

SENSITIVITY ANALYSIS OF THE EFFECT OF VARIOUS AGE-SPECIFIC EXPOSURE PARAMETERS AND AGE BINS ON CANCER RISK ESTIMATES AND PRELIMINARY REMEDIATION GOALS USING EPA’S NEW SUPPLEMENTAL GUIDANCE FOR EARLY LIFE EXPOSURE TO CARCINOGENS

INTRODUCTION

This memo presents a sensitivity analysis of cancer risk estimates and Preliminary Remediation Goals (PRGs), derived using EPA’s new Supplemental Guidance for Early Life Exposure to Carcinogens (Supplemental Guidance).

OBJECTIVE

The objective of this analysis is to quantify the effects of using different exposure parameters and age bins on the resulting cancer risk estimates and PRGs calculated for a chemical or compound that applies the default Age-Dependant Adjustment Factors (ADAFs).

BASIC METHOD

The basic method used in the sensitivity analysis is as follows:

- Calculate cancer risk to a resident (0-30 years) using the exposure parameters and age bins recommended by current Superfund Guidance and apply the default ADAFs recommended by the Supplemental Guidance (Default Superfund Approach or “Base Case” Approach).
- Calculate cancer risk to a resident (0-30 years) using alternate approach “X” (e.g., using alternate exposure parameters or alternate age bins) and apply the default ADAFs recommended by the Supplemental Guidance.
- Calculate the cancer risk for Approach “x”, relative to the Base Case Approach:

$$\text{Relative Risk Ratio} = \frac{\text{CancerRisk (Approach "X")}}{\text{CancerRisk (BaseCaseApproach)}}$$

- Calculate the resulting effect on the PRG:

$$\text{Relative PRG} = \frac{\text{PRG(Base Case)}}{\text{Relative Risk Ratio}}$$

Note: for this example a hypothetical PRG of 100 (mg/kg or mg/L) was used as the PRG for the Base Case Approach for all media.

RISK CALCULATION APPROACHES

There are 2 types of variables that can be changed in quantifying cancer risks using the new Supplemental Guidance:

- 1) Exposure Parameter Values. Values for the exposure parameters can be obtained from different sources, including: EPA's Exposure Factors Handbook (EFH), EPA's Child-Specific Exposure Factors Handbook (CSEFH), and OSWER directives with default exposure parameters for Superfund.
- 2) Age bins. The age interval or "bin" over which exposure is quantified can be varied. For example, the default age bins for a resident under current Superfund Guidance (0-6 years, 7-30 years), 1 year age bins, multiple year age bins, etc., may be selected.

Table 1 lists the exposure parameters and the age bins for a "Base Case" and for 5 alternative approaches. The exposure parameter values for each age bin for the "Base Case" and for each alternative case are provided in Attachment A.

RESULTS

Table 2 presents the resulting Relative Risk Ratios and Relative PRGs for each approach for the following 3 exposure pathways: (1) incidental ingestion of soil, (2) dermal exposure to soil, and (3) ingestion of groundwater.

Inspection of Table 2 yields the following:

- For the soil ingestion pathway, applying Exposure Factors Handbook and Child-Specific Exposure Factors Handbook exposure parameters and more refined (smaller) age bins results in cancer risk estimates using the new Supplemental Guidance that are as little as 1% up to a maximum of 60% higher than cancer risks calculated for a resident using the Base Case Approach. The Resulting PRGs are as little as 1% lower up to a maximum of 60% lower.
- For dermal exposure to soil, cancer risk estimates using alternate exposure parameters and age bins are as little as 16% to a maximum of 60% higher than cancer risks calculated for a resident by the Base Case Approach. The resulting PRGs are as little as 16% to as high as 60% lower.
- For the water ingestion pathway, cancer risk estimates range are 24% to 50% higher than cancer risks calculated for a resident using current Superfund Guidance. The resulting PRGs are 24% to 50% lower.

CONCLUSION

As seen, depending on the exposure pathway evaluated, the effects of varying the exposure parameters and age bins on cancer risk estimates and PRGs calculated using the new Supplemental Guidance range from being negligible (cancer risks that are 1%

higher, PRGs that are 1% lower) to significant (cancer risks that are 60% higher and PRGs that are 60% lower). Because the range in sensitivity of the exposure parameters and age bins are so variable, risk assessors should select the age-specific exposure assessment that makes the most sense for their site.

ATTACHMENT A
EXPOSURE PARAMETERS USED
IN THE RISK CALCULATION APPROACHES

- A-1 Superfund Default Exposure Parameters and Superfund Default/Supplemental Guidance “Hybrid” Age Bins
- A-2 Exposure Factors Handbook Age-Specific Exposure Parameters and 1 Year Age Bins, 30-Year Resident
- A-3 Child-Specific Exposure Factors Handbook, Age-Specific Exposure Parameters and 1 Year Age Bins, 30-Year Resident
- A-4 Exposure Factors Handbook Age-Specific Exposure Parameters Grouped by Supplemental Guidance Age Bins
- A-5 Child-Specific Exposure Factors Handbook, Grouped by Supplemental Guidance Age Bins
- A-6 Child-Specific Exposure Factors Handbook, Age Grouping Guidance Age Bins

TABLE 1. APPROACHES EVALUATED

APPROACH	EXPOSURE PARAMETERS	AGE BINS	
		number of bins	description of bins
a (BASE CASE)	Superfund Recommended Defaults (USEPA 1989; 1991; 1993)	4	Superfund Default/Supplemental Guidance "Hybrid" bins: 0 - <2 years 2 - <6 years 6 - <16 years 16 - <30 years
b	Exposure Factors Handbook (EFH) Recommendations (USEPA 1997).	30	1 year bins: 0-30 years
c	Child-Specific EFH Recommendations (USEPA 2002)	30	1 year bins: 0-30 years
d	Exposure Factors Handbook (EFH) Recommendations (USEPA 1997).	3	Supplemental Guidance Bins: 0 - <2 2 - <16 16 - 30
e	Child-Specific EFH Recommendations (USEPA 2002)	3	Supplemental Guidance Bins: 0 - <2 2 - <16 16 - 30
f	Child-Specific EFH values, as recommended by the Age Grouping Guidance (USEPA 2005b), Table A-1.	11	USEPA 2005b Bins: < 1month 1- < 3 months 3 - < 6 months 6 - < 12 months 1 - < 2 years 2 - < 3 years 3 - < 6 years 6 - < 11 years 11 - < 16 years 16 - < 21 years 21 - <30 years

USEPA 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03. March.

USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.

USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

USEPA 1997. Exposure Factors Handbook.

USEPA 2002. Child-Specific Exposure Factors Handbook.

USEPA 2004. Estimated Per Capita Water Ingestion and Body Weight in the United States- An Update. Office of Water. October.

USEPA 2005a. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. March.

USEPA 2005b. Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants. EPA/630/P-03/003F. November.

TABLE 2. RELATIVE RISK AND PRG CALCULATIONS

APPROACH	EXPOSURE PARAMETERS	AGE BINS FOR EXPOSURE PARAMETERS		RELATIVE RISK RATIO (Risk _{Approach x} /Risk _{Approach a})			RELATIVE PRGs (100/Relative Risk Ratio)		
		number of bins	description of age bins	Soil (Ingestion)	Soil (Dermal)	Water (Ingestion)	Soil (mg/kg) (Ingestion)	Soil (mg/kg) (Dermal)	Water (mg/L)
a [Base Case]	Superfund Default (see Table A-1)	4	Superfund Default/Supplemental Guidance "Hybrid" bins: 0 - <2 years 2 - <6 years 6 - <16 years 16 - <30 years	[1.0]	[1.0]	[1.0]	[100]	[100]	[100]
b	EFH (see Table A-2)	30	1 Year Bins 0-30 years	1.13	1.24	1.32	88	81	76
c	CSEFH (see Table A-3)	30	1 Year Bins 0-30 years	1.37	1.47	1.35	73	68	74
d	EFH across age bins (see Table A-4)	3	Supplemental Guidance Bins: 0 - <2 2 - <16 16 - 30	1.01	1.17	1.24	99	86	81
e	CSEFH across age bins (see Table A-5)	3	Supplemental Guidance Bins: 0 - <2 2 - <16 16 - 30	1.19	1.33	1.27	84	75	79
f	Age Grouping Guidance Recommendations (Table A-1) for Child EFH values (see Table A-6)	11	Age Grouping Guidance/Supplemental Guidance Bins: < 1 month 1 - < 3 months 3 - < 6 months 6 - < 12 months 1 - < 2 years 2 - < 3 years 3 - < 6 years 6 - < 11 years 11 - < 16 years 16 - < 21 years 21 - 30 years	1.56	1.63	1.47	64	61	68

ADAF = Age-Dependant Adjustment Factor
BW = Body Weight
CSEFH = Child-Specific Exposure Factors Handbook
EFH = Exposure Factors Handbook

TABLE A-1. SUPERFUND DEFAULT EXPOSURE PARAMETERS
AND SUPERFUND DEFAULT/SUPPLEMENTAL GUIDANCE "HYBRID" AGE BINS^[1]
RME Resident

RECEPTOR	AGE (years)	BW (kg)	EF (days/year)	ED (years)	WATER	SOIL	DERMAL - SOIL			
					IR (L/day)	IR (mg/day)	AF (mg/cm2-event)	SA (cm2)	EV (event/day)	ABSd [2] (unitless)
Resident	0 - <2	15	350	2	1	200	0.2	2800	1	0.13
	2 - <6	15	350	4	1	200	0.2	2800	1	0.13
	6 - <16	70	350	10	2	100	0.07	5700	1	0.13
	16 - <30	70	350	14	2	100	0.07	5700	1	0.13

USEPA 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03. March.

USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure. Draft.

USEPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal

[1] Because the age bins for the Superfund Default Exposure Parameters for a resident (0-6 and 7-30 years) do not match up with the ADAF age bins in the Supplemental Guidance (0-<2; 2-<6, 6-<16, 16-<30 years), a 'hybrid' age bin approach was used that splits the 2 exposure parameter age bins into the 4 Supplemental Guidance ADAF age bins.

[2] Chemical Specific. Value is for benzo[a]pyrene

TABLE A-2. EXPOSURE FACTORS HANDBOOK EXPOSURE PARAMETERS AND 1 YEAR AGE BINS

30 year Resident

AGE (year)	ADAF [1] (unitless)	BW [2] (kg)	EF [3] (days/year)	ED (years)	WATER	SOIL - Residential	DERMAL - SOIL			
					IR [4] (L/day)	IR [5] (mg/day)	AF [6] (mg/cm ² -event)	SA [7] (cm ²)	EV [8] (event/day)	ABSd [9] (unitless)
0	10	11.3	350	1	0.76	200	0.2	2,625	1	0.13
1	10	13.3	350	1	1.5	200	0.2	2,571	1	0.13
2	3	15.3	350	1	1.5	200	0.2	2,434	1	0.13
3	3	17.4	350	1	1.5	200	0.2	2,893	1	0.13
4	3	19.7	350	1	1.5	200	0.2	3,175	1	0.13
5	3	22.6	350	1	1.5	200	0.2	3,255	1	0.13
6	3	24.9	350	1	1.5	100	0.2	2,949	1	0.13
7	3	28.1	350	1	1.5	100	0.2	3,182	1	0.13
8	3	31.5	350	1	1.5	100	0.2	3,434	1	0.13
9	3	36.3	350	1	1.5	100	0.2	3,657	1	0.13
10	3	41.1	350	1	1.5	100	0.2	3,819	1	0.13
11	3	45.3	350	1	2	100	0.2	4,111	1	0.13
12	3	50.4	350	1	2	100	0.2	4,453	1	0.13
13	3	56	350	1	2	100	0.07	4,916	1	0.13
14	3	58.1	350	1	2	100	0.07	5,205	1	0.13
15	3	62.6	350	1	2	100	0.07	5,386	1	0.13
16	1	63.2	350	1	2	100	0.07	5,534	1	0.13
17	1	65.1	350	1	2	100	0.07	5,641	1	0.13
18	1	66	350	1	2	100	0.07	5,700	1	0.13
19	1	67.2	350	1	2	100	0.07	5,700	1	0.13
20	1	67.2	350	1	2	100	0.07	5,700	1	0.13
21	1	67.2	350	1	2	100	0.07	5,700	1	0.13
22	1	67.2	350	1	2	100	0.07	5,700	1	0.13
23	1	67.2	350	1	2	100	0.07	5,700	1	0.13
24	1	71.5	350	1	2	100	0.07	5,700	1	0.13
25	1	71.5	350	1	2	100	0.07	5,700	1	0.13
26	1	71.5	350	1	2	100	0.07	5,700	1	0.13
27	1	71.5	350	1	2	100	0.07	5,700	1	0.13
28	1	71.5	350	1	2	100	0.07	5,700	1	0.13
29	1	71.5	350	1	2	100	0.07	5,700	1	0.13

ADAF = Age dependant adjustment factor.

AF = Adherence Factor

BW = Body Weight

ED = Exposure Duration

EF = Exposure Frequency

EV = Event Frequency

IR = Intake Rate

SA = Surface Area of Exposed Skin

Sources:

[1] EPA 2005. Supplemental Guidance for Early-Life Exposure to Carcinogens

[2] EPA 1997. Exposure Factors Handbook. Tables 7-2 (adults) and 7-3 (children), mean. Values are mean of male and female. Source: National Center of Health Statistics (NCHS) 1987.

[3] EPA 1991. Standard Default Exposure Factors. Default for resident.

[4] EPA 1997. Exposure Factors Handbook. Table 3-30 - Summary of Recommended Drinking Water Intake Rates. 95th Percentile.

[5] EPA 1991. Standard Default Exposure Factors. Default for resident child and adult.

[6] EPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).

adherence factor for children playing in wet soil of was used for children 6 - 12, as a central tendency estimate of a high end soil contact activity (see Exhibit 3-3).

[7] EPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).

Calculated from Exhibit C-1 - Body Part-Specific Surface Area Calculations (Children). Data from EPA 1997, Tables 6-6, 6-7 and 6-8.

Surface area of head, forearms, hands, lower legs and feet (for child <6 years); feet excluded from surface area calculation for >6 years.

Surface area for >18 is recommended default for adult resident (EPA 2004).

[8] EPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).

Recommended default for RME resident for soil contact.

[9] Chemical specific. Value shown is USEPA 2004 recommended value for benzo[a]pyrene.

Note: ages are not inclusive. For example 0 -30 years includes exposure from birth up until the 30th birthday (total duration = 30 years); exposure from 3-6 years includes exposure during years 3, 4, 5 up until the 6th birthday (total duration 3 years).

TABLE A-3. CHILD-SPECIFIC EXPOSURE FACTORS HANDBOOK EXPOSURE PARAMETERS
AND 1 YEAR AGE BINS

30 year Resident

AGE (year)	ADAF [1] (unitless)	BW [2, 3] (kg)	EF [4] (days/year)	ED (years)	WATER	SOIL - Residential	DERMAL - SOIL			
					IR [5] (L/day)	IR [6, 4] (mg/day)	AF [7] (mg/cm2-event)	SA [8] (cm2)	EV (event/day)	ABSd [9] (unitless)
0	10	8.4	350	1	1.055	200	0.2	2,625	1	0.13
1	10	11.4	350	1	0.972	200	0.2	2,571	1	0.13
2	3	12.9	350	1	0.924	200	0.2	2,434	1	0.13
3	3	15.1	350	1	0.924	200	0.2	2,893	1	0.13
4	3	17.1	350	1	1.15	200	0.2	3,175	1	0.13
5	3	19.4	350	1	1.15	200	0.2	3,255	1	0.13
6	3	21.7	350	1	1.15	100	0.2	2,949	1	0.13
7	3	25.5	350	1	1.202	100	0.2	3,182	1	0.13
8	3	28.1	350	1	1.202	100	0.2	3,434	1	0.13
9	3	32.7	350	1	1.202	100	0.2	3,657	1	0.13
10	3	35.6	350	1	1.202	100	0.2	3,819	1	0.13
11	3	41.5	350	1	1.717	100	0.2	4,111	1	0.13
12	3	46.9	350	1	1.717	100	0.2	4,453	1	0.13
13	3	55.1	350	1	1.717	100	0.07	4,916	1	0.13
14	3	61.1	350	1	1.717	100	0.07	5,205	1	0.13
15	3	62.8	350	1	2.063	100	0.07	5,386	1	0.13
16	1	65.8	350	1	2.063	100	0.07	5,534	1	0.13
17	1	65.1	350	1	2.063	100	0.07	5,641	1	0.13
18	1	66	350	1	2.063	100	0.07	5,700	1	0.13
19	1	67.2	350	1	2.063	100	0.07	5,700	1	0.13
20	1	67.2	350	1	3.041	100	0.07	5,700	1	0.13
21	1	67.2	350	1	3.041	100	0.07	5,700	1	0.13
22	1	67.2	350	1	3.041	100	0.07	5,700	1	0.13
23	1	67.2	350	1	3.041	100	0.07	5,700	1	0.13
24	1	71.5	350	1	3.041	100	0.07	5,700	1	0.13
25	1	71.5	350	1	2.863	100	0.07	5,700	1	0.13
26	1	71.5	350	1	2.863	100	0.07	5,700	1	0.13
27	1	71.5	350	1	2.863	100	0.07	5,700	1	0.13
28	1	71.5	350	1	2.863	100	0.07	5,700	1	0.13
29	1	71.5	350	1	2.863	100	0.07	5,700	1	0.13

ADAF = Age dependant adjustment factor.

AF = Adherence Factor

BW = Body Weight

ED = Exposure Duration

EF = Exposure Frequency

EV = Event Frequency

IR = Intake Rate

SA = Surface Area of Exposed Skin

Sources:

[1] EPA 2005. Supplemental Guidance for Early-Life Exposure to Carcinogens

[2] EPA 2002. Children's Exposure Factors Handbook. Table 11-6. Male and female, mean (1-17 years). Source: USEPA 2000. Body Weight Estimates of NHANES III data.

[3] EPA 1997. Exposure Factors Handbook. Tables 7-2 (adults) - ages 18 - 70 and 7-3 (children) - ages 17-18, mean. Values are mean of male and female. Source: National Center of Health Statistics (NCHS) 1987.

[4] EPA 1991. Standard Default Exposure Factors. Default for resident.

[5] EPA 2004. Estimated Per Capita Water Ingestion and Body Weight in the United States - An Update. Table 5.1.A1. - Estimated Direct and Indirect Community Water Ingestion by Gender and Fine Age Categories. Part c. Both sexes, 95th Percentile.

[6] EPA 2002. Child-Specific Exposure Factors Handbook. Table 5-19, conservative estimate of the mean.

[7] EPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).

Recommended default adherence factor for a child resident (0.2) and adult resident (0.07). For older children, the geometric mean weighted

[8] EPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).

Calculated from Exhibit C-1 - Body Part-Specific Surface Area Calculations (Children). Data from Exposure Factors Handbook, Tables 6-6, 6-7 and 6-8.

Surface area of head, forearms, hands, lower legs and feet (for child <6 years); feet excluded from surface area calculation for >6 years.

Surface area for >18 is recommended default for adult resident (EPA 2004).

[9] Chemical specific. Value shown is USEPA 2004 recommended value for benzo[a]pyrene.

Note: ages are not inclusive. For example 0 -30 years includes exposure from birth up until the 30th birthday (total duration = 30 years); exposure from 3-6 years includes exposure during years 3, 4, 5 up until the 6th birthday (total duration 3 years).

TABLE A-4. EXPOSURE FACTORS HANDBOOK
AGE-SPECIFIC EXPOSURE PARAMETERS
GROUPED BY SUPPLEMENTAL GUIDANCE AGE BINS

RECEPTOR	AGE (year)	BW (kg)	EF (days/year)	ED (years)	WATER	SOIL	AIR	DERMAL - SOIL			
					IR (L/day)	IR (mg/day)	IR (m3/day)	AF (mg/cm2-event)	SA (cm2)	EV (event/day)	ABSd [1] (unitless)
Resident	0-<2	12.3	350	2	1.13	200	6.8	0.2	2,598	1	0.13
	2-<16	36.4	350	14	1.7	129	11.8	0.17	3,893	1	0.13
	16-<30	68.5	350	14	2	100	13.4	0.07	5,684	1	0.13

Note: Values calculated by averaging exposure parameters in Table 3 (EFH) across age intervals.

[1] Chemical Specific. Value is for benzo[a]pyrene

TABLE A-5. CHILD-SPECIFIC EXPOSURE FACTORS HANDBOOK
AGE-SPECIFIC EXPOSURE PARAMETERS
GROUPED BY SUPPLEMENTAL GUIDANCE AGE BINS

RECEPTOR	AGE (year)	BW (kg)	EF (days/year)	ED (years)	WATER	SOIL	AIR	DERMAL - SOIL			
					IR (L/day)	IR (mg/day)	IR (m3/day)	AF (mg/cm2-event)	SA (cm2)	EV (event/day)	ABSd [1] (unitless)
Resident	0-<2	9.9	350	2	1.0	200	5.65	0.2	2,598	1	0.13
	2-<16	34.0	350	14	1.4	129	11.2	0.17	3776.2	1	0.13
	16-<30	68.7	350	14	2.7	100	13.5	0.07	5683.9	1	0.13

Note: Values calculated by averaging exposure parameters in Table 4 (Child-Specific EFH) across age intervals.

[1] Chemical Specific. Value is for benzo[a]pyrene

TABLE A-6. CHILD-SPECIFIC EXPOSURE FACTORS HANDBOOK
AGE-SPECIFIC EXPOSURE PARAMETERS
BY AGE GROUPING GUIDANCE AGE BINS

RECEPTOR	AGE [8]	BW [1] (kg)	EF [2] (days/year)	ED (years)	WATER	SOIL	DERMAL - SOIL			
					IR [3] (L/day)	IR [2, 4] (mg/day)	AF [5] (mg/cm2-event)	SA [6] (cm2)	EV (event/day)	ABSd [7] (unitless)
Resident	0 - < 1 month	3.3	350	0.08	1.0	200	0.2	2,625	1	0.13
	1 - < 3 month	4.1	350	0.17	1.0	200	0.2	2,625	1	0.13
	3 - < 6 month	5.7	350	0.25	1.0	200	0.2	2,625	1	0.13
	6 - < 12 month	9.2	350	0.5	1.1	200	0.2	2,625	1	0.13
	1 - < 2 years	11.2	350	1	0.9	200	0.2	2,571	1	0.13
	2 - < 3 years	13.1	350	1	0.9	200	0.2	2,434	1	0.13
	3 - < 6 years	17.1	350	3	1.1	200	0.2	3,107	1	0.13
	6 - < 11 years	27.6	350	5	1.2	100	0.2	3,408	1	0.13
	11 - < 16 years	48.6	350	5	1.8	100	0.1	4,814	1	0.13
	16 - < 21 years	63.2	350	5	2.3	100	0.07	5,655	1	0.13
	21 - < 30 years	70	350	9	2.9	100	0.07	5,700	1	0.13

[1] Ages 0 -19: EPA 2002. Child-Specific Exposure Factors Handbook. Tables 11-1 and 11-2, as recommended by EPA 2005. 50th percentile, mean of male and female. Ages 20-<30: EPA 1997. Exposure Factors Handbook, Table 7-2; mean of male and female.

[2] EPA 1991. Standard Default Exposure Factors. OSWER Directive 9285.6-03. Default for resident

[3] EPA 2004. Estimated Per Capita Water Ingestion and Body Weight in the United States - An Update. Table 5.1.A1. - Estimated Direct and Indirect Community Water Ingestion by Gender and Fine Age Categories. Part c. Both sexes, 95th Percentile.

[4] EPA 2002. Child-Specific Exposure Factors Handbook. Table 5-19, conservative estimate of the mean.

[5] EPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).

Recommended default adherence factor for a child resident (0.2) and adult resident (0.07). For older children, the geometric mean weighted

[6] EPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).

Calculated from Exhibit C-1 - Body Part-Specific Surface Area Calculations (Children). Data from Exposure Factors Handbook, Tables 6-6, 6-7 and 6-8.

Surface area of head, forearms, hands, lower legs and feet (for child <6 years); feet excluded from surface area calculation for >6 years.

Surface area for >18 is recommended default for adult resident (EPA 2004).

[7] Chemical Specific. Value is for benzo[a]pyrene

[8] As recommended by EPA 2005 Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants.