APPENDIX A

TABLE 1: PREDICTED Kp ESTIMATES FOR COMMON POLLUTANTS

Chemical	CAS No.	MWT	log Kow	(cm/hr)
Acetaldehyde	75070	44.1	-0.22	7.2e-04
Acetamide	60355	59.0	-1.26	1.1e-04
Acetylaminofluorene, 2-	53963	223.0	3.24	1.7e-02
Acrolein	107028	56.1	-0.10	7.4e-04
Acrylamide	79061	71.0	-0.67	2.4e-04
Acrylonitrile	107131	53.1	0.25	0.0014
Aldrin	309002	365.0	3.01	1.6e-03
Allyl chloride	107051	76.5	1.45	7.0e-03
1-Amino-2 methylanthraquinone	82280	237.3	2.80	6.6e-03
Aminoanthraquinone, 2-	117793	223.0	2.15	2.8e-03
Aminoazobenzene, p-	60093	197.0	2.62	8.7e-03
Aminoazotoluene, o-	97563	225.3	3.92	4.9e-02
Aminobiphenyl, 4-	92671	169.2	2.80	1.7e-02
Aniline	62533	93.1	0.90	2.2e-03
Anisidine, o-	90040	145.0	1.18	1.7e-03
Auramine	492808	267.4	3.54	1.5e-02
Benzo-b-fluroanthene	205992	252.3	6.12	1.2e+00
Benzene	71432	78.1	2.13	2.1e-02
Benzidine	92875	184.2	1.34	1.3e-03
Benzo-a-anthracene	56553	228.3	5.66	8.1e-01
Benzo-a-pyrene	50328	250.0	6.10	1.2e+00
Benzoic acid	65850	122.0	1.87	7.3e-03
Benzotrichloride	98077	195.0	2.92	1.5e-02
Benzyl chloride	100447	127.0	2.30	1.4e-02
Bis(2-chlorethyl)ether	111444	143.0	1.29	2.1e-03
Bromodichloromethane	75274	163.8	2.09	5.8e-03
Bromoform	75252	252.8	2.37	2.6e-03
Bromomethane	74839	95.0	1.19	3.5e-03
Bromophenol, p-	106412	173.0	2.65	1.3e-02
Butadiene, 1,3-	106990	54.0	1.99	2.3e-02
Butanediol, 2,3-	513859	90.1	-0.92	1.2e-04
Butanol, n-	71363	74.1	0.65	1.9e-03
Butoxyethanol, 2-	111762	118.0	0.83	1.4e-03
Captan	133062	300.0	2.35	1.3e-.03
Carbon disulfide	75150	80.0	2.24	2.4e-02
Carbon tetrachloride	56235	153.8	2.83	2.2e-02
Chlordane	57749	409.8	5.54	5.2e-02
Chlordane (cis)	5103719	410.0	5.47	0.046
Chlordane (trans)	5103742	410.0	5.47	0.046
Chlorobenzene	108907	112.6	2.84	4.1e-02

SOURCE: U.S. Environmental Protection Agency. January 1992. Interim Report Dermal Exposure Assessent: Princicles and Applications. EPA/600/8-9 011

TABLE 1: (Continued)

Chemical	CAS No.	MWT	log Kow	Kp (cm/hr)
Chlorocresol	59507	142.6	3.10	4.1e-02
Chlorodibromomethane	124481	208.3	2.23	3.9e-03
Chloroethane	75003	64.5	1.43	8.0e-03
Chloroform	67663	119.4	1.97	8.9e-03
Chloromethane	74873	50.5	0.91	0.0042
Chloromethyl methyl ether	107302	80.5	0.00	6.2e-04
Chorophenol, o-	95578	128.6	2.16	1.1e-02
Chlorophenol, p-	106489	128.6	2.39	1.6e-02
Chlorothalonil	1897456	265.9	3.86	2.5e-02
Chloroxylenol	-	135.2	-	-
Chrysene	218019	228.3	5.66	8.1e-01
Cresidine, p-	120718	137.2	1.67	4.3e-03
Cresol, m-	108394	108.1	1.96	1.0e-02
Cresol, o-	95487	108.1	1.95	1.0e-02
Cresol, p-	106445	108.1	1.94	1.0e-02
D&C Red No. 19	81889	479.0	0.00	2.3e-06
DDD	72548	320.0	5.80	2.8e-01
DDE	72559	318.0	5.69	2.4e-01
DDT	50293	355.0	6.36	4.3e-01
Decanol	112301	158.3	4.11	1.7e-01
Di-2-ethylhexyl phthalate	117817	391.0	5.11	3.3e-02
Diaminoanisole, 2,4-	615054	138.2	-0.12	2.3e-04
Diaminotoluene	95807	122.0	0.34	6.0e-04
Diaminotoluene, 2,4-	101804	200.0	2.06	3.3e-03
Dibenzo (a,h)anthracene	226368	278.4	6.84	2.7e+00
Dibutyl phthalate	84742	278.0	4.13	3.3e-02
Dichlorobenzene, 1,2-	95501	147.0	3.38	6.1e-02
Dichlorobenzene, 1,3-	541731	147.0	3.60	8.7e-02
Dichlorobenzene, 1,4-	106467	147.0	3.39	6.2e-02
Dichlorobenzidine, 3,3'	91941	253.1	3.51	1.7e-02
Dichlorodifluoromethane	75718	120.9	2.16	1.2e-02
Dichloroethane, 1,1-	75343	99.0	1.79	8.9e-03
Dichloroethane, 1,2-	107062	99.0	1.48	5.3e-03
Dichloroethylene, 1,1-	75354	96.9	2.13	1.6e-02
Dichloroethylene, 1,2-	156592	96.9	1.86	1.0e-02
Dichlorophenol, 2,4-	102832	163.0	2.92	2.3e-02
Dichloropropane, 1,2-	78875	113.0	2.00	0.01
Dichloropropene, 1,3-	542756	111.0	1.60	0.0055
Dichlorvos	62737	221.0	1.47	9.5e-04
Dieldrin	60571	381.0	4.56	1.6e-02
Diepoxybutane	1464535	86.1	-1.84	2.8e-05
Diethyl phthalate	84662	222.0	2.47	4.8e-03
Diethyl sulfate	64675	154.0	1.14	1.4e-03

TABLE 1: (Continued)

Chemical	CAS No.	MWT	log Kow	Kp (cm/hr)
Dimethoxybenzidine, 3,3'-	119904	254.4	1.81	0.001
Dimethyl phthalate	131113	194.0	1.56	1.6e-03
Dimethyl sulfate	77781	126.0	1.16	2.2e-03
Dimethylamine, n-nitroso-	62759	74.1	-0.57	2.7e-04
Dimethylaminoazobenzene, 4-	60117	225.0	4.58	1.4e-01
Dimethylbenzidine, 3,3'-	119937	212.3	2.34	4.4e-03
Dimethlycarbamyl chloride	79447	107.5	0.00	4.2e-04
Dimethylhylhydrazine, 1,1-	57147	60.0	-1.50	7.1e-05
Dimethylphenol, 2,4-	105679	122.2	2.30	1.5e-02
Dimethylphenol, 3,4-	95658	122.2	2.23	1.3e-02
Dinitrotoluene, 2,4-	121142	182.1	1.98	3.8e-03
Dinitrophenol, 2,4-	51285	184.1	1.54	0.0018
Dinitrotoluene, 2,6-	606202	182.1	1.72	0.0025
Dioxane, 1,4-	123911	88.1	-0.27	3.6e-04
Diphenylamine, n-nitroso-	86306	198.2	3.50	3.6e-02
Diphenylhydrazine, 1,2-	122667	184.2	2.94	1.8e-02
Dipropylamine, n-nitroso-	621647	130.2	1.36	2.8e-03
Endrin	72208	381.0	4.56	1.6e-02
Epichlorohydrin	106898	92.0	-0.21	3.7e-04
Ethanol	64175	46.0	-0.31	6.0e-04
Ethanol, 2-(2-butoxyethoxy)-	112345	162.0	-0.92	4.4e-05
Ethanol, 2-(2-ethoxyethoxy)-	111900	134.0	-0.08	2.5e-04
Ethanol, 2-(2-methoxyethoxy)-	111773	120.0	-0.42	1.8e-04
Ethoxyethanol, 2-	110805	90.0	-0.10	4.6e-04
Ethoxyethyl acetate, 2-	111159	132.0	0.65	8.6e-04
Ethyl acrylate	140885	100.0	1.32	4.0e-03
Ethyl carbamate	51796	89.0	-0.15	4.3e-04
Ethyl ether	60297	74.1	0.89	2.9e-03
Ethylbenzene	100414	106.2	3.15	7.4e-02
Ethylene oxide	75218	44.1	-0.30	6.3e-04
Ethylenedibromide	106934	188.0	1.96	3.3e-03
Ethyleneimine	151564	43.0	-1.12	1.7e-04
Ethylenethiourea	96457	96.0	-0.66	1.7e-04
Ethylphenol, p-	123079	120.0	2.26	1.4e-02
Fluoranthene	206440	202.3	4.95	3.6e-01
Formaldehyde	50000	30.0	0.35	2.2e-03
Glycerol	56815	92.1	-1.76	2.9e-05
Heptachlor	76448	373.5	4.27	1.1e-02
Heptanol	111706	116.0	2.41	1.9e-02
Hexachlorobenzene	118741	284.8	5.31	0.21
Hexachlorobutadiene	87683	260.8	4.78	1.2e-01
Hexachloroethane	67721	236.7	3.93	4.2e-02
Hexamethylphosophoramide	680319	179.0	0.03	1.6e-04

TABLE 1: (Continued)

Chemical	CAS No.	MWT	log Kow	Kp (cm/hr)
Hexanol	111273	102.0	2.03	1.3e-02
Hydrazine/Hydrazine sulfate	302012	32.0	-2.07	4.1e-05
Indeno(1,2,3-CD)pyrene	193395	276.3	6.58	1.9e+00
Isophorone	78591	138.2	1.70	4.4e-03
Lindane	58899	291.0	3.72	1.4e-02
Maneb	12427382	265.3	0.00	4.6e-05
Mechlorethamine	51752	156.0	1.07	1.2e-03
Methanol	67561	32.0	-0.77	0.00035
Methoxyethanol, 2-	109864	76.0	-0.77	0.00019
Methoxypropan-2-ol, 1-	107982	90.0	-0.18	0.0004
Methyl ethyl ketone	78933	72.0	0.29	1.1e-03
Methyl hydroxybenzoate	99763	152.1	1.92	0.0052
Methyl iodide	74884	142.0	1.51	3.1e-03
Methylaziridine, 2-	75558	57.0	-0.60	3.2e-04
Methylene bis(2-chloroaniline), 4,4'-	101144	267.2	3.94	2.8e-02
Methylene bis(N,N'-dimethyl)aniline, 4,4'-	101611	254.0	4.75	1.3-01
Methylene chloride	75092	84.9	1.25	4.5e-03
Methylenedianiline, 4,4'-	101779	198.0	1.59	1.6e-03
Michler's ketone	90948	268.4	4.07	3.4e-02
Mustard Gas	505602	159.1	2.03	5.6e-03
Naphthalene	91203	128.2	3.30	6.9e-02
Naphthol, b-	135193	144.2	2.84	2.6e-02
Naphthylamine, 1-	134327	143.2	2.25	1.0e-02
Naphthylamine, 2-	91598	143.2	2.28	1.1e-02
Nitrilotriacetic acid	139139	191.0	-0.18	9.7e-05
Nitro-o-anisidine, 5-	99592	152.7	1.47	2.5e-03
Nitrobiphenyl, 4-	92933	199.2	3.77	5.5e-02
Nitrofen	1836755	284.1	5.53	3.0e-01
Nitrophenol, 2-	88755	139.1	1.79	5.0e-03
Nitrophenol, 2-amino-4	99570	154.1	1.36	2.0e-03
Nitrophenol, 3-	554847	139.1	2.00	7.1e-03
Nitrophenol, 4-	100027	139.1	1.91	6.1e-03
Nitrophenol, 4-amino-2-	119346	154.1	0.96	1.1e-03
Nitropropane, 2-	79469	110.0	0.55	1.0e-03
Nitroso-di-n-butylamine, n-	924163	158.2	1.92	4.8e-03
Nitroso-N-ethylurea, n-	759739	117.1	0.23	0.00054
Nitroso-N-methylurea, n-	684935	103.1	-0.03	4.3e-04
Nitrosodiethanolamine, n-	1116547	134.0	-1.58	2.2e-05
Nitrosodiethylamine, n-	55185	88.0	0.48	1.2e-03
Nitrosodiphenylamine, p-	156105	198.2	3.50	3.6e-02
Nitrosomethylvinylamine, n-	4549400	86.1	0.00	5.7e-04
Nitrosomorpholine, n-	59892	116.1	-0.44	1.8e-04
Nitrosonornicotine, n-	16543558	177.2	0.03	1.7e-04

TABLE 1: (Continued)

Chemical	CAS No.	MWT	log Kow	Kp (cm/hr)
Nitrosopiperidine, n-	100754	350.3	0.36	2.5e-05
Nonanol	143088	144.0	3.47	7.3e-02
Octanol	111875	130.0	2.97	3.9e-02
Parathion	56382	291.0	3.83	1.7e-02
PCB-chlorobiphenyl, 4-	2051629	292.0	6.50	1.3
PCB-hexachlorobiphenyl	26601649	361.0	6.72	0.71
Pentachloronitrobenzene	82688	295.3	4.64	0.059
Pentachlorophenol	87865	266.4	5.86	6.5e-01
Pentanol	71410	88.0	1.56	0.0071
Pentanone, 4-methyl-2-	108101	100.0	1.19	3.3e-03
Phenanthrene	85018	178.2	4.57	2.7e-01
Phenol	108952	94.0	1.46	5.5e-03
Phenol, 4,6-dinitro-2-methyl-	534521	198.1	2.12	3.8e-03
Propanol	71238	60.0	0.30	1.3e-03
Propiolactone, beta-	57578	575.8	-0.46	3.3e-04
Propylene oxide	75569	58.1	0.03	8.9e-04
Resorcinol	108463	110.1	0.80	1.5e-03
Safrole	94597	162.2	2.66	1.5e-02
Styrene	100425	104.1	2.95	5.5e-02
Styrene oxide	96093	120.0	1.61	4.9e-03
TCDD	1746016	322.0	6.8	1.4e+00
Tetrachlorethylene	127184	165.8	3.40	4.8e-02
Tetrachloroethane, 1,1,2,2-	79345	167.9	2.39	9.0e-03
Thioacetamide	62555	75.0	0.71	2.1e-03
Thiodianiline, 4,4'-	139651	216.0	2.03	2.5e-03
Thiourea	62566	76.0	-0.95	1.4e-04
Thymol	89838	150.2	3.30	5.1e-02
Toluene	108883	92.1	2.73	4.5e-02
Toluidine hydrochloride, o-	636215	143.2	0.00	2.1e-03
Toluidine,o-	95534	107.0	1.32	0.0037
Toxaphene	8001352	414.0	4.82	1.5e-02
Tricholorbenzene, 1,2,4-	120821	181.5	3.98	1.0e-01
Trichloroethane, 1,1,1-	71556	133.4	2.49	1.7e-02
Trichloroethane, 1,1,2-	79005	133.4	2.05	8.4e-03
Trichloroethylene	79016	131.4	2.42	1.6e-02
Trichlorofluoromethane	75694	137.4	2.53	1.7e-02
Trichlorophenol, 2,4,6-	88062	197.5	3.69	5.0e-02
Tris(2,3-dibromopropyl)phosphate	126727	697.6	4.98	3.6e-04
Tris(aziridinyl)-para-benzoquinone	68768	231.3	-1.34	8.3e-06
Urea	57136	60.0	-2.11	2.6e-05
Vinyl bromide	593602	107.0	1.57	5.5e-03
Vinyl chloride	75014	62.5	1.36	7.3e-03
Water	7732185	18.0	-1.38	1.6e-04
Xylene, m-	108383	106.2	3.20	8.0e-02

TABLE 2: SCREENING LEVEL DERMAL ABSORPTION FRACTIONS (ABS) FROM SOIL

Compound Class		Absorption Fraction[1]	References
Chlorinated Insecticides		0.05	Wester, et al., 1990a; Wester, et al., 1992a
Polynuclear Aromatic Hydrocarbons		0.15	Wester, et al., 1990a
Organophosphates		0.25	Cal/EPA Office of Environmental Health Hazard
			Assessment
Pentachlorophenol		0.25	Wester, et al., 1993b
Polychlorinated Dibenzo-p-dioxins and		0.03	USEPA, 1992
Dibenzofurans			
Polychlorinated Biphenyls (PCB)		0.15	Wester, et al., 1993c
Other Organic Chemicals		0.10	SCAQMD, 1988
Cadmium		0.001	Wester, et al., 1992b
Arsenic		0.03	Wester, et al., 1993a
Hexavalent Chromium		0%	Not shown to be a systemic carcinogen via
			dermal exposure
Other metals and complexed cyanides		0.01	SCAQMD, 1988
Free Cyanide		0.10	SCAQMD, 1988

1. Dermal absorption values from soil are based on, in order of preference: in vivo, animal studies on dermal absorption from soil; in vivo, animal studies on dermal absorption from an applicable cosolvent; in vitro, human skin dermal absorption studies; in vitro, animal skin dermal absorption studies. Actual dermal absorption from soil may vary from these estimates due to exposure conditions or soil chsracteristics which differ from the experimental conditions.

TABLE 3: PHYSICAL AND CHEMICAL PROPERTIES FOR VOLATILE COMPOUNDS (OSA, Jul-93)

Chemical	MW (g/mol)	Hc (atm-m3/mol)	Di (cm^2/sec)	Koc (l/kg)	S (mg/l)	VP (mm Hg)	Log Kow	BP Celsius	MP Celsius
Acetone	58.0	3.67E-05	0.103	2.20	1000000.00	231	-0.24	56.2	-95.4
Benzene	78.1	5.43E-03	0.088	65.00	1791.00	95	2.13	80.1	5.5
Carbon tetrachloride	154.0	3.04E-02	0.080	110.00	805.00	114	2.83	76.5	-23
Chlorobenzene	113.0	3.45E-03	0.072	160.00	471.70	11.9	2.84	132	-45.6
Chloroform	119.0	4.35E-03	0.089	31.00	7970.00	246	1.97	61.7	-63.5
1,2-Dibromoethane (EDB)	188.0	3.20E-04	0.073	28.10	3400.00	-	-	-	-
1,2-Dichlorobenzene	147.0	1.20E-03	0.130	1148.00	156.00	1.5	3.83	180.5	-17
1,4-Dichlorobenzene	147.0	1.50E-03	0.130	1175.00	87.00	1.8	3.52	174	53.1
1,1-Dichloroethane	99.0	5.87E-03	0.091	30.00	5060.00	227	1.79	57.3	-97
1,2-Dichloroethane (EDC)	99.0	9.77E-04	0.091	14.00	8524.00	78.7	1.48	83.5	-35.4
1,1-Dichloroethylene	97.0	1.54E-01	0.079	65.00	400.00	-	-	-	-
1,2-Dichloroethylene (trans)	97.0	6.72E-03	0.079	59.00	6300.00	340	2.06	48	-50
1,2-Dichloropropane	113.0	2.07E-03	0.080	51.00	2740.00	49.7	1.99	96.4	-100.5
Ethylbenzene	106.2	8.44E-03	0.075	220.00	161.00	9.5	3.15	136.2	-95
Methylene chloride	85.0	2.68E-03	0.101	8.80	13000.00	435	1.25	39.8	-95.1
Methyl ethyl ketone	72.0	1.05E-05	0.090	4.50	239000.00	90.6	0.29	79.6	-86.4
PAH Acenaphthene	154.2	1.20E-03	0.064	4600.00	3.88	-	-	-	-
PAH Anthracene	178.0	3.40E-05	0.058	12589.00	0.08	-	-	-	-
PAH Fluorene	166.2	6.42E-05	0.061	7900.00	1.90	-	-	-	-
PAH Naphthalene	128.2	5.00E-04	0.069	1288.00	31.70	0.082	3.3	217.9	80.2
Styrene	104.2	2.81E-03	0.071	360.00	310.00	6.6	2.95	145.2	-30.6
1,1,2,2-Tetrachloroethane	168.0	4.55E-04	0.073	218.78	2962.00	6.1	2.39	146.5	-36
Tetrachloroethylene (PCE)	165.8	1.49E-02	0.072	660.69	150.30	18.5	3.4	121	-19
Toluene	92.0	5.94E-03	0.078	257.04	534.80	28.4	2.73	110.6	-95
1,1,1-Trichloroethane	133.0	8.00E-03	0.080	150.00	1495.00	123.7	2.49	74.1	-30.4
1,1,2-Trichloroethane	133.0	1.20E-03	0.080	56.23	4420.00	30.3	2.07	113.8	-36.5
Trichloroethylene (TCE)	131.0	1.03E-02	0.081	125.89	1100.00	69	2.42	87	-73
Xylene (mixed)	106.2	5.30E-03	0.087	240.00	200.00	-	-	-	-

TABLE 4: SAMPLE EXPOSURE PATHWAY ANALYSIS FOR AN ECOLOGICAL SCREENING EVALUATION

Habitat Type	Potential Contaminants or Classess of Contaminants of Concern	Contaminated Media	Food Web Exposure	Potential Exposure Pathway	Complete Exposure Pathway
Chaparral	DDT	Soil		Direct Ingestion	Yes
	DDT	Soil	Invertebrates to Mouse	Ingestion of Prey	Yes
	Chloroform	Ground Water		Inhalation of Soil Gases	Yes
	Chloroform	Ground Water		Direct Ingestion	No
Footnote a	Footnote b		Footnote c	Footnote d	Footnote e

a. Examples of habitat types include freshwater wetland, conifer forest, oak woodland and riparian.
b. Indicate the specific chemical or family of chemicals, based on potential significance to the risk assessment. physical or chemical properties such as volatility, bioaccumulative potential, tendency to sorb to soils or sediments and water solubility may be important.
c. Indicate the food web transfers for those indirect exposures through the food web.
d. Indicate the potential exposure pathway such as inhalation of volatile compounds from surface or subsurface contamination, incidental soil or sediment ingestion, ingestion of contaminated food items, or dermal contact with contaminated media.
e. Indicate whether the potential exposure pathway is complete given site-specific characteristics.

APPENDIX B

(Note: See Errata Sheet, Item 3, at end of Chapter 2.)

Volatile Emission Model (EPA, 1991; 1992b; 1992c)

Step 1: Calculate the Saturation Concentration

Use soil bulk concentrations to calculate emission rates, first estimate the saturation concentration (C_{sat}) for each contaminant in the vadose zone. C_{sat} for each contaminant is the concentration at which the adsorptive limit of the soil plus the theoretical dissolution limit of the contaminant in the available soil moisture has been reached. Concentrations greater than C_{sat} indicate "free-phase" contaminants within the soil matrix. In such an instance, the VOC emission model contained in Step 2 is not valid, and this screening procedure cannot be used.

$$C_{sat} = \frac{(K_d \times C_w \times \beta) + (C_w \times P_w) + (C_w \times H' \times P_a)}{\beta}$$

Where:

C_{sat} = soil saturation concentration, mg/kg

C_w = Upper limit of free moisture in soil (mg/L-water),
= $s \times \Theta_m$

Where:

S = solubility of contaminant in water,mg/L-water
(values can be found in Table 4 of Appendix C)

Θ_m = soil moisture content, kg-water/kg-soil
(default = 0.1)

ß = soil bulk density (kg/L) (default = 1.5)

P_w = water filled soil porosity (unitless)
= $P_t - P_a$ (default = 0.434-0.284 = 0.15)

Where:

P_t = total soil porosity (unitless)
= 1 - ß/σ
= 0.434

Where:

ß = soil bulk density,
(default = 1.5 g/cm^3)

σ = particle density,
(default = 2.65 g/cm^3)

P_a = air-filled porosity (unitless)
= P_t - ßΘ_m
= 0.284

Where:
ß = soil bulk density,g/cm^3, (default = 1.5)
Θ_m = soil moisture content,
cm^3/g (= g-water/g-soil), (default = 0.1)

H' = Henry's Law constant (unitless)
= H_c x 41

Where:
41 = a conversion factor to change H_c to dimensionless form
H_c = the Henry's Law constant, atm-m^3/mole

K_d = soil/water partition coefficient, cm^3-water/g-soil (= L/kg)

$$K_d = K_{oc} \times f_{oc}$$

Where:
K_{oc} = organic carbon partition coefficient, cm^3-water/g-soil (= L/kg)
(Values can be found in Table 4 of Appendix C.)

f_{oc} = fraction of organic carbon in soil, g/g
(default = 0.02)

If K_d and/or K_{oc} are not available in Table 4 or in the scientific literature, then estimate them as follows. Use one of the following equations based on the chemical class closest to the subject contaminant.

For aromatic or polynuclear aromatic contaminants:

$$K_{oc} = 10^{((1.00 \log K_{ow}) - 0.21)}$$

For herbicides, fungicides, and non-chlorinated insecticides:

$$K_{oc} = 10^{((1.029 \log_{ow}) - 0.18)}$$

For contaminants which do not fit into either of the classes listed above, use this third equation, which is based primarily on pesticides:

$$K_{oc} = 10^{((0.544 \log K_{ow}) + 1.377)}$$

Where:

K_{oc} = organic carbon partition coefficient, L/kg (mL/g)

K_{ow} = octanol/water partition coefficient, L/kg (Ml/g)

Step 2: Calculate the Total Emission Rate

If bulk soil concentrations do not exceed C_{sat}, then calculate an emission rate for each contaminant using the equation below. This equation assumes the bulk soil concentration of the contaminant is less than the saturation concentration, C_{sat}. The default values are the same as those stated in EPA (1991b), except for the area of contamination, (A), the fraction of organic carbon in the soil (f_{oc}), and the exposure interval (T). The default value for the exposed surface area is equal to 5,000 square feet (4.84×10^6 cm^2 or 484 m^2), the minimum dimensions of a residential lot in California (Hadley and Sedman, 1990). The default value for soil organic carbon is 0.02 (1992b). The default values for exposure interval are 30 yr for carcinogenic risk and 6 yr for non-carcinogenic hazard.

$$E = \frac{2\, A\, D_{ei}\, P_a\, K_{as}\, C_i \times 10^3 \ \ mg/g}{\sqrt{\pi\, \alpha\, T}}$$

Where:

E_i = average emission rate of contaminant i over the residential lot during the exposure interval, mg/sec

A = area of contamination, cm^2; default = $4.84 \times 10^{+6}$ cm^2,

D_{ei} = effective diffusivity of compound, cm^2/sec
= $D_i\ (P_a^{3.33}/P_t^2)$

Where:

D_i = diffusivity in air, cm^2/s.
(Values are shown in Appendix C, Table 4. If the desired value is not found in Table 4, refer to USEPA (1992b), equation (9), page 13.)

P_t = total soil porosity, unitless
= 1-(ß/ρ)

Where:

ß = soil bulk density, g/cm^3 (default = 1.5 g/cm^3)

ρ = particle density, g/cm^3 (default = 2.65 g/cm^3)

P_t = 0.434

P_a = air filled soil porosity, unitless
= $P_t - \Theta_m$ ß

Where:

Θ_m = soil moisture content, cm^3/g (default = 0.1 cm^3/g)

P_a = 0.284

K_{as} = soil/air partition coefficient, g/cm^3
= $(H_c/K_d) \times 41$

Where:

H_c = Henry's Law constant, atm-m^3/mole

41 = conversion factor to change H_c to dimensionless form

K_d = soil-water partition coefficient (cm^3-water/g-soil)
(= L/kg)

C_i = bulk soil concentration of contaminant i, g/g-soil

T = exposure interval, sec (default = 30 yr = 9.5×10^8 seconds)

α = conversion factor composed of quantities defined above

$$\alpha = \frac{D_{ei} \times P_a}{P_a + [(\rho)(1 - P_a)/ K_{as}]}$$

DERIVATIONS FOR SCREENING EVALUATION EQUATIONS

Original Equations:

$$\mathbf{Risk_{water} = SF_o \times C_w \times \frac{IR_{w,adult} \times EF \times ED_{adult}}{BW_{adult} \times AT \times 365\ day/yr}}$$

$$\mathbf{+ SF_o \times C_w \times \frac{IR_{w,child} \times EF \times ED_{child}}{BW_{child} \times AT \times 365\ day/yr}}$$

$$\mathbf{+ SF_o \times C_s \times \frac{SA_{adult} \times K_p \times EF \times ED_{adult} \times ET_{adult} \times 1\ L/1000\ cm^3}{BW_{adult} \times AT \times 365\ days/yr}}$$

$$\mathbf{+ SF_o \times C_s \times \frac{SA_{child} \times K_p \times EF \times ED_{child} \times ET_{child} \times 1\ L/1000\ cm^3}{BW_{child} \times AT \times 365\ days/yr}}$$

Default exposure factors:

BW	=	body weight, (70 kg adult; 15 kg child)
AT	=	averaging time, 70 yr
EF	=	exposure frequency, 350 day/yr (EPA, 1991)
ED	=	exposure duration (24 yr adult; 6 yr child)
IR_w	=	intake rate (adult = 2 L/day; child = 1L/day)
ET	=	exposure time during showering/bathing (adult, 15 min/shower = 0.25 hr/day; child, four 15 min baths/week = 0.14 hr/day [USEPA, 1992a])
SA	=	skin surface area available for contact (cm^2) (adults, 23,000 cm^2 [USEPA, 1992a]; child, 7,200 cm^2 [USEPA, 1989b])
K_p	=	chemical-specific dermal permeability coefficient from water, cm^2/hr.

Reduced Equations:

$$\mathbf{Risk_{water} = (SF_o \times C_w \times 0.0149) + (SF_o \times C_w \times 0.0325 \times K_p)}$$

FIGURE 1: DERIVATION OF RISK EQUATION FOR non-VOCs IN WATER

Original Equations:

$$\mathbf{Risk_{water} = SF_o \times C_w \times \frac{IR_{w,adult} \times EF \times ED_{adult}}{BW_{adult} \times AT \times 365\ day/yr}}$$

$$\mathbf{+ SF_o \times C_w \times \frac{IR_{w,child} \times EF \times ED_{child}}{BW_{child} \times AT \times 365\ day/yr}}$$

$$\mathbf{+ SF_o \times C_s \times \frac{SA_{adult} \times K_p \times EF \times ED_{adult} \times ET_{adult} \times 1\ L/1000\ cm^3}{BW_{adult} \times AT \times 365\ days/yr}}$$

$$\mathbf{+ SF_o \times C_s \times \frac{SA_{child} \times K_p \times EF \times ED_{child} \times ET_{child} \times 1\ L/1000\ cm^3}{BW_{child} \times AT \times 365\ days/yr}}$$

Default exposure factors:

BW	=	body weight, (70 kg adult; 15 kg child)
AT	=	averaging time, 70 yr
EF	=	exposure frequency, 350 day/yr (EPA, 1991)
ED	=	exposure duration (24 yr adult; 6 yr child)
IR_w	=	intake rate (adult = 2 L/day; child = 1L/day)
ET	=	exposure time during showering/bathing (adult, 15 min/shower = 0.25 hr/day; child, four 15 min baths/week = 0.14 hr/day [USEPA, 1992a])
SA	=	skin surface area available for contact (cm^2) (adults, 23,000 cm^2 [USEPA, 1992a]; child, 7,200 cm^2 [USEPA, 1989b])
K_p	=	chemical-specific dermal permeability coefficient from water, cm^2/hr.

Reduced Equations:

$$\mathbf{Risk_{water} = (SF_o \times C_w \times 0.0149) + (SF_o \times C_w \times 0.0325 \times K_p)}$$

FIGURE 2: DERIVATION OF RISK EQUATION FOR VOCs IN WATER

Original Equations:

$$\mathbf{Risk_{voc,water} = Risk_{water} + \frac{SF_i \times C_w \times IR_{voc,adult} \times EF \times ED_{adult}}{BW_{adult} \times AT \times 365\ days/yr}}$$

$$\mathbf{+ \frac{SF_i \times C_w \times IR_{voc,child} \times EF \times ED_{child}}{BW_{child} \times AT \times 365\ days/yr}}$$

Default exposure factors:

BW	=	body weight, (70 kg adult; 15 kg child)
AT	=	averaging time, 70 yr
EF	=	exposure frequency, 350 day/yr (EPA, 1991)
ED	=	exposure duration (24 yr adult; 6 yr child)
IR_{voc}	=	intake from inhalation of VOCs from domestic use of water is equivalent to the amount of ingested water (USEPA, 1989c).

Reduced Equations:

$$\mathbf{Risk_{water} = [0.0149 \times ((SF_o \times C_w) + (SF_i \times C_w))] + (SF_o \times C_w \times 0.0325 \times K_p)}$$

FIGURE 3: DERIVATION OF HAZARD EQUATION FOR non-VOCs IN WATER

Original Equation:

$$\text{Hazard}_w = (1/RfD_o) \times \frac{C_w \times IR_w \times EF \times ED}{BW \times AT \times 365\ \text{day/yr}} +$$

$$(1/RfD_o) \times \frac{C_w \times SA \times K_p \times ET \times EF \times ED \times (1\ L/1000\ cm^3)}{BW \times AT \times 365\ \text{day/yr}}$$

Default exposure factors (for childhood exposure from birth to six years of age):

BW = body weight = 15 kg
AT = averaging time = 6 yr
EF = exposure frequency = 350 day/year (EPA, 1991)
ED = exposure duration = 6 yr
IR_w = daily intake of water = 1 L/day
ET = exposure time = 0.14 hours/day; based on the assumption of four 15 minute baths taken weekly.
SA = skin surface area (cm^2) exposed during bathing = 7,200 cm^2
K_p = chemical-specific dermal permeability coefficient from water

Reduced Equations:

$$\text{Hazard}_{water} = ((C_w/RfD_o) \times 0.0639) + ((C_w/RfD_o) \times 0.0644 \times K_p)$$

FIGURE 4: DERIVATION OF HAZARD EQUATION FOR VOCs IN WATER

Original Equation:

$$\text{Hazard}_w = (1/RfD_o) \times \frac{C_w \times IR_w \times EF \times ED}{BW \times AT \times 365\ \text{day/yr}} +$$

$$(1/RfD_i) \times \frac{C_w \times IR_{w,voc} \times EF \times ED}{BW \times AT \times 365\ \text{day/yr}} +$$

$$(1/RfD_o) \times \frac{C_w \times SA \times K_p \times ET \times EF \times ED \times (1\ L/1000\ cm^3)}{BW \times AT \times 365\ \text{days/yr}}$$

Default exposure factors (for childhood exposure from birth to six years of age):

BW = body weight = 15 kg

AT = averaging time = 6 yr

EF = exposure frequency = 350 day/year (EPA, 1991)

ED = exposure duration = 6 yr

$IR_{w,voc}$ = intake from inhalation of VOCs~ ingestion rate = 1L/day (A chemical is a VOC if it has a vapor pressure greater than 1 x 10^{-3} mm Hg or a Henry's Law constant greater than 1 x 10^{-5} atm-m^3/mole). The increased intake for VOCs is to account for the additional exposure via inhalation of volatilized compounds from domestic use of water (USEPA, 1989c).

ET = exposure time = 0.14 hours/day; based on the assumption of four 15 minute baths taken weekly.

SA = skin surface area (cm^2) exposed during bathing = 7,200 cm^2

K_p = chemical-specific dermal permeability coefficient from water

Reduced Equations:

$$\text{Hazard}_{water} = [0.0639 \times ((C_w/RfD_o) + (C_w/RfD_i))] + [(C_w/RfD_o) \times 0.0644 \times K_p]$$

FIGURE 5: DERIVATION OF RISK EQUATION FOR SOIL

Original Equation:

$$\text{Risk}_{soil} = SF_o \times C_s \times \frac{IR_{s,adult} \times EF \times ED_{adult} \times 10^{-6}\ kg/mg}{BW_{adult} \times AT \times 365\ days/yr}$$

$$+ SF_o \times C_s \times \frac{IR_{s,child} \times EF \times ED_{child} \times 10^{-6}\ kg/mg}{BW_{child} \times AT \times 365\ days/yr}$$

$$+ SF_o \times C_s \times \frac{SA_{adult} \times AF \times ABS \times EF_{adult} \times ED_{adult} \times 10^{-6}\ kg/mg}{BW_{adult} \times AT \times 365\ days/yr}$$

$$+ SF_o \times C_s \times \frac{SA_{child} \times AF \times ABS \times EF_{child} \times ED_{child} \times 10^{-6}\ kg/mg}{BW_{child} \times AT \times 365\ days/yr}$$

Default exposure factors:

AT = averaging time = 70 years

EF = exposure frequency for soil ingestion = 350 day/yr (EPA, 1991a)

= exposure frequency for dermal contact = 2 events/week or 100 day/yr for adults, and 7 events/week or 350 days/year for children (USEPA, 1991a)

ED = exposure duration; 24 yr for adults and 6 yr for children

IR_s = incidental soil ingestion rate, mg/day; 100 mg/day for adults and 200 mg/day for children (USEPA, 1991a)

BW = body weight; adults = 70 kg, children = 15 kg (USEPA, 1991a)

SA = skin surface area exposed (cm^2); adult = 5,800 cm^2/day, child = 2,000 cm^2/day (DTSC, 1992, Chapter 1)

AF = soil to skin adherence factor, mg/cm^2; default value is 1.00 mg/cm^2 (EPA, 1992)

ABS = absorption fraction of chemical from soil

Reduced Equation:

$$\text{Risk}_{soil} = (SF_o \times C_s \times 4.7 \times 10^{-7}) + (SF_o \times C_s \times 1.1 \times 10^{-6}) +$$

$$(SF_o \times C_s \times 7.8 \times 10^{-6} \times ABS) + (SF_o \times C_s \times 1.1 \times 10^{-5} \times ABS)$$

FIGURE 6: DERIVATION OF HAZARD EQUATION FOR SOIL

Original Equation:

$$\text{Hazard}_{soil} = (1/RfD_o) \times C_s \times \frac{IR_s \times EF \times ED \times 10^{-6}\ kg/mg}{BW \times AT \times 365\ day/yr}$$

$$+ (1/RfD_o) \times C_s \times \frac{SA \times AF \times ABS \times EF \times ED \times 10^{-6}\ kg/mg}{BW \times AT \times 365\ days/yr}$$

Default exposure factors (based on childhood exposure from birth to six years of age):

IR_s	=	incidental soil ingestion rate = 200 mg/day
EF	=	exposure frequency, 350 days/year for soil ingestion and dermal contact (EPA, 1991)
ED	=	exposure duration = 6 years
BW	=	body weight = 15 kg (USEPA, 1991a)
AT	=	averaging time = 6 years
SA	=	skin surface area exposed = 2,000 cm^2
AF	=	soil to skin adherence factor = 1 mg/cm^2 (USEPA, 1992a)
ABS	=	absorption fraction of chemical from soil (See Table 3)

Reduced Equation:

$$\text{Hazard}_{soil} = [(C_s/RfD_o) \times 1.28 \times 10^{-5})] + [(C_s/RfD_o) \times 1.28 \times 10^{-4} \times ABS]$$

FIGURE 7: DERIVATION OF RISK EQUATION FOR AIR

Original Equation:

$$\mathbf{Risk_{air} = SF_i \times C_a \times \frac{IR_{adult} \times EF \times ED_{adult}}{BW_{adult} \times AT \times 365\ days/yr}}$$

$$\mathbf{+ SF_i \times C_a \times \frac{IR_{child} \times EF \times ED_{child}}{BW_{child} \times AT \times 365\ day/yr}}$$

Default exposure factors for risk:

BW	=	body weight = 70 kg for adults, 15 kg for children
AT	=	averaging time, 70 yr
EF	=	exposure frequency, 350 day/yr (EPA, 1991)
ED	=	exposure duration = 24 yr for adults, 6 yr for children
IR_a	=	inhalation rate = 20 m^3/day for adults, 10 m^3/day for children (EPA, 1989a; Schum, et al., 1993).

Reduced Equation:

$$\mathbf{Risk_{air} = (SF_i \times C_a \times 0.0939) + (SF_i \times C_a \times 0.0548)}$$

$$\mathbf{= SF_i \times C_a \times 0.149}$$

FIGURE 8: DERIVATION OF HAZARD EQUATION FOR AIR

Original Equation:

$$\textbf{Hazard}_{air} = (1/RfD_i) \times C_a \times \frac{IR \times EF \times ED}{BW \times AT \times 365\ day/yr}$$

Default exposure factors (based on childhood exposure from birth to six years):

BW = body weight, 15 kg

AT = averaging time, 6 years

EF = exposure frequency, 350 day/yr

ED = exposure duration, 6 yr

IR_a = inhalation rate, 10 m^3/day (Schum, et al., 1993)

Reduced Equation:

$$\textbf{Hazard}_{air} = (1/RfD_i) \times C_a \times 0.639$$