



**U.S. Army
Corps of Engineers**

New England District
Concord, Massachusetts



**U.S. Environmental
Protection Agency**

New England Region
Boston, Massachusetts

**HUMAN HEALTH RISK ASSESSMENT
GE/HOUSATONIC RIVER SITE
REST OF RIVER**

**VOLUME IIIB
APPENDIX B
PHASE 2 DIRECT CONTACT RISK ASSESSMENT
FIGURES**

DCN: GE-021105-ACMT

February 2005

**Environmental Remediation Contract
GE/Housatonic River Project
Pittsfield, Massachusetts**

Contract No. DACW33-00-D-0006

Task Order 0003

**HUMAN HEALTH RISK ASSESSMENT
GE/HOUSATONIC RIVER SITE
REST OF RIVER**

**VOLUME IIIB
APPENDIX B
PHASE 2 DIRECT CONTACT RISK ASSESSMENT
FIGURES**

**ENVIRONMENTAL REMEDIATION CONTRACT
GENERAL ELECTRIC (GE)/HOUSATONIC RIVER PROJECT
PITTSFIELD, MASSACHUSETTS**

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Prepared for

U.S. Army Corps of Engineers
New England District
Concord, Massachusetts

and

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New England Region
Boston, Massachusetts

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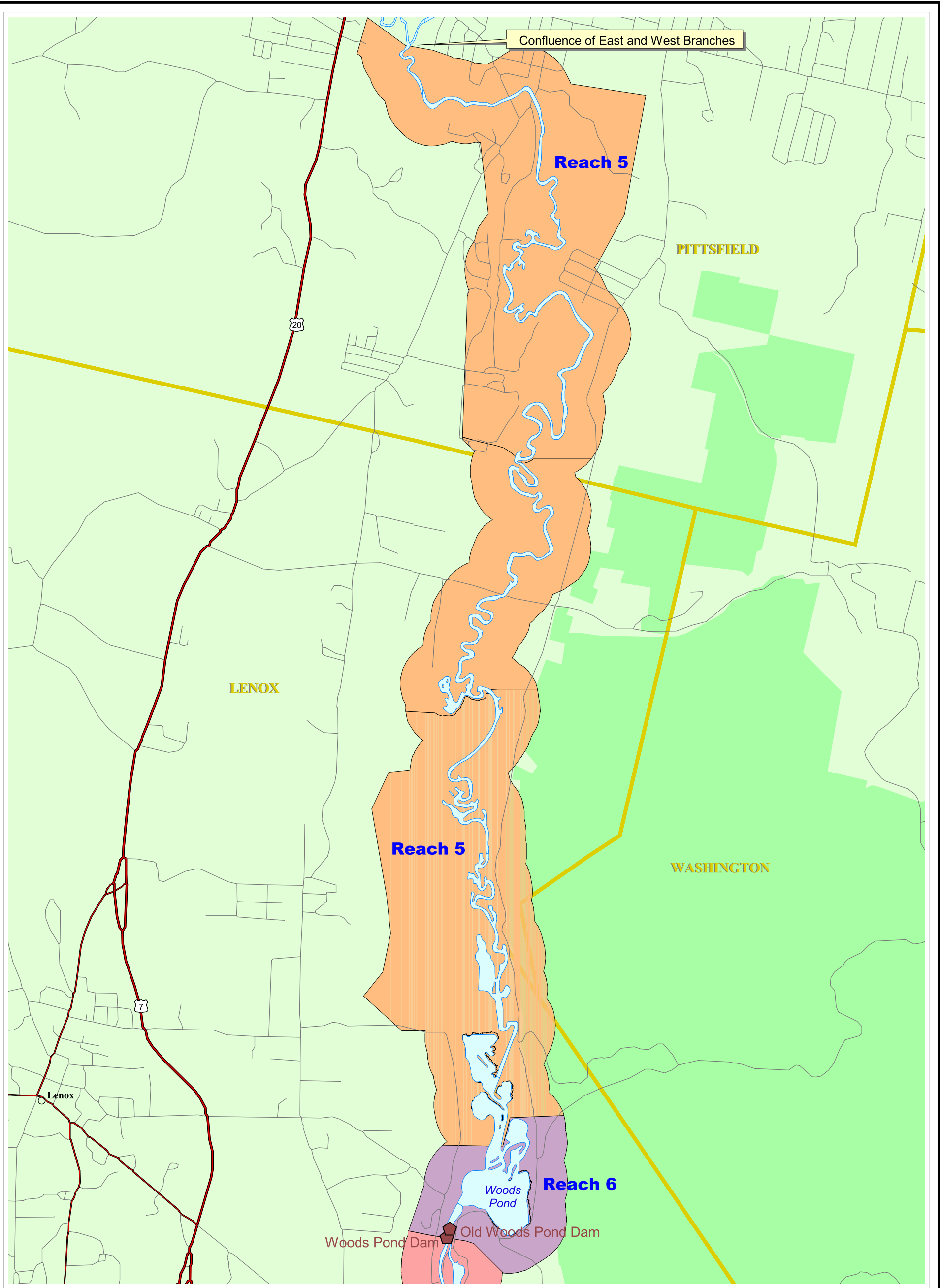
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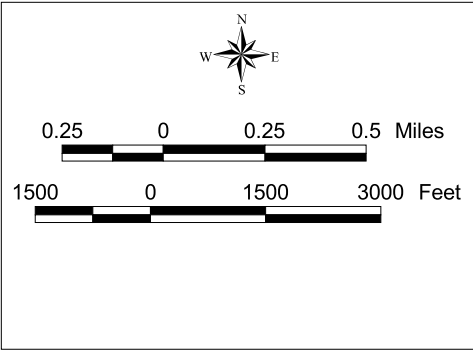
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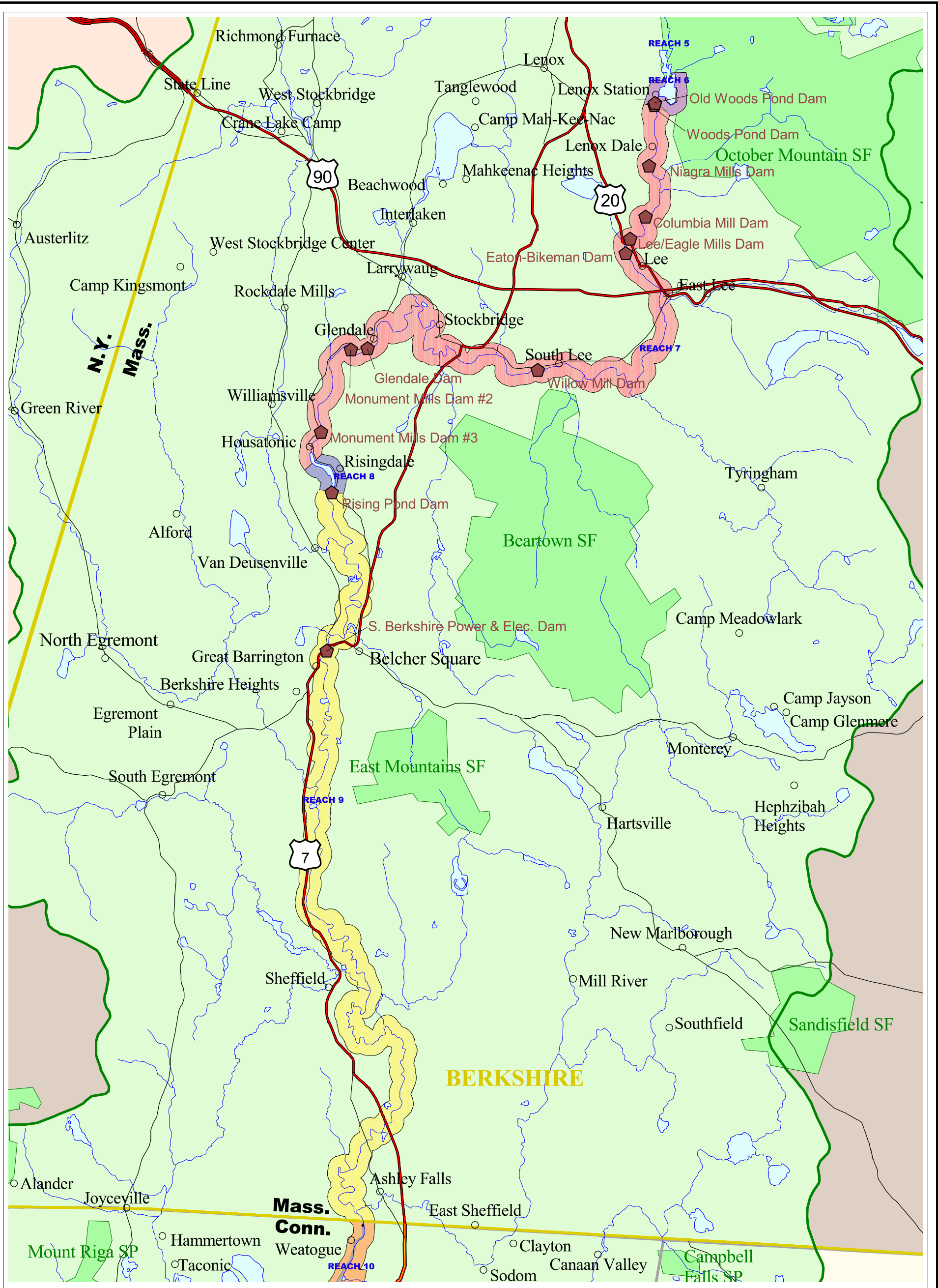
LEGEND:

- Town/City
- Roads
- Housatonic River
- State Park
- Municipal Boundary
- Reach 5
- Reach 6



Direct Contact Human Health Risk Assessment
GE/Housatonic River Site, Rest of River

**FIGURE 1-1
PRIMARY STUDY AREA**



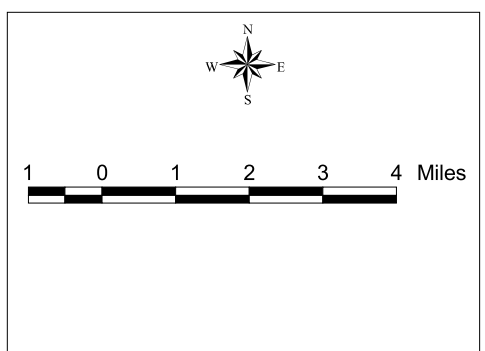
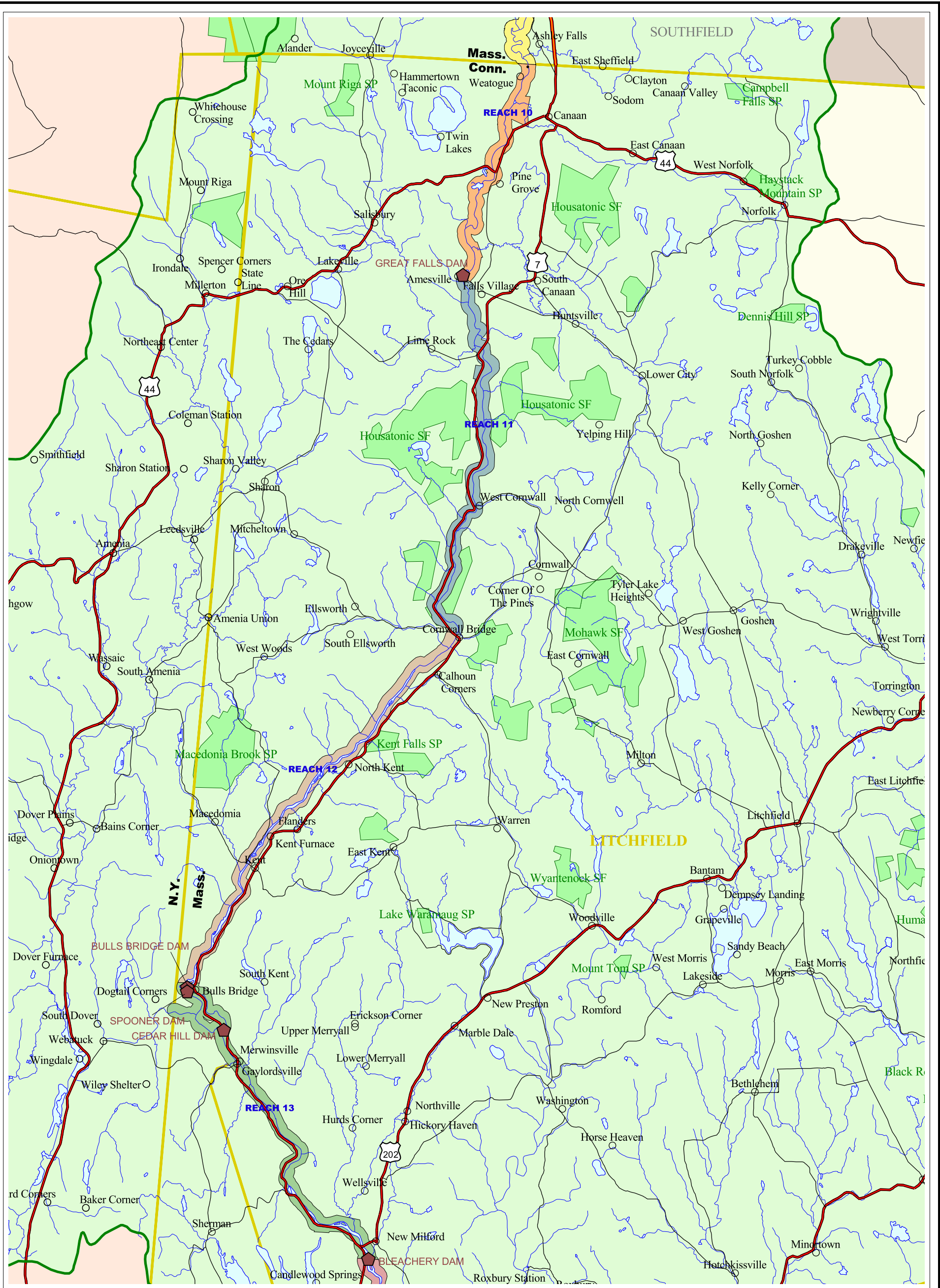
LEGEND:

- Town/City
- Dam
- Roads
- Housatonic River
- Housatonic Watershed
- State Park
- County Boundary
- Reach 7
- Reach 8
- Reach 9

Scale: 1 0 1 2 Miles

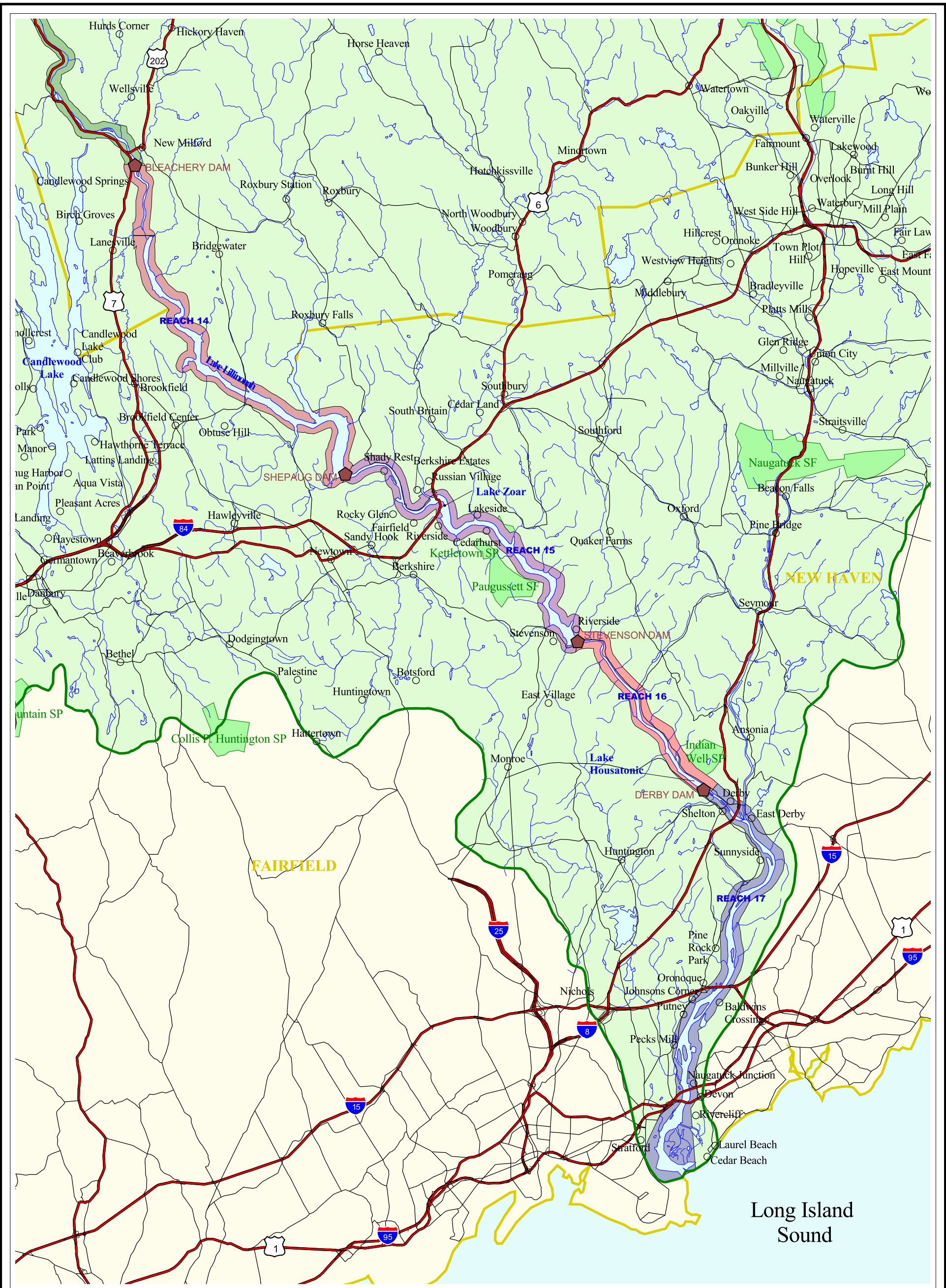
Direct Contact Human Health Risk Assessment
GE/Housatonic River Site, Rest of River

**FIGURE 1-2
REACHES 7 TO 9**



Direct Contact Human Health Risk Assessment
GE/Housatonic River Site, Rest of River

**FIGURE 1-3
REACHES 10 TO 13**



LEGEND:

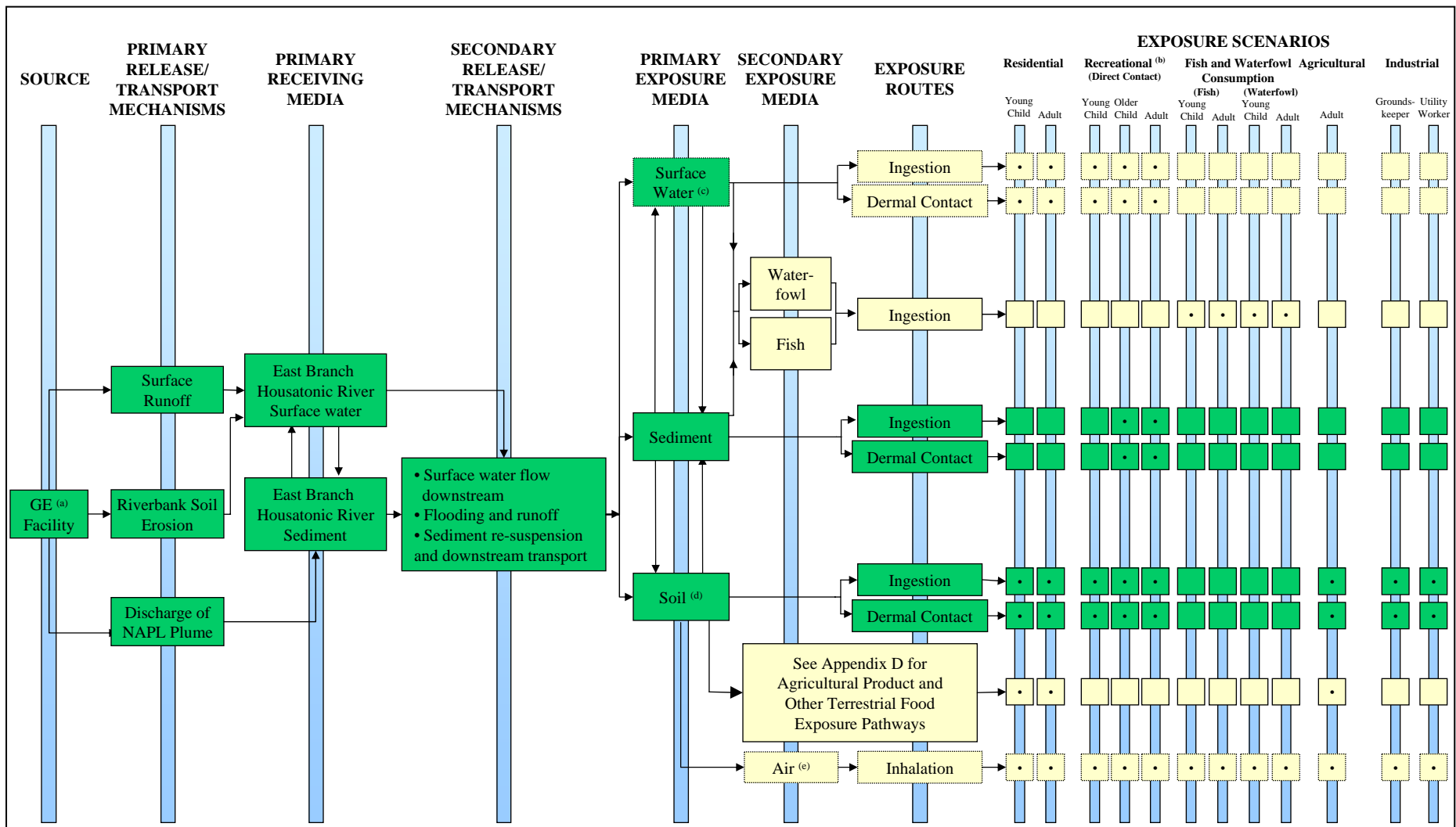
	Town/City		Reach 14
	Dam		Reach 15
	Roads		Reach 16
	Housatonic River		Reach 17
	State Park		
	County Boundary		
	Housatonic Watershed		

North arrow and scale bar.

1 0 1 2 3 4 Miles

Direct Contact Human Health Risk Assessment
GE/Housatonic River Site, Rest of River

**FIGURE 1-4
REACHES 14 TO 17**



- = Complete exposure pathway
- = Incomplete exposure pathway
- = Not evaluated quantitatively.
- = Pathways of concern.

NAPL = nonaqueous phase liquid.

(a) = Includes all facility-related sources such as site soils, Unkamet Brook, Silver Lake, former oxbows, fill areas, etc.

(b) = There are seven variations of the recreational scenario, including: general recreation, ATV/dirt and mountain biker, marathon canoeist, recreational canoeist, angler, waterfowl hunter, and sediment exposure. The scenario selected will depend on the medium and exposure area of concern being evaluated.

(c) = Chemical concentrations in surface water were compared to conservative, site-specific screening risk based concentrations (SRBCs) as an initial screening step. Results of the screening process indicated chemical concentrations in surface water below levels of human health concern. Thus, direct contact to surface water was not evaluated quantitatively.

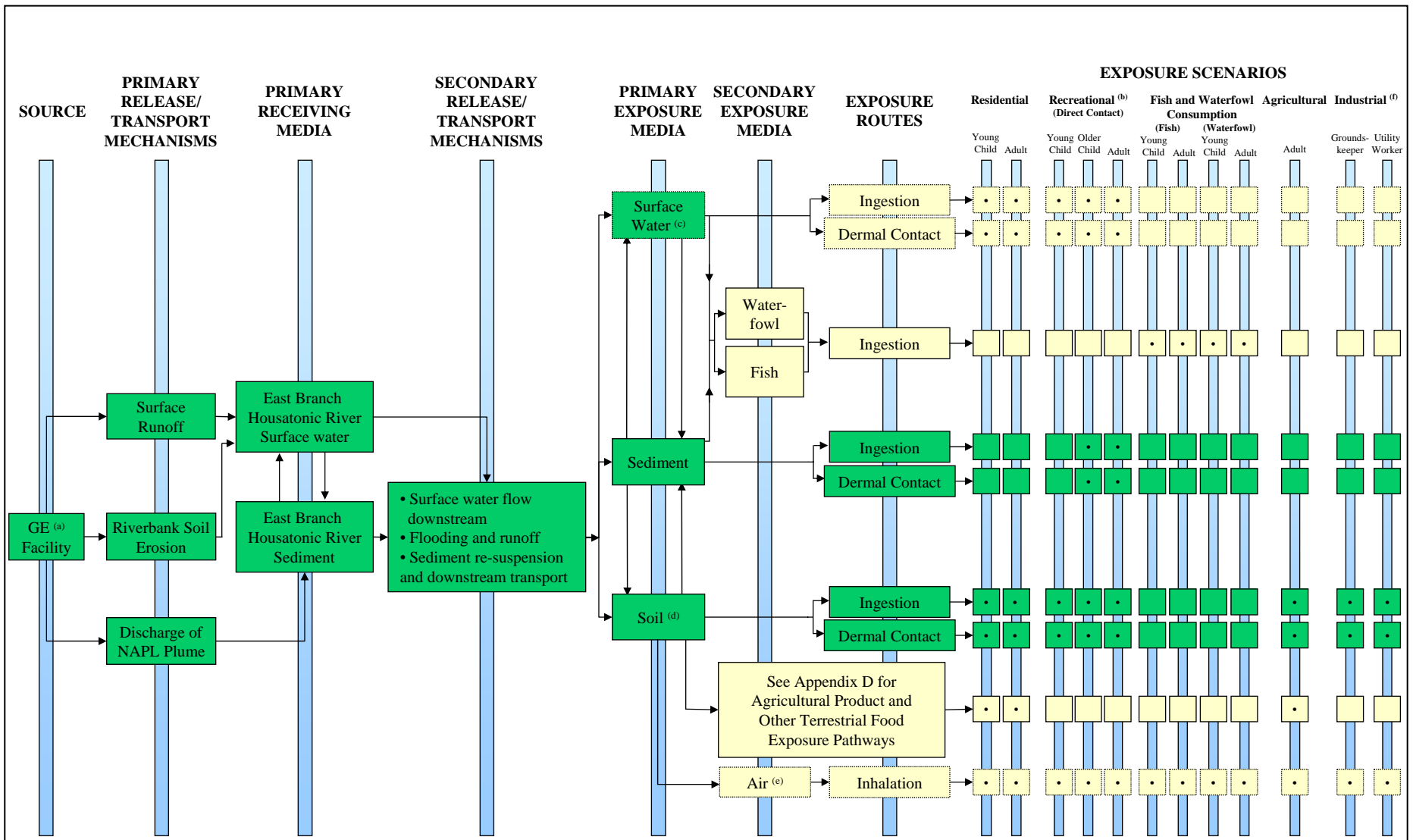
(d) = Includes floodplain and riverbank soil.

(e) = Air sampling conducted at various points along the Lower River resulted in low concentrations of PCBs. An additional sampling and screening level risk assessment was performed. Results of the screening process indicated chemical concentrations in air below levels of human health concern. Thus, inhalation of air was not evaluated quantitatively.

Direct Contact Human Health Risk Assessment
GE/Housatonic River Site,
Rest of River

Figure 1-5

Conceptual Site Model



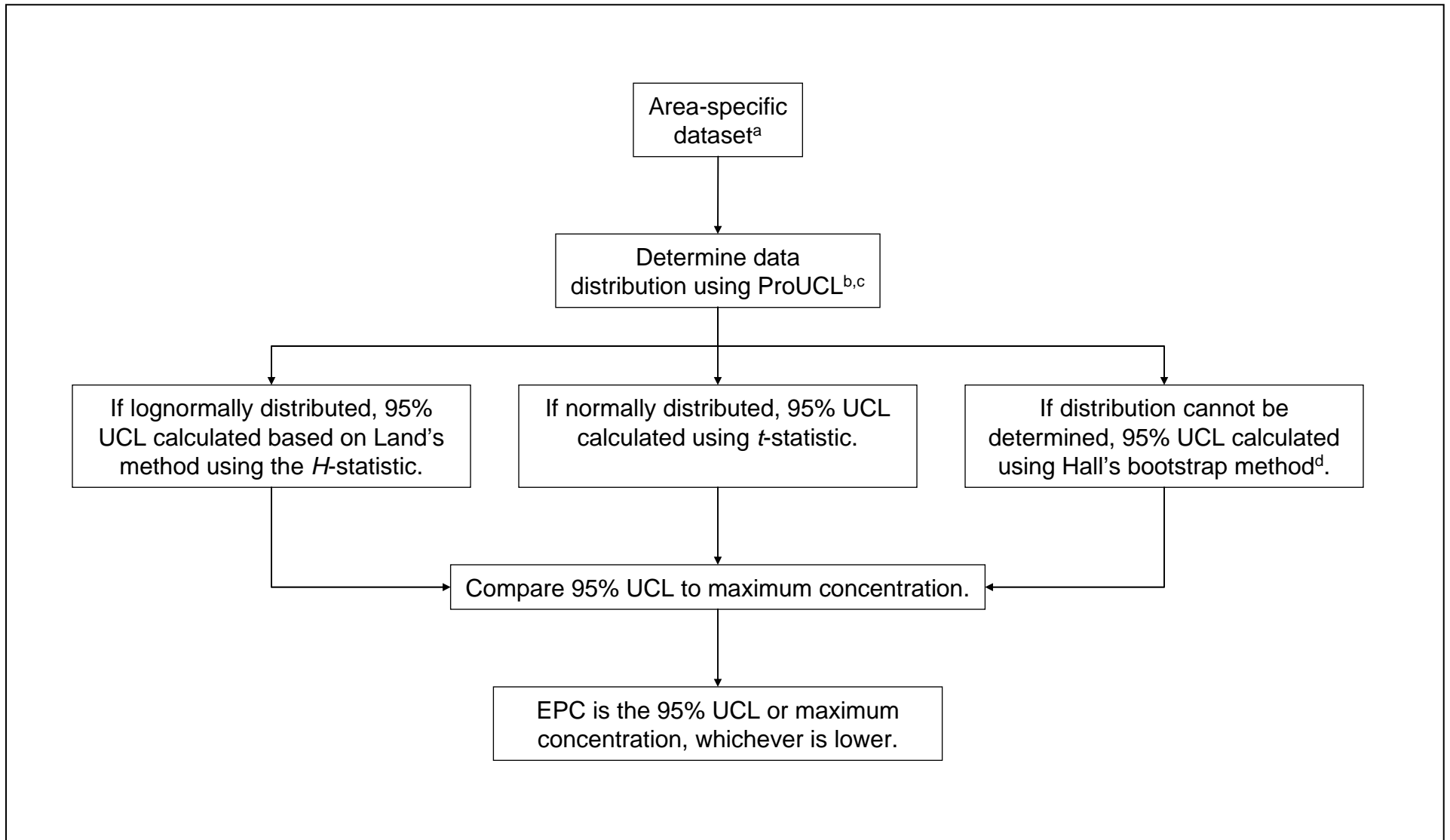
◻ = Complete exposure pathway
 ◻ = Incomplete exposure pathway
 ◻ = Not evaluated quantitatively.
 ◻ = Pathways of concern.
 NAPL = nonaqueous phase liquid.

- (a) = Includes all facility-related sources such as site soils, Unkamet Brook, Silver Lake, former oxbows, fill areas.
- (b) = There are seven variations of the recreational scenario, including general recreation, ATV/dirt and mountain biker, marathon canoeist, recreational canoeist, angler, waterfowl hunter, and sediment exposure. The scenario selected will depend on the medium and exposure area of concern being evaluated.
- (c) = Chemical concentrations in surface water were compared to conservative, site-specific screening risk based concentrations (SRBCs) as an initial screening step. Results of the screening process indicated chemical concentrations in surface water below levels of human health concern. Thus, direct contact to surface water was not evaluated quantitatively.
- (d) = Includes floodplain and riverbank soil.
- (e) = Air sampling conducted at various points along the Lower River resulted in low concentrations of PCBs. An additional sampling and screening level risk assessment was performed. Results of the screening process indicated chemical concentrations in air below levels of human health concern. Thus, inhalation of air was not evaluated quantitatively.
- (f) = A construction worker was considered, but not evaluated quantitatively. It was assumed that given the lack of roads in the floodplain and the restrictions on building in the floodplain, that a utility worker would be a more conservative exposure scenario.

Direct Contact Human Health Risk Assessment
GE/Housatonic River Site
Rest of River

Figure 4-1

Conceptual Site Model



Notes:

^a For Reaches 5 and 6 soil, the EPCs were typically calculated based on spatially and use weighted tPCB concentrations (see Section 4.4.1). For Reach 7 soil and the sediment data, the EPCs were calculated using measured tPCB concentrations (see Sections 4.4.2 and 4.4.3).

^b For samples sizes less than 50, the Shapiro-Wilk test (alpha=0.05) was used. For sample sizes greater than or equal to 50, the Lilliefors test (alpha=0.05) was used (EPA, 2004a, 99-1041).

^c For Reaches 5 and 6 soil, the data distribution was based on the spatially and use weighted data points.

^d The degrees of freedom were based on the number of actual measured data points.

95% UCL = 95% upper confidence limit of the mean.

EPC = exposure point concentration.

**Direct Contact Human Health Risk Assessment
GE/Housatonic River Site
Rest of River**

Figure 4-2

**Exposure Point Concentration
Calculation Method Flow Chart**

APPENDIX B FIGURES

FIGURE 5-1A TO 5-21

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FIGURE 5-22 TO 5-52

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FIGURE 5-53 TO 5-72

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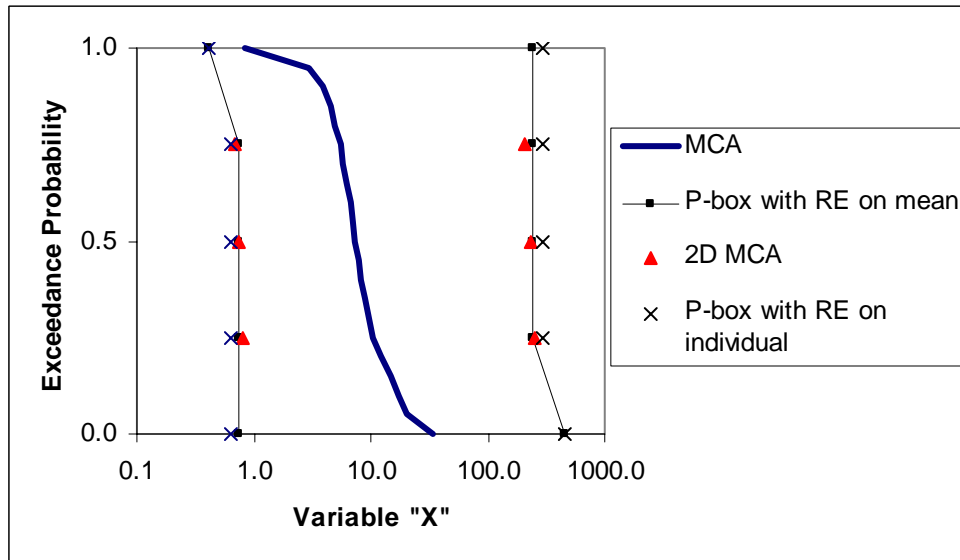
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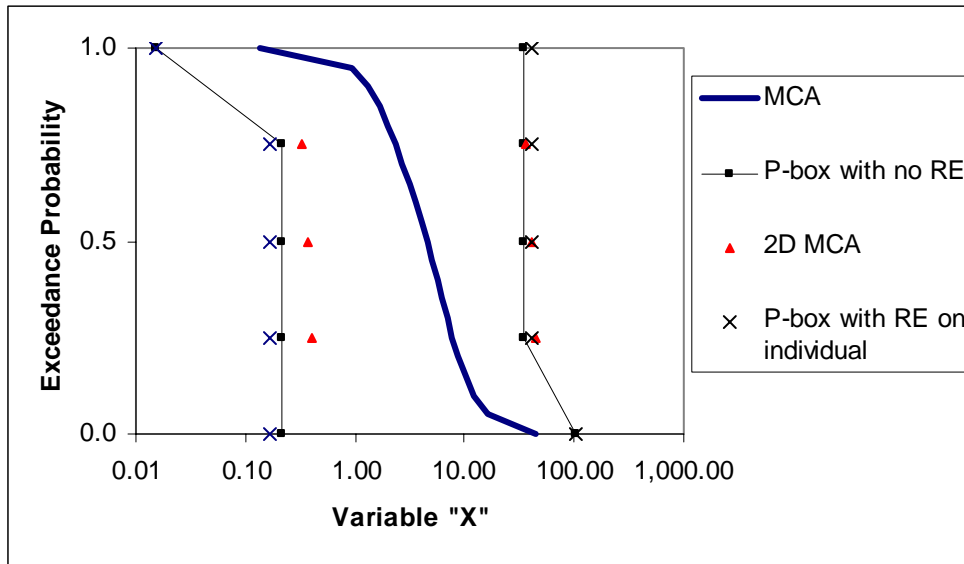
Notes: "MCA" is the MCA Analog Distribution of Variability.

"P-box with RE on mean" denotes the approximate calculation of p-box bounds, which takes account of uncertainty in the regression model prediction of means for body part surface areas.

"P-box with RE on individual" denotes the approximate calculation of p-box bounds, which takes account of uncertainty in the regression model prediction at a specific X value.

The "2D MCA" bounds are the minimum and maximum values for each of five percentiles (0, 25, 50, 75, 100) from 1,000 x 10,000 MC simulations.

Figure 6-1 Young Child General Recreation P-Box Estimated Using Different Methods



Notes: "MCA" is the MCA Analog Distribution of Variability.

"P-box with no RE" denotes the approximate calculation of p-box bounds that excludes regression error.

"P-box with RE on individual" denotes the approximate calculation of p-box bounds, which takes account of uncertainty in the regression model prediction at a specific X value.

The "2D MCA" bounds are the minimum and maximum values for each of five percentiles (0, 25, 50, 75, 100) from 500 x 10,000 MC simulations.

Figure 6-2 Adult General Recreation P-Box Estimated Using Different Methods

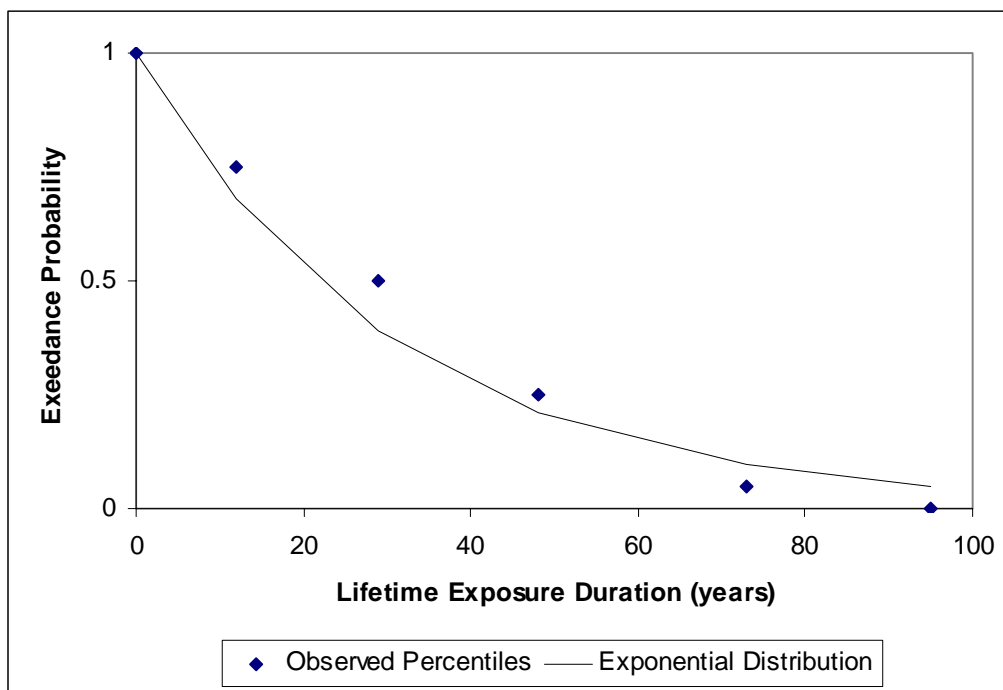
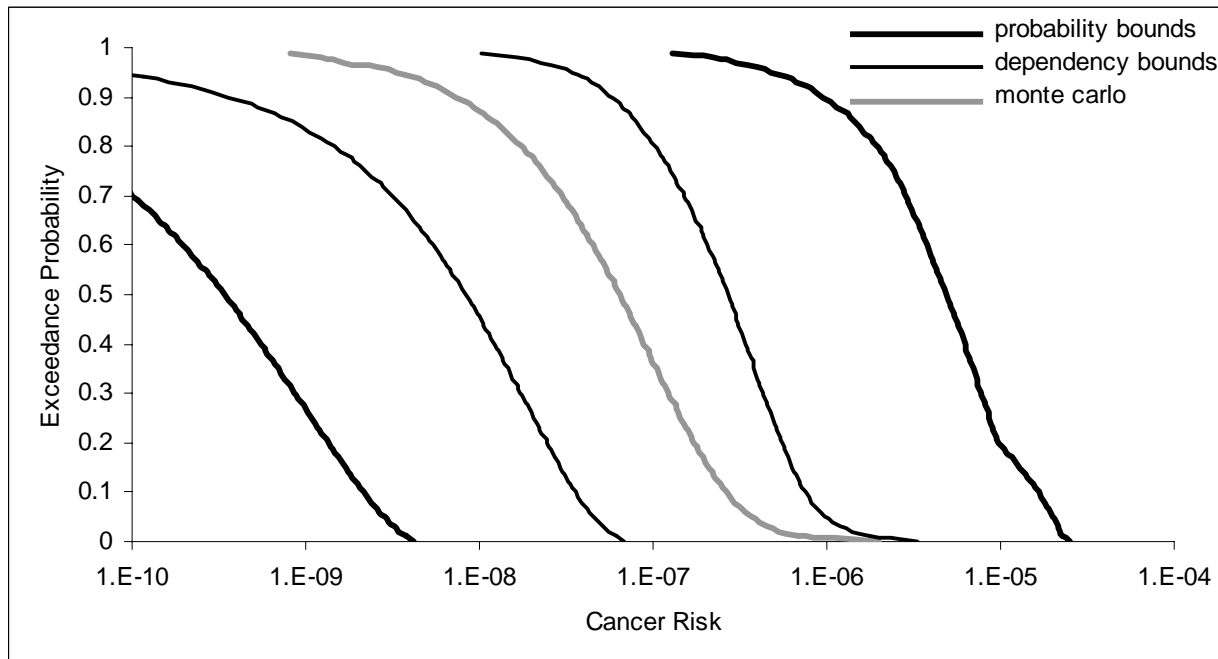
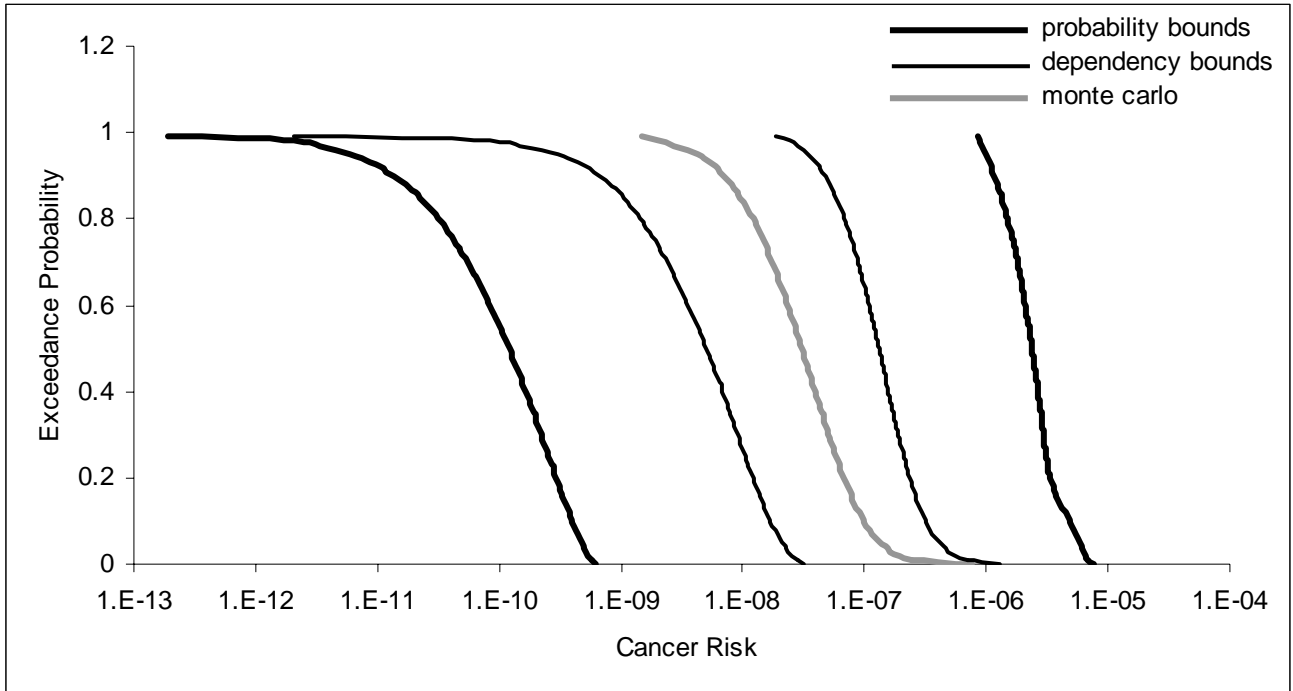


Figure 6-3 Years Living in the Housatonic River Area (MDPH, 2001)



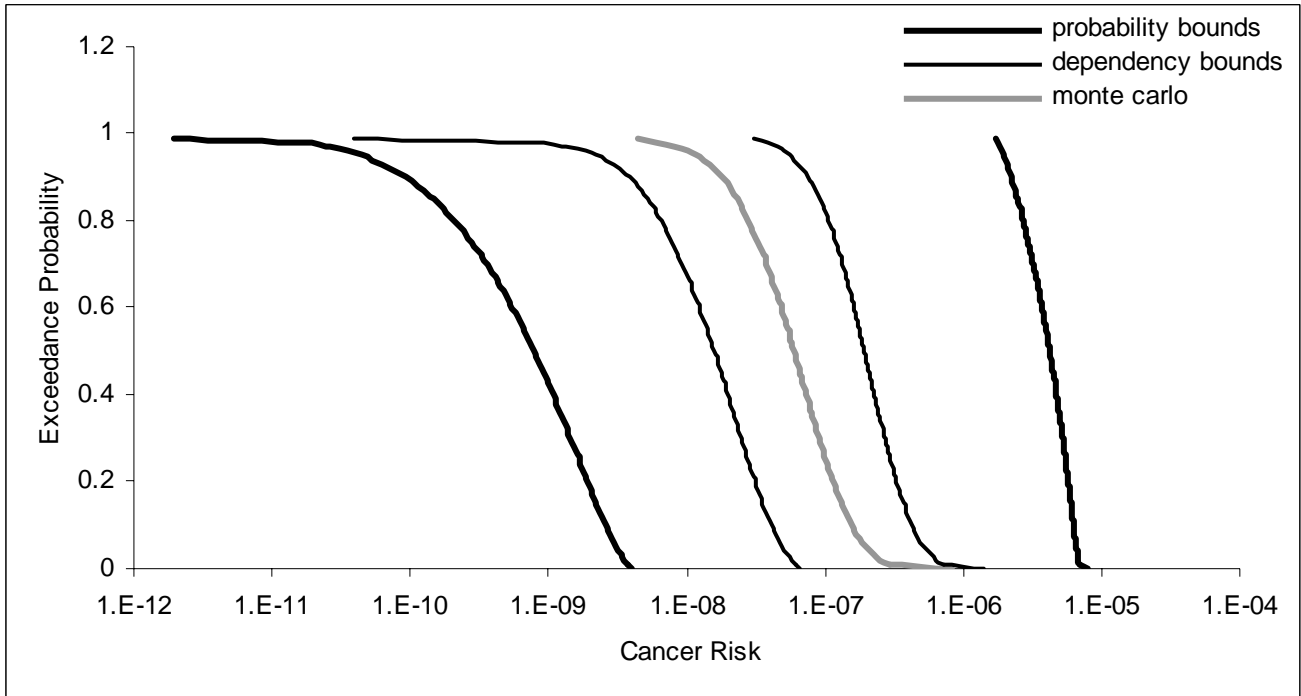
Note: x-axis is in log-scale

Figure 6-4 Cancer Risk for General Recreation—Adult



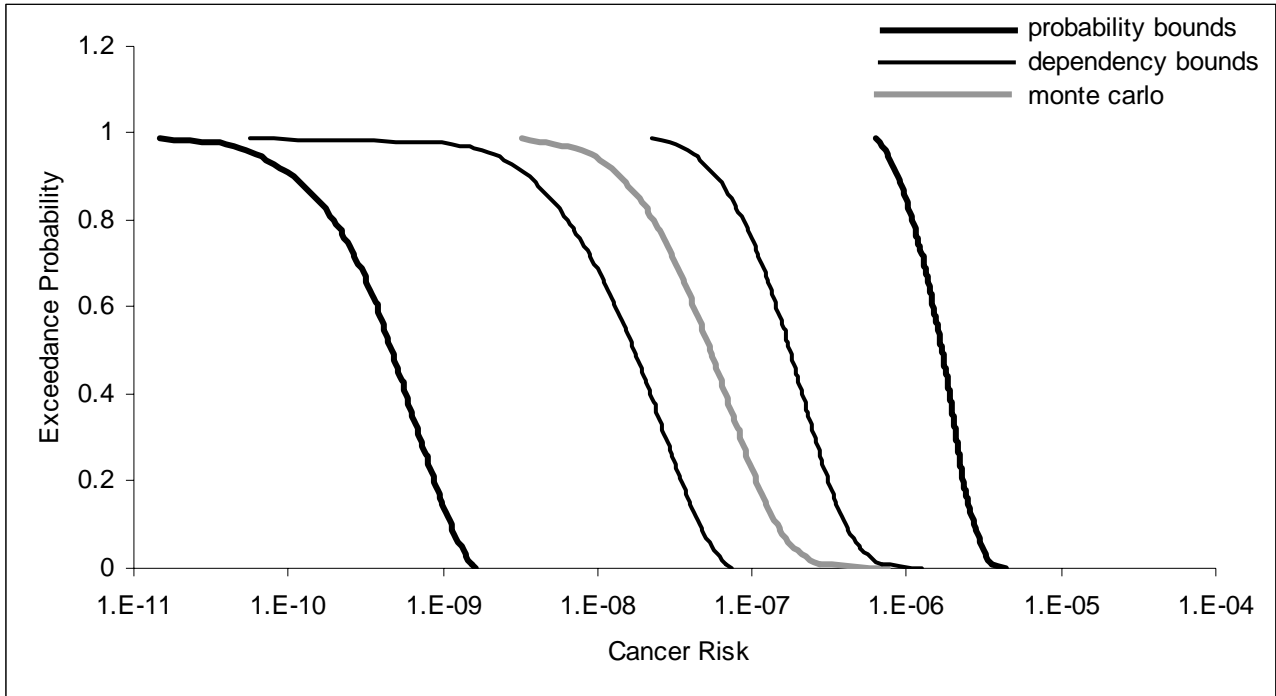
Note: x-axis is in log-scale

Figure 6-5 Cancer Risk for General Recreation—Older Child



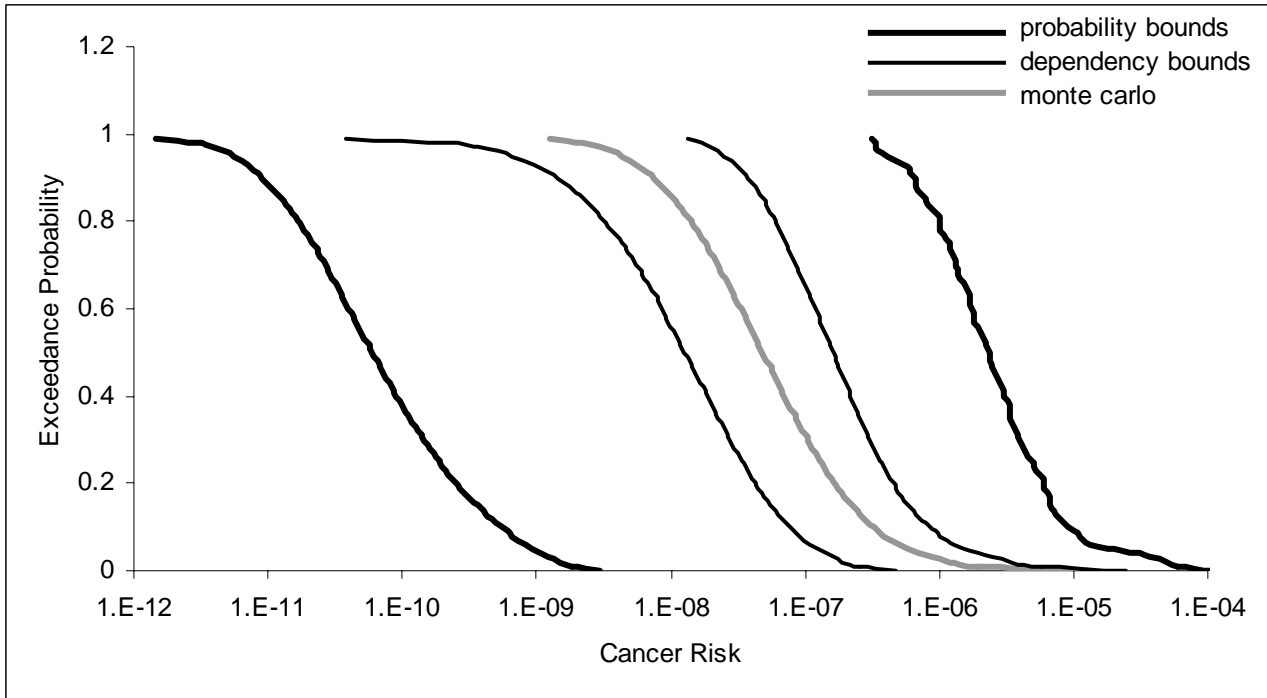
Note: x-axis is in log-scale

Figure 6-6 Cancer Risk for General Recreation—Young Child



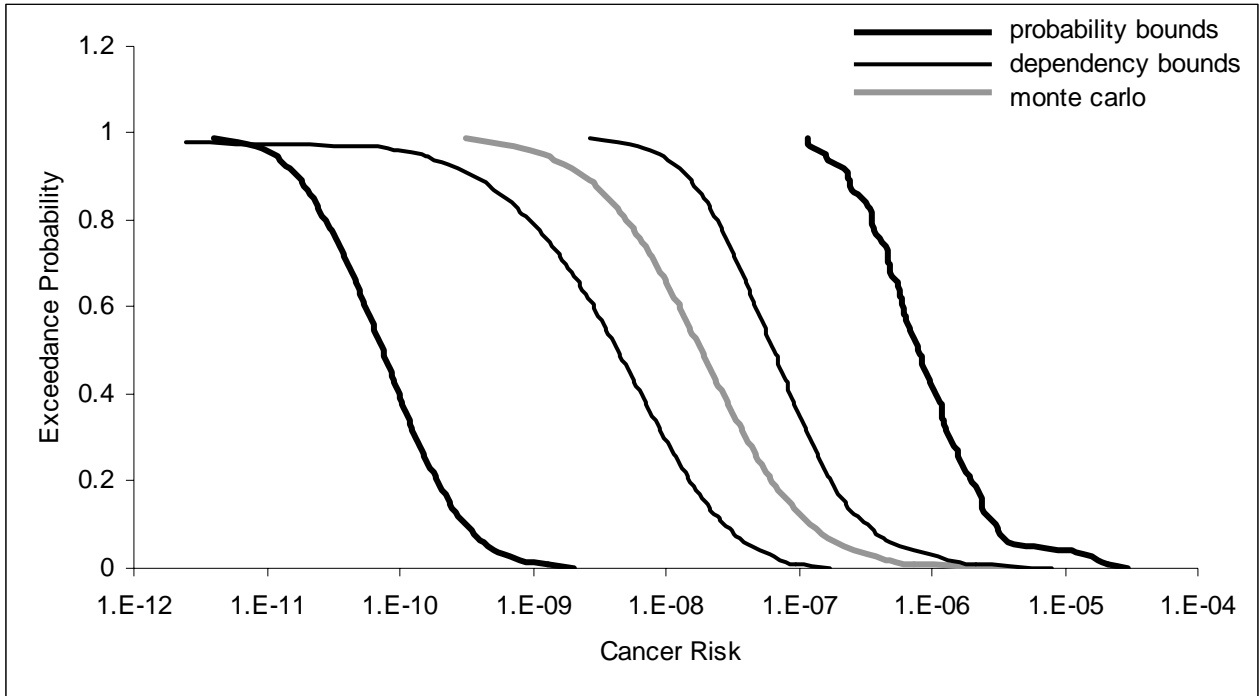
Note: x-axis is in log-scale

Figure 6-7 Cancer Risk for ATV/Biker—Older Child



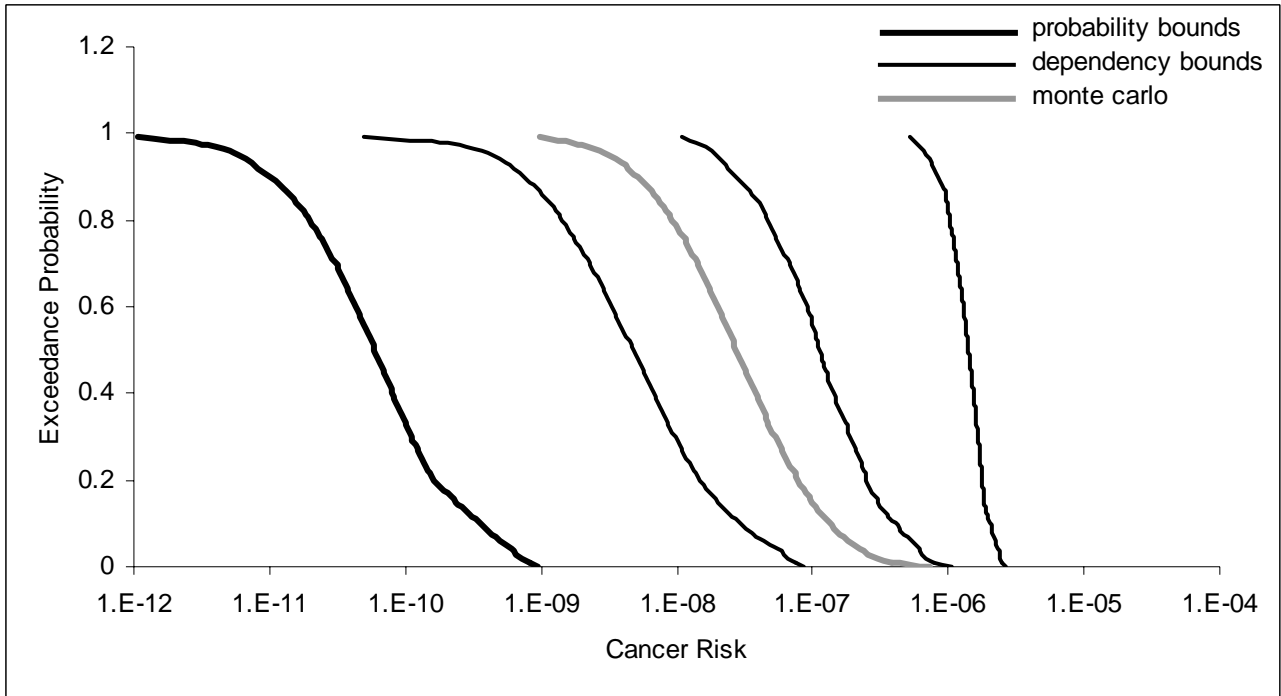
Note: x-axis is in log-scale

Figure 6-8 Cancer Risk for Angler—Adult



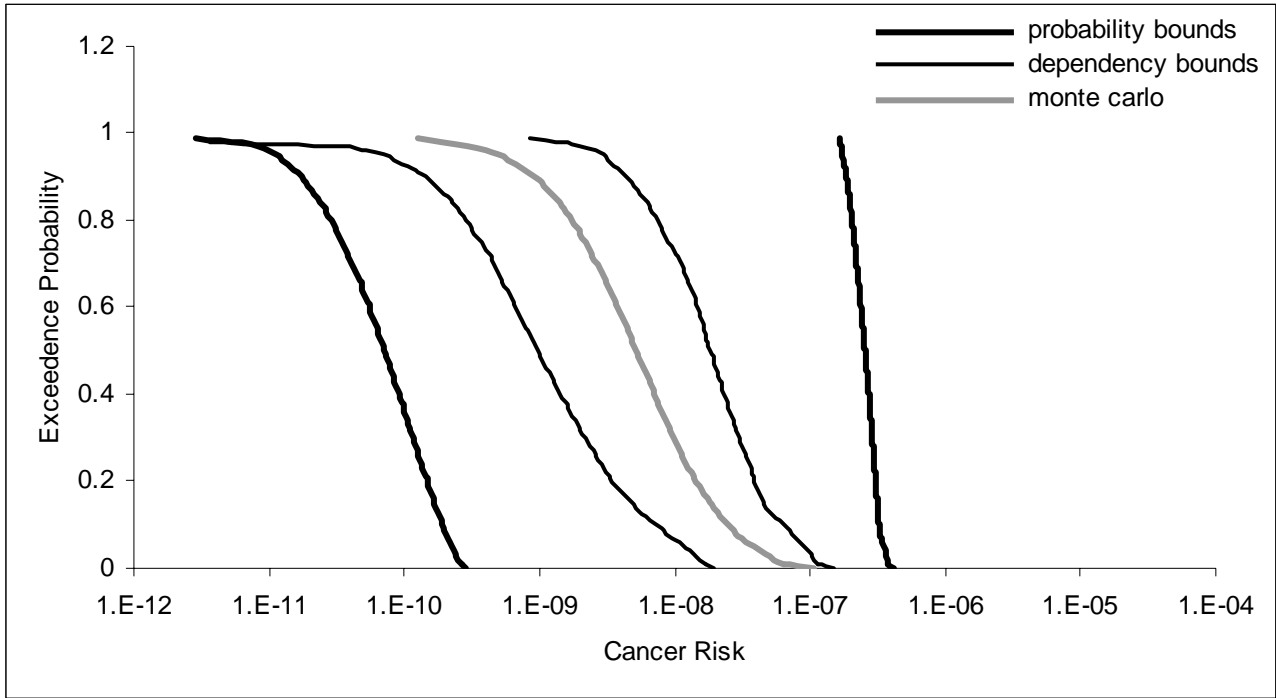
Note: x-axis is in log-scale

Figure 6-9 Cancer Risk for Angler—Older Child



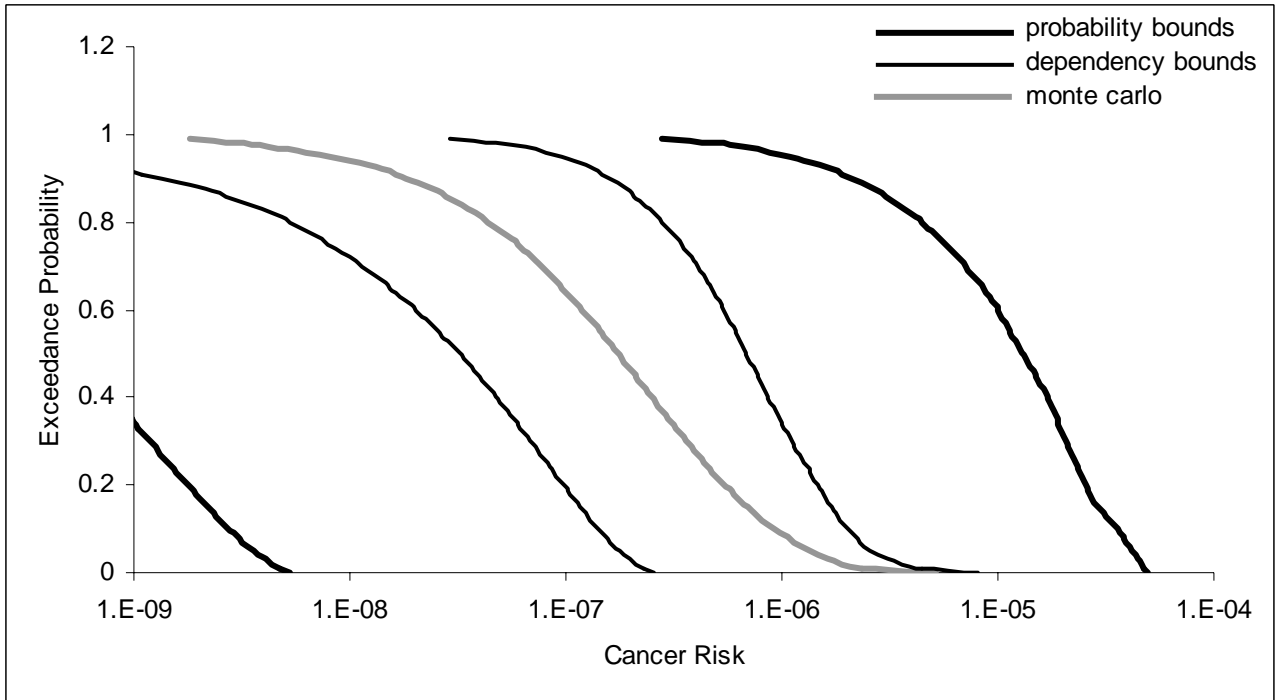
Note: x-axis is in log-scale

Figure 6-10 Cancer Risk for Waterfowl Hunter—Adult



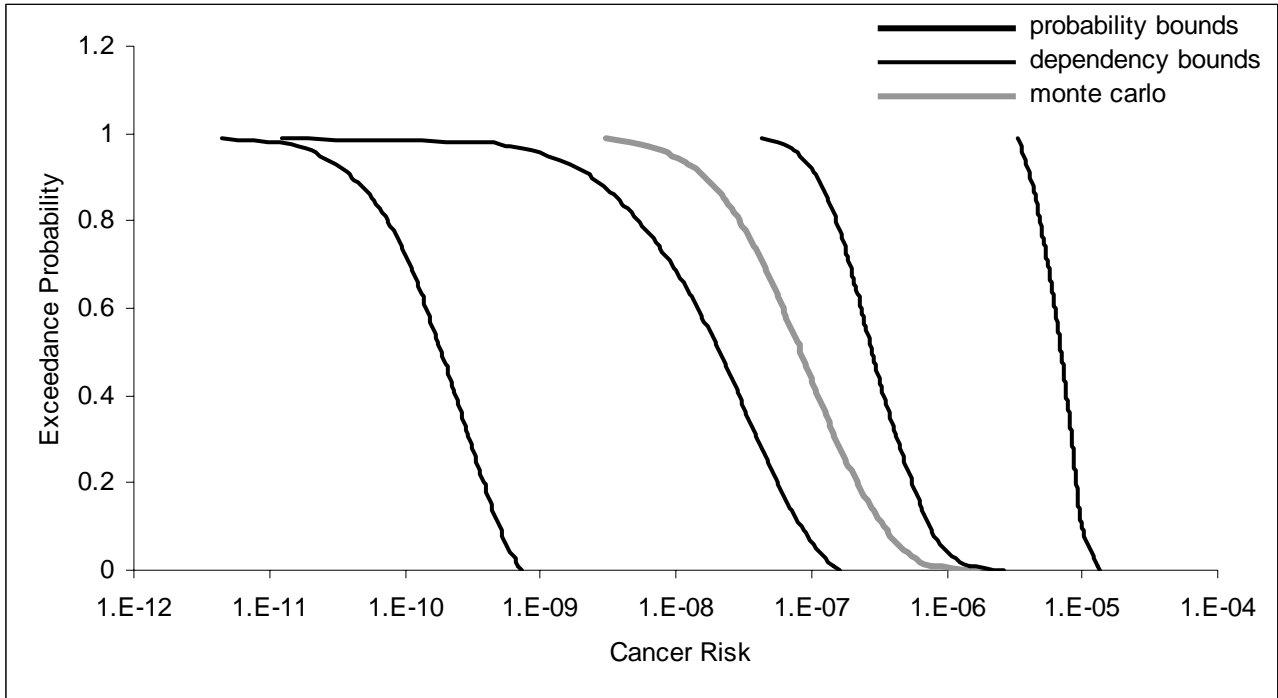
Note: x-axis is in log-scale

Figure 6-11 Cancer Risk for Waterfowl Hunter—Older Child



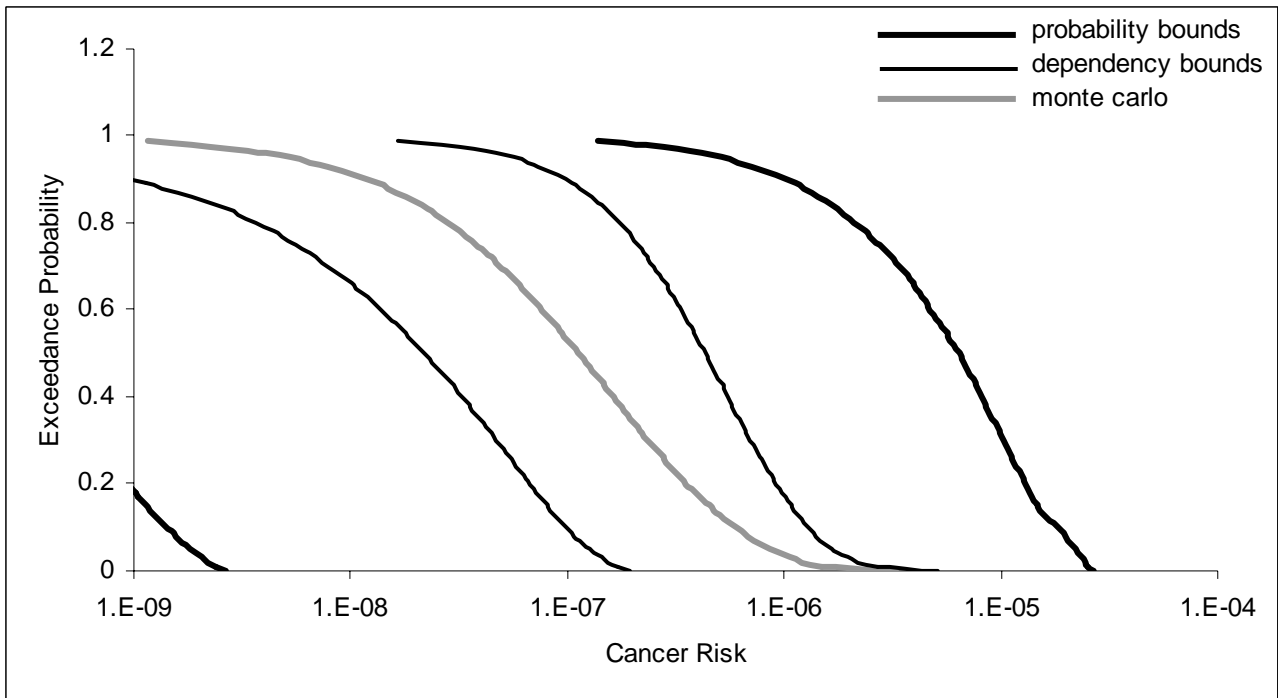
Note: x-axis is in log-scale

Figure 6-12 Cancer Risk for Canoeist/Boater—Adult



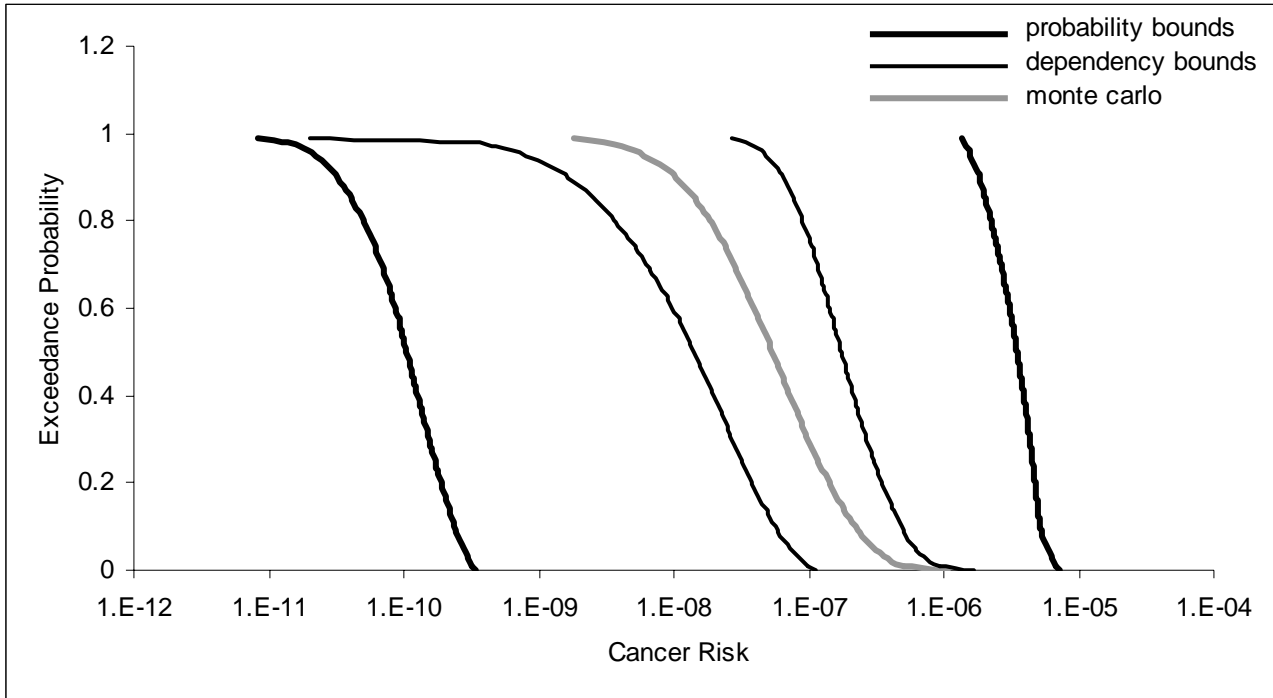
Note: x-axis is in log-scale

Figure 6-13 Cancer Risk for Canoeist/Boater—Older Child



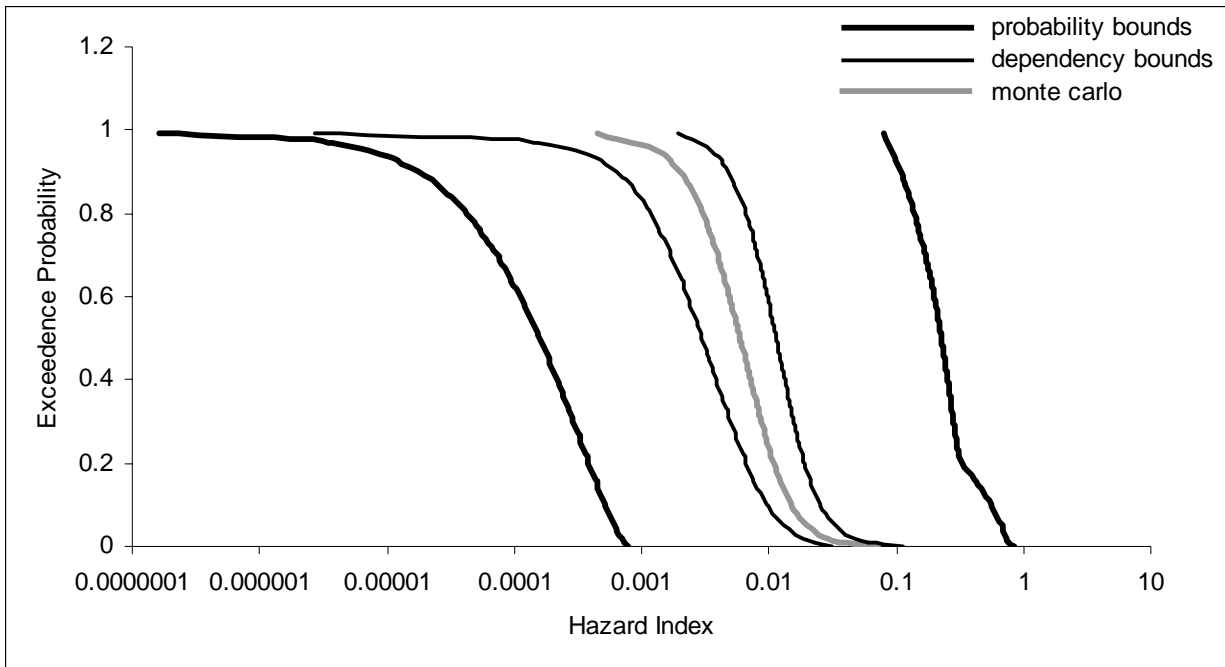
Note: x-axis is in log-scale

Figure 6-14 Cancer Risk for Sediment Exposure—Adult



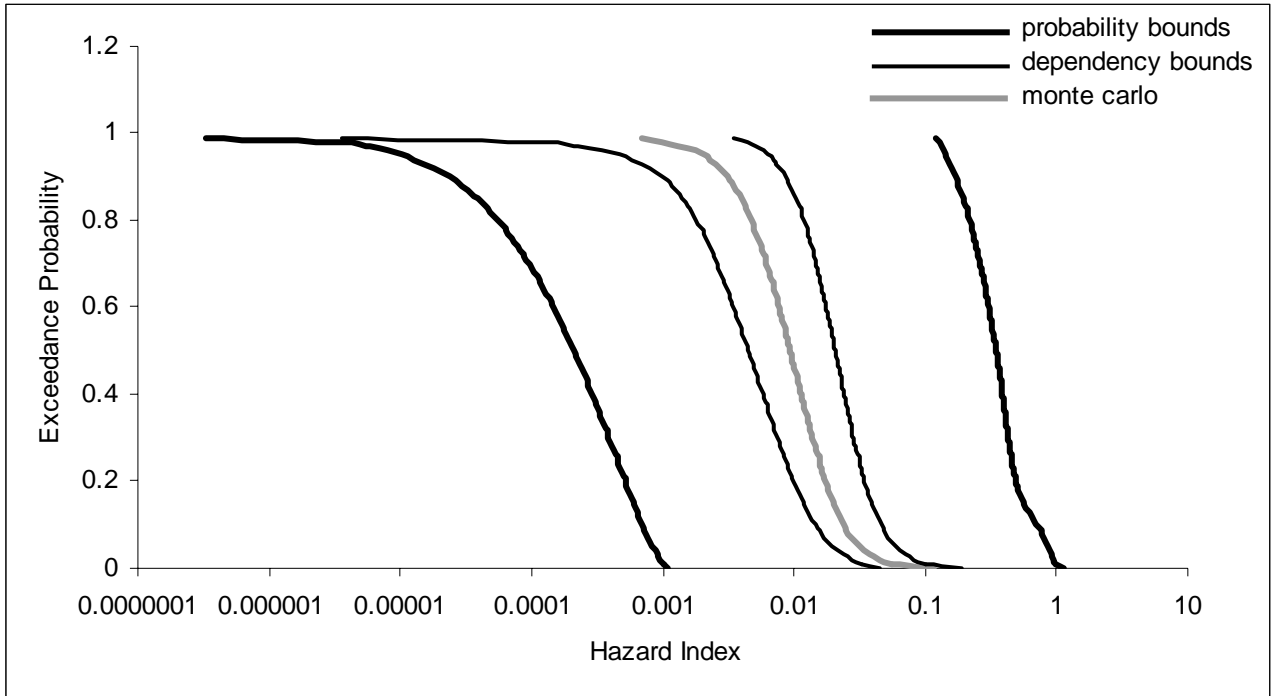
Note: x-axis is in log-scale

Figure 6-15 Cancer Risk for Sediment Exposure—Older Child



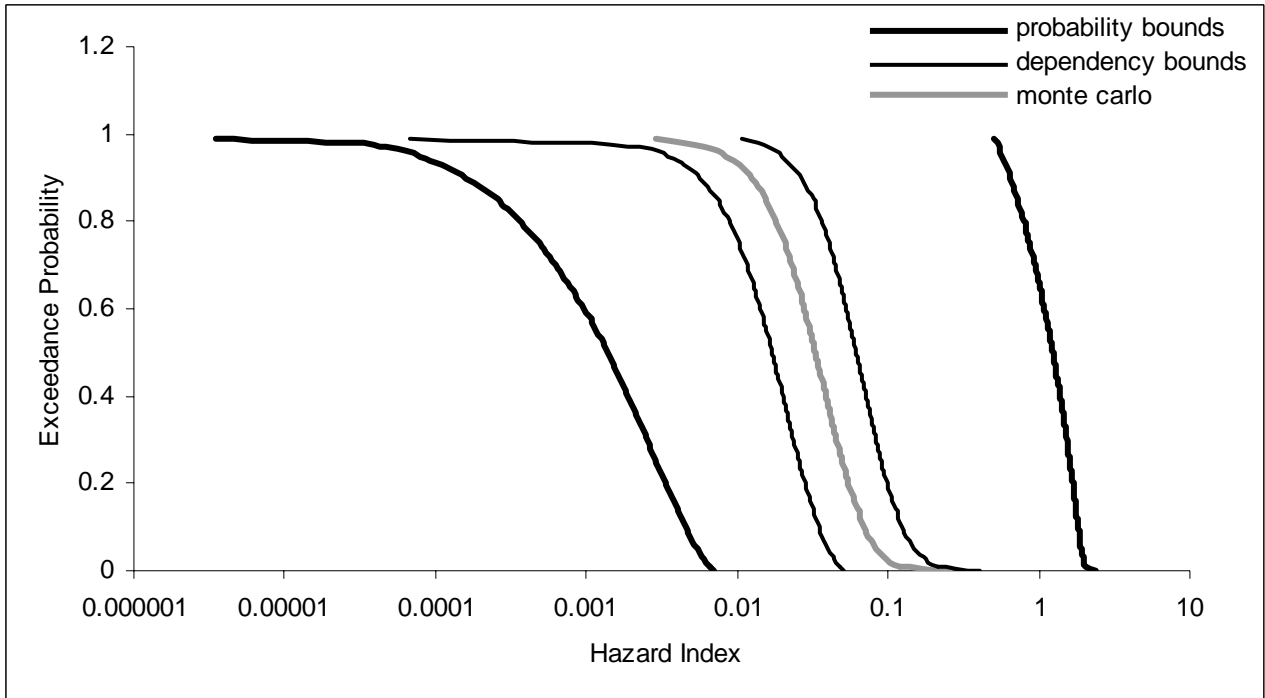
Note: x-axis is in log-scale

Figure 6-16 Hazard Index for General Recreation—Adult



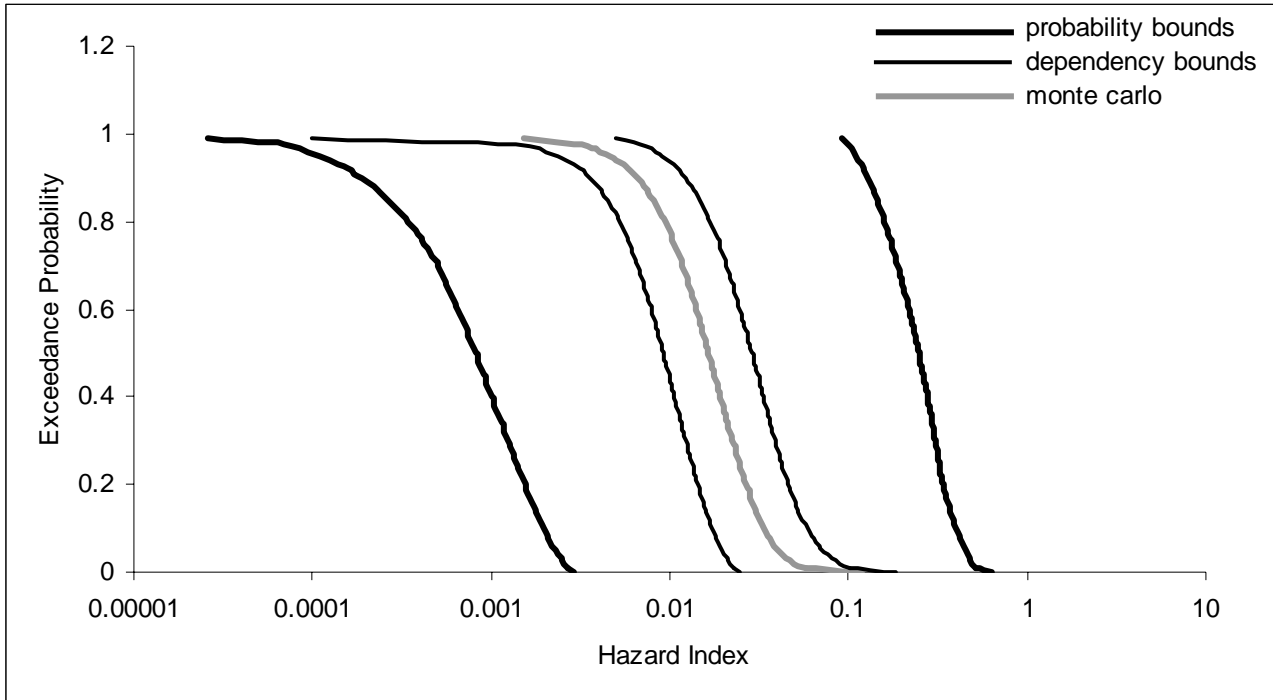
Note: x-axis is in log-scale

Figure 6-17 Hazard Index for General Recreation—Older Child



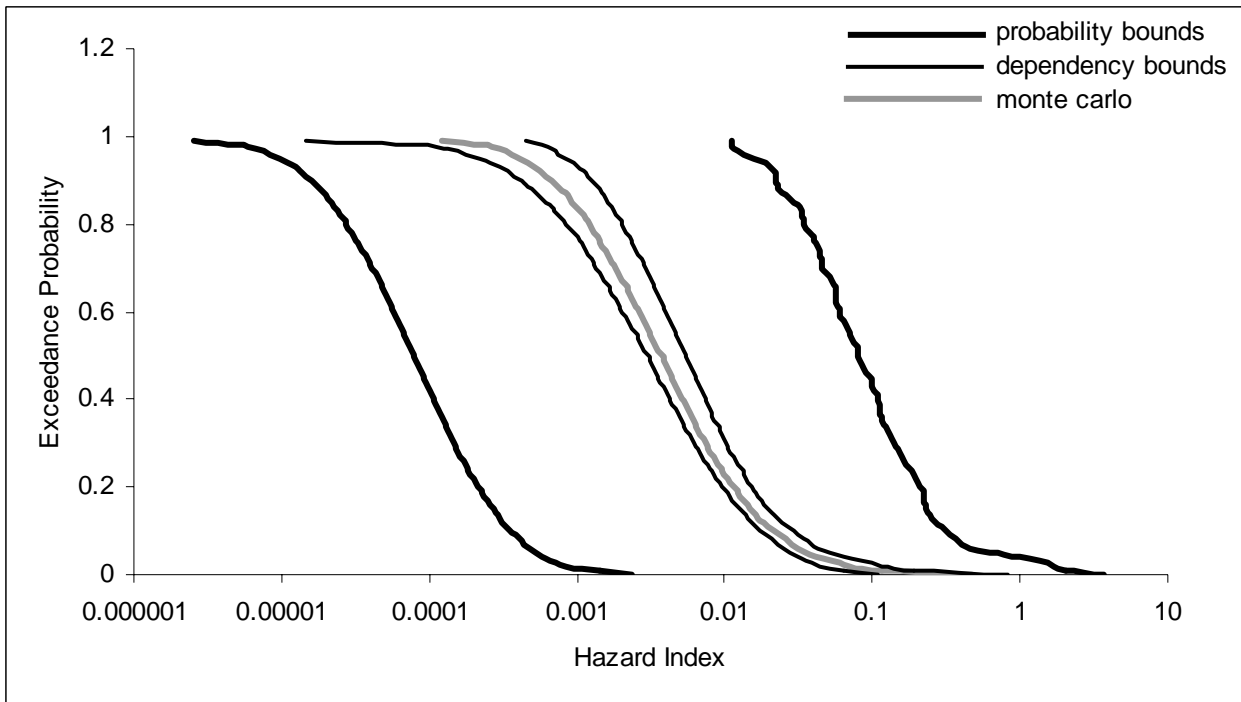
Note: x-axis is in log-scale

Figure 6-18 Hazard Index for General Recreation—Young Child



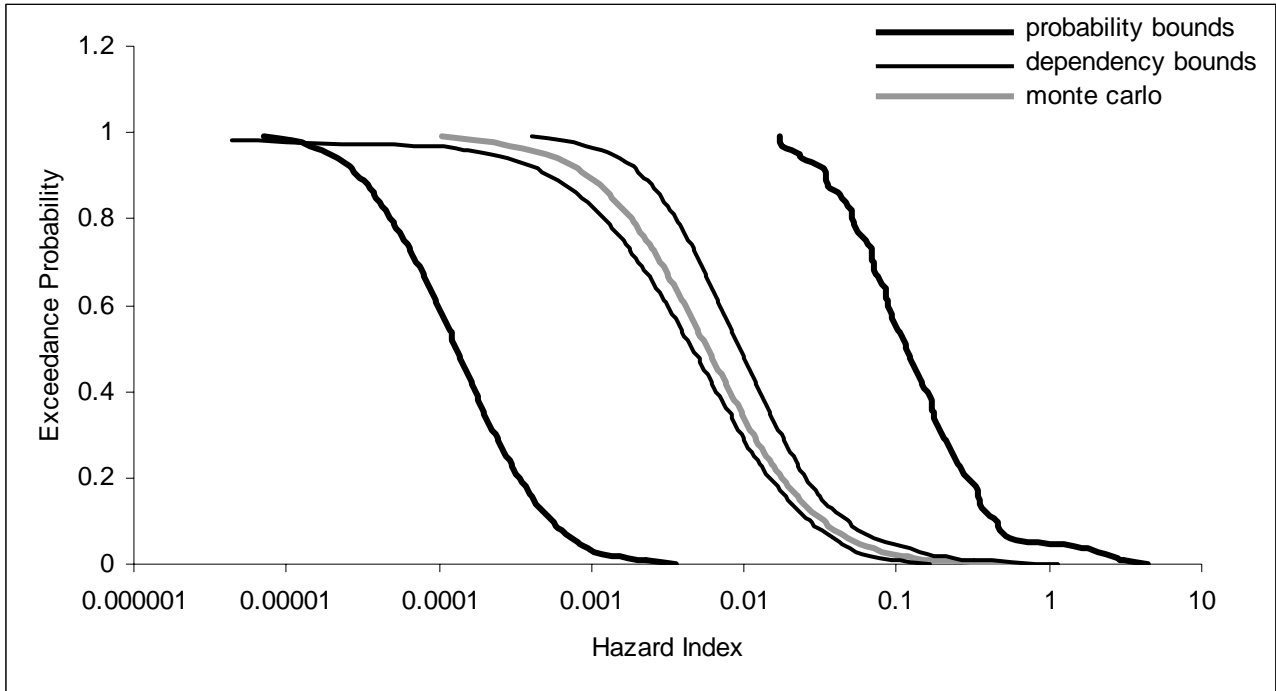
Note: x-axis is in log-scale

Figure 6-19 Hazard Index for ATV/Biker—Older Child



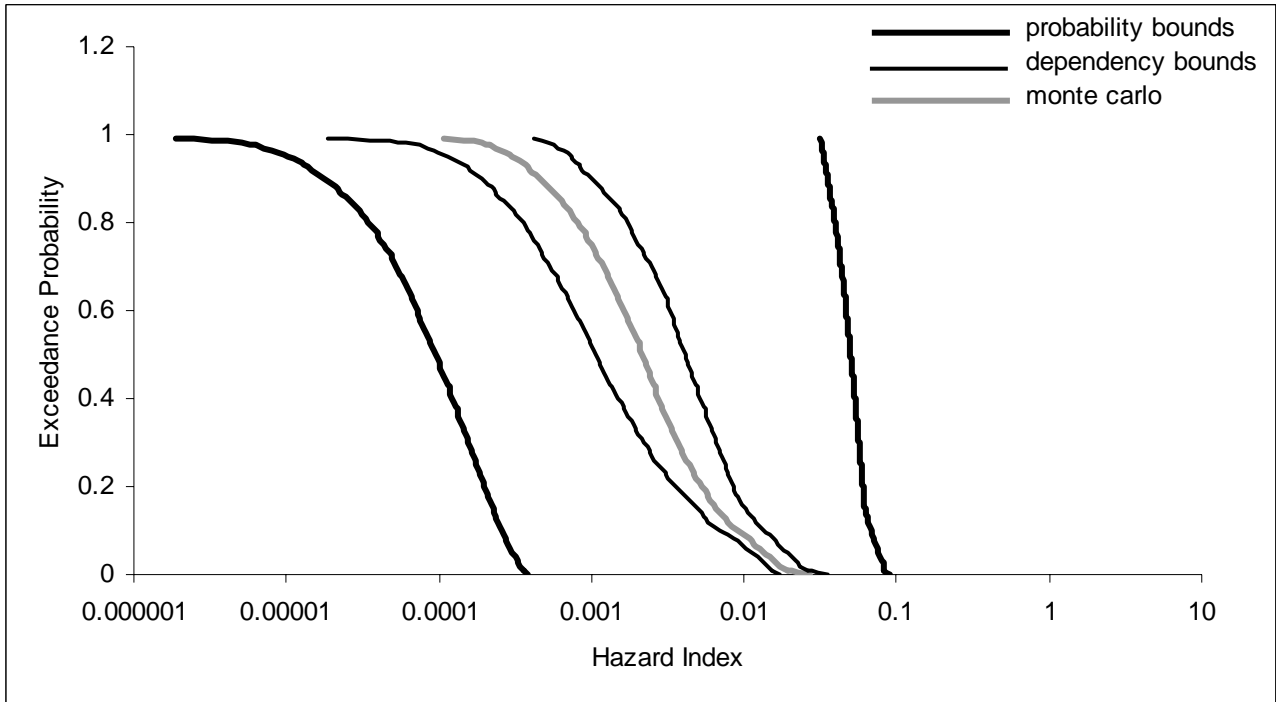
Note: x-axis is in log-scale

Figure 6-20 Hazard Index for Angler—Adult



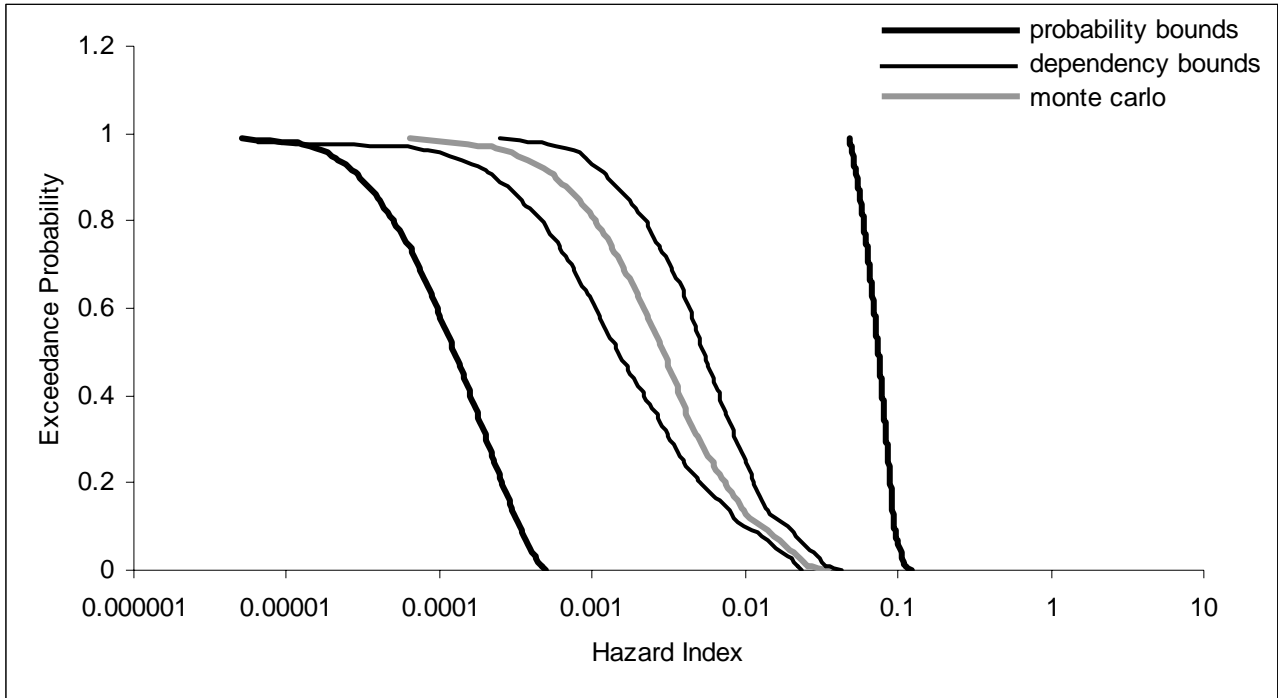
Note: x-axis is in log-scale

Figure 6-21 Hazard Index for Angler—Older Child



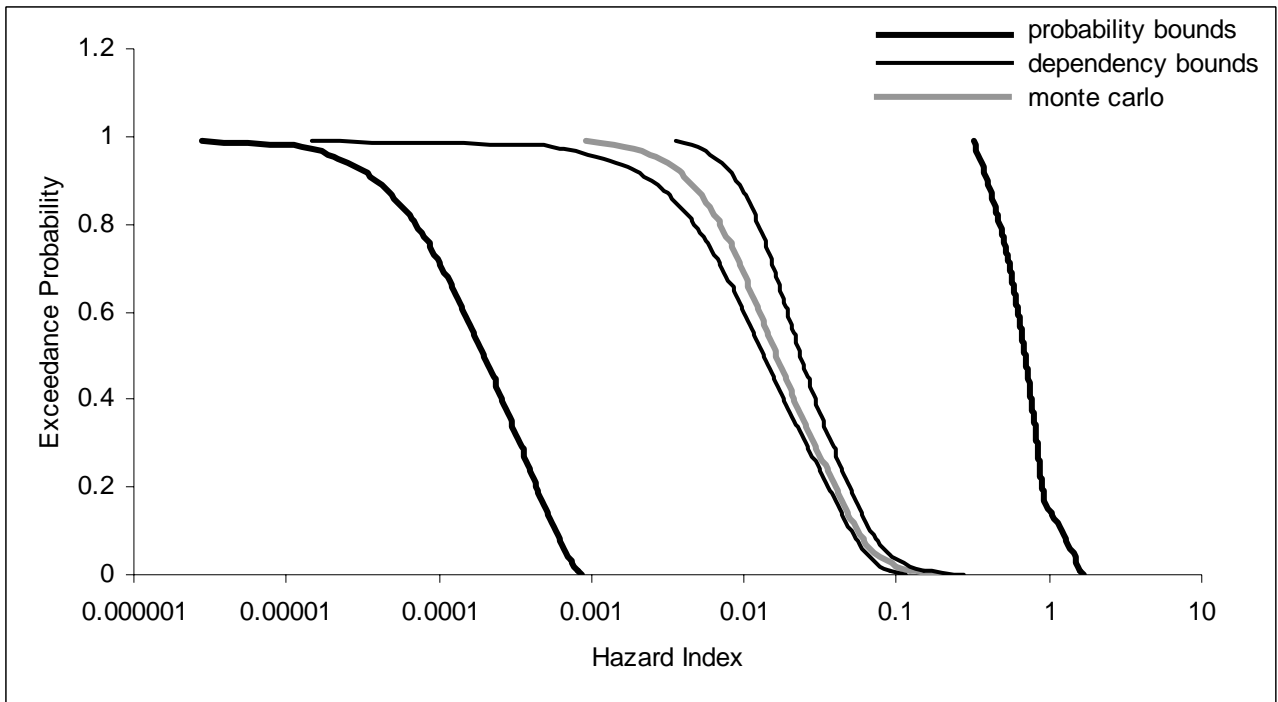
Note: x-axis is in log-scale

Figure 6-22 Hazard Index for Waterfowl Hunter—Adult



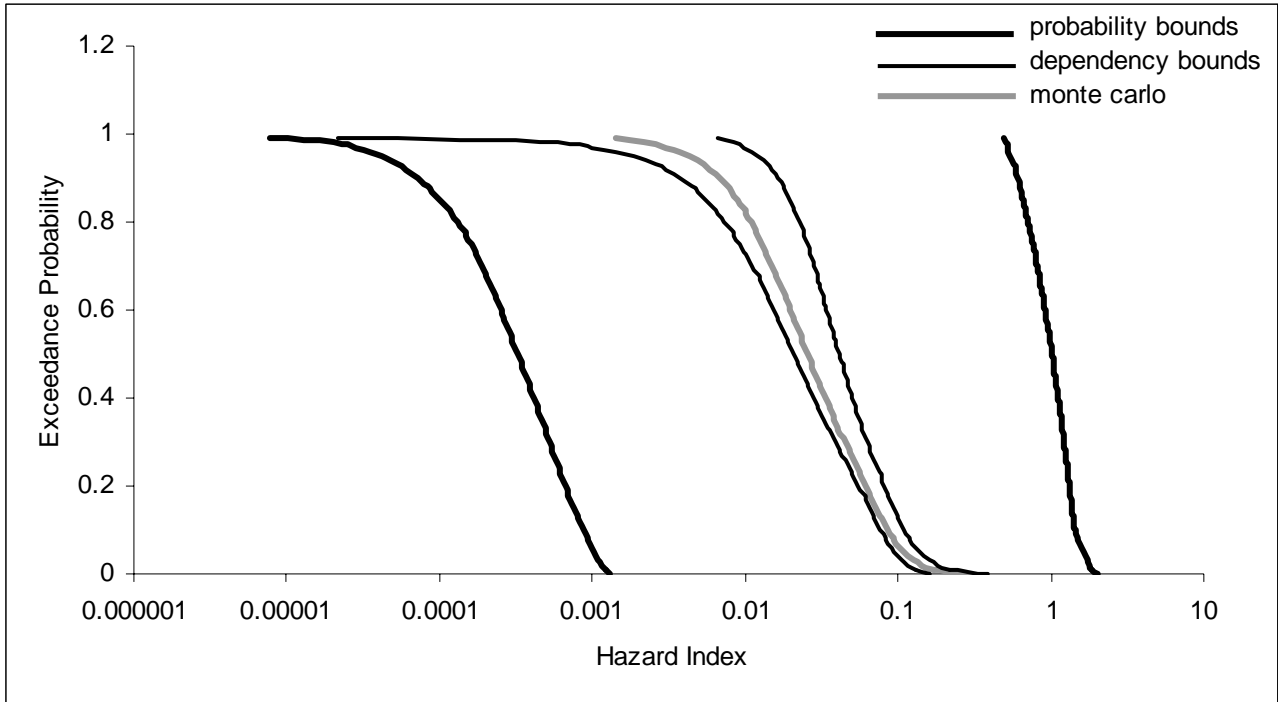
Note: x-axis is in log-scale

Figure 6-23 Hazard Index for Waterfowl Hunter—Older Child



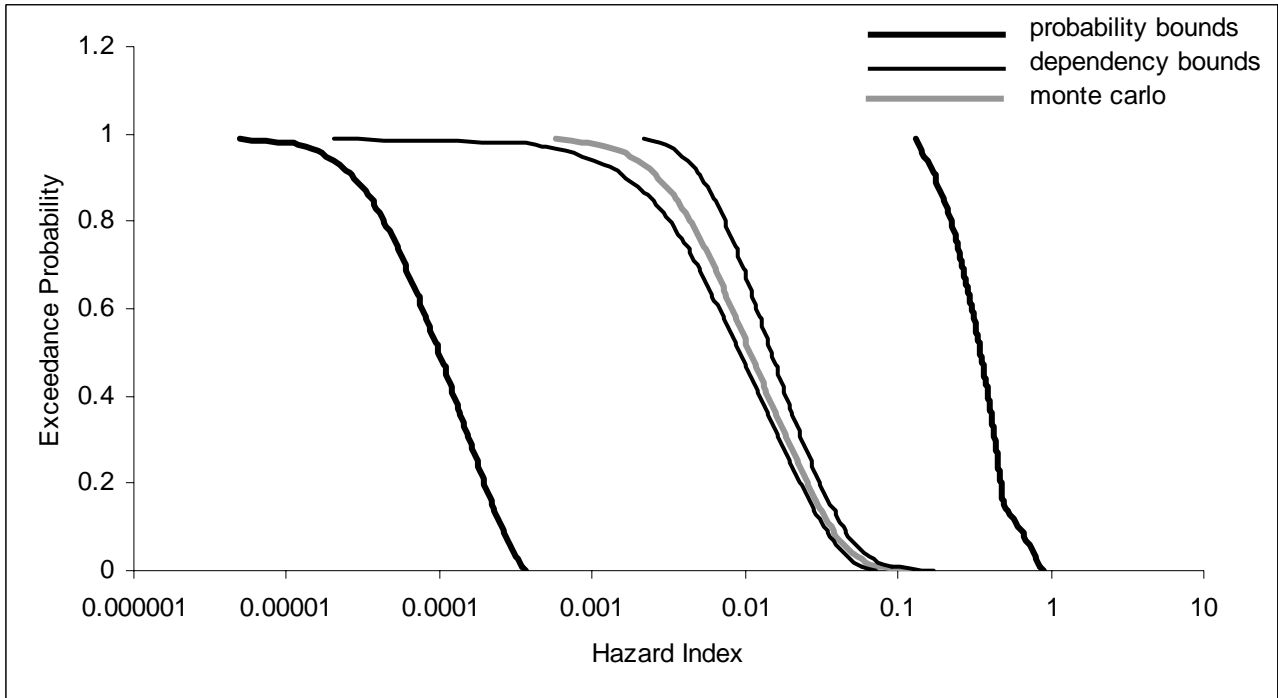
Note: x-axis is in log-scale

Figure 6-24 Hazard Index for Canoeist/Boater—Adult



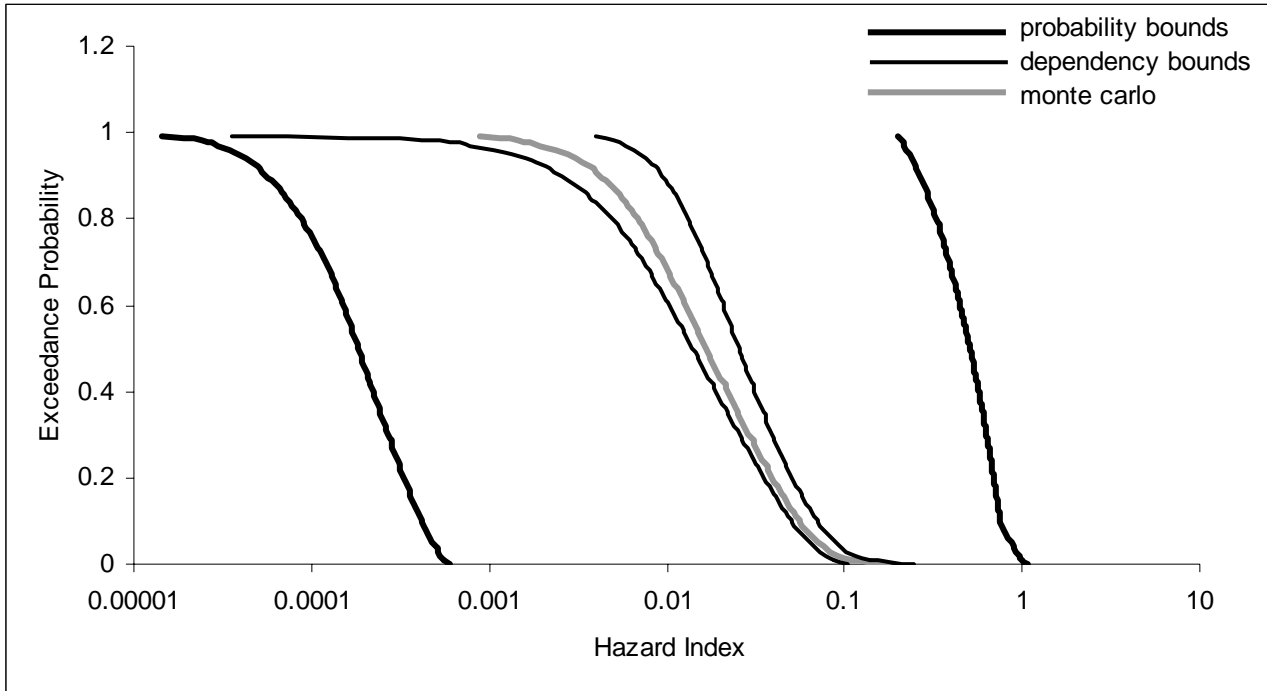
Note: x-axis is in log-scale

Figure 6-25 Hazard Index for Canoeist/Boater—Older Child



Note: x-axis is in log-scale

Figure 6-26 Hazard Index for Sediment Exposure—Adult



Note: x-axis is in log-scale

Figure 6-27 Hazard Index for Sediment Exposure—Older Child

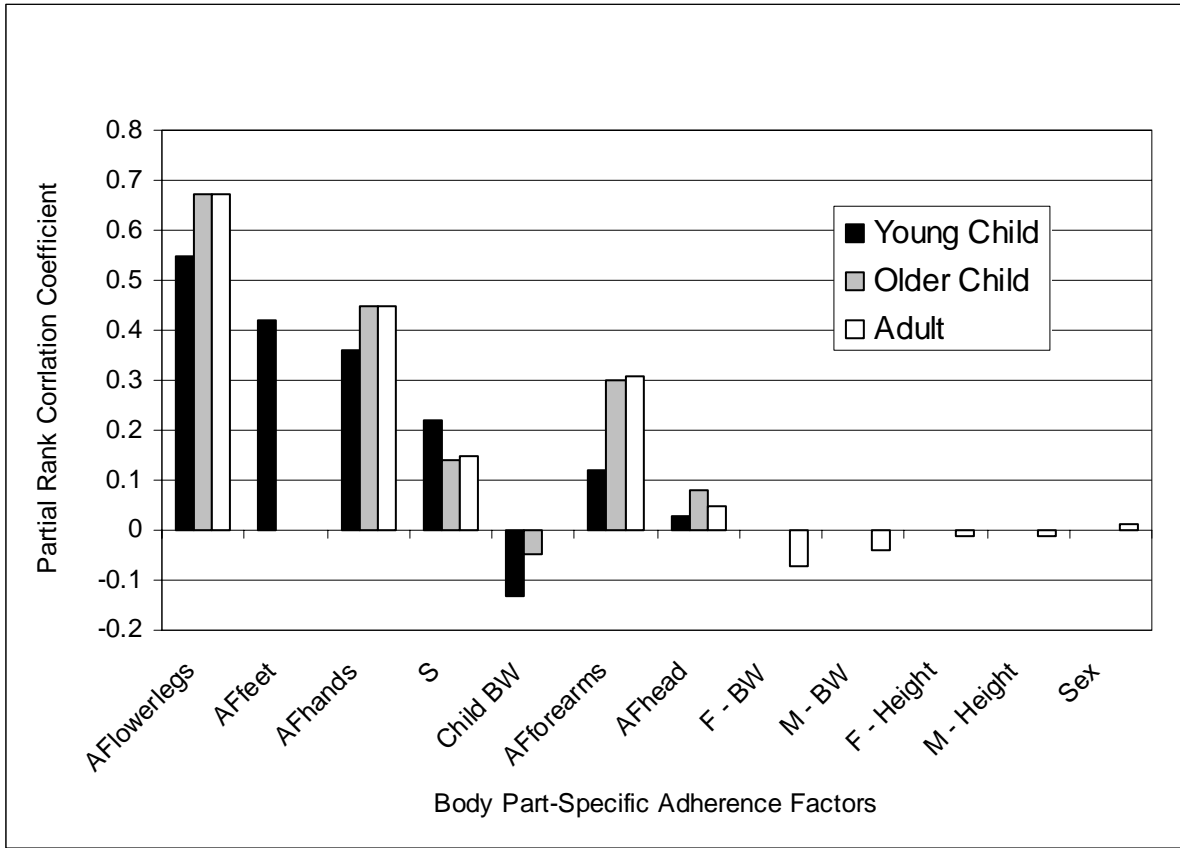


Figure 6-28 Sensitivity Analysis for Variability In “X”: General Recreation Scenarios

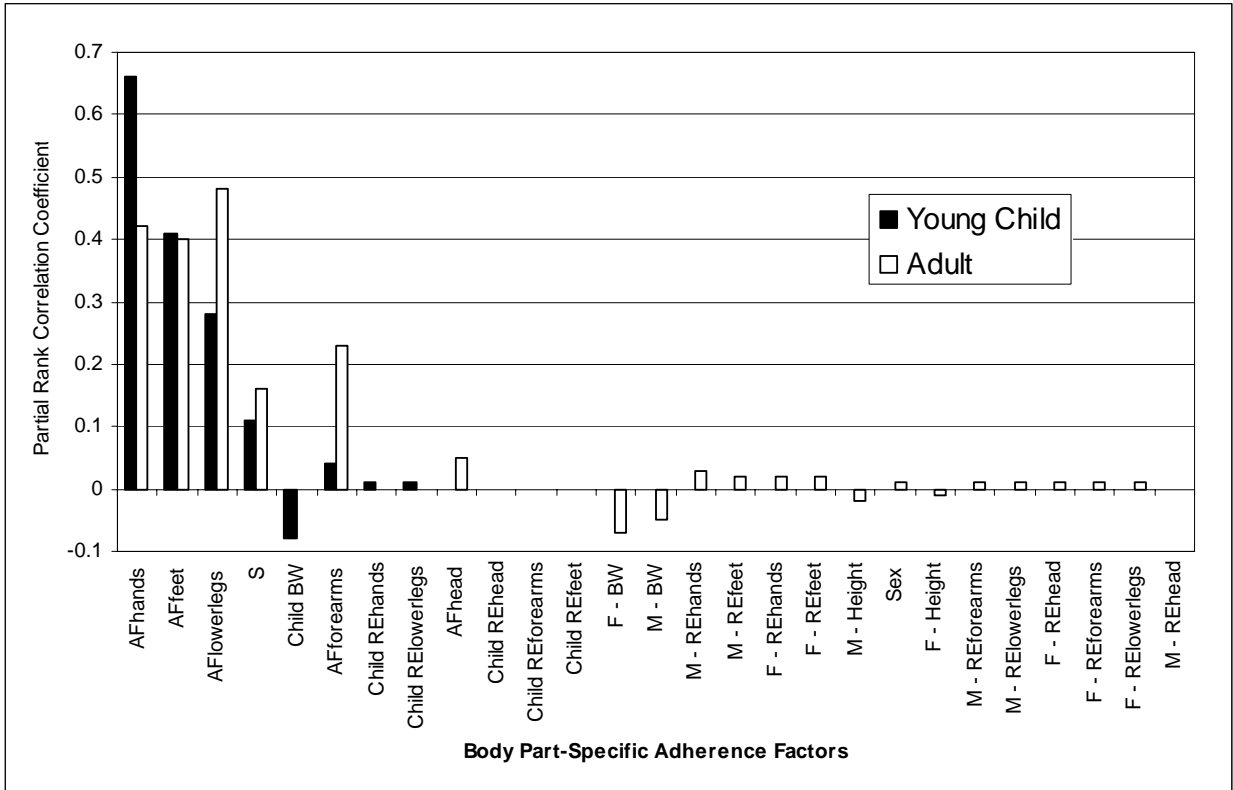
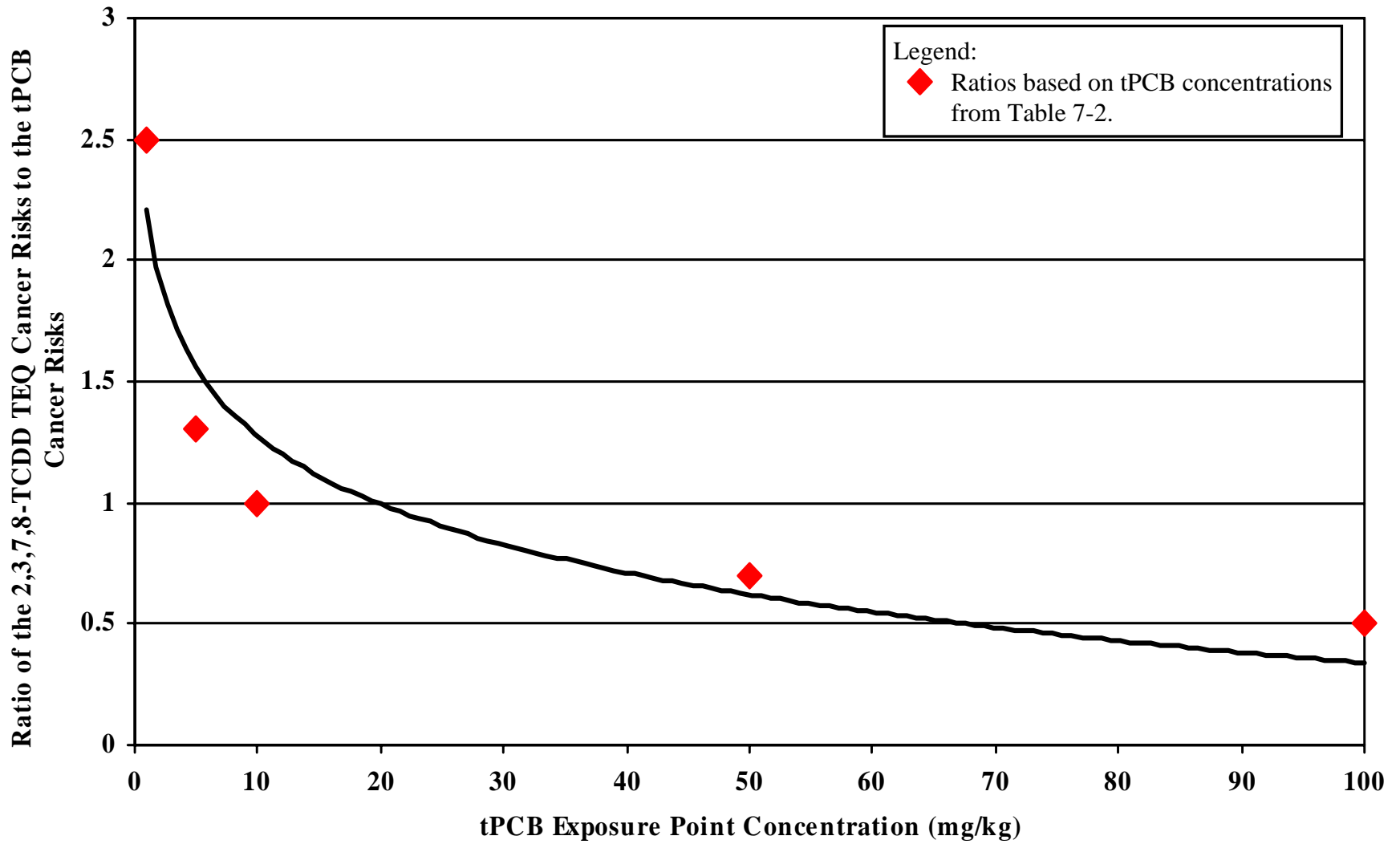


Figure 6-29 Sensitivity Analysis for Variability Plus Uncertainty in “X”: General Recreation Scenarios

Figure 7-1

tPCB Exposure Point Concentrations Versus the Ratio of 2,3,7,8-TCDD TEQ Cancer Risks to tPCB Cancer Risks - General Recreation Scenario (EF - 90 days/year), Adult Receptor



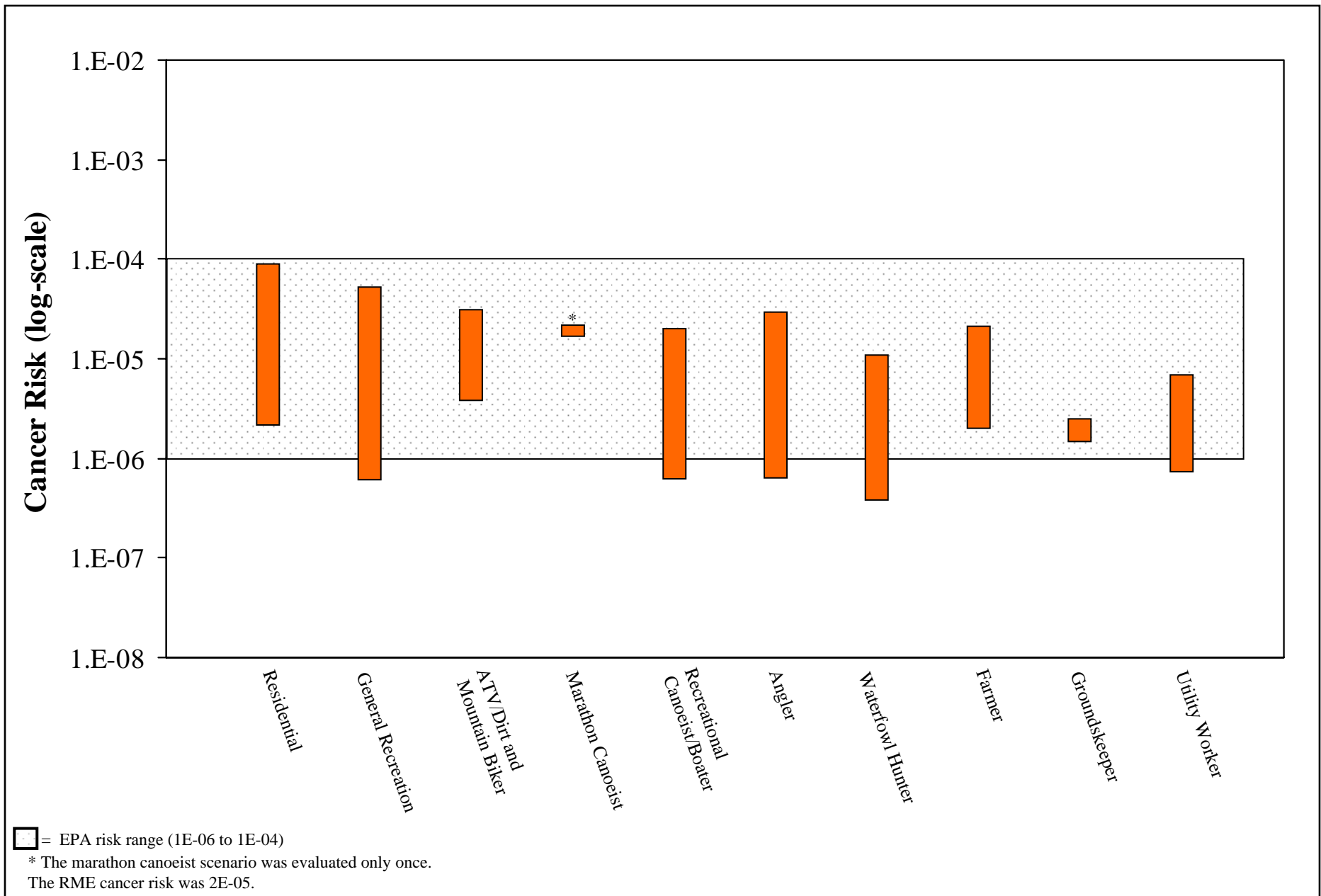


Figure 8-1 Summary of the Ranges of the tPCB RME Cancer Risks from Exposure to Soil

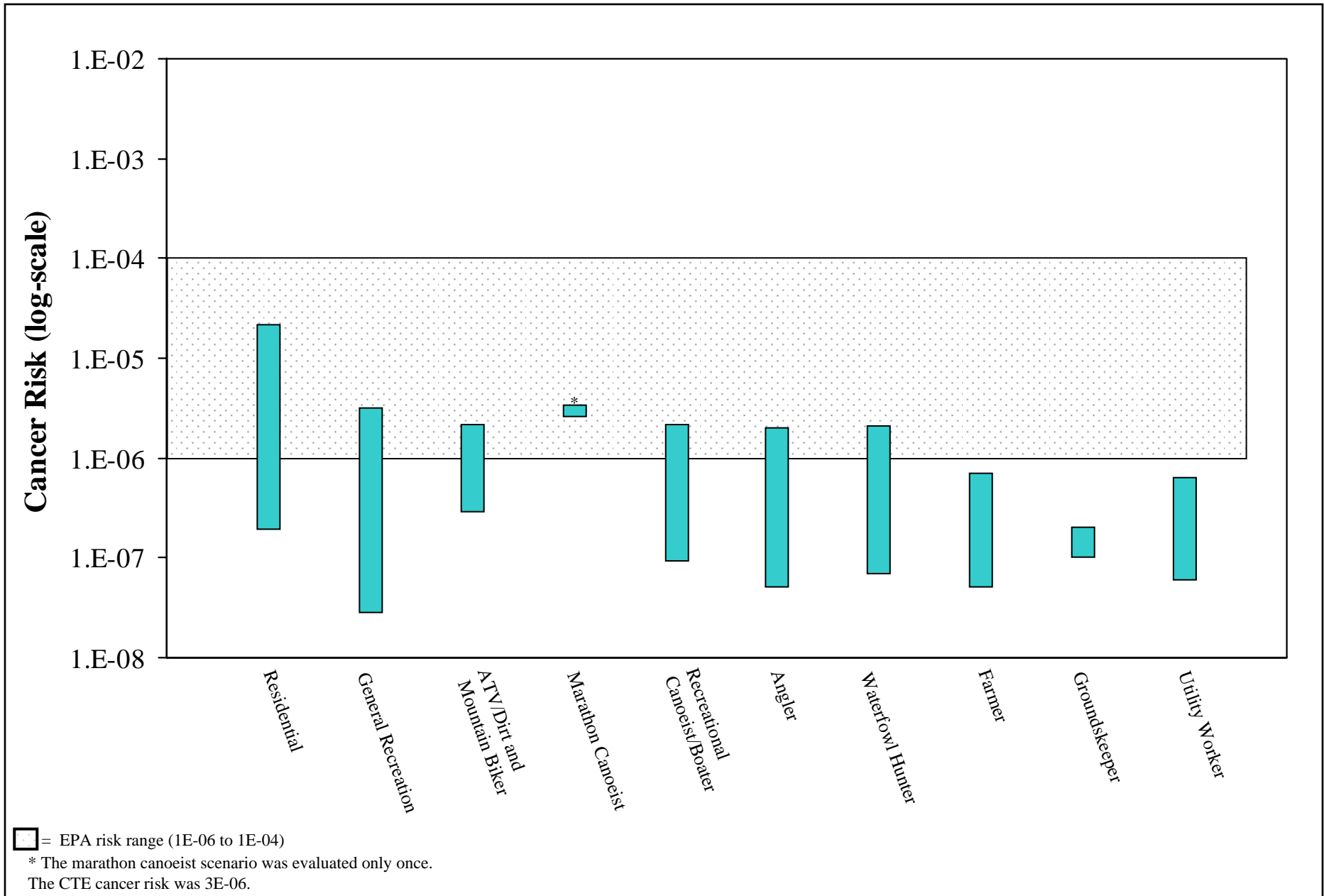


Figure 8-2 Summary of the Ranges of the tPCB CTE Cancer Risks from Exposure to Soil

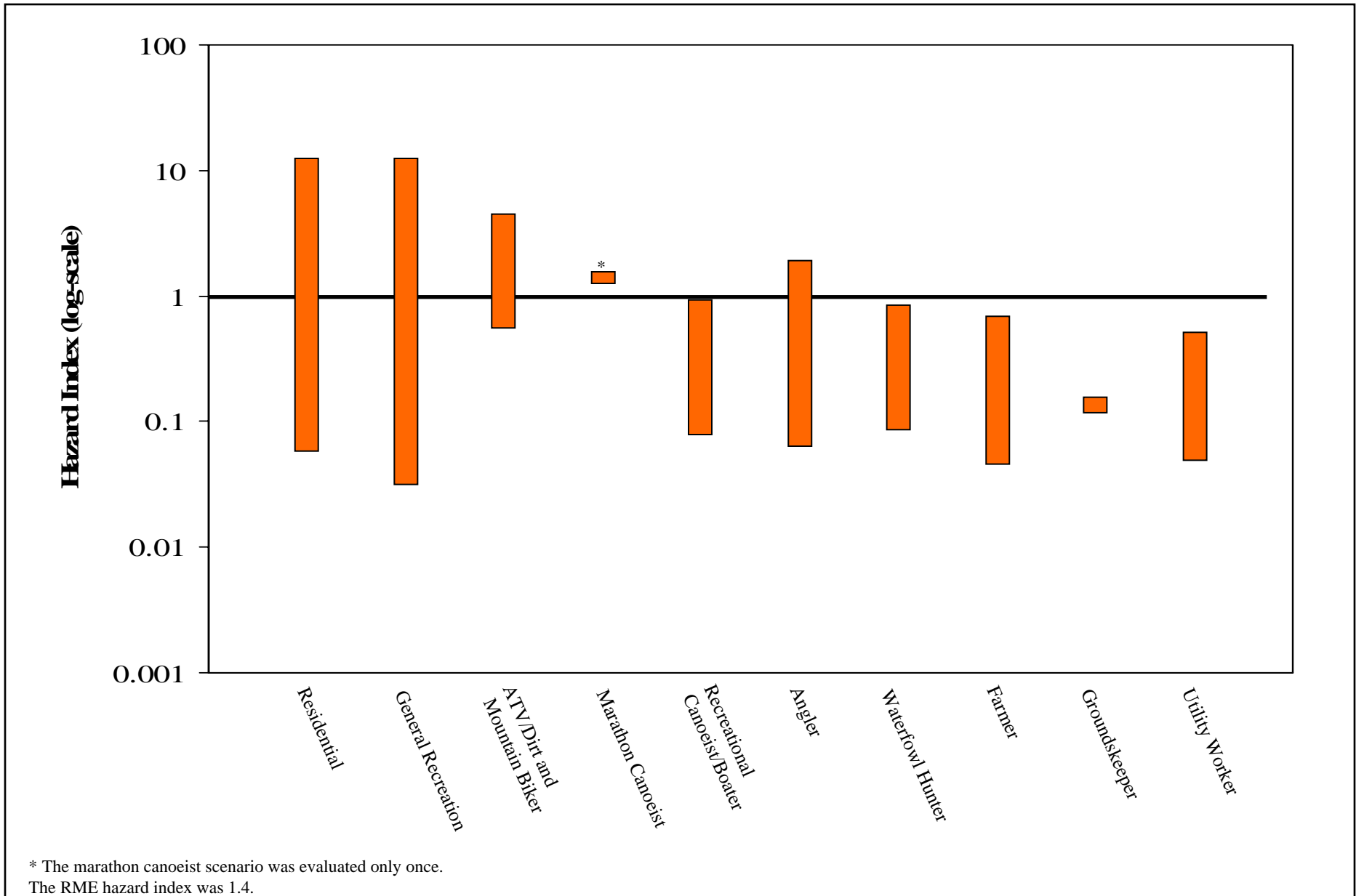


Figure 8-3 Summary of the Ranges of the tPCB RME Hazard Indices from Exposure to Soil

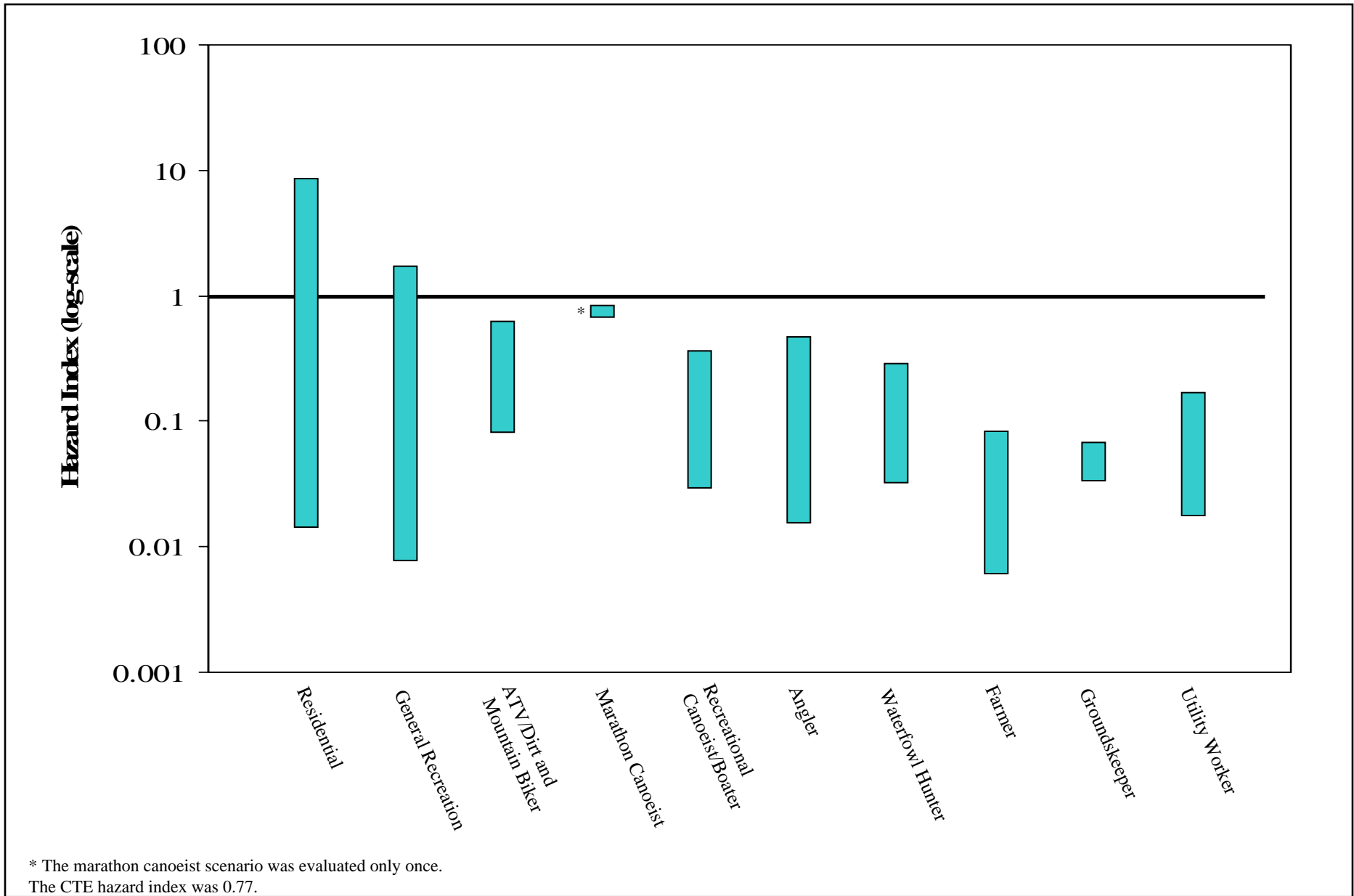


Figure 8-4 Summary of the Ranges of the tPCB CTE Hazard Indices from Exposure to Soil

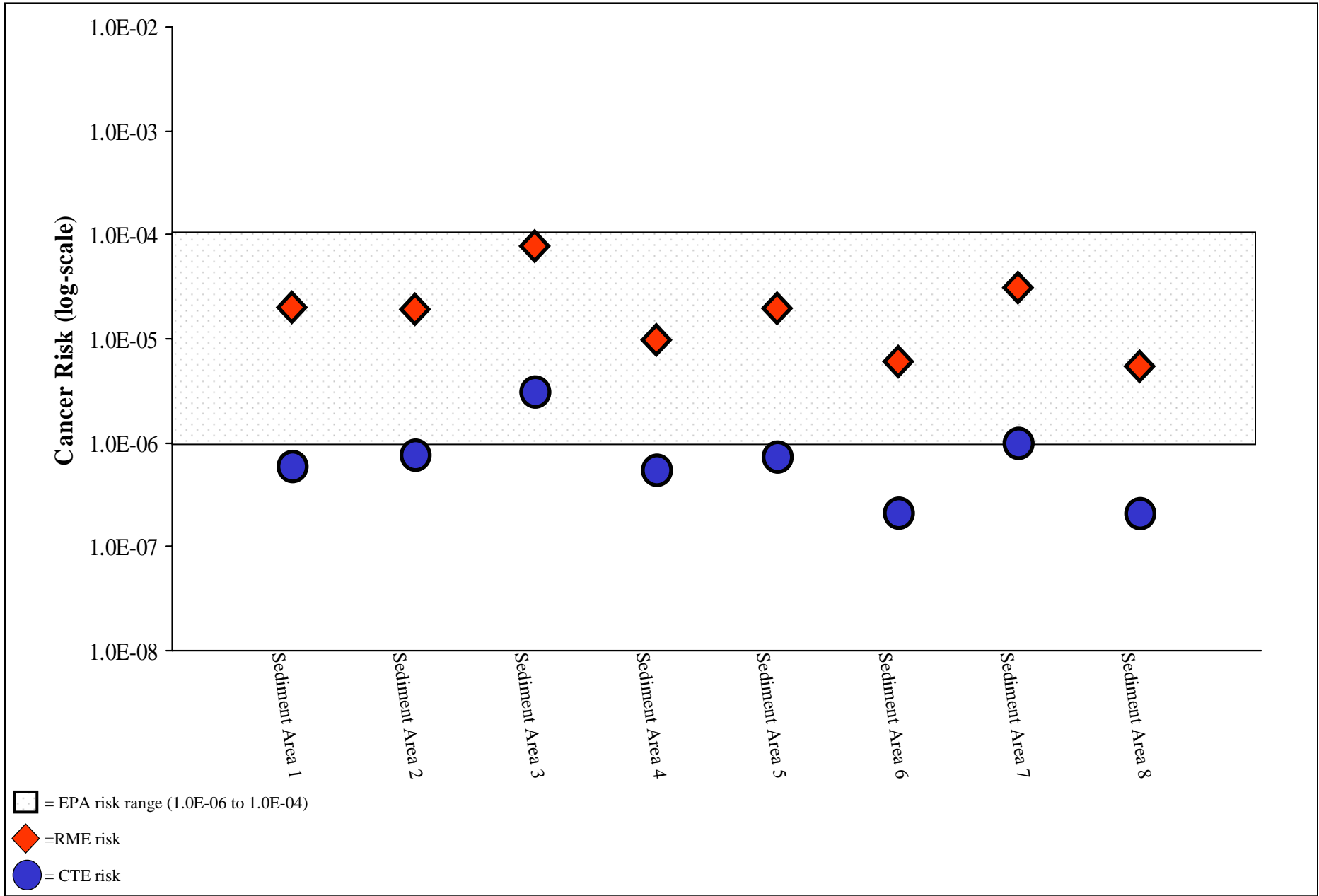


Figure 8-5 Summary of the Range of tPCB Cancer Risks from Exposure to Sediment

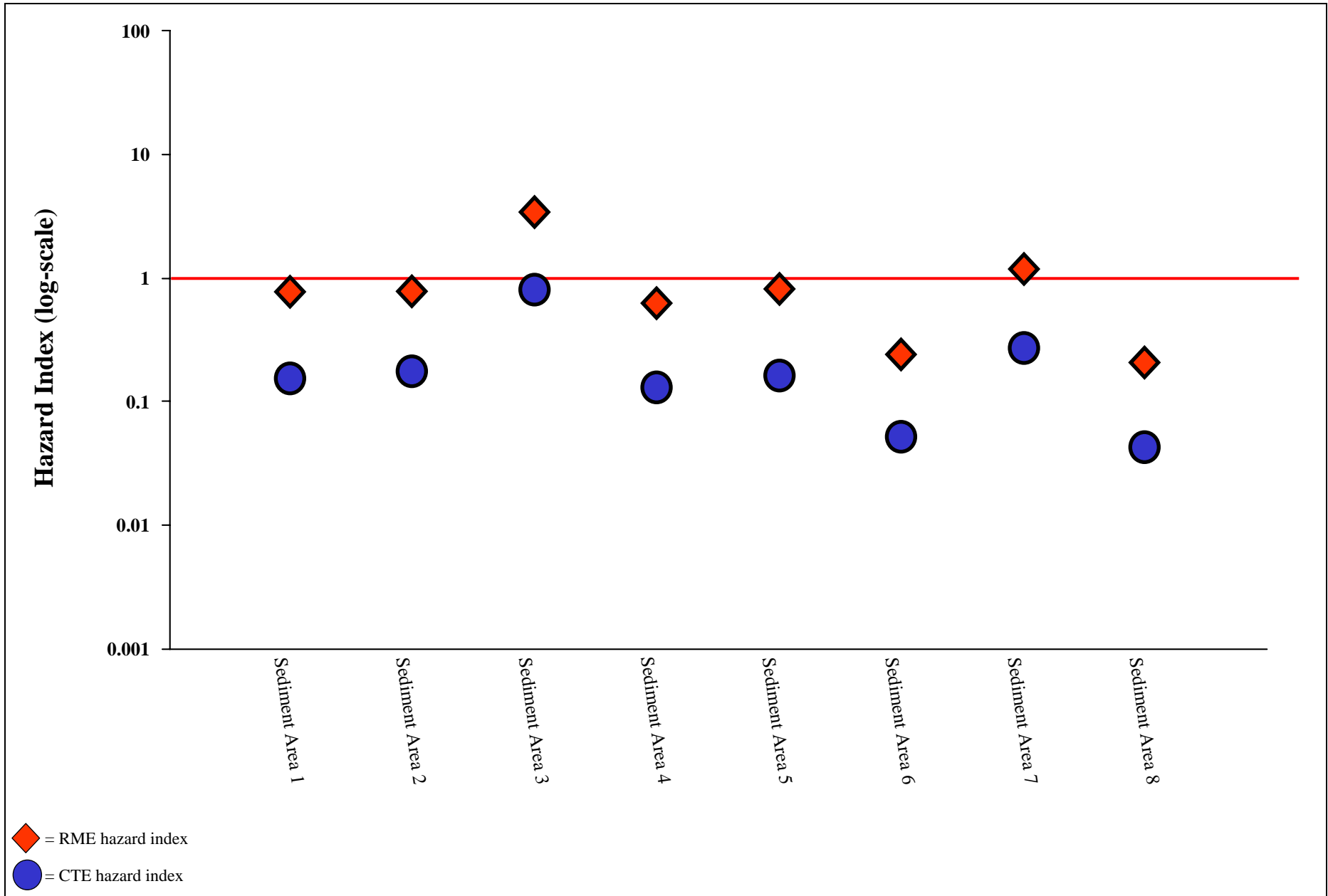
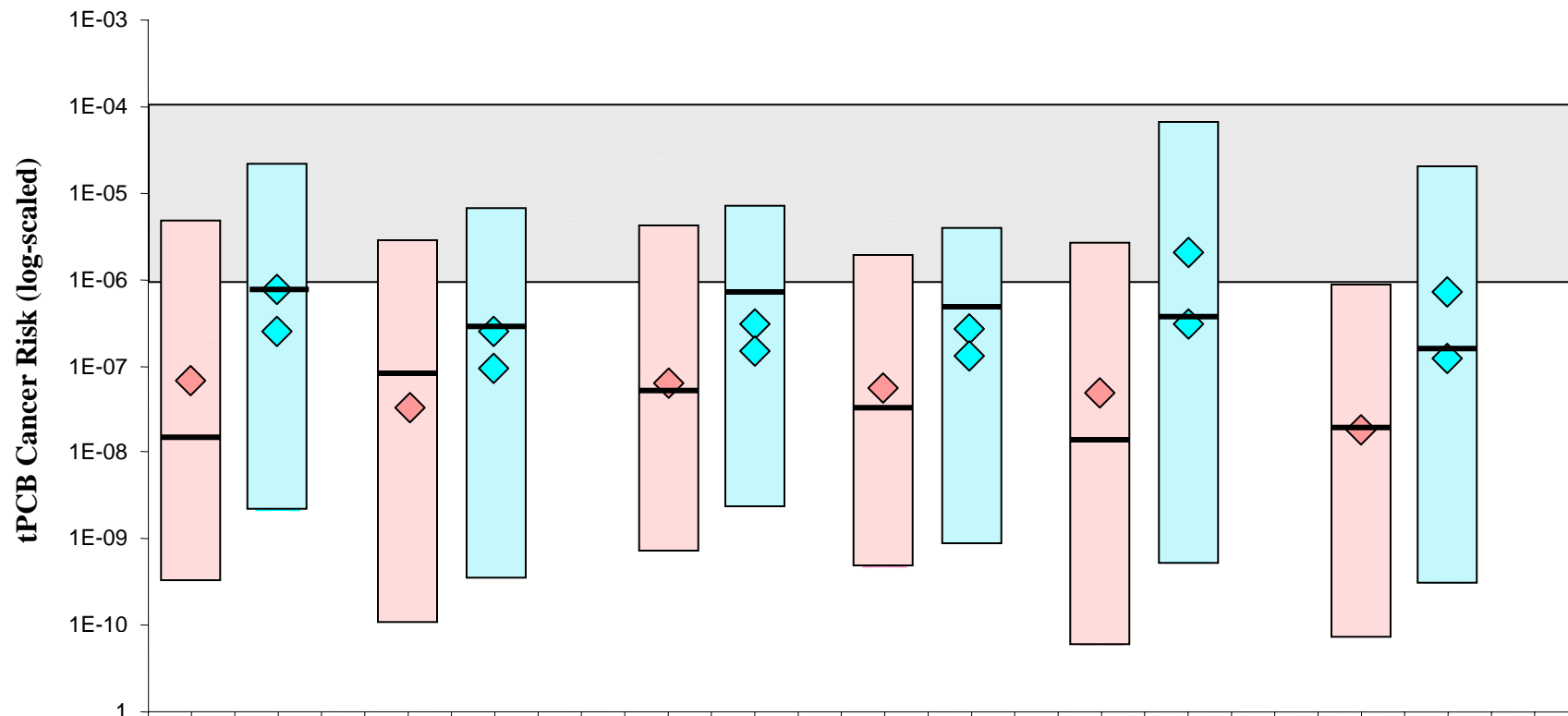


Figure 8-6 Summary of the Range of tPCB Hazard Indices from Exposure to Sediment

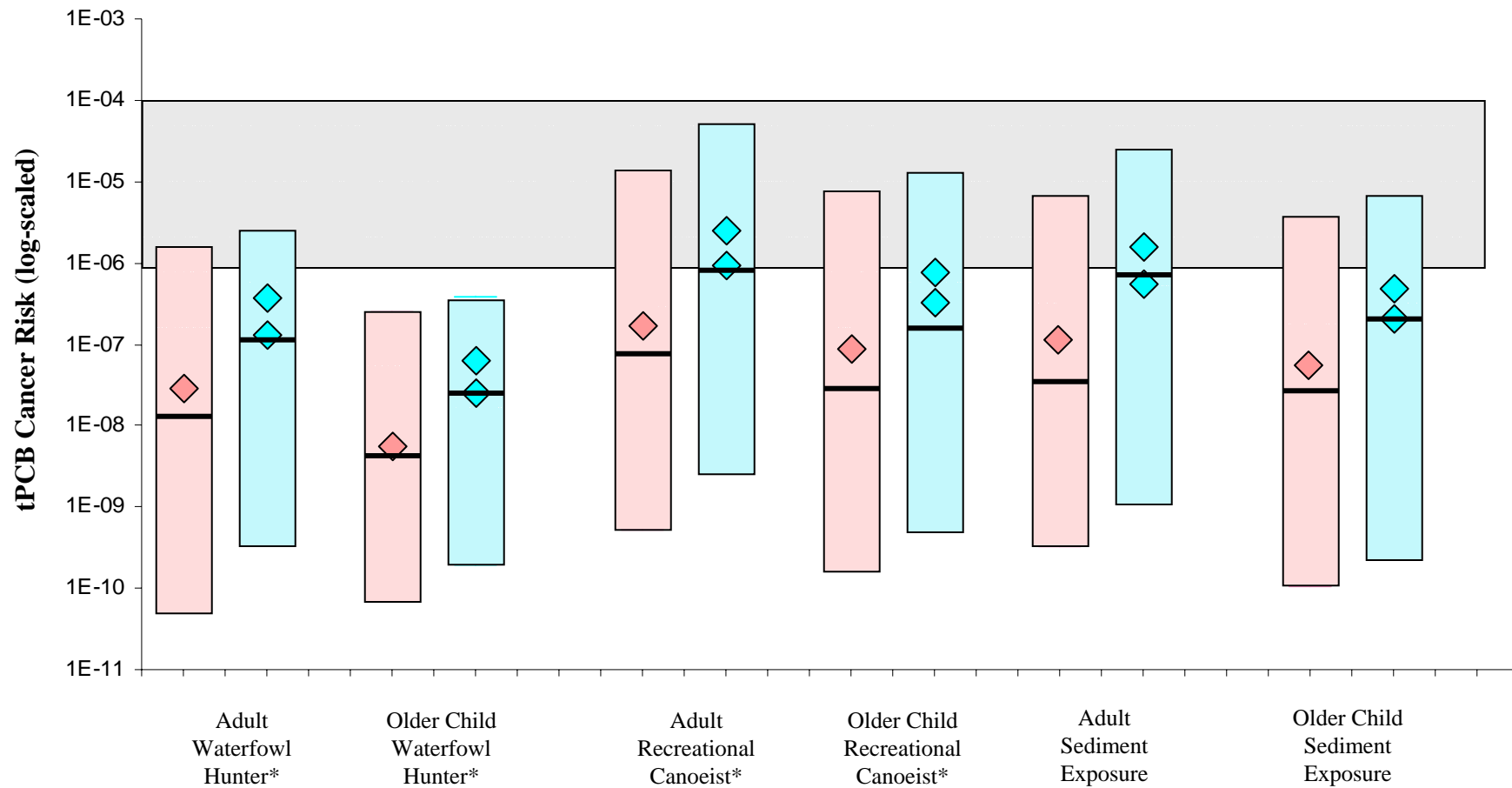


Adult - General Recreation* Older Child - General Recreation* Young Child - General Recreation* Older Child ATV/Dirt and Mountain Biker Adult Angler Older Child Angler

- = CTE and RME point estimates
- ◆ = 1-D Monte Carlo analog median
- = 1-D Probability Bounds Analysis median
- ◆ = RME Range Monte Carlo analog analysis
- = RME Range probability bounds analysis
- = EPA risk range (1E-06 to 1E-04)
- * = Point Estimate calculated assuming "high use" exposure frequency

**Direct Contact Human Health Risk Assessment
GE/Housatonic River Site
Rest of River**

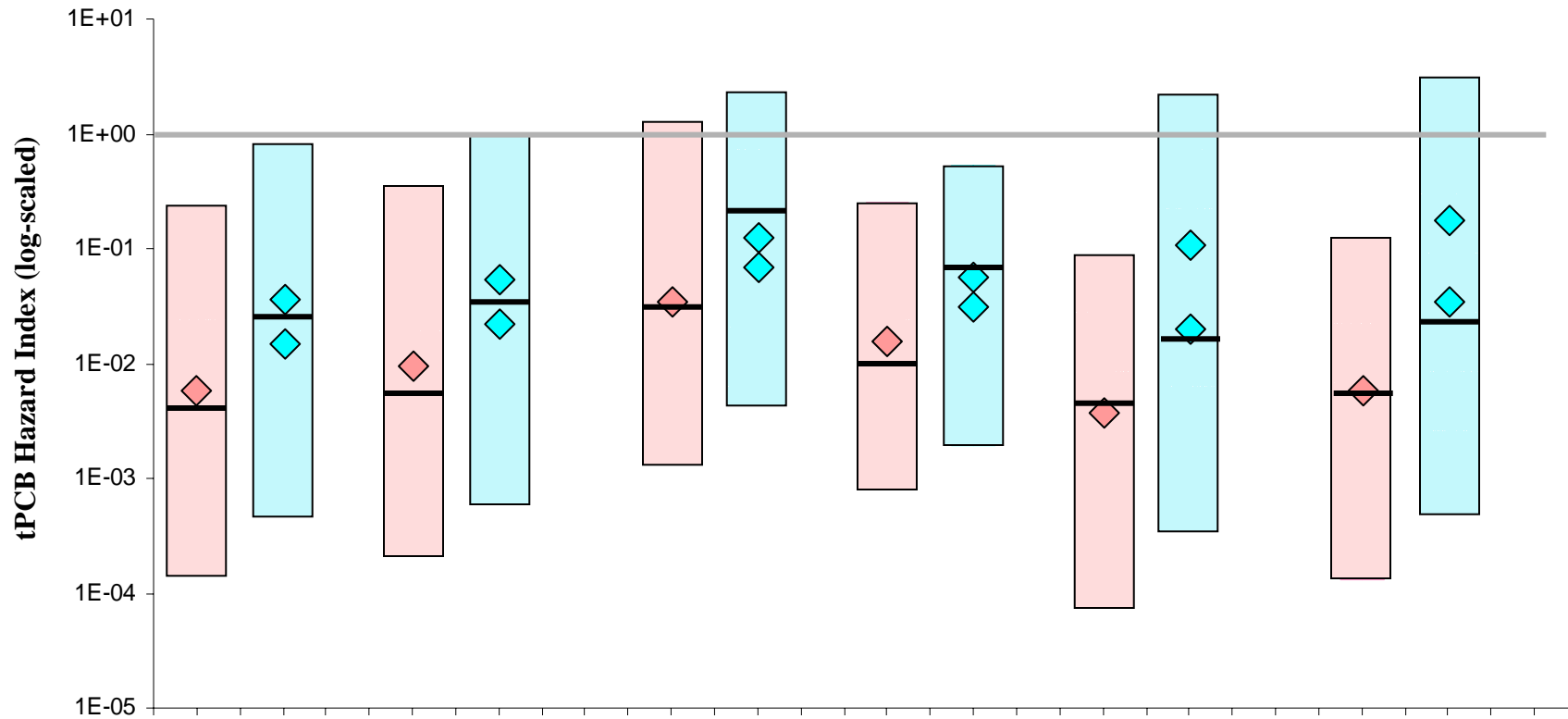
Figure 8-7a
**Relationship Between Point Estimate, Monte Carlo Analog, and
Probability Bounds Analyses for tPCB Cancer Risk - Floodplain Soil
Exposure**



- = CTE and RME point estimates
- ◆ = 1-D Monte Carlo analog median
- = 1-D Probability Bounds Analysis median
- ◆ = RME Range Monte Carlo analog analysis
- = RME Range probability bounds analysis
- = EPA risk range (1E-06 to 1E-04)
- * = Hunters and canoeists are exposed to floodplain soil.

**Direct Contact Human Health Risk Assessment
GE/Housatonic River Site
Rest of River**

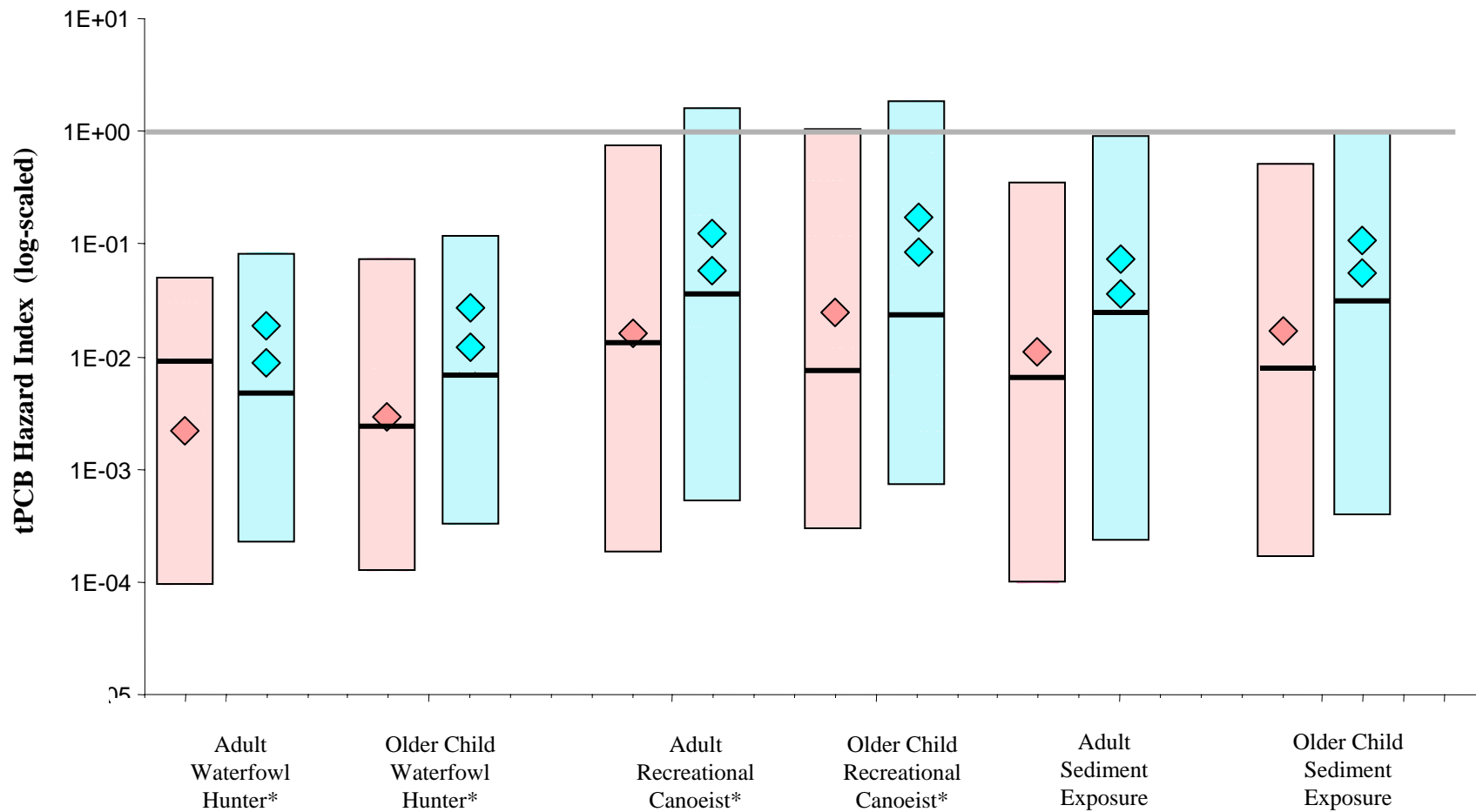
**Figure 8-7b
Relationship Between Point Estimate, Monte Carlo Analog, and
Probability Bounds Analyses for tPCB Cancer Risk – Floodplain Soil and
Sediment Exposure**



- = EPA hazard benchmark
- = CTE and RME point estimates
- ◆ = Median Monte Carlo analog analysis
- = Median probability bounds analysis
- ◆ = RME Range Monte Carlo analog analysis
- = RME Range probability bounds analysis
- * = Point Estimate calculated assuming “high use” exposure frequency

Direct Contact Human Health Risk Assessment
GE/Housatonic River Site
Rest of River

Figure 8-8a
Relationship Between Point Estimate, Monte Carlo Analog, and
Probability Bounds Analyses for tPCB Hazard Indices – Floodplain Soil
Exposure



- = EPA hazard benchmark
- = CTE and RME point estimates
- ◆ = Median Monte Carlo analog analysis
- = Median probability bounds analysis
- ◆ = RME Range Monte Carlo analog analysis
- = RME Range probability bounds analysis
- * = Hunters and canoeists are exposed to floodplain soil.

Direct Contact Human Health Risk Assessment
GE/Housatonic River Site
Rest of River
Figure 8-8b
Relationship Between Point Estimate, Monte Carlo Analog, and
Probability Bounds Analyses for tPCB Hazard Indices –Floodplain Soil and
Sediment Exposure