APPENDIX B

MEDIA CONCENTRATION CALCULATIONS

Table B1-1. Benzene Summary

	Concentration from Project	Background Concentration[1]	Total Concentration (Background & Project)	Ecological Screening Level[2]	Total Concentration Percent of ESL	Ecological Screening Quotient
Soil (mg/kg)	2.32E-08	N/A	N/A	2.55E-01	N/A	0.00
Water (mg/L)	1.79E-15	1.00E-03	1.00E-03	1.14E-01	0.88%	N/A
Sediment (mg/kg)	4.43E-15	N/A	N/A	1.42E-01	N/A	0.00

Notes:

[1] Water background concentration assumed to be the average concentration from water samples in or near Jefferson County, obtained from the IEPA on 01/19/11 via J. Schewe of Falcon Engineering.

[2] U.S. EPA Region 5 Waste Division, RCRA Corrective Action Guidance and Policy Documents, Ecological Screening Levels, August 22, 2003 available at http://www.epa.gov/reg5rcra/ca/guidance.htm.

Table B1-2. Benzene Soil Concentration

$Cs = Ds * [1 - exp(-ks * tD)] / ks$		
Cs	**2.32E-08**	Benzene concentration in soil (mg benzene/kg soil)
tD	**1.00E+02**	Time period over which deposition occurs (yr) (default value from SLERA Protocol Table B-1-1)
Ds	**1.28E-05**	Deposition term (mg benzene/kg soil/yr)
$Ds = 100/(Z_s * BD) * [F_v (Dydv + Dywv) + (Dywp + Dydp) * (1 - F_v)]$		
	1.00E+02	Units conversion factor (m^2-mg/cm^2-kg)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-1, use 1 cm for untilled and 20 cm tilled soil)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-1)
F_v	1.00E+00	Fraction of benzene air concentration in vapor phase (SLERA Protocol Table A-2-18)
Dydv + Dywv	3.83E-06	Maximum yearly average total (wet+dry) deposition from vapor phase from model (g/m^2-yr)
Dywp + Dydp	-	Maximum yearly average total (wet+dry) deposition from particle phase from model (g/m^2-yr)
ks	**5.49E+02**	benzene soil loss constant due to all soil processes (yr-1)
ks = ksg + kse + ksr + ksl + ksv		
ksg	3.89E+00	Benzene loss constant due to biotic and abiotic degradation (yr-1) (SLERA Protocol Table A-2-18)
kse	0.00E+00	Benzene loss constant due to soil erosion (yr-1) (default value from SLERA Protocol Table B-1-2)
ksr	1.12E+00	Benzene loss constant due to surface runoff (yr-1)
ksl	0.00E+00	Benzene loss constant due to leaching (yr-1)
ksv	5.44E+02	Benzene loss constant due to volatilization (yr-1)
ksr	**1.12E+00**	Benzene loss constant due to surface runoff (yr-1)
$ksr = RO / (\theta_{sw} * Z_s) * \{1/[1 + (Kd_s * BD/\theta_{sw})]\}$		
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS Groundwater Atlas of the United States: Illinois, Indiana, Kentucky, Ohio, Tennessee available at http://pubs.usgs.gov/ha/ha730/ch_k/k-regionalsum.html)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-4)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-4, use 1 cm for untilled and 20 cm tilled soil)
Kd_s	6.20E-01	Soil-water partition coefficient (mL/g) (SLERA Protocol Table A-2-18)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-4)
ksl	**0.00E+00**	Benzene loss constant due to leaching (yr-1)
$ksl = (P + I - RO - E_v) / \{\theta_{sw} * Z_s * [1.0 + (BD * Kd_s / \theta_{sw})]\}$		
P	1.02E+02	Annual average precipitation (cm/yr) (NOAA, Local Climatological Data, Normal Yearly Precipitation)
I	0.00E+00	Average annual irrigation (cm/yr) (Baes Reference to SLERA Protocol Table B-1-5, Assumed due to low
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS Groundwater Atlas of the United States: Illinois, Indiana, Kentucky, Ohio, Tennessee available at http://pubs.usgs.gov/ha/ha730/ch_k/k-regionalsum.html)
E_v	7.62E+01	Average annual evapotranspiration (cm/yr) (Baes Reference to SLERA Protocol Table B-1-5)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-5)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-5, use 1 cm for untilled and 20 cm tilled soil)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-5)
Kd_s	6.20E-01	Soil-water partition coefficient (mL/g) (SLERA Protocol Table A-2-18)
ksv	**5.44E+02**	Benzene loss constant due to volatilization (yr-1)
$ksv = [3.1536 \times 10^7 * H / (Z_s * Kd_s * R * T_a * BD)] * [D_a / Z_s] * [1 - (BD/\rho_s) - \theta_{sw}]$		
	3.15E+07	Units conversion factor (s/yr)
H	5.49E-03	Henry's Law constant (atm-m3/mol) (SLERA Protocol Table A-2-18)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-6, use 1 cm for untilled and 20 cm tilled soil)
Kd_s	6.20E-01	Soil-water partition coefficient (mL/g) (SLERA Protocol Table A-2-18)
R	8.21E-05	Universal gas constant (atm-m^3/mol-K)
T_a	2.98E+02	Ambient air temperature (K) (default value from SLERA Protocol Table B-1-6)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-6)
ρ_s	2.70E+00	Solids particle density (g/cm^3) (default value from SLERA Protocol Table B-1-6)
D_a	1.17E-01	Diffusivity of Benzene in air (cm2/s) (SLERA Protocol Table A-2-18)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-6)

Table B1-3. Benzene Load to Water Body

$L_T = L_{DEP} + L_{Dif} + L_{RI} + L_R + L_E + L_I$		
L_T	**3.24E+02**	Total COPC load to the water body (including deposition, runoff, and erosion) (g/yr)
L_{DEP}	**2.29E+02**	Total (wet and dry) particle phase and wet vapor phase COPC direct deposition load to water body (g/yr)
$L_{DEP} = A_w * [F_v * Dwvp + (1-F_v) * Dwdpp]$		
A_w	5.98E+07	Water body surface area (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
F_v	1.00E+00	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-18)
Dwvp	3.83E-06	Yearly average wet deposition from vapor phase from model (over water body)(g/m^2-yr)
Dwdpp	0.00E+00	Yearly average total (wet and dry) deposition from particle phase from model (over water body) (g/m^2-yr)
L_{Dif}	**5.58E-05**	Vapor phase COPC diffusion (dry deposition) load to water body (g/yr)
$L_{Dif} = (K_v * F_v * Cvp * 1.0 \times 10^{-6})/(H/(R*T_{wk}))$		
K_v	8.69E+02	Overall transfer rate coefficient (m/yr)
F_v	1.00E+00	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-18)
Cvp	1.44E-02	Yearly average air concentration from vapor phase from model (over water body) (mg/m^3)
H	5.49E-03	Henry's Law constant (atm-m3/mol) (SLERA Protocol Table A-2-18)
R	8.21E-05	Universal gas constant (atm-m^3/mol-K)
T_{wk}	2.98E+02	Water body temperature (K) (default value from SLERA Protocol Table B-2-3)
L_{RI}	**8.35E+01**	Runoff load from impervious sources (g/yr)
$L_{RI} = A_I * [F_v * Dwvp + (1-F_v) * Dwdpp]$		
F_v	1.00E+00	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-18)
Dwvp	3.83E-06	Yearly average wet deposition from vapor phase from model (over water body)(g/m^2-yr)
Dwdpp	0.00E+00	Yearly average total (wet and dry) deposition from particle phase from model (over water body) (g/m^2-yr)
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
L_R	**1.17E+01**	Runoff load from pervious sources (g/yr)
$L_R = RO * (A_L - A_I) * [(Cs * BD)/(\theta_{sw} + Kd_s * BD)] * 0.01$		
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS Groundwater Atlas of the United States: Illinois, Indiana, Kentucky, Ohio, Tennessee available at http://pubs.usgs.gov/ha/ha730/ch_k/k-regionalsum.html)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
Cs	2.32E-08	COPC concentration in soil (mg/kg)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-2-5)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-2-5)
Kd_s	6.20E-01	Soil-water partition coefficient (cm3/g) (SLERA Protocol Table A-2-18)
	1.00E-02	Units conversion factor (kg-cm^2/mg-m^2)
L_E	**1.85E-01**	Soil erosion load (g/yr)
$L_E = X_e * (A_L - A_I) * SD * ER * [(Cs * Kd_s * BD)/(\theta_{sw} + Kd_s * BD)] * 0.001$		
X_e	2.54E+01	Unit soil loss (kg/m^2-yr)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
SD	8.55E-02	Watershed sediment delivery ratio (unitless)
ER	3.00E+00	Soil enrichment ratio (unitless) (Per SLERA Protocol Table B-2-6, value is 1 for Inorganic COPC's and 3 for Organic COPC's)
Cs	2.32E-08	COPC concentration in soil (mg/kg)
Kd_s	6.20E-01	Soil-water partition coefficient (cm3/g) (SLERA Protocol Table A-2-18)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-2-6)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-2-6)
	1.00E-03	Units conversion factor (g/mg)
L_I	**0.00E+00**	Internal transfer load (g/yr) (default value from SLERA Protocol Section 3.11.2.1)
X_e	**2.54E+01**	Unit soil loss (kg/m^2-yr)
$X_e = RF * K * LS * C * PF * (907.18/4047)$		
RF	3.00E+02	Universal Soil Loss Equation (USLE) rainfall (or erosivity) factor (yr^{-1}) (Highest value from range listed in SLERA Protocol Table B-2-7)
K	3.60E-01	USLE erodibility factor (ton/acre) (Default value from SLERA Protocol Table B-2-7[1])
LS	1.50E+00	USLE length-slope factor (unitless) (default value for representative watershed from SLERA Protocol Table B-2-7[2])
C	7.00E-01	USLE cover management factor (unitless)(Value based on agricultural row cropland from SLERA Protocol Table B-2-7)
PF	1.00E+00	USLE supporting practice factor (unitless) (Assumes no erosion control measures are in place)
	9.07E+02	Units conversion factor (kg/ton)
	4.05E+03	Units conversion factor (m^2/acre)
SD	**8.55E-02**	Watershed sediment delivery ratio (unitless)
$SD = a * (A_L)^{-b}$		
a	1.20E+00	Empirical intercept coefficient (unitless) (Value from Table B-2-8 based on watershed area[3])
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
b	1.25E-01	Empirical slope coefficient (unitless) (default value from Table B-2-8)

[1]Based on other available data, silty loam soils such as those found in this watershed have K values ranging from 0.25 - 0.4.

[2]Majority of watershed area has slopes 0% - 10%, therefore default value of 1.5 LS is used.

[3]Watershed area estimated to be receiving COPC is between 10 and 100 square miles.

Table B1-4. Benzene Water Body Concentration

$C_{w,tot} = L_T / [Vf_s * f_{wc} + k_{wt} * A_W * (d_{wc} + d_{bs})]$		
C_{wtot}	**2.04E-15**	Total water body COPC concentration, including water column and bed sediment (mg/L)
L_T	**3.24E+02**	Total COPC load to the water body (including deposition, runoff, and erosion) (g/yr)
Vf_s	**1.32E+08**	Average volumetric flow rate through water body (m^3/yr)
f_{wc}	**8.15E-01**	Fraction of total water body COPC concentration that occurs in the water column (unitless)
$f_{wc} = [(1 + Kd_{ss} * TSS * 10^{-6}) * d_{wc}/d_z] / [(1 + Kd_{ss} * TSS * 1 \times 10^{-6}) * d_{wc}/d_z + (q_{bs} + Kd_{bs} * BS) * d_{bs}/d_z]$		
$f_{bs} = 1 - f_{wc}$		
f_{bs}	1.85E-01	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
Kd_{ss}	4.65E+00	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-18)
TSS	3.00E+02	Total suspended solids concentration (mg/L)(High value for range listed in SLERA Protocol Table B-2-10[2])
	1.00E-06	Units conversion factor (kg/mg)
d_{wc}	4.05E-01	Depth of water column (m)[3]
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-10)
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-10, $d_z = d_{wc} + d_{bs}$)
BS	1.00E+00	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-10)
q_{bs}	6.00E-01	Bed sediment porosity ($L_{water}/L_{sediment}$) (default value from SLERA Protocol Table B-2-10)
Kd_{bs}	2.48E+00	Bed sediment/sediment pore water partition coefficient (L/kg) (SLERA Protocol Table A-2-18)
k_{wt}	**6.09E+09**	Overall total water body COPC dissipation rate constant (yr^{-1})[4]
$k_{wt} = f_{wc} * k_v + f_{bs} * k_b$		
f_{wc}	8.15E-01	Fraction of total water body COPC concentration that occurs in the water column (unitless)
k_v	1.99E+03	Water column volatilization rate constant (yr^{-1})
f_{bs}	1.85E-01	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
k_b	3.28E+10	Benthic burial rate constant (yr^{-1})
A_W	**5.98E+07**	Water body surface area (m^2)
k_v	**1.99E+03**	Water column volatilization rate constant (yr^{-1})
$k_v = K_v / [d_z * (1 + Kd_{ss} * TSS * 10^{-6})]$		
K_v	8.69E+02	Overall COPC transfer rate coefficient (m/yr)
d_{wc}	4.05E-01	Depth of water column (m)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from Table B-2-12)
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-12, $d_z = d_{wc} + d_{bs}$)
Kd_{ss}	4.65E+00	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-18)
TSS	3.00E+02	Total suspended solids concentration (mg/L)
	1.00E-06	Units conversion factor (kg/mg)
K_v	**8.69E+02**	Overall COPC transfer rate coefficient (m/yr)
$K_v = \{K_L^{-1} + [K_G * H/(R * T_{wk})]^{-1}\}^{-1} * q^{(Twk - 293)}$		
K_L	8.43E+02	Liquid-phase transfer coefficient (m/yr)
K_G	3.65E+04	Gas-phase transfer coefficient (m/yr)
H	5.49E-03	Henry's Law constant (atm-m3/mol) (SLERA Protocol Table A-2-18)
R	8.21E-05	Universal gas constant (atm-m^3/mol-K)
T_{wk}	2.98E+02	Water body temperature (K) (default value from SLERA Protocol Table B-2-13)
q	1.03E+00	Temperature correction factor (unitless) (default value from SLERA Protocol Table B-2-13)
K_L	**8.43E+02**	Liquid-phase transfer coefficient for flowing streams or rivers (m/yr)
$K_L = SQRT(10^{-4} * D_w * u / d_z) * 3.1536 \times 10^7$		
D_w	1.02E-05	Diffusivity of COPC in water (cm^2/s) (SLERA Protocol Table A-2-175)
u	3.05E-01	Current velocity (m/s)[5]
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-14, $d_z = d_{wc} + d_{bs}$)
	3.15E+07	Units conversion constant (s/yr)
K_G	**3.65E+04**	Gas-phase transfer coefficient for flowing streams or rivers (m/yr) (default value from SLERA Protocol Table B-2-15)
k_b	**3.28E+10**	Benthic burial rate constant (yr^{-1})
$k_b = [X_e * A_L * SD * 10^3 - Vf_s * TSS / (A_W * TSS)] * [TSS * 10^{-6} / (BS * d_{bs})]$		
X_e	2.54E+01	Unit soil loss (kg/m^2-yr)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2)
SD	8.55E-02	Watershed sediment delivery ratio (unitless)
Vf_s	1.32E+08	Average volumetric flow rate through water body (m^3/yr)
TSS	3.00E+02	Total suspended solids concentration (mg/L)
A_W	5.98E+07	Water body surface area (m^2)
BS	1.00E+00	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-16)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-16)

Notes:

[1]Assume pH = 8.0 based on water quality data provided by EPA Region 5

[2]Values found for data from Mississippi River near St. Louis range from 50-350 mg/L, therefore used high end of SLERA default range.

[3]Based on minimum depth required by Corps of Engineers

[4]Assume COPC does not dissipate based on Henry's Law constant of zero.

[5]Current velocity ranges from 3-7 ft/s based on information from several sources.

Table B1-5. Benzene Concentration in Water Column

$C_{wctot} = f_{wc} * C_{wtot} * (d_{wc} + d_{bs}) / d_{wc}$		
C_{wctot}	**1.79E-15**	Total COPC concentration in water column (mg/L)
f_{wc}	8.15E-01	Fraction of total water body COPC concentration that occurs in the water column (unitless)
C_{wtot}	2.04E-15	Total water body COPC concentration, including water column and bed sediment (mg/L)
d_{wc}	4.05E-01	Depth of water column (m)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-17)

Table B1-6. Benzene Dissolved Phase Water Concentration

$C_{dw} = C_{wctot} / (1+Kd_{sw}*TSS*10^{-6})$			
C_{dw}		**1.79E-15**	Dissolved phase water concentration (mg/L)
	C_{wctot}	1.79E-15	Total COPC concentration in water column (mg/L)
	Kd_{sw}	4.65E+00	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-18)
	TSS	3.00E+02	Total suspended solids concentration (mg/L)

Table B1-7. Benzene Concentration in Bed Sediment

$C_{sed} = f_{bs} * C_{wtot} * [Kd_{bs}/(q_{bs} + Kd_{bs} * BS)] * [(d_{wc} + d_{bs})/d_{bs}]$		
C_{sed}	**4.43E-15**	COPC concentration in bed sediment (mg/kg)
f_{bs}	**1.85E-01**	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
C_{wtot}	**2.04E-15**	Total water body COPC concentration, including water column and bed sediment (mg/L)
Kd_{bs}	**2.48E+00**	Bed sediment/sediment pore water partition coefficient (L/kg) (SLERA Protocol Table A-2-18)
q_{bs}	**6.00E-01**	Bed sediment porosity ($L_{water}/L_{sediment}$) (default value from SLERA Protocol Table B-2-10)
BS	**1.00E+00**	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-10)
d_{wc}	**4.05E-01**	Depth of water column (m)*
d_{bs}	**3.00E-02**	Depth of upper benthic sediment layer (m) (default value from Table B-2-12)

Table B2-1. Methylene Chloride Summary

	Concentration from Project	Background Concentration	Total Concentration (Background & Project)	Ecological Screening Level[1]	Total Concentration Percent of ESL	Ecological Screening Quotient
Soil (mg/kg)	1.25E-06	N/A	N/A	4.05E+00	N/A	0.00
Water (mg/L)	6.04E-13	N/A	N/A	9.40E-01	N/A	0.00
Sediment (mg/kg)	2.42E-13	N/A	N/A	1.59E-01	N/A	0.00

Notes:

[1] U.S. EPA Region 5 Waste Division, RCRA Corrective Action Guidance and Policy Documents, Ecological Screening Levels, August 22, 2003 available at http://www.epa.gov/reg5rcra/ca/guidance.htm.

Table B2-2. Methylene Chloride Soil Concentration

$Cs = Ds * [1 - exp(-ks * tD)] / ks$		
Cs	**1.25E-06**	Methylene chloride concentration in soil (mg methylene chloride/kg soil)
tD	**1.00E+02**	Time period over which deposition occurs (yr) (default value from SLERA Protocol Table B-1-1)
Ds	**1.37E-03**	Deposition term (mg methylene chloride/kg soil/yr)
$Ds = 100/(Z_s * BD) * [F_v (Dydv + Dywv) + (Dywp + Dydp) * (1 - F_v)]$		
	1.00E+02	Units conversion factor (m^2-mg/cm^2-kg)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-1, use 1 cm for untilled and 20 cm tilled soil)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-1)
F_v	1.00E+00	Fraction of methylene chloride air concentration in vapor phase (SLERA Protocol Table A-2-143)
Dydv + Dywv	4.11E-04	Maximum yearly average total (wet+dry) deposition from vapor phase from model (g/m^2-yr)
Dywp + Dydp	-	Maximum yearly average total (wet+dry) deposition from particle phase from model (g/m^2-yr)
ks	**1.10E+03**	Methylene chloride soil loss constant due to all soil processes (yr^{-1})
ks = ksg + kse + ksr + ksl + ksv		
ksg	9.03E+00	Methylene chloride loss constant due to biotic and abiotic degradation (yr-1) (SLERA Protocol Table A-2-143)
kse	0.00E+00	Methylene chloride loss constant due to soil erosion (yr-1) (default value from SLERA Protocol Table B-1-2)
ksr	3.63E+00	Methylene chloride loss constant due to surface runoff (yr-1)
ksl	0.00E+00	Methylene chloride loss constant due to leaching (yr-1)
ksv	1.09E+03	Methylene chloride loss constant due to volatilization (yr-1)
ksr	**3.63E+00**	Methylene chloride loss constant due to surface runoff (yr-1)
$ksr = RO / (\theta_{sw} * Z_s) * \{1/[1 + (Kd_s * BD/\theta_{sw})]\}$		
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS Groundwater Atlas of the United States: Illinois, Indiana, Kentucky, Ohio, Tennessee available at http://pubs.usgs.gov/ha/ha730/ch_k/k-regionalsum.html)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-4)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-4, use 1 cm for untilled and 20 cm tilled soil)
Kd_s	1.00E-01	Soil-water partition coefficient (mL/g) (SLERA Protocol Table A-2-143)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-4)
ksl	**0.00E+00**	Methylene chloride loss constant due to leaching (yr-1)
$ksl = (P + I - RO - E_v) / \{\theta_{sw} * Z_s * [1.0 + (BD * Kd_s / \theta_{sw})]\}$		
P	1.02E+02	Annual average precipitation (cm/yr) (NOAA, Local Climatological Data, Normal Yearly Precipitation)
I	0.00E+00	Average annual irrigation (cm/yr) (Baes Reference to SLERA Protocol Table B-1-5, Assumed due to low irrigation
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS Groundwater Atlas of the United States: Illinois, Indiana, Kentucky, Ohio, Tennessee available at http://pubs.usgs.gov/ha/ha730/ch_k/k-regionalsum.html)
E_v	7.62E+01	Average annual evapotranspiration (cm/yr) (Baes Reference to SLERA Protocol Table B-1-5)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-5)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-5, use 1 cm for untilled and 20 cm tilled soil)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-5)
Kd_s	1.00E-01	Soil-water partition coefficient (mL/g) (SLERA Protocol Table A-2-143)
ksv	**1.09E+03**	Methylene chloride loss constant due to volatilization (yr-1)
$ksv = [3.1536 \times 10^7 * H / (Z_s * Kd_s * R * T_a * BD)] * [D_a / Z_s] * [1 - (BD/\rho_s) - \theta_{sw}]$		
	3.15E+07	Units conversion factor (s/yr)
H	2.38E-03	Henry's Law constant (atm-m3/mol) (SLERA Protocol Table A-2-143)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-6, use 1 cm for untilled and 20 cm tilled soil)
Kd_s	1.00E-01	Soil-water partition coefficient (mL/g) (SLERA Protocol Table A-2-143)
R	8.21E-05	Universal gas constant (atm-m^3/mol-K)
T_a	2.98E+02	Ambient air temperature (K) (default value from SLERA Protocol Table B-1-6)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-6)
ρ_s	2.70E+00	Solids particle density (g/cm^3) (default value from SLERA Protocol Table B-1-6)
D_a	8.69E-02	Diffusivity of methylene chloride in air (cm^2/s) (SLERA Protocol Table A-2-143)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-6)

Table B2-3. Methylene Chloride Load to Water Body

$L_T = L_{DEP} + L_{Dif} + L_{RI} + L_R + L_E + L_I$		
L_T	**3.56E+04**	Total COPC load to the water body (including deposition, runoff, and erosion) (g/yr)
L_{DEP}	**2.46E+04**	Total (wet and dry) particle phase and wet vapor phase COPC direct deposition load to water body (g/yr)
$L_{DEP} = A_w * [F_v * Dwvp + (1-F_v) * Dwdpp]$		
A_w	5.98E+07	Water body surface area (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
F_v	1.00E+00	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-143)
Dwvp	4.11E-04	Yearly average wet deposition from vapor phase from model (over water body)(g/m^2-yr)
Dwdpp	0.00E+00	Yearly average total (wet and dry) deposition from particle phase from model (over water body) (g/m^2-yr)
L_{Dif}	**5.02E-03**	Vapor phase COPC diffusion (dry deposition) load to water body (g/yr)
$L_{Dif} = (K_v * F_v * Cvp * 1.0 \times 10^{-6})/(H/(R*T_{wk}))$		
K_v	8.40E+02	Overall transfer rate coefficient (m/yr)
F_v	1.00E+00	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-143)
Cvp	5.82E-01	Yearly average air concentration from vapor phase from model (over water body) (mg/m^3)
H	2.38E-03	Henry's Law constant (atm-m3/mol) (SLERA Protocol Table A-2-143)
R	8.21E-05	Universal gas constant (atm-m^3/mol-K)
T_{wk}	2.98E+02	Water body temperature (K) (default value from SLERA Protocol Table B-2-3)
L_{RI}	**8.98E+03**	Runoff load from impervious sources (g/yr)
$L_{RI} = A_I * [F_v * Dwvp + (1-F_v) * Dwdpp]$		
F_v	1.00E+00	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-143)
Dwvp	4.11E-04	Yearly average wet deposition from vapor phase from model (over water body)(g/m^2-yr)
Dwdpp	0.00E+00	Yearly average total (wet and dry) deposition from particle phase from model (over water body) (g/m^2-yr)
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
L_R	**2.02E+03**	Runoff load from pervious sources (g/yr)
$L_R = RO * (A_L - A_I) * [(Cs * BD)/(\theta_{sw} + Kd_s * BD)] * 0.01$		
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS Groundwater Atlas of the United States: Illinois, Indiana, Kentucky, Ohio, Tennessee available at http://pubs.usgs.gov/ha/ha730/ch_k/k-regionalsum.html)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
Cs	1.25E-06	COPC concentration in soil (mg/kg)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-2-5)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-2-5)
Kd_s	1.00E-01	Soil-water partition coefficient (cm3/g) (SLERA Protocol Table A-2-143)
	1.00E-02	Units conversion factor ($kg\text{-}cm^2/mg\text{-}m^2$)
L_E	**5.19E+00**	Soil erosion load (g/yr)
$L_E = X_e * (A_L - A_I) * SD * ER * [(Cs * Kd_s * BD)/(\theta_{sw} + Kd_s * BD)] * 0.001$		
X_e	2.54E+01	Unit soil loss (kg/m^2-yr)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
SD	8.55E-02	Watershed sediment delivery ratio (unitless)
ER	3.00E+00	Soil enrichment ratio (unitless) (Per SLERA Protocol Table B-2-6, value is 1 for Inorganic COPC's and 3 for Organic COPC's)
Cs	1.25E-06	COPC concentration in soil (mg/kg)
Kd_s	1.00E-01	Soil-water partition coefficient (cm3/g) (SLERA Protocol Table A-2-143)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-2-6)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-2-6)
	1.00E-03	Units conversion factor (g/mg)
L_I	**0.00E+00**	Internal transfer load (g/yr) (default value from SLERA Protocol Section 3.11.2.1)
X_e	**2.54E+01**	Unit soil loss (kg/m^2-yr)
$X_e = RF * K * LS * C * PF * (907.18/4047)$		
RF	3.00E+02	Universal Soil Loss Equation (USLE) rainfall (or erosivity) factor (yr^{-1}) (Highest value from range listed in SLERA Protocol Table B-2-7)
K	3.60E-01	USLE erodibility factor (ton/acre) (Default value from SLERA Protocol Table B-2-7[1])
LS	1.50E+00	USLE length-slope factor (unitless) (default value for representative watershed from SLERA Protocol Table B-2-7[2])
C	7.00E-01	USLE cover management factor (unitless)(Value based on agricultural row cropland from SLERA Protocol Table B-2-7)
PF	1.00E+00	USLE supporting practice factor (unitless) (Assumes no erosion control measures are in place)
	9.07E+02	Units conversion factor (kg/ton)
	4.05E+03	Units conversion factor (m^2/acre)
SD	**8.55E-02**	Watershed sediment delivery ratio (unitless)
$SD = a * (A_L)^{-b}$		
a	1.20E+00	Empirical intercept coefficient (unitless) (Value from Table B-2-8 based on watershed area[3])
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
b	1.25E-01	Empirical slope coefficient (unitless) (default value from Table B-2-8)

[1]Based on other available data, silty loam soils such as those found in this watershed have K values ranging from 0.25 - 0.4.

[2]Majority of watershed area has slopes 0% - 10%, therefore default value of 1.5 LS is used.

[3]Watershed area estimated to be receiving COPC is between 10 and 100 square miles.

Table B2-4. Methylene Chloride Water Body Concentration

$C_{wtot} = L_T / [Vf_v * f_{wc} + k_{wt} * A_W * (d_{wc} + d_{bs})]$		
C_{wtot}	**6.04E-13**	Total water body COPC concentration, including water column and bed sediment (mg/L)
L_T	**3.56E+04**	Total COPC load to the water body (including deposition, runoff, and erosion) (g/yr)
Vf_v	**1.32E+08**	Average volumetric flow rate through water body (m^3/yr)
f_{wc}	**9.31E-01**	Fraction of total water body COPC concentration that occurs in the water column (unitless)
$f_{wc} = [(1 + Kd_{sw} * TSS * 10^{-6}) * d_{wc}/d_z] / [(1 + Kd_{sw} * TSS * 1 \times 10^{-6}) * d_{wc}/d_z + (q_{bs} + Kd_{bs} * BS) * d_{bs}/d_z]$		
$f_{bs} = 1 - f_{wc}$		
f_{bs}	6.89E-02	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
Kd_{sw}	7.50E-01	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-143)
TSS	3.00E+02	Total suspended solids concentration (mg/L)(High value for range listed in SLERA Protocol Table B-2-10[2])
	1.00E-06	Units conversion factor (kg/mg)
d_{wc}	4.05E-01	Depth of water column (m)[3]
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-10)
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-10, $d_z = d_{wc} + d_{bs}$)
BS	1.00E+00	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-10)
q_{bs}	6.00E-01	Bed sediment porosity ($L_{water}/L_{sediment}$) (default value from SLERA Protocol Table B-2-10)
Kd_{bs}	4.00E-01	Bed sediment/sediment pore water partition coefficient (L/kg) (SLERA Protocol Table A-2-143)
k_{wt}	**2.26E+09**	Overall total water body COPC dissipation rate constant (yr^{-1})[4]
$k_{wt} = f_{wc} * k_v + f_{bs} * k_b$		
f_{wc}	9.31E-01	Fraction of total water body COPC concentration that occurs in the water column (unitless)
k_v	1.93E+03	Water column volatilization rate constant (yr^{-1})
f_{bs}	6.89E-02	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
k_b	3.28E+10	Benthic burial rate constant (yr^{-1})
A_w	**5.98E+07**	Water body surface area (m^2)
k_v	**1.93E+03**	Water column volatilization rate constant (yr^{-1})
$k_v = K_v / [d_z * (1 + Kd_{sw} * TSS * 10^{-6})]$		
K_v	8.40E+02	Overall COPC transfer rate coefficient (m/yr)
d_{wc}	4.05E-01	Depth of water column (m)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from Table B-2-12)
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-12, $d_z = d_{wc} + d_{bs}$)
Kd_{sw}	7.50E-01	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-143)
TSS	3.00E+02	Total suspended solids concentration (mg/L)
	1.00E-06	Units conversion factor (kg/mg)
K_v	**8.40E+02**	Overall COPC transfer rate coefficient (m/yr)
$K_v = \{K_L^{-1} + [K_G * H/(R * T_{wk})]^{-1}\}^{-1} * q^{(Twk - 293)}$		
K_L	9.33E+02	Liquid-phase transfer coefficient (m/yr)
K_G	3.65E+04	Gas-phase transfer coefficient (m/yr)
H	2.38E-03	Henry's Law constant (atm-m3/mol) (SLERA Protocol Table A-2-143)
R	8.21E-05	Universal gas constant (atm-m^3/mol-K)
T_{wk}	2.98E+02	Water body temperature (K) (default value from SLERA Protocol Table B-2-13)
q	1.03E+00	Temperature correction factor (unitless) (default value from SLERA Protocol Table B-2-13)
K_L	**9.33E+02**	Liquid-phase transfer coefficient for flowing streams or rivers (m/yr)
$K_L = SQRT(10^{-4} * D_w * u / d_z) * 3.1536 \times 10^7$		
D_w	1.25E-05	Diffusivity of COPC in water (cm^2/s) (SLERA Protocol Table A-2-143)
u	3.05E-01	Current velocity (m/s)[5]
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-14, $d_z = d_{wc} + d_{bs}$)
	3.15E+07	Units conversion constant (s/yr)
K_G	**3.65E+04**	Gas-phase transfer coefficient for flowing streams or rivers (m/yr) (default value from SLERA Protocol Table B-2-15)
k_b	**3.28E+10**	Benthic burial rate constant (yr^{-1})
$k_b = [X_e * A_L * SD * 10^3 - Vf_v * TSS / (A_W * TSS)] * [TSS * 10^{-6} / (BS * d_{bs})]$		
X_e	2.54E+01	Unit soil loss (kg/m^2-yr)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2)
SD	8.55E-02	Watershed sediment delivery ratio (unitless)
Vf_v	1.32E+08	Average volumetric flow rate through water body (m^3/yr)
TSS	3.00E+02	Total suspended solids concentration (mg/L)
A_W	5.98E+07	Water body surface area (m^2)
BS	1.00E+00	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-16)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-16)

Notes:

[1]Assume pH = 8.0 based on water quality data provided by EPA Region 5

[2]Values found for data from Mississippi River near St. Louis range from 50-350 mg/L, therefore used high end of SLERA default range.

[3]Based on minimum depth required by Corps of Engineers

[4]Assume COPC does not dissipate based on Henry's Law constant of zero.

[5]Current velocity ranges from 3-7 ft/s based on information from several sources.

Table B2-5. Methylene Chloride Concentration in Water Column

$C_{wctot} = f_{wc} * C_{wtot} * (d_{wc} + d_{bs}) / d_{wc}$		
C_{wctot}	**6.04E-13**	Total COPC concentration in water column (mg/L)
f_{wc}	9.31E-01	Fraction of total water body COPC concentration that occurs in the water column (unitless)
C_{wtot}	6.04E-13	Total water body COPC concentration, including water column and bed sediment (mg/L)
d_{wc}	4.05E-01	Depth of water column (m)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-17)

Table B2-6. Methylene Chloride Dissolved Phase Water Concentration

$C_{dw} = C_{wctot} / (1+Kd_{sw}*TSS*10^{-6})$		
C_{dw}	**6.04E-13**	Dissolved phase water concentration (mg/L)
C_{wctot}	6.04E-13	Total COPC concentration in water column (mg/L)
Kd_{sw}	7.50E-01	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-143)
TSS	3.00E+02	Total suspended solids concentration (mg/L)

Table B2-7. Methylene Chloride Concentration in Bed Sediment

$C_{sed} = f_{bs} * C_{wtot} * [Kd_{bs}/(q_{bs} + Kd_{bs} * BS)] * [(d_{wc} + d_{bs})/d_{bs}]$		
C_{sed}	**2.42E-13**	COPC concentration in bed sediment (mg/kg)
f_{bs}	**6.89E-02**	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
C_{wtot}	**6.04E-13**	Total water body COPC concentration, including water column and bed sediment (mg/L)
Kd_{bs}	**4.00E-01**	Bed sediment/sediment pore water partition coefficient (L/kg) (SLERA Protocol Table A-2-143)
q_{bs}	**6.00E-01**	Bed sediment porosity ($L_{water}/L_{sediment}$) (default value from SLERA Protocol Table B-2-10)
BS	**1.00E+00**	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-10)
d_{wc}	**4.05E-01**	Depth of water column (m)*
d_{bs}	**3.00E-02**	Depth of upper benthic sediment layer (m) (default value from Table B-2-12)

Table B3-1. Toluene Summary

	Concentration from Project	Background Concentration[1]	Total Concentration (Background & Project)	Ecological Screening Level[2]	Project Increase Percent of ESL	Ecological Screening Quotient
Soil (mg/kg)	1.86E-06	N/A	N/A	5.45E+00	N/A	0.00
Water (mg/L)	3.07E-14	1.00E-03	1.00E-03	2.53E-01	0.40%	N/A
Sediment (mg/kg)	1.72E-13	N/A	N/A	1.22E+00	N/A	0.00

Notes:

[1] Water background concentration assumed to be the average concentration from water samples in or near Jefferson County, obtained from the IEPA on 01/19/11 via J. Schewe of Falcon Engineering.

[2] U.S. EPA Region 5 Waste Division, RCRA Corrective Action Guidance and Policy Documents, Ecological Screening Levels, August 22, 2003 available at http://www.epa.gov/reg5rcra/ca/guidance.htm.

Table B3-2. Toluene Soil Concentration

$Cs = Ds * [1 - exp(-ks * tD)] / ks$		
Cs	**1.86E-06**	Toluene concentration in soil (mg toluene/kg soil)
tD	**1.00E+02**	Time period over which deposition occurs (yr) (default value from SLERA Protocol Table B-1-1)
Ds	**4.37E-04**	Deposition term (mg toluene/kg soil/yr)
$Ds = 100/(Z_s * BD) * [F_v (Dydv + Dywv) + (Dywp + Dydp) * (1 - F_v)]$		
	1.00E+02	Units conversion factor (m^2-mg/cm^2-kg)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-1, use 1 cm for untilled and 20 cm tilled soil)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-1)
F_v	1.00E+00	Fraction of toluene air concentration in vapor phase (SLERA Protocol Table A-2-185)
Dydv + Dywv	1.31E-04	Maximum yearly average total (wet+dry) deposition from vapor phase from model (g/m^2-yr)
Dywp + Dydp	-	Maximum yearly average total (wet+dry) deposition from particle phase from model (g/m^2-yr)
ks	**2.36E+02**	Toluene soil loss constant due to all soil processes (yr^{-1})
ks = ksg + kse + ksr + ksl + ksv		
ksg	1.15E+01	Toluene loss constant due to biotic and abiotic degradation (yr^{-1}) (SLERA Protocol Table A-2-185)
kse	0.00E+00	Toluene loss constant due to soil erosion (yr^{-1}) (default value from SLERA Protocol Table B-1-2)
ksr	5.52E-01	Toluene loss constant due to surface runoff (yr-1)
ksl	0.00E+00	Toluene loss constant due to leaching (yr^{-1})
ksv	2.24E+02	Toluene loss constant due to volatilization (yr^{-1})
ksr	**5.52E-01**	Toluene loss constant due to surface runoff (yr-1)
$ksr = RO / (\theta_{sw} * Z_s) * \{1/[1 + (Kd_s * BD/\theta_{sw})]\}$		
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-4)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-4, use 1 cm for untilled and 20 cm tilled soil)
Kd_s	1.40E+00	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-185)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-4)
ksl	**0.00E+00**	Toluene loss constant due to leaching (yr^{-1})
$ksl = (P + I - RO - E_v) / \{\theta_{sw} * Z_s * [1.0 + (BD * Kd_s / \theta_{sw})]\}$		
P	1.02E+02	Annual average precipitation (cm/yr) (NOAA)
I	0.00E+00	Average annual irrigation (cm/yr) (Assumed due to low irrigation percentage in Illinois)
RO	2.54E+01	Average annual surface runoff (cm/yr)
E_v	7.62E+01	Average annual evapotranspiration (cm/yr)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-5)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-5, use 1 cm for untilled and 20 cm tilled soil)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-5)
Kd_s	1.40E+00	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-185)
ksv	**2.24E+02**	Toluene loss constant due to volatilization (yr-1)
$ksv = [3.1536 \times 10^7 * H / (Z_s * Kd_s * R * T_a * BD)] * [D_a / Z_s] * [1 - (BD/\rho_s) - \theta_{sw}]$		
	3.15E+07	Units conversion factor (s/yr)
H	6.13E-03	Henry's Law constant (atm-m^3/mol) (SLERA Protocol Table A-2-185)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-6, use 1 cm for untilled and 20 cm tilled soil)
Kd_s	1.40E+00	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-185)
R	8.21E-05	Universal gas constant (atm-m^3/mol-K)
T_a	2.98E+02	Ambient air temperature (K) (default value from SLERA Protocol Table B-1-6)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-6)
ρ_s	2.70E+00	Solids particle density (g/cm^3) (default value from SLERA Protocol Table B-1-6)
D_a	9.72E-02	Diffusivity of toluene in air (cm^2/s) (SLERA Protocol Table A-2-185)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-6)

Table B3-3. Toluene Load to Water Body

$L_T = L_{DEP} + L_{Dif} + L_{RI} + L_R + L_E + L_I$		
L_T	**1.12E+04**	Total COPC load to the water body (including deposition, runoff, and erosion) (g/yr)
L_{DEP}	**7.85E+03**	Total (wet and dry) particle phase and wet vapor phase COPC direct deposition load to water body (g/yr)
$L_{DEP} = A_w * [F_v * Dwvp + (1-F_v) * Dwdpp]$		
A_w	5.98E+07	Water body surface area (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
F_v	1.00E+00	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-185)
Dwvp	1.31E-04	Yearly average wet deposition from vapor phase from model (over water body)(g/m^2-yr)
Dwdpp	0.00E+00	Yearly average total (wet and dry) deposition from particle phase from model (over water body) (g/m^2-yr)
L_{Dif}	**2.09E-03**	Vapor phase COPC diffusion (dry deposition) load to water body (g/yr)
$L_{Dif} = (K_v * F_v * Cvp * 1.0 \times 10^{-6})/(H/(R*T_{wk}))$		
K_v	8.38E+02	Overall transfer rate coefficient (m/yr)
F_v	1.00E+00	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-185)
Cvp	6.25E-01	Yearly average air concentration from vapor phase from model (over water body) (mg/m^3)
H	6.13E-03	Henry's Law constant ($atm\text{-}m^3/mol$) (SLERA Protocol Table A-2-185)
R	8.21E-05	Universal gas constant ($atm\text{-}m^3/mol\text{-}K$)
T_{wk}	2.98E+02	Water body temperature (K) (default value from SLERA Protocol Table B-2-3)
L_{RI}	**2.87E+03**	Runoff load from impervious sources (g/yr)
$L_{RI} = A_I * [F_v * Dwvp + (1-F_v) * Dwdpp]$		
F_v	1.00E+00	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-185)
Dwvp	1.31E-04	Yearly average wet deposition from vapor phase from model (over water body)(g/m^2-yr)
Dwdpp	0.00E+00	Yearly average total (wet and dry) deposition from particle phase from model (over water body) (g/m^2-yr)
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
L_R	**4.58E+02**	Runoff load from pervious sources (g/yr)
$L_R = RO * (A_L - A_I) * [(Cs * BD)/(\theta_{sw} + Kd_s * BD)] * 0.01$		
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS Groundwater Atlas of the United States: Illinois, Indiana, Kentucky, Ohio, Tennessee available at http://pubs.usgs.gov/ha/ha730/ch_k/k-regionalsum.html)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
Cs	1.86E-06	COPC concentration in soil (mg/kg)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-2-5)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-2-5)
Kd_s	1.40E+00	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-185)
	1.00E-02	Units conversion factor ($kg\text{-}cm^2/mg\text{-}m^2$)
L_E	**1.65E+01**	Soil erosion load (g/yr)
$L_E = X_e * (A_L - A_I) * SD * ER * [(Cs * Kd_s * BD)/(\theta_{sw} + Kd_s * BD)] * 0.001$		
X_e	2.54E+01	Unit soil loss (kg/m^2-yr)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2)
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2)
SD	8.55E-02	Watershed sediment delivery ratio (unitless)
ER	3.00E+00	Soil enrichment ratio (unitless) (Per SLERA Protocol Table B-2-6, value is 1 for Inorganic COPC's and 3 for Organic COPC's)
Cs	1.86E-06	COPC concentration in soil (mg/kg)
Kd_s	1.40E+00	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-185)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-2-6)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-2-6)
	1.00E-03	Units conversion factor (g/mg)
L_I	**0.00E+00**	Internal transfer load (g/yr) (default value from SLERA Protocol Section 3.11.2.1)
X_e	**2.54E+01**	Unit soil loss (kg/m^2-yr)
$X_e = RF * K * LS * C * PF * (907.18/4047)$		
RF	3.00E+02	Universal Soil Loss Equation (USLE) rainfall (or erosivity) factor (yr^{-1}) (Highest value from range listed in SLERA Protocol Table B-2-7)
K	3.60E-01	USLE erodibility factor (ton/acre) (Default value from SLERA Protocol Table B-2-7[1])
LS	1.50E+00	USLE length-slope factor (unitless) (default value for representative watershed from SLERA Protocol Table B-2-7[2])
C	7.00E-01	USLE cover management factor (unitless)(Value based on agricultural row cropland from SLERA Protocol Table B-2-7)
PF	1.00E+00	USLE supporting practice factor (unitless) (Assumes no erosion control measures are in place)
	9.07E+02	Units conversion factor (kg/ton)
	4.05E+03	Units conversion factor (m^2/acre)
SD	**8.55E-02**	Watershed sediment delivery ratio (unitless)
$SD = a * (A_L)^{-b}$		
a	1.20E+00	Empirical intercept coefficient (unitless) (Value from Table B-2-8 based on watershed area[3])
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
b	1.25E-01	Empirical slope coefficient (unitless) (default value from Table B-2-8)

Notes:

[1] Based on other available data, silty loam soils such as those found in this watershed have K values ranging from 0.25 - 0.4.

[2] Majority of watershed area has slopes 0% - 10%, therefore default value of 1.5 LS is used.

[3] Watershed area estimated to be receiving COPC is between 10 and 100 square miles.

Table B3-4. Toluene Water Body Concentration

$C_{wtot} = L_T / [Vf_s * f_{wc} + k_{wt} * A_W * (d_{wc} + d_{bs})]$		
C_{wtot}	**4.17E-14**	Total water body COPC concentration, including water column and bed sediment (mg/L)
L_T	**1.12E+04**	Total COPC load to the water body (including deposition, runoff, and erosion) (g/yr)
Vf_s	**1.32E+08**	Average volumetric flow rate through water body (m^3/yr)
f_{wc}	**6.86E-01**	Fraction of total water body COPC concentration that occurs in the water column (unitless)
$f_{wc} = [(1 + Kd_{sw} * TSS * 10^{-6}) * d_{wc}/d_z] / [(1 + Kd_{sw} * TSS * 1 \times 10^{-6}) * d_{wc}/d_z + (q_{bs} + Kd_{bs} * BS) * d_{bs}/d_z]$		
$f_{bs} = 1 - f_{wc}$		
f_{bs}	3.14E-01	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
Kd_{sw}	1.05E+01	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-185)
TSS	3.00E+02	Total suspended solids concentration (mg/L)(High value for range listed in SLERA Protocol Table B-2-10[2])
	1.00E-06	Units conversion factor (kg/mg)
d_{wc}	4.05E-01	Depth of water column (m)[3]
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-10)
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-10, $d_z = d_{wc} + d_{bs}$)
BS	1.00E+00	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-10)
q_{bs}	6.00E-01	Bed sediment porosity ($L_{water}/L_{sediment}$) (default value from SLERA Protocol Table B-2-10)
Kd_{bs}	5.60E+00	Bed sediment/sediment pore water partition coefficient (L/kg) (SLERA Protocol Table A-2-185)
k_{wt}	**1.03E+10**	Overall total water body COPC dissipation rate constant (yr^{-1})
$k_{wt} = f_{wc} * k_v + f_{bs} * k_b$		
f_{wc}	6.86E-01	Fraction of total water body COPC concentration that occurs in the water column (unitless)
k_v	1.92E+03	Water column volatilization rate constant (yr^{-1})
f_{bs}	3.14E-01	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
k_b	3.28E+10	Benthic burial rate constant (yr^{-1})
A_w	**5.98E+07**	Water body surface area (m^2)
k_v	**1.92E+03**	Water column volatilization rate constant (yr^{-1})
$k_v = K_v / [d_w * (1 + Kd_{sw} * TSS * 10^{-6})]$		
K_v	8.38E+02	Overall COPC transfer rate coefficient (m/yr)
d_{wc}	4.05E-01	Depth of water column (m)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from Table B-2-12)
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-12, $d_z = d_{wc} + d_{bs}$)
Kd_{sw}	1.05E+01	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-185)
TSS	3.00E+02	Total suspended solids concentration (mg/L)
	1.00E-06	Units conversion factor (kg/mg)
K_v	**8.38E+02**	Overall COPC transfer rate coefficient (m/yr)
$K_v = \{K_L^{-1} + [K_G * H/(R * T_{wk})]^{-1}\}^{-1} * q^{(Twk - 293)}$		
K_L	8.02E+02	Liquid-phase transfer coefficient (m/yr)
K_G	3.65E+04	Gas-phase transfer coefficient (m/yr)
H	6.13E-03	Henry's Law constant (atm-m^3/mol) (SLERA Protocol Table A-2-185)
R	8.21E-05	Universal gas constant (atm-m^3/mol-K)
T_{wk}	2.98E+02	Water body temperature (K) (default value from SLERA Protocol Table B-2-13)
q	1.03E+00	Temperature correction factor (unitless) (default value from SLERA Protocol Table B-2-13)
K_L	**8.02E+02**	Liquid-phase transfer coefficient for flowing streams or rivers (m/yr)
$K_L = SQRT (10^{-4} * D_w * u / d_z) * 3.1536 \times 10^7$		
D_w	9.23E-06	Diffusivity of COPC in water (cm^2/s) (SLERA Protocol Table A-2-185)
u	3.05E-01	Current velocity (m/s)[4]
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-14, $d_z = d_{wc} + d_{bs}$)
	3.15E+07	Units conversion constant (s/yr)
K_G	**3.65E+04**	Gas-phase transfer coefficient for flowing streams or rivers (m/yr) (default value from SLERA Protocol Table B-2-15)
k_b	**3.28E+10**	Benthic burial rate constant (yr^{-1})
$k_b = [X_e * A_L * SD * 10^3 - Vf_s * TSS / (A_W * TSS)] * [TSS * 10^{-6} / (BS * d_{bs})]$		
X_e	2.54E+01	Unit soil loss (kg/m^2-yr)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2)
SD	8.55E-02	Watershed sediment delivery ratio (unitless)
Vf_s	1.32E+08	Average volumetric flow rate through water body (m^3/yr)
TSS	3.00E+02	Total suspended solids concentration (mg/L)
A_W	5.98E+07	Water body surface area (m^2)
BS	1.00E+00	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-16)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-16)

Notes:

[1] Assume pH = 8.0 based on water quality data provided by EPA Region 5

[2] Values found for data from Mississippi River near St. Louis range from 50-350 mg/L, therefore used high end of SLERA default range.

[3] Based on minimum depth required by Corps of Engineers

[4] Current velocity ranges from 3-7 ft/s based on information from several sources.

Table B3-5. Toluene Concentration in Water Column

$C_{wctot} = f_{wc} * C_{wtot} * (d_{wc} + d_{bs}) / d_{wc}$		
C_{wctot}	**3.07E-14**	Total COPC concentration in water column (mg/L)
f_{wc}	6.86E-01	Fraction of total water body COPC concentration that occurs in the water column (unitless)
C_{wtot}	4.17E-14	Total water body COPC concentration, including water column and bed sediment (mg/L)
d_{wc}	4.05E-01	Depth of water column (m)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-17)

Table B3-6. Toluene Dissolved Phase Water Concentration

$C_{dw} = C_{wctot} / (1+Kd_{sw}*TSS*10^{-6})$			
C_{dw}		**3.06E-14**	Dissolved phase water concentration (mg/L)
	C_{wctot}	3.07E-14	Total COPC concentration in water column (mg/L)
	Kd_{sw}	1.05E+01	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-185)
	TSS	3.00E+02	Total suspended solids concentration (mg/L)

Table B3-7. Toluene Concentration in Bed Sediment

$C_{sed} = f_{bs} * C_{wtot} * [Kd_{bs}/(q_{bs} + Kd_{bs} * BS)] * [(d_{wc} + d_{bs})/d_{bs}]$		
C_{sed}	**1.72E-13**	COPC concentration in bed sediment (mg/kg)
f_{bs}	**3.14E-01**	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
C_{wtot}	**4.17E-14**	Total water body COPC concentration, including water column and bed sediment (mg/L)
Kd_{bs}	**5.60E+00**	Bed sediment/sediment pore water partition coefficient (L/kg) (SLERA Protocol Table A-2-185)
q_{bs}	**6.00E-01**	Bed sediment porosity ($L_{water}/L_{sediment}$) (default value from SLERA Protocol Table B-2-10)
BS	**1.00E+00**	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-10)
d_{wc}	**4.05E-01**	Depth of water column (m)*
d_{bs}	**3.00E-02**	Depth of upper benthic sediment layer (m) (default value from Table B-2-12)

Table B4-1. Benzo(a)anthracene Summary

	Concentration from Project	Background Concentration[1]	Total Concentration (Background & Project)	Ecological Screening Level[2]	Toxicity Reference Value[3]	Project Increase Percent of Background Concentration	Ecological Screening Quotient
Soil (mg/kg)	3.98E-08	1.60E+01	1.60E+01	5.21E+00	2.50E+01	0.00%	N/A
Water (mg/L)	5.56E-21	N/A	N/A	2.50E-05	2.70E-05	N/A	0.00
Sediment (mg/kg)	8.45E-18	N/A	N/A	1.08E-01	1.90E-02	N/A	0.00

Notes:

[1] Soil background concentration obtained from USGS survey of the area around Chicago, IL; Kay, R.T., et. al, Concentrations of PolynuclearAromatic Hydrocarbons and Inorganic Constituents in Ambient Surface Soils, Chicago, Illinois: 2001-2002. United States Geological Survey, 2003.

[2] U.S. EPA Region 5 Waste Division, RCRA Corrective Action Guidance and Policy Documents, Ecological Screening Levels, August 22, 2003 available at http://www.epa.gov/reg5rcra/ca/guidance.htm.

[3] U.S. EPA, Office of Solid Waste. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Volume 1. EPA 530-D-99-001A. August 1999.

Table B4-2. Benzo(a)anthracene Soil Concentration

$Cs = Ds * [1 - exp(-ks * tD)] / ks$		
Cs	**3.98E-08**	COPC concentration in soil (mg COPC/kg soil)
tD	**1.00E+02**	Time period over which deposition occurs (yr) (default value from SLERA Protocol Table B-1-1)
Ds	**1.48E-08**	Deposition term (mg COPC/kg soil/yr)
$Ds = 100/(Zs * BD) * [Fv (Dydv + Dywv) + (Dywp + Dydp) * (1 - Fv)]$		
	1.00E+02	Units conversion factor (m^2-mg/cm^2-kg)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-1, use 1 cm for untilled and 20 cm tilled soil)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-1)
F_v	8.81E-01	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-19)
Dydv + Dywv	5.00E-09	Maximum yearly average total (wet+dry) deposition from vapor phase from model (g/m^2-yr)
Dywp + Dydp	3.60E-10	Maximum yearly average total (wet+dry) deposition from particle phase from model (g/m^2-yr)
ks	**3.72E-01**	COPC soil loss constant due to all soil processes (yr^{-1})
ks = ksg + kse + ksr + ksl + ksv		
ksg	3.72E-01	COPC loss constant due to biotic and abiotic degradation (yr^{-1}) (SLERA Protocol Table A-2-19[1])
kse	0.00E+00	COPC loss constant due to soil erosion (yr^{-1}) (default value from SLERA Protocol Table B-1-2)
ksr	3.26E-04	COPC loss constant due to surface runoff (yr-1)
ksl	0.00E+00	COPC loss constant due to leaching (yr^{-1})
ksv	1.81E-05	COPC loss constant due to volatilization (yr^{-1})
ksr	**3.26E-04**	COPC loss constant due to surface runoff (yr-1)
$ksr = RO / (\theta_{sw} * Z_s) * \{1/[1 + (Kd_s * BD/\theta_{sw})]\}$		
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS Groundwater Atlas of the United States: Illinois, Indiana, Kentucky, Ohio, Tennessee available at http://pubs.usgs.gov/ha/ha730/ch_k/k-regionalsum.html)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-4)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-4, use 1 cm for untilled and 20 cm tilled soil)
Kd_s	2.60E+03	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-19[2])
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-4)
ksl	**0.00E+00**	COPC loss constant due to leaching (yr^{-1})
$ksl = (P + I - RO - E_v) / \{\theta_{sw} * Z_s * [1.0 + (BD * Kd_s / \theta_{sw})]\}$		
P	1.02E+02	Annual average precipitation (cm/yr) (NOAA)
I	0.00E+00	Average annual irrigation (cm/yr) (Baes Reference to SLERA Protocol Table B-1-5, Assumed due to low irrigation percentage in Illinois)
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS Groundwater Atlas of the United States: Illinois, Indiana, Kentucky, Ohio, Tennessee available at http://pubs.usgs.gov/ha/ha730/ch_k/k-regionalsum.html)
E_v	7.62E+01	Average annual evapotranspiration (cm/yr)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-5)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-5, use 1 cm for untilled and 20 cm tilled soil)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-5)
Kd_s	2.60E+03	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-19[2])
ksv	**1.81E-05**	
$ksv = [3.1536 \times 10^7 * H / (Z_s * Kd_s * R * T_a * BD)] * [D_a / Z_s] * [1 - (BD/\rho_s) - \theta_{sw}]$		
	3.15E+07	Units conversion factor (s/yr)
H	3.62E-06	Henry's Law constant (atm-m^3/mol) (SLERA Protocol Table A-2-19)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-6, use 1 cm for untilled and 20 cm tilled soil)
Kd_s	2.60E+03	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-19[2])
R	8.21E-05	Universal gas constant (atm-m^3/mol-K)
T_a	2.98E+02	Ambient air temperature (K) (default value from SLERA Protocol Table B-1-6)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-6)
ρ_s	2.70E+00	Solids particle density (g/cm^3) (default value from SLERA Protocol Table B-1-6)
D_a	2.47E-02	Diffusivity of COPC in air (cm^2/s) (SLERA Protocol Table A-2-19)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-6)

[1]Assume ND = 0.

[2]Assume pH = 6.8 based on USGS data on Casey Fork near Mount Vernon

Table B4-3. Benzo(a)anthracene Load to Water Body

$L_T = L_{DEP} + L_{DIF} + L_{RI} + L_R + L_E + L_I$		
L_T	**4.98E-01**	Total COPC load to the water body (including deposition, runoff, and erosion) (g/yr)
L_{DEP}	**2.66E-01**	Total (wet and dry) particle phase and wet vapor phase COPC direct deposition load to water body (g/yr)
$L_{DEP} = A_w * [F_v * Dwvp + (1-F_v) * Dwdpp]$		
A_w	5.98E+07	Water body surface area (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
F_v	8.81E-01	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-19)
Dwvp	5.00E-09	Yearly average wet deposition from vapor phase from model (over water body)(g/m^2-yr)
Dwdpp	3.60E-10	Yearly average total (wet and dry) deposition from particle phase from model (over water body) (g/m^2-yr)
L_{DIF}	**0.00E+00**	Vapor phase COPC diffusion (dry deposition) load to water body (g/yr)[1]
$L_{DIF} = (K_v * F_v * Cvp * 1.0 \times 10^{-6})/(H/(R*T_{wb}))$		
K_v	6.09E+00	Overall transfer rate coefficient (m/yr)
F_v	8.81E-01	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-19)
Cvp	0.00E+00	Yearly average air concentration from vapor phase from model (over water body) (mg/m^3)
H	3.62E-06	Henry's Law constant ($atm\text{-}m^3/mol$) (SLERA Protocol Table A-2-19)
R	8.21E-05	Universal gas constant ($atm\text{-}m^3/mol\text{-}K$)
T_{wb}	2.98E+02	Water body temperature (K) (default value from SLERA Protocol Table B-2-3)
L_{RI}	**9.71E-02**	Runoff load from impervious sources (g/yr)
$L_{RI} = A_I * [F_v * Dwvp + (1-F_v) * Dwdpp]$		
F_v	8.81E-01	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-19)
Dwvp	5.00E-09	Yearly average wet deposition from vapor phase from model (over water body)(g/m^2-yr)
Dwdpp	3.60E-10	Yearly average total (wet and dry) deposition from particle phase from model (over water body) (g/m^2-yr)
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
L_R	**5.79E-03**	Runoff load from pervious sources (g/yr)
$L_R = RO * (A_L - A_I) * [(Cs * BD)/(\theta_{rw} + Kd_s * BD)] * 0.01$		
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS Groundwater Atlas of the United States: Illinois, Indiana, Kentucky, Ohio, Tennessee available at http://pubs.usgs.gov/ha/ha730/ch_k/k-regionalsum.html)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
Cs	3.98E-08	COPC concentration in soil (mg/kg)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-2-5)
θ_{rw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-2-5)
Kd_s	2.60E+03	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-19)
	1.00E-02	Units conversion factor ($kg\text{-}cm^2/mg\text{-}m^2$)
L_E	**1.29E-01**	Soil erosion load (g/yr)
$L_E = X_e * (A_L - A_I) * SD * ER * [(Cs * Kd_s * BD)/(\theta_{rw} + Kd_s * BD)] * 0.001$		
X_e	2.54E+01	Unit soil loss (kg/m^2-yr)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
SD	8.55E-02	Watershed sediment delivery ratio (unitless)
ER	1.00E+00	Soil enrichment ratio (unitless) (Per SLERA Protocol Table B-2-6, value is 1 for Inorganic COPC's and 3 for Organic COPC's)
Cs	3.98E-08	COPC concentration in soil (mg/kg)
Kd_s	2.60E+03	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-19)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-2-6)
θ_{rw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-2-6)
	1.00E-03	Units conversion factor (g/mg)
L_I	**0.00E+00**	Internal transfer load (g/yr) (default value from SLERA Protocol Section 3.11.2.1)
X_e	**2.54E+01**	Unit soil loss (kg/m^2-yr)
$X_e = RF * K * LS * C * PF * (907.18/4047)$		
RF	3.00E+02	Universal Soil Loss Equation (USLE) rainfall (or erosivity) factor (yr^{-1}) (Highest value from range listed in SLERA Protocol Table B-2-7)
K	3.60E-01	USLE erodibility factor (ton/acre) (Default value from SLERA Protocol Table B-2-7[2])
LS	1.50E+00	USLE length-slope factor (unitless) (default value for representative watershed from SLERA Protocol Table B-2-7[3])
C	7.00E-01	USLE cover management factor (unitless)(Value based on agricultural row cropland from SLERA Protocol Table B-2-7)
PF	1.00E+00	USLE supporting practice factor (unitless) (Assumes no erosion control measures are in place)
	9.07E+02	Units conversion factor (kg/ton)
	4.05E+03	Units conversion factor (m^2/acre)
SD	**8.55E-02**	Watershed sediment delivery ratio (unitless)
$SD = a * (A_L)^{-b}$		
a	1.20E+00	Empirical intercept coefficient (unitless) (Value from Table B-2-8 based on watershed area[4])
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
b	1.25E-01	Empirical slope coefficient (unitless) (default value from Table B-2-8)

Notes:

[1] Assume vapor phase COPC diffusion load to water body is zero for Benzo(a)anthracene.

[2] Based on other available data, silty loam soils such as those found in this watershed have K values ranging from 0.25 - 0.4.

[3] Majority of watershed area has slopes 0% - 10%, therefore default value of 1.5 LS is used.

[4] Watershed area estimated to be receiving COPC is between 10 and 100 square miles.

Table B4-4. Benzo(a)anthracene Water Body Concentration

$C_{wtot} = L_T / [Vf_x * f_{wc} + k_{wt} * A_W * (d_{wc} + d_{bs})]$		
C_{wtot}	**5.87E-19**	Total water body COPC concentration, including water column and bed sediment (mg/L)
L_T	**4.98E-01**	Total COPC load to the water body (including deposition, runoff, and erosion) (g/yr)
Vf_x	**1.32E+08**	Average volumetric flow rate through water body (m^3/yr)
f_{wc}	**8.82E-03**	Fraction of total water body COPC concentration that occurs in the water column (unitless)
$f_{wc} = [(1 + Kd_{sw} * TSS * 10^{-6}) * d_{wc}/d_z] / [(1 + Kd_{sw} * TSS * 1 \times 10^{-6}) * d_{wc}/d_z + (\theta_{bs} + Kd_{bs} * BS) * d_{bs}/d_z]$		
$f_{bs} = 1 - f_{wc}$		
f_{bs}	9.91E-01	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
Kd_{sw}	1.95E+04	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-19[1])
TSS	3.00E+02	Total suspended solids concentration (mg/L)(High value for range listed in SLERA Protocol Table B-2-10[2])
	1.00E-06	Units conversion factor (kg/mg)
d_{wc}	4.05E-01	Depth of water column (m)[3]
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-10)
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-10, $d_z = d_{wc} + d_{bs}$)
BS	1.00E+00	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-10)
θ_{bs}	6.00E-01	Bed sediment porosity ($L_{water}/L_{sediment}$) (default value from SLERA Protocol Table B-2-10)
Kd_{bs}	1.04E+04	Bed sediment/sediment pore water partition coefficient (L/kg) (SLERA Protocol Table A-2-19[1])
k_{wt}	**3.25E+10**	Overall total water body COPC dissipation rate constant (yr^{-1})[4]
$k_{wt} = f_{wc} * k_v + f_{bs} * k_b$		
f_{wc}	8.82E-03	Fraction of total water body COPC concentration that occurs in the water column (unitless)
k_v	2.04E+00	Water column volatilization rate constant (yr^{-1})
f_{bs}	9.91E-01	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
k_b	3.28E+10	Benthic burial rate constant (yr^{-1})
A_w	**5.98E+07**	Water body surface area (m^2)
k_v	**2.04E+00**	Water column volatilization rate constant (yr^{-1})
$k_v = K_v / [d_z * (1 + Kd_{sw} * TSS * 10^{-6})]$		
K_v	6.09E+00	Overall COPC transfer rate coefficient (m/yr)
d_{wc}	4.05E-01	Depth of water column (m)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from Table B-2-12)
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-12, $d_z = d_{wc} + d_{bs}$)
Kd_{sw}	1.95E+04	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-19)
TSS	3.00E+02	Total suspended solids concentration (mg/L)
	1.00E-06	Units conversion factor (kg/mg)
K_v	**6.09E+00**	Overall COPC transfer rate coefficient (m/yr)
$K_v = \{K_L^{-1} + [K_G * H/(R * T_{wk})]^{-1}\}^{-1} * q^{(Twk - 293)}$		
K_L	6.58E+02	Liquid-phase transfer coefficient (m/yr)
K_G	3.65E+04	Gas-phase transfer coefficient (m/yr)
H	3.62E-06	Henry's Law constant (atm-m^3/mol) (SLERA Protocol Table A-2-19)
R	8.21E-05	Universal gas constant (atm-m^3/mol-K)
T_{wk}	2.98E+02	Water body temperature (K) (default value from SLERA Protocol Table B-2-13)
q	1.03E+00	Temperature correction factor (unitless) (default value from SLERA Protocol Table B-2-13)
K_L	**6.58E+02**	Liquid-phase transfer coefficient for flowing streams or rivers (m/yr)
$K_L = SQRT (10^{-4} * D_w * u / d_z) * 3.1536 \times 10^7$		
D_w	6.21E-06	Diffusivity of COPC in water (cm^2/s) (SLERA Protocol Table A-2-19)
u	3.05E-01	Current velocity (m/s)[4]
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-14, $d_z = d_{wc} + d_{bs}$)
	3.15E+07	Units conversion constant (s/yr)
K_G	**3.65E+04**	Gas-phase transfer coefficient for flowing streams or rivers (m/yr) (default value from SLERA Protocol Table B-2-15)
k_b	**3.28E+10**	Benthic burial rate constant (yr^{-1})
$k_b = [X_o * A_L * SD * 10^3 - Vf_x * TSS / (A_W * TSS)] * [TSS * 10^{-6} / (BS * d_{bs})]$		
X_o	2.54E+01	Unit soil loss (kg/m^2-yr)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2)
SD	8.55E-02	Watershed sediment delivery ratio (unitless)
Vf_x	1.32E+08	Average volumetric flow rate through water body (m^3/yr)
TSS	3.00E+02	Total suspended solids concentration (mg/L)
A_W	5.98E+07	Water body surface area (m^2)
BS	1.00E+00	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-16)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-16)

Notes:

[1] Assume pH = 6.8 based on USGS data on Casey Fork near Mount Vernon

[2] No data available for location of deposition, therefore used high end of SLERA default range.

[3] Assumed based on USGS data from Casey Fork near Mount Vernon.

[4] Assumed based on USGS data from Casey Fork near Mount Vernon.

Table B4-5. Benzo(a)anthracene Concentration in Water Column

$C_{wctot} = f_{wc} * C_{wtot} * (d_{wc} + d_{bs}) / d_{wc}$		
C_{wctot}	**5.56E-21**	Total COPC concentration in water column (mg/L)
f_{wc}	8.82E-03	Fraction of total water body COPC concentration that occurs in the water column (unitless)
C_{wtot}	5.87E-19	Total water body COPC concentration, including water column and bed sediment (mg/L)
d_{wc}	4.05E-01	Depth of water column (m)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-17)

Table B4-6. Benzo(a)anthracene Dissolved Phase Water Concentration

$C_{dw} = C_{wctot} / (1+Kd_{sw}*TSS*10^{-6})$			
C_{dw}		**8.12E-22**	Dissolved phase water concentration (mg/L)
	C_{wctot}	5.56E-21	Total COPC concentration in water column (mg/L)
	Kd_{sw}	1.95E+04	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-19)
	TSS	3.00E+02	Total suspended solids concentration (mg/L)

Table B4-7. Benzo(a)anthracene Concentration in Bed Sediment

$C_{sed} = f_{bs} * C_{wtot} * [Kd_{bs}/(\theta_{bs} + Kd_{bs} * BS)] * [(d_{wc} + d_{bs})/d_{bs}]$		
C_{sed}	**8.45E-18**	COPC concentration in bed sediment (mg/kg)
f_{bs}	**9.91E-01**	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
C_{wtot}	**5.87E-19**	Total water body COPC concentration, including water column and bed sediment (mg/L)
Kd_{bs}	**1.04E+04**	Bed sediment/sediment pore water partition coefficient (L/kg) (SLERA Protocol Table A-2-19)
θ_{bs}	**6.00E-01**	Bed sediment porosity ($L_{water}/L_{sediment}$) (default value from SLERA Protocol Table B-2-10)
BS	**1.00E+00**	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-10)
d_{wc}	**4.05E-01**	Depth of water column (m)*
d_{bs}	**3.00E-02**	Depth of upper benthic sediment layer (m) (default value from Table B-2-12)

Table B5-1. Benzo(a)pyrene Summary

	Concentration from Project	Background Concentration[1,2]	Total Concentration (Background & Project)	Ecological Screening Level[3]	Toxicity Reference Value[4]	Project Increase Percent of Background Concentration	Ecological Screening Quotient
Soil (mg/kg)	9.47E-09	1.70E+01	1.70E+01	1.52E+00	2.50E+01	0.00%	N/A
Water (mg/L)	1.42E-21	2.00E-05	2.00E-05	1.40E-05	1.40E-05	0.00%	N/A
Sediment (mg/kg)	2.41E-18	N/A	N/A	1.50E-01	8.40E-02	N/A	0.00

Notes:

[1] Soil background concentration obtained from USGS survey of the area around Chicago, IL; Kay, R.T., et. al, Concentrations of PolynuclearAromatic Hydrocarbons and Inorganic Constituents in Ambient Surface Soils, Chicago, Illinois: 2001-2002. United States Geological Survey, 2003.

[2] Water background concentration assumed to be the average concentration from water samples in or near Jefferson County, obtained from the IEPA on 01/19/11 via J. Schewe of Falcon Engineering.

[3] U.S. EPA Region 5 Waste Division, RCRA Corrective Action Guidance and Policy Documents, Ecological Screening Levels, August 22, 2003 available at http://www.epa.gov/reg5rcra/ca/guidance.htm.

[4] U.S. EPA, Office of Solid Waste. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Volume 1. EPA 530-D-99-001A. August 1999.

Table B5-2. Benzo(a)pyrene Soil Concentration

$Cs = Ds * [1 - exp(-ks * tD)] / ks$		
Cs	**9.47E-09**	COPC concentration in soil (mg COPC/kg soil)
tD	**1.00E+02**	Time period over which deposition occurs (yr) (default value from SLERA Protocol Table B-1-1)
Ds	**4.52E-09**	Deposition term (mg COPC/kg soil/yr)
$Ds = 100/(Zs * BD) * [Fv (Dydv + Dywv) + (Dywp + Dydp) * (1 - Fv)]$		
	1.00E+02	Units conversion factor (m^2-mg/cm^2-kg)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-1, use 1 cm for untilled and 20 cm tilled soil)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-1)
F_v	2.65E-01	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-20)
Dydv + Dywv	1.04E-09	Maximum yearly average total (wet+dry) deposition from vapor phase from model (g/m^2-yr)
Dywp + Dydp	1.47E-09	Maximum yearly average total (wet+dry) deposition from particle phase from model (g/m^2-yr)
ks	**4.77E-01**	COPC soil loss constant due to all soil processes (yr^{-1})
$ks = ksg + kse + ksr + ksl + ksv$		
ksg	4.77E-01	COPC loss constant due to biotic and abiotic degradation (yr^{-1}) (SLERA Protocol Table A-2-20[1])
kse	0.00E+00	COPC loss constant due to soil erosion (yr^{-1}) (default value from SLERA Protocol Table B-1-2)
ksr	8.74E-05	COPC loss constant due to surface runoff (yr-1)
ksl	0.00E+00	COPC loss constant due to leaching (yr^{-1})
ksv	9.88E-07	COPC loss constant due to volatilization (yr^{-1})
ksr	**8.74E-05**	COPC loss constant due to surface runoff (yr-1)
$ksr = RO / (\theta_{sw} * Z_s) * \{1/[1 + (Kd_s * BD/\theta_{sw})]\}$		
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS Groundwater Atlas of the United States: Illinois, Indiana, Kentucky, Ohio, Tennessee available at http://pubs.usgs.gov/ha/ha730/ch_k/k-regionalsum.html)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-4)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-4, use 1 cm for untilled and 20 cm tilled soil)
Kd_s	9.69E+03	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-20[2])
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-4)
ksl	**0.00E+00**	COPC loss constant due to leaching (yr^{-1})
$ksl = (P + I - RO - E_v) / \{\theta_{sw} * Z_s * [1.0 + (BD * Kd_s / \theta_{sw})]\}$		
P	1.02E+02	Annual average precipitation (cm/yr) (NOAA)
I	0.00E+00	Average annual irrigation (cm/yr) (Baes Reference to SLERA Protocol Table B-1-5, Assumed due to low irrigation percentage in Illinois)
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS Groundwater Atlas of the United States: Illinois, Indiana, Kentucky, Ohio, Tennessee available at http://pubs.usgs.gov/ha/ha730/ch_k/k-regionalsum.html)
E_v	7.62E+01	Average annual evapotranspiration (cm/yr)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-5)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-5, use 1 cm for untilled and 20 cm tilled soil)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-5)
Kd_s	9.69E+03	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-20[2])
ksv	**9.88E-07**	
$ksv = [3.1536 \times 10^7 * H / (Z_s * Kd_s * R * T_a * BD)] * [D_a / Z_s] * [1 - (BD/\rho_s) - \theta_{sw}]$		
	3.15E+07	Units conversion factor (s/yr)
H	8.36E-07	Henry's Law constant (atm-m^3/mol) (SLERA Protocol Table A-2-20)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-6, use 1 cm for untilled and 20 cm tilled soil)
Kd_s	9.69E+03	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-20[2])
R	8.21E-05	Universal gas constant (atm-m^3/mol-K)
T_a	2.98E+02	Ambient air temperature (K) (default value from SLERA Protocol Table B-1-6)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-6)
ρ_s	2.70E+00	Solids particle density (g/cm^3) (default value from SLERA Protocol Table B-1-6)
D_a	2.18E-02	Diffusivity of COPC in air (cm^2/s) (SLERA Protocol Table A-2-20)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-6)

[1]Assume ND = 0.

[2]Assume pH = 6.8 based on USGS data on Casey Fork near Mount Vernon

Table B5-3. Benzo(a)pyrene Load to Water Body

$L_T = L_{DEP} + L_{DIF} + L_{RI} + L_R + L_E + L_I$		
L_T	**1.42E-01**	Total COPC load to the water body (including deposition, runoff, and erosion) (g/yr)
L_{DEP}	**8.11E-02**	Total (wet and dry) particle phase and wet vapor phase COPC direct deposition load to water body (g/yr)
$L_{DEP} = A_w * [F_v * Dwvp + (1-F_v) * Dwdpp]$		
A_w	5.98E+07	Water body surface area (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
F_v	2.65E-01	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-20)
Dwvp	1.04E-09	Yearly average wet deposition from vapor phase from model (over water body)(g/m^2-yr)
Dwdpp	1.47E-09	Yearly average total (wet and dry) deposition from particle phase from model (over water body) (g/m^2-yr)
L_{DIF}	**0.00E+00**	Vapor phase COPC diffusion (dry deposition) load to water body (g/yr)[1]
$L_{DIF} = (K_v * F_v * Cvp * 1.0 \times 10^{-6})/(H/(R*T_{wb}))$		
K_v	1.42E+00	Overall transfer rate coefficient (m/yr)
F_v	2.65E-01	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-20)
Cvp	0.00E+00	Yearly average air concentration from vapor phase from model (over water body) (mg/m^3)
H	8.36E-07	Henry's Law constant ($atm\text{-}m^3/mol$) (SLERA Protocol Table A-2-20)
R	8.21E-05	Universal gas constant ($atm\text{-}m^3/mol\text{-}K$)
T_{wb}	2.98E+02	Water body temperature (K) (default value from SLERA Protocol Table B-2-3)
L_{RI}	**2.96E-02**	Runoff load from impervious sources (g/yr)
$L_{RI} = A_I * [F_v * Dwvp + (1-F_v) * Dwdpp]$		
F_v	2.65E-01	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-20)
Dwvp	1.04E-09	Yearly average wet deposition from vapor phase from model (over water body)(g/m^2-yr)
Dwdpp	1.47E-09	Yearly average total (wet and dry) deposition from particle phase from model (over water body) (g/m^2-yr)
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
L_R	**3.70E-04**	Runoff load from pervious sources (g/yr)
$L_R = RO * (A_L - A_I) * [(Cs * BD)/(\theta_{sw} + Kd_s * BD)] * 0.01$		
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS Groundwater Atlas of the United States: Illinois, Indiana, Kentucky, Ohio, Tennessee available at http://pubs.usgs.gov/ha/ha730/ch_k/k-regionalsum.html)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
Cs	9.47E-09	COPC concentration in soil (mg/kg)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-2-5)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-2-5)
Kd_s	9.69E+03	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-20)
	1.00E-02	Units conversion factor ($kg\text{-}cm^2/mg\text{-}m^2$)
L_E	**3.07E-02**	Soil erosion load (g/yr)
$L_E = X_e * (A_L - A_I) * SD * ER * [(Cs * Kd_s * BD)/(\theta_{sw} + Kd_s * BD)] * 0.001$		
X_e	2.54E+01	Unit soil loss (kg/m^2-yr)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
SD	8.55E-02	Watershed sediment delivery ratio (unitless)
ER	1.00E+00	Soil enrichment ratio (unitless) (Per SLERA Protocol Table B-2-6, value is 1 for Inorganic COPC's and 3 for Organic COPC's)
Cs	9.47E-09	COPC concentration in soil (mg/kg)
Kd_s	9.69E+03	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-20)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-2-6)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-2-6)
	1.00E-03	Units conversion factor (g/mg)
L_I	**0.00E+00**	Internal transfer load (g/yr) (default value from SLERA Protocol Section 3.11.2.1)
X_e	**2.54E+01**	Unit soil loss (kg/m^2-yr)
$X_e = RF * K * LS * C * PF * (907.18/4047)$		
RF	3.00E+02	Universal Soil Loss Equation (USLE) rainfall (or erosivity) factor (yr^{-1}) (Highest value from range listed in SLERA Protocol Table B-2-7)
K	3.60E-01	USLE erodibility factor (ton/acre) (Default value from SLERA Protocol Table B-2-7[2])
LS	1.50E+00	USLE length-slope factor (unitless) (default value for representative watershed from SLERA Protocol Table B-2-7[3])
C	7.00E-01	USLE cover management factor (unitless)(Value based on agricultural row cropland from SLERA Protocol Table B-2-7)
PF	1.00E+00	USLE supporting practice factor (unitless) (Assumes no erosion control measures are in place)
	9.07E+02	Units conversion factor (kg/ton)
	4.05E+03	Units conversion factor (m^2/acre)
SD	**8.55E-02**	Watershed sediment delivery ratio (unitless)
$SD = a * (A_L)^{-b}$		
a	1.20E+00	Empirical intercept coefficient (unitless) (Value from Table B-2-8 based on watershed area[4])
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
b	1.25E-01	Empirical slope coefficient (unitless) (default value from Table B-2-8)

Notes:

[1] Assume vapor phase COPC diffusion load to water body is zero for Benzo(a)pyrene.

[2] Based on other available data, silty loam soils such as those found in this watershed have K values ranging from 0.25 - 0.4.

[3] Majority of watershed area has slopes 0% - 10%, therefore default value of 1.5 LS is used.

[4] Watershed area estimated to be receiving COPC is between 10 and 100 square miles.

Table B5-4. Benzo(a)pyrene Water Body Concentration

$C_{wtot} = L_T / [Vf_x * f_{wc} + k_{wt} * A_W * (d_{wc} + d_{bs})]$		
C_{wtot}	**1.67E-19**	Total water body COPC concentration, including water column and bed sediment (mg/L)
L_T	**1.42E-01**	Total COPC load to the water body (including deposition, runoff, and erosion) (g/yr)
Vf_x	**1.32E+08**	Average volumetric flow rate through water body (m^3/yr)
f_{wc}	**7.90E-03**	Fraction of total water body COPC concentration that occurs in the water column (unitless)
$f_{wc} = [(1 + Kd_{sw} * TSS * 10^{-6}) * d_{wc}/d_z] / [(1 + Kd_{sw} * TSS * 1 \times 10^{-6}) * d_{wc}/d_z + (\theta_{bs} + Kd_{bs} * BS) * d_{bs}/d_z]$		
$f_{bs} = 1 - f_{wc}$		
f_{bs}	9.92E-01	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
Kd_{sw}	7.27E+04	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-20[1])
TSS	3.00E+02	Total suspended solids concentration (mg/L)(High value for range listed in SLERA Protocol Table B-2-10[2])
	1.00E-06	Units conversion factor (kg/mg)
d_{wc}	4.05E-01	Depth of water column (m)[3]
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-10)
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-10, $d_z = d_{wc} + d_{bs}$)
BS	1.00E+00	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-10)
θ_{bs}	6.00E-01	Bed sediment porosity ($L_{water}/L_{sediment}$) (default value from SLERA Protocol Table B-2-10)
Kd_{bs}	3.87E+04	Bed sediment/sediment pore water partition coefficient (L/kg) (SLERA Protocol Table A-2-20[1])
k_{wt}	**3.26E+10**	Overall total water body COPC dissipation rate constant (yr^{-1})[4]
$k_{wt} = f_{wc} * k_v + f_{bs} * k_b$		
f_{wc}	7.90E-03	Fraction of total water body COPC concentration that occurs in the water column (unitless)
k_v	1.43E-01	Water column volatilization rate constant (yr^{-1})
f_{bs}	9.92E-01	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
k_b	3.28E+10	Benthic burial rate constant (yr^{-1})
A_w	**5.98E+07**	Water body surface area (m^2)
k_v	**1.43E-01**	Water column volatilization rate constant (yr^{-1})
$k_v = K_v / [d_z * (1 + Kd_{sw} * TSS * 10^{-6})]$		
K_v	1.42E+00	Overall COPC transfer rate coefficient (m/yr)
d_{wc}	4.05E-01	Depth of water column (m)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from Table B-2-12)
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-12, $d_z = d_{wc} + d_{bs}$)
Kd_{sw}	7.27E+04	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-20)
TSS	3.00E+02	Total suspended solids concentration (mg/L)
	1.00E-06	Units conversion factor (kg/mg)
K_v	**1.42E+00**	Overall COPC transfer rate coefficient (m/yr)
$K_v = \{K_L^{-1} + [K_G * H/(R * T_{wk})]^{-1}\}^{-1} * q^{(Twk - 293)}$		
K_L	6.38E+02	Liquid-phase transfer coefficient (m/yr)
K_G	3.65E+04	Gas-phase transfer coefficient (m/yr)
H	8.36E-07	Henry's Law constant (atm-m^3/mol) (SLERA Protocol Table A-2-20)
R	8.21E-05	Universal gas constant (atm-m^3/mol-K)
T_{wk}	2.98E+02	Water body temperature (K) (default value from SLERA Protocol Table B-2-13)
q	1.03E+00	Temperature correction factor (unitless) (default value from SLERA Protocol Table B-2-13)
K_L	**6.38E+02**	Liquid-phase transfer coefficient for flowing streams or rivers (m/yr)
$K_L = SQRT (10^{-4} * D_w * u / d_z) * 3.1536 \times 10^7$		
D_w	5.85E-06	Diffusivity of COPC in water (cm^2/s) (SLERA Protocol Table A-2-20)
u	3.05E-01	Current velocity (m/s)[4]
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-14, $d_z = d_{wc} + d_{bs}$)
	3.15E+07	Units conversion constant (s/yr)
K_G	**3.65E+04**	Gas-phase transfer coefficient for flowing streams or rivers (m/yr) (default value from SLERA Protocol Table B-2-15)
k_b	**3.28E+10**	Benthic burial rate constant (yr^{-1})
$k_b = [X_c * A_L * SD * 10^3 - Vf_x * TSS / (A_W * TSS)] * [TSS * 10^{-6} / (BS * d_{bs})]$		
X_c	2.54E+01	Unit soil loss (kg/m^2-yr)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2)
SD	8.55E-02	Watershed sediment delivery ratio (unitless)
Vf_x	1.32E+08	Average volumetric flow rate through water body (m^3/yr)
TSS	3.00E+02	Total suspended solids concentration (mg/L)
A_W	5.98E+07	Water body surface area (m^2)
BS	1.00E+00	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-16)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-16)

Notes:

[1] Assume pH = 6.8 based on USGS data on Casey Fork near Mount Vernon

[2] No data available for location of deposition, therefore used high end of SLERA default range.

[3] Assumed based on USGS data from Casey Fork near Mount Vernon.

[4] Assumed based on USGS data from Casey Fork near Mount Vernon.

Table B5-5. Benzo(a)pyrene Concentration in Water Column

$C_{wctot} = f_{wc} * C_{wtot} * (d_{wc} + d_{bs}) / d_{wc}$		
C_{wctot}	**1.42E-21**	Total COPC concentration in water column (mg/L)
f_{wc}	7.90E-03	Fraction of total water body COPC concentration that occurs in the water column (unitless)
C_{wtot}	1.67E-19	Total water body COPC concentration, including water column and bed sediment (mg/L)
d_{wc}	4.05E-01	Depth of water column (m)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-17)

Table B5-6. Benzo(a)pyrene Dissolved Phase Water Concentration

$C_{dw} = C_{wctot} / (1+Kd_{sw}*TSS*10^{-6})$			
C_{dw}		**6.22E-23**	Dissolved phase water concentration (mg/L)
	C_{wctot}	1.42E-21	Total COPC concentration in water column (mg/L)
	Kd_{sw}	7.27E+04	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-20)
	TSS	3.00E+02	Total suspended solids concentration (mg/L)

Table B5-7. Benzo(a)pyrene Concentration in Bed Sediment

$C_{sed} = f_{bs} * C_{wtot} * [Kd_{bs}/(\theta_{bs} + Kd_{bs} * BS)] * [(d_{wc} + d_{bs})/d_{bs}]$		
C_{sed}	**2.41E-18**	COPC concentration in bed sediment (mg/kg)
f_{bs}	**9.92E-01**	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
C_{wtot}	**1.67E-19**	Total water body COPC concentration, including water column and bed sediment (mg/L)
Kd_{bs}	**3.87E+04**	Bed sediment/sediment pore water partition coefficient (L/kg) (SLERA Protocol Table A-2-20)
θ_{bs}	**6.00E-01**	Bed sediment porosity ($L_{water}/L_{sediment}$) (default value from SLERA Protocol Table B-2-10)
BS	**1.00E+00**	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-10)
d_{wc}	**4.05E-01**	Depth of water column (m)*
d_{bs}	**3.00E-02**	Depth of upper benthic sediment layer (m) (default value from Table B-2-12)

Table B6-1. Benzo(b)fluoranthene Summary

	Concentration from Project	Background Concentration[1]	Total Concentration (Background & Project)	Ecological Screening Level[2]	Toxicity Reference Value[3]	Total Concentration Percent of ESL	Ecological Screening Quotient
Soil (mg/kg)	3.61E-09	1.80E+01	1.80E+01	5.98E+01	2.50E+01	30.10%	N/A
Water (mg/L)	4.89E-22	N/A	N/A	9.07E-03	2.70E-05	N/A	0.00
Sediment (mg/kg)	8.24E-19	N/A	N/A	1.04E+01	3.70E-02	N/A	0.00

Notes:

[1] Soil background concentration obtained from USGS survey of the area around Chicago, IL; Kay, R.T., et. al, Concentrations of PolynuclearAromatic Hydrocarbons and Inorganic Constituents in Ambient Surface Soils, Chicago, Illinois: 2001-2002. United States Geological Survey, 2003.

[2] U.S. EPA Region 5 Waste Division, RCRA Corrective Action Guidance and Policy Documents, Ecological Screening Levels, August 22, 2003 available at http://www.epa.gov/reg5rcra/ca/guidance.htm.

[3] U.S. EPA, Office of Solid Waste. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Volume 1. EPA 530-D-99-001A. August 1999.

Table B6-2. Benzo(b)fluoranthene Soil Concentration

$Cs = Ds * [1 - exp(-ks * tD)] / ks$		
Cs	**3.61E-09**	COPC concentration in soil (mg COPC/kg soil)
tD	**1.00E+02**	Time period over which deposition occurs (yr) (default value from SLERA Protocol Table B-1-1)
Ds	**1.50E-09**	Deposition term (mg COPC/kg soil/yr)
$Ds = 100/(Zs * BD) * [Fv (Dydv + Dywv) + (Dywp + Dydp) * (1 - Fv)]$		
	1.00E+02	Units conversion factor (m^2-mg/cm^2-kg)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-1, use 1 cm for untilled and 20 cm tilled soil)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-1)
F_v	8.22E-01	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-21)
Dydv + Dywv	4.30E-10	Maximum yearly average total (wet+dry) deposition from vapor phase from model (g/m^2-yr)
Dywp + Dydp	5.40E-10	Maximum yearly average total (wet+dry) deposition from particle phase from model (g/m^2-yr)
ks	**4.15E-01**	COPC soil loss constant due to all soil processes (yr^{-1})
$ks = ksg + kse + ksr + ksl + ksv$		
ksg	4.15E-01	COPC loss constant due to biotic and abiotic degradation (yr^{-1}) (SLERA Protocol Table A-2-21[1])
kse	0.00E+00	COPC loss constant due to soil erosion (yr^{-1}) (default value from SLERA Protocol Table B-1-2)
ksr	1.01E-04	COPC loss constant due to surface runoff (yr-1)
ksl	0.00E+00	COPC loss constant due to leaching (yr^{-1})
ksv	8.86E-06	COPC loss constant due to volatilization (yr^{-1})
ksr	**1.01E-04**	COPC loss constant due to surface runoff (yr-1)
$ksr = RO / (\theta_{sw} * Z_s) * \{1/[1 + (Kd_s * BD/\theta_{sw})]\}$		
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS Groundwater Atlas of the United States: Illinois, Indiana, Kentucky, Ohio, Tennessee available at http://pubs.usgs.gov/ha/ha730/ch_k/k-regionalsum.html)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-4)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-4, use 1 cm for untilled and 20 cm tilled soil)
Kd_s	8.36E+03	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-21[2])
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-4)
ksl	**0.00E+00**	COPC loss constant due to leaching (yr^{-1})
$ksl = (P + I - RO - E_v) / \{\theta_{sw} * Z_s * [1.0 + (BD * Kd_s / \theta_{sw})]\}$		
P	1.02E+02	Annual average precipitation (cm/yr) (NOAA)
I	0.00E+00	Average annual irrigation (cm/yr) (Baes Reference to SLERA Protocol Table B-1-5, Assumed due to low irrigation percentage in Illinois)
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS Groundwater Atlas of the United States: Illinois, Indiana, Kentucky, Ohio, Tennessee available at http://pubs.usgs.gov/ha/ha730/ch_k/k-regionalsum.html)
E_v	7.62E+01	Average annual evapotranspiration (cm/yr)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-5)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-5, use 1 cm for untilled and 20 cm tilled soil)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-5)
Kd_s	8.36E+03	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-21[2])
ksv	**8.86E-06**	
$ksv = [3.1536 \times 10^7 * H / (Z_s * Kd_s * R * T_a * BD)] * [D_a / Z_s] * [1 - (BD/\rho_s) - \theta_{sw}]$		
	3.15E+07	Units conversion factor (s/yr)
H	6.18E-06	Henry's Law constant (atm-m^3/mol) (SLERA Protocol Table A-2-21)
Z_s	2.00E+01	Soil mixing zone depth (cm) (per SLERA Protocol Table B-1-6, use 1 cm for untilled and 20 cm tilled soil)
Kd_s	8.36E+03	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-21[2])
R	8.21E-05	Universal gas constant (atm-m^3/mol-K)
T_a	2.98E+02	Ambient air temperature (K) (default value from SLERA Protocol Table B-1-6)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-1-6)
ρ_s	2.70E+00	Solids particle density (g/cm^3) (default value from SLERA Protocol Table B-1-6)
D_a	2.28E-02	Diffusivity of COPC in air (cm^2/s) (SLERA Protocol Table A-2-21)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-1-6)

[1]Assume ND = 0.

[2]Assume pH = 6.8 based on USGS data on Casey Fork near Mount Vernon

Table B6-3. Benzo(b)fluoranthene Load to Water Body

$L_T = L_{DEP} + L_{DIF} + L_{RI} + L_R + L_E + L_I$		
L_T	**4.86E-02**	Total COPC load to the water body (including deposition, runoff, and erosion) (g/yr)
L_{DEP}	**2.69E-02**	Total (wet and dry) particle phase and wet vapor phase COPC direct deposition load to water body (g/yr)
$L_{DEP} = A_w * [F_v * Dwvp + (1-F_v) * Dwdpp]$		
A_w	5.98E+07	Water body surface area (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
F_v	8.22E-01	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-21)
Dwvp	4.30E-10	Yearly average wet deposition from vapor phase from model (over water body)(g/m^2-yr)
Dwdpp	5.40E-10	Yearly average total (wet and dry) deposition from particle phase from model (over water body) (g/m^2-yr)
L_{DIF}	**0.00E+00**	Vapor phase COPC diffusion (dry deposition) load to water body (g/yr)[1]
$L_{DIF} = (K_v * F_v * Cvp * 1.0 \times 10^{-6})/(H/(R*T_{wb}))$		
K_v	1.03E+01	Overall transfer rate coefficient (m/yr)
F_v	8.22E-01	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-21)
Cvp	0.00E+00	Yearly average air concentration from vapor phase from model (over water body) (mg/m^3)
H	6.18E-06	Henry's Law constant (atm-m^3/mol) (SLERA Protocol Table A-2-21)
R	8.21E-05	Universal gas constant (atm-m^3/mol-K)
T_{wb}	2.98E+02	Water body temperature (K) (default value from SLERA Protocol Table B-2-3)
L_{RI}	**9.82E-03**	Runoff load from impervious sources (g/yr)
$L_{RI} = A_I * [F_v * Dwvp + (1-F_v) * Dwdpp]$		
F_v	8.22E-01	Fraction of COPC air concentration in vapor phase (SLERA Protocol Table A-2-21)
Dwvp	4.30E-10	Yearly average wet deposition from vapor phase from model (over water body)(g/m^2-yr)
Dwdpp	5.40E-10	Yearly average total (wet and dry) deposition from particle phase from model (over water body) (g/m^2-yr)
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
L_R	**1.63E-04**	Runoff load from pervious sources (g/yr)
$L_R = RO * (A_L - A_I) * [(Cs * BD)/(\theta_{sw} + Kd_s * BD)] * 0.01$		
RO	2.54E+01	Average annual surface runoff (cm/yr) (USGS Groundwater Atlas of the United States: Illinois, Indiana, Kentucky, Ohio, Tennessee available at http://pubs.usgs.gov/ha/ha730/ch_k/k-regionalsum.html)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
Cs	3.61E-09	COPC concentration in soil (mg/kg)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-2-5)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-2-5)
Kd_s	8.36E+03	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-21)
	1.00E-02	Units conversion factor (kg-cm^2/mg-m^2)
L_E	**1.17E-02**	Soil erosion load (g/yr)
$L_E = X_e * (A_L - A_I) * SD * ER * [(Cs * Kd_s * BD)/(\theta_{sw} + Kd_s * BD)] * 0.001$		
X_e	2.54E+01	Unit soil loss (kg/m^2-yr)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
A_I	2.18E+07	Impervious watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
SD	8.55E-02	Watershed sediment delivery ratio (unitless)
ER	1.00E+00	Soil enrichment ratio (unitless) (Per SLERA Protocol Table B-2-6, value is 1 for Inorganic COPC's and 3 for Organic COPC's)
Cs	3.61E-09	COPC concentration in soil (mg/kg)
Kd_s	8.36E+03	Soil-water partition coefficient (cm^3/g) (SLERA Protocol Table A-2-21)
BD	1.50E+00	Soil bulk density (g/cm^3) (default value from SLERA Protocol Table B-2-6)
θ_{sw}	2.00E-01	Soil volumetric water content (mL/cm^3) (default value from SLERA Protocol Table B-2-6)
	1.00E-03	Units conversion factor (g/mg)
L_I	**0.00E+00**	Internal transfer load (g/yr) (default value from SLERA Protocol Section 3.11.2.1)
X_e	**2.54E+01**	Unit soil loss (kg/m^2-yr)
$X_e = RF * K * LS * C * PF * (907.18/4047)$		
RF	3.00E+02	Universal Soil Loss Equation (USLE) rainfall (or erosivity) factor (yr^{-1}) (Highest value from range listed in SLERA Protocol Table B-2-7)
K	3.60E-01	USLE erodibility factor (ton/acre) (Default value from SLERA Protocol Table B-2-7[2])
LS	1.50E+00	USLE length-slope factor (unitless) (default value for representative watershed from SLERA Protocol Table B-2-7[3])
C	7.00E-01	USLE cover management factor (unitless)(Value based on agricultural row cropland from SLERA Protocol Table B-2-7)
PF	1.00E+00	USLE supporting practice factor (unitless) (Assumes no erosion control measures are in place)
	9.07E+02	Units conversion factor (kg/ton)
	4.05E+03	Units conversion factor (m^2/acre)
SD	**8.55E-02**	Watershed sediment delivery ratio (unitless)
$SD = a * (A_L)^{-b}$		
a	1.20E+00	Empirical intercept coefficient (unitless) (Value from Table B-2-8 based on watershed area[4])
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2) (Illinois Department of Agriculture. 2007. Land Cover of Illinois. Available online at http://www.agr.state.il.us/gis/landcover99-00.html#class accessed [12/06/2010])
b	1.25E-01	Empirical slope coefficient (unitless) (default value from Table B-2-8)

Notes:

[1] Assume vapor phase COPC diffusion load to water body is zero for Benzo(b)fluoranthene.

[2] Based on other available data, silty loam soils such as those found in this watershed have K values ranging from 0.25 - 0.4.

[3] Majority of watershed area has slopes 0% - 10%, therefore default value of 1.5 LS is used.

[4] Watershed area estimated to be receiving COPC I between 10 and 100 square miles.

Table B6-4. Benzo(b)fluoranthene Water Body Concentration

$C_{wtot} = L_T / [Vf_z * f_{wc} + k_{wt} * A_W * (d_{wc} + d_{bs})]$		
C_{wtot}	**5.72E-20**	Total water body COPC concentration, including water column and bed sediment (mg/L)
L_T	**4.86E-02**	Total COPC load to the water body (including deposition, runoff, and erosion) (g/yr)
Vf_z	**1.32E+08**	Average volumetric flow rate through water body (m^3/yr)
f_{wc}	**7.95E-03**	Fraction of total water body COPC concentration that occurs in the water column (unitless)
$f_{wc} = [(1 + Kd_{sw} * TSS * 10^{-6}) * d_{wc}/d_z] / [(1 + Kd_{sw} * TSS * 1 \times 10^{-6}) * d_{wc}/d_z + (\theta_{bs} + Kd_{bs} * BS) * d_{bs}/d_z]$		
$f_{bs} = 1 - f_{wc}$		
f_{bs}	9.92E-01	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
Kd_{sw}	6.27E+04	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-21[1])
TSS	3.00E+02	Total suspended solids concentration (mg/L)(High value for range listed in SLERA Protocol Table B-2-10[2])
	1.00E-06	Units conversion factor (kg/mg)
d_{wc}	4.05E-01	Depth of water column (m)[3]
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-10)
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-10, $d_z = d_{wc} + d_{bs}$)
BS	1.00E+00	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-10)
θ_{bs}	6.00E-01	Bed sediment porosity ($L_{water}/L_{sediment}$) (default value from SLERA Protocol Table B-2-10)
Kd_{bs}	3.34E+04	Bed sediment/sediment pore water partition coefficient (L/kg) (SLERA Protocol Table A-2-21[1])
k_{wt}	**3.26E+10**	Overall total water body COPC dissipation rate constant (yr^{-1})[4]
$k_{wt} = f_{wc} * k_v + f_{bs} * k_b$		
f_{wc}	7.95E-03	Fraction of total water body COPC concentration that occurs in the water column (unitless)
k_v	1.20E+00	Water column volatilization rate constant (yr^{-1})
f_{bs}	9.92E-01	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
k_b	3.28E+10	Benthic burial rate constant (yr^{-1})
A_w	**5.98E+07**	Water body surface area (m^2)
k_v	**1.20E+00**	Water column volatilization rate constant (yr^{-1})
$k_v = K_v / [d_z * (1 + Kd_{sw} * TSS * 10^{-6})]$		
K_v	1.03E+01	Overall COPC transfer rate coefficient (m/yr)
d_{wc}	4.05E-01	Depth of water column (m)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from Table B-2-12)
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-12, $d_z = d_{wc} + d_{bs}$)
Kd_{sw}	6.27E+04	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-21)
TSS	3.00E+02	Total suspended solids concentration (mg/L)
	1.00E-06	Units conversion factor (kg/mg)
K_v	**1.03E+01**	Overall COPC transfer rate coefficient (m/yr)
$K_v = \{K_L^{-1} + [K_G * H/(R * T_{wk})]^{-1}\}^{-1} * q^{(Twk - 293)}$		
K_L	6.18E+02	Liquid-phase transfer coefficient (m/yr)
K_G	3.65E+04	Gas-phase transfer coefficient (m/yr)
H	6.18E-06	Henry's Law constant (atm-m^3/mol) (SLERA Protocol Table A-2-21)
R	8.21E-05	Universal gas constant (atm-m^3/mol-K)
T_{wk}	2.98E+02	Water body temperature (K) (default value from SLERA Protocol Table B-2-13)
q	1.03E+00	Temperature correction factor (unitless) (default value from SLERA Protocol Table B-2-13)
K_L	**6.18E+02**	Liquid-phase transfer coefficient for flowing streams or rivers (m/yr)
$K_L = SQRT (10^{-4} * D_w * u / d_z) * 3.1536 \times 10^7$		
D_w	5.49E-06	Diffusivity of COPC in water (cm^2/s) (SLERA Protocol Table A-2-21)
u	3.05E-01	Current velocity (m/s)[4]
d_z	4.35E-01	Total water body depth (m) (Per SLERA Protocol Table B-2-14, $d_z = d_{wc} + d_{bs}$)
	3.15E+07	Units conversion constant (s/yr)
K_G	**3.65E+04**	Gas-phase transfer coefficient for flowing streams or rivers (m/yr) (default value from SLERA Protocol Table B-2-15)
k_b	**3.28E+10**	Benthic burial rate constant (yr^{-1})
$k_b = [X_c * A_L * SD * 10^3 - Vf_z * TSS / (A_W * TSS)] * [TSS * 10^{-6} / (BS * d_{bs})]$		
X_c	2.54E+01	Unit soil loss (kg/m^2-yr)
A_L	1.51E+09	Total watershed area receiving COPC deposition (m^2)
SD	8.55E-02	Watershed sediment delivery ratio (unitless)
Vf_z	1.32E+08	Average volumetric flow rate through water body (m^3/yr)
TSS	3.00E+02	Total suspended solids concentration (mg/L)
A_W	5.98E+07	Water body surface area (m^2)
BS	1.00E+00	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-16)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-16)

Notes:

[1] Assume pH = 6.8 based on USGS data on Casey Fork near Mount Vernon

[2] No data available for location of deposition, therefore used high end of SLERA default range.

[3] Assumed based on USGS data from Casey Fork near Mount Vernon.

[4] Assumed based on USGS data from Casey Fork near Mount Vernon.

Table B6-5. Benzo(b)fluoranthene Concentration in Water Column

$C_{wctot} = f_{wc} * C_{wtot} * (d_{wc} + d_{bs}) / d_{wc}$		
C_{wctot}	**4.89E-22**	Total COPC concentration in water column (mg/L)
f_{wc}	7.95E-03	Fraction of total water body COPC concentration that occurs in the water column (unitless)
C_{wtot}	5.72E-20	Total water body COPC concentration, including water column and bed sediment (mg/L)
d_{wc}	4.05E-01	Depth of water column (m)
d_{bs}	3.00E-02	Depth of upper benthic sediment layer (m) (default value from SLERA Protocol Table B-2-17)

Table B6-6. Benzo(b)fluoranthene Dissolved Phase Water Concentration

$C_{dw} = C_{wctot} / (1+Kd_{sw}*TSS*10^{-6})$			
C_{dw}		**2.47E-23**	Dissolved phase water concentration (mg/L)
	C_{wctot}	4.89E-22	Total COPC concentration in water column (mg/L)
	Kd_{sw}	6.27E+04	Suspended sediments/surface water partition coefficient (L/kg) (SLERA Protocol Table A-2-21)
	TSS	3.00E+02	Total suspended solids concentration (mg/L)

Table B6-7. Benzo(b)fluoranthene Concentration in Bed Sediment

$C_{sed} = f_{bs} * C_{wtot} * [Kd_{bs}/(\theta_{bs} + Kd_{bs} * BS)] * [(d_{wc} + d_{bs})/d_{bs}]$		
C_{sed}	**8.24E-19**	COPC concentration in bed sediment (mg/kg)
f_{bs}	**9.92E-01**	Fraction of total water body COPC concentration that occurs in the benthic sediment (unitless)
C_{wtot}	**5.72E-20**	Total water body COPC concentration, including water column and bed sediment (mg/L)
Kd_{bs}	**3.34E+04**	Bed sediment/sediment pore water partition coefficient (L/kg) (SLERA Protocol Table A-2-21)
θ_{bs}	**6.00E-01**	Bed sediment porosity ($L_{water}/L_{sediment}$) (default value from SLERA Protocol Table B-2-10)
BS	**1.00E+00**	Benthic solids concentration (g/cm^3) (equivalent to kg/L) (default value from SLERA Protocol Table B-2-10)
d_{wc}	**4.05E-01**	Depth of water column (m)*
d_{bs}	**3.00E-02**	Depth of upper benthic sediment layer (m) (default value from Table B-2-12)

Table B7-1. Benzo(k)fluoranthene Summary

	Concentration from Project	Background Concentration[1]	Total Concentration (Background & Project)	Ecological Screening Level[2]	Toxicity Reference Value[3]	Total Concentration Percent of ESL	Ecological Screening Quotient
Soil (mg/kg)	6.77E-08	1.00E+01	1.00E+01	1.48E+02	2.50E-01	6.76%	N/A
Water (mg/L)	4.20E-21	N/A	N/A	N/A	2.70E-05	N/A	0.00
Sediment (mg/kg)	7.09E-18	N/A	N/A	2.40E-01	3.70E-02	N/A	0.00

Notes:

[1] Soil background concentration obtained from USGS survey of the area around Chicago, IL; Kay, R.T., et. al, Concentrations of PolynuclearAromatic Hydrocarbons and Inorganic Constituents in Ambient Surface Soils, Chicago, Illinois: 2001-2002. United States Geological Survey, 2003.

[2] U.S. EPA Region 5 Waste Division, RCRA Corrective Action Guidance and Policy Documents, Ecological Screening Levels, August 22, 2003 available at http://www.epa.gov/reg5rcra/ca/guidance.htm.

[3] U.S. EPA, Office of Solid Waste. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Volume 1. EPA 530-D-99-001A. August 1999.