INGESTION-DERMAL EXPOSURE PATHWAY
SOIL REMEDIATION STANDARDS

BASIS AND BACKGROUND

June, 2008

Table of Contents

BASIS AND BACKGROUND
Combined Ingestion and Dermal Absorption
Soil Remediation Standards

I. Introduction

The Department proposes to use the U.S. Environmental Protection Agency's (USEPA's) current soil screening level equations to calculate soil standards that combine the direct ingestion and dermal absorption pathways (USEPA, 2002a). This approach acknowledges that concurrent exposure occurs via the two pathways through children's outdoor play; and gardening, landscaping, and excavation by adults. The Department has determined that soil standards for restricted and unrestricted land use should be protective of both exposures. A combined exposure pathway is developed for carcinogens and noncarcinogens under residential and non-residential (industrial outdoor worker) scenarios. Evaluation of the dermal absorption component is limited to seven individual chemicals and two chemical classes. Approximately half of the chemicals with residential and non-residential standards include a dermal component, while the remaining standards are based on ingestion alone. Each combined pathway equation employs the same target risks as the other pathways and is based upon an incremental lifetime cancer risk of 10^{-6} or a hazard quotient (HQ) of one for noncarcinogenic effects.

While the Department employs USEPA's equations and default parameters for the combined pathway, the list of chemicals and the toxicity data used may differ from USEPA due to the Department's preference to be consistent with other departmental programs. These differences are discussed in Sections II, IV, and V. Because different health effects may be associated with the inhalation of contaminants, the Department will continue to evaluate the inhalation pathway separately as recommended by USEPA (2002a).

II. Methodology for Developing Generic Standards

A. Ingestion Component

The ingestion component of the ingestion-dermal absorption pathway addresses the potential for human exposure to chemicals through direct ingestion of contaminated soil and dust. Inadvertent soil ingestion among children may occur through mouthing of objects or unintentional hand-to-mouth activity, which is considered a normal phase of childhood development. Children have a greater potential than adults for exposure to soil through ingestion as a result of these behavioral patterns that are present throughout early childhood. Adults may also ingest soil or dust particles that adhere to objects, food, cigarettes, or their hands.

Calculation of remediation standards for the direct ingestion of soil is based on USEPA's risk assessment methodology. The procedure for calculating residential and nonresidential exposure scenarios is presented in *Risk Assessment Guidance for Superfund Human Health Evaluation Manual, Part B* (RAGS HHEM, Part B; USEPA, 1991), *Soil Screening Guidance: Technical Background Document* (USEPA, 1996a), and *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2002a).

Residential Exposure Scenario

The ingestion component of the Department's residential scenario employs an age-adjusted soil ingestion factor for *carcinogenic* contaminants (Appendix Equation A-1). This factor takes into account the difference in daily soil ingestion rates, body weights, and exposure duration for children from 1 to 6 years old and others from 7 to 31 years old. The higher intake rate of soil and lower body weight of young children lead to a more protective, risk-based concentration compared to adult-only assumptions. USEPA's *Soil Screening Guidance* (1996a & 2002a) uses this age-adjusted approach for carcinogens for the residential scenario shown in Equation 3 of this document.

Under a residential scenario, the Department has adopted USEPA's *Soil Screening Guidance's* approach for *noncarcinogenic* contaminants that uses a protective "childhood only" exposure. The equation includes an averaging time based on exposure during a 6-year childhood period, a 15-kg body weight, and a soil ingestion rate of 200 mg/day (as shown in the ingestion portion of Equation 4).

Non-residential (Outdoor Industrial Worker) Exposure Scenario

Under an industrial worker scenario for both *carcinogens* and *noncarcinogens*, direct ingestion is calculated for an adult outdoor worker and does not consider childhood exposure, therefore, neither the age-adjustment factor nor the "childhood only" exposure duration applies (shown in ingestion portion of Equations 5 & 6). A soil ingestion rate of 100 mg/day is employed to reflect an increased exposure to soils by the outdoor worker compared to the amount a typical indoor worker might contact during work hours. The sources of these equations are USEPA's *RAGS HHEM, Part B* and *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 1991 & 2002a).

B. Dermal Absorption Component

The dermal absorption component of this pathway is derived from risk assessment methodology outlined in USEPA's *Risk Assessment Guidance for Superfund: (Part E, Supplemental Guidance for Dermal Risk Assessment) Final* (USEPA, 2004). Currently, soil contaminants evaluated for dermal exposure are limited to several individual compounds and two chemical classes (Table 1). USEPA has not developed default dermal absorption values for volatile organic compounds because they tend to volatilize from the soil adhered to skin, and exposure should be accounted for via the inhalation route of exposure. Additionally, few inorganics, other than cadmium and arsenic, have sufficient data to develop reasonable default values.

The dermal pathway is considered under both the residential and industrial soil exposure scenarios. For those chemicals identified in Table 1, USEPA has developed a method to extrapolate oral toxicity values to toxicity factors appropriate for evaluating dermal toxicity.

Most oral toxicity factors are based on administered dose and do not take into account the fact that only a fraction of the dose is actually absorbed into the body through the gastrointestinal system, while dermal exposure equations incorporate an absorption factor to estimate absorbed dose. For this reason, a gastrointestinal absorption factor is applied to the available oral toxicity values to account for the absorption efficiency of an administered dose across the gastrointestinal tract and into the bloodstream (Equations 1 & 2). Oral toxicity values are adjusted when the gastrointestinal absorption of the chemical is significantly less than 50 percent (Appendix Table A-1). Chemical specific dermal absorption fractions are then applied to the adjusted toxicity factors in the equations to evaluate the dermal pathway.

Residential Exposure Scenario

For the Department's residential scenario for *carcinogens*, the dermal component uses an age-adjusted dermal factor (Appendix Equation A-2) that considers changes in skin surface area, body weight, and adherence factor over a 30-year period of time.

While children have less total skin surface area (SA=2800 cm^2) than adults (5700 cm^2), children have a higher soil-to-skin adherence factor (AF= 0.2 mg/cm^2-event) than adults (.07 mg/cm^2-event). The skin surface area default values represent the 50^{th} percentile for children and adults (USEPA, 1997a). Other default values include an event frequency of one and the chemical-specific dermal absorption fraction (ABS_d) discussed above, which are presented in Table 1 and Equation 3. For compounds classified as both semi-volatile and as a PAH, the ABS_d for PAHs should be used.

The residential *noncarcinogenic* dermal endpoint focuses on a "childhood only" exposure scenario defaulting to a receptor between the ages of 1 through 6 and incorporating a child's soil adherence factor and skin surface area (Equation 4).

Table 1

Compounds and Recommended Dermal Absorption Fractions

Source: USEPA. 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Final.

Compound	Dermal Absorption Fraction (ABS_d)
Arsenic	0.03
Benzo(a)pyrene	0.13
Cadmium	0.001
Chlordane	0.04
DDT	0.03
Lindane	0.04
PAHs	0.13
Pentachlorophenol	0.25
Semi-volatile organic compounds	0.1

Non-residential (Outdoor Industrial Worker) Exposure Scenario

Under the industrial scenario, the Department has chosen to protect the full time adult worker whose daily activities are related to outdoor maintenance. Since adult workers will have only their arms, hands, and face exposed, the skin surface area is reduced to 3,300 cm^2 with an adherence factor of 0.2 mg soil per sq. cm. The Department proposes to use USEPA's default value of 225 days/year for the exposure frequency and 25 years for exposure duration. Outdoor worker scenarios for both *carcinogens* and *noncarcinogens* are based on adult only exposures (Equations 5 & 6).

Equation 1
Calculation of Carcinogenic Dermal Toxicity Values

Source: USEPA. 2004. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final.

$$SF_{ABS} = \frac{SF_o}{ABS_{GI}}$$

Parameter/Definition (units)	Default
SF_{ABS}/dermally adjusted slope factor $(mg/kg\text{-}d)^{-1}$	chemical-specific
SF_o/oral slope factor $(mg/kg\text{-}d)^{-1}$	chemical-specific
ABS_{GI}/gastrointestinal absorption factor (unitless)	chemical-specific (Appendix Table A1)

Equation 2
Calculation of Noncarcinogenic Dermal Toxicity Values

Source: USEPA. 2004. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final.

$$RfD_{ABS} = RfD_o * ABS_{GI}$$

Parameter/Definition (units)	Default
RfD_{ABD}/dermally adjusted reference dose (mg/kg-d)	chemical-specific
RfD_o/oral reference dose (mg/kg-d)	chemical-specific
ABS_{GI}/gastrointestinal absorption factor (unitless)	chemical-specific (Appendix Table A1)

Equation 3

Combined Ingestion and Dermal Absorption Exposure to Carcinogenic Contaminants in Soil
Residential Scenario

Source: USEPA. 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Final.

$$\text{Remediation Standard} = \frac{TR * AT * 365 d/yr}{(EF * 10^{-6} kg/mg)\left[(SF_o * IF_{soil/adj}) + (SF_{ABS} * SFS * ABS_d * EV)\right]}$$

(mg/kg)

Parameter/Definition (units)	Default
TR/target cancer risk (unitless)	10^{-6}
AT/averaging time (years)	70
EF/exposure frequency (days/year)	350
SF_{ABS}/dermally adjusted cancer slope factor $(mg/kg\text{-}d)^{-1}$	chemical-specific (Equation 1)
SFS/age-adjusted dermal factor (mg-yr/kg-event)	360 (Equation A-2)
ABS_d/dermal absorption fraction (unitless)	chemical-specific (Table 1)
EV/event frequency (events/day)	1
SF_o/oral cancer slope factor $(mg/kg\text{-}d)^{-1}$	chemical-specific
$IF_{soil/adj}$/age-adjusted soil ingestion factor (mg-yr/kg-d)	114

Equation 4

Combined Ingestion and Dermal Absorption Exposure to Noncarcinogenic Contaminants in Soil Residential Scenario

Source: USEPA. 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Final.

Remediation Standard =

$$\frac{THQ * BW * AT * 365 d/yr}{\left(EF * ED * 10^{-6} kg/mg\right)\left[\left(\frac{1}{RfD_o} * IR\right) + \left(\frac{1}{RfD_{ABS}} * AF * ABS_d * EV * SA\right)\right]}$$

(mg/kg)

Parameter/Definition (units)	Default
THQ/target hazard quotient (unitless)	1
BW/body weight (kg)	15
AT/averaging time (years)	6
EF/exposure frequency (days/year)	350
ED/exposure duration (years)	6
RfD_o/oral reference dose (mg/kg-d)	chemical-specific
IR/soil ingestion rate (mg/d)	200
RfD_{ABS}/dermally adjusted reference dose (mg/kg-d)	chemical-specific (Equation 2)
AF/skin-soil adherence factor (mg/cm^2-event)	0.2
ABS_d/dermal absorption factor (unitless)	chemical-specific (Table 1)
EV/event frequency (events/day)	1
SA/skin surface area exposed-child (cm^2)	2,800

Equation 5

Combined Ingestion and Dermal Absorption Exposure to Carcinogenic Contaminants in Soil
Non-Residential Outdoor Worker Scenario

Source: USEPA. 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Final.

Remediation Standard = $\frac{TR * BW * AT * 365\,d/yr}{\left(EF * ED * 10^{-6}\ kg/mg\right)\left(\left(SF_o * IR\right) * \left(SF_{ABS} * AF * ABS_d * SA * EV\right)\right)}$ (mg/kg)

Parameter/Definition (units)	Default
TR/target cancer risk (unitless)	10^{-6}
BW/body weight (kg)	70
AT/averaging time (years)	70
EF/exposure frequency (days/year)	225
ED/exposure duration (years)	25
SF_o/oral cancer slope factor $(mg/kg\text{-}d)^{-1}$	chemical-specific
IR/soil ingestion rate (mg/d)	100
SF_{ABS}/dermally adjusted cancer slope factor $(mg/kg\text{-}d)^{-1}$	chemical-specific (Equation 1)
AF/skin-soil adherence factor (mg/cm^2-event)	0.2
ABS_d/dermal absorption fraction (unitless)	chemical-specific (Table 1)
SA/skin surface exposed (cm^2)	3,300
EV/event frequency (events/day)	1

Equation 6

Combined Ingestion and Dermal Absorption Exposure to Noncarcinogenic Contaminants in Soil
Non-Residential Outdoor Worker Scenario

Source: USEPA. 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Final.

Remediation Standard = $$\frac{THQ * BW * AT * 365\,d/yr}{\left(EF * ED * 10^{-6}\,kg/mg\right)\left[\left(\frac{1}{RfD_o} * IR\right) + \left(\frac{1}{RfD_{ABS}} * AF * ABS_d * SA * EV\right)\right]}$$

(mg/kg)

Parameter/Definition (units)	Default
THQ/target hazard quotient (unitless)	1
BW/body weight (kg)	70
AT/averaging time (years)	25
EF/exposure frequency (days/years)	225
ED/exposure duration (years)	25
RfD_o/oral reference dose (mg/kg-d)	chemical-specific
IR/soil ingestion rate (mg/d)	100
RfD_{ABS}/dermally adjusted reference dose (mg/kg-d)	chemical-specific (Equation 2)
AF/skin-soil adherence factor (mg/cm^2-event)	0.2
ABS_d/dermal absorption fraction (unitless)	chemical-specific (Table 1)
SA/skin surface exposed (cm^2)	3,300
EV/event frequency (events/day)	1

C. Chemical-Specific Information

1. Lead

Lead remediation standards are not derived by the same procedures used to develop other chemical standards. There is no apparent threshold for some effects caused by lead exposure in humans, which does not permit the development of a Reference Dose (RfD). An RfD is an estimate of a daily exposure to a human population that is likely to be without an appreciable risk of deleterious effects over a lifetime. Due to no threshold and a pre-existing lead body burden in humans that varies with age, health, and nutrition, other risk assessment methods and tools have been developed to assess lead standards that focus on blood lead levels.

The residential lead remediation standard is based on the determination of USEPA and the Centers for Disease Control and Prevention (CDC) that childhood blood-lead concentrations at or above 10 micrograms per deciliter of blood presents risks to children's health. The Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) (USEPA, 1994a) is designed to predict the probable blood-lead concentrations for children between six months and seven years of age who have been exposed to lead through environmental media (air, water, soil, dust, and diet). Using default parameters, a soil ingestion remediation standard of 400 mg/kg has been set for lead based on the *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (USEPA, 1994b). While the IEUBK model may be run using default values, an alternative cleanup standard may be requested using site-specific data for soil and dust lead concentrations. Site data may also support refined estimates for other exposure-related model parameters such as bioavailability.

The non-residential lead remediation standard of 800 ppm is based on the USEPA recommended interim approach for determining acceptable adult nonresidential lead levels in soil. The methodology is presented in the document *Recommendations of the Technical Review Workgroup (TRW) for Lead for an Interim Approach to Assessing Risk Associated with Adult Exposures to Lead in Soil* (USEPA, 1996b). The standard is based on consideration of the developing fetus of a woman exposed to lead under a nonresidential exposure scenario.

As described by USEPA, the methodology uses a simplified lead biokinetics model to predict steady state adult blood lead levels under routine exposure assumptions. The methodology includes consideration of the relationship between soil lead intake and blood lead concentrations in women of childbearing age. The methodology further relates the estimated maternal adult blood lead level to the estimated fetal blood lead concentration. The USEPA model calculates cleanup goals that would have no more than a 5% probability that a fetus exposed to lead would exceed the recommended blood lead level. The fetal blood lead goal of 10 micrograms of lead per deciliter of blood (ug/dl) is utilized in the lead methodology. Currently, the methodology does not consider the dermal uptake of lead in the calculations due to the uncertainty associated with the determination of a dermal absorption factor representative of the numerous inorganic forms of lead found in the environment.

The USEPA document, *Blood Lead Concentrations of U.S. Adult Females: Summary Statistics From Phases I and II of the National Health and Nutrition Evaluation Survey (NHANES III)* (USEPA, 2002b) updates two input parameters used in the above lead model. The updated values for the background blood lead concentration ($PbB_{adult,0}$) and the geometric standard deviation among adults ($GSD_{i,adults}$) are based on the latest national information obtained from the NHANES III study. The 800 ppm soil lead level is the concentration associated with the protection of the most sensitive population after consideration of the available national data. USEPA's fact sheet concerning updates to the model entitled, *Adult Lead Model (ALM) Frequently Asked Question (FAQs),* cites the use of the 800 ppm value as a cleanup goal protective for all subpopulations (USEPA, 2003a). The Department is, therefore, proposing to use the above USEPA methodology and the resulting cleanup goal of 800 ppm as the restricted lead remediation standard.

The soil lead remediation standard of 800 ppm is also within the range of soil lead concentrations found to be acceptable when considering another health endpoint, that of hypertension. Stern (1996) relates the population shift in systolic blood pressure to the ingestion of lead contaminated soil in "Derivation of a Target Concentration of Pb in Soil Based on Elevation of Adult Blood Pressure." This approach also considers the baseline distribution of blood lead and

systolic pressure in the population as a simultaneous function of soil lead exposure. Based on Stern's analysis, the above soil lead concentration will result in a *de minimus* population-based increase in systolic blood pressure.

An ingestion based non-residential soil remediation standard for lead of 800 ppm is deemed appropriate for sites within New Jersey. Site specific information may be submitted for the Department's consideration in the generation of an alternative remediation standard (ARS) using the above USEPA methodology.

An ARS may be requested for lead contaminated sites under a recreational or park scenario. EPA's guidance, *Assessing Intermittent or Variable Exposures at Lead Sites* (EPA, 2003b), addresses the assessment of non-continuous exposure that may be appropriate for all ages rather than young children (IEUBK model) or adults (ALM model). The application of this guidance will vary with the exposure intensity and complexity of the site; therefore, the DEP will review requests on a case-by-case basis.

2. Polychlorinated Biphenyls (PCBs)

A PCB Work Group representing the Department and the NJ Department of Health and Senior Services (DHSS) has drafted a recommendation (NJDEP, 1997) to revise the A-280 amendments toxicity information to reflect the findings of USEPA's final document entitled *PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures* (1996c). The PCB Work Group recommends that USEPA's slope factor for PCB mixtures of high risk and persistence (2 $(mg/kg/day)^{-1}$) be adopted by New Jersey as the health basis for the drinking water Maximum Contaminant Level, ground water, surface water and soil standards. The ingestion soil standard for PCBs reflects this recommendation.

3. Thallium

The IRIS database does not include toxicity values for thallium. In the development of the ingestion based remediation standards for thallium, the Department employed USEPA's IRIS

reference dose (RfD) for thallium sulfate that is based on the no-observed-adverse-effect level (NOAEL). Since thallium is the toxicologically relevant element in the thallium sulfate compound, the NOAEL and resulting RfD are based on the thallium component of the compound. The Department calculated the equivalent dose of thallium in the thallium sulfate compound based on the percentage of thallium in Tl_2SO_4 by weight.

The NOAEL for thallium sulfate presented in IRIS is 0.25 mg/kg/day. The NOAEL for the thallium components of Tl_2SO_4 is then determined by multiplying the percent of thallium in Tl_2SO_4 (0.8097%) by the NOAEL (0.25 mg/kg/day). The resulting NOAEL for thallium is 0.2025 mg/kg/day.

The thallium NOAEL is then divided by the IRIS recommended uncertainty factor of 3000 to generate a thallium RfD of 7.0×10^{-5} mg/kg/day. The combined pathway standard reflects the use of the above toxicity factor.

III. SOIL REMEDIATION STANDARDS FOR THE INGESTION AND DERMAL ABSORPTION PATHWAY

Chemical	CAS No.	Ingestion-Dermal (mg/kg) Unrestricted (Residential)		Ingestion-Dermal (mg/kg) Restricted (Outdoor Worker)	
Acenaphthene	83-32-9	3400	a	37000	a
Acenaphthylene	208-96-8	---	f	---	f
Acetone (2-Propanone)	67-64-1	70000	a,d	1000000	a,d
Acetophenone	98-86-2	6100	a	68000	a
Acrolein	107-02-8	39	a,d	570	a,d
Acrylonitrile	107-13-1	1	b,d	6	b,d
Aldrin	309-00-2	0.04	b,d	0.2	b,d
Aluminum	7429-90-5	78000	a,d	1100000	a,d
Anthracene	120-12-7	17000	a	180000	a
Antimony	7440-36-0	31	a,d	450	a,d
Arsenic	7440-38-2	0.4	b	2	b
Atrazine	1912-24-9	210	a,c	2400	a,c
Barium	7440-39-3	16000	a,d	230000	a,d
Benzaldehyde	100-52-7	6100	a	68000	a
Benzene	71-43-2	3	b,d	14	b,d
Benzidine	92-87-5	0.002	b	0.008	b
Benzo(a)anthracene (1,2-Benzanthracene)	56-55-3	0.6	b	2	b
Benzo(a)pyrene	50-32-8	0.06	b	0.2	b
Benzo(b)fluoranthene (3,4-Benzofluoranthene)	205-99-2	0.6	b	2	b
Benzo(ghi)perylene	191-24-2	---	f	---	f
Benzo(k)fluoranthene	207-08-9	6	b	23	b
Beryllium	7440-41-7	16	a,c,d	230	a,c,d
1,1'-Biphenyl	92-52-4	3100	a	34000	a
Bis(2-chloroethyl)ether	111-44-4	0.4	b	2	b
Bis(2-chloroisopropyl)ether	108-60-1	2400	a	27000	a
Bis(2-ethylhexyl) phthalate	117-81-7	35	b	140	b
Bromodichloromethane (Dichlorobromomethane)	75-27-4	10	b,d	51	b,d
Bromoform	75-25-2	81	b,d	400	b,d
Bromomethane (Methyl bromide)	74-83-9	110	a,d	1600	a,d
2-Butanone (Methyl ethyl ketone) (MEK)	78-93-3	3100	a,d	44000	a,d
Butyl benzyl phthalate	85-68-7	1200	a,c	14000	a,c
Cadmium	7440-43-9	78	a	1100	a
Caprolactam	105-60-2	31000	a	340000	a
Carbazole	86-74-8	24	b	96	b
Carbon disulfide	75-15-0	7800	a,d	110000	a,d
Carbon tetrachloride	56-23-5	7	b,d	35	b,d
Chlordane (alpha and gamma)	57-74-9	0.2	b	1	b
Chlorobenzene	108-90-7	510	a,d	7400	a,d
Chloroethane (Ethyl chloride)	75-00-3	220	b,d	1100	b,d

Chemical	CAS No.	Ingestion-Dermal (mg/kg) Unrestricted (Residential)		Ingestion-Dermal (mg/kg) Restricted (Outdoor Worker)	
Chloroform	67-66-3	780	a,d	11000	a,d
Chloromethane (Methyl chloride)	74-87-3	---	f	---	f
4-Chloro-3-methyl phenol (p-Chloro-m-cresol)	59-50-7	---	f	---	f
2-Chlorophenol (o-Chlorophenol)	95-57-8	310	a	3400	a
Chromium (III) (Trivalent chromium)	16065-83-1	---	g	---	g
Chromium(VI) (Hexavalent chromium)	18540-29-9	---	g	---	g
Chromium (total)	7440-47-3	---	g	---	g
Chrysene	218-01-9	62	b	230	b
Cobalt	7440-48-4	1600	a,d	23000	a,d
Copper	7440-50-8	3100	a,d	45000	a,d
Cyanide	57-12-5	1600	a,d	23000	a,d
4,4'-DDD	72-54-8	3	b,d	13	b,d
4,4'-DDE	72-55-9	2	b,d	9	b,d
4,4'-DDT	50-29-3	2	b	8	b
Dibenz(a,h)anthracene	53-70-3	0.06	b	0.2	b
Dibenzofuran	132-64-9	---	f	---	f
Dibromochloromethane (Chlorodibromomethane)	124-48-1	8	b,d	38	b,d
1,2-Dibromo-3-chloropropane	96-12-8	0.3	b	1	b
1,2-Dibromoethane	106-93-4	0.008	b,d	0.04	b,d
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	5300	a	59000	a
1,3-Dichlorobenzene (m-Dichlorobenzene)	541-73-1	5300	a	59000	a
1,4-Dichlorobenzene (p-Dichlorobenzene)	106-46-7	610	a,c	6800	a,c
3,3'-Dichlorobenzidine	91-94-1	1	b	4	b
Dichlorodifluoromethane	75-71-8	16000	a,d	230000	a,d
1,1-Dichloroethane	75-34-3	510	a,d	7400	a,d
1,2-Dichloroethane	107-06-2	5	b,d	26	b,d
1,1-Dichloroethene (1,1-Dichloroethylene)	75-35-4	11	a,c,d	160	a,c,d
1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	156-59-2	780	a,d	11000	a,d
1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	156-60-5	1300	a,d	19000	a,d
2,4-Dichlorophenol	120-83-2	180	a	2100	a
1,2-Dichloropropane	78-87-5	9	b,d	47	b,d
1,3-Dichloropropene (cis and trans)	542-75-6	6	b,d	32	b,d
Dieldrin	60-57-1	0.04	b,d	0.2	b,d
Diethyl phthalate	84-66-2	49000	a	550000	a
2,4-Dimethyl phenol	105-67-9	1200	a	14000	a
Dimethylphthalate	131-11-3	---	f	---	f
Di-n-butyl phthalate	84-74-2	6100	a	68000	a
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	534-52-1	6	a	68	a
2,4-Dinitrophenol	51-28-5	120	a	1400	a
2,4-Dinitrotoluene	121-14-2	0.7	b	3	b
2,6-Dinitrotoluene	606-20-2	0.7	b	3	b
2,4-Dinitrotoluene/2,6-Dinitrotoluene (mixture)	25321-14-6	0.7	b	3	b
Di-n-octyl phthalate	117-84-0	2400	a	27000	a
1,2-Diphenylhydrazine	122-66-7	0.6	b	2	b
Endosulfan I and Endosulfan II (alpha and beta)	115-29-7	470	a,d	6800	a,d
Endosulfan sulfate	1031-07-8	470	a,d	6800	a,d
Endrin	72-20-8	23	a,d	340	a,d

Chemical	CAS No.	Ingestion-Dermal (mg/kg) Unrestricted (Residential)		Ingestion-Dermal (mg/kg) Restricted (Outdoor Worker)	
Ethyl benzene	100-41-4	7800	a,d	110000	a,d
Fluoranthene	206-44-0	2300	a	24000	a
Fluorene	86-73-7	2300	a	24000	a
alpha-HCH (alpha-BHC)	319-84-6	0.1	b,d	0.5	b,d
beta-HCH (beta-BHC)	319-85-7	0.4	b,d	2	b,d
Heptachlor	76-44-8	0.1	b,d	0.7	b,d
Heptachlor epoxide	1024-57-3	0.07	b,d	0.3	b,d
Hexachlorobenzene	118-74-1	0.3	b	1	b
Hexachloro-1,3-butadiene	87-68-3	6	b	25	b
Hexachlorocyclopentadiene	77-47-4	370	a	4100	a
Hexachloroethane	67-72-1	35	b	140	b
2-Hexanone	591-78-6	---	f	---	f
Indeno(1,2,3-cd)pyrene	193-39-5	0.6	b	2	b
Isophorone	78-59-1	510	b	2000	b
Lead	7439-92-1	400	e	800	e
Lindane (gamma-HCH) (gamma-BHC)	58-89-9	0.4	b	2	b
Manganese	7439-96-5	11000	a,d	160000	a,d
Mercury	7439-97-6	23	a,d,h	340	a,d,h
Methoxychlor	72-43-5	390	a,d	5700	a,d
Methyl acetate	79-20-9	78000	a,d	1100000	a,d
Methylcyclohexane	108-87-2	---	f	---	f
Methylene chloride (Dichloromethane)	75-09-2	46	b,d	230	b,d
2-Methylnaphthalene	91-57--6	230	a	2400	a
4-Methyl-2-pentanone (MIBK)	108-10-1	---	f	---	f
2-Methylphenol (o-Creosol)	95-48-7	310	a,c	3400	a,c
4-Methylphenol (p-Creosol)	106-44-5	31	a,c	340	a,c
Methyl tert-butyl ether (MTBE)	1634-04-4	780	a,c,d	11000	a,c,d
Naphthalene	91-20-3	2400	a,c	25000	a,c
Nickel (Soluble salts)	7440-02-0	1600	a,d	23000	a,d
2-Nitroaniline	88-74-4	---	f	---	f
Nitrobenzene	98-95-3	31	a	340	a
4-Nitrophenol	100-02-7	---	f	---	f
N-Nitrosodimethylamine	62-75-9	0.01	b,d	0.06	b,d
N-Nitrosodi-n-propylamine	621-64-7	0.07	b	0.3	b
N-Nitrosodiphenylamine	86-30-6	99	b	390	b
Pentachlorophenol	87-86-5	3	b	10	b
Phenanthrene	85-01-8	---	f	---	f
Phenol	108-95-2	18000	a	210000	a
Polychlorinated biphenyls (PCBs)	1336-36-3	0.2	b	1	b
Pyrene	129-00-0	1700	a	18000	a
Selenium	7782-49-2	390	a,d	5700	a,d
Silver	7440-22-4	390	a,d	5700	a,d
Styrene	100-42-5	16000	a,d	230000	a,d
Tertiary butyl alcohol (TBA)	75-65-0	1400	a,c,d	20000	a,c,d
1,1,2,2-Tetrachloroethane	79-34-5	10	a,c,d	150	a,c,d
Tetrachloroethene (PCE) (Tetrachloroethylene)	127-18-4	8	b,d	39	b,d
Thallium	7440-28-0	5	a,d	79	a,d

Chemical	CAS No.	Ingestion-Dermal (mg/kg) Unrestricted (Residential)		Ingestion-Dermal (mg/kg) Restricted (Outdoor Worker)	
Toluene	108-88-3	6,300	a,d	91000	a,d
Toxaphene	8001-35-2	0.6	b,d	3	b,d
1,2,4-Trichlorobenzene	120-82-1	73	a	820	a
1,1,1-Trichloroethane	71-55-6	290	a,d	4200	a,d
1,1,2-Trichloroethane	79-00-5	31	a,c,d	440	a,c,d
Trichloroethene (TCE) (Trichloroethylene)	79-01-6	21	b,d	100	b,d
Trichlorofluoromethane	75-69-4	23000	a,d	340000	a,d
2,4,5-Trichlorophenol	95-95-4	6100	a	68000	a
2,4,6-Trichlorophenol	88-06-2	19	b	74	b
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	2300000	a,d	34000000	a,d
Vanadium	7440-62-2	78	a,d	1100	a,d
Vinyl chloride	75-01-4	2	b,d	8	b,d
Xylenes	1330-20-7	12000	a,d	170000	a,d
Zinc	7440-66-6	23000	a,d	340000	a,d

Footnotes:

a. Calculated values correspond to a non cancer hazard quotient of 1
b. Calculated values correspond to a cancer risk of 1 in 1,000,000
c. Calculated values based on DEP C-carcinogen policy that includes and additional safety factor of 10
d. No dermal absorption data available or standard based on ingestion data only
e. Lead standards based on the IEUBK and adult lead models
f. No toxicity data available
g. Chemical not regulated in pathway at this time
h. Standard for mercury based on RfD for mercuric chloride (CAS # 007847-94-7)

Both carcinogenic and non carcinogenic calculations are presented in Appendix Table A-2. Supporting benchmarks and toxicity data are found in Appendix Tables A-3 and A-4.

IV. HIERARCHY FOR TOXICITY SOURCE INFORMATION

The toxicity information used to generate ingestion-dermal absorption standards is obtained from a variety of sources; however, the Department uses a preferred hierarchy for obtaining this information. The hierarchy is listed below:

1. Toxicity information which forms the basis for drinking water standards adopted by the Department pursuant to the A-280 Amendment to the NJ Safe Drinking Water Act

2. EPA's Integrated Risk Information System (IRIS: USEPA, 2007)

3. Other potential sources including EPA's National Center for Environmental Assessment's (NCEA, 2007) Provisional Peer-Reviewed Toxicity Values (PPRTV), USEPA's Health Effects Assessment Summary Tables (HEAST), and toxicity factors developed by NJDEP as the basis for New Jersey Interim Specific Ground Water Criteria. Also California Environmental Protection Agency's (CAL EPA, 2007) toxicity values and the Agency for Toxic Substances and Disease Registry's (ATSDR) minimal risk levels (MRLs) may be considered (ATSDR, 2006).

The A-280 Amendments (1984) to the New Jersey Safe Drinking Water Act (P.L.1983, c.443) mandated the establishment of Maximum Contaminated Levels (MCLs) for a list of specific contaminants and provided for the establishment of MCLs for additional contaminants based on occurrence and potential for human health effects. MCLs were adopted as the Department's drinking water quality standards and are currently used as the basis for New Jersey's Ground Water Quality Standards and Surface Water Quality Standards. In order to maintain consistency with other State standards, the A-280 contaminant toxicity information is the preferred by the Department as the first source of toxicity information for the development of soil ingestion-dermal absorption standards. Supporting documentation for A-280 toxicity information may be found in the New Jersey Drinking Water Quality Institute's *Maximum Contaminant Level*

Recommendations for Hazardous Contaminants in Drinking Water, Appendix A, Health-Based Maximum Contaminant Level Support Documents and Addenda (NJDWQI, 1987 &1994).

For those chemicals not addressed by the A-280 amendments, the Department's preferred source of toxicity information is USEPA's Integrated Risk Information System (IRIS) database which provides regularly updated, peer reviewed reference doses and slope factors. (USEPA, 2007).

USEPA's National Center for Environmental Assessment (NCEA) in Cincinnati, Ohio is currently reevaluating and peer-reviewing toxicity values in the USEPA Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997b). NCEA's Provisional Peer-Reviewed Toxicity Values (PPRTV) provide information for chemicals that do not have A-280 or IRIS toxicity values (NCEA, 2007). After review by DEP toxicologists, these values were used as the basis for a number of the Department's ingestion/dermal standards.

For some contaminants, toxicity factors used were developed from the primary scientific literature by NJDEP as the basis for Interim Specific Ground Water Criteria. The Department also may develop toxicity factors that differ from those based on the sources cited above if warranted by scientific evidence or for contaminants that are not addressed in these sources.

V. POLICY FOR POSSIBLE HUMAN CARCINOGENS (GROUP C)

The Department has adopted a policy for the development of soil ingestion-dermal absorption standards for C-carcinogen contaminants classified as possible human carcinogens (USEPA carcinogen Group C) under the *1986 Guidelines for Carcinogen Risk Assessment* (USEPA, 1986). These are contaminants for which some evidence of human carcinogenicity exists, but for which there is insufficient evidence to classify the contaminants as Known Human Carcinogens (Group A) or Probable Human Carcinogens (Group B). This policy will be used in developing Departmental health-based standards including drinking water health-based MCLs, ground water criteria, and human health-based surface water criteria. USEPA policy for the risk assessment of Group C chemicals is not consistent between programs, with differing approaches used by the Office of Water and Superfund.

Under the DEP policy, risk assessments for possible human carcinogens will be based upon a slope factor, at the one in one million risk level calculated from a slope factor, if such a factor is available in IRIS and deemed appropriate for use by DEP. If a slope factor is not available on IRIS or the Department determines that the available slope factor is inappropriate for use, the risk assessment for the Group C chemical will be based on the Reference Dose for non-carcinogenic effects. An additional uncertainty factor of 10 will be applied to account for potential carcinogenic effects not addressed by the RfD.

The Department is aware that USEPA has finalized *Guidelines for Carcinogen Risk Assessment* (USEPA, 2005), and that these guidelines recommend using narrative descriptors for weight of evidence of carcinogenicity in place of the existing alphabetic classification system. The contaminants for which the Department is proposing soil standards were evaluated under the alphabetic classification system, and our policy will remain unchanged for chemicals categorized as Group C, Possible Human Carcinogen, under this system. As the practical implications of the narrative descriptors in the new guidelines become clear, the Department will consider adapting its policy for chemicals that are evaluated under these narrative descriptors as they become available.

VI. ALTERNATIVE REMEDIATION STANDARDS

The Department will review proposals for alternative remediation standards on a site-by-site basis and render a decision on the acceptability of the proposal for the site. An alternative remediation standard for the ingestion-dermal pathway may be requested based on: (1) advancements in risk-related methodology that support standards derivation such as new toxicity or exposure information, improved or advanced models and methods; (2) appropriate site-specific default parameters (for lead models); or (3) different land use determinations such as park and recreational scenarios. No specific default values are given for park/recreational scenarios due to their site specific nature and variability. These pathways will be developed on a case-by-case basis, following careful consideration of the appropriate land use and applicable exposure variables.

Option 1- Advancements in Risk Related Information & Methodology

The Department will accept for review an ARS based on new toxicity or exposure information, updated versions of models, and new risk assessment methodology as it becomes available.

Option 2 – Site Specific Default Values

The ingestion-dermal pathway uses EPA recommended default exposure parameters for residential and non-residential scenarios for all standards, except lead. These parameters are generic and reflect a reasonable maximum exposure (RME) that may not be adjusted.

For lead, other risk assessment tools have been developed that use models to predict appropriate blood lead levels. The Department may accept an application for an ARS for residential exposure based on input parameters identified by the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) (USEPA, 1994a) using site-specific data for soil and dust lead concentrations. Site data may be used to refine estimates for other exposure –related model parameters such as bioavailability.

The Department may accept an application for alternative remediation standard for lead for non-residential site use based on input parameters identified in the document, Recommendations of the Technical Review Workgroup (TRW) for Lead for an Interim Approach to Assessing Risk Associated with Adult Exposures to Lead in Soil (USEPA, 1996b).

The Department may accept an application for an alternative remediation standard for a recreational land use at a lead site based on the assessment of non-continuous exposure for all ages identified in the EPA guidance, *Assessing Intermittent or Variable Exposures at Lead Sites* (EPA, 2003c).

Option 3 – Recreational Land Use Scenario

An alternative remediation standard may be based on use of the site for recreational purposes. Recreational purposes are site-specific uses that do not reflect either a residential or non-

residential land use scenario. Alternative standards may be based on site-specific land use scenarios that effect the amount of time that people are likely to spend at a site that is designated for recreational use. There are two basic types of recreational land use scenarios, active and passive, that may be considered. Examples of active recreational land use are sports playing fields and playgrounds. Examples of passive recreational land use are walking or bike trails. The approval of an alternative remediation standard for recreational land use will be contingent on the use of proper institutional controls to ensure the continued use of the site for the proposed recreational use.

VII. COMPLIANCE

Based on the anticipated land use for the site, concentrations of contaminants found in the soil are compared to their corresponding ingestion/dermal absorption standards. The standard for the residential pathway is considered protective for unrestricted land use, while the outdoor worker scenario is used for non-residential for sites that will have a restricted land use. When a standard for the ingestion-dermal pathway is not exceeded, that contaminant may be eliminated from concern. However, all sampled contaminants that exceed their relevant ingestion-dermal absorption standard must be addressed during remediation.

A. Site Wide Averaging

The Department does not routinely accept USEPA's methodology that allows site wide averaging of contaminant soil samples for comparison to ingestion/dermal absorption standards for the following reasons:

- Site wide averaging is only appropriate where contact with soil over all areas of the site is equally probable. When using site wide averaging, contamination may be allowed to remain in areas that are frequented more readily (e.g. playground), resulting in exposure to unacceptable levels of contaminants.

- The ingestion/dermal standards are based on protection from chronic health effects. Site wide averaging increases the probability of leaving concentrations of contaminants on site that may exceed acute toxicity levels. Currently, there is limited consensus as to the appropriate data for evaluating acute toxicity concerns.

- Data needed to support a site wide averaging approach is inconsistent with the Department's current sampling philosophy which biases sampling to areas of greatest contamination.

The Department may accept site wide averaging on a case-by-case basis when sampling on a grid basis (random & unbiased) is deemed to be representative of concentrations across the site. Averaging may also be considered appropriate for sporadic low levels of contaminants with no discernable source areas or where minimal exceedances of the standard are detected during post excavation sampling.

B. Area of Concern (AOC) Compliance Averaging

While currently allowed under the Technical Regulations (NJAC 7:26E-4.8 (c) 3.i.(5)), compliance averaging over an area of concern is limiting and used infrequently, if at all, throughout the Department's Site Remediation and Waste Management programs. The Department allows averaging of sporadic low levels of contaminants with no discernable source area and minimal exceedances of a standard during post excavation sampling.

VIII. REFERENCES

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CAL EPA. California Environmental Protection Agency. 2007. Toxicity Criteria Database. www.oehha.ca.gov/risk/ChemicalDB.html

NCEA. National Center for Environmental Assessment. 2007. Database currently under development. Contact hotline at ☎ (513) 569-7300 for NCEA's Provisional Peer-Reviewed Toxicity Values (PPRTV).

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U.S. Environmental Protection Agency (USEPA). 2003b. Assessing Intermittent or Variable Exposures at Lead Sites, Office of Solid Waste and Emergency Response, OSWER 9285.7-76.

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IX. APPENDIX

Equation A-1
Derivation of the Age-Adjusted Soil Ingestion Factor

Source: USEPA. 1991. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Part B.

$$IF_{soil/adj} = \left[\frac{IR_{soil/age1-6} * ED_{age1-6}}{BW_{age1-6}}\right] + \left[\frac{IR_{soil/age7-31} * ED_{age7-31}}{BW_{age7-31}}\right]$$

Parameter/Definition (units)	Default
$IF_{soil/adj}$/age-adjusted soil ingestion factor (mg-yr/kg-d)	114
$IR_{soil/age1-6}$/ingestion rate of soil age 1-6 (mg/d)	200
ED_{age1-6}/exposure duration during ages 1-6 (yr)	6
$IR_{soil/age7-31}$/ingestion rate of soil age 7-31 (mg/d)	100
$ED_{age7-31}$/exposure duration during ages 7-31 (yr)	24
BW_{age1-6}/average body weight from ages 1-6 (kg)	15
$BW_{age7-31}$/average body weight from ages 7-31 (kg)	70

Equation A-2
Derivation of the Age-Adjusted Dermal Factor

Source: USEPA. 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final.

$$SFS = \left[\frac{SA_{1-6} * AF_{1-6} * ED_{1-6}}{BW_{1-6}}\right] + \left[\frac{SA_{7-31} * AF_{7-31} * ED_{7-31}}{BW_{7-31}}\right]$$

Parameter/Definition (units)	Default
SFS/age-adjusted dermal factor (mg-yr/kg-event)	360
SA_{1-6}/skin surface area exposed-child (cm^2)	2,800
SA_{7-31}/skin surface area exposed-adult (cm^2)	5,700
AF_{1-6}/skin-soil adherence factor-child (mg/cm^2-event)	0.2
AF_{7-31}/ skin-soil adherence factor-adult (mg/cm^2-event)	0.07
ED_{1-6}/exposure duration-child (years)	6
ED_{7-31}/exposure duration-adult (years)	24
BW_{1-6}/body weight-child (kg)	15
BW_{7-31}/body weight-adult (kg)	70

Table A-1
Gastrointestinal Absorption Efficiencies and Adjustment of Dermal Toxicity Factors

Source: USEPA. 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Final.

Compound	**Percent Absorbed**	**ABS_{GI} Gastrointestinal Absorption Factor (unitless)**
Organics		
Chlordane	80%	1
DDT	70-90%	1
Pentachlorophenol	76-100%	1
Polycyclic aromatic hydrocarbons (PAHs)	58-89%	1
Other Dioxins/Dibenzofurans	>50%	1
All other organic compounds	generally >50%	1
Inorganics		
Arsenic	95%	1
Cadmium	2.5-5%	0.025

Table A-2 ***Ingestion-Dermal Absorption Pathway for Carcinogenic and Noncarcinogenic Effects***

Chemical	CAS No.	Ingestion-Dermal (mg/kg) Unrestricted (Residential)		Ingestion-Dermal (mg/kg) Restricted (Outdoor Worker)	
		Carcinogen	Non-Carcinogen	Carcinogen	Non-Carcinogen
Acenaphthene	83-32-9		3.44E+03		3.67E+04
Acenaphthylene	208-96-8				
Acetone (2-Propanone)	67-64-1		7.04E+04		1.02E+06
Acetophenone	98-86-2		6.11E+03		6.84E+04
Acrolein	107-02-8		3.91E+01		5.68E+02
Acrylonitrile	107-13-1	1.19E+00	7.82E+01	5.89E+00	1.14E+03
Aldrin	309-00-2	3.77E-02	2.35E+00	1.87E-01	3.41E+01
Aluminum	7429-90-5		7.82E+04		1.14E+06
Anthracene	120-12-7		1.72E+04		1.83E+05
Antimony	7440-36-0		3.13E+01		4.54E+02
Arsenic	7440-38-2	3.90E-01	2.16E+01	1.77E+00	2.84E+02
Atrazine	1912-24-9		2.14E+02		2.39E+03
Barium	7440-39-3		1.56E+04		2.27E+05
Benzaldehyde	100-52-7		6.11E+03		6.84E+04
Benzene	71-43-2	2.78E+00		1.38E+01	
Benzidine	92-87-5	2.12E-03	1.83E+02	8.33E-03	2.05E+03
Benzo(a)anthracene (1,2-Benzanthracene)	56-55-3	6.22E-01		2.34E+00	
Benzo(a)pyrene	50-32-8	6.22E-02		2.34E-01	
Benzo(b)fluoranthene (3,4-Benzofluoranthene)	205-99-2	6.22E-01		2.34E+00	
Benzo(ghi)perylene	191-24-2				
Benzo(k)fluoranthene	207-08-9	6.22E+00		2.34E+01	
Beryllium	7440-41-7		1.56E+01		2.27E+02
1,1'-Biphenyl	92-52-4		3.06E+03		3.42E+04
Bis(2-chloroethyl)ether	111-44-4	4.42E-01		1.74E+00	
Bis(2-chloroisopropyl)ether	108-60-1		2.44E+03		2.74E+04
Bis(2-ethylhexyl) phthalate	117-81-7	3.48E+01	1.22E+03	1.37E+02	1.37E+04
Bromodichloromethane (Dichlorobromomethane)	75-27-4	1.03E+01	1.56E+03	5.13E+01	2.27E+04
Bromoform	75-25-2	8.11E+01	1.56E+03	4.02E+02	2.27E+04
Bromomethane (Methyl bromide)	74-83-9		1.10E+02		1.59E+03
2-Butanone (Methyl ethyl ketone) (MEK)	78-93-3		3.05E+03		4.43E+04
Butyl benzyl phthalate	85-68-7		1.22E+03		1.37E+04
Cadmium	7440-43-9		7.8E+01		1.13E+03
Caprolactam	105-60-2		3.06E+04		3.42E+05
Carbazole	86-74-8	2.43E+01		9.58E+01	
Carbon disulfide	75-15-0		7.82E+03		1.14E+05
Carbon tetrachloride	56-23-5	7.04E+00		3.49E+01	
Chlordane (alpha and gamma)	57-74-9	2.47E-01		1.09E+00	

Table A-2 (cont.) ***Ingestion-Dermal Absorption Pathway for Carcinogenic and Noncarcinogenic Effects***

Chemical	CAS No.	Ingestion-Dermal (mg/kg) Unrestricted (Residential)		Ingestion-Dermal (mg/kg) Restricted (Outdoor Worker)	
		Carcinogen	Non-Carcinogen	Carcinogen	Non-Carcinogen
Chlorobenzene	108-90-7		5.08E+02		7.38E+03
Chloroethane (Ethyl chloride)	75-00-3	2.21E+02	3.13E+04	1.10E+03	4.54E+05
Chloroform	67-66-3		7.82E+02		1.14E+04
Chloromethane (Methyl chloride)	74-87-3				
4-Chloro-3-methyl phenol (p-Chloro-m-cresol)	59-50-7				
2-Chlorophenol (o-Chlorophenol)	95-57-8		3.06E+02		3.42E+03
Chromium (III) (Trivalent chromium)	16065-83-1				
Chromium(VI) (Hexavalent chromium)	18540-29-9				
Chromium (total)	7440-47-3				
Chrysene	218-01-9	6.22E+01		2.34E+02	
Cobalt	7440-48-4		1.56E+03		2.27E+04
Copper	7440-50-8		3.13E+03		4.54E+04
Cyanide	57-12-5		1.56E+03		2.27E+04
4,4'-DDD	72-54-8	2.67E+00	1.56E+02	1.32E+01	2.27E+03
4,4'-DDE	72-55-9	1.88E+00		9.35E+00	
4,4'-DDT	50-29-3	1.72E+00	3.61E+01	7.81E+00	4.74E+02
Dibenz(a,h)anthracene	53-70-3	6.22E-02		2.34E-01	
Dibenzofuran	132-64-9				
Dibromochloromethane (Chlorodibromomethane)	124-48-1	7.62E+00	1.56E+03	3.79E+01	2.27E+04
1,2-Dibromo-3-chloropropane	96-12-8	3.48E-01		1.37E+00	
1,2-Dibromoethane	106-93-4	7.53E-03	7.04E+02	3.74E-02	1.02E+04
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1		5.26E+03		5.88E+04
1,3-Dichlorobenzene (m-Dichlorobenzene)	541-73-1		5.26E+03		5.88E+04
1,4-Dichlorobenzene (p-Dichlorobenzene)	106-46-7		6.11E+02		6.84E+03
3,3'-Dichlorobenzidine	91-94-1	1.08E+00		4.26E+00	
Dichlorodifluoromethane	75-71-8		1.56E+04		2.27E+05
1,1-Dichloroethane	75-34-3		5.08E+02		7.38E+03
1,2-Dichloroethane	107-06-2	5.34E+00		2.65E+01	
1,1-Dichloroethene	75-35-4		1.10E+01		1.59E+02
1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	156-59-2		7.82E+02		1.14E+04
1,2-Dichloroethene (trans)(t-1,2-dichloroethylene)	156-60-5		1.33E+03		1.93E+04
2,4-Dichlorophenol	120-83-2		1.83E+02		2.05E+03
1,2-Dichloropropane	78-87-5	9.42E+00		4.68E+01	
1,3-Dichloropropene (cis and trans)	542-75-6	6.40E+00	2.35E+03	3.18E+01	3.41E+04
Dieldrin	60-57-1	4.00E-02	3.91E+00	1.99E-01	5.68E+01
Diethyl phthalate	84-66-2		4.89E+04		5.47E+05
2,4-Dimethyl phenol	105-67-9		1.22E+03		1.37E+04
Dimethylphthalate	131-11-3				
Di-n-butyl phthalate	84-74-2		6.11E+03		6.84E+04
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	534-52-1		6.11E+00		6.84E+01
2,4-Dinitrophenol	51-28-5		1.22E+02		1.37E+03
2,4-Dinitrotoluene	121-14-2	7.16E-01	1.22E+02	2.82E+00	1.37E+03

Table A-2 (cont.) ***Ingestion-Dermal Absorption Pathway for Carcinogenic and Noncarcinogenic Effects***

Chemical	CAS No.	Ingestion-Dermal (mg/kg) Unrestricted (Residential)		Ingestion-Dermal (mg/kg) Restricted (Outdoor Worker)	
		Carcinogen	Non-Carcinogen	Carcinogen	Non-Carcinogen
2,6-Dinitrotoluene	606-20-2	7.16E-01	6.11E+01	2.82E+00	6.84E+02
2,4-Dinitrotoluene/2,6-Dinitrotoluene	25321-14-6	7.16E-01		2.82E+00	
Di-n-octyl phthalate	117-84-0		2.44E+03		2.74E+04
1,2-Diphenylhydrazine	122-66-7	6.08E-01		2.39E+00	
Endosulfan I and Endosulfan II (alpha and beta)	115-29-7		4.69E+02		6.81E+03
Endosulfan sulfate	1031-07-8		4.69E+02		6.81E+03
Endrin	72-20-8		2.35E+01		3.41E+02
Ethyl benzene	100-41-4		7.82E+03		1.14E+05
Fluoranthene	206-44-0		2.29E+03		2.44E+04
Fluorene	86-73-7		2.29E+03		2.44E+04
alpha-HCH (alpha-BHC)	319-84-6	1.02E-01		5.05E-01	
beta-HCH (beta-BHC)	319-85-7	3.56E-01		1.77E+00	
Heptachlor	76-44-8	1.42E-01	3.91E+01	7.07E-01	5.68E+02
Heptachlor epoxide	1024-57-3	7.04E-02	1.02E+00	3.49E-01	1.48E+01
Hexachlorobenzene	118-74-1	3.04E-01	4.89E+01	1.20E+00	5.47E+02
Hexachloro-1,3-butadiene	87-68-3	6.24E+00	1.22E+01	2.46E+01	1.37E+02
Hexachlorocyclopentadiene	77-47-4		3.67E+02		4.10E+03
Hexachloroethane	67-72-1	3.48E+01	6.11E+01	1.37E+02	6.84E+02
2-Hexanone	591-78-6				
Indeno(1,2,3-cd)pyrene	193-39-5	6.22E-01		2.34E+00	
Isophorone	78-59-1	5.12E+02	1.22E+04	2.02E+03	1.37E+05
Lead	7439-92-1				
Lindane (gamma-HCH) (gamma-BHC)	58-89-9	4.37E-01	2.11E+01	1.93E+00	2.70E+02
Manganese	7439-96-5		1.10E+04		1.59E+05
Mercury *	7439-97-6		2.35E+01		3.41E+02
Methoxychlor	72-43-5		3.91E+02		5.68E+03
Methyl acetate	79-20-9		7.82E+04		1.14E+06
Methylcyclohexane	108-87-2				
Methylene chloride (Dichloromethane)	75-09-2	4.57E+01		2.27E+02	
2-Methylnaphthalene	91-57-6		2.29E+02		2.44E+03
4-Methyl-2-pentanone (MIBK)	108-10-1				
2-Methylphenol (o-Creosol)	95-48-7		3.06E+02		3.42E+03
4-Methylphenol (p-Creosol)	106-44-5		3.06E+01		3.42E+02
Methyl tert-butyl ether (MTBE)	1634-04-4		7.82E+02		1.14E+04
Naphthalene	91-20-3		2.35E+03		2.51E+04
Nickel (Soluble salts)	7440-02-0		1.56E+03		2.27E+04
2-Nitroaniline	88-74-4				
Nitrobenzene	98-95-3		3.06E+01		3.42E+02
4-Nitrophenol	100-02-7				
N-Nitrosodimethylamine	62-75-9	1.26E-02	6.26E-01	6.23E-02	9.08E+00
N-Nitrosodi-n-propylamine	621-64-7	6.95E-02		2.74E-01	
N-Nitrosodiphenylamine	86-30-6	9.93E+01	1.22E+02	3.91E+02	1.37E+03

Table A-2 (cont.) ***Ingestion-Dermal Absorption Pathway for Carcinogenic and Noncarcinogenic Effects***

Chemical	CAS No.	Ingestion-Dermal (mg/kg) Unrestricted (Residential)		Ingestion-Dermal (mg/kg) Restricted (Outdoor Worker)	
		Carcinogen	Non-Carcinogen	Carcinogen	Non-Carcinogen
Pentachlorophenol	87-86-5	2.98E+00	1.38E+03	1.00E+01	1.29E+04
Phenanthrene	85-01-8				
Phenol	108-95-2		1.83E+04		2.05E+05
Polychlorinated biphenyls (PCBs)	1336-36-3	2.43E-01		9.58E-01	
Pyrene	129-00-0		1.72E+03		1.83E+04
Selenium	7782-49-2		3.91E+02		5.68E+03
Silver	7440-22-4		3.91E+02		5.68E+03
Styrene	100-42-5		1.56E+04		2.27E+05
Tertiary butyl alcohol (TBA)	75-65-0		1.41E+03		2.04E+04
1,1,2,2-Tetrachloroethane	79-34-5		1.05E+01		1.52E+02
Tetrachloroethene (PCE) (Tetrachloroethylene)	127-18-4	7.81E+00		3.88E+01	
Thallium	7440-28-0		5.48E+00		7.95E+01
Toluene	108-88-3		6.26E+03		9.08E+04
Toxaphene	8001-35-2	5.82E-01		2.89E+00	
1,2,4-Trichlorobenzene	120-82-1		7.33E+01		8.21E+02
1,1,1-Trichloroethane	71-55-6		2.89E+02		4.20E+03
1,1,2-Trichloroethane	79-00-5		3.05E+01		4.43E+02
Trichloroethene (TCE) (Trichloroethylene)	79-01-6	2.07E+01		1.03E+02	
Trichlorofluoromethane	75-69-4		2.35E+04		3.41E+05
2,4,5-Trichlorophenol	95-95-4		6.11E+03		6.84E+04
2,4,6-Trichlorophenol	88-06-2	1.87E+01		7.37E+01	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1		2.35E+06		3.41E+07
Vanadium	7440-62-2		7.82E+01		7.57E+00
Vinyl chloride	75-01-4	1.52E+00		7.57E+00	
Xylenes	1330-20-7		1.17E+04		1.70E+05
Zinc	7440-66-6		2.35E+04		3.41E+05

Mercury* - standard is based on RfD for mercuric chloride (CAS# 007847-94-7)

Table A-3 ***Benchmarks Supporting Ingestion-Dermal Absorption Standards***

Chemical	CAS No.	Dermal Absorption Fraction (ABS_d)	Dermal Slope Factor (SF)	Dermal Reference Dose (RfD)	Gastro-intestinal Absorption Fraction (ABS_{GI})
Acenaphthene	83-32-9	0.13		6.00E-02	1
Acenaphthylene	208-96-8				
Acetone (2-Propanone)	67-64-1			9.00E-01	
Acetophenone	98-86-2	0.1		1.00E-01	1
Acrolein	107-02-8			5.00E-04	
Acrylonitrile	107-13-1		0.54	1.00E-03	
Aldrin	309-00-2		17	3.00E-05	1
Aluminum	7429-90-5			1.00E+00	
Anthracene	120-12-7	0.13		3.00E-01	1
Antimony	7440-36-0			4.00E-04	
Arsenic	7440-38-2	0.03	1.5	3.00E-04	1
Atrazine	1912-24-9	0.1		3.50E-03	1
Barium	7440-39-3			2.00E-01	
Benzaldehyde	100-52-7	0.1		1.00E-01	1
Benzene	71-43-2		0.23	4.00E-03	
Benzidine	92-87-5	0.1	230	3.00E-03	1
Benzo(a)anthracene (1,2-Benzanthracene)	56-55-3	0.13	0.73		1
Benzo(a)pyrene	50-32-8	0.13	7.3		1
Benzo(b)fluoranthene (3,4-Benzofluoranthene)	205-99-2	0.13	0.73		1
Benzo(ghi)perylene	191-24-2				
Benzo(k)fluoranthene	207-08-9	0.13	0.073		1
Beryllium	7440-41-7			2.00E-04	
1,1'-Biphenyl	92-52-4	0.1		5.00E-02	1
Bis(2-chloroethyl)ether	111-44-4	0.1	1.1		1
Bis(2-chloroisopropyl)ether	108-60-1	0.1		4.00E-02	1
Bis(2-ethylhexyl) phthalate	117-81-7	0.1	0.014	2.00E-02	1
Bromodichloromethane (Dichlorobromomethane)	75-27-4		0.062	2.00E-02	
Bromoform	75-25-2		0.0079	2.00E-02	
Bromomethane (Methyl bromide)	74-83-9			1.40E-03	
2-Butanone (Methyl ethyl ketone) (MEK)	78-93-3			3.90E-02	
Butyl benzyl phthalate	85-68-7	0.1		2.00E-02	1
Cadmium	7440-43-9	0.001		1.00E-03	0.025
Caprolactam	105-60-2	0.1		5.00E-01	1
Carbazole	86-74-8	0.1	0.02		1
Carbon disulfide	75-15-0			1.00E-01	
Carbon tetrachloride	56-23-5		0.091	7.00E-04	
Chlordane (alpha and gamma)	57-74-9	0.04	2.3	5.00E-4	1
Chlorobenzene	108-90-7			6.50E-03	
Chloroethane (Ethyl chloride)	75-00-3		0.0029	4.00E-01	
Chloroform	67-66-3			1.00E-02	
Chloromethane (Methyl chloride)	74-87-3				
4-Chloro-3-methyl phenol (p-Chloro-m-cresol)	59-50-7				
2-Chlorophenol (o-Chlorophenol)	95-57-8	0.1		5.00E-03	1

Table A-3 (cont.) ***Benchmarks Supporting Ingestion-Dermal Absorption Standards***

Chemical	CAS No.	Dermal Absorption Fraction (ABS_d)	Dermal Slope Factor (SF)	Dermal Reference Dose (RfD)	Gastro-Intestinal Absorption Fraction (ABS_{GI})
Chromium (III) (Trivalent chromium)	16065-83-1				
Chromium(VI) (Hexavalent chromium)	18540-29-9				
Chromium (total)	7440-47-3				
Chrysene	218-01-9	0.13	0.0073		1
Cobalt	7440-48-4			2.00E-02	
Copper	7440-50-8			4.00E-02	
Cyanide	57-12-5			2.00E-02	
4,4'-DDD	72-54-8		0.24	2.00E-03	
4,4'-DDE	72-55-9		0.34		
4,4'-DDT	50-29-3	0.03	0.34	5.00E-04	1
Dibenz(a,h)anthracene	53-70-3	0.13	7.3		1
Dibenzofuran	132-64-9				
Dibromochloromethane (Chlorodibromomethane)	124-48-1		0.084	2.00E-02	
1,2-Dibromo-3-chloropropane	96-12-8	0.1	1.4		1
1,2-Dibromoethane	106-93-4		2	9.00E-03	
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	0.1		8.60E-02	1
1,3-Dichlorobenzene (m-Dichlorobenzene)	541-73-1	0.1		8.60E-02	1
1,4-Dichlorobenzene (p-Dichlorobenzene)	106-46-7	0.1		1.00E-02	1
3,3'-Dichlorobenzidine	91-94-1	0.1	0.45		1
Dichlorodifluoromethane	75-71-8			2.00E-01	
1,1-Dichloroethane	75-34-3			6.50E-03	
1,2-Dichloroethane	107-06-2		0.12		
1,1-Dichloroethene	75-35-4			1.40E-04	
1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	156-59-2			1.00E-02	
1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	156-60-5			1.70E-02	
2,4-Dichlorophenol	120-83-2	0.1		3.00E-03	1
1,2-Dichloropropane	78-87-5		0.068		
1,3-Dichloropropene (cis and trans)	542-75-6		0.1	3.00E-02	
Dieldrin	60-57-1		16	5.00E-05	
Diethyl phthalate	84-66-2	0.1		8.00E-01	1
2,4-Dimethyl phenol	105-67-9	0.1		2.00E-02	1
Dimethylphthalate	131-11-3				
Di-n-butyl phthalate	84-74-2	0.1		1.00E-01	1
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	534-52-1	0.1		1.00E-04	1
2,4-Dinitrophenol	51-28-5	0.1		2.00E-03	1
2,4-Dinitrotoluene	121-14-2	0.1	0.68	2.00E-03	1
2,6-Dinitrotoluene	606-20-2	0.1	0.68	1.00E-03	1
2,4-Dinitrotoluene/2,6-Dinitrotoluene (mixture)	25321-14-6	0.1	0.68		1
Di-n-octyl phthalate	117-84-0	0.1		4.00E-02	1
1,2-Diphenylhydrazine	122-66-7	0.1	0.8		1
Endosulfan I & Endosulfan II (alpha and beta)	115-29-7			6.00E-03	
Endosulfan sulfate	1031-07-8			6.00E-03	
Endrin	72-20-8			3.00E-04	

Table A-3 (cont.) ***Benchmarks Supporting Ingestion-Dermal Absorption Standards***

Chemical	CAS No.	Dermal Absorption Fraction (ABS_d)	Dermal Slope Factor (SF)	Dermal Reference Dose (RfD)	Gastro-Intestinal Absorption Fraction (ABS_{GI})
Ethyl benzene	100-41-4			1.00E-01	
Fluoranthene	206-44-0	0.13		4.00E-02	1
Fluorene	86-73-7	0.13		4.00E-02	1
alpha-HCH (alpha-BHC)	319-84-6		6.3		
beta-HCH (beta-BHC)	319-85-7		1.8		
Heptachlor	76-44-8		4.5	5.00E-04	
Heptachlor epoxide	1024-57-3		9.1	1.30E-05	
Hexachlorobenzene	118-74-1	0.1	1.6	8.00E-04	1
Hexachloro-1,3-butadiene	87-68-3	0.1	0.078	2.00E-04	1
Hexachlorocyclopentadiene	77-47-4	0.1		6.00E-03	1
Hexachloroethane	67-72-1	0.1	0.014	1.00E-03	1
2-Hexanone	591-78-6				
Indeno(1,2,3-cd)pyrene	193-39-5	0.13	0.73		1
Isophorone	78-59-1	0.1	0.00095	2.00E-01	1
Lead	7439-92-1				
Lindane (gamma-HCH) (gamma-BHC)	58-89-9	0.04	1.3	3.00E-04	1
Manganese	7439-96-5			1.4E-01	
Mercury *	7439-97-6			3.00E-04	
Methoxychlor	72-43-5			5.00E-03	
Methyl acetate	79-20-9			1.00E+00	
Methylcyclohexane	108-87-2				
Methylene chloride (Dichloromethane)	75-09-2		0.014	6.00E-02	
2-Methylnaphthalene	91-57-6	0.13		4.00E-03	1
4-Methyl-2-pentanone (MIBK)	108-10-1				
2-Methylphenol (o-Creosol)	95-48-7	0.1		5.00E-03	1
4-Methylphenol (p-Creosol)	106-44-5	0.1		5.00E-04	1
Methyl tert-butyl ether (MTBE)	1634-04-4			1.00E-02	
Naphthalene	91-20-3	0.13		4.10E-02	1
Nickel (Soluble salts)	7440-02-0			2.00E-02	
2-Nitroaniline	88-74-4				
Nitrobenzene	98-95-3	0.1		5.00E-04	1
4-Nitrophenol	100-02-7				
N-Nitrosodimethylamine	62-75-9		51	8.00E-06	
N-Nitrosodi-n-propylamine	621-64-7	0.1	7		1
N-Nitrosodiphenylamine	86-30-6	0.1	0.0049	2.00E-03	1
Pentachlorophenol	87-86-5	0.25	0.12	3.00E-02	1
Phenanthrene	85-01-8				
Phenol	108-95-2	0.1		3.00E-01	1
Polychlorinated biphenyls (PCBs)	1336-36-3	0.1	2		1
Pyrene	129-00-0	0.13		3.00E-02	1
Selenium	7782-49-2			5.00E-03	
Silver	7440-22-4			5.00E-03	
Styrene	100-42-5			2.00E-01	

Table A-3 (cont.) ***Benchmarks Supporting Ingestion-Dermal Absorption Standards***

Chemical	CAS No.	Dermal Absorption Fraction (ABS_d)	Dermal Slope Factor (SF)	Dermal Reference Dose (RfD)	Gastro-intestinal Absorption Fraction (ABS_{GI})
Tertiary butyl alcohol (TBA)	75-65-0			1.80E-02	
1,1,2,2-Tetrachloroethane	79-34-5			1.34E-04	
Tetrachloroethene (PCE) (Tetrachloroethylene)	127-18-4		0.082		
Thallium	7440-28-0			7.00E-05	
Toluene	108-88-3			8.00E-02	
Toxaphene	8001-35-2		1.1		
1,2,4-Trichlorobenzene	120-82-1	0.1		1.20E-03	1
1,1,1-Trichloroethane	71-55-6			3.70E-03	
1,1,2-Trichloroethane	79-00-5			3.90E-04	
Trichloroethene (TCE) (Trichloroethylene)	79-01-6		0.031		
Trichlorofluoromethane	75-69-4			3.00E-01	
2,4,5-Trichlorophenol	95-95-4	0.1		1.00E-01	1
2,4,6-Trichlorophenol	88-06-2	0.1	0.026		1
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1			3.00E+01	
Vanadium	7440-62-2			1.00E-03	
Vinyl chloride	75-01-4		0.42		
Xylenes	1330-20-7			1.50E-01	
Zinc	7440-66-6			3.00E-01	

Blanks indicate that no information is available.
Mercury* - standard is based on RfD for mercuric chloride (CAS# 007847-94-7)

Table A-4 ***Toxicity Information Supporting Ingestion-Dermal Absorption Pathway***

Chemical	CAS No.	Cancer Slope Factor (mg/kg-d)$^{-1}$			Reference Dose (mg/kg-d)	
		Carc Class	SF	Ref	RfD	Ref
Acenaphthene	83-32-9				6.00E-02	IRIS
Acenaphthylene	208-96-8	D				
Acetone (2-Propanone)	67-64-1	D/INAD			9.00E-01	IRIS
Acetophenone	98-86-2	D			1.00E-01	IRIS
Acrolein	107-02-8	INAD			5.00E-04	IRIS
Acrylonitrile	107-13-1	B1	5.40E-01	IRIS	1.00E-03	HEAST
Aldrin	309-00-2	B2	1.70E+01	IRIS	3.00E-05	IRIS
Aluminum	7429-90-5	D			1.00E+00	NCEA
Anthracene	120-12-7	D			3.00E-01	IRIS
Antimony	7440-36-0				4.00E-04	IRIS
Arsenic	7440-38-2	A	1.50E+00	IRIS	3.00E-04	IRIS
Atrazine	1912-24-9	C/DEP			^3.50E-03	IRIS
Barium	7440-39-3	D/NLIK			2.00E-01	IRIS
Benzaldehyde	100-52-7				1.00E-01	IRIS
Benzene (A-280)	71-43-2	A/KNOWN	2.30E-01	DEP	4.00E-03	IRIS
Benzidine	92-87-5	A	2.30E+02	IRIS	3.00E-03	IRIS
Benzo(a)anthracene	56-55-3	B2	7.30E-01	NCEA		
Benzo(a)pyrene	50-32-8	B2	7.30E+00	IRIS		
Benzo(b)fluoranthene	205-99-2	B2	7.30E-01	NCEA		
Benzo(ghi)perylene	191-24-2	D				
Benzo(k)fluoranthene	207-08-9	B2	7.30E-02	NCEA		
Beryllium	7440-41-7	C/DEP			^2.00E-04	IRIS
1,1'-Biphenyl	92-52-4	D			5.00E-02	IRIS
Bis(2-chloroethyl)ether	111-44-4	B2	1.10E+00	IRIS		
Bis(2-chloroisopropyl)ether	108-60-1				4.00E-02	IRIS
Bis(2-ethylhexyl) phthalate	117-81-7	B2	1.40E-02	IRIS	2.00E-02	IRIS
Bromodichloromethane	75-27-4	B2	6.20E-02	IRIS	2.00E-02	IRIS
Bromoform	75-25-2	B2	7.90E-03	IRIS	2.00E-02	IRIS
Bromomethane (Methyl bromide)	74-83-9	D			1.40E-03	IRIS
2-Butanone (Methyl ethyl ketone) (A-280)	78-93-3	D			3.90E-02	DEP
Butyl benzyl phthalate	85-68-7	C/DEP			^2.00E-02	IRIS
Cadmium	7440-43-9				1.00E-03	IRIS
Caprolactam	105-60-2				5.00E-01	IRIS
Carbazole	86-74-8	B2-HEAST	2.00E-02	HEAST		
Carbon disulfide	75-15-0				1.00E-01	IRIS
Carbon tetrachloride (A-280)	56-23-5	B2	9.10E-02	DEP	7.00E-04	IRIS
Chlordane (alpha and gamma) (A-280)	57-74-9	B2/LIK	2.30E+00	DEP	5.00E-04	IRIS
Chlorobenzene (A-280)	108-90-7	D			6.50E-03	DEP
Chloroethane (Ethyl chloride)	75-00-3	B2-NCEA	2.90E-03	NCEA	4.00E-01	NCEA
Chloroform	67-66-3	B2			1.00E-02	IRIS
Chloromethane (Methyl chloride)	74-87-3					
4-Chloro-3-methyl phenol	59-50-7					

Table A-4 (cont.) ***Toxicity Information Supporting Ingestion-Dermal Absorption Pathway***

Chemical	CAS No.	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Reference Dose (mg/kg-d)	
		Carc Class	SF	Ref	RfD	Ref
2-Chlorophenol (o-Chlorophenol)	95-57-8				5.00E-03	IRIS
Chromium (III) (Trivalent chromium)	16065-83-1					
Chromium(VI) (Hexavalent chromium)	18540-29-9					
Chromium (total)	7440-47-3					
Chrysene	218-01-9	B2	7.30E-03	NCEA		
Cobalt	7440-48-4				2.00E-02	NCEA
Copper	7440-50-8	D			4.00E-02	HEAST
Cyanide	57-12-5	D			2.00E-02	IRIS
4,4'-DDD	72-54-8	B2	2.40E-01	IRIS	2.00E-03	NCEA
4,4'-DDE	72-55-9	B2	3.40E-01	IRIS		
4,4'-DDT	50-29-3	B2	3.40E-01	IRIS	5.00E-04	IRIS
Dibenz(a,h)anthracene	53-70-3	B2	7.30E+00	NCEA		
Dibenzofuran	132-64-9					
Dibromochloromethane	124-48-1	C	8.40E-02	IRIS	2.00E-02	IRIS
1,2-Dibromo-3-chloropropane	96-12-8	B2-HEAST	1.40E+00	HEAST		
1,2-Dibromoethane	106-93-4	B2/LIK	2.00E+00	IRIS	9.00E-03	IRIS
1,2-Dichlorobenzene (A-280)	95-50-1	D			8.60E-02	DEP
1,3-Dichlorobenzene (A-280)	541-73-1	D			8.60E-02	DEP
1,4-Dichlorobenzene (A280)	106-46-7	C/DEP			^1.00E-02	DEP
3,3'-Dichlorobenzidine	91-94-1	B2	4.50E-01	IRIS		
Dichlorodifluoromethane	75-71-8				2.00E-01	IRIS
1,1-Dichloroethane (A-280)	75-34-3	D/DEP			6.50E-03	DEP
1,2-Dichloroethane (A-280)	107-06-2	B2	1.20E-01	DEP		
1,1-Dichloroethene (A-280)	75-35-4	C			^1.40E-04	DEP
1,2-Dichloroethene (cis) (A-280)	156-59-2	D			1.00E-02	DEP
1,2-Dichloroethene (trans) (A-280)	156-60-5				1.70E-02	DEP
2,4-Dichlorophenol	120-83-2				3.00E-03	IRIS
1,2-Dichloropropane	78-87-5	B2-HEAST	6.80E-02	HEAST		
1,3-Dichloropropene (cis and trans)	542-75-6	B2/LIK	1.00E-01	IRIS	3.00E-02	IRIS
Dieldrin	60-57-1	B2	1.60E+01	IRIS	5.00E-05	IRIS
Diethyl phthalate	84-66-2	D			8.00E-01	IRIS
2,4-Dimethyl phenol	105-67-9				2.00E-02	IRIS
Dimethylphthalate	131-11-3	D				
Di-n-butyl phthalate	84-74-2	D			1.00E-01	IRIS
4,6-Dinitro-2-methylphenol	534-52-1				1.00E-04	NCEA
2,4-Dinitrophenol	51-28-5				2.00E-03	IRIS
2,4-Dinitrotoluene	121-14-2	B2	6.80E-01	IRIS	2.00E-03	IRIS
2,6-Dinitrotoluene	606-20-2	B2	6.80E-01	IRIS	1.00E-03	NCEA
2,4-Dinitrotoluene/2,6-Dinitrotoluene	25321-14-6	B2	6.80E-01	IRIS		
Di-n-octyl phthalate	117-84-0				4.00E-02	NCEA
1,2-Diphenylhydrazine	122-66-7	B2	8.00E-01	IRIS		
Endosulfan I & Endosulfan II (alpha & beta)	115-29-7				6.00E-03	IRIS
Endosulfan sulfate	1031-07-8				6.00E-03	IRIS
Endrin	72-20-8	D			3.00E-04	IRIS
Ethyl benzene	100-41-4	D			1.00E-01	IRIS

Table A-4 (cont.) ***Toxicity Information Supporting Ingestion-Dermal Absorption Pathway***

Chemical	CAS No.	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Reference Dose (mg/kg-d)	
		Carc Class	SF	Ref	RfD	Ref
Fluoranthene	206-44-0	D			4.00E-02	IRIS
Fluorene	86-73-7	D			4.00E-02	IRIS
alpha-HCH (alpha-BHC)	319-84-6	B2	6.30E+00	IRIS		
beta-HCH (beta-BHC)	319-85-7	C	1.80E+00	IRIS		
Heptachlor	76-44-8	B2	4.50E+00	IRIS	5.00E-04	IRIS
Heptachlor epoxide	1024-57-3	B2	9.10E+00	IRIS	1.30E-05	IRIS
Hexachlorobenzene	118-74-1	B2	1.60E+00	IRIS	8.00E-04	IRIS
Hexachloro-1,3-butadiene	87-68-3	C	7.80E-02	IRIS	2.00E-04	HEAST
Hexachlorocyclopentadiene	77-47-4	D			6.00E-03	IRIS
Hexachloroethane	67-72-1	C	1.40E-02	IRIS	1.00E-03	IRIS
2-Hexanone	591-78-6					
Indeno(1,2,3-cd)pyrene	193-39-5	B2	7.30E-01	NCEA		
Isophorone	78-59-1	C	9.50E-04	IRIS	2.00E-01	IRIS
Lead	7439-92-1	B2				
Lindane (gamma-HCH) (gamma-BHC)	58-89-9	B2-HEAST	1.30E+00	HEAST	3.00E-04	IRIS
Manganese	7439-96-5	D			1.4E-01	IRIS
Mercury*	7439-97-6	D/DEP			3.00E-04	IRIS
Methoxychlor	72-43-5	D			5.00E-03	IRIS
Methyl acetate	79-20-9				1.00E+00	HEAST
Methylcyclohexane	108-87-2					
Methylene chloride (A-280)	75-09-2	B2	1.40E-02	DEP	6.00E-2	IRIS
2-Methylnaphthalene	91-57-6				4.00E-03	IRIS
4-Methyl-2-pentanone (MIBK)	108-10-1					
2-Methylphenol (o-Creosol)	95-48-7	C			^5.00E-03	IRIS
4-Methylphenol (p-Creosol)	106-44-5	C			^5.00E-04	HEAST
Methyl tert-butyl ether (MTBE) (A-280)	1634-04-4	C/DEP			^1.00E-02	DEP
Naphthalene (A-280)	91-20-3	C/DEP			^4.10E-02	DEP
Nickel (Soluble salts)	7440-02-0				2.00E-02	IRIS
2-Nitroaniline	88-74-4					
Nitrobenzene	98-95-3	D			5.00E-04	IRIS
4-Nitrophenol	100-02-7	D-NCEA				
N-Nitrosodimethylamine	62-75-9	B2	5.10E+01	IRIS	8.00E-06	NCEA
N-Nitrosodi-n-propylamine	621-64-7	B2	7.00E+00	IRIS		
N-Nitrosodiphenylamine	86-30-6	B2	4.90E-03	IRIS	2.00E-03	NCEA
Pentachlorophenol	87-86-5	B2	1.20E-01	IRIS	3.00E-02	IRIS
Phenanthrene	85-01-8	D				
Phenol	108-95-2	D			3.00E-01	IRIS
Polychlorinated biphenyls (A-280)	1336-36-3	B2	2.00E+00	DEP		
Pyrene	129-00-0	D			3.00E-02	IRIS
Selenium	7782-49-2	D			5.00E-03	IRIS
Silver	7440-22-4	D			5.00E-03	IRIS
Styrene	100-42-5				2.00E-01	IRIS
Tertiary butyl alcohol (TBA)	75-65-0	C/DEP			^1.80E-02	DEP
1,1,2,2-Tetrachloroethane (A-280)	79-34-5	C/DEP			^1.34E-04	DEP
Tetrachloroethene (PCE) (A-280)	127-18-4		8.20E-02	DEP	1.00E-02	IRIS
Thallium	7440-28-0				7.00E-05	DEP

Table A-4 (cont.) ***Toxicity Information Supporting Ingestion-Dermal Absorption Pathway***

Chemical	CAS No.	Cancer Slope Factor (mg/kg-d)$^{-1}$			Reference Dose (mg/kg-d)	
		Carc Class	SF	Ref	RfD	Ref
Toluene	108-88-3	D			8.00E-02	IRIS
Toxaphene	8001-35-2	B2	1.10E+00	IRIS		
1,2,4-Trichlorobenzene (A-280)	120-82-1	D			1.20E-03	DEP
1,1,1-Trichloroethane (A-280)	71-55-6	D			3.70E-03	DEP
1,1,2-Trichloroethane (A-280)	79-00-5	C			^3.90E-04	DEP
Trichloroethene (TCE) (A-280)	79-01-6		3.10E-02	DEP		
Trichlorofluoromethane	75-69-4				3.00E-01	IRIS
2,4,5-Trichlorophenol	95-95-4				1.00E-01	IRIS
2,4,6-Trichlorophenol (A-280)	88-06-2	B2	2.60E-02	DEP		
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1				3.00E+01	IRIS
Vanadium	7440-62-2				1.00E-03	NCEA
Vinyl chloride (A-280)	75-01-4	A	4.20E-01	DEP		
Xylenes (A-280)	1330-20-7	D			1.50E-01	DEP
Zinc	7440-66-6	D/INAD			3.00E-01	IRIS

FOOTNOTES:

1. Carcinogen Classification

All classifications are based on IRIS unless stated otherwise

1999 Cancer Draft Guidelines*:*

KNOWN - Known carcinogen
CANTDET - Can not determine carcinogenic classification
LIK - Likely to be a human carcinogen
NLIK - Not likely to be a carcinogen
INAD - Inadequate data
ORL - Oral exposure route
INHL - Inhalation exposure route

1986 Cancer Guidelines*:*

Group A - Human carcinogen
Group B - Probable human carcinogen
Group B2 - Sufficient evidence from animal studies and inadequate or no data from epidemiologic studies
Group C - Possible human carcinogen
Group D - Not classifiable as to human carcinogenicity
Group E - Evidence on non-carcinogenicity for humans

2. References:

IRIS - Integrated Risk Information System
HEAST- Health Effects Assessment Summary Tables
NCEA - National Center for Environmental Assessment/EPA Provisional Value
DEP- NJ Department of Environmental Protection
^ - DEP C Carcinogen Policy: RfD includes an additional safety factor of 10
A-280 - Chemicals regulated under A-280 Amendments to NJ Safe Drinking water Act (P. L. 1983, c.443)
Blanks indicate that no information is available
Mercury* - standard is based on RfD for mercuric chloride (CAS# 007847-94-7)