APPENDIX C

MEDIA-TO-RECEPTOR BIOCONCENTRATION FACTORS (*BCF*s)

Screening Level Ecological Risk Assessment Protocol

August 1999

APPENDIX C

TABLE OF CONTENTS

Section **Page**

APPENDIX C

MEDIA-TO-RECEPTOR *BCF*s

Appendix C provides recommended guidance for determining values for media-to-receptor bioconcentration factors (*BCF*s) based on values reported in the scientific literature, or estimated using physical and chemical properties of the compound. Guidance on use of *BCF* values in the screening level ecological risk assessment is provided in Chapter 5.

Section C-1.0 provides the general guidance recommended to select or estimate *BCF* values. Sections C-1.1 through C-1.7 further discuss determination of *BCF*s for specific media and receptors. References cited in Sections C-1.1 through C-1.7 are located following Section C-1.7.

For the compounds commonly identified in risk assessments for combustion facilities (identified in Chapter 2), *BCF* values have been determined following the guidance in Sections C-1.1 through C-1.7. *BCF* values for these limited number of compounds are included in this appendix in Tables C-1 through C-7 to facilitate the completion of screening ecological risk assessments. However, it is expected that additional compounds may require evaluation on a site specific basis, and in such cases, *BCF* values for these additional compounds could be determined following the same guidance (Sections C-1.1 through C-1.7) used in determination of the *BCF* values reported in this appendix. For reproducibility and to facilitate comparison of new data and values as they become available, all data reviewed in the selection of the *BCF* values provided at the end of this appendix are also included in Tables C-1 through C-7. References cited in Tables C-1 through C-7 (Media-to-Receptor *BCF* Values) are located following Table C-7.

For additional discussion on some of the references and equations cited in Sections C-1.1 through C-1.7, the reader is recommended to review the Human Health Risk Assessment Protocol (HHRAP) (U.S. EPA 1998) (see Appendix A-3), and the source documents cited in the reference section of this appendix.

C-1.0 GENERAL GUIDANCE

This section summarizes the recommended general guidance for determining compound-specific *BCF* values (media-to-receptors) provided in Tables C-1 through C-7. As a preference, *BCF* values were selected from empirical field and/or laboratory data generated from reviewed studies that are published in the scientific literature. Information used from these studies included calculated *BCF* values, as well as, collocated media and organism concentration data from which *BCF* values could be calculated. If two or more *BCF* values, or two or more sets of collocated data, were available in the published scientific literature, the geometric mean of the values was used.

Field-derived *BCF* values were considered more indicative of the level of bioconcentration occurring in the natural environment than laboratory-derived values. Therefore, when available and appropriate, field-derived *BCF* values were given priority over laboratory-derived values. In some cases, confidence in the methods used to determine or report field-derived *BCF* values was less than for the laboratory-derived values. In those cases, the laboratory-derived values were used for the recommended *BCF* values.

When neither field or laboratory data were available for a specific compound, data from a potential surrogate compound were evaluated. The appropriateness of the surrogate was determined by comparing the structures of the two compounds. Where an appropriate surrogate was not identified, a regression equation based on the compound's log K_{ow} value was used to calculate the recommended *BCF* value.

With the exception of the air-to-plant biotransfer factors (*Bv*), recommended *BCF* values provided in the tables at the end of this appendix are based on wet tissue weight and dry media weight (except for water). As necessary, reported values were converted to these units using the referenced tissue or media wet weight percentages. The conversion factors, equations, and references for these conversions are discussed in Sections C-1.1 through C-1.7 where appropriate, and are presented at the end of each table (Tables C-1 through C-7).

C-1.1 SOIL-TO-SOIL INVERTEBRATE BIOCONCENTRATION FACTORS

Soil-to-soil invertebrate *BCF* values (see Table C-1) were developed mainly from data for earthworms. Measured experimental results were primarily in the form of ratios of compound concentrations in a earthworm and the compound concentrations in the soil in which the earthworm was exposed. As necessary, values were converted to wet tissue and dry media weight assuming a moisture content (by mass) of 83.3 percent for earthworms and 20 percent for soil (Pietz et al. 1984).

Organics For organic compounds with no field or laboratory data available, recommended *BCF* values were estimated using the following regression equation**:**

$$\log BCF = 0.819 \log K_{ow} - 1.146 \qquad \text{Equation C-1-1}$$

- Southworth, G.R., J.J. Beauchamp, and P.K. Schmieder. 1978. "Bioaccumulation Potential of Polycyclic Aromatic Hydrocarbons in *Daphnia Pulex." Water Research*. Volume 12. Pages 973-977.

Inorganics For inorganic compounds with no field or laboratory data available, the recommended *BCF* value is equal to the arithmetic average of the available *BCF* values for other inorganics as specified in Table C-1.

C-1.2 SOIL-TO-PLANT AND SEDIMENT-TO-PLANT BIOCONCENTRATION FACTORS

Soil-to-plant *BCF* values (see Table C-2) account for plant uptake of compounds from soil. Data for a variety of plants and food crops were used to determine recommended *BCF* values.

Organics For all organics (including PCDDs and PCDFs) with no available field or laboratory data, the following regression equation was used to calculate recommended values:

$$\log BCF = 1.588 - 0.578 \log K_{ow} \qquad \text{Equation C-1-2}$$

- Travis, C.C. and A.D. Arms. 1988. "Bioconcentration of Organics in Beef, Milk, and Vegetation." *Environmental Science and Technology*. 22:271-274.

Inorganics For most metals, *BCF* values were based on empirical data reported in the following:

- Baes, C.F., R.D. Sharp, A.L. Sjoreen, and R.W. Shor. 1984. "Review and Analysis of Parameters and Assessing Transport of Environmentally Released Radionuclides Through Agriculture." Oak Ridge National Laboratory, Oak Ridge, Tennessee.

The scientific literature also was searched to identify studies. Although U.S. EPA (1995a) provides values for certain metals calculated on the basis of plant uptake response slope factors, it is unclear how the *BCF*

values were calculated or which sources or references were used. Therefore, values reported in U.S. EPA (1995a) were not used.

C-1.3 WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS

Experimental data for crustaceans, aquatic insects, bivalves, and other aquatic invertebrates were used to determine recommended *BCF* values for water-to-aquatic invertebrate (see Table C-3). Both marine and freshwater exposures were reviewed. As necessary, available results were converted to wet tissue weight assuming that invertebrate moisture content (by mass) is 83.3 percent (Pietz et al. 1984).

Organics Reported field values for organic compounds were assumed to be total compound concentrations in water and, therefore, were converted to dissolved compound concentrations in water using the following equation from U.S. EPA (1995b):

$$BCF \text{ (dissolved)} = (BCF \text{ (total)} / f_{fd}) - 1 \qquad \text{Equation C-1-3}$$

where

BCF (dissolved)	=	*BCF* based on dissolved concentration of compound in water
BCF (total)	=	BCF based on the field derived data for total concentration of compound in water
f_{fd}	=	Fraction of compound that is freely dissolved in the water

and,

f_{fd}	=	$1 / [1 + ((DOC \times K_{ow}) / 10) + (POC \times K_{ow})]$
DOC	=	Dissolved organic carbon, kilograms of organic carbon / liter of water (2.0×10^{-06} Kg/L)
K_{ow}	=	Octanol-water partition coefficient of the compound, as reported in U.S. EPA (1994a)
POC	=	Particulate organic carbon, kilograms of organic carbon / liter of water (7.5×10^{-09} Kg/L)

Laboratory data were assumed to be based on dissolved compound concentrations.

For organic compounds with no field or laboratory data available, *BCF* values were determined from surrogate compounds or calculated using the following regression equation:

$$log\ BCF = 0.819 \times log\ K_{ow} - 1.146 \qquad \text{Equation C-1-4}$$

- Southworth, G.R., J.J. Beauchamp, and P.K. Schmieder. 1978. "Bioaccumulation Potential of Polycyclic Aromatic Hydrocarbons in *Daphnia Pulex.*" *Water Research*. Volume 12. Pages 973-977.

Inorganics For inorganic compounds with no field or laboratory data available, the recommended *BCF* values were estimated as the arithmetic average of the available *BCF* values for other inorganics, as specified in Table C-3.

C-1.4 WATER-TO-ALGAE BIOCONCENTRATION FACTORS

Experimental data for both marine and freshwater algal species were reviewed. As necessary, available results were converted to wet tissue weight assuming that algae moisture content (by mass) is 65.7 percent (Isensee et al. 1973).

Organics For organic compounds with no field or laboratory data available, *BCF* values were calculated using the following regression equation:

$$log\ BCF = 0.819 \times log\ K_{ow} - 1.146 \qquad \text{Equation C-1-5}$$

- Southworth, G.R., J.J. Beauchamp, and P.K. Schmieder. 1978. "Bioaccumulation Potential of Polycyclic Aromatic Hydrocarbons in *Daphnia Pulex.*" *Water Research*. Volume 12. Pages 973-977.

Inorganics For inorganics, available field or laboratory data were evaluated for each compound.

C-1.5 WATER-TO-FISH BIOCONCENTRATION FACTORS

Experimental data for a variety of marine and freshwater fish were used to determine recommended *BCF* values (see Table C-5). As necessary, values were converted to wet tissue weight assuming that fish moisture content (by mass) is 80.0 percent (Holcomb et al. 1976).

For both organic and inorganic compounds, reported field values were considered bioaccumulation factors (*BAF*s) based on contributions of compounds from food sources as well as media. Therefore, field values were converted to *BCF*s based on the trophic level of the test organism using the following equation:

$$BCF = (BAF_{TLn} / FCM_{TLn}) - 1 \qquad \text{Equation C-1-6}$$

where

BAF_{TLn}	=	The reported field bioaccumulation factor for the trophic level "n" of the study species.
FCM_{TLn}	=	The food chain multiplier for the trophic level "n" of the study species.

Organics Reported field values for organic compounds were assumed to be total compound concentrations in water and, therefore, were converted to dissolved compound concentrations in water using the following equation from U.S. EPA (1995b):

$$BAF\ (\text{dissolved}) = (BAF\ (\text{total}) / f_{fd}) - 1 \qquad \text{Equation C-1-7}$$

where

BAF (dissolved)	=	*BAF* based on dissolved concentration of compound in water
BAF (total)	=	*BAF* based on the field derived data for total concentration of compound in water
f_{fd}	=	Fraction of compound that is freely dissolved in the water

and,

f_{fd}	=	1 / [1 + ((DOC x K_{ow}) / 10) + (POC x K_{ow})]
DOC	=	Dissolved organic carbon, Kg of organic carbon / L of water (2.0 x 10^{-06} Kg/L)
K_{ow}	=	Octanol-water partition coefficient of the compound, as reported in U.S. EPA (1994a)
POC	=	Particulate organic carbon, Kg of organic carbon / L of water (7.5 x 10^{-09} Kg/L)

Laboratory data were assumed to be based on dissolved compound concentrations.

For organics for which no field or laboratory data were available, the following regression equation was used to calculate the recommended *BCF* values:

$$log\ BCF = 0.91 \times log\ K_{ow} - 1.975 \times log\ (6.8E\text{-}07 \times K_{ow} + 1.0) - 0.786 \qquad \text{Equation C-1-8}$$

- Bintein, S., J. Devillers, and W. Karcher. 1993. "Nonlinear Dependence of Fish Bioconcentrations on n-Octanol/Water Partition Coefficients." *SAR and QSAR in Environmental Research*. Vol. 1. Pages 29-39.

<u>*Inorganics*</u> For inorganic compounds with no available field or laboratory data, the recommended *BCF* values were estimated as the arithmetic average of the available *BCF* values reported for other inorganics.

C-1.6 SEDIMENT-TO-BENTHIC INVERTEBRATE BIOCONCENTRATION FACTORS

Experimental data for a variety of benthic infauna, worms, insects, and other invertebrates were used to determine the recommended *BCF* values for sediment-to-benthic invertebrate (see Table C-6). As necessary, values were converted to wet tissue weight assuming that benthic invertebrate moisture content (by mass) is 83.3 percent (Pietz et al. 1984).

<u>*Organics*</u> For organic compound (including PCDDs and PCDFs) with no available field or laboratory data, the recommended *BCF* values were determined using the following regression equation:

$$log\ BCF = 0.819 \times log\ K_{ow} - 1.146 \qquad \text{Equation C-1-9}$$

- Southworth, G.R., J.J. Beauchamp, and P.K. Schmieder. 1978. "Bioaccumulation Potential of Polycyclic Aromatic Hydrocarbons in *Daphnia Pulex.*" *Water Research*. Volume 12. Pages 973-977.

<u>*Inorganics*</u> For inorganic compound with no available field or laboratory data, the recommended *BCF* values were estimated as the arithmetic average of the available *BCF* values for other inorganics.

C-1.7 AIR-TO-PLANT BIOCONCENTRATION FACTORS

The air-to-plant bioconcentration (*Bv*) factor (see Table C-7) is defined as the ratio of compound concentrations in exposed aboveground plant parts to the compound concentration in air. Bv values in Table C-7 are reported on dry-weight basis since the plant concentration equations (see Chapter 3) already include a dry-weight to wet-weight conversion factor.

Organics For organics (excluding PCDDs and PCDFs), the air-to-plant bioconcentration factor was calculated using regression equations derived for azalea leaves in the following documents:

- Bacci E., D. Calamari, C. Gaggi, and M. Vighi. 1990. "Bioconcentration of Organic Chemical Vapors in Plant Leaves: Experimental Measurements and Correlation." *Environmental Science and Technology*. Volume 24. Number 6. Pages 885-889.

- Bacci E., M. Cerejeira, C. Gaggi, G. Chemello, D. Calamari, and M. Vighi. 1992. "Chlorinated Dioxins: Volatilization from Soils and Bioconcentration in Plant Leaves." *Bulletin of Environmental Contamination and Toxicology*. Volume 48. Pages 401-408.

Bacci et al. (1992) developed a regression equation using empirical data collected for the uptake of 1,2,3,4-TCDD in azalea leaves and data obtained from Bacci et al. (1990). The bioconcentration factor obtained was included in a series of 14 different organic compounds to develop a correlation equation with K_{ow} and H (defined below). Bacci et al. (1992) derived the following equations:

$$\log B_{vol} = 1.065 \log K_{ow} - \log \left(\frac{H}{RT}\right) - 1.654 \qquad (r = 0.957) \qquad \text{Equation C-1-10}$$

$$Bv = \frac{\rho_{air} \cdot B_{vol}}{(1 - f_{water}) \cdot \rho_{forage}} \qquad \text{Equation C-1-11}$$

where

B_{vol}	=	Volumetric air-to-plant biotransfer factor (fresh-weight basis)
Bv	=	Air-to-plant biotransfer factor (dry-weight basis)
ρ_{air}	=	1.19 g/L (Weast 1986)
ρ_{forage}	=	770 g/L (Macrady and Maggard 1993)
f_{water}	=	0.85 (fraction of forage that is water—Macrady and Maggard [1993])
H	=	Henry's Law constant (atm-m^3/mole)
R	=	Universal gas constant (atm-m^3/mole °K)
T	=	Temperature (25°C, 298°K)

Equations C-1-10 and C-1-11 are used to calculate *Bv* values (see Table C-7) using the recommended values of H and K_{ow} provided in Appendix A at a temperature (T) of 25 °C or 298.1 K. The following uncertainty should be noted with use of *Bv* values calculated using these equations:

- For organics (except PCDDs and PCDFs), U.S. EPA (1993) recommended that *Bv* values be reduced by a factor of 10 before use. This was based on the work conducted by U.S. EPA (1993) for U.S. EPA (1994b) as an interim correction factor. Welsch-Pausch, McLachlan, and Umlauf (1995) conducted experiments to determine concentrations of PCDDs and PCDFs in air and resulting biotransfer to welsh ray grass. This was documented in the following:

  - Welsch-Pausch, K.M. McLachlan, and G. Umlauf. 1995. "Determination of the Principal Pathways of Polychlorinated Dibenzo-p-dioxins and Dibenzofurans to Lolium Multiflorum (Welsh Ray Grass)". *Environmental Science and Technology*. 29: 1090-1098.

  A follow-up study based on Welsch-Pausch, McLachlan, and Umlauf (1995) experiments was conducted by Lorber (1995) (see discussion below for PCDDs and PCDFs). In a following publication, Lorber (1997) concluded that the Bacci factor reduced by a factor of 100 was close in line with observations made by him through various studies, including the Welsch-Pausch, McLachlan, and Umlauf (1995) experiments. Therefore, this guidance recommends that *Bv* values be calculated using the Bacci, Cerejeira, Gaggi, Chemello, Calamari, and Vighi (1992) correlation equations and then reduced by a factor of 100 for all organics, excluding PCDDs and PCDFs.

PCDDs and PCDFs For PCDDs and PCDFs, *Bv* values, on a dry weight basis, were obtained from the following:

- Lorber, M., and P. Pinsky. 1999. "An Evaluation of Three Empirical Air-to-Leaf Models for Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans." National Center for Environmental Assessment (NCEA). U. S. EPA, 401 M St. SW, Washington, DC. *Accepted for Publication in Chemosphere*.

U.S. EPA (1993) stated that, for dioxin-like compounds, the use of the Bacci, Cerejeira, Gaggi, Chemello, Calamari, and Vighi (1992) equations may overpredict *Bv* values by a factor of 40. This was because the Bacci, Calamari, Gaggi, and Vighi (1990) and Bacci, Cerejeira, Gaggi, Chemello, Calamari, and Vighi (1992) experiments did not take photodegradation effects into account. Therefore, *Bv* values calculated using Equations C-10 and C-11 were recommended to be reduced by a factor of 40 for dioxin-like compounds.

However, according to Lorber (1995), the Bacci algorithm divided by 40 may not be appropriate because (1) the physical and chemical properties of dioxin congeners are generally outside the range of the 14 organic compounds used by Bacci, Calamari, Gaggi, and Vighi (1990), and (2) the factor of 40 derived from one experiment on 2,3,7,8-TCDD may not apply to all dioxin congeners.

Welsch-Pausch, McLachlan, and Umlauf (1995) conducted experiments to obtain data on uptake of PCDDs and PCDFs from air to *Lolium Multiflorum* (Welsh Ray grass). The data includes grass concentrations and air concentrations for dioxin-congener groups, but not the invidual congeners. Lorber (1995) used data from Welsch-Pausch, McLachlan, and Umlauf (1995) to develop an air-to-leaf transfer factor for each dioxin-congener group. *Bv* values developed by Lorber (1995) were about an order of magnitude less than values that would have been calculated using the Bacci, Calamari, Gaggi, and Vighi (1990; 1992) correlation equations. Lorber (1995) speculated that this difference could be attributed to several factors including experimental design, climate, and lipid content of plant species used.

Lorber (1999) conducted an evaluation of three empirical air-to-leaf models for estimating grass concentraions of PCDDs and PCDFs from air concentrations of these compounds described and tested against field data. *Bv* values recommended for PCDDs and PCDFs in this guidance were obtained from the experimentally derived values of Lorber (1999).

Metals For metals, no literature sources were available for *Bv* values. U.S. EPA (1995a) quoted from the following document, that metals were assumed not to experience air to leaf transfer:

- Belcher, G.D., and C.C. Travis. 1989. "Modeling Support for the RURA and Municipal Waste Combustion Projects: Final Report on Sensitivity and Uncertainty Analysis for the Terrestrial Food Chain Model." Interagency Agreement No. 1824-A020-A1. Office of Risk Analysis, Health and Safety Research Division. Oak Ridge National Laboratory. Oak Ridge, Tennessee. October.

Consistent with the above references, *Bv* values for metals (excluding elemental mercury) were assumed to be zero (see Table C-7).

Mercuric Compounds Mercury emissions are assumed to consist of both the elemental and divalent forms. However, only small amounts of elemental mercury is assumed to be deposited (see Chapter 2). Elemental mercury either dissipates into the global cycle or is converted to the divalent form. Methyl mercury is assumed not to exist in the stack emissions or in the air phase. Consistent with various discussions in Chapter 2 concerning mercury, (1) elemental mercury reaching or depositing onto the plant surfaces is negligible, and (2) biotransfer of methyl mercury from air is zero. This is based on assumptions made regarding speciation and fate and transport of mercury from stack emissions. Therefore, the *Bv* value for (1) elemental mercury was assumed to be zero, and (2) methyl mercury was assumed not to be applicable. *Bv* values for mercuric chloride (dry weight basis) were obtained from U.S. EPA (1997).

It should be noted that uptake of mercury from air into the aboveground plant tissue is primarily in the divalent form. A part of the divalent form of mercury is assumed to be converted to the methyl mercury form once in the plant tissue.

REFERENCES
APPENDIX C TEXT

Bacci E., D. Calamari, C. Gaggi, and M. Vighi. 1990. "Bioconcentration of Organic Chemical Vapors in Plant Leaves: Experimental Measurements and Correlation." *Environmental Science and Technology*. Volume 24. Number 6. Pages 885-889.

Bacci E., M. Cerejeira, C. Gaggi, G. Chemello, D. Calamari, and M. Vighi. 1992. "Chlorinated Dioxins: Volatilization from Soils and Bioconcentration in Plant Leaves." *Bulletin of Environmental Contamination and Toxicology*. Volume 48. Pages 401-408.

Baes, C.F., R.D. Sharp, A.L. Sjoreen, and R.W. Shor. 1984. "Review and Analysis of Parameters and Assessing Transport of Environmentally Released Radionuclides through Agriculture." Oak Ridge National Laboratory. Oak Ridge, Tennessee.

Belcher, G.D., and C.C. Travis. 1989. "Modeling Support for the RURA and Municipal Waste Combustion Projects: Final Report on Sensitivity and Uncertainty Analysis for the Terrestrial Food Chain Model." Interagency Agreement No. 1824-A020-A1. Office of Risk Analysis, Health and Safety Research Division. Oak Ridge National Laboratory. Oak Ridge, Tennessee. October.

Bintein, S., J. Devillers, and W. Karcher. 1993. "Nonlinear Dependence of Fish Bioconcentrations on n-Octanol/Water Partition Coefficients." *SAR and QSAR in Environmental Research.* Vol. 1. Pages 29-39.

Holcombe, G.W., D.A. Benoit, E.N. Leonard, and J.M. McKim. 1976. "Long-term Effects of Lead Exposure on Three Generations of Brook Trout (*Salvenius fontinalis*)." *Journal, Fisheries Research Board of Canada*. Volume 33. Pages 1731-1741.

Isensee, A.R., P.C. Kearney, E.A. Woolson, G.E. Jones, and V.P. Williams. 1973. "Distribution of Alkyl Arsenicals in Model Ecosystems." *Environmental Science and Technology.* Volume 7, Number 9. Pages 841-845.

Lorber, M. 1995. "Development of an Air-to-plant Vapor Phase Transfer for Dioxins and Furans. Presented at the 15th International Symposium on Chlorinated Dioxins and Related Compounds". August 21-25, 1995 in Edmonton, Canada. Abstract in *Organohalogen Compounds*. 24:179-186.

Lorber, M., and P. Pinsky. 1999. "An Evaluation of Three Empirical Air-to-Leaf Models for Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans." National Center for Environmental Assessment (NCEA). U. S. EPA, 401 M St. SW, Washington, DC. *Accepted for Publication in Chemosphere.*

McCrady, J.K., S.P. Maggard. 1993. "Uptake and Photodegradation of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Sorbed to Grass Foliage." *Environmental Science and Technology*. 27:343-350.

Pietz, R.I., J.R. Peterson, J.E. Prater, and D.R. Zenz. 1984. "Metal Concentrations in Earthworms From Sewage Sludge-Amended Soils at a Strip Mine Reclamation Site." *J. Environmental Qual.* Vol. 13, No. 4. Pp 651-654.

Southworth, G.R., J.J. Beauchamp, and P.K. Schmieder. 1978. "Bioaccumulation Potential of Polycyclic Aromatic Hydrocarbons in *Daphnia Pulex." Water Research*. Volume 12. Pages 973-977.

Travis, C.C., and A.D. Arms. 1988. "Bioconcentration of Organics in Beef, Milk, and Vegetation." *Environmental Science and Technology*. 22:271-274.

U.S. EPA. 1993. *Review Draft Addendum to the Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions*. Office of Health and Environmental Assessment. Office of Research and Development. EPA-600-AP-93-003. November 10.

U.S. Environmental Protection Agency (U.S. EPA). 1994a. *Draft Report Chemical Properties for Soil Screening Levels*. Prepared for the Office of Emergency and Remedial Response. Washington, D.C. July 26.

U.S. EPA. 1994b. *Estimating Exposure to Dioxin-Like Compounds*. Draft Report. Office of Research and Development. Washington, D.C. EPA/600/6-88/005Ca,b,c. June.

U.S. EPA. 1995a. *Review Draft Development of Human Health-Based and Ecologically-Based Exit Criteria for the Hazardous Waste Identification Project*. Volumes I and II. Office of Solid Waste. March 3.

U.S. EPA. 1995b. Great Lakes Water Quality Initiative Technical Support Document for the Procedure to Determine Bioaccumulation Factors. EPA-820-B-95-005. Office of Water, Washington, D.C. March.

U.S. EPA. 1997. *Mercury Study Report to Congress, Volumes I through VIII*. Office of Air Quality Planning and Standards and ORD. EPA/452/R-97-001. December.

U.S. EPA. 1998. *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilitites*. External Peer Review Draft. U.S. EPA Region 6 and U.S. EPA OSW. Volumes 1-3. EPA530-D-98-001A. July.

Veith, G.D., K.J. Macek, S.R. Petrocelli, and J. Carroll. 1980. "An Evaluation of Using Partition Coefficients and Water Solubility to Estimate Bioconcentration Factors for Organic Chemicals in Fish." Pages 116-129. In J. G. Eaton, P. R. Parrish, and A. C. Hendricks (eds.), *Aquatic Toxicology*. ASTM STP 707. American Society for Testing and Materials, Philadelphia.

Welsch-Pausch, K.M. McLachlan, and G. Umlauf. 1995. "Determination of the Principal Pathways of Polychlorinated Dibenzo-p-dioxins and Dibenzofurans to Lolium Multiflorum (Welsh Ray Grass)". *Environmental Science and Technology*. 29: 1090-1098.

Weast, R.C. 1986. *Handbook of Chemistry and Physics*. 66th Edition. Cleveland, Ohio. CRC Press.

MEDIA-TO-RECEPTOR *BCF* VALUES

Screening Level Ecological Risk Assessment Protocol

August 1999

TABLE C-1

SOIL-TO-SOIL INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC/kg wet tissue) / (mg COPC/kg dry soil)

15Reported Values[a]	References	Experimental Parameters	Species
Dioxins and Furans			
Compound: 2,3,7,8-tetrachlorodibenzo-p-dioxin			Recommended BCF Value: 1.59
The BCF was calculated using the geometric mean of 5 laboratory values for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) as follows:			
14.5	Martinucci, Crespi, Omodeo, Osella, and Traldi (1983)	20-day exposure	Not specified
9.41 0.64 0.68 0.17	Reinecke and Nash (1984)	20-day exposure	*Allolobaphora caliginosa* *Lumbricus rubellus*
Compound: 1,2,3,7,8-pentachlorodibenzo-p-dioxin			Recommended Value: 1.46
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1.59 x 0.92 =1.46			
Compound: 1,2,3,4,7,8-hexachlorodibenzo-p-dioxin			Recommended Value: 0.49
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1.59 x 0.31 =0.49			
Compound: 1,2,3,6,7,8-hexachlorodibenzo-p-dioxin			Recommended Value: 0.19
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1.59 x 0.12 = 0.19			
Compound: 1,2,3,7,8,9-hexachlorodibenzo-p-dioxin			Recommended Value: 0.22
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1.59 x 0.14 = 0.22			
Compound: 1,2,3,4,6,7,8,-heptachlorodibenzo-p-dioxin			Recommended Value: 0.081
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1.59 x 0.051 = 0.081			
Compound: Octachlorodibenzo-p-dioxin			Recommended Value: 0.019
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1.59 x 0.012 = 0.019			
Compound: 2,3,7,8-tetrachlorodibenzofuran			Recommended BCF Value: 1.27
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1.59 x 0.80 =1.27			
Compound: 1,2,3,7,8-pentachlorodibenzofuran			Recommended BCF Value: 0.32

TABLE C-1

SOIL-TO-SOIL INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC/kg wet tissue) / (mg COPC/kg dry soil)

16Reported Values[a]	References	Experimental Parameters	Species
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1.59 x 0.22 = 0.32			
Compound: 2,3,4,7,8-pentachlorodibenzofuran			Recommended BCF Value: 2.54
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1.59 x 1.6 =2.54			
Compound: 1,2,3,4,7,8-hexachlorodibenzofuran			Recommended BCF Value: 0.121
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1.59 x 0.076 = 0.121			
Compound: 1,2,3,6,7,8-hexachlorodibenzofuran			Recommended BCF Value: 0.30
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1.59 x 0.19 = 0.30			
Compound: 2,3,4,6,7,8-hexachlorodibenzofuran			Recommended BCF Value: 1.07
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1.59 x 0.67 =1.07			
Compound: 1,2,3,7,8,9-hexachlorodibenzofuran			Recommended BCF Value: 1.00
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1.59 x 0.63 = 1.00			
Compound: 1,2,3,4,6,7,8-heptachlorodibenzofuran			Recommended BCF Value: 0.017
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1.59 x 0.011 = 0.017			
Compound: 1,2,3,4,7,8,9-heptachlorodibenzofuran			Recommended BCF Value: 0.62
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1.59 x 0.39 = 0.62			
Compound: Octochlorodibenzofuran			Recommended BCF Value: 0.025
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1.59 x 0.016 = 0.025			
Polynuclear Aromatic Hydrocarbons (PAHs)			
Compound: Benzo(a)pyrene			Recommended BCF Value: 0.07
The BCF was calculated using the geometric mean of 6 laboratory values for benzo(a)pyrene. The values reported in Rhett, Simmers, and Lee (1988) were converted to earthworm wet weight over soil dry weight using a conversion factor of 5.99[a].			

TABLE C-1

SOIL-TO-SOIL INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC/kg wet tissue) / (mg COPC/kg dry soil)

17Reported Values[a]	References	Experimental Parameters	Species
0.12 0.14 0.05 0.04 0.06 0.06	Rhett, Simmers, and Lee (1988)	28-day exposure	*Eisenia foetida*
Compoound: Benzo(a)anthracene			Recommended BCF Value: 0.03
The BCF was calculated using the geometric mean of 15 values for benzo(a)anthracene. The values reported in Marquenie, Simmers, and Kay (1987) were converted to wet weight over dry weight using a conversion factor of 5.99 [a].			
0.07 0.02 0.08 0.02 0.05 0.07 0.07 0.003 0.07 0.05 0.02 0.01 0.01 0.01 0.09	Marquenie, Simmers, and Kay (1987)	32-day exposure	*Eisenia foetida*
Compound: Benzo(b)fluoranthene			Recommended BCF Value: 0.07
The BCF was calculated using the geometric mean of 6 laboratory values for benzo(b)fluoranthene. The values reported in Rhett, Simmers, and Lee (1988) were converted to wet weight over dry weight using a conversion factor of 5.99 [a].			
0.11 0.16 0.06 0.04 0.06 0.05	Rhett, Simmers, and Lee (1988)	28-day exposure	*Eisenia foetida*
Compound: Benzo(k)fluoranthene			Recommended BCF Value: 0.08
The BCF was calculated using the geometric mean of 15 laboratory values for benzo(k)fluoranthene. The values reported in Marquenie, Simmers, and Kay (1987) were converted to wet weight over dry weight using a conversion factor of 5.99[a].			
0.13 0.15 0.12 0.11 0.07 0.24 0.12 0.02 0.10 0.03 0.07 0.03 0.06 0.04	Marquenie, Simmers, and Kay (1987)	32-day exposure	*Eisenia foetida*

TABLE C-1

SOIL-TO-SOIL INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC/kg wet tissue) / (mg COPC/kg dry soil)

18Reported Values[a]	References	Experimental Parameters	Species
Compound: Chrysene			Recommended BCF Value: 0.04
The BCF was calculated using the geometric mean of 15 laboratory values for chrysene. The values reported in Marquenie, Simmers, and Kay (1987) were converted to wet weight over dry weight using a conversion factor of 5.99 [a].			
0.06 0.03 0.09 0.04 0.09 0.07 0.14 0.007 0.14 0.02 0.04 0.02 0.03 0.01 0.10	Marquenie, Simmers, and Kay (1987)	32-day exposure	*Eisenia foetida*
Compound: Dibenzo(a,h)anthracene			Recommended BCF Value: 0.07
The BCF was calculated using the geometric mean of 15 laboratory values for Dibenz(a,h)anthrcene. The values reported in Marquenie, Simmers, and Kay (1987) were converted to wet weight over dry weight using a conversion factor of 5.99 [a].			
0.18 0.13 0.10 0.06 0.06 0.07 0.04 0.10 0.12 0.05 0.07 0.04 0.04 0.05 0.05	Marquenie, Simmers, and Kay (1987)	32-day exposure	*Eisenia foetida*
Compound: Indeno(1,2,3-cd)pyrene			Recommended BCF Value: 0.08
The BCF was calculated using the geometric mean of 6 laboratory values for indeno(1,2,3-cd)pyrene. The values reported in Rhett, Simmers, and Lee (1988) were converted to wet weight over dry weight using a conversion factor of 5.99[a].			
0.07 0.13 0.08 0.09 0.06 0.05	Rhett, Simmers, and Lee (1988)	28-day exposure	*Eisenia foetida*
Polychlorinated Biphenyls (PCBs)			
Compound: Aroclor 1016			Recommended BCF Value: 1.13

TABLE C-1

SOIL-TO-SOIL INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC/kg wet tissue) / (mg COPC/kg dry soil)

19Reported Values[a]	References	Experimental Parameters	Species
The BCF was calculated using the geometric mean of 7 laboratory values for a mixture of PCB congeners. The values reported in Rhett, Simmers, and Lee (1988) and Kreis, Edwards, Cuendet, and Tarradellas (1987) were converted to wet weight over dry weight using a conversion factor of 5.99 [a].			
1.43 0.81 0.75 1.07 1.17	Rhett, Simmers, and Lee (1988)	28-day exposure	*Eisenia foetida*
1.92 1.16	Kreis, Edwards, Cuendet, and Tarradellas (1987)	Chronic exposure	*Nicodrilus* sp.
Compound: Aroclor 1254			Recommended BCF Value: 1.13
The BCF was calculated using the geometric mean of 7 laboratory values for a mixture of PCB congeners. The values reported in Rhett, Simmers, and Lee (1988) and Kreis, Edwards, Cuendet, and Tarradellas (1987) were converted to wet weight over dry weight using a conversion factor of 5.99 [a].			
1.43 0.81 0.75 1.07 1.17	Rhett, Simmers, and Lee (1988)	28-day exposure	*Eisenia foetida*
1.92 1.16	Kreis, Edwards, Cuendet, and Tarradellas (1987)	Chronic exposure	*Nicodrilus* sp.

TABLE C-1

SOIL-TO-SOIL INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC/kg wet tissue) / (mg COPC/kg dry soil)

20Reported Values[a]	References	Experimental Parameters	Species
Nitroaromatics			
Compound: 1,3-Dinitrobenzene			Recommended BCF Value: 1.19
No empirical data were available for 1,3-dinitrobenzene or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 1.491 (U.S. EPA 1994b).			
Compound: 2,4-Dinitrotoluene			Recommended BCF Value: 3.08
No empirical data were available for 2,4-dinitrotoluene or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 1.996 (U.S. EPA 1994b).			
Compound: 2,6-Dinitrotoluene			Recommended BCF Value: 2.50
No empirical data were available for 2,6-dinitrotoluene or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 1.886 (U.S. EPA 1994b).			
Compound: Nitrobenzene			Recommended BCF Value: 2.26
No empirical data were available for nitrobenzene or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 1.833 (U.S. EPA 1994b).			
Compound: Pentachloronitrobenzene			Recommended BCF Value: 451
No empirical data were available for pentachloronitrobenzene or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 4.640 (U.S. EPA 1994b).			
Phthalate Esters			
Compound: Bis(2-ethylhexyl)phthalate			Recommended BCF Value: 1,309
No empirical data were available for bis(2-ethylhexyl)phthalate or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 5.205 (U.S. EPA 1994b).			
Compound: Di(n)octyl phthalate			Recommended BCF Value: 3,128,023
No empirical data were available for di(n)octyl phthalate or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 9.330 (U.S. EPA 1994b).			

TABLE C-1

SOIL-TO-SOIL INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC/kg wet tissue) / (mg COPC/kg dry soil)

21Reported Values[a]	References	Experimental Parameters	Species
Volatile Organic Compounds			
Compound: Acetone			Recommended BCF Value: 0.05
No empirical data were available for acetone or for a structurally-similar surrogate compound.The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder (1978), where log K_{ow} = -0.222 (Karickoff and Long 1995).			
Compound: Acrylonitrile			Recommended BCF Value: 0.11
No empirical data were available for acrylonitrile or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 0.250 (Karickoff and Long 1995).			
Compound: Chloroform			Recommended BCF Value: 2.82
No empirical data were available for chloroform or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 1.949 (U.S. EPA 1994b).			
Compound: Crotonaldehyde			Recommended BCF Value: 0.20
No empirical data were available for crotonaldehyde or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 0.55 (Based on equations developed by Hansch and Leo 1979, calculated in NRC (1981)).			
Compound: 1,4-Dioxane			Recommended BCF Value: 0.04
No empirical data were available for 1,4-dioxane or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = -0.268 (U.S. EPA 1995a).			
Compound: Formaldehyde			Recommended BCF Value: 0.14
No empirical data were available for formaldehyde or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 0.342 (U.S. EPA 1995a).			
Compound: Vinyl chloride			Recommended BCF Value: 0.62
No empirical data were available for vinyl chloride or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 1.146 (U.S. EPA 1994b).			

TABLE C-1

SOIL-TO-SOIL INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC/kg wet tissue) / (mg COPC/kg dry soil)

22Reported Values[a]	References	Experimental Parameters	Species
Other Chlorinated Organics			
Compound: Carbon Tetrachloride			Recommended BCF Value: 12.0
No empirical data were available for carbon tetrachloride or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 2.717 (U.S. EPA 1994b).			
Compound: Hexachlorobenzene			Recommended BCF Value: 2,296
No empirical data were available for hexachlorobenzene or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 5.503 (U.S. EPA 1994b).			
Compound: Hexachlorobutadiene			Recommended BCF Value: 535
No empirical data were available for hexachlorobutadiene or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978) where log K_{ow} = 4.731 (U.S. EPA 1994b).			
Compound: Hexachlorocyclopentadiene			Recommended BCF Value: 745
No empirical data were available for hexachlorocyclopentadiene or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder (1978), where log K_{ow} = 4.907 (U.S. EPA 1994b).			
Compound: Pentachlorobenzene			Recommended BCF Value: 1,050
No empirical data were available for pentachlorobenzene or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder (1978), where log K_{ow} = 5.088 (U.S. EPA 1994b).			
Compound: Pentachlorophenol			Recommended BCF Value: 1,034
No empirical data were available for pentachlorophenol or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder (1978), where log K_{ow} = 5.080 (U.S. EPA 1994b).			
Pesticides			
Compound: 4,4'-DDE			Recommended BCF Value: 1.26
Empirical data for 4,4'-DDE were not available. The BCF was calculated using the geometric mean of 13 laboratory values for 4,4'-DDT. The first six values reported in Gish (1970), Davis (1971), and Beyer and Gish (1980) were converted to wet weight over dry weight using a conversion factor of 5.99[a].			
0.08 0.39 0.29 0.41	Davis (1971)	Chronic exposure	*Lumbricus terrestris*

TABLE C-1

SOIL-TO-SOIL INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC/kg wet tissue) / (mg COPC/kg dry soil)

23Reported Values[a]	References	Experimental Parameters	Species
0.83	Beyer and Gish (1980)	Chronic exposure	*Aporrectodea trapezoides* *Aparrectodea turgida* *Allolobophora chlorotica* *Lumbricus terrestris*
0.85 1.20 2.40 4.60 2.50 1.60	Wheatley and Hardman (1968)	Chronic exposure	Not specified
10.00 14.46	Yadav, Mittad, Agarwal, and Pillai (1981)	Chronic exposure	*Pheretima posthuma*
Compound: Heptachlor			Recommended BCF Value: 1.40
Empirical data for heptachlor were not available. The BCF was calculated using 1 laboratory value for heptachlor epoxide. The value reported in Beyer and Gish (1980) was converted to wet weight over dry weight using a conversion factor of 5.99[a].			
1.40	Beyer and Gish (1980)	Chronic exposure	*Aporrectodea trapezoides* *Aparrectodea turgida* *Allolobophora chlorotica* *Lumbricus terrestris*
Compound: Hexachlorophene			Recommended BCF Value: 106,970
No empirical data were available for hexachlorophene or for a structurally-similar surrogate compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder (1978), where log K_{ow} = 7.540 (Karickoff and Long 1995).			
Inorganics			
Compound: Aluminum			Recommended BCF Value: 0.22
Empirical data for aluminum were not available. The recommended BCF is the arithmetic mean of the recommended values for those inorganics with empirical data available (arsenic, cadmium, chromium, copper, lead, inorganic mercury, nickel, and zinc).			
Compound: Antimony			Recommended BCF Value: 0.22
Empirical data for antimony were not available. The recommended BCF is the arithmetic mean of the recommended values for those inorganics with empirical data available (arsenic, cadmium, chromium, copper, lead, inorganic mercury, nickel, and zinc).			
Compound: Arsenic			Recommended BCF Value: 0.11

TABLE C-1

SOIL-TO-SOIL INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC/kg wet tissue) / (mg COPC/kg dry soil)

24Reported Values[a]	References	Experimental Parameters	Species
The BCF was calculated using the geometric mean of 5 laboratory values for arsenic as listed below. The values reported in Rhett, Simmers, and Lee (1988) were converted to wet weight over dry weight using a conversion factor of 5.99 [a].			
0.14 0.10 0.10 0.17 0.06	Rhett, Simmers, and Lee (1988)	28-day exposure	*Eisenia foetida*
Compound: Barium			Recommended BCF Value: 0.22
Empirical data for barium were not available. The recommended BCF is the arithmetic mean of the recommended values for those inorganics with empirical data available (arsenic, cadmium, chromium, copper, lead, inorganic mercury, nickel, and zinc).			
Compound: Beryllium			Recommended BCF Value: 0.22
Empirical data for beryllium were not available. The recommended BCF is the arithmetic mean of the recommended values for those inorganics with empirical data available (arsenic, cadmium, chromium, copper, lead, inorganic mercury, nickel, and zinc).			
Compound: Cadmium			Recommended BCF Value: 0.96
The BCF was calculated using the geometric mean of 22 laboratory values for cadmium. The values reported in Rhett, Simmers, and Lee (1988) and Simmers, Rhett, and Lee (1983) were converted to wet weight over dry weight using a conversion factor of 5.99[a].			
0.33 0.72 0.25 0.19 3.17 0.55 0.70 0.35	Rhett, Simmers, and Lee (1988)	28-day exposure	*Eisenia foetida*
0.13 0.50 0.29 8.77 1.25 7.86 0.17 6.67 0.11 3.95 8.01 1.50 4.39 2.10	Simmers, Rhett, and Lee (1983)	Chronic exposure	*Allolobophora longa* *A. caliginosa* *A. rosea* *A. chlorotica* *Lumbricus terrestris* *A. lumbricus* *Octolasium* sp.
Compound: Chromium (total)			Recommended BCF Value: 0.01
The BCF was calculated using the geometric mean of 3 laboratory values for chromium. The values reported in Rhett, Simmers, and Lee (1988) were converted to wet weight over dry weight using a conversion factor of 5.99[a].			

TABLE C-1

SOIL-TO-SOIL INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC/kg wet tissue) / (mg COPC/kg dry soil)

25Reported Values[a]	References	Experimental Parameters	Species
0.004 0.004 0.05	Rhett, Simmers, and Lee (1988)	28-day exposure	*Eisenia foetida*
Compound: Copper			Recommended BCF Value: 0.04
The BCF was calculated using the geometric mean of 9 laboratory values for copper. The values reported in Rhett, Simmers, and Lee (1988) were converted to wet weight over dry weight using a conversion factor of 5.99[a].			
0.02 0.03 0.01 0.03 0.20 0.03 0.04 0.04	Rhett, Simmers, and Lee (1988)	28-day exposure	*Eisenia foetida*
0.24	Ma (1987)	Chronic exposure	*Lumbricus rubellus*

TABLE C-1

SOIL-TO-SOIL INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC/kg wet tissue) / (mg COPC/kg dry soil)

26Reported Values[a]	References	Experimental Parameters	Species
Compound: Cyanide (total)			Recommended BCF Value: 1.12
Empirical data for cyanide were not available. The recommended BCF is the arithmetic mean of the recommended values for those inorganics with empirical data available (arsenic, cadmium, chromium, copper, lead, inorganic mercury, methyl mercury, nickel, and zinc).			
Compound: Lead			Recommended BCF Value: 0.03
The BCF was calculated using the geometric mean of 6 laboratory values for lead. The values reported in Rhett, Simmers, and Lee (1988), Ma (1987), and Van Hook (1974) were converted to wet weight over dry weight using a conversion factor of 5.99[a].			
0.02 0.006 0.07	Rhett, Simmers, and Lee (1988)	28-day exposure	*Eisenia foetida*
0.19	Ma (1987)	Chronic exposure	Not specified
0.12	Ma (1982)		Not specified
0.03	Van Hook (1974)	Chronic exposure	*Alabophera* sp. *Lumbricus* sp. *Octolasium* sp.
Compound: Mercuric chloride			Recommended BCF Value: 0.04
The BCF was calculated using the geometric mean of 5 laboratory values for mercuric chloride. The values reported in Rhett, Simmers, and Lee (1988) were converted to wet weight over dry weight using a conversion factor of 5.99[a].			
0.04 0.04 0.06 0.04 0.02	Rhett, Simmers, and Lee (1988)	28-day exposure; tissue concentrations of <0.05 were reported for the first three ratios, however, a concentration of 0.05 was used in order to calculate a conservative BCF value.	*Eisenia foetida*
Compound: Methyl mercury			Recommended BCF Value: 8.50
The BCF was calculated using the geometric mean of 3 laboratory values as presented below. The values reported in Beyer, Cromartie, and Moment (1985) were earthworm wet weight over soil wet weight with 60 percent soil moisture. The soil weight was converted to dry weight to result in the values presented below:			
8.25 8.31 8.95	Beyer, Cromartie, and Moment (1985)	6 to 12-week exposure	*Eisenia foetida*

TABLE C-1

SOIL-TO-SOIL INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC/kg wet tissue) / (mg COPC/kg dry soil)

27Reported Values[a]	References	Experimental Parameters	Species
Compound: Nickel			Recommended BCF Value: 0.02
The BCF was calculated using the geometric mean of 3 laboratory values for nickel. The values reported in Rhett, Simmers, and Lee (1988) were converted to wet weight over dry weight using a conversion factor of 5.99[a].			
0.03 0.01 0.04	Rhett, Simmers, and Lee 1988	28-day exposure	*Eisenia foetida*
Compound: Selenium			Recommended BCF Value: 0.22
Empirical data for selenium were not available. The recommended BCF is the arithmetic mean of the recommended values for those inorganics with empirical data available (arsenic, cadmium, chromium, copper, lead, inorganic mercury, nickel, and zinc).			
Compound: Silver			Recommended BCF Value: 0.22
Empirical data for silver were not available. The recommended BCF is the arithmetic mean of the recommended values for those inorganics with empirical data available (arsenic, cadmium, chromium, copper, lead, inorganic mercury, nickel, and zinc).			
Compound: Thallium			Recommended BCF Value: 0.22
Empirical data for thallium were not available. The recommended BCF is the arithmetic mean of the recommended values for those inorganics with empirical data available (arsenic, cadmium, chromium, copper, lead, inorganic mercury, nickel, and zinc).			

TABLE C-1

SOIL-TO-SOIL INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC/kg wet tissue) / (mg COPC/kg dry soil)

28Reported Values[a]	References	Experimental Parameters	Species
Compound: Zinc			Recommended BCF Value: 0.56
The BCF was calculated using the geometric mean of 5 laboratory values for zinc. The values reported in Rhett, Simmers, and Lee (1988), Ma (1987), and Van Hook (1974) were converted to wet weight over dry weight using a conversion factor of 5.99 [a].			
0.11 0.06 0.58	Rhett, Simmers, and Lee (1988)	28-day exposure	*Eisenia foetida*
10.79	Ma (1987)	Chronic exposure	Not specified
1.28	Van Hook (1974)	Chronic exposure	*Alabophera* sp. *Lumbricus* sp. *Octolasium* sp.

Notes:

(a) The reported values are presented as the amount of COPC in invertebrate tissue divided by the amount of COPC in the soil. If the values reported in the studies were presented as dry tissue weight over dry soil weight, they were converted to wet weight over dry weight by dividing the concentration in dry earthworm tissue weight by 5.99. This conversion factor assumes an earthworm's total weight is 83.3 percent moisture (Pietz et al. 1984).

The conversion factor was calculated as follows:

$$Conversion\ factor = \frac{1.0\ gram\ (g)\ earthworm\ total\ weight}{1.0\ g\ earthworm\ total\ weight - 0.833\ g\ earthworm\ wet\ weight}$$

TABLE C-2

SOIL-TO-PLANT AND SEDIMENT-TO- PLANT BIOCONCENTRATION FACTORS
(mg COPC/kg dry tissue) / (mg COPC/kg dry soil or sediment)

Reported Values	References	Experimental Parameters	Species
Dioxins and Furans			
Compound: 2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)			Recommended BCF Value: 0.0056
The BCF for these constituents were calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 6.64 (U.S. EPA 1994a).			
Compound: 1,2,3,7,8-Tetrachlorodibenzo-p-dioxin (1,2,3,7,8-PeCDD)			Recommended BCF Value: 0.0052
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 0.0056 x 0.92 =0.0052			
Compound: 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (1,2,3,4,7,8-HxCDD)			Recommended BCF Value: 0.0017
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 0.0056 x0.31 = 0.0017			
Compound: 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (1,2,3,6,7,8-HxCDD)			Recommended BCF Value: 0.00067
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 0.0056 x0.12 = 0.00067			
Compound: 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (1,2,3,7,8,9-HxCDD)			Recommended BCF Value: 0.00078
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 0.0056 x 0.14 = 0.00078			
Compound: 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (1,2,3,4,6,7,8-HpCDD)			Recommended BCF Value: 0.00029
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 0.0056 x0.051 = 0.00029			
Compound: Octachlorodibenzo-p-dioxin (OCDD)			Recommended BCF Value: 0.000067
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 0.0056 x 0.012 = 0.000067			
Compound: 2,3,7,8-Tetrachlorodibenzo-p-furan (2,3,7,8-TCDF)			Recommended BCF Value: 0.0045
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 0.0056 x0.80 = 0.0045			
Compound: 1,2,3,7,8-Pentachlorodibenzo-p-furan (1,2,3,7,8-PeCDF)			Recommended BCF Value: 0.0011
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 0.0056 x0.22 = 0.0011			
Compound: 2,3,4,7,8-Pentachlorodibenzo-p-furan (2,3,4,7,8-PeCDF)			Recommended BCF Value: 0.0090
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 0.0056 x1.6 = 0.0090			

TABLE C-2

SOIL-TO-PLANT AND SEDIMENT-TO- PLANT BIOCONCENTRATION FACTORS
(mg COPC/kg dry tissue) / (mg COPC/kg dry soil or sediment)

Reported Values	References	Experimental Parameters	Species
Compound: 1,2,3,4,7,8-Hexachlorodibenzo-p-furan (1,2,3,4,7,8-HxCDF)			Recommended BCF Value: 0.00043
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 0.0056 x 0.076 = 0.00043			
Compound: 1,2,3,6,7,8-Hexachlorodibenzo-p-furan (1,2,3,6,7,8-HxCDF)			Recommended BCF Value: 0.0011
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 0.0056 x0.19 = 0.0011			
Compound: 2,3,4,6,7,8-Hexachlorodibenzo-p-furan (2,3,4,6,7,8-HxCDF)			Recommended BCF Value: 0.0038
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 0.0056 x0.67 = 0.0038			
Compound: 1,2,3,7,8,9-Hexachlorodibenzo-p-furan (1,2,3,7,8,9-HxCDF)			Recommended BCF Value: 0.0035
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 0.0056 x0.63 = 0.0035			
Compound: 1,2,3,4,6,7,8-Heptachlorodibenzo-p-furan (1,2,3,4,6,7,8-HpCDF)			Recommended BCF Value: 0.000062
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =0.0056 x0.011 = 0.00062			
Compound: 1,2,3,4,7,8,9-Heptachlorodibenzo-p-furan (1,2,3,4,7,8,9-HpCDF)			Recommended BCF Value: 0.0022
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 0.0056 x0.39 = 0.0022			
Compound: Octachlorodibenzo-p-furan (OCDF)			Recommended BCF Value: 0.000090
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 0.0056 x0.016 = 0.000090			
Polynuclear Aromatic Hydrocarbons (PAH)			
Compound: Benzo(a)pyrene			Recommended BCF Value: 0.0
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 6.129 (U.S. EPA 1994b).			
Compound: Benzo(a)anthracene			Recommended BCF Value: 0.0202
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 5.679 (U.S. EPA 1994b).			
Compound Benzo(b)fluoranthene			Recommended BCF Value: 0.0101
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 6.202 (U.S. EPA 1994b).			
Compound: Benzo(k)fluoranthene			Recommended BCF Value: 0.0101

TABLE C-2

SOIL-TO-PLANT AND SEDIMENT-TO- PLANT BIOCONCENTRATION FACTORS
(mg COPC/kg dry tissue) / (mg COPC/kg dry soil or sediment)

Reported Values	References	Experimental Parameters	Species
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 6.2 (Karickhoff and Long 1995).			
Compound: Chrysene			Recommended BCF Value: 0.0187
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 5.739 (U.S. EPA 1994b).			
Compound: Dibenzo(a,h)anthracene			Recommended BCF Value: 0.0064
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 6.547 (U.S. EPA 1994b).			
Compound: Indeno(1,2,3-cd)pyrene			Recommended BCF Value: 0.0039
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 6.915 (U.S. EPA 1994b).			
Polychlorinated Biphenyls (PCBs)			
Compound: Aroclor 1016			Recommended BCF Value: 0.01
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988); using the log K_{ow} for Aroclor 1254, where log K_{ow}= 6.207 (U.S. EPA 1994b).			
Compound: Aroclor 1254			Recommended BCF Value: 0.01
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988); using the log K_{ow} for Aroclor 1254, where log K_{ow}= 6.207 (U.S. EPA 1994b).			
Nitroaromatics			
Compound: 1,3-Dinitrobenzene			Recommended BCF Value: 5.32
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 1.491 (U.S. EPA 1994b).			
Compound: 2,4-Dinitrotoluene			Recommended BCF Value: 2.72
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} =1.996 (U.S. EPA 1994b).			
Compound 2,6-Dinitrotoluene			Recommended BCF Value: 3.15
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 1.886 (U.S. EPA 1994b).			
Compound: Nitrobenzene			Recommended BCF Value: 3.38

TABLE C-2

SOIL-TO-PLANT AND SEDIMENT-TO- PLANT BIOCONCENTRATION FACTORS
(mg COPC/kg dry tissue) / (mg COPC/kg dry soil or sediment)

Reported Values	References	Experimental Parameters	Species
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 1.833 (U.S. EPA 1994b).			
Compound: Pentachloronitrobenzene			Recommended BCF Value: 0.08
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 4.640 (U.S. EPA 1994b).			
Phthalate Esters			
Compound: Bis(2-ethylhexyl)phthalate			Recommended BCF Value: 0.038
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 5.205 (U.S. EPA 1994b).			
Compound: Di(n)octyl phthalate			Recommended BCF Value: 0.000157
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 9.33 (U.S. EPA 1994b).			
Volatile organic compounds			
Compound: Acetone			Recommended BCF Value: 52
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = -0.222 (U.S. EPA 1994c).			
Compound: Acrylonitrile			Recommended BCF Value: 27.77
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 0.250 (Karickhoff and Long 1995).			
Compound: Chloroform			Recommended BCF Value: 2.9
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 1.949 (U.S. EPA 1994b).			
Compound: Crotonaldehyde			Recommended BCF Value: 18.63
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 0.55 (Hansch and Leo 1979).			
Compound: 1,4-Dioxane			Recommended BCF Value: 55.32
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = -0.268 (U.S. EPA 1995c).			
Compound: Formaldehyde			Recommended BCF Value: 24.57
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 0.342 (U.S. EPA (1995c).			
Compound: Vinyl chloride			Recommended BCF Value: 8.43

TABLE C-2

SOIL-TO-PLANT AND SEDIMENT-TO- PLANT BIOCONCENTRATION FACTORS
(mg COPC/kg dry tissue) / (mg COPC/kg dry soil or sediment)

Reported Values	References	Experimental Parameters	Species
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988). where log K_{ow} = 1.146 (U.S. EPA 1994b).			
Other Chlorinated Organics			
Compound: Carbon tetrachloride			Recommended BCF Value: 1.04
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 2.717 (U.S. EPA 1994b).			
Compound: Hexachlorobenzene			Recommended BCF Value: 0.0255
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 5.503 (U.S. EPA 1994b).			
Compound: Hexachlorobutadiene			Recommended BCF Value: 0.0714
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 4.731 (U.S. EPA 1994b).			
Compound: Hexachlorocyclopentadiene			Recommended BCF Value: 0.0565
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 4.907 (U.S. EPA 1994b).			
Compound: Pentachlorobenzene			Recommended BCF Value: 0.044
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 5.088 (U.S. EPA 1994b).			
Compound: Pentachlorophenol			Recommended BCF Value: 0.0449
The BCF was calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988), where log K_{ow} = 5.08 (U.S. EPA 1994b).			
Pesticides			
Compound: 4,4-DDE			Recommended BCF Value: 0.00937
The BCF for these constituents were calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988)., where log K_{ow} = 6.256 (U.S. EPA 1994b).			
Compound: Heptachlor			Recommended BCF Value: 0.0489
The BCF for these constituents were calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988)., where log K_{ow} = 5.015 (U.S. EPA 1994b).			
Compound: Hexachlorophene			Recommended BCF Value: 0.0017

TABLE C-2

SOIL-TO-PLANT AND SEDIMENT-TO- PLANT BIOCONCENTRATION FACTORS
(mg COPC/kg dry tissue) / (mg COPC/kg dry soil or sediment)

Reported Values	References	Experimental Parameters	Species
The BCF for these constituents were calculated using the following regression equation: log BCF = 1.588 - 0.578 x log K_{ow} (Travis and Arms 1988)., where log K_{ow} = 7.54 (Karickhoff and Long 1995).			
Inorganics			
Compound: Aluminum			Recommended BCF Value: 0.004
The BCF for this constituent was based on empirical data reported in Baes, Sharp, Sjoreen and Shor (1984). Experimental parameters were not reported.			
Compound: Antimony			Recommended BCF Value: 0.2
The BCF for this constituent was based on empirical data reported in Baes, Sharp, Sjoreen and Shor (1984). Experimental parameters were not reported.			
Compound: Arsenic			Recommended BCF Value: 0.036
The BCF for this constituent was based on empirical data reported in U.S. EPA (1992c). Experimental parameters were not reported.			
Compound Barium			Recommended BCF Value: 0.15
The BCF for this constituent was based on empirical data reported in Baes, Sharp, Sjoreen and Shor (1984). Experimental parameters were not reported.			
Compound: Beryllium			Recommended BCF Value: 0.01
The BCF for this constituent was based on empirical data reported in Baes, Sharp, Sjoreen and Shor (1984). Experimental parameters were not reported.			
Compound: Cadmium			Recommended BCF Value: 0.364
The BCF for this constituent was based on empirical data reported in U.S. EPA (1992c). Experimental parameters were not reported.			
Compound: Chromium (total)			Recommended BCF Value: 0.0075
The BCF for this constituent was based on empirical data reported in Baes, Sharp, Sjoreen and Shor (1984). Experimental parameters were not reported.			
Compound: Copper			Recommended BCF Value: 0.4
The BCF for this constituent was based on empirical data reported in Baes, Sharp, Sjoreen and Shor (1984). Experimental parameters were not reported.			
Compound: Cyanide (total)			Recommended BCF Value: No data
No empirical or K_{ow} data were available for this constituent.			
Compound: Lead			Recommended BCF Value: 0.045

TABLE C-2

SOIL-TO-PLANT AND SEDIMENT-TO- PLANT BIOCONCENTRATION FACTORS
(mg COPC/kg dry tissue) / (mg COPC/kg dry soil or sediment)

Reported Values	References	Experimental Parameters	Species
The BCF for this constituent was based on empirical data reported in Baes, Sharp, Sjoreen and Shor (1984). Experimental parameters were not reported.			
Compound: Mercuric chloride			Recommended BCF Value: 0.0375
The BCF was calculated using the geometric mean of 3 values for mercuric chloride ($HgCl_2$).			
0.022 0.032 0.075	Cappon (1981)	The values were derived from studies during one growing season using 20 food crop vegetables.	Not specified.
Compound: Methyl mercury			Recommended BCF Value: 0.137
The BCF was calculated using the geometric mean of 3 values for methyl mercury.			
0.062 0.149 0.277	Cappon (1981)	The values were derived from studies during one growing season using 20 food crop vegetables.	Not specified.
Compound: Nickel			Recommended BCF Value: 0.032
The BCF for this constituent was based on empirical data reported in U.S. EPA (1992c). Experimental parameters were not reported.			
Compound: Selenium			Recommended BCF Value: 0.016
The BCF for this constituent was based on empirical data reported in U.S. EPA (1992c). Experimental parameters were not reported.			
Compound: Silver			Recommended BCF Value: 0.4
The BCF for this constituent was based on empirical data reported in Baes, Sharp, Sjoreen and Shor (1984). Experimental parameters were not reported.			
Compound: Thallium			Recommended BCF Value: 0.004
The BCF for this constituent was based on empirical data reported in Baes, Sharp, Sjoreen and Shor (1984). Experimental parameters were not reported.			
Compound: Zinc			Recommended BCF Value: 0.0000000000012
The BCF for this constituent was based on empirical data reported in U.S. EPA (1992c). Experimental parameters were not reported.			

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
Dioxins and Furans			
Compound: 2,3,7,8-Tetrachlorodibenzo(p)dioxin (2,3,7,8-TCDD)			Recommended BCF Value: 1,560
The BCF value was calculated using the geometric mean of 2 values from data reported for 2,3,7,8-tetrachlorodibenzo(p)dioxin (2,3,7,8-TCDD).			
1,762 1,381	Yockim, Isensee, and Jones (1978)	32-day exposure duration	Daphnid; *Heliosoma* sp.
Compound: 1,2,3,7,8-Pentachlorodibenzo(p)dioxin (1,2,3,7,8-PeCDD)			Recommended BCF Value: 1,435
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1,560 x 0.92 =1,435			
Compound: 1,2,3,4,7,8-Hexachlorodibenzo(p)dioxin (1,2,3,4,7,8-HxCDD)			Recommended BCF Value: 483.6
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1,560 x 0.31 =483.6			
Compound: 1,2,3,6,7,8-Hexachlorodibenzo(p)dioxin (1,2,3,6,7,8-HxCDD)			Recommended BCF Value: 187.2
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1,560 x 0.12 =187.2			
Compound: 1,2,3,7,8,9-Hexachlorodibenzo(p)dioxin (1,2,3,7,8,9-HxCDD)			Recommended BCF Value: 218.4
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1,560 x 0.14 = 218.4			
Compound: 1,2,3,4,6,7,8-Heptachlorodibenzo(p)dioxin (1,2,3,4,6,7,8-HpCDD)			Recommended BCF Value: 79.6
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1,560 x 0.051 = 79.6			
Compound: Octachlorodibenzo(p)dioxin (OCDD)			Recommended BCF Value: 18.7
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1,560 x 0.012 = 18.7			
Compound: 2,3,7,8-Tetrachlorodibenzofuran (2,3,7,8-TCDF)			Recommended BCF Value: 1248
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1,560 x 0.80 = 124			
Compound: 1,2,3,7,8-Pentachlorodibenzofuran (1,2,3,7,8-PeCDF)			Recommended BCF Value: 343.2
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1,560 x 0.22 = 343.2			
Compound: 2,3,4,7,8-Pentachlorodibenzofuran (2,3,4,7,8-PeCDF)			Recommended BCF Value: 2,496

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1,560 x 1.6 = 2,496			
Compound: 1,2,3,4,7,8-Hexachlorodibenzofuran (1,2,3,4,7,8-HxCDF)			Recommended BCF Value: 118.6
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1,560 x 0.076 = 118.6			
Compound: 1,2,3,6,7,8-Hexachlorodibenzofuran (1,2,3,6,7,8-HxCDF)			Recommended BCF Value: 296.4
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1,560 x 0.19 = 296.4			
Compound: 2,3,4,6,7,8-Hexachlorodibenzofuran (2,3,4,6,7,8-HxCDF)			Recommended BCF Value: 1,045
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1,560 x 0.67 = 1,045			
Compound: 1,2,3,7,8,9-Hexachlorodibenzofuran (1,2,3,7,8,9-HxCDF)			Recommended BCF Value: 982.8
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1,560 x 0.63 = 982.8			
Compound: 1,2,3,4,6,7,8-Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)			Recommended BCF Value: 17.2
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1,560 x 0.011 = 17.2			
Compound: 1,2,3,4,7,8,9-Heptachlorodibenzofuran (1,2,3,4,7,8,9-HpCDF)			Recommended BCF Value: 608.4
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1,560 x 0.39 = 608.4			
Compound: Octachlorodibenzofuran (OCDF)			Recommended BCF Value: 25.0
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =1,560 x 0.016 = 25.0			
Polynuclear Aromatic Hydrocarbons (PAHs)			
Compound: Benzo(a)pyrene			Recommended BCF Value: 4,697
The BCF value was calculated using the geometric mean of 6 laboratory values as follows:			
55,000	Eadie, Landrum, and Faust (1982)	Reported as the mean of the measured PAH concentrations in the test species and the sediment	*Pontoporcia hoyi*
12,761	Newsted and Giesy (1987)	24-hour exposure duration	*Daphnia magna*

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
861	Roesijadi, Anderson, and Blaylock (1978)	7-day exposure duration	*Macoma inquinata*
3,000	Lee, Gardner, Anderson, Blaytock, and Barwell-Clarke (1978)	8-day exposure duration. The reported value was calculated by dividing the wet tissue concentration by the medium concentration [(µg/g)/(µg/L)] conversion factor of 1 x 10^3 was applied to the value.	*Crassostrea virginica*
2,745 2,158	Leversee, Landrum, Giesy, and Fannin (1983)	6-hour exposure duration; 0.2 ppm concentrated humic acid added to test medium	*Daphnia magna*
Compound: Benzo(a)anthracene			Recommended BCF Value: 12,299
The BCF value was calculated using the geometric mean of 3 laboratory values as follows:			
18,000	Lee, Gardner, Anderson, Blaytock, and Barwell-Clarke (1978)	8-day exposure duration; The reported value was calculated by dividing the wet tissue concentration by the medium concentration [(µg/g)/(µg/L)] conversion factor of 1 x 10^3 was applied to the value.	*Crassostrea virginica*
10,225	Newsted and Giesy (1987)	24-hour exposure duration	*Daphnia magna*
10,109	Southworth, Beauchamp, and Schmieder (1978)	24-hour exposure duration	*Daphnia pulex*
Compound: Benzo(b)fluoranthene			Recommended BCF Value: 4,697
Laboratory data were not available for this constituent. The BCF for benzo(a)pyrene was used as a surrogate.			
Compound: Benzo(k)fluoranthene			Recommended BCF Value: 13,225
The BCF value was based on one laboratory value as follows:			
13,225	Newsted and Giesy (1987)	24-hour exposure duration	*Daphnia magna*
Compound: Chrysene			Recommended BCF Value: 980
The BCF value was calculated using the geometric mean of 7 laboratory values as follows:			
5,500	Eastmond, Booth, and Lee (1984)	Not reported	*Daphnia magna*

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
248 199 1,809 418	Millea, Corliss, Farragut, and Thompson (1982)	28-day exposure duration; reported values were based on accumulation in the cephalothorax and abdomen at exposures of 1 or 5 µg/L in a cloed seawater system.	*Penaeus duorarum*
6,088	Newsted and Giesy (1987)	24-hour exposure duration	*Daphnia magna*
694	Roesijadi, Anderson, and Blaylock (1978)	7-day exposure duration	*Macoma inquinata*
Compound: Dibenzo(a,h)anthracene			Recommended BCF Value: 710
The BCF value was calculated using the geometric mean of 2 laboratory values as follows:			
652 773	Leversee, Landrum, Giesy, and Fannin (1983)	6-hour exposure duration	*Daphnia magna*
Compound: Indeno(1,2,3-cd)pyrene			Recommended BCF Value: 4,697
Laboratory data were not available for this constituent. The BCF for benzo(a)pyrene was used as a surrogate.			
Polychlorinated Biphenyls (PCBs)			
Compound: Aroclor 1016			Recommended BCF Value: 13,000
The BCF value for Aroclor 1016 was calulated using one laboratory value as follows:			
13,000	Parrish et al. (1974) as cited in EPA (1980b)	84 day exposure Edible portion	*Crassostrea virginica*
Compound: Aroclor 1254			Recommended BCF Value: 5,538
The BCF value for Aroclor 1254 was calulated using the geometric mean 13 laboratory values as follows:			
41,857 6,900 5,679	Rice and White (1987)	Field study	*Sphaerium striatum*

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
750 740 3,800 1,500 6,200 3,500 2,600 2,700	Mayer, Mehrle, and Sanders (1977)	4 to 21-day exposure	*Orconectes nais; Daphnia magna; Gammarus pseudolimnaeus; Palaemontes kadiakensis; Corydalus cornutus; Culex tarsalis; Chaoborus punctipennis*
120,000	Veith, Kuehl, Puglisi, Glass, and Eaton (177)	Field samples	Zooplankton
340,000 in lipid 51,000 dry tissue	Scura and Theilacker (1977)	45 days exposure	*Brachionus plicatilis*
>27,000	Nimmo et al. (1977) as cited in EPA (1980b)	Field data Whole body	Invertebrates
740	Mayer et al. (1977) as cited in EPA (1980b)	21 days exposure	*Pteronarcys dorsata*
1,500	Mayer et al. (1977) as cited in EPA (1980b)	7 days exposre	*Corydalus cornutus*
750	Mayer et al. (1977) as cited in EPA (1980b)	21 days exposure	*Orconectes nais*
373	Mayer et al. (1977) as cited in EPA (1980b)	5 days exposure	*Nereis diversicolor*
140	Duke et al. (1970) as cited in EPA (1980b)	2 day exposure	*Penaeus duorarum*
8,100	Duke et al. (1970) as cited in EPA (1980b)	2 days exposure	*Crassostrea virginica*
236	Courtney and Langston (1978) as cited in EPA (1980b)	5 days exposure	*Arenicola marina*
Nitroaromatics			
Compound: 1,3-Dinitrobenzene			Recommended BCF Value: 13

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
Laboratory data were not available for this constituent. BCF for 2,4-dinitrotoluene was used as a surrogate.			
Compound: 2,4-Dinitrotoluene			Recommended BCF Value: 13
The recommended BCF value is based on one study as follows:			
13	Liu, Bailey, and Pearson (1983)	4-day exposure duration	*Daphnia magna*
Compound: 2,6-Dinitrotoluene			Recommended BCF Value: 13
Laboratory data were not available for this constituent. BCF for 2,4-dinitrotoluene was used as a surrogate.			
Compound: Nitrobenzene			Recommended BCF Value: 13
Laboratory data were not available for this constituent. BCF for 2,4-dinitrotoluene was used as a surrogate.			
Compound: Pentachloronitrobenzene			Recommended BCF Value: 13
Laboratory data were not available for this constituent. BCF for 2,4-dinitrotoluene was used as a surrogate.			
Phthalate Esters			
Compound: Bis(2-ethylhexyl)phthalate			Recommended BCF Value: 318
The BCF value was calculated using the geometric mean of 12 laboratory values as follows:			
2,497	Brown and Thompson (1982)	14 to 28-day exposure duration	*Mytilus edulis*
257	Perez, Davey, Lackie, Morrison, Murphy, Soper, and Winslow (1983)	30-day exposure duration	*Pitar morrhauna*
48 2237	Sanders, Mayer, and Walsh (1973)	14-day exposure duration; The reported value was calculated by dividing the wet tissue concentration by the medium concentration [(µg/g)/(µg/L)], and a conversion factor of 1 x 10^3 was applied to the value. The reported value was also converted from dry weight to wet weight using a conversion factor of 5.99[a].	*Gammarus pseudolimnacus*
1,214 17,473 2,271 24,456	Sodergren (1982)	27-day exposure duration	*Chironomus* sp.; *Sialis* sp.; *Phanorbis corneus*; *Gammarus pulex*

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
11 10 7 17	Wofford, Wilsey, Neff, Giam, and Neff (1981)	24-hour exposure duration	*Crassostrea virginica*; *Penaeus aztecus*
Compound: Di(n)octyl phahalate			Recommended BCF Value: 5,946
The BCF value was calculated using the geometric mean of 2 laboratory values as follows:			
13,600 2,600	Sanborn, Metcalf, Yu, and Lu (1975)	Not reported	*Physia* sp.; *Daphnia* sp.
Volatile Organic Compounds			
Compound: Acetone			Recommended BCF Value: 0.05
Laboratory data were not available for this constituent. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = -0.222 (Karickoff and Long 1995).			
Compound: Acrylonitrile			Recommended BCF Value: 0.11
Laboratory data were not available for this constituent. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where Log K_{ow} = 0.250 (Karickoff and Long 1995).			
Compound: Chloroform			Recommended BCF Value: 2.82
Laboratory data were not available for this constituent. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 1.949 (U.S. EPA 1994b).			
Compound: Crotonaldehyde			Recommended BCF Value: 0.20
Laboratory data were not available for this constituent. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978) where, log K_{ow} = 0.55 (Based on equation developed by Hansch and Leo (1979), as calculated in NRC (1981)).			
Compound: 1,4-Dioxane			Recommended BCF Value: 0.043
Laboratory data were not available for this constituent. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978) where, log K_{ow} = -0.268 (U.S. EPA 1995a).			
Compound: Formaldehyde			Recommended BCF Value: 0.14
Laboratory data were not available for this constituent. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978) where, log K_{ow} = 0.342 (U.S. EPA 1995a).			

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
Compound: Vinyl chloride			Recommended BCF Value: 0.62
Laboratory data were not available for this constituent.The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978) where, log K_{ow} = 1.146 (U.S. EPA 1994b).			
Other Chlorinated Organics			
Compound: Carbon tetrachloride			Recommended BCF Value: 12
Laboratory data were not available for this constituent. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978) where, log K_{ow} = 2.717 (U.S. EPA 1994b).			
Compound: Hexachlorobenzene			Recommended BCF Value: 2,595
The BCF value was calculated using the geometric mean of 16 laboratory values as follows:			
215,331 8,051 11,064	Baturo and Lagadic (1996)	48 to 120-hour exposure duration	*Lymnaea palustris*
1,360 770 1,510 940 1,630 1,030	Isensee, Holden, Woolson, and Jones (1976)	31-day exposure duration	*Heliosoma* sp.*; Daphnia magna*
287 1,247	Metcalf, Kapoor, Lu, Schuth, and Sherman (1973)	1 to 33-day exposure duration	*Daphnia magna; Physa* sp.
17,140 21,820 5,000	Nebeker, Griffis, Wise, Hopkins, and Barbitta (1989)	28-day exposure duration	*Oligochaete*
24,000	Oliver (1987)	79-day exposure duration	*Oligochaete*
5.5	Schauerte, Lay, Klein, and Korte (1982)	4 to 6-week exposure duration	*Dytiscus marginalis*
Compound: Hexachlorobutadiene			Recommended BCF Value: 10.5
The BCF value was based on four laboratory values from one study as follows:			

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
6.27 45.4 11.1 3.86	Laseter, Bartell, Laska, Holmquist, Condie, Brown, and Evans (1976)	10-day exposure duration	*Procambarus clarki*
Compound: Hexachlorocyclopentadiene			Recommended BCF Value: 1,232
The BCF value was calculated using the geometric mean of 2 laboratory values as follows:			
929 1,634	Lu, Metcalf, Hirwe, and Williams (1975)	Not reported	*Physa* sp. *Culex* sp.
Compound: Pentachlorobenzene			Recommended BCF Value: 2,595
Laboratory data were not available for this constituent. The BCF for hexachlorobenzene was used as a surrogate.			
Compound: Pentachlorophenol			Recommended BCF Value: 52
The BCF value was calculated using the geometric mean of 13 laboratory values as follows:			
145 342	Makela and Oikari (1990)	1-day exposure duration	*Anodonta anatina*
165	Lu and Metcalf (1975)	1-day exposure duration	*Daphnia magna*
81 461	Makela, Petanen, Kukkonen, and Oikari (1991)	Multiple exposure durations	*Anodonta anatina*
80 61 121 85	Makela and Oikari (1995)	2 to 36-week exposure duration	*Anodonta anatina*; *Pseudanodonta complanta*
42 0.26 72 1.7	Schimmel, Patrick, and Faas (1978)	28-day exposure duration	*Crassostrea virginica*; *Penaeus aztecus*; *Palaemonetes pugio*
Pesticides			
Compound: 4,4'-DDE			Recommended BCF Value: 11,930
The recommended BCF value was calculated using the geometric mean of 14 field values[(b)] (Reich, Perkins, and Cutter 1986).			

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
19,400 4,421 207,070 8,782 67,641 2,374 5,099 2,197 8,344 46,953 15,369 35,373 4,983 3,972	Reich, Perkins, and Cutter (1986)	Field samples.	*Tubificidae; Chironomidae; Corixidae*
36,342 39,390	Metcalf, Sanborn, Lu, and Nye (1975)	33-day exposure duration	*Physa* sp.; *Culex pipiens quinquefasciatus*
28,600 1310 63,500 51,600 36,400	Hamelink, Waybrant, and Yant (1977)	Not reported	Zooplankton
19,528 5,024	Metcalf, Sangha, and Kapoor (1971)	33-day exposure duration; The value reported in Hamelink and Waybrant (1976) was converted to wet weight over dry weight using a conversion factor was 5.99[a].	*Physa* sp.; *Culex pipiens quinquefasciatus*
19,529	Metcalf, Kapoor, Lu, Schuth, and Sherman (1973)	33-day exposure duration	*Physa* sp.
Compound: Heptachlor			Recommended BCF Value: 3,807
The BCF value was calculated using the geometric mean of 4 laboratory values as follows:			
37,153 31,403	Lu, Metcalf, Plummer, and Mandel (1975)	Not reported	*Physa* sp. *Culex* sp.
300 600	Schimmel, Patrick, and Forester (1976)	96 hour exposure duration	*Penaeus duorarum*
Compound: Hexachloropehene			Recommended BCF Value: 970
The BCF value was based on one study as follows:			
970	Sanborn (1974)	Not reported	*Physa* sp.
Inorganics			
Compound: Aluminum			Recommended BCF Value: 4,066

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
Laboratory data were not available for this constituent. The recommended BCF is the arithmetic mean of the recommended values for 14 inorganics with laboratory data available (antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc).			
Compound: Antimony			Recommended BCF Value: 7
The BCF value was calculated using the geometric means of 2 laboratory values as follows:			
10	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Freshwater and marine invertebrates
Compound: Arsenic			Recommended BCF Value: 73
The BCF value was calculated using the geometric mean of 5 laboratory values as follows:			
33 50 45 219 131	Spehar, Fiandt, Anderson, and DeFoe (1980)	21 to 28-day exposure duration	*Pteronarcys dorsata*; *Daphnia magna*
Compound: Barium			Recommended BCF Value: 200
The BCF was based on one study as follows:			
200	Thompson, Burton, Quinn and Ng (1972)	Not reported	Freshwater invertebrate
Compound: Beryllium			Recommended BCF Value: 45
The BCF value was calculated using the geometric mean of 2 laboratory values as follows:			
10 200	Thompson, Burton, Quinn and Ng (1972)	Not reported	Freshwater invertebrate
Compound: Cadmium			Recommended BCF Value: 3,461
The BCF value was calculated using the geometric mean of 8 field values as follows:			
238 549 894 3,577 11,383 15,936 9,897 27,427	Saiki, Castleberry, May, Martin, and Bullard (1995)	Field samples.	*Chironomidea; Ephermeroptera*

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
1,490 2,460 720	Eisler, Zaroogian, and Hennekey (1972)	3-week exposure duration	*Crassostrea virginica*; *Aquipecten irradians*; *Homarus americanus*
165	George and Coombs (1977)	28-day exposure duration	*Mytilus edulis*
1,359 137 2,939 217 615 1,850 573 1,530 1,082 781 775 553	Giesy, Kanio, Boling, Knight, Mashburn, and Clarkin (1977)	52-week exposure duration; the reported value was calculated by dividing the dry tissue concentration by the medium concentration [(µg/g)/(µg/L)] conversion factor of 1 x 10^3 was applied to the value. A conversion factor or 5.99[(a)] was used to convert dry weight to wet weight.	*Ceratopogonidae; Chironomidae;* Beetle*; Anisotptera; Zygoptera; Ephemeroptera*
1,840	Gillespie, Reisine, and Massaro (1977)	8-day exposure duration; the reported value was calculated by dividing the dry tissue concentration by the medium concentration [(ppm)/(ppb)] and a conversion factor of 1 x 10^3 was applied to the value.	*Orconectes propinquos propinquos*
3,770 1,752	Graney, Cherry, and Cairns (1983)	28-day exposure duration	*Corbicula fluminea*
1.86 6.88 7.18	Jennings and Rainbow (1979)	40-day exposure duration; the reported value was calculated by dividing the dry tissue concentration by the medium concentration [(mg/g)/(ppm)] conversion factor of 1 x 10^3 was applied to the value. A conversion factor or 5.99[(a)] was used to convert dry weight to wet weight.	*Carcinus maenas*
660 3400	Klockner (1979)	64-day exposure duration	*Ophryothochadiadema* sp.
48 33 57 34 55 23	Nimmo, Lightner, and Bahner (1977)	28 to 30-day exposure duration	*Penaeus duorarum*
1,023 17.7 1,477 17.5 2,412 30 3,406 28.7 37.2	Pesch and Stewart (1980)	42-day exposure duration; the values reported in Pesch and Stewart (1980) were converted to wet weight using a conversion factor of 5.99[(a)].	*Argopecten irradians*; *Palaemonetes pugio*

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
57 301 341 167	Phillips (1976)	35-day exposure duration; the reported value was calculated by dividing the wet tissue concentration by the medium concentration [(µg/g)/(µg/L)] conversion factor of 1 x 10^3 was applied to the value.	*Mytilus edulis*
160	Pringle, Hissong, Katz, and Mulawka (1968)	70-day exposure duration	*Mya arenaria*
3,500	Sundelin (1983)	66-week exposure duration	*Pontoporeia affinis*
123 89 93 67 48 115	Theede, Scholz, and Fischer (1979)	7 and 10-day exposure duration; the reported value was calculated by dividing the dry tissue concentration by the medium concentration [(µg/g)/(µg/L)] conversion factor of 1 x 10^3 was applied to the value. A conversion factor or 5.99[a] was used to convert dry weight to wet weight.	*Laomedea loveni*
2,150 13,600	Zaroogian and Cheer (1976)	40-week exposure	*Crassostrea virginica*
Compound: Chromium (total)			Recommended BCF Value: 3,000
The BCF value was based on 1 field value as follows:			
3,000	Namminga and Wilhm (1977)	Field samples.	*Chironomidae*
1,900	NAS (1974)	Not reported	Zooplankton
2,000	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Freshwater invertebrates
Compound: Copper			Recommended BCF Value: 3,718
The BCF value was calculated using the geometric mean of 9 field values as follows:			
546	Namminga and Wilhm (1977)	Field samples.	*Chironomidae*
2,896 3,066 5,111 4,940 11,130 4,174 8,347 2,862	Saiki, Castleberry, May, Martin, and Bullard (1995)	Field samples.	*Chironomidae*; *Ephemeroptera*

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
373	Eisler (1977)	14-day exposure duration	*Mya arenara*
17,720 22,571	Graney, Cherry, and Cairns (1983)	28-day exposure duration	*Corbicula fluminea*
54 53 87 48 70 57 35 44	Jones, Jones and Radlett (1976)	25-day exposure duration	*Nereis diversicolor*
800	Majori and Petronio (1973)	8-day exposure duration	*Mytilus galloprovincialis*
104 2,792	McLusky and Phillips (1975)	21-day exposure duration	*Phylloduce maculata*
37 40 43 42	Nehring (1976)	14-day exposure duration; the value reported was converted to wet weight using a conversion factor of 5.99[(a)].	*Pteronarcys californica*
2,462	Pesch and Morgan (1978)	28-day exposure duration	*Nereis arenaceodentata*
35 185.5 69 26.5	Phillips (1976)	35-day exposure duration; the reported value was calculated by dividing the wet tissue concentration by the medium concentration [(µg/g)/(µg/L)], a conversion factor of 1 x 10^3 was applied to the value.	*Mytilus edulis*
5,160 11,800 6,800 19,000 11,560 27,800 12,540 22,500	Shuster and Pringle (1968)	35, 70, 105, and 140-day exposure duration	*Crassostrea virginica*
160	Pringle, Hissong, Katz, and Mulawka (1968)	70-day exposure duration	*Mya arenaria*
Compound: Cyanide (total)			Recommended BCF Value: 4,066
Laboratory data were not available for this constituent. The recommended BCF is the arithmetic mean of the recommended values for 14 inorganics with laboratory data available (antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc).			
Compound: Lead			Recommended BCF Value: 5,059
The BCF value was calculated using the geometric mean of 6 field values as follows:			

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

(Page 15 of 18)

Reported Values[a]	Reference	Experimental Parameters	Species
8,076 7,237 3,636 3,575 5,671 3,890	Nehring, Nisson, and Minasian (1979)	Field samples.	*Tipulidae*; *Para quetina* sp.; *Heptageniidae; Nemoura* sp.; *Macronenum* sp.; *Anisoptera*
2500	Borgmann, Kramar, and Loveridge (1978)	120-day exposure duration	*Lymnaea palustris*
357	Eisler (1977)	14-day exposure duration	*Mya arenara*
111 50 63 71 63	Nehring (1976)	14-day exposure duration; the reported value was converted from dry weight to wet weight using a conversion factor of 5.99[(a)].	*Petronarcys californica*
1520 502.5 765 555	Phillips (1976)	35-day exposure duration; the reported value was calculated by dividing the wet tissue concentration by the medium concentration [(µg/g)/(µg/L)], and an unit conversion factor of 1 x 10^3 was applied to the value.	*Mytilus edulis*
578 1,097	Zaroogian, Morrison, Heltshe (1979)	20-day exposure duration; The reported value was calculated by dividing the dry tissue concentration by the medium concentration [(µg/g)/(µg/kg)], and an unit conversion factor of 1 x 10^3 was applied to the value. A conversion factor or 5.99[(a)] was used to convert dry weight to wet weight.	*Crassostrea virginica*
Compound: Mercuric chloride			Recommended BCF Value: 20,184
The BCF value was based on 6 laboratory values as follows:			
100,000	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Marine and freshwater invertebrates
12,000	Kopfter (1974)	74-day exposure duration; the reported value was calculated by dividing the dry tissue concentration by the medium concentration [(ppm)/(ppb)], and an unit conversion factor of 1 x 10^3 was applied to the value.	*Crassostrea virginica*
13,633 14,600 14,217 19,916	Thurberg, Calabrese, Gould, Greig, Dawson, and Tucker (1977)	30 to 60-day exposure duration; The reported value was calculated by dividing the dry tissue concentration by the medium concentration [(ppm)/(ppb)], and an unit conversion factor of 1 x 10^3 was applied to the value.	*Homarus americanus*

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
Compound: Methyl mercury			Recommended BCF Value: 55,000
The BCF value was based on 1 laboratory value as follows:			
55,000	Kopfter (1974)	74-day exposure duration; The reported value was calculated by dividing the dry tissue concentration by the medium concentration [(ppm)/(ppb)] and a conversion factor of 1 x 10^3 was applied to the value.	*Crassostrea virginica*
Compound: Nickel			Recommended BCF Value: 28
The BCF value was calculated using the geometric mean of 4 laboratory values as follows:			
100 250	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Freshwater and marine invertebrates
2 12	Watras, MacFarlane, and Morel (1985)	Reported values adopted from a high and low range.	*Daphnia magna*
Compound: Selenium			Recommended BCF Value: 1,262
The BCF value was calculated using the geometric mean of 5 laboratory values as follows:			
229,000	Besser, Canfield, and LaPoint (1993)	96-hour exposure duration	*Daphnia magna*
90 930	Hermanutz, Allen, Roush, and Hedtke (1992)	365-day exposure duration	*Lepomis macrochirus*
167 1,000	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Freshwater and marine invertebrates
Compound: Silver			Recommended BCF Value: 298
The BCF value was calculated using the geometric mean of 12 laboratory values as follows:			
1,391 5,100 2,203 1,056 6,500 1,435	Calabrese, MacInnes, Nelson, Greig, and Yevich (1984)	540 to 630 day exposure duration; he reported value was calculated by dividing the wet tissue concentration by the medium concentration [(mg/kg)/(µg/L)], and an unit conversion factor of 1 x 10^3 was applied to the value.	*Mytilus edulis*

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
1,711	Metayer, Amiard-Triquet and Baud (1990)	14-day exposure duration	*Crassostrea gigas*
30 22 18 13 12	Nehring (1976)	14-day exposure duration; the reported value in Nehring (1976) was converted from dry weight to wet weight using a conversion factor of 5.99[(a)].	*Pteronarcys californica*
Compound: Thallium			Recommended BCF Value: 15,000
The BCF value was calculated using the geometric mean of 2 laboratory values as follows:			
15,000 15,000	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Freshwater and marine invertebrates
Compound: Zinc			Recommended BCF Value: 4,578
The BCF value was calculated using the geometric mean of 9 field values as follows:			
30,036	Namminga and Wilhm (1977)	Field samples.	*Chironomidae* sp.
2,613 2,199 1,282 3,210 4,718 6,625 3,876 10,274	Saiki, Castleberry, May, Martin, and Bullard (1995)	Field samples; the reported value was converted from dry weight to wet weight using a conversion factor of 5.99[(a)].	*Chironomidae* sp.; *Ephemeroptera* sp.
50 3,000	Deutch, Borg, Kloster, Meyer, and Moller (1980)	9-day exposure duration	Marine invertebrates
143	Eisler (1977)	14-day exposure duration	*Mya arenaria*
358 511 631	Graney, Cherry, and Cairns (1983)	28-day exposure duration	*Corbicula fluminea*
499 326 159 92 43 95 53 25 15 7	Nehring (1976)	14-day exposure duration; the reported value was converted from dry weight to wet weight using a conversion factor of 5.99[(a)].	*Ephemerella grandis*; *Pteronarcys californica*

TABLE C-3

WATER-TO-AQUATIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
519 2,615 315 184	Phillips (1976)	35-day exposure duration	Mytilus edulis
85	Pringle, Hissong, Katz, and Mulawka (1968)	50-day exposure duration	*Mya arenaria*

Notes:

(a) The reported values are presented as the amount of COPC in invertebrate tissue divided by the amount of COPC in the water. If the values reported in the studies were presented as dry tissue weight over amount of COPC in water, they were converted to wet weight by dividing the concentration in dry invertebrate tissue weight by 5.99. This conversion factor assumes an invertebrate's total weight is 83.3 percent moisture, which is based on the moisture content of the earthworm (Pietz et al. 1984).

The conversion factor was calculated as follows:

$$Conversion\ factor = \frac{1.0\ gram\ (g)\ invertebrate\ total\ weight}{1.0\ gram\ (g)\ invertebrate\ total\ weight - 0.833\ g\ invertebrate\ wet\ weight}$$

(b) Reported field values for organic COPCs are assumed to be total COPC concentration in water and, therefore, were converted to dissolved COPC concentration in water using the following equation from U.S.EPA (1995b):

$BCF\ (dissolved) = (BCF\ (total) / f_{fd}) - 1$

where: BCF (dissolved) = BCF based on dissolved concentration of COPC in water
BCF (total) = BCF based on the field derived data for total concentration of COPC in water
f_{fd} = Fraction of COPC that is freely dissolved in the water

where: $f_{fd} = 1 / [1 + ((DOC \times K_{ow}) / 10) + (POC \times K_{ow})]$
DOC = Dissolved organic carbon, kilograms of organic carbon / liter of water (2.0×10^{-06} Kg/L)
K_{ow} = Octanol-water partition coefficient of the COPC, as reported in U.S. EPA (1994b)
POC = Particulate organic carbon, kilograms of organic carbon / liter of water (7.5×10^{-09} Kg/L)

TABLE C-4

WATER-TO-ALGAE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
Dioxins and Furans			
Compound: 2,3,7,8-Tetrachlorodibenzo(p)dioxin (2,3,7,8-TCDD)			Recommended BCF value: 3,302
The recommended BCF value was calculated using the geometric mean of 3 laboratory values as follows:			
4,000 9,000	Yockim, Isensee, and Jones (1978)	Values adopted from a high to low range; reported values were for 2,3,7,8-tetrachlorodibenzo(p)dioxin (2,3,7,8-TCDD).	*Leona minor*
1,000	Yockim, Isensee, and Jones (1978)	32-day exposure duration; reported values were for 2,3,7,8-TCDD.	*Oedogonium cardiacum*
Compound: 1,2,3,7,8-Pentachlorodibenzo(p)dioxin (1,2,3,7,8-PeCDD)			Recommended BCF value: 3,038
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 3,302 x 0.92 = 3,038			
Compound: 1,2,3,4,7,8-Hexachlorodibenzo(p)dioxin (1,2,3,4,7,8-HxCDD)			Recommended BCF value: 1,024
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 3,302 x0.31 = 1,024			
Compound: 1,2,3,6,7,8-Hexachlorodibenzo(p)dioxin (1,2,3,6,7,8-HxCDD)			Recommended BCF value: 396.2
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 3,302 x0.12 = 396.2			
Compound: 1,2,3,7,8,9-Hexachlorodibenzo(p)dioxin (1,2,3,7,8,9-HxCDD)			Recommended BCF value: 462.3
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 3,302 x0.14 = 462.3			
Compound: 1,2,3,4,6,7,8-Heptachlorodibenzo(p)dioxin (1,2,3,4,6,7,8-HpCDD)			Recommended BCF value: 168.4
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 3,302 x0.051 = 168.4			
Compound: Octachlorodibenzo(p)dioxin (OCDD)			Recommended BCF value: 39.6
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 3,302 x0.012 = 39.6			
Compound: 2,3,7,8-Tetrachlorodibenzofuran (2,3,7,8-TCDF)			Recommended BCF value: 2,642
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 3,302 x0.80 = 2,642			
Compound: 1,2,3,7,8-Pentachlorodibenzofuran 1,(2,3,7,8-PeCDF)			Recommended BCF value: 726.4
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 3,302 x0.22 =726.4			

TABLE C-4

WATER-TO-ALGAE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
Compound: 2,3,4,7,8-Pentachlorodibenzofuran (2,3,4,7,8-PeCDF)			Recommended BCF value: 5,283
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 3,302 x1.6 = 5,283			
Compound: 1,2,3,4,7,8-Hexachlorodibenzofuran (1,2,3,4,7,8-HxCDF)			Recommended BCF value: 251.0
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 3,302 x 0.076 = 251.0			
Compound: 1,2,3,6,7,8-Hexachlorodibenzofuran (1,2,3,6,7,8-HxCDF)			Recommended BCF value: 627.4
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 3,302 x0.19 = 627.4			
Compound: 2,3,4,6,7,8-Hexachlorodibenzofuran (2,3,4,6,7,8-HxCDF)			Recommended BCF value: 2,212
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 3,302 x0.67 = 2,212			
Compound: 1,2,3,7,8,9-Hexachlorodibenzofuran (1,2,3,7,8,9-HxCDF)			Recommended BCF value: 2,080
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 3,302 x 0.63 = 2,080			
Compound: 1,2,3,4,6,7,8-Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)			Recommended BCF value: 36.3
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 3,302 x0.011 = 36.3			
Compound: 1,2,3,4,7,8,9-Heptachlorodibenzofuran (1,2,3,4,7,8,9-HpCDF)			Recommended BCF value: 1,288
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 3,302 x0.39 = 1,288			
Compound: Octachlorodibenzofuran (OCDF)			Recommended BCF value: 52.8
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF = 3,302 x 0.016 = 52.8			
Polynuclear Aromatic Hydrocarbons (PAHs)			
Compound: Benzo(a)pyrene			Recommended BCF value: 5,258
The recommended BCF value was based on a single measured value for benzo(a)pyrene. This value was also used as a surrogate for all high molecular weight PAHs for which laboratory data were not available.			
5,258	Lu, Metcalf, Plummer, and Mandel (1977)	3-day exposure duration	*Oedogonium cardiacum*
Compound: Benzo(a)anthracene			Recommended BCF value: 5,258

TABLE C-4

WATER-TO-ALGAE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
Laboratory data were not available for this compound. The BCF for benzo(a)pyrene was used as a surrogate.			
Compound: Benzo(b)fluoranthene			Recommended BCF value: 5,258
Laboratory data were not available for this compound. The BCF for benzo(a)pyrene was used as a surrogate.			
Compound: Benzo(k)fluoranthene			Recommended BCF value: 5,258
Laboratory data were not available for this compound. The BCF for benzo(a)pyrene was used as a surrogate.			
Compound: Chrysene			Recommended BCF value: 5,258
Laboratory data were not available for this compound. The BCF for benzo(a)pyrene was used as a surrogate.			
Compound: Dibenz(a,h)anthracene			Recommended BCF value: 5,258
Laboratory data were not available for this compound. The BCF for benzo(a)pyrene was used as a surrogate.			
Compound: Indeno(1,2,3-cd)pyrene			Recommended BCF value: 5,258
Laboratory data were not available for this compound. The BCF for benzo(a)pyrene was used as a surrogate.			
Polychlorinated Biphenyls (PCBs)			
Compound: Aroclor 1016			Recommended BCF value: 476,829
The reported value was calculated by dividing the wet tissue concentration by the medium concentration (ppm/pptr). A conversion factor of 1 x 10^6 was applied to the value. The BCF value is based on Aroclor 1254 since there was no available data for total PCB.			
476,829	Scura and Theilacker (1977)	45-day exposure to Aroclor 1254	*Dunaliella* sp.
Compound: Aroclor 1254			Recommended BCF value: 476,829
The reported value was calculated by dividing the wet tissue concentration by the medium concentration (ppm/pptr). A conversion factor of 1 x 10^6 was applied to the value. The BCF value is based on Aroclor 1254 since there was no available data for total PCB.			
476,829	Scura and Theilacker (1977)	45-day exposure to Aroclor 1254	*Dunaliella* sp.

TABLE C-4

WATER-TO-ALGAE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
Nitroaromatics			
Compound: 1,3-Dinitrobenzene			Recommended BCF value: 2,507
Laboratory data were not available for this compound. The BCF for 2,4-dinitrotoluene was used as a surrogate.			
Compound: 2,4-Dinitrotoluene			Recommended BCF value: 2,507
The recommended BCF value was based on one study as follows:			
2,507	Liu, Bailey, and Pearson (1983)	4-day exposure duration	*Selanastrum capricornatum*
Compound: 2,6-Dinitrobenzene			Recommended BCF value: 2,507
Laboratory data were not available for this compound. The BCF for 2,4-dinitrotoluene was used as a surrogate.			
Compound: Nitrobenzene			Recommended BCF value: 24
The recommended BCF value was based on one study as follows:			
24	Geyer, Viswanathan, Freitag, and Korte (1981)	1-day exposure duration	*Chlorella fusca*
Compound: Pentachloronitrobenzene			Recommended BCF value: 4,740
The recommended BCF value calculated using the geometric mean of 4 laboratory values as follows:			
3,100	Geyer, Viswanathan, Freitag, and Korte (1981)	1-day exposure duration	*Chlorella fusca*
4,795 7,534	Korte, Freitag, Geyer, Klein, Kraus, and Lahaniatis (1978)	1-day exposure duration; The values reported in Korte, Freitag, Geyer, Klein, Kraus, and Lahaniatis (1978) were converted to wet weight using a conversion factor of 2.92 [a].	*Chlorella fusca*
4,508	Wang, Harada, Watanabe, Koshikawa, and Geyer (1996)	Not reported	*Chlorella fusca*
Phthalate Esters			
Compound: Bis(2-ethylhexyl)phthalate			Recommended BCF value: 9,931

TABLE C-4

WATER-TO-ALGAE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
The recommended BCF value was calculated using the geometric mean of 2 laboratory values as follows:			
5,400	Geyer, Viswanathan, Freitag, and Korte (1981)	1-day exposure duration	*Chlorella fusca*
18,263	Sodergren (1982)	27-day exposure duration	*Chara chara*
Compound: Di(n)octyl phthalate			Recommended BCF value: 28,500
The recommended BCF value was based on one study as follows:			
28,500	Sanborn, Metcalf, Yu, and Lu (1975)	33-day exposure duration	*Oedogonium cardiacum*
Volatile Organic Compounds			
Compound: Acetone			Recommended BCF value: 0.05
Laboratory data were not available for this compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = -0.222 (Karickoff and Long 1995)			
Compound: Acrylonitrile			Recommended BCF value: 0.11
Laboratory data are not available for this compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 0.250 (Karickoff and Long 1995)			
Compound: Chloroform			Recommended BCF value: 2.82
Laboratory data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 1.949 (U.S. EPA 1994b)			
Compound: Crotonaldehyde			Recommended BCF value: 0.20
Laboratory data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 0.55 (based on equation developed by Hansch and Leo 1979, calculated in NRC (1981))			
Compound: 1,4-Dioxane			Recommended BCF value: 0.04
Laboratory data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = -0.268 (U.S. EPA 1995a)			
Compound: Formaldehyde			Recommended BCF value: 0.14

TABLE C-4

WATER-TO-ALGAE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
Laboratory data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 0.342 (U.S. EPA 1995a)			
Compound: Vinyl chloride			Recommended BCF value: 0.62
Laboratory data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 1.146 (U.S. EPA 1994b)			
Other Chlorinated Organics			
Compound: Carbon tetrachloride			Recommended BCF value: 300
The recommended BCF value was based on laboratory data as follows:			
300	Geyer, Politzki and Freitag (1984)	1-day exposure duration	*Chlorella fusca*
Compound: Hexachlorobenzene			Recommended BCF value: 11,134
The recommended BCF value was calculated using the geometric mean of 4 laboratory values as follows:			
24,800	Geyer, Politzki, and Freitag (1984)	1-day exposure duration	*Chlorella fusca*
610	Isensee, Holden, Woolson and Jones (1976)	31-day exposure duration	*Oedogonium cardiacum*
41,096	Korte, Freitag, Geyer, Klein, Kraus, and Lahaniatis (1978)	1-day exposure duration; the values reported in Korte, Freitag, Geyer, Klein, Kraus, and Lahaniatis (1978) were converted to wet weight using an unit conversion factor of 2.92 [a] .	*Chlorella fusca*
24,717	Wang, Harada, Watanabe, Koshikawa, and Geyer (1996)	Not reported	*Chlorella fusca*
Compound: Hexachlorobutadiene			Recommended BCF value: 160
The recommended BCF value calculated using the geometric mean of 2 laboratory values as follows:			
160	Laseter, Bartell, Laska, Holmquist, Condie, Brown, and Evans (1976)	7-day exposure duration	*Oedogonium cardiacum*
160	U.S. EPA (1976)	Not reported	Algae
Compound: Hexachlorocyclopentadiene			Recommended BCF value: 610

TABLE C-4

WATER-TO-ALGAE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
The recommended BCF value was calculated using the geometric mean of 2 laboratory values as follows:			
1,090	Geyer, Viswanathan, Freitag, and Korte (1981)	Not reported	*Chlorella fusca*
341	Lu, Metcalf, Hirwe, and Williams (1975)	Not reported	*Oedogonium cardiacum*
Compound: Pentachlorobenzene			Recommended BCF value: 4,000
The recommended BCF value was based on one study as follows:			
4,000	Geyer, Politzki, and Freitag (1984)	1-day exposure duration	*Chlorella fusca*
Compound: Pentachlorophenol			Recommended BCF value: 1,711
The recommended BCF value calculated using the geometric mean of 4 laboratory values as follows:			
1,250	Geyer, Viswanathan, Freitag, and Korte (1981)	1-day exposure duration	*Chlorella fusca*
2,055 2,534 1,781	Korte, Freitag, Geyer, Klein, Kraus, and Lahaniatis (1978)	1-day exposure duration; the values reported in Korte, Freitag, Geyer, Klein, Kraus, and Lahaniatis (1978) were converted to wet weight using an unit conversion factor of 2.92 [a].	*Chlorella fusca*
1,266	Wang, Harada, Watanabe, Koshikawa, and Geyer (1996)	Not reported	*Chlorella fusca*
Pesticides			
Compound: 4,4'-DDE			Recommended BCF value: 11,251
The recommended BCF value was based on one study as follows:			
11,251	Metcalf, Sanborn, Lu, and Nye (1975)	33-day exposure duration	*Oedogonium cardiacum*
Compound: Heptachlor			Recommended BCF value: 21,000
The recommended BCF value was based on one study as follows:			
21,000	U.S. EPA (1979)	Not reported	Algae

TABLE C-4

WATER-TO-ALGAE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
Compound: Hexachlorophene			Recommended BCF value: 1,500
The recommended BCF value was based on one study as follows:			
1,500	Sanborn (1974)	Not reported	Algae
Inorganics			
Compound: Aluminum			Recommended BCF value: 833
The recommended BCF value was based on one study as follows:			
600	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Algae (marine plants)
Compound: Antimony			Recommended BCF value: 1,475
The recommended value was calculated using the geometric mean of 2 laboratory values as follows:			
1,500 1,450	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Not reported
Compound: Arsenic			Recommended BCF value: 293
The recommended value was calculated using the geometric mean of 3 laboratory values as follows:			
5	Anderson et al. (1979)	42-day exposure duration	*Lemna minor*
3,000 1,670	Thompson, Burton, Quinn, and Ng 1972	Not reported	Not reported
Compound: Barium			Recommended BCF value: 260
The recommended BCF value was based on one study as follows:			
260	Schroeder (1970)	Not reported	Brown algae
Compound: Beryllium			Recommended BCF value: 141
The recommended value was calculated using the geometric mean of 2 laboratory values as follows:			
20 1,000	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Not reported

TABLE C-4

WATER-TO-ALGAE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
Compound: Cadmium			Recommended BCF value: 782
The recommended BCF value was calculated using the geometric mean of 6 laboratory values as follows:			
300 1,000 370 1,000	Fisher, Bohe, and Teyessie (1984)	Not reported	*Thalassiosira pseudonana* *Dunaliella tertiolecta* *Emiliania huxleyi* *Oscillatoria woronichinii*
2,065	Hutchinson and Czyrska (1972)	21-day exposure duration; The values reported in Hutchinson and Czyrska (1972) were converted to wet weight using a conversion factor of 2.92 [a].	*Lemna valdiviana*
1,000	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Not reported
Compound: Chromium (total)			Recommended BCF value: 4,406
The recommended BCF value was calculated using the geometric mean of 8 laboratory values as follows:			
343	Jouany, Vasseur, and Ferard (1982)	28-day exposure duration; the values reported in Jouany, Vasseur, and Ferard (1982) were converted to wet weight using an unit conversion factor of 2.92 [a].	*Chlorella vulgaris*
1,600	NAS (1974)	Not reported	Benthic algae
26,316 8,485 29,000 5,000	Patrick, Bott, and Larson (1975)	4 experiments consisting of 1-month exposure durations	Mixed algae
4,000 2,000	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Not reported
Compound: Copper			Recommended BCF value: 541
The recommended BCF value was calculated using the geometric mean of 5 laboratory values as follows:			
17	Bastien and Cote (1989)	50-day exposure duration	*Scenedesmus quadricauda*
827 1,644	Stokes, Hutchinson, and Krauter (1973)	2-day exposure duration	*Scenedesmus* sp.

TABLE C-4

WATER-TO-ALGAE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
2,000 1,000	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Freshwater and marine plants
Compound: Cyanide (total)			Recommended BCF value: 22
The recommended BCF value was based on one study as follows:			
22	Low and Lee (1981)	72-hour exposure duration	*Eichhornia crassipes*
Compound: Lead			Recommended BCF value: 1,706
The recommended BCF value was calculated using the geometric mean of 3 laboratory values as follows:			
100 5,000	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Not reported
9,931	Vighi (1981)	28-day exposure duration; the values reported in Vighi (1981) were converted to wet weight using an unit conversion factor of 2.92 [a].	*Selenastrum capricornutum*
Compound: Mercury chloride			Recommended BCF value: 24,762
The recommended BCF value was based on one study as follows:			
24,762	Watras and Bloom (1992)	Field samples	Phytoplankton
Compound: Methyl mercury			Recommended BCF value: 80,000
The recommended BCF value was based on one study as follows:			
80,000	Watras and Bloom (1992)	Field samples	Phytoplankton
Compound: Nickel			Recommended BCF value: 61
The recommended BCF value was calculated using the geometric mean of 4 laboratory values as follows:			
32 34	Hutchinson and Stokes (1975)	6-day exposure duration	*Scenedesmus* sp.
50 250	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Not reported

TABLE C-4

WATER-TO-ALGAE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
Compound: Selenium			Recommended BCF value: 1,845
The recommended BCF value was calculated using the geometric mean of 3 laboratory values as follows:			
15,700	Besser, Canfield, and LaPoint (1993)	24-hour exposure duration	*Chlamydomonas reinhardtii*
400	Dobbs, Cherry, and Cairns (1996)	25-day exposure duration	*Chlorella vulgaris*
1,000	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Not reported
Compound: Silver			Recommended BCF value: 10,696
The recommended BCF value was calculated using the geometric mean of 5 laboratory values as follows:			
34,000 13,000 24,000 66,000	Fisher, Bohe, and Teyssie (1984)	Not reported	*Thalassiosira pseudonana* *Dunaliella tertiolecta* *Emiliania huxleyi* *Oscillatoria woronichinii*
200	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Not reported
Compound: Thallium			Recommended BCF value: 15,000
The recommendedBCF was based on one study as follows:			
15,000	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Not reported
Compound: Zinc			Recommended BCF value: 2,175
The recommended BCF value was calculated using the geometric mean of 17 laboratory values as follows:			
285 4,395	Andryushhenko and Polikarpou (1973)	5-day exposure duration	*Ulva rigida*
4,680	Baudin (1974)	34-day exposure duration	*Cladophoea*
70 600 1,200 1,400 170,000	Deutch, Borg, Kloster, Meyer, and Moller (1980)	9-day exposure duration	*Codium fragile* *Enteromorpha* sp. *Ulva lactuca* *Fucus serratus* Marine plankton

TABLE C-4

WATER-TO-ALGAE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values[a]	Reference	Experimental Parameters	Species
12,000 10,000 4,600 5,200	Fisher, Bohe, and Teyssie (1984)	Not reported	*Thalassiosira pseudonana* *Dunaliella tertiolecta* *Emiliania huxleyi* *Oscillatoria woronichinii*
524 1,015	Munda (1979)	12-day exposure; The values reported in Munda (1979) were converted to wet weight using a conversion factor of 2.92 [a].	*Enteromorpha prolifera* *Fucus vivsoides*
255	U.S. EPA (1987a)	6-day exposure duration	*Ulva lactuca*
20,000 1,000	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Not reported

Notes:

(a) The reported values are presented as the amount of COPC in algae divided by the amount of COPC in water. If the values reported in the studies were presented as dry tissue weight over the amount of COPC in water, they were converted to wet weight over dry weight by dividing the concentration in dry algae tissue weight by 2.92. This conversion factor assumes an algae total weight is 65.7 percent moisture (Isensee, Kearney, Woolson, Jones and Williams 1973). The conversion factor was calculated as follows:

$$Conversion\ factor = \frac{1.0\ g\ algae\ total\ weight}{1.0\ g\ algae\ total\ weight - 0.675\ g\ algae\ wet\ weight}$$

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values	Reference	Experimental Parameters	Species
Dioxins and Furans			
Compound: 2,3,7,8-Tetrachlorinated dibenzo(p)dioxin (2,3,7,8-TCDD)			Recommended BCF value: 4,235
The recommended value was calculated using the geometric mean of 12 laboratory values for several PCDD compounds as follows:			
5,800	Adams, DeGraeve, Sabourin, Cooney, and Mosher (1986)	28-day exposure duration, 20-day elimination; reported data were for 2,3,7,8-tetrachlorodibenzo(p)dioxin (2,3,7,8-TCDD)	*Pimephales promelas*
9,270	Branson, Takahashi, Parker, and Blau (1985)	6-hour exposure duration, 139-day depuration	*Oncorhynchus mykiss*
39,000	Mehrle, Buckler, Little, Smith, Petty, Peterman, Stalling, DeGraeve, Coyle, and Adams (1988)	28-day exposure duration	*Oncorhynchus mykiss*
810 2,840 513 5,834	Muir, Marshall, and Webster (1985)	4 to 5-day exposure duration, 24 to 28-day depuration; values are based on a high to low range of reported values.	*Oncorhynchus mykiss* *Pimephales promelas*
2,769 2,269	Yockim, Isensee, and Jones (1978)	15-day exposure duration	*Gambusia affinis* *Ictalurus* sp.
5,000 9,300 7,900	U.S. EPA (1985)	Not reported	*Pimephales promelas*
Compound: 1,2,3,7,8-Pentachlorodibenzo(p)dioxin (1,2,3,7,8-PeCDD)			Recommended BCF value: 3,896
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =4,235 x 0.92 =3,896			
Compound: 1,2,3,4,7,8-Hexachlorodibenzo(p)dioxin (1,2,3,4,7,8-HxCDD)			Recommended BCF value: 1,313
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =4,235 x 0.31 =1313			
Compound: 1,2,3,6,7,8-Hexachlorodibenzo(p)dioxin (1,2,3,6,7,8-HxCDD)			Recommended BCF value: 508.2
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =4,235 x 0.12 =508.2			

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values	Reference	Experimental Parameters	Species
Compound: 1,2,3,7,8,9-Hexachlorodibenzo(p)dioxin (1,2,3,7,8,9-HxCDD)		Recommended BCF value:	592.9
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =4,235 x 0.14 =592.9			
Compound: 1,2,3,4,6,7,8-Heptachlorodibenzo(p)dioxin (1,2,3,4,6,7,8-HpCDD)		Recommended BCF value:	215.9
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =4,235 x 0.051 =215.9			
Compound: Octachlorodibenzo(p)dioxin (OCDD)		Recommended BCF value:	50.8
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =4,235 x 0.012 =50.8			
Compound: 2,3,7,8-Tetrachlorinated dibenzofuran (2,3,7,8-TCDF)Compound:		Recommended BCF value:	3,388
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =4,235 x 0.80 =3,388			
Compound: 1,2,3,7,8-Pentachlorodibenzo(p)furan (1,2,3,7,8-PeCDF)		Recommended BCF value:	931.7
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =4,235 x 0.22 =931.7			
Compound: 2,3,4,7,8-Pentachlorodibenzo(p)furan (2,3,4,7,8-PeCDF)		Recommended BCF value:	6,776
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =4,235 x1.6 =6,776			
Compound: 1,2,3,4,7,8-Hexachlorodibenzo(p)furan (1,2,3,4,7,8-HxCDF)		Recommended BCF value:	3,21.9
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =4,235 x 0.076 =3,21.9			
Compound: 1,2,3,6,7,8-Hexachlorodibenzo(p)furan (1,2,3,6,7,8-HxCDF)		Recommended BCF value:	804.7
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =4,235 x 0.19 =804.7			
Compound: 2,3,4,6,7,8-Hexachlorodibenzo(p)furan (2,3,4,6,7,8-HxCDF)		Recommended BCF value:	2,837
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =4,235 x 0.67 = 2,837			
Compound: 1,2,3,7,8,9-Hexachlorodibenzo(p)furan (1,2,3,7,8,9-HxCDF)		Recommended BCF value:	2,668
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =4,235 x 0.63 =2,668			

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values	Reference	Experimental Parameters	Species
Compound: 1,2,3,4,6,7,8,-Heptachlorodibenzo(p)furan (1,2,3,4,6,7,8-HpCDF)			Recommended BCF value: 46.6
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =4,235 x 0.011 =46.6			
Compound: 1,2,3,4,7,8,9-Heptachlorodibenzo(p)furan (1,2,3,4,7,8,9-HpCDF)			Recommended BCF value: 1,651
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =4,235 x 0.39 =1,651			
Compound: Octachlorodibenzo(p)furan (OCDF)			Recommended BCF value: 67.8
The BCF was calculated using the TCDD BCF and a bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =4,235 x 0.016 =67.8			
Polynuclear Aromatic Hydrocarbons (PAHs)			
Compound: Benzo(a)pyrene			Recommended BCF value: 500
The recommended value is that presented in Stephan (1993), which was the geometric mean of 16 laboratory values. This BCF for benzo(a)pyrene is also recommended for high molecular weight PAH for which empirical data are not available.			
500	Stephan (1993)	Not reported	Not reported
Compound: Benzo(a)anthracene			Recommended BCF value: 500
Empirical data were not available for this compound. The BCF for benzo(a)pyrene was used as a surrogate.			
Compound: Benzo(b)fluoranthene			Recommended BCF value: 500
Empirical data were not available for this compound. The BCF for benzo(a)pyrene was used as a surrogate.			
Compound: Benzo(k)fluoranthene			Recommended BCF value: 500
Empirical data were not available for this compound. The BCF for benzo(a)pyrene was used as a surrogate.			
Compound: Chrysene			Recommended BCF value: 500
Empirical data were not available for this compound. The BCF for benzo(a)pyrene was used as a surrogate.			
Compound: Dibenz(a,h)anthracene			Recommended BCF value: 500
Empirical data were not available for this compound. The BCF for benzo(a)pyrene was used as a surrogate.			

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values	Reference	Experimental Parameters	Species
Compound: Indeno(1,2,3-cd)pyrene			Recommended BCF value: 500
Empirical data were not available for this compound. The BCF for benzo(a)pyrene was used as a surrogate.			
Polychlorinated Biphenyls (PCBs)			
Compound: Aroclor 1016			Recommended BCF value: 22,649
The recommended BCF value was calculated using the geometric mean of 4 field values as follows[b, c, d]:			
25,000	Hansen et al. (1975) as cited in U.S. EPA (1980b)	28 days exposure 1.1 percent lipid Adult	*Cyprinodon variegatus*
43,000	Hansen et al. (1975) as cited in U.S. EPA (1980b)	28 days exposure Whole body Juvenile	*Cyprinodon variegatus*
14,400	Hansen et al. (1975) as cited in U.S. EPA (1980b)	28 days exposure Whole body Fry	*Cyprinodon variegatus*
17,000	Hansen et al. (1974) as cited in U.S. EPA (1980b)	21 to 28 days exposure Whole body	*Lagodon rhomboides*
Compound: Aroclor 1254			Recommended BCF value: 230,394
The recommended BCF value was calculated using the geometric mean of 7 field values as follows[b, c, d]:			
238,000 females 235,000 males	Nebeker, Puglisi, and DeFoe (1974)	Fish exposed for eight months. Residues measured in males and females.	*Pimephales promeles*
35,481 354,813 281,838	Rice and White (1987)	Field study	*Pimephales promeles*
46,000	Bills and Marking (1987)	30-day exposure duration Whole body	*Oncorhynchus mykiss*

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values	Reference	Experimental Parameters	Species
13,000,000 in lipid 1,030,000 dry tissue	Scura and Theilacker (1977)	45 days exposure	*Engraulis mordex*
370,000 1,200,000	Veith et al. (1977)	Field samples	Sculpins (bottom fish) Pelagic fish
47,000	Mauck et al. (1978) as cited in U.S. EPA (1980b)	118 days exposure Whole body	*Salvellnus fontinalis*
42,000	Snarski and Puglisi (1976) as cited in U.S. EPA (1980b)	500 days exposure Body lipid 2.9 percent Whole body	*Salvellnus fontinalis*
37,000	Hansen et al. (1971) as cited in EPA (1980b)	28 days exposure 1.1 percent lipid Whole body	*Leiostomus xanthurus*
30,000	Hansen et al. (1973) as cited in EPA (1980b)	28 days exposure 3.6 percent lipid Whole body	*Cyprinodon variegatus*
>670,00	Duke et al. (1970) and Nimmo et al. (1977) as cited in EPA (1980b)	Field data Whole body	*Cynoscion nebulosus*
>133,000	Nimmo et al. (1977) as cited in EPA (1980b)	Field data	Fishes
38,000	Halter (1974) as cited in EPA (1980b)	24 days exposure	*Salmo gairdneri*
61,200	Mayer et al. (1977) as cited in EPA (1980b)	77 days exposure Whole body	*Ictalurus punctatus*
Nitroaromatics			
Compound: 1,3-Dinitrobenzene			Recommended BCF value: 74
The BCF for 1,3 -dinitrobenzene was based on one laboratory value as follows:			
74	Deener, Sinnige, Seinen, and Hemens (1987)	3-day exposure duration	*Poecilia reticulata*
Compound: 2,4-Dinitrotoluene			Recommended BCF value: 21.04

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values	Reference	Experimental Parameters	Species
Empirical data for this compound were not available. The BCF for nitrobenzene was used as a surrogate.			
Compound: 2,6-Dinitrotoluene			Recommended BCF value: 21.04
Empirical data for this compound were not available. The BCF for nitrobenzene used as a surrogate.			
Compound: Nitrobenzene			Recommended BCF value: 21.04
The recommended BCF value was calculated using the geometric mean of 2 laboratory values as follows:			
29.5	Deneer, Sinnige, Seinen, and Hermens (1987)	3-day exposure duration	*Poecilia reticulata*
15	Veith, DeFoe, and Bergstedt (1979)	28-day exposure duration	*Pimephales promelas*
Compound: Pentachloronitrobenzene			Recommended BCF value: 214
The recommended BCF value was calculated using the geometric mean of 7 laboratory values as follows:			
238	Kanazawa (1981)	Continuous flow test	*Pseudorasbora parva*
250 320 380	Korte, Freitag, Geyer, Klein, Kraus, and Lahaniatis (1978)	24-hr exposure duration	*Leucisens idus melanotus*
114 147 169	Niimi, Lee, and Kissoon (1989)	20, 28, and 36-day exposure duration	*Oncorhynchus mykiss*
Phthalate Esters			
Compound: Bis(2-ethylhexyl)phthalate			Recommended BCF value: 70
The recommended BCF value was calculated using the geometric mean of 14 laboratory values as follows:			
91 569	Mayer (1976)	56-day exposure duration; based on a high to low range of reported values.	*Pimephales promelas*
155 42	Mehrle and Mayer (1976)	36 to 56-day exposure	*Pimephales promelas* *Oncorhynchus mykiss*

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values	Reference	Experimental Parameters	Species
178 10,563 306	Sodergren (1982)	27-day exposure duration	*Phoxinus phoxinus* *Lampetra planeri* *Pungitis pungitis*
51.5 8.9 1.6	Tarr, Barron, and Hayton (1990)	Not reported	*Salmo gairdneri*
4	U.S. EPA (1992a)	Not reported	Fish
851	Veith, DeFoe, and Bergstedt (1979)	Not reported	*Pimephales promelas*
10.7 13.5	Wofford, Wilsey, Neff, Giam, and Neff (1981)	24-hour exposure duration	*Cypinodon variegatus*
Compound: Di(n)octyl phthalate			Recommended BCF value: 9,400
The recommended BCF value was based on data from one study as follows:			
9,400	Sanborn, Metcalf, Yu, and Lu (1975)	Not reported	*Gambusia affinis*
Volatile Organic Compounds			
Compound: Acetone			Recommended BCF value: 0.10
Empirical data were not available for this compound. The BCF was calculated using the following regression equation: log BCF = 0.91 x log K_{ow} - 1.975 x log(6.8E-07 x K_{ow} + 1.0) - 0.786 (Bintein et al. 1993), where log K_{ow} = -0.222 (Karickoff and Long 1995)			
Compound: Acrylonitrile			Recommended BCF value: 48
The recommended BCF value was based on data from one study as follows:			
48	Barrows, Petrocelli, Macek, and Carroll (1978)	28-day exposure duration	*Lepomis macrochirus*
Compound: Chloroform			Recommended BCF value: 3.59
The recommended BCF value was calculated using the geometric mean of 3 laboratory values follows:			
5.6 3.44 2.4	Anderson and Lusty (1980)	24-hr exposure, 24-hr depuration	*Oncorhynchus mykiss* *Leponis macrochinus* *Micropterus salmoides*

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values	Reference	Experimental Parameters	Species
Compound: Crotonaldehyde			Recommended BCF value: 0.52
Empirical data were not available for this compound. The BCF was calculated using the following regression equation: log BCF = 0.91 x log K_{ow} - 1.975 x log(6.8E-07 x K_{ow} + 1.0) - 0.786 (Bintein et al. 1993), where log K_{ow} = 0.55 (based on equation in Hansch and Leo 1979, as calculated in NRC (1981)).			
Compound: Formaldehyde			Recommended BCF value: 0.34
Empirical data were not available for this compound. The BCF was calculated using the following regression equation: log BCF = 0.91 x log K_{ow} - 1.975 x log(6.8E-07 x K_{ow} + 1.0) - 0.786 (Bintein et al. 1993), where log K_{ow} = 0.342 (U.S. EPA 1995a)			
Compound: Vinyl chloride			Recommended BCF value: 1.81
Empirical data were not available for this compound. The BCF was calculated using the following regression equation: log BCF = 0.91 x log K_{ow} - 1.975 x log(6.8E-07 x K_{ow} + 1.0) - 0.786 (Bintein et al. 1993), where log K_{ow} =1.146 (U.S. EPA 1994b)			
Other Chlorinated Organics			
Compound: Carbon tetrachloride			Recommended BCF value: 30
The recommended BCF value was based on 1 laboratory values as follows:			
30	Barrows, Petrocelli, Macek, and Carroll (1978)	28-day exposure duration	*Lepomis macrochirus*
Compound: Hexachlorobenzene			Recommended BCF value: 253
The recommended BCF value on 1 field value as follows[b, c]			
253	Oliver and Niimi (1988)	Field samples.	Freshwater fish
22,000	Carlson and Kosian (1987)	32-day exposure duration	*Pimephales promelas*
1,260 2,040 6,160 15,850	Isensee, Holden, Woolson, and Jones (1976)	31-day exposure duration	*Gambusia affinis* *Ictalurus punctatus*
290,000	Koneman and van Leeuwen (1980)	Not reported	*Poecilia reticulata*
400 420	Korte, Freitag, Geyer, Klein, Kraus, and Lahaniatis (1978)	1-day exposure duration	*Zeucisens idus melanotus*

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values	Reference	Experimental Parameters	Species
32,000 39,000	Kosian, Lemke, Studders, and Veith (1981)	28-day exposure duration	*Pimephales promelas*
5,200 6,970	Lores, Patrick, and Summers (1993)	30-day exposure duration; based on a high to low range of reported values.	*Cyprinodon variegatus*
93 287	Metcalf, Kapoor, Lu, Schuth, and Sherman (1973)	3 to 32-day exposure duration	*Gambusia affinis*
12,240 12,600 15,250 13,330 21,140	Nebeker, Griffis, Wise, Hopkins, and Barbittas (1989)	28-day exposure duration	*Pimephales promelas*
253,333	Oliver and Niimi (1983)	119-day exposure duration	*Oncorhynchus mykiss*
27,000	Schrap and Opperhuizen (1990)	Not reported	*Poecilia reticulata*
18,500	Veith, DeFoe, and Bergstedt (1979)	32-day exposure duration	*Pimephales promelas*
7,800	U.S. EPA (1987)	Not reported	*Oncorhynchus mykiss*
8,690	U.S. EPA (1980h)	Not reported	*Pimephales promelas*
253	Oliver and Niimi (1988)	Field samples.	Freshwater fish
Compound: Hexachlorobutadiene			Recommended BCF value: 783
The recommended BCF value was calculated using the geometric mean of 3 laboratory values as follows:			
920 1,200	Leeuwangh, Bult, and Schneiders (1975)	49-day exposure duration; 15-day depuration. The values reported in Leeuwangh, Bult, and Schneiders (1975) were converted to wet weight using an unit conversion factor of 5.0 [a].	*Carassius auratus*
435	Laska, Bartell, Laseter (1976)	Not reported	*Gambusia affinis*
Compound: Hexachlorocyclopentadiene			Recommended BCF value: 165
The recommended BCF value was calculated using the geometric mean of 6 laboratory values as follows:			

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values	Reference	Experimental Parameters	Species
1,230	Freitag, Geyer, Kraus, Viswanathan, Kotzias, Attar, Klein, and Korte (1982)	3-day exposure duration	*Leuciscus idus*
448	Lu and Metcalf (1975)	Not reported. The values reported in Lu and Metcalf (1975) were converted to wet weight using an unit conversion factor of 5.0 [a]	*Gambusia affinis*
100 1,148	Podowski and Khan (1984)	16-day exposure duration	*Carassius auratus*
11	Spehar, Veith, DeFoe, and Bergstedt (1979)	30-day exposure duration	*Pimephales promelas*
29	Veith, DeFoe, and Bergstedt (1979)	32-day exposure duration	*Pimephales promelas*
Compound: Pentachlorobenzene			Recommended BCF value: 12,690
The recommended BCF value was calculated using the geometric mean of 12 laboratory values as follows:			
5,100 7,100 7,300	Banerjee, Suggatt, and O'Grady (1984)	2-day exposure duration	*Lepomis macrochirus* *Oncorynchus mykiss* *Poecilia reticulata*
26,000	Bruggeman, Oppenhuizen, Wijbenga, and Hutzinger (1984)	Not reported	*Poecilia reticulata*
8,400	Carlson and Kosian (1987)	31-day exposure duration	*Pimephales promelas*
28,183	Ikemoto, Motoba, Suzuki, Uchida (1992)	24-hour exposure duration	*Oryzias latipes*
260,000	Konemann and van Leeuwen (1980)	Not reported	*Poecilia reticulata*
17,000	Opperhuizen, Velde, Gobas, Liem, and Steen (1985)	Multiple exposure durations	*Poecilia reticulata*
6,600	Qiao and Farrell (1996)	10-day exposure duration	*Oncorhynchus mykiss*
23,000	Schrap and Opperhuizen (1990)	Not reported	*Poecilia reticulata*
4,700	Van Hoogen and Opperhuizen (1988)	5-day exposure duration; 21-day depuration	*Poecilia reticulata*
3,400	Veith, Macek, Petrocelli, and Carroll (1980)	28-day exposure duration	*Lepomis macrochirus*

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values	Reference	Experimental Parameters	Species
Compound: Pentachlorophenol			Recommended BCF value: 109
The recommended BCF value was calculated using the geometric mean of 20 laboratory values as follows:			
128 776	Garten and Trabalka (1983)	Not reported	Fish
189.5	Gates and Tjeerdema (1993)	1-day exposure duration	*Morone saxatilis*
2 131	Kobayashi and Kishino (1980)	1-hour exposure duration	*Carassius auratus*
350	Korte, Freitag, Geyer, Klein, Karus, and Lahaniatis (1978)	1-day exposure duration	*Zeucisens idus melanotus*
16 48 5 27	Parrish, Dyar, Enos, and Wilson (1978)	28 to 151-day exposure duration	*Cyprinodon variegatus*
30 38	Schimmel, Patrick, and Faas (1978)	28-day exposure duration	*Funidulus similis* *Mugil cephalus*
216	Smith, Bharath, Mallard, Orr, McCarty, and Ozburn (1990)	28-day exposure; 14-day depuration	*Jordanella floridae*
1,066 434 426 281	Spehar , Nelson, Swanson, and Renoos (1985)	32-day exposure duration	*Pimephales promelas*
52.3 607	Stehly and Hayton (1990)	96-hour exposure	*Carassius auratus*
770	Veith, DeFoe, and Bergstedt (1979)	32-day exposure	*Pimephales promelas*
Pesticides			
Compound: 4,4-DDE			Recommended BCF value: 25,512

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values	Reference	Experimental Parameters	Species
The recommended BCF value was calculated using the geometric mean of 11 laboratory values as follows:			
12,037	Metcalf, Sanborn, Lu, and Nye (1975)	Not reported	Fish
51,285 27,542	Garten and Trabalka (1983)	Freshwater	Fish
5,010 110,000 106,000 181,000	Hamelink and Waybrant (1976)	Not reported	*Lepomis macrochirus* *Oncorhynchus mykiss*
27,358	Metcalf, Sangha, and Kapoor (1971)	33-day exposure duration	*Gambusia affinis*
217 27,358	Metcalf, Kapoor, Lu, Schuth, and Sherman (1973)	3 to 33-day exposure duration	*Gambusia affinis*
81,000	Oliver and Niimi (1985)	96-day exposure duration	*Oncorhynchus mykiss*
51,000	Veith, DeFoe, and Bergstedt (1979)	32-day exposure duration	*Pimephales promelas*
Compound: Heptachlor			Recommended BCF value: 5,522
The recommended BCF value was calculated using the geometric mean of 7 laboratory values as follows:			
3,700 2,400 4,600	Goodman, Hansen, Couch, and Forester (1978)	28-day exposure duration	*Cyprinodon variegatus*
3,600 10,000	Schimmel, Patrick, and Forester (1976)	96-hour exposure duration	*Leiostomus xanthurus*
11,200	U.S. EPA (1980a)	Not reported	Fish
9,500	Veith, DeFoe, and Bergstedt (1979)	32-day exposure duration	*Pimephales promelas*
Compound: Hexachlorophene			Recommended BCF value: 278
The recommended BCF value was based on data from one study as follows:			
278	Sanborn (1974)	Not reported	*Oncorhychus mykiss*

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values	Reference	Experimental Parameters	Species
Inorganics			
Compound: Aluminum			Recommended BCF value: 2.70
The recommended BCF value was calculated using the geometric mean of 7 laboratory values as follows:			
0.05 1.25 0.05 0.35	Cleveland, Little, Hamilton, Buckler, and Hunn (1986)	37-day exposure duration	*Salvelinus fontinalis*
36 123 215	Cleveland, Buckler, and Brumbaugh (1991)	56-day exposure duration; 28-day depuration	*Salvelinus fontinalis*
Compound: Antimony			Recommended BCF value: 40
The recommended BCF value was based on one study as follows:			
40	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Fish
Compound: Arsenic			Recommended BCF value: 114
The recommended BCF value was calculated using the geometric mean of 3 laboratory values as follows:			
333 100	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Fish
44	U.S. EPA (1992b)	Not reported	Fish
Compound: Barium			Recommended BCF value: 633
Empirical data for this compound were not available. The recommended BCF is the arithmetic mean of the recommended values for 14 inorganics with empirical data available (aluminum, antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc).			
Compound: Beryllium			Recommended BCF value: 62
The recommended BCF value was calculated using the geometric mean of 4 laboratory values as follows:			

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

(Page 14 of 19)

Reported Values	Reference	Experimental Parameters	Species
200 200	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Fish
19	U.S. EPA (1992b)	Not reported	Fish
19	U.S. EPA (1978)	28-day exposure duration	Fish
Compound: Cadmium			Recommended BCF value: 907
The recommended BCF value was calculated using the geometric mean of 4 field values.			
558 1,295 729 1,286	Saiki, Castleberry, May, Martin, and Ballard (1995)	Field samples. The field values reported in Saiki, Castleberry, May, Martin, and Ballard (1995) were converted to wet weight using a conversion factor of 5.0[a]. The field values are also based on mean values calculated for each of the 4 fish species.	*Catostomus occidentalis* *Gasterosteus aculeatus* *Ptychocheilus grandis* *Oncorhynchus tshawytasch*
716	Benoit, Leonard, Christensen, and Fiandt (1976)	38-week exposure duration; based on mean values calculated from various tissue concentrations in the kidney, liver, spleen, gonad, gills, and muscle/red blood cells. A unit conversion of 1,000 was applied to the value.	*Salvelinus fontanilis*
480	Eisler, Zaroogian, and Hennekey (1972)	3-week exposure duration	*Fundulus heteroclitus*
161 51	Harrison and Klaverkamp (1989)	72-day exposure duration, 25 and 63-day depuration	*Oncorhynchus mykiss* *Coregonus clupeatormis*
33	Kumada, Kimura, and Yokote (1980)	10 week exposure duration	*Oncorhynchus mykiss*
8 3,333	Kumada, Kimura, Yokote, and Matida (1973)	280-day exposure; values are based on a high to low range of values. The values reported in Kumada, Kimura, Yokote, and Matida (1973) were converted to wet weight using a conversion factor of 5.0[a].	*Oncorhynchus mykiss*
4.4	Spehar (1976)	30-day exposure duration	*Jordanella floridae*
3,000 200	Thompson, Burton, Quinn and Ng (1972)	Not reported	Fish

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

(Page 15 of 19)

Reported Values	Reference	Experimental Parameters	Species
4,100	Williams and Giesy (1979)	56-day exposure duration	Fish
Compound: Chromium (total)			Recommended BCF value: 19
The recommended BCF value was calculated using the geometric mean of 4 laboratory values as follows:			
1.27 1.34	Fromm and Stokes (1962)	30-day exposure duration; values are based on a high to low range of reported values.	*Oncorhynchus mykiss*
200 400	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Fish
Compound: Copper			Recommended BCF value: 710
The recommended BCF value was calculated using the geometric mean of 4 field values as follows:			
761 697 1,236 387	Saiki, Castleberry, May, Martin, and Ballard (1995)	Field samples	*Catostomus occidentalis* *Gasterosteus aculeatus* *Ptychocheilus grandis* *Oncorhynchus tshawytasch*
50 500 667	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Fish
36	U.S. EPA (1992b)	Not reported	Fish

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values	Reference	Experimental Parameters	Species
Compound: Cyanide (total)			Recommended BCF value: 633
Empirical data for this compound were not available. The recommended BCF is the arithmetic mean of the recommended values for 14 inorganics with empirical data available (aluminum, antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc).			
Compound: Lead			Recommended BCF value: 0.09
The recommended BCF value based on one field value:			
0.09	Atchinson, Murphy, Bishop, McIntosh, and Mayes (1977)	Field samples. The values reported in Atchinson, Murphy, Bishop, McIntosh, and Mayes (1977) were converted to wet weight using a conversion factor of 5.0[a].	*Lepomis macrochiras*
0.15 0.17	Holcombe, Benoit, Leonard, and McKim (1976)	266-day exposure duration. The values reported in Holcombe, Benoit, Leonard, and McKim (1976) were converted to wet weight using a conversion factor of 5.0[a]. Mean values were calculated based on tissue concentrations in the red blood cells, kidney, and muscle.	*Salvelinus fontanilis*
300 100	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Fish
Compound: Mercuric chloride			Recommended BCF value: 3,530
The recommended BCF value was calculated using the geometric mean of 3 laboratory values as follows:			
1,800	Boudou and Ribeyre (1984)	60-day exposure duration	*Oncorhynchus mykiss*
4,380 5,580	Snarski and Olson (1982)	287-day exposure duration; values are based on a high to low range of reported values.	*Pimephales promelas*
Compound: Methyl mercury			Recommended BCF value: 11,168
The recommended BCF value was calculated using the geometric mean of 3 laboratory values as follows:			
11,000	Boudou and Ribeyre (1984)	60-day exposure duration	*Oncorhynchus mykiss*

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values	Reference	Experimental Parameters	Species
10,800 11,724	McKim, Olson, Holcome, and Hunt (1976)	756-day exposure duration	*Salvelinus fontinalis*
Compound: Nickel			Recommended BCF value: 78
The recommended BCF value was calculated using the geometric mean of 3 laboratory values as follows:			
100 100	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Fish
47	U.S. EPA (1992b)	Not reported	Fish
Compound: Selenium			Recommended BCF value: 129
The recommended BCF value was calculated using the geometric mean of 12 laboratory values as follows:			
18	Adams (1976)	96-day exposure duration	Fish
4,900	Besser, Canfield, and LaPoint (1993)	30-day exposure duration	*Lepomis reinhardtii*
5 7	Cleveland , Little, Buckler, and Wiedmeyer (1993)	60-day exposure duration; values are based on a high to low range of reported values.	*Lepomis macrochirus*
154 711	Dobbs, Cherry, and Cairns (1996)	25-day exposure duration	*Pimephales promelas*
3 240	Hodson, Spry, and Blunt (1980)	351-day exposure duration; values represent a high to low range of reported values based on BCFs for peritoneal fat and the liver.	*Oncorhynchus mykiss*
285 465	Lemly (1982)	120-day exposure duration	*Micropterus salmoides* *Lepomis macrochirus*
4,000 167	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Fish
Compound: Silver			Recommended BCF value: 87.71
The recommended BCF value was calculated using the geometric mean of 2 laboratory values as follows:			
3,330	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Fish

TABLE C-5

WATER-TO-FISH BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg dissolved COPC / L water)

Reported Values	Reference	Experimental Parameters	Species
Compound: Thallium			Recommended BCF value: 10,000
The recommended BCF value was calculated using the geometric mean of 2 laboratory values as follows:			
10,000 10,000	Thompson, Burton, Quinn, and Ng (1972)	Not reported	Fish
Compound: Zinc			Recommended BCF value: 2,059
The recommended BCF value was calculated using the geometric mean of 4 field values as follows:			
2,299 2,265 4,290 804	Saiki, Castleberry, May, Martin, and Ballard (1995)	Field samples.	*Catostomus occidentalis* *Gasteroteus aculeatus* *Ptychocheilus grandis* *Oncorhynchus tshawytasch*
50 130 130 200	Deutch, Borg, Kloster, Meyer, and Moller (1980)	9-day exposure duration	*Spinachia vulgaris* *Gasterosteus acul.* *Pungitius pungitius* *Cottus scorpius*
373 8,853	Pentreath (1973)	180-day exposure duration; values are based on a high to low range of reported values	*Pleuronectes platessa*
1,000 2,000 2,000	Thompson, Burton, Quinn and Ng (1972)	Not reported	Fish
47	U.S. EPA (1992b)	Not reported	Fish

Notes:

(a) The reported values are presented as the amount of COPC in fish tissue divided by the amount of COPC in water. If the values reported in the studies were presented as dry tissue weight, they were converted to wet weight by dividing the concentration in dry fish tissue weight by 5.0. This conversion factor assumes a fish's total weight is 80.0 percent moisture (Holcomb, Benoit, Leonard, and McKim 1976).

The conversion factor was calculated as follows:

$$Conversion\ factor = \frac{1.0\ g\ fish\ total\ weight}{1.0\ g\ fish\ total\ weight - 0.80\ g\ fish\ wet\ weight}$$

(b) The equation used to convert the total organic COPC concentrations in field samples to dissolved COPC concentrations is from U.S. EPA (1995a) as follows:

$BAF\ (dissolved) = (BAF\ (total) / f_{fd}) - 1$

where: *BAF (dissolved)* = *BAF* based on dissolved concentration of COPC in water
BAF (total) = *BAF* based on the field derived data for total concentration of COPC in water
f_{fd} = Fraction of COPC that is freely dissolved in the water
where: $f_{fd} = 1 / [1 + ((DOC \times K_{ow}) / 10) + (POC \times K_{ow})]$
DOC = Dissolved organic carbon, Kg of organic carbon / L of water (2.0×10^{-06} kg/L)
K_{ow} = Octanol-water partition coefficient of the COPC, as reported in U.S. EPA (1994b)
POC = Particulate organic carbon, Kg of organic carbon / L of water (7.5×10^{-09} Kg/L)

(c) The reported field *BAF*s were converted to *BCF*s as follows:

$BCF = (BAF_{TLn} / FCM_{TLn}) - 1$

where: BAF_{TLn} = The reported field bioaccumulation factor for the trophic level "n" of the study species.
FCM_{TLn} = The food chain multiplier for the trophic level "n" of the study species.

(d) PCB values were converted to dissolved COPC BCFs based on the K_{ow} for Aroclor 1254.

(e) The geometric mean of the converted field derived BCFs was compared to the geometric mean of the laboratory derived BCFs. The higher of the two values was selected as the COPC BCF.

TABLE C-6

SEDIMENT-TO-BENTHIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg COPC / kg dry sediment)

Reported Values[a]	Reference	Experimental Parameters	Species
Dioxins and Furans			
Compound: 2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)			Recommended BCF value: 19,596
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 6.64 (U.S. EPA 1994a)			
Compound: 1,2,3,7,8-Pentachlorodibenzo(p)dioxin (1,2,3,7,8-PeCDD)			Recommended BCF value: 18,023
The BCF was calculated using the TCDD BCF and a congener-speccific bioaccumulation equivalency factor (BEF) (U.S. EPA 1995b) as follows: BCF =19,596 x 0.92 = 3,896			
Compound: 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (1,2,3,4,7,8-HxCDD)			Recommended BCF value: 6,075
The BCF was calculated using the TCDD BCF and a congener-specific BEF (U.S. EPA 1995b) as follows: BCF =19,596 x 0.31 =1313			
Compound: 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (1,2,3,6,7,8-HxCDD)			Recommended BCF value: 2,351
The BCF was calculated using the TCDD BCF and a congener-specific BEF (U.S. EPA 1995b) as follows: BCF =19,596 x 0.12 =2,351			
Compound: 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (1,2,3,7,8,9-HxCDD)			Recommended BCF value: 2,743
The BCF was calculated using the TCDD BCF and a congener-specific BEF (U.S. EPA 1995b) as follows: BCF =19,596 x 0.14 =2,743			
Compound: 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (1,2,3,4,6,7,8-HpCDD)			Recommended BCF value: 99.4
The BCF was calculated using the TCDD BCF and a congener-specific BEF (U.S. EPA 1995b) as follows: BCF =19,596 x 0.051 =99.4			
Compound: Octachlorodibenzo-p-dioxin (OCDD)			Recommended BCF value: 23.5
The BCF was calculated using the TCDD BCF and a congener-specific BEF (U.S. EPA 1995b) as follows: BCF =19,596 x 0.012 =23.5			
Compound: 2,3,7,8-Tetrachlorodibenzofuran (2,3,7,8-TCDF)			Recommended BCF value: 2,642
The BCF was calculated using the TCDD BCF and a congener-specific BEF (U.S. EPA 1995b) as follows: BCF = 3,302 x0.80 = 2,642			
Compound: 1,2,3,7,8-Pentachlorodibenzo-p-furan (1,2,3,7,8-PeCDF)			Recommended BCF value: 4,311
The BCF was calculated using the TCDD BCF and a congener-specific BEF (U.S. EPA 1995b) as follows: BCF =19,596 x 0.22 =4,311			
Compound: 2,3,4,7,8-Pentachlorodibenzo-p-furan (2,3,4,7,8-PeCDF)			Recommended BCF value: 31,354
The BCF was calculated using the TCDD BCF and a congener-specific BEF (U.S. EPA 1995b) as follows: BCF =19,596 x 1.6 =31,354			

TABLE C-6

SEDIMENT-TO-BENTHIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg COPC / kg dry sediment)

Reported Values[a]	Reference	Experimental Parameters	Species
Compound: 1,2,3,4,7,8-Hexachlorodibenzo-p-furan (1,2,3,4,7,8-HxCDF)			Recommended BCF value: 1,489
The BCF was calculated using the TCDD BCF and a congener-specific BEF (U.S. EPA 1995b) as follows: BCF =19,596 x 0.076 =1,489			
Compound: 1,2,3,6,7,8-Hexachlorodibenzo-p-furan (1,2,3,6,7,8-HxCDF)			Recommended BCF value: 3,723
The BCF was calculated using the TCDD BCF and a congener-specific BEF (U.S. EPA 1995b) as follows: BCF =19,596 x 0.19 =3,723			
Compound: 2,3,4,6,7,8-Hexachlorodibenzo-p-furan (2,3,4,6,7,8-HxCDF)			Recommended BCF value: 13,129
The BCF was calculated using the TCDD BCF and a congener-specific BEF (U.S. EPA 1995b) as follows: BCF =19,596 x 0.67 = 13,129			
Compound: 1,2,3,7,8,9-Hexachlorodibenzo-p-furan (1,2,3,7,8,9-HxCDF)			Recommended BCF value: 12,345
The BCF was calculated using the TCDD BCF and a congener-specific BEF (U.S. EPA 1995b) as follows: BCF =19,596 x 0.63 =12,345			
Compound: 1,2,3,4,6,7,8,-Heptachlorodibenzo-p-furan (1,2,3,4,6,7,8-HpCDF)			Recommended BCF value: 215.6
The BCF was calculated using the TCDD BCF and a congener-specific BEF (U.S. EPA 1995b) as follows: BCF =19,596 x 0.011 =215.6			
Compound: 1,2,3,4,7,8,9-Heptachlorodibenzo-p-furan (1,2,3,4,7,8,9-HpCDF)			Recommended BCF value: 7,642
The BCF was calculated using the TCDD BCF and a congener-specific (U.S. EPA 1995b) as follows: BCF =19,596 x 0.39 =7,642			
Compound: Octachlorodibenzo-p-furan (OCDF)			Recommended BCF value: 313.5
The BCF was calculated using the TCDD BCF and a congener-specific BEF (U.S. EPA 1995b) as follows: BCF =19,596 x 0.016 =313.5			
Polynuclear Aromatic Hydrocarbons (PAHs)			
Compound: Benzo(a)pyrene			Recommended BCF value: 1. 59
The recommended BCF value was calculated using the geometric mean of 8 values as follows:			
5.2 2.8	Augenfeld, Anderson, Riley, and Thomas (1982)	60-day exposure duration	*Macoma inquinata* *Abarenicola pacifica*
0.4 0.65 7.4	Driscoll and McElroy (1996)	6 to 12-day exposure duration	*Nereis diversicolor* *Scolecolipides virdis* *Leitoscoloplos fragilis*

TABLE C-6

SEDIMENT-TO-BENTHIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg COPC / kg dry sediment)

Reported Values[a]	Reference	Experimental Parameters	Species
2.3 6.9	Landrum, Eadie, and Faust (1991)	Mixture of PAH at four concentrations	*Diporeia* sp.
0.09	Roesijadi, Anderson, and Blaylock (1978)	7-day exposure duration	*Macoma inquinata*
Compound: Benzo(a)anthracene			Recommended BCF value: 1.45
Empirical data for this compound were not available. Therefore, the BCF for benzo(a)pyrene was used as a surrogate.			
Compound: Benzo(b)fluoranthene			Recommended BCF value: 1.61
Empirical data for this compound were not available. Therefore, the BCF for benzo(a)pyrene was used as a surrogate.			
Compound: Benzo(k)fluoranthene			Recommended BCF value: 1.61
Empirical data for this compound were not available. Therefore, the BCF for benzo(a)pyrene was used as a surrogate.			
Compound: Chrysene			Recommended BCF value: 1.38
BCF value was calculated using the geometric mean of 3 values as follows:			
0.04	Roesijadi, Anderson, and Blaylock (1978)	7-day exposure duration	*Macoma inquinata*
11.6 5.64	Augenfeld, Anderson, Riley, and Thomas (1982)	60-day exposure duration	*Macoma inquinata* *Abarenicola pacifica*
Compound: Dibenz(a,h)anthracene			Recommended BCF value: 1.61
Empirical data for this compound were not available. Therefore, the BCF for benzo(a)pyrene was used as a surrogate.			
Compound: Indeno(1,2,3-cd)pyrene			Recommended BCF value: 1.61
Empirical data for this compound were not available. Therefore, the BCF for benzo(a)pyrene was used as a surrogate.			
Polychlorinated Biphenyls (PCBs)			
Compound: Aroclor 1016			Recommended BCF value: 0.53
The recommended BCF value was calculated using the geometric mean of 2 empirical values as follows:			

TABLE C-6

SEDIMENT-TO-BENTHIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg COPC / kg dry sediment)

Reported Values[a]	Reference	Experimental Parameters	Species
0.2 1.4	Wood, O'Keefe, and Bush (1997)	12-day exposure duration; 1-day depuration	*Chironomus tentans*
Compound: Aroclor 1254			Recommended BCF value: 0.53
The recommended BCF value was calculated using the geometric mean of 2 empirical values as follows:			
0.2 1.4	Wood, O'Keefe, and Bush (1997)	12-day exposure duration; 1-day depuration	*Chironomus tentans*
Nitroaromatics			
Compound: 1,3-Dinitrobenzene			Recommended BCF value: 1.19
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 1.491 (U.S. EPA 1994b)			
Compound: 2,4-Dinitrotoluene			Recommended BCF value: 58
The recommended BCF value was based on 1 study as follows:			
58	Liu, Bailey, and Pearson (1983)	4-day exposure duration	*Lumbriculus variegatus*
Compound: 2,6-Dinitrotoluene			Recommended BCF value: 2.50
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 1.886 (U.S. EPA 1994b)			
Compound: Nitrobenzene			Recommended BCF value: 2.27
Empirical data were not available for this compound. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 1.833 (U.S. EPA 1994b)			
Compound: Pentachloronitrobenzene			Recommended BCF value: 451
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 4.640 (U.S. EPA 1994b)			
Phthalate Esters			
Compound: Bis(2-ethylhexyl)phthalate			Recommended BCF value: 1,309

TABLE C-6

SEDIMENT-TO-BENTHIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg COPC / kg dry sediment)

Reported Values[a]	Reference	Experimental Parameters	Species
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 5.205 (U.S. EPA 1994b)			
Compound: Di(n)octyl phthalate			Recommended BCF value: 3,128,023
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 9.330 (U.S. EPA 1994b)			
Volatile Organic Compounds			
Compound: Acetone			Recommended BCF value: 0.05
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = -0.222 (Karickoff and Long 1995)			
Compound: Acrylonitrile			Recommended BCF value: 0.11
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 0.250 (Karickoff and Long 1995)			
Compound: Chloroform			Recommended BCF value: 2.82
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 1.949 (U.S. EPA 1994b)			
Compound: Crotonaldehyde			Recommended BCF value: 0.20
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 0.55 (based on equations developed by Hansch and Leo 1979, as calculated in NRC 1981)			
Compound: 1,4-Dioxane			Recommended BCF value: 0.04
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = -0.268 (U.S. EPA 1995a)			
Compound: Formaldehyde			Recommended BCF value: 0.14
Empirical data for this compound were not available.The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 0.342 (U.S. EPA 1995a)			
Compound: Vinyl chloride			Recommended BCF value: 0.62

TABLE C-6

SEDIMENT-TO-BENTHIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg COPC / kg dry sediment)

Reported Values[a]	Reference	Experimental Parameters	Species
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 1.146 (U.S. EPA 1994b)			
Other Chlorinated Organics			
Compound: Carbon tetrachloride			Recommended BCF value: 12
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 2.717 (U.S. EPA 1994b)			
Compound: Hexachlorobenzene			Recommended BCF value: 2,296
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 5.503 (U.S. EPA 1994b)			
Compound: Hexachlorobutadiene			Recommended BCF value: 0.44
The recommended BCF value was based on empirical data from one study as follows:			
0.44	Oliver (1987)	79-day exposure duration; The values reported in Oliver (1987) were converted to wet weight over dry weight using a conversion factor of 5.99[a].	Oligochaetes
Compound: Hexachlorocyclopentadiene			Recommended BCF value: 746
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 4.907 (U.S. EPA 1994b)			
Compound: Pentachlorobenzene			Recommended BCF value: 0.32
The recommended BCF value is based on 1 study as follows:			
0.32	Oliver (1987)	79-day exposure duration; The values reported in Oliver (1987) were converted to wet weight over dry weight using a conversion factor of 5.99[a].	Oligochaetes
Compound: Pentachlorophenol			Recommended BCF value: 1,034
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 5.080 (U.S. EPA 1994b)			

TABLE C-6

SEDIMENT-TO-BENTHIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg COPC / kg dry sediment)

Reported Values[a]	Reference	Experimental Parameters	Species
Pesticides			
Compound: 4,4'-DDE			Recommended BCF value: 0.95
The recommended BCF value was calculated using the geometric mean of 13 values as follows:			
2.9 1.3 0.4 0.2 2.2 0.1 1.2 9.6 2.1 24.6 1.8 0.1 0.07	Reich, Perkins, and Cutter (1986)	Field samples	Tubificidae Chironomidae Croixidae
Compound: Heptachlor			Recommended BCF value: 1.67
Empirical data for heptachlor were not available. The BCF was calculated from 1 field-derived value for heptachlor epoxide as follows:			
10.0	Beyer and Gish (1980)	Field samples; The value reported in Beyer and Gish (1980) was converted to wet weight over dry weight using a conversion factor of 5.99[a].	*Aporrectodea trapezoides* *Aparrectodea turgida* *Allolobophora chlorotica* *Lumbricus terrestris*
Compound: Hexachlorophene			Recommended BCF value: 106,970
Empirical data for this compound were not available. The BCF was calculated using the following regression equation: log BCF = 0.819 x log K_{ow} - 1.146 (Southworth, Beauchamp, and Schmieder 1978), where log K_{ow} = 7.540 (Karickoff and Long 1995)			
Inorganics			
Compound: Aluminum			Recommended BCF value: 0.90
Empirical data for this compound were not available. The recommended BCF value is the arithmetic average of 6 recommended values for those metals with empirical data (cadmium, chromium, copper, lead, inorganic mercury, and zinc).			
Compound: Antimony			Recommended BCF value: 0.90
Empirical data for this compound were not available. The recommended BCF value is the arithmetic average of 6 recommended values for those metals with empirical data (cadmium, chromium, copper, lead, inorganic mercury, and zinc).			

TABLE C-6

SEDIMENT-TO-BENTHIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg COPC / kg dry sediment)

Reported Values[a]	Reference	Experimental Parameters	Species
Compound: Arsenic			Recommended BCF value: 0.90
Empirical data for this compound were not available. The recommended BCF value is the arithmetic average of 6 recommended values for those metals with empirical data (cadmium, chromium, copper, lead, inorganic mercury, and zinc).			
Compound: Barium			Recommended BCF value: 0.90
Empirical data for this compound were not available. The recommended BCF value is the arithmetic average of 6 recommended values for those metals with empirical data (cadmium, chromium, copper, lead, inorganic mercury, and zinc).			
Compound: Beryllium			Recommended BCF value: 0.90
Empirical data for this compound were not available. The recommended BCF value is the arithmetic average of 6 recommended values for those metals with empirical data (cadmium, chromium, copper, lead, inorganic mercury, and zinc).			
Compound: Cadmium			Recommended BCF value: 3.4
The recommended BCF value was calculated using the geometric mean of 8 field-derived values as follows:			
3.33 7.68 1.79 7.15 1.67 2.34 2.27 6.29	Saiki, Castleberry, May, Martin, and Bullard (1995)	Field samples; The values reported in Saiki, Castleberry, May, Martin, and Bullard (1995) were converted to wet weight over dry weight using a conversion factor of 5.99[a].	Chironomidae Epheroptera
Compound: Chromium (total)			Recommended BCF value: 0.39
The recommended BCF value was based on 1 field-derived value as follows:			
0.39	Namminga and Wilhm (1977)	Field samples	Chironomidae
0.03 0.07 0.001 0.003	Capuzzo and Sasner (1977)	168-day exposure duration; The reported value was calculated by dividing the tissue concentration by the media concentration [(µg/g)/(mg/g)] and a conversion factor of $1x10^{-3}$ was applied to the value. A conversion factor of 5.99[a] was applied to convert dry tissue weight to wet weight.	*Mya arenaria*
Compound: Copper			Recommended BCF value: 0.30

TABLE C-6

SEDIMENT-TO-BENTHIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg COPC / kg dry sediment)

Reported Values[a]	Reference	Experimental Parameters	Species
The recommended BCF value was calculated using the geometric mean of 9 field values as follows:			
0.11 0.22 0.13 0.32	Jones, Jones, and Radlett (1976)	25-day exposure duration; The values reported in Jones, Jones, and Radlett (1976) were converted to wet weight over dry weight using a conversion factor of 5.99[a].	*Nereis diveriscolor*
1.1	Namminga and Wilhm (1977)	Field samples	Chironomidae
0.29 0.36 0.16 0.73 0.31 0.36 0.06 0.25	Saiki, Castleberry, May, Martin and Bullard (1995)	Field samples; The values reported in Saiki, Castleberry, May, Martin and Bullard (1995) were converted to wet weight over dry weight using a conversion factor of 5.99[a].	Chironomidae Ephemeroptera
Compound: Cyanide (total)			Recommended BCF value: 0.90
Empirical data were not available for this compound. The recommended BCF value is the arithmetic average of 6 recommended values for those metals with empirical data (cadmium, chromium, copper, lead, inorganic mercury, and zinc).			
Compound: Lead			Recommended BCF value: 0.63
The recommended BCF value was based on 1 study follows:			
0.4 1.0	Harrahy and Clements (1997)	14-day exposure duration	*Chironomus tentans*
Compound: Mercuric chloride			Recommended BCF value: 0.068
The recommended BCF value was based on 6 field values as follows:			
0.08	Saouter, Hare, Campbell, Boudou, and Ribeyre (1993)	9-day exposure duration	*Hexagenia rigida*
0.16 0.08 0.04 0.04 0.08 0.06	Hildebrand, Strand, and Huckabee (1980)	Field samples	Hydropsychidae, Corydalus, Decapoda, Aterix, Psephenidae, and unspecified other benthic invertebrates
Compound: Methyl mercury			Recommended BCF value: 0.48
The recommended BCF value was based on 6 field values as follows:			

TABLE C-6

SEDIMENT-TO-BENTHIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg COPC / kg dry sediment)

Reported Values[a]	Reference	Experimental Parameters	Species
4.0	Saouter, Hare, Campbell, Boudou, and Ribeyre (1993)	9-day exposure duration	*Hexagenia rigida*
1.45 0.50 0.26	Hildebrand, Strand, and Huckabee (1980)	Field samples	Hydropsychidae, Corydalus, Decapoda, Aterix, Psephenidae, and unspecified other benthic invertebrates
Compound: Nickel			Recommended BCF value: 0.90
Empirical data for this compound were not available. The recommended BCF value is the arithmetic average of 6 recommended values for those metals with empirical data (cadmium, chromium, copper, lead, inorganic mercury, and zinc).			
Compound: Selenium			Recommended BCF value: 0.90
Empirical data for this compound were not available. The recommended BCF value is the arithmetic average of 6 recommended values for those metals with empirical data (cadmium, chromium, copper, lead, inorganic mercury, and zinc).			
Compound: Silver			Recommended BCF value: 0.90
Empirical data for this compound were not available. The recommended BCF value is the arithmetic average of 6 recommended values for those metals with empirical data (cadmium, chromium, copper, lead, inorganic mercury, and zinc).			
Compound: Thallium			Recommended BCF value: 0.90
Empirical data for this compound were not available. The recommended BCF value is the arithmetic average of 6 recommended values for those metals with empirical data (cadmium, chromium, copper, lead, inorganic mercury, and zinc).			
Compound: Zinc			Recommended BCF value: 0.57
The recommended BCF value was calculated using the geometric mean of 8 field values as follows:			
3.6	Namminga and Wilhm (1977)	Not reported	Chironomidae
0.46 0.38 0.13 0.79 0.83 1.16 0.39 1.57	Saiki, Castleberry, May, Martin, and Bullard (1995)	Field samples; the values reported in Saiki, Castleberry, May, Martin and Bullard (1995) were converted to wet weight over dry weight using an unit conversion factor of 5.99[a].	Chironomidae Ephemeroptera

TABLE C-6

SEDIMENT-TO-BENTHIC INVERTEBRATE BIOCONCENTRATION FACTORS
(mg COPC / kg wet tissue) / (mg COPC / kg dry sediment)

Notes:

(a) The reported values are presented as the amount of compound in invertebrate tissue divided by the amount of compound in the sediment. If the values reported in the studies were presented as dry tissue weight over dry sediment weight, they were converted to wet weight over dry weight by dividing the concentration in dry invertebrate tissue weight by 5.99. This conversion factor assumes an earthworm's total weight is 83.3 percent moisture (Pietz et al. 1984).

The conversion factor was calculated as follows:

$$Conversion\ factor = \frac{1.0\ g\ invertebrate\ total\ weight}{1.0\ g\ invertebrate\ total\ weight - 0.833\ g\ invertebrate\ wet\ weight}$$

TABLE C-7

AIR-TO-PLANT BIOTRANSFER FACTORS
(µg COPC / g dry plant) / (µg COPC / g air)

Compound	*Bv* Value[a]	Compound	*Bv* Value
Dioxins and furans			
2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)	6.55E+04	1,2,3,7,8-Pentachlorodibenzo-p-furan (1,2,3,7,8-PeCDF)	9.75E+04
1,2,3,7,8-Pentachlorodibenzo(p)dioxin (1,2,3,7,8-PeCDD)	2.39E+05	2,3,4,7,8-Pentachlorodibenzo-p-furan (2,3,4,7,8-PeCDF)	9.75E+04
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (1,2,3,4,7,8-HxCDD)	5.20E+05	1,2,3,4,7,8-Hexachlorodibenzo-p-furan (1,2,3,4,7,8-HxCDF)	1.62E+05
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (1,2,3,6,7,8-HxCDD)	5.20E+05	1,2,3,6,7,8-Hexachlorodibenzo-p-furan (1,2,3,6,7,8-HxCDF)	1.62E+05
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (1,2,3,7,8,9-HxCDD)	5.20E+05	2,3,4,6,7,8-Hexachlorodibenzo-p-furan (2,3,4,6,7,8-HxCDF)	1.62E+05
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (1,2,3,4,6,7,8-HpCDD)	9.10E+05	1,2,3,7,8,9-Hexachlorodibenzo-p-furan (1,2,3,7,8,9-HxCDF)	1.62E+05
Octachlorodibenzo-p-dioxin (OCDD)	2.36E+06	1,2,3,4,6,7,8,-Heptachlorodibenzo-p-furan (1,2,3,4,6,7,8-HpCDF)	8.30E+05
2,3,7,8-Tetrachlorodibenzofuran (2,3,7,8-TCDF)	4.57E+04	1,2,3,4,7,8,9-Heptachlorodibenzo-p-furan (1,2,3,4,7,8,9-HpCDF)	8.30E+05
Octachlorodibenzo-p-furan (OCDF)	2.28E+06		
Polynuclear aromatic hydrocarbons (PAHs)			
Benzo(a)pyrene	2.25E+05	Chrysene	5.97E+04
Benzo(a)anthracene	1.72E+04	Dibenzo(a,h)anthracene	4.68E+07
Benzo(b)fluoranthene	3.65E+04	Ideno(1,2,3-cd)pyrene	2.67E+08
Benzo(k)fluoranthene	5.40E+05		
Polychlorinated biphenyls (PCBs)			
Aroclor 1016	7.52E+01	Aroclor 1254	3.09E+02
Nitroaromatics			
1,3-Dinitrobenzene	1.74E+01	Nitrobenzene	2.43E-01
2,4-Dintrotoluene	5.10E+01	Pentachloronitrobenzene	1.71E-01

TABLE C-7

AIR-TO-PLANT BIOTRANSFER FACTORS
(µg COPC / g dry plant) / (µg COPC / g air)

Compound	*Bv* Value[a]	Compound	*Bv* Value
2,6-Dinitrotoluene	4.41E+01		
Phthalate esters			
Bis(2-ethylhexyl)phthalate	2.33E+03	Di(n)octyl phthalate	6.30E+08
Volatile organic compounds			
Acetone	1.13E-03	1,4-Dioxane	5.93E-03
Acrylonitrile	1.04E-03	Formaledehyde	4.65E-04
Chloroform	1.65E-03	Vinyl chloride	2.95E-06
Crotonaldehyde	Not Available		
Other chlorinated organics			
Carbon Tetrachloride	1.52E-03	Pentachlorphenol	1.02E+03
Hexachlorbenzene	7.57E+01	4,4'-DDE	2.08E+03
Hexachlorobutadiene	2.55E-01	Heptachlor	2.09E+03
Hexachlorocyclopentadiene	5.47E-01	Hexachlorophene	1.23E+10
Pentachlorobenzene	6.04E-01		
Inorganics			
Aluminum	0	Lead	0
Antimony	0	Mercuric chloride	1.80E+03
Arsenic	0	Methyl mercury	Not Applicable
Barium	0	Nickel	0
Beryllium	0	Selenium	0

TABLE C-7

AIR-TO-PLANT BIOTRANSFER FACTORS
(µg COPC / g dry plant) / (µg COPC / g air)

Compound	*Bv* Value[a]	Compound	*Bv* Value
Cadmium	0	Silver	0
Chromium (hexavalent)	0	Thallium	0
Copper	0	Zinc	0
Cyanide (total)	0		

Notes:

(a) The reported values were obtained from the references cited in Section C-1.7, and are consistent with the values provided in U.S. EPA (1998). Values for dioxin and furan congeners were obtained from the following:

Lorber, M., and P. Pinsky. 1999. "An Evaluation of Three Empirical Air-to-Leaf Models for Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans." National Center for Environmental Assessment (NCEA). U. S. EPA, 401 M St. SW, Washington, DC. *Accepted for Publication in Chemosphere*.

REFERENCES
APPENDIX C - BCF TABLES

Adams, W.C. 1976. *The Toxicity and Residue Dynamics of Selenium in Fish and Aquatic Invertebrates*. Ph.D. Thesis. Michigan State University. East Lansing, Michigan.

Adams, W.J., G.M. DeGraeve, T.D. Sabourin, J.D. Cooney, and G.M. Mosher. 1986. "Toxicity and Bioconcentration of 2,3,7,8-TCDD to Fathead Minnows *(Pimephales promelas)*." *Chemosphere*. Volume 15, Numbers 9-12. Pages 1503-1511.

Anderson, A.C., et al. 1979. "Fate of the Herbicide MSMA in Microcosms." In D.D. Hemphill (ed.). *Trace Substances in Environmental Health XIII*. University of Missouri, Columbia.

Anderson, D.R., and E.B. Lusty. 1980. "Acute Toxicity and Bioaccumulation of Chloroform to Four Species of Freshwater Fish: *Salmo gairdneri*, Rainbow Trout; *Lepomis macrochirus*, Bluegill; *Micropterus salmoides*, Largemouth Bass; *Ictalurus punctatus*, Channel Catfish." Prepared for U.S. Nuclear Regulatory Commission, NUREG/CR-0893, Prepared by Pacific Northwest Laboratory, PNL-3046.

Andryushchenko, V.V., and G.G. Polikarpov. 1973. "An Experimental Study of Uptake of Zn^{65} and DDT by *Ulva rigid* from Seawater Polluted with Both Agents." *Hydrobiological Journal.* Volume 4. Pages 41-46.

Atchison, G.J., B.R. Murphy, W.E. Bishop, A.W. McIntosh, and R.A. Mayes. 1977. "Trace metal contamination of bluegill (*Lepomis macrochirus*) from two Indiana lakes." *Transactions, American Fisheries Society*. Volume 106, Number 6. Pages 637-640.

Augenfeld, J.M., J.W. Anderson, R.G. Riley, and B.L. Thomas. 1982. "The Fate of Polyaromatic Hydrocarbons in an Intertidal Sediment Exposure System: Bioavailability to *Macoma inquinata* (Mollusca: Pelecypoda) and *Abarenicola pacifica* (Annelida: Polychaeta)." *Marine Environmental Research.* Volume 7. Pages 31-50.

Baes, C.F., III, R.D. Sharp, A.L. Sjoreen, and R.W. Shor. 1984. "A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides Through Agriculture." Oakridge National Laboratory, ORNL-5786. Tennessee.

Banerjee, S., R.H. Suggatt, and D.P. O'Grady. 1984. "A Simple Method for Determining Bioconcentration Parameters of Hydrophobic Compounds." *Environmental Science and Technology.* Volume 18. Pages 78-81.

Barrows, M.E., S.R. Petrocelli, K.J. Macek, and J. Carroll. 1978. "Bioconcentration and Elimination of Selected Water Pollutants by Bluegill Sunfish." Preprints of Papers Presented at the 176th National Meeting, American Chemical Society, Miami Beach, Florida, September 10-15, 1978 Volume 18, Number 2. Pages 345-346.

Bastien, C., and R. Cote. 1989. "Temporal Variations of the Ultrastructure in *Scendesmus quadricauda* Exposed to Copper in a Long Term Experiment." *Int. Rev. ges. Hydrobiol* Volume 74, Number 2. Pages 207-219.

Baturo, W., and L. Lagadic. 1996. "Benzo[a]pyrene Hydroxylase and Glutathione S-Transferase Activities as Biomarkers in *Lymnaea palustris* Mollusca, Gastropoda) Exposed to Atrazine and Hexachlorobenzene in Freshwater Mesocosms." *Environmental Toxicology and Chemistry*. Volume 15, Number 5. Pages 771-781.

Baudin, J. P. 1974. "Premieres Donnees sur l'Etude Experimentale du Cycle du Zinc dans l'Etang de l'Olivier." *Jie Millieu*. Volume 24. Series B. Page 59.

Benoit, D.A., E.N. Leonard, G.M. Christensen, and J.T. Fiandt. 1976. "Toxic Effects of Cadmium on Three Generations of Brook Trout (*Salvelinus fontinalis*)." *Transactions, American Fisheries Society*. Volume 105, Number 2. Pages 550-358.

Besser, J.M., T.J. Canfield, and T.W. LaPoint. 1993. "Bioaccumulation of Organic and Inorganic Selenium in a Laboratory Food Chain." *Environmental Toxicology and Chemistry*. Volume 12. Pages 57-72.

Beyer, W.N. and C.D. Gish. 1980. "Persistence in Earthworms and Potential Hazards to Birds of Soil Applied 1,1'-(4,4-Dichlorodiphenyltrichloroethane (DDT), Dieldrin, and Heptachlor". *J. Appl. Ecol*. 17: 295-307. In Beyer 1990.

Beyer, W.N., E. Cromartie, and G.B. Moment. 1985. "Accumulation of Methylmercury in the Earthworm, *Eisenia foetida*, and its Effect on Regeneration." *Bulletin of Environmental Contamination and Toxicology*. Volume 35. Pages 157-162.

Bills, T.D., and L.L. Marking. 1977. "Effects of Residues of the Polychlorinated Biphenyl Aroclor 1254 on the Sensitivity of Rainbow Trout to Selected Environmental Contaminants." *The Progressive Fish-Culturist*. Volume 39. Page 150.

Borgmann, U., O. Kramar, and C. Loveridge. 1978. "Rates of Mortality, Growth, and Biomass Production of *Lymnnaea palustris* During Chronic Exposure to Lead." *Journal of Fisheries Resources Board of Canada*. Volume 35. Pages 1109-1115.

Boudou, A., and F. Ribeyre. 1984. "Influence of Exposure Length on the Direct Bioaccumulation of Two Mercury Compounds by *Salmo gairdneri* (Fry) and the Relationship Between Organism Weight and Mercury Concentrations." *Water Research*. Volume 18, Number 1. Pages 81-86.

Branson, D.R., I.T. Takahashi, W. M. Parker, and G.E. Blau. 1985. "Bioconcentration Kinetics of 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin in Rainbow Trout." *Environmental Toxicology and Chemistry*. Volume 4. Pages 779-788.

Brown, D., and R.S. Thompson. 1982. "Phthalates and the Aquatic Environment: Part II. The Bioconcentration and Depuration of Di-2-ethylhexyl Phthalate (DEHP) and Di-isodecyl Phthalate (DIDP) in Mussels (*Mytilus edulis*)." *Chemosphere*. Volume 11, Number 4. Pages 427-435.

Bruggeman, W.A., A. Oppenhuizen, A. Wijbenga, and O. Hutzinger. 1984. "Bioaccumulation of Super-Lipophilic Chemicals in Fish." *Toxicological and Environmental Chemistry*. Volume 7. Pages 173-189.

Calabrese, A., J.R. MacInnes, D.A. Nelson, R.A. Greig, and P.P. Yevich. 1984. "Effects of Long-Term Exposure to Silver and Copper on Growth, Bioaccumulation and Histopathology in the Blue Mussel *Mytilus edulis*." *Marine Environmental Research*. Volume 11. Pages 253-274.

Cappon, C.J. 1981. "Mercury and Selenium Content and Chemical Form in Vegetable Crops Grown in Sludge-Amended Soil." *Archives of Environmental Contamination and Toxicology*. Volume 10. Pages 673-689.

Capuzzo, J.M., and J.J. Sasner. 1977. "The Effect of Chromium on Filtration Rates and Metabolic Activity of *Mytilus edulis* L. and *Mya arenaria* L." In F.J. Vernberg, A. Calabrese, F.P. Thurberg, and W.B. Vernberg (eds). *Physiological Responses of Marine Biota to Pollutants*. Academic Press. New York, New York.

Carlson, A.R., and P.A. Kosian. 1987. "Toxicity of Chlorinated Benzenes to Fathead Minnows (*Pimephales promelas*)." *Archives, Environmental Contamination and Toxicology*. Volume 16. Pages 129-135.

Cleveland, L., D.R. Buckler, and W.G. Brumbaugh. 1991. "Residue Dynamics and Effects of Aluminum on Growth and Mortality in Brook Trout." *Environmental Toxicology and Chemistry. Volume* 10. Pages 243-248.

Cleveland, L., E.E. Little, D.R. Buckler, and R.H. Wiedmeyer. 1993. "Toxicity and Bioaccumulation of Waterborne and Dietary Selenium in Juvenile Bluegill *(Lepomis macrochirus)*." *Aquatic Toxicology*. Volume 27. Pages 265-280.

Cleveland, L., E.E. Little, S.J. Hamilton, D.R. Buckler, and J.B. Hunn. 1986. "Interactive Toxicity of Aluminum and Acidity to Early Life Stages of Brook Trout." *Transactions, American Fisheries Society*. *Volume* 115. Pages 610-620.

Courtney, W.A. and W.J. Langston. 1978. "Uptake of Polychlorinated Biphenyl (Aroclor 1254) from Sediment and from Seawater in Two Intertidal Polychaetes." *Environ. Pollut*. Volume 15, Number 303.

Davis, B.N.K. 1971. "Laboratory Studies on the Uptake of Dieldrin and DDT by Earthworms." *Soil Biol. Biochem*. 3:221-233. In Beyer 1990.

De Kock, A.C., and D. A. Lord. 1988. "Kinetics of the Uptake and Elimination of Polychlorinated Biphenyls by an Estuarine Fish Species (*Rhabdosargus holubi*) After Aqueous Exposure." *Chemosphere*. Volume 17, Number 12. Pages 2381-2390.

Deneer, J.W., T.L. Sinnige, W. Seinen, and J.L.M. Hermens. 1987. "Quantitative Structure-Activity

Relationships for the Toxicity and Bioconcentration Factor of Nitrobenzene Derivatives towards the Guppy (*Poecilia reticulata*). *Aquatic Toxicology*. Volume 10. Pages 115-129.

Deutch, B., B. Borg, L. Kloster, H. Meyer, and M. M. Moller. 1980. "The Accumulation of ^{65}Zn by Various Marine Organisms." *Ophelia* (Suppl). Volume 1, Pages 235-240.

Dobbs, M.G., D.S. Cherry, and J. Cairns, Jr. 1996. "Toxicity and Bioaccumulation of Selenium to a Three-Trophic Level Food Chain." *Environmental Toxicology and Chemistry*. Volume 15, Number 3. Pages 340-347.

Driscoll, A.K., and A.E. McElroy. 1996. "Bioaccumulation and Metabolism of Benzo(a)Pyrene in Three Species of Polychaete Worms." *Environmental Toxicology and Chemistry*. Volume 15, Number 8. Pages 1401-1410.

Duke, T.W., et al. (1970). "A Polychlorinated Biphenyl (Aroclor 1254) in the Water, Sediment and Biota of Escambia Bay, Florida." *Bull. Environmental Contam. Toxicol*. Volume 5, Number 171.

Eadie, B.J., P.F. Landrum, and W. Faust. 1982. "Polycyclic Aromatic Hydrocarbons in Sediment, Pore Water, and the Amphipod *Pontoporeia hoyi* from Lake Michigan." *Chemosphere*. Volume 11, Number 9. Pages 847-858.

Eastmond, D.A., G.M. Booth, M.L. Lee. 1984. "Toxicity, Accumulation, and Elimination of Polycyclic Aromatic Sulfur Heterocycles in *Daphnia magna*." *Archives, Environmental Contamination and Toxicology*. Volume 13. Pages 105-111.

Eisler, R. 1977. "Toxicity Evaluation of a Complex Metal Mixture to the Softshell Clam *Mya arenaria.*" *Marine Biology*. Volume 43. Pages 265-276.

Eisler, R., G.E. Zaroogian, and R.J. Hennekey. 1972. "Cadmium Uptake by Marine Organisms." *Journal of Fisheries Research Board of Canada*. Volume 29. Pages 1367-1369.

Fisher, N.S., M. Bohe, and J.L. Teyssie. 1984. "Accumulation and Toxicity of Cd, Zn, Ag, and Hg in Four Marine Phytoplankters." *Marine Ecology - Progress Series*. Volume 18. Pages 210-213.

Freitag, D., H. Geyer, A. Kraus, R. Viswanathan, D. Kotzias, A. Attar, W. Klein, and F. Korte. 1982. "Ecotoxicological Profile Analysis. VII. Screening Chemicals for Their Environmental Behavior by Comparative Evaluation." *Ecotoxicology and Environmental Safety*. Volume 6. Pages 60-81.

Fromm, P.O., and R.M. Stokes. 1962. "Assimilation and Metabolism of Chromium by Trout." *Journal of Water Pollution Control Federation*. Volume 34. Pages 1151-1155.

Garten, C.T., Jr., and J.R. Trabalka. 1983. "Evaluation of Models for Predicting Terrestrial Food Chain Behavior of Xenobiotics." *Environmental Science and Technology*. *Volume* 17, Number 10. Pages 590-595.

Gates, V.L., and R.S. Tjeerdema. 1993. "Disposition and Biotransformation of Pentachlorophenol in the Striped Bass (*Morone saxatilis)*." *Pesticide Biochemistry and Physiology*. Volume 46. Pages 161-170.

George, S.G., and T.L. Coombs. 1977. "The Effects of Chelating Agents on the Uptake and Accumulation of Cadmium by *Mytilus edulis*." *Marine Biology*. Volume 39. Pages 261-268.

Geyer, H., G. Politzki, and D. Freitag. 1984. "Prediction of Ecotoxicological Behaviour of Chemicals: Relationship Between *n*-Octanol/Water Partition Coefficient and Bioaccumulation of Organic Chemicals by Alga *Chlorella*." *Chemosphere*. Volume 13, Number 2, Pages 269-284.

Geyer, H., R. Viswanathan, D. Freitag, and F. Korte. 1981. "Relationship Between Water Solubility of Organic Chemicals and Their Bioaccumulation by the Alga *Chlorella*." *Chemosphere*. Volume 10, Number 11/12. Pages 1307-1313.

Giesy, J.P., Jr., H.J. Kanio, J.W. Boling, R.L. Knight, S. Mashburn, and S. Clarkin. 1977. "Effects of Naturaly Occurring Aquatic Organic Fractions on Cadmium Toxicity to *Simocephalus serrulatus* (Daphnidae) and *Gambusia affinis* (Poecilidae)." *Water Research*. Volume 11. Pages 1013-1020.

Gilek, M., M. Bjork, D. Broman, N. Kautsky, and C. Naf. 1996. "Enhanced Accumulation of PCB Congeners by Baltic Sea Blue Mussels, *Mytilus edulis*, with Increased Algae Enrichment." *Environmental Toxicology and Chemistry*. Volume 15, Number 9. Pages 1597-1605.

Gillespie, R., T. Reisine, and E.J. Massaro. 1977. "Cadmium Uptake by the Crayfish, *Orconectes propinquus*." *Environmental Research*. Volume 13. Pages 364-368.

Gish, C.D. 1970. "Organochlorine Insecticide Residues in Soils and Soil Invertebrates from Agricultural Lands." *Pestic. Monit. J.* 3:241-252.

Goodman, L.R., D.J. Hansen, J.A. Couch, and J. Forester. 1978. "Effects of Heptachlor and Toxaphene on Laboratory-Reared Embryos and Fry of the Sheepshead Minnow." In W.A. Rogers, R. Dimmick, and R. Summerfelt (eds.) *Proceedings, 30th Annual Conference Southeast Association of Game Fish Commissions*. October 24-27, 1976. Jackson, Mississippi.

Graney, R.L., Jr.,D.S. Cherry, and J. Cairns, Jr. 1983. "Heavy Metal Indicator Potential of the Asiatic Clam (*Corbicula fluminea*) in Artificial Stream Systems." *Hydrobiologia*. Volume 102. Pages 81-88.

Halter, M.T. 1974. "The Acute Toxicity Polychlorinated Biphenyl, Aroclor 1254, to the Early like Stages of Coho Salmon and Steelhead Trout." *PCB Newsletter*. U.S. Environmental Protection Agency. National Water Quality Laboratory. Duluth, Minnesota. August 5.

Hamelink, J.L., and R.C. Waybrant. 1976. "DDE and Lindane in a Large-Scale Model Lentic Ecosystem." *Transactions, American Fisheries Society*. Volume 105. Pages 124-134.

Hamelink, J.L., and R.C. Waybrant. 1977. "DDE and Lindane in a Large-Scale Model Lentic Ecosystem." *Transactions of the American Fisheries Society*. Volume 105. Pages 124-134.

Hansch, C. and A. Leo. 1979. "The Fragment Method of Calculating Partition Coefficients." Chapter 4. In *Substituent Constants for Correlation Analysis in Chemistry and Biology*. Wiley-Interscience. New York. As cited in NRC (1981).

Hansen, D.J., et al. 1971. "Chronic Toxicity, uptake and Retention of Aroclor 1254 in Two Estuarine Fishes." *Bull. Environ. Contam. Toxicol.* 6: 113.

Hansen, D.J., et al. 1973. "Aroclor 1254 in Eggs of Sheepshead Minnows: Effect on Fertilization Success and Survival of Embryos and Fry." Proceedings 27th Annual Conference South East Game Fish Comm. Page 420.

Hansen, D.J., et al. 1974. "Aroclor 1016: Toxicity to and Uptake by Estuarine Animals." *Environ. Res.* 7: 363.

Hansen, D.J., et al. 1975. "Effects of Aroclor 1016 on Embryos, Fry, Juveniles, and Adults of Sheepshead Minnows (*Cyprinodon variegatus*)." *Trans. Am. Fish. Soc.* 104: 584.

Harrahy, E., and W. Clements. 1997. "Toxicity and Bioaccumulation of a Mixture of Heavy Metals in *Chironomus tentans* (Diptera: Chironomidae) in Synthetic Sediment." *Environmental Toxicology and Chemistry*. Volume 16, Number 2. Pages 317-327.

Harrison, S.E., and J.F. Klaverkamp. 1989. "Uptake, Elimination and Tissue Distribution of Dietary and Aqueous Cadmium by Rainbow Trout *(Salmo gairdneri* Richardson) and Lake Whitefish *(Coregonus clupeaformis* Mitchill)." *Environmental Toxicology and Chemistry*. Volume 8. Pages 87-97.

Hermanutz, R.O., K.N. Allen, T.H. Roush, and S.F. Hedtke. 1992. "Effects of Elevated Selenium Concentrations on Bluegills *(Lepomis macrochirus)* in Outdoor Experimental Streams." *Environmental Toxicology and Chemistry*. Volume 11. Pages 217-224.

Hildebrand, S.G., R.H. Strand, and J.W. Huckabee. 1980. "Mercury Accumulation in Fish and Invertebrates of the North Fork Holston River, Virginia and Tennessee." *Journal of Environmental Quality*. Volume 9, Number 3. Pages 393-400.

Hodson, P.V., D.J. Spry, and B.R. Blunt. 1980. "Effects on Rainbow Trout *(Salmo gairdneri)* of a Chronic Exposure to Waterborne Selenium." *Canadian Journal of Fisheries and Aquatic Sciences*. Volume 37. Pages 233-240.

Holcombe, G.W., D.A. Benoit, E.N. Leonard, and J.M. McKim. 1976. "Long-term Effects of Lead Exposure on Three Generations of Brook Trout (*Salvenius fontinalis*)." *Journal of Fisheries Research Board of Canada*. Volume 33. Pages 1731-1741.

Howard, P. H. 1989-1993. *Handbook of Environmental Fate and Exposure Data for Organic Chemicals. Volume I: Large Production and Priority Pollutants (1989). Volume II: Solvents (1990). Volume II: Pesticides (1991). Volume IV: Solvents (1993).* Lewis Publishers. Chelsea, Michigan.

Hutchinson, T.C., and H. Czyrska. 1972. "Cadmium and Zinc Toxicity and Synergism to Floating Aquatic Plants." In *Water Pollution Research in Canada*. 7th Canadian Symposium Water Pollution Research. Institute of Environmental Sciences.

Hutchinson, T.C., and P.M. Stokes. 1975. "Heavy Metal Toxicity and Algal Bioassays." In *Water Quality Parameters*, ASTM STP 573, American Society for Testing and Materials, Philadelphia.

Ikemoto, Y., K. Motoba, T. Suzuki, and M. Uchida. 1992. "Quantitative Structure-Activity Relationships of Nonspecific and Specific Toxicants in Several Organism Species." *Environmental Toxicology and Chemistry*. Volume 11. Pages 931-939.

Isensee, A.R., E.R. Holden, E.A. Woolson, and G.E. Jones. 1976. "Soil Persistence and Aquatic Bioaccumulation Potential of Hexachlorobenzene (HCB). *Journal of Agriculture and Food Chemistry*. Volume 24, Number 6. Pages 1210-1214.

Isensee, A.R., P.C. Kearney, E.A. Woolson, G.E. Jones, and V.P. Williams. 1973. "Distribution of Alkyl Arsenicals in Model Ecosystems." *Environmental Science and Technology.* Volume 7, Number 9. Pages 841-845.

Jennings, J.R., and P.S. Rainbow. 1979. "Studies on the Uptake of Cadmium by the Crab *Carcinus maenus* in the Laboratory. I. Accumulation from Seawater and a Food Source." *Marine Biology.* Volume 50. Pages 131-139.

Jones, L.H., N.V. Jones, and A.J. Radlett. 1976. "Some Effects of Salinity on the Toxicity of Copper to the Polychaete *Nereis diversicolor*." *Estuarine Coastal Marine Science.* Volume 4. Pages 107-111.

Jouany, J.M., P. Vasseur, and J.F. Ferard. 1982. "Ecotoxicite Directe et Integree du Chrome Hexavalent sur Deux Niveaux Trophiques Associes: *Chlorella vulgaris* et *Daphnia magna*." *Environmental Pollution*. Volume 27A. Pages 207-221.

Kanazawa, J. 1981. "Measurement of the Bioconcentration Factors of Pesticides by Freshwater Fish and Their Correlation with Physicochemical Properties or Acute Toxicities." *Pesticide Science.* Volume 12. Pages 417-424.

Karickhoff, S. W., and J. M. Long. 1995. "Internal Report on Summary of Measured, Calculated, and Recommend Log K_{ow} Values." Environmental Research Laboratory. Athens, GA. April 10.

Karickhoff, S.W., D.S. Brown, and T.A. Scott. 1979. "Sorption of Hydrophobic Pollutants on Natural Sediments." *Water Research.* Volume 13. Pages 241-248.

Klockner, K. 1979. "Uptake and Accumulation of Cadmium by *Ophryotrocha diadema* (Polychaeta)." *Marine Ecology-Progress Series.* Volume 1. Pages 71 to 76.

Kobayashi, K., and T. Kishino. 1980. "Effect of pH on the Toxicity and Accumulation of Pentachlorophenol in Goldfish." *Bulletin, Japanese Society of Scientific Fisheries.* Volume 46, Number 2. Pages 167-170.

Konemann, H., and K. van Leeuwen. 1980. "Toxicokinetics in Fish: Accumulation and Elimination of Six Chlorobenzenes by Guppies." *Chemosphere.* Volume 9, Number 1. Pages 3-19.

Kopfter, F.C. 1974. "The Accumulation of Organic and Inorganic Mercury Compounds by the Eastern Oyster (*Crassostrea virginica*)." *Bulletin, Environmental Contamination and Toxicology.* Volume 11. Page 275.

Korte, F., D. Freitag, H. Geyer, W. Klein, A.G. Kraus, and E. Lahaniatis. 1978. "Ecotoxicologic Profile

Analysis: A Concept for Establishing Ecotoxicologic Priority Lists for Chemicals." *Chemosphere.* Volume 7, Number 1. Pages 79-102.

Kosian, P., A. Lemke, K. Studders, and G. Veith. 1981. "The Precision of the ASTM Bioconcentration Test." U.S. Environmental Protection Agency, EPA 600/3-81-022. Environmental Research Laboratory-Duluth, Center for Lake Superior Environmental Studies, University of Wisconsin-Superior, Superior, Wisconsin. February.

Kreis, B., P. Edwards, G. Cuendet, and J. Tarradellas. 1987. "The Dynamics of PCBs Between Earthworm Populations and Agricultural Soils." *Pedobiologia.* 30: 379-388. In Beyer 1990.

Kucklick, J.R., H.R. Harvey, P.H. Ostrom, N.E. Ostrom, and J.E. Baker. 1996. "Organochlorine Dynamics in the Pelagic Food Web of Lake Baikal." *Environmental Toxicology and Chemistry*. Volume 15, Number 8. Pages 1388-1400.

Kumada, H., S. Kimura, and M. Yokote. 1980. "Accumulation and Biological Effects of Cadmium in Rainbow Trout." *Bulletin, Japanese Society of Scientific Fisheries.* Volume 46, Number 1. Pages 97-103.

Kumada, H., S. Kimura, M. Yokote, and Y. Matida. 1973. "Acute and Chronic Toxicity, Uptake and Retention of Cadmium in Freshwater Organisms." *Bulletin, Freshwater Fisheries Research Laboratory (Toyoko).* Volume 22, Number 2. Pages 57-165.

Landrum, P.F., B.J. Eadie, and W.R. Faust. 1991. "Toxicokinetics and Toxicity of a Mixture of Sediment-Associated Polycyclic Aromatic Hydrocarbons to the Amphipod Diporeia sp." *Environmental Toxicology and Chemistry*. Volume 10. Pages 35-46.

Laska, A.L., C.K. Bartell, J.L. Laseter. 1976. "Distribution of Hexachlorobenzene and Hexachlorobutadiene in Water, Soil, and Selected Aquatic Organisms Along the Lower Mississippi River, Louisiana. *Bulletin of Environmental Contamination.* Volume 15, Number 5. Pages 535-542.

Laseter, J.L., C.K. Bartell, A.L. Laska, D.G. Holmquist, D.B. Condie, J.W. Brown, and R.L. Evans. 1976. "An Ecological Study of Hexachlorobutadiene (HCBD)." U.S. Environmental Protection Agency, EPA 560/6-76-010. Washington, DC.

Lee, R.F., W.S. Gardner, J.W. Anderson, J.W. Blaytock, and J. Barwell-Clarke. 1978. "Fate of Polycyclic Aromatic Hydrocarbons in Controlled Ecosystem Enclosure." *Environmental Science and Technology*. Volume 12, Number 7. Pages 832-838.

Leeuwangh, P., H. Bult, and L. Schneiders. 1975. "Toxicity of Hexachlorobutadiene in Aquatic Organisms." Pages 167-176. In: Sublethal Effects of Toxic Chemicals on Aquatic Animals. Proceedings, Swedish-Netherlands Symposium, September 2-5. Elsevier Scientific. New York, New York.

Lemly, A.D. 1982. "Response of Juvenile Centrarchids to Sublethal Concentrations of Waterborne Selenium. I. Uptake, Tissue Distribution, and Retention." *Aquatic Toxicology.* Volume 2. Pages 235-252.

Leversee, G.J., P.F. Landrum, J.P. Giesy, and T. Fannin. 1983. "Humic Acids Reduce Bioaccumulation of Some Polycyclic Aromatic Hydrocarbons." *Canadian Journal of Fisheries and Aquatic Science*. Volume 40 (Supplement 2). Pages 63-69.

Liu, D.H.W., H.C. Bailey, and J.G. Pearson. 1983. "Toxicity of a Complex Munitions Wastewater to Aquatic Organisms." Pages 135-150. In W.E. Bishop, R. D. Cardwell, and B.B. Heidolph (eds), *Aquatic Toxicology and Hazard Assessment: Sixth Symposium*, ASTM STP 802, American Society for Testing and Materials, Philadelphia.

Lorber, M., and P. Pinsky. 1999. "An Evaluation of Three Empirical Air-to-Leaf Models for Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans." National Center for Environmental Assessment (NCEA). U. S. EPA, 401 M St. SW, Washington, DC. *Accepted for Publication in Chemosphere*.

Lores, E.M., J.M. Patrick, and J.K. Summers. 1993. "Humic Acid Effects on Uptake of Hexachlorobenzene and Hexachlorobiphenyl by Sheepshead Minnows in Static Sediment/Water Systems." *Environmental Toxicology and Chemistry*. Volume 12. Pages 541-550.

Lu, P.Y. and R.L. Metcalf. 1975. "Environmental Fate and Biodegradability of Benzene Derivatives as Studied in a Model Aquatic Ecosystem." *Environmental Health Perspectives*. Volume 10. Pages 269-284.

Lu, P.Y., R.L. Metcalf, A.S. Hirwe, and J.W. Williams. 1975. "Evaluation of Environmental Distribution and Fate of Hexachlorocyclopentadiene, Chlorodane, Heptachlor, Heptachlor Epoxide in a Laboratory Model Ecosystem." *Journal of Agricultural and Food Chemistry*. Volume 23, Number 5. Pages 967-973.

Lu, P.Y., R.L. Metcalf, N. Plummer, and D. Mandel. 1977. "The Environmental Fate of 3 Carcinogens: Benzo(a)pyrene, Benzidine, and Vinyl Chloride Evaluated in Laboratory Model Ecosystems." *Archives of Environmental Contamination and Toxicology*. Volume 6. Pages 129-142.

Ma, W. 1982. "The Influence of Soil Properties and Worm-Related Factors on the Concentration of Heavy Metals in Earthworms." *Pedobiologia*. Volume 24. Pages 109-119.

Ma, W.C. 1987. "Heavy Metal Accumulation in the Mole, *Talpa europea*, and Earthworms as an Indicator of Bioavailability in Terrestrial Environments." *Bull. Environ. Contam. Toxicol.* 39:933-938. As cited in Beyer (1990).

Mackay, D. W.Y. Shiu, and K.C. Ma. 1992. *Illustrated Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals. Volume I—Monoaromatic Hydrocarbons, Chlorobenzenes, and PCBs. Volume II—Polynuclear Aromatic Hydrocarbons, Polychlorinated Dioxins, and Dibenzofurans. Volume III—Volatile Organic Chemicals.* Lewis Publishers. Chelsea, Michigan.

Makela, T.P., T. Petanen, J. Kukkonen, and A.O.J. Oikari. 1991. "Accumulation and Depuration of Chlorinated Phenolics in the Freshwater Mussel (*Anodonta anatina*)." *Ecotoxicology and Environmental Safety*. Vol 22. Pages 153-163.

Makela, T.P., and A.O.J. Oikari. 1990. "Uptake and Body Distribution of Chlorinated Phenolics in the

Freshwater Mussel, *Anodonta anatina* L." *Ecotoxicology and Environmental Safety*. Volume 20. Pages 354-362.

Makela, T.P., and A.O.J. Oikari. 1995. "Pentachlorophenol Accumulation in the Freshwater Mussels *Anodonta anatina* and *Pseudanodonta complanata*, and some Physiological Consequences of Laboratory Maintenance." Chemosphere. Volume 31, Number 7. Pages 3651-3662.

Majori, L., and F. Petronio. 1973. "Marine Pollution by Metals and Their Accumulation by Biological Indicators (Accumulation Factor)." *Rev. Intern. Oceanogr. Med.* Volume 31-32. Pages 55-90.

Marquerie, J.M., J.W. Simmers, and S.H. Kay. 1987. "Preliminary Assessment of Bioaccumulation of Metals and Organic Contaminants at the Times Beach Confined Disposal Site, Buffalo, N.Y." Miscellaneous Paper EL-87-6. U.S. Army Corps of Engineers. Waterways Experiment Station, Vicksburg, Miss. 67 pp. In Beyer 1990.

Martinucci, G.B., P. Crespi, P. Omodeo, G. Osella, and G. Traldi. 1983. "Earthworms and TCDD (2,3,7,8-Tetrachlorodibenzo-p-dioxin) in Sevesco." Pp 275-283. In Satchell 1983 . As cited in Beyer (1990).

Mauck, W.L., et al. 1978. "Effects of the Polychlorinated Biphenyl Aroclor 1254 on Growth, Survival, and Bone Development in Brook Trout (*Salvelinus fontinalis*)." *Journal of Fisheries Research Board of Canada*. Volume 35. Page 1084.

Mayer, F.L., Jr. 1976. "Residue Dynamics of Di-2-ethylhexyl Phthalate in Fathead Minnows (*Pimephales promelas*)." *Journal of Fisheries Research Board of Canada*. Volume 33. Pages 2610-2613.

Mayer, F.L, Jr., P.M. Mehrle, and H.O. Sanders. 1977. "Residue Dynamics and Biological Effects of Polychlorinated Biphenyls in Aquatic Organisms." *Archives, Environmental Contamination and Toxicology*. Volume 5. Pages 501-511.

McKim, J.M., G.F. Olson, G.W. Holcombe, and E.P. Hunt. 1976. "Long-term Effects of Methylmercuric Chloride on Three Generations of Brook Trout *(Salvelinus fontinalis):* Toxicity, Accumulation, Distribution, and Elimination." *Journal of Fisheries Research Board of Canada.* Volume 33. Pages 2726-2739.

McLusky, D.S., and C.N.K. Phillips. 1975. "Some Effects of Copper on the Polychaete *Phyllodoce maculata*." *Estuarine and Coastal Marine Science.* Volume 3. Pages 103-108.

Mehrle, P. M., D. R. Buckler, E.E. Little, L.M. Smith, J.D. Petty, P.H. Peterman, D.L. Stalling, G.M. DeGraeve, J.T. Coyle, and W.J. Adams. 1988. "Toxicity and Bioconcentrations of 2,3,7,8-Tetrachlorodibenzodioxin and 2,3,7,8-Tetrachlorodibenzofuran in Rainbow Trout." *Environmental Toxicology and Chemistry*. Volume 7. Pages 47-62.

Mehrle, P.M., and F.L. Mayer. 1976. "Di-2-Ethylhexyl Phthalate: Residue Dynamics and Biological Effects in Rainbow Trout and Fathead Minnows." *Trace Substances in Environmental Health-X, Proceedings, University of Missouri's 10th Annual Conference on Trace Substances in Environmental Health, June 8-10, 1976*. University of Missouri Press, Columbia.

Metayer, C., C. Amiard-Triquet, and J.P. Baud. 1990. "Variations Inter-Specificques de la Bioaccumulation et de la Toxicite de L'Argent A L'Egard de Trois Mollusques Bivalves Marins." *Water Research*. Vol 24, Number 8. Pages 995-1001.

Metcalf, R.L., I.P. Kapoor, P.U. Lu, C.K. Schuth, and P. Sherman. 1973. "Model Ecosystem Studies of the Environmental Fate of Six Organochlorine Pesticides." *Environmental Health Perspectives.* Volume 4. Pages 35-44.

Metcalf, R.L., J.R. Sanborn, P.-Y. Lu, and D. Nye. 1975. "Laboratory Model Ecosystem Studies of the Degradation and fate of Radio-labeled Tri-, Tetra-, and Pentachlorobiphenyl Compared with DDE." *Archives, Environmental Contamination and Toxicology*. Volume 3, Number 2. Pages 151-165.

Metcalf, R.L., G.K. Sangha, and I.P. Kapoor. 1971. "Model Ecosystem for the Evaluation of Pesticide Biodegradability and Ecological Magnification." *Environmental Science and Technology*. Volume 5, Number 8. Pages 709-713.

Muir, D.C.G., W.K. Marshall, and G.R.B. Webster. 1985. "Bioconcentration of PCDDs by Fish: Effects of Molecular Structure and Water Chemistry." *Chemosphere*. Volume 14. Pages 829-833.

Munda, I.M. 1979. "Temperature Dependence of Zinc Uptake in *Fucus virsoides* (Don.) J. Ag. and *Enteromorpha prolifera* (O.F. Mull.) J. Ag. from the Adriatic Sea." *Botanica Marina*. Volume 22. Pages 149-152.

Namminga, H., and J. Wilhm. 1977. "Heavy Metals in Water, Sediments, and Chironomids." *Journal of Water Pollution Control Federation.* Volume 49, Number 7. Pages 1725-1731.

National Academy of Sciences. (NAS). 1974. Chromium. Pages 86-89. U.S. Government Printing Office. Washington, D.C.

National Research Council (NRC). 1979. Polychlorinated Biphenyls. National Academy of Sciences. Washington, D.C.

National Research Council (NRC). 1981. *Formaldehyde an Other Aldehydes*. National Academy Press. Washington, D.C.

Nebeker, A.V., F.A. Puglisi, and D.L. DeFoe. 1974. "Effect of Polychlorinated Biphenyl Compounds on Survival and Reproduction of the Fathead Minnow and Flagfish." *Transactions, American Fisheries Society.* Volume 103. Pages 562-568.

Nebeker, A.V., W.L. Griffis, C.M. Wise, E. Hopkins, and J.A. Barbitta. 1989. "Survival, Reproduction, and Bioconcentration in Invertebrates and Fish Exposed to Hexachlorobenzene." *Environmental Toxicology and Chemistry.* Volume 8, Number 601-611.

Nehring, R.B. 1976. "Aquatic Insects as Biological Monitors of Heavy Metal Pollution." *Bulletin, Environmental Contamination and Toxicology.* Volume 15, Number 2. Pages 147-154.

Nehring, R.B., R. Nisson, and G. Minasian. 1979. "Reliability of Aquatic Insects Versus Water Samples as Measures of Aquatic Lead Pollution." *Bulletin, Environmental Contamination and*

Toxicology. Volume 22, Number ½. Pages 103-108.

Newsted, J.L., and J.P. Giesy. 1987. "Predictive Models for Photoinduced Acute Toxicity of Polycyclic Aromatic Hydrocarbons to *Daphnia magna*, Strauss (Cladocera, Crustacea)." *Environmental Toxicology and Chemistry*. Volume 6. Pages 445-461.

Niimi, A.J., H.B. Lee, and G.P. Kissoon. 1989. "Octanol/Water Partition Coefficients and Bioconcentration Factors of Chloronitrobenzenes in Rainbow Trout *(Salmo gairdneri)*." *Environmental Toxicology and Chemistry*. Volume 8. Pages 817-823.

Nimmo, D.R., et al. 1975. "Toxicity of Aroclor 1254 and its Physiological Activity in Several Estuarine Organisms." *Arch. Environ. Contam. Toxicol*. Volume 3. Page 22.

Nimmo, D.W.R., D.V. Lightner and L.H. Bahner. 1977. "Effects of Cadmium on the Shrimps, *Penaeus duorarum*, *Palaemonetes pugio*, and *Palaemonetes vulgaris*." Pages 131-183. In F.J. Vernberg, A. Calabrese, F.P. Thurberg, and W.B. Vernberg (eds). *Physiological Responses of Marine Biota to Pollutants*. Academic Press, Inc. New York, New York.

Oliver, B.G. 1987. "Biouptake of Chlorinated Hydrocarbons from Laboratory-Spiked and Field Sediments by Oligochaete Worms." *Environmental Science and Technology*. Volume 21. Pages 785-790.

Oliver, B.G., and A.J. Niimi. 1983. "Bioconcentration of Chlorobenzenes from Water by Rainbow Trout: Correlations with Partition Coefficients and Environmental Residues." *Environmental Science and Technology*. Volume 17. Pages 287-291.

Oliver, B.G., and A.J. Niimi. 1985. "Bioconcentration Factors of Some Halogenated Organics for Rainbow Trout: Limitations on Their Use for Prediction of Environmental Residues." *Environmental Science and Technology*. Volume 19. Pages 842-849.

Oliver, B.G., and A.J. Niimi. 1988. "Trophodynamic Analysis of Polychlorinated Biphenyl Congeners and Other Chlorinated Hydrocarbons in the Lake Ontario Ecosystem." *Environmental Science and Technology*. Volume 22. Pages 388-397.

Opperhuizen, A., E.W.v.d. Velde, F.A.P.C. Gobas, D.A.K. Liem, and J.M.D.v.d. Steen. 1995. "Relationship Between Bioconcentration in Fish and Steric Factors of Hydrophobic Chemicals." *Chemosphere*. Volume 14. Pages 1871-1896.

Parrish, P.R., et al. 1974. "Effects of Polychlorinated Biphenyl, Aroclor 1016, on Estuarine Animals." *Association South East Biol. Bull*. Volume 21. Page 74.

Parrish, P.R., E.E. Dyar, J.M. Enos, and W.G. Wilson. 1978. "Chronic Toxicity of Chlordane, Trifluralin, and Pentachlorophenol to Sheepshead Minnows (*Cyprinodon variegatus*)." U.S. Environmental Protection Agency, EPA 600/3-78-010. Gulf Breeze, Florida. January.

Patrick, R., T. Bott, and R. Larsen. 1975. "The Role of Trace Elements in Management of Nuisance Growths." U.S. Environmental Protection Agency, EPA 660/2-75-008. Corvallis, Oregon.

Pentreath, J.R. 1973. "The Accumulation and Retention of ^{65}Zn and ^{54}Mn by the Plaice, *Pleuronectes*

platessa L. *Journal of Experimental Marine Biology and Ecology*. Vol 12. Pages 1-18. As cited in U.S. EPA (1980g).

Perez, K.T., E.W. Davey, N.F. Lackie, G.E. Morrison, P.G. Murphy, A.E. Soper, and D.L. Winslow. 1983. "Environmental Assessment of a Phthalate Ester, Di(2-Ethylhexyl) Phthalate (DEHP), Derived from a Marine Microcosm." Pages 180-191. In: Bishop W.E., R. D. Cardwell and B. B. Heidolph (Eds.) *Aquatic Toxicology and Hazard Assessment: Sixth Symposium*. ASTM STP 802. American Society for Testing and Materials, Philadelphia.

Pesch, C.E., and D. Morgan. 1978. "Influence of Sediment in Copper Toxicity Tests with Polychaete *Neanthes arenaceodentata*." *Water Research*. Volume 12. Pages 747-751.

Pesch, G.G., and N.E. Stewart. 1980. "Cadmium Toxicity to Three Species of Estuarine Invertebrates." *Marine Environmental Research.* Volume 3. Pages 145-156.

Phillips, D.J.H. 1976. "The Common Mussel *Mytilus edulis* as an Indicator of Pollution by Zinc, Cadmium, Lead, and Copper. I. Effects of Environmental Variables on Uptake of Metals." *Marine Biology*. Volume 38. Pages 59-69.

Pietz, R.I., J.R. Peterson, J.E. Prater, and D.R. Zenz. 1984. "Metal Concentrations in Earthworms From Sewage Sludge-Amended Soils at a Strip Mine Reclamation Site." *J. Environmental Qual.* Vol. 13, No. 4. Pp 651-654.

Podowski, A.A., and M.A.Q. Khan. 1984. "Fate of Hexachlorocyclopentadiene in Water and Goldfish." *Archives, Environmental Contamination and Toxicology*. Volume 13. Pages 471-481.

Pringle, B.H., D.E. Hissong, E.L. Katz, and S.T. Mulawka. 1968. "Trace Metal Accumulation by Estuarine Mollusks." *Journal of Sanitary Engineers Division.* Volume 94. Pages 455-475.

Qiao, P., and A. P. Farrell. 1996. "Uptake of Hydrophobic Xenobiotics by Fish in Water Laden with Sediments from the Fraser River." *Environmental Toxicology and Chemistry*. Volume 15, Number 9. Pages 1555-1563.

Reich, A.R., J.L. Peerkins, and G. Cutter. 1986. "DDT Contamination of a North Alabama Aquatic Ecosystem." *Environmental Toxicology and Chemistry*. Volume 5. Pages 725-736.

Rice, C.P., and D.S. White. 1987. "PCB Availability Assessment of River Dredging Using Caged Clams and Fish." *Environmental Toxicology and Chemistry*. Volume 6. Pages 259-274.

Reinecke, A.J., and G. Nash. 1984. "Toxicity of 2, 3, 7, 8-TCDD and Short Term Bioaccumulation by Earthworms (*Oligochaeta*)." *Soil Biol. Biochem.* 1: 39-44. In Beyer 1990.

Rhett, R.G., J.W. Simmers, and C.R. Lee. 1988. "*Eisenia Foetida* Used as a Biomonitoring Tool to Predict the Potential Bioaccumulation of Contaminants from Contaminated Dredged Material." in Edwards and Neuhauser 1988.

Roesijadi, G., J.W. Anderson, and J.W. Blaylock. 1978. "Uptake of Hydrocarbons from Marine Sediments Contaminated with Prudhoe Bay Crude Oil: Influence of Feeding Type of Test Species

and Availability of Polycyclic Aromatic Hydrocarbons." *Journal of Fisheries Research Board of Canada*. Volume 35. Pages 608-614.

Saiki, M.K., D.T. Castleberry, T.W. May, B.A. Martin, and F.N. Bullard. 1995. "Copper, Cadmium, and Zinc Concentrations in Aquatic Food Chains from the Upper Sacramento River (California) and Selected Tributaries." *Archives in Environmental Contamination and Toxicology*. Volume 29. pages 484-491.

Sanborn, J.R. 1974. "The Fate of Select Pesticides in the Aquatic Environment." U.S. Environmental Protection Agency, EPA-660/3-74-025. Corvallis, Oregon.

Sanborn, J.R. , R.L. Metcalf, C.C. Yu, and P.Y. Lu. 1975. "Plasticizers in the Environment: The Fate of Di-*N*-Octyl Phthalate (DOP) in Two Model Ecosystems and Uptake and Metabolism of DOP by Aquatic Organisms." *Archives, Environmental Contamination and Toxicology*. Volume 3, Number 2. Pages 244-255.

Sanders, H.O., F.L. Mayer, Jr., and D.F. Walsh. 1973. "Toxicity Residue Dynamics, and Reproductive Effects of Phthalate Esters in Aquatic Invertebrates." *Environmental Research*. Volume 6, Number 1. Pages 84-90.

Saouter, E., L. Hare, P.G.C. Campbell, A. Boudou, and F. Ribeyre. 1993. "Mercury Accumulation in the Burrowing Mayfly, *Hexagenia rigida* (Ephemeroptera) Exposed to CH_3HgCL or $HgCL_2$ in Water and Sediment." *Water Research*. Volume 27, Number 6. Pages 1041-1048.

Schauerte, W., J.P. Lay, W. Klein, and F. Korte. 1982. "Long-Term Fate of Organochlorine Xenobiotics in Aquatic Ecosystems." *Ecotoxicology and Environmental Safety*. Volume 6. Pages 560-569.

Schimmel, S.C., J.M. Patrick, Jr. and J. Forester. 1976. "Heptachlor: Toxicity to and Uptake by Several Estuarine Organisms." *Journal of Toxicology and Environmental Health.* Volume 1. Pages 955-965.

Schimmel, S.C., J.M. Patrick, Jr., and L.F. Faas. 1978. "Effects of Sodium Pentachlorophenate on Several Estuarine Animals: Toxicity Uptake and Depuration." Pages 147-155. In K.R. Rao. (Ed). *Penachlorophenol: Chemistry, Pharmacology, and Environmental Toxicology*. Plenum Press. New York, New York.

Schrap, S.M., and A. Opperhuizen. 1990. "Relationship Between Bioavailability and Hydrophobicity: Reduction of the Uptake of Organic Chemicals by Fish Due to the Sorption of Particles." *Environmental Toxicology and Chemistry.* Volume 9. Pages 715-724.

Schroeder, H.A. 1970. "Barium Air Quality Monograph." American Petroleum Institute, Air Quality Monograph Number 70-12.

Scura, E.D. and G.H. Theilacker. 1977. "Transfer of the Chlorinated Hydrocarbon PCB in a Laboratory Marine Food Chain." *Marine Biology*. Volume 40. Pages 317-325.

Shuster, C.N., Jr., and B.H. Pringle. 1968. "Effects of Trace Metals on Estuarine Mollusks." *Proceedings, First Mid-Atlantic Industrial Waste Conference*, November 13-15, 1967. Pages 285-304.

Simmers, J.W., R.G. Rhett, and C.R. Lee. 1983. Application of a Terrestrial Animal Bioassay for Determining Toxic Metal Uptake from Dredged Materila. International Congress Heavy Metals on the Environment, Heidelberg. 1284 pp. In Rhett 1988. Cited in Edwards and Neuhauser 1988.

Snarski, V.M., and G. F. Olson. 1982. "Chronic Toxicity and Bioaccumulation of Mercuric Chloride in the Fathead Minnow (*Pimephales promelas*)." *Aquatic Toxicology*. Volume 2. Pages 143-156.

Snarski, V.M., and F. A. Puglisi. 1976. *Effects of Aroclor 1254 on Brook Trout* (*Salvelinus fontinalis*). U.S. Environmental Protection Agency, EPA-600/3-76-112. Environmental Research Laboratory-Duluth. Duluth, Minnesota.

Sodergren, A. 1982. "Significance of Interfaces in the Distribution and Metabolism of Di-2-ethylhexyl Phthalate in an Aquatic Laboratory Model Ecosystem." *Environmental Pollution (Series A)*. Volume 27. Pages 263-274.

Southworth, G.R., J.J. Beauchamp, and P.K. Schmieder. 1978. "Bioaccumulation Potential of Polycyclic Aromatic Hydrocarbons in *Daphnia Pulex." Water Research*. Volume 12. Pages 973-977. As cited in Lyman, Reehl, and Rosenblatt (1982). As cited in Lyman, Reehl, and Rosenblatt (1982).

Spehar, R.L. 1976. "Cadmium and Zinc Toxicity to *Jordanella floridae*." U.S. Environmental Protection Agency, EPA-600/3-76-096. Environmental Research Laboratory-Duluth. Office of Research and Development. Duluth, Minnesota. November.

Spehar, R.L., J.T. Fiandt, R.L. Anderson, and D.L. DeFoe. 1980. "Comparative Toxicity of Arsenic Compounds and Their Accumulation in Invertebrates and Fish." *Archives, Environmental Contamination and Toxicology*. Volume 9. Pages 53-63.

Spehar, R.L., H.P. Nelson, M.J. Swanson, and J.W. Renoos. 1985. "Pentachlorophenol Toxicity to Amphipods and Fathead Minnows at Different Test pH Values." *Environmental Toxicology and Chemistry*. Volume 4. Pages 389-397.

Spehar, R.L., G.D. Veith, D.L. DeFoe, and B.V. Bergstedt. 1979. "Toxicity and Bioaccumulation of Hexachlorocyclopentadiene, Hexachloronorbornadiene and Heptachloronorbornene in Larval and Early Juvenile Fathead Minnows, (*Pimephales promelas*)." *Bulletin, Environmental Contamination and Toxicology*. Volume 21. Pages 576-583.

Stehly, G.R., and W.L. Hayton. 1990. "Effect of pH of the Accumulation Kinetics of Pentachlorophenol in Goldfish." *Archives of the Environmental Contamination and Toxicology*. Volume 19. Pages 464-470.

Stephan, C.E. 1993. "Derivation of Proposed Human Health and Wildlife Bioaccumulation Factors for the Great Lakes Initiative." U.S. Environmental Protection Agency, Office of Research and Development. U.S. Environmental Research Laboratory. NTIS PB93-154672.

Stokes, P.M., T.C. Hutchinson, and K. Krauter. 1973. "Heavy Metal Tolerance in Algae Isolated From

Polluted Lakes Near the Sudbury, Ontario Smelters." *Water Pollution Research Journal of Canada*. Volume 8. Pages 178-201. (Abstract only).

Sundelin, B. 1983. "Effects of Cadmium on *Pontoporeia affinis* (Crustacea: Amphipoda) in Laboratory Soft-Bottom Microcosms." *Marine Biology*. Volume 74. Pages 203-212.

Tarr, B.D., M.G. Barron, and W.L. Hayton. 1990. "Effect of Body Size on the Uptake and Bioconcentration of Di-2-ethylhexyl Phthalate in Rainbow Trout." *Environmental Toxicology and Chemistry*. Volume 9. Pages 989-995.

Theede, H., N. Scholz, and H. Fischer. 1979. "Temperature and Salinity Effects on the Acute Toxicity of Cadmium to *Laomedea loveni* (Hydrozoa)." *Marine Ecology - Progress Series*. Volume 1. Pages 13-19.

Thompson, S.E., C.A. Burton, D.L. Quinn, and Y.C. Ng. 1972. *Concentration Factors of Chemical Elements in Edible Aquatic Organisms*. UCRL-50564 Rev. 1. Lawrence Livermore Laboratory. University of California.

Thurberg, F.P., A. Calabrese, E. Gould, R.A. Greig, M.A. Dawson, and R.K. Tucker. 1977. "Response of the Lobster, *Homarus americanus*, to Sublethal Levels of Cadmium and Mercury." In: Vernberg, F.J., A. Calabrese, F.P. Thurberg, and W.B. Verberg (eds.). *Physiological Responses of Marine Biota to Pollutants*. Academic Press. New York, NY.

Travis, C.C., and A.D. Arms. 1988. "Bioconcentration of Organics in Beef, Milk, and Vegetation." *Environmental Science and Technology*. 22(3): 271-274.

U.S. EPA. 1976. "An Ecological Study of Hexachlorobutadiene (HCBD)." Office of Toxic Substances. Washington, D.C. EPA 560/6-76/010.

U.S. EPA. 1978. "In-depth Studies on Health and Environmental Impacts of Selected Water Pollutants." Washington, D.C.

U.S. EPA. 1979. "Water Related Environmental Fate of 129 Priority Pollutants." EPA Monitoring and Data Support Division. Washington, D.C. Volume I and II. EPA 440/4-79-029a.

U.S. EPA. 1980a. "Ambient Water Quality Criteria for Heptachlor." Office of Water Regulations and Standards. Criteria and Standards Division. Washington, D.C. EPA 440/5-80-052. October.

U.S. EPA. 1980b. "Ambient Water Quality Criteria for Polychlorinated Biphenyls." EPA 400/5-80/068. Office of Water Regulations and Standards Division. Washington, D.C.

U.S. EPA. 1980c. "Ambient Water Quality Criteria for Hexachlorobenzene. EPA 400/5-80/. Office of Water Regulations and Standards. Washington, D.C.

U.S. EPA. 1985. "Health Assessment Document for Polychlorinated Dibenzo-p-dioxins." Office of Health and Environmental Assessment. Washington, D.C. EPA 600/8-84/014F.

U.S. EPA. 1987. "Health Advisories for Hexachlorobenzene." Office of Drinking Water, Washington, D.C.

U.S. EPA. 1992a. "National Study of Chemical Residues in Fish." Office of Science and Technology. EPA 823/R-92/008b. September.

U.S. EPA. 1992b. "Criteria and Related Information for Toxic Pollutants." Water Management Division, EPA Region VI.

U.S. EPA. 1992c. Technical Support Document for Land Application of Sewage Sludge. Office of Water. EPA 822/R-93/001a. November.

U.S. EPA. 1992d. *Estimating Exposure to Dioxin-Like Compounds*. Draft Report. Office of Research and Development. Washington, D.C. EPA/600/6-88/005B. August.

U.S. EPA. 1994a. *Estimating Exposure to Dioxin-Like Compounds*. Draft Report. Office of Research and Development. Washington, D.C. EPA/600/6-88/005a,b,c. June.

U.S. EPA. 1994b. *Draft Report Chemical Properties for Soil Screening Levels*. Prepared for the Office of Emergency and Remedial Response. Washington, D.C. July 26.

U.S. EPA. 1994c. *Review Draft Technical Background Document for Soil Screening Guidance*. Office of Solid Waste Emergency Response. EPA/540/R-94/106. December.

U.S. EPA. 1994d. *CHEM8--Compound Properties Estimation and Data*. Version 1.00. CHEMDAT8 Air Emissions Program. Prepared for Chemical and Petroleum Branch, OAQPS. Research Triangle Park, North Carolina. November 18.

U.S. EPA. 1994e. *Revised Draft Guidance for Performing Screening Level Risk Analyses at Combustion Facilities Burning Hazardous Wastes: Attachment C, Draft Exposure Assessment Guidance for RCRA Hazardous Waste Combustion Facilities*. Office of Emergency and Remedial Response. Office of Solid Waste. December 14.

U.S. EPA. 1995a. *Review Draft Development of Human Health Based and Ecologically Based Exit Criteria for the Hazardous Wastes Identification Project.* Volumes I and II. Office of Solid Waste. March 3.

U.S. EPA. 1995b. "Great Lakes Water Quality Initiative Technical Support Document for the Procedure to Determine Bioaccumulation Factors." EPA 820/B-95/005. March.

U.S. EPA. 1996. *Ecological Data Quality Levels Reference Database, Version 3.0.* EPA Region 5, Wastes, Pesticides, and Toxics Division.

U.S. EPA. 1998. *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilitites*. External Peer Review Draft. U.S. EPA Region 6 and U.S. EPA OSW. Volumes 1-3. EPA530-D-98-001A. July.

Van Hoogen, G., and A. Opperhuizen. 1988. "Toxicokinetics of Chlorobenzenes in Fish." *Environmental Toxicology and Chemistry*. Volume 7. Pages 213-219.

Van Hook, R.I. 1974. "Cadmium, Lead, and Zinc Distributions Between Earthworms and Soils: Potentials for Biological Accumulation." *Bull. Contam. Toxicol.* 12:509-512.

Veith, G.D., D.L. DeFoe and B.V. Bergstedt. 1979. "Measuring and Estimating the Bioconcentration Factor of Chemicals in Fish." *Journal of Fisheries Research Board of Canada.* Volume 36. Pages 1040-1048.

Veith, G.D., D.W. Kuehl, F.A. Puglisis, G.E. Glass, and J.G. Eaton. 1977. "Residues of PCBs and DDT in the Western Lake Superior Ecosystem." *Archives of Environmental Contamination and Toxicology.* Volume 5. Pages 487-499.

Veith, G.D., K.J. Macek, S.R. Petrocelli, and J. Carroll. 1980. "An Evaluation of Using Partition Coefficients and Water Solubility to Estimate Bioconcentration Factors for Organic Chemicals in Fish." Pages 116-129. In J. G. Eaton, P. R. Parrish, and A. C. Hendricks (eds.), *Aquatic Toxicology.* ASTM STP 707. American Society for Testing and Materials, Philadelphia.

Vighi, M. 1981. "Lead Uptake and Release in an Experimental Trophic Chain." *Ecotoxicology and Environmental Safety.* Volume 5. Pages 177-193.

Wang, X., S. Harada, M. Watanabe, H. Koshikawa, and H.J. Geyer. 1996. "Modelling the Bioconcentration of Hydrophobic Organic Chemicals in Aquatic Organisms." *Chemosphere.* Vol 32, Number 9. Pages 1783-1793.

Watras, C.J., and N.S. Bloom. 1992. "Mercury and Methylmercury in Individual Zooplankton: Implications for Bioaccumulation." *Limnology and Oceanography.* Volume 37, Number 6. Pages 1313-1318.

Watras, C.J., J. MacFarlane, and F.M.M. Morel. 1985. "Nickel Accumulation by *Scenedesmus* and *Daphnia*: Food Chain Transport and Geochemical Implications." *Canadian Journal of Fisheries and Aquatic Science.* Volume 42. Pages 724-730.

Williams, D.R., and J.P.Giesy, Jr. 1979. "Relative Importance of Food and Water Sources to Cadmium Uptake by *Gambusia affinis* (Poecilidae)." *Environmental Research.* Volume 16. Pages 326-332.

Wofford, H.W., C.D. Wilsey, G.S. Neff, C.S. Giam, and J.M. Neff. 1981. "Bioaccumulation and Metabolism of Phthalate Esters by Oysters, Brown Shrimp, and Sheepshead Minnows." *Ecotoxicology and Environmental Safety.* Volume 5. Pages 202-210.

Wood, L.W., P. O'Keefe, and B. Bush. 1997. "Similarity Analysis of PAH and PCB Bioaccumulation Patterns in Sediment-Exposed *Chironomus tentans* Larvae." *Environmental Toxicology and Chemistry.* Volume 16, Number 2. Pages 283-292.

Yockim, R.S., A.R. Isensee, and G.E. Jones. 1978. "Distribution and Toxicity of TCDD and 2,4,5-T in an Aquatic Model Ecosystem." *Chemosphere.* Volume 7, Number 3. Pages 215-220.0

Zaroogian, G.E., and S. Cheer. 1976. "Accumulation of Cadmium by the American Oyster, *Crassostrea virginica.*" *Nature.* Volume 261. Pages 408-410.

Zaroogian, G.E., G. Morrison, and J.F. Heltshe. 1979. "*Crassostrea virginica* as an Indicator of Lead Pollution." *Marine Biology.* Volume 52. Pages 189-196.