.0,       0.0,       0.0);
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(   1200.0,    1800.0,       0.0,       0.0);
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(   1200.0,    1500.0,       0.0,       0.0);
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(   1000.0,     800.0,       0.0,       0.0);
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(   1200.0,     800.0,       0.0,       0.0);
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(   1150.0,     850.0,       0.0,       0.0);
(   1250.0,     850.0,       0.0,       0.0);
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(    900.0,     900.0,       0.0,       0.0);
(   1000.0,     900.0,       0.0,       0.0);
(   1100.0,     900.0,       0.0,       0.0);
(   1200.0,     900.0,       0.0,       0.0);
(   1300.0,     900.0,       0.0,       0.0);
(   1400.0,     900.0,       0.0,       0.0);
(    850.0,     950.0,       0.0,       0.0);
(   1000.0,    1150.0,       0.0,       0.0);
(   1000.0,    1250.0,       0.0,       0.0);
(   1000.0,    1350.0,       0.0,       0.0);
(   1000.0,    1450.0,       0.0,       0.0);
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(   1200.0,    1550.0,       0.0,       0.0);
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(   1050.0,    1000.0,       0.0,       0.0);
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(    950.0,     800.0,       0.0,       0.0);
(   1050.0,     800.0,       0.0,       0.0);
(   1150.0,     800.0,       0.0,       0.0);
(   1250.0,     800.0,       0.0,       0.0);
(   1350.0,     800.0,       0.0,       0.0);
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(   1000.0,     850.0,       0.0,       0.0);
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(   1200.0,     850.0,       0.0,       0.0);
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(   1400.0,     850.0,       0.0,       0.0);
(    850.0,     900.0,       0.0,       0.0);
(    950.0,     900.0,       0.0,       0.0);
(   1050.0,     900.0,       0.0,       0.0);
(   1150.0,     900.0,       0.0,       0.0);
(   1250.0,     900.0,       0.0,       0.0);
(   1350.0,     900.0,       0.0,       0.0);
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(    900.0,     950.0,       0.0,       0.0);
```

```
                                             *** DISCRETE CARTESIAN RECEPTORS ***
                                               (X-COORD, Y-COORD, ZELEV, ZFLAG)
                                                           (METERS)

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   (   1350.0,     950.0,       0.0,       0.0);         (   1400.0,     950.0,       0.0,       0.0);
   (    800.0,    1000.0,       0.0,       0.0);         (    850.0,    1000.0,       0.0,       0.0);
   (    900.0,    1000.0,       0.0,       0.0);         (    950.0,    1000.0,       0.0,       0.0);
   (   1250.0,    1000.0,       0.0,       0.0);         (   1300.0,    1000.0,       0.0,       0.0);
   (   1350.0,    1000.0,       0.0,       0.0);         (   1400.0,    1000.0,       0.0,       0.0);
   (    800.0,    1050.0,       0.0,       0.0);         (    850.0,    1050.0,       0.0,       0.0);
   (    900.0,    1050.0,       0.0,       0.0);         (    950.0,    1050.0,       0.0,       0.0);
   (   1250.0,    1050.0,       0.0,       0.0);         (   1300.0,    1050.0,       0.0,       0.0);
   (   1350.0,    1050.0,       0.0,       0.0);         (   1400.0,    1050.0,       0.0,       0.0);
   (    800.0,    1100.0,       0.0,       0.0);         (    850.0,    1100.0,       0.0,       0.0);
   (    900.0,    1100.0,       0.0,       0.0);         (    950.0,    1100.0,       0.0,       0.0);
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   (   1350.0,    1100.0,       0.0,       0.0);         (   1400.0,    1100.0,       0.0,       0.0);
   (    800.0,    1150.0,       0.0,       0.0);         (    850.0,    1150.0,       0.0,       0.0);
   (    900.0,    1150.0,       0.0,       0.0);         (    950.0,    1150.0,       0.0,       0.0);
   (   1250.0,    1150.0,       0.0,       0.0);         (   1300.0,    1150.0,       0.0,       0.0);
   (   1350.0,    1150.0,       0.0,       0.0);         (   1400.0,    1150.0,       0.0,       0.0);
   (    800.0,    1200.0,       0.0,       0.0);         (    850.0,    1200.0,       0.0,       0.0);
   (    900.0,    1200.0,       0.0,       0.0);         (    950.0,    1200.0,       0.0,       0.0);
   (   1250.0,    1200.0,       0.0,       0.0);         (   1300.0,    1200.0,       0.0,       0.0);
   (   1350.0,    1200.0,       0.0,       0.0);         (   1400.0,    1200.0,       0.0,       0.0);
   (    800.0,    1250.0,       0.0,       0.0);         (    850.0,    1250.0,       0.0,       0.0);
   (    900.0,    1250.0,       0.0,       0.0);         (    950.0,    1250.0,       0.0,       0.0);
   (   1250.0,    1250.0,       0.0,       0.0);         (   1300.0,    1250.0,       0.0,       0.0);
   (   1350.0,    1250.0,       0.0,       0.0);         (   1400.0,    1250.0,       0.0,       0.0);
   (    800.0,    1300.0,       0.0,       0.0);         (    850.0,    1300.0,       0.0,       0.0);
   (    900.0,    1300.0,       0.0,       0.0);         (    950.0,    1300.0,       0.0,       0.0);
   (   1250.0,    1300.0,       0.0,       0.0);         (   1300.0,    1300.0,       0.0,       0.0);
   (   1350.0,    1300.0,       0.0,       0.0);         (   1400.0,    1300.0,       0.0,       0.0);
   (    800.0,    1350.0,       0.0,       0.0);         (    850.0,    1350.0,       0.0,       0.0);
   (    900.0,    1350.0,       0.0,       0.0);         (    950.0,    1350.0,       0.0,       0.0);
   (   1250.0,    1350.0,       0.0,       0.0);         (   1300.0,    1350.0,       0.0,       0.0);
   (   1350.0,    1350.0,       0.0,       0.0);         (   1400.0,    1350.0,       0.0,       0.0);
   (    800.0,    1400.0,       0.0,       0.0);         (    850.0,    1400.0,       0.0,       0.0);
   (    900.0,    1400.0,       0.0,       0.0);         (    950.0,    1400.0,       0.0,       0.0);
   (   1250.0,    1400.0,       0.0,       0.0);         (   1300.0,    1400.0,       0.0,       0.0);
   (   1350.0,    1400.0,       0.0,       0.0);         (   1400.0,    1400.0,       0.0,       0.0);
   (    800.0,    1450.0,       0.0,       0.0);         (    850.0,    1450.0,       0.0,       0.0);
   (    900.0,    1450.0,       0.0,       0.0);         (    950.0,    1450.0,       0.0,       0.0);
   (   1250.0,    1450.0,       0.0,       0.0);         (   1300.0,    1450.0,       0.0,       0.0);
   (   1350.0,    1450.0,       0.0,       0.0);         (   1400.0,    1450.0,       0.0,       0.0);
```

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

```
(     800.0,    1500.0,       0.0,       0.0);        (     850.0,    1500.0,       0.0,       0.0);
(     900.0,    1500.0,       0.0,       0.0);        (     950.0,    1500.0,       0.0,       0.0);
(    1250.0,    1500.0,       0.0,       0.0);        (    1300.0,    1500.0,       0.0,       0.0);
(    1350.0,    1500.0,       0.0,       0.0);        (    1400.0,    1500.0,       0.0,       0.0);
(     800.0,    1550.0,       0.0,       0.0);        (     850.0,    1550.0,       0.0,       0.0);
(     900.0,    1550.0,       0.0,       0.0);        (     950.0,    1550.0,       0.0,       0.0);
(    1250.0,    1550.0,       0.0,       0.0);        (    1300.0,    1550.0,       0.0,       0.0);
(    1350.0,    1550.0,       0.0,       0.0);        (    1400.0,    1550.0,       0.0,       0.0);
(     800.0,    1600.0,       0.0,       0.0);        (     850.0,    1600.0,       0.0,       0.0);
(     900.0,    1600.0,       0.0,       0.0);        (     950.0,    1600.0,       0.0,       0.0);
(    1250.0,    1600.0,       0.0,       0.0);        (    1300.0,    1600.0,       0.0,       0.0);
(    1350.0,    1600.0,       0.0,       0.0);        (    1400.0,    1600.0,       0.0,       0.0);
(     800.0,    1650.0,       0.0,       0.0);        (     850.0,    1650.0,       0.0,       0.0);
(     900.0,    1650.0,       0.0,       0.0);        (     950.0,    1650.0,       0.0,       0.0);
(    1250.0,    1650.0,       0.0,       0.0);        (    1300.0,    1650.0,       0.0,       0.0);
(    1350.0,    1650.0,       0.0,       0.0);        (    1400.0,    1650.0,       0.0,       0.0);
(     800.0,    1700.0,       0.0,       0.0);        (     850.0,    1700.0,       0.0,       0.0);
(     900.0,    1700.0,       0.0,       0.0);        (     950.0,    1700.0,       0.0,       0.0);
(    1250.0,    1700.0,       0.0,       0.0);        (    1300.0,    1700.0,       0.0,       0.0);
(    1350.0,    1700.0,       0.0,       0.0);        (    1400.0,    1700.0,       0.0,       0.0);
(     800.0,    1750.0,       0.0,       0.0);        (     850.0,    1750.0,       0.0,       0.0);
(     900.0,    1750.0,       0.0,       0.0);        (     950.0,    1750.0,       0.0,       0.0);
(    1250.0,    1750.0,       0.0,       0.0);        (    1300.0,    1750.0,       0.0,       0.0);
(    1350.0,    1750.0,       0.0,       0.0);        (    1400.0,    1750.0,       0.0,       0.0);
(     800.0,    1800.0,       0.0,       0.0);        (     850.0,    1800.0,       0.0,       0.0);
(     900.0,    1800.0,       0.0,       0.0);        (     950.0,    1800.0,       0.0,       0.0);
(    1250.0,    1800.0,       0.0,       0.0);        (    1300.0,    1800.0,       0.0,       0.0);
(    1350.0,    1800.0,       0.0,       0.0);        (    1400.0,    1800.0,       0.0,       0.0);
(     800.0,    1850.0,       0.0,       0.0);        (     850.0,    1850.0,       0.0,       0.0);
(     900.0,    1850.0,       0.0,       0.0);        (     950.0,    1850.0,       0.0,       0.0);
(    1250.0,    1850.0,       0.0,       0.0);        (    1300.0,    1850.0,       0.0,       0.0);
(    1350.0,    1850.0,       0.0,       0.0);        (    1400.0,    1850.0,       0.0,       0.0);
(     800.0,    1900.0,       0.0,       0.0);        (     850.0,    1900.0,       0.0,       0.0);
(     900.0,    1900.0,       0.0,       0.0);        (     950.0,    1900.0,       0.0,       0.0);
(    1250.0,    1900.0,       0.0,       0.0);        (    1300.0,    1900.0,       0.0,       0.0);
(    1350.0,    1900.0,       0.0,       0.0);        (    1400.0,    1900.0,       0.0,       0.0);
(     800.0,    1950.0,       0.0,       0.0);        (     850.0,    1950.0,       0.0,       0.0);
(     900.0,    1950.0,       0.0,       0.0);        (     950.0,    1950.0,       0.0,       0.0);
(    1250.0,    1950.0,       0.0,       0.0);        (    1300.0,    1950.0,       0.0,       0.0);
(    1350.0,    1950.0,       0.0,       0.0);        (    1400.0,    1950.0,       0.0,       0.0);
(     800.0,    2000.0,       0.0,       0.0);        (     850.0,    2000.0,       0.0,       0.0);
(     900.0,    2000.0,       0.0,       0.0);        (     950.0,    2000.0,       0.0,       0.0);
(    1250.0,    2000.0,       0.0,       0.0);        (    1300.0,    2000.0,       0.0,       0.0);
(    1350.0,    2000.0,       0.0,       0.0);        (    1400.0,    2000.0,       0.0,       0.0);
(     800.0,    2050.0,       0.0,       0.0);        (     850.0,    2050.0,       0.0,       0.0);
```

**MODELOPTs: CONC RURAL FLAT DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

```
(    900.0,    2050.0,       0.0,       0.0);         (    950.0,    2050.0,       0.0,       0.0);
(   1000.0,    2050.0,       0.0,       0.0);         (   1050.0,    2050.0,       0.0,       0.0);
(   1100.0,    2050.0,       0.0,       0.0);         (   1150.0,    2050.0,       0.0,       0.0);
(   1200.0,    2050.0,       0.0,       0.0);         (   1250.0,    2050.0,       0.0,       0.0);
(   1300.0,    2050.0,       0.0,       0.0);         (   1350.0,    2050.0,       0.0,       0.0);
(   1400.0,    2050.0,       0.0,       0.0);         (    800.0,    2100.0,       0.0,       0.0);
(    850.0,    2100.0,       0.0,       0.0);         (    900.0,    2100.0,       0.0,       0.0);
(    950.0,    2100.0,       0.0,       0.0);         (   1000.0,    2100.0,       0.0,       0.0);
(   1050.0,    2100.0,       0.0,       0.0);         (   1100.0,    2100.0,       0.0,       0.0);
(   1150.0,    2100.0,       0.0,       0.0);         (   1200.0,    2100.0,       0.0,       0.0);
(   1250.0,    2100.0,       0.0,       0.0);         (   1300.0,    2100.0,       0.0,       0.0);
(   1350.0,    2100.0,       0.0,       0.0);         (   1400.0,    2100.0,       0.0,       0.0);
(    800.0,    2150.0,       0.0,       0.0);         (    850.0,    2150.0,       0.0,       0.0);
(    900.0,    2150.0,       0.0,       0.0);         (    950.0,    2150.0,       0.0,       0.0);
(   1000.0,    2150.0,       0.0,       0.0);         (   1050.0,    2150.0,       0.0,       0.0);
(   1100.0,    2150.0,       0.0,       0.0);         (   1150.0,    2150.0,       0.0,       0.0);
(   1200.0,    2150.0,       0.0,       0.0);         (   1250.0,    2150.0,       0.0,       0.0);
(   1300.0,    2150.0,       0.0,       0.0);         (   1350.0,    2150.0,       0.0,       0.0);
(   1400.0,    2150.0,       0.0,       0.0);         (    800.0,    2200.0,       0.0,       0.0);
(    850.0,    2200.0,       0.0,       0.0);         (    900.0,    2200.0,       0.0,       0.0);
(    950.0,    2200.0,       0.0,       0.0);         (   1000.0,    2200.0,       0.0,       0.0);
(   1050.0,    2200.0,       0.0,       0.0);         (   1100.0,    2200.0,       0.0,       0.0);
(   1150.0,    2200.0,       0.0,       0.0);         (   1200.0,    2200.0,       0.0,       0.0);
(   1250.0,    2200.0,       0.0,       0.0);         (   1300.0,    2200.0,       0.0,       0.0);
(   1350.0,    2200.0,       0.0,       0.0);         (   1400.0,    2200.0,       0.0,       0.0);
```

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

```
1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1
```

NOTE: METEOROLOGICAL DATA ACTUALLY PROCESSED WILL ALSO DEPEND ON WHAT IS INCLUDED IN THE DATA FILE.

*** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***
(METERS/SEC)

1.54,   3.09,   5.14,   8.23, 10.80,

*** WIND PROFILE EXPONENTS ***

STABILITY	WIND SPEED CATEGORY					
CATEGORY	1	2	3	4	5	6
A	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
B	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
C	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00
D	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00
E	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00
F	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00

*** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***
(DEGREES KELVIN PER METER)

STABILITY	WIND SPEED CATEGORY					
CATEGORY	1	2	3	4	5	6
A	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
B	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
C	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
D	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
E	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01
F	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: C:\Beework\METDATA\ALBAN91.MET
FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,i4,f7.2)
SURFACE STATION NO.: 14735   UPPER AIR STATION NO.: 14735
NAME: UNKNOWN   NAME: UNKNOWN
YEAR: 1991   YEAR: 1991

YR	MN	DY	HR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	IPCODE	PRATE (mm/HR)
91	1	1	1	121.0	2.57	263.7	6	1179.8	484.0	0.0000	0.0	0.0000	0	0.00
91	1	1	2	188.0	1.54	263.1	6	1179.0	484.0	0.0000	0.0	0.0000	0	0.00
91	1	1	3	214.0	1.54	264.3	6	1178.2	484.0	0.0000	0.0	0.0000	0	0.00
91	1	1	4	13.0	1.54	263.1	7	1177.3	484.0	0.0000	0.0	0.0000	0	0.00
91	1	1	5	33.0	2.06	263.1	6	1176.5	484.0	0.0000	0.0	0.0000	0	0.00
91	1	1	6	352.0	2.57	262.6	6	1175.7	484.0	0.0000	0.0	0.0000	0	0.00
91	1	1	7	355.0	0.00	262.6	7	1174.8	484.0	0.0000	0.0	0.0000	0	0.00
91	1	1	8	323.0	2.06	263.7	6	86.1	534.5	0.0000	0.0	0.0000	0	0.00
91	1	1	9	357.0	4.12	265.4	5	266.6	640.2	0.0000	0.0	0.0000	0	0.00
91	1	1	10	351.0	4.63	267.0	4	447.1	746.0	0.0000	0.0	0.0000	0	0.00
91	1	1	11	354.0	4.12	269.3	3	627.6	851.7	0.0000	0.0	0.0000	0	0.00
91	1	1	12	346.0	3.09	270.4	4	808.0	957.5	0.0000	0.0	0.0000	0	0.00
91	1	1	13	353.0	2.57	271.5	4	988.5	1063.2	0.0000	0.0	0.0000	0	0.00
91	1	1	14	359.0	3.60	271.5	4	1169.0	1169.0	0.0000	0.0	0.0000	0	0.00
91	1	1	15	2.0	3.60	272.0	4	1169.0	1169.0	0.0000	0.0	0.0000	0	0.00
91	1	1	16	354.0	3.09	272.0	4	1169.0	1169.0	0.0000	0.0	0.0000	0	0.00
91	1	1	17	341.0	4.12	272.6	4	1163.8	1163.8	0.0000	0.0	0.0000	0	0.00
91	1	1	18	347.0	5.14	273.1	4	1154.6	1154.6	0.0000	0.0	0.0000	0	0.00
91	1	1	19	344.0	6.17	272.6	4	1145.4	1145.4	0.0000	0.0	0.0000	0	0.00
91	1	1	20	347.0	4.63	272.0	5	1136.2	789.4	0.0000	0.0	0.0000	0	0.00
91	1	1	21	340.0	5.14	271.5	5	1127.1	683.0	0.0000	0.0	0.0000	0	0.00
91	1	1	22	342.0	5.14	271.5	5	1117.9	576.7	0.0000	0.0	0.0000	0	0.00
91	1	1	23	350.0	4.63	270.9	5	1108.7	470.3	0.0000	0.0	0.0000	0	0.00
91	1	1	24	340.0	4.63	270.9	5	1099.5	364.0	0.0000	0.0	0.0000	0	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

1000.00	1100.00	47.50103	1000.00	1150.00	50.25271
1000.00	1200.00	52.20403	1000.00	1250.00	53.62135
1000.00	1300.00	54.71456	1000.00	1350.00	55.58282
1000.00	1400.00	56.27484	1000.00	1450.00	56.81124
1000.00	1500.00	57.23437	1000.00	1550.00	57.48371
1000.00	1600.00	57.61974	1000.00	1650.00	57.64756
1000.00	1700.00	57.56608	1000.00	1750.00	57.34848
1000.00	1800.00	56.93792	1000.00	1850.00	56.19948
1000.00	1900.00	54.97485	1000.00	1950.00	52.66998
1000.00	2000.00	40.45110	1050.00	2000.00	62.16137
1100.00	2000.00	63.03386	1150.00	2000.00	59.93647
1200.00	2000.00	30.52155	1200.00	1950.00	58.85975
1200.00	1900.00	63.55464	1200.00	1850.00	65.82605
1200.00	1800.00	67.10719	1200.00	1750.00	67.85329
1200.00	1700.00	68.33302	1200.00	1650.00	68.63849
1200.00	1600.00	68.85168	1200.00	1550.00	68.93349
1200.00	1500.00	68.93752	1200.00	1450.00	68.80656
1200.00	1400.00	68.57832	1200.00	1350.00	68.25227
1200.00	1300.00	67.80934	1200.00	1250.00	67.23401
1200.00	1200.00	66.43845	1200.00	1150.00	65.28090
1200.00	1100.00	63.53041	1200.00	1050.00	60.45412
1200.00	1000.00	43.19268	1150.00	1000.00	57.37995
1100.00	1000.00	56.52396	1050.00	1000.00	51.99488
800.00	800.00	1.71132	850.00	800.00	2.09794
900.00	800.00	2.65345	950.00	800.00	3.53305
1000.00	800.00	4.89268	1050.00	800.00	6.23722
1100.00	800.00	7.07984	1150.00	800.00	7.05333
1200.00	800.00	6.19377	1250.00	800.00	5.06923
1300.00	800.00	4.12667	1350.00	800.00	3.57315
1400.00	800.00	3.20853	800.00	850.00	1.82337
850.00	850.00	2.27357	900.00	850.00	2.92581
950.00	850.00	3.99271	1000.00	850.00	5.83157
1050.00	850.00	7.75454	1100.00	850.00	8.76458
1150.00	850.00	8.74653	1200.00	850.00	7.60235
1250.00	850.00	6.02888	1300.00	850.00	4.96236
1350.00	850.00	4.31338	1400.00	850.00	3.80759
800.00	900.00	1.92499	850.00	900.00	2.44381
900.00	900.00	3.23949	950.00	900.00	4.57338
1000.00	900.00	7.22578	1050.00	900.00	10.17241

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** THE ANNUAL (1 YRS) AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP: ALL   ***
INCLUDING SOURCE(S):   RIVER   ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF OTHER   IN PG/M   **

X-COORD (M)	Y-COORD (M)	CONC	X-COORD (M)	Y-COORD (M)	CONC
1100.00	900.00	11.47499	1150.00	900.00	11.62601
1200.00	900.00	9.99092	1250.00	900.00	7.56808
1300.00	900.00	6.22603	1350.00	900.00	5.24577
1400.00	900.00	4.47277	800.00	950.00	2.02206
850.00	950.00	2.60182	900.00	950.00	3.54064
950.00	950.00	5.29063	1000.00	950.00	9.69326
1050.00	950.00	14.87307	1100.00	950.00	17.25429
1150.00	950.00	17.74545	1200.00	950.00	14.76254
1250.00	950.00	10.28474	1300.00	950.00	7.88130
1350.00	950.00	6.24828	1400.00	950.00	5.13477
800.00	1000.00	2.14564	850.00	1000.00	2.79230
900.00	1000.00	3.87225	950.00	1000.00	6.07374
1250.00	1000.00	14.04338	1300.00	1000.00	9.51243
1350.00	1000.00	7.17653	1400.00	1000.00	5.74568
800.00	1050.00	2.23053	850.00	1050.00	2.92121
900.00	1050.00	4.10313	950.00	1050.00	6.68728
1250.00	1050.00	15.74475	1300.00	1050.00	10.40069
1350.00	1050.00	7.73811	1400.00	1050.00	6.13843
800.00	1100.00	2.27582	850.00	1100.00	3.02233
900.00	1100.00	4.35000	950.00	1100.00	7.49496
1250.00	1100.00	16.49319	1300.00	1100.00	10.80454
1350.00	1100.00	8.01431	1400.00	1100.00	6.36010
800.00	1150.00	2.34492	850.00	1150.00	3.16385
900.00	1150.00	4.66363	950.00	1150.00	8.40458
1250.00	1150.00	16.97028	1300.00	1150.00	11.06846
1350.00	1150.00	8.18003	1400.00	1150.00	6.47795
800.00	1200.00	2.43513	850.00	1200.00	3.32748
900.00	1200.00	5.03939	950.00	1200.00	9.24351
1250.00	1200.00	17.28089	1300.00	1200.00	11.23282
1350.00	1200.00	8.29107	1400.00	1200.00	6.56854
800.00	1250.00	2.53023	850.00	1250.00	3.52037
900.00	1250.00	5.41777	950.00	1250.00	9.99459
1250.00	1250.00	17.57410	1300.00	1250.00	11.37267
1350.00	1250.00	8.39251	1400.00	1250.00	6.64296
800.00	1300.00	2.64137	850.00	1300.00	3.72551
900.00	1300.00	5.78423	950.00	1300.00	10.66136
1250.00	1300.00	17.77308	1300.00	1300.00	11.44867
1350.00	1300.00	8.44976	1400.00	1300.00	6.68927
800.00	1350.00	2.76531	850.00	1350.00	3.93330
900.00	1350.00	6.12460	950.00	1350.00	11.23338

**MODELOPTs: CONC RURAL FLAT DFAULT

*** THE ANNUAL (1 YRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): RIVER ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF OTHER IN PG/M **

X-COORD (M)	Y-COORD (M)	CONC	X-COORD (M)	Y-COORD (M)	CONC
1250.00	1350.00	17.92351	1300.00	1350.00	11.48068
1350.00	1350.00	8.47758	1400.00	1350.00	6.72504
800.00	1400.00	2.89661	850.00	1400.00	4.13610
900.00	1400.00	6.42739	950.00	1400.00	11.70851
1250.00	1400.00	18.02281	1300.00	1400.00	11.48968
1350.00	1400.00	8.44733	1400.00	1400.00	6.73121
800.00	1450.00	3.02478	850.00	1450.00	4.32314
900.00	1450.00	6.69188	950.00	1450.00	12.09709
1250.00	1450.00	18.07342	1300.00	1450.00	11.47856
1350.00	1450.00	8.46418	1400.00	1450.00	6.71343
800.00	1500.00	3.14226	850.00	1500.00	4.48695
900.00	1500.00	6.91755	950.00	1500.00	12.40904
1250.00	1500.00	18.07918	1300.00	1500.00	11.44505
1350.00	1500.00	8.42549	1400.00	1500.00	6.67164
800.00	1550.00	3.24445	850.00	1550.00	4.62138
900.00	1550.00	7.10563	950.00	1550.00	12.64957
1250.00	1550.00	18.03699	1300.00	1550.00	11.38648
1350.00	1550.00	8.35973	1400.00	1550.00	6.60078
800.00	1600.00	3.32626	850.00	1600.00	4.71823
900.00	1600.00	7.25438	950.00	1600.00	12.82312
1250.00	1600.00	17.94057	1300.00	1600.00	11.29694
1350.00	1600.00	8.26190	1400.00	1600.00	6.48852
800.00	1650.00	3.38384	850.00	1650.00	4.80180
900.00	1650.00	7.35930	950.00	1650.00	12.92826
1250.00	1650.00	17.77885	1300.00	1650.00	11.16586
1350.00	1650.00	8.11881	1400.00	1650.00	6.31361
800.00	1700.00	3.41242	850.00	1700.00	4.84942
900.00	1700.00	7.41567	950.00	1700.00	12.95698
1250.00	1700.00	17.53460	1300.00	1700.00	10.97170
1350.00	1700.00	7.89871	1400.00	1700.00	6.05283
800.00	1750.00	3.42700	850.00	1750.00	4.86509
900.00	1750.00	7.41404	950.00	1750.00	12.90482
1250.00	1750.00	17.17905	1300.00	1750.00	10.66610
1350.00	1750.00	7.55333	1400.00	1750.00	5.68428
800.00	1800.00	3.42856	850.00	1800.00	4.82506
900.00	1800.00	7.33115	950.00	1800.00	12.73545
1250.00	1800.00	16.63605	1300.00	1800.00	10.17012
1350.00	1800.00	7.04240	1400.00	1800.00	5.19690
800.00	1850.00	3.42112	850.00	1850.00	4.80525
900.00	1850.00	7.25945	950.00	1850.00	12.48831

**MODELOPTs: CONC RURAL FLAT DFAULT

*** THE ANNUAL (1 YRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): RIVER ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF OTHER IN PG/M **

X-COORD (M)	Y-COORD (M)	CONC	X-COORD (M)	Y-COORD (M)	CONC
1250.00	1850.00	15.76420	1300.00	1850.00	9.37212
1350.00	1850.00	6.31179	1400.00	1850.00	4.59092
800.00	1900.00	3.41695	850.00	1900.00	4.75733
900.00	1900.00	7.09176	950.00	1900.00	12.08076
1250.00	1900.00	14.28900	1300.00	1900.00	8.13863
1350.00	1900.00	5.38364	1400.00	1900.00	3.91706
800.00	1950.00	3.40993	850.00	1950.00	4.70961
900.00	1950.00	6.91910	950.00	1950.00	11.51345
1250.00	1950.00	11.62837	1300.00	1950.00	6.50294
1350.00	1950.00	4.38036	1400.00	1950.00	3.24484
800.00	2000.00	3.36931	850.00	2000.00	4.61827
900.00	2000.00	6.70275	950.00	2000.00	10.85766
1250.00	2000.00	7.90739	1300.00	2000.00	4.88160
1350.00	2000.00	3.44472	1400.00	2000.00	2.62147
800.00	2050.00	3.36040	850.00	2050.00	4.57935
900.00	2050.00	6.57309	950.00	2050.00	10.35232
1000.00	2050.00	19.72559	1050.00	2050.00	25.73849
1100.00	2050.00	25.86624	1150.00	2050.00	22.77712
1200.00	2050.00	13.24762	1250.00	2050.00	6.22397
1300.00	2050.00	3.99196	1350.00	2050.00	2.87120
1400.00	2050.00	2.21432	800.00	2100.00	3.38354
850.00	2100.00	4.55844	900.00	2100.00	6.41473
950.00	2100.00	9.62609	1000.00	2100.00	15.19395
1050.00	2100.00	18.84926	1100.00	2100.00	18.71589
1150.00	2100.00	16.01717	1200.00	2100.00	10.17593
1250.00	2100.00	5.47558	1300.00	2100.00	3.57546
1350.00	2100.00	2.57722	1400.00	2100.00	1.97631
800.00	2150.00	3.37633	850.00	2150.00	4.48595
900.00	2150.00	6.17376	950.00	2150.00	8.79050
1000.00	2150.00	12.48498	1050.00	2150.00	14.92951
1100.00	2150.00	14.71947	1150.00	2150.00	12.48565
1200.00	2150.00	8.45336	1250.00	2150.00	4.97807
1300.00	2150.00	3.28740	1350.00	2150.00	2.38715
1400.00	2150.00	1.83961	800.00	2200.00	3.34134
850.00	2200.00	4.38106	900.00	2200.00	5.85992
950.00	2200.00	7.99835	1000.00	2200.00	10.58626
1050.00	2200.00	12.26181	1100.00	2200.00	12.08466
1150.00	2200.00	10.25024	1200.00	2200.00	7.28442
1250.00	2200.00	4.60203	1300.00	2200.00	3.06388
1350.00	2200.00	2.23310	1400.00	2200.00	1.72748

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** THE SUMMARY OF MAXIMUM ANNUAL (1 YRS) RESULTS ***

** CONC OF OTHER   IN PG/M   **

GROUP ID		AVERAGE CONC	RECEPTOR (XR, YR, ZELEV, ZFLAG)				OF TYPE	NETWORK GRID-ID
ALL	1ST HIGHEST VALUE IS	68.93752 AT (	1200.00,	1500.00,	0.00,	0.00)	DC	NA
	2ND HIGHEST VALUE IS	68.93349 AT (	1200.00,	1550.00,	0.00,	0.00)	DC	NA
	3RD HIGHEST VALUE IS	68.85168 AT (	1200.00,	1600.00,	0.00,	0.00)	DC	NA
	4TH HIGHEST VALUE IS	68.80656 AT (	1200.00,	1450.00,	0.00,	0.00)	DC	NA
	5TH HIGHEST VALUE IS	68.63849 AT (	1200.00,	1650.00,	0.00,	0.00)	DC	NA
	6TH HIGHEST VALUE IS	68.57832 AT (	1200.00,	1400.00,	0.00,	0.00)	DC	NA
	7TH HIGHEST VALUE IS	68.33302 AT (	1200.00,	1700.00,	0.00,	0.00)	DC	NA
	8TH HIGHEST VALUE IS	68.25227 AT (	1200.00,	1350.00,	0.00,	0.00)	DC	NA
	9TH HIGHEST VALUE IS	67.85329 AT (	1200.00,	1750.00,	0.00,	0.00)	DC	NA
	10TH HIGHEST VALUE IS	67.80934 AT (	1200.00,	1300.00,	0.00,	0.00)	DC	NA

*** RECEPTOR TYPES: GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR
BD = BOUNDARY

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** Message Summary : ISCST3 Model Execution ***

--------- Summary of Total Messages --------

A Total of 0 Fatal Error Message(s)
A Total of 0 Warning Message(s)
A Total of 1217 Informational Message(s)

A Total of 1217 Calm Hours Identified

******** FATAL ERROR MESSAGES ********
*** NONE ***

******** WARNING MESSAGES ********
*** NONE ***

****
*** ISCST3 Finishes Successfully ***
****

Appendix C

Monte Carlo Analysis Attachments

Table C-1
Monte Carlo Summary - Mean

Run	Exp Duration	Ingestion	PCB Conc	Cooking Loss	Cancer Risk	Hazard Index
				Max	8.53E-04	101.5
				Min	2.84E-05	4.8
				Ratio	30.05	21.14
				Base	2.42E-04	40.3
28	B	ME	B	B	1.24E-04	20.3
29	B	ME	B	H	1.63E-04	26.8
30	B	ME	B	L	1.01E-04	16.6
31	B	ME	H	B	2.09E-04	34.2
32	B	ME	H	H	2.72E-04	44.1
33	B	ME	H	L	1.60E-04	25.8
34	B	ME	L	B	5.07E-05	8.5
35	B	ME	L	H	6.57E-05	11.1
36	B	ME	L	L	3.91E-05	6.6
19	B	MI	B	B	2.56E-04	41.8
20	B	MI	B	H	3.36E-04	54.3
21	B	MI	B	L	2.03E-04	33.2
22	B	MI	H	B	4.17E-04	68.1
23	B	MI	H	H	5.39E-04	87.9
24	B	MI	H	L	3.15E-04	51.8
25	B	MI	L	B	1.08E-04	18.4
26	B	MI	L	H	1.30E-04	22.2
27	B	MI	L	L	7.84E-05	13.3
1	B	NY	B	B	2.42E-04	40.3
2	B	NY	B	H	3.14E-04	51.5
3	B	NY	B	L	1.81E-04	29.4
4	B	NY	H	B	3.91E-04	63.9
5	B	NY	H	H	5.14E-04	85.8
6	B	NY	H	L	2.97E-04	48.5
7	B	NY	L	B	1.04E-04	17.4
8	B	NY	L	H	1.29E-04	22.3
9	B	NY	L	L	7.96E-05	13.5
10	B	Ont	B	B	9.95E-05	16.2
11	B	Ont	B	H	1.18E-04	19.4
12	B	Ont	B	L	7.04E-05	11.5
13	B	Ont	H	B	1.62E-04	26.5
14	B	Ont	H	H	1.98E-04	32.2
15	B	Ont	H	L	1.17E-04	19.0
16	B	Ont	L	B	4.18E-05	7.0
17	B	Ont	L	H	4.89E-05	8.3
18	B	Ont	L	L	2.84E-05	4.8
64	H	ME	B	B	1.95E-04	23.7
65	H	ME	B	H	2.50E-04	30.2
66	H	ME	B	L	1.49E-04	18.2
67	H	ME	H	B	3.35E-04	40.0
68	H	ME	H	H	4.26E-04	50.7
69	H	ME	H	L	2.43E-04	29.2
70	H	ME	L	B	7.59E-05	10.0
71	H	ME	L	H	9.37E-05	12.4
72	H	ME	L	L	5.94E-05	7.8
55	H	MI	B	B	4.12E-04	50.0
56	H	MI	B	H	5.12E-04	62.3
57	H	MI	B	L	3.14E-04	38.0
58	H	MI	H	B	6.57E-04	78.9
59	H	MI	H	H	8.53E-04	101.5
60	H	MI	H	L	5.02E-04	60.2
61	H	MI	L	B	1.62E-04	21.0
62	H	MI	L	H	2.00E-04	26.4
63	H	MI	L	L	1.18E-04	15.6
37	H	NY	B	B	3.93E-04	47.2
38	H	NY	B	H	5.11E-04	61.1
39	H	NY	B	L	2.90E-04	35.3
40	H	NY	H	B	6.80E-04	82.1
41	H	NY	H	H	8.21E-04	98.4
42	H	NY	H	L	4.79E-04	57.2
43	H	NY	L	B	1.59E-04	20.8
44	H	NY	L	H	1.92E-04	25.4
45	H	NY	L	L	1.15E-04	15.2
46	H	Ont	B	B	1.50E-04	18.2
47	H	Ont	B	H	1.91E-04	23.0
48	H	Ont	B	L	1.11E-04	13.6
49	H	Ont	H	B	2.41E-04	28.8
50	H	Ont	H	H	3.18E-04	38.1
51	H	Ont	H	L	1.82E-04	22.0
52	H	Ont	L	B	6.15E-05	8.0
53	H	Ont	L	H	7.49E-05	9.9
54	H	Ont	L	L	4.41E-05	5.8

B = Base Case
H = High-End
L = Low-End

Table C-2
Monte Carlo Summary - 5th Percentile

				Max	4.77E-05	6.6
				Min	7.05E-07	0.1
				Ratio	67.70	44.74
				Base	5.49E-06	1.2
Run	Exp Duration	Ingestion	PCB Conc	Cooking Loss	Cancer Risk	Hazard Index
28	B	ME	B	B	2.54E-06	0.5
29	B	ME	B	H	3.08E-06	0.6
30	B	ME	B	L	1.82E-06	0.4
31	B	ME	H	B	4.03E-06	0.9
32	B	ME	H	H	4.55E-06	1.0
33	B	ME	H	L	2.82E-06	0.6
34	B	ME	L	B	9.58E-07	0.2
35	B	ME	L	H	1.22E-06	0.3
36	B	ME	L	L	7.22E-07	0.2
19	B	MI	B	B	9.80E-06	2.1
20	B	MI	B	H	1.32E-05	2.8
21	B	MI	B	L	7.81E-06	1.7
22	B	MI	H	B	1.53E-05	3.3
23	B	MI	H	H	2.05E-05	4.2
24	B	MI	H	L	1.18E-05	2.5
25	B	MI	L	B	4.44E-06	1.0
26	B	MI	L	H	5.51E-06	1.2
27	B	MI	L	L	3.13E-06	0.7
1	B	NY	B	B	5.49E-06	1.2
2	B	NY	B	H	6.93E-06	1.6
3	B	NY	B	L	4.01E-06	0.9
4	B	NY	H	B	8.43E-06	1.9
5	B	NY	H	H	1.04E-05	2.3
6	B	NY	H	L	6.10E-06	1.3
7	B	NY	L	B	2.34E-06	0.5
8	B	NY	L	H	3.08E-06	0.7
9	B	NY	L	L	1.73E-06	0.4
10	B	Ont	B	B	2.19E-06	0.4
11	B	Ont	B	H	2.78E-06	0.6
12	B	Ont	B	L	1.59E-06	0.3
13	B	Ont	H	B	3.24E-06	0.7
14	B	Ont	H	H	4.29E-06	0.9
15	B	Ont	H	L	2.43E-06	0.5
16	B	Ont	L	B	8.67E-07	0.2
17	B	Ont	L	H	1.08E-06	0.2
18	B	Ont	L	L	7.05E-07	0.1
64	H	ME	B	B	5.92E-06	0.8
65	H	ME	B	H	7.86E-06	1.0
66	H	ME	B	L	4.14E-06	0.5
67	H	ME	H	B	9.22E-06	1.2
68	H	ME	H	H	1.15E-05	1.5
69	H	ME	H	L	6.91E-06	0.9
70	H	ME	L	B	2.38E-06	0.3
71	H	ME	L	H	2.95E-06	0.4
72	H	ME	L	L	1.87E-06	0.3
55	H	MI	B	B	2.60E-05	3.4
56	H	MI	B	H	3.22E-05	4.2
57	H	MI	B	L	1.98E-05	2.7
58	H	MI	H	B	3.96E-05	5.4
59	H	MI	H	H	4.77E-05	6.6
60	H	MI	H	L	2.87E-05	3.7
61	H	MI	L	B	1.05E-05	1.5
62	H	MI	L	H	1.28E-05	1.7
63	H	MI	L	L	7.79E-06	1.1
37	H	NY	B	B	1.35E-05	1.8
38	H	NY	B	H	1.63E-05	2.2
39	H	NY	B	L	1.01E-05	1.3
40	H	NY	H	B	2.02E-05	2.7
41	H	NY	H	H	2.63E-05	3.5
42	H	NY	H	L	1.57E-05	2.1
43	H	NY	L	B	5.47E-06	0.8
44	H	NY	L	H	6.79E-06	0.9
45	H	NY	L	L	4.14E-06	0.6
46	H	Ont	B	B	4.63E-06	0.6
47	H	Ont	B	H	5.92E-06	0.8
48	H	Ont	B	L	3.67E-06	0.5
49	H	Ont	H	B	7.70E-06	1.0
50	H	Ont	H	H	9.56E-06	1.3
51	H	Ont	H	L	5.24E-06	0.7
52	H	Ont	L	B	1.92E-06	0.3
53	H	Ont	L	H	2.41E-06	0.3
54	H	Ont	L	L	1.49E-06	0.2

B = Base Case
H = High-End
L = Low-End

Table C-3
Monte Carlo Summary - 10th Percentile

				Max	7.86E-05	10.2
				Min	1.28E-06	0.3
				Ratio	61.51	39.04
				Base	9.58E-06	1.9
Run	Exp Duration	Ingestion	PCB Conc	Cooking Loss	Cancer Risk	Hazard Index
28	B	ME	B	B	4.69E-06	0.9
29	B	ME	B	H	5.93E-06	1.2
30	B	ME	B	L	3.48E-06	0.7
31	B	ME	H	B	7.56E-06	1.6
32	B	ME	H	H	8.84E-06	1.8
33	B	ME	H	L	5.62E-06	1.2
34	B	ME	L	B	1.97E-06	0.4
35	B	ME	L	H	2.41E-06	0.5
36	B	ME	L	L	1.55E-06	0.3
19	B	MI	B	B	1.75E-05	3.6
20	B	MI	B	H	2.27E-05	4.7
21	B	MI	B	L	1.40E-05	2.9
22	B	MI	H	B	2.68E-05	5.5
23	B	MI	H	H	3.69E-05	7.6
24	B	MI	H	L	2.10E-05	4.4
25	B	MI	L	B	8.08E-06	1.6
26	B	MI	L	H	9.42E-06	2.0
27	B	MI	L	L	5.76E-06	1.2
1	B	NY	B	B	9.58E-06	1.9
2	B	NY	B	H	1.15E-05	2.2
3	B	NY	B	L	6.80E-06	1.4
4	B	NY	H	B	1.45E-05	2.9
5	B	NY	H	H	1.81E-05	3.6
6	B	NY	H	L	1.09E-05	2.2
7	B	NY	L	B	3.98E-06	0.8
8	B	NY	L	H	4.95E-06	1.0
9	B	NY	L	L	2.88E-06	0.6
10	B	Ont	B	B	3.93E-06	0.8
11	B	Ont	B	H	4.91E-06	1.0
12	B	Ont	B	L	2.95E-06	0.6
13	B	Ont	H	B	6.30E-06	1.2
14	B	Ont	H	H	7.60E-06	1.5
15	B	Ont	H	L	4.54E-06	0.9
16	B	Ont	L	B	1.60E-06	0.3
17	B	Ont	L	H	2.04E-06	0.4
18	B	Ont	L	L	1.28E-06	0.3
64	H	ME	B	B	1.04E-05	1.4
65	H	ME	B	H	1.32E-05	1.7
66	H	ME	B	L	7.55E-06	1.0
67	H	ME	H	B	1.63E-05	2.1
68	H	ME	H	H	2.03E-05	2.6
69	H	ME	H	L	1.22E-05	1.6
70	H	ME	L	B	4.31E-06	0.6
71	H	ME	L	H	5.21E-06	0.7
72	H	ME	L	L	3.20E-06	0.4
55	H	MI	B	B	4.10E-05	5.3
56	H	MI	B	H	5.10E-05	6.6
57	H	MI	B	L	3.12E-05	4.1
58	H	MI	H	B	6.35E-05	8.3
59	H	MI	H	H	7.86E-05	10.2
60	H	MI	H	L	4.62E-05	6.0
61	H	MI	L	B	1.66E-05	2.3
62	H	MI	L	H	2.06E-05	2.8
63	H	MI	L	L	1.22E-05	1.7
37	H	NY	B	B	1.95E-05	2.4
38	H	NY	B	H	2.39E-05	2.9
39	H	NY	B	L	1.46E-05	1.8
40	H	NY	H	B	3.10E-05	3.8
41	H	NY	H	H	3.99E-05	5.0
42	H	NY	H	L	2.33E-05	2.9
43	H	NY	L	B	7.71E-06	1.0
44	H	NY	L	H	9.34E-06	1.2
45	H	NY	L	L	5.75E-06	0.8
46	H	Ont	B	B	8.24E-06	1.1
47	H	Ont	B	H	1.05E-05	1.4
48	H	Ont	B	L	6.30E-06	0.8
49	H	Ont	H	B	1.31E-05	1.7
50	H	Ont	H	H	1.69E-05	2.1
51	H	Ont	H	L	9.41E-06	1.2
52	H	Ont	L	B	3.42E-06	0.5
53	H	Ont	L	H	4.12E-06	0.6
54	H	Ont	L	L	2.51E-06	0.4

B = Base Case
H = High-End
L = Low-End

Table C-4
Monte Carlo Summary - 25th Percentile

				Max	1.72E-04	21.7
				Min	3.43E-06	0.7
				Ratio	50.09	32.89
				Base	2.33E-05	4.4
Run	Exp Duration	Ingestion	PCB Conc	Cooking Loss	Cancer Risk	Hazard Index
28	B	ME	B	B	1.22E-05	2.3
29	B	ME	B	H	1.60E-05	3.0
30	B	ME	B	L	9.62E-06	1.8
31	B	ME	H	B	2.03E-05	3.8
32	B	ME	H	H	2.53E-05	4.8
33	B	ME	H	L	1.54E-05	2.9
34	B	ME	L	B	5.35E-06	1.0
35	B	ME	L	H	6.51E-06	1.2
36	B	ME	L	L	3.95E-06	0.7
19	B	MI	B	B	4.39E-05	8.4
20	B	MI	B	H	5.47E-05	10.5
21	B	MI	B	L	3.36E-05	6.5
22	B	MI	H	B	6.73E-05	12.9
23	B	MI	H	H	8.99E-05	17.0
24	B	MI	H	L	5.52E-05	10.4
25	B	MI	L	B	1.92E-05	3.7
26	B	MI	L	H	2.29E-05	4.4
27	B	MI	L	L	1.38E-05	2.7
1	B	NY	B	B	2.33E-05	4.4
2	B	NY	B	H	2.73E-05	5.2
3	B	NY	B	L	1.68E-05	3.2
4	B	NY	H	B	3.63E-05	6.9
5	B	NY	H	H	4.38E-05	8.1
6	B	NY	H	L	2.64E-05	5.1
7	B	NY	L	B	9.20E-06	1.8
8	B	NY	L	H	1.17E-05	2.3
9	B	NY	L	L	6.89E-06	1.3
10	B	Ont	B	B	1.09E-05	2.1
11	B	Ont	B	H	1.33E-05	2.5
12	B	Ont	B	L	7.99E-06	1.5
13	B	Ont	H	B	1.70E-05	3.2
14	B	Ont	H	H	2.15E-05	4.0
15	B	Ont	H	L	1.26E-05	2.4
16	B	Ont	L	B	4.56E-06	0.9
17	B	Ont	L	H	5.42E-06	1.0
18	B	Ont	L	L	3.43E-06	0.7
64	H	ME	B	B	2.38E-05	3.0
65	H	ME	B	H	3.05E-05	3.8
66	H	ME	B	L	1.75E-05	2.2
67	H	ME	H	B	3.78E-05	4.8
68	H	ME	H	H	4.81E-05	6.0
69	H	ME	H	L	2.84E-05	3.6
70	H	ME	L	B	9.63E-06	1.3
71	H	ME	L	H	1.18E-05	1.6
72	H	ME	L	L	7.30E-06	1.0
55	H	MI	B	B	8.51E-05	11.0
56	H	MI	B	H	1.10E-04	13.9
57	H	MI	B	L	6.78E-05	8.5
58	H	MI	H	B	1.34E-04	17.1
59	H	MI	H	H	1.72E-04	21.7
60	H	MI	H	L	1.02E-04	12.8
61	H	MI	L	B	3.40E-05	4.7
62	H	MI	L	H	4.22E-05	5.7
63	H	MI	L	L	2.64E-05	3.6
37	H	NY	B	B	4.51E-05	5.6
38	H	NY	B	H	5.47E-05	6.9
39	H	NY	B	L	3.28E-05	4.2
40	H	NY	H	B	7.05E-05	9.0
41	H	NY	H	H	8.94E-05	11.4
42	H	NY	H	L	5.26E-05	6.6
43	H	NY	L	B	1.76E-05	2.4
44	H	NY	L	H	2.13E-05	2.9
45	H	NY	L	L	1.32E-05	1.8
46	H	Ont	B	B	2.07E-05	2.6
47	H	Ont	B	H	2.55E-05	3.2
48	H	Ont	B	L	1.54E-05	2.0
49	H	Ont	H	B	3.16E-05	4.0
50	H	Ont	H	H	4.14E-05	5.2
51	H	Ont	H	L	2.43E-05	3.1
52	H	Ont	L	B	8.16E-06	1.1
53	H	Ont	L	H	1.00E-05	1.4
54	H	Ont	L	L	6.01E-06	0.8

B = Base Case
H = High-End
L = Low-End

Table C-5
Monte Carlo Summary - 50th Percentile

				Max	4.12E-04	51.5
				Min	9.69E-06	1.8
				Ratio	42.48	28.75
				Base	6.38E-05	11.4

Run	Exp Duration	Ingestion	PCB Conc	Cooking Loss	Cancer Risk	Hazard Index
28	B	ME	B	B	3.44E-05	6.1
29	B	ME	B	H	4.66E-05	8.1
30	B	ME	B	L	2.78E-05	4.9
31	B	ME	H	B	5.81E-05	10.4
32	B	ME	H	H	7.39E-05	13.1
33	B	ME	H	L	4.24E-05	7.7
34	B	ME	L	B	1.47E-05	2.7
35	B	ME	L	H	1.90E-05	3.4
36	B	ME	L	L	1.10E-05	2.0
19	B	MI	B	B	1.14E-04	20.1
20	B	MI	B	H	1.42E-04	25.2
21	B	MI	B	L	8.83E-05	15.7
22	B	MI	H	B	1.77E-04	31.6
23	B	MI	H	H	2.33E-04	41.2
24	B	MI	H	L	1.42E-04	25.3
25	B	MI	L	B	4.78E-05	8.9
26	B	MI	L	H	5.96E-05	10.8
27	B	MI	L	L	3.60E-05	6.5
1	B	NY	B	B	6.38E-05	11.4
2	B	NY	B	H	7.85E-05	13.9
3	B	NY	B	L	4.82E-05	8.5
4	B	NY	H	B	1.04E-04	18.7
5	B	NY	H	H	1.24E-04	22.3
6	B	NY	H	L	7.52E-05	13.4
7	B	NY	L	B	2.72E-05	4.8
8	B	NY	L	H	3.34E-05	6.0
9	B	NY	L	L	2.00E-05	3.7
10	B	Ont	B	B	3.14E-05	5.7
11	B	Ont	B	H	3.81E-05	6.9
12	B	Ont	B	L	2.30E-05	4.1
13	B	Ont	H	B	5.08E-05	9.0
14	B	Ont	H	H	6.20E-05	11.1
15	B	Ont	H	L	3.66E-05	6.6
16	B	Ont	L	B	1.32E-05	2.4
17	B	Ont	L	H	1.59E-05	2.9
18	B	Ont	L	L	9.69E-06	1.8
64	H	ME	B	B	6.20E-05	7.8
65	H	ME	B	H	7.97E-05	9.8
66	H	ME	B	L	4.66E-05	5.8
67	H	ME	H	B	1.02E-04	12.6
68	H	ME	H	H	1.28E-04	16.0
69	H	ME	H	L	7.68E-05	9.4
70	H	ME	L	B	2.46E-05	3.3
71	H	ME	L	H	3.11E-05	4.2
72	H	ME	L	L	1.88E-05	2.5
55	H	MI	B	B	2.05E-04	25.7
56	H	MI	B	H	2.64E-04	32.7
57	H	MI	B	L	1.56E-04	19.8
58	H	MI	H	B	3.19E-04	39.7
59	H	MI	H	H	4.12E-04	51.5
60	H	MI	H	L	2.43E-04	30.6
61	H	MI	L	B	8.07E-05	10.9
62	H	MI	L	H	1.02E-04	13.9
63	H	MI	L	L	6.24E-05	8.4
37	H	NY	B	B	1.12E-04	13.9
38	H	NY	B	H	1.43E-04	18.1
39	H	NY	B	L	8.57E-05	10.7
40	H	NY	H	B	1.88E-04	23.3
41	H	NY	H	H	2.37E-04	29.0
42	H	NY	H	L	1.33E-04	16.6
43	H	NY	L	B	4.49E-05	6.1
44	H	NY	L	H	5.49E-05	7.4
45	H	NY	L	L	3.35E-05	4.5
46	H	Ont	B	B	5.38E-05	6.8
47	H	Ont	B	H	6.78E-05	8.4
48	H	Ont	B	L	4.09E-05	5.1
49	H	Ont	H	B	8.54E-05	10.6
50	H	Ont	H	H	1.11E-04	13.6
51	H	Ont	H	L	6.34E-05	7.9
52	H	Ont	L	B	2.19E-05	2.9
53	H	Ont	L	H	2.66E-05	3.6
54	H	Ont	L	L	1.58E-05	2.1

B = Base Case
H = High-End
L = Low-End

Table C-6
Monte Carlo Summary - 75th Percentile

				Max	9.61E-04	117.5
				Min	2.71E-05	4.7
				Ratio	35.49	24.90
				Base	1.83E-04	30.8
Run	Exp Duration	Ingestion	PCB Conc	Cooking Loss	Cancer Risk	Hazard Index
28	B	ME	B	B	1.09E-04	18.5
29	B	ME	B	H	1.33E-04	23.0
30	B	ME	B	L	8.41E-05	14.5
31	B	ME	H	B	1.73E-04	29.6
32	B	ME	H	H	2.25E-04	38.5
33	B	ME	H	L	1.31E-04	22.3
34	B	ME	L	B	4.41E-05	7.9
35	B	ME	L	H	5.54E-05	9.7
36	B	ME	L	L	3.22E-05	5.7
19	B	MI	B	B	2.79E-04	47.7
20	B	MI	B	H	3.71E-04	61.7
21	B	MI	B	L	2.24E-04	37.8
22	B	MI	H	B	4.53E-04	77.3
23	B	MI	H	H	5.98E-04	99.7
24	B	MI	H	L	3.55E-04	60.7
25	B	MI	L	B	1.20E-04	20.7
26	B	MI	L	H	1.47E-04	25.5
27	B	MI	L	L	9.11E-05	15.8
1	B	NY	B	B	1.83E-04	30.8
2	B	NY	B	H	2.23E-04	37.3
3	B	NY	B	L	1.33E-04	22.1
4	B	NY	H	B	2.92E-04	48.9
5	B	NY	H	H	3.71E-04	62.6
6	B	NY	H	L	2.13E-04	35.9
7	B	NY	L	B	7.39E-05	12.8
8	B	NY	L	H	9.50E-05	16.3
9	B	NY	L	L	5.62E-05	9.8
10	B	Ont	B	B	8.75E-05	14.8
11	B	Ont	B	H	1.08E-04	18.4
12	B	Ont	B	L	6.53E-05	11.2
13	B	Ont	H	B	1.45E-04	24.9
14	B	Ont	H	H	1.78E-04	29.9
15	B	Ont	H	L	1.07E-04	17.8
16	B	Ont	L	B	3.80E-05	6.7
17	B	Ont	L	H	4.64E-05	8.1
18	B	Ont	L	L	2.71E-05	4.7
64	H	ME	B	B	1.78E-04	21.8
65	H	ME	B	H	2.26E-04	27.7
66	H	ME	B	L	1.32E-04	16.3
67	H	ME	H	B	2.93E-04	35.9
68	H	ME	H	H	3.75E-04	45.3
69	H	ME	H	L	2.20E-04	26.7
70	H	ME	L	B	7.06E-05	9.3
71	H	ME	L	H	8.77E-05	11.6
72	H	ME	L	L	5.26E-05	7.0
55	H	MI	B	B	4.59E-04	57.2
56	H	MI	B	H	5.95E-04	71.5
57	H	MI	B	L	3.53E-04	43.4
58	H	MI	H	B	7.52E-04	91.7
59	H	MI	H	H	9.61E-04	117.5
60	H	MI	H	L	5.82E-04	70.4
61	H	MI	L	B	1.85E-04	24.3
62	H	MI	L	H	2.28E-04	30.2
63	H	MI	L	L	1.38E-04	18.0
37	H	NY	B	B	2.94E-04	35.6
38	H	NY	B	H	3.77E-04	46.1
39	H	NY	B	L	2.18E-04	26.5
40	H	NY	H	B	5.07E-04	61.2
41	H	NY	H	H	6.23E-04	74.9
42	H	NY	H	L	3.63E-04	42.8
43	H	NY	L	B	1.16E-04	15.1
44	H	NY	L	H	1.45E-04	19.4
45	H	NY	L	L	8.84E-05	11.5
46	H	Ont	B	B	1.42E-04	17.7
47	H	Ont	B	H	1.84E-04	22.4
48	H	Ont	B	L	1.08E-04	13.4
49	H	Ont	H	B	2.30E-04	28.1
50	H	Ont	H	H	2.96E-04	36.8
51	H	Ont	H	L	1.73E-04	20.9
52	H	Ont	L	B	5.89E-05	7.8
53	H	Ont	L	H	7.21E-05	9.5
54	H	Ont	L	L	4.15E-05	5.6

B = Base Case
H = High-End
L = Low-End

Table C-7
Monte Carlo Summary - 90th Percentile

				Max	1.94E-03	233.5
				Min	6.63E-05	11.2
				Ratio	29.21	20.85
				Base	4.90E-04	82.0
Run	Exp Duration	Ingestion	PCB Conc	Cooking Loss	Cancer Risk	Hazard Index
28	B	ME	B	B	2.99E-04	48.8
29	B	ME	B	H	3.74E-04	63.5
30	B	ME	B	L	2.29E-04	38.4
31	B	ME	H	B	5.04E-04	81.8
32	B	ME	H	H	6.21E-04	103.0
33	B	ME	H	L	3.68E-04	59.6
34	B	ME	L	B	1.19E-04	19.9
35	B	ME	L	H	1.56E-04	26.9
36	B	ME	L	L	9.49E-05	16.0
19	B	MI	B	B	5.98E-04	96.8
20	B	MI	B	H	7.80E-04	123.1
21	B	MI	B	L	4.95E-04	77.9
22	B	MI	H	B	9.87E-04	158.3
23	B	MI	H	H	1.26E-03	204.3
24	B	MI	H	L	7.37E-04	121.8
25	B	MI	L	B	2.53E-04	42.3
26	B	MI	L	H	3.07E-04	51.9
27	B	MI	L	L	1.90E-04	31.4
1	B	NY	B	B	4.90E-04	82.0
2	B	NY	B	H	6.19E-04	102.2
3	B	NY	B	L	3.45E-04	57.9
4	B	NY	H	B	7.76E-04	129.6
5	B	NY	H	H	1.04E-03	170.3
6	B	NY	H	L	5.77E-04	93.8
7	B	NY	L	B	1.95E-04	33.6
8	B	NY	L	H	2.50E-04	43.2
9	B	NY	L	L	1.54E-04	26.6
10	B	Ont	B	B	2.25E-04	36.5
11	B	Ont	B	H	2.71E-04	44.4
12	B	Ont	B	L	1.66E-04	26.3
13	B	Ont	H	B	3.63E-04	60.5
14	B	Ont	H	H	4.42E-04	72.5
15	B	Ont	H	L	2.72E-04	45.0
16	B	Ont	L	B	9.40E-05	15.8
17	B	Ont	L	H	1.12E-04	19.0
18	B	Ont	L	L	6.63E-05	11.2
64	H	ME	B	B	4.52E-04	56.2
65	H	ME	B	H	5.96E-04	71.3
66	H	ME	B	L	3.54E-04	43.2
67	H	ME	H	B	7.95E-04	93.9
68	H	ME	H	H	1.02E-03	122.9
69	H	ME	H	L	5.63E-04	68.5
70	H	ME	L	B	1.79E-04	23.4
71	H	ME	L	H	2.21E-04	29.3
72	H	ME	L	L	1.43E-04	18.7
55	H	MI	B	B	9.38E-04	114.3
56	H	MI	B	H	1.18E-03	143.3
57	H	MI	B	L	7.02E-04	87.0
58	H	MI	H	B	1.49E-03	178.8
59	H	MI	H	H	1.94E-03	233.5
60	H	MI	H	L	1.17E-03	137.4
61	H	MI	L	B	3.78E-04	48.4
62	H	MI	L	H	4.58E-04	60.1
63	H	MI	L	L	2.69E-04	36.0
37	H	NY	B	B	7.86E-04	95.6
38	H	NY	B	H	9.74E-04	117.6
39	H	NY	B	L	5.67E-04	69.6
40	H	NY	H	B	1.35E-03	162.8
41	H	NY	H	H	1.64E-03	196.1
42	H	NY	H	L	9.38E-04	112.6
43	H	NY	L	B	3.06E-04	40.8
44	H	NY	L	H	3.78E-04	49.5
45	H	NY	L	L	2.28E-04	29.7
46	H	Ont	B	B	3.33E-04	42.0
47	H	Ont	B	H	4.45E-04	54.6
48	H	Ont	B	L	2.51E-04	31.2
49	H	Ont	H	B	5.69E-04	66.9
50	H	Ont	H	H	7.11E-04	85.0
51	H	Ont	H	L	4.22E-04	51.8
52	H	Ont	L	B	1.38E-04	18.6
53	H	Ont	L	H	1.74E-04	22.7
54	H	Ont	L	L	1.00E-04	13.0

B = Base Case
H = High-End
L = Low-End

Table C-8
Monte Carlo Summary - 95th Percentile

Run	Exp Duration	Ingestion	PCB Conc	Cooking Loss	Cancer Risk	Hazard Index
				Max	3.14E-03	366.2
				Min	1.13E-04	18.6
				Ratio	27.69	19.74
				Base	8.67E-04	136.5
28	B	ME	B	B	5.17E-04	84.7
29	B	ME	B	H	6.73E-04	114.4
30	B	ME	B	L	4.29E-04	68.6
31	B	ME	H	B	9.03E-04	147.9
32	B	ME	H	H	1.09E-03	176.7
33	B	ME	H	L	6.52E-04	107.3
34	B	ME	L	B	2.16E-04	35.4
35	B	ME	L	H	2.81E-04	48.2
36	B	ME	L	L	1.69E-04	29.2
19	B	MI	B	B	9.52E-04	152.6
20	B	MI	B	H	1.24E-03	200.8
21	B	MI	B	L	7.62E-04	122.2
22	B	MI	H	B	1.55E-03	248.5
23	B	MI	H	H	2.00E-03	321.0
24	B	MI	H	L	1.19E-03	187.6
25	B	MI	L	B	4.00E-04	65.2
26	B	MI	L	H	4.78E-04	79.6
27	B	MI	L	L	2.91E-04	47.9
1	B	NY	B	B	8.67E-04	136.5
2	B	NY	B	H	1.13E-03	178.6
3	B	NY	B	L	6.27E-04	99.6
4	B	NY	H	B	1.45E-03	225.9
5	B	NY	H	H	1.91E-03	303.0
6	B	NY	H	L	1.07E-03	169.1
7	B	NY	L	B	3.63E-04	59.8
8	B	NY	L	H	4.62E-04	76.4
9	B	NY	L	L	2.79E-04	47.3
10	B	Ont	B	B	3.96E-04	61.5
11	B	Ont	B	H	4.58E-04	75.6
12	B	Ont	B	L	2.79E-04	44.8
13	B	Ont	H	B	6.50E-04	103.8
14	B	Ont	H	H	7.63E-04	124.2
15	B	Ont	H	L	4.78E-04	75.7
16	B	Ont	L	B	1.59E-04	25.9
17	B	Ont	L	H	1.90E-04	32.5
18	B	Ont	L	L	1.13E-04	18.6
64	H	ME	B	B	8.23E-04	100.3
65	H	ME	B	H	1.05E-03	128.2
66	H	ME	B	L	6.35E-04	77.1
67	H	ME	H	B	1.42E-03	173.1
68	H	ME	H	H	1.77E-03	214.0
69	H	ME	H	L	9.99E-04	120.2
70	H	ME	L	B	3.11E-04	40.6
71	H	ME	L	H	3.84E-04	51.4
72	H	ME	L	L	2.58E-04	33.7
55	H	MI	B	B	1.50E-03	180.9
56	H	MI	B	H	1.84E-03	222.7
57	H	MI	B	L	1.11E-03	131.1
58	H	MI	H	B	2.30E-03	275.6
59	H	MI	H	H	3.14E-03	366.2
60	H	MI	H	L	1.79E-03	210.8
61	H	MI	L	B	5.80E-04	74.6
62	H	MI	L	H	7.05E-04	93.1
63	H	MI	L	L	4.14E-04	54.4
37	H	NY	B	B	1.39E-03	163.1
38	H	NY	B	H	1.73E-03	210.5
39	H	NY	B	L	1.04E-03	124.9
40	H	NY	H	B	2.46E-03	291.2
41	H	NY	H	H	2.83E-03	341.8
42	H	NY	H	L	1.66E-03	193.3
43	H	NY	L	B	5.47E-04	72.3
44	H	NY	L	H	6.59E-04	84.7
45	H	NY	L	L	4.19E-04	55.1
46	H	Ont	B	B	5.74E-04	68.7
47	H	Ont	B	H	7.46E-04	88.8
48	H	Ont	B	L	4.36E-04	52.6
49	H	Ont	H	B	9.56E-04	112.4
50	H	Ont	H	H	1.20E-03	144.2
51	H	Ont	H	L	7.07E-04	86.4
52	H	Ont	L	B	2.37E-04	29.7
53	H	Ont	L	H	2.88E-04	37.1
54	H	Ont	L	L	1.69E-04	21.9

B = Base Case
H = High-End
L = Low-End

Table C-9
Monte Carlo Summary - 99th Percentile

				Max	1.20E-02	1515.1
				Min	2.88E-04	47.0
				Ratio	41.43	32.23
				Base	3.75E-03	638.7
Run	Exp Duration	Ingestion	PCB Conc	Cooking Loss	Cancer Risk	Hazard Index
28	B	ME	B	B	1.47E-03	219.5
29	B	ME	B	H	1.96E-03	290.6
30	B	ME	B	L	1.25E-03	189.3
31	B	ME	H	B	2.35E-03	372.5
32	B	ME	H	H	3.44E-03	528.2
33	B	ME	H	L	2.02E-03	293.6
34	B	ME	L	B	5.75E-04	90.9
35	B	ME	L	H	7.29E-04	116.9
36	B	ME	L	L	4.51E-04	72.4
19	B	MI	B	B	2.06E-03	320.5
20	B	MI	B	H	2.76E-03	407.7
21	B	MI	B	L	1.68E-03	243.2
22	B	MI	H	B	3.67E-03	526.7
23	B	MI	H	H	4.56E-03	697.3
24	B	MI	H	L	2.60E-03	401.8
25	B	MI	L	B	8.70E-04	141.7
26	B	MI	L	H	1.02E-03	164.1
27	B	MI	L	L	5.95E-04	93.7
1	B	NY	B	B	3.75E-03	638.7
2	B	NY	B	H	4.51E-03	802.9
3	B	NY	B	L	2.62E-03	456.4
4	B	NY	H	B	5.65E-03	939.2
5	B	NY	H	H	7.42E-03	1266.9
6	B	NY	H	L	4.42E-03	768.2
7	B	NY	L	B	1.53E-03	257.2
8	B	NY	L	H	1.99E-03	339.6
9	B	NY	L	L	1.16E-03	206.6
10	B	Ont	B	B	1.09E-03	166.2
11	B	Ont	B	H	1.20E-03	195.0
12	B	Ont	B	L	7.15E-04	110.8
13	B	Ont	H	B	1.72E-03	277.5
14	B	Ont	H	H	2.18E-03	352.2
15	B	Ont	H	L	1.27E-03	193.5
16	B	Ont	L	B	4.64E-04	75.1
17	B	Ont	L	H	4.90E-04	82.5
18	B	Ont	L	L	2.88E-04	47.0
64	H	ME	B	B	2.15E-03	256.7
65	H	ME	B	H	2.73E-03	331.2
66	H	ME	B	L	1.65E-03	197.9
67	H	ME	H	B	3.73E-03	432.0
68	H	ME	H	H	4.74E-03	566.8
69	H	ME	H	L	2.79E-03	331.6
70	H	ME	L	B	8.43E-04	111.7
71	H	ME	L	H	1.00E-03	128.7
72	H	ME	L	L	6.51E-04	85.1
55	H	MI	B	B	3.08E-03	365.6
56	H	MI	B	H	3.72E-03	431.6
57	H	MI	B	L	2.40E-03	282.3
58	H	MI	H	B	4.95E-03	595.3
59	H	MI	H	H	6.50E-03	735.6
60	H	MI	H	L	3.72E-03	428.1
61	H	MI	L	B	1.16E-03	146.9
62	H	MI	L	H	1.47E-03	190.4
63	H	MI	L	L	8.11E-04	108.5
37	H	NY	B	B	5.45E-03	670.2
38	H	NY	B	H	7.82E-03	909.4
39	H	NY	B	L	4.31E-03	521.9
40	H	NY	H	B	1.01E-02	1216.1
41	H	NY	H	H	1.20E-02	1515.1
42	H	NY	H	L	7.29E-03	854.6
43	H	NY	L	B	2.32E-03	316.6
44	H	NY	L	H	2.94E-03	386.3
45	H	NY	L	L	1.59E-03	221.0
46	H	Ont	B	B	1.49E-03	175.0
47	H	Ont	B	H	1.95E-03	217.1
48	H	Ont	B	L	1.03E-03	125.8
49	H	Ont	H	B	2.33E-03	284.0
50	H	Ont	H	H	3.68E-03	409.5
51	H	Ont	H	L	1.84E-03	210.3
52	H	Ont	L	B	6.07E-04	77.2
53	H	Ont	L	H	7.46E-04	93.4
54	H	Ont	L	L	4.50E-04	55.7

B = Base Case
H = High-End
L = Low-End

Appendix D

PCB Toxicological Profile

D.1 Introduction

Polychlorinated biphenyls (PCBs) represent a group of synthetic organic chemicals that consists of 209 individual chlorinated biphenyls (called congeners) (reviewed in ATSDR, 1997). Pure PCBs are either colorless or light yellow in color and can be oily liquids or solids depending on the composition of the mixture. Because of their insulating capacity, stability, and low burning capacity, PCBs were used in capacitors, transformers, and other electrical equipment prior to 1977. Commercially available PCB mixtures are known in the U.S. by their industrial trade name, Aroclor. The name, Aroclor 1254, for example, means that the molecule contains 12 carbon atoms (the first 2 digits) and approximately 54% chlorine by weight (second 2 digits). Use of PCBs was generally banned in 1977 after they were found to build up in the environment and to have harmful health effects. PCB mixtures found in the environment have a different pattern of PCB congeners than the commercial PCB mixtures, due to differential partitioning, transformation, and bioaccumulation in the environment (USEPA, 1996b).

Although PCB use was generally stopped over 20 years ago, they still exist in old electrical equipment and environmental media to which humans can be exposed (reviewed in ATSDR, 1997). Because of the ubiquitous presence of PCBs in the environment, general routes of human exposures can include contaminated outdoor or indoor air, drinking water, direct dermal contact, and food. Fish can have levels of PCBs much higher than the water in which they swim from exposure to contaminated sediments and/or eating prey that contain PCBs. Beef and dairy cattle can contain PCBs from grazing on PCB-containing plants. People can be exposed to PCBs in the workplace primarily through inhalation and dermal contact due to repair, maintenance and disposal of PCB-containing electrical equipment. Specific routes of exposures applicable for the Hudson River are discussed in Section 2.1.3 Potential Exposure Routes.

There is currently no scientific consensus about the primary mechanisms of PCB toxicity and carcinogenicity. It is likely that different PCB congeners act *via* different biological mechanisms to cause adverse health effects. Proposed mechanisms of action of PCB toxicity include binding the aryl hydrocarbon (Ah) receptor (coplanar PCB congeners), estrogenic and anti-estrogenic activities, inhibition of dopamine synthesis, alteration of thyroid hormones, effects on insulin release, effects on neutrophil function, alteration in calcium homeostasis and activation/translocation of protein kinase C, and changes in signal transduction systems (Fischer *et al.*, 1998; Porterfield, 2000; Seegal, 1996).

D.2 Summary of IRIS - PCB Carcinogenicity

D.2.1 Carcinogenic Potential in Animals

The USEPA has determined that sufficient evidence exists to show that PCB mixtures are carcinogenic in animals. PCB animal carcinogenicity studies are summarized in USEPA's 1996 reassessment of the toxicity data on the potential carcinogenic potency of PCBs (USEPA, 1996b), as well as in the USEPA's Integrated Risk Information System (IRIS), an electronic database that provides the Agency's consensus review of chemical-specific toxicity data (USEPA, 1999c). Of the studies presented that support observations of animal carcinogenicity, the most thorough is a study by Brunner *et al.*, (1996) later published by Mayes *et al*. (1998). In this study, equal numbers of female and male Sprague Dawley rats were used to examine the carcinogenic potential of a number of different Aroclors (1260, 1254, 1242, and 1016) at a number of different dose levels (25, 50, or 100 ppm for Aroclor 1254 and 1260; 50 or 100 ppm for Aroclor 1242; and 50, 100 or 200 ppm for Aroclor 1016) through feeding with an exposure duration of 104 weeks. These mixtures contain overlapping groups of congeners that span the range of congeners most often found in environmental mixtures (USEPA, 1996b). In female rats, a statistically significant increase in liver adenomas or carcinomas were observed with exposure to all Aroclors tested. In male rats, a significant increase in liver cancers was observed for Aroclor 1260. Some of these tumors were hepatocholangiomas, a rare bile duct tumor seldom seen in control rats. Additionally, thyroid gland follicular cell adenomas or carcinomas were increased for all Aroclors in male rats only, with a significant dose trend noted for Aroclors 1254 and 1242. These investigators observed a decrease in mammary tumors in female rats exposed to Aroclor 1254 and, to a lesser extent, to Aroclors 1260 or 1242, this result was not observed for Aroclor 1016.

A number of other animal studies also demonstrated an increase in cancer incidence with exposure to PCB mixtures (USEPA, 1999c; 1996b). Kimbrough *et al*. (1975) observed liver carcinomas in female Sherman rats fed diets of 100 ppm Aroclor 1260 for 21 months. The National Cancer Institute (NCI) observed hepatocellular adenomas and carcinomas in female and male Fischer 344 rats fed 100 ppm Aroclor 1254 for 24 months (NCI, 1978). Similarly, Norback and Weltman (1985) observed a statistically significant increase in hepatocellular carcinomas in female and male Sprague-Dawley rats exposed to 100 ppm Aroclor 1260 in the diet for 16 months, 50 ppm for 8 months, followed by 5 months on a control diet when compared to the control rats. In males and female rats fed Aroclor 1260, liver foci appeared at 3 months, area lesions at 6 months, neoplastic nodules at 12 months, trabecular carcinomas at 15 months, and adenocarcinomas at 24 months, demonstrating progression of liver lesions to carcinomas. Gastric lesions in rats from this NCI study were further examined and found to have a statistically increased level of adenocarcinomas (Morgan *et al*., 1981; Ward, 1985).

D.2.2 Carcinogenic Potential in Humans

The USEPA has classified PCBs as a probable human carcinogen (B2), based on a number of studies in animals showing liver tumors with a number of different PCB mixtures which are believed to span the range of congeners found in environmental mixtures (USEPA, 1996b,c). As stated in USEPA (1996b), "PCBs are absorbed through ingestion, inhalation, and dermal exposure, after which they are transported similarly through the circulation. This provides a reasonable basis for expecting similar internal effects from different routes of environmental exposure."

According to USEPA, human carcinogenicity data for PCB mixtures are currently "inadequate, but suggestive" (USEPA, 1999c). USEPA (1996b) describes a number of studies including three specific cohort studies that analyzed deaths from cancer in PCB capacitor manufacturing plant workers. In the first study, 2100 capacitor manufacturing plant workers in Italy were followed and deaths attributed to cancer were determined (Bertazzi *et al*., 1987). The study included 1,556 females and 544 males that had worked for at least one week at the capacitor plant. Both Aroclor 1242 and 1254 had been used at the facility. At the end of the followup in 1982, there were 64 deaths reported, 26 from cancer. For females, an excess risk of death from hematologic cancer was reported. This excess was statistically significant compared to local rates, but not to national rates. In males, an increase in death from gastrointestinal tract cancer was observed. This increase was statistically significant when compared to both local and national rates.

In the second study, Sinks *et al.* (1992) conducted a retrospective cohort study of 3,588 electrical capacitor workers employed at least 1 day, with known exposures to PCBs in air based on distance from the impregnation ovens (based on 5 zones of exposure). At the end of the follow-up in 1986, there were 192 deaths reported, 54 from cancer. There were more deaths observed than expected for malignant melanoma and cancer of the brain and nervous system. The risk of malignant melanoma was not related to cumulative PCB exposure (*i.e.*, no dose-response, but the exposure information was poor). Compared with national rates, a statistically significant excess risk of death from skin cancer was reported; all were malignant melanomas. A proportional hazards analysis revealed no pattern of association with exposure zone; however, the numbers are small.

In the third cohort study, Brown (1987) determined the cancer mortality rate for capacitor manufacturing workers in two capacitor manufacturing plants in New York and Massachusetts. In this study, 2,588 workers (1,318 females and 1,270 males) that had worked for at least 3 months in areas thought to have potential high exposure to PCB mixtures were followed. Aroclors 1254, 1242 and 1016 were used at different times in both plants. At the end of the follow-up in 1982, there were 295 deaths reported, 62 from cancer. The investigators observed a statistically significant increase in death from cancer of the liver, gall bladder, and biliary tract compared to national rates. Four of the five observed cancers occurred among females employed at the Massachusetts plant.

A summary of additional epidemiology studies is presented later in this appendix.

D.2.3 IRIS PCB Cancer Slope Factors

The Cancer Slope Factor, or CSF, is an upper bound estimate of carcinogenic potency of a chemical used to calculate cancer risk from exposure to carcinogens, by relating estimates of lifetime average chemical intake to the incremental risk of an individual developing cancer over their lifetime. In IRIS, which provides the Agency's consensus review of toxicity data (USEPA, 1999a-c), both upper-bound and central-estimate CSFs for three different tiers of PCB mixtures are provided. These CSFs are based on the USEPA's 1996 reassessment of the toxicity data on the potential carcinogenic potency of PCBs (USEPA, 1996b). The PCB CSFs were derived following the proposed revisions to the USEPA Carcinogen Risk Assessment Guidelines (USEPA, 1996a). Following these guidelines, a range of potency estimates were determined using studies for a range of mixtures, instead of focusing on the highest-potency mixture. For low dose extrapolation, an LED10 (95% lower bound on the ED10) approach replaced the linearized multistage procedure since the ED10 (estimated dose associated with a 10% increased cancer incidence) provides a statistically stable method for deriving central estimates of low-dose slopes. The dose calculations use the interagency consensus cross species scaling factors based on the 3/4 power of relative body weight (USEPA, 1996b). The proposed guidelines' emphasis on circumstances that affect cancer risks, especially exposure route considerations, is found throughout the reassessment. None of these features, however, is inconsistent with previous guidelines (USEPA, 1986), whose intent is "to permit sufficient flexibility to accommodate new knowledge and new assessment methods as they emerge."

In order to develop CSFs for use in human health risk assessments for exposure to environmental PCBs, USEPA (1999c) reviewed all of the relevant animal and human data, and focused on two studies: Brunner *et al*. (1996) and Norback and Weltman (1985). Human equivalent doses were determined from dose-response data from these two studies. A tiered approach for cancer potencies of PCB mixtures was then developed based on both exposure route, persistence in the environment, and congener type.

The first tier, "High Risk and Persistence," applicable to food chain exposures, sediment or soil ingestion, dust or aerosol inhalation, dermal exposure if an absorption factor has been applied, early-life exposure, and mixtures with dioxin-like, tumor promoting, or persistent congeners, has an upper-bound and central-estimate CSF of 2.0 and 1.0 $(mg/kg\text{-}day)^{-1}$, respectively. The second tier, "Low Risk and Persistence," applicable to ingestion of water-soluble congeners, inhalation of evaporated congeners, and dermal exposure (if no absorption factor has been applied), has an upper-bound and central-estimate CSF of 0.4 and 0.3 $(mg/kg\text{-}day)^{-1}$, respectively. The third tier, "Lowest Risk and Persistence," applicable only to mixtures where congeners with more than four chlorines comprise less than one-half percent of the total PCBs, has an upper-bound and central-estimate CSF of 0.07 and 0.04 $(mg/kg\text{-}day)^{-1}$, respectively.

Cancer risk is estimated by multiplying the appropriate CSF by a lifetime average daily dose. Using this method, USEPA has calculated an upper-bound unit cancer risk for ingestion of PCB congeners in water to be 1×10^{-5} per μg/L. Drinking water concentrations associated with a risk of 1 in 10,000, 100,000, and 1,000,000 are 10, 1, and 0.1 μg/L, respectively.

USEPA's reassessment of the cancer toxicity of PCBs (USEPA, 1996b) concludes, "uncertainty around the CSF estimates extends in both directions. The CSF ranges primarily reflect mixture variability, and so are not necessarily appropriate for probabilistic analyses that attempt to describe model uncertainty and parameter uncertainty." This document was also externally peer-reviewed. As described in the 1996 reassessment document (USEPA, 1996b, pgs 51-53), a number of factors contribute to the uncertainty in the CSF, including the following major points:

- The rat study (Brunner *et al*., 1996) upon which the CSF was conducted is quite extensive in design and conduct, going beyond standard designs for cancer studies in many respects;
- There is a 30-fold range in potency based on variability in commercial mixture composition for the four Aroclors tested in female Sprague-Dawley rats; this entire range was used to represent environmental mixtures;
- Variability across strains varies up to 15-fold; potency and cancer slope estimates were derived from a strain in the middle of the range;

- Potency and cancer slope factors were based on female rats, whose liver responses were greater than that of males;
- Lot-to-lot variability was reflected by using estimates from different experimental studies; and
- A default cross-species scaling factor was used as an unbiased projection to account for animal-to-human extrapolation (USEPA, 1992b).

However, overall, the CSFs developed by USEPA represent plausible upper bound estimates, which means that USEPA is reasonably confident that the actual cancer risk will not exceed the estimated risk calculated using the CSF.

D.3 Summary of IRIS - PCB Non-cancer Toxicity

D.3.1 Potential for Non-cancer Effects in Humans and Animals

A number of non-cancer health effects have been associated with PCB exposure (reviewed in USEPA, 1999a,b). The prominent observed effect in workers exposed to large quantities of PCBs was a skin condition known as chloracne (USEPA, 1999b). Other effects such as depression, fatigue, nose irritation, and gastrointestinal discomfort were suggested to be associated with workplace PCB exposure (USEPA, 1997). Studies in rats that have been exposed to high doses of PCBs have shown mild liver damage, stomach effects, thyroid gland injuries, acne, and with high enough doses, death (USEPA, 1999b). Studies in rabbits exposed to high PCB doses have also shown kidney effects. In low-dose, long-term exposure studies, reproductive, eye, and nail effects have also been observed (USEPA, 1999b)

D.3.2 IRIS PCB Reference Doses

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 subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime. Chronic RfDs are specifically developed to be protective for long-term exposure to a compound, with chronic duration ranging from seven years to a lifetime as a Superfund guideline (USEPA, 1989b). IRIS, which provides the Agency's consensus review of toxicity data (USEPA, 1999a-b), provides RfDs for two Aroclor mixtures, Aroclor 1016 and Aroclor 1254; there is no RfD available for Total PCBs. Although there is an IRIS file for Aroclor 1248, the USEPA determined the available health effects data to be inadequate for derivation of an oral RfD (USEPA, 1999d). There are no inhalation Reference Concentrations (RfCs) currently available for either Total PCBs or any of the Aroclor mixtures (USEPA, 1999a-c).

D.3.2.1Aroclor 1016 RfD

The USEPA derived an oral RfD of 7×10^{-5} mg/kg-day for Aroclor 1016 based on a series of reports of a single study conducted in rhesus monkeys (Barsotti and van Miller, 1984; Levin *et al*., 1988; Schantz *et al*., 1989, 1991; as summarized in USEPA, 1999a). In this study, female rhesus monkeys were administered Aroclor 1016 in the diet for 22 months at doses of 0, 7, and 28 μg/kg-day. Animals were exposed 7 months prior to breeding and exposure continued until offspring were 4 months of age. Although there was no evidence of overt toxicity observed in the adult rhesus monkeys, hairline hyperpigmentation, decreased birth weight, and possible neurologic impairment were observed in the offspring. The observed hyperpigmentation occurred at the lowest dose tested (7 μg/kg-day), but was not considered by the USEPA to be a critical adverse effect. Both reduced birth weight and possible neurologic impairment were observed at 28 μg/kg-day. USEPA chose a No Observed Adverse Effect Level (NOAEL) of 7 μg/kg-day and a Lowest Observed Adverse Effects Level (LOAEL) of 28 μg/kg-day based on reduced birth weight.

The method described in Section 4.1 was used to develop RfDs. The USEPA used an uncertainty factor (UF) of 100 based on the following: intraspecies variability and protection of sensitive individuals since these studies indicate that infants exposed transplacentally represent a sensitive subpopulation (UF=3), interspecies variability extrapolated from animal to humans based on the physiological similarities between these species (UF=3), database limitations such as the lack of data on male reproductive effects (UF=3), and the use of a subchronic study (UF=3). Application of the total UF of 100 to the NOAEL of 7 μg/kg-day results in an oral RfD for Aroclor 1016 of 7×10^{-5} mg/kg-day.

D.3.2.2Aroclor 1254 RfD

The USEPA has derived an RfD for chronic oral exposure to Aroclor 1254 based on effects observed in rhesus monkeys fed Aroclor 1254 (USEPA, 1999b). Female rhesus monkeys were fed daily dosages of 0, 5, 20, 40 or 80 μg/kg-day of Aroclor 1254 in gelatin capsules for more than five years. A number of investigators evaluated health effects over the five-year period. General health and clinical pathology evaluations were conducted during the first 37 months and reported by Arnold *et al*. (1993a,b, as summarized in USEPA, 1999b). Immunologic evaluations were conducted after 23 and 66 months by Tryphonas *et al*. (1989; 1991a,b, as summarized in USEPA, 1999b). Truelove *et al*. (1990, as summarized in USEPA, 1999b) and Arnold *et al*. (1993a, as summarized in USEPA, 1999b) evaluated the monkeys for reproductive endocrinology changes after 24 or 29 months. Hydrocortisone levels were evaluated after 22 months and reported by Loo *et al*. (1989, as summarized in USEPA, 1999b) and Arnold (1993b, as summarized in USEPA, 1999b). Although a number of other toxicological parameters were evaluated, the five studies by Arnold *et al*. (1993a, 1993b, as summarized in USEPA, 1999b) and Tryphonas *et al*. (1989, 1991a,b, as summarized in USEPA, 1999b) were the studies used by the USEPA to derive the oral RfD.

Arnold *et al*. (1993a) identified eye toxicity and finger and toe nail changes as part of their general health and clinical pathology evaluations as the critical effect. These investigators observed a significant increase in the frequency of inflamed and/or prominence of the Meibomian (tarsal) glands and incidence of eye exudate in treated monkeys as compared to controls. Additionally, a statistically significant increase in the incidence of certain finger and toe nail changes (nail folding on themselves, elevated nails, nail separation, prominent nail beds) was observed in treated animals. Both the eye and nail effects were observed at the lowest dose of 5 μg/kg-day and the differences between treatment and control groups were statistically significant (p less than or equal to 0.05).

Tryphonas *et al*. (1989; 1991a,b) examined changes in IgG, IgM, T-helper lymphocyte cells, and T-suppressor lymphocyte cells following a challenge with sheep red blood cells in Rhesus monkeys exposed to Aroclor 1254 for 23 months. These researchers noted statistically significant reductions in IgG and IgM at the lowest dose tested (5 μg/kg-day) and T-lymphocyte cell changes at the 80 μg/kg-day dose level.

USEPA derived the oral RfD based on a lowest-observed-adverse-effect-level (LOAEL) of 5 μg/kg-day and the observance of the following critical effects: ocular exudate, inflamed and prominent Meibomian glands, distorted growth of finger and toe nails and decreased antibody (IgG and IgM) response to sheep erythrocytes. An UF of 300 was applied by USEPA to derive an oral RfD of 2×10^{-5} mg/kg-day to account for: intraspecies variability and sensitive populations (UF=10), interspecies variability (UF=3), the use of a LOAEL value (UF=3), and the use of a subchronic study (UF=3).

D.4 Review of Additional PCB Studies

Based on an electronic literature search (Medline and Toxline), a number of human epidemiological and animal studies on PCB toxicity and carcinogenicity were identified that have been published in the past five years. A subset of the recent human studies are summarized in Table D-1, including those epidemiological studies suggested by the peer review panel, and selected other human studies that are commonly referenced by the scientific community. Note that this summary is intended to supplement toxicity summaries presented by USEPA in the PCB, Aroclor 1016 and Aroclor 1254 IRIS files (USEPA, 1999 a,b,c).

The column labeled "Results Reported by Author(s)" in Table D-1 is a summary of the study findings as characterized by the authors. The studies are included to provide updated information published in the scientific literature and respond to the peer review comment, and are not necessarily representative of Agency policies or positions.

As part of the PCB reassessment of non-cancer health effects, USEPA is currently in the process of performing a more critical evaluation of these recent studies, in addition to other human studies, animal toxicity studies, and other studies providing supporting information. The exposure estimates provided in the third column of Table D-1 are not intended to be used for direct quantitative comparisons, but instead to give a general idea of the level of PCB exposures in the respective studies. As additional perspective, ATSDR reports average PCB concentrations of 0.5 to 4 ppm in human milk fat, <5 ppb for blood plasma, and 0.5 to 10 ppm for adipose tissue (ATSDR, 1997).[1] However, as discussed in Section D.4.4 below, there are numerous reasons why PCB levels in different studies may not be directly comparable.

[1] The USEPA is aware that ATSDR has released a revised Draft Toxicological Profile for PCBs (ATSDR, 1998). That document went through external peer review and is currently being revised.

Recent human epidemiological studies have focused on potential carcinogenicity, developmental and neurotoxic effects, thyroid effects, immunological effects, and reproductive effects of PCB exposures. Reported effects in recent animal studies generally support the findings in human epidemiological studies. The impact of these new studies on PCB risk assessment, and other important issues in assessing PCB cancer risks and non-cancer health hazards are discussed in the remainder of this section. These summaries are provided for background information, as USEPA is currently re-evaluating the non-cancer toxicity data as part of the IRIS process. This process involves a critical evaluation of the available scientific literature to identify the critical study (or studies) and health effect, determination of Uncertainty Factors and Modifying Factors, determination of oral RfDs and inhalation RfCs where appropriate, external peer-review, and internal USEPA consensus review before the revised file is listed on IRIS. At this time, it is premature to prejudge the outcome of this assessment, so the studies presented are summaries of the existing literature and not an indication that the current RfDs in IRIS will necessarily change.

D.4.1 Cancer

USEPA reassessed the cancer toxicity of PCBs in 1996 (USEPA, 1996b). Recently, Dr. Kimbrough and colleagues (1999) published a paper describing a study of 7,075 male and female workers from two GE capacitor manufacturing plants in New York State. In this study, mortality (deaths) from all cancers was determined for the study group, which comprised 7,075 female and male workers who worked at the GE facilities for at least 90 days between 1946 and 1977. The total number of deaths from all causes was 1,195 people and the total number of deaths caused by cancer was 353 people. No significant elevations in mortality for any site-specific cause were found in the hourly cohort. No significant elevations were seen in the most highly exposed workers. Mortality from all cancers was significantly below expected in hourly male workers, and comparable to expected for hourly female workers (Kimbrough *et al*., 1999).

USEPA performed a preliminary review of the Kimbrough *et al.* (1999a) study and identified aspects of the study (discussed in the Upper Hudson HHRA, USEPA, 1999b, pp. C2-C3) that limit its usefulness for Superfund risk assessments. The primary limitation, which is shared by other similar epidemiological studies, is that the degree of exposure is not well characterized. Other scientists have identified this and other limitations of the Kimbrough *et al.* (1999a) study (see Bove et al., 1999; Frumkin and Orris, 1999, and Kimbrough et al., 1999b).

Based on the limitations of the Kimbrough *et al*. (1999a) study, USEPA expects that the study will not provide sufficient information to change the Agency's conclusions regarding the weight of evidence of the human PCB data or the health effects of PCBs in general. For these reasons, in the Revised HHRA, USEPA used the IRIS cancer slope factors and did not attempt to develop new cancer slope factors based on the Kimbrough et al. (1999a) study.

Table D-1 summarizes a number of other studies that have evaluated potential associations between PCBs and cancer for both occupational populations and the general population. As shown in this summary, recent studies have investigated PCB exposures and breast cancer; the results from some have suggested that PCBs increase the risk of breast cancer after menopause (Moysick et al., 1998), while other studies have failed to show an association between PCB exposure and breast cancer (reviewed in USEPA, 1997, also see Table D-1). Overall, the USEPA Risk Assessment Forum concluded that it is not possible to attribute a cause and effect association between PCB exposure and breast cancer given the sparse data currently available.

The published occupational and population studies (including the recent Kimbrough study) indicate both positive and negative causal relationships between PCB exposure and cancer. There are a number of limitations with these studies, including lack of sufficient exposure information, failure to adequately account for co-exposure to other compounds, questions about the appropriateness of the control populations, the influence of the timing of exposure especially at critical periods during a lifetime, and inconsistency between studies.

D.4.2 Developmental/Neurotoxic and Reproductive Effects

A number of recent studies have investigated possible developmental and neurotoxic effects in children from pre-natal or post-natal exposures to PCBs. These studies are based on national and international cohorts of children perinatally exposed to PCBs who have been evaluated over a number of years, as they mature. The results from some of these studies are summarized in Table D-1.

A brief summary of the human epidemiological studies in children is provided below. The results from these studies are consistent with those from animal studies, *e.g.*, Rice (1997; 1998; 1999).

Lake Michigan Study. This longitudinal prospective study investigated developmental and cognitive deficits in children whose mothers consumed Lake Michigan fish contaminated with PCBs and other possible contaminants during the six years preceeding pregnancy and who continued to do so during the pregnancy. Prenatal PCB exposure was associated with reduced birth weight, smaller head circumference, shorter gestational age, adverse behavioral outcomes, and poorer visual recognition memory at 5-7 months (Fein *et al.*, 1984). At four years of age, pre-natal PCB exposure was associated with cognitive deficits (poorer performance on McCarthy tests of verbal and numerical memory) and lower body weights; at eleven years of age, prenatal PCB exposure was associated with decreased full-scale and verbal IQ scores (Jacobson and Jacobson, 1996; Jacobson and Jacobson, 1997, Schantz, 1996).

North Carolina Study. The North Carolina Breast Milk and Formula project investigated the potential effects of pre-natal and lactational exposures to PCB and DDE in a cohort selected from the general population in North Carolina (Rogan and Gladen, 1985). Association between pre-natal PCB exposures and adverse behavioral outcomes were reported, but unlike the Jacobson studies, no differences in birth weight or head circumference were found (Rogan *et al.*, 1986a). At 6, 12, and 24 months, pre-natal PCB exposures were associated with lower psychomotor scores (Rogan and Gladen, 1991). No effect on performance on McCarthy tests at 3, 4, and 5 years of age were found (Gladen and Rogan, 1991).

Dutch Studies. A cohort of Dutch mother infant pairs are being studied to investigate possible effects of general population exposures to PCBs and dioxins from dietary sources other than fish (Sauer *et al.*, 1994). Effects on growth and development reported to date include lower birth weights and decreased postnatal growth, delays in psychomotor development and neurodevelopment, and alterations in thyroid hormones and immunological status, primarily associated with prenatal PCB and dioxin exposures and not lactational exposures (Patandin *et al.*, 1998; Koopman-Esseboom *et al.*, 1996; Huisman *et al.*, 1995a; Koopman-Esseboom *et al.*, 1994; Weisglas-Kuperus *et al.*, 1995).

Michigan Adult Study. Studies of neurobehavioral effects in PCB-exposed adults have also been performed. Ongoing studies are also being done on a subset of the Michigan Department of Health's cohort of fisheaters (individuals who consumed 24 lbs of Lake Michigan fish annually in 1980-1982), and nonfisheater controls (Schantz *et al.*, 1996). DDT and PCB concentrations in trout and salmon ranged from 10-20 ppm during the time period when the cohort was first recruited (Humphrey *et al*., 2000). The subset of cohort members who were >50 years old in 1992 were selected for further analysis, to investigate whether susceptibility to neurological effects increases with age. Although the fish consumption rate for this subcohort has decreased with time (mean annual fish consumption in 1992 = 7 lbs), PCB levels in blood continue to be significantly elevated (mean 14 ppb) compared to nonfish-eaters (mean 4.6 ppb) (Humphrey *et al.*, 2000). No correlation was found between their PCB exposure levels and impairment of fine motor function (hand steadiness or visual-motor coordination) (Schantz *et al.*, 1999). Assessments of other health endpoints in this subcohort are planned.

New York State Angler Cohort Study of Reproductive Health Effects. Possible reproductive effects from maternal or paternal exposures to PCBs have also been investigated in recent studies. One of the larger studies of a fish-eating population is the New York State Angler Cohort Study (Mendola *et al*., 1995a; Vena *et al*., 1996). Fish consumption rates, reproductive and medical histories, sociodemographic information were collected using a questionnaire for a cohort of over 10,000 licensed male and female anglers and their families living in sixteen counties surrounding Lake Ontario. Lake Ontario fish are known to be contaminated with a variety of compounds, including PCBs. Subsets of the larger cohort are being studied to investigate a number of different reproductive and developmental health endpoints. There was a significant association between consumption of PCB-contaminated fish and decreased menstrual cycle length (Mendola *et al*., 1997). However, there was no evidence that PCB exposures increased the risk of spontaneous fetal death (Mendola *et al*., 1995b), nor was there evidence that maternal or paternal consumption of PCB-contaminated fish caused conception delay (Buck *et al*., 1997; Buck *et al*., 1999).

As part of the PCB reassessment of non-cancer health effects, USEPA will evaluate these studies in addition to a number of other studies including animal toxicity and supporting information to determine the most appropriate critical studies and critical effects to determine whether the current RfD requires changes. At this time, it is premature to make any determinations on the impact of these new studies on the current RfD since a consensus has not been reached within the USEPA regarding the critical studies, critical effects, uncertainty factors and modifying factors. Once completed, the toxicological summaries will be externally and internally peer reviewed before adding the chemical file containing the RfDs to IRIS.

D.4.3 Immunotoxicity and Thyroid Effects

As shown in Table D-1, PCB exposures have been associated with immunotoxicity and changes in thyroid hormone levels in some studies.

Since immuno-suppression is a risk factor for non-Hodgkin's lymphoma, the immunotoxic effects of PCBs have been hypothesized to increase the risk for non-Hodgkin's lymphoma (Hardell *et al.*, 1997; Hardell *et al.*, 1998). The findings that groups of non-Hodgkin's lymphoma patients had higher concentrations of 14 specific PCB congeners in adipose tissue (Hardell *et al.*, 1996) or higher concentrations of total serum PCBs (Rothman *et al.*, 1997), support this hypothesis.

D.4.4 Endocrine Disruption

PCBs have also been investigated as potential endocrine disruptor chemicals (EDCs), which could lead to both cancer and non-cancer health effects (USEPA, 1997). An environmental endocrine disruptor is defined as "an exogenous agent that interferes with the synthesis, secretion, transport, binding, action, or elimination of natural hormones in the body that are responsible for the maintenance of homeostasis, development, and/or behavior" (USEPA, 1997, pg. 1). For example, some studies have suggested that PCBs increase the risk of breast cancer, while other studies have failed to show an association between PCB exposure and breast cancer (reviewed in USEPA, 1997). Overall, the USEPA Risk Assessment Forum concluded that it is not possible to attribute a cause and effect association between PCB exposure and breast cancer given the sparse data currently available. Similarly, an association between endometriosis and high levels of PCBs in blood has been reported, but the evidence for a causal relationship is considered very weak (reviewed in USEPA, 1997). Due to the similar structural properties of PCBs and normal thyroid hormones, PCBs may also cause thyroid effects such as hypothyroidism *via* competition for receptor binding sites (reviewed in USEPA, 1997).

There is currently considerable scientific debate about whether environmental chemicals acting *via* endocrine disruptor mechanisms are responsible for adverse health effects in humans (reviewed in USEPA, 1997). Because the human body has negative feedback mechanisms to control the fluctuations of hormone levels, exposures to chemicals at the levels found in the environment may be insufficient to disrupt endocrine homeostasis. Current screening assays that measure hormone receptor binding thus may or may not be associated with a corresponding adverse health effect.

Overall, the USEPA is aware and concerned about the potential effects of environmental endocrine disruptors on human health, and is currently supporting significant research in this area along with other federal agencies. USEPA's "Research Plan for Endocrine Disruptors" was published in February 1998 (EPA/600/R-98/087) and describes the USEPA's ongoing research on EDCs. However, "there is little knowledge of or agreement on the extent of the problem," and "further research and testing are needed" (USEPA, 1997b, pg. vii). The USEPA Science Policy Council's Interim Position is that "based on the current state of the science, the Agency does not consider endocrine disruption to be an adverse endpoint per se, but rather to be a mode or mechanism of action potentially leading to other outcomes, for example, carcinogenic, reproductive, or developmental effects, routinely considered in reaching regulatory decisions" (USEPA, 1997b, pg. viii). As part of the non-cancer reassessment, USEPA will evaluate the current data on EDCs.

D.4.5 Additional Considerations

Exposure Index. Elevated PCB levels in human blood have been linked to high consumption rates of PCB-contaminated fish (*e.g.*, Asplund *et al.*, 1994; Svensson *et al.*, 1995). However, measurements of PCB levels in blood or other biological samples or tissues are not always elevated in populations known to be exposed to environmental PCB contamination (Seegal, 1996). It is therefore unclear which PCB exposure index is most appropriate to evaluate potential adverse health effects. For example, elevated levels of more heavily chlorinated PCBs in cord blood were correlated with fish consumption, PCB levels in breast milk, and impaired performance on neonatal behavioral tests, even though total serum PCB levels were not significantly different between fish consumers and non-fish eaters (Stewart *et al.*, 2000). The most appropriate exposure index may vary depending on the health endpoint of concern.

In addition, the fact that different studies have used different exposure indices makes comparisons of exposures across studies, or to site-specific PCB exposures, problematic. The various types of exposure indices that have been used include measurements of total PCBs, classes of PCB congeners (more highly *versus* less highly chlorinated congeners), and individual congeners, in samples of blood (adult, maternal, cord, and child blood), breastmilk, and other tissues. In some but not all studies, concentrations are lipid normalized (Dekoning and Karmaus, 2000). Differences in analytical methods between studies further complicate comparisons. Another uncertainty in evaluating the results of PCB epidemiology studies is that in many studies, the time periods for which PCB exposure levels were measured did not coincide with the time periods for which adverse health effects were monitored. Overall, biological PCB measurements are not an exact indicator of the amount or type of PCBs an individual has been exposed to, or how long exposure has occurred (Brouwer *et al*., 1999).

PCB exposures to fetuses, nursing infants, and offspring can be even more complicated. Transfer of maternal PCBs across the placenta and into breast milk can clearly result in significant exposures *in utero* and to a nursing infant (DeKoning and Karmaus, 2000). Exposure to PCBs in breast milk is estimated to be a major contributor to a child's body burden at 42 months of age (Lanting *et al*., 1998a), and to account for over 10% of one's cumulative PCB intake through 25 years of age (Patandin *et al*., 1999a). Elevated PCB levels in human breast milk have been linked to high maternal consumption of PCB-contaminated fish (*e.g.*, Fitzgerald *et al*., 1998).

Methods to model PCB concentrations in serum or *in utero*/lactational exposures are not well established, and as noted above, it is not clear which type of biological measurements are most appropriate for evaluating potential adverse health effects. In the case of consumption of PCB contaminated fish, exposure depends not only on the consumption rate of fish and the PCB concentrations in fish, but also on an individual's age, the half-life of the individual congener, and the temporal pattern of their previous PCB exposures.

The half-lives of PCB congeners in the human body have not been well established, but are dependent in part on the number and position of chlorines present in each PCB congener. Half-lives tend to increase with the number of chlorines (USEPA, 1996b). One group of scientists have estimated PCB half-lives to range from 5 to 15 years (Patandin *et al.*, 1999a). Other scientists have concluded that half-lives for PCB congeners frequently found in blood are unlikely to be less than one year, or greater that ten years (Shirai and Kissel, 1996). It is difficult to measure PCB half-lives even in workers occupationally exposed to PCBs, due to complications with continued low level exposure. ATSDR summarized that PCB congeners can remain in the body for months to years (ATSDR, 1993).

Thus, at any one time, an individual's body burden is a function of their current and past exposures, and may also be affected by significant fluctuations in an individual's weight. PCB exposures *in utero* are based on the mother's current and past history of PCB exposures. PCB exposures in breast milk depend not only on maternal PCB exposure levels, but can also be significantly influenced by factors such as maternal age, number of children, length of time between children, and duration of breastfeeding (Vartiainen *et al*., 1998; Rogan *et al*., 1986). A mother's body burden of PCBs has been estimated to decrease 20% for every 3-6 months of breast feeding (Patandin *et al*., 1999a; Rogan and Gladen, 1985), after which PCB body burdens are gradually restored.

Although some investigators have attempted to model quantitative estimates of concentrations of total PCBs or individual congeners in serum or breast milk (*e.g.*, Vartiainen *et al.*, 1998; Rylander *et al.*, 1998; ATSDR, 1997), many of the necessary parameters are not well established, and so there are still considerable uncertainties involved. For example, PCB concentrations in serum and milk collected from seven lactating women from the New York State Angler Survey were not well correlated; serum/milk ratios ranged from 0.18 to 1.66, or 1.1 to 2.8 using lipid adjusted values (Greizerstein *et al.*, 1999). Also, PCB concentrations in serum and breastmilk for consumers of PCB-contaminated fish were not well correlated with the reported number of fish meals consumed per year (Greizerstein *et al.*, 1999). Although based on a relatively small sample size, these results indicate significant inter-individual variability, making accurate predictions of PCB levels in blood or breast milk difficult.

Other Contaminants. PCB-contaminated fish are often contaminated with a variety of other contaminants, including PCDDs, DDT, mercury, arsenic, and lead. This is a challenge in designing human epidemiological studies to evaluate the potential contributions from these individual chemicals and in chemical mixtures.

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TABLE D-1
SUMMARY OF SELECTED RECENT STUDIES OF HUMAN EXPOSURES TO POLYCHLORINATED BIPHENYLS (PCB)

Reference	Source of PCB Exposure	Measurement of PCB Exposure	Study Population	Results Reported by Author(s)*
Developmental/Neurotoxic Effects from In Utero / Breast Milk Exposures				
Gladen *et al.*, 2000	General population exposure	Median transplacental PCB index = 1.7 ppm milk fat	Children 10-14 years old (n=594) (North Carolina)	Association between pre-natal PCB exposures and increased weight only for white female children. No effect of lactational PCB exposure on pubertal growth and development.
Huisman *et al.*, 1995a	General population exposure	Median sum of PCB congeners 118, 138, 153, and 180 in breast milk = 404 ng/g fat	Dutch newborns (n=418) (Dutch PCB/Dioxin Study)	Association between PCBs, PCDDs, and PCDFs in breast milk and reduced neonatal neurological optimality 10-21 days after birth (postnatal exposures). Association between planar PCBs in breast milk and higher incidence of hypotonia. No association between PCBs in cord and maternal blood (pre-natal exposures).
Huisman *et al.*, 1995b	General population exposure	Median sum of PCB congeners 118, 138, 153, and 180 in cord blood = 0.43 µg/L	Dutch children, 18 months old (n=418) (Dutch PCB/Dioxin Study)	Association between PCB and dioxin levels in cord and maternal blood and neurological condition at 18 months of age (based on pre-natal exposures). No association with lactational exposure to PCBs or dioxins (post-natal exposures).
Jacobson and Jacobson, 1996	Prenatal exposure due to maternal consumption of Lake Michigan fish	Mean PCBs in maternal serum = 6 ng/ml Mean PCBs in breast milk = 841 ng/g fat	11-year old children born to women consuming ≥ 11.8 lbs of Lake Michigan salmon or trout during the six years preceding the child's birth (n=212) (Michigan)	Significant association between prenatal exposure to PCBs (determined as a composite measure of cord serum, breast milk, and maternal serum) and lower full scale and verbal IQ scores at age 11, particularly affecting memory and attention after controlling for confounding variables such as socioeconomics. No association with measures of postnatal exposure (PCB levels in breastmilk and duration of breastfeeding, and child's serum at 4 or 11 years of age), despite significant postnatal exposure through breast feeding suggesting the developing fetal brain is particularly sensitive.

**These studies provide information published in the scientific literature, in response to peer review comment. These studies are not necessarily representative of Agency policies or positions.*

TABLE D-1
SUMMARY OF SELECTED RECENT STUDIES OF HUMAN EXPOSURES TO POLYCHLORINATED BIPHENYLS (PCB*)*

Reference	Source of PCB Exposure	Measurement of PCB Exposure	Study Population	Results Reported by Author(s)*
Koopman-Esseboom *et al.*, 1996	General population exposure	Average sum of PCB congeners 118, 138, 153, and 180 in cord blood = 0.5 µg/L	Dutch mother-infant pairs (n=207) (Dutch PCB/Dioxin Study)	Association with prenatal PCB exposure and small negative effect on psychomotor score at 3 months. PCB and dioxin exposure through breastfeeding adversely affected psychomotor outcome at 7 months.
Lanting *et al.*, 1998b	General population exposure	Average sum of PCB congeners 118, 138, 153, and 180 in cord blood = 0.4 µg/L	Dutch mother-child pairs (n=394) (Dutch PCB/Dioxin Study)	No association between prenatal or postnatal PCB exposure and neurological condition at 42 months of age after adjustment for covariates.
Patandin *et al.*, 1998b	General population exposure	Average sum of PCB congeners 118, 138, 153, and 180 in cord blood = 0.4 µg/L	Dutch children (n=207) (Dutch PCB/Dioxin Study)	Prenatal PCB exposure (cord blood and maternal blood) associated with decreased birth weight and lower growth rate from birth to 3 months. No association with post-natal PCB exposure up to 42 months of age.
Patandin *et al.*, 1999	General population exposure	Average sum of PCB congeners 118, 138, 153, and 180 in maternal blood = 2 µg/L	Dutch children (n=395) (Dutch PCB/Dioxin Study)	Prenatal PCB exposure (maternal PCB blood levels) associated with lower scores on cognitive tests administered at 42 months of age. No association with cognitive performance found for lactational exposure, or child's PCB body burden at 42 months of age.
Rogan and Gladen, 1991	General population exposure	Transplacental PCB index = >4 ppm milk fat in highest exposure category	Children 18-24 months old (n=670) (North Carolina)	Decreased psychomotor skills at 24 months associated with prenatal exposure to PCBs.
Rylander *et al.*, 1995b	Prenatal exposure due to maternal consumption of Baltic Sea fish	Mean fish consumption = 5-8 meals per month	Fisherman's wives from the east (n=38) and west (n=31) coasts of Sweden, and referents (n=69)	Decreased birth weight for fisherman's wives from the east coast of Sweden, which is more heavily contaminated with PCBs and other contaminants, but not from the west coast.

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TABLE D-1
SUMMARY OF SELECTED RECENT STUDIES OF HUMAN EXPOSURES TO POLYCHLORINATED BIPHENYLS (PCB)

Reference	Source of PCB Exposure	Measurement of PCB Exposure	Study Population	Results Reported by Author(s)*
Rylander *et al*., 1996	Prenatal exposure due to maternal consumption of Baltic Sea fish	≥ 4 fatty fish meals per month in highest exposure category	Low birthweight children (n=72 cases) born to fisherman's wives from the east coast of Sweden, and matched controls (n=162)	Suggestion of increased risk for low birth weight associated with high current consumption of fish from the east coast of Sweden, which is more heavily contaminated with PCBs and other contaminants, but no clear dose-response. Increased risk for low birth weight associated with mothers who grew up in a fishing village.
Rylander *et al*., 1998	Prenatal exposure due to maternal consumption of Baltic Sea fish	Current maternal plasma levels of PCB congener 153 = 190 ng/g lipid	Low birthweight children (n=57 cases) born to fisherman's wives from the east coast of Sweden, and matched controls (n=135)	Increased risk for low birth weight associated with modeled maternal plasma levels of 300-400 ng/g lipid for PCB congener 153 at the time of birth.
Stewart *et al*., 2000	Prenatal exposure due to maternal consumption of Lake Ontario fish (at least 40 PCB-equivalent lbs over lifetime)	Median total PCBs in cord blood = 0.525 ng/g	Children of women who were frequent consumers of Lake Ontario fish (n=141), or nonconsumers (n=152) (Oswego Newborn and Infant Development Project, New York)	Significant correlation between pre-natal exposure to more heavily chlorinated PCBs and impaired performance on the neonatal behavioral assessment scale 25-48 hours after birth, particularly the habituation and autonomic tests.
Vartiainen *et al*., 1998	General population PCB exposure, likely fish consumption	Mean total PCB in breastmilk (first time mothers) = 496 ng/g lipid	Mothers who had just given birth (n=167) (Finland)	No correlation between PCBs, PCDDs, or PCDFs in breastmilk and child's birth weight.
Winneke *et al*., 1998	General population exposure	Mean sum of PCB congeners 138, 153, and 180 in breast milk = 427 ng/g fat	Healthy mother-infant pairs (n=171) (Dusseldorf, Germany)	The sum of PCB congeners 138, 153, and 180 associated with decreased performance on tests of cognitive development, language development, and personal/social development at 7 months of age.

Thyroid and Immunological Effects from In Utero / Breast Milk Exposures

Reference	Source of PCB Exposure	Measurement of PCB Exposure	Study Population	Results Reported by Author(s)*
Koopman-Esseboom *et al*., 1994	General population exposure	Mean total PCB-dioxin TEQ = 75 pg TEQ/g fat	Mother-infant pairs (n=105) (Dutch PCB/Dioxin Study)	Increased levels of PCDD, PCDF, and PCBs in human milk significantly associated with altered maternal and infant thyroid hormone status.

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TABLE D-1
SUMMARY OF SELECTED RECENT STUDIES OF HUMAN EXPOSURES TO POLYCHLORINATED BIPHENYLS (PCB)

Reference	Source of PCB Exposure	Measurement of PCB Exposure	Study Population	Results Reported by Author(s)*
Longnecker *et al*., 2000	General population exposure	Median PCB level in milk at birth = 1.8 mg/kg lipid	Children (n=160) (North Carolina)	No association between in utero exposure to total PCBs and changes in thyroid hormone or TSH levels at birth.
Nagayama *et al*., 1998a	General population exposure	Mean TEQ of PCDDs, PCDFs, and PCBs = 1.05 ppt	Breast-fed infants (n=36) (Japan)	Exposure to PCDD, PCDF, and coplanar PCBs in breast milk associated with decreased levels of thyroid hormones.
Nagayama *et al*., 1998b	General population exposure	Mean TEQ of PCDDs, PCDFs, and PCBs = 1.05 ppt	Breast-fed infants (n=36) (Japan)	Exposure to PCDD, PCDF, and coplanar PCBs in breast milk associated with altered levels of peripheral lymphocyte subpopulations.
Osius *et al*., 1999	Residing near an industrial waste incinerator, licensed to burn PCB-contaminated material	Median sum of 7 PCB congeners = 0.47 µg/L in blood	Children 7-10 years old (n=320)	Increased blood levels of PCB congener 118 significantly associated with an increase in thyroid stimulating hormone. Increased blood levels of PCB congeners 138, 153, 180, 183, and 187 significantly associated with a decrease in free triiodothyronine.
Weisglas-Kuperus, *et al*., 1995	General population exposure	Mean sum of PCB congeners 118, 138, 153, and 180 in plasma = 2.25 µg/L	Mother-child pairs (n=207) (Dutch PCB/Dioxin Study)	Prenatal and postnatal PCB/dioxin exposure associated with measures of immunological effects. No relationship between PCB/dioxin exposure and upper or lower respiratory tract symptoms or humoral antibody production.

Reproductive Effects

Buck *et al*., 1997	Consumption of Lake Ontario fish	≥ 7 years of Lake Ontario fish consumption in highest exposure category	A subset of female members of the New York State Angler Cohort (n=874)	Preliminary findings provide no evidence that maternal consumption of PCB-contaminated fish increases the time-to-pregnancy.

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TABLE D-1
SUMMARY OF SELECTED RECENT STUDIES OF HUMAN EXPOSURES TO POLYCHLORINATED BIPHENYLS (PCB)

Reference	Source of PCB Exposure	Measurement of PCB Exposure	Study Population	Results Reported by Author(s)*
Buck *et al*., 1999	Consumption of Lake Ontario fish	>1 fish meal/month in highest exposure category	A subset of households in the New York State Angler Cohort (n= 785)	These findings suggest that, based on paternal self reports, Lake Ontario fish consumption does not increase the risk of conception delay
Courval *et al*., 1999; Stein *et al*., 1999	Consumption of Great Lake fish	Lifetime fish consumption = 271-1127 meals in highest exposure category	Licensed anglers and their families (n=626) (Michigan)	A modest association between sport-caught fish consumption in men and risk of conception delay. There was no evidence that non-response bias affected the results (Stein *et al*., 1999).
Mendola *et al*., 1995b	Prenatal exposure due to maternal consumption of Lake Ontario fish	Lifetime PCB exposure > 7 mg in highest exposure category	Pregnant mothers (n=1,820) (New York State Angler Cohort)	No evidence that PCB exposures increase the risk of spontaneous fetal death.
Mendola *et al*., 1997	Consumption of Lake Ontario fish	>1 fish meal/month in highest exposure category	A subset of female members of the New York State Angler Cohort (n=2,223)	Significant association between maternal consumption of PCB-contaminated fish (>1 fish meal/month) and a reduction of about one day in menstrual cycle length.

Cancer

Guttes *et al*., 1998	General population exposure	Mean PCB 118 in breast tissue = 85 µg/kg fat	Breast cancer cases (n=45), and benign breast disease cases (n=20) (Germany)	Concentrations of PCB congeners 118, 138, 153, and 180 higher in breast tissue from breast cancer cases, but only weakly significant for one of the congeners, 118.
Hardell *et al*., 1996	General population exposure	Mean total PCB in adipose tissue in cases = 1614 ng/g lipid	Non-Hodgkin's lymphoma cases (n=28), and matched controls (n=17) (Sweden)	Significantly higher concentrations of 14 specific PCB congeners in adipose tissue in Non-Hodgkin's lymphoma cases. No association with PCDDs, PCDFs, DDE, or hexachlorobenzene.

**These studies provide information published in the scientific literature, in response to peer review comment. These studies are not necessarily representative of Agency policies or positions.*

TABLE D-1
SUMMARY OF SELECTED RECENT STUDIES OF HUMAN EXPOSURES TO POLYCHLORINATED BIPHENYLS (PCB)

Reference	Source of PCB Exposure	Measurement of PCB Exposure	Study Population	Results Reported by Author(s)*
Hoyer *et al.*, 1998	General population exposure	Median total PCB in blood = 1099 ng/g lipid	Breast cancer cases (n=240), and matched controls (n=477) (Participants in the Copenhagen City Heart Study, Denmark)	No association between PCBs, DDT, lindane, or chlordane levels in serum and breast cancer. Association between dieldrin in serum and breast cancer risk. No evidence of a synergistic effect between various organochlorine compounds.
Hoyer *et al.*, 2000	General population exposure	Median total PCB in serum = 979.2 to 1101.5 ng/g lipid	Breast cancer cases (n=240), and matched controls (n=477) (Participants in the Copenhagen City Heart Study, Denmark)	No association between repeated measurements of total PCBs in serum and breast cancer. Increased breast cancer risk with increased serum levels of PCB congeners 118 and 138, but trend not significant. Significant, dose-dependent association between serum DDT and breast cancer.
Hunter *et al.*, 1997	General population exposure	Median total PCB in serum = about 5 ppb in cases and controls	Breast cancer and matched controls (n=230 pairs) (Participants in Nurses Health Study)	No evidence of increased risk of breast cancer with increased serum levels of PCBs or DDT.
Kimbrough *et al.*, 1999	Inhalation and dermal exposures while working in a capacitor manufacturing plant	Total serum PCBs in subset = 6-2,530 ng/mL for lower chlorinated PCBs, 1-546 ng/mL for higher chlorinated PCBs	Male and female workers in a capacitor manufacturing plant (n=7075) (New York)	No significant elevations in mortality for any site-specific cause were found in the hourly cohort. No significant elevations were seen in the most highly exposed workers. Mortality from all cancers was significantly below expected in hourly male workers, and comparable to expected for hourly female workers.
Moysich *et al.*, 1998	General population exposure	Mean total PCB in serum = about 4 ng/g in cases and controls	Postmenopausal breast cancer cases (n=154), and matched controls (n=192) (New York)	No association between serum DDE, HCB, mirex, or total PCBs and risk of breast cancer in total cohort. Some evidence of increased breast cancer risk in total cohort with detectable levels of less chlorinated PCBs in serum, but no dose-response relationship. Association between PCB exposure and breast cancer risk only for women who had given birth but never breastfed.

**These studies provide information published in the scientific literature, in response to peer review comment. These studies are not necessarily representative of Agency policies or positions.*

TABLE D-1
SUMMARY OF SELECTED RECENT STUDIES OF HUMAN EXPOSURES TO POLYCHLORINATED BIPHENYLS (PCB)

Reference	Source of PCB Exposure	Measurement of PCB Exposure	Study Population	Results Reported by Author(s)*
Moysich *et al.*, 1999	General population exposure	Median total PCB in serum = 3.7 ng/g	Postmenopausal breast cancer cases (n=154), and matched controls (n=192) (New York)	Increased risk of breast cancer only seen in women with both serum PCB levels greater than the median, and a variant genotype for cytochrome P4501A1 (CYP1A1).
Rothman *et al.*, 1997	General population exposure	Median total PCB in serum in cases = 951 ng/g lipid	Non-Hodgkin's lymphoma cases (n=74), and matched controls (n=147) (Maryland)	Significant, dose-dependent association between serum PCB concentrations and non-Hodgkin's lymphoma. Authors recommend further investigation. No association with DDT.
Rylander *et al.*, 1995a	Consumption of Baltic Sea fish	Mean fish consumption = 8-10 meals per month	Fisherman's wives from the east (n=100) and west (n=100) coast of Sweden, and general population controls (n=200)	Increased mortality from breast cancer for fisherman's wives from the east coast of Sweden, which is more heavily contaminated with PCBs and other contaminants, but not from the west coast.
Neuropsychological Effects in Adults				
Schantz *et al.*, 1999	Consumption of Lake Michigan fish (median = 38.5 lbs fish/yr in 1980-1982, =7 lbs fish/yr in 1992)	Mean serum PCB ≥ 13.9 ppb in highest exposure category	Consumers of Lake Michigan fish, aged 50-90 (n=104) (Great Lakes fisheater cohort)	No association between PCB/DDE exposure and impaired fine motor function (hand steadiness, visual-motor coordination).

Note: Please see reference list at end of Appendix D for full citations for references listed above.

**These studies provide information published in the scientific literature, in response to peer review comment. These studies are not necessarily representative of Agency policies or positions.*

Appendix E

Tables and Figures for Mid-Hudson Risk Assessment

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

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.
					Child	Ingestion	On-Site	Quant	
	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 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 minimis risk. Included to address public concerns.
					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 swimming.
					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. 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. 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)	0.19	N/A	2.4	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 1999-2046 (USEPA, 2000).

(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, 2000).

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 2-3

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)	0.19	N/A	0.95	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 1999-2046 (USEPA, 2000).

(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, 2000).

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)	2.2E-06	N/A	3.2E-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 1999-2046 (USEPA, 2000).

(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, 2000).

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	38.4%	14%
Bullhead	23	1,092	558	24.3	61.9	300	36.7%	14%
Carp	2	[b]	90	45.0	42.4	75	5.9%	2%
Catfish	11	158	113	10.3	15.5	50	7.4%	3%
Eel	4	38	38	9.5	10.6	25	2.5%	0.9%
Perch	17	833	139	8.2	12.5	51	9.1%	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
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, see Table 2-5.*
[2] *From 1991/92 and 1996 NYSDOH study of Hudson River anglers (NYSDOH, 1999).*

Table 2-7
Species-Group Intake Percentages

Group 1		Group 2		Group 3		Group 4		Group 5	
Brown bullhead	36.7%	White Perch	7.6%	Yellow Perch	1.4%	Largemouth Bass	15%	Striped Bass	23%
Carp	5.9%								
Catfish	7.4%								
Eel	2.5%								
Species Group Totals	53%		7.6%		1.4%		15%		23%

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

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	1.2	**	1.7	N/A	mg/kg wet weight	1.3	Mean-N	Averaged over RME ED	1.5	Mean-N	Averaged over CT ED
in Yellow Perch	mg/kg wet weight	0.35	**	0.67	N/A	mg/kg wet weight	0.38	Mean-N	Averaged over RME ED	0.52	Mean-N	Averaged over CT ED
in Largemouth Bass	mg/kg wet weight	0.89	**	1.9	N/A	mg/kg wet weight	0.96	Mean-N	Averaged over RME ED	1.3	Mean-N	Averaged over CT ED
in Striped Bass	mg/kg wet weight	1.2	**	2.4	N/A	mg/kg wet weight	1.3	Mean-N	Averaged over RME ED	1.8	Mean-N	Averaged over CT ED
in White Perch	mg/kg wet weight	0.57	**	1.5	N/A	mg/kg wet weight	0.62	Mean-N	Averaged over RME ED	1.0	Mean-N	Averaged over CT ED
Species-weighted for adult exposure (1)	mg/kg wet weight	0.99	**	1.7	N/A	mg/kg wet weight	1.2	Mean-N	Averaged over RME ED	1.5	Mean-N	Averaged over CT ED
Species-weighted for adolescent exposure (1)	mg/kg wet weight	0.99	**	1.7	N/A	mg/kg wet weight	1.3	Mean-N	Averaged over RME ED	1.6	Mean-N	Averaged over CT ED
Species-weighted for child exposure (1)	mg/kg wet weight	0.99	**	1.7	N/A	mg/kg wet weight	1.5	Mean-N	Averaged over RME ED	1.6	Mean-N	Averaged over CT ED
Species-weighted for chronic exposure (2)	mg/kg wet weight	0.99	**	1.7	N/A	mg/kg wet weight	1.5	Mean-N	Averaged over RME ED	dependent on receptor (4)	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 adult, adolescent, and child exposure durations (6, 3, and 3 years, respectively) to calculate the CT EPCs, and over the RME adult, adolescent, and child exposure durations (22, 12, and 6 years, respectively) to calculate the RME EPCs 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 7 years to calculate the RME EPC for non-cancer hazards.

(3) Mean/maximum modeled concentration between 1999-2046 (USEPA, 2000).

(4) CT EPC for chronic exposure is dependent on exposure duration for each receptor (1.4 mg/kg adult; 1.5 mg/kg adolescent/child).

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	0.5	**	0.7	N/A	mg/kg						
Adult							0.57	Mean-N	Averaged over RME ED	0.67	Mean-N	Averaged over CT ED
Adolescent							0.62	Mean-N	Averaged over RME ED	0.68	Mean-N	Averaged over CT ED
Child							0.66	Mean-N	Averaged over RME ED	0.68	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 1999-2046 (USEPA, 2000).

(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
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	6.8E-06	**	1.8E-05	N/A	mg/L						
Adult							9.3E-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	1.7E-05	Mean-N	Averaged over CT ED
Child							1.4E-05	Mean-N	Averaged over RME ED	1.7E-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 1999-2046 (USEPA, 2000).

(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.

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.

Table 2-13
County-to-County In-Migration Data for Dutchess 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							Dutchess	Albany	Columbia	Greene	Rensselaer	Ulster	
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

	No Move	Move In											Total from Outside Region[a]
		Total	From Abroad	Domestic									
				Total	Outside Region[a]	Inside Region							
						Total	From						
Age Group							Greene	Albany	Columbia	Duchess	Rensselaer	Ulster	
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.

Table 2-15
County-to-County In-Migration Data for Rensselaer 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							Rensselaer	Albany	Columbia	Duchess	Greene	Ulster	
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.

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

Age Group	No Move	Move In: Total	Move In: 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)		$In_{1985\text{-}90,k}$ [a]	$Start_{1985\text{-}90,k}$ [b]	$Start_{1985\text{-}90,k+1}$ [c]	$Out_{1985\text{-}90,k}$ [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 $_{1985\text{-}90,k}$ in the preceding row.*
d. *$Out_{1985\text{-}90,k} = (Start_{1985\text{-}90,k} - Start_{1985\text{-}90,k+1}) + In_{1985\text{-}90,k}$*
e. *Set equal to $(Out_{1985\text{-}90,k}) / (Start_{1985\text{-}90,k} + In_{1985\text{-}90,k})$.*
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 $_{1985\text{-}90,7}$ to make Start $_{1985\text{-}90,6}$ and Start $_{1985\text{-}90,7}$ 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 $_{1985\text{-}90,13}$.*
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 2-19a

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	1.2	See Table 2-8	1.5	See Table 2-8	Average Daily Intake (mg/kg-day) =
	C_{fish}-NC	PCB Concentration in Fish (Non-cancer)**	mg/kg wet weight	1.5	See Table 2-8	1.5	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	22	derived from 95th percentile value, based on 1991 NY Angler and 1990 US Census data.	6	derived from 50th percentile value, based on 1991 NY Angler and 1990 US Census data.	
	ED	Exposure Duration (Noncancer)	years	7	see text	6	derived from 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.	2,190	ED (years) x 365 days/year.	

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

TABLE 2-19b

VALUES USED FOR DAILY INTAKE CALCULATIONS

MID-HUDSON RIVER FISH - Adolescent Angler

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish
Receptor Population: Angler
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_{fish}-C	PCB Concentration in Fish (Cancer)**	mg/kg wet weight	1.3	See Table 2-8	1.6	See Table 2-8	Average Daily Intake (mg/kg-day) =
	C_{fish}-NC	PCB Concentration in Fish (Non-cancer)**	mg/kg wet weight	1.5	See Table 2-8	1.6	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	21.3	2/3 of RME adult ingestion rate.	2.7	2/3 of RME adult ingestion rate.	
	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	12	derived from 95th percentile value, based on 1991 NY Angler and 1990 US Census data.	3	derived from 50th percentile value, based on 1991 NY Angler and 1990 US Census data.	
	ED	Exposure Duration (Noncancer)	years	7	see text	3	derived from 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	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	2,555	ED (years) x 365 days/year.	1,095	ED (years) x 365 days/year.	

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

TABLE 2-19c

VALUES USED FOR DAILY INTAKE CALCULATIONS

MID-HUDSON RIVER FISH - Child Angler

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish
Receptor Population: Angler
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_{fish}-C	PCB Concentration in Fish**	mg/kg wet weight	1.5	See Table 2-8	1.6	See Table 2-8	Average Daily Intake (mg/kg-day) =
	IR_{fish}	Ingestion Rate of Fish	grams/day	10.6	1/3 of RME adult ingestion rate.	1.3	1/3 of CT adult ingestion rate.	C_{fish} x IR_{fish} x (1 - Loss) X FS x EF x ED x CF x 1/BW x 1/AT
	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	years	6	derived from 95th percentile value, based on 1991 NY Angler and 1990 US Census data.	3	derived from 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	15	Mean child body weight (USEPA, 1989b).	15	Mean child body weight (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.	

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

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	0.57	See Table 2-9	0.67	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 5 Mid-Hudson Counties (see text)	5	derived from 50th percentile of residence duration in 5 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	0.57	See Table 2-9	0.67	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 5 Upper Hudson Counties (see text)	5	derived from 50th percentile of residence duration in 5 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.	

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	0.62	See Table 2-9	0.68	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 5 Mid-Hudson Counties (see text)	3	derived from 50th percentile of residence duration in 5 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	0.62	See Table 2-9	0.68	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 5 Mid-Hudson Counties (see text)	3	derived from 50th percentile of residence duration in 5 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.	

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	0.66	See Table 2-9	0.68	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 5 Mid-Hudson Counties (see text)	3	derived from 50th percentile of residence duration in 5 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	0.66	See Table 2-9	0.68	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 5 Mid-Hudson Counties (see text)	3	derived from 50th percentile of residence duration in 5 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	9.3E-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	cm²	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 5 Mid-Hudson Counties (see text)	5	derived from 50th percentile of residence duration in 5 Mid-Hudson Counties (see text)	
	CF	Conversion Factor	L/cm³	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.	

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	1.7E-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 5 Mid-Hudson Counties (see text)	3	derived from 50th percentile of residence duration in 5 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.	

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	1.7E-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	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 5 Mid-Hudson Counties (see text)	3	derived from 50th percentile of residence duration in 5 Mid-Hudson Counties (see text)	
	CF	Conversion Factor	L/cm^3	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.	

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	9.3E-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 5 Mid-Hudson Counties (see text)	5	derived from 50th percentile of residence duration in 5 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.	

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	1.7E-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 5 Mid-Hudson Counties (see text)	3	derived from 50th percentile of residence duration in 5 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.	

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	1.7E-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 5 Mid-Hudson Counties (see text)	3	derived from 50th percentile of residence duration in 5 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.	

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	2.0E-05 (2)	mg/kg-d	--	--	--	LOAEL	300	IRIS	6/1/97
Aroclor 1016		7.0E-05 (3)	mg/kg-d	--	--	--	NOAEL	100	IRIS	6/1/97

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	6/1/97
	2 (3)	--	--	$(mg/kg\text{-}d)^{-1}$	B2	IRIS	6/1/97
	0.3 (4)	--	--	$(mg/kg\text{-}d)^{-1}$	B2	IRIS	6/1/97
	0.4 (5)	--	--	$(mg/kg\text{-}d)^{-1}$	B2	IRIS	6/1/97

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 4-1a-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	1.5	mg/kg wt weight	1.5	mg/kg wt weight	M	6.8E-04	mg/kg-day	2.0E-05	mg/kg-day	N/A	N/A	34
Total Hazard Index Across All Exposure Routes/Pathways													34

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

TABLE 4-1a-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	1.5	mg/kg wt weight	1.5	mg/kg wt weight	M	6.9E-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.

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

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish
Receptor Population: Angler
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	1.5	mg/kg wt weight	1.5	mg/kg wt weight	M	7.4E-04	mg/kg-day	2.0E-05	mg/kg-day	N/A	N/A	37
Total Hazard Index Across All Exposure Routes/Pathways													37

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

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

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish
Receptor Population: Angler
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	1.6	mg/kg wt weight	1.6	mg/kg wt weight	M	8.0E-05	mg/kg-day	2.0E-05	mg/kg-day	N/A	N/A	4
Total Hazard Index Across All Exposure Routes/Pathways													4

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

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

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish
Receptor Population: Angler
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	1.5	mg/kg wt weight	1.5	mg/kg wt weight	M	1.1E-03	mg/kg-day	2.0E-05	mg/kg-day	N/A	N/A	53
Total Hazard Index Across All Exposure Routes/Pathways													53

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

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

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish
Receptor Population: Angler
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	1.6	mg/kg wt weight	1.6	mg/kg wt weight	M	1.1E-04	mg/kg-day	2.0E-05	mg/kg-day	N/A	N/A	6
												Total Hazard Index Across All Exposure Routes/Pathways	6

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

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	0.57	mg/kg	0.57	mg/kg	M	1.5E-08	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.00021
Dermal	PCBs	0.57	mg/kg	0.57	mg/kg	M	7.4E-08	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0011
Total Hazard Index Across All Exposure Routes/Pathways													0.0013

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

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	0.67	mg/kg	0.67	mg/kg	M	9.2E-09	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.00013
Dermal	PCBs	0.67	mg/kg	0.67	mg/kg	M	4.7E-08	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.00067
Total Hazard Index Across All Exposure Routes/Pathways													0.00080

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

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	0.62	mg/kg	0.62	mg/kg	M	7.7E-08	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0011
Dermal	PCBs	0.62	mg/kg	0.62	mg/kg	M	2.3E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0033
Total Hazard Index Across All Exposure Routes/Pathways													0.0044

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

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	0.68	mg/kg	0.68	mg/kg	M	4.3E-08	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.00062
Dermal	PCBs	0.68	mg/kg	0.68	mg/kg	M	1.3E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0018
Total Hazard Index Across All Exposure Routes/Pathways													0.0025

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

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	0.66	mg/kg	0.66	mg/kg	M	1.6E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0022
Dermal	PCBs	0.66	mg/kg	0.66	mg/kg	M	1.2E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0018
												Total Hazard Index Across All Exposure Routes/Pathways	0.0040

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

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	0.68	mg/kg	0.68	mg/kg	M	8.7E-08	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0012
Dermal	PCBs	0.68	mg/kg	0.68	mg/kg	M	6.8E-08	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0010
Total Hazard Index Across All Exposure Routes/Pathways													0.0022

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

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	9.3E-06	mg/L	9.3E-06	mg/L	M	1.1E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0015
Total Hazard Index Across All Exposure Routes/Pathways													0.0015

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

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	1.5E-05	mg/L	1.5E-05	mg/L	M	9.3E-08	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0013
Total Hazard Index Across All Exposure Routes/Pathways													0.0013

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

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	1.2E-05	mg/L	1.2E-05	mg/L	M	4.9E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0070
Total Hazard Index Across All Exposure Routes/Pathways													0.0070

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

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	1.7E-05	mg/L	1.7E-05	mg/L	M	3.5E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0051
Total Hazard Index Across All Exposure Routes/Pathways													0.0051

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

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	1.4E-05	mg/L	1.4E-05	mg/L	M	2.9E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0041
Total Hazard Index Across All Exposure Routes/Pathways													0.0041

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

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	1.7E-05	mg/L	1.7E-05	mg/L	M	1.9E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0027
Total Hazard Index Across All Exposure Routes/Pathways													0.0027

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

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	9.3E-06	mg/L	9.3E-06	mg/L	M	2.9E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0042
Total Hazard Index Across All Exposure Routes/Pathways													0.0042

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

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
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	1.5E-05	mg/L	1.5E-05	mg/L	M	2.9E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0041
Total Hazard Index Across All Exposure Routes/Pathways													0.0041

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

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
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	1.2E-05	mg/L	1.2E-05	mg/L	M	6.2E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0088
Total Hazard Index Across All Exposure Routes/Pathways													0.0088

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

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
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	1.7E-05	mg/L	1.7E-05	mg/L	M	5.3E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.0076
												Total Hazard Index Across All Exposure Routes/Pathways	0.0076

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

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
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	1.4E-05	mg/L	1.4E-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													0.019

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

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
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	1.7E-05	mg/L	1.7E-05	mg/L	M	9.5E-07	mg/kg-day	7.0E-05	mg/kg-day	N/A	N/A	0.014
Total Hazard Index Across All Exposure Routes/Pathways													0.014

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

TABLE 4-11a-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	1.2	mg/kg wt weight	1.2	mg/kg wt weight	M	1.7E-04	mg/kg-day	2	$(mg/kg\text{-}day)^{-1}$	3.4E-04
Total Risk Across All Exposure Routes/Pathways											3.4E-04

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

TABLE 4-11a-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	1.5	mg/kg wt weight	1.5	mg/kg wt weight	M	5.9E-06	mg/kg-day	1	$(mg/kg\text{-}day)^{-1}$	5.9E-06
							Total Risk Across All Exposure Routes/Pathways				5.9E-06

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

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

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish
Receptor Population: Angler
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	1.3	mg/kg wt weight	1.3	mg/kg wt weight	M	1.1E-04	mg/kg-day	2	$(mg/kg\text{-}day)^{-1}$	2.2E-04
							Total Risk Across All Exposure Routes/Pathways				2.2E-04

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

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

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish
Receptor Population: Angler
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	1.6	mg/kg wt weight	1.6	mg/kg wt weight	M	3.4E-06	mg/kg-day	1	$(mg/kg\text{-}day)^{-1}$	3.4E-06
Total Risk Across All Exposure Routes/Pathways											3.4E-06

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

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

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish
Receptor Population: Angler
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	1.5	mg/kg wt weight	1.5	mg/kg wt weight	M	9.1E-05	mg/kg-day	2	$(mg/kg\text{-}day)^{-1}$	1.8E-04
							Total Risk Across All Exposure Routes/Pathways				1.8E-04

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

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

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish
Exposure Point: Mid-Hudson Fish
Receptor Population: Angler
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	1.6	mg/kg wt weight	1.6	mg/kg wt weight	M	4.8E-06	mg/kg-day	1	$(mg/kg\text{-}day)^{-1}$	4.8E-06
							Total Risk Across All Exposure Routes/Pathways				4.8E-06

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

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	0.57	mg/kg	0.57	mg/kg	M	4.8E-09	mg/kg-day	2	$(mg/kg\text{-}day)^{-1}$	9.5E-09
Dermal	PCBs	0.57	mg/kg	0.57	mg/kg	M	2.4E-08	mg/kg-day	2	$(mg/kg\text{-}day)^{-1}$	4.9E-08
										Total Risk Across All Exposure Routes/Pathways	5.8E-08

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

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	0.67	mg/kg	0.67	mg/kg	M	6.6E-10	mg/kg-day	1	$(mg/kg\text{-}day)^{-1}$	6.6E-10
Dermal	PCBs	0.67	mg/kg	0.67	mg/kg	M	3.3E-09	mg/kg-day	1	$(mg/kg\text{-}day)^{-1}$	3.3E-09
							Total Risk Across All Exposure Routes/Pathways				4.0E-09

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

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	0.62	mg/kg	0.62	mg/kg	M	1.3E-08	mg/kg-day	2	$(mg/kg\text{-}day)^{-1}$	2.6E-08
Dermal	PCBs	0.62	mg/kg	0.62	mg/kg	M	3.9E-08	mg/kg-day	2	$(mg/kg\text{-}day)^{-1}$	7.9E-08
Total Risk Across All Exposure Routes/Pathways											1.1E-07

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

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	0.68	mg/kg	0.68	mg/kg	M	1.9E-09	mg/kg-day	1	$(mg/kg\text{-}day)^{-1}$	1.9E-09
Dermal	PCBs	0.68	mg/kg	0.68	mg/kg	M	5.5E-09	mg/kg-day	1	$(mg/kg\text{-}day)^{-1}$	5.5E-09
										Total Risk Across All Exposure Routes/Pathways	7.4E-09

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

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	0.66	mg/kg	0.66	mg/kg	M	1.3E-08	mg/kg-day	2	$(mg/kg\text{-}day)^{-1}$	2.7E-08
Dermal	PCBs	0.66	mg/kg	0.66	mg/kg	M	1.1E-08	mg/kg-day	2	$(mg/kg\text{-}day)^{-1}$	2.1E-08
Total Risk Across All Exposure Routes/Pathways											4.8E-08

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

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	0.68	mg/kg	0.68	mg/kg	M	3.7E-09	mg/kg-day	1	$(mg/kg\text{-}day)^{-1}$	3.7E-09
Dermal	PCBs	0.68	mg/kg	0.68	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		6.6E-09

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

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	9.3E-06	mg/L	9.3E-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.

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	1.5E-05	mg/L	1.5E-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.

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	1.2E-05	mg/L	1.2E-05	mg/L	M	8.4E-08	mg/kg-day	0.4	$(mg/kg\text{-}day)^{-1}$	3.3E-08
Total Risk Across All Exposure Routes/Pathways											3.3E-08

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

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	1.7E-05	mg/L	1.7E-05	mg/L	M	1.5E-08	mg/kg-day	0.3	$(mg/kg\text{-}day)^{-1}$	4.6E-09
										Total Risk Across All Exposure Routes/Pathways	4.6E-09

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

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	1.4E-05	mg/L	1.4E-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.

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	1.7E-05	mg/L	1.7E-05	mg/L	M	8.0E-09	mg/kg-day	0.3	$(mg/kg\text{-}day)^{-1}$	2.4E-09
										Total Risk Across All Exposure Routes/Pathways	2.4E-09

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

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
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	9.3E-06	mg/L	9.3E-06	mg/L	M	9.6E-08	mg/kg-day	0.4	$(mg/kg\text{-}day)^{-1}$	3.9E-08
							Total Risk Across All Exposure Routes/Pathways				3.9E-08

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

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
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	1.5E-05	mg/L	1.5E-05	mg/L	M	2.1E-08	mg/kg-day	0.3	$(mg/kg\text{-}day)^{-1}$	6.2E-09
								Total Risk Across All Exposure Routes/Pathways			6.2E-09

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

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	1.2E-05	mg/L	1.2E-05	mg/L	M	1.1E-07	mg/kg-day	0.4	$(mg/kg\text{-}day)^{-1}$	4.2E-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.

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
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	1.7E-05	mg/L	1.7E-05	mg/L	M	2.3E-08	mg/kg-day	0.3	$(mg/kg\text{-}day)^{-1}$	6.8E-09
							Total Risk Across All Exposure Routes/Pathways				6.8E-09

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

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	1.4E-05	mg/L	1.4E-05	mg/L	M	1.2E-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.

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	1.7E-05	mg/L	1.7E-05	mg/L	M	4.1E-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.

TABLE 4-21a-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	3.4E-04	--	--	3.4E-04	PCBs	LOAEL	34	--	--	34
						Total Risk Across Fish	3.4E-04					Total Hazard Index Across All Media and All Exposure Routes	34
						Total Risk Across All Media and All Exposure Routes	3.4E-04						
												Total LOAEL HI =	34

TABLE 4-21a-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	5.9E-06	--	--	5.9E-06	PCBs	LOAEL	3	--	--	3
						Total Risk Across Fish	5.9E-06					Total Hazard Index Across All Media and All Exposure Routes	3
						Total Risk Across All Media and All Exposure Routes	5.9E-06					Total LOAEL HI =	3

TABLE 4-21b-RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

MID-HUDSON RIVER - Adolescent Angler

Scenario Timeframe: Current/Future
Receptor Population: Angler
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
Fish	Fish	Mid-Hudson Fish	PCBs	2.2E-04	--	--	2.2E-04	PCBs	LOAEL	37	--	--	37
						Total Risk Across Fish	2.2E-04					Total Hazard Index Across All Media and All Exposure Routes	37
						Total Risk Across All Media and All Exposure Routes	2.2E-04						
												Total LOAEL HI =	37

TABLE 4-21b-CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY EXPOSURE

MID-HUDSON RIVER - Adolescent Angler

Scenario Timeframe: Current/Future
Receptor Population: Angler
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
Fish	Fish	Mid-Hudson Fish	PCBs	3.4E-06	--	--	3.4E-06	PCBs	LOAEL	4	--	--	4
						Total Risk Across Fish	3.4E-06					Total Hazard Index Across All Media and All Exposure Routes	4
						Total Risk Across All Media and All Exposure Routes	3.4E-06						
												Total LOAEL HI =	4

TABLE 4-21c-RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

MID-HUDSON RIVER - Child Angler

Scenario Timeframe: Current/Future
Receptor Population: Angler
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
Fish	Fish	Mid-Hudson Fish	PCBs	1.8E-04	--	--	1.8E-04	PCBs	LOAEL	53	--	--	53
						Total Risk Across Fish	1.8E-04					Total Hazard Index Across All Media and All Exposure Routes	53
						Total Risk Across All Media and All Exposure Routes	1.8E-04						
												Total LOAEL HI =	53

TABLE 4-21c-CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY EXPOSURE

MID-HUDSON RIVER - Child Angler

Scenario Timeframe: Current/Future
Receptor Population: Angler
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
Fish	Fish	Mid-Hudson Fish	PCBs	4.8E-06	--	--	4.8E-06	PCBs	LOAEL	6	--	--	6
						Total Risk Across Fish	4.8E-06					Total Hazard Index Across All Media and All Exposure Routes	6
						Total Risk Across All Media and All Exposure Routes	4.8E-06						
												Total LOAEL HI =	6

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	9.5E-09	--	4.9E-08	5.8E-08	PCBs	NOAEL	0.00021	--	0.0011	0.0013
River Water	River Water	Mid-Hudson River	PCBs	--	--	1.4E-08	1.4E-08	PCBs	NOAEL	--	--	0.0015	0.0015

Total Risk Across Sediment	5.8E-08
Total Risk Across River Water	1.4E-08
Total Risk Across All Media and All Exposure Routes	7.2E-08
Total Hazard Index Across All Media and All Exposure Routes	0.0028
Total NOAEL HI =	0.0028

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	6.6E-10	--	3.3E-09	4.0E-09	PCBs	NOAEL	0.00013	--	0.00067	0.00080
River Water	River Water	Mid-Hudson River	PCBs	--	--	2.0E-09	2.0E-09	PCBs	NOAEL	--	--	0.0013	0.0013

Total Risk Across Sediment	4.0E-09
Total Risk Across River Water	2.0E-09
Total Risk Across All Media and All Exposure Routes	6.0E-09
Total Hazard Index Across All Media and All Exposure Routes	0.0021
Total NOAEL HI =	0.0021

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	2.6E-08	--	7.9E-08	1.1E-07	PCBs	NOAEL	0.0011	--	0.0033	0.0044
River Water	River Water	Mid-Hudson River	PCBs	--	--	3.3E-08	3.3E-08	PCBs	NOAEL	--	--	0.0070	0.0070

Total Risk Across Sediment	1.1E-07
Total Risk Across River Water	3.3E-08
Total Risk Across All Media and All Exposure Routes	1.4E-07
Total Hazard Index Across All Media and All Exposure Routes	0.011
Total NOAEL HI =	0.011

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	1.9E-09	--	5.5E-09	7.4E-09	PCBs	NOAEL	0.00062	--	0.0018	0.0025
River Water	River Water	Mid-Hudson River	PCBs	--	--	4.6E-09	4.6E-09	PCBs	NOAEL	--	--	0.0051	0.0051
						Total Risk Across Sediment	7.4E-09					Total Hazard Index Across All Media and All Exposure Routes	0.0075
						Total Risk Across River Water	4.6E-09						
						Total Risk Across All Media and All Exposure Routes	1.2E-08					Total NOAEL HI =	0.0075

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	2.7E-08	--	2.1E-08	4.8E-08	PCBs	NOAEL	0.0022	--	0.0018	0.0040
River Water	River Water	Mid-Hudson River	PCBs	--	--	9.8E-09	9.8E-09	PCBs	NOAEL	--	--	0.0041	0.0041

Total Risk Across Sediment	4.8E-08
Total Risk Across River Water	9.8E-09
Total Risk Across All Media and All Exposure Routes	5.8E-08
Total Hazard Index Across All Media and All Exposure Routes	0.0081
Total NOAEL HI =	0.0081

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	3.7E-09	--	2.9E-09	6.6E-09	PCBs	NOAEL	0.0012	--	0.0010	0.0022
River Water	River Water	Mid-Hudson River	PCBs	--	--	2.4E-09	2.4E-09	PCBs	NOAEL	--	--	0.0027	0.0027
						Total Risk Across Sediment	6.6E-09	Total Hazard Index Across All Media and All Exposure Routes					0.0049
						Total Risk Across River Water	2.4E-09						
						Total Risk Across All Media and All Exposure Routes	9.0E-09					Total NOAEL HI =	0.0049

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	3.9E-08	--	--	3.9E-08	PCBs	NOAEL	0.0042	--	--	0.0042
						Total Risk Across All Media and All Exposure Routes	3.9E-08					Total Hazard Index Across All Media and All Exposure Routes	0.0042

Total NOAEL HI = 0.0042

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	6.2E-09	--	--	6.2E-09	PCBs	NOAEL	0.0041	--	--	0.0041
						Total Risk Across All Media and All Exposure Routes	6.2E-09			Total Hazard Index Across All Media and All Exposure Routes			0.0041

Total NOAEL HI = 0.0041

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	4.2E-08	--	--	4.2E-08	PCBs	NOAEL	0.0088	--	--	0.0088
						Total Risk Across All Media and All Exposure Routes	4.2E-08					Total Hazard Index Across All Media and All Exposure Routes	0.0088

Total NOAEL HI = 0.0088

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	6.8E-09	--	--	6.8E-09	PCBs	NOAEL	0.0076	--	--	0.0076
				Total Risk Across All Media and All Exposure Routes			6.8E-09		Total Hazard Index Across All Media and All Exposure Routes				0.0076

Total NOAEL HI = 0.0076

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	NOAEL	0.019	--	--	0.019
						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 NOAEL HI = 0.019

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	NOAEL	0.014	--	--	0.014
				Total Risk Across All Media and All Exposure Routes			1.2E-08	Total Hazard Index Across All Media and All Exposure Routes					0.014

Total NOAEL HI = 0.014

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

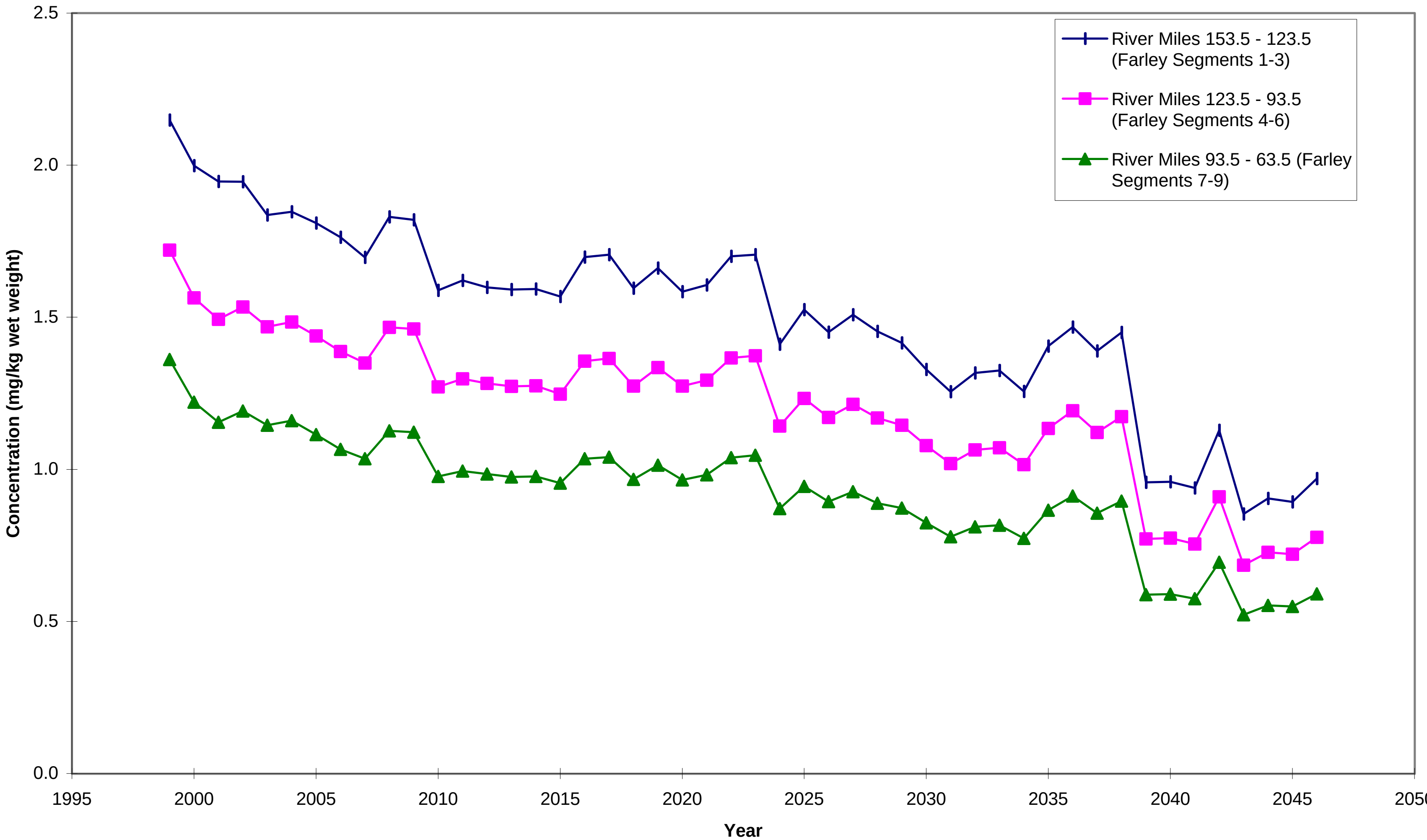


Figure 2-2
Average PCB Concentration in Yellow Perch
Mid-Hudson River

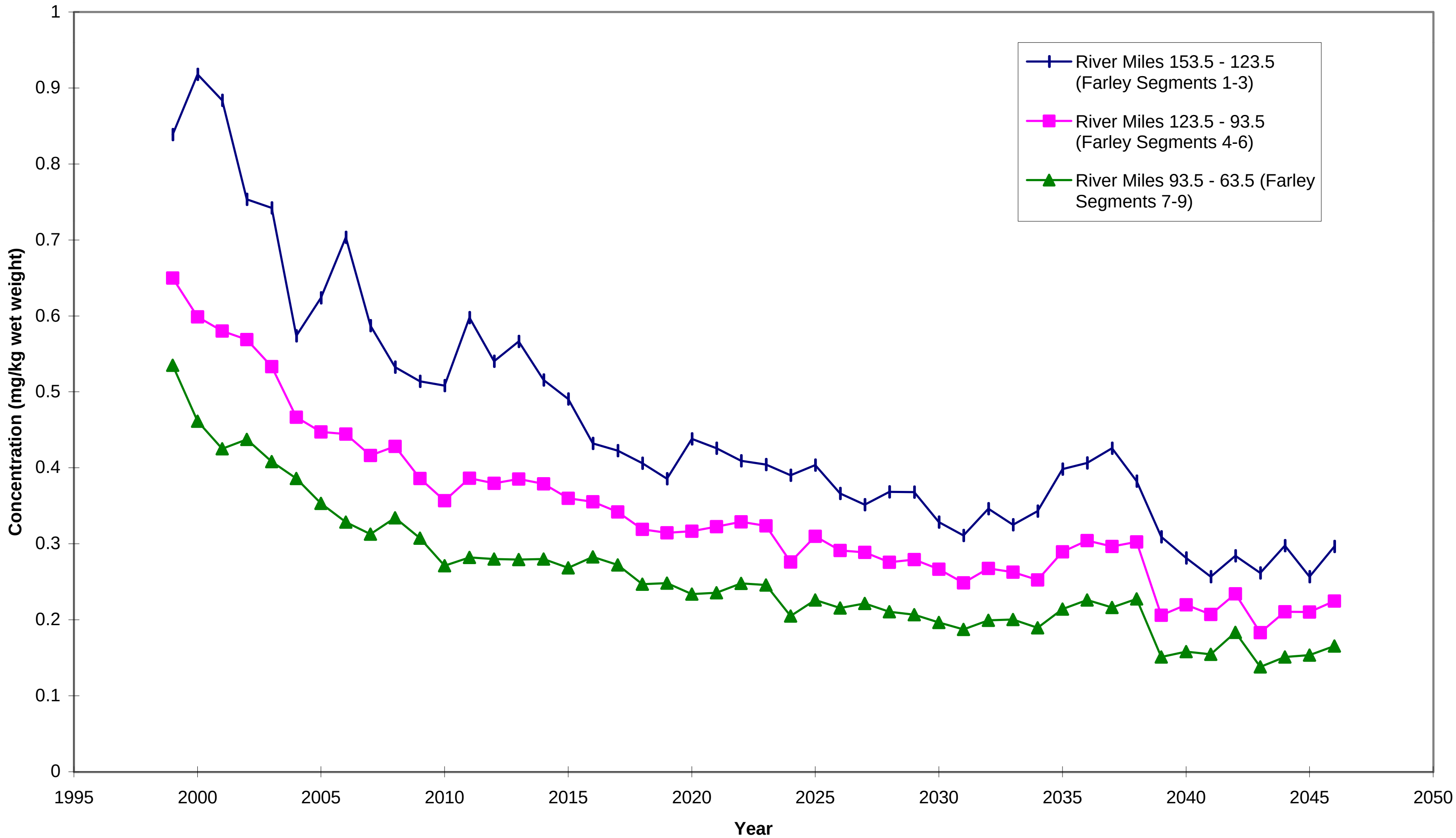
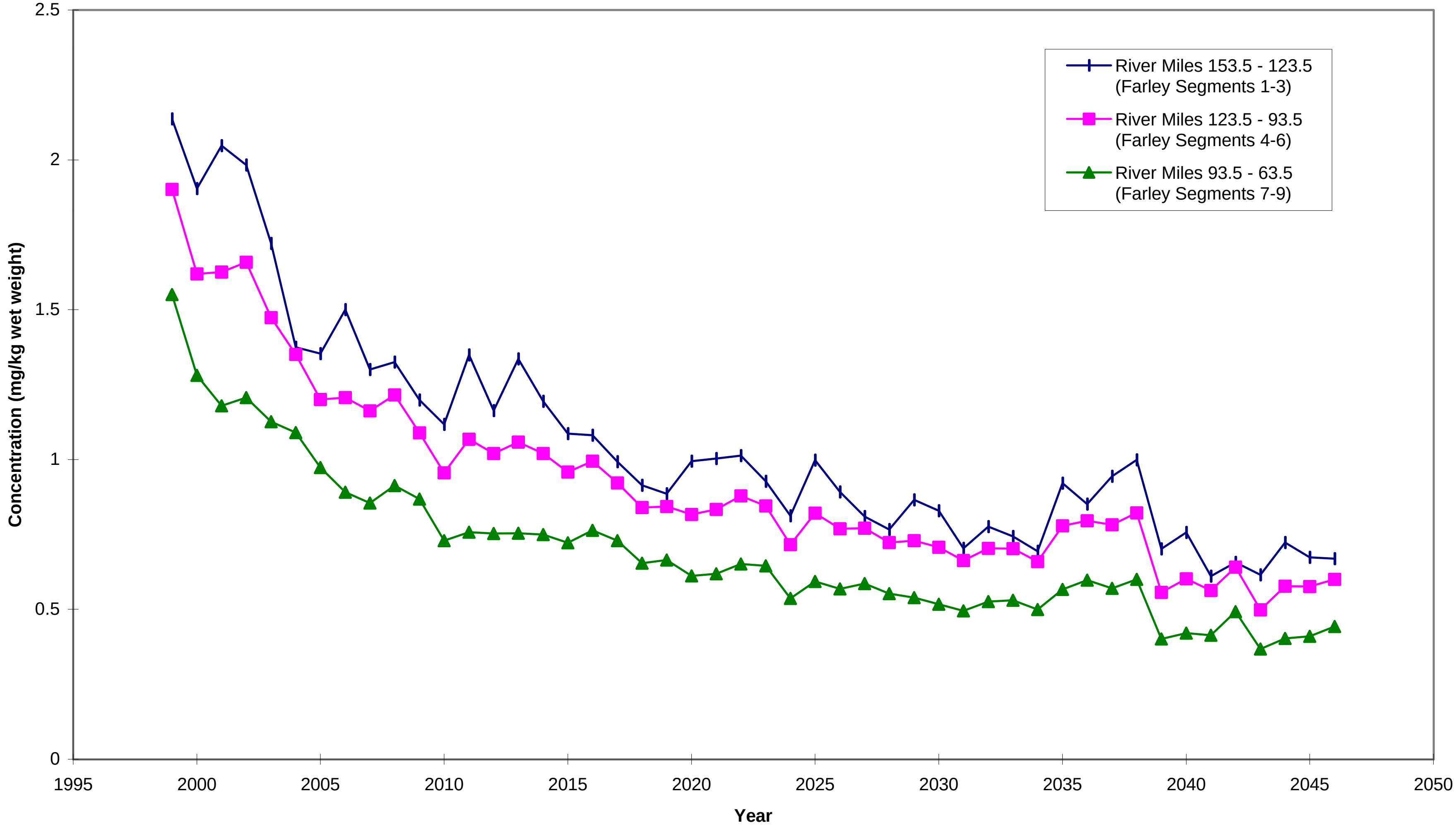
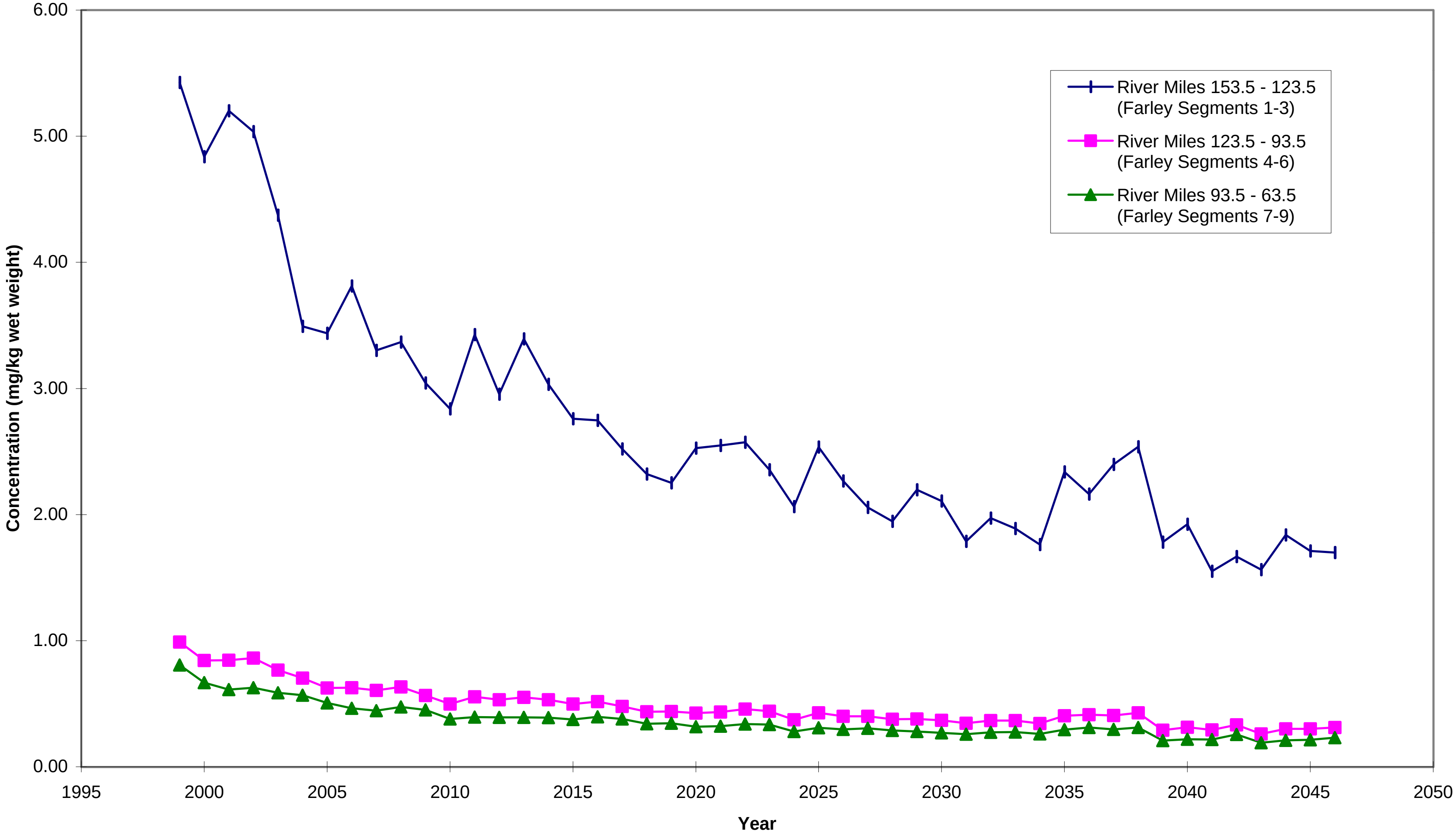


Figure 2-3
Average PCB Concentration in Largemouth Bass
Mid-Hudson River



TAMS/ *Gradient* *Corporation*

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



TAMS/ *Gradient* *Corporation*

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

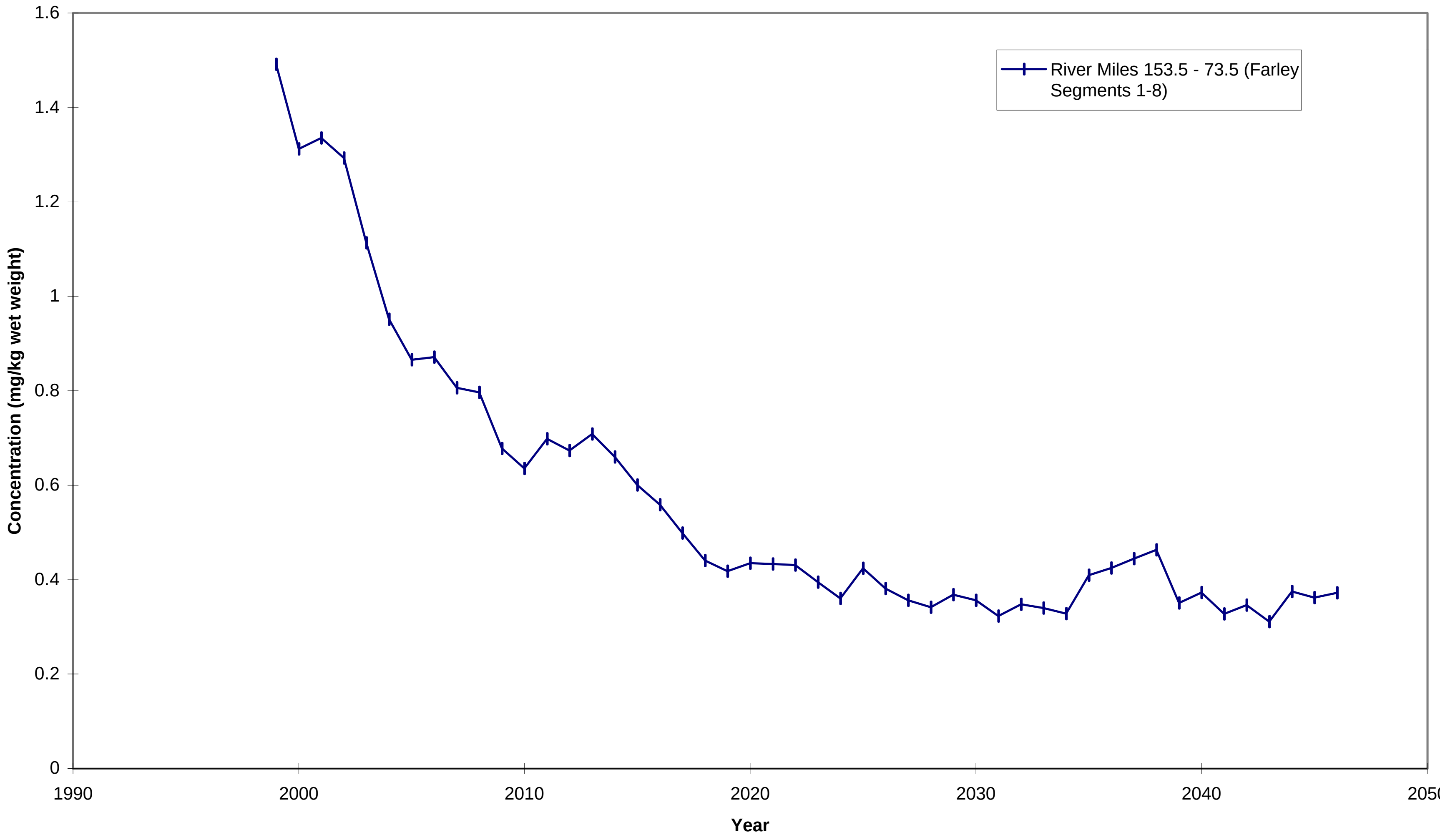


Figure 2-6
Average PCB Concentration by Species (averaged over location)
Mid-Hudson River

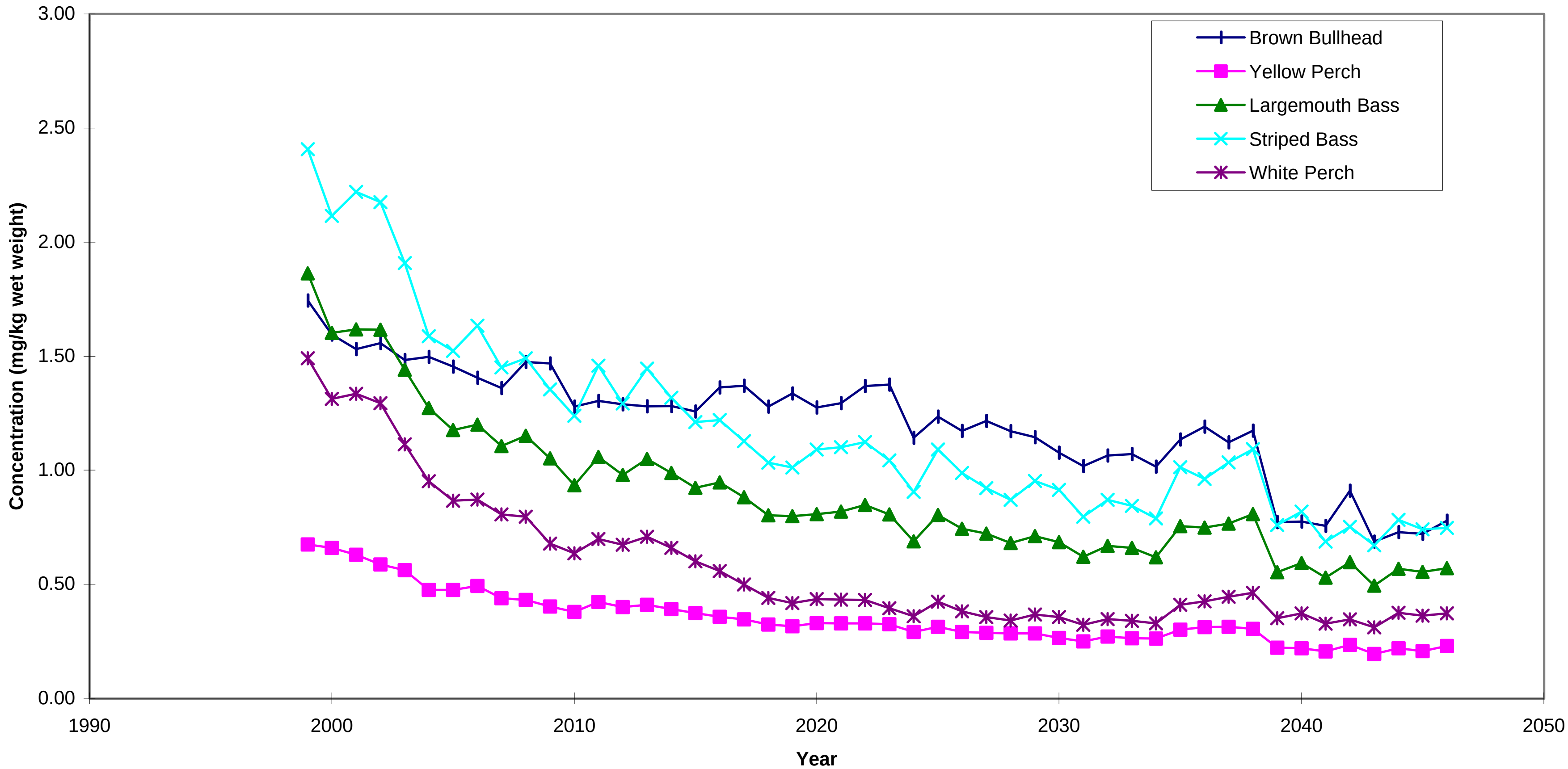


Figure 2-7
Average Total PCB Concentration in Sediment
Mid-Hudson River

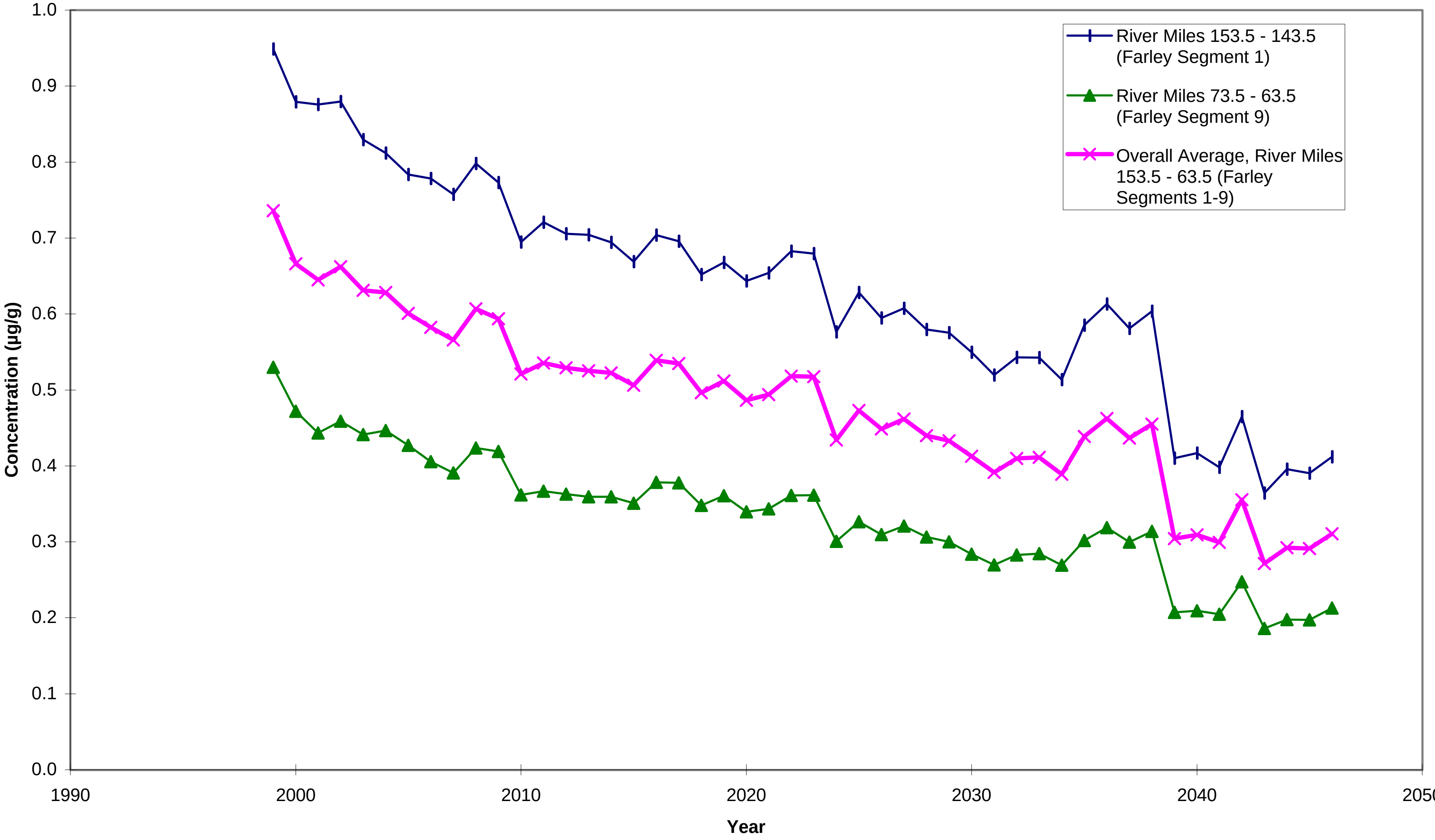
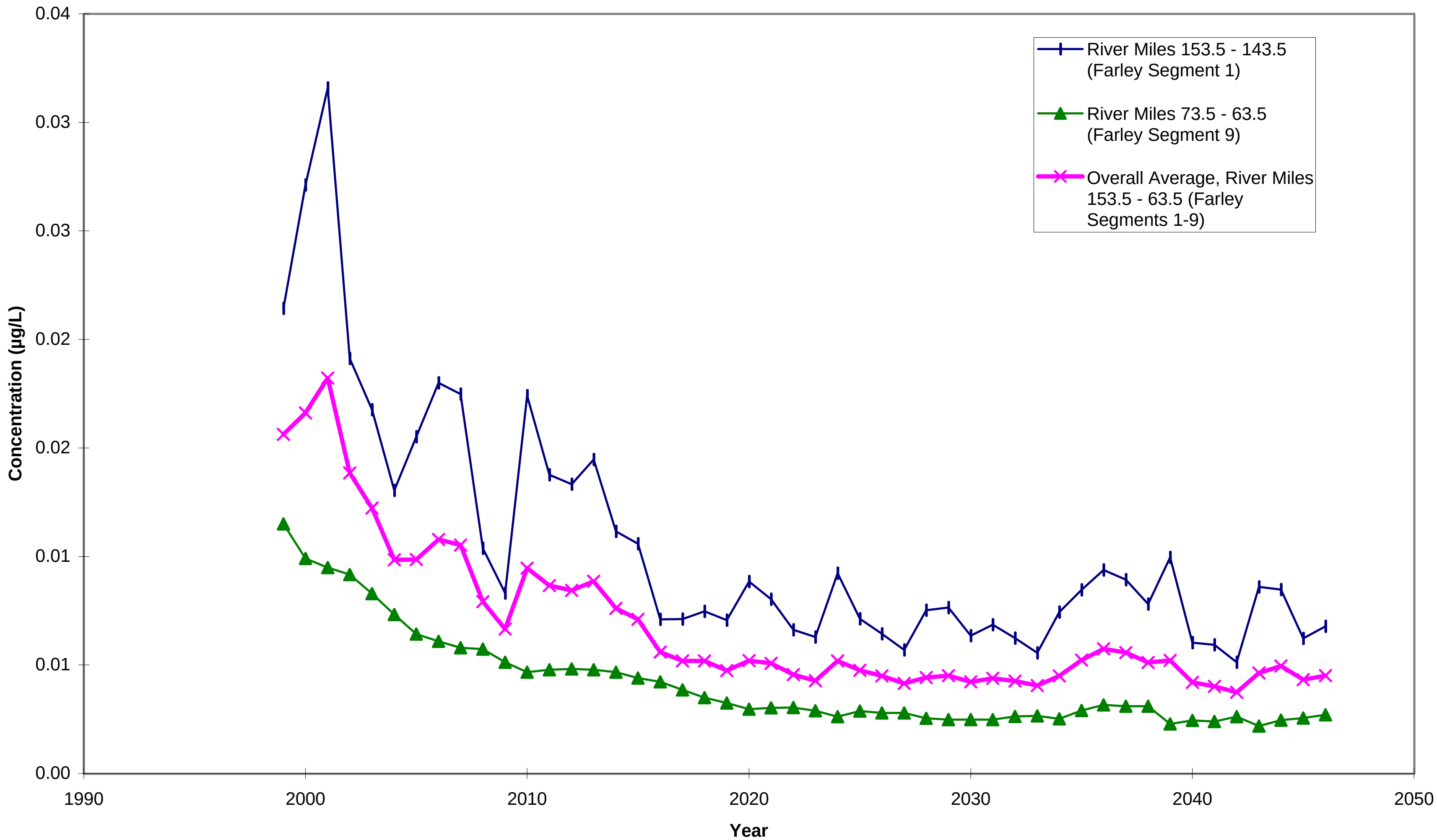
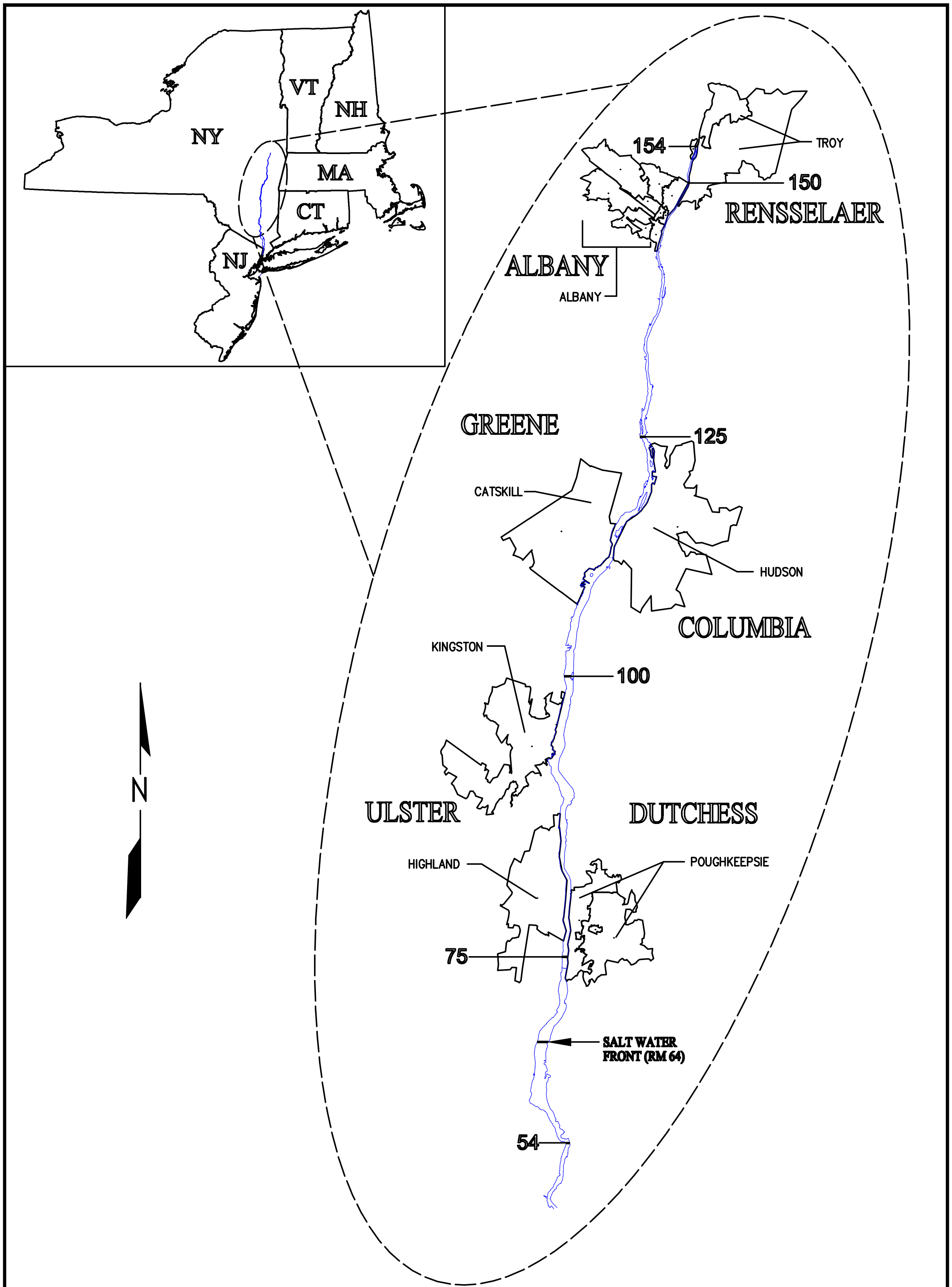


Figure 2-8
Average Total PCB Concentration in River Water
Mid-Hudson River



TAMS/ *Gradient* *Corporation*



LEGEND

— 75 RIVER MILE (RM) UPSTREAM OF THE BATTERY

SCALE IN MILES

10 5 0 10

MAP SOURCE: ESRI DATA & MAPS, SHAPEFILES

PLATE 2				
MID-HUDSON RIVER STUDY AREA				
TAMS/*Gradient*				
DWG: HUDSON.DWG	DATE: 12/7/99	PROJECT#: 8708676	FIGURE NO. 1	
DRAWN: JJC	SCALE: AS SHOWN			