5 QUANTIFYING MEDIA CONCENTRATIONS AND EXPOSURES

5.1 QUANTIFYING MEDIA CONCENTRATIONS

This section describes how the media concentrations were quantified before they were used in the exposure pathway calculations. For this MPHRA, COPC concentrations were determined for the following media:

- air
- soil
- surface water
- above-ground (exposed and protected) fruits and vegetables
- below-ground vegetables and protected fruits
- beef
- pork
- dairy milk
- breast milk
- poultry and eggs
- fish

The COPC concentrations in the various media are needed to supply inputs to the exposure calculations for the identified human receptors. Appendix D describes in detail the methods used to quantify media concentrations for exposure pathways assessed in this MPHRA. Figure 5-1 shows the relationships between the different media concentrations (e.g., the concentration in fish tissue depends on the concentration in surface water, which depends on the soil concentration). Figure 5-1 also identifies the section in Appendix D that presents the detailed calculation methods for each media. Sections E.1 through E.7 in Appendix E present an example step-by-step calculation of media concentrations for a single COPC, vinyl chloride. (Sections E.8 and E.9 continue the example through the exposure calculations.)

The total exposure periods used in this MPHRA are as follows:

- 1 year for an infant
- 5 years for a child
- 25 to 40 years for the adult populations (25 years for the adult worker, 30 years for the adult resident and subsistence fisher, and 40 years for the adult subsistence farmer)

Ambient air concentrations and wet and dry deposition rates resulting from PCAPP and EDS sources will occur only during the 5-year operational period of the PCAPP or EDS; therefore, the direct exposure to COPCs through inhalation will only occur during their respective 5-year operating periods. The remaining exposure to COPCs will occur through indirect pathways, such as food consumption, where residual COPC concentrations may exist in the media over the entire exposure period. The infant and child are assumed to be directly and indirectly exposed to COPCs during the 5-year PCAPP and EDS operational periods, and the adult populations are assumed to be exposed directly to COPCs during the 5-year operational periods and indirectly for the entire population-specific exposure duration (25, 30, or 40 years). In real situations, COPCs deposited onto the soil and taken up by plants or animals will slowly be depleted once emissions cease. However, except for soil concentrations, the media concentration equations used in the indirect pathway analysis conservatively assume that the concentrations and deposition rates occurring during the operating period will continue to occur over the entire 25-, 30-, or 40-year exposure period (i.e., the air pollutants are emitted for a

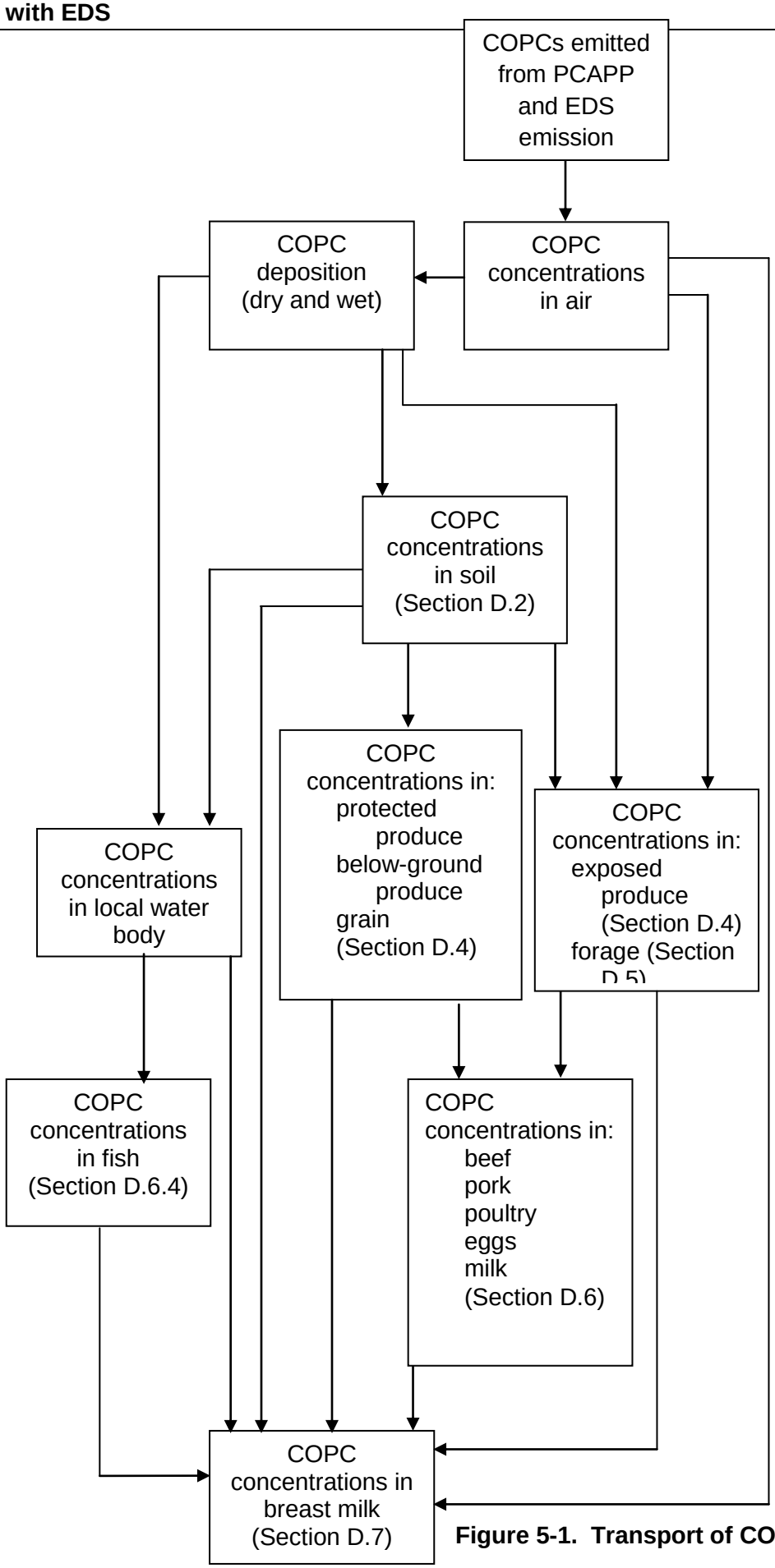

Figure 5-1. Transport of COPCs to evaluated media.

total of 25, 30, or 40 years). The resulting media concentrations used to estimate the indirect exposure to the adult populations are therefore overestimated.

Specific input parameters applicable to the site and appropriate COPCs and pathways were developed and entered into the exposure model. (USEPA [1994a and 2005a] has defined lists of COPCs that are associated with specific pathways.) The following subsections generally discuss the methods detailed in Appendix D, and illustrated in Appendix E, as well as the different types of parameter values used to quantify the COPC media concentrations. Table 5-1 identifies the types of parameters needed for performing these calculations and the location within this report where the detailed parameter values can be found.

Table 5-1. Types of Parameters Needed to Quantify Media Concentrations and Exposures

Parameter Type	Example of Parameter	Parameter Values
Environmental concentrations (modeled values)	Air concentration Deposition rates	Unit response output from AERMOD, see Tables 5-2, 5-3, and 5-4
Site-specific values	Precipitation amount Water body surface area Watershed area	See Appendix F.2 and Table F-3
Chemical-specific values	Emission rates Transport properties Biotransfer factors Toxicity data	See Tables 2-2 and 2-3; Appendix F.4; Tables F-7 through F-10; and Tables 6-1 and 6-2
Exposure scenario-specific values	Food consumption rate Exposure duration Soil ingestion rate	See Appendix F.3 and Tables 4-1, 4-2, and 4-3
Default values	USEPA recommended inputs when specific data are lacking	See Appendix F.1 and Table F-2

5.1.1 COPC Concentrations in Air

Maximum COPC air concentrations are obtained from the AERMOD unit response outputs discussed in Section 3. Maximum annual and 1-hour unit responses at any receptor were used to calculate COPC concentrations for use in the chronic and acute risk assessments, respectively. (Air [i.e., inhalation] is the only medium that enters into the acute risk assessment.) The COPC concentrations for the chronic assessment were calculated as the maximum annual average concentration at any model receptor (i.e., the average of the 6 individual years of annual average concentrations at the maximum impact receptor location [RME individual location]). The COPC concentrations for the acute assessment were calculated as the highest 1-hour average concentration from the entire 6-year meteorological data set. Table 5-2 presents the annual average and 1-hour COPC-specific air concentrations used in the chronic and acute risk assessments. The annual water body air concentration in Table 5-2 is the maximum air concentration over the water body for which exposure calculations were performed. Concentrations in the surface water body are discussed further in subsection 5.1.3.

Table 5-2. Maximum Annual Average and 1-hour Chemical-specific Air Concentrations[a]

COPC	Maximum Annual Off-site Air Concentration		Maximum Annual Off-site Water Body Air Concentration		Maximum 1-hour Air Concentrations	
	Vapor Phase ($\mu g/m^3$)	Particle Phase ($\mu g/m^3$)	Particle Phase ($\mu g/m^3$)	Particle Phase ($\mu g/m^3$)	On-Site ($\mu g/m^3$)	Off-Site (Fenceline) ($\mu g/m^3$)
1,1,2,2-tetrachloroethane	5.04E-05	4.99E-05	1.67E-05	1.64E-05	1.62E-01	5.79E-02
1,1-dichloroethane	6.96E-06	6.88E-06	2.33E-06	2.29E-06	2.70E-02	8.07E-03
1,1-dichloroethene	1.27E-11	1.25E-11	4.13E-12	3.99E-12	4.79E-05	2.26E-06
1,2,3-trichlorobenzene	4.73E-08	4.67E-08	1.57E-08	1.54E-08	1.50E-04	5.41E-05
1,2,4-trichlorobenzene	2.21E-14	2.17E-14	7.17E-15	6.91E-15	8.32E-08	3.93E-09
1,2,4-trimethyl benzene	6.61E-07	6.52E-07	1.76E-07	1.70E-07	6.20E-04	1.01E-04
1,2-dichlorobenzene	4.25E-14	4.18E-14	1.38E-14	1.33E-14	1.60E-07	7.58E-09
1,2-dichlorobutane	2.03E-04	2.01E-04	6.73E-05	6.62E-05	6.63E-01	2.33E-01
1,2-dichloroethane	5.92E-03	5.86E-03	2.00E-03	1.96E-03	1.79E+01	6.01E+00
1,2-dichloropropane	1.25E-07	1.24E-07	4.16E-08	4.09E-08	4.26E-04	1.45E-04
1,3-dichlorobenzene	3.80E-14	3.73E-14	1.23E-14	1.19E-14	1.43E-07	6.76E-09
1,4-dichlorobenzene	4.23E-14	4.16E-14	1.38E-14	1.33E-14	1.60E-07	7.54E-09
1,4-dithiane	2.43E-03	2.40E-03	8.05E-04	7.91E-04	7.86E+00	2.79E+00
1,4-oxathiane	2.62E-03	2.59E-03	8.69E-04	8.54E-04	8.60E+00	3.01E+00
1-chlorobutane	8.10E-09	8.01E-09	2.69E-09	2.64E-09	2.88E-05	9.42E-06
1-hexene	2.80E-06	2.77E-06	9.30E-07	9.14E-07	1.08E-02	3.31E-03
2,4-dichlorophenol	7.86E-15	7.72E-15	2.55E-15	2.46E-15	2.96E-08	1.40E-09
2-butanone	2.66E-05	2.63E-05	8.89E-06	8.73E-06	9.26E-02	3.04E-02
2-chlorobutane	3.40E-05	3.36E-05	1.13E-05	1.11E-05	1.27E-01	3.99E-02
2-chloroethoxyethane	3.78E-04	3.74E-04	1.25E-04	1.23E-04	1.20E+00	4.33E-01
2-ethyl 1,3-butadiene	5.90E-07	5.83E-07	1.97E-07	1.93E-07	2.09E-03	6.76E-04
2-hexanone	6.46E-06	6.38E-06	2.02E-06	1.96E-06	1.25E-02	4.53E-03
2-methyl phenol	2.01E-13	1.97E-13	6.53E-14	6.29E-14	6.36E-07	3.00E-08
2-methylnaphthalene	1.33E-13	1.30E-13	4.31E-14	4.15E-14	4.23E-07	2.00E-08
3-methyl phenol	6.95E-08	6.87E-08	2.30E-08	2.27E-08	2.21E-04	7.96E-05
4-methyl phenol	6.95E-08	6.87E-08	2.30E-08	2.27E-08	2.21E-04	7.96E-05
4-methyl-2-pentanone	4.18E-06	4.14E-06	1.39E-06	1.36E-06	1.37E-02	4.81E-03
acenaphthylene	3.49E-14	3.42E-14	1.13E-14	1.09E-14	1.29E-07	6.11E-09
acetone	1.24E-04	1.22E-04	4.20E-05	4.12E-05	4.54E-01	1.38E-01
acetylene	8.91E-07	8.75E-07	2.90E-07	2.79E-07	5.74E+00	2.71E-01
acrolein	2.06E-06	2.03E-06	5.50E-07	5.29E-07	1.93E-03	3.16E-04
alpha-methylstyrene	7.93E-07	7.82E-07	2.12E-07	2.04E-07	7.44E-04	1.22E-04
benzene	1.35E-06	1.33E-06	4.47E-07	4.40E-07	4.84E-03	1.61E-03
bis(2-chloroisopropyl) ether	4.54E-14	4.46E-14	1.48E-14	1.42E-14	1.71E-07	8.09E-09
carbon disulfide	7.68E-06	7.57E-06	2.05E-06	1.97E-06	8.60E-02	4.88E-03

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Table 5-2. Maximum Annual Average and 1-hour Chemical-specific Air Concentrations[a] (continued)

COPC	Maximum Annual Off-site Air Concentration		Maximum Annual Off-site Water Body Air Concentration		Maximum 1-hour Air Concentrations	
	Vapor Phase ($\mu g/m^3$)	Particle Phase ($\mu g/m^3$)	Particle Phase ($\mu g/m^3$)	Particle Phase ($\mu g/m^3$)	On-Site ($\mu g/m^3$)	Off-Site (Fenceline) ($\mu g/m^3$)
chlorobenzene	7.02E-13	6.89E-13	2.28E-13	2.20E-13	2.64E-06	1.25E-07
chloroethane	2.27E-05	2.24E-05	6.07E-06	5.84E-06	2.13E-02	3.49E-03
chloroform	3.69E-06	3.65E-06	1.24E-06	1.21E-06	1.20E-02	3.70E-03
chloromethane	5.85E-06	5.79E-06	1.93E-06	1.89E-06	6.07E-02	9.70E-03
chloromethoxyethane	2.15E-03	2.12E-03	7.12E-04	7.00E-04	6.82E+00	2.46E+00
cis-1,2-dichloroethene	4.12E-11	4.05E-11	1.34E-11	1.29E-11	1.55E-04	7.31E-06
dichlorodifluoromethane	2.40E-10	2.36E-10	7.80E-11	7.52E-11	9.05E-04	4.27E-05
diethyl ether	4.10E-06	4.06E-06	1.36E-06	1.34E-06	2.00E-02	5.08E-03
ethane	7.08E-05	7.00E-05	2.28E-05	2.23E-05	2.07E+00	3.24E-01
ethanol	4.60E-08	4.52E-08	1.49E-08	1.44E-08	2.76E-01	1.30E-02
ethylbenzene	9.52E-06	9.38E-06	2.54E-06	2.44E-06	8.93E-03	1.46E-03
HD	6.26E-06	6.17E-06	1.68E-06	1.62E-06	1.30E-02	1.31E-03
hexane	1.43E-06	1.41E-06	3.81E-07	3.67E-07	1.34E-03	2.19E-04
methane	2.22E-05	2.18E-05	7.22E-06	6.96E-06	1.15E+02	5.42E+00
methyl tert-butyl ether	5.29E-06	5.21E-06	1.41E-06	1.36E-06	4.96E-03	8.11E-04
methylene chloride	2.29E-05	2.27E-05	7.69E-06	7.55E-06	1.02E-01	2.71E-02
monoethanolamine	3.05E-06	3.00E-06	9.91E-07	9.55E-07	1.13E+01	5.33E-01
naphthalene	6.34E-08	6.27E-08	2.10E-08	2.07E-08	2.02E-04	7.27E-05
nitrobenzene	8.28E-15	8.13E-15	2.69E-15	2.59E-15	3.12E-08	1.47E-09
octane	3.17E-06	3.13E-06	8.47E-07	8.15E-07	2.98E-03	4.86E-04
pentane	3.44E-06	3.39E-06	9.17E-07	8.82E-07	3.22E-03	5.27E-04
phenanthrene	1.23E-14	1.20E-14	3.99E-15	3.84E-15	3.92E-08	1.85E-09
phenol	4.17E-13	4.10E-13	1.36E-13	1.31E-13	1.33E-06	6.27E-08
propene	4.23E-06	4.17E-06	1.13E-06	1.09E-06	3.97E-03	6.48E-04
styrene	6.61E-12	6.50E-12	2.15E-12	2.07E-12	2.48E-05	1.17E-06
tert-butyl alcohol	2.62E-06	2.58E-06	6.99E-07	6.72E-07	2.45E-03	4.01E-04
tetrachloroethene	5.06E-05	5.01E-05	1.70E-05	1.67E-05	1.59E-01	5.60E-02
thiirane	5.31E-06	5.26E-06	1.77E-06	1.74E-06	2.15E-02	6.32E-03
thiodiglycol	1.54E-05	1.52E-05	5.28E-06	5.18E-06	6.79E-01	1.04E-01
toluene	1.26E-05	1.24E-05	3.36E-06	3.23E-06	7.15E-02	4.79E-03
trans-1,2-dichloroethene	1.76E-11	1.73E-11	5.72E-12	5.52E-12	6.62E-05	3.13E-06
trichloroethene	1.95E-05	1.92E-05	6.62E-06	6.49E-06	6.13E-02	2.07E-02
vinyl chloride	1.52E-03	1.50E-03	4.23E-04	4.08E-04	2.64E+00	5.19E-01
xylenes	2.81E-05	2.77E-05	7.49E-06	7.21E-06	2.63E-02	4.33E-03
aluminum	1.27E-07	1.24E-07	4.11E-08	3.97E-08	7.53E-01	3.56E-02
ammonia	2.38E-02	2.36E-02	8.29E-03	8.13E-03	5.50E+01	1.17E+01

Table 5-2. Maximum Annual Average and 1-hour Chemical-specific Air Concentrations[a] (continued)

COPC	Maximum Annual Off-site Air Concentration		Maximum Annual Off-site Water Body Air Concentration		Maximum 1-hour Air Concentrations	
	Vapor Phase ($\mu g/m^3$)	Particle Phase ($\mu g/m^3$)	Particle Phase ($\mu g/m^3$)	Particle Phase ($\mu g/m^3$)	On-Site ($\mu g/m^3$)	Off-Site (Fenceline) ($\mu g/m^3$)
arsenic	2.91E-09	2.85E-09	9.44E-10	9.11E-10	1.52E-02	7.20E-04
cadmium	1.46E-09	1.43E-09	4.73E-10	4.56E-10	8.74E-03	4.13E-04
chlorine	7.92E-04	7.81E-04	2.11E-04	2.03E-04	7.43E-01	1.21E-01
copper	3.07E-08	3.02E-08	9.98E-09	9.62E-09	1.93E-01	9.12E-03
hydrogen chloride	9.24E-04	9.11E-04	2.47E-04	2.37E-04	8.66E-01	1.42E-01
hydrogen cyanide	2.13E-07	2.09E-07	6.91E-08	6.67E-08	1.37E+00	6.48E-02
lead	1.12E-08	1.10E-08	3.62E-09	3.50E-09	6.56E-02	3.10E-03
silver	6.60E-11	6.48E-11	2.14E-11	2.07E-11	3.95E-04	1.87E-05

a. The 79 COPCs whose emissions could be quantified are listed in this table.

5.1.2 COPC Concentrations in Soil

Annual average COPC concentrations in soil were obtained from the AERMOD wet and dry deposition unit response outputs discussed in Section 3 at the receptor locations of maximum wet and dry deposition rates. Individual COPC soil concentrations were determined separately for carcinogenic and noncarcinogenic effects for each exposure scenario duration. COPC concentrations in soil resulting from wet and dry deposition onto the soil are impacted by subsequent soil loss processes, including leaching, erosion, runoff, degradation, and volatilization. The maximum annual COPC deposition rates were calculated as the highest total deposition rate at a specific receptor for each COPC occurring over the 6 years of meteorological data (i.e., the annual results from each receptor for each of the 6 years of meteorological data are summed and then divided by the number of years processed). Table 5-3 presents the annual COPC-specific dry and wet deposition rates used in the chronic risk assessment. Soil concentration does not enter into the acute risk assessment.

Chemical concentrations in soil were used to calculate uptake of contaminants by direct soil ingestion and through dermal contact, and also to estimate chemical concentrations in fruits and vegetables, animal feed, beef, dairy milk, pork, fish, breast milk, and poultry meat and eggs.

5.1.3 COPC Concentrations in Surface Water

COPCs from PCAPP and EDS emission sources may be introduced into local surface water bodies through the following mechanisms:

- diffusive transfer from air into the water body
- deposition directly into the water bodies
- runoff from impervious surfaces
- runoff from pervious surfaces
- erosion of COPC-containing soils

The equations used in this MPHRA to quantify the COPC concentrations in surface water calculate the loading into water bodies through the mechanisms discussed above and the partitioning between the sediment and aqueous phase of the water column. Additionally, these equations calculate the losses of COPCs in the water bodies from water column volatilization and burial in sediment.

Two different sets of AERMOD receptors were used to quantify COPC concentrations in surface water. The first set includes receptors located over local water bodies. These receptors were used to determine the location of maximum air concentrations and deposition rates at the surface of the water bodies. The second set of AERMOD receptor locations is the same as was discussed in Section 5.1.1 (RME individual location) and was used to estimate the loading from impervious surface runoff, pervious surface runoff, and erosion. The use of these two AERMOD receptors constitutes a maximum annual water body loading. Table 5-2 presents the annual COPC-specific air concentrations for the RME individual location. Tables 5-3 and 5-4 present the annual COPC-specific deposition rates for the RME location and maximum water body receptor locations, respectively. The annual COPC concentrations in the water body associated with these receptors were then used in the calculations for several exposure pathways, including consumption of locally caught fish, ingestion of human breast milk, incidental surface water ingestion during swimming, and dermal exposure during swimming.

Table 5-3. Chemical-specific Annual Deposition Rates at the RME Location[a,b]

COPC	Vapor Phase Deposition Rates		Particle Phase Deposition Rates	
	Dry Deposition (g/m^2-yr)	Wet Deposition (g/m^2-yr)	Dry Deposition (g/m^2-yr)	Wet Deposition (g/m^2-yr)[c]
1,1,2,2-tetrachloroethane	7.21E-06	1.55E-07	2.36E-06	0
1,1-dichloroethane	1.06E-06	2.35E-08	3.66E-07	0
1,1-dichloroethene	2.24E-12	3.04E-14	9.24E-13	0
1,2,3-trichlorobenzene	6.75E-09	1.45E-10	2.21E-09	0
1,2,4-trichlorobenzene	3.89E-15	5.27E-17	1.60E-15	0
1,2,4-trimethyl benzene	1.93E-07	6.30E-09	1.01E-07	0
1,2-dichlorobenzene	7.51E-15	1.02E-16	3.09E-15	0
1,2-dichlorobutane	2.90E-05	6.24E-07	9.48E-06	0
1,2-dichloroethane	1.07E-03	2.57E-05	4.26E-04	0
1,2-dichloropropane	1.79E-08	3.86E-10	5.87E-09	0
1,3-dichlorobenzene	6.70E-15	9.07E-17	2.76E-15	0
1,4-dichlorobenzene	7.47E-15	1.01E-16	3.07E-15	0
1,4-dithiane	3.47E-04	7.46E-06	1.13E-04	0
1,4-oxathiane	3.74E-04	8.06E-06	1.22E-04	0
1-chlorobutane	1.17E-09	2.52E-11	3.84E-10	0
1-hexene	4.01E-07	8.63E-09	1.31E-07	0
2,4-dichlorophenol	1.39E-15	1.88E-17	5.71E-16	0
2-butanone	4.00E-06	8.84E-08	1.37E-06	0
2-chlorobutane	4.86E-06	1.05E-07	1.59E-06	0
2-chloroethoxyethane	5.40E-05	1.16E-06	1.76E-05	0
2-ethyl 1,3-butadiene	8.87E-08	1.96E-09	3.05E-08	0
2-hexanone	1.41E-06	3.82E-08	6.49E-07	0
2-methyl phenol	3.54E-14	4.80E-16	1.46E-14	0
2-methylnaphthalene	2.34E-14	3.17E-16	9.63E-15	0
3-methyl phenol	9.93E-09	2.13E-10	3.25E-09	0
4-methyl phenol	9.93E-09	2.13E-10	3.25E-09	0
4-methyl-2-pentanone	5.97E-07	1.28E-08	1.95E-07	0
acenaphthylene	6.15E-15	8.33E-17	2.53E-15	0
acetone	2.14E-05	5.06E-07	8.25E-06	0
acetylene	1.57E-07	2.13E-09	6.47E-08	0
acrolein	6.01E-07	1.97E-08	3.15E-07	0
alpha-methylstyrene	2.31E-07	7.56E-09	1.21E-07	0
benzene	1.93E-07	4.15E-09	6.31E-08	0
bis(2-chloroisopropyl) ether	8.01E-15	1.08E-16	3.30E-15	0
carbon disulfide	2.24E-06	7.31E-08	1.17E-06	0
chlorobenzene	1.24E-13	1.68E-15	5.10E-14	0
chloroethane	6.62E-06	2.17E-07	3.48E-06	0
chloroform	6.80E-07	1.66E-08	2.76E-07	0
chloromethane	1.10E-06	2.76E-08	4.61E-07	0
chloromethoxyethane	3.07E-04	6.59E-06	1.00E-04	0
cis-1,2-dichloroethene	7.27E-12	9.84E-14	2.99E-12	0
dichlorodifluoromethane	4.24E-11	5.74E-13	1.74E-11	0
diethyl ether	5.87E-07	1.27E-08	1.92E-07	0
ethane	1.33E-05	3.41E-07	5.73E-06	0
ethanol	8.12E-09	1.10E-10	3.34E-09	0
ethylbenzene	2.77E-06	9.07E-08	1.46E-06	0
HD	1.81E-06	5.91E-08	9.52E-07	0

Table 5-3. Chemical-specific Annual Deposition Rates at the RME Location[a,b] (continued)

COPC	Vapor Phase Deposition Rates		Particle Phase Deposition Rates	
	Dry Deposition (g/m^2-yr)	Wet Deposition (g/m^2-yr)	Dry Deposition (g/m^2-yr)	Wet Deposition (g/m^2-yr)[c]
hexane	4.16E-07	1.36E-08	2.18E-07	0
methane	3.92E-06	5.31E-08	1.61E-06	0
methyl tert-butyl ether	1.54E-06	5.04E-08	8.08E-07	0
methylene chloride	3.54E-06	7.95E-08	1.25E-06	0
monoethanolamine	5.38E-07	7.29E-09	2.21E-07	0
naphthalene	9.06E-09	1.95E-10	2.96E-09	0
nitrobenzene	1.46E-15	1.98E-17	6.01E-16	0
octane	9.24E-07	3.02E-08	4.85E-07	0
pentane	1.00E-06	3.28E-08	5.26E-07	0
phenanthrene	2.16E-15	2.93E-17	8.91E-16	0
phenol	7.37E-14	9.97E-16	3.03E-14	0
propene	1.23E-06	4.03E-08	6.47E-07	0
styrene	1.17E-12	1.58E-14	4.80E-13	0
tert-butyl alcohol	7.62E-07	2.49E-08	4.00E-07	0
tetrachloroethene	7.91E-06	1.79E-07	2.81E-06	0
thiirane	7.65E-07	1.65E-08	2.52E-07	0
thiodiglycol	2.37E-06	5.65E-08	8.31E-07	0
toluene	3.64E-06	1.19E-07	1.91E-06	0
trans-1,2-dichloroethene	3.11E-12	4.21E-14	1.28E-12	0
trichloroethene	3.38E-06	7.97E-08	1.30E-06	0
vinyl chloride	4.14E-04	1.31E-05	2.12E-04	0
xylenes	8.17E-06	2.67E-07	4.29E-06	0
aluminum	2.23E-08	3.02E-10	9.20E-09	0[c]
ammonia	3.77E-03	8.93E-05	1.25E-03	0
arsenic	5.13E-10	6.94E-12	2.11E-10	0
cadmium	2.57E-10	3.48E-12	1.06E-10	0
chlorine	2.31E-04	7.55E-06	1.21E-04	0
copper	5.42E-09	7.34E-11	2.23E-09	0
hydrogen chloride	2.69E-04	8.81E-06	1.41E-04	0
hydrogen cyanide	3.76E-08	5.08E-10	1.55E-08	0
lead	1.97E-09	2.66E-11	8.10E-10	0
silver	1.16E-11	1.58E-13	4.79E-12	0

a. The 79 COPCs whose emissions could be quantified are listed in this table.
b. Listed deposition rates are the combined maximum annual unit response deposition rates for each source group adjusted by the corresponding long-term COPC-specific emission rates for each source group. Particle phase deposition only occurred for the metals (the unshaded cells) because the fraction in the vapor phase was equal to 1 for the other COPCs.
c. The zero values for Wet Deposition Rate from Particle Phase are artifacts of an AERMOD limitation. AERMOD can only output values greater than or equal to 0.00001; unit response values less than this are output as zero and cannot be adjusted by the actual COPC emission rate.

Table 5-4. Chemical-specific Annual Deposition Rates in the Water Body[a,b]

COPC	Vapor Phase Deposition Rates		Particle Phase Deposition Rates	
	Dry Deposition (g/m^2-yr)	Wet Deposition (g/m^2-yr)	Dry Deposition (g/m^2-yr)	Wet Deposition (g/m^2-yr)[c]
1,1,2,2-tetrachloroethane	1.69E-06	4.47E-08	7.59E-07	0
1,1-dichloroethane	2.46E-07	7.19E-09	1.18E-07	0
1,1-dichloroethene	5.21E-13	1.01E-14	3.51E-13	0
1,2,3-trichlorobenzene	1.58E-09	4.18E-11	7.11E-10	0
1,2,4-trichlorobenzene	9.03E-16	1.76E-17	6.08E-16	0
1,2,4-trimethyl benzene	4.11E-08	2.62E-09	3.22E-08	0
1,2-dichlorobenzene	1.74E-15	3.39E-17	1.17E-15	0
1,2-dichlorobutane	6.79E-06	1.80E-07	3.06E-06	0
1,2-dichloroethane	2.46E-04	8.97E-06	1.37E-04	0
1,2-dichloropropane	4.20E-09	1.11E-10	1.89E-09	0
1,3-dichlorobenzene	1.55E-15	3.02E-17	1.05E-15	0
1,4-dichlorobenzene	1.73E-15	3.37E-17	1.17E-15	0
1,4-dithiane	8.11E-05	2.15E-06	3.65E-05	0
1,4-oxathiane	8.76E-05	2.32E-06	3.95E-05	0
1-chlorobutane	2.73E-10	7.31E-12	1.24E-10	0
1-hexene	9.37E-08	2.49E-09	4.22E-08	0
2,4-dichlorophenol	3.22E-16	6.26E-18	2.17E-16	0
2-butanone	9.34E-07	2.68E-08	4.43E-07	0
2-chlorobutane	1.14E-06	3.02E-08	5.13E-07	0
2-chloroethoxyethane	1.26E-05	3.34E-07	5.69E-06	0
2-ethyl 1,3-butadiene	2.07E-08	5.95E-10	9.82E-09	0
2-hexanone	3.16E-07	1.52E-08	2.08E-07	0
2-methyl phenol	8.22E-15	1.60E-16	5.53E-15	0
2-methylnaphthalene	5.43E-15	1.06E-16	3.65E-15	0
3-methyl phenol	2.32E-09	6.15E-11	1.05E-09	0
4-methyl phenol	2.32E-09	6.15E-11	1.05E-09	0
4-methyl-2-pentanone	1.40E-07	3.70E-09	6.29E-08	0
acenaphthylene	1.43E-15	2.78E-17	9.60E-16	0
acetone	4.96E-06	1.71E-07	2.66E-06	0
acetylene	3.65E-08	7.10E-10	2.46E-08	0
acrolein	1.28E-07	8.19E-09	1.00E-07	0
alpha-methylstyrene	4.93E-08	3.15E-09	3.86E-08	0
benzene	4.51E-08	1.20E-09	2.03E-08	0
bis(2-chloroisopropyl) ether	1.86E-15	3.62E-17	1.25E-15	0
carbon disulfide	4.77E-07	3.05E-08	3.73E-07	0
chlorobenzene	2.87E-14	5.59E-16	1.93E-14	0
chloroethane	1.41E-06	9.03E-08	1.11E-06	0
chloroform	1.56E-07	5.89E-09	8.89E-08	0
chloromethane	2.52E-07	1.00E-08	1.48E-07	0
chloromethoxyethane	7.18E-05	1.90E-06	3.23E-05	0
cis-1,2-dichloroethene	1.69E-12	3.28E-14	1.14E-12	0
dichlorodifluoromethane	9.83E-12	1.91E-13	6.62E-12	0
diethyl ether	1.37E-07	3.65E-09	6.20E-08	0
ethane	3.03E-06	1.26E-07	1.84E-06	0
ethanol	1.88E-09	3.66E-11	1.27E-09	0
ethylbenzene	5.92E-07	3.78E-08	4.63E-07	0
HD	3.89E-07	2.46E-08	3.04E-07	0

Table 5-4. Chemical-specific Annual Deposition Rates in the Water Body[a,b] (continued)

COPC	Vapor Phase Deposition Rates		Particle Phase Deposition Rates	
	Dry Deposition (g/m^2-yr)	Wet Deposition (g/m^2-yr)	Dry Deposition (g/m^2-yr)	Wet Deposition (g/m^2-yr)[c]
hexane	8.87E-08	5.67E-09	6.95E-08	0
methane	9.10E-07	1.77E-08	6.12E-07	0
methyl tert-butyl ether	3.29E-07	2.10E-08	2.57E-07	0
methylene chloride	8.26E-07	2.47E-08	4.02E-07	0
monoethanolamine	1.25E-07	2.43E-09	8.40E-08	0
naphthalene	2.12E-09	5.61E-11	9.54E-10	0
nitrobenzene	3.39E-16	6.59E-18	2.28E-16	0
octane	1.97E-07	1.26E-08	1.54E-07	0
pentane	2.14E-07	1.36E-08	1.67E-07	0
phenanthrene	5.02E-16	9.77E-18	3.38E-16	0
phenol	1.71E-14	3.32E-16	1.15E-14	0
propene	2.63E-07	1.68E-08	2.06E-07	0
styrene	2.71E-13	5.27E-15	1.82E-13	0
tert-butyl alcohol	1.63E-07	1.04E-08	1.27E-07	0
tetrachloroethene	1.84E-06	5.60E-08	9.07E-07	0
thiirane	1.79E-07	4.80E-09	8.12E-08	0
thiodiglycol	5.53E-07	1.63E-08	2.65E-07	0
toluene	7.77E-07	4.94E-08	6.07E-07	0
trans-1,2-dichloroethene	7.21E-13	1.40E-14	4.85E-13	0
trichloroethene	7.82E-07	2.69E-08	4.19E-07	0
vinyl chloride	8.93E-05	5.40E-06	6.75E-05	0
xylenes	1.74E-06	1.11E-07	1.36E-06	0
aluminum	5.18E-09	1.01E-10	3.49E-09	0[c]
ammonia	8.89E-04	2.38E-05	3.96E-04	0
arsenic	1.19E-10	2.31E-12	8.01E-11	0
cadmium	5.96E-11	1.16E-12	4.01E-11	0
chlorine	4.92E-05	3.14E-06	3.85E-05	0
copper	1.26E-09	2.45E-11	8.46E-10	0
hydrogen chloride	5.74E-05	3.67E-06	4.49E-05	0
hydrogen cyanide	8.71E-09	1.69E-10	5.86E-09	0
lead	4.57E-10	8.88E-12	3.07E-10	0
silver	2.70E-12	5.26E-14	1.82E-12	0

a. The 79 COPCs whose emissions could be quantified are listed in this table.
b. Listed deposition rates are the combined maximum annual unit response deposition rates at the water body for each source group adjusted by the corresponding long-term COPC-specific emission rates for each source group. Particle phase deposition only occurred for the metals (the unshaded cells) because the fraction in the vapor phase was equal to 1 for the other COPCs.
c. The zero values for Wet Deposition Rate from Particle Phase are artifacts of an AERMOD limitation. AERMOD can only output values greater than or equal to 0.00001; unit response values less than this are output as zero and cannot be adjusted by the actual COPC emission rate.

5.1.4 COPC Concentrations in Produce for Human Consumption

COPC concentrations in above-ground (exposed) fruits and vegetables are attributable to several uptake mechanisms, including direct deposition onto the plant with subsequent absorption, direct uptake of vapor-phase chemicals through plant foliage, and root uptake of chemicals deposited on soil. The COPC concentrations in above-ground, exposed plants due to exposure to PCAPP and EDS emissions are the sum of these uptake processes. COPC concentrations in below-ground vegetables and above-ground protected fruits and vegetables are attributed to root uptake of chemicals deposited on soil. Protected fruits include above-ground produce in which the edible portion of the plant is covered by a protective inedible coating (e.g., corn or watermelon) that prevents uptake of chemicals into the edible portion by direct deposition or air-to-plant transfer. Annual COPC concentrations in produce were used to quantify human uptake of contaminants through ingestion of the various produce types and to quantify the COPC concentrations in human breast milk.

5.1.5 COPC Concentrations in Animal Products and Fish

COPC concentrations in animal products occur by consumption of contaminated feed and incidental ingestion of contaminated soil by the animal. The feed items may be contaminated through the three major mechanisms discussed above for human-consumed produce: direct deposition onto and vapor-phase air-to-plant transfer into forage and silage and direct uptake from soil through the plant roots for forage, silage, and grain. Soil may become contaminated through wet and dry depositional processes. COPC concentrations in forage, silage, grain, and soil were calculated at the location of the maximum annual off-site air concentration and deposition rate. These concentrations were then used to calculate COPC concentrations in animal products (beef, pork, poultry, eggs, and dairy milk). Chemical concentrations in fish occur due to chemicals in surface water. The COPC concentrations in animal products and fish were used to quantify human exposure to COPCs through ingestion of contaminated animal products and fish and to quantify COPC concentrations in human breast milk.

5.1.6 COPC Concentrations in Breast Milk

The National Center for Environmental Assessment (NCEA) report (USEPA, 1998) describing the breast milk pathway includes three groups of chemicals which may be found in breast milk: lipophilic compounds (i.e., dioxins and polychlorinated biphenyls [PCBs]), organic chemicals with low octanol/water partitioning coefficients, and inorganic (metallic or organometallic) compounds. The current PCAPP and EDS designs do not emit any COPCs that fall into the lipophilic class of compounds. COPC concentrations for the other groups of chemicals in breast milk were calculated for COPCs with available toxicity data that were identified in literature (USEPA, 1998; Agency for Toxic Substances and Disease Registry [ATSDR] Toxicological Profiles, 2007; and Byczkowski et al, 1994) as inorganic compounds or organic chemicals with low octanol/water partitioning coefficients that may be found in the aqueous or lipid phase of breast milk. Table 5-5 presents the COPCs that are identified in the references as chemicals that may be found in the aqueous or lipid phase of breast milk.

As illustrated in Table 5-5, chronic toxicity data are available for 36 of the 39 COPCs potentially found in breast milk. A total of 16 of these COPCs have carcinogenic toxicity data available, and 35 of the COPCs have noncarcinogenic toxicity data available. Emission rates are available for all of the COPCs potentially found in breast milk except for 1,1,1-trichloroethane, acetaldehyde, methyl tert-butyl ether, and tert-butyl alcohol. Concentrations of all 34 COPCs with emission rates were quantified for both the aqueous and lipid portions of breast milk. Risk

and hazard from exposure to COPCs in breast milk were calculated for the COPCs for which toxicity data were available. Conservative assumptions regarding the partitioning of chemicals in the mother's body were made due to a lack of chemical-specific partitioning parameters and are further detailed in Appendix D. COPC concentrations in human breast milk were used to quantify human infant COPC exposure through ingestion of breast milk.

Table 5-5. COPCs Potentially Found in Breast Milk

COPCs with Chronic Toxicity Data			
CAS No.	**Compound Name**	**CAS No.**	**Compound Name**
71-55-6	1,1,1-trichloroethane	67-66-3	chloroform
87-61-6	1,2,3-trichlorobenzene	7440-50-8	copper
120-82-1	1,2,4-trichlorobenzene	75-71-8	dichlorodifluoromethane
107-06-2	1,2-dichloroethane	100-41-4	ethylbenzene
95-50-1	1,2-dichlorobenzene	110-54-3	hexane
106-46-7	1,4-dichlorobenzene	7439-92-1	lead
78-93-3	2-butanone (MEK)	1634-04-4	methyl tert-butyl ether
108-10-1	4-methyl-2-pentanone (MIBK)	75-09-2	methylene chloride
75-07-0	acetaldehyde	91-20-3	naphthalene
67-64-1	acetone	7440-02-0	nickel
98-83-9	alpha-methylstyrene	108-95-2	phenol
7429-90-5	aluminum	115-07-1	propene
7440-38-2	arsenic	7440-22-4	silver
71-43-2	benzene	100-42-5	styrene
7440-43-9	cadmium	127-18-4	tetrachloroethene
75-15-0	carbon disulfide	108-88-3	toluene
108-90-7	chlorobenzene	79-01-6	trichloroethene
75-00-3	chloroethane	1330-20-7	xylenes
COPCs without Chronic Toxicity Data			
541-73-1	1,3-dichlorobenzene	75-65-0	tert-butyl alcohol
64-17-5	ethanol		

5.1.7 Results of Quantified Media Concentrations

Because the media concentrations discussed in this section were quantified for each COPC, results obtained from the use of the procedures described above and the equations in Appendix D yield large arrays of values. COPC-specific values for each medium are provided in various areas of this report. Table 5-2 presented the COPC-specific concentrations for air, and Tables 5-3 and 5-4 presented the COPC-specific wet and dry depositions rates. These two sets of results were used to generate all other COPC-specific media concentrations. Although the parameter values influence the individual results, the results are less sensitive to the different COPC-specific parameter values than to the COPC-specific emission rates. Appendix D contains some discussion of the sensitivity of the results to parameter values incorporated into the equations. Appendix G presents a full listing of the COPC-specific concentrations for each medium, as input into the exposure calculation routine, presented as a series of tables.

5.2 QUANTIFICATION OF EXPOSURES

5.2.1 Direct Exposure Through Inhalation

The intake of COPCs into each human receptor through direct inhalation was calculated using the COPC-specific air concentrations. Appendix D, Section D.8, presents the calculation procedure used to determine direct exposure through inhalation. Because toxicity values are based on COPC concentrations in the inhaled air and time, quantification of direct intake of

COPCs through inhalation must also be in terms of COPC concentration and time to allow for comparison. In addition to the COPC concentrations in air, exposure time, exposure frequency, exposure duration, and averaging time are used in the calculation of direct inhalation exposure. Tables 4-1 through 4-3 provide the exposure parameters needed to convert media concentrations into exposure (intake) concentrations.

To accommodate the 5-year PCAPP and EDS operating periods, the maximum exposure duration for direct exposures (i.e., inhalation) was established as 5 years; this exposure duration was used for all adult and child exposure scenarios, while a 1-year exposure duration was used for all infant exposure scenarios. Per EPA guidance, the exposure was averaged over a lifetime (78 years) for carcinogenic effects; for noncarcinogenic effects, the exposure was averaged over the period of PCAPP and EDS operations (5 years).

Table 5-6 presents the calculated COPC-specific intakes for COPCs with potential carcinogenic health effects through the direct inhalation pathway for all exposure scenarios. Table 5-7 presents the calculated COPC-specific intakes for COPCs with potential noncarcinogenic health hazards through the direct inhalation pathway for all exposure scenarios.

5.2.2 Indirect Exposures

5.2.2.1 COPC Intake through Ingestion

COPC ingestion occurs through the following ingestion pathways:

- incidental soil ingestion
- consumption of contaminated locally grown produce
- consumption of contaminated locally raised animal products
- incidental surface water ingestion while swimming
- consumption of breast milk (for infant exposure scenarios only)

Appendix D, Section D.9, presents the equations for calculating COPC intake through each ingestion pathway. In general, COPC intake is calculated by multiplying the COPC concentration in a given medium by the consumption rate of the medium and the fraction of consumed medium that is contaminated.

Table 5-6. Calculated Direct Inhalation Exposures to COPCs with Carcinogenic Effects for All Exposure Scenarios[a]

COPC	Direct Inhalation Exposure Concentration (μg COPC/m^3)			
	Adult Exposure Scenarios		All Child Exposure Scenarios	All Infant Exposure Scenarios
	Resident, Subsistence Fisher, and Subsistence Farmer	Worker		
1,1,2,2-tetrachloroethane	3.10E-06	7.38E-07	3.10E-06	6.20E-07
1,1-dichloroethane	4.28E-07	1.02E-07	4.28E-07	8.56E-08
1,2-dichloroethane	3.64E-04	8.67E-05	3.64E-04	7.28E-05
1,2-dichloropropane	7.71E-09	1.84E-09	7.71E-09	1.54E-09
1,4-dichlorobenzene	2.60E-15	6.19E-16	2.60E-15	5.20E-16
benzene	8.28E-08	1.97E-08	8.28E-08	1.66E-08
bis(2-chloroisopropyl) ether	2.79E-15	6.64E-16	2.79E-15	5.58E-16
chloroform	2.27E-07	5.40E-08	2.27E-07	4.54E-08
ethylbenzene	5.85E-07	1.39E-07	5.85E-07	1.17E-07
HD	3.85E-07	9.16E-08	3.85E-07	7.70E-08
methyl tert-butyl ether	3.25E-07	7.74E-08	3.25E-07	6.50E-08
methylene chloride	1.41E-06	3.36E-07	1.41E-06	2.82E-07
naphthalene	3.90E-09	9.28E-10	3.90E-09	7.79E-10
nitrobenzene	5.09E-16	1.21E-16	5.09E-16	1.02E-16
tetrachloroethene	3.11E-06	7.41E-07	3.11E-06	6.22E-07
trichloroethene	1.20E-06	2.85E-07	1.20E-06	2.39E-07
vinyl chloride	9.32E-05	2.22E-05	9.32E-05	1.86E-05
arsenic	1.75E-10	4.18E-11	1.75E-10	3.51E-11
cadmium	8.79E-11	2.09E-11	8.79E-11	1.76E-11
lead	6.74E-10	1.61E-10	6.74E-10	1.35E-10

a. The 20 carcinogenic COPCs with inhalation toxicity values whose emissions could be quantified are listed in this table.

Table 5-7. Calculated Direct Inhalation Exposure Concentration to COPCs with Noncarcinogenic Effects for All Exposure Scenarios[a]

COPC	Direct Inhalation Exposure Concentration (μg COPC/m^3)			
	Adult Exposure Scenarios		All Child Exposure Scenarios	All Infant Exposure Scenarios
	Resident, Subsistence Fisher, and Subsistence Farmer	Worker		
1,1,2,2-tetrachloroethane	4.84E-05	1.15E-05	4.84E-05	4.84E-05
1,1-dichloroethane	6.67E-06	1.59E-06	6.67E-06	6.67E-06
1,1-dichloroethene	1.22E-11	2.90E-12	1.22E-11	1.22E-11
1,2,3-trichlorobenzene	4.53E-08	1.08E-08	4.53E-08	4.53E-08
1,2,4-trichlorobenzene	2.12E-14	5.04E-15	2.12E-14	2.12E-14
1,2,4-trimethyl benzene	6.34E-07	1.51E-07	6.34E-07	6.34E-07
1,2-dichlorobenzene	4.08E-14	9.71E-15	4.08E-14	4.08E-14
1,2-dichloroethane	5.68E-03	1.35E-03	5.68E-03	5.68E-03
1,2-dichloropropane	1.20E-07	2.86E-08	1.20E-07	1.20E-07
1,4-dichlorobenzene	4.06E-14	9.66E-15	4.06E-14	4.06E-14
1,4-dithiane	2.33E-03	5.54E-04	2.33E-03	2.33E-03
1-chlorobutane	7.77E-09	1.85E-09	7.77E-09	7.77E-09
2,4-dichlorophenol	7.54E-15	1.79E-15	7.54E-15	7.54E-15
2-butanone	2.55E-05	6.08E-06	2.55E-05	2.55E-05
2-hexanone	6.19E-06	1.47E-06	6.19E-06	6.19E-06
2-methyl phenol	1.93E-13	4.58E-14	1.93E-13	1.93E-13
2-methylnaphthalene	1.27E-13	3.03E-14	1.27E-13	1.27E-13
3-methyl phenol	6.66E-08	1.59E-08	6.66E-08	6.66E-08
4-methyl phenol	6.66E-08	1.59E-08	6.66E-08	6.66E-08
4-methyl-2-pentanone	4.01E-06	9.54E-07	4.01E-06	4.01E-06
acetone	1.18E-04	2.82E-05	1.18E-04	1.18E-04
acrolein	1.98E-06	4.71E-07	1.98E-06	1.98E-06
alpha-methylstyrene	7.61E-07	1.81E-07	7.61E-07	7.61E-07
benzene	1.29E-06	3.08E-07	1.29E-06	1.29E-06
bis(2-chloroisopropyl) ether	4.35E-14	1.04E-14	4.35E-14	4.35E-14
carbon disulfide	7.36E-06	1.75E-06	7.36E-06	7.36E-06
chlorobenzene	6.73E-13	1.60E-13	6.73E-13	6.73E-13
chloroethane	2.18E-05	5.19E-06	2.18E-05	2.18E-05
chloroform	3.54E-06	8.43E-07	3.54E-06	3.54E-06
chloromethane	5.61E-06	1.34E-06	5.61E-06	5.61E-06
cis-1,2-dichloroethene	3.95E-11	9.40E-12	3.95E-11	3.95E-11
dichlorodifluoromethane	2.30E-10	5.48E-11	2.30E-10	2.30E-10
diethyl ether	3.93E-06	9.36E-07	3.93E-06	3.93E-06
ethylbenzene	9.13E-06	2.17E-06	9.13E-06	9.13E-06
HD	6.00E-06	1.43E-06	6.00E-06	6.00E-06
hexane	1.37E-06	3.26E-07	1.37E-06	1.37E-06
methyl tert-butyl ether	5.07E-06	1.21E-06	5.07E-06	5.07E-06
methylene chloride	2.20E-05	5.24E-06	2.20E-05	2.20E-05
naphthalene	6.08E-08	1.45E-08	6.08E-08	6.08E-08
nitrobenzene	7.94E-15	1.89E-15	7.94E-15	7.94E-15
pentane	3.30E-06	7.85E-07	3.30E-06	3.30E-06
phenol	4.00E-13	9.53E-14	4.00E-13	4.00E-13
propene	4.06E-06	9.66E-07	4.06E-06	4.06E-06
styrene	6.34E-12	1.51E-12	6.34E-12	6.34E-12
tetrachloroethene	4.85E-05	1.16E-05	4.85E-05	4.85E-05
thiodiglycol	1.48E-05	3.51E-06	1.48E-05	1.48E-05
toluene	1.20E-05	2.87E-06	1.20E-05	1.20E-05
trans-1,2-dichloroethene	1.69E-11	4.02E-12	1.69E-11	1.69E-11
trichloroethene	1.87E-05	4.45E-06	1.87E-05	1.87E-05
vinyl chloride	1.45E-03	3.46E-04	1.45E-03	1.45E-03
xylenes	2.69E-05	6.41E-06	2.69E-05	2.69E-05

Table 5-7. Calculated Direct Inhalation Exposure Concentration to COPCs with Noncarcinogenic Effects for All Exposure Scenarios[a] (continued)

COPC	Direct Inhalation Exposure Concentration (µg COPC/m^3)			
	Adult Exposure Scenarios		All Child Exposure Scenarios	All Infant Exposure Scenarios
	Resident, Subsistence Fisher, and Subsistence Farmer	Worker		
aluminum	1.19E-07	2.84E-08	1.19E-07	1.19E-07
ammonia	2.28E-02	5.44E-03	2.28E-02	2.28E-02
arsenic	2.74E-09	6.52E-10	2.74E-09	2.74E-09
cadmium	1.37E-09	3.26E-10	1.37E-09	1.37E-09
chlorine	7.60E-04	1.81E-04	7.60E-04	7.60E-04
copper	2.89E-08	6.89E-09	2.89E-08	2.89E-08
hydrogen chloride	8.86E-04	2.11E-04	8.86E-04	8.86E-04
hydrogen cyanide	2.04E-07	4.86E-08	2.04E-07	2.04E-07
silver	6.22E-11	1.48E-11	6.22E-11	6.22E-11

a. The 60 noncarcinogenic COPCs with inhalation toxicity values whose emissions could be quantified are listed in this table.

Tables 4-1 through 4-3 presented exposure parameters, including consumption rates and fractions contaminated, and Appendix G presents the media concentrations.

Cumulative ingestion exposure is the sum of ingestion exposure through each of the individual ingestion routes. Intake through ingestion (in units of milligrams per day) was used along with exposure frequency, exposure duration, body weight, and averaging time to determine the total ingestion exposure in units of milligrams of COPC per kilogram of body weight per day (mg COPC/kg of body weight-day).

5.2.2.2 COPC Intake through Dermal Absorption

Daily intakes of COPCs via dermal uptake from soil and surface water were calculated for the adult and child resident, subsistence fisher, and subsistence farmer receptors. Appendix D, Section D.9, presents the calculation procedures used to determine dermal COPC uptake. Dermal uptake is dependent on the absorbed dose per event, the exposed skin surface area, event frequency, exposure frequency, exposure duration, body weight, and averaging time. The absorbed dose per event depends on the chemical and physical properties of each individual COPC and was calculated following procedures outlined in *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* (USEPA, 2004a).

5.2.2.3 Total Indirect COPC Exposure

The total indirect COPC exposure is the sum of the total COPC ingestion exposure and the COPC intake through dermal absorption. Appendix G presents detailed summary tables of the calculated indirect exposures of COPCs for all exposure scenarios. Table 5-8 presents the calculated total indirect exposures of COPCs with potential carcinogenic health effects for all exposure scenarios. Table 5-9 presents the calculated total indirect exposures of COPCs with potential noncarcinogenic health hazards for all exposure scenarios.

Table 5-8. Calculated Total Indirect Exposures to COPCs with Carcinogenic Effects[a]

COPC	Total Indirect Exposure (mg COPC/kg body weight-day)									
	Adult Resident	Adult Subsistence Fisher	Adult Subsistence Farmer	Adult Worker	Child Resident	Child Subsistence Fisher	Child Subsistence Farmer	Infant Resident	Infant Subsistence Fisher	Infant Subsistence Farmer
1,1,2,2-tetrachloroethane	2.27E-09	5.05E-09	3.44E-09	3.35E-15	1.35E-09	2.29E-09	2.38E-09	2.59E-10	3.93E-10	5.12E-10
1,1-dichloroethane	8.52E-11	2.02E-10	1.16E-10	9.01E-18	3.32E-11	7.14E-11	3.95E-11	4.68E-12	1.01E-11	6.25E-12
1,2,4-trichlorobenzene	1.74E-17	4.05E-17	2.51E-17	1.95E-23	8.48E-18	1.63E-17	1.33E-17	4.00E-18	8.32E-18	6.28E-18
1,2-dichloroethane	5.92E-08	1.31E-07	8.75E-08	2.17E-14	3.31E-08	5.67E-08	5.43E-08	2.65E-08	3.98E-08	3.57E-08
1,2-dichloropropane	2.26E-12	5.40E-12	3.07E-12	4.35E-19	8.58E-13	1.89E-12	1.01E-12	1.22E-13	2.70E-13	1.59E-13
1,4-dichlorobenzene	1.33E-17	3.24E-17	1.82E-17	3.17E-24	4.95E-18	1.13E-17	5.93E-18	2.70E-18	6.24E-18	3.62E-18
benzene	2.65E-11	6.33E-11	3.57E-11	2.77E-18	9.49E-12	2.16E-11	1.03E-11	7.83E-12	1.46E-11	9.31E-12
bis(2-chloroisopropyl) ether	3.06E-17	3.61E-17	7.19E-17	1.82E-21	6.44E-17	6.83E-17	1.57E-16	1.39E-17	1.45E-17	3.43E-17
chloroform	7.76E-11	1.87E-10	1.05E-10	8.37E-18	2.84E-11	6.43E-11	3.15E-11	2.25E-11	4.28E-11	2.71E-11
ethylbenzene	2.37E-09	5.77E-09	3.18E-09	2.04E-16	8.10E-10	1.93E-09	8.62E-10	4.63E-10	1.09E-09	5.88E-10
HD	5.63E-10	1.38E-09	7.66E-10	2.43E-16	1.99E-10	4.66E-10	2.19E-10	2.84E-11	6.64E-11	3.28E-11
methyl tert-butyl ether	9.48E-11	1.98E-10	1.52E-10	1.31E-16	7.59E-11	1.10E-10	1.50E-10	3.89E-11	5.80E-11	6.38E-11
methylene chloride	1.22E-10	2.74E-10	1.75E-10	2.26E-17	6.17E-11	1.12E-10	9.06E-11	7.52E-11	1.03E-10	8.96E-11
naphthalene	2.12E-11	3.85E-11	3.90E-11	2.75E-15	2.94E-11	3.58E-11	6.68E-11	8.67E-12	1.20E-11	1.86E-11
nitrobenzene	1.97E-18	2.26E-18	4.69E-18	5.47E-23	4.47E-18	4.61E-18	1.10E-17	9.42E-19	9.63E-19	2.33E-18
tetrachloroethene	1.16E-08	2.86E-08	1.55E-08	1.12E-16	3.87E-09	9.45E-09	3.98E-09	2.26E-09	5.41E-09	2.83E-09
trichloroethene	8.15E-10	1.98E-09	1.09E-09	8.35E-17	2.82E-10	6.66E-10	2.99E-10	1.93E-10	4.10E-10	2.36E-10
vinyl chloride	1.47E-08	3.42E-08	1.97E-08	3.19E-16	5.55E-09	1.20E-08	5.84E-09	6.57E-10	1.57E-09	7.28E-10
arsenic	3.99E-12	4.88E-12	1.21E-11	4.29E-21	1.97E-12	2.27E-12	4.64E-12	9.27E-12	1.13E-11	2.76E-11
cadmium	3.92E-12	7.37E-12	8.49E-12	1.16E-19	1.62E-12	2.75E-12	2.91E-12	1.86E-09	3.48E-09	4.00E-09
lead	1.30E-11	1.30E-11	4.35E-11	1.33E-17	7.09E-12	7.09E-12	1.77E-11	6.22E-09	6.22E-09	2.05E-08

a. The 21 carcinogenic COPCs with oral toxicity values whose emissions could be quantified are listed in this table.

Table 5-9. Calculated Total Indirect Exposures to COPCs with Noncarcinogenic Effects[a]

COPC	Total Indirect Exposure (mg COPC/kg body weight-day)									
	Adult Resident	Adult Subsistence Fisher	Adult Subsistence Farmer	Adult Worker	Child Resident	Child Subsistence Fisher	Child Subsistence Farmer	Infant Resident	Infant Subsistence Fisher	Infant Subsistence Farmer
1,1,2,2-tetrachloroethane	1.06E-08	1.81E-08	1.89E-08	4.48E-14	2.10E-08	3.58E-08	3.71E-08	2.02E-08	3.07E-08	3.99E-08
1,1-dichloroethane	2.50E-10	5.53E-10	3.01E-10	1.21E-16	5.18E-10	1.11E-09	6.17E-10	3.65E-10	7.91E-10	4.87E-10
1,1-dichloroethene	7.84E-16	1.87E-15	8.10E-16	7.14E-23	1.59E-15	3.73E-15	1.64E-15	1.05E-15	2.57E-15	1.09E-15
1,2,3-trichlorobenzene	4.01E-10	8.02E-10	5.98E-10	8.19E-14	8.92E-10	1.68E-09	1.43E-09	5.19E-09	1.01E-08	7.85E-09
1,2,4-trichlorobenzene	6.85E-17	1.31E-16	1.08E-16	2.61E-22	1.32E-16	2.55E-16	2.07E-16	9.18E-16	1.68E-15	1.44E-15
1,2,4-trimethyl benzene	1.04E-09	2.47E-09	1.14E-09	2.86E-15	2.05E-09	4.86E-09	2.25E-09	1.50E-09	3.50E-09	1.74E-09
1,2-dichlorobenzene	3.39E-17	7.51E-17	4.29E-17	1.70E-22	6.68E-17	1.48E-16	8.42E-17	5.29E-16	1.03E-15	6.47E-16
1,2-dichloroethane	2.49E-07	4.36E-07	4.21E-07	2.91E-13	5.16E-07	8.84E-07	8.48E-07	1.85E-05	2.08E-05	2.07E-05
1,2-dichloropropane	6.54E-12	1.47E-11	7.72E-12	5.83E-18	1.34E-11	2.95E-11	1.57E-11	9.55E-12	2.10E-11	1.24E-11
1,4-dichlorobenzene	3.93E-17	8.94E-17	4.74E-17	4.24E-23	7.72E-17	1.76E-16	9.25E-17	5.94E-16	1.21E-15	7.01E-16
1,4-dithiane	1.56E-05	1.60E-05	3.86E-05	1.62E-10	3.56E-05	3.64E-05	8.79E-05	3.93E-05	3.99E-05	9.78E-05
1-chlorobutane	1.04E-12	2.49E-12	1.08E-12	8.78E-19	2.07E-12	4.94E-12	2.16E-12	1.43E-12	3.47E-12	1.53E-12
2,4-dichlorophenol	2.20E-15	2.47E-15	5.21E-15	1.10E-20	4.16E-15	4.70E-15	9.83E-15	4.99E-15	5.37E-15	1.21E-14
2-butanone	1.81E-08	1.92E-08	4.41E-08	1.94E-13	4.42E-08	4.64E-08	1.08E-07	3.11E-07	3.24E-07	6.60E-07
2-hexanone	3.14E-09	3.37E-09	7.59E-09	3.14E-14	7.13E-09	7.59E-09	1.73E-08	7.76E-09	8.08E-09	1.91E-08
2-methyl phenol	4.05E-15	4.23E-15	9.94E-15	2.98E-20	7.66E-15	8.01E-15	1.88E-14	6.07E-15	6.32E-15	1.49E-14
2-methylnaphthalene	3.84E-16	6.57E-16	6.83E-16	3.53E-20	7.91E-16	1.33E-15	1.43E-15	7.48E-16	1.13E-15	1.49E-15
3-methyl phenol	1.40E-09	1.54E-09	3.36E-09	3.15E-14	3.21E-09	3.48E-09	7.72E-09	3.46E-09	3.65E-09	8.46E-09
4-methyl phenol	4.09E-11	5.89E-11	8.22E-11	1.09E-15	1.03E-10	1.38E-10	2.16E-10	9.46E-11	1.20E-10	2.11E-10
4-methyl-2-pentanone	5.31E-09	5.39E-09	1.32E-08	8.64E-14	1.42E-08	1.44E-08	3.54E-08	8.26E-08	8.36E-08	1.89E-07
acetone	5.04E-08	5.54E-08	1.21E-07	3.02E-13	1.11E-07	1.21E-07	2.65E-07	9.86E-07	1.05E-06	1.92E-06
acrolein	7.37E-10	8.48E-10	1.73E-09	5.70E-15	1.70E-09	1.92E-09	3.99E-09	1.79E-09	1.95E-09	4.33E-09
alpha-methylstyrene	1.05E-09	2.37E-09	1.28E-09	6.26E-15	2.08E-09	4.68E-09	2.52E-09	1.50E-08	3.12E-08	1.80E-08
benzene	7.28E-11	1.69E-10	7.95E-11	3.71E-17	1.48E-10	3.37E-10	1.61E-10	4.38E-09	5.55E-09	4.47E-09
bis(2-chloroisopropyl) ether	4.40E-16	4.71E-16	1.07E-15	2.44E-20	1.02E-15	1.08E-15	2.49E-15	1.10E-15	1.15E-15	2.71E-15
carbon disulfide	9.07E-10	2.17E-09	9.21E-10	5.21E-17	1.84E-09	4.33E-09	1.86E-09	3.09E-08	4.63E-08	3.11E-08
chlorobenzene	2.08E-16	4.37E-16	2.83E-16	1.67E-22	4.83E-16	9.35E-16	7.37E-16	4.42E-15	7.22E-15	5.44E-15
chloroethane	6.58E-10	1.50E-09	7.02E-10	7.10E-17	1.44E-09	3.10E-09	1.53E-09	6.69E-08	7.71E-08	6.74E-08
chloroform	2.16E-10	5.00E-10	2.41E-10	1.12E-16	4.43E-10	1.00E-09	4.92E-10	1.22E-08	1.57E-08	1.25E-08
chloromethane	2.00E-10	4.66E-10	2.15E-10	4.73E-17	4.31E-10	9.56E-10	4.64E-10	2.75E-10	6.50E-10	3.14E-10
cis-1,2-dichloroethene	2.77E-14	3.07E-14	6.62E-14	9.86E-20	5.38E-14	5.97E-14	1.28E-13	6.38E-14	6.80E-14	1.55E-13
dichlorodifluoromethane	1.94E-14	4.28E-14	2.42E-14	4.57E-20	3.96E-14	8.56E-14	4.94E-14	8.60E-13	1.14E-12	9.21E-13
diethyl ether	4.69E-10	5.99E-10	1.02E-09	1.79E-15	1.03E-09	1.29E-09	2.26E-09	1.04E-09	1.23E-09	2.42E-09
ethylbenzene	6.40E-09	1.53E-08	6.83E-09	2.73E-15	1.26E-08	3.01E-08	1.35E-08	1.03E-07	2.11E-07	1.08E-07
HD	1.52E-09	3.64E-09	1.64E-09	3.26E-15	3.10E-09	7.27E-09	3.41E-09	2.21E-09	5.18E-09	2.56E-09
hexane	2.95E-09	7.25E-09	2.95E-09	2.79E-17	5.80E-09	1.43E-08	5.80E-09	3.96E-08	9.22E-08	3.96E-08
methyl tert-butyl ether	5.40E-10	8.10E-10	1.07E-09	1.75E-15	1.18E-09	1.72E-09	2.34E-09	2.07E-08	2.40E-08	2.77E-08
methylene chloride	4.48E-10	8.43E-10	6.81E-10	3.03E-16	9.62E-10	1.74E-09	1.41E-09	6.50E-08	6.98E-08	6.80E-08
naphthalene	1.80E-10	2.31E-10	3.98E-10	3.68E-14	4.66E-10	5.66E-10	1.06E-09	2.55E-09	3.18E-09	5.50E-09
nitrobenzene	2.84E-17	2.96E-17	6.98E-17	7.32E-22	6.98E-17	7.22E-17	1.72E-16	7.36E-17	7.53E-17	1.82E-16
pentane	2.78E-09	6.80E-09	2.78E-09	3.37E-17	5.48E-09	1.34E-08	5.48E-09	3.76E-09	9.41E-09	3.77E-09
phenol	4.85E-15	4.98E-15	1.20E-14	1.18E-19	1.30E-14	1.33E-14	3.23E-14	6.66E-14	6.82E-14	1.63E-13
propene	1.70E-10	4.00E-10	1.72E-10	9.60E-18	3.56E-10	8.07E-10	3.58E-10	1.30E-08	1.58E-08	1.30E-08

Table 5-9. Calculated Total Indirect Exposures to COPCs with Noncarcinogenic Effects[a] (continued)

COPC	Total Indirect Exposure (mg COPC/kg body weight-day)									
	Adult Resident	Adult Subsistence Fisher	Adult Subsistence Farmer	Adult Worker	Child Resident	Child Subsistence Fisher	Child Subsistence Farmer	Infant Resident	Infant Subsistence Fisher	Infant Subsistence Farmer
styrene	7.84E-14	8.16E-14	1.93E-13	6.07E-19	3.80E-13	3.87E-13	9.44E-13	1.15E-12	1.19E-12	2.81E-12
tetrachloroethene	3.06E-08	7.48E-08	3.15E-08	1.50E-15	6.04E-08	1.47E-07	6.21E-08	5.05E-07	1.04E-06	5.17E-07
thiodiglycol	6.84E-05	6.87E-05	1.71E-04	1.44E-11	1.35E-04	1.36E-04	3.37E-04	1.64E-04	1.65E-04	4.10E-04
toluene	3.99E-09	9.42E-09	4.28E-09	1.82E-15	7.92E-09	1.86E-08	8.48E-09	8.11E-08	1.47E-07	8.50E-08
trans-1,2-dichloroethene	1.03E-15	2.42E-15	1.11E-15	3.69E-22	2.10E-15	4.84E-15	2.25E-15	1.43E-15	3.38E-15	1.61E-15
trichloroethene	2.19E-09	5.23E-09	2.32E-09	1.12E-15	4.40E-09	1.04E-08	4.66E-09	7.72E-08	1.14E-07	7.88E-08
vinyl chloride	3.94E-08	9.02E-08	4.17E-08	4.27E-15	8.66E-08	1.87E-07	9.11E-08	5.13E-08	1.23E-07	5.68E-08
xylenes	1.87E-08	4.42E-08	2.04E-08	4.41E-14	3.70E-08	8.72E-08	4.04E-08	3.01E-07	6.13E-07	3.24E-07
aluminum	3.91E-10	3.93E-10	9.76E-10	8.55E-18	1.25E-09	1.26E-09	3.13E-09	6.10E-09	6.12E-09	1.47E-08
ammonia	8.18E-06	8.77E-06	1.98E-05	1.10E-11	1.73E-05	1.85E-05	4.19E-05	1.97E-05	2.05E-05	4.84E-05
arsenic	1.04E-11	1.27E-11	2.36E-11	5.81E-20	3.08E-11	3.53E-11	7.24E-11	1.92E-09	2.31E-09	4.22E-09
cadmium	1.02E-11	1.92E-11	1.66E-11	1.58E-18	2.52E-11	4.29E-11	4.54E-11	3.87E-07	7.16E-07	6.20E-07
chlorine	4.17E-07	4.63E-07	9.93E-07	2.53E-12	9.95E-07	1.09E-06	2.38E-06	1.04E-06	1.11E-06	2.54E-06
copper	1.30E-10	1.30E-10	3.24E-10	1.59E-16	4.34E-10	4.35E-10	1.09E-09	5.02E-06	5.04E-06	1.21E-05
hydrogen chloride	4.04E-07	4.56E-07	9.55E-07	5.66E-13	8.68E-07	9.70E-07	2.05E-06	9.61E-07	1.03E-06	2.33E-06
hydrogen cyanide	1.69E-11	2.14E-11	3.76E-11	5.99E-18	4.65E-11	5.53E-11	1.06E-10	5.01E-11	5.64E-11	1.19E-10
silver	9.02E-13	9.43E-13	2.21E-12	1.01E-20	4.20E-12	4.28E-12	1.04E-11	3.37E-08	3.52E-08	8.18E-08

a. The 60 noncarcinogenic COPCs with oral toxicity values whose emissions could be quantified are listed in this table.