Changes in Calculation of Tier 1 Risk-Based Target Levels for Departmental Missouri Risk-Based Corrective Action Technical Guidance
September 12, 2005
Information for Risk-Based Remediation Rule Workgroup

This information identifies the changes, discussed at the Workgroup meeting on August 23, 2005 that will affect the calculation of Tier 1 risk-based target levels (RBTLs) for the Departmental Missouri Risk-Based Corrective action (MRBCA) Technical Guidance. Note that, as in the past, information on petroleum-related chemicals is not included in the Departmental MRBCA Technical Guidance.

1. Changes in toxicity value: Based on the Department of Health and Senior Services' (DHSS) comments and updates to the United States Environmental Protection Agency (USEPA) Region IX Preliminary Remediation Goal (PRG) Tables, toxicity values for 20 chemicals were changed. These new values are presented in Table 1. The revised Table E-1 of the Departmental MRBCA Technical Guidance is attached.

2. Addition of perchlorate: Revised Tables E-1 and E-2 of the Departmental MRBCA Technical Guidance include toxicity and physical/chemical properties of perchlorate. When input parameters are finalized, RBTLs will be calculated for this chemical and included in Appendix B.

3. Adoption of USEPA's Risk Assessment Guidance for Superfund (RAGS) Part E: Based on this Workgroup action, the following changes were adopted:

   - Changes in equations: Revisions to the equations for calculating dermal risk from exposure to contaminated groundwater involve additional input parameters. Additional parameters are required to calculate the risk from both incidental dermal contact with groundwater (such as contact outdoors with groundwater) and whole-body contact with groundwater (such as showering). The additional input parameters are listed below in the section entitled additional exposure factors. Revised Section E.12 of the Departmental MRBCA Technical Guidance is attached.

   - Change in exposure scenario: For the chemicals without maximum contaminant levels (MCLs), Tier 1 RBTLs for domestic water use will include the whole-body dermal contact with, ingestion of, and inhalation of vapors from water.

   - Changes in skin surface area: The guidance will use updated skin surface area for (i) incidental dermal contact with soil, (ii) incidental dermal contact with water, and (iii) whole-body contact with water (new parameter). Specifically, these changes are:

Parameter	Unit	Previous Value	New Value
Skin Surface Area for Incidental Dermal Contact with Soil			
Resident Child	cm^2/day	4236	2800
Resident Adult	cm^2/day	4714	5700
Non-residential Worker	cm^2/day	4714	3300
Construction Worker	cm^2/day	4714	3300
Skin Surface Area for Incidental Dermal Contact with Water			
Resident Child	cm^2/day	4236	2800
Resident Adult	cm^2/day	4714	5700
Non-residential Worker	cm^2/day	4714	3300
Construction Worker	cm^2/day	4714	3300
Skin Surface Area for Whole-body Dermal Contact with Water			
Resident Child	cm^2/day	NR	6600
Resident Adult	cm^2/day	NR	18000

NR: Not required

- Changes in soil adherence factor: Specifically, these changes are:

Parameter	Unit	Previous Value	New Value
Soil Adherence Factor			
Resident Child	mg/cm^2	1	0.2
Resident Adult	mg/cm^2	1	0.07
Non-residential Worker	mg/cm^2	1	0.2
Construction Worker	mg/cm^2	1	0.3

- Additional exposure factors: With the adoption of RAGS Part E, the following exposure factors require default values. The following values were adopted at the August 23, 2005 meeting:
  - Event frequency for incidental dermal contact with soil: 1 event/day
  - Event frequency for incidental dermal contact with water: 1 event/day
  - Event frequency for whole-body contact with water: 1 event/day
  - Event duration for incidental dermal contact with water: 1 hour/event
  - Event duration for whole-body contact with water: 0.25 hour/event for adult and 0.33 hour/event for child

4. Changes in inhalation rate of construction worker: An inhalation rate of 1.8 m^3/hour has been recommended for construction worker. The exposure time has been changed from 12 hours/day to 10 hours/day.

All of these changes in exposure parameters are shown in the revised Table E-3, attached.

Attachments: Table 1
Table E-1 of Departmental MRBCA Technical Guidance
Table E-2 of Departmental MRBCA Technical Guidance
Table E-3 of Departmental MRBCA Technical Guidance
Section E.12 of Departmental MRBCA Technical Guidance

Table 1
Updates in Toxicity Values
MRBCA Technical Guidance

Chemicals	CAS #	Slope Factor					Reference Dose				
		Oral, SF_o $(mg/kg\text{-}day)^{-1}$		Inhalation, SF_i $(mg/kg\text{-}day)^{-1}$		Dermal, SF_d $(mg/kg\text{-}day)^{-1}$	Oral, RfD_o (mg/kg-day)		Inhalation, RfD_i (mg/kg-day)		Dermal, RfD_d (mg/kg-day)
Chemicals Listed in DHSS Comments and Updated											
1,2-Dichloropropane	78-87-5	3.6E-02	*c*	3.5E-02	*c*	3.6E-02	1.1E-03	*r*	1.1E-03	*i*	1.1E-03
1,2-Dichloropropane	78-87-5	3.6E-02	*c*	**3.6E-02**	*c*	3.6E-02	1.1E-03	*r*	1.1E-03	*i*	1.1E-03
Tetrachloroethylene	127-18-4	5.2E-02	*n*	1.0E-02	*n*	5.2E-02	1.0E-02	*i*	1.7E-01	*n*	1.0E-02
Tetrachloroethylene	127-18-4	**5.4E-01**	***c***	**2.1E-02**	***c***	5.4E-01	1.0E-02	*i*	1.7E-01	*n*	1.0E-02
Bis(2-ethylhexyl)phthalate	117-81-7	1.4E-02	*i*			1.4E-02	2.0E-02	*i*	2.0E-02	*r*	2.0E-02
Bis(2-ethylhexyl)phthalate	117-81-7	1.4E-02	*i*	**1.4E-02**	***r***	1.4E-02	2.0E-02	*i*	2.0E-02	*r*	2.0E-02
2-Methyl-4,6-dinitrophenol	534-52-1						2.0E-03	*t*	8.6E-05	*t*	2.0E-03
2-Methyl-4,6-dinitrophenol	534-52-1						**1.0E-04**	*p*	8.6E-05	*t*	**1.0E-04**
3-Nitroaniline	99-09-2	2.1E-02	*p*	2.1E-02	*r*	2.1E-02	3.0E-04	*p*	2.9E-04	*p*	3.0E-04
3-Nitroaniline	99-09-2	2.1E-02	*p*	2.1E-02	*r*	2.1E-02	3.0E-04	*p*	**3.0E-04**	***p***	3.0E-04
alpha-Hexachlorocyclohexane	319-84-6	6.3E+00	*i*	6.3E+00	*i*	6.3E+00	5.0E-04	*n*	5.0E-05	*r*	5.0E-04
alpha-Hexachlorocyclohexane	319-84-6	6.3E+00	*i*	6.3E+00	*i*	6.3E+00	5.0E-04	*n*	**5.0E-04**	***r***	5.0E-04
Chemicals Not Listed in DHSS Comments, but Updated in 2004 PRG Table											
Allyl chloride	107-05-1	2.1E-02	*c*	2.1E-02	*c*	2.1E-02	5.0E-02	*h*	2.9E-04	*i*	5.0E-02
Allyl chloride	107-05-1	2.1E-02	*c*	2.1E-02	*c*	2.1E-02	**2.9E-04**	***r***	2.9E-04	*i*	2.9E-04
Chloroform	67-66-3	3.1E-02	*c*	8.1E-02	*i*	3.1E-02	1.0E-02	*i*	8.6E-04	*n*	1.0E-02
Chloroform	67-66-3	3.1E-02	*c*	8.1E-02	*i*	3.1E-02	1.0E-02	*i*	**1.4E-02**	***n***	1.0E-02
Chloromethane	74-87-3	1.3E-02	*h*	6.3E-03	*h*	1.3E-02	2.6E-02	*r*	2.6E-02	*i*	2.6E-02
Chloromethane	74-87-3	**1.3E-02**	***t***	**6.3E-03**	***t***	**1.3E-02**	2.6E-02	*r*	2.6E-02	*i*	2.6E-02
1,3-Dichlorobenzene	541-73-1						9.0E-04	*n*	9.0E-04	*r*	9.0E-04
1,3-Dichlorobenzene	541-73-1						**3.0E-02**	***n***	**3.0E-02**	***r***	**3.0E-02**
1,4-Dichlorobenzene	106-46-7	5.4E-03	*c*	2.2E-02	*n*	5.4E-03	3.0E-02	*n*	2.3E-01	*i*	3.0E-02
1,4-Dichlorobenzene	106-46-7	5.4E-03	*c*	2.2E-02	*n*	5.4E-03	**2.3E-01**	***n***	2.3E-01	*i*	2.3E-01
1,3-Dichloropropene	542-75-6	1.0E-01	*i*	1.4E-02	*i*	1.0E-01	3.0E-02	*i*	5.7E-03	*i*	3.0E-02
1,3-Dichloropropene	542-75-6	1.0E-01	*i*	1.4E-02	*i*	1.0E-01	**2.0E-02**	***p***	**2.0E-02**	***r***	**2.0E-02**
n-Hexane	110-54-3						6.0E-02	*h*	5.7E-02	*i*	6.0E-02
n-Hexane	110-54-3						**1.1E+01**	***p***	5.7E-02	*i*	**1.1E+01**
3-Nitrotoluene	99-08-1						2.0E-02	*p*	1.0E-02	*r*	2.0E-02
3-Nitrotoluene	99-08-1						2.0E-02	*p*	**2.0E-02**	***r***	2.0E-02
Tetrachloroethylene	127-18-4	5.2E-02	*n*	1.0E-02	*n*	5.2E-02	1.0E-02	*i*	1.7E-01	*n*	1.0E-02
Tetrachloroethylene	127-18-4	**5.4E-01**	***c***	**2.1E-02**	***c***	**5.4E-01**	1.0E-02	*i*	**7.7E-02**	***t***	1.0E-02

Notes:
Chemicals and values in bold present the updates based on the DHSS comments or 2004 PRG Table

Table 1
Updates in Toxicity Values
MRBCA Technical Guidance

Chemicals	CAS #	Slope Factor					Reference Dose				
		Oral, SF_o $(mg/kg\text{-}day)^{-1}$		Inhalation, SF_i $(mg/kg\text{-}day)^{-1}$		Dermal, SF_d $(mg/kg\text{-}day)^{-1}$	Oral, RfD_o (mg/kg-day)		Inhalation, RfD_i (mg/kg-day)		Dermal, RfD_d (mg/kg-day)
1,2,4-Trichlorobenzene	120-82-1	3.6E-03	*c*	3.6E-03	*r*	3.6E-03	1.0E-02	*i*	1.1E-03	*p*	1.0E-02
1,2,4-Trichlorobenzene	120-82-1	3.6E-03	*c*	3.6E-03	*r*	3.6E-03	1.0E-02	*i*	**1.0E-03**	***p***	1.0E-02
Dibenzofuran	132-64-9						4.0E-03	*n*	4.0E-03	*r*	4.0E-03
Dibenzofuran	132-64-9						**2.0E-03**	***n***	**2.0E-03**	***r***	**2.0E-03**
2-Nitroaniline	88-74-4						3.0E-03	*p*	2.9E-05	*p*	3.0E-03
2-Nitroaniline	88-74-4						3.0E-03	*p*	**3.0E-05**	***p***	3.0E-03
4-Nitroaniline	100-01-6	2.1E-02	*p*	2.1E-02	*r*	2.1E-02	3.0E-03	*p*	1.1E-03	*p*	3.0E-03
4-Nitroaniline	100-01-6	2.1E-02	*p*	2.1E-02	*r*	2.1E-02	3.0E-03	*p*	**1.0E-03**	***p***	3.0E-03
n-Nitrosodimethylamine	62-75-9	5.1E+01	*i*	4.9E+01	*i*	5.1E+01	8.3E-06	*p*	8.3E-06	*r*	8.3E-06
n-Nitrosodimethylamine	62-75-9	5.1E+01	*i*	4.9E+01	*i*	5.1E+01	**8.0E-06**	***p***	**8.0E-06**	***r***	**8.0E-06**
New Chemical Added											
Perchlorate	14797-73-0						7.0E-04	*i*	7.0E-04	*r*	7.0E-04

Notes:
Chemicals and values in bold present the updates based on the DHSS comments or 2004 PRG Table

The letters in the table represent following sources
i - USEPA IRIS
p - USEPA PPRTV's
n - USEPA NCEA
c - CALEPA OEHHA
h - HEAST
t - TCEQ's TRRP Tier 1 PCL Table
r - Missing value; value showing is identical to a value available for another route of exposur
m -MDNR/DHHS Memo, August 12, 2004
u - Value kept from MDNR Tanks-RBCA Guidance
a - Values assigned based on the most conservative Aroclor values found in the tiered hierarch

Table E-1
Toxicity Values of Chemicals

Chemicals	CAS #	Slope Factor					Reference Dose					Absorption Factor			Permeability Constant, K_p	
		Oral, SF_o (mg/kg-day)$^{-1}$		Inhalation, SF_i (mg/kg-day)$^{-1}$		Dermal, SF_d (mg/kg-day)$^{-1}$	Oral, RfD_o (mg/kg-day)		Inhalation, RfD_i (mg/kg-day)		Dermal, RfD_d (mg/kg-day)	Dermal, RAF_d (unitless)		Oral, RAF_o (unitless)	(cm/hr)	
VOCs																
Acetone	67-64-1						9.0E-01	*i*	9.0E-01	*r*	9.0E-01	0.1	*RA*	1.0	5.23E-04	*e*
Acetonitrile	75-05-8						1.7E-02	*r*	1.7E-02	*i*	1.7E-02	0.1	*RA*	1.0	5.57E-04	*e*
Acrylonitrile	107-13-1	5.4E-01	*i*	2.4E-01	*i*	5.4E-01	1.0E-03	*t*	5.7E-04	*i*	1.0E-03	0.1	*RA*	1.0	1.20E-03	*RE*
Allyl alcohol	107-18-6						5.0E-03	*i*	5.0E-03	*r*	5.0E-03	0.1	*RA*	1.0	9.70E-04	*e*
Allyl chloride	107-05-1	2.1E-02	*c*	2.1E-02	*c*	2.1E-02	2.9E-04	*r*	2.9E-04	*i*	2.9E-04	0.1	*RA*	1.0	5.40E-03	*RE*
Benzene	71-43-2															
1,1-Biphenyl	92-52-4						5.0E-02	*i*	5.0E-02	*r*	5.0E-02	0.1	*RA*	1.0	6.54E-02	*e*
Bis(chloromethyl)ether	542-88-1	2.2E+02	*i*	2.2E+02	*i*	2.2E+02						0.1	*RA*	1.0	8.62E-04	*e*
Bromochloromethane	74-97-5						4.0E-02	*t*	1.429E-02	*t*	4.0E-02	0.1	*RA*	1.0	2.22E-03	*e*
Bromodichloromethane	75-27-4	6.2E-02	*i*	1.3E-01	*c*	6.2E-02	2.0E-02	*i*	2.0E-02	*r*	2.0E-02	0.1	*RA*	1.0	4.60E-03	*RE*
Bromoform	75-25-2	7.9E-03	*i*	3.9E-03	*i*	7.9E-03	2.0E-02	*i*	2.0E-02	*r*	2.0E-02	0.1	*RA*	1.0	2.20E-03	*RE*
Bromomethane	74-83-9						1.4E-03	*i*	1.4E-03	*i*	1.4E-03	0.1	*RA*	1.0	2.80E-03	*RE*
n-Butylbenzene	104-51-8						4.0E-02	*n*	4.0E-02	*r*	4.0E-02	0.1	*RA*	1.0	2.01E-01	*e*
sec-Butylbenzene	135-98-8						4.0E-02	*n*	4.0E-02	*r*	4.0E-02	0.1	*RA*	1.0	1.48E-01	*e*
tert-Butylbenzene	98-06-6						4.0E-02	*n*	4.0E-02	*r*	4.0E-02	0.1	*RA*	1.0	1.70E-01	*e*
Carbon disulfide	75-15-0						1.0E-01	*i*	2.0E-01	*i*	1.0E-01	0.1	*RA*	1.0	1.70E-02	*RE*
Carbon tetrachloride	56-23-5	1.3E-01	*i*	5.3E-02	*i*	1.3E-01	7.0E-04	*i*	1.1E-02	*c*	7.0E-04	0.1	*RA*	1.0	1.60E-02	*RE*
Chlorobenzene	108-90-7						2.0E-02	*i*	1.7E-02	*n*	2.0E-02	0.1	*RA*	1.0	2.80E-02	*RE*
Chloroethane	75-00-3	2.9E-03	*n*	2.9E-03	*r*	2.9E-03	4.0E-01	*n*	2.9E+00	*i*	4.0E-01	0.1	*RA*	1.0	6.10E-03	*RE*
Chloroform	67-66-3	3.1E-02	*c*	8.1E-02	*i*	3.1E-02	1.0E-02	*i*	1.4E-02	*n*	1.0E-02	0.1	*RA*	1.0	6.80E-03	*RE*
Chloromethane	74-87-3	1.3E-02	*t*	6.3E-03	*t*	1.3E-02	2.6E-02	*r*	2.6E-02	*i*	2.6E-02	0.1	*RA*	1.0	3.30E-03	*RE*
2-Chloronaphthalene	91-58-7						8.0E-02	*i*	8.0E-02	*r*	8.0E-02	0.1	*RA*	1.0	6.62E-02	*e*
2-Chlorophenol	95-57-8						5.0E-03	*i*	5.0E-03	*r*	5.0E-03	0.1	*RA*	1.0	8.00E-03	*RE*
2-Chlorotoluene	95-49-8						2.0E-02	*i*	2.0E-02	*r*	2.0E-02	0.1	*RA*	1.0	3.99E-02	*e*
4-Chlorotoluene	106-43-4						2.0E-02	*t*	7.4E-05	*t*	2.0E-02	0.1	*RA*	1.0	4.70E-02	*e*
Dibromochloromethane	124-48-1	8.4E-02	*i*	9.5E-02	*c*	8.4E-02	2.0E-02	*i*	2.0E-02	*r*	2.0E-02	0.1	*RA*	1.0	3.20E-03	*RE*
1,2-Dichlorobenzene	95-50-1						9.0E-02	*i*	5.7E-02	*h*	9.0E-02	0.1	*RA*	1.0	4.10E-02	*RE*
1,3-Dichlorobenzene	541-73-1						3.0E-02	*n*	3.0E-02	*r*	3.0E-02	0.1	*RA*	1.0	5.80E-02	*RE*
1,4-Dichlorobenzene	106-46-7	5.4E-03	*c*	2.2E-02	*n*	5.4E-03	2.3E-01	*n*	2.3E-01	*i*	2.3E-01	0.1	*RA*	1.0	4.20E-02	*RE*
Dichlorodifluoromethane	75-71-8						2.0E-01	*i*	5.7E-02	*h*	2.0E-01	0.1	*RA*	1.0	9.00E-03	*RE*
1,1-Dichloroethane	75-34-3	5.7E-03	*c*	5.6E-03	*c*	5.7E-03	1.0E-01	*h*	1.4E-01	*h*	1.0E-01	0.1	*RA*	1.0	6.70E-03	*RE*
1,1-Dichloroethylene	75-35-4						5.0E-02	*i*	5.7E-02	*i*	5.0E-02	0.1	*RA*	1.0	1.20E-02	*RE*
cis-1,2-Dichloroethylene	156-59-2						1.0E-02	*p*	1.0E-02	*r*	1.0E-02	0.1	*RA*	1.0	7.67E-03	*e*
trans-1,2-Dichloroethylene	156-60-5						2.0E-02	*i*	2.0E-02	*r*	2.0E-02	0.1	*RA*	1.0	1.06E-02	*e*
1,2-Dichloropropane	78-87-5	3.6E-02	*c*	3.6E-02	*c*	3.6E-02	1.1E-03	*r*	1.1E-03	*i*	1.1E-03	0.1	*RA*	1.0	7.80E-03	*RE*
1,3-Dichloropropene	542-75-6	1.0E-01	*i*	1.4E-02	*i*	1.0E-01	2.0E-02	*p*	2.0E-02	*r*	2.0E-02	0.1	*RA*	1.0	4.30E-03	*RE*
Diisopropyl ether (DIPE)	108-20-3															
1,4-Dioxane	123-91-1	1.1E-02	*i*	2.7E-02	*c*	1.1E-02	8.6E-01	*r*	8.6E-01	*c*	8.6E-01	0.1	*RA*	1.0	3.30E-04	*RE*
Ethanol	64-17-5															
Ethylbenzene	100-41-4															

Table E-1
Toxicity Values of Chemicals

Chemicals	CAS #	Slope Factor					Reference Dose					Absorption Factor			Permeability Constant, K_p	
		Oral, SF_o (mg/kg-day)$^{-1}$		Inhalation, SF_i (mg/kg-day)$^{-1}$		Dermal, SF_d (mg/kg-day)$^{-1}$	Oral, RfD_o (mg/kg-day)		Inhalation, RfD_i (mg/kg-day)		Dermal, RfD_d (mg/kg-day)	Dermal, RAF_d (unitless)		Oral, RAF_o (unitless)	(cm/hr)	
Ethylene dibromide (EDB)	106-93-4															
Ethylene dichloride (EDC)	107-06-2															
Ethyl-tert-butyl-ether (ETBE)	637-92-3															
n-Hexane	110-54-3						1.1E+01	*p*	5.7E-02	*i*	1.1E+01	0.1	*RA*	1.0	7.74E-02	*e*
Isopropylbenzene (Cumene)	98-82-8						1.0E-01	*i*	1.1E-01	*i*	1.0E-01	0.1	*RA*	1.0	6.36E-02	*e*
4-Isopropyltoluene	99-87-6						3.0E-01	*i*	3.0E-01	*r*	3.0E-01	0.1	*RA*	1.0	1.52E-01	*e*
Methanol	67-56-1															
Methyl ethyl ketone	78-93-3						6.0E-01	*i*	1.4E+00	*i*	6.0E-01	0.1	*RA*	1.0	9.60E-04	*RE*
Methyl iodide	74-88-4						1.4E-03	*t*	3.4E-03	*t*	1.4E-03	0.1	*RA*	1.0	2.50E-03	*RE*
Methyl butyl ketone	591-78-6						6.0E-02	*t*	1.1E-03	*t*	6.0E-02	0.1	*RA*	1.0	4.15E-03	*e*
Methyl isobutyl ketone	108-10-1						8.0E-02	*h*	8.6E-01	*i*	8.0E-02	0.1	*RA*	1.0	2.70E-03	*RE*
Methyl teriary butyl ether (MTBE)	1634-04-4															
Methylene chloride	75-09-2	7.5E-03	*i*	1.6E-03	*i*	7.5E-03	6.0E-02	*i*	1.1E-01	*c*	6.0E-02	0.1	*RA*	1.0	3.50E-03	*RE*
Nitrobenzene	98-95-3						5.0E-04	*i*	5.7E-04	*h*	5.0E-04	0.1	*RA*	1.0	5.07E-03	*e*
n-Propylbenzene	103-65-1						4.0E-02	*n*	4.0E-02	*r*	4.0E-02	0.1	*RA*	1.0	9.74E-02	*e*
Styrene	100-42-5						2.0E-01	*i*	2.9E-01	*i*	2.0E-01	0.1	*RA*	1.0	3.70E-02	*RE*
1,1,1,2-Tetrachloroethane	630-20-6	2.6E-02	*i*	2.6E-02	*i*	2.6E-02	3.0E-02	*i*	3.0E-02	*r*	3.0E-02	0.1	*RA*	1.0	1.57E-02	*e*
1,1,2,2-Tetrachloroethane	79-34-5	2.0E-01	*i*	2.0E-01	*i*	2.0E-01	6.0E-02	*p*	6.0E-02	*r*	6.0E-02	0.1	*RA*	1.0	6.90E-03	*RE*
1,2,4,5-Tetrachlorobenzene	95-94-3						3.0E-04	*i*	3.0E-04	*r*	3.0E-04	0.1	*RA*	1.0	1.02E-01	*e*
Tetrachloroethylene	127-18-4	5.4E-01	*c*	2.1E-02	*c*	5.4E-01	1.0E-02	*i*	7.7E-02	*t*	1.0E-02	0.1	*RA*	1.0	3.30E-02	*RE*
Tetrahydrofuran	109-99-9	7.6E-03	*n*	6.8E-03	*n*	7.6E-03	2.1E-01	*n*	8.6E-02	*n*	2.1E-01	0.1	*RA*	1.0	1.62E-03	*e*
Tertiary-amyl-methyl-ether (TAME)	994-05-8															
Tertiary-butyl-alcohol (TBA)	75-65-0															
Toluene	108-88-3															
1,2,4-Trichlorobenzene	120-82-1	3.6E-03	*c*	3.6E-03	*r*	3.6E-03	1.0E-02	*i*	1.0E-03	*p*	1.0E-02	0.1	*RA*	1.0	6.60E-02	*RE*
1,3,5-Trichlorobenzene	108-70-3						3.0E-03	*t*	1.1E-02	*t*	3.0E-03	0.1	*RA*	1.0	8.90E-02	*e*
1,1,1-Trichloroethane	71-55-6						2.8E-01	*n*	6.3E-01	*p*	2.8E-01	0.1	*RA*	1.0	1.30E-02	*RE*
1,1,2-Trichloroethane	79-00-5	5.7E-02	*i*	5.6E-02	*i*	5.7E-02	4.0E-03	*i*	4.0E-03	*r*	4.0E-03	0.1	*RA*	1.0	6.40E-03	*RE*
Trichloroethylene	79-01-6	1.3E-02	*c*	7.0E-03	*c*	1.3E-02	1.7E-01	*r*	1.7E-01	*c*	1.7E-01	0.1	*RA*	1.0	1.20E-02	*RE*
Trichlorofluoromethane	75-69-4						3.0E-01	*i*	2.0E-01	*h*	3.0E-01	0.1	*RA*	1.0	1.30E-02	*RE*
1,2,3-Trichloropropane	96-18-4	2.0E+00	*n*	2.0E+00	*r*	2.0E+00	6.0E-03	*i*	1.4E-03	*n*	6.0E-03	0.1	*RA*	1.0	1.06E-02	*e*
1,1,2-Trichlorotrifluoroethane	76-13-1						3.0E+01	*i*	8.6E+00	*h*	3.0E+01	0.1	*RE*	1.0	1.55E-02	*e*
1,2,4-Trimethylbenzene	95-63-6						5.0E-02	*n*	1.7E-03	*p*	5.0E-02	0.1	*RA*	1.0	8.63E-02	*e*
1,3,5-Trimethylbenzene	108-67-8						5.0E-02	*n*	1.7E-03	*p*	5.0E-02	0.1	*RA*	1.0	9.31E-02	*e*
Vinyl chloride*	75-01-4	1.4E+00	*i*	3.1E-02	*i*	1.4E+00	3.0E-03	*i*	2.9E-02	*i*	3.0E-03	0.1	*RA*	1.0	5.60E-03	*RE*
Xylenes (total)	1330-20-7															
SVOCs																
Acenaphthene	83-32-9															
Acenaphthylene	208-96-8						6.0E-02	*t*	6.0E-02	*r*	6.0E-02	0.1	*RE*	1.0	8.84E-02	*e*
Acrylamide	79-06-1	4.5E+00	*i*	4.5E+00	*i*	4.5E+00	2.0E-04	*i*	2.0E-04	*r*	2.0E-04	0.1	*RE*	1.0	2.20E-04	*RE*
Acrylic acid	79-10-7						5.0E-01	*i*	2.9E-04	*i*	5.0E-01	0.1	*RE*	1.0	1.23E-03	*e*

Table E-1
Toxicity Values of Chemicals

Chemicals	CAS #	Slope Factor					Reference Dose					Absorption Factor			Permeability Constant, K_p	
		Oral, SF_o (mg/kg-day)$^{-1}$		Inhalation, SF_i (mg/kg-day)$^{-1}$		Dermal, SF_d (mg/kg-day)$^{-1}$	Oral, RfD_o (mg/kg-day)		Inhalation, RfD_i (mg/kg-day)		Dermal, RfD_d (mg/kg-day)	Dermal, RAF_d (unitless)		Oral, RAF_o (unitless)	(cm/hr)	
Aniline	62-53-3	5.7E-03	*i*	5.7E-03	*c*	5.7E-03	7.0E-03	*p*	2.9E-04	*i*	7.0E-03	0.1	*RE*	1.0	1.90E-03	*RE*
Anthracene	120-12-7															
Aroclor 1016	12674-11-2	7.0E-02	*a*	7.0E-02	*a*	7.0E-02	7.0E-05	*i*	7.0E-05	*r*	7.0E-05	0.14	*RE*	1.0	2.84E-01	*e*
Aroclor 1221	11104-28-2	2.0E+00	*a*	2.0E+00	*a*	2.0E+00	2.0E-05	*a*	2.0E-05	*a*	2.0E-05	0.14	*RE*	1.0	1.51E-01	*e*
Aroclor 1242	53469-21-9	2.0E+00	*a*	2.0E+00	*a*	2.0E+00	2.0E-05	*a*	2.0E-05	*a*	2.0E-05	0.14	*RE*	1.0	2.53E-01	*e*
Aroclor 1248	12672-29-6	2.0E+00	*a*	2.0E+00	*a*	2.0E+00	2.0E-05	*a*	2.0E-05	*a*	2.0E-05	0.14	*RE*	1.0	4.11E-01	*e*
Aroclor 1254	11097-69-1	2.0E+00	*a*	2.0E+00	*a*	2.0E+00	2.0E-05	*i*	2.0E-05	*r*	2.0E-05	0.14	*RE*	1.0	4.56E-01	*e*
Aroclor 1260	11096-82-5	2.0E+00	*a*	2.0E+00	*a*	2.0E+00	2.0E-05	*a*	2.0E-05	*a*	2.0E-05	0.14	*RE*	1.0	3.84E-01	*e*
Azobenzene	103-33-3	1.1E-01	*i*	1.1E-01	*i*	1.1E-01						0.1	*RE*	1.0	2.12E-01	*e*
Benzidine	92-87-5	2.3E+02	*i*	2.3E+02	*i*	2.3E+02	3.0E-03	*i*	3.0E-03	*r*	3.0E-03	0.1	*RA*	1.0	1.10E-03	*RE*
Benzo(a)anthracene	56-55-3															
Benzo(a)pyrene	50-32-8															
Benzo(b)fluoranthene	205-99-2															
Benzo(g,h,i)perylene	191-24-2						3.0E-02	*t*	3.0E-02	*r*	3.0E-02	0.13	*RE*	1.0	1.19E+00	*e*
Benzo(k)fluoranthene	207-08-9															
Benzoic acid	65-85-0						4.0E+00	*i*	4.0E+00	*r*	4.0E+00	0.1	*RE*	1.0	5.70E-03	*RE*
Benzyl alcohol	100-51-6						3.0E-01	*h*	3.0E-01	*r*	3.0E-01	0.1	*RE*	1.0	2.03E-03	*e*
Bis(2-chloroethyl) ether	111-44-4	1.1E+00	*i*	1.2E+00	*i*	1.1E+00						0.1	*RE*	1.0	1.80E-03	*RE*
Bis(2-chloroisopropyl)ether	108-60-1	7.0E-02	*t*	3.5E-02	*t*	7.0E-02	4.0E-02	*i*	4.0E-02	*r*	4.0E-02	0.1	*RE*	1.0	8.81E-03	*e*
Bis(2-ethylhexyl)phthalate	117-81-7	1.4E-02	*i*	1.4E-02	*r*	1.4E-02	2.0E-02	*i*	2.0E-02	*r*	2.0E-02	0.1	*RE*	1.0	2.50E-02	*RE*
4-Bromophenyl phenyl ether	101-55-3	1.5E+01	*t*	1.2E+01	*t*	1.5E+01						0.1	*RE*	1.0	1.86E-01	*e*
Butyl benzyl phthalate	85-68-7						2.0E-01	*i*	2.0E-01	*r*	2.0E-01	0.1	*RE*	1.0	4.42E-02	*e*
Carbazole	86-74-8	2.0E-02	*h*	2.0E-02	*r*	2.0E-02						0.1	*RE*	1.0	2.49E-02	*e*
p-Chloroaniline	106-47-8						4.0E-03	*i*	4.0E-03	*r*	4.0E-03	0.1	*RE*	1.0	4.18E-03	*e*
4-Chlorophenyl phenyl ether	7005-72-3	1.5E+01	*t*	1.2E+01	*t*	1.5E+01						0.1	*RE*	1.0	2.40E-01	*e*
Chrysene	218-01-9															
Dibenzo(a,h)anthracene	53-70-3															
Dibenzofuran	132-64-9						2.0E-03	*n*	2.0E-03	*r*	2.0E-03	0.03	*RE*	1.0	7.87E-02	*e*
1,2-Dibromo-3-chloropropane	96-12-8	1.4E+00	*h*	1.4E+00	*r*	1.4E+00	5.7E-05	*r*	6.9E-05	*i*	5.7E-05	0.1	*RE*	1.0	4.42E-03	*e*
Dibutyl phthalate	84-74-2						1.0E-01	*i*	1.0E-01	*r*	1.0E-01	0.1	*RE*	1.0	2.40E-02	*RE*
3,3-Dichlorobenzidine	91-94-1	4.5E-01	*i*	1.2E+00	*c*	4.5E-01						0.1	*RE*	1.0	1.30E-02	*RE*
2,4-Dichlorophenol	120-83-2						3.0E-03	*i*	3.0E-03	*r*	3.0E-03	0.1	*RE*	1.0	2.10E-02	*RE*
Diethyl phthalate	84-66-2						8.0E-01	*i*	8.0E-01	*r*	8.0E-01	0.1	*RE*	1.0	3.90E-03	*RE*
2,4-Dimethylphenol	105-67-9						2.0E-02	*i*	2.0E-02	*r*	2.0E-02	0.1	*RE*	1.0	1.10E-02	*RE*
2,6-Dimethylphenol	576-26-1						6.0E-04	*i*	6.0E-04	*r*	6.0E-04	0.1	*RE*	1.0		
Dimethyl phthalate	131-11-3						1.0E+01	*h*	1.0E+01	*r*	1.0E+01	0.1	*RE*	1.0	1.40E-03	*RE*
1,3-Dinitrobenzene	99-65-0						1.0E-04	*i*	1.0E-04	*r*	1.0E-04	0.1	*RE*	1.0	2.16E-03	*e*
2,4-Dinitrophenol	51-28-5						2.0E-03	*i*	2.0E-03	*r*	2.0E-03	0.1	*RE*	1.0	1.50E-03	*RE*
2,4-Dinitrotoluene	121-14-2	3.1E-01	*c*	3.1E-01	*c*	3.1E-01	2.0E-03	*i*	2.0E-03	*r*	2.0E-03	0.1	*RE*	1.0	3.10E-03	*RE*
2,6-Dinitrotoluene	606-20-2	6.8E-01	*i*	6.8E-01	*r*	6.8E-01	1.0E-03	*h*	1.0E-03	*r*	1.0E-03	0.1	*RE*	1.0	2.10E-03	*RE*
4-Amino-2,6-dinitrotoluene	19406-51-0	1.0E-02	*t*	1.0E-02	*r*	1.0E-02	1.7E-04	*t*	2.9E-05	*t*	1.7E-04	0.1	*RE*	1.0	6.69E-03	*e*

Table E-1
Toxicity Values of Chemicals

Chemicals	CAS #	Slope Factor					Reference Dose					Absorption Factor			Permeability Constant, K_p	
		Oral, SF_o (mg/kg-day)$^{-1}$		Inhalation, SF_i (mg/kg-day)$^{-1}$		Dermal, SF_d (mg/kg-day)$^{-1}$	Oral, RfD_o (mg/kg-day)		Inhalation, RfD_i (mg/kg-day)		Dermal, RfD_d (mg/kg-day)	Dermal, RAF_d (unitless)		Oral, RAF_o (unitless)	(cm/hr)	
2-Amino-4,6-dinitrotoluene	35572-78-2	1.0E-02	*t*	1.0E-02	*r*	1.0E-02	1.7E-04	*t*	2.9E-05	*t*	1.7E-04	0.1	*RE*	1.0	8.79E-03	*e*
Di(2-ethylhexyl)adipate	103-23-1	1.2E-03	*i*	1.2E-03	*r*	1.2E-03	6.0E-01	*i*	6.0E-01	*r*	6.0E-01	0.1	*RE*	1.0	3.03E+00	*e*
Di-n-octylphthalate	117-84-0						4.0E-02	*p*	4.0E-02	*r*	4.0E-02	0.1	*RE*	1.0	4.60E+00	*e*
1,2-Diphenylhydrazine	122-66-7	8.0E-01	*i*	7.7E-01	*i*	8.0E-01						0.1	*RE*	1.0	1.30E-02	*RE*
Diphenylamine	122-39-4						2.5E-02	*i*	2.9E-03	*t*	2.5E-02	0.1	*RE*	1.0	2.66E-02	*e*
Ethylene glycol	107-21-1						2.0E+00	*i*	1.1E-01	*c*	2.0E+00	0.1	*RE*	1.0	1.15E-04	*e*
Ethylene thiourea	96-45-7	4.5E-02	*c*	4.5E-02	*c*	4.5E-02	8.0E-05	*i*	8.0E-05	*r*	8.0E-05	0.1	*RE*	1.0	1.70E-04	*RE*
Fluoranthene	206-44-0															
Fluorene	86-73-7															
Formaldehyde	50-00-0	4.5E-02	*r*	4.5E-02	*i*	4.5E-02	2.0E-01	*i*	8.6E-04	*c*	2.0E-01	0.1	*RE*	1.0	1.80E-03	*RE*
Hexachlorobenzene	118-74-1	1.6E+00	*i*	1.6E+00	*i*	1.6E+00	8.0E-04	*i*	8.0E-04	*r*	8.0E-04	0.1	*RE*	1.0	1.30E-01	*RE*
Hexachlorobutadiene	87-68-3	7.8E-02	*i*	7.7E-02	*i*	7.8E-02	3.0E-04	*n*	3.0E-04	*r*	3.0E-04	0.1	*RE*	1.0	8.10E-02	*RE*
Hexachlorocyclopentadiene	77-47-4						6.0E-03	*i*	5.7E-05	*i*	6.0E-03	0.1	*RE*	1.0	5.31E-02	*e*
Hexachloroethane	67-72-1	1.4E-02	*i*	1.4E-02	*i*	1.4E-02	1.0E-03	*i*	1.0E-03	*r*	1.0E-03	0.1	*RE*	1.0	3.00E-02	*RE*
Hexachlorophene	70-30-4						3.0E-04	*i*	3.0E-04	*r*	3.0E-04	0.1	*RE*	1.0	3.09E-01	*e*
HMX	2691-41-0						5.0E-02	*i*	7.7E-04	*t*	5.0E-02	0.1	*RE*	1.0	4.82E-06	*e*
Indeno(1,2,3-cd)pyrene	193-39-5	1.2E+00	*c*	3.9E-01	*c*	1.2E+00						0.13	*RE*	1.0	1.00E+00	*RE*
Isophorone	78-59-1	9.5E-04	*i*	9.5E-04	*r*	9.5E-04	2.0E-01	*i*	5.7E-01	*c*	2.0E-01	0.1	*RE*	1.0	3.40E-03	*RE*
Maleic anhydride	108-31-6						1.0E-01	*i*	2.0E-04	*c*	1.0E-01	0.1	*RE*	1.0	5.25E-03	*e*
2-Methyl-4,6-dinitrophenol	534-52-1						1.0E-04	*p*	8.6E-05	*t*	1.0E-04	0.1	*RE*	1.0	3.10E-03	*RE*
2-Methylnaphthalene	91-57-6						4.0E-03	*i*	4.0E-03	*r*	4.0E-03	0.1	*RE*	1.0	7.20E-02	*e*
2-Methylphenol	95-48-7						5.0E-02	*i*	5.0E-02	*r*	5.0E-02	0.1	*RE*	1.0	7.70E-03	*RE*
3-Methylphenol	108-39-4						5.0E-02	*i*	5.0E-02	*r*	5.0E-02	0.1	*RE*	1.0	7.80E-03	*RE*
4-Methylphenol	106-44-5						5.0E-03	*h*	5.0E-03	*r*	5.0E-03	0.1	*RE*	1.0	7.70E-03	*RE*
Methyl-2,4,6-trinitrophenylnitramine	479-45-8						1.0E-02	*t*	2.9E-05	*t*	1.0E-02	0.1	*RE*	1.0	8.68E-04	*e*
m-Phenylenediamine	108-45-2						6.0E-03	*i*	6.0E-03	*r*	6.0E-03	0.1	*RE*	1.0	2.17E-04	*e*
Naphthalene	91-20-3															
2-Nitroaniline	88-74-4						3.0E-03	*p*	3.0E-05	*p*	3.0E-03	0.1	*RE*	1.0	3.54E-01	*e*
3-Nitroaniline	99-09-2	2.1E-02	*p*	2.1E-02	*r*	2.1E-02	3.0E-04	*p*	3.0E-04	*p*	3.0E-04	0.1	*RE*	1.0	2.87E+01	*e*
4-Nitroaniline	100-01-6	2.1E-02	*p*	2.1E-02	*r*	2.1E-02	3.0E-03	*p*	1.0E-03	*p*	3.0E-03	0.1	*RE*	1.0	1.36E-03	*e*
Nitroglycerin	55-63-0	1.4E-02	*n*	1.4E-02	*r*	1.4E-02	7.0E-05	*t*	7.0E-05	*r*	7.0E-05	0.1	*RE*	1.0	1.77E-03	*e*
2-Nitrophenol	88-75-5						2.0E-03	*t*	1.1E-03	*t*	2.0E-03	0.1	*RE*	1.0	4.00E-03	*RE*
4-Nitrophenol	100-02-7						2.0E-03	*t*	2.9E-04	*t*	2.0E-03	0.1	*RE*	1.0	4.80E-03	*RE*
2-Nitrotoluene	88-72-2	2.3E-01	*p*	2.3E-01	*r*	2.3E-01	1.0E-02	*t*	3.1E-03	*t*	1.0E-02	0.1	*RE*	1.0	9.73E-03	*e*
3-Nitrotoluene	99-08-1						2.0E-02	*p*	2.0E-02	*r*	2.0E-02	0.1	*RE*	1.0	9.73E-03	*e*
4-Nitrotoluene	99-99-0	1.7E-02	*p*	1.7E-02	*r*	1.7E-02	1.0E-02	*p*	1.0E-02	*r*	1.0E-02	0.1	*RE*	1.0	9.73E-03	*e*
n-Nitrosodimethylamine	62-75-9	5.1E+01	*i*	4.9E+01	*i*	5.1E+01	8.0E-06	*p*	8.0E-06	*r*	8.0E-06	0.1	*RE*	1.0	2.50E-04	*RE*
n-Nitrosodi-n-propylamine	621-64-7	7.0E+00	*i*	7.0E+00	*c*	7.0E+00						0.1	*RE*	1.0	2.30E-03	*RE*
n-Nitrosodiphenylamine	86-30-6	4.9E-03	*i*	9.0E-03	*c*	4.9E-03	2.0E-02	*p*	2.0E-02	*r*	2.0E-02	0.1	*RE*	1.0	1.50E-02	*RE*
n-Nitrosopyrrolidine*	930-55-2	2.1E+00	*i*	2.1E+00	*i*	2.1E+00						0.1	*RE*	1.0	6.19E-04	*e*
Pentachlorobenzene	608-93-5						8.0E-04	*i*	8.0E-04	*r*	8.0E-04	0.1	*RE*	1.0	1.75E-01	*e*

Table E-1
Toxicity Values of Chemicals

Chemicals	CAS #	Slope Factor					Reference Dose					Absorption Factor			Permeability Constant, K_p	
		Oral, SF_o (mg/kg-day)$^{-1}$		Inhalation, SF_i (mg/kg-day)$^{-1}$		Dermal, SF_d (mg/kg-day)$^{-1}$	Oral, RfD_o (mg/kg-day)		Inhalation, RfD_i (mg/kg-day)		Dermal, RfD_d (mg/kg-day)	Dermal, RAF_d (unitless)		Oral, RAF_o (unitless)	(cm/hr)	
Pentachloronitrobenzene	82-68-8	2.6E-01	*h*	2.6E-01	*r*	2.6E-01	3.0E-03	*i*	3.0E-03	*r*	3.0E-03	0.1	*RE*	1.0	4.20E-02	*RE*
Pentachlorophenol	87-86-5	1.2E-01	*i*	1.8E-02	*c*	1.2E-01	3.0E-02	*i*	3.0E-02	*r*	3.0E-02	0.25	*RE*	1.0	3.90E-01	*RE*
Pentaerythritol tetranitrate	78-11-5						4.0E-01	*t*	4.0E-01	*r*	4.0E-01	0.1	*RE*	1.0	9.55E-03	*e*
Phenanthrene	85-01-8						3.0E-02	*t*	3.0E-02	*r*	3.0E-02	0.1	*RE*	1.0	1.40E-01	*RE*
Phenol	108-95-2						3.0E-01	*i*	5.7E-02	*c*	3.0E-01	0.1	*RE*	1.0	4.30E-03	*RE*
Polychlorinated biphenyls (PCBs)	1336-36-3	2.0E+00	*i*	3.5E-01	*i*	2.0E+00						0.14	*RE*	1.0	3.41E-01	*e*
Pyrene	129-00-0															
RDX	121-82-4	1.1E-01	*i*	1.1E-01	*r*	1.1E-01	3.0E-03	*i*	3.0E-03	*r*	3.0E-03	0.1	*RE*	1.0	6.42E-04	*e*
2,4,5-Trichlorophenol	95-95-4						1.0E-01	*i*	1.0E-01	*r*	1.0E-01	0.1	*RE*	1.0	2.34E-02	*e*
2,4,6-Trichlorophenol	88-06-2	1.1E-02	*i*	1.1E-02	*i*	1.1E-02	1.0E-04	*n*	1.0E-04	*r*	1.0E-04	0.1	*RE*	1.0	3.50E-02	*RE*
1,3,5-Trinitrobenzene	99-35-4						3.0E-02	*i*	3.0E-02	*r*	3.0E-02	0.1	*RE*	1.0	9.13E-04	*e*
2,4,6-Trinitrotoluene (TNT)	118-96-7	3.0E-02	*i*	3.0E-02	*r*	3.0E-02	5.0E-04	*i*	5.0E-04	*r*	5.0E-04	0.1	*RE*	1.0	1.75E-03	*e*
Pesticides																
Acetochlor	34256-82-1						2.0E-02	*i*	2.0E-02	*r*	2.0E-02	0.1	*RA*	1.0	2.11E-03	*e*
Acifluorfen	62476-59-9						1.3E-02	*i*	2.9E-03	*t*	1.3E-02	0.1	*RA*	1.0	2.63E-05	*e*
Acrolein	107-02-8						5.0E-04	*i*	5.7E-06	*i*	5.0E-04	0.1	*RA*	1.0	6.50E-04	*RE*
Alachlor	15972-60-8	5.6E-02	*c*	8.0E-02	*r*	5.6E-02	1.0E-02	*i*	1.0E-02	*r*	1.0E-02	0.1	*RA*	1.0	8.22E-03	*e*
Aldicarb	116-06-3						1.0E-03	*i*	1.0E-03	*r*	1.0E-03	0.1	*RA*	1.0	1.08E-03	*e*
Aldicarb sulfone	1646-88-4						1.0E-03	*i*	1.0E-03	*r*	1.0E-03	0.1	*RA*	1.0	3.28E-05	*e*
Aldrin	309-00-2	1.7E+01	*i*	1.7E+01	*i*	1.7E+01	3.0E-05	*i*	3.0E-05	*r*	3.0E-05	0.1	*RA*	1.0	1.40E-03	*RE*
alpha-Hexachlorocyclohexane	319-84-6	6.3E+00	*i*	6.3E+00	*i*	6.3E+00	5.0E-04	*n*	5.0E-04	*r*	5.0E-04	0.1	*RA*	1.0	2.42E-02	*e*
Ametryn	834-12-8						9.0E-03	*i*	9.0E-03	*r*	9.0E-03	0.1	*RA*	1.0	6.78E-03	*e*
Atrazine	1912-24-9	2.3E-01	*c*	2.2E-01	*r*	2.3E-01	3.5E-02	*i*	3.5E-02	*r*	3.5E-02	0.1	*RA*	1.0	7.13E-03	*e*
Baygon	114-26-1						4.0E-03	*i*	4.0E-03	*r*	4.0E-03	0.1	*RA*	1.0		
Butylate	2008-41-5						5.0E-02	*i*	5.0E-02	*r*	5.0E-02	0.1	*RA*	1.0	3.36E-02	*e*
beta-Hexachlorocyclohexane	319-85-7	1.8E+00	*i*	1.8E+00	*i*	1.8E+00	2.0E-04	*n*	2.0E-04	*r*	2.0E-04	0.1	*RA*	1.0	2.42E-02	*e*
4-(2,4-Dichlorophenoxy) butyric acid (2,4-DB)	94-82-6						8.0E-03	*i*	8.0E-03	*r*	8.0E-03	0.04	*RE*	1.0	2.02E-02	*e*
Captan	133-06-2	2.3E-03	*c*	2.3E-03	*c*	2.3E-03	1.3E-01	*i*	1.3E-01	*r*	1.3E-01	0.1	*RA*	1.0	1.20E-03	*RE*
Carbaryl	63-25-2						1.0E-01	*i*	1.1E-01	*r*	1.0E-01	0.1	*RA*	1.0	4.21E-03	*e*
Carbofuran	1563-66-2						5.0E-03	*i*	5.0E-03	*r*	5.0E-03	0.1	*RA*	1.0	3.01E-03	*e*
Carboxin	5234-68-4						1.0E-01	*i*	1.0E-01	*r*	1.0E-01	0.1	*RA*	1.0	7.51E-03	*e*
Chloramben	133-90-4						1.5E-02	*i*	1.5E-02	*r*	1.5E-02	0.1	*RA*	1.0	4.80E-03	*e*
Chlordane (technical)	12789-03-6	3.5E-01	*i*	3.5E-01	*i*	3.5E-01	5.0E-04	*i*	2.0E-04	*i*	5.0E-04	0.1	*RA*	1.0	1.83E-01	*e*
Chlordane, gamma	57-74-9	3.5E-01	*t*	3.5E-01	*t*	3.5E-01	5.0E-04	*t*	2.0E-04	*t*	5.0E-04	0.04	*RE*	1.0	3.80E-02	*RE*
Chlorothalonil	1897-45-6	3.1E-03	*c*	3.1E-03	*c*	3.1E-03	1.5E-02	*i*	1.5E-02	*r*	1.5E-02	0.04	*RE*	1.0	1.90E-02	*RE*
Chlorpyrifos	2921-88-2						3.0E-03	*i*	3.0E-03	*r*	3.0E-03	0.1	*RA*	1.0	2.05E-02	*e*
Coumaphos	56-72-4						7.0E-03	*t*	7.0E-03	*r*	7.0E-03	0.1	*RA*	1.0	9.55E-03	*e*
Cyanazine	21725-46-2	8.4E-01	*h*	8.4E-01	*r*	8.4E-01	2.0E-03	*h*	2.0E-03	*r*	2.0E-03	0.1	*RA*	1.0	9.71E-04	*e*
Dacthal	1861-32-1						1.0E-02	*i*	1.0E-02	*r*	1.0E-02	0.1	*RA*	1.0	2.81E-02	*e*
Dalapon, sodium salt	75-99-0						3.0E-02	*i*	3.0E-02	*r*	3.0E-02	0.1	*RA*	1.0	2.85E-03	*e*
DDD	72-54-8	2.4E-01	*i*	2.4E-01	*c*	2.4E-01						0.1	*RA*	1.0	1.80E-01	*RE*
DDE	72-55-9	3.4E-01	*i*	3.4E-01	*c*	3.4E-01						0.1	*RA*	1.0	1.60E-01	*RE*

Table E-1
Toxicity Values of Chemicals

Chemicals	CAS #	Slope Factor					Reference Dose					Absorption Factor			Permeability Constant, K_p	
		Oral, SF_o (mg/kg-day)$^{-1}$		Inhalation, SF_i (mg/kg-day)$^{-1}$		Dermal, SF_d (mg/kg-day)$^{-1}$	Oral, RfD_o (mg/kg-day)		Inhalation, RfD_i (mg/kg-day)		Dermal, RfD_d (mg/kg-day)	Dermal, RAF_d (unitless)		Oral, RAF_o (unitless)	(cm/hr)	
DDT	50-29-3	3.4E-01	*i*	3.4E-01	*i*	3.4E-01	5.0E-04	*i*	5.0E-04	*r*	5.0E-04	0.1	*RA*	1.0	2.70E-01	*RE*
DEF	78-48-8						3.0E-05	*i*	3.0E-05	*r*	3.0E-05	0.03	*RE*	1.0	1.59E-01	*e*
delta-Hexachlorocyclohexane	319-86-8	1.8E+00	*t*	1.8E+00	*t*	1.8E+00	3.0E-04	*t*	3.0E-04	*r*	3.0E-04	0.1	*RA*	1.0	1.63E-02	*e*
Demeton	8065-48-3						4.0E-04	*i*	4.0E-05	*r*	4.0E-04	0.1	*RA*	1.0	5.17E-03	*e*
Diazinon	333-41-5						9.0E-04	*h*	9.0E-04	*r*	9.0E-04	0.1	*RA*	1.0	1.11E-02	*e*
Dicamba	1918-00-9						3.0E-02	*i*	3.0E-02	*r*	3.0E-02	0.1	*RA*	1.0	2.37E-03	*e*
2,4-Dichlorophenoxy acetic acid (2,4-D)	94-75-7						1.0E-02	*i*	1.0E-02	*r*	1.0E-02	0.1	*RA*	1.0	4.89E-03	*e*
Dichloroprop (2,4-DP)	120-36-5						1.0E-02	*t*	1.0E-02	*r*	1.0E-02	0.05	*RE*	1.0	1.09E-02	*e*
Dieldrin	60-57-1	1.6E+01	*i*	1.6E+01	*i*	1.6E+01	5.0E-05	*i*	5.0E-05	*r*	5.0E-05	0.1	*RA*	1.0	1.20E-02	*RE*
Dimethoate	60-51-5						2.0E-04	*i*	2.0E-04	*r*	2.0E-04	0.1	*RA*	1.0	1.26E-04	*e*
2,4-Dinitro-6-sec-butylphenol (Dinoseb)	88-85-7						1.0E-03	*i*	1.0E-03	*r*	1.0E-03	0.1	*RA*	1.0	1.90E-02	*e*
Diquat	85-00-7						2.2E-03	*i*	2.2E-03	*r*	2.2E-03	0.1	*RA*	1.0	2.58E-07	*e*
Disulfoton	298-04-4						4.0E-05	*i*	4.0E-05	*r*	4.0E-05	0.1	*RA*	1.0	1.63E-02	*e*
Diuron	330-54-1						2.0E-03	*i*	2.0E-03	*r*	2.0E-03	0.1	*RA*	1.0	4.56E-03	*e*
Endosulfan	115-29-7						6.0E-03	*i*	6.0E-03	*r*	6.0E-03	0.1	*RA*	1.0	2.85E-03	*e*
Endothall	145-73-3						2.0E-02	*i*	2.0E-02	*r*	2.0E-02	0.1	*RA*	1.0	2.54E-03	*e*
Endrin	72-20-8						3.0E-04	*i*	3.0E-04	*r*	3.0E-04	0.1	*RA*	1.0	1.20E-02	*RE*
Endrin aldehyde	7421-93-4						3.0E-04	*t*	3.0E-04	*r*	3.0E-04	0.1	*RA*	1.0	2.07E-01	*e*
Endrin Ketone	53494-70-5						3.0E-04	*t*	2.9E-05	*t*	3.0E-04	0.1	*RA*	1.0	3.84E-02	*e*
Eptam	759-94-4						2.5E-02	*i*	2.5E-02	*r*	2.5E-02	0.1	*RA*	1.0	1.35E-02	*e*
Ethoprop	13194-48-4	2.8E-02	*t*	2.8E-02	*r*	2.8E-02	1.0E-04	*t*	1.0E-04	*r*	1.0E-04	0.1	*RA*	1.0	8.23E-03	*e*
Fenamiphos	22224-92-6						2.5E-04	*i*	2.5E-04	*r*	2.5E-04	0.1	*RA*	1.0		
Fenthion	55-38-9						7.0E-05	*t*	7.0E-05	*r*	7.0E-05	0.1	*RA*	1.0	4.58E-03	*e*
Fluometuron	2164-17-2						1.3E-02	*i*	1.3E-02	*r*	1.3E-02	0.1	*RA*	1.0		
Fonofos	944-22-9						2.0E-03	*i*	2.0E-03	*r*	2.0E-03	0.1	*RA*	1.0	2.89E-02	*e*
gamma-Hexachlorocyclohexane	58-89-9	1.1E+00	*c*	1.1E+00	*c*	1.1E+00	3.0E-04	*i*	3.0E-04	*r*	3.0E-04	0.1	*RA*	1.0	1.10E-02	*RE*
Glyphosate	1071-83-6						1.0E-01	*i*	1.0E-01	*r*	1.0E-01	0.1	*RA*	1.0	1.57E-05	*e*
Guthion	86-50-0						1.5E-03	*t*	1.5E-03	*r*	1.5E-03	0.1	*RA*	1.0	1.18E-03	*e*
Heptachlor	76-44-8	4.5E+00	*i*	4.5E+00	*i*	4.5E+00	5.0E-04	*i*	5.0E-04	*r*	5.0E-04	0.1	*RA*	1.0	8.60E-03	*RE*
Heptachlor epoxide	1024-57-3	9.1E+00	*i*	9.1E+00	*i*	9.1E+00	1.3E-05	*i*	1.3E-05	*r*	1.3E-05	0.1	*RA*	1.0	1.81E-02	*e*
Hexazinone	51235-04-2						3.3E-02	*i*	3.3E-02	*r*	3.3E-02	0.1	*RA*	1.0	1.61E-03	*e*
Malathion	121-75-5						2.0E-02	*i*	2.0E-02	*r*	2.0E-02	0.1	*RA*	1.0	7.24E-04	*e*
Maleic hydrazide	123-33-1						5.0E-01	*i*	5.0E-01	*r*	5.0E-01	0.1	*RA*	1.0	9.70E-05	*e*
Maneb	12427-38-2						5.0E-03	*i*	5.0E-03	*r*	5.0E-03	0.1	*RA*	1.0		
Methomyl	16752-77-5						2.5E-02	*i*	2.5E-02	*r*	2.5E-02	0.1	*RA*	1.0	4.95E-04	*e*
Methoxychlor	72-43-5						5.0E-03	*i*	5.0E-03	*r*	5.0E-03	0.1	*RA*	1.0	1.01E-01	*e*
2-Methyl-4-chlorophenoxyacetic acid (MCPA)	94-74-6						5.0E-04	*i*	5.0E-04	*r*	5.0E-04	0.1	*RA*	1.0	2.06E-02	*e*
MCPP	93-65-2						1.0E-03	*i*	1.0E-03	*r*	1.0E-03	0.1	*RA*	1.0	1.16E-02	*e*
Metolachlor	51218-45-2						1.5E-01	*i*	1.5E-01	*r*	1.5E-01	0.1	*RA*	1.0	3.33E-03	*e*
Metribuzin	21087-64-9						2.5E-02	*i*	2.5E-02	*r*	2.5E-02	0.1	*RA*	1.0	1.76E-04	*e*
Mirex	2385-85-5	1.8E+01	*c*	1.8E+01	*c*	1.8E+01	2.0E-04	*i*	2.0E-04	*r*	2.0E-04	0.1	*RA*	1.0	2.54E+01	*e*
Naled	300-76-5						2.0E-03	*i*	2.0E-03	*r*	2.0E-03	0.1	*RA*	1.0	1.33E-04	*e*

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Toxicity Values of Chemicals

Chemicals	CAS #	Slope Factor					Reference Dose					Absorption Factor			Permeability Constant, K_p	
		Oral, SF_o (mg/kg-day)$^{-1}$		Inhalation, SF_i (mg/kg-day)$^{-1}$		Dermal, SF_d (mg/kg-day)$^{-1}$	Oral, RfD_o (mg/kg-day)		Inhalation, RfD_i (mg/kg-day)		Dermal, RfD_d (mg/kg-day)	Dermal, RAF_d (unitless)		Oral, RAF_o (unitless)	(cm/hr)	
o,o,o-Triethylphosphorothioate	126-68-1						8.3E-06	*t*	8.3E-06	*r*	8.3E-06	0.1	*RA*	1.0	6.80E-03	*e*
Oxamyl	23135-22-0						2.5E-02	*i*	2.5E-02	*r*	2.5E-02	0.1	*RA*	1.0	1.52E-05	*e*
Paraquat	4685-14-7						4.5E-03	*i*	4.5E-03	*r*	4.5E-03	0.1	*RA*	1.0	6.16E-08	*e*
ethyl-Parathion	56-38-2						6.0E-03	*h*	6.0E-03	*r*	6.0E-03	0.1	*RA*	1.0	1.30E-02	*RE*
methyl-Parathion	298-00-0						2.5E-04	*i*	2.5E-04	*r*	2.5E-04	0.1	*RA*	1.0	3.47E-03	*e*
Pendimethalin	40487-42-1						4.0E-02	*i*	4.0E-02	*r*	4.0E-02	0.1	*RA*	1.0	1.48E-01	*e*
Phenylmercuric acetate	62-38-4						8.0E-05	*i*	8.0E-05	*r*	8.0E-05	0.1	*RA*	1.0	7.97E-05	*e*
Phorate	298-02-2						2.0E-04	*h*	2.0E-04	*r*	2.0E-04	0.1	*RA*	1.0	9.21E-03	*e*
Picloram	1918-02-1						7.0E-02	*i*	7.0E-02	*r*	7.0E-02	0.1	*RA*	1.0	6.14E-03	*e*
Prometon	1610-18-0						1.5E-02	*i*	1.5E-02	*r*	1.5E-02	0.1	*RA*	1.0	6.90E-03	*e*
Pronamide	23950-58-5						7.5E-02	*i*	7.5E-02	*r*	7.5E-02	0.1	*RA*	1.0	1.33E-02	*e*
Propachlor	1918-16-7						1.3E-02	*i*	1.3E-02	*r*	1.3E-02	0.1	*RA*	1.0		
Propanil	709-98-8						5.0E-03	*i*	5.0E-03	*r*	5.0E-03	0.1	*RA*	1.0	8.75E-03	*e*
Propazine	139-40-2	4.5E-02	*t*	4.5E-02	*r*	4.5E-02	2.0E-02	*i*	2.0E-02	*r*	2.0E-02	0.1	*RA*	1.0	1.14E-02	*e*
Propham	122-42-9						2.0E-02	*i*	2.0E-02	*r*	2.0E-02	0.1	*RA*	1.0	8.95E-03	*e*
Silvex (2,4,5-TP)	93-72-1						8.0E-03	*i*	8.0E-03	*r*	8.0E-03	0.1	*RA*	1.0	1.32E-02	*e*
Simazine	122-34-9	1.2E-01	*h*	1.2E-01	*r*	1.2E-01	5.0E-03	*i*	2.0E-03	*r*	5.0E-03	0.1	*RA*	1.0	6.50E-03	*e*
Strychnine	57-24-9						3.0E-04	*i*	3.0E-04	*r*	3.0E-04	0.1	*RA*	1.0	3.52E-04	*e*
Tebuthiuron	34014-18-1						7.0E-02	*i*	7.0E-02	*r*	7.0E-02	0.1	*RA*	1.0	1.27E-03	*e*
Terbacil	5902-51-2						1.3E-02	*i*	1.3E-02	*r*	1.3E-02	0.1	*RA*	1.0		
Terbufos	13071-79-9						2.5E-05	*h*	2.5E-05	*r*	2.5E-05	0.1	*RA*	1.0	2.26E-02	*e*
Terbutryn	886-50-0						1.0E-03	*i*	1.0E-03	*r*	1.0E-03	0.1	*RA*	1.0	2.07E-02	*e*
Toxaphene	8001-35-2	1.1E+00	*i*	1.1E+00	*i*	1.1E+00						0.1	*RA*	1.0	1.20E-02	*RE*
Triallate	2303-17-5						1.3E-02	*i*	1.3E-02	*r*	1.3E-02	0.1	*RA*	1.0	3.24E-02	*e*
2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)	93-76-5						1.0E-02	*i*	1.0E-02	*r*	1.0E-02	0.1	*RA*	1.0	8.42E-03	*e*
Trifluralin	1582-09-8	7.7E-03	*i*	7.7E-03	*r*	7.7E-03	7.5E-03	*i*	7.5E-03	*r*	7.5E-03	0.1	*RA*	1.0	6.73E-02	*e*
Warfarin	81-81-2						3.0E-04	*i*	2.9E-05	*t*	3.0E-04	0.1	*RA*	1.0	3.84E-03	*e*
Metals																
Aluminum	7429-90-5						1.0E+00	*p*	1.4E-03	*p*	1.0E+00	0.01	*RA*	1.0	1.00E-03	*e*
Antimony	7440-36-0						4.0E-04	*i*	1.4E-05	*t*	4.0E-04	0.01	*RA*	1.0	1.00E-03	*e*
Arsenic	7440-38-2															
Barium	7440-39-3															
Beryllium	7440-41-7	8.4E+00	*r*	8.4E+00	*i*	8.4E+00	2.0E-03	*i*	5.7E-06	*i*	2.0E-03	0.01	*RA*	1.0	1.00E-03	*e*
Cadmium	7440-43-9															
Chromium (III) total chromium	7440-47-3															
Chromium (VI)	18540-29-9															
Copper	7440-50-8						4.0E-02	*h*	2.9E-04	*t*	4.0E-02	0.01	*RA*	1.0	1.00E-03	*e*
Lead	7439-92-1															
Manganese	7439-96-5						1.4E-01	*i*	1.4E-05	*i*	1.4E-01	0.01	*RA*	1.0	1.00E-03	*e*
Mercury	7439-97-6								8.6E-05	*i*		0.01	*RA*	1.0	1.00E-03	*e*
Molybdenum	7439-98-7						5.0E-03	*i*	1.4E-03	*t*	5.0E-03	0.01	*RA*	1.0	1.00E-03	*e*
Nickel	7440-02-0			9.1E-01	*c*		2.0E-02	*i*	2.6E-05	*t*	2.0E-02	0.01	*RA*	1.0	2.00E-04	*e*

Table E-1
Toxicity Values of Chemicals

Chemicals	CAS #	Slope Factor			Reference Dose					Absorption Factor			Permeability Constant, K_p	
		Oral, SF_o (mg/kg-day)$^{-1}$	Inhalation, SF_i (mg/kg-day)$^{-1}$	Dermal, SF_d (mg/kg-day)$^{-1}$	Oral, RfD_o (mg/kg-day)		Inhalation, RfD_i (mg/kg-day)		Dermal, RfD_d (mg/kg-day)	Dermal, RAF_d (unitless)		Oral, RAF_o (unitless)	(cm/hr)	
Selenium	7782-49-2													
Silver	7440-22-4				5.0E-03	*i*	2.9E-06	*t*	5.0E-03	0.01	*RA*	1.0	6.00E-04	*e*
Strontium	7440-24-6				6.0E-01	*i*			6.0E-01	0.01	*RA*	1.0	1.00E-03	*e*
Thallium chloride	7791-12-0				8.0E-05	*i*	2.9E-05	*t*	8.0E-05	0.01	*RA*	1.0	1.00E-03	*e*
Vanadium	7440-62-2				7.0E-03	*h*	1.4E-05	*t*	7.0E-03	0.01	*RA*	1.0	1.00E-03	*e*
Zinc	7440-66-6				3.0E-01	*i*			3.0E-01	0.01	*RA*	1.0	6.00E-04	*e*
Inorganics														
Ammonia	7664-41-7						2.9E-02	*i*		0.1	*RA*	1.0	1.00E-03	*e*
Cyanide	57-12-5				2.0E-02	*i*	1.4E-03	*t*	2.0E-02	0.1	*RA*	1.0	1.00E-03	*e*
Cyanide (as Sodium Cyanide)	143-33-9				4.0E-02	*i*			4.0E-02	0.1	*RA*	1.0	1.00E-03	*e*
Cyanogen bromide	506-68-3				9.0E-02	*i*	9.0E-02	*r*	9.0E-02	0.1	*RA*	1.0	1.00E-03	*e*
Fluoride (as Sodium Fluoride)	7681-49-4									0.1	*RA*	1.0	1.00E-03	*e*
Perchlorate	14797-73-0				7.0E-04	*i*	7.0E-04	*r*	7.0E-04	0.1	*RA*	1.0		
White phosphorus	7723-14-0				2.0E-05	*i*	2.9E-05	*t*	2.0E-05	0.1	*RA*	1.0	1.00E-03	*e*
Petroleum Hydrocarbons														
TPH-GR0														
Aliphatics - > C6-C8	NA													
Aliphatics - > C8-C10	NA													
Aromatics - >C8-C10	NA													
TPH-DR0														
Aliphatics - >C10-C12	NA													
Aliphatics - >C12-C16	NA													
Aliphatics - >C16-C21	NA													
Aromatics - >C10-C12	NA													
Aromatics - >C12-C16	NA													
Aromatics - >C16-C21	NA													
TPH-ORO														
Aliphatics - >C21-C35	NA													
Aromatics - >C21-C35	NA													

The letters in the table represent following sources:
i - USEPA IRIS
p - USEPA PPRTV's
n - USEPA NCEA
c - CALEPA OEHHA
t - TCEQ's TRRP Tier 1 PCL Table
h - HEAST
r - Missing value; value showing is identical to a value available for another route of exposure
m -MDNR/DHSS Memo, August 12, 2004
u - Value kept from MDNR Tanks-RBCA Guidance
a - Values assigned based on the most conservative Aroclor values found in the tiered hierarchy
e - Estimated by RAGS Part E
RA - RAGS Part A
RE - RAGS Part E

Colors:
Yellow - Some or all toxicity values identified
Orange - Lead is evaluated seperately using IEUBK model
White - Chemicals in MRBCA Tanks guidance

* (Vinyl chloride): For non-residential scenario use SFo of 0.72 mg/kg/day and a Unit Risk of 0.0044 mg/m^3

Table E-2
Physical and Chemical Properties of Chemicals

Chemicals	CAS #	MCL (mg/L)	Molecular Weight, MW (g/mol)	Water Solubility, S (mg/L)	Henry's Law Constant, H (L-water/L-air)	Organic Carbon Adsorption Coefficient, K_{oc} (cm^3/g)	Soil-Water Partition Coefficient, K_d (L/kg)	Diffusion Coefficient in Air, D_i (cm^2/s)	Diffusion Coefficient in Water, D_w (cm^2/s)	Vapor Pressure, P (mmHg)	Octanol-Water Partition Coefficient, K_{ow} (cm^3/g)
VOCs											
Acetone	67-64-1		58	1.00E+06	1.59E-03	5.75E-01	NA	1.24E-01	1.14E-05	2.27E+02	5.80E-01
Acetonitrile	75-05-8		41	1.00E+06	1.41E-03	1.56E+01	NA	1.30E-01	1.70E-05	9.00E+01	4.57E-01
Acrylonitrile	107-13-1		53	7.45E+04	5.66E-03	8.50E-01	NA	1.08E-01	1.34E-05	1.10E+02	1.62E+00
Allyl alcohol	107-18-6		58	3.17E+05	2.05E-04	2.95E+01	NA	1.14E-01	1.10E-05	2.63E+01	1.48E+00
Allyl chloride	107-05-1		81	1.00E+06	3.12E-05	5.00E+01	NA	9.80E-02	1.08E-05	3.60E+02	8.51E+01
Benzene	71-43-2										
1,1-Biphenyl	92-52-4		154	6.94E+00	1.67E-02	1.40E+03	NA	4.04E-02	8.20E-06	2.94E+02	5.71E+03
Bis(chloromethyl) ether	542-88-1		115	2.20E+04	8.45E-03	1.20E+00	NA	8.87E-02	9.40E-06	3.00E+01	3.76E+00
Bromochloromethane	74-97-5		129	2.40E+04	3.69E-02	2.75E+01	NA	9.65E-02	1.12E-05	1.06E+02	2.09E+01
Bromodichloromethane	75-27-4	0.08	164	6.74E+03	6.56E-02	5.50E+01	NA	2.98E-02	1.06E-05	5.84E+01	4.07E+01
Bromoform	75-25-2	0.08	253	3.10E+03	2.19E-02	8.71E+01	NA	1.49E-02	1.03E-05	5.60E+00	6.17E+01
Bromomethane	74-83-9		95	1.50E+04	2.60E-01	9.00E+00	NA	7.30E-02	1.20E-05	1.64E+03	1.51E+01
n-Butylbenzene	104-51-8		130	1.40E+01	5.40E-01	2.80E+03	NA	7.50E-02	7.80E-06	8.14E-01	1.95E+04
sec-Butylbenzene	135-98-8		130	1.70E+01	7.70E-01	2.20E+03	NA	7.50E-02	7.80E-06	1.25E+00	1.23E+04
tert-Butylbenzene	98-06-6		130	3.00E+01	5.00E-01	2.20E+03	NA	7.50E-02	7.80E-06	1.76E+00	1.51E+04
Carbon disulfide	75-15-0		76	1.19E+03	1.24E+00	4.57E+01	NA	1.04E-01	1.00E-05	3.40E+02	8.71E+01
Carbon tetrachloride	56-23-5	0.005	154	7.93E+02	1.25E+00	1.74E+02	NA	7.80E-02	8.80E-06	1.12E+02	2.75E+02
Chlorobenzene	108-90-7		113	4.72E+02	1.52E-01	2.19E+02	NA	7.30E-02	8.70E-06	1.21E+01	4.37E+02
Chloroethane	75-00-3		65	5.70E+03	4.50E-01	1.50E+01	NA	1.00E-01	1.20E-05	1.20E+03	3.80E+01
Chloroform	67-66-3	0.08	119	7.92E+03	1.52E-01	3.98E+01	NA	1.04E-01	1.00E-05	1.98E+02	3.31E+01
Chloromethane	74-87-3		51	8.20E+03	9.80E-01	3.50E+01	NA	1.10E-01	6.50E-06	3.77E+03	1.23E+01
2-Chloronaphthalene	91-58-7		160	1.20E+01	1.30E-02	1.60E+03	NA	2.50E-02	8.80E-06	1.70E-02	6.51E+03
2-Chlorophenol	95-57-8		129	2.20E+04	1.60E-02	3.88E+02	NA	5.01E-02	9.46E-06	1.42E+00	1.45E+02
2-Chlorotoluene	95-49-8		127	1.54E+02	1.35E-01	4.07E+02	NA	7.01E-02	8.01E-06	3.90E-03	1.59E+03
4-Chlorotoluene	106-43-4		127	1.18E+02	1.33E-01	4.96E+02	NA	6.76E-02	7.96E-06	2.27E+00	2.02E+03
Dibromochloromethane	124-48-1	0.08	208	2.60E+03	3.21E-02	6.31E+01	NA	1.96E-02	1.05E-05	1.50E+01	5.01E+01
1,2-Dichlorobenzene	95-50-1	0.6	147	1.56E+02	7.79E-02	6.17E+02	NA	6.90E-02	7.90E-06	1.36E+00	1.91E+03
1,3-Dichlorobenzene	541-73-1		150	1.60E+02	7.80E-02	6.20E+02	NA	6.90E-02	7.90E-06	2.30E+00	1.91E+03
1,4-Dichlorobenzene	106-46-7	0.075	147	7.38E+01	9.96E-02	6.17E+02	NA	6.90E-02	7.90E-06	1.06E+00	1.91E+03
Dichlorodifluoromethane	75-71-8		120	2.80E+02	4.10E+00	5.80E+01	NA	8.00E-02	1.10E-05	4.80E+03	6.54E+01
1,1-Dichloroethane	75-34-3		99	5.10E+03	2.30E-01	3.20E+01	NA	7.40E-02	1.10E-05	2.28E+02	5.75E+01
1,1-Dichloroethylene	75-35-4	0.007	97	2.25E+03	1.07E+00	5.89E+01	NA	9.00E-02	1.04E-05	5.91E+02	1.32E+02
cis-1,2-Dichloroethylene	156-59-2	0.07	97	3.50E+03	1.67E-01	3.55E+01	NA	7.36E-02	1.13E-05	1.75E+02	7.24E+01
trans-1,2-Dichloroethylene	156-60-5	0.1	97	6.30E+03	3.85E-01	5.25E+01	NA	7.07E-02	1.19E-05	3.52E+02	1.18E+02
1,2-Dichloropropane	78-87-5	0.005	113	2.80E+03	1.15E-01	4.37E+01	NA	7.82E-02	8.73E-06	5.00E+01	1.78E+02
1,3-Dichloropropene	542-75-6		111	2.80E+03	7.26E-01	4.57E+01	NA	6.26E-02	1.00E-05	3.12E+01	5.62E+01
Diisopropyl ether (DIPE)	108-20-3										
1,4-Dioxane	123-91-1		88	1.00E+06	1.97E-04	1.70E+01	NA	2.30E-01	1.00E-05	3.80E+01	4.79E-01
Ethanol	64-17-5										
Ethylbenzene	100-41-4										
Ethylene dibromide (EDB)	106-93-4										
Ethylene dichloride (EDC)	107-06-2										

Table E-2
Physical and Chemical Properties of Chemicals

Chemicals	CAS #	MCL (mg/L)	Molecular Weight, MW (g/mol)	Water Solubility, S (mg/L)	Henry's Law Constant, H (L-water/L-air)	Organic Carbon Adsorption Coefficient, K_{oc} (cm^3/g)	Soil-Water Partition Coefficient, K_d (L/kg)	Diffusion Coefficient in Air, D_i (cm^2/s)	Diffusion Coefficient in Water, D_w (cm^2/s)	Vapor Pressure, P (mmHg)	Octanol-Water Partition Coefficient, K_{ow} (cm^3/g)
Ethyl-tert-butyl-ether (ETBE)	637-92-3										
n-Hexane	110-54-3		86	9.50E+00	7.38E+01	8.90E+02	NA	2.00E-01	7.77E-06	1.52E+02	1.95E+03
Isopropylbenzene (Cumene)	98-82-8		120	6.13E+01	3.57E+00	4.54E+02	NA	7.50E-02	7.10E-06	4.60E+00	2.82E+03
4-Isopropyltoluene	99-87-6		134	1.72E+01	4.66E-01	2.29E+03	NA	5.72E-02	6.73E-06	1.08E+00	1.38E+04
Methanol	67-56-1										
Methyl ethyl ketone	78-93-3		72	2.23E+05	2.33E-03	4.50E+00	NA	8.95E-02	9.80E-06	9.10E+01	1.80E+00
Methyl iodide	74-88-4		142	1.39E+04	2.16E-01	1.58E+02	NA	1.02E-01	1.17E-05	3.79E+02	3.55E+01
Methyl butyl ketone	591-78-6		100	1.79E+04	3.38E-03	1.79E+01	NA	6.96E-02	7.75E-06	1.11E+01	3.04E+01
Methyl isobutyl ketone	108-10-1		100	1.90E+04	5.66E-03	1.34E+02	NA	7.50E-02	7.80E-06	1.45E+02	1.45E+01
Methyl teriary butyl ether (MTBE)	1634-04-4										
Methylene chloride	75-09-2	0.005	85	1.30E+04	8.98E-02	1.17E+01	NA	1.01E-01	1.17E-05	4.55E+02	2.19E+01
Nitrobenzene	98-95-3		123	2.09E+03	9.84E-04	6.46E+01	NA	7.60E-02	8.60E-06	2.44E-01	6.46E+01
n-Propylbenzene	103-65-1		120	5.22E+01	4.31E-01	7.41E+02	NA	7.50E-02	7.80E-06	2.71E+00	5.37E+03
Styrene	100-42-5	0.1	104	3.10E+02	1.13E-01	7.76E+02	NA	7.10E-02	8.00E-06	6.24E+00	7.94E+02
1,1,1,2-Tetrachloroethane	630-20-6		168	1.10E+03	9.92E-02	7.90E+01	NA	7.10E-02	7.90E-06	1.22E+01	8.57E+02
1,1,2,2-Tetrachloroethane	79-34-5		168	2.97E+03	1.41E-02	9.33E+01	NA	7.10E-02	7.90E-06	5.17E+00	1.55E+02
1,2,4,5-Tetrachlorobenzene	95-94-3		216	3.00E-01	4.99E-02	1.60E+03	NA	2.11E-02	8.80E-06	5.40E-03	3.72E+04
Tetrachloroethylene	127-18-4	0.005	166	2.00E+02	7.54E-01	1.55E+02	NA	7.20E-02	8.20E-06	1.84E+01	9.23E+02
Tetrahydrofuran	109-99-9		72	1.00E+06	2.89E-03	9.50E-01	NA	9.80E-02	1.10E-05	1.59E+02	4.22E+00
Tertiary-amyl-methyl-ether (TAME)	994-05-8										
Tertiary-butyl-alcohol (TBA)	75-65-0										
Toluene	108-88-3	1									
1,2,4-Trichlorobenzene	120-82-1	0.07	181	3.00E+02	5.80E-02	1.78E+03	NA	3.00E-02	8.20E-06	3.36E+01	8.44E+03
1,3,5-Trichlorobenzene	108-70-3		181	6.01E+00	8.98E-02	7.08E+02	NA	6.25E-02	7.66E-06	1.11E-01	1.55E+04
1,1,1-Trichloroethane	71-55-6	0.2	133	1.33E+03	7.05E-01	1.10E+02	NA	7.80E-02	8.80E-06	1.24E+02	4.79E+02
1,1,2-Trichloroethane	79-00-5	0.005	133	4.42E+03	3.74E-02	5.01E+01	NA	7.80E-02	8.80E-06	2.52E+01	1.02E+02
Trichloroethylene	79-01-6	0.005	131	1.10E+03	4.22E-01	1.66E+02	NA	7.90E-02	9.10E-06	7.20E+01	2.95E+02
Trichlorofluoromethane	75-69-4		90	2.05E+03	3.97E+00	1.60E+02	NA	8.70E-02	1.30E-05	6.87E+02	1.35E+02
1,2,3-Trichloropropane	96-18-4		147	1.75E+03	1.41E-02	5.10E+01	NA	7.10E-02	7.90E-06	3.70E+00	3.19E+02
1,1,2-Trichlorotrifluoroethane	76-13-1		187	1.70E+02	2.16E+01	3.72E+02	NA	2.88E-02	8.07E-06	3.60E+02	1.23E+03
1,2,4-Trimethylbenzene	95-63-6		120	5.70E+01	2.53E-01	3.72E+03	NA	7.50E-02	7.10E-06	1.59E+00	4.47E+03
1,3,5-Trimethylbenzene	108-67-8		120	4.82E+01	3.60E-01	8.19E+02	NA	7.50E-02	7.10E-06	2.13E+00	5.01E+03
Vinyl chloride	75-01-4	0.002	63	2.76E+03	1.11E+00	1.86E+01	NA	1.06E-01	1.23E-06	2.80E+03	4.17E+01
Xylenes (total)	1330-20-7										
SVOCs											
Acenaphthene	83-32-9										
Acenaphthylene	208-96-8		152	3.93E+00	4.74E-03	6.92E+03	NA	4.39E-02	7.07E-06	2.90E-02	8.63E+03
Acrylamide	79-06-1		71	6.40E+05	4.10E-08	5.00E+01	NA	9.70E-02	1.28E-05	7.00E-03	1.56E-01
Acrylic acid	79-10-7		72	1.00E+06	4.80E-06	1.13E+00	NA	9.08E-02	1.06E-05	3.72E+00	2.77E+00
Aniline	62-53-3		93	3.60E+04	5.82E-05	9.12E+00	NA	7.00E-02	8.30E-06	6.69E-01	1.20E+01
Anthracene	120-12-7										
Aroclor 1016	12674-11-2		258	4.20E-01	1.19E-02	1.80E+05	NA	1.92E-02	6.60E-06	4.00E-04	3.98E+05
Aroclor 1221	11104-28-2		201	5.90E-01	1.41E-01	5.80E+03	NA	2.85E-02	7.00E-06	6.70E-03	5.01E+04

Table E-2
Physical and Chemical Properties of Chemicals

Chemicals	CAS #	MCL (mg/L)	Molecular Weight, MW (g/mol)	Water Solubility, S (mg/L)	Henry's Law Constant, H (L-water/L-air)	Organic Carbon Adsorption Coefficient, K_{oc} (cm^3/g)	Soil-Water Partition Coefficient, K_d (L/kg)	Diffusion Coefficient in Air, D_i (cm^2/s)	Diffusion Coefficient in Water, D_w (cm^2/s)	Vapor Pressure, P (mmHg)	Octanol-Water Partition Coefficient, K_{ow} (cm^3/g)
Aroclor 1242	53469-21-9		267	3.40E-01	2.10E-02	6.30E+03	NA	1.86E-02	6.50E-06	4.06E-04	3.98E+05
Aroclor 1248	12672-29-6		300	6.00E-02	1.13E-01	2.77E+05	NA	1.56E-02	6.10E-06	4.94E-04	1.58E+06
Aroclor 1254	11097-69-1		327	5.70E-02	8.20E-02	5.30E+05	NA	1.56E-02	5.00E-06	7.71E-05	3.16E+06
Aroclor 1260	11096-82-5		376	8.00E-02	1.85E-01	6.70E+06	NA	1.16E-02	6.00E-06	4.05E-05	6.31E+06
Azobenzene	103-33-3		*182*	*1.60E+00*	*1.89E-03*	*5.32E+04*	NA	*4.96E-02*	*6.36E-06*	*3.02E-04*	*5.86E+04*
Benzidine	92-87-5		**184**	**3.22E+02**	**1.59E-09**	**1.74E+05**	NA	*3.40E-02*	*1.50E-05*	*8.36E-08*	*2.19E+01*
Benzo(a)anthracene	56-55-3										
Benzo(a)pyrene	50-32-8										
Benzo(b)fluoranthene	205-99-2										
Benzo(g,h,i)perylene	191-24-2		*276*	*2.60E-04*	*5.82E-06*	*1.58E+06*	NA	*4.90E-02*	*5.65E-05*	*1.00E-10*	*5.01E+06*
Benzo(k)fluoranthene	207-08-9										
Benzoic acid	65-85-0		**122**	**3.50E+03**	**6.31E-05**	**6.00E-01**	NA	**5.36E-02**	**7.97E-06**	*6.51E-03*	*7.41E+01*
Benzyl alcohol	100-51-6		*108*	*4.00E+04*	*1.62E-05*	*1.20E+01*	NA	*8.00E-02*	*8.00E-06*	*1.06E-01*	*1.20E+01*
Bis(2-chloroethyl)ether	111-44-4		**143**	**1.72E+04**	**7.38E-04**	**1.55E+01**	NA	**6.90E-02**	**7.53E-06**	*1.34E+00*	*3.63E+01*
Bis(2-chloroisopropyl)ether	108-60-1		**171**	**1.70E+03**	**4.60E-03**	**5.70E+01**	NA	**6.30E-02**	**6.40E-06**	*8.50E-01*	*3.80E+02*
Bis(2-ethylhexyl)phthalate	117-81-7	0.006	**391**	**3.40E-01**	**4.18E-06**	**1.51E+07**	NA	**3.51E-02**	**3.66E-06**	*6.45E-06*	*2.45E+08*
4-Bromophenyl phenyl ether	101-55-3		**249**	**1.45E+00**	**4.80E-03**	**1.70E+04**	NA	*4.75E-02*	*6.28E-06*	*5.85E-04*	*1.78E+05*
Butyl benzyl phthalate	85-68-7		**312**	**2.69E+00**	**5.17E-05**	**5.75E+04**	NA	**1.74E-02**	**4.83E-06**	*1.20E-05*	*6.92E+04*
Carbazole	86-74-8		**167**	**7.48E+00**	**6.27E-07**	**3.39E+03**	NA	**3.90E-02**	**7.03E-06**	*2.66E-04*	*1.70E+03*
p-Chloroaniline	106-47-8		**128**	**5.30E+03**	**1.36E-05**	**6.61E+01**	NA	**4.83E-02**	**1.01E-05**	*2.35E-02*	*5.25E+01*
4-Chlorophenyl phenyl ether	7005-72-3		*205*	*1.43E+00*	*1.30E-02*	*1.31E+04*	NA	*4.89E-02*	*6.19E-06*	*1.66E-03*	*1.10E+05*
Chrysene	218-01-9										
Dibenzo(a,h)anthracene	53-70-3										
Dibenzofuran	132-64-9		**168**	**4.22E+00**	**8.73E-03**	**7.76E+03**	NA	**6.01E-02**	**1.00E-05**	*1.64E-03*	*9.92E+03*
1,2-Dibromo-3-chloropropane	96-12-8	0.0002	**236**	**1.23E+03**	**6.03E-03**	**2.80E+01**	NA	**7.00E-06**	**7.00E-06**	*7.60E-01*	*4.79E+02*
Dibutyl phthalate	84-74-2		**278**	**1.12E+01**	**3.85E-08**	**3.39E+04**	NA	**4.38E-02**	**7.86E-06**	*4.25E-05*	*4.07E+04*
3,3-Dichlorobenzidine	91-94-1		**253**	**3.11E+00**	**1.64E-07**	**7.24E+02**	NA	**1.94E-02**	**6.74E-06**	*2.20E-07*	*1.62E+03*
2,4-Dichlorophenol	120-83-2		**163**	**4.50E+03**	**1.30E-04**	**1.47E+02**	NA	**3.46E-02**	**8.77E-06**	*7.15E-02*	*6.31E+02*
Diethyl phthalate	84-66-2		**222**	**1.08E+03**	**1.85E-05**	**2.88E+02**	NA	**2.56E-02**	**6.35E-06**	*1.65E-03*	*4.42E+02*
2,4-Dimethylphenol	105-67-9		**122**	**7.87E+03**	**8.20E-05**	**2.09E+02**	NA	**5.84E-02**	**8.69E-06**	*1.26E-01*	*4.07E+02*
2,6-Dimethylphenol	576-26-1		**122**	**6.05E+03**	**2.73E-04**	**1.60E+03**	NA	**5.84E-02**	**8.69E-06**	NA	NA
Dimethyl phthalate	131-11-3		**194**	**4.00E+03**	**4.31E-06**	**4.00E+01**	NA	*5.68E-02*	*6.30E-06*	*9.12E-03*	*4.57E+01*
1,3-Dinitrobenzene	99-65-0		**168**	**5.33E+01**	**1.53E-05**	**1.06E+02**	NA	*2.80E-01*	*7.60E-06*	*2.49E-04*	*4.27E+01*
2,4-Dinitrophenol	51-28-5		**184**	**2.79E+03**	**1.82E-05**	**1.00E-02**	NA	**2.73E-02**	**9.06E-06**	*1.14E-04*	*5.37E+01*
2,4-Dinitrotoluene	121-14-2		**182**	**2.70E+02**	**3.80E-06**	**9.55E+01**	NA	**2.03E-01**	**7.06E-06**	*1.74E-04*	*1.50E+02*
2,6-Dinitrotoluene	606-20-2		**182**	**1.82E+02**	**3.06E-05**	**6.92E+01**	NA	**3.27E-02**	**7.26E-06**	*5.70E-04*	*1.50E+02*
4-Amino-2,6-dinitrotoluene	19406-51-0		*197*	*3.64E+01*	*1.74E-07*	*3.63E+02*	NA	*5.60E-02*	*7.31E-06*	*5.86E-07*	*4.17E+02*
2-Amino-4,6-dinitrotoluene	35572-78-2		*197*	*1.73E+01*	*1.19E-07*	*5.62E+02*	NA	*5.60E-02*	*7.30E-06*	*1.19E-07*	*6.31E+02*
Di(2-ethylhexyl)adipate	103-23-1	0.4	*371*	*1.71E-03*	*9.78E-01*	*3.80E+05*	NA	*3.56E-02*	*3.72E-06*	*8.25E-05*	*1.30E+08*
Di-n-octylphthalate	117-84-0		**391**	**2.00E-02**	**2.74E-03**	**2.39E+03**	NA	**1.51E-02**	**3.58E-06**	*4.47E-06*	*3.64E+08*
1,2-Diphenylhydrazine	122-66-7		*184*	*1.84E+03*	*1.42E-07*	*6.61E+02*	NA	*5.62E-02*	*5.70E-06*	*2.60E-05*	*1.14E+03*
Diphenylamine	122-39-4		**169**	**5.30E+01**	**1.39E-04**	**6.00E+02**	NA	*6.08E-02*	*6.30E-06*	*4.26E-03*	*1.96E+03*
Ethylene glycol	107-21-1		**62**	**1.00E+06**	**2.46E-06**	**4.00E+00**	NA	*1.08E-01*	*1.22E-05*	*7.00E-02*	*6.31E-02*

Table E-2
Physical and Chemical Properties of Chemicals

Chemicals	CAS #	MCL (mg/L)	Molecular Weight, MW (g/mol)	Water Solubility, S (mg/L)	Henry's Law Constant, H (L-water/L-air)	Organic Carbon Adsorption Coefficient, K_{oc} (cm^3/g)	Soil-Water Partition Coefficient, K_d (L/kg)	Diffusion Coefficient in Air, D_i (cm^2/s)	Diffusion Coefficient in Water, D_w (cm^2/s)	Vapor Pressure, P (mmHg)	Octanol-Water Partition Coefficient, K_{ow} (cm^3/g)
Ethylene thiourea	96-45-7		102	2.00E+04	1.26E-08	1.00E+01	NA	7.15E-02	1.02E-05	8.36E-02	3.23E-01
Fluoranthene	206-44-0		202	2.06E-01	6.60E-04	1.07E+05	NA	3.02E-02	6.35E-06	8.13E-06	8.57E+04
Fluorene	86-73-7		166	1.98E+00	2.61E-03	1.38E+04	NA	3.63E-02	7.88E-06	3.24E-03	1.04E+04
Formaldehyde	50-00-0		30	4.00E+05	1.38E-05	2.19E+00	NA	1.80E-01	2.00E-05	3.88E+03	2.24E+00
Hexachlorobenzene	118-74-1	0.001	285	6.20E+00	5.41E-02	5.50E+04	NA	5.42E-02	5.91E-06	1.23E-05	7.24E+05
Hexachlorobutadiene	87-68-3		261	3.23E+00	3.34E-01	5.37E+04	NA	5.61E-02	6.16E-06	1.77E-01	5.21E+04
Hexachlorocyclopentadiene	77-47-4	0.05	273	1.80E+00	1.11E+00	2.00E+05	NA	1.61E-02	7.21E-06	7.32E-02	4.22E+04
Hexachloroethane	67-72-1		237	5.00E+01	1.59E-01	1.78E+03	NA	2.50E-03	6.80E-06	4.72E-01	1.08E+04
Hexachlorophene	70-30-4		407	1.40E+02	2.25E-11	5.00E+03	NA	8.00E-02	8.00E-06	2.74E-12	8.36E+06
HMX	2691-41-0		296	1.40E+02	3.55E-08	3.70E+01	NA	3.74E-02	6.34E-06	4.75E-15	5.00E-02
Indeno(1,2,3-cd)pyrene	193-39-5		276	2.20E-05	6.56E-05	3.47E+06	NA	1.90E-02	5.66E-06	1.40E-10	4.98E+06
Isophorone	78-59-1		138	1.20E+04	2.72E-04	4.68E+01	NA	6.23E-02	6.76E-06	4.10E-01	4.15E+02
Maleic anhydride	108-31-6		98	4.91E+03	1.61E-04	2.57E+01	NA	9.50E-02	1.11E-05	1.34E-03	4.17E+01
2-Methyl-4,6-dinitrophenol	534-52-1		198	3.00E+03	1.07E-07	3.16E-02	NA	5.31E-02	7.27E-06	2.87E-05	1.17E+02
2-Methylnaphthalene	91-57-6		142	2.54E+01	1.85E-02	4.32E+03	NA	6.29E-02	7.20E-06	6.57E-02	5.20E+03
2-Methylphenol	95-48-7		108	2.60E+04	4.92E-05	9.12E+01	NA	7.40E-02	8.30E-06	3.20E-01	1.15E+02
3-Methylphenol	108-39-4		108	2.27E+04	3.55E-05	3.46E+01	NA	7.40E-02	1.00E-05	1.40E-01	1.15E+02
4-Methylphenol	106-44-5		108	2.15E+04	4.10E-05	4.90E+01	NA	7.40E-02	1.00E-05	1.30E-01	1.15E+02
Methyl-2,4,6-trinitrophenylnitramine	479-45-8		287	7.50E+01	8.31E-11	2.34E+02	NA	5.69E-02	6.40E-06	4.00E-10	1.10E+02
m-Phenylenediamine	108-45-2		108	2.38E+05	3.91E-09	1.10E+00	NA	6.63E-02	9.90E-06	2.28E-02	4.06E-01
Naphthalene	91-20-3										
2-Nitroaniline	88-74-4		138	1.26E+03	2.08E-05	2.69E+01	NA	5.99E-02	7.18E-06	4.75E-03	1.05E+02
3-Nitroaniline	99-09-2		138	4.56E+02	2.31E-07	3.94E+01	NA	6.73E-02	8.59E-06	1.39E-05	4.20E+07
4-Nitroaniline	100-01-6		138	6.49E+02	3.33E-08	1.12E+01	NA	6.69E-02	8.59E-06	2.86E-06	1.18E+01
Nitroglycerin	55-63-0		227	6.70E+04	3.40E-06	9.25E+01	NA	5.53E-02	7.34E-06	1.00E-04	1.00E+02
2-Nitrophenol	88-75-5		139	1.73E+04	2.21E-05	2.09E+01	NA	6.87E-02	8.47E-06	5.03E-02	2.23E+02
4-Nitrophenol	100-02-7		139	4.49E+03	3.24E-08	3.16E+00	NA	6.73E-02	8.66E-06	1.91E-05	5.33E+01
2-Nitrotoluene	88-72-2		137	6.00E+02	1.87E-03	1.41E+02	NA	6.47E-02	7.73E-06	1.50E-01	2.28E+02
3-Nitrotoluene	99-08-1		137	4.98E+02	2.24E-03	1.41E+02	NA	6.42E-02	7.69E-06	1.50E-01	2.28E+02
4-Nitrotoluene	99-99-0		137	4.00E+02	2.29E-03	1.41E+02	NA	6.40E-02	7.70E-06	1.20E-01	2.28E+02
n-Nitrosodimethylamine	62-75-9		74	1.00E+06	7.46E-05	1.20E+01	NA	1.34E-01	9.72E-06	5.37E+00	2.30E-01
n-Nitrosodi-n-propylamine	621-64-7		130	9.89E+03	9.35E-05	2.00E+01	NA	5.45E-02	8.17E-06	4.00E-01	2.24E+01
n-Nitrosodiphenylamine	86-30-6		198	3.51E+01	2.05E-04	1.29E+03	NA	3.12E-02	6.35E-06	9.88E-02	1.45E+03
n-Nitrosopyrrolidine	930-55-2		100	7.80E+05	7.48E-07	6.50E-01	NA	8.00E-02	8.00E-06	1.75E-01	1.70E+00
Pentachlorobenzene	608-93-5		250	1.33E+00	2.91E-02	4.00E+04	NA	6.70E-02	6.30E-06	1.67E-03	1.66E+05
Pentachloronitrobenzene	82-68-8		295	5.50E-01	3.28E-03	2.66E+04	NA	1.59E-02	6.10E-06	1.13E-04	1.07E+05
Pentachlorophenol	87-86-5	0.001	266	1.95E+03	1.00E-06	5.92E+02	NA	5.60E-02	6.10E-06	1.70E-05	5.50E+04
Pentaerythritol tetranitrate	78-11-5		316	2.66E+01	5.60E-05	6.29E+03	NA	4.48E-02	6.20E-06	8.63E-05	7.31E+03
Phenanthrene	85-01-8		178	9.94E-01	5.40E-03	1.41E+04	NA	3.33E-02	7.47E-06	6.80E-04	2.24E+04
Phenol	108-95-2		94	8.28E+04	1.63E-05	2.88E+01	NA	8.20E-02	9.10E-06	4.63E-01	3.24E+01
Polychlorinated biphenyls (PCBs)	1336-36-3	0.0005	326	4.30E-02	1.16E-02	3.09E+05	NA	1.04E-01	1.00E-05	7.60E-05	2.00E+06
Pyrene	129-00-0										
RDX	121-82-4		173	9.33E+02	2.28E-06	6.31E+01	NA	6.65E-02	6.39E-06	1.00E-09	7.41E+00

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Chemicals	CAS #	MCL (mg/L)	Molecular Weight, MW (g/mol)	Water Solubility, S (mg/L)	Henry's Law Constant, H (L-water/L-air)	Organic Carbon Adsorption Coefficient, K_{oc} (cm^3/g)	Soil-Water Partition Coefficient, K_d (L/kg)	Diffusion Coefficient in Air, D_i (cm^2/s)	Diffusion Coefficient in Water, D_w (cm^2/s)	Vapor Pressure, P (mmHg)	Octanol-Water Partition Coefficient, K_{ow} (cm^3/g)
2,4,5-Trichlorophenol	95-95-4		197	1.20E+03	1.78E-04	1.60E+03	NA	2.91E-02	7.03E-06	1.63E-02	2.79E+03
2,4,6-Trichlorophenol	88-06-2		197	8.00E+02	3.19E-04	3.81E+02	NA	3.18E-02	6.25E-06	1.18E-02	2.79E+03
1,3,5-Trinitrobenzene	99-35-4		213	2.78E+02	1.36E-08	1.41E+01	NA	8.00E-02	8.00E-06	9.90E-05	2.79E+01
2,4,6-Trinitrotoluene (TNT)	118-96-7		227	1.30E+02	1.87E-05	3.08E+02	NA	5.41E-02	6.57E-06	1.24E-04	9.85E+01
Pesticides											
Acetochlor	34256-82-1		270	2.23E+02	2.86E-06	2.00E+02	NA	5.01E-02	6.00E-06	3.40E-08	3.00E+02
Acifluorfen	62476-59-9		362	2.50E+05	8.31E-13	1.13E+02	NA	1.45E-02	4.40E-06	9.75E-09	2.36E+00
Acrolein	107-02-8		56	2.10E+05	4.90E-03	2.10E+01	NA	1.10E-01	1.20E-05	2.65E+02	7.94E-01
Alachlor	15972-60-8	0.002	270	2.40E+02	3.41E-07	1.91E+02	NA	1.94E-02	5.83E-06	2.20E-05	2.34E+03
Aldicarb	116-06-3	0.003	190	6.03E+03	5.90E-08	1.60E+01	NA	3.05E-02	7.20E-06	2.90E-05	2.29E+01
Aldicarb sulfone	1646-88-4	0.003	222	7.80E+03	1.38E-07	3.00E+00	NA	5.55E-02	5.79E-06	9.00E-05	2.16E-01
Aldrin	309-00-2		365	1.80E-01	6.97E-03	2.45E+06	NA	1.32E-02	4.86E-06	1.67E-05	5.62E+06
alpha-Hexachlorocyclohexane	319-84-6		291	2.00E+00	4.35E-04	1.23E+03	NA	1.42E-02	7.34E-06	4.26E-05	1.82E+04
Ametryn	834-12-8		227	1.85E+02	1.88E-07	3.89E+02	NA	4.24E-02	5.70E-06	1.81E-07	7.67E+02
Atrazine	1912-24-9	0.003	216	2.80E+01	1.83E-07	4.89E+02	NA	5.64E-02	5.58E-06	3.00E-07	6.60E+02
Baygon	114-26-1		209	1.86E+03	1.64E-05	1.60E+02	NA	5.67E-02	7.41E-06	NA	NA
Butylate	2008-41-5		217	4.60E+01	3.50E-03	1.26E+02	NA	4.89E-02	5.14E-06	1.30E-02	7.13E+03
beta-Hexachlorocyclohexane	319-85-7		291	2.40E-01	3.05E-05	1.26E+03	NA	1.42E-02	7.34E-06	4.90E-07	1.82E+04
4-(2,4-Dichlorophenoxy) butyric acid (2,4-DB)	94-82-6		249	5.30E+01	9.39E-08	5.30E+02	NA	4.41E-02	6.13E-06	1.82E-07	6.12E+03
Captan	133-06-2		301	3.30E+00	2.95E-04	1.98E+02	NA	1.83E-02	4.90E-06	7.50E-06	6.98E+01
Carbaryl	63-25-2		201	8.26E+01	5.37E-02	1.02E+02	NA	2.78E-02	5.60E-06	1.36E-06	2.24E+02
Carbofuran	1563-66-2	0.04	221	3.20E+01	1.27E-07	4.80E+01	NA	5.35E-02	5.40E-06	8.30E-06	2.00E+02
Carboxin	5234-68-4		235	1.99E+02	1.15E+01	8.46E+02	NA	4.48E-02	6.14E-06	4.82E-08	1.05E+03
Chloramben	133-90-4		206	7.00E+02	1.59E-05	1.90E+02	NA	5.71E-02	7.46E-06	1.94E-05	3.02E+02
Chlordane (technical)	12789-03-6		410	5.60E-02	1.99E-03	1.20E+05	NA	1.18E-02	4.37E-06	1.00E-05	3.98E+06
Chlordane, gamma	57-74-9	0.002	410	2.28E-02	4.11E-03	3.93E+05	NA	3.32E-02	4.65E-06	4.17E-06	9.25E+06
Chlorothalonil	1897-45-6		266	6.00E-01	8.20E-05	5.78E+03	NA	4.90E-02	6.57E-06	2.41E-06	2.88E+03
Chlorpyrifos	2921-88-2		351	4.00E-01	1.20E-04	1.86E+03	NA	4.85E-02	5.11E-06	1.87E-05	4.57E+04
Coumaphos	56-72-4		363	3.86E-01	2.17E-07	1.60E+04	NA	3.53E-02	4.81E-06	4.22E-09	1.82E+04
Cyanazine	21725-46-2		241	1.70E+02	1.05E+01	2.00E+02	NA	4.33E-02	5.83E-06	7.28E-09	5.25E+01
Dacthal	1861-32-1		332	2.20E-01	9.35E-06	4.68E+04	NA	4.20E-02	2.05E+00	1.13E-07	5.13E+04
Dalapon, sodium salt	75-99-0	0.2	143	7.43E+03	2.64E-06	2.30E+00	NA	6.98E-02	8.70E-06	1.30E-01	3.98E+01
DDD	72-54-8		320	9.00E-02	1.64E-04	1.00E+06	NA	1.69E-02	4.76E-06	8.66E-07	7.47E+05
DDE	72-55-9		318	1.20E-01	8.61E-04	4.47E+06	NA	1.44E-02	5.87E-06	5.66E-06	9.90E+05
DDT	50-29-3		354	2.50E-02	3.32E-04	2.63E+06	NA	1.37E-02	4.95E-06	3.93E-07	6.23E+06
DEF	78-48-8		315	2.30E+00	1.20E-05	3.16E+05	NA	1.45E-02	5.90E-06	1.38E-05	5.01E+05
delta-Hexachlorocyclohexane	319-86-8		291	3.14E+01	1.76E-05	4.26E+03	NA	4.50E-02	6.20E-06	2.87E-05	1.00E+04
Demeton	8065-48-3		258	7.20E+02	6.65E-03	2.69E+02	NA	4.56E-02	5.45E-06	1.00E-04	9.33E+02
Diazinon	333-41-5		304	4.00E+01	4.63E-06	2.29E+02	NA	1.80E-02	4.90E-06	8.40E-05	7.31E+03
Dicamba	1918-00-9		221	4.50E+03	8.94E-08	1.15E+02	NA	6.02E-02	6.69E-06	9.70E-05	1.38E+02
2,4-Dichlorophenoxy acetic acid (2,4-D)	94-75-7	0.07	221	6.77E+02	4.18E-07	8.91E+02	NA	5.90E-02	6.50E-06	2.40E-05	4.14E+02
Dichloroprop (2,4-DP)	120-36-5		235	2.30E+02	9.00E-07	2.86E-02	NA	4.70E-02	6.43E-06	1.60E-05	1.83E+03
Dieldrin	60-57-1		381	1.95E-01	6.19E-04	2.14E+04	NA	1.25E-02	4.74E-06	9.96E-07	2.82E+05

Table E-2
Physical and Chemical Properties of Chemicals

Chemicals	CAS #	MCL (mg/L)	Molecular Weight, MW (g/mol)	Water Solubility, S (mg/L)	Henry's Law Constant, H (L-water/L-air)	Organic Carbon Adsorption Coefficient, K_{oc} (cm^3/g)	Soil-Water Partition Coefficient, K_d (L/kg)	Diffusion Coefficient in Air, D_i (cm^2/s)	Diffusion Coefficient in Water, D_w (cm^2/s)	Vapor Pressure, P (mmHg)	Octanol-Water Partition Coefficient, K_{ow} (cm^3/g)
Dimethoate	60-51-5		229	2.38E+04	4.31E-09	2.70E+01	NA	8.00E-02	8.00E-06	5.09E-06	1.90E+00
2,4-Dinitro-6-sec-butylphenol (Dinoseb)	88-85-7	0.007	240	5.20E+01	1.87E-05	1.24E+02	NA	2.25E-02	6.25E-06	7.52E-02	4.71E+03
Diquat	85-00-7	0.02	344	7.08E+04	5.82E-12	2.04E+02	NA	5.52E-02	5.52E-06	1.00E-07	1.51E-03
Disulfoton	298-04-4		274	1.63E+01	1.64E-04	1.60E+00	NA	8.00E-02	8.00E-06	2.30E-04	7.24E+03
Diuron	330-54-1		233	4.20E+01	1.11E-04	3.80E+02	NA	5.40E-02	5.30E-06	1.00E-07	4.71E+02
Endosulfan	115-29-7		407	5.10E-01	4.59E-04	2.14E+03	NA	1.15E-02	4.55E-06	9.96E-06	6.92E+03
Endothall	145-73-3	0.1	186	1.00E+05	1.48E-13	1.23E+02	NA	5.72E-02	7.50E-06	1.80E-04	7.76E+01
Endrin	72-20-8	0.002	381	2.50E-01	3.08E-04	1.23E+04	NA	1.25E-02	4.74E-06	5.84E-07	2.82E+05
Endrin aldehyde	74-21-93-4		381	1.68E-02	1.80E-02	2.14E+06	NA	2.97E-02	3.83E-06	1.46E-05	2.75E+06
Endrin Ketone	53494-70-5		381	8.60E-01	3.66E-05	1.74E+05	NA	3.10E-02	4.46E-06	1.51E-06	2.14E+05
Eptam	759-94-4		189	3.70E+02	4.57E-03	2.40E+02	NA	5.35E-02	5.65E-06	1.60E-01	1.04E+03
Ethoprop	13194-48-4		242	7.50E+02	6.73E-06	1.22E+03	NA	4.16E-02	5.56E-06	3.80E-04	1.38E+03
Fenamiphos	22224-92-6		303	3.29E+02	4.96E-08	3.31E+02	NA	1.82E-02	4.88E-06	NA	NA
Fenthion	55-38-9		278	2.17E+01	2.13E-05	1.10E+03	NA	4.35E-02	5.42E-06	1.38E-04	1.15E+03
Fluometuron	2164-17-2		232	1.10E+02	7.38E-08	1.75E+02	NA	4.38E-02	5.66E-06	NA	NA
Fonofos	944-22-9		246	1.60E+01	2.21E-04	3.58E+03	NA	4.65E-02	5.52E-06	3.43E-01	1.00E+04
gamma-Hexachlorocyclohexane	58-89-9	0.0002	291	6.80E+00	5.74E-04	1.07E+03	NA	1.42E-02	7.34E-06	3.72E-05	1.81E+04
Glyphosate	1071-83-6	0.7	169	1.20E+04	1.67E-17	3.63E+03	NA	5.07E-02	8.30E-06	7.50E-08	2.51E-02
Guthion	86-50-0		317	9.00E-02	8.80E-11	2.51E+02	NA	4.11E-02	5.34E-06	4.70E-09	3.16E+02
Heptachlor	76-44-8	0.0004	373	1.80E-01	6.10E+01	1.41E+06	NA	1.12E-02	5.69E-06	3.26E-04	1.61E+06
Heptachlor epoxide	1024-57-3	0.0002	389	2.00E-01	3.90E-04	8.32E+04	NA	1.32E-02	4.23E-06	4.34E-06	8.04E+04
Hexazinone	51235-04-2		252	3.30E+04	1.69E-11	3.72E+01	NA	5.08E-02	5.11E-06	2.03E-07	1.42E+02
Malathion	121-75-5		330	1.43E+02	9.84E-07	1.80E+03	NA	1.50E-02	4.40E-06	7.90E-06	1.94E+02
Maleic hydrazide	123-33-1		112	6.00E+03	1.09E-09	4.15E+01	NA	9.00E-02	1.11E-05	7.50E-08	1.30E-01
Maneb	12427-38-2		295	6.00E+00	2.31E-05	5.50E+02	NA	1.59E-02	6.10E-06	NA	NA
Methomyl	16752-77-5		162	5.80E+04	7.54E-09	1.50E+01	NA	6.93E-02	1.00E-05	5.00E-05	4.07E+00
Methoxychlor	72-43-5	0.04	346	4.50E-02	6.48E-04	9.77E+04	NA	1.56E-02	4.46E-06	1.23E-06	4.65E+05
2-Methyl-4-chlorophenoxyacetic acid (MCPA)	94-74-6		201	1.17E+03	5.45E-08	8.90E+01	NA	5.12E-02	6.82E-06	6.99E-06	2.45E+03
MCPP	93-65-2		215	2.80E+02	1.00E-06	1.73E-02	NA	4.70E-02	6.36E-06	2.50E-05	1.36E+03
Metolachlor	51218-45-2		284	5.30E+02	3.69E-07	7.03E+02	NA	3.61E-02	5.10E-06	2.29E-06	7.87E+02
Metribuzin	21087-64-9		214	1.22E+03	7.42E-11	9.50E+01	NA	4.51E-02	5.98E-06	5.16E-05	2.36E+00
Mirex	2385-85-5		546	3.28E+00	2.11E-02	5.57E+03	NA	3.50E-02	4.08E-06	7.50E-07	1.00E+11
Naled	300-76-5		381	2.00E+03	2.05E-05	1.33E+02	NA	4.40E-02	6.80E-06	2.00E-04	3.98E+01
o,o,o-Triethylphosphorothioate	126-68-1		198	8.45E+02	2.08E-02	4.90E+02	NA	5.26E-02	6.24E-06	7.30E-01	4.37E+02
Oxamyl	23135-22-0	0.2	219	2.80E+05	9.72E-09	8.00E+00	NA	5.57E-02	5.75E-06	3.83E-07	6.32E-02
Paraquat	4685-14-7		257	6.20E+05	4.10E-08	1.55E+04	NA	3.74E-02	3.57E-06	1.45E-06	3.16E-05
ethyl-Parathion	56-38-2		291	1.18E+01	2.37E-05	5.60E+03	NA	1.70E-02	5.80E-06	1.73E-05	5.38E+03
methyl-Parathion	298-00-0		263	3.70E+01	4.10E-06	5.10E+03	NA	8.00E-02	8.00E-06	1.52E-05	5.61E+02
Pendimethalin	40487-42-1		281	2.75E-01	3.51E-05	1.91E+05	NA	3.81E-02	5.26E-06	7.31E-07	2.34E+05
Phenylmercuric acetate	62-38-4		337	4.70E+03	2.32E-08	6.70E+01	NA	8.00E-02	8.00E-06	3.04E-06	7.76E+00
Phorate	298-02-2		260	5.00E+01	2.36E-04	6.61E+02	NA	8.00E-02	8.00E-06	1.30E-03	2.33E+03
Picloram	1918-02-1	0.5	241	4.30E+02	1.66E+02	2.60E+01	NA	5.50E-02	7.27E-06	2.15E-06	8.71E+02
Prometon	1610-18-0		225	7.50E+02	8.12E-08	5.25E+02	NA	4.25E-02	5.54E-06	3.43E-06	7.59E+02

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Physical and Chemical Properties of Chemicals

Chemicals	CAS #	MCL (mg/L)	Molecular Weight, MW (g/mol)	Water Solubility, S (mg/L)	Henry's Law Constant, H (L-water/L-air)	Organic Carbon Adsorption Coefficient, K_{oc} (cm^3/g)	Soil-Water Partition Coefficient, K_d (L/kg)	Diffusion Coefficient in Air, D_i (cm^2/s)	Diffusion Coefficient in Water, D_w (cm^2/s)	Vapor Pressure, P (mmHg)	Octanol-Water Partition Coefficient, K_{ow} (cm^3/g)
Pronamide	23950-58-5		256	1.50E+01	7.83E-05	2.00E+02	NA	8.00E-02	8.00E-06	4.00E-04	3.76E+03
Propachlor	1918-16-7		212	6.13E+02	4.47E-06	2.63E+02	NA	8.03E-02	8.03E-06	NA	NA
Propanil	709-98-8		218	2.25E+02	1.85E-07	9.03E+02	NA	4.93E-02	6.59E-06	8.99E-07	9.43E+02
Propazine	139-40-2		230	8.60E+00	1.89E-07	1.55E+02	NA	4.40E-02	5.69E-06	1.23E-06	1.78E+03
Propham	122-42-9		179	3.20E+01	1.58E-06	8.90E+01	NA	5.71E-02	6.28E-06	1.35E-04	4.57E+02
Silvex (2,4,5-TP)	93-72-1	0.05	270	1.40E+02	3.71E-07	5.60E+01	NA	1.94E-02	5.80E-06	5.20E-06	4.78E+03
Simazine	122-34-9	0.004	202	5.70E+00	1.38E-07	1.38E+02	NA	4.90E-02	6.37E-06	9.10E-07	4.37E+02
Strychnine	57-24-9		334	1.60E+02	3.10E-12	7.94E+01	NA	8.00E-02	8.00E-06	1.67E-10	7.04E+01
Tebuthiuron	34014-18-1		228.31	2.50E+03	4.99E-11	3.13E+01	NA	5.62E-02	5.85E-06	2.03E-05	6.17E+01
Terbacil	5902-51-2		217	7.10E+02	4.92E-09	4.10E+01	NA	4.95E-02	6.61E-06	NA	NA
Terbufos	13071-79-9		288	5.07E+00	9.84E-04	6.61E+02	NA	4.18E-02	5.08E-06	2.96E-02	1.57E+04
Terbutryn	886-50-0		241	2.50E+01	1.30E-06	1.63E+03	NA	5.60E-02	6.00E-06	2.10E-06	5.50E+03
Toxaphene	8001-35-2	0.003	414	7.40E-01	2.46E-04	2.57E+05	NA	1.16E-02	4.34E-06	4.19E-06	6.24E+06
Triallate	2303-17-5		305	4.00E+00	7.91E-04	2.24E+03	NA	4.58E-02	4.84E-06	1.20E-04	3.72E+04
2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)	93-76-5		255	2.78E+02	3.62E-07	5.30E+01	NA	8.00E-02	8.00E-06	3.61E-06	1.83E+03
Trifluralin	1582-09-8		335	8.11E+00	1.08E-03	1.38E+04	NA	1.49E-02	4.70E-06	1.10E-04	2.05E+05
Warfarin	81-81-2		308	1.70E+01	1.14E-07	9.19E+02	NA	1.63E-02	4.40E-06	1.16E-07	1.58E+03
Metals											
Aluminum	7429-90-5		27	NA	0.00E+00	NA	3.53E+02	NA	NA	NA	2.13E+00
Antimony	7440-36-0	0.006	122	NA	0.00E+00	NA	4.47E+01	NA	NA	NA	1.00E+00
Arsenic	7440-38-2										
Barium	7440-39-3										
Beryllium	7440-41-7	0.004	9	NA	0.00E+00	NA	2.29E+01	NA	NA	NA	3.72E+00
Cadmium	7440-43-9										
Chromium (III) total chromium	7440-47-3										
Chromium (VI)	18540-29-9										
Copper	7440-50-8		64	NA	0.00E+00	NA	3.98E+01	NA	NA	NA	2.69E-01
Lead	7439-92-1										
Manganese	7439-96-5		55	NA	0.00E+00	NA	5.01E+01	NA	NA	NA	1.00E+00
Mercury	7439-97-6		401	3.00E-02	4.67E-01	NA	4.00E-02	3.07E-02	6.30E-06	1.30E-03	3.38E-01
Molybdenum	7439-98-7		96	NA	0.00E+00	NA	2.00E+01	NA	NA	NA	1.00E+00
Nickel	7440-02-0		59	NA	0.00E+00	NA	1.59E+01	NA	NA	NA	2.69E-01
Selenium	7782-49-2										
Silver	7440-22-4		108	NA	0.00E+00	NA	1.00E+00	NA	NA	NA	1.00E+00
Strontium	7440-24-6		88	NA	0.00E+00	NA	2.00E+00	NA	NA	NA	1.00E+00
Thallium chloride	7791-12-0		240	2.90E+03	0.00E+00	NA	4.37E+01	NA	NA	NA	NA
Vanadium	7440-62-2		51	NA	0.00E+00	NA	1.00E+03	NA	NA	NA	1.00E+00
Zinc	7440-66-6		65	NA	0.00E+00	NA	1.59E+01	NA	NA	NA	3.38E-01
Inorganics											
Ammonia	7664-41-7		17	5.31E+05	1.36E-02	3.09E+00	NA	2.59E-01	6.93E-05	7.47E+03	1.69E+00
Cyanide	57-12-5		26	1.00E+05	0.00E+00	NA	9.90E+00	5.21E-01	2.28E-05	1.38E+01	2.03E-01
Cyanide (as Sodium Cyanide)	143-33-9	0.2	49	5.80E+05	0.00E+00	NA	NA	NA	6.64E-06	NA	2.00E-02
Cyanogen bromide	506-68-3		106	8.50E+03	2.05E-01	2.60E+01	NA	9.60E-02	1.00E-05	NA	NA

Table E-2
Physical and Chemical Properties of Chemicals

Chemicals	CAS #	MCL (mg/L)	Molecular Weight, MW (g/mol)	Water Solubility, S (mg/L)	Henry's Law Constant, H (L-water/L-air)	Organic Carbon Adsorption Coefficient, K_{oc} (cm^3/g)	Soil-Water Partition Coefficient, K_d (L/kg)	Diffusion Coefficient in Air, D_i (cm^2/s)	Diffusion Coefficient in Water, D_w (cm^2/s)	Vapor Pressure, P (mmHg)	Octanol-Water Partition Coefficient, K_{ow} (cm^3/g)
Fluoride (as Sodium Fluoride)	7681-49-4	4	42	4.00E+04	0.00E+00	NA	NA	NA	6.15E-06	NA	1.70E-01
Perchlorate	14797-73-0		*99.5*	NA	0.00E+00	NA	NA	NA	NA	NA	NA
White phosphorus	7723-14-0		**31**	**3.00E+00**	*5.65E-02*	*1.12E+03*	NA	**1.85E-01**	**1.68E-05**	*2.50E-02*	*1.20E+03*
Petroleum Hydrocarbons											
TPH-GR0											
Aliphatics - > C6-C8	NA										
Aliphatics - > C8-C10	NA										
Aromatics - >C8-C10	NA										
TPH-DR0											
Aliphatics - >C10-C12	NA										
Aliphatics - >C12-C16	NA										
Aliphatics - >C16-C21	NA										
Aromatics - >C10-C12	NA										
Aromatics - >C12-C16	NA										
Aromatics - >C16-C21	NA										
TPH-ORO											
Aliphatics - >C21-C35	NA										
Aromatics - >C21-C35	NA										

Sources for properties:

Regular underlined font:	Properties kept from department's Tanks MRBCA Guidance.
Bold font:	CALM (1998) as revised in 2001, Table A4.
Bold and italic font:	EPA Region IX, PRGs InterCalc Tables: Phys-Chem Data (10/01/02).
Italic font:	Texas Comission on Environmental Quality's TRRP Chemical/Physical Properties Table; March, 2004.
Regular font:	Idaho Risk Based Decision-Making for Remedial Action Guidance Document, Appendix G, 2003.
Bold underlined font: Properties developed using the following equation:	$D_1 = \left(\frac{MW_2}{MW_1}\right)^{1/2} \times D_2$

where,
D_1 = Diffusuion coefficient of chemical 1 (cm^2/s)
D_2 = Diffusuion coefficient of chemical 2 (cm^2/s)
MW_1 = Molecular weight of chemical 1 (g/mol)
MW_2 = Molecular weight of chemical 2 (g/mol)

This equation comes from Handbook of Chemical Property Estimation Methods (Lyman et at., 1990).

MCLs: (Maximum Contaminant Level) USEPA (Winter 2004) Edition of Drinking Water Standards and Health Advisories.

Table E-3
Exposure Factors

Parameter	Symbol	Unit	Default
Averaging Time for Carcinogen	AT_c	year	70
Averaging Time for Non-Carcinogen	AT_{nc}	year	=ED
Body Weight:			
Resident Child	BW	kg	15
Resident Adult	BW	kg	70
Non-Residential Worker	BW	kg	70
Construction Worker	BW	kg	70
Exposure Duration:			
Resident Child	ED	year	6
Resident Adult	ED	year	24
Non-Residential Worker	ED	year	25
Construction Worker	ED	year	1
Exposure Frequency:			
Resident Child	EF	day/year	350
Resident Adult	EF	day/year	350
Non-Residential Worker	EF	day/year	250
Construction Worker	EF	day/year	90
Soil Ingestion Rate:			
Resident Child	IR_{soil}	mg/day	200
Resident Adult	IR_{soil}	mg/day	100
Non-Residential Worker	IR_{soil}	mg/day	100
Construction Worker	IR_{soil}	mg/day	100
Groundwater Ingestion Rate:			
Resident Child	IR^w	L/day	1
Resident Adult	IR^w	L/day	2
Indoor Inhalation Rate (hourly):			
Resident Child	IRai	m^3/hr	0.416
Resident Adult	IRai	m^3/hr	0.833
Non-Residential Worker	IRai	m^3/hr	0.833
Exposure Time for Indoor Inhalation:			
Resident Child	ET_{in}	hr/day	18
Resident Adult	ET_{in}	hr/day	18
Non-Residential Worker	ET_{in}	hr/day	18
Indoor Inhalation Rate (daily):			
Resident Child	IR_a	m^3/day	7.5
Resident Adult	IR_a	m^3/day	15.0
Non-Residential Worker	IR_a	m^3/day	15.0

Table E-3
Exposure Factors

Parameter	Symbol	Unit	Default
Outdoor Inhalation Rate (hourly):			
Resident Child	IR_{ao}	m^3/hr	0.416
Resident Adult	IR_{ao}	m^3/hr	0.833
Non-Residential Worker	IR_{ao}	m^3/hr	0.833
Construction Worker	IR_{ao}	m^3/hr	1.8
Exposure Time for Outdoor Inhalation:			
Resident Child	ET_{out}	hr/day	6
Resident Adult	ET_{out}	hr/day	6
Non-Residential Worker	ET_{out}	hr/day	6
Construction Worker	ET_{out}	hr/day	10
Outdoor Inhalation Rate (daily):			
Resident Child	IR_a	m^3/day	2.5
Resident Adult	IR_a	m^3/day	5.0
Non-Residential Worker	IR_a	m^3/day	5.0
Construction Worker	IR_a	m^3/day	18.0
Skin Surface Area for Incidental Dermal Contact with Soil:			
Resident Child	SA_{soil}	cm^2/day	2800
Resident Adult	SA_{soil}	cm^2/day	5700
Non-Residential Worker	SA_{soil}	cm^2/day	3300
Construction Worker	SA_{soil}	cm^2/day	3300
Skin Surface Area for Incidental Dermal Contact with Water:			
Resident Child	SA_{gw}	cm^2/day	2800
Resident Adult	SA_{gw}	cm^2/day	5700
Non-Residential Worker	SA_{gw}	cm^2/day	3300
Construction Worker	SA_{gw}	cm^2/day	3300
Skin Surface Area for Whole-Body Dermal Contact with Water:			
Resident Child	$SA_{gw\text{-}wb}$	cm^2/day	6600
Resident Adult	$SA_{gw\text{-}wb}$	cm^2/day	18000
Soil to Skin Adherence Factor:			
Resident Child	AF	mg/cm^2	0.2
Resident Adult	AF	mg/cm^2	0.07
Non-Residential Worker	AF	mg/cm^2	0.2
Construction Worker	AF	mg/cm^2	0.3

Table E-3
Exposure Factors

Parameter	Symbol	Unit	Default
Event Frequency for Incidental Dermal Contact with Soil			
Resident Child	EV_{soil}	event/day	1
Resident Adult	EV_{soil}	event/day	1
Non-Residential Worker	EV_{soil}	event/day	1
Construction Worker	EV_{soil}	event/day	1
Event Frequency for Incidental Dermal Contact with Water			
Resident Child	EV_{gw}	event/day	1
Resident Adult	EV_{gw}	event/day	1
Non-Residential Worker	EV_{gw}	event/day	1
Construction Worker	EV_{gw}	event/day	1
Event Frequency for Whole-Body Dermal Contact with Water			
Resident Child	EV_{gw_wb}	event/day	1
Resident Adult	EV_{gw_wb}	event/day	1
Event Duration for Incidental Dermal Contact with Water			
Resident Child	t_{event}	hr/event	1
Resident Adult	t_{event}	hr/event	1
Non-Residential Worker	t_{event}	hr/event	1
Construction Worker	t_{event}	hr/event	1
Event Duration for Whole-Body Dermal Contact with Water			
Resident Child	t_{event_wb}	hr/event	0.25
Resident Adult	t_{event_wb}	hr/event	0.33
Target Risk Level	TR	--	1.00E-05
Target Hazard Quotient	THQ	--	1

E.12 MODELS/EQUATIONS FOR ESTIMATING DTLs, TIER 1, AND TIER 2 TARGET LEVELS WITHIN THE MRBCA PROCESS

		Page
1	Indoor Inhalation of Vapors (Child and Adult Resident, Non-residential Worker, and Construction Worker)	E-14
2	Outdoor Inhalation of Vapors (Construction Worker)	E-15
3	Dermal Contact with Chemicals in Water (Child and Adult Resident)	E-16
4	Domestic Use of Water (Child and Adult Resident)	E-18
5	Dermal Contact with Chemicals in Soil (Child and Adult Resident, Non-residential Worker, and Construction Worker)	E-20
6	Ingestion of Chemicals in Soil (Child and Adult Resident, Non-residential Worker, and Construction Worker)	E-21
7	Inhalation of Vapors and Particulates of Chemicals in Soil (Child and Adult Resident, Non-residential Worker, and Construction Worker)	E-22
8	Inhalation of Vapors and Particulates, Dermal Contact with and Ingestion of Chemicals in Soil (Child and Adult Resident, Non-residential Worker, and Construction Worker)	E-23
9	Indoor Inhalation of Vapors (Age-Adjusted Resident)	E-25
10	Dermal Contact with Chemicals in Water (Age-Adjusted Resident)	E-27
11	Domestic Use of Water (Age-Adjusted Resident)	E-29
12	Dermal Contact with Chemicals in Soil (Age-Adjusted Resident)	E-32
13	Ingestion of Chemicals in Soil (Age-Adjusted Resident)	E-34
14	Inhalation of Vapors and Particulates of Chemicals in Soil (Age-Adjusted Resident)	E-36
15	Inhalation of Vapors and Particulates, Dermal Contact and Ingestion of Chemicals in Soil (Age-Adjusted Resident)	E-38
16	Subsurface Soil Vapor Concentrations Protective of Indoor Vapor Inhalation	E-39
17	Subsurface Soil Concentrations Protective of Indoor Vapor Inhalation	E-40
18	Groundwater Concentrations Protective of Indoor Vapor Inhalation	E-41
19	Groundwater Concentrations Protective of Outdoor Vapor Inhalation	E-42
20	Volatilization Factors	E-43
21	Effective Diffusion Coefficients	E-49
22	Subsurface Soil Concentrations Protective of Leaching to Groundwater	E-50
23	Leaching Factor from Subsurface Soil to Groundwater	E-51
24	Soil Concentration at Which Dissolved Pore Water and Vapor Phases Become Saturated	E-52
25	Soil Vapor Concentration at Which Vapor Phase Becomes Saturated	E-53
26	Domenico Model: Dilution Attenuation Factor (DAF) in the Saturated Zone	E-54
27	Allowable Soil and Groundwater Concentration for Groundwater Resource Protection	E-55
28	Allowable Soil and Groundwater Concentration Protective of Indoor Inhalation for Resident and Non-residential Worker	E-56
28	Stream Protection: Allowable Groundwater Concentration at the Point of Discharge	E-57
29	Stream Protection: Allowable Soil and Groundwater Concentration at the Source & POC	E-58

INDOOR INHALATION OF VAPORS
(CHILD AND ADULT RESIDENT; AND NON-RESIDENTIAL WORKER)

Carcinogenic effects

$$RBTL_{ai} = \frac{TR \times BW \times AT_c \times 365}{IR_{ai} \times ET_{in} \times ED \times EF \times SF_i}$$

Non-carcinogenic effects

$$RBTL_{ai} = \frac{THQ \times BW \times AT_{nc} \times 365 \times RfD_i}{IR_{ai} \times ET_{in} \times ED \times EF}$$

Source: RAGS, Vol. I, Part A, 1989, p. 6-44

where:

$RBTL_{ai}$	=	Risk-based target level in indoor air [mg/m^3]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
BW	=	Body weight [kg]
AT_c	=	Averaging time for carcinogens[year]
AT_{nc}	=	Averaging time for non-carcinogens[year]
IR_{ai}	=	Indoor inhalation rate [m^3/hr]
ET_{in}	=	Indoor Exposure time [hr/day]
ED	=	Exposure duration [year]
EF	=	Exposure frequency [day/year]
RfD_i	=	Chemical-specific inhalation reference dose [mg/kg-day]
SF_i	=	Chemical-specific inhalation cancer slope or potency factor [(mg/kg-day)$^{-1}$]
365	=	Converts AT_c, AT_{nc} in years to days [day/year]

OUTDOOR INHALATION OF VAPORS (CONSTRUCTION WORKER)

Carcinogenic effects

$$RBTL_{ao} = \frac{TR \times BW \times AT_c \times 365}{IR_{ao} \times ET_{out} \times ED \times EF \times SF_i}$$

Non-carcinogenic effects

$$RBTL_{ao} = \frac{THQ \times BW \times AT_{nc} \times 365 \times RfD_i}{IR_{ao} \times ET_{out} \times ED \times EF}$$

Source: RAGS, Vol. I, Part A, 1989, p. 6-44

where:

$RBTL_{ao}$	=	Risk-based target level in outdoor air [mg/m^3]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
BW	=	Body weight [kg]
AT_c	=	Averaging time for carcinogens[year]
AT_{nc}	=	Averaging time for non-carcinogens[year]
IR_{ao}	=	Outdoor inhalation rate [m^3/hr]
ET_{out}	=	Outdoor Exposure time [hr/day]
ED	=	Exposure duration [year]
EF	=	Exposure frequency [day/year]
RfD_i	=	Chemical-specific inhalation reference dose [mg/kg-day]
SF_i	=	Chemical-specific inhalation cancer slope or potency factor [(mg/kg-day)$^{-1}$]
365	=	Converts AT_c, AT_{nc} in years to days [day/year]

DERMAL CONTACT WITH CHEMICALS IN WATER
(CHILD AND ADULT RESIDENT; NON-RESIDENTIAL WORKER; AND CONSTRUCTION WORKER)

Carcinogenic effects

$$RBTL_{dw} = \frac{TR \times BW \times AT_c \times 365 \times 1000}{SF_d \times SA_{gw} \times EV_{gw} \times Z \times EF \times ED}$$

Non-carcinogenic effects

$$RBTL_{dw} = \frac{THQ \times BW \times AT_{nc} \times 365 \times 1000 \times RfD_d}{SA_{gw} \times EV_{gw} \times Z \times EF \times ED}$$

For organic chemicals,

If $t_{event} < t^*$, then $Z = 2 \times FA \times K_p \sqrt{6\tau_{event} \frac{t_{event}}{\pi}}$

If $t_{event} > t^*$, then $Z = FA \times K_p \left[\frac{t_{event}}{1+B} + 2\tau_{event} \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right]$

For inorganic chemicals, $Z = K_p \times t_{event}$

where:

$RBTL_{dw}$ = Risk-based target level for dermal contact with groundwater [mg/L]
TR = Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ = Target hazard quotient for individual constituents [-]
BW = Body weight [kg]
AT_c = Averaging time for carcinogens[year]
AT_{nc} = Averaging time for non-carcinogens[year]
SA_{gw} = Skin surface area available for contact with water [cm^2]
EV_{gw} = Event frequency [event/day]
ED = Exposure duration [year]
EF = Exposure frequency [day/year]
RfD_d = Chemical-specific dermal reference dose [mg/kg-day]
SF_d = Chemical-specific dermal cancer slope or potency factor $[mg/(kg\text{-}day)]^{-1}$
365 = Converts AT_c, AT_{nc} in years to days [day/year]
1000 = Conversion factor from cm^3 to L [cm^3/L]
t_{event} = Event duration [hr/event]
t^* = Chemical-specific time to reach steady-state [hr]
Z = Chemical-specific dermal factor [cm/event]
K_p = Chemical-specific dermal permeability coefficient [cm/hr]
FA = Chemical-specific fraction absorbed in water [-]
τ_{event} = Chemical-specific lag time [hr/event]
B = Chemical-specific relative contribution of permeability coefficient [-]

$B = K_P \frac{\sqrt{MW}}{2.6}$ $\log K_P = -2.80 + 0.66 \log K_{OW} - 0.0056MW$ If B<0.6 or B=0.6, then, $t^* = 2.4\tau_{event}$ If B>0.6 then, $t^* = 6\tau_{event} \times (b - \sqrt{b^2 - c^2})$ where, $c = \frac{1 + 3B + 3B^2}{3(1+B)}$ $b = 2 \times \frac{(1+B^2)}{\pi} - c$ $\tau_{event} = 0.105 \times 10^{(0.0056MW)}$ Source: Modified from RAGS, Vol. I, Part E, 2004.	where: MW = Molecular weight [g/mole] K_{ow} = Octanol water partition coefficient [L/kg]

DOMESTIC WATER USE (CHILD AND ADULT RESIDENT)
(ONLY FOR CHEMICALS WITHOUT MAXIMUM CONTAMINANT LEVELS)

Carcinogenic effects

$$RBTL_w = \frac{TR \times BW \times AT_c \times 365}{ED \times EF \times \left[\left(SF_o \times IR_w\right) + \left(SF_i \times ET \times K_f \times IR_a\right) + \left(\frac{SF_d}{1000} \times SA_{wb} \times EV_{wb} \times Z_{wb}\right) \right]}$$

Non-carcinogenic effects

$$RBTL_w = \frac{THQ \times BW \times AT_{nc} \times 365}{ED \times EF \times \left[\left(\frac{1}{RfD_o} \times IR_w\right) + \left(\frac{1}{RfD_i} \times K_f \times ET \times IR_a\right) + \left(\frac{SA_{wb} \times EV_{wb} \times Z_{wb}}{RfD_d \times 1000}\right) \right]}$$

For organic chemicals,

If $t_{wb\text{-}event} < t^*$, then $Z_{wb} = 2 \times FA \times K_p \sqrt{6\tau_{event} \frac{t_{wb-event}}{\pi}}$

If $t_{wb\text{-}event} > t^*$, then $Z_{wb} = FA \times K_p \left[\frac{t_{wb-event}}{1+B} + 2\tau_{event} \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right]$

For inorganic chemicals, $Z_{wb} = K_p \times t_{wb-event}$

Source: Modified from RAGS, Vol. I, Part E, 2004.

where:

$RBTL_w$	=	Risk-based target level for ingestion of groundwater [mg/L-H_2O]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
BW	=	Body weight [kg]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
IR_w	=	Water ingestion rate [L/day]
IR_a	=	Indoor inhalation rate [m^3/hr]
ED	=	Exposure duration [year]
EF	=	Exposure frequency [day/year]
K_f	=	Volatilization factor [L/m^3]
ET	=	Exposure time [hr/day]
SA_{wb}	=	Skin surface area available for whole-body contact with water [cm^2]
EV_{wb}	=	Event frequency for whole-body contact with water [event/day]
RfD_o	=	Chemical-specific oral reference dose [mg/kg-day]
RfD_i	=	Chemical-specific inhalation reference dose [mg/kg-day]
RfD_d	=	Chemical-specific dermal reference dose [mg/kg-day]
SF_o	=	Chemical-specific oral cancer slope or potency factor [mg/(kg-day)]$^{-1}$
SF_i	=	Chemical-specific inhalation cancer slope or potency factor [(mg/kg-day)$^{-1}$]
SF_d	=	Chemical-specific dermal cancer slope or potency factor [mg/(kg-day)]$^{-1}$
365	=	Converts AT_c, AT_{nc} in years to days [day/year]
1000	=	Conversion factor from cm^3 to L [cm^3/L]
$t_{wb\text{-}event}$	=	Event duration for whole-body contact [hr/event]
t^*	=	Chemical-specific time to reach steady-state [hr]
Z_{wb}	=	Chemical-specific dermal factor for whole-body contact [cm/event]
K_p	=	Chemical-specific dermal permeability coefficient [cm/hr]
FA	=	Chemical-specific fraction absorbed in water [-]
τ_{event}	=	Chemical-specific lag time [hr/event]
B	=	Chemical-specific relative contribution of permeability coefficient [-]

DERMAL CONTACT WITH CHEMICALS IN SOIL
(CHILD AND ADULT RESIDENT; NON-RESIDENTIAL WORKER; AND CONSTRUCTION WORKER)

Carcinogenic effects

$$RBTL_{dcss} = \frac{TR \times BW \times AT_c \times 365}{EF \times ED \times SF_d \times 10^{-6} \times SA_{soil} \times EV_{soil} \times AF \times RAF_d}$$

Non-carcinogenic effects

$$RBTL_{dcss} = \frac{THQ \times BW \times AT_{nc} \times 365 \times RfD_d}{EF \times ED \times 10^{-6} \times SA_{soil} \times EV_{soil} \times AF \times RAF_d}$$

Source: Modified from RAGS, Vol. I, Part E, 2004.

where:

$RBTL_{dcss}$	=	Risk-based target level for dermal contact of chemicals in surficial soil [mg/kg]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
BW	=	Body weight [kg]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
ED	=	Exposure duration [year]
EF	=	Exposure frequency [day/year]
SA_{soil}	=	Skin surface area available for contact with soil [cm^2]
EV_{soil}	=	Event frequency [event/day]
AF	=	Soil to skin adherence factor [mg/cm^2-event]
RAF_d	=	Chemical-specific dermal relative absorption factor [-]
SF_d	=	Dermal cancer slope factor [$(mg/kg\text{-}day)^{-1}$]
RfD_d	=	Chemical-specific oral reference dose [mg/kg-day]
365	=	Converts AT_c, AT_{nc} in years to days [day/year]

INGESTION OF CHEMICALS IN SOIL
(CHILD AND ADULT RESIDENT; NON-RESIDENTIAL WORKER; AND CONSTRUCTION WORKER)

Carcinogenic effects

$$RBTL_{ingss} = \frac{TR \times BW \times AT_c \times 365}{EF \times ED \times SF_o \times 10^{-6} \times IR_{soil} \times RAF_o}$$

Non-carcinogenic effects

$$RBTL_{ingss} = \frac{THQ \times BW \times AT_{nc} \times 365 \times RfD_o}{EF \times ED \times 10^{-6} \times IR_{soil} \times RAF_o}$$

where:

$RBTL_{ingss}$	=	Risk-based target level for ingestion of chemicals in surficial soil [mg/kg]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
BW	=	Body weight [kg]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
ED	=	Exposure duration [year]
EF	=	Exposure frequency [day/year]
IR_{soil}	=	Soil ingestion rate [mg/day]
RAF_o	=	Oral relative absorption factor [-]
SF_o	=	Oral cancer slope factor [(mg/kg-day)$^{-1}$]
365	=	Converts AT_c, AT_{nc} in years to days [day/year]

INHALATION OF VAPORS AND PARTICULATES OF CHEMICALS IN SOIL (CHILD AND ADULT RESIDENT; NON-RESIDENTIAL WORKER; AND CONSTRUCTION WORKER)

Carcinogenic effects

$$RBTL_{inhss} = \frac{TR \times BW \times AT_c \times 365}{EF \times ED \times SF_i \times IR_{ao} \times ET_{out} \times (VF_{SS} + VF_p)}$$

Non-carcinogenic effects

$$RBTL_{inhss} = \frac{THQ \times BW \times AT_{nc} \times 365 \times RfD_i}{EF \times ED \times ET_{out} \times IR_{ao} \times (VF_{ss} + VF_p)}$$

Note: VF_{ss} = 0 for non-volatile chemicals (i.e. chemicals with a molecular weight > 200 and Henry's Law Constant (dimensionless) < 4.2 x 10^{-4} or Henry's Law Constant (atm-m^3/mol) <1.5 x 10^{-5}).

where:

$RBTL_{inhss}$	=	Risk-based target level of inhalation of chemicals in surficial soil [mg/kg]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
BW	=	Body weight [kg]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
ED	=	Exposure duration [year]
EF	=	Exposure frequency [day/year]
IR_{ao}	=	Outdoor inhalation rate [m^3/hr]
ET_{out}	=	Outdoor Exposure time [hr/day]
SF_i	=	Inhalation cancer slope factor [(mg/kg-day)$^{-1}$]
RfD_i	=	The chemical-specific inhalation reference dose [mg/kg-day]
VF_p	=	Volatilization factor for particulate emissions from surficial soil [(mg/m^3-air)/(mg/kg-soil)]
VF_{ss}	=	Volatilization factor for vapor emissions from surficial soil [(mg/m^3-air)/(mg/kg-soil)]
365	=	Converts AT_c, AT_{nc} in years to days [day/year]

Note: The depth to surficial soil for a construction worker is up to the typical construction depth.

INHALATION OF VAPORS AND PARTICULATES, DERMAL CONTACT AND INGESTION OF CHEMICALS IN SOIL
(CHILD AND ADULT RESIDENT; NON-RESIDENTIAL WORKER; AND CONSTRUCTION WORKER)

Carcinogenic effects

$$RBTL_{ss} = \frac{TR \times BW \times AT_c \times 365}{EF \times ED \times \left[\left(SF_o \times 10^{-6} \times IR_{soil} \times RAF_o\right) + \left(SF_d \times 10^{-6} \times SA_{soil} \times EV_{soil} \times AF \times RAF_d\right) + \left(SF_i \times IR_{ao} \times ET_{out} \times \left(VF_{ss} + VF_p\right)\right)\right]}$$

Non-carcinogenic effects

$$RBTL_{ss} = \frac{THQ \times BW \times AT_{nc} \times 365}{EF \times ED \times \left[\frac{10^{-6} \times IR_{soil} \times RAF_o}{RfD_o} + \frac{10^{-6} \times SA_{soil} \times EV_{soil} \times AF \times RAF_d}{RfD_d} + \frac{ET_{out} \times IR_{ao} \times \left(VF_{ss} + VF_p\right)}{RfD_i}\right]}$$

Source: Modified from RAGS, Vol. I, Part E, 2004.

where:

$RBTL_{ss}$	=	Risk-based target level of surficial soil [mg/kg]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
BW	=	Body weight [kg]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
ED	=	Exposure duration [year]
EF	=	Exposure frequency [day/year]
IR_{soil}	=	Soil ingestion rate [mg/day]
RAF_o	=	Oral relative absorption factor [-]
SA	=	Skin surface area [cm^2/day]
EV_{soil}	=	Event frequency [event/day]
AF	=	Soil to skin adherence factor [mg/cm^2]
RAF_d	=	Dermal relative adsorption factor [-]
IR_{ao}	=	Outdoor inhalation rate [m^3/hr]
ET_{out}	=	Outdoor Exposure time [hr/day]
SF_o	=	Oral cancer slope factor [$(mg/kg\text{-}day)^{-1}$]
SF_i	=	Inhalation cancer slope factor [$(mg/kg\text{-}day)^{-1}$]
RfD_o	=	The chemical-specific oral reference dose [mg/kg-day]
RfD_i	=	The chemical-specific inhalation reference dose [mg/kg-day]
VF_p	=	Volatilization factor for particulate emissions from surficial soil [(mg/m^3-air)/(mg/kg-soil)]
VF_{ss}	=	Volatilization factor for vapor emissions from surficial soil [(mg/m^3-air)/(mg/kg-soil)]
365	=	Converts AT_c, AT_{nc} in years to days [day/year]

INDOOR INHALATION OF VAPORS (AGE-ADJUSTED RESIDENT)

Carcinogenic effects

$$RBTL_{ai\text{-}adj} = \frac{TR \times AT_c \times 365}{IR_{ai-aa} \times SF_i}$$

Non-carcinogenic effects

$$RBTL_{ai\text{-}adj} = \frac{THQ \times AT_{nc} \times 365 \times RfD_i}{IR_{ai-aa}}$$

where:

$$IR_{ai-aa} = \frac{IR_{ai-c} \times ED_c \times EF_c \times ET_{i-c}}{BW_c} + \frac{IR_{ai-a} \times ED_a \times EF_a \times ET_{i-a}}{BW_a}$$

Source: Modified from RAGS, Vol. I, Part B, 1991

where:

$RBTL_{ai\text{-}adj}$	=	Age-adjusted risk-based target level in indoor air [mg/m^3]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
$IR_{ai\text{-}aa}$	=	Age-adjusted indoor inhalation rate [m^3/ kg]
$IR_{ai\text{-}c}$	=	Resident Child indoor inhalation rate [m^3/hr]
$IR_{ai\text{-}a}$	=	Resident Adult indoor inhalation rate [m^3/hr]
ED_c	=	Exposure duration for child [year]
ED_a	=	Exposure duration for an adult [year]
EF_c	=	Exposure frequency for a child [day/year]
EF_a	=	Exposure frequency for an adult [day/year]
$ET_{i\text{-}c}$	=	Indoor exposure time for a child [hour/day]
$ET_{i\text{-}a}$	=	Indoor exposure time for an adult [hour/day]
BW_c	=	Resident Child body weight [kg]
BW_a	=	Resident Adult body weight [kg]
RfD_i	=	Chemical-specific inhalation reference dose [mg/kg-day]
SF_i	=	Chemical-specific inhalation cancer slope factor [mg/kg-day]$^{-1}$
365	=	Conversion factor [day/year]

DERMAL CONTACT WITH CHEMICALS IN WATER (AGE-ADJUSTED RESIDENT)

Carcinogenic effects

$$RBTL_{dcw\text{-}adj} = \frac{TR \times AT_c \times 365 \times 1000}{SF_d \times \left(DC_{w-c} \times Z_c + DC_{w-a} \times Z_a\right)}$$

Non-carcinogenic effects

$$RBTL_{dcw\text{-}adj} = \frac{THQ \times AT_{nc} \times 365 \times 1000 \times RfD_d}{DC_{w-c} \times Z_c + DC_{w-a} \times Z_a}$$

where :

$$DC_{w\text{-}c} = \frac{ED_c \times EF_c \times SA_{gw-c} \times EV_{gw-c}}{BW_c}$$

$$DC_{w\text{-}a} = \frac{ED_a \times EF_a \times SA_{gw-a} \times EV_{gw-a}}{BW_a}$$

For organic chemicals,

If $t_{event} < t^*$, then $Z = 2 \times FA \times K_p \sqrt{6\tau_{event} \frac{t_{event}}{\pi}}$

If $t_{event} > t^*$, then

$$Z = FA \times K_p \left[\frac{t_{event}}{1+B} + 2\tau_{event} \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right]$$

For inorganic chemicals, $Z = K_p \times t_{event}$

Source: Modified from RAGS, Vol. I, Part E, 2004.

where:

$RBTL_{dcw\text{-}adj}$	=	Age-adjusted risk-based target level for dermal contact with chemicals in groundwater [mg/L-water]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
RfD_d	=	Chemical-specific dermal reference dose [mg/kg-day]
SF_d	=	Chemical-specific dermal cancer slope or potency factor [(mg/kg-day) $^{-1}$]
365	=	Converts AT_c, AT_{nc} in years to days [day/year]
1000	=	Conversion factor from cm^3 to L [cm^3/L]
t_{event}	=	Event duration [hr/event]
t^*	=	Chemical-specific time to reach steady-state [hr]
K_p	=	Chemical-specific dermal permeability coefficient [cm/hr]
FA	=	Chemical-specific fraction absorbed in water [-]
τ_{event}	=	Chemical-specific lag time [hr/event]
B	=	Chemical-specific relative contribution of permeability coefficient [-]
$DC_{w\text{-}c}$	=	Child dermal contact rate with groundwater [cm^2-event/kg]
$DC_{w\text{-}a}$	=	Adult dermal contact rate with groundwater [cm^2-event/kg]
$EV_{gw\text{-}c}$	=	Resident child event frequency [event/day]
$EV_{gw\text{-}a}$	=	Resident adult event frequency [event/day]
Z_c	=	Resident child chemical-specific dermal factor [cm/event]
Z_a	=	Resident adult chemical-specific dermal factor [cm/event]
$SA_{gw\text{-}c}$	=	Resident child skin surface area available for contact with water [cm^2]
$SA_{gw\text{-}a}$	=	Resident adult skin surface area available for contact with water [cm^2]
BW_c	=	Resident Child body weight [kg]
BW_a	=	Resident Adult body weight [kg]
ED_c	=	Resident Child exposure duration [year]
ED_a	=	Resident Adult exposure duration [year]
EF_c	=	Exposure frequency for a child [day/year]
EF_a	=	Exposure frequency for an adult [day/year]

DOMESTIC WATER USE (AGE-ADJUSTED RESIDENT)
(ONLY FOR CHEMICALS WITHOUT MAXIMUM CONTAMINANT LEVELS)

Carcinogenic effects

$$RBTL_{w\text{-}adj} = \frac{TR \times AT_c \times 365}{\left[\left(SF_o \times IR_{w\text{-}aa}\right) + \left(SF_i \times K_f \times IR_{a\text{-}aa}\right) + \left(\frac{SF_d}{1000} \times \left(DC_{wb-c} \times Z_{wb-c} + DC_{wb-a} \times Z_{wb-a}\right)\right)\right]}$$

Non-carcinogenic effects

$$RBTL_{w\text{-}adj} = \frac{THQ \times AT_{nc} \times 365}{\left[\left(\frac{1}{RfD_o} \times IR_{w-aa}\right) + \left(\frac{1}{RfD_i} \times K_f \times IR_{a-aa}\right) + \left(\frac{\left(DC_{wb-c} \times Z_{wb-c} + DC_{wb-a} \times Z_{wb-a}\right)}{RfD_d \times 1000}\right)\right]}$$

where:

$$IR_{w\text{-}aa} = \frac{ED_c \times EF_c \times IR_{w-c}}{BW_c} + \frac{ED_a \times EF_a \times IR_{w-a}}{BW_a}$$

$$IR_{a\text{-}aa} = \frac{ED_c \times EF_c \times ET_c \times IR_{a-c}}{BW_c} + \frac{ED_a \times EF_a \times ET_a \times IR_{a-a}}{BW_a}$$

$$DC_{wb\text{-}c} = \frac{ED_c \times EF_c \times SA_{wb-c} \times EV_{wb-c}}{BW_c} \quad \text{and} \quad DC_{wb\text{-}a} = \frac{ED_a \times EF_a \times SA_{wb-a} \times EV_{wb-a}}{BW_a}$$

For organic chemicals,

If $t_{wb\text{-}event} < t^*$, then $Z_{wb} = 2 \times FA \times K_p \sqrt{6\tau_{event} \frac{t_{wb-event}}{\pi}}$

If $t_{wb\text{-}event} > t^*$, then $Z_{wb} = FA \times K_p \left[\frac{t_{wb-event}}{1+B} + 2\tau_{event} \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right]$

For inorganic chemicals, $Z_{wb} = K_p \times t_{wb-event}$

Source: Modified from RAGS, Vol. I, Part E, 2004.

where:

$RBTL_{w\text{-}adj}$	=	Age-adjusted risk-based target level for ingestion of groundwater [mg/L-H_2O]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
RfD_o	=	Chemical-specific oral reference dose [mg/kg-day]
RfD_d	=	Chemical-specific dermal reference dose [mg/kg-day]
SF_o	=	Chemical-specific oral cancer slope or potency factor [(mg/kg-day)$^{-1}$]
SF_i	=	Chemical-specific inhalation cancer slope or potency factor [(mg/kg-day)$^{-1}$]
SF_d	=	Chemical-specific dermal cancer slope or potency factor [mg/(kg-day)]$^{-1}$
$IR_{w\text{-}aa}$	=	Age-adjusted groundwater ingestion rate [L/kg]
$IR_{w\text{-}c}$	=	Resident Child groundwater ingestion rate [L/day]
$IR_{a\text{-}c}$	=	Resident Child inhalation rate [m^3/hr]
$IR_{w\text{-}a}$	=	Resident Adult groundwater ingestion rate [L/day]
$IR_{a\text{-}a}$	=	Resident Adult inhalation rate [m^3/hr]
$DC_{wb\text{-}c}$	=	Child dermal whole-body contact rate with groundwater [cm^2-event/kg]

$DC_{wb\text{-}a}$	=	Adult dermal whole-body contact rate with groundwater [cm^2-event/kg]
BW_c	=	Resident Child body weight [kg]
BW_a	=	Resident Adult body weight [kg]
ED_c	=	Resident Child exposure duration [year]
ET_c	=	Resident Child exposure time [hr/day]
ET_a	=	Resident Adult exposure time [hr/day]
ED_a	=	Resident Adult exposure duration [year]
EF_c	=	Exposure frequency for a child [day/year]
EF_a	=	Exposure frequency for an adult [day/year]
K_f	=	Volatilization factor [L/m^3]
SA_{wb}	=	Skin surface area available for whole-body contact with water [cm^2]
EV_{wb}	=	Event frequency for whole-body contact with water [event/day]
365	=	Conversion factor [day/year]
1000	=	Conversion factor from cm^3 to L [cm^3/L]
$t_{wb\text{-}event}$	=	Event duration for whole-body contact [hr/event]
t^*	=	Chemical-specific time to reach steady-state [hr]
Z_{wb}	=	Chemical-specific dermal factor for whole-body contact [cm/event]
K_p	=	Chemical-specific dermal permeability coefficient [cm/hr]
FA	=	Chemical-specific fraction absorbed in water [-]
τ_{event}	=	Chemical-specific lag time [hr/event]
B	=	Chemical-specific relative contribution of permeability coefficient [-]

DERMAL CONTACT WITH CHEMICALS IN SOIL (AGE-ADJUSTED RESIDENT)

Carcinogenic effects

$$RBTL_{dcss\text{-}adj} = \frac{TR \times AT_c \times 365}{SF_d \times SA_{soil-aa} \times RAF_d \times 10^{-6}}$$

Non-carcinogenic effects

$$RBTL_{dcss\text{-}adj} = \frac{THQ \times AT_{nc} \times 365 \times RfD_d}{SA_{soil-aa} \times RAF_d \times 10^{-6}}$$

where:

$$SA_{soil-aa} = \frac{ED_c \times EF_c \times AF_c \times SA_{soil-c} \times EV_{soil-c}}{BW_c} + \frac{ED_a \times EF_a \times AF_a \times SA_{soil-a} \times EV_{soil-a}}{BW_a}$$

Source: Modified from RAGS, Vol. I, Part E, 2004.

where:

$RBTL_{dcss\text{-}adj}$	=	Age-adjusted risk-based target level for dermal contact with soil [mg/kg-wet soil]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
EF_c	=	Exposure frequency for a child [day/year]
EF_a	=	Exposure frequency for an adult [day/year]
RAF_d	=	Dermal relative absorption factor [-]
AF_c	=	Resident Child soil to skin adherence factor [mg/cm^2-event]
AF_a	=	Resident Adult soil to skin adherence factor [mg/cm^2-event]
RfD_d	=	Chemical-specific dermal reference dose [(mg/kg-day)]
SF_d	=	Chemical-specific dermal cancer slope or potency factor [(mg/kg-day)$^{-1}$]
SA_{aa}	=	Age-adjusted skin surface area [mg/ kg]
BW_c	=	Resident Child body weight [kg]
BW_a	=	Resident Adult body weight [kg]
ED_c	=	Resident Child exposure duration [year]
ED_a	=	Resident Adult exposure duration [year]
$SA_{soil\text{-}c}$	=	Resident Child skin surface area available for contact with soil [cm^2/day]
$SA_{soil\text{-}a}$	=	Resident Adult skin surface area available for contact with soil [cm^2/day]
$EV_{soil\text{-}c}$	=	Resident Child event frequency [event/day]
$EV_{soil\text{-}a}$	=	Resident Child event frequency [event/day]
365	=	Conversion factor [day/year]
10^{-6}	=	Conversion factor [kg/mg]

INGESTION OF CHEMICALS IN SOIL (AGE-ADJUSTED RESIDENT)

Carcinogenic effects

$$RBTL_{ingss-adj} = \frac{TR \times AT_c \times 365}{SF_o \times IR_{s-aa} \times RAF_o \times 10^{-6}}$$

Non-carcinogenic effects

$$RBTL_{ingss-adj} = \frac{THQ \times AT_{nc} \times 365 \times RfD_o}{IR_{s-aa} \times RAF_o \times 10^{-6}}$$

where :

$$IR_{s-aa} = \frac{ED_c \times EF_c \times IR_{s-c}}{BW_c} + \frac{ED_a \times EF_a \times IR_{s-a}}{BW_a}$$

Source: Modified from RAGS, Vol. I, Part A, 1989

where:

$RBTL_{ingss\text{-}adj}$	=	Risk-based target level for ingestion of soil [mg/kg-wet soil]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
RAF_o	=	Oral relative absorption factor [-]
RfD_o	=	Chemical-specific oral reference dose [mg/kg-day]
SF_o	=	Chemical-specific oral cancer slope or potency factor [$(mg/kg\text{-}day)^{-1}$]
$IR_{s\text{-}aa}$	=	Age-adjusted soil ingestion rate [mg/kg]
$IR_{s\text{-}c}$	=	Resident child soil ingestion rate [mg/day]
$IR_{s\text{-}a}$	=	Resident adult soil ingestion rate [mg/day]
BW_c	=	Resident child body weight [kg]
BW_a	=	Resident adult body weight [kg]
ED_c	=	Resident child exposure duration [year]
ED_a	=	Resident adult exposure duration [year]
EF_c	=	Exposure frequency for a child [day/year]
EF_a	=	Exposure frequency for an adult [day/year]
365	=	Conversion factor [day/year]
10^{-6}	=	Conversion factor [kg/mg]

INHALATION OF VAPORS AND PARTICULATES OF CHEMICALS IN SOIL (AGE-ADJUSTED RESIDENT)

Carcinogenic effects

$$RBTL_{ss-adj} = \frac{TR \times AT_c \times 365}{IR_{ao-aa} \times SF_i \times \left(VF_{ss} + VF_p\right)}$$

Non-carcinogenic effects

$$RBTL_{ss-adj} = \frac{THQ \times AT_{nc} \times 365 \times RfD_i}{IR_{ao-aa} \times \left(VF_{ss} + VF_p\right)}$$

where:

$$IR_{ao-aa} = \frac{IR_{ao-c} \times ED_c \times EF_c \times ET_{o-c}}{BW_c} + \frac{IR_{ao-a} \times ED_a \times EF_a \times ET_{o-a}}{BW_a}$$

Note: VF_{ss} = 0 for non-volatile chemicals (i.e., chemicals with a molecular weight > 200 and Henry's Law Constant (dimensionless) < 4.2×10^{-4} or Henry's Law Constant (atm-m^3/mol) <1.5×10^{-5}).

Source: Modified from RAGS, Vol. I, Part B, 1991

where:

$RBTL_{ss\text{-}adj}$	=	Age-adjusted risk-based target level in surficial soil [mg/kg]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
VF_{ss}	=	Volatilization factor for vapor emissions from surficial soil[kg-soil/m^3-air]
VF_p	=	Volatilization factor for particulate emissions from surficial soil [kg-soil/m^3-air]
$IR_{ao\text{-}aa}$	=	Age-adjusted outdoor inhalation rate [m^3/kg]
$IR_{ao\text{-}c}$	=	Resident Child outdoor inhalation rate [m^3/hr]
$IR_{ao\text{-}a}$	=	Resident Adult outdoor inhalation rate [m^3/hr]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
ED_c	=	Exposure duration for child [year]
ED_a	=	Exposure duration for an adult [year]
EF_c	=	Exposure frequency for a child [day/year]
EF_a	=	Exposure frequency for an adult [day/year]
$ET_{o\text{-}c}$	=	Outdoor exposure time for a child [hour/day]
$ET_{o\text{-}a}$	=	Outdoor exposure time for an adult [hour/day]
RfD_i	=	Chemical-specific inhalation reference dose [mg/kg-day]
SF_i	=	Chemical-specific inhalation cancer slope factor [$(mg/kg\text{-}day)^{-1}$]
365	=	Conversion factor [day/year]

INHALATION OF VAPORS AND PARTICULATES, DERMAL CONTACT WITH, AND INGESTION OF CHEMICALS IN SOIL (AGE-ADJUSTED RESIDENT)

Carcinogenic effects

$$RBTL_{ss-combined} = \frac{TR \times AT_c \times 365}{\left(SF_o \times 10^{-6} \times IR_{s-aa} \times RAF_o\right) + \left(SF_d \times 10^{-6} \times SA_{soil-aa} \times RAF_d\right) + SF_i \times IR_{ao-aa} \times \left(VF_{ss} + VF_p\right)}$$

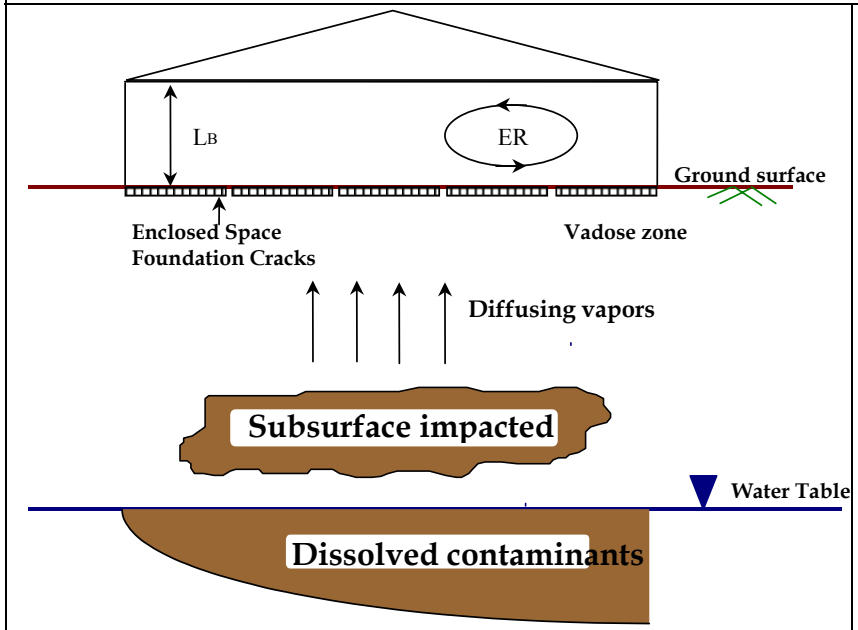
Non-carcinogenic effects

$$RBTL_{ss-combined} = \frac{THQ \times AT_{nc} \times 365}{\frac{1}{RfD_o} \times 10^{-6} \times IR_{s-aa} \times RAF_o + \frac{1}{RfD_d} \times 10^{-6} \times SA_{soil-aa} \times RAF_d + \frac{1}{RfD_i} \times IR_{ao-aa} \times \left(VF_{ss} + VF_p\right)}$$

Note: All parameters are defined under the individual pathway equations.

Source: Modified from RAGS, Vol. I, Part E, 2004.

SUBSURFACE SOIL VAPOR CONCENTRATIONS PROTECTIVE OF INDOOR VAPOR INHALATION



$$RBTL_{svi} = \frac{RBTL_{ai}}{VF_{sv}}$$

where:

$RBTL_{svi}$ = Risk-based target level for indoor inhalation of vapors from subsurface [mg/m^3-air]

$RBTL_{ai}$ = Risk-based target level for indoor inhalation of air [mg/m^3-air]

VF_{sv} = Volatilization factor from subsurface soil vapor to indoor (enclosed space) air [-]

Source: ASTM E1739-95

SUBSURFACE SOIL CONCENTRATIONS PROTECTIVE OF INDOOR VAPOR INHALATION

$$RBTL_{si} = \frac{RBTL_{ai}}{VF_{sesp}}$$

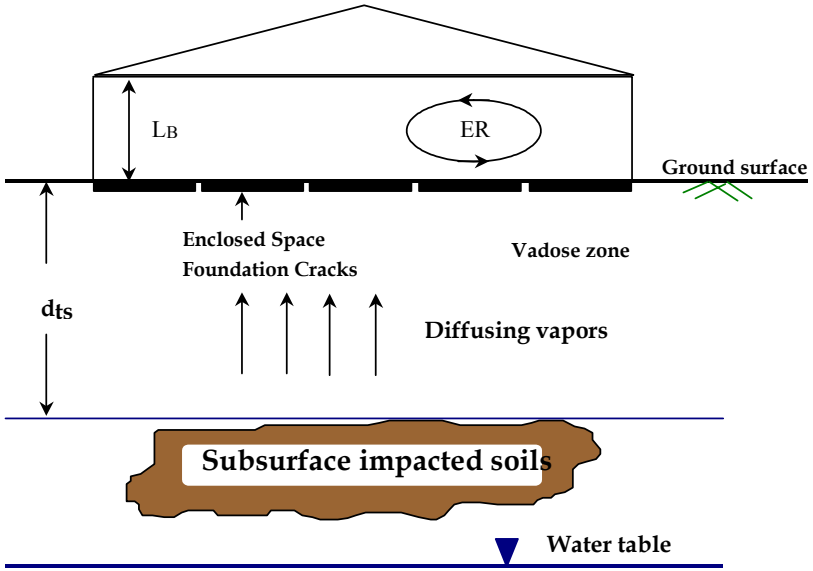
where:

$RBTL_{si}$ = Risk-based target level for indoor inhalation of vapors from subsurface soils [mg/kg-soil]

$RBTL_{ai}$ = Risk-based target level for indoor inhalation of air [mg/m^3-air]

VF_{sesp} = Volatilization factor from subsurface soil to indoor (enclosed space) air [(mg/m^3-air)/(mg/kg-soil)]

Source: ASTM E1739-95



GROUNDWATER CONCENTRATIONS PROTECTIVE OF INDOOR VAPOR INHALATION

$$RBTL_{wi} = \frac{RBTL_{ai}}{VF_{wesp}}$$

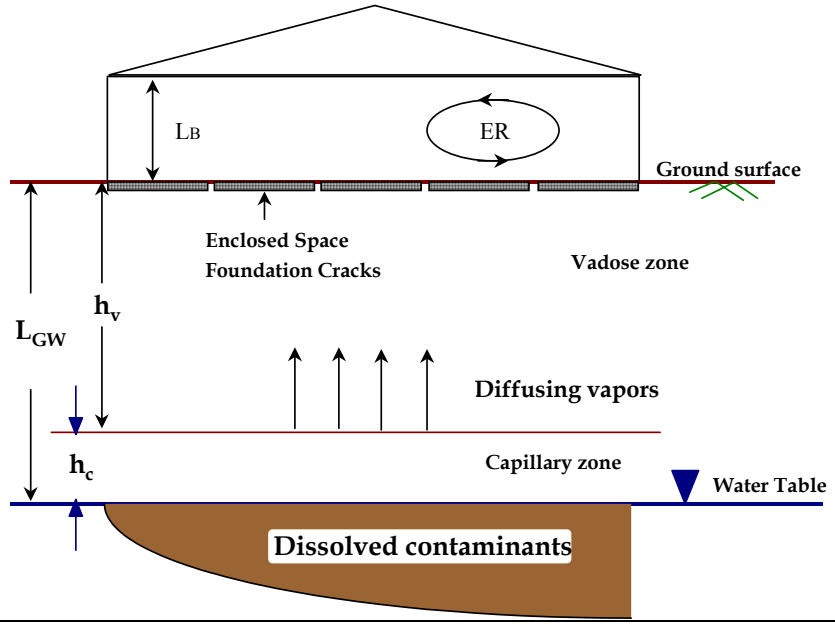
where:

$RBTL_{wi}$ = Risk-based target level for indoor inhalation of vapors from groundwater [mg/L-water]

$RBTL_{ai}$ = Risk-based target level for indoor inhalation of air (mg/m^3-air)

VF_{wesp} = Volatilization factor from groundwater to indoor (enclosed space) air [(mg/m^3-air)/(mg/L-water)]

Source: ASTM E1739-95



GROUNDWATER CONCENTRATIONS PROTECTIVE OF OUTDOOR VAPOR INHALATION

$$RBTL_{wi} = \frac{RBTL_{ao}}{VF_{wamb}}$$

where:

$RBTL_{wi}$ = Risk-based target level for indoor inhalation of vapors from groundwater [mg/L-water]
$RBTL_{ao}$ = Risk-based target level for outdoor inhalation of air (mg/m^3-air)
VF_{wamb} = Volatilization factor from groundwater to outdoor air [(mg/m^3-air)/(mg/L-water)]

Source: ASTM E1739-95

VOLATILIZATION FACTORS
(SURFICIAL SOIL TO OUTDOOR AIR)

$$VF_{ss} = \left[Q/C \times \frac{\left(3.14 \times D_A \times \tau\right)^{1/2}}{\left(2 \times \rho_s \times D_A\right)} \times 10^{-4} \right]^{-1}$$

where:

$$D_A = \frac{\left(\theta_{as}^{10/3} \times D^a \times H + \theta_{ws}^{10/3} \times D^w\right) / \theta_T^2}{\rho_s \times K_{sv} + \theta_{ws} + \theta_{as} \times H}$$

or

$$VF_{ss} = \frac{W_a \times \rho_s \times d_s}{U_m \times \delta_a \times \tau} \times 10^3$$

Use smaller of the two VF_{ss}.

Source: Soil Screening Guidance, 1996

where:

VF_{ss}	=	Volatilization factor from surficial soil to outdoor (ambient) air [kg-soil/m^3-air]
Q/C	=	Inverse of the mean concentration at the center of square source [(g/m^2-s)/(kg/m^3)]
D_A	=	Apparent diffusivity [cm^2/s]
τ	=	Averaging time for vapor flux [s]
ρ_s	=	Vadose zone dry soil bulk density of surficial soil [g-soil/cm^3-soil]
K_{sv}	=	Chemical-specific solid-water sorption coefficient [cm^3-water/g-soil]
D^a	=	Chemical-specific diffusion coefficient in air [cm^2/s]
D^w	=	Chemical-specific diffusion coefficient in water [cm^2/s]
θ_T	=	Total soil porosity in the surficial soils [cm^3/cm^3-soil]
θ_{as}	=	Volumetric air content in the surficial soils [cm^3-air/cm^3-soil]
θ_{ws}	=	Volumetric water content in the surficial soils [cm^3-water/cm^3-soil]
H	=	Chemical-specific Henry's Law constant [(L-water)/(L-air)]
10^{-4}	=	Conversion factor [m^2/cm^2]
W_a	=	Dimension of soil source area parallel to wind direction [cm]
d_s	=	Depth to base of surficial soil zone [cm]
U_m	=	Mean annual wind speed [m/s]
δ_a	=	Breathing zone height [cm]
10^3	=	Conversion factor [(cm^3-kg)/(m^3-g)]

Note: Surficial soil properties are assumed same as the vadose zone properties.

VOLATILIZATION FACTORS (PARTICULAR EMISSIONS FROM SURFICIAL SOIL)	
$$VF_p = \left[Q/C \times \frac{3600}{0.036 \times (1 - V) \times \left(U_m / U_t\right)^3 \times F(x)} \right]^{-1}$$ Source: Soil Screening Guidance, 1996	where: VF_p = Volatilization factor for particulate emissions from surficial soil [kg-soil/m^3-air] Q/C = Inverse of the mean concentration at the center of square source [(g/m^2-s)/(kg/m^3)] V = Fraction of vegetative cover [-] U_m = Mean annual wind speed [m/s] U_t = Equivalent threshold value of wind speed at 7 m [m/s] $F(x)$ = Function dependent on U_m/U_t derived using Cowherd *et al.* 1985 [-] 0.036 = Empirical constant [g/m^2-hr]

VOLATILIZATION FACTORS
(SUBSURFACE SOIL VAPOR TO INDOOR AIR)

$$VF_{sv} = \frac{\left[\dfrac{D_s^{eff} / d_{sv}}{ER \times L_B}\right]}{1 + \left[\dfrac{D_s^{eff} / d_{sv}}{ER \times L_B}\right] + \left[\dfrac{D_s^{eff} / d_{sv}}{\left(D_{crack}^{eff} / L_{crack}\right) \times \eta}\right]}$$

Source: ASTM E1739-95

where:

VF_{sv}	=	Volatilization factor from subsurface soil vapor to indoor (enclosed space) air [-]
θ_{ws}	=	Volumetric water content in vadose zone soils [cm^3-water/cm^3-soil]
θ_{as}	=	Volumetric air content in vadose zone soils [cm^3-air/cm^3-soil
d_{sv}	=	Depth to subsurface soil vapor samples taken [cm]
L_B	=	Enclosed space volume/infiltration area ratio [cm]
L_{crack}	=	Enclosed space foundation or wall thickness [cm]
ER	=	Enclosed space air exchange rate [1/s]
D_s^{eff}	=	Effective diffusion coefficient in soil based on vapor-phase concentration [cm^2/s]
D_{crack}^{eff}	=	Effective diffusion coefficient through foundation cracks [cm^2/s]
η	=	Area fraction of cracks in foundation and/or walls [cm^2-cracks/ cm^2-total area]

VOLATILIZATION FACTORS
(SUBSURFACE SOIL TO INDOOR AIR)

$$VF_{sesp} = \frac{\dfrac{H \times \rho_s}{[\theta_{ws} + (K_{sv} \times \rho_s) + (H \times \theta_{as})]} \times \left[\dfrac{D_s^{eff} / d_{ts}}{ER \times L_B}\right]}{1 + \left[\dfrac{D_s^{eff} / d_{ts}}{ER \times L_B}\right] + \left[\dfrac{D_s^{eff} / d_{ts}}{(D_{crack}^{eff} / L_{crack}) \times \eta}\right]} \times 10^3$$

Source: ASTM E1739-95

where:

VF_{sesp}	=	Volatilization factor from subsurface soil to indoor (enclosed space) air [m^3-air/(mg/kg-soil)]
H	=	Chemical-specific Henry's Law constant [L-water/L-air]
ρ_s	=	Dry soil bulk density [g-soil/cm^3-soil]
θ_{ws}	=	Volumetric water content in vadose zone soils [cm^3-water/cm^3-soil]
K_{sv}	=	$f_{ocv} \times K_{oc}$
	=	Chemical-specific soil-water sorption coefficient in vadose zone [cm^3-water/g-soil]
θ_{as}	=	Volumetric air content in vadose zone soils [cm^3-air/cm^3-soil
d_{ts}	=	Depth to subsurface soil sources [cm]
L_B	=	Enclosed space volume/infiltration area ratio [cm]
L_{crack}	=	Enclosed space foundation or wall thickness [cm]
ER	=	Enclosed space air exchange rate [1/s]
D_s^{eff}	=	Effective diffusion coefficient in soil based on vapor-phase concentration [cm^2/s]
D_{crack}^{eff}	=	Effective diffusion coefficient through foundation cracks [cm^2/s]
η	=	Area fraction of cracks in foundation and/or walls [cm^2-cracks/ cm^2-total area]
10^3	=	Conversion factor [(cm^3-kg)/(m^3-g)]

VOLATILIZATION FACTORS
(GROUNDWATER TO INDOOR AIR)

$$VF_{wesp} = \frac{H \times \left[\frac{D_{ws}^{eff} / L_{GW}}{ER \times L_B} \right]}{1 + \left[\frac{D_{ws}^{eff} / L_{GW}}{ER \times L_B} \right] + \left[\frac{D_{ws}^{eff} / L_{GW}}{\left(D_{crack}^{eff} / L_{crack} \right) \times \eta} \right]} \times 10^3$$

Source: ASTM E1739-95

where:

VF_{wesp}	=	Volatilization factor from groundwater to indoor (enclosed space) air [(mg/m^3-air)/(mg/L-water)]
H	=	Vadose zone chemical specific Henry's Law constant [(L-water)/(L-air)]
L_{GW}	=	Depth to groundwater [cm]
L_B	=	Enclosed space volume/infiltration area ratio [cm]
L_{crack}	=	Enclosed space foundation or wall thickness [cm]
ER	=	Enclosed space air exchange rate [1/s]
D_{ws}^{eff}	=	Effective diffusion coefficient between groundwater and soil surface [cm^2/s]
D_{crack}^{eff}	=	Effective diffusion coefficient through foundation cracks [cm^2/s]
η	=	Area fraction of cracks in foundation and/or walls [cm^2-cracks/ cm^2-total area]
10^3	=	Conversion factor [L/m^3]

VOLATILIZATION FACTORS
(GROUNDWATER TO OUTDOOR AIR)

$$VF_{wamb} = \frac{H}{1 + \left(\frac{100 \times U_m \times \delta_a \times L_{GW}}{W_{ga} \times D_{ws}^{eff}} \right)} \times 10^3$$

Source: ASTM E1739-95

where:

VF_{wamb}	=	Volatilization factor from groundwater to outdoor air [(mg/m^3-air)/(mg/L-water)]
H	=	Vadose zone chemical specific Henry's Law constant [(L-water)/(L-air)]
U_m	=	Mean annual wind speed [m/s]
δ_a	=	Breathing zone height [cm]
L_{GW}	=	Depth to groundwater [cm]
D_{ws}^{eff}	=	Effective diffusion coefficient between groundwater and soil surface [cm^2/s]
W_{ga}	=	Dimension of soil source area parallel to wind direction [cm]
100	=	Conversion factor [cm/m]
10^3	=	Conversion factor [L/m^3]

EFFECTIVE DIFFUSION COEFFICIENTS

D_s^{eff} : effective diffusion coefficient in soil based on vapor-phase concentration [cm^2/s]

$$D_s^{eff} = D^a \times \frac{\theta_{as}^{3.33}}{\theta_T^2} + D^w \times \frac{1}{H} \times \frac{\theta_{ws}^{3.33}}{\theta_T^2}$$

where:

D^a	=	Chemical-specific diffusion coefficient in air [cm^2/s]
D^w	=	Chemical-specific diffusion coefficient in water [cm^2/s]
θ_{as}	=	Volumetric air content in vadose zone soils [cm^3-air/cm^3-soil]
θ_{ws}	=	Volumetric water content in vadose zone soils [cm^3-water/cm^3-soil]
θ_T	=	Total soil porosity in the impacted zone [cm^3/cm^3-soil]
H	=	Chemical-specific Henry's Law constant [L-water/L-air]

D_{ws}^{eff} : effective diffusion coefficient between groundwater and surface soil [cm^2/s]

$$D_{ws}^{eff} = (h_c + h_v) \times \left[\frac{h_{cap}}{D_{cap}^{eff}} + \frac{h_v}{D_s^{eff}} \right]^{-1}$$

where:

h_c	=	Thickness of capillary fringe [cm]
h_v	=	Thickness of vadose zone [cm]
D_{cap}^{eff}	=	Effective diffusion coefficient through capillary fringe [cm^2/s]
D_s^{eff}	=	Effective diffusion coefficient in soil based on vapor-phase concentration [cm^2/s]
L_{GW}	=	Depth to groundwater ($h_c + h_v$) [cm]

D_{cap}^{eff} : effective diffusion coefficient for the capillary fringe [cm^2/s]

$$D_{cap}^{eff} = D^a \times \frac{\theta_{acap}^{3.33}}{\theta_T^2} + D^w \times \frac{1}{H} \times \frac{\theta_{wcap}^{3.33}}{\theta_T^2}$$

where:

D^a	=	Chemical-specific diffusion coefficient in air [cm^2/s]
D^w	=	Chemical-specific diffusion coefficient in water [cm^2/s]
θ_{acap}	=	Volumetric air content in capillary fringe soils [cm^3-air/cm^3-soil]
θ_{wcap}	=	Volumetric water content in capillary fringe soils [cm^3-water/cm^3-soil]
θ_T	=	Total soil porosity [cm^3/cm^3-soil]
H	=	Chemical-specific Henry's Law constant [L-water/L-air]

D_{crack}^{eff} : effective diffusion coeff. through foundation cracks [cm^2/s]

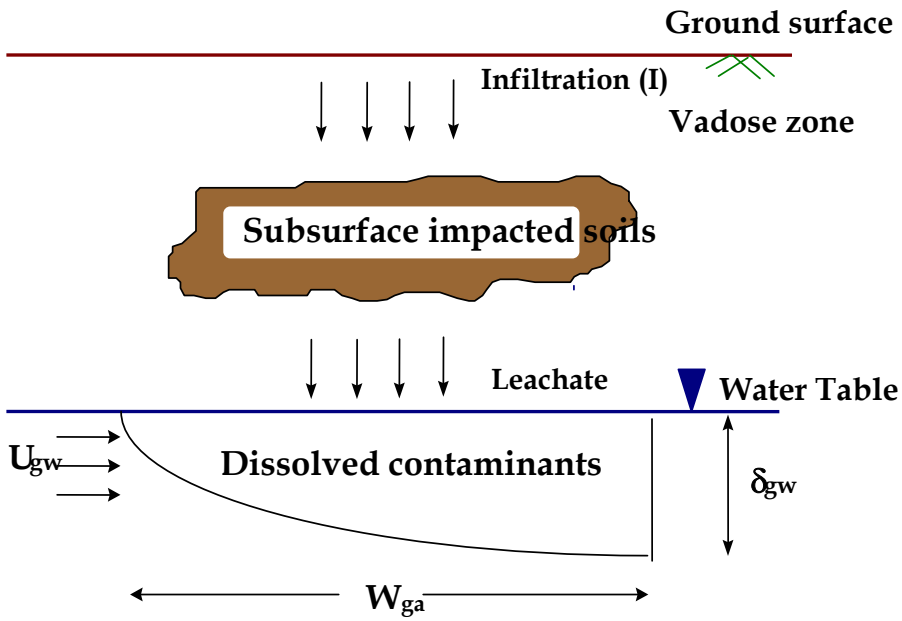
$$D_{crack}^{eff} = D^a \times \frac{\theta_{acrack}^{3.33}}{\theta_T^2} + D^w \times \frac{1}{H} \times \frac{\theta_{wcrack}^{3.33}}{\theta_T^2}$$

where:

D^a	=	Chemical-specific diffusion coefficient in air [cm^2/s]
D^w	=	Chemical-specific diffusion coefficient in water [cm^2/s]
θ_{acrack}	=	Volumetric air content in foundation/wall cracks [cm^3-air/cm^3-total volume]
θ_{wcrack}	=	Volumetric water content in foundation/wall cracks [cm^3-water/cm^3-total volume]
θ_T	=	Total soil porosity [cm^3/cm^3-soil]
H	=	Chemical-specific Henry's Law constant [L-water/L-air]

Source: ASTM E1739-95

SUBSURFACE SOIL CONCENTRATIONS PROTECTIVE OF LEACHING TO GROUNDWATER



$$RBTL_{SL} = \frac{RBTL_w}{LF_{SW}}$$

where:

$RBTL_{SL}$	=	Risk-based target level for leaching to groundwater from subsurface soil [mg/kg-soil]
$RBTL_w$	=	Risk-based target level for ingestion of groundwater [mg/L-water]
LF_{SW}	=	Leaching Factor (from subsurface soil to groundwater) [(mg/L-water)/(mg/kg-soil)]

Source: ASTM E1739-95

LEACHING FACTOR FROM SUBSURFACE SOIL TO GROUNDWATER

$$LF_{SW} = \frac{\rho_s}{[\theta_{ws} + K_{sv}\,\rho_s + H \times \theta_{as}] \times \left(1 + \frac{U_{gw} \times \delta_{gw}}{I \times W_{ga}}\right)}$$

where:

LF_{SW} = Leaching factor from subsurface soil to groundwater [(mg/L-water)/(mg/kg-soil)]
ρ_s = Vadose zone dry soil bulk density [g-soil/cm^3-soil]
θ_{ws} = Volumetric water content in vadose zone soils [cm^3-water/cm^3- soil]
K_{sv} = $f_{ocv} \times K_{oc}$ = Chemical-specific soil-water sorption coefficient in vadose zone [cm^3-water/g-soil]
H = Chemical-specific Henry's Law constant [L-water/L-air]
θ_{as} = Volumetric air content in the vadose zone soils [cm^3-air/cm^3-soil]
U_{gw} = Ki = Groundwater Darcy Velocity [cm/yr]
K = Hydraulic conductivity of the saturated zone [cm/year]
i = Hydraulic gradient in the saturated zone [-]
δ_{gw} = Groundwater mixing zone thickness [cm]
I = Infiltration rate of water through vadose zone [cm/year]
W_{ga} = Groundwater dimension parallel to groundwater flow direction [cm]

This equation consists of two parts (i) the Summer's model and (ii) equilibrium conversion of the leachate concentration to a soil concentration on a dry weight basis.

Source: ASTM E1739-95

SOIL CONCENTRATION AT WHICH DISSOLVED PORE WATER AND VAPOR PHASES BECOME SATURATED

Single Component

$$C_s^{SAT} = \frac{S}{\rho_s} \times [H \times \theta_{as} + \theta_{ws} + K_{sv}\rho_s]$$

Multiple Components

$$C_s^{SAT} = \frac{S_{ei}}{\rho_s} \times [H \times \theta_{as} + \theta_{ws} + K_{sv}\rho_s]$$

where:

C_s^{SAT} = Soil concentration at which dissolved pore water and vapor phases become saturated [(mg/kg-soil)]
S = Pure component solubility in water [mg/L-water]
S_{ei} = Effective solubility of component i in water = $x_i \times S$ [mg/L-water]
x_i = Mole fraction of component $i = (w_i \times MW_{avg})/MW_i$ [-]
w_i = Weight fraction of component i [-]
MW_{avg} = Average molecular weight of mixture [g/mole]
MW_i = Molecular weight of component i [g/mole]
ρ_s = Vadose zone dry soil bulk density [g-soil/cm^3-soil]
H = Chemical-specific Henry's Law constant [L-water/L-air]
θ_{as} = Volumetric air content in the vadose zone soils [cm^3-air/cm^3-soil]
θ_{ws} = Volumetric water content in vadose zone soils [cm^3-water/cm^3- soil]
K_{sv} = $f_{ocv} \times K_{oc}$ = Chemical-specific soil-water sorption coefficient in vadose zone [cm^3-water/g-soil]
f_{ocv} = Fraction organic carbon in vadose zone [g-C/g-soil]

Source: ASTM E1739-95

SOIL VAPOR CONCENTRATION AT WHICH VAPOR PHASE BECOMES SATURATED

Single Component

$$C_v^{SAT} = \frac{P^s \times MW}{R \times T} \times 10^6$$

Multiple Components

$$C_v^{SAT} = \frac{x_i \times P_i^s \times MW_i}{R \times T} \times 10^6$$

where:

C_v^{SAT}	=	Soil vapor concentration at which vapor phase become saturated [mg/m^3-air]
P^s	=	Saturate vapor pressure [atm]
P_i^s	=	Effective vapor pressure of component i in water = $x_i \times P^s$ [atm]
R	=	Ideal gas constant [0.08206 atm•L/mol•K]
T	=	Temperature [K]
S_{ei}	=	Effective solubility of component i in water = $x_i \times S$ [mg/L-water]
x_i	=	Mole fraction of component i = $(w_i \times MW_{avg})/MW_i$ [-]
w_i	=	Weight fraction of component i [-]
MW_{avg}	=	Average molecular weight of mixture [g/mole]
MW_i	=	Molecular weight of component i [g/mole]
ρ_s	=	Vadose zone dry soil bulk density [g-soil/cm^3-soil]
10^6	=	Conversion factor [(g/L)/(mg/m^3)]

Source: ASTM E1739-95

DOMENICO MODEL: DILUTION ATTENUATION FACTOR (DAF) IN THE SATURATED ZONE

Domenico model for multi-dimensional transport with decay and continuous source:

$$\frac{C(x,y,z,t)}{C_o} = (1/8)\ exp\left[\frac{x}{2\alpha_x}\left[1 - \sqrt{1+\frac{4\lambda\alpha_x}{v}}\right]\right] \times erfc\left[\frac{\left[(x-vt)\sqrt{1+\frac{4\lambda\alpha_x}{v}}\right]}{2\sqrt{\alpha_x \times v \times t}}\right] \times$$

$$\left[erf\left[\frac{(y+Y/2)}{2\sqrt{\alpha_y x}}\right] - erf\left[\frac{(y-Y/2)}{2\sqrt{\alpha_y x}}\right]\right] \times \left[erf\left[\frac{(z+Z)}{2\sqrt{\alpha_z x}}\right] - erf\left[\frac{(z-Z)}{2\sqrt{\alpha_z x}}\right]\right]$$

where:

C	=	Dissolved-phase concentration [mg/L]
C_o	=	Dissolved-phase concentration at the source (at x=y=z=0) [mg/L]
v	=	Retarded seepage velocity [m/sec]
λ	=	Overall first order bio-decay rate [1/day]
α_x	=	Longitudinal dispersivity [m]
α_y	=	Lateral dispersivity [m]
α_z	=	Vertical dispersivity [m]
x, y, z	=	Spatial coordinates [m]
t	=	Time [day]
x	=	Distance along the centerline measured from the downgradient edge of the groundwater source [m]
Y	=	GW source dimension perpendicular to GW flow direction [m]
Z	=	GW source (mixing zone) thickness [m]
DA F_{sat}	=	$C_o/C(x)$

At the centerline, for steady-state (after a long time) the concentration can be obtained by setting $y = 0$, $z = 0$, and $x << v \times t$ as:

$$\frac{C(x)}{C_o} = exp\left[\frac{x}{2\alpha_x}\left[1 - \sqrt{1+\frac{4\lambda\alpha_x}{v}}\right]\right] \times erf\left[\frac{Y}{4\sqrt{\alpha_y x}}\right] \times erf\left[\frac{Z}{2\sqrt{\alpha_z x}}\right]$$

At the centerline, for steady-state the concentration without decay can be obtained by setting y = 0, z = 0, x << vt, and λ = 0 as:

$$\frac{C(x)}{C_o} = erf\left[\frac{Y}{4\sqrt{\alpha_y x}}\right] \times erf\left[\frac{Z}{2\sqrt{\alpha_z x}}\right]$$

Note: Compare to ASTM E1739-95, p. 31, where $Y = S_w$ $Z = S_d$, $v = u$, and $C_o = C_{source}$

Source: Domenico, P.A. and F.W. Schwartz, 1990, Physical and Chemical Hydrogeology. John Wiley and Sons, NY, 824 p. (Eqn. 17.21)

ALLOWABLE SOIL AND GROUNDWATER CONCENTRATION FOR GROUNDWATER RESOURCE PROTECTION

$$\text{Allowable soil concentration at the source [mg/kg]} = \text{Target groundwater concentration at the POE} \times \frac{DAF_{POE}}{LF_{SW}} \times DAF_{unsat}$$

$$\text{Allowable groundwater concentration at the POD [mg/L]} = \text{Target groundwater concentration at the POE} \times \frac{DAF_{POE}}{DAF_{POD}}$$

where:

POE	=	Point of exposure
POD	=	Point of demonstration
DAF_{POE}	=	Dilution attenuation factor between the point of exposure and source estimated using Domenico's equation
DAF_{POD}	=	Dilution attenuation factor between the point of demonstration and source estimated using Domenico's equation
DAF_{unsat}	=	Dilution attenuation factor in the unsaturated zone
LF_{SW}	=	Dry soil leaching factor [(mg/L-water)/(mg/kg-soil)]

Concentration at POE is expressed in mg/L-water. Additional relationships used in the calculation of allowable soil and groundwater concentration with chemical degradation:

$$\text{First order decay rate [1/day]} = \frac{0.693}{Half\ \ Life}; \quad v = \frac{Ki}{\theta_{TS} R_s}$$

$$\text{Retardation factor for organics in the saturated zone } (R_s) = 1 + \left(\frac{\rho_{ss} \times K_{ss}}{\theta_{TS}} \right), \quad K_{ss} = f_{ocs} \times K_{oc} \text{ (for organics only)}$$

where:

v	=	Regarded seepage velocity [cm/year]
K	=	Hydraulic conductivity in saturated zone [cm/year]
i	=	Hydraulic gradient in saturated zone [-]
ρ_{ss}	=	Saturated zone dry soil bulk density [g-soil/cm^3-soil]
K_{ss}	=	Chemical-specific soil-water sorption coefficient in the saturated zone [cm^3-water/g-soil]
K_{oc}	=	Chemical-specific normalized partition coefficient [cm^3/g-C]
θ_{TS}	=	Total porosity in the saturated zone [cm^3/g-C]
f_{ocs}	=	Fractional organic carbon content in the saturated zone [g-C/g-soil]

ALLOWABLE SOIL AND GROUNDWATER CONCENTRATION PROTECTIVE OF INDOOR INHALATION FOR RESIDENT AND NON-RESIDENTIAL WORKER

$$\text{Allowable soil concentration at the source [mg/kg]} = \text{Target groundwater concentration below on/off - site building} \times \frac{DAF_{bldg}}{LF_{SW}} \times DAF_{unsat}$$

$$\text{Allowable groundwater concentration at the POD [mg/L]} = \text{Target groundwater concentration below on/off - site building} \times \frac{DAF_{bldg}}{DAF_{POD}}$$

where:

POD	=	Point of demonstration
DAF_{bldg}	=	Dilution attenuation factor between the on/off-site building and source estimated using Domenico's equation
DAF_{POD}	=	Dilution attenuation factor between the point of demonstration and source estimated using Domenico's equation
DAF_{unsat}	=	Dilution attenuation factor in the unsaturated zone
LF_{SW}	=	Dry soil leaching factor [(mg/L-water)/(mg/kg-soil)]

Concentration below on/off-site building is expressed in mg/L-water

STREAM PROTECTION: ALLOWABLE GROUNDWATER CONCENTRATION AT THE POINT OF DISCHARGE

$$C_{gw} = \frac{C_{sw}\left(Q_{gw} + Q_{sw}\right)}{Q_{gw}} - C_{su}\left(\frac{Q_{sw}}{Q_{gw}}\right)$$

$$Q_{gw} = \left(Z + \sqrt{\alpha_z X_s}\right) \times \left(Y + 2\sqrt{\alpha_y X_s}\right) \times U_{gw}$$

where:

Q_{gw}	=	Impacted groundwater discharge into the stream [ft^3/day]
C_{gw}	=	Allowable concentration in groundwater at the point of discharge into the stream [mg/L]
Q_{sw}	=	Stream flow upstream of the point of groundwater discharge (stream flow rate) [ft^3/day]
C_{sw}	=	Allowable concentration at the downstream edge of the stream's mixing zone, i.e., the applicable stream water quality criteria [mg/L]
C_{su}	=	The COCs' concentration upstream of the groundwater plume discharge [mg/L]
Y	=	GW source dimension perpendicular to GW flow direction [ft]
Z	=	GW source (mixing zone) thickness [ft]
α_y	=	Lateral dispersivity [ft]
α_z	=	Vertical dispersivity [ft]
X_s	=	Distance from the downgradient edge of the groundwater source to the stream [ft]
U_{gw}	=	Darcy velocity [ft/day]

STREAM PROTECTION: ALLOWABLE SOIL AND GROUNDWATER CONCENTRATION AT THE SOURCE & POD

$$\text{Allowable soil concentration at the source [mg/kg]} = \text{Target concentration at the POE [mg/L]} \times \frac{DAF_{POE}}{LF_{SW}} \times DAF_{unsat}$$

$$\text{Allowable groundwater concentration at the POD [mg/L]} = \text{Target concentration at the POE [mg/L]} \times \frac{DAF_{POE}}{DAF_{POD}}$$

where:

POE	=	Point of exposure
POD	=	Point of demonstration
DAF_{POE}	=	Dilution attenuation factor between the point of exposure and source estimated using Domenico's equation
DAF_{POD}	=	Dilution attenuation factor between the point of demonstration and the source estimated using Domenico's equation
DAF_{unsat}	=	Dilution attenuation factor in the unsaturated zone
LF_{SW}	=	Dry soil leaching factor [(mg/L-water)/(mg/kg-soil)]

For calculation of DAF_{POE} and DAF_{POD}, please refer to Domenico's model.