Appendix A.
SPECIFICATIONS OF TRIM.FATE SIMULATIONS

This appendix summarizes the specifications of the TRIM.FaTE simulations.

- Section A.1 lists the chemicals modeled in these simulations and describes how the chemical-specific emission rates were calculated.

- The spatial layout and the methodology used to develop the layout are described in Section A.2.

- Sections A.3, A.4, and A.5, describe the meteorological, environmental setting, and biotic data used in the simulations.

- The overall simulation settings – including the data, simulation, and output time steps and output data export settings – are described in Section A.6.

References are included at the end of the appendix.

This information is supplemented by Appendices B and C, which provide detailed documentation of the values and references for all the input parameters used in the TRIM.FaTE simulations for this analysis. The modeling concepts, approaches, algorithms, equations, and assumptions used in TRIM.FaTE (including the TRIM.FaTE library used in this analysis) are documented in detail in a two-volume Technical Support Document (EPA 2002a and b) and are not discussed at length here.

A.1 Modeled Chemicals and Emission Rates

A.1.1 Chemical Data

Each of the TRIM.FaTE simulations included in this analysis modeled the fate and transport of the same 17 individual dioxin and furan congeners addressed in the Lorber et al. 2000 report. These congeners are listed in Table 2 of the report along with the abbreviations that are commonly used for them. The chemical properties used in TRIM.FaTE for the these congeners are documented in Appendix B.

The fate and transport of these 17 congeners were modeled in TRIM.FaTE individually. To facilitate comparison with the results presented in the Lorber et al. reports, the individual results for these chemicals were subsequently combined into toxic equivalent (TEQ) concentrations. These TEQ concentrations were calculated by multiplying the compartment concentrations of each congener by its corresponding toxicity equivalent factor (TEF), which were the exact same as used by Lorber et al. (2000) and described in Appendix C, and then summing the resulting products across all of the congeners. In addition, congener-specific compartment results for TCDD and OCDD from TRIM.FaTE are compared to the corresponding results from the Lorber et al. 2000 report. These congeners were chosen because they were the only two congeners in the Lorber et al. 2000 report for which individual results are presented both on tables and in spatial plots.

A.1.2 Calculating Chemical-specific Emission Rates

Emissions from stack tests conducted at the CMSWTE facility in 1992 (Ohio EPA 1994) and 1994 (SWA 1994) that were used in the Lorber et al. 2000 report were also used as the basis for chemical-specific emission rates for this analysis. The detailed calculations using the stack test data to obtain chemical-specific emission rates for TRIM.FaTE are included in Appendix C. In these calculations, the 1992 and 1994 stack test data were converted to the correct units for TRIM.FaTE (grams of chemical emitted per day) and adjusted for usage based on the assumption that on average 4.22 boilers were used continuously at the facility. This same methodology was used to calculate the emissions used in the Lorber report as well. Appendix C summarizes the chemical-specific emission rates that were modeled using the 1992 and 1994 stack tests.

A.1.3 Calculating Specific Emission Rates for each Stack Test

The Lorber et al. 2000 analysis reported emission rates in terms of TEQ emissions. Because TRIM.FaTE modeled each congener individually, instead of as TEQ emissions, congener-specific emission rates needed to be developed. Using the stack tests referenced as the source of emissions data for the Lorber et al. 2000 report, emission rates were calculated for each congener (these calculations are described in detail in Appendix C).

The 1994 emissions reflected a combustion improvements at the facility that reduced emissions by approximately 73 percent in terms of TEQ concentration. The congener-specific emission rates for 1994 are not all reduced by 73 percent, this only refers to the TEQ concentration; in fact, some of the congener (e.g., OCDD) concentrations increase from 1992 to 1994.

To confirm the calculations were correct, the congener-specific emission rates from the 1992 and 1994 stack test were converted into TEQ emission rates (in grams per second) and compared to the emission rates reported in two Lorber et al. reports (1996 and 2000). This comparison showed that the emission rates used in the TRIM.FaTE simulations were consistent with emissions used by Lorber et al. Appendix C summarizes the emissions in TEQ modeled for each stack test.

A.2 Spatial Layout

The spatial layout of parcels provides the underlying framework for a TRIM.FaTE simulation. Thus, it is important to create a layout that is representative of the area being modeled and, in this application, similar to the areas outlined in the reports to which these results were to be compared. The process of designing the spatial layout for this TRIM.FaTE analysis involved defining the modeling region (Section A.2.1) and delineating this region into surface parcels (Section A.2.2) and air parcels (Section A.2.3). Definitions for important spatial terms used in this section are summarized in the text box below.

> A **parcel** is a planar (i.e., two-dimensional), horizontal geographical area used to subdivide the modeling region. Parcels, which are polygons of virtually any size or shape, are the basis for defining volume elements and do not change for a given scenario. There can be separate parcels for air and for the land surface (soil or surface water).
> A **volume element** is a bounded three-dimensional space that defines the location of one or more compartments.
> A **compartment** is defined as a unit of space characterized by its homogeneous physical composition and within which it is assumed, for modeling purposes, that all chemical mass is homogeneously distributed and is in phase equilibrium.

A.2.1 Modeling Region

For this analysis, the overall size and extent of the area for which pollutant fate and transport were modeled (i.e., the modeling region) was determined based on the location of the emissions source, expected mobility of the chemicals of primary interest (i.e., chemicals listed in Table A.1), locations or receptors of interest (e.g., dairy farms, monitoring stations), and watershed boundaries for the water bodies of interest. The size and extent of the modeling region was determined by identifying the location of interest farthest from the source and creating a square centered on the source that captured this location[1]. A square shape was selected to allow for an equal number of air parcels in each direction. The modeling region was centered on the source location because the locations of interest (primarily the monitoring locations discussed in the Lorber et al. 2000 report) are scattered around the facility, rather than on one side, and the wind direction in the Columbus area (based on the available meteorological data) varies across the site.

A.2.2 Surface Layout

The surface parcels were designed based on the source location, locations of water bodies, watershed boundaries for these water bodies, and locations and receptors of interest. The layout is centered on a square source parcel that approximates the surface area of the facility. Surface parcels included either soil or water parcels.

Four primary water bodies were identified within the modeling region: Scioto River, Olentangy River, Walnut Creek, and Alum Creek. Surface parcels were created for the Scioto River and Olentangy River based on the path and average width of these water bodies. Walnut Creek and Alum Creek were combined into a single surface parcel because they run together for nearly half of their distance within the modeling region. The remaining surface parcels were delineated based on the monitoring and modeling locations in the Lorber et al. 2000 report, as well as the watershed boundaries within the modeling region.

The resulting surface parcel layout, presented in Figure 1 in the main body of this report, consists of 27 soil parcels (including a small source parcel centered on the emission source) and three surface water parcels, for a total of 30 surface parcels.

For each soil parcel, four volume elements were defined (i.e., surface soil, root soil, vadose soil, and groundwater) that correspond to soil layers. The depths for these volume elements were 1 cm, 81 cm, 153 cm, and 3 m, respectively[2]. Associated with each surface water parcels is a surface water volume element above a sediment volume element. The depths of the surface water and sediment volume elements were based on site-specific or regional data and professional judgment, and are presented in Appendix B.

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[1]See TRIM.FaTE User's Guide (EPA 2003) for more information on TRIM.FaTE parcel designs.

[2]It is important to note that TRIM.FaTE is very flexible with respect to assigning the depths of different compartments, including surface soil. The algorithms associated with the surface soil compartments have been evaluated and shown to be valid at depths of up to one meter. The soil depths in TRIM.FaTE for this application were selected based on site-specific data and configurations used in previous TRIM.FaTE applications.

A.2.3 Air Layout

The air parcels were designed based on the source location, the degradation rates of the modeled chemicals, the locations and receptors of interest, and the desire to maintain a regular, symmetric layout in an “approximated radial grid” shape. The air portion of the modeling region was divided into two vertical layers of volume elements. The boundary between the two layers corresponds to the atmospheric mixing height and varies with time. The air layer closest to the ground was divided into individual parcels (and associated volume elements) designed to provide higher spatial resolution near the facility (where the gradient of concentrations is greater) and less resolution further from the facility (where the gradient of concentrations is smaller). This bottom air layer was centered on a source parcel that matches exactly with the source parcel in the surface parcel layout. The remaining air parcels in the bottom layer were arranged in a grid of polygons designed to approximate a polar grid originating from the source parcel. The radial distances between the parcels were selected to maintain a consistent relative decrease in estimated air concentrations with distance from the source. The upper air layer was designed as a single air volume element covering the entire modeling region with the top of the layer set to 4.0 kilometers, which is approximately 1.0 kilometer above the maximum mixing height for the meteorological data used at the site. This upper air layer was included to track emissions released above the mixing height (i.e., during times when the mixing height is lower than the source elevation) and is considered a sink for the purposes of this report since the mass released to the upper layer remains there and is no longer available.

The resulting air configuration is presented in Figure 2 in the Report. This figure shows the 33 individual air parcels in the bottom layer. The top layer consists of a single volume element with the same outer boundary as the outer boundary of the bottom layer. The air parcels do not line up exactly with the surface parcels, although the outer boundaries of both parcel sets are the same. Figure 2 also shows the air monitoring locations from the Lorber et al. 2000 report.

A.3 Meteorological Data

The meteorological data used in this analysis correspond exactly to the 1989 data used in the Lorber et al. 2000 report for the soil analyses, and the 1994 local airport data for the air analyses. The surface air data were from Columbus, Ohio, and the upper air data are from Dayton, Ohio. These data were downloaded from EPA's Support Center for Regulatory Air Models web site (see http://www.epa.gov/ttn/scram/). All meteorological data required by TRIM.FaTE were presented in one-hour time steps.

The soil results from the Lorber et al. 2000 report were modeled using only one year of meteorological data (1989) and assumed that deposition in subsequent years was identical to the modeled year; therefore, in the two 12-year TRIM.FaTE simulations used for the soil comparisons, the 1989 meteorological data were repeated for all of the years over the course of the simulation.

A.4 Abiotic Compartment Data

For this report, the results from the TRIM.FaTE model simulations were compared only to the air and soil concentrations in the Lorber et al. 2000 report. Therefore, only air, surface soil, and root zone soil compartments, as well as the other compartment types that significantly impact the overall mass balance, were needed in the simulations. Abiotic media included in these TRIM.FaTE simulations were air, soil (surface, root zone, and vadose zone), groundwater, surface water, and sediment.

For the environmental setting (i.e., abiotic) input data, site-specific values were obtained or calculated, when possible, using U.S. Geological Survey data, topographic maps, and other resources with local or regional information. The representativeness of the data was evaluated, if possible, based on the purpose of the simulation and resources available. Appendix B contains the documentation of values for all environmental setting data. Chemical-specific input data for the abiotic compartments were obtained for the 17 dioxin-like compounds and are also documented in Appendix B. Calculations and assumptions for the surface water data are detailed at the end of Appendix B for the three surface water bodies included in the TRIM.FaTE simulations.

A.5 Biotic Compartment Data

There are no comparison data for biota in the Lorber et al. 2000 report. Based on results from previous TRIM.FaTE analyses, the presence of vegetation has the potential to affect the mass balance in other compartments, such as air (e.g., via the intake of chemicals to leaves through the stomata) and soil (via transfer of the chemical to soil during litter fall); therefore, plant compartments were included wherever appropriate. Other biotic compartments, such as terrestrial and aquatic animals, are not expected to significantly impact air or soil concentrations and, thus, were not considered in this analysis.

Terrestrial vegetation types (i.e., grasses/herbs, agriculture, and deciduous forests) were assigned to all surface parcels based on land use information from the National Land Cover Data database. Based on these data, most of the surface parcels were assigned grasses/herbs. One of the surface parcels was assigned the deciduous forest vegetation type, and two were assigned agricultural vegetation. The remaining surface parcel corresponded to the source location and was not assigned any vegetation. Documentation of the vegetation types of each plant compartment, as well as and the corresponding input data are included in Appendix B.

A.6 Simulation Settings

This section describes the settings for the TRIM.FaTE simulations included in the analysis. Section A.6.1 describes the details of the scenario setup, Section A.6.2 describes the time-varying inputs used in the analysis, Section A.6.3 describes the selected simulation and output time steps, and Section A.6.4 describes the selected options for exporting results from TRIM.FaTE.

A.6.1 Scenario Setup

Table A-2 lists the three simulations modeled for this comparison report with the details of the setup. The emissions, summarized in Section A.1, refer to the stack tests upon which they are based. The modeling period used for this comparison report lists the time period that was chosen to correspond to the those used in the Lorber et al. 2000 report. All of the simulations were set up using only plants for biota, all 17 dioxins/furans used in the Lorber report, a meteorological data time step of one hour (the smallest increment that the data are reported), a simulation time step of one hour (see Section A.6.2), and an output time step of monthly or hourly (see Section A.6.2).

Table A-2. Detailed List of TRIM.FaTE Simulations

Emissions	Modeling Period Used for Comparison	Biota	Chemicals	Met Data Time Step	Sim Time Step	Output Time Step	Compartments Used for Comparison
1994 stack test	1 year	Vegetation only	17 dioxin/ furans	1hr	1hr	1hr	Air
1992 stack test	12 years	Vegetation only	17 dioxin/ furans	1hr	1hr	Monthly (i.e., 730 hrs)	Surface and root zone soil
1994 stack test	12 years	Vegetation only	17 dioxin/ furans	1hr	1hr	Monthly (i.e., 730 hrs)	Surface and root zone soil

A.6.2 Time-varying Inputs

Some of the inputs to the TRIM.FaTE simulations described in this report varied with time: meteorological data and vegetation data (i.e., AllowExchange and litter fall rate). The AllowExchange property is a Boolean property that indicates whether it is the growing season for each vegetation type. For this application, the grasses/herbs, agriculture, and deciduous forest compartments had a growing season starting on April 15th (the local spring thaw) and ending on November 5th (the local fall freeze) of each year modeled. The litter fall rate property is a seasonal property used to model the loss of plant leaves (and particles on leaves) to soil. For all three vegetation types modeled, litter fall was set to begin at this site with the first frost on November 5th of every year, and ended December 4th, and assumed that 99 percent of leaves fall at a constant rate over these 30 days.

A.6.3 Simulation and Output Time Steps

The simulation and output time steps are simulation settings used to specify how often the model will calculate the mass and concentration in each compartment and how often these data will be output. The simulation time step specifies the frequency at which the model will calculate transfer factors and chemical mass exchange between compartments. For all simulations associated with this analysis, the simulation time step was set to one hour, corresponding to the smallest input data time step (i.e., the time-varying data that changes most frequently).

The output time step specifies how often the model outputs (e.g., mass and concentrations in each compartment, deposition rates to surface soil compartments) will be reported. The output time step was either monthly[3] (for the simulations used for comparison to soil concentrations) or hourly (for the simulation used for comparison to air concentrations). Because soil concentrations change more gradually over time than air concentrations and thus do not need to be output as frequently, monthly time steps were used for the simulations used in the surface soil comparisons to reduce the volume of output data generated by TRIM.FaTE. Conversely, air concentrations can change significantly from hour to hour based on changes in the meteorological conditions and thus the simulations used in the air comparisons used hourly output time steps.

A.6.4 Output Data Export Settings

For each TRIM.FaTE simulation included in this analysis, the following types of outputs were selected:

- Moles of each modeled chemical in each compartment at each output time step;
- Mass of each modeled chemical in each compartment at each output time step;
- Concentration of each modeled chemical in each compartment at each output time step; and
- Wet and dry particle and vapor deposition rates to each surface soil compartment at each output time step.

In addition to these outputs, several diagnostic outputs (e.g., HTML export) were generated to provide additional insight into how the model is working. Although the comparisons focused on the concentration outputs, the additional outputs were useful for interpreting results.

[3] The monthly output time step outputs the results every 730 hours to approximate the average number of hours in a month.

References

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Appendix B
DOCUMENTATION OF TRIM.FaTE INPUT PARAMETERS

This appendix contains the following sets of tables, including supplemental tables with calculations and discussion where appropriate, listing and describing the input parameters used in TRIM.FaTE:

- chemical-independent parameters for abiotic and biotic (i.e., plant) compartment types;
- chemical-dependent (i.e., value varies by chemical) parameters independent of compartment type;
- chemical-dependent parameters for abiotic and biotic (i.e., plant) compartment types.

For each parameter listed, the parameter name, input units, value used, and a reference are given. Full citations for each reference are provided at the end. Several attachments, referred to in the tables, provide additional detailed documentation.

Within the framework of the TRIM.FaTE computer model, several different kinds of "properties" are defined and used. The input parameters listed in this appendix fall into the following categories of TRIM.FaTE properties:

- compartment properties (includes by far the largest number of input parameters);
- volume element (VE) properties;
- link properties;
- chemical properties;
- source properties; and
- scenario properties.

In the following tables, the property type is identified for all input parameters that are not compartment properties.

Note that the units listed in these tables are the units in which model input values need to be expressed. In a few cases, these computer model input units do not match the units used for the same parameter in equations and derivations in TRIM.FaTE Techincal Support Document Volume II. In such cases, there are internal units conversions in the computer model that account for the differences.

Chemical-Independent/Abiotic -- Documentation for OH WTE Dioxin Test Case (same values used for all air compartments)

Air Compartment Type

Parameter Name	Units	Value Used	Reference
Atmospheric dust load	kg[dust]/m^3[air]	7.80E-08	Bidleman 1988
Density of air	g/cm^3	0.0012	U.S. EPA 1997
Dust density	kg[dust]/m^3[dust]	1,400	Bidleman 1988
Fraction organic matter on particulates	unitless	0.2	Harner and Bidleman 1998
Height [VE property] [a]	m	mixing height (varies hourly)	Local airport meteorological data, 1989 and 1994
Washout ratio	[mass chem/volume rain]/[mass chem/volume air]	33,495	Vulykh and Shatalov 2001

[a]Height of air volume elements is set in TRIM.FaTE using two properties, the bottom of the volume element (set at 0 meters) and the top of the volume element (set to the mixing height, which varies hourly).

Chemical-Independent/Abiotic -- Documentation for OH WTE Dioxin Test Case
(same values used for all soil compartments of each type, except where noted)

Soil Compartment Types

Parameter Name	Units	Value Used	Reference
Surface Soil Compartment Type			
Air content	volume[air]/volume[compartment]	0.25	McKone et al. 2001 (Table A-2)
Average vertical velocity of water (percolation)	m/day	7.00E-02	Professional judgment, based on water balance calculations
Density of soil solids (dry weight)	kg[soil]/m^3[soil]	2600	McKone et al. 2001 (Table 3)
Depth [VE property] [a]	m	0.01	Professional judgment, based on McKone et al. 2001 (p. 30)
Erosion fraction [Link property]	unitless	compartment boundary-specific[a]	See "Erosion and Runoff Fractions" table
Fraction of area available for erosion	m^2[area available]/m^2[total]	varies by parcel	Calculated based on the percentage of parcel area covered by roads and based on the estimated density of development; see "Fraction of Area Available for Erosion and Runoff" table
Fraction of area available for runoff	m^2[area available]/m^2[total]	1	Professional judgment; all area assumed to be available for runoff
Fraction of area available for vertical diffusion	m^2[area available]/m^2[total]	varies by parcel	Calculated based on the percentage of parcel area covered by roads and based on the estimated density of development; see "Fraction of Area Available for Erosion and Runoff" table
Organic carbon fraction	unitless	0.02	Lorber et al. 1996 (Table 1)
Water content	volume[water]/volume[compartment]	0.22	McKone et al. 2001 (Table A-2)
Boundary layer thickness above surface soil	m	0.005	Thibodeaux 1996; McKone et al. 2001 (Table 3)
Total erosion rate	kg [soil]/m^2/day	5.50E-04	van der Leeden et al. 1991, as cited in McKone et al. 2001, p.23
Total runoff rate	m^3[water]/m^2/day	0.0011	van der Leeden et al. 1991, as cited in McKone et al. 2001, p.18
Root Zone Soil Compartment Type			
Air content	volume[air]/volume[compartment]	0.19	McKone et al. 2001 (Table A-3)
Average vertical velocity of water (percolation)	m/day	7.00E-02	Professional judgment, based on water balance calculations
Density of soil solids (dry weight)	kg[soil]/m^3[soil]	2,600	McKone et al. 2001 (Table 3)

Chemical-Independent/Abiotic -- Documentation for OH WTE Dioxin Test Case
(same values used for all soil compartments of each type, except where noted)

Soil Compartment Types

Parameter Name	Units	Value Used	Reference
Depth [VE property] [a]	m	0.81	McKone et al. 2001 (Table A-3)
Organic carbon fraction	unitless	0.007	McKone et al. 2001 (Table A-3)
Water content	volume[water]/volume[compartment]	0.24	McKone et al. 2001 (Table A-3)
Vadose Zone Soil Compartment Type			
Air content	volume[air]/volume[compartment]	0.16	McKone et al. 2001 (Table A-4)
Average vertical velocity of water (percolation)	m/day	7.00E-02	Professional judgment, based on water balance calculations
Density of soil solids (dry weight)	kg[soil]/m^3[soil]	2,600	McKone et al. 2001 (Table 3)
Depth [VE property] [a]	m	1.53	McKone et al. 2001 (Table A-4)
Organic carbon fraction	unitless	0.002	McKone et al. 2001 (Table A-4)
Water content	volume[water]/volume[compartment]	0.23	McKone et al. 2001 (Table A-4)
Ground Water Compartment Type			
Depth [VE property] [a]	m	3	McKone et al. 2001 (Table 3)
Organic carbon fraction	unitless	0.002	McKone et al. 2001 (Table A-4)
Porosity	volume[total pore space]/volume[compartment]	0.2	McKone et al. 2001 (Table 3)
Solid material density in aquifer	kg[soil]/m^3[soil]	2,600	McKone et al. 2001 (Table 3)

[a]Set using the volume element properties named "top" and "bottom."
[b]See separate erosion/runoff fraction table.

Chemical-Independent/Abiotic -- Documentation for OH WTE Dioxin Test Case
Fraction of Area Available for Erosion and Runoff

Compartment	Percentage of Total Area Covered by Roads	Urban?	Fraction of Area Available for Erosion	Fraction of Area Available for Vertical Diffusion (Runoff)
SurfSoil_E1	10.64%	Y	0.79	0.79
SurfSoil_E2	10.64%	Y	0.79	0.79
SurfSoil_ESE2	4.56%	N	0.95	0.95
SurfSoil_ESE3	3.54%	N	0.96	0.96
SurfSoil_N1	14.98%	Y	0.70	0.70
SurfSoil_NE2	8.08%	N	0.92	0.92
SurfSoil_NNE2	14.31%	Y	0.71	0.71
SurfSoil_NNW1	14.98%	Y	0.70	0.70
SurfSoil_NNW2	13.16%	Y	0.74	0.74
SurfSoil_NNW3	11.99%	Y	0.76	0.76
SurfSoil_NW2	7.55%	N	0.92	0.92
SurfSoil_NW3	3.52%	N	0.96	0.96
SurfSoil_NWFarm	13.61%	N	0.86	0.86
SurfSoil_SE2	3.72%	N	0.96	0.96
SurfSoil_SE3	2.25%	N	0.98	0.98
SurfSoil_Source	8.71%	Y	0.83	0.83
SurfSoil_SW1	3.85%	N	0.96	0.96
SurfSoil_SW2	3.85%	N	0.96	0.96

Chemical-Independent/Abiotic -- Documentation for OH WTE Dioxin Test Case
Fraction of Area Available for Erosion and Runoff

Compartment	Percentage of Total Area Covered by Roads	Urban?	Fraction of Area Available for Erosion	Fraction of Area Available for Vertical Diffusion (Runoff)
SurfSoil_SW3	3.85%	N	0.96	0.96
SurfSoil_SW4	2.32%	N	0.98	0.98
SurfSoil_W1	8.21%	Y	0.84	0.84
SurfSoil_WNW1	8.21%	Y	0.84	0.84
SurfSoil_WNW2	8.21%	Y	0.84	0.84
SurfSoil_WNW3	3.42%	N	0.97	0.97
SurfSoil_WSW1	3.66%	N	0.96	0.96
SurfSoil_WSW2	3.66%	N	0.96	0.96
SurfSoil_WSW3	2.87%	N	0.97	0.97

Methodology: First, we calculated the percentage of each parcel covered by roads using GIS. We assumed each road was 25 feet wide, based on the assumption that each lane is, on average, 8 feet wide and there is a mixture of different numbers of lanes throughout the study area. We then identified which parcels appeared to be highly developed (using USGS quad maps) (these are indicated by a "Y" in the "Urban?" column) and assumed that the percentage of area available for erosion and vertical diffusion in these parcels was twice the area covered by roads (to account for buildings, sidewalks, parking lots, etc.). For the remaining parcels, we assumed the percentage of area available for erosion and vertical diffusion was equal to the percentage of area covered by roads.

Erosion and Runoff Fractions -- Documentation for OH WTE Dioxin Test Case

Surface Soil Compartment Type

Originating Compartment	Destination Compartment	Runoff/Erosion Fraction[a]
SurfSoil_Source	SurfSoil_N1	0.00
	SurfSoil_W1	0.00
	SW_Scioto	1.00
SurfSoil_N1	SurfSoil_Source	0.30
	SurfSoil_W1	0.20
	SurfSoil_NNW1	0.00
	SW_Scioto	0.50
SurfSoil_NNW1	SW_Scioto	0.30
	SurfSoil_Source	0.15
	SurfSoil_WNW1	0.30
	SurfSoil_NWFarm	0.25
	SurfSoil_NW2	0.00
SurfSoil_NWFarm	SW_Scioto	1.00
	SurfSoil_NNW1	0.00
	SurfSoil_NW2	0.00
SurfSoil_NW2	SW_Scioto	0.69
	SurfSoil_NWFarm	0.29
	SurfSoil_NNW1	0.02
	SurfSoil_NW3	0.00
SurfSoil_NW3	SW_Scioto	0.34
	SurfSoil_NW2	0.00
	SurfSoil_WNW2	0.36
	out	0.30
SurfSoil_NNW2	SW_Scioto	0.55
	SW_Olentangy	0.45
	SurfSoil_NNW3	0.00
SurfSoil_NNW3	SW_Scioto	0.30
	SW_Olentangy	0.67
	SurfSoil_NNW2	0.03
SurfSoil_W1	SurfSoil_Source	0.00
	SW_Scioto	0.90
	SurfSoil_SW1	0.10
	SurfSoil_WNW1	0.00
	SurfSoil_N1	0.00
SurfSoil_WNW1	SurfSoil_W1	0.98
	SurfSoil_SW2	0.00
	SurfSoil_WSW1	0.02
	SurfSoil_WNW2	0.00
	SurfSoil_NNW1	0.00

Erosion and Runoff Fractions -- Documentation for OH WTE Dioxin Test Case

Surface Soil Compartment Type

Originating Compartment	Destination Compartment	Runoff/Erosion Fraction[a]
SurfSoil_WNW2	SurfSoil_WNW3	0.17
	SurfSoil_WNW1	0.77
	SurfSoil_WSW2	0.06
	SurfSoil_NNW1	0.00
SurfSoil_WNW3	SurfSoil_WNW2	0.03
	SurfSoil_WSW3	0.97
	SurfSoil_NW3	0.00
	out	0.00
SurfSoil_SW1	SurfSoil_W1	0.00
	SurfSoil_SW2	0.00
	SW_Scioto	1.00
SurfSoil_SW2	SurfSoil_SW3	0.10
	SurfSoil_WSW1	0.00
	SurfSoil_WNW1	0.00
	SurfSoil_SW1	0.00
	SW_Scioto	0.90
SurfSoil_SW3	SW_Scioto	0.55
	SurfSoil_SW4	0.45
	SurfSoil_WSW2	0.00
	SurfSoil_SW2	0.00
SurfSoil_WSW1	SurfSoil_SW2	1.00
	SurfSoil_WSW2	0.00
	SurfSoil_WNW1	0.00
SurfSoil_WSW2	SurfSoil_WSW3	0.40
	SurfSoil_WSW1	0.25
	SurfSoil_WNW2	0.30
	SurfSoil_SW3	0.00
	SurfSoil_SW4	0.05
SurfSoil_WSW3	SurfSoil_WSW2	0.00
	SurfSoil_WNW3	0.00
	SurfSoil_SW4	1.00
	out	0.00
SurfSoil_SW4	SW_Scioto	0.39
	SurfSoil_SW3	0.00
	SurfSoil_WSW2	0.00
	SurfSoil_WSW3	0.00
	out	0.61
SurfSoil_E1	SurfSoil_E2	0.00
	SW_Scioto	1.00

Erosion and Runoff Fractions -- Documentation for OH WTE Dioxin Test Case

Surface Soil Compartment Type

Originating Compartment	Destination Compartment	Runoff/Erosion Fraction[a]
SurfSoil_E2	SurfSoil_E1	0.10
	SurfSoil_NNE2	0.00
	SW_Combined	0.50
	SW_Scioto	0.40
SurfSoil_NNE2	SurfSoil_E2	0.55
	SW_Olentangy	0.39
	SW_Combined	0.06
	out	0.00
SurfSoil_NE2	SurfSoil_ESE2	0.99
	SW_Combined	0.01
	out	0.00
SurfSoil_SE2	SurfSoil_ESE2	0.00
	SurfSoil_ESE3	0.00
	SurfSoil_SE3	0.56
	SW_Combined	0.44
SurfSoil_ESE2	SurfSoil_NE2	0.01
	SurfSoil_ESE3	0.39
	SurfSoil_SE2	0.58
	SW_Combined	0.02
	out	0.00
SurfSoil_ESE3	SurfSoil_ESE2	0.00
	SurfSoil_SE2	1.00
	SurfSoil_SE3	0.00
	out	0.00
SurfSoil_SE3	SurfSoil_SE2	0.08
	SurfSoil_ESE3	0.00
	SW_Scioto	0.32
	out	0.60

[a]Link properties - all values estimated using site watershed and topographic maps.

Chemical-Independent Properties -- Documentation for OH WTE Dioxin Site
Scioto River

Parameter Name	Units	Value Used	Reference
Algae carbon content (fraction)	unitless	0.465	APHA 1995
Algae density in water column	g[algae]/L[water]	0.0025	Derived from Millard et al. 1996
Algae growth rate	1/day	0.7	Hudson et al. 1994 as cited in Mason et al. 1995
Algae radius	um	2.5	Mason et al. 1995
Algae water content (fraction)	unitless	0.9	APHA 1995
Average algae cell density (per vol cell, not water)	g[algae]/m^3[algae]	1,000,000	Mason et al. 1995, Mason et al. 1996
Boundary layer thickness above sediment	m	0.02	Cal EPA 1993
Chloride concentration	mg/L	42.1	USGS 2003a[d]
Chlorophyll concentration	mg/L	1.48E-02	U.S. EPA 2003a[d]
Current velocity[a]	m/s	5.30E-01	USGS 2003a[d]
Depth [VE property]	m	0.67	Professional judgment, based on maps, stream orders, and Keup 1985
Diffusive exchange coefficient [Link property][b]	m^2/day	2.25E-04	Ambrose et al. 1995
Dimensionless viscous sublayer thickness	unitless	4	Ambrose et al. 1995
Drag coefficient for water body	unitless	0.0011	Ambrose et al. 1995
Flush rate[c]	1/year	5.64E+02	USGS 2003a, professional judgement[d]
Organic carbon fraction in suspended sediments	unitless	0.02	McKone et al. 2001 (Table 3)
pH	unitless	7.72	USGS 2003a[d]
Suspended sediment density	kg[sediment]/m^3 [sediment]	2.65E+03	U.S. EPA 1998
Suspended sediment deposition velocity	m/day	2	U.S. EPA 1997
Total suspended sediment concentration	kg[sediment]/m^3 [water column]	2.63E-01	USGS 2003c[d]
Water temperature [VE property]	degrees K	289.3	USGS 2003a[d]

[a]Flowing water bodies only (i.e., rivers, streams).
[b]For all surface water compartments connected to other surface water compartments.
[c]For all surface water compartments connected to a flush rate sink (i.e., all or part of discharge modeled to a sink).
[d]See following sections, "Surface Water Calculations" and "Surface Water Properties" for a detailed description of calculations.

Chemical-Independent Properties -- Documentation for OH WTE Dioxin Site
Olentangy River

Parameter Name	Units	Value Used	Reference
Algae carbon content (fraction)	unitless	0.465	APHA 1995
Algae density in water column	g[algae]/L[water]	0.0025	Derived from Millard et al. 1996
Algae growth rate	1/day	0.7	Hudson et al. 1994 as cited in Mason et al. 1995
Algae radius	um	2.5	Mason et al. 1995
Algae water content (fraction)	unitless	0.9	APHA 1995
Average algae cell density (per vol cell, not water)	g[algae]/m^3[algae]	1,000,000	Mason et al. 1995, Mason et al. 1996
Boundary layer thickness above sediment	m	0.02	Cal EPA 1993
Chloride concentration	mg/L	48.2	USGS 2003b[c]
Chlorophyll concentration	mg/L	1.48E-02	U.S. EPA 2003a[c]
Current velocity[a]	m/s	8.30E-01	USGS 2003b[c]
Depth [VE property]	m	0.33	Professional judgment, based on maps, stream orders, and Keup 1985
Diffusive exchange coefficient [Link property][b]	m^2/day	2.25E-04	Ambrose et al. 1995
Dimensionless viscous sublayer thickness	unitless	4	Ambrose et al. 1995
Drag coefficient for water body	unitless	0.0011	Ambrose et al. 1995
Organic carbon fraction in suspended sediments	unitless	0.02	McKone et al. 2001 (Table 3)
pH	unitless	7.87	USGS 2003b[c]
Suspended sediment density	kg[sediment]/m^3 [sediment]	2.65E+03	U.S. EPA 1998
Suspended sediment deposition velocity	m/day	2	U.S. EPA 1997
Total suspended sediment concentration	kg[sediment]/m^3 [water column]	4.50E-02	USGS 2003b[c]
Water temperature [VE property]	degrees K	289.9	USGS 2003b[c]

[a]Flowing water bodies only (i.e., rivers, streams).

[b]For all surface water compartments connected to other surface water compartments.

[c]See following sections, "Surface Water Calculations" and "Surface Water Properties" for a detailed description of caluclations.

Chemical-Independent Properties -- Documentation for OH WTE Dioxin Site
Combined Water Body

Parameter Name	Units	Value Used	Reference
Algae carbon content (fraction)	unitless	0.465	APHA 1995
Algae density in water column	g[algae]/L[water]	0.0025	Derived from Millard et al. 1996
Algae growth rate	1/day	0.7	Hudson et al. 1994 as cited in Mason et al. 1995
Algae radius	um	2.5	Mason et al. 1995
Algae water content (fraction)	unitless	0.9	APHA 1995
Average algae cell density (per vol cell, not water)	g[algae]/m^3[algae]	1,000,000	Mason et al. 1995, Mason et al. 1996
Boundary layer thickness above sediment	m	0.02	Cal EPA 1993
Chloride concentration	mg/L	39.0	USGS 2003c,d[c]
Chlorophyll concentration	mg/L	1.83E-02	U.S. EPA 2003a[c]
Current velocity[a]	m/s	3.60E-01	USGS 2003c,d[c]
Depth [VE property]	m	0.31	Professional judgment, based on maps, stream orders, and Keup 1985
Diffusive exchange coefficient [Link property][b]	m^2/day	2.25E-04	Ambrose et al. 1995
Dimensionless viscous sublayer thickness	unitless	4	Ambrose et al. 1995
Drag coefficient for water body	unitless	0.0011	Ambrose et al. 1995
Organic carbon fraction in suspended sediments	unitless	0.02	McKone et al. 2001 (Table 3)
pH	unitless	7.88	USGS 2003c,d[c]
Suspended sediment density	kg[sediment]/m^3 [sediment]	2.65E+03	U.S. EPA 1998
Sediment deposition velocity	m/day	2	U.S. EPA 1997
Total suspended sediment concentration	kg[sediment]/m^3 [water column]	2.63E-01	USGS 2003c[c]
Water temperature [VE property]	degrees K	286.2	USGS 2003c,d[c]

[a]Flowing water bodies only (i.e., rivers, streams).

[b]For all surface water compartments connected to other surface water compartments.

[c]See following sections, "Surface Water Calculations" and "Surface Water Properties" for a detailed description of caluclations.

Link Properties for Surface Water Compartments -- Documentation for OH WTE Dioxin Test Case

Parameter Name	Units	Value Used	Reference
Link: Surface water in Olentangy River to surface water in Scioto River			
Bulk water flow [Link property]	m^3[water]/-day	1.34E+06	USGS 2003b[a]
Distance between midpoints [Link property]	m	10725	Site-specific value; calculated using GIS.
Diffusive exchange coefficient [Link property]	m^2/day	2.25E-04	Ambrose et al. 1995
Link: Surface water in Combined Creek to surface water in Scioto River			
Bulk water flow [Link property]	m^3[water]/-day	1.22E+06	USGS 2003d[a]
Distance between midpoints [Link property]	m	25524	Site-specific value; calculated using GIS.
Diffusive exchange coefficient [Link property]	m^2/day	2.25E-04	Ambrose et al. 1995
Links: Groundwater to Surface Water			
Recharge Rate [Link property]	m^3[water]/m^2[area]-day	-	Value not required because there is no horizontal or vertical overlap between surface water and groundwater.

[a]See following section, "Surface Water Calculations," for a detailed description of caluclations.

Chemical-Independent/Abiotic -- Documentation for OH WTE Dioxin Test Case
(same values used for all sediment compartments)

Sediment Compartment Type

Parameter Name	Units	Value Used	Reference
Depth [VE property] [a]	m	0.05	McKone et al. 2001 (Table 3)
Organic carbon fraction	unitless	0.02	McKone et al. 2001 (Table 3)
Porosity of the sediment zone	volume[total pore space]/volume[sediment compartment]	0.6	U.S. EPA 1998
Solid material density in sediment	kg[sediment]/m^3[sediment]	2,650	U.S. EPA 1998

[a]Set using the volume element properties named "top" and "bottom."

Surface Water Calculations

Three surface water bodies were modeled in the Ohio TRIM.FaTE application: the Scioto River, the Olentangy River, and a combined water body representing Alum Creek and Big Walnut Creek (denoted as Combined Water Body). The following outlines the calculations and assumptions used to develop the surface water properties for these three water bodies.

Surface Water Flow Calculations

Properties related to surface water flow algorithms in TRIM.FaTE are:

- river current velocities;
- bulk flow rates between water bodies;
- runoff rates for the amount of precipitation that enters surface water bodies; and
- flushing rates to sinks.

The general method applied to define these properties and calculate consistent flow rates for the Ohio site involved finding measured and regional average flow data for rivers and streams near the site, gathering watershed areas and other site data, and identifying methods to maintain a water balance in the system. Specific data used were surface water flow rates from nearby USGS gages (USGS 2003a,b,c,d), watershed areas from the USGS and GIS data, surface water body properties from GIS analysis, and stream dimension data from a nation-wide study of streams and rivers (Keup 1985). The Keup data were used to help define stream physical properties (e.g., depth) in the absence of (or in conjunction with) site-specific data, and are described below in the discussion of depth. Details of the calculations are shown below, and all property values used for the Ohio TRIM.FaTE scenario are documented in the input tables included as Appendix A to this report.

Current Velocities. The average annual stream flow rate was divided by the reported watershed area draining to the gage site to obtain a stream flow per unit watershed area. The mean annual stream flow rate was calculated from USGS data; the watershed area is a product of average width, calculated from GIS, and depth, calculated as described in the following section on surface water properties.

- Scioto: 0.53 m^3/m^2-s, where flow rate = 1387.3 cfs = 39.2 m^3/s, based on the average of the flows at the two stations in or near the modeling region (817 cfs and 1432 cfs) and the estimated flow leaving the modeling region (2100 cfs). Average width = 110 m, and depth = 0.67 m. Current Velocity: 39.2 $m^3/s \div 73.7$ m2 = 0.53 m^3/m^2-s.

- Olentangy: 0.83 m^3/m^2-s, where flow rate = 500 cfs = 14.1 m^3/s, based on the average of the station just north of the modeling region (450 cfs) and the estimated flow at the intersection with the Scioto (550 cfs). Average width = 50 m, and depth = 0.33 m. Current Velocity: 14.1 $m^3/s \div 17\ m^2 = 0.83\ m^3/m^2$-s.

- Combined Water Body: 0.36 m^3/m^2-s, where flow rate = 300 cfs = 8.5 m^3/s, based on the average of the stations along Alum Creek (104 cfs and 196 cfs) and Big Walnut Creek (217 cfs and 481 cfs) and the estimated flow at the intersection with the Scioto (500 cfs). Average width = 75 m, and depth = 0.31 m. Current Velocity: 8.5 $m^3/s \div 23.3\ m^2 = 0.36\ m^3/m^2$-s.

Bulk Flow Rates. The bulk flow rates between water bodies were determined using flow data at appropriate USGS gaging stations located near the junction of the water bodies.

- Olentangy River to Scioto River: 550 cfs = 1.34E+06 m^3/day, based on 450 cfs estimate at upstream station (Olentangy R NR Worthington OH) and assuming a 100 cfs increase in flow from station to junction with the Scioto River; 100 cfs increase was estimated using the increase in flow in the Scioto River when it merged with the Olentangy River.

- Combined Water Body to Scioto River: 500 cfs = 1.22E+06 m^3/day, based on estimates ranging from 468 to 496 cfs at station (Big Walnut C at Rees OH) just upstream from junction with the Scioto River and assuming a small increase in flow from the station to the junction.

Runoff Rates. The overall erosion rate for the Ohio site was estimated using a regional erosion rate (van der Leeden et al. 1990) and assuming that the rate was approximately uniform throughout the modeled site. Runoff and erosion fractions between parcels were estimated using the basic methods described in the TRIM.FaTE User's Guide (U.S. EPA 2003b). Watershed data and USGS 1:24,000 scale topographic maps were used for the site. A transparent overlay with parcel boundaries was created to place over the topographic map. Erosion and runoff fractions were determined using this parcel layout and identifying watershed boundaries and flow paths on the map.

Flushing Rates. Flush rates for water bodies that flow out of the modeled area were calculated by dividing the flow rate leaving the water body by the water body's volume. Flow rates were calculated using USGS data, and water body volumes are a product of area (based on GIS data) and depth (see following section on surface water properties).

- Scioto River: 564.1 flushes/yr, calculated by dividing the annual mean flow rate leaving the modeling region (1.88E+09 m^3/yr) by the volume of the water body (3.32E+06 m^2). The flow rate was estimated based on sum of the flows from an upstream station on the Scioto River of 1,432 cfs, from a downstream station representing the flow from the Combined Creek of 500 cfs, and an approximated flow of 170 cfs due to the runoff from the remaining portion of the river (i.e., downstream from where the Combined Creek merges into the Scioto River to the edge of the modeling region). The volume was calculated by multiplying the area of the water body (4.96E+06 m^2) by the depth (0.67 m).

Surface Water Properties

Where possible, site-specific or regional values were used for water body parameters, such as algae properties, chloride and chlorophyll concentrations, depth, suspended sediment properties, pH, and water temperature. Site-specific properties for the Scioto and Olentangy Rivers were available from USGS monitoring stations in the river (USGS 2003a,b,c,d). Specific site data for the Ohio site were also available from the EPA's STORET database (U.S. EPA 2003a) and from Alum and Big Walnut Creeks (USGS 2003c,d). The time period of the data collection (number of years, period) were checked to verify representation of annual conditions. Data from the specific water body were used, if available. If data were not available, the next closest site was used, minding distance and location (e.g., north) from downtown Columbus. More general "default" values obtained from the literature were defined for the remaining required parameters where site-specific or regional measurements were not found. Details of assumptions for all calculated properties in the various water bodies are included below. See Appendix A for specific values and data sources for all surface water properties.

Chloride Concentration.

• Scioto River: 42.1 mg/L, based on the average of 31 measurements from 1965-1996 at USGS station on Scioto River at Columbus, OH (near center of volume element).

• Olentangy River: 48.2 mg/L, based on the average of 39 measurements from 1964-1977 at USGS station on Olentangy River near Worthington, OH (near northern tip of volume element).

• Combined Water Body: 39.0 mg/L, based on the average of values from USGS station on Alum Creek (near center of volume element) and values from Big Walnut Creek (just north of volume element).

Chlorophyll Concentration.

• Scioto and Olentangy Rivers: 1.48E-02 mg/L, based on the average of 20 Chl-A and 17 Chl-B measurements from 1988-1995 at USGS station on Olentangy River near I270 Bridge station.

• Combined Water Body: 1.83E-02 mg/L, based on the average of 19 Chl-A and 19 Chl-B measurements at Alum Creek-Columbus USGS station.

Depth. The mean depth of each of the surface water bodies was approximated using stream orders that were estimated based on watershed maps and USGS mean annual discharge data in cfs, using the information in Table 1 of Keup (1985).

• Scioto River: Based on mapping, the Scioto River appears to be either a 4th or 5th order stream. The annual average discharge of the Scioto River ranges from 815 cfs to 1,431 cfs, which falls between the calculated discharges in Table 1 of 5th (380 cfs) and 6th (1,800 cfs) order streams. Based on this and the stream order of the Olentangy River (see below, because the order of the Olentangy River influences the order of the Scioto River since they merge), the Scioto River was assumed to be a 5th order stream. Mean depth = 2.20 ft.

• Olentangy River: Based on mapping, the Olentangy River appears to be either a 3rd or 4th order stream. The annual average discharge of the Olentangy River ranges from 158 cfs to 450 cfs, which falls between the calculated discharges in Table 1 of 4th (73 cfs) and 5th (380 cfs) order streams. Therefore, the Olentangy River was assumed to be a 4th order stream. Mean depth = 1.10 ft.

• Alum Creek: Based on mapping, Alum Creek appears to be a 3rd order stream. The annual average discharge of Alum Creek ranges from 110 cfs to 177 cfs. These values fall between the calculated discharges in Table 1 of 4th (73 cfs) and 5th (380 cfs) order streams, but are closer to the values for 4th order streams. The calculated discharge of 3rd order streams (according to Table 1) is 15.6 cfs. Because the measured discharge is higher and the mapping process includes uncertainties, an average of the mean depth values for 3rd (0.58 feet) and 4th (1.10 feet) order streams was used. Mean depth = (0.58 + 1.10)/2 = 0.84 ft.

• Big Walnut Creek: Based on mapping, Big Walnut Creek appears to be a 3rd order stream. The annual average discharge of Big Walnut Creek ranges from 114 cfs to 478 cfs, which is substantially higher than the calculated discharge for 3rd order streams in Table 1 (15.6 cfs) . These discharge values fall between the calculated discharges in Table 1 of 4th (73 cfs) and 6th (1,800 cfs) order streams. Because it is fairly clear from the map that Big Walnut Creek is not a 5th or 6th order stream, but because the discharge data indicate that Big Walnut Creek is larger than a 3rd order stream, Big Walnut Creek was assumed to be a 4th order stream. Mean depth = 1.10 feet.

• Combined Water Body: Big Walnut Creek mean depth was weighted twice as much as Alum Creek mean depth because its flow contributed approximately twice as much to the overall flow for the combined water body. Mean depth = (0.84 + 2*1.10)/3= 1.013 feet.

pH.

• Scioto River: 7.72, based on the average of 34 measurements from 1965-1996 at USGS station on Scioto River at Columbus, OH.

• Olentangy River: 7.87, based on the average of 40 measurements from 1964-1989 at USGS station on Olentangy River near Worthington, OH.

• Combined Water Body: 7.88, based on the average of values from USGS station on Alum Creek and values from Big Walnut Creek.

Total Suspended Sediment Concentration. Based on data available from around Columbus, OH, suspended sediment concentrations are very site-specific and variable, due to impact from several environmental variables (e.g., sediment type, flow volume, flow velocity, runoff volume, land-use around the area). When available, site-specific data were therefore used over regional data.

• Scioto River and Combined Water Body: 2.63E-01 kg[sediment]/m3[water column], based on the average of 49 measurements from 1969-1973 at USGS station on Alum Creek at Africa, OH. Data were not available for either the Scioto River or Big Walnut Creek. The station at Africa, OH was chosen because it is upstream of Columbus and probably would be less impacted by urban activities.

• Olentangy River: 4.50E-02 kg[sediment]/m^3[water column], based on the average of 4 measurements from 1966 at USGS station on Olentangy River near Worthington, OH.

Water Temperatures.

• Scioto River: 16.2 degrees C, based on average temp from 51 measurements from 1965-1996 at USGS station on Scioto River at Columbus, OH.

• Olentangy River: 16.8 degrees C, based on average temp from 48 measurements from 1965-1989 at USGS station on Olentangy River near Worthington, OH.

• Combined Waterbody: 13.9 degrees C, based on average of 54 measurements taken over 28 years at monitoring station on Big Walnut Creek and 33 measurements taken over 12 years at monitoring station on Alum Creek. Big Walnut Creek average temperature was weighted twice as much as Alum Creek average temperature because its flow contributed approximately twice as much to the overall flow for the combined water body.

Terrestrial Vegetation Types -- Documentation for OH WTE Dioxin Test Case[a]

Terrestrial Vegetation

Surface Soil Volume Element	Deciduous Forest	Grasses/Herbs	Agricultural	None
Source				X
NNW1		X		
WNW1		X		
WSW2		X		
SW1		X		
E1		X		
WNW2		X		
WSW3		X		
SW2		X		
SE2		X		
ESE2			X	
SE3		X		
ESE3		X		
NE2	X			
NNE2		X		
NNW2		X		
NW2		X		
NWFarm			X	
NNW3		X		
NW3		X		

[a] Assignments made based on review of land use maps.

Terrestrial Vegetation Compartment Types

		Deciduous[a]		Grass/Herb[a]		Agricultural[a]	
Parameter Name	**Units**	**Value Used**	**Reference**	**Value Used**	**Reference**	**Value Used**	**Reference**
Leaf Compartment Type							
Allow exchange	1=yes, 0=no	seasonal[b]	See note b	seasonal[b]	See note b	seasonal[b]	See note b
Average leaf area index	m^2[total leaf area]/m^2[underlying soil area]	3.4	Harvard Forest, dom. red oak and red maple, CDIAC website	5	Mid-range of 4-6 for old fields, R.J. Luxmoore, ORNL	2	GLEAMS 1993, average for crops
Calculate wet dep interception fraction	1=yes, 0=no	0	Professional judgment	0	Professional judgment	0	Professional judgment
Correction exponent, octanol to lipid	unitless	0.76	Trapp 1995, from roots	0.76	Trapp 1995, from roots	0.76	Trapp 1995, from roots
Degree stomatal opening	unitless	1	Set to 1 for daytime based on professional judgment (stomatal diffusion is turned off at night using a different property, IsDay)	1	Set to 1 for daytime based on professional judgment (stomatal diffusion is turned off at night using a different property, IsDay)	1	Set to 1 for daytime based on professional judgment (stomatal diffusion is turned off at night using a different property, IsDay)
Density of wet leaf	kg[leaf wet wt]/m^3[leaf]	820	Paterson et al. 1991	820	Paterson et al. 1991	820	Paterson et al. 1991
Leaf wetting factor	m	3.00E-04	Muller and Prohl 1993, 1E-04 to 6E-04 for different crops and elements	3.00E-04	Muller and Prohl 1993, 1E-04 to 6E-04 for different crops and elements	3.00E-04	Muller and Prohl 1993, 1E-04 to 6E-04 for different crops and elements
Length of leaf	m	0.1	Professional judgment	0.05	Professional judgment	0.05	Professional judgment
Lipid content	kg[lipid]/kg[leaf wet wt]	0.00224	Riederer 1995, European beech	0.00224	Riederer 1995, European beech	0.00224	Riederer 1995, European beech
Litter fall rate	1/day	seasonal[c]	See note c	seasonal[c]	See note c	seasonal[c]	See note c
Stomatal area, normalized for effective diffusion path length	1/m	200	Wilmer and Fricker 1996	200	Wilmer and Fricker 1996	200	Wilmer and Fricker 1996
Vegetation attenuation factor	m^2/kg	2.9	Baes et al. 1984, grass/hay	2.9	Baes et al. 1984, grass/hay	2.9	Baes et al. 1984, grass/hay
Water content	unitless (kg[water]/kg[leaf wet wt])	0.8	Paterson et al. 1991	0.8	Paterson et al. 1991	0.8	Paterson et al. 1991
Wet dep interception fraction	unitless	0.2	Calculated based on 5 years of met data from the Maine test case, 1987-1991	0.2	Calculated based on 5 years of met data from the Maine test case, 1987-1991	0.2	Calculated based on 5 years of met data from the Maine test case, 1987-1991
Wet mass of leaf per unit area	kg[fresh leaf]/m^2[area]	0.6	Calculated from leaf area index, leaf thickness (Simonich & Hites, 1994), density of wet foliage	0.6	Calculated from leaf area index and Leith 1975	0.4	Calculated from leaf area index and Leith 1975
Particle on Leaf Compartment Type							
Allow exchange	1=yes, 0=no	seasonal[b]	Professional judgment	seasonal[b]	Professional judgment	seasonal[b]	Professional judgment

Terrestrial Vegetation Compartment Types

Parameter Name	Units	Deciduous[a] Value Used	Deciduous[a] Reference	Grass/Herb[a] Value Used	Grass/Herb[a] Reference	Agricultural[a] Value Used	Agricultural[a] Reference
Volume particle per area leaf	m^3[leaf particles]/m^2[leaf]	1.00E-09	Coe and Lindberg. 1987, based on particle density and size distribution for atmospheric particles measured on an adhesive surface	1.00E-09	Coe and Lindberg. 1987, based on particle density and size distribution for atmospheric particles measured on an adhesive surface	1.00E-09	Coe and Lindberg. 1987, based on particle density and size distribution for atmospheric particles measured on an adhesive surface
Root Compartment Type - Nonwoody Vegetation Only[d]							
Allow exchange	1=yes, 0=no			seasonal[b]	Professional judgment	seasonal[b]	Professional judgment
Correction exponent, octanol to lipid	unitless			0.76	Trapp 1995	0.76	Trapp 1995
Lipid content of root	kg[lipid]/kg [root wet wt]			0.011	Calculated	0.011	Calculated
Water content of root	kg[water]/kg[root wet wt])			0.8	Professional judgment	0.8	Professional judgment
Wet density of root	kg[leaf wet wt]/m^3[root]			820	soybean, Paterson et al. 1991	820	soybean, Paterson et al. 1991
Wet mass per area	kg[root wet wt]/m^2[soil]			1.4	temperate grassland, Jackson et al. 1996	0.15	crops, Jackson et al. 1996
Stem Compartment Type - Nonwoody Vegetation Only[d]							
Allow exchange	1=yes, 0=no			seasonal[b]	Professional judgment	seasonal[b]	Professional judgment
Correction exponent, octanol to lipid	unitless			0.76	from roots, Trapp 1995	0.76	Trapp 1995
Density of phloem fluid	kg[phloem]/m^3[phloem]			1,000	Professional judgment	1,000	Professional judgment
Density of xylem fluid	kg[xylem]/m^3[xylem]			900	Professional judgment	900	Professional judgment
Flow rate of transpired water per leaf area	m^3[water]/m^2 [leaf]-day			0.0048	Crank et al. 1981	0.0048	Crank et al. 1981
Fraction of transpiration flow rate that is phloem rate	unitless			0.05	Paterson et al. 1991	0.05	Paterson et al. 1991
Lipid content of stem	kg[lipid]/kg [stem wet wt]			0.00224	Riederer 1995, leaves of European beech	0.00224	Riederer 1995, leaves of European beech
Water content of stem	kg[water]/kg[stem wet wt]			0.8	Paterson et al. 1991	0.8	Paterson et al. 1991
Wet density of stem	kg[stem wet wt]/m^3[root]			830	Professional judgment	830	Professional judgment
Wet mass per area	kg[stem wet wt]/m^2[soil]			0.24	Calculated from leaf and root biomass density, based on professional judgment	0.16	Calculated from leaf and root biomass density, based on professional judgment

[a]See attached table for assignment of vegetation types to surface soil volume elements.

[b]Begins April 15 (set to 1), ends November 5 (set to 0). Set to average days of last and first frost, based on meteorological data for Ohio site.

[c]Begins November 5, ends December 4; rate = 0.15/day during this time (value assumes first-order relationship and that 99 percent of leaves fall in 30 days).
Rate is zero at all other times.

[d]Roots and stems are not modeled for deciduous forests in the current version of TRIM.FaTE.

	Diffusion coefficient in pure air		Diffusion coefficient in pure water		Henry's Law Constant	
Chemical	Value (m^2/d)	Reference	Value (m^2/d)	Reference	Value (Pa-m^3/mol)	Reference
2,3,7,8-TCDD	1.06E-01	U.S. EPA 1999	5.68E-05	U.S. EPA 1999	3.33	Mackay et al. 1992 as cited in U.S. EPA 2000a
1,2,3,7,8-PeCDD	1.01E-01	U.S. EPA 1999	3.65E-05	U.S. EPA 1999	3.33	Mackay et al. 1992 as cited in U.S. EPA 2000a; value is for 2,3,7,8-TCDD
1,2,3,4,7,8-HxCDD	9.58E-02	U.S. EPA 1999	3.43E-05	U.S. EPA 1999	1.08	Mackay et al. 1992 as cited in U.S.EPA 2000
1,2,3,6,7,8-HxCDD	9.58E-02	U.S. EPA 1999	3.43E-05	U.S. EPA 1999	1.08	Mackay et al. 1992 as cited in U.S. EPA 2000a; value is for 1,2,3,4,7,8-HxCDD
1,2,3,7,8,9-HxCDD	9.58E-02	U.S. EPA 1999	3.43E-05	U.S. EPA 1999	1.08	Mackay et al. 1992 as cited in U.S. EPA 2000a; value is for 1,2,3,4,7,8-HxCDD
1,2,3,4,6,7,8-HpCDD	9.25E-02	U.S. EPA 1999	3.24E-05	U.S. EPA 1999	1.28	Mackay et al. 1992 as cited in U.S. EPA 2000a
1,2,3,4,6,7,8,9-OCDD	8.83E-02	U.S. EPA 1999	3.08E-06	U.S. EPA 1999	0.68	Mackay et al. 1992 as cited in U.S. EPA 2000a
2,3,7,8-TCDF	1.49E-01	U.S. EPA 1999	4.04E-05	U.S. EPA 1999	1.46	Mackay et al. 1992 as cited in U.S. EPA 2000a
1,2,3,7,8-PeCDF	1.42E-01	U.S. EPA 1999	3.76E-05	U.S. EPA 1999	0.50	Mackay et al. 1992 as cited in U.S. EPA 2000a; value is for 2,3,4,7,8-PeCDF
2,3,4,7,8-PeCDF	1.42E-01	U.S. EPA 1999	3.76E-05	U.S. EPA 1999	0.50	Mackay et al. 1992 as cited in U.S. EPA 2000a
1,2,3,4,7,8-HxCDF	1.35E-01	U.S. EPA 1999	3.53E-05	U.S. EPA 1999	1.45	Calculated by the VP/WS ratio technique as cited in U.S. EPA 2000a
1,2,3,6,7,8-HxCDF	1.35E-01	U.S. EPA 1999	3.53E-05	U.S. EPA 1999	0.74	Mackay et al. 1992 as cited in U.S. EPA 2000a
1,2,3,7,8,9-HxCDF	1.35E-01	U.S. EPA 1999	3.53E-05	U.S. EPA 1999	0.74	Mackay et al. 1992 as cited in U.S. EPA 2000a; value is for 1,2,3,6,7,8-HxCDF
2,3,4,6,7,8-HxCDF	1.35E-01	U.S. EPA 1999	3.53E-05	U.S. EPA 1999	0.74	Mackay et al. 1992 as cited in U.S. EPA 2000a; value is for 1,2,3,6,7,8-HxCDF
1,2,3,4,6,7,8-HpCDF	1.29E-01	U.S. EPA 1999	3.33E-05	U.S. EPA 1999	1.43	Mackay et al. 1992 as cited in U.S. EPA 2000a
1,2,3,4,7,8,9-HpCDF	1.29E-01	U.S. EPA 1999	3.33E-05	U.S. EPA 1999	1.43	Mackay et al. 1992 as cited in U.S. EPA 2000a; value is for 1,2,3,4,6,7,8-HpCDF
1,2,3,4,6,7,8,9-OCDF	1.23E-01	U.S. EPA 1999	3.15E-05	U.S. EPA 1999	0.19	Calculated by the VP/WS ratio technique as cited in U.S. EPA 2000a

	Octanol-water partition coefficient (K[ow])		Melting Point		Molecular Weight	
Chemical	Value (unitless)	Reference	Value (Kelvin)	Reference	Value (g/mol)	Reference
2,3,7,8-TCDD	6.31E+06	Mackay et al. 1992 as cited in U.S. EPA 2000a	578	Mackay et al. 2000, U.S. EPA 2000b	322	Mackay et al. 2000, NLM 2002
1,2,3,7,8-PeCDD	4.37E+06	Sijm et al. 1989 as cited in U.S. EPA 2000a	513	U.S. EPA 2000b	356.4	ATSDR 1998
1,2,3,4,7,8-HxCDD	6.31E+07	Mackay et al. 1992 as cited in U.S. EPA 2000a	546	Mackay et al. 2000, U.S. EPA 2000b	391	Mackay et al. 2000
1,2,3,6,7,8-HxCDD	1.62E+08	U.S. EPA 2000b; calculated	558	U.S. EPA 2000b	390.84	NLM 2002
1,2,3,7,8,9-HxCDD	1.62E+08	U.S. EPA 2000b; calculated	517	NLM 2002	390.84	NLM 2002
1,2,3,4,6,7,8-HpCDD	1.00E+08	Mackay et al. 1992 as cited in U.S. EPA 2000a	538	Mackay et al. 2000, ATSDR 1998	425.2	Mackay et al. 2000
1,2,3,4,6,7,8,9-OCDD	1.58E+08	Mackay et al. 1992 as cited in U.S. EPA 2000a	603	Mackay et al. 2000, NLM 2002, U.S. EPA 2000b	460	Mackay et al. 2000
2,3,7,8-TCDF	1.26E+06	Mackay et al. 1992 as cited in U.S. EPA 2000a	500	Mackay et al. 2000	306	Mackay et al. 2000
1,2,3,7,8-PeCDF	6.17E+06	Sijm et al. 1989 as cited in U.S. EPA 2000a	499	ATSDR 1998	340.42	ATSDR 1998, Atkinson 1996 as cited in U.S. EPA 2000a, U.S. EPA 2000b
2,3,4,7,8-PeCDF	3.16E+06	Mackay et al. 1992 as cited in U.S. EPA 2000a	469.25	Mackay et al. 2000	340.42	Mackay et al. 2000, ATSDR 1998, Atkinson 1996 as cited in U.S. EPA 2000a, U.S. EPA 2000b
1,2,3,4,7,8-HxCDF	1.00E+07	Mackay et al. 1992 as cited in U.S. EPA 2000a	499	Mackay et al. 2000	374.87	Mackay et al. 2000, ATSDR 1998, Atkinson 1996 as cited in U.S. EPA 2000a, U.S. EPA 2000b
1,2,3,6,7,8-HxCDF	8.24E+07	U.S. EPA 2000b; calculated	506	ATSDR 1998	374.87	ATSDR 1998, Atkinson 1996 as cited in U.S. EPA 2000a, U.S. EPA 2000b
1,2,3,7,8,9-HxCDF	3.80E+07	U.S. EPA 2000b; calculated	508.95	U.S. EPA 2000b	374.87	ATSDR 1998, Atkinson 1996 as cited in U.S. EPA 2000a, U.S. EPA 2000b
2,3,4,6,7,8-HxCDF	8.31E+07	U.S. EPA 2000b; calculated	512.5	ATSDR 1998	374.87	ATSDR 1998, Atkinson 1996 as cited in U.S. EPA 2000a, U.S. EPA 2000b
1,2,3,4,6,7,8-HpCDF	2.51E+07	Mackay et al. 1992 as cited in U.S. EPA 2000a	236.5	Mackay et al. 2000	409.31	Mackay et al. 2000, ATSDR 1998, Atkinson 1996 as cited in U.S. EPA 2000a, U.S. EPA 2000b
1,2,3,4,7,8,9-HpCDF	7.94E+06	Mackay et al. 2000; calculated	222	Mackay et al. 2000	409.31	Mackay et al. 2000, ATSDR 1998, Atkinson 1996 as cited in U.S. EPA 2000a, U.S. EPA 2000b
1,2,3,4,6,7,8,9-OCDF	1.00E+08	Mackay et al. 1992 as cited in U.S. EPA 2000a	259	Mackay et al. 2000	443.76	Mackay et al. 2000, ATSDR 1998, U.S. EPA 2000b

Chemical-Dependent/Abiotic -- Documentation for the OH WTE Dioxin Test Case
(same values used for all abiotic compartments of a given type, except where noted)

Property Type	Units	Value							Reference
		2,3,7,8-TCDD	1,2,3,7,8-PeCDD	1,2,3,4,7,8-HxCDD	1,2,3,6,7,8-HxCDD	1,2,3,7,8,9-HxCDD	1,2,3,4,6,7,8-HpCDD	1,2,3,4,6,7,8,9-OCDD	
Air Compartment									
Halflife[a]	day	12	18	42	28	28	64	162	Atkinson 1996 as cited in U.S. EPA 2000s; vapor phase reaction with hydroxyl radical
Groundwater									
Halflife	day	1008	1008	1008	1008	1008	1008	1008	Average value of the range presented in Mackay et al. 2000; based on estimated unacclimated aerobic biodegradation half-life, value is for 2,3,7,8-TCDD
Sediment									
Halflife[a]	day	1095	1095	1095	1095	1095	1095	1095	Estimation based on Adriaens and Grbic-Galic 1992,1993 and Adriaens et al. 1995 as cited in U.S. EPA 2000a
Soil - Root Zone									
Halflife[a]	day	3650	3650	3650	3650	3650	3650	3650	Mackay et al. 2000; the degradation rate was cited by multiple authors, value is for 2,3,7,8-TCDD
Soil - Surface									
Halflife[a]	day	3650	3650	3650	3650	3650	3650	3650	Mackay et al. 2000; the degradation rate was cited by multiple authors, value is for 2,3,7,8-TCDD
Soil - Vadose Zone									
Halflife[a]	day	1008	1008	1008	1008	1008	1008	1008	Average value of the range presented in Mackay et al. 2000; based on estimated unacclimated aerobic biodegradation half-life, value is for 2,3,7,8-TCDD
Surface water									
Halflife[a]	day	2.7	2.7	6.3	6.3	6.3	47	0.67	2,3,7,8-TCDD and 1,2,3,7,8-PeCDD: Podoll et al. 1986 as cited in U.S. EPA 2000a; sunlight, water: acetonitrile (1:1 v/v), value is for 2,3,7,8-TCDD; All HxCDD's: Choudry and Webster 1989 as cited in U.S. EPA 2000a; Hg lamp, water:acetonitrile (2:3 v/v) (value for 1,2,3,4,7,8-HxCDD); 1,2,3,4,6,7,8-HpCDD: Choudry and Webster 1989 as cited in U.S. EPA 2000a; Hg lamp, water:acetonitrile; 1,2,3,4,6,7,8,9-OCDD: Kim and O'Keefe 1998 as cited in U.S. EPA 2000; sunlight, water from 7 ponds/lakes.

[a]See "Discussion of Half-life value selection in TRIM.FaTE vs. Lorber et al. (2000)" following this table.

Chemical-Dependent/Abiotic -- Documentation for the OH WTE Dioxin Test Case
(same values used for all abiotic compartments of a given type, except where noted)

Property Type	Units	Value										Reference
		2,3,7,8-TCDF	1,2,3,7,8-PeCDF	2,3,4,7,8-PeCDF	1,2,3,4,7,8-HxCDF	1,2,3,6,7,8-HxCDF	1,2,3,7,8,9-HxCDF	2,3,4,6,7,8-HxCDF	1,2,3,4,6,7,8 HpCDF	1,2,3,4,7,8,9 HpCDF	1,2,3,4,6,7,8,9- OCDF	
Air Compartment												
Halflife[a]	day	19	31	33	78	55	51	59	137	122	321	Atkinson 1996 as cited in U.S. EPA 2000a; vapor phase reaction with hydroxyl radical
Groundwater												
Halflife[a]	day	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	Average value of the range presented in Mackay et al. 2000; based on estimated unacclimated aerobic biodegradation half-life, value is for 2,3,7,8-TCDD
Sediment												
Halflife[a]	day	1095	1095	1095	1095	1095	1095	1095	1095	1095	1095	Estimation based on Adriaens and Grbic-Galic 1992,1993 and Adriaens et al. 1995 as cited in U.S. EPA 2000a
Soil - Root Zone												
Halflife[a]	day	3650	3650	3650	3650	3650	3650	3650	3650	3650	3650	Mackay et al. 2000; the degradation rate was cited by multiple authors, value is for 2,3,7,8-TCDD
Soil - Surface												
Halflife[a]	day	3650	3650	3650	3650	3650	3650	3650	3650	3650	3650	Mackay et al. 2000; the degradation rate was cited by multiple authors, value is for 2,3,7,8-TCDD
Soil - Vadose Zone												
Halflife[a]	day	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	Average value of the range presented in Mackay et al. 2000; based on estimated unacclimated aerobic biodegradation half-life, value is for 2,3,7,8-TCDD
Surface water												
Halflife[a]	day	0.18	0.19	0.19	0.58	0.58	0.58	0.58	0.58	0.58	0.58	2,3,7,8-TCDF: Kim and O'Keefe 1998 as cited in U.S. EPA 2000a; sunlight, water from 7 ponds/lakes; 1,2,3,7,8-PeCDF and 2,3,4,7,8-PeCDF: Friesen et al. 1993 as cited in U.S. EPA 2000a; sunlight, lake water (value for 2,3,4,7,8-PeCDF); All other furans: Kim and O'Keefe 1998 as cited in U.S. EPA 2000a; sunlight, water from 7 ponds/lakes (value is for OCDF).

[a]See "Discussion of Half-life value selection in TRIM.FaTE vs. Lorber et al. (2000)" following this table.

Discussion of Half-life value selection in TRIM.FaTE vs. Lorber et al. (2000)

The model results presented in the Lorber et al. (2000) report were calculated using a dioxin dissipation rate, which corresponds to a half-life of 25 years (the same value was used for all congeners). This rate included dioxin removal from the soil by both chemical degradation and physical processes (e.g., runoff and erosion). According to Lorber et al. (2000), 25 years was selected as a mid-range value between a half-life of ten years, which is often used for surface dioxin residues, and 100 years, which is speculated to be an upper range for subsurface dioxin residues. Also, a study was cited that reported a measured half-life of 20 years for physical and chemical removal processes of dioxins from soil.

TRIM.FaTE models chemical degradation and physical removal separately. The chemical degradation rate used by TRIM.FaTE for all congeners corresponds to a half-life of ten years. The ten-year degradation half-life for TRIM.FaTE was selected based on multiple studies cited in Mackay et al. (2000), most of which ranged from one to 12 years for soil or surface soil, although one study reported that half-lives could be as high as 100 years for subsurface soil. It is not always clear whether half-lives reported are degradation or dissipation half-lives. Because most of the dioxin mass remains in the surface soil (with a depth of 1 cm), ten years was selected as a half-life. Although ten years is near the top of the range given by Mackay et al. (excluding the subsurface soil value), the half-life when physical removal processes are taken into account is closer to the middle of the range.

The physical removal processes in TRIM.FaTE are not modeled with a single rate constant, but are modeled with multiple algorithms and parameters based on chemical properties and region-specific runoff and erosion parameters. To gauge the magnitude of the impact of these processes on the TRIM.FaTE effective dissipation half-life (i.e., chemical degradation plus physical removal processes), the dissipation half-life was calculated empirically from the decrease in soil concentration when there is no input from the source. The TRIM.FaTE effective dissipation half-life is different for each chemical because of different chemical properties, so half-lives for two representative chemicals, 2,3,7,8-TCDD and 1,2,3,4,6,7,8,9-OCDD, were calculated. The 2,3,7,8-TCDD dissipation half-life in the TRIM.FaTE surface soil is on average 6.5 years, and the 1,2,3,4,6,7,8,9-OCDD dissipation half-life is on average 9 years. The difference between the chemicals is due primarily to the higher volatilization rate of 2,3,7,8-TCDD. Therefore, due to the range of half-lives available in the literature, different assumptions for taking into account subsurface dissipation rates, and different methods used to account for physical removal processes, the dioxin dissipation half-life used by Lorber et al. is approximately three times longer than the effective dissipation half-life used in TRIM.FaTE.

Chemical-Dependent/Biotic -- Documentation for the OH WTE Dioxin Test Case
(same values used for all biotic compartments of a given type, except where noted)

Compartment	Property	Units	Value							Reference
			2,3,7,8-TCDD	1,2,3,7,8-PeCDD	1,2,3,4,7,8-HxCDD	1,2,3,6,7,8-HxCDD	1,2,3,7,8,9-HxCDD	1,2,3,4,6,7,8-HpCDD	1,2,3,4,6,7,8,9-OCDD	
Terrestrial Vegetation										
Leaf - Agriculture - General in Agriculture - General	Halflife	day	70	70	70	70	70	70	70	Arjmand and Sandermann 1985, as cited in Komoba, et al. 1995; soybean root cell culture metabolism test data for DDE.
Leaf - Agriculture - General in Agriculture - General	TransferFactortoLeaf Particle	1/day	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	Calculated as 1 percent of transfer factor to leaf; highly uncertain.
Leaf - Coniferous Forest in Coniferous Forest	Halflife	day	70	70	70	70	70	70	70	Arjmand and Sandermann 1985, as cited in Komoba, et al. 1995; soybean root cell culture metabolism test data for DDE.
Leaf - Coniferous Forest in Coniferous Forest	TransferFactortoLeaf Particle	1/day	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	Calculated as 1 percent of transfer factor to leaf; highly uncertain.
Leaf - Deciduous Forest in Deciduous Forest	Halflife	day	70	70	70	70	70	70	70	Arjmand and Sandermann 1985, as cited in Komoba, et al. 1995; soybean root cell culture metabolism test data for DDE.
Leaf - Deciduous Forest in Deciduous Forest	TransferFactortoLeaf Particle	1/day	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	Calculated as 1 percent of transfer factor to leaf; highly uncertain.
Leaf - Grasses/Herbs in Grasses/Herbs	Halflife	day	70	70	70	70	70	70	70	Arjmand and Sandermann 1985, as cited in Komoba, et al. 1995; soybean root cell culture metabolism test data for DDE.
Leaf - Grasses/Herbs in Grasses/Herbs	TransferFactortoLeaf Particle	1/day	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	Calculated as 1 percent of transfer factor to leaf; highly uncertain.
Particle on Leaf - Agriculture - General in Agriculture - General	Halflife	day	4.4	4.4	4.4	4.4	4.4	4.4	4.4	McCrady and Maggard 1993; photodegradation sorbed to grass foliage in sunlight; assumed 10 hours of sunlight per day.
Particle on Leaf - Agriculture - General in Agriculture - General	TransferFactortoLeaf	1/day	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	Professional judgment based on U.S. EPA 2000a (an estimate for mercury) and Trapp 1995; highly uncertain.
Particle on Leaf - Coniferous Forest in Coniferous Forest	Halflife	day	4.4	4.4	4.4	4.4	4.4	4.4	4.4	McCrady and Maggard 1993; photodegradation sorbed to grass foliage in sunlight; assumed 10 hours of sunlight per day.
Particle on Leaf - Coniferous Forest in Coniferous Forest	TransferFactortoLeaf	1/day	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	Professional judgment based on U.S. EPA 2000a (an estimate for mercury) and Trapp 1995; highly uncertain
Particle on Leaf - Deciduous Forest in Deciduous Forest	Halflife	day	4.4	4.4	4.4	4.4	4.4	4.4	4.4	McCrady and Maggard 1993; photodegradation sorbed to grass foliage in sunlight; assumed 10 hours of sunlight per day.
Particle on Leaf - Deciduous Forest in Deciduous Forest	TransferFactortoLeaf	1/day	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	Professional judgment based on U.S. EPA 2000a (an estimate for mercury) and Trapp 1995; highly uncertain.
Particle on Leaf - Grasses/Herbs in Grasses/Herbs	Halflife	day	4.4	4.4	4.4	4.4	4.4	4.4	4.4	McCrady and Maggard 1993; photodegradation sorbed to grass foliage in sunlight; assumed 10 hours of sunlight per day.
Particle on Leaf - Grasses/Herbs in Grasses/Herbs	TransferFactortoLeaf	1/day	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	Professional judgment based on U.S. EPA 2000a (an estimate for mercury) and Trapp 1995; highly uncertain.
Root - Agriculture - General in Agriculture - General	Halflife	day	70	70	70	70	70	70	70	Arjmand and Sandermann 1985, as cited in Komoba, et al. 1995; soybean root cell culture metabolism test data for DDE.
Root - Agriculture - General in Agriculture - General	RootSoilWater Interaction_Alpha	unitless	0.95	0.95	0.95	0.95	0.95	0.95	0.95	Professional judgment
Root - Grasses/Herbs in Grasses/Herbs	Halflife	day	70	70	70	70	70	70	70	Arjmand and Sandermann 1985, as cited in Komoba, et al. 1995; soybean root cell culture metabolism test data for DDE.
Root - Grasses/Herbs in Grasses/Herbs	RootSoilWater Interaction_Alpha	unitless	0.95	0.95	0.95	0.95	0.95	0.95	0.95	Professional judgment
Stem - Agriculture - General in Agriculture - General	Halflife	day	70	70	70	70	70	70	70	Arjmand and Sandermann 1985, as cited in Komoba, et al. 1995; soybean root cell culture metabolism test data for DDE.
Stem - Grasses/Herbs in Grasses/Herbs	Halflife	day	70	70	70	70	70	70	70	Arjmand and Sandermann 1985, as cited in Komoba, et al. 1995; soybean root cell culture metabolism test data for DDE.

Chemical-Dependent/Biotic -- Documentation for the OH WTE Dioxin Test Case
(same values used for all biotic compartments of a given type, except where noted)

Compartment	Property	Units	Value										Reference
			2,3,7,8-TCDF	1,2,3,7,8-PeCDF	2,3,4,7,8-PeCDF	1,2,3,4,7,8-HxCDF	1,2,3,6,7,8-HxCDF	1,2,3,7,8,9-HxCDF	2,3,4,6,7,8-HxCDF	1,2,3,4,6,7,8-HpCDF	1,2,3,4,7,8,9-HpCDF	1,2,3,4,6,7,8,9-OCDF	
Terrestrial Vegetation													
Leaf - Agriculture - General in Agriculture - General	Halflife	day	70	70	70	70	70	70	70	70	70	70	Arjmand and Sandermann 1985, as cited in Komoba, et al. 1995; soybean root cell culture metabolism test data for DDE.
Leaf - Agriculture - General in Agriculture - General	TransferFactortoLeaf Particle	1/day	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	Calculated as 1 percent of transfer factor to leaf; highly uncertain.
Leaf - Coniferous Forest in Coniferous Forest	Halflife	day	70	70	70	70	70	70	70	70	70	70	Arjmand and Sandermann 1985, as cited in Komoba, et al. 1995; soybean root cell culture metabolism test data for DDE.
Leaf - Coniferous Forest in Coniferous Forest	TransferFactortoLeaf Particle	1/day	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	Calculated as 1 percent of transfer factor to leaf; highly uncertain.
Leaf - Deciduous Forest in Deciduous Forest	Halflife	day	70	70	70	70	70	70	70	70	70	70	Arjmand and Sandermann 1985, as cited in Komoba, et al. 1995; soybean root cell culture metabolism test data for DDE.
Leaf - Deciduous Forest in Deciduous Forest	TransferFactortoLeaf Particle	1/day	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	Calculated as 1 percent of transfer factor to leaf; highly uncertain.
Leaf - Grasses/Herbs in Grasses/Herbs	Halflife	day	70	70	70	70	70	70	70	70	70	70	Arjmand and Sandermann 1985, as cited in Komoba, et al. 1995; soybean root cell culture metabolism test data for DDE.
Leaf - Grasses/Herbs in Grasses/Herbs	TransferFactortoLeaf Particle	1/day	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	Calculated as 1 percent of transfer factor to leaf; highly uncertain.
Leaf Particle - Agriculture - General in Agriculture - General	Halflife	day	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	McCrady and Maggard 1993; photodegradation of 2,3,7,8-TCDD sorbed to grass foliage in sunlight; assumed 10 hours of sunlight per day.
Leaf Particle - Agriculture - General in Agriculture - General	TransferFactortoLeaf	1/day	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	Professional judgment based on TCDD information in U.S. EPA 2000a (an estimate for mercury) and Trapp 1995; highly uncertain.
Leaf Particle - Coniferous Forest in Coniferous Forest	Halflife	day	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	McCrady and Maggard 1993; photodegradation of 2,3,7,8-TCDD sorbed to grass foliage in sunlight; assumed 10 hours of sunlight per day.
Leaf Particle - Coniferous Forest in Coniferous Forest	TransferFactortoLeaf	1/day	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	Professional judgment based on TCDD information in U.S. EPA 2000a (an estimate for mercury) and Trapp 1995; highly uncertain.
Leaf Particle - Deciduous Forest in Deciduous Forest	Halflife	day	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	McCrady and Maggard 1993; photodegradation of 2,3,7,8-TCDD sorbed to grass foliage in sunlight; assumed 10 hours of sunlight per day.
Leaf Particle - Deciduous Forest in Deciduous Forest	TransferFactortoLeaf	1/day	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	Professional judgment based on TCDD information in U.S. EPA 2000a (an estimate for mercury) and Trapp 1995; highly uncertain.
Leaf Particle - Grasses/Herbs in Grasses/Herbs	Halflife	day	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	McCrady and Maggard 1993; photodegradation of 2,3,7,8-TCDD sorbed to grass foliage in sunlight; assumed 10 hours of sunlight per day.
Leaf Particle - Grasses/Herbs in Grasses/Herbs	TransferFactortoLeaf	1/day	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	Professional judgment based on TCDD information in U.S. EPA 2000a (an estimate for mercury) and Trapp 1995; highly uncertain.
Root - Agriculture - General in Agriculture - General	Halflife	day	70	70	70	70	70	70	70	70	70	70	Arjmand and Sandermann 1985, as cited in Komoba, et al. 1995; soybean root cell culture metabolism test data for DDE.
Root - Agriculture - General in Agriculture - General	RootSoilWater Interaction_Alpha	unitless	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	Professional judgment
Root - Grasses/Herbs in Grasses/Herbs	Halflife	day	70	70	70	70	70	70	70	70	70	70	Arjmand and Sandermann 1985, as cited in Komoba, et al. 1995; soybean root cell culture metabolism test data for DDE.
Root - Grasses/Herbs in Grasses/Herbs	RootSoilWater Interaction_Alpha	unitless	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	Professional judgment
Stem - Agriculture - General in Agriculture - General	Halflife	day	70	70	70	70	70	70	70	70	70	70	Arjmand and Sandermann 1985, as cited in Komoba, et al. 1995; soybean root cell culture metabolism test data for DDE.

Chemical-Dependent/Biotic -- Documentation for the OH WTE Dioxin Test Case
(same values used for all biotic compartments of a given type, except where noted)

Compartment	Property	Units	2,3,7,8-TCDF	1,2,3,7,8-PeCDF	2,3,4,7,8-PeCDF	1,2,3,4,7,8-HxCDF	1,2,3,6,7,8-HxCDF	1,2,3,7,8,9-HxCDF	2,3,4,6,7,8-HxCDF	1,2,3,4,6,7,8-HpCDF	1,2,3,4,7,8,9-HpCDF	1,2,3,4,6,7,8,9-OCDF	Reference
Stem - Grasses/Herbs in Grasses/Herbs	Halflife	day	70	70	70	70	70	70	70	70	70	70	Arjmand and Sandermann 1985, as cited in Komoba, et al. 1995; soybean root cell culture metabolism test data for DDE.

Meteorological and Other Settings --Documentation for the OH WTE Dioxin Test Case

Parameter Name	Units	Value Used	Reference
Meteorological Inputs (all TRIM.FaTE scenario properties, except mixing height)[a]			
Air temperature	degrees K	varies hourly	From hourly local composite met data, 1989 and 1994
Horizontal wind speed	m/sec	varies hourly	From hourly local composite met data, 1989 and 1994
Wind direction	degrees clockwise from N (blowing from)	varies hourly	From hourly local composite met data, 1989 and 1994
Rainfall rate	m^3[rain]/m^2[surface area]-day	varies hourly	From hourly local composite met data, 1989 and 1994
Mixing height (used to set air VE property named "top")	m	varies hourly	From hourly local composite met data, 1989 and 1994 (used values for rural setting)
Day/night	1=day, 0=night	varies hourly	Based on sunrise/sunset data for source latitude and longitude
Other Settings (all TRIM.FaTE scenario properties)			
Start of simulation	date/time	1/1/1994 or 1/1/1989	Selected to match start of the air (1994) and soil (1989) simulations described in Lorber et al. 2000
End of simulation	date/time	1/1/1995 or 1/1/2001	Selected to match end of the air (1995) and soil (2001) simulations described in Lorber et al. 2000
Simulation time step	hr	1	Selected value
Output time step[b]	hr	1 or 730	Selected value of one hour for air simulation and 730 hours (approximatly one month) for the soil simulations.

[a]Input data used repeats in one-year cycle throughout modeling period for the 1989 met data.

[b]Output time step is set in TRIM.FaTE using the scenario property "simulationStepsPerOutputStep."

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Appendix C
DOCUMENTATION OF FACILITY EMISSIONS FOR TRIM.FaTE INPUT PARAMETERS

This appendix contains the following sets of tables, including calculations where appropriate, listing and describing the input parameters used in TRIM.FaTE for the Columbus, Ohio WTE Facility source emissions:

- summary of TRIM.FaTE source input parameters
- calculations for facility emissions for 1992 and 1994 stack test emissions

References are included at the end of the appendix.

Source Data -- Documentation for Ohio Dioxin Application

Property	Units	Value
Stack Elevation	m	82.9
X-coordinate	m (UTM)	327174.5
Y-coordinate	m (UTM)	4418908.1

Chemical	Units	Emission Rate	
		1992 Stack Test	1994 Stack Test
1,2,3,4,6,7,8,9-OCDD	g/day	4.41E+00	6.53E+00
1,2,3,4,6,7,8,9-OCDF	g/day	1.79E+00	2.00E+00
1,2,3,4,6,7,8-HpCDD	g/day	4.00E+00	2.87E+00
1,2,3,4,6,7,8-HpCDF	g/day	7.40E+00	4.54E+00
1,2,3,4,7,8,9-HpCDF	g/day	3.02E+00	3.41E-01
1,2,3,4,7,8-HxCDD	g/day	6.04E-01	3.59E-01
1,2,3,4,7,8-HxCDF	g/day	2.46E+00	7.36E-01
1,2,3,6,7,8-HxCDD	g/day	7.96E-01	2.93E-01
1,2,3,6,7,8-HxCDF	g/day	2.61E+00	6.56E-01
1,2,3,7,8,9-HxCDD	g/day	7.46E-01	2.31E-01
1,2,3,7,8,9-HxCDF	g/day	5.03E-01	2.93E-02
1,2,3,7,8-PeCDD	g/day	7.18E-01	2.16E-01
1,2,3,7,8-PeCDF	g/day	1.58E+00	1.91E-01
2,3,4,6,7,8-HxCDF	g/day	2.96E+00	9.01E-01
2,3,4,7,8-PeCDF	g/day	1.63E+00	3.50E-01
2,3,7,8-TCDD	g/day	1.64E-01	1.38E-02
2,3,7,8-TCDF	g/day	5.99E-01	8.64E-02
All 17 dioxin/furans	g TEQ/day	2.69E+00	7.22E-01
All 17 dioxin/furans	g TEQ/sec	3.10E-05	8.35E-06

Percent reduction from 1992 to 1994 emissions (for TEQ) = 73

Calculations for Emissions of Dioxin-like Compounds at the Columbus WTE Facility - Documentation for Ohio Dioxin Application

Steps to convert data from 1992 stack tests to emissions data for TRIM.FaTE:

1) Compiled stack data using information Table 2 in the Ohio EPA report from Sept 1994
2) Converted data from grains per dry standard cubic foot (gr/DSCF) to grams per DSCF (g/DSCF)
3) Using flow rates (DSCF/min) from Ohio EPA (1994) report, converted data to grams per minute
4) Converted stack emissions to grams per second
5) Adjusted stack emissions for usage, based on the assumption that on average 4.22 boilers are used continuously (i.e., multiplied by 4.22)
6) Converted emissions to grams per day to be consistent with units in TRIM.FaTE
7) Converted emissions to toxicity equivalent (TEQ) emissions by multiplying by toxicity equivalency factors (TEFs) for comparison (from Ohio EPA 1994; same as Lorber et al. 2000)
8) Compared TEQ (in grams per year) to Lorber et al., 1996 and 2000 reports

Conversion factors and other constants:

grams per grain	6.48E-02
sec/min	60
sec/day	8.64E+04
Number of boilers in use	4.22

Flow Rate (DSCF/min)				
Run 1	**Run 2**	**Run 3**	**Run 3-1**	**Run 3-2**
1.17E+05	1.16E+05	1.15E+05	1.15E+05	1.05E+05

Calculations for Emissions of Dioxin-like Compounds at the Columbus WTE Facility - Documentation for Ohio Dioxin Application

	STEP 1					STEP 2				
	Stack Emissions (gr/DSCF)					Stack Emissions (g/DSCF)				
	Run 1	Run 2	Run 3	Run 3-1	Run 3-2	Run 1	Run 2	Run 3	Run 3-1	Run 3-2
2,3,7,8 TCDD	2.65E-09	5.13E-09	4.84E-09	3.95E-09	1.50E-09	1.7E-10	3.3E-10	3.1E-10	2.6E-10	9.69E-11
1,2,3,7,8 PeCDD	1.64E-08	2.20E-08	1.91E-08	2.03E-08	9.35E-10	1.1E-09	1.4E-09	1.2E-09	1.3E-09	6.06E-11
1,2,3,4,7,8 HxCDD	1.52E-08	1.59E-08	1.20E-08	1.56E-08	8.29E-09	9.8E-10	1.0E-09	7.8E-10	1.0E-09	5.37E-10
1,2,3,6,7,8 HxCDD	2.02E-08	2.08E-08	1.40E-08	2.27E-08	1.04E-08	1.3E-09	1.3E-09	9.1E-10	1.5E-09	6.75E-10
1,2,3,7,8,9 HxCDD	1.77E-08	2.20E-08	1.53E-08	1.91E-08	8.29E-09	1.1E-09	1.4E-09	9.9E-10	1.2E-09	5.37E-10
1,2,3,4,6,7,8 HpCDD	9.98E-08	1.08E-07	7.01E-08	1.17E-07	4.81E-08	6.5E-09	7.0E-09	4.5E-09	7.6E-09	3.12E-09
OCDD	1.52E-07	1.10E-07	8.03E-08	8.86E-08	5.62E-08	9.8E-09	7.1E-09	5.2E-09	5.7E-09	3.64E-09
2,3,7,8 TCDF	1.01E-08	1.59E-08	1.66E-08	1.56E-08	8.28E-09	6.6E-10	1.0E-09	1.1E-09	1.0E-09	5.37E-10
1,2,3,7,8 PeCDF	2.65E-08	4.64E-08	4.46E-08	4.31E-08	1.39E-08	1.7E-09	3.0E-09	2.9E-09	2.8E-09	9.00E-10
2,3,4,7,8 PeCDF	3.54E-08	4.27E-08	3.70E-08	4.31E-08	2.24E-08	2.3E-09	2.8E-09	2.4E-09	2.8E-09	1.45E-09
1,2,3,4,7,8 HxCDF	5.69E-08	6.96E-08	5.61E-08	6.22E-08	2.67E-08	3.7E-09	4.5E-09	3.6E-09	4.0E-09	1.73E-09
1,2,3,6,7,8 HxCDF	5.69E-08	7.82E-08	6.12E-08	6.70E-08	2.48E-08	3.7E-09	5.1E-09	4.0E-09	4.3E-09	1.61E-09
1,2,3,7,8,9 HxCDF	1.25E-08	2.08E-08	1.12E-08	7.66E-09	3.21E-09	8.1E-10	1.3E-09	7.3E-10	5.0E-10	2.08E-10
2,3,4,6,7,8 HxCDF	4.30E-08	1.83E-07	3.19E-08	4.43E-08	2.41E-08	2.8E-09	1.2E-08	2.1E-09	2.9E-09	1.56E-09
1,2,3,4,6,7,8 HpCDF	2.02E-07	1.83E-07	1.53E-07	1.91E-07	8.82E-08	1.3E-08	1.2E-08	9.9E-09	1.2E-08	5.71E-09
1,2,3,4,7,8,9 HpCDF	1.90E-08	2.69E-07	1.66E-08	1.91E-08	9.09E-09	1.2E-09	1.7E-08	1.1E-09	1.2E-09	5.89E-10
OCDF	6.19E-08	5.62E-08	4.84E-08	6.10E-11	3.21E-08	4.0E-09	3.6E-09	3.1E-09	4.0E-12	2.08E-09

Calculations for Emissions of Dioxin-like Compounds at the Columbus WTE Facility - Documentation for Ohio Dioxin Application

STEP 3	Stack Emissions (g/min)				
	Run 1	Run 2	Run 3	Run 3-1	Run 3-2
2,3,7,8 TCDD	2.02E-05	3.84E-05	3.62E-05	2.95E-05	1.02E-05
1,2,3,7,8 PeCDD	1.25E-04	1.65E-04	1.43E-04	1.52E-04	6.39E-06
1,2,3,4,7,8 HxCDD	1.15E-04	1.19E-04	8.96E-05	1.16E-04	5.66E-05
1,2,3,6,7,8 HxCDD	1.54E-04	1.56E-04	1.05E-04	1.70E-04	7.12E-05
1,2,3,7,8,9 HxCDD	1.35E-04	1.65E-04	1.14E-04	1.43E-04	5.66E-05
1,2,3,4,6,7,8 HpCDD	7.60E-04	8.05E-04	5.25E-04	8.76E-04	3.29E-04
OCDD	1.15E-03	8.24E-04	6.01E-04	6.62E-04	3.84E-04
2,3,7,8 TCDF	7.70E-05	1.19E-04	1.24E-04	1.16E-04	5.66E-05
1,2,3,7,8 PeCDF	2.02E-04	3.48E-04	3.34E-04	3.22E-04	9.49E-05
2,3,4,7,8 PeCDF	2.69E-04	3.20E-04	2.77E-04	3.22E-04	1.53E-04
1,2,3,4,7,8 HxCDF	4.33E-04	5.21E-04	4.20E-04	4.65E-04	1.83E-04
1,2,3,6,7,8 HxCDF	4.33E-04	5.85E-04	4.58E-04	5.01E-04	1.70E-04
1,2,3,7,8,9 HxCDF	9.51E-05	1.56E-04	8.39E-05	5.72E-05	2.19E-05
2,3,4,6,7,8 HxCDF	3.27E-04	1.37E-03	2.38E-04	3.31E-04	1.64E-04
1,2,3,4,6,7,8 HpCDF	1.54E-03	1.37E-03	1.14E-03	1.43E-03	6.02E-04
1,2,3,4,7,8,9 HpCDF	1.44E-04	2.01E-03	1.24E-04	1.43E-04	6.21E-05
OCDF	4.71E-04	4.21E-04	3.62E-04	4.56E-07	2.19E-04

STEP 4 Stack Emissions (g/sec)				
Run 1	Run 2	Run 3	Run 3-1	Run 3-2
3.36E-07	6.40E-07	6.04E-07	4.92E-07	1.70E-07
2.08E-06	2.74E-06	2.38E-06	2.53E-06	1.06E-07
1.92E-06	1.98E-06	1.49E-06	1.94E-06	9.43E-07
2.56E-06	2.59E-06	1.75E-06	2.83E-06	1.19E-06
2.24E-06	2.74E-06	1.91E-06	2.39E-06	9.43E-07
1.27E-05	1.34E-05	8.74E-06	1.46E-05	5.48E-06
1.92E-05	1.37E-05	1.00E-05	1.10E-05	6.39E-06
1.28E-06	1.98E-06	2.07E-06	1.94E-06	9.43E-07
3.37E-06	5.79E-06	5.56E-06	5.36E-06	1.58E-06
4.49E-06	5.34E-06	4.61E-06	5.36E-06	2.55E-06
7.21E-06	8.69E-06	6.99E-06	7.75E-06	3.04E-06
7.21E-06	9.76E-06	7.63E-06	8.35E-06	2.83E-06
1.59E-06	2.59E-06	1.40E-06	9.54E-07	3.65E-07
5.45E-06	2.29E-05	3.97E-06	5.51E-06	2.74E-06
2.56E-05	2.29E-05	1.91E-05	2.39E-05	1.00E-05
2.40E-06	3.36E-05	2.07E-06	2.39E-06	1.03E-06
7.85E-06	7.02E-06	6.04E-06	7.61E-09	3.65E-06

Calculations for Emissions of Dioxin-like Compounds at the Columbus WTE Facility - Documentation for Ohio Dioxin Application

	STEP 5 Facility Emissions, Adjusted for Usage (g/sec)				
	Run 1	**Run 2**	**Run 3**	**Run 3-1**	**Run 3-2**
2,3,7,8 TCDD	1.42E-06	2.70E-06	2.55E-06	2.07E-06	7.19E-07
1,2,3,7,8 PeCDD	8.79E-06	1.16E-05	1.01E-05	1.07E-05	4.49E-07
1,2,3,4,7,8 HxCDD	8.12E-06	8.37E-06	6.30E-06	8.18E-06	3.98E-06
1,2,3,6,7,8 HxCDD	1.08E-05	1.09E-05	7.38E-06	1.19E-05	5.01E-06
1,2,3,7,8,9 HxCDD	9.47E-06	1.16E-05	8.05E-06	1.01E-05	3.98E-06
1,2,3,4,6,7,8 HpCDD	5.34E-05	5.66E-05	3.69E-05	6.16E-05	2.31E-05
OCDD	8.12E-05	5.79E-05	4.23E-05	4.66E-05	2.70E-05
2,3,7,8 TCDF	5.41E-06	8.36E-06	8.72E-06	8.18E-06	3.98E-06
1,2,3,7,8 PeCDF	1.42E-05	2.44E-05	2.35E-05	2.26E-05	6.68E-06
2,3,4,7,8 PeCDF	1.89E-05	2.25E-05	1.95E-05	2.26E-05	1.08E-05
1,2,3,4,7,8 HxCDF	3.04E-05	3.67E-05	2.95E-05	3.27E-05	1.28E-05
1,2,3,6,7,8 HxCDF	3.04E-05	4.12E-05	3.22E-05	3.52E-05	1.19E-05
1,2,3,7,8,9 HxCDF	6.69E-06	1.09E-05	5.90E-06	4.03E-06	1.54E-06
2,3,4,6,7,8 HxCDF	2.30E-05	9.65E-05	1.68E-05	2.33E-05	1.16E-05
1,2,3,4,6,7,8 HpCDF	1.08E-04	9.65E-05	8.05E-05	1.01E-04	4.24E-05
1,2,3,4,7,8,9 HpCDF	1.01E-05	1.42E-04	8.72E-06	1.01E-05	4.37E-06
OCDF	3.31E-05	2.96E-05	2.55E-05	3.21E-08	1.54E-05

Calculations for Emissions of Dioxin-like Compounds at the Columbus WTE Facility - Documentation for Ohio Dioxin Application

	STEP 6 Facility Emissions, Adjusted for Usage (g/day)						
	Run 1	**Run 2**	**Run 3**	**Run 3-1**	**Run 3-2**	***Average***	**% Total**
2,3,7,8 TCDD	1.23E-01	2.33E-01	2.20E-01	1.79E-01	6.21E-02	1.64E-01	0.5%
1,2,3,7,8 PeCDD	7.59E-01	1.00E+00	8.69E-01	9.24E-01	3.88E-02	7.18E-01	2.0%
1,2,3,4,7,8 HxCDD	7.01E-01	7.23E-01	5.45E-01	7.07E-01	3.44E-01	6.04E-01	1.7%
1,2,3,6,7,8 HxCDD	9.35E-01	9.45E-01	6.37E-01	1.03E+00	4.33E-01	7.96E-01	2.2%
1,2,3,7,8,9 HxCDD	8.18E-01	1.00E+00	6.95E-01	8.70E-01	3.44E-01	7.46E-01	2.1%
1,2,3,4,6,7,8 HpCDD	4.62E+00	4.89E+00	3.19E+00	5.33E+00	2.00E+00	4.00E+00	11.1%
OCDD	7.02E+00	5.01E+00	3.65E+00	4.03E+00	2.33E+00	4.41E+00	12.2%
2,3,7,8 TCDF	4.68E-01	7.23E-01	7.53E-01	7.07E-01	3.44E-01	5.99E-01	1.7%
1,2,3,7,8 PeCDF	1.23E+00	2.11E+00	2.03E+00	1.96E+00	5.77E-01	1.58E+00	4.4%
2,3,4,7,8 PeCDF	1.64E+00	1.95E+00	1.68E+00	1.96E+00	9.31E-01	1.63E+00	4.5%
1,2,3,4,7,8 HxCDF	2.63E+00	3.17E+00	2.55E+00	2.83E+00	1.11E+00	2.46E+00	6.8%
1,2,3,6,7,8 HxCDF	2.63E+00	3.56E+00	2.78E+00	3.04E+00	1.03E+00	2.61E+00	7.2%
1,2,3,7,8,9 HxCDF	5.78E-01	9.45E-01	5.10E-01	3.48E-01	1.33E-01	5.03E-01	1.4%
2,3,4,6,7,8 HxCDF	1.99E+00	8.34E+00	1.45E+00	2.01E+00	9.98E-01	2.96E+00	8.2%
1,2,3,4,6,7,8 HpCDF	9.35E+00	8.34E+00	6.95E+00	8.70E+00	3.66E+00	7.40E+00	20.6%
1,2,3,4,7,8,9 HpCDF	8.76E-01	1.22E+01	7.53E-01	8.70E-01	3.77E-01	3.02E+00	8.4%
OCDF	2.86E+00	2.56E+00	2.20E+00	2.77E-03	1.33E+00	1.79E+00	5.0%

Calculations for Emissions of Dioxin-like Compounds at the Columbus WTE Facility - Documentation for Ohio Dioxin Application

	STEP 7						
		TEF Converted Emissions (g/day)					
	Run 1	**Run 2**	**Run 3**	**Run 3-1**	**Run 3-2**	**TEF**	***Average***
2,3,7,8 TCDD	1.23E-01	2.33E-01	2.20E-01	1.79E-01	6.21E-02	1	1.64E-01
1,2,3,7,8 PeCDD	3.80E-01	5.00E-01	4.35E-01	4.62E-01	1.94E-02	0.5	3.59E-01
1,2,3,4,7,8 HxCDD	7.01E-02	7.23E-02	5.45E-02	7.07E-02	3.44E-02	0.1	6.04E-02
1,2,3,6,7,8 HxCDD	9.35E-02	9.45E-02	6.37E-02	1.03E-01	4.33E-02	0.1	7.96E-02
1,2,3,7,8,9 HxCDD	8.18E-02	1.00E-01	6.95E-02	8.70E-02	3.44E-02	0.1	7.46E-02
1,2,3,4,6,7,8 HpCDD	4.62E-02	4.89E-02	3.19E-02	5.33E-02	2.00E-02	0.01	4.00E-02
1,2,3,4,6,7,8,9-OCDD	7.02E-03	5.01E-03	3.65E-03	4.03E-03	2.33E-03	0.001	4.41E-03
2,3,7,8 TCDF	4.68E-02	7.23E-02	7.53E-02	7.07E-02	3.44E-02	0.1	5.99E-02
1,2,3,7,8 PeCDF	6.14E-02	1.06E-01	1.01E-01	9.78E-02	2.88E-02	0.05	7.90E-02
2,3,4,7,8 PeCDF	8.18E-01	9.73E-01	8.40E-01	9.78E-01	4.66E-01	0.5	8.15E-01
1,2,3,4,7,8 HxCDF	2.63E-01	3.17E-01	2.55E-01	2.83E-01	1.11E-01	0.1	2.46E-01
1,2,3,6,7,8 HxCDF	2.63E-01	3.56E-01	2.78E-01	3.04E-01	1.03E-01	0.1	2.61E-01
1,2,3,7,8,9 HxCDF	5.78E-02	9.45E-02	5.10E-02	3.48E-02	1.33E-02	0.1	5.03E-02
2,3,4,6,7,8 HxCDF	1.99E-01	8.34E-01	1.45E-01	2.01E-01	9.98E-02	0.1	2.96E-01
1,2,3,4,6,7,8 HpCDF	9.35E-02	8.34E-02	6.95E-02	8.70E-02	3.66E-02	0.01	7.40E-02
1,2,3,4,7,8,9 HpCDF	8.76E-03	1.22E-01	7.53E-03	8.70E-03	3.77E-03	0.01	3.02E-02
1,2,3,4,6,7,8,9-OCDF	2.86E-03	2.56E-03	2.20E-03	2.77E-06	1.33E-03	0.001	1.79E-03
TEQ (g/day)	2.61E+00	4.01E+00	2.70E+00	3.02E+00	1.11E+00		2.69E+00
TEQ (g/yr)	9.54E+02	1.47E+03	9.87E+02	1.10E+03	4.07E+02		**9.83E+02**

STEP 8) Verify emissions with previous reports		
	TEQ (g/s)	**TEQ (g/yr)**
Ohio EPA, 1994 (from Step 7)	-	9.83E+02
TEQ emissions used in Lorber et al, 1996	3.10E-05	9.78E+02
TEQ emissions used in Lorber et al, 2000	-	9.84E+02

Calculations for Emissions of Dioxin-like Compounds at the Columbus WTE Facility - Documentation for Ohio Dioxin Application

Steps to convert data from 1994 stack tests to emissions data for TRIM.FaTE:

1) Compiled stack data using information tables in the Solid Waste Authority of Central Ohio report dated October 26, 1994 (to EPA Region 5)
2) Converted data from nanograms per dry standard cubic meters (ng/DSCM) to grams per DSCM (g/DSCM)
3) Using flow rates (DSCM/min) from Solid Waste Authority report, converted data to grams per minute (g/min)
4) Converted stack emissions to grams per second (g/s)
5) Adjusted stack emissions for usage, based on the assumption that on average 4.22 boilers are used continuously (i.e., multiplied by 4.22)
6) Converted emissions to grams per day to be consistent with units in TRIM.FaTE
7) Converted emissions to toxicity equivalent (TEQ) emissions by multiplying by toxicity equivalency factors (TEFs) for comparison (from Ohio EPA 1994; same as Lorber et al. 2000)
8) Compared TEQ (in grams per year) to Lorber et al., 1996 and 2000 reports

Conversion factors and other constants:

g/ng	1.0E-09
sec/min	60
sec/day	8.64E+04
Number of boilers in use	4.22

Flow Rate (DSCM/min)		
Run 1	**Run 2**	**Run 3**
1977	1936	1962

Calculations for Emissions of Dioxin-like Compounds at the Columbus WTE Facility - Documentation for Ohio Dioxin Application

	STEP 1 Stack Emissions (ng/DSCM)			STEP 2 Stack Emissions (g/DSCM)			STEP 3 Stack Emissions (g/min)		
Stack C for boiler 6	**Run 1**	**Run 2**	**Run 3**	**Run 1**	**Run 2**	**Run 3**	**Run 1**	**Run 2**	**Run 3**
2,3,7,8 TCDD	2.08	0.89	0.487	2.1E-09	8.9E-10	4.9E-10	4.11E-06	1.72E-06	9.55E-07
1,2,3,7,8 PeCDD	28.9	18.3	7.23	2.9E-08	1.8E-08	7.2E-09	5.71E-05	3.54E-05	1.42E-05
1,2,3,4,7,8 HxCDD	43.3	33.0	14.2	4.3E-08	3.3E-08	1.4E-08	8.56E-05	6.39E-05	2.79E-05
1,2,3,6,7,8 HxCDD	34.4	28.0	11.4	3.4E-08	2.8E-08	1.1E-08	6.80E-05	5.42E-05	2.24E-05
1,2,3,7,8,9 HxCDD	29.7	20.2	8.21	3.0E-08	2.0E-08	8.2E-09	5.87E-05	3.91E-05	1.61E-05
1,2,3,4,6,7,8 HpCDD	281	294	148	2.8E-07	2.9E-07	1.5E-07	5.56E-04	5.69E-04	2.90E-04
OCDD	572	642	434.0	5.7E-07	6.4E-07	4.3E-07	1.13E-03	1.24E-03	8.52E-04
2,3,7,8 TCDF	11.2	6.78	3.77	1.1E-08	6.8E-09	3.8E-09	2.21E-05	1.31E-05	7.40E-06
1,2,3,7,8 PeCDF	25.4	14.9	7.83	2.5E-08	1.5E-08	7.8E-09	5.02E-05	2.88E-05	1.54E-05
2,3,4,7,8 PeCDF	44.6	29.5	14.0	4.5E-08	3.0E-08	1.4E-08	8.82E-05	5.71E-05	2.75E-05
1,2,3,4,7,8 HxCDF	88.3	64.5	32.6	8.8E-08	6.5E-08	3.3E-08	1.75E-04	1.25E-04	6.40E-05
1,2,3,6,7,8 HxCDF	79.9	54.3	31.0	8.0E-08	5.4E-08	3.1E-08	1.58E-04	1.05E-04	6.08E-05
1,2,3,7,8,9 HxCDF	3.1	2.83	1.46	3.1E-09	2.8E-09	1.5E-09	6.13E-06	5.48E-06	2.86E-06
2,3,4,6,7,8 HxCDF	92.5	85.3	49.4	9.3E-08	8.5E-08	4.9E-08	1.83E-04	1.65E-04	9.69E-05
1,2,3,4,6,7,8 HpCDF	479	423	243	4.8E-07	4.2E-07	2.4E-07	9.47E-04	8.19E-04	4.77E-04
1,2,3,4,7,8,9 HpCDF	32.3	34.8	18.9	3.2E-08	3.5E-08	1.9E-08	6.39E-05	6.74E-05	3.71E-05
OCDF	172	202	130	1.7E-07	2.0E-07	1.3E-07	3.40E-04	3.91E-04	2.55E-04

Calculations for Emissions of Dioxin-like Compounds at the Columbus WTE Facility - Documentation for Ohio Dioxin Application

	STEP 4 Stack Emissions (g/sec)			STEP 5 Facility Emissions, Adjusted for			STEP 6 Facility Emissions, Adjusted for Usage (g/day)				
	Run 1	**Run 2**	**Run 3**	**Run 1**	**Run 2**	**Run 3**	**Run 1**	**Run 2**	**Run 3**	***Average***	**% Total**
2,3,7,8 TCDD	6.85E-08	2.87E-08	1.59E-08	2.89E-07	1.21E-07	6.72E-08	2.50E-02	1.05E-02	5.81E-03	1.38E-02	0.1%
1,2,3,7,8 PeCDD	9.52E-07	5.90E-07	2.36E-07	4.02E-06	2.49E-06	9.98E-07	3.47E-01	2.15E-01	8.62E-02	2.16E-01	1.1%
1,2,3,4,7,8 HxCDD	1.43E-06	1.06E-06	4.64E-07	6.02E-06	4.49E-06	1.96E-06	5.20E-01	3.88E-01	1.69E-01	3.59E-01	1.8%
1,2,3,6,7,8 HxCDD	1.13E-06	9.03E-07	3.73E-07	4.78E-06	3.81E-06	1.57E-06	4.13E-01	3.29E-01	1.36E-01	2.93E-01	1.4%
1,2,3,7,8,9 HxCDD	9.79E-07	6.52E-07	2.68E-07	4.13E-06	2.75E-06	1.13E-06	3.57E-01	2.38E-01	9.79E-02	2.31E-01	1.1%
1,2,3,4,6,7,8 HpCDD	9.26E-06	9.49E-06	4.84E-06	3.91E-05	4.00E-05	2.04E-05	3.38E+00	3.46E+00	1.76E+00	2.87E+00	14.1%
OCDD	1.88E-05	2.07E-05	1.42E-05	7.95E-05	8.74E-05	5.99E-05	6.87E+00	7.55E+00	5.17E+00	6.53E+00	32.1%
2,3,7,8 TCDF	3.69E-07	2.19E-07	1.23E-07	1.56E-06	9.23E-07	5.20E-07	1.35E-01	7.98E-02	4.49E-02	8.64E-02	0.4%
1,2,3,7,8 PeCDF	8.37E-07	4.81E-07	2.56E-07	3.53E-06	2.03E-06	1.08E-06	3.05E-01	1.75E-01	9.34E-02	1.91E-01	0.9%
2,3,4,7,8 PeCDF	1.47E-06	9.52E-07	4.58E-07	6.20E-06	4.02E-06	1.93E-06	5.36E-01	3.47E-01	1.67E-01	3.50E-01	1.7%
1,2,3,4,7,8 HxCDF	2.91E-06	2.08E-06	1.07E-06	1.23E-05	8.78E-06	4.50E-06	1.06E+00	7.59E-01	3.89E-01	7.36E-01	3.6%
1,2,3,6,7,8 HxCDF	2.63E-06	1.75E-06	1.01E-06	1.11E-05	7.39E-06	4.28E-06	9.60E-01	6.39E-01	3.70E-01	6.56E-01	3.2%
1,2,3,7,8,9 HxCDF	1.02E-07	9.13E-08	4.77E-08	4.31E-07	3.85E-07	2.01E-07	3.72E-02	3.33E-02	1.74E-02	2.93E-02	0.1%
2,3,4,6,7,8 HxCDF	3.05E-06	2.75E-06	1.62E-06	1.29E-05	1.16E-05	6.82E-06	1.11E+00	1.00E+00	5.89E-01	9.01E-01	4.4%
1,2,3,4,6,7,8 HpCDF	1.58E-05	1.36E-05	7.95E-06	6.66E-05	5.76E-05	3.35E-05	5.75E+00	4.98E+00	2.90E+00	4.54E+00	22.3%
1,2,3,4,7,8,9 HpCDF	1.06E-06	1.12E-06	6.18E-07	4.49E-06	4.74E-06	2.61E-06	3.88E-01	4.09E-01	2.25E-01	3.41E-01	1.7%
OCDF	5.67E-06	6.52E-06	4.25E-06	2.39E-05	2.75E-05	1.79E-05	2.07E+00	2.38E+00	1.55E+00	2.00E+00	9.8%

Calculations for Emissions of Dioxin-like Compounds at the Columbus WTE Facility - Documentation for Ohio Dioxin Application

	STEP 7 TEF Converted Emissions (g/day) Run 1	Run 2	Run 3	TEF	*Average*
2,3,7,8 TCDD	2.50E-02	1.05E-02	5.81E-03	1	1.38E-02
1,2,3,7,8 PeCDD	1.74E-01	1.08E-01	4.31E-02	0.5	1.08E-01
1,2,3,4,7,8 HxCDD	5.20E-02	3.88E-02	1.69E-02	0.1	3.59E-02
1,2,3,6,7,8 HxCDD	4.13E-02	3.29E-02	1.36E-02	0.1	2.93E-02
1,2,3,7,8,9 HxCDD	3.57E-02	2.38E-02	9.79E-03	0.1	2.31E-02
1,2,3,4,6,7,8 HpCDD	3.38E-02	3.46E-02	1.76E-02	0.01	2.87E-02
1,2,3,4,6,7,8,9-OCDD	6.87E-03	7.55E-03	5.17E-03	0.001	6.53E-03
2,3,7,8 TCDF	1.35E-02	7.98E-03	4.49E-03	0.1	8.64E-03
1,2,3,7,8 PeCDF	1.53E-02	8.76E-03	4.67E-03	0.05	9.56E-03
2,3,4,7,8 PeCDF	2.68E-01	1.74E-01	8.35E-02	0.5	1.75E-01
1,2,3,4,7,8 HxCDF	1.06E-01	7.59E-02	3.89E-02	0.1	7.36E-02
1,2,3,6,7,8 HxCDF	9.60E-02	6.39E-02	3.70E-02	0.1	6.56E-02
1,2,3,7,8,9 HxCDF	3.72E-03	3.33E-03	1.74E-03	0.1	2.93E-03
2,3,4,6,7,8 HxCDF	1.11E-01	1.00E-01	5.89E-02	0.1	9.01E-02
1,2,3,4,6,7,8 HpCDF	5.75E-02	4.98E-02	2.90E-02	0.01	4.54E-02
1,2,3,4,7,8,9 HpCDF	3.88E-03	4.09E-03	2.25E-03	0.01	3.41E-03
1,2,3,4,6,7,8,9-OCDF	2.07E-03	2.38E-03	1.55E-03	0.001	2.00E-03
TEQ (g/day)	1.05E+00	7.46E-01	3.74E-01		7.22E-01
TEQ (g/yr)	3.82E+02	2.72E+02	1.36E+02		**2.63E+02**

STEP 8) Verify emissions with previous reports	**TEQ (g/s)**	**TEQ (g/yr)**
(from Step 7)	-	2.63E+02
emission used in Lorber et al, 1996 * 0.27	8.37E-06	2.64E+02
emission used in Lorber et al, 2000 * 0.27	-	2.67E+02

Source Data -- Documentation for Ohio Dioxin Application

References

Solid Waste Authority of Central Ohio. 1994. Corrected Data for March 16-18, 1994 Dioxin Test Waste to Energy Facility. Memorandum to U.S. EPA Region 5. October 26, 1994.

Lorber, M.; Cleverly, D.; and J. Schaum. 1996. A screening-level risk assessment of the indirect impacts from the Columbus waste to energy facility in Columbus, Ohio. Proceedings of an International Specialty Conference, sponsored by the Air and Waste Management Association and the United States Environmental Protection Agency, held April 18-21, 1996 in Washington, D.C. Published in Solid Waste Management: Thermal Treatment & Waste-to-Energy Technologies, VIP - 53. pp. 262-278. Air & Waste Management Association, One Gateway Center, Third Floor, Pittsburgh, PA 15222.

Lorber, M.; Eschenroeder, A.; and R. Robinson. 2000. Testing the USA EPA's ISCST-Version 3 model on dioxins: A comparison of predicted and observed air and soil concentrations. Atmospheric Environment 34 (2000), pp. 3995-4010.

Ohio Environmental Protection Agency (OEPA) (1994) Risk assessment of potential health effects of dioxins and dibenzofurans emitted from the Columbus solid waste authority's reduction facility. The Ohio Environmental Protection Agency, Division of Air Pollution Control. February 28, 1994.

Appendix D.
WIND ROSES

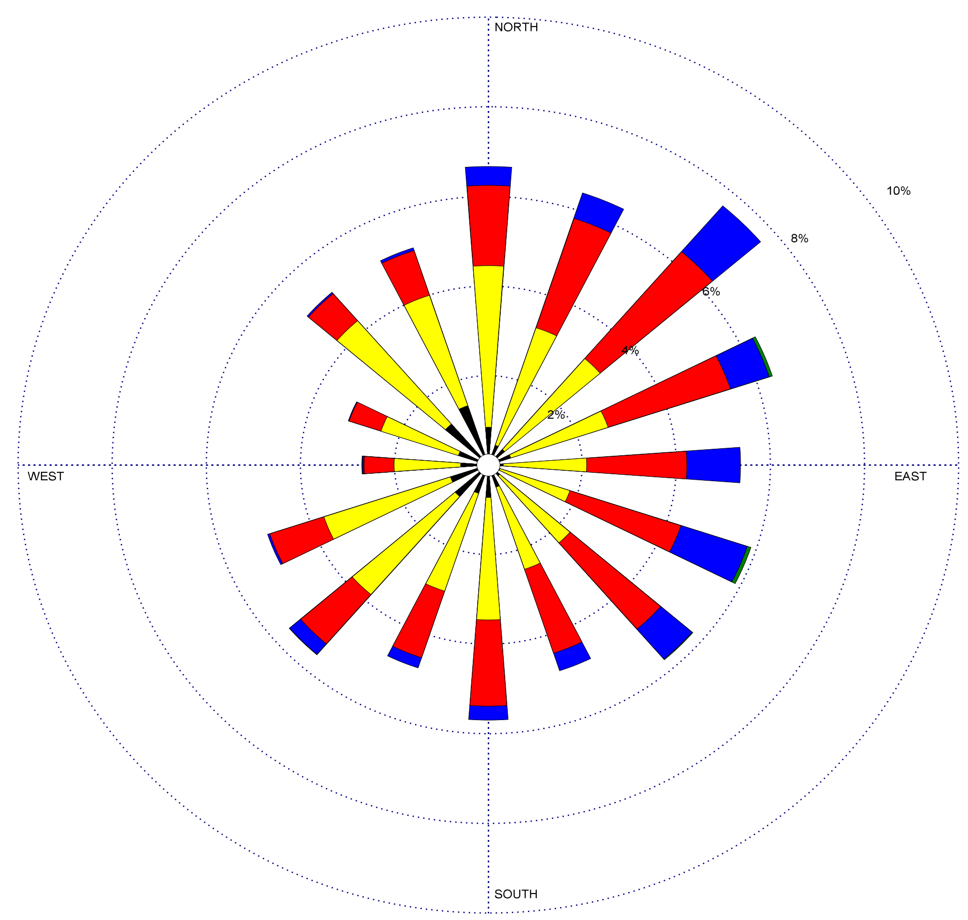
This appendix contains the following wind roses using the appropriate meteorological data:

- Wind rose for Columbus, Ohio using local airport meteorological data from 1989;
- Wind rose for Columbus, Ohio using local airport meteorological data from 1994;
- Wind rose for Columbus, Ohio using local airport meteorological data from March 15 through 17, 1994.

Wind Rose for Columbus, Ohio - 1989

WIND ROSE PLOT

Station #14821 - COLUMBUS/PORT COLUMBUS INT'L, OH



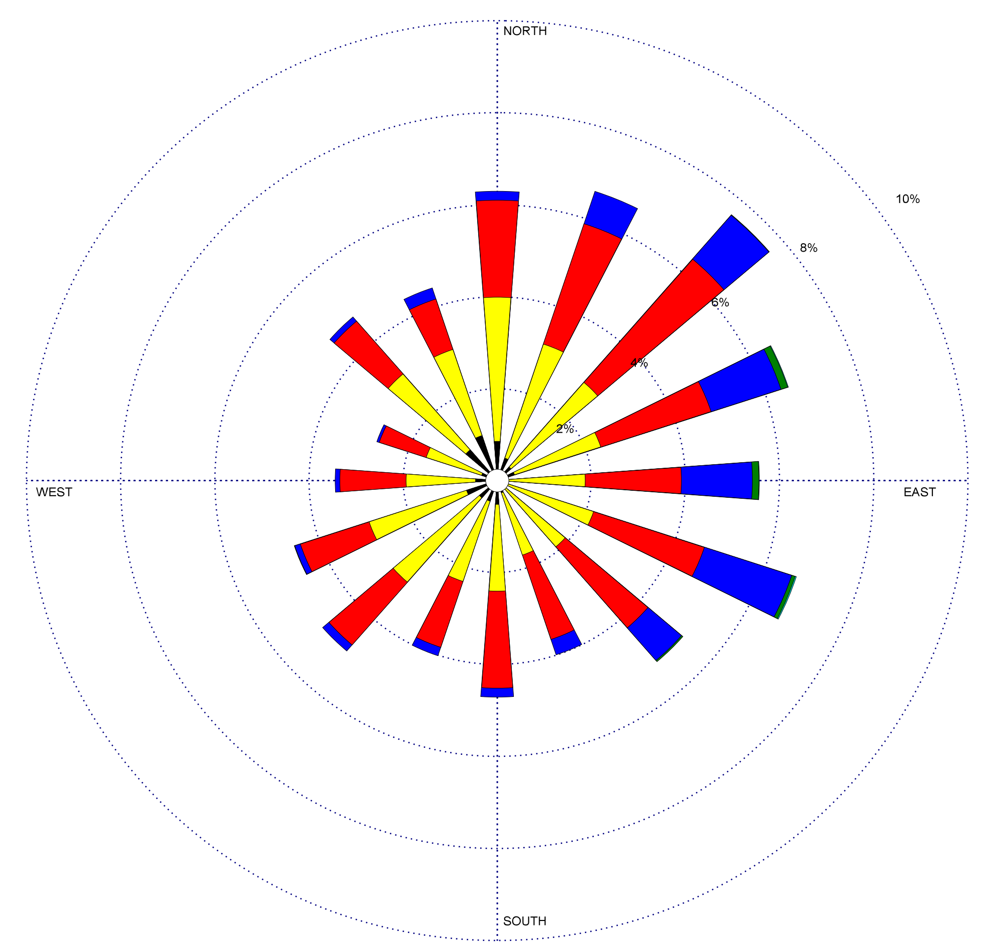
Wind Speed (m/s)	MODELER	DATE 1/6/2004	COMPANY NAME
> 11.06 8.49 - 11.06 5.40 - 8.49 3.34 - 5.40 1.80 - 3.34 0.51 - 1.80	DISPLAY Wind Speed	UNIT m/s	COMMENTS
	AVG. WIND SPEED 3.36 m/s	CALM WINDS 14.09%	
	ORIENTATION Flow Vector (blowing to)	PLOT YEAR-DATE-TIME 1989 Jan 1 - Dec 31 Midnight - 11 PM	PROJECT/PLOT NO.

WRPLOT View 3.5 by Lakes Environmental Software - www.lakes-environmental.com

Wind Rose for Columbus, Ohio - 1994

WIND ROSE PLOT

Station #14821 - COLUMBUS/PORT COLUMBUS INT'L, OH

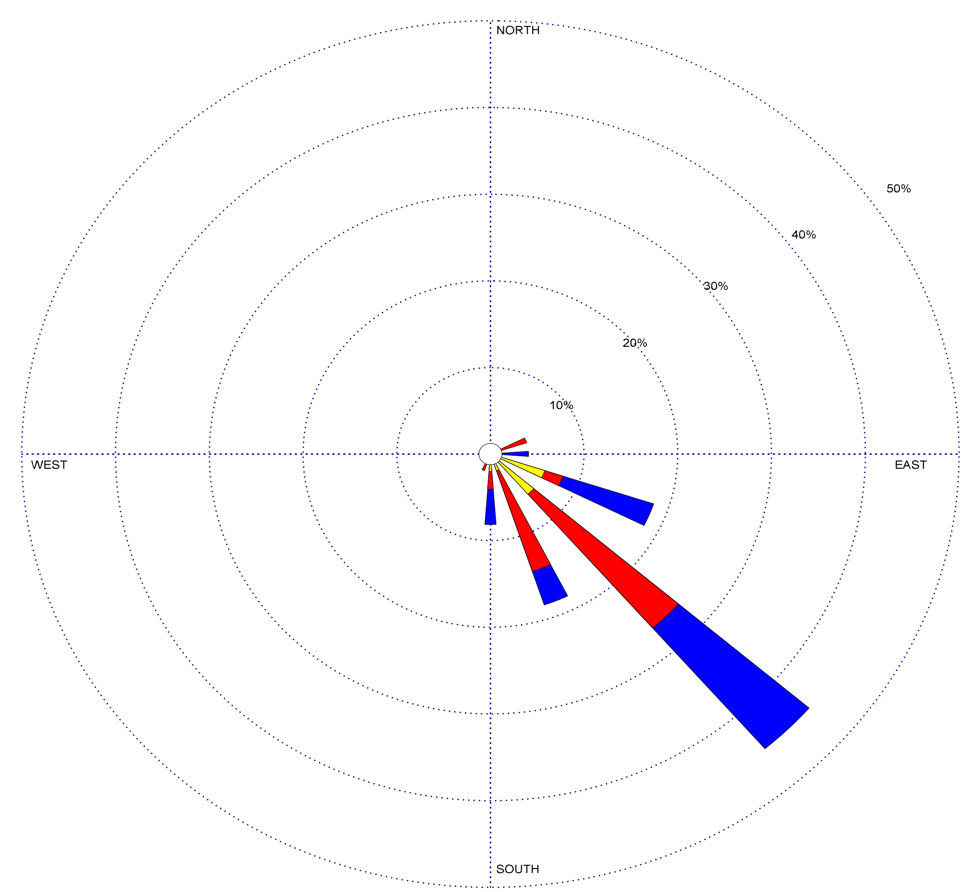


Wind Speed (m/s)	MODELER	DATE 1/6/2004	COMPANY NAME
> 11.06 8.49 - 11.06 5.40 - 8.49	DISPLAY Wind Speed	UNIT m/s	COMMENTS
3.34 - 5.40	AVG. WIND SPEED 3.61 m/s	CALM WINDS 18.08%	
1.80 - 3.34 0.51 - 1.80	ORIENTATION Flow Vector (blowing to)	PLOT YEAR-DATE-TIME 1994 Jan 1 - Dec 31 Midnight - 11 PM	PROJECT/PLOT NO.

WRPLOT View 3.5 by Lakes Environmental Software - www.lakes-environmental.com

Wind Rose for Columbus, Ohio -
March 15 through March 17, 1994

WIND ROSE PLOT
Station #14821 - COLUMBUS/PORT COLUMBUS INT'L, OH



Wind Speed (m/s)	MODELER	DATE	COMPANY NAME
> 11.06		1/6/2004	
8.49 - 11.06	DISPLAY Wind Speed	UNIT m/s	COMMENTS
5.40 - 8.49	AVG. WIND SPEED 5.19 m/s	CALM WINDS 0.00%	
3.34 - 5.40 1.80 - 3.34 0.51 - 1.80	ORIENTATION Flow Vector (blowing to)	PLOT YEAR-DATE-TIME 1994 Mar 15 - Mar 17 Midnight - 11 PM	PROJECT/PLOT NO.

WRPLOT View 3.5 by Lakes Environmental Software - www.lakes-environmental.com

Appendix E.
DETAILED TRIM.FATE RESULTS BY CONGENER

This appendix provides charts with congener specific TRIM.FaTE results for:

- The overall distribution of dioxin TEQ mass over time in compartments and sinks.
- The distribution of dioxin TEQ mass over time in abiotic compartments.

Figure E-1
1,2,3,4,6,7,8-HpCDF Mass: Overall Distribution in Compartments and Sinks

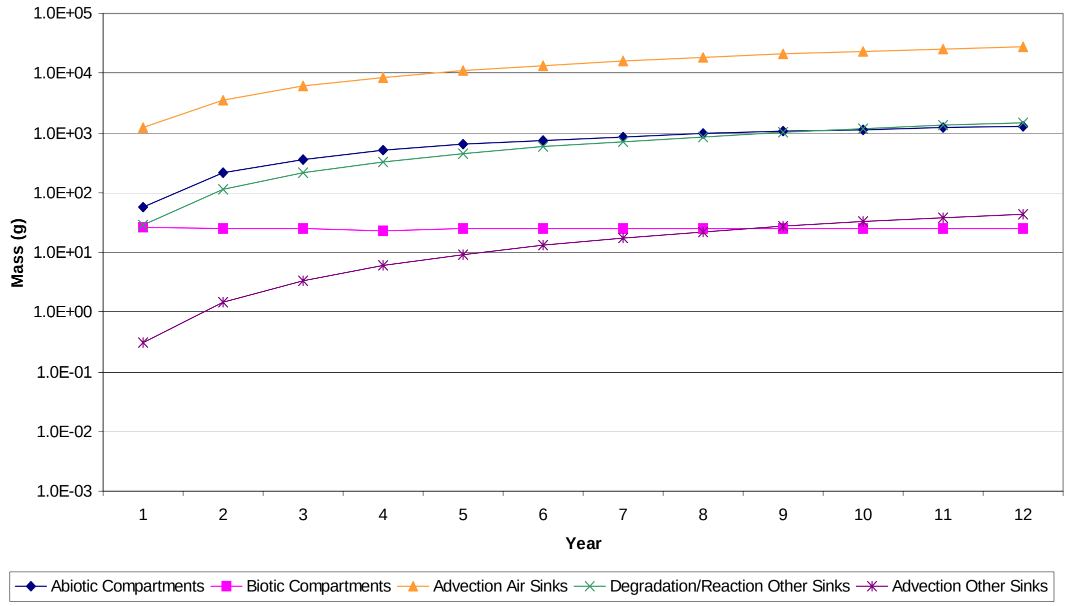


Figure E-2
1,2,3,4,7,8-HxCDD Mass: Overall Distribution in Compartments and Sinks

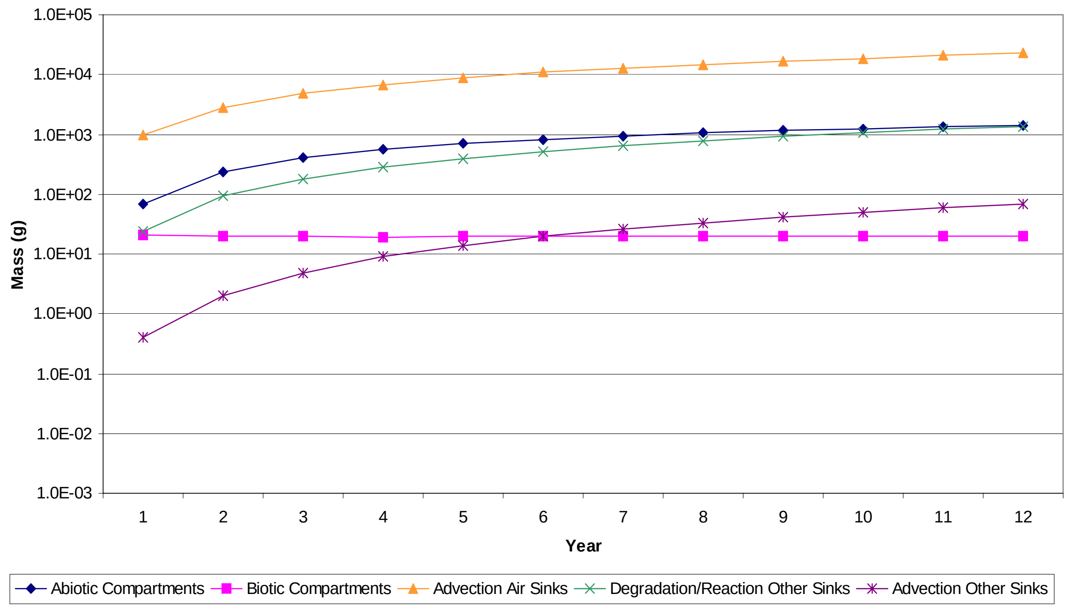


Figure E-3
1,2,3,4,6,7,8,9-OCDD Mass: Overall Distribution in Compartments and Sinks

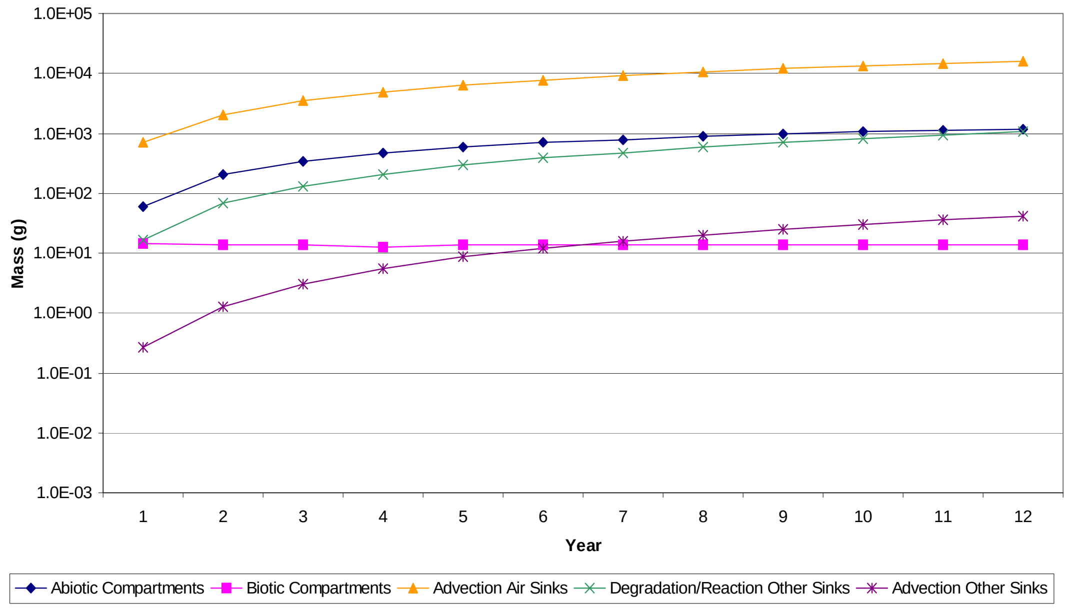


Figure E-4
1,2,3,4,6,7,8-HpCDD Mass: Overall Distribution in Compartments and Sinks

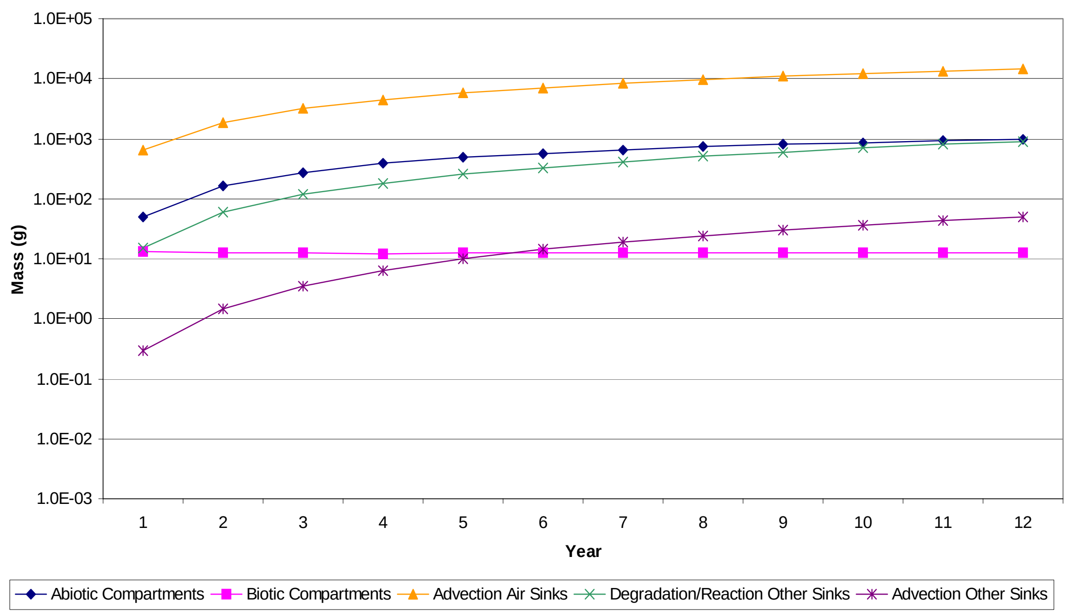


Figure E-5
2,3,4,6,7,8-HxCDF Mass: Overall Distribution in Compartments and Sinks

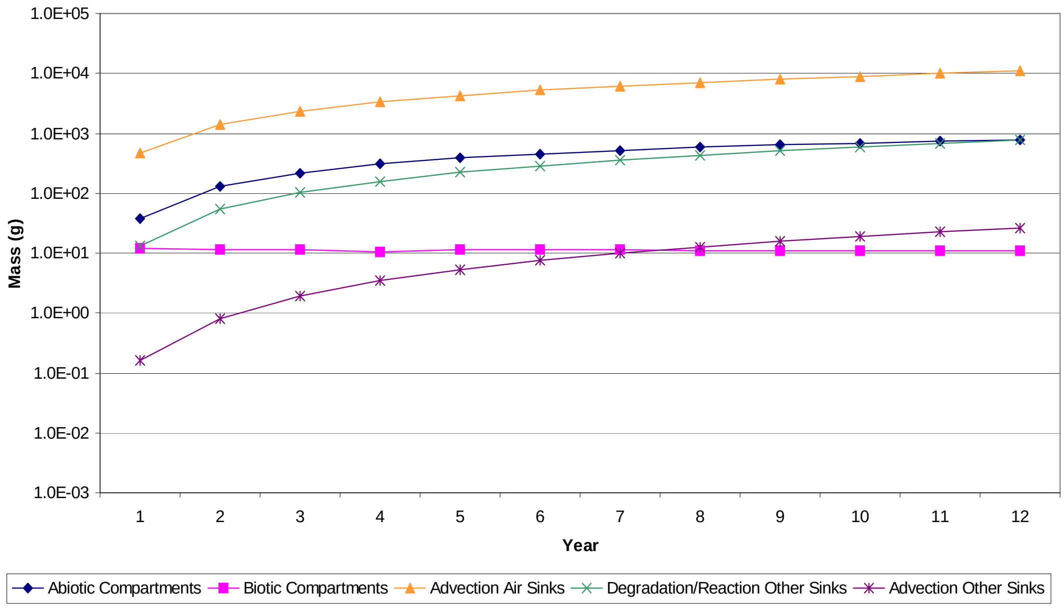


Figure E-6
1,2,3,6,7,8-HxCDF Mass: Overall Distribution in Compartments and Sinks

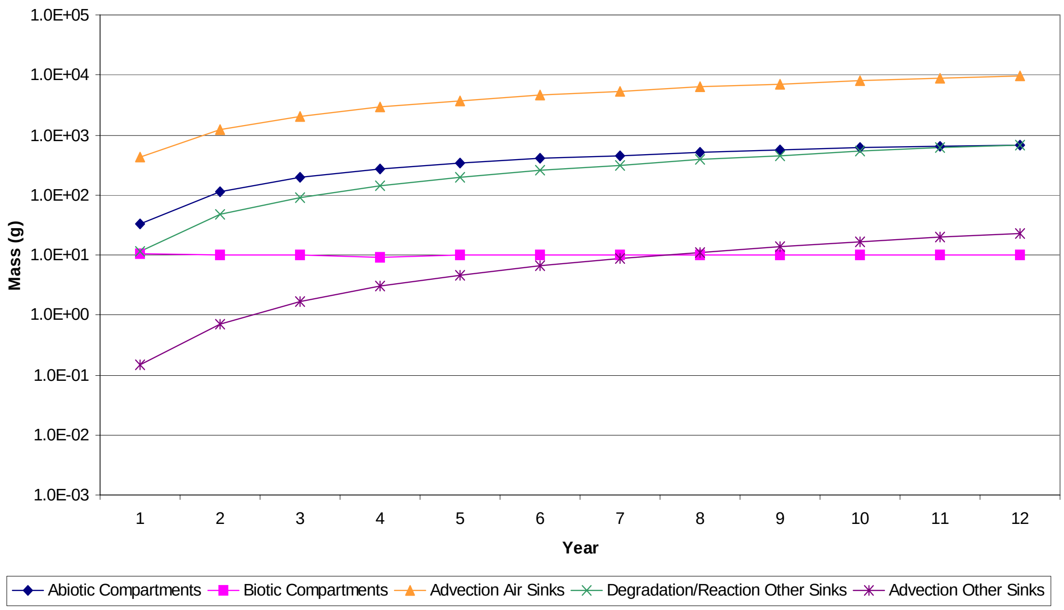


Figure E-7
1,2,3,4,6,7,8,9-OCDF Mass: Overall Distribution in Compartments and Sinks

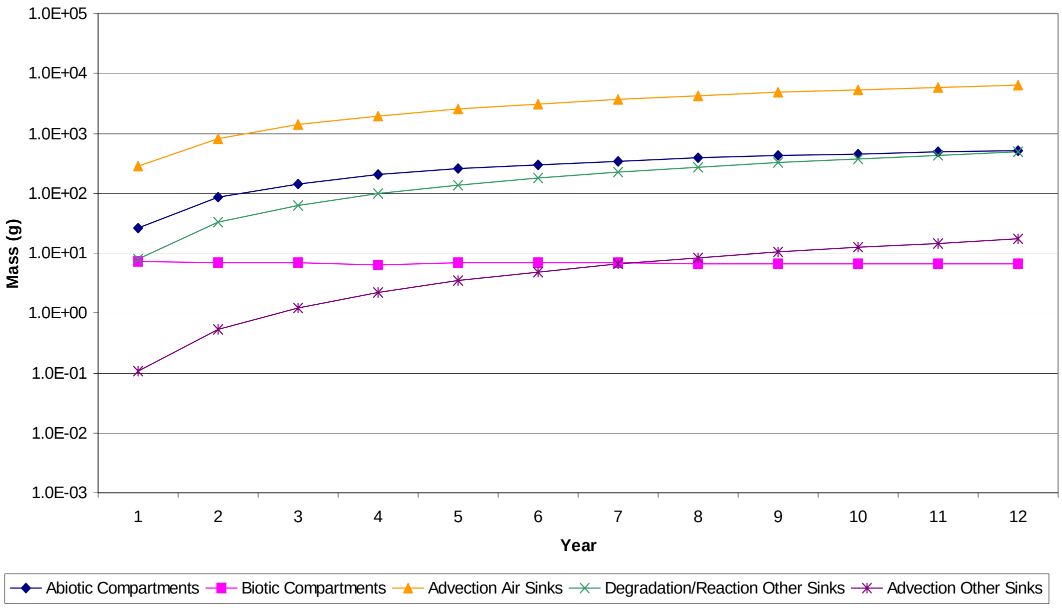


Figure E-8
1,2,3,4,7,8,9-HpCDF Mass: Overall Distribution in Compartments and Sinks

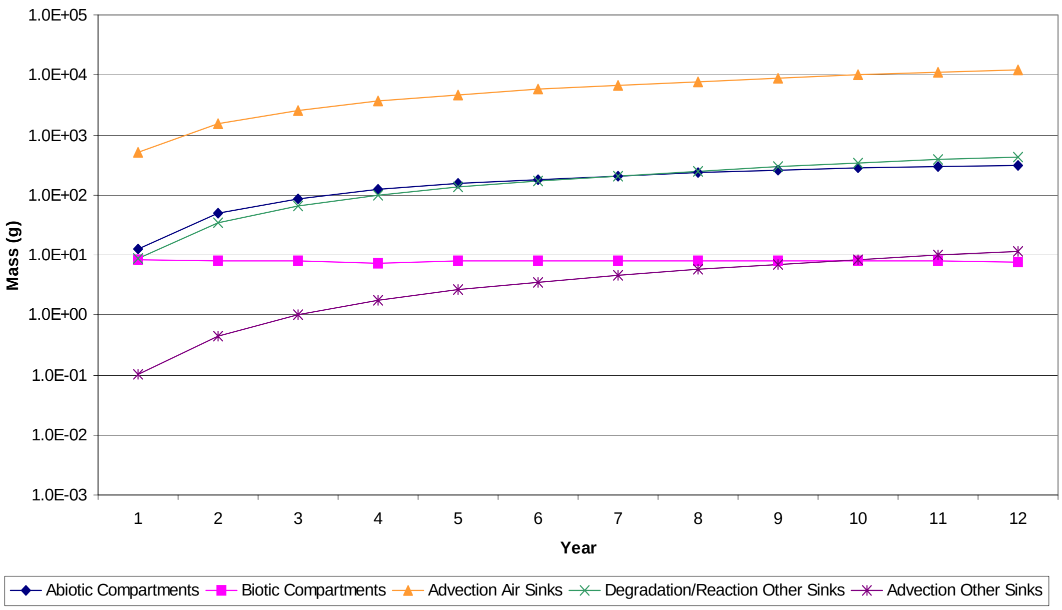


Figure E-9
1,2,3,4,7,8-HxCDF Mass: Overall Distribution in Compartments and Sinks

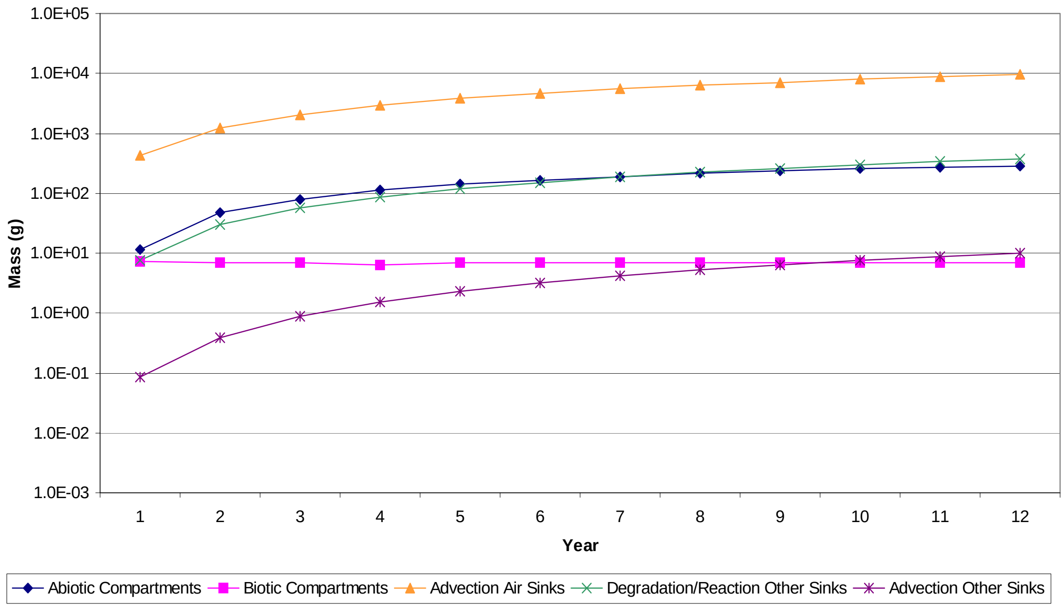


Figure E-10
1,2,3,7,8-PeCDF Mass: Overall Distribution in Compartments and Sinks

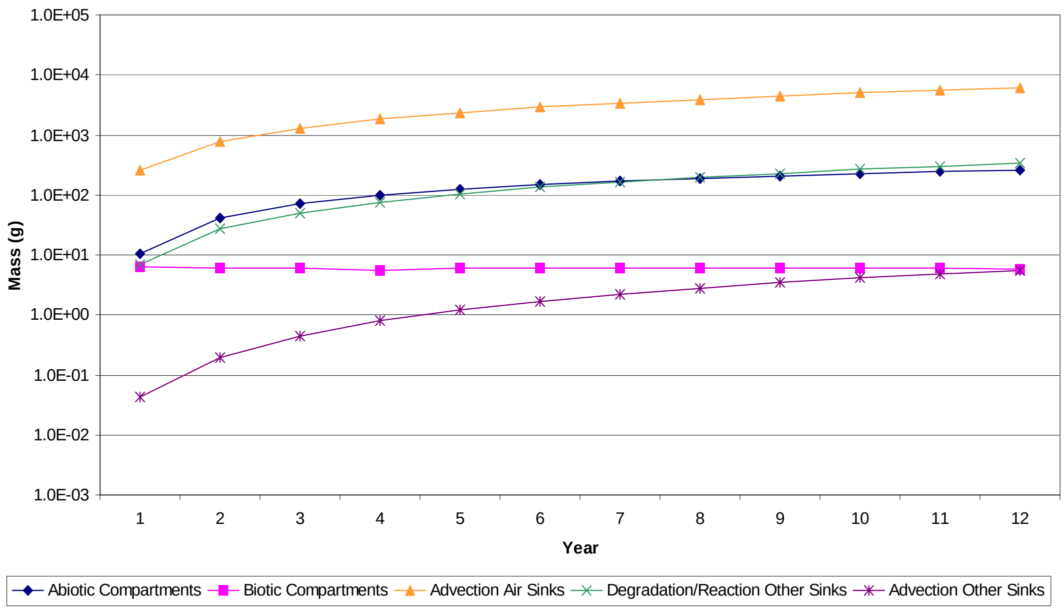


Figure E-11
2,3,4,7,8-PeCDF Mass: Overall Distribution in Compartments and Sinks

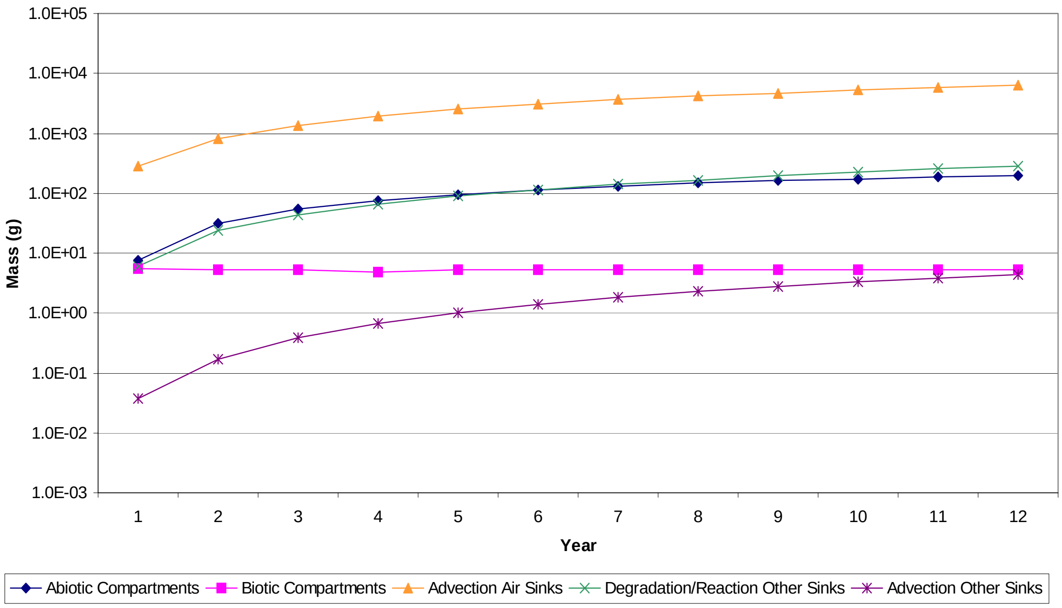


Figure E-12
1,2,3,6,7,8-HxCDD Mass: Overall Distribution in Compartments and Sinks

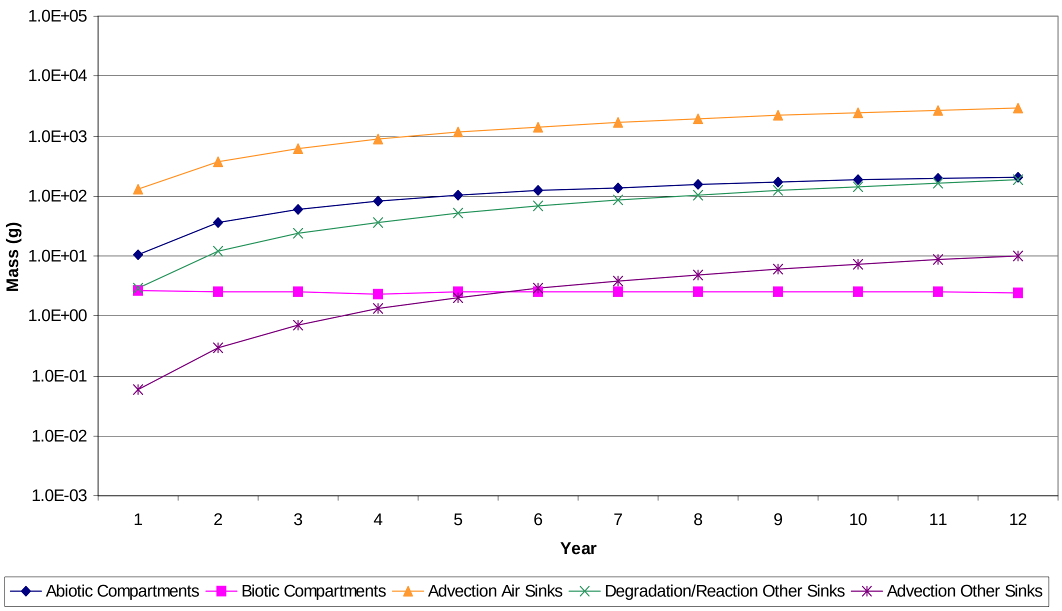


Figure E-13
1,2,3,7,8,9-HxCDD Mass: Overall Distribution in Compartments and Sinks

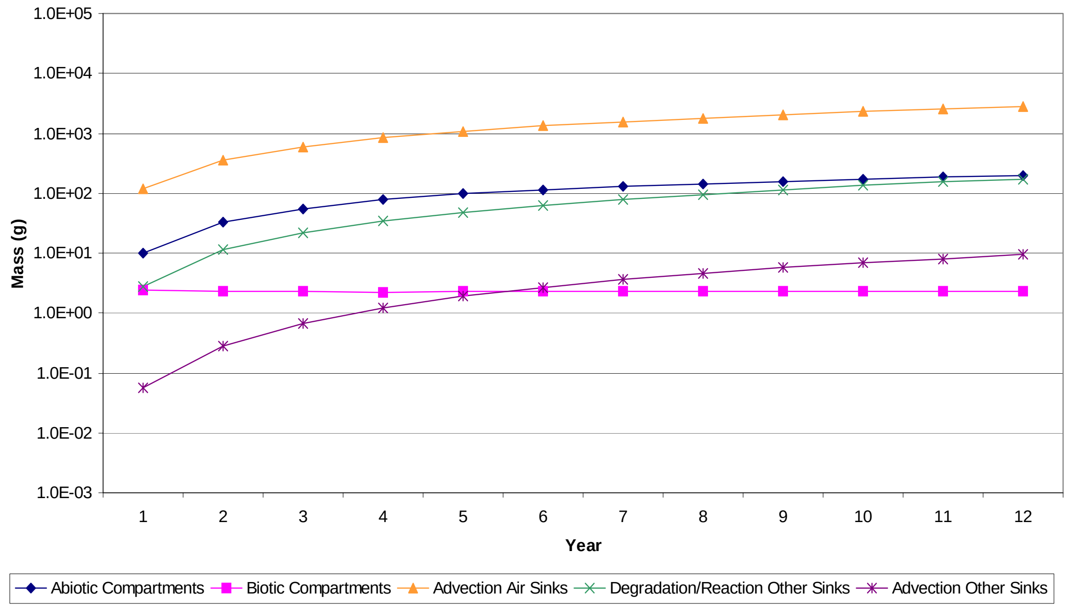


Figure E-14
1,2,3,7,8,9-HxCDF Mass: Overall Distribution in Compartments and Sinks

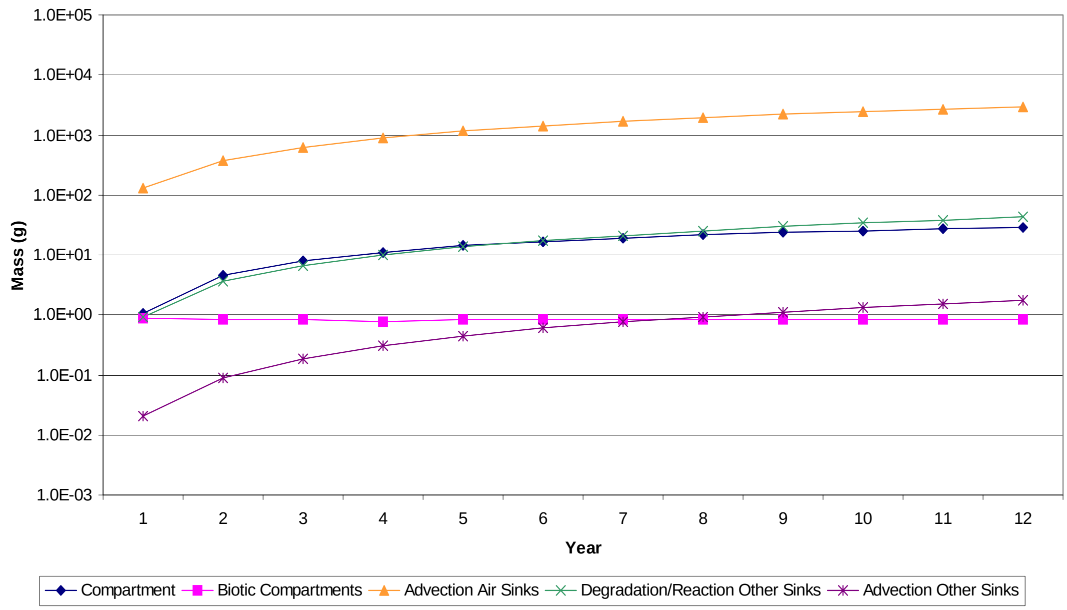


Figure E-15
1,2,3,7,8-PeCDD Mass: Overall Distribution in Compartments and Sinks

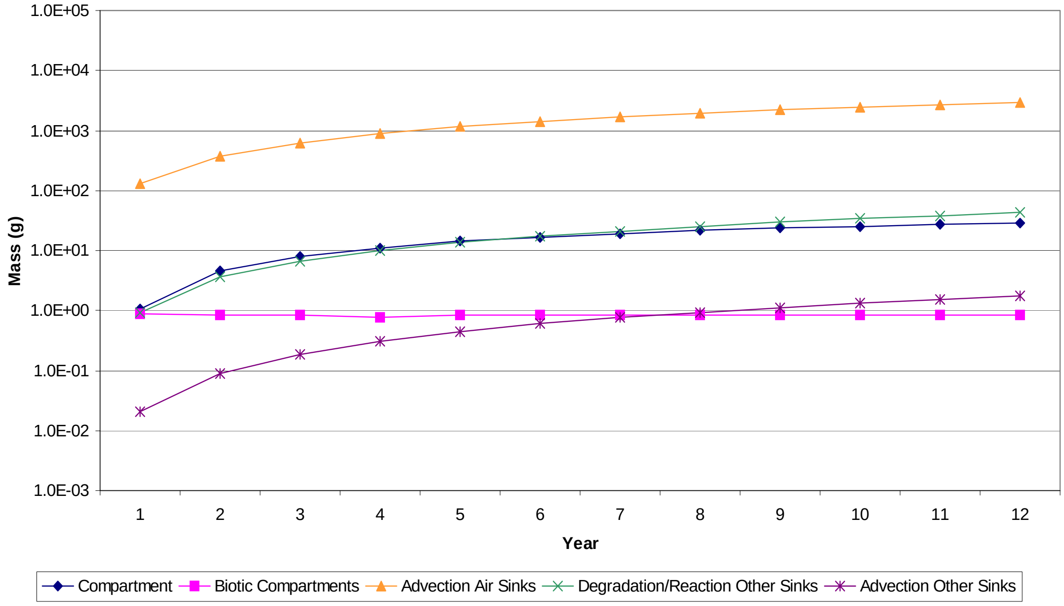


Figure E-16
2,3,7,8-TCDF Mass: Overall Distribution in Compartments and Sinks

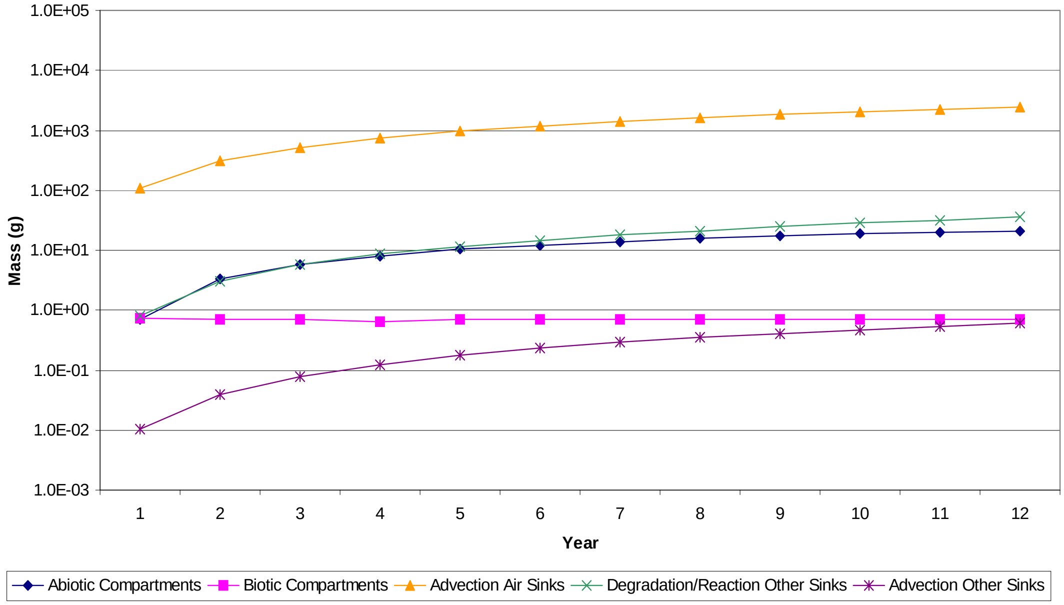


Figure E-17
2,3,7,8-TCDD Mass: Overall Distribution in Compartments and Sinks

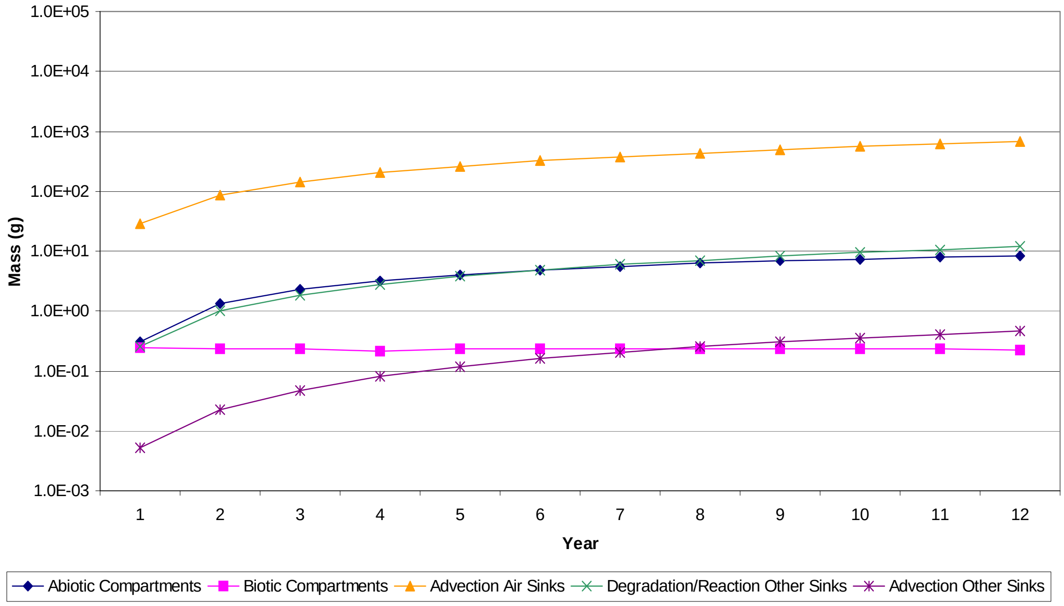


Figure E-18
1,2,3,4,6,7,8-HpCDF Mass: Distribution in Abiotic Compartments

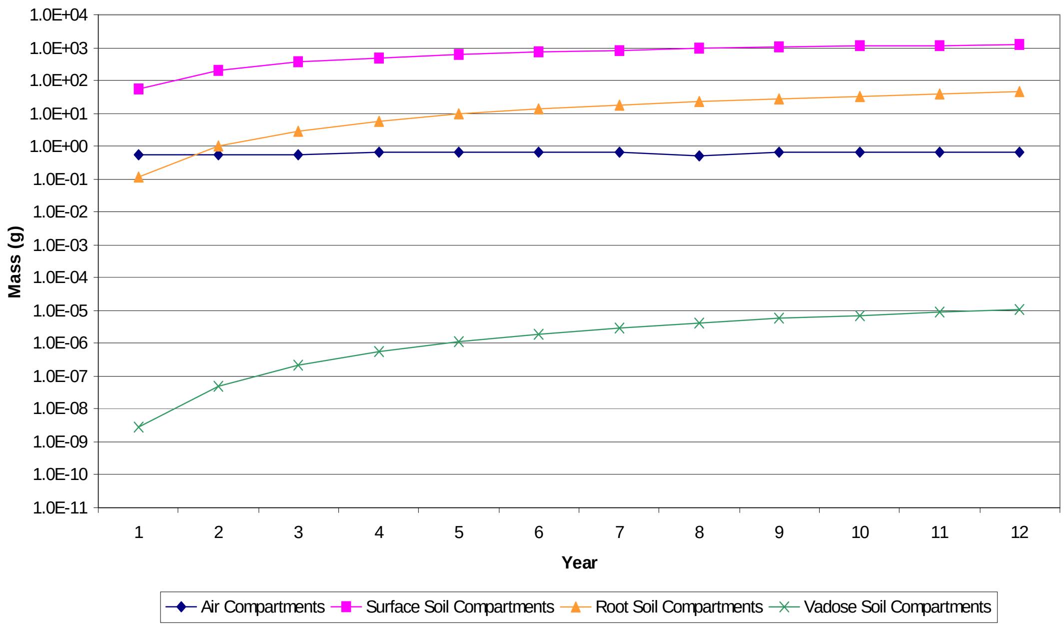


Figure E-19
1,2,3,4,7,8-HxCDD Mass: Distribution in Abiotic Compartments

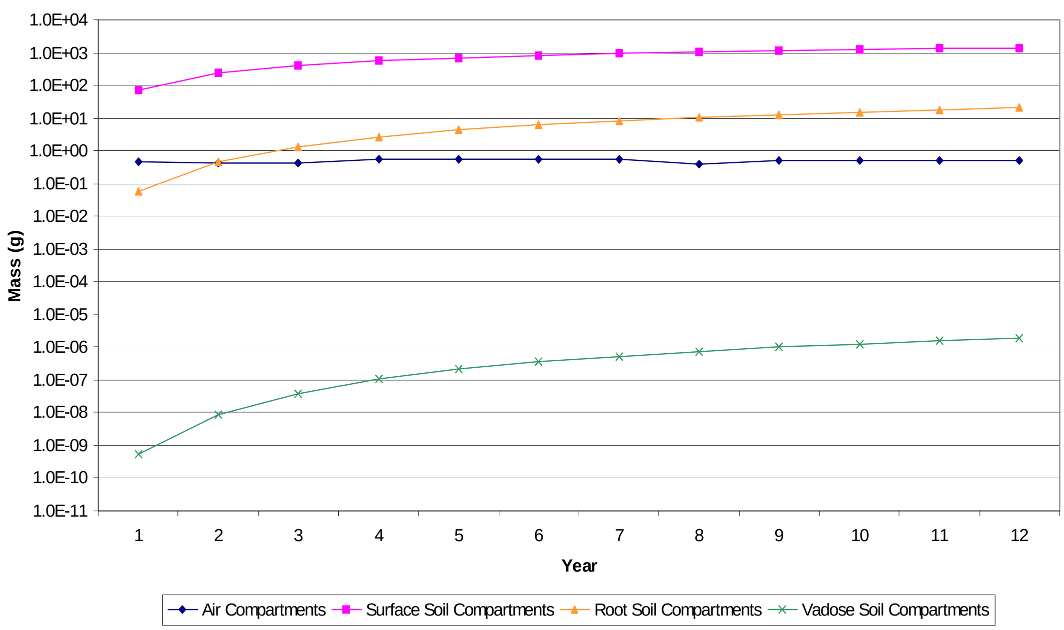


Figure E-20
1,2,3,4,6,7,8,9-OCDD Mass: Distribution in Abiotic Compartments

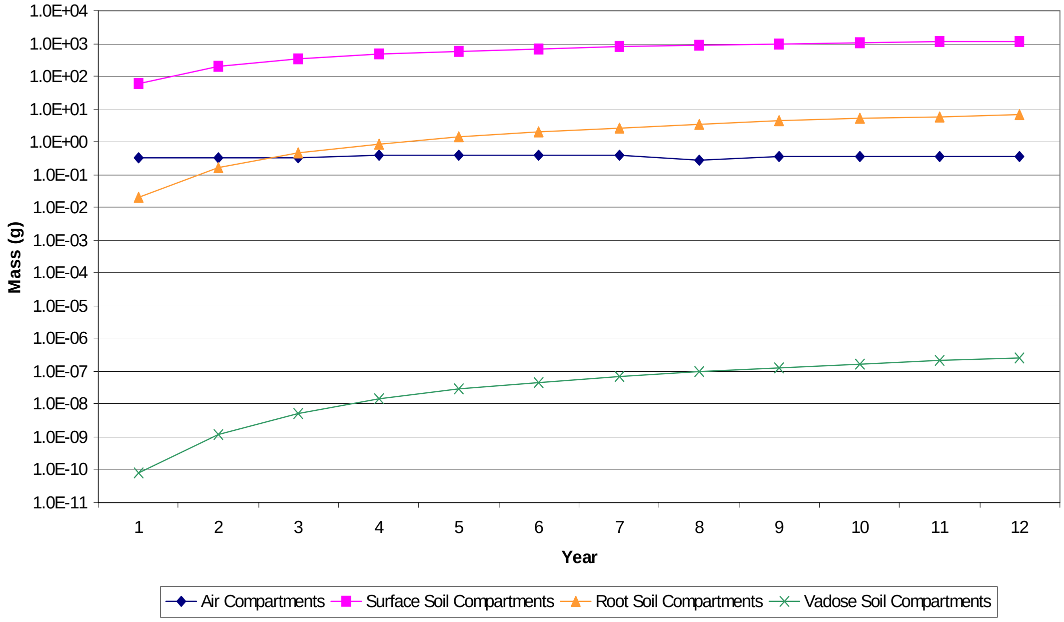


Figure E-21
1,2,3,4,6,7,8-HpCDD Mass: Distribution in Abiotic Compartments

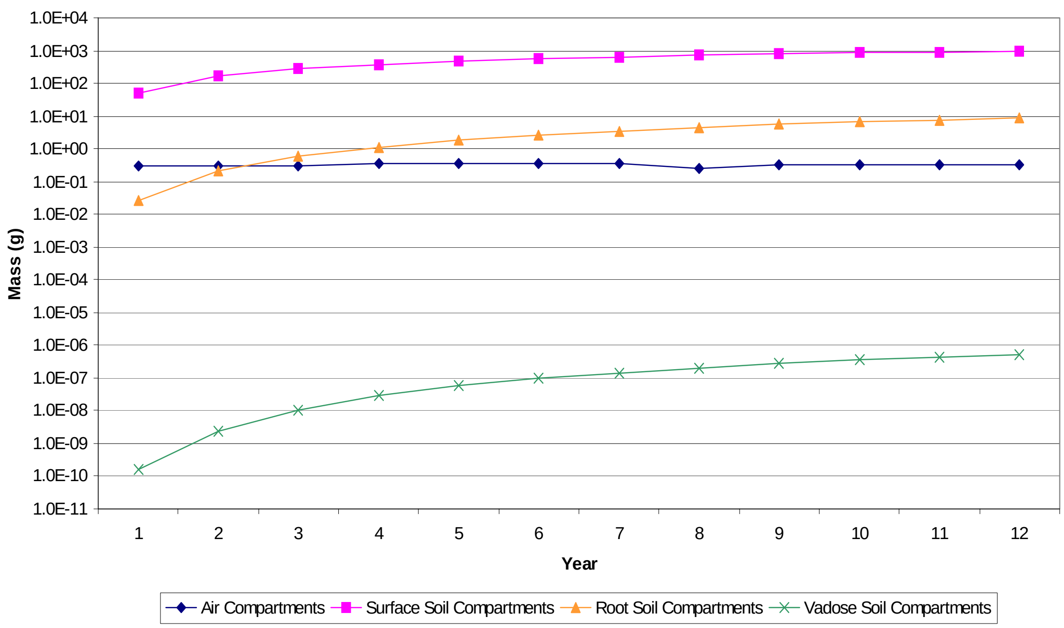


Figure E-22
2,3,4,6,7,8-HxCDF Mass: Distribution in Abiotic Compartments

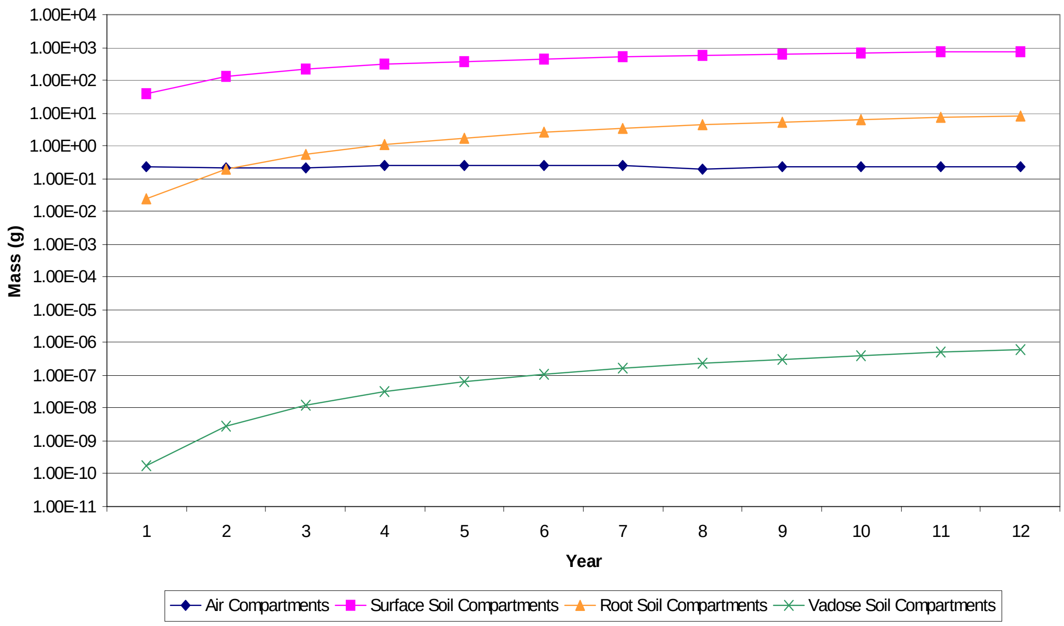


Figure E-23
1,2,3,6,7,8-HxCDF Mass: Distribution in Abiotic Compartments

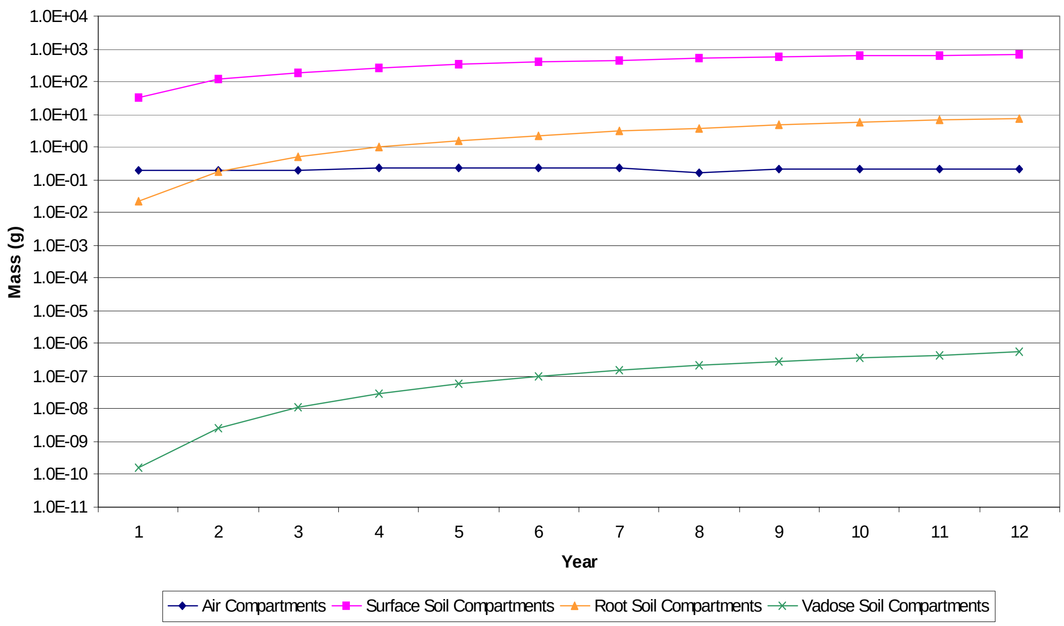


Figure E-24
1,2,3,4,6,7,8,9-OCDF Mass: Distribution in Abiotic Compartments

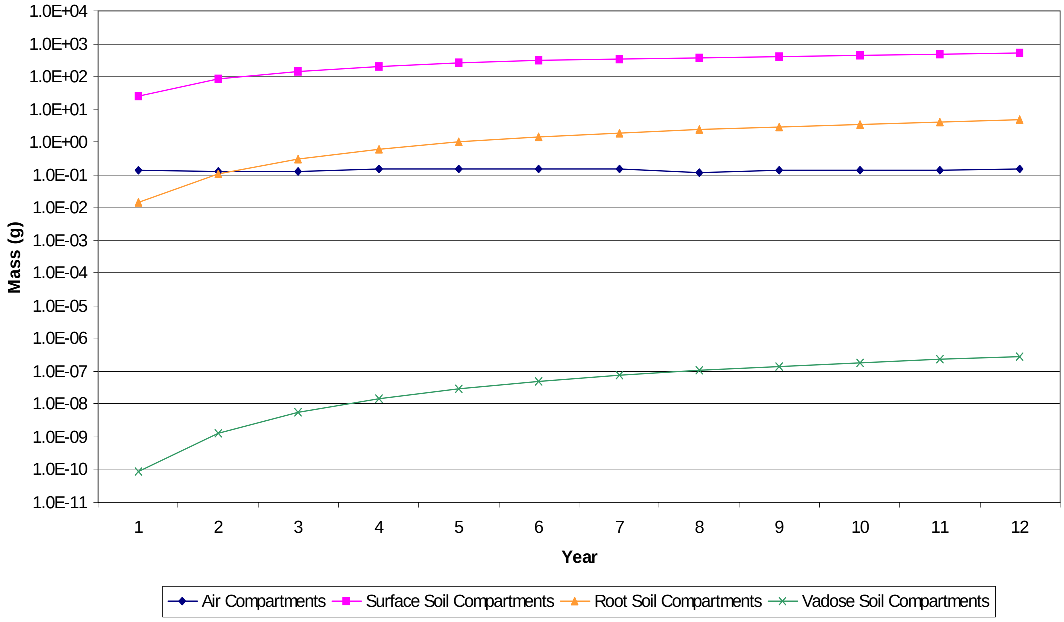


Figure E-25
1,2,3,4,7,8,9-HpCDF Mass: Distribution in Abiotic Compartments

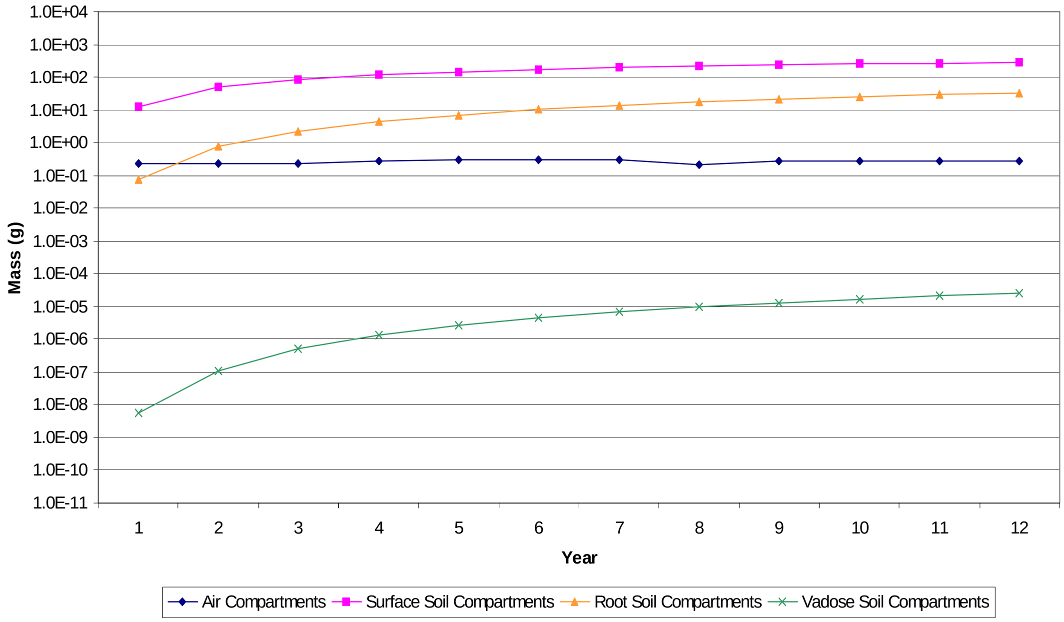


Figure E-26
1,2,3,4,7,8-HxCDF Mass: Distribution in Abiotic Compartments

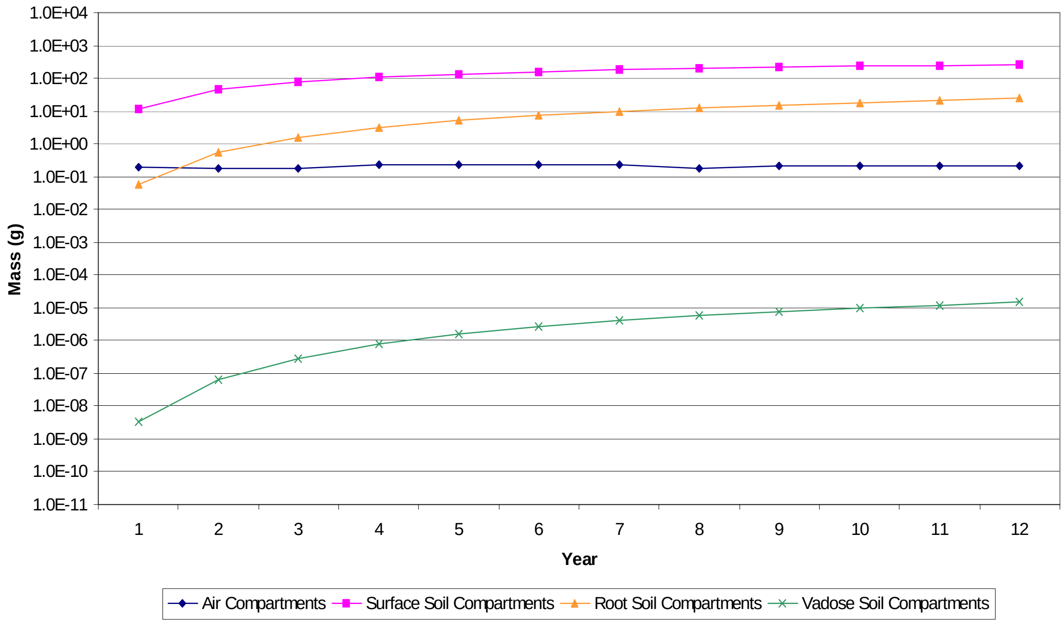


Figure E-27
1,2,3,7,8-PeCDF Mass: Distribution in Abiotic Compartments

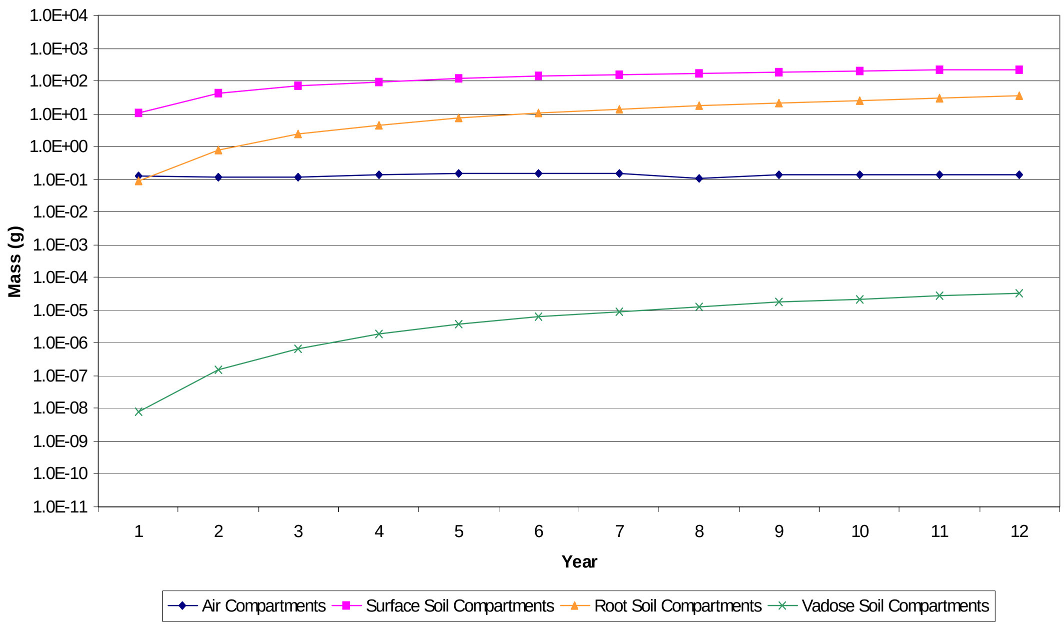


Figure E-28
2,3,4,7,8-PeCDF Mass: Distribution in Abiotic Compartments

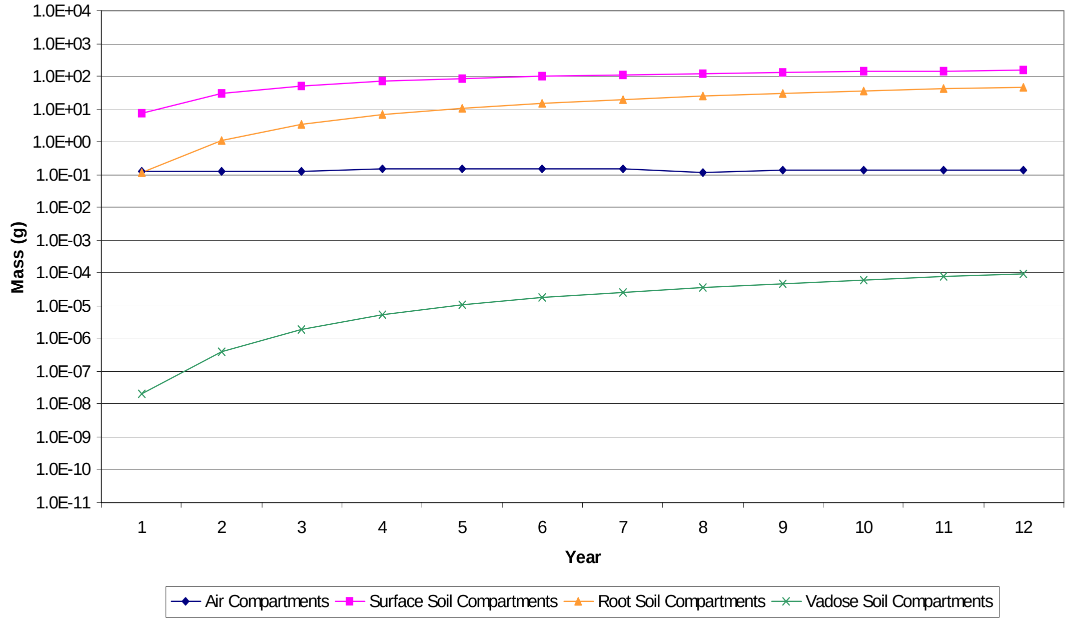


Figure E-29
1,2,3,6,7,8-HxCDD Mass: Distribution in Abiotic Compartments

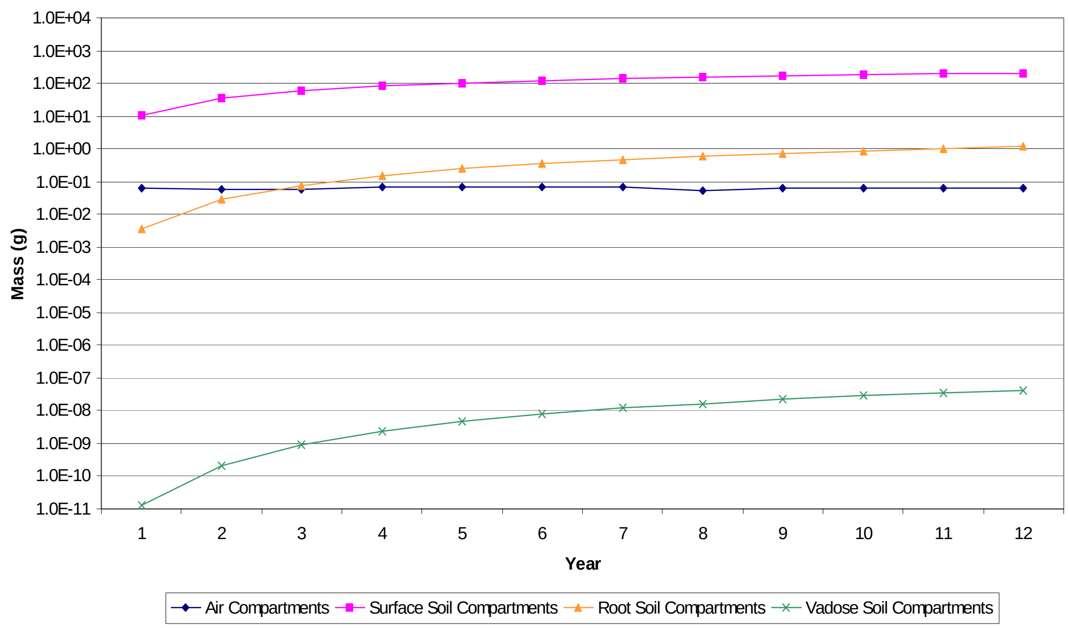


Figure E-30
1,2,3,7,8,9-HxCDD Mass: Distribution in Abiotic Compartments

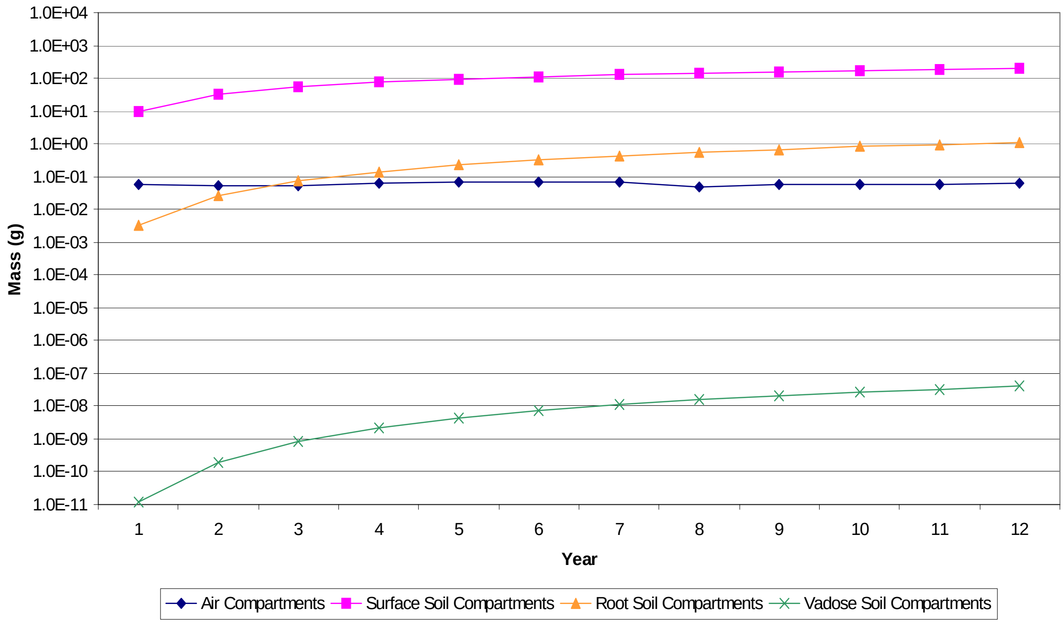


Figure E-31
1,2,3,7,8,9-HxCDF Mass: Distribution in Abiotic Compartments

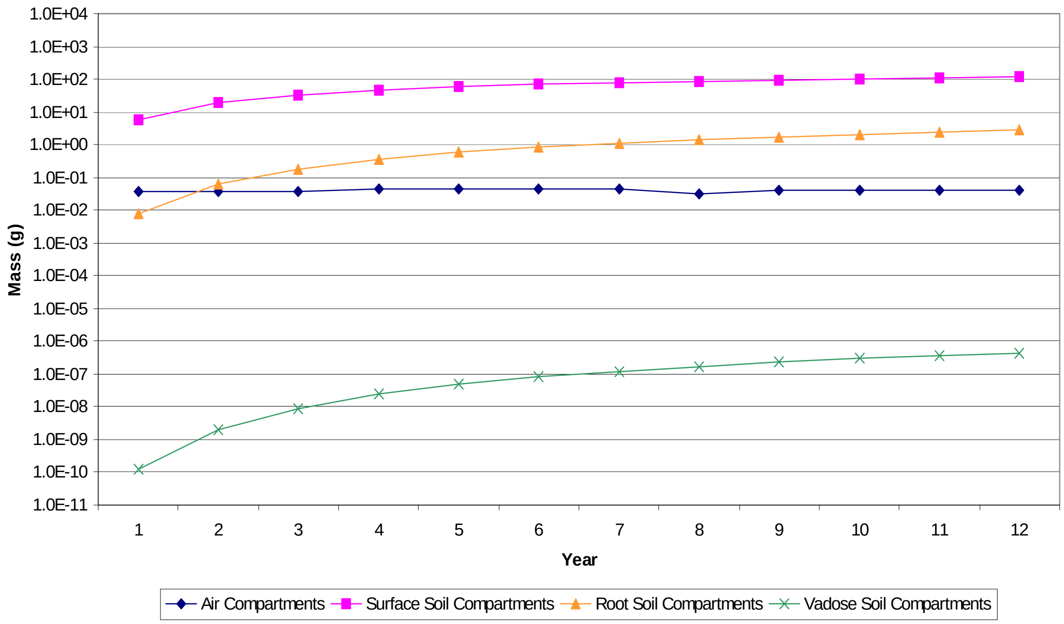


Figure E-32
1,2,3,7,8-PeCDD Mass: Distribution in Abiotic Compartments

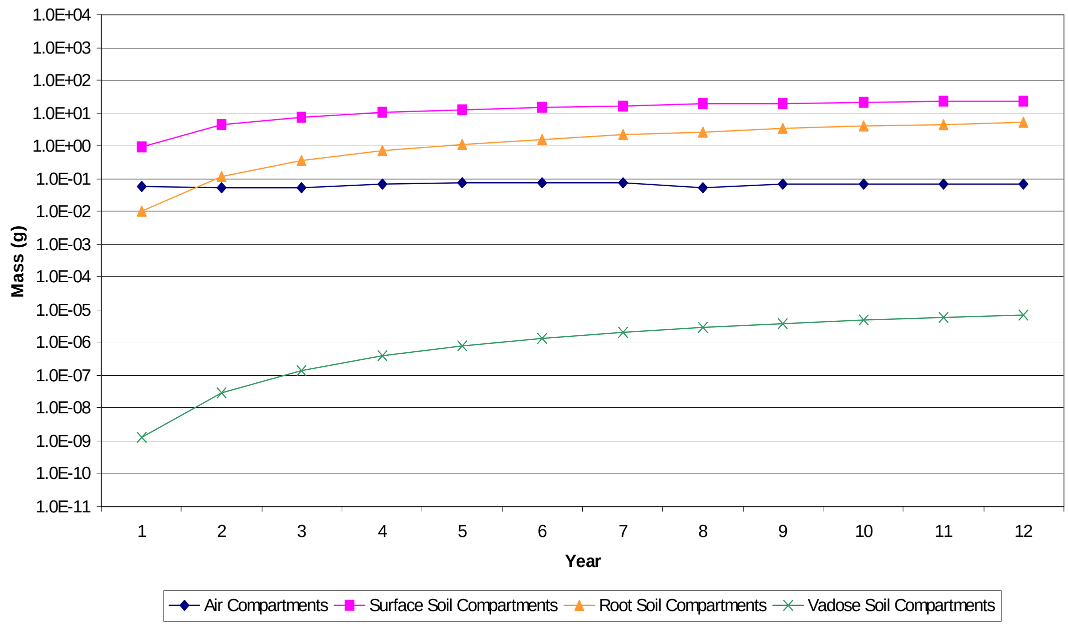


Figure E-33
2,3,7,8-TCDF Mass: Distribution in Abiotic Compartments

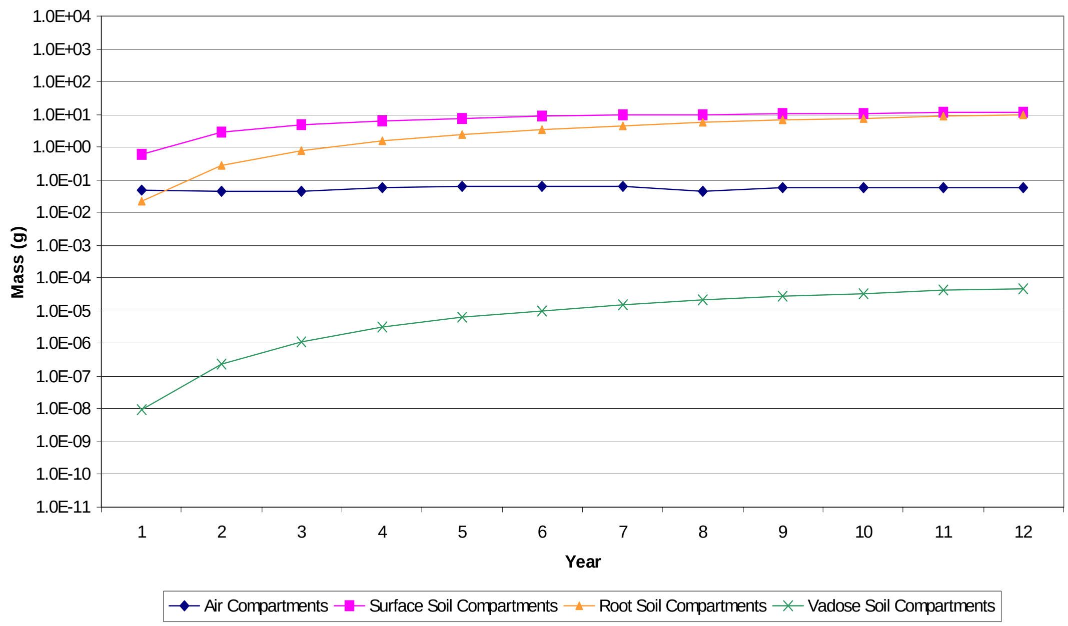
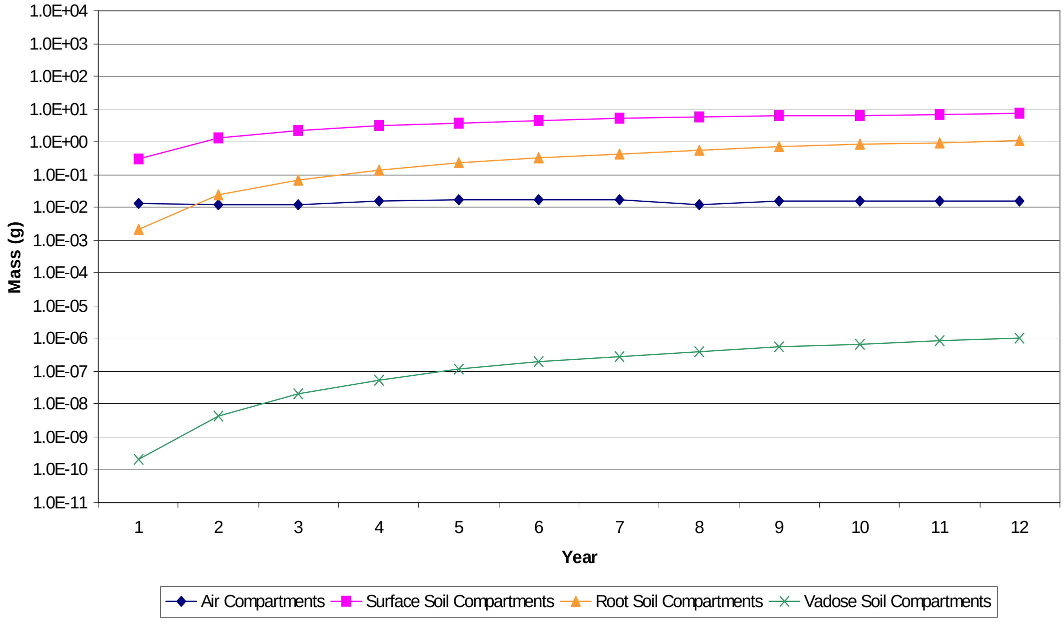


Figure E-34
2,3,7,8-TCDD Mass: Distribution in Abiotic Compartments



Appendix F
DOCUMENTATION OF TRIM.FaTE CONCENTRATION RESULTS - SPATIAL DISTRIBUTIONS

This appendix contains the following sets of tables for the following TRIM.FaTE results:

- annual average air TEQ concentrations using 1994 stack test emissions and 1994 meteorological data;
- average 48-hour air individual congener and TEQ concentrations using 1994 stack test emissions and 1994 meteorological data;
- annual average (for year 12 of the simulation) surface soil, root zone soil, vadose zone soil groundwater, and surface water TEQ concentrations using 1992 stack test emissions and 1989 meteorological data.

Total Dioxin TEQ Concentration: Air Compartments (1994 stack test emissions)

Air compartment	Annual Average TEQ Concentration (g/m3)
Source	8.3E-12
NNW1	1.5E-12
NNE1	1.4E-12
SSW1	1.2E-12
WNW1	1.2E-12
SSE1	1.2E-12
WSW1	1.1E-12
ENE1	1.0E-12
ESE1	1.0E-12
NNW2	7.6E-13
NNE2	7.5E-13
SSW2	5.9E-13
WNW2	5.8E-13
SSE2	5.7E-13
WSW2	5.7E-13
ENE2	5.0E-13
ESE2	4.6E-13
NNE3	2.6E-13
NNW3	2.5E-13
SSE3	1.9E-13
SSW3	1.9E-13
WSW3	1.9E-13
WNW3	1.8E-13
ESE3	1.6E-13
ENE3	1.4E-13
NNW4	8.8E-14
NNE4	8.7E-14
WSW4	6.2E-14
SSW4	6.2E-14
WNW4	5.7E-14
SSE4	5.6E-14
ESE4	5.2E-14
ENE4	4.9E-14

Individual Congeners and Total Dioxin TEQ Concentrations: Air Compartments (1994 stack test emissions)

Air compartment	Average 48-hour Concentration (ug/m3)							
	1,2,3,4,6,7,8,9-OCDD	1,2,3,4,6,7,8,9-OCDF	1,2,3,4,6,7,8 HpCDD	1,2,3,4,6,7,8 HpCDF	1,2,3,4,7,8,9 HpCDF	1,2,3,4,7,8 HxCDD	1,2,3,4,7,8 HxCDF	1,2,3,6,7,8 HxCDD
Source	1.2E-05	3.6E-06	5.2E-06	8.3E-06	6.2E-07	6.5E-07	1.3E-06	5.3E-07
ESE1	5.1E-06	1.6E-06	2.2E-06	3.5E-06	2.7E-07	2.8E-07	5.7E-07	2.3E-07
SSE1	4.8E-06	1.5E-06	2.1E-06	3.4E-06	2.5E-07	2.7E-07	5.5E-07	2.2E-07
ESE2	3.0E-06	9.1E-07	1.3E-06	2.1E-06	1.6E-07	1.6E-07	3.4E-07	1.3E-07
SSE2	2.7E-06	8.4E-07	1.2E-06	1.9E-06	1.4E-07	1.5E-07	3.1E-07	1.2E-07
ENE1	2.7E-06	8.1E-07	1.2E-06	1.8E-06	1.4E-07	1.5E-07	3.0E-07	1.2E-07
SSW1	2.5E-06	7.6E-07	1.1E-06	1.7E-06	1.3E-07	1.4E-07	2.8E-07	1.1E-07
ENE2	1.1E-06	3.4E-07	4.9E-07	7.7E-07	5.8E-08	6.1E-08	1.3E-07	5.0E-08
ESE3	1.1E-06	3.4E-07	4.8E-07	7.7E-07	5.8E-08	6.0E-08	1.2E-07	4.9E-08
SSE3	9.9E-07	3.0E-07	4.3E-07	6.9E-07	5.2E-08	5.4E-08	1.1E-07	4.4E-08
SSW2	9.9E-07	3.0E-07	4.4E-07	6.9E-07	5.2E-08	5.4E-08	1.1E-07	4.4E-08
ESE4	4.2E-07	1.3E-07	1.8E-07	3.0E-07	2.2E-08	2.3E-08	4.8E-08	1.9E-08
SSE4	4.0E-07	1.2E-07	1.8E-07	2.8E-07	2.1E-08	2.2E-08	4.6E-08	1.8E-08
ENE3	3.0E-07	9.1E-08	1.3E-07	2.1E-07	1.6E-08	1.6E-08	3.4E-08	1.3E-08
SSW3	2.5E-07	7.7E-08	1.1E-07	1.7E-07	1.3E-08	1.4E-08	2.8E-08	1.1E-08
NNE1	1.7E-07	5.1E-08	7.4E-08	1.2E-07	8.8E-09	9.2E-09	1.9E-08	7.5E-09
ENE4	8.8E-08	2.7E-08	3.9E-08	6.2E-08	4.7E-09	4.9E-09	1.0E-08	4.0E-09
WSW1	8.9E-08	2.7E-08	3.9E-08	6.2E-08	4.7E-09	4.9E-09	1.0E-08	4.0E-09
NNW1	7.7E-08	2.4E-08	3.4E-08	5.4E-08	4.0E-09	4.3E-09	8.7E-09	3.5E-09
SSW4	7.4E-08	2.3E-08	3.3E-08	5.2E-08	3.9E-09	4.1E-09	8.5E-09	3.3E-09
NNE2	7.3E-08	2.2E-08	3.2E-08	5.1E-08	3.8E-09	4.0E-09	8.3E-09	3.3E-09
WNW1	4.3E-08	1.3E-08	1.9E-08	3.0E-08	2.2E-09	2.3E-09	4.8E-09	1.9E-09
WSW2	2.4E-08	7.2E-09	1.0E-08	1.6E-08	1.2E-09	1.3E-09	2.7E-09	1.1E-09
NNW2	2.1E-08	6.5E-09	9.3E-09	1.5E-08	1.1E-09	1.2E-09	2.4E-09	9.5E-10
NNE3	1.6E-08	4.9E-09	7.0E-09	1.1E-08	8.3E-10	8.7E-10	1.8E-09	7.1E-10
WNW2	7.2E-09	2.2E-09	3.2E-09	5.0E-09	3.8E-10	4.0E-10	8.1E-10	3.2E-10
WSW3	3.4E-09	1.0E-09	1.5E-09	2.4E-09	1.8E-10	1.9E-10	3.9E-10	1.5E-10
NNW3	3.1E-09	9.5E-10	1.4E-09	2.2E-09	1.6E-10	1.7E-10	3.5E-10	1.4E-10
NNE4	2.1E-09	6.3E-10	9.1E-10	1.4E-09	1.1E-10	1.1E-10	2.3E-10	9.2E-11
WNW3	7.3E-10	2.2E-10	3.2E-10	5.1E-10	3.8E-11	4.0E-11	8.3E-11	3.3E-11
NNW4	3.8E-10	1.2E-10	1.7E-10	2.7E-10	2.0E-11	2.1E-11	4.4E-11	1.7E-11
WSW4	3.6E-10	1.1E-10	1.6E-10	2.5E-10	1.9E-11	2.0E-11	4.1E-11	1.6E-11
WNW4	7.6E-11	2.3E-11	3.3E-11	5.3E-11	4.0E-12	4.2E-12	8.6E-12	3.4E-12

Individual Congeners and Total Dioxin TEQ Concentrations: Air Compartments (1994 stack test emissions)

Air compartment	Average 48-hour Concentration (ug/m3)									
	1,2,3,6,7,8 HxCDF	1,2,3,7,8,9 HxCDD	1,2,3,7,8,9 HxCDF	1,2,3,7,8 PeCDD	1,2,3,7,8 PeCDF	2,3,4,6,7,8 HxCDF	2,3,4,7,8 PeCDF	2,3,7,8 TCDD	2,3,7,8 TCDF	TEQ
Source	1.2E-06	4.2E-07	5.3E-08	3.9E-07	3.5E-07	1.6E-06	6.4E-07	2.5E-08	1.6E-07	1.3E-06
ESE1	5.1E-07	1.8E-07	2.3E-08	1.7E-07	1.5E-07	7.0E-07	2.7E-07	1.1E-08	6.7E-08	5.6E-07
SSE1	4.9E-07	1.7E-07	2.2E-08	1.6E-07	1.4E-07	6.7E-07	2.6E-07	1.0E-08	6.4E-08	5.4E-07
ESE2	3.0E-07	1.1E-07	1.3E-08	9.9E-08	8.7E-08	4.1E-07	1.6E-07	6.3E-09	3.9E-08	3.3E-07
SSE2	2.8E-07	9.7E-08	1.2E-08	9.1E-08	8.0E-08	3.8E-07	1.5E-07	5.8E-09	3.6E-08	3.0E-07
ENE1	2.7E-07	9.4E-08	1.2E-08	8.8E-08	7.8E-08	3.7E-07	1.4E-07	5.6E-09	3.5E-08	2.9E-07
SSW1	2.5E-07	8.8E-08	1.1E-08	8.2E-08	7.3E-08	3.4E-07	1.3E-07	5.3E-09	3.3E-08	2.8E-07
ENE2	1.1E-07	3.9E-08	5.0E-09	3.7E-08	3.3E-08	1.5E-07	6.0E-08	2.4E-09	1.5E-08	1.2E-07
ESE3	1.1E-07	3.9E-08	4.9E-09	3.7E-08	3.2E-08	1.5E-07	5.9E-08	2.3E-09	1.5E-08	1.2E-07
SSE3	9.9E-08	3.5E-08	4.4E-09	3.3E-08	2.9E-08	1.4E-07	5.3E-08	2.1E-09	1.3E-08	1.1E-07
SSW2	9.9E-08	3.5E-08	4.4E-09	3.3E-08	2.9E-08	1.4E-07	5.3E-08	2.1E-09	1.3E-08	1.1E-07
ESE4	4.2E-08	1.5E-08	1.9E-09	1.4E-08	1.2E-08	5.8E-08	2.3E-08	9.0E-10	5.7E-09	4.7E-08
SSE4	4.0E-08	1.4E-08	1.8E-09	1.4E-08	1.2E-08	5.5E-08	2.2E-08	8.6E-10	5.4E-09	4.5E-08
ENE3	3.0E-08	1.0E-08	1.3E-09	9.9E-09	8.7E-09	4.1E-08	1.6E-08	6.3E-10	3.9E-09	3.3E-08
SSW3	2.5E-08	8.9E-09	1.1E-09	8.3E-09	7.4E-09	3.5E-08	1.3E-08	5.3E-10	3.3E-09	2.8E-08
NNE1	1.7E-08	5.9E-09	7.5E-10	5.6E-09	4.9E-09	2.3E-08	9.0E-09	3.5E-10	2.2E-09	1.9E-08
ENE4	8.9E-09	3.1E-09	4.0E-10	3.0E-09	2.6E-09	1.2E-08	4.8E-09	1.9E-10	1.2E-09	9.9E-09
WSW1	8.9E-09	3.1E-09	4.0E-10	3.0E-09	2.6E-09	1.2E-08	4.8E-09	1.9E-10	1.2E-09	9.8E-09
NNW1	7.8E-09	2.7E-09	3.5E-10	2.6E-09	2.3E-09	1.1E-08	4.2E-09	1.6E-10	1.0E-09	8.6E-09
SSW4	7.5E-09	2.6E-09	3.3E-10	2.5E-09	2.2E-09	1.0E-08	4.0E-09	1.6E-10	1.0E-09	8.3E-09
NNE2	7.3E-09	2.6E-09	3.3E-10	2.4E-09	2.1E-09	1.0E-08	3.9E-09	1.6E-10	9.7E-10	8.1E-09
WNW1	4.3E-09	1.5E-09	1.9E-10	1.4E-09	1.2E-09	5.9E-09	2.3E-09	9.0E-11	5.7E-10	4.7E-09
WSW2	2.4E-09	8.4E-10	1.1E-10	7.8E-10	6.9E-10	3.3E-09	1.3E-09	5.0E-11	3.1E-10	2.6E-09
NNW2	2.1E-09	7.5E-10	9.5E-11	7.0E-10	6.2E-10	2.9E-09	1.1E-09	4.5E-11	2.8E-10	2.3E-09
NNE3	1.6E-09	5.6E-10	7.1E-11	5.3E-10	4.7E-10	2.2E-09	8.6E-10	3.4E-11	2.1E-10	1.8E-09
WNW2	7.2E-10	2.6E-10	3.2E-11	2.4E-10	2.1E-10	1.0E-09	3.9E-10	1.5E-11	9.6E-11	8.0E-10
WSW3	3.4E-10	1.2E-10	1.5E-11	1.1E-10	1.0E-10	4.7E-10	1.8E-10	7.2E-12	4.5E-11	3.8E-10
NNW3	3.1E-10	1.1E-10	1.4E-11	1.0E-10	9.2E-11	4.3E-10	1.7E-10	6.6E-12	4.2E-11	3.5E-10
NNE4	2.1E-10	7.3E-11	9.3E-12	6.9E-11	6.1E-11	2.8E-10	1.1E-10	4.4E-12	2.8E-11	2.3E-10
WNW3	7.4E-11	2.6E-11	3.3E-12	2.4E-11	2.2E-11	1.0E-10	3.9E-11	1.6E-12	9.8E-12	8.1E-11
NNW4	3.8E-11	1.4E-11	1.7E-12	1.3E-11	1.1E-11	5.3E-11	2.1E-11	8.2E-13	5.1E-12	4.3E-11
WSW4	3.6E-11	1.3E-11	1.6E-12	1.2E-11	1.1E-11	5.0E-11	2.0E-11	7.7E-13	4.8E-12	4.0E-11
WNW4	7.6E-12	2.7E-12	3.4E-13	2.5E-12	2.2E-12	1.0E-11	4.1E-12	1.6E-13	1.0E-12	8.4E-12

Total Dioxin TEQ Concentration:
Soil, Groundwater, Surface Water and Sediment Compartments (1992 stack test emissions)

	Average Annual TEQ Concentration (Year 12)					
Compartment	Surface Soil	Root Zone Soil	Vadose Zone Soil	Groundwater	Surface Water	Sediment
	g/g dry weight	g/g dry weight	g/g dry weight	g/L	g/g dry weight	g/g dry weight
Source	1.6E-09	1.0E-12	7.3E-19	4.1E-25	N/A[a]	N/A[a]
W1	2.5E-10	2.2E-13	1.7E-19	9.9E-26		
N1	1.8E-10	1.5E-13	1.2E-19	6.7E-26		
SW1	1.4E-10	1.2E-13	9.4E-20	5.5E-26		
E1	1.1E-10	9.2E-14	7.1E-20	4.1E-26		
NWFarm	6.7E-11	4.8E-14	3.5E-20	2.0E-26		
NNW1	5.4E-11	4.7E-14	3.6E-20	2.1E-26		
WNW1	5.1E-11	4.4E-14	3.4E-20	2.0E-26		
WSW1	5.0E-11	4.7E-14	3.7E-20	2.2E-26		
SW2	4.9E-11	4.3E-14	3.3E-20	2.0E-26		
E2	3.2E-11	2.7E-14	2.1E-20	1.3E-26		
NNW2	2.2E-11	1.9E-14	1.5E-20	8.6E-27		
NW2	2.0E-11	1.7E-14	1.4E-20	8.0E-27		
WSW3	1.9E-11	1.8E-14	1.4E-20	8.6E-27		
NNW3	1.9E-11	1.7E-14	1.3E-20	7.7E-27		
NNE2	1.8E-11	1.6E-14	1.3E-20	7.5E-27		
WSW2	1.7E-11	1.7E-14	1.4E-20	8.2E-27		
NW3	1.6E-11	1.4E-14	1.1E-20	6.8E-27		
WNW3	1.6E-11	1.4E-14	1.1E-20	6.6E-27		
SW3	1.6E-11	1.4E-14	1.1E-20	6.5E-27		
SW4	1.5E-11	1.4E-14	1.1E-20	6.5E-27		
WNW2	1.5E-11	1.4E-14	1.1E-20	6.5E-27		
SE2	1.2E-11	1.0E-14	8.0E-21	4.7E-27		
SE3	1.2E-11	1.1E-14	8.5E-21	5.0E-27		
ESE2	1.1E-11	8.0E-15	6.0E-21	3.4E-27		
NE2	1.1E-11	8.8E-15	6.8E-21	4.0E-27		
ESE3	1.0E-11	8.8E-15	6.9E-21	4.1E-27		

[a]Surface water and sediment results are not included because an incorrect value for the RatioOfConcInAlgaeToConcDissolvedInWater property was used. This property does not significantly impact any of the other abiotic results used in this report; however, it does impact the dissolved surface water concentrations and sediment concentrations, and thus, these values are not reported.

Total Dioxin TEQ Concentration:
Calculated Soil Compartments at a Depth of 7.5 cm (1994 stack test emissions)

Compartment	Instantaneous TEQ Concentration (at Year 11.5)			
	Surface Soil	Root Zone Soil	Soil at 7.5 - minimum [a]	Soil at 7.5 - maximum [b]
	g/g dry weight	g/g dry weight	g/g dry weight	g/g dry weight
Source	2.8E-10	9.5E-14	3.7E-11	3.8E-11
W1	4.1E-11	1.9E-14	5.5E-12	5.7E-12
N1	3.0E-11	1.3E-14	4.0E-12	4.2E-12
SW1 [c]	2.2E-11	1.0E-14	3.0E-12	3.1E-12
E1 [c]	1.9E-11	8.0E-15	2.5E-12	2.6E-12
NWFarm [c]	1.1E-11	4.2E-15	1.5E-12	1.5E-12
NNW1 [c]	8.8E-12	4.0E-15	1.2E-12	1.2E-12
WNW1 [c]	8.3E-12	3.7E-15	1.1E-12	1.1E-12
WSW1 [c]	8.0E-12	3.9E-15	1.1E-12	1.1E-12
SW2 [c]	8.0E-12	3.6E-15	1.1E-12	1.1E-12
E2 [c]	5.3E-12	2.4E-15	7.1E-13	7.3E-13
NNW2 [c]	3.7E-12	1.6E-15	4.9E-13	5.0E-13
NW2 [c]	3.2E-12	1.5E-15	4.3E-13	4.5E-13
NNW3 [c]	3.1E-12	1.4E-15	4.1E-13	4.3E-13
WSW3 [c]	3.0E-12	1.5E-15	4.0E-13	4.2E-13
NNE2 [c]	2.9E-12	1.4E-15	3.9E-13	4.1E-13
WSW2 [c]	2.8E-12	1.4E-15	3.7E-13	3.8E-13
NW3 [c]	2.6E-12	1.2E-15	3.5E-13	3.7E-13
WNW3 [c]	2.6E-12	1.2E-15	3.5E-13	3.6E-13
SW3 [c]	2.6E-12	1.2E-15	3.4E-13	3.5E-13
SW4 [c]	2.5E-12	1.2E-15	3.3E-13	3.4E-13
WNW2 [c]	2.5E-12	1.2E-15	3.3E-13	3.4E-13
SE2 [c]	2.1E-12	8.9E-16	2.7E-13	2.8E-13
SE3 [c]	2.0E-12	9.2E-16	2.7E-13	2.8E-13
ESE2 [c]	1.8E-12	7.0E-16	2.4E-13	2.5E-13
NE2 [c]	1.7E-12	7.6E-16	2.3E-13	2.4E-13
ESE3 [c]	1.7E-12	7.6E-16	2.3E-13	2.3E-13

[a] Soil concentration calculated by dividing the surface soil concentration (i.e., total mass/volume) by 7.5

[b] Soil concentration calculated by dividing the total mass in the surface and root zone soil compartments by the volume to a depth of 7.5 cm

[c] Concentrations for this compartment are below the background concentration (4E-12 g/g) presented in Lorber et al. (2000)