New Jersey
Department of Environmental Protection

SOIL REMEDIATION STANDARDS FOR THE INGESTION-DERMAL EXPOSURE PATHWAY

BASIS AND BACKGROUND

May 2024

Contents

Tables

1. Introduction

As per the *Remediation Standards* (N.J.A.C. 7:26D), the Department has developed soil remediation standards (SRS) for the ingestion-dermal exposure pathway based on residential and nonresidential land use. The Department uses the U.S. Environmental Protection Agency's (USEPA's) risk-based equations to calculate soil standards that combine the ingestion and dermal exposure pathways (USEPA, 2018b). This approach acknowledges that concurrent exposure occurs via the two exposure pathways through children's outdoor play; and gardening, landscaping, and excavation by adults. Health-based criteria are developed for carcinogens and non-carcinogens under the residential and nonresidential land use scenario. The SRS incorporate default residential and nonresidential exposure parameters consistent with those used by USEPA in the Superfund program (USEPA 2014, USEPA 2018b). In the development of the health-based SRS, the Department applies a cancer risk of $1\text{x}10^{-6}$ and a Hazard Quotient of 1, as mandated by the *Brownfield and Contaminated Site Remediation Act* (N.J.S.A. 58:10B-1 et seq.).

While the Department employs USEPA's equations (USEPA, 2018b) and default parameters (USEPA, 2014) for the exposure pathways, the procedures and 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 this document. Because different health effects may be associated with the inhalation route, the Department will continue to evaluate the inhalation exposure pathway separately as recommended by USEPA (2002a).

2. Methodology for Developing Soil Remediation Standards for the Ingestion – Dermal Exposure Pathway

2.1. Overview

2.1.1. Ingestion Component

The ingestion component of the ingestion-dermal exposure pathway addresses the potential for human exposure to chemicals through incidental 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 incidental ingestion of soil and dust is based on USEPA's risk assessment methodology. The procedure for calculating residential and nonresidential SRS for the ingestion-dermal exposure pathway is presented in N.J.A.C. 7:26D Appendix 2, along with this document, and is based on USEPA's *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), *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2002a), and the *Regional Screening Levels Users Guide* (USEPA, 2018b).

2.1.1.1. Residential Land Use

The ingestion component of the calculations for the Department's residential health-based SRS (Section 2.2, Equation 1) employs an age-adjusted soil ingestion factor for carcinogenic contaminants (Section 2.2., Equation 1.1**)**. 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 26 years old (USEPA, 2014). 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) and the *Regional Screening Levels Users Guide* (USEPA, 2018b) use this age-adjusted approach for carcinogens for residential land use.

The Department has adopted Superfund's approach for non-carcinogenic contaminants that uses a protective "childhood only" exposure for the residential land use scenario (USEPA, 1996a & 2002a). 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 (USEPA, 2014) (as shown in the ingestion portion of Equation 2 in Section 2.2).

2.1.1.2. Nonresidential Land Use

For nonresidential land use, the ingestion exposure pathway component is based on an adult outdoor worker and does not consider childhood exposure for carcinogens and non-carcinogens. As a result, neither the age-adjustment factor nor the "childhood only" exposure duration applies (shown in ingestion portion of Equations 3 and 4 in Section 2.2). 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 for 225 days per year for 25 years (USEPA, 2014). These equations presented in N.J.A.C. 7:26D Appendix 2, along with this document, are based on USEPA's *Regional Screening Levels, Users Guide* (USEPA, 2018b).

2.1.2. Dermal Component

The dermal exposure pathway component is derived from risk assessment methodology outlined in USEPA's *Risk Assessment Guidance for Superfund: Part E, Supplemental Guidance for Dermal Risk Assessment* (USEPA, 2004). Currently, soil contaminants evaluated for dermal exposure are limited to several individual compounds and four chemical classes (Table 1). The assigned dermal absorption fractions listed in Table 1 are consistent with those used by USEPA. 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 exposure pathway is considered for residential and nonresidential land use. 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 fraction 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 (Section 2.2, Equations 1.3 and 2.1). Oral toxicity values are adjusted when the gastrointestinal absorption of the chemical is significantly less than 50 percent (**Table A-3**). Chemical specific dermal absorption fractions are then applied to the adjusted toxicity factors in the equations to evaluate the dermal exposure pathway.

Table 1
Compounds and Recommended Dermal Absorption Fractions

Source: USEPA. 2004. Risk Assessment Guidance for Superfund, Vol. 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final EPA/540/R/99/005, OSWER 9285.7-02EP

Compound	Dermal Absorption Fraction (ABS_d)
Arsenic	0.03
Cadmium	0.001
Chlordane	0.04
DDT	0.03
Lindane	0.04
PAHs	0.13
Pentachlorophenol	0.25
Polychlorinated biphenyls (PCBs)	0.14
Semi-volatile organic compounds	0.1
TCDD and other dioxins	0.03

2.1.2.1. Residential Land Use

The dermal component of the Department's residential SRS for carcinogens uses an age-adjusted dermal factor (Section 2.2, Equation 1.2) that considers changes in skin surface area, body weight and adherence factor over a 26-year period of time (USEPA, 2014).

While children have less total skin surface area (SA= 2,373 cm^2) than adults (6,032 cm^2), children have a higher soil-to-skin adherence factor (AF= 0.2 mg/cm^2-event) than adults (0.07 mg/cm^2-event) (USEPA, 2014). The skin surface area default values represent the weighted average of mean values for children and adults (USEPA, 2011). 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 1. For compounds classified as both semi-volatile and as a PAH, the ABS_d for PAHs should be used (USEPA, 2002a).

The residential non-carcinogenic 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 (Section 2.2, Equation 2) (USEPA, 2014).

2.1.2.2. Nonresidential Land Use

Under nonresidential land use, the Department has chosen to protect the full-time adult worker whose daily activities are outdoor maintenance activities. Since adult workers will have only arms, hands and head exposed, the skin surface area is reduced to 3,527 cm^2 with an adherence factor of 0.12 mg/cm^2-event (USEPA, 2014). The Department uses USEPA's default value of 225 days/year for the outdoor worker's exposure frequency and 25 years for the exposure duration (USEPA, 2014). The nonresidential SRS for both carcinogens and non-carcinogens are based on adult only exposures (Section 2.2, Equations 3 and 4).

2.2. Equations

The risk-based equations and input parameters included in N.J.A.C. 7:26D Appendix 2 and presented below are used in the development of the residential and nonresidential health-based criteria for the ingestion-dermal exposure pathway. Carcinogenic and non-carcinogenic human health-based criteria are calculated for the listed contaminants under a residential and nonresidential land use scenario, when applicable toxicity information is available. Equations 1 through 4 below are derived from the *USEPA RSLs, Users Guide* (USEPA 2018b). A detailed explanation of the derivation of Equations 1 through 4 is contained in N.J.A.C. 7:26D Appendix 12.

Equation 1

Residential Carcinogenic Ingestion-Dermal Human Health-based Criteria

$$ID_c = \frac{TR * AT * LT}{(10^{-6} kg/mg) * [(CSF_O * IFS_{adj}) + (CSF_D * DFS_{adj} * ABS_d)]}$$

Parameter	Definition	Units	Default
ID_c	Carcinogenic ingestion-dermal human health-based criterion	mg/kg	Chemical-specific
TR	Target cancer risk	unitless	1×10^{-6}
AT	Averaging time	days/year	365
LT	Lifetime	years	70
CSF_o	Oral cancer slope factor	$(mg/kg\text{-}day)^{-1}$	Chemical-specific
IFS_{adj}	Age-adjusted soil ingestion rate	mg/kg	36,750
CSF_D	Dermal cancer slope factor	$(mg/kg\text{-}day)^{-1}$	Chemical-specific
DFS_{adj}	Age-adjusted soil dermal contact factor	mg/kg	103,390
ABS_d	Dermal absorption fraction	unitless	Chemical-specific

Where:

(Equation 1.1)

$$IFS_{adj} = \frac{EF_c * ED_c * IR_c}{BW_c} + \frac{EF_a * ED_a * IR_a}{BW_a}$$

Parameter	Definition	Units	Default
IFS_{adj}	Age-adjusted soil ingestion rate	mg/kg	36,750
EF_c	Exposure frequency – child	days/year	350
EF_a	Exposure frequency – adult	days/year	350
ED_c	Exposure duration – child	years	6
ED_a	Exposure duration – adult	years	20
IR_c	Soil ingestion rate – child	mg/day	200
IR_a	Soil ingestion rate – adult	mg/day	100
BW_c	Body weight – child	kg	15
BW_a	Body weight – adult	kg	80

Where:

(Equation 1.2)

$$DFS_{adj} = \frac{EF_c * ED_c * SA_c * AF_c}{BW_c} + \frac{EF_a * ED_a * SA_a * AF_a}{BW_a}$$

Parameter	Definition	Units	Default
DFS_{adj}	Age-adjusted soil dermal contact factor	mg/kg	103,390
EF_c	Exposure frequency – child	days/year	350
EF_a	Exposure frequency – adult	days/year	350
ED_c	Exposure duration – child	years	6
ED_a	Exposure duration – adult	years	20
SA_c	Skin surface area – child	cm^2/day	2,373
SA_a	Skin surface area – adult	cm^2/day	6,032
AF_c	Soil adherence factor – child	mg/cm^2	0.2
AF_a	Soil adherence factor – adult	mg/cm^2	0.07

BW_c	Body weight – child	kg	15
BW_a	Body weight – adult	kg	80

Where:

(Equation 1.3)

$$CSF_D = \frac{CSF_O}{GIABS}$$

Parameter	Definition	Units	Default
CSF_D	Dermal cancer slope factor	$(mg/kg\text{-}day)^{-1}$	Chemical-specific
CSF_O	Oral cancer slope factor	$(mg/kg\text{-}day)^{-1}$	Chemical-specific
GIABS	Gastro-intestinal absorption fraction	unitless	Chemical-specific

Equation 2

Residential Non-carcinogenic Ingestion-Dermal Human Health-based Criteria

$$ID_{nc} = \frac{THQ * AT * ED * BW}{(EF * ED * 10^{-6}\,kg/mg) * [(\frac{1}{RfD_O} * IR) + (\frac{1}{RfD_D} * SA * AF * ABS_d)]}$$

Parameter	Definition	Units	Default
ID_{nc}	Non-carcinogenic ingestion-dermal human health-based criterion	mg/kg	Chemical-specific
THQ	Target hazard quotient	unitless	1
AT	Averaging time	days/year	365
ED	Exposure duration	years	6
BW	Body weight-child	kg	15
EF	Exposure frequency	days/year	350
RfD_O	Oral reference dose	mg/kg-day	Chemical-specific
IR	Soil ingestion rate-child	mg/day	200

RfD_D	Dermal	mg/kg-day	Chemical-specific
SA	Skin surface area-child	cm^2/day	2,373
AF	Soil adherence factor-child	mg/cm^2	0.2
ABS_d	Dermal absorption fraction	unitless	Chemical-specific

Where:

(Equation 2.1)

$$RfD_D = RfD_O * GIABS$$

Parameter	Definition	Units	Default
RfD_D	Dermal reference dose	mg/kg-day	Chemical-specific
RfD_O	Oral reference dose	mg/kg-day	Chemical-specific
GIABS	Gastro-intestinal absorption fraction	unitless	Chemical-specific

Equation 3

Nonresidential Carcinogenic Ingestion-Dermal Human Health-based Criteria

$$ID_c = \frac{TR * AT * LT * BW}{EF * ED * 10^{-6}\, kg/mg * [(CSF_O * IR) + (CSF_D * SA * AF * ABS_d)]}$$

Parameter	Definition	Units	Default
ID_c	Carcinogenic ingestion-dermal human health-based criterion	mg/kg	Chemical-specific
TR	Target cancer risk	unitless	1 x 10^{-6}
AT	Averaging time	days/year	365
LT	Lifetime	years	70
BW	Body weight - adult	kg	80
EF	Exposure frequency-outdoor worker	days/year	225
ED	Exposure duration	years	25

CSF_o	Oral cancer	(mg/kg-day)$^{-1}$	Chemical-specific
	slope factor		
IR	Soil ingestion rate -outdoor worker	mg/day	100
CSF_D	Dermal cancer slope factor	(mg/kg-day)$^{-1}$	Chemical-specific
SA	Skin surface area - worker	cm^2/day	3,527
AF	Soil adherence factor-worker	mg/cm^2	0.12
ABS_d	Dermal absorption fraction	unitless	Chemical-specific

Where:

(Equation 3.1)

$$CSF_D = \frac{CSF_O}{GIABS}$$

Parameter	Definition	Units	Default
CSF_D	Dermal cancer slope factor	(mg/kg-day)$^{-1}$	Chemical-specific
CSF_O	Oral cancer slope factor	(mg/kg-day)$^{-1}$	Chemical-specific
GIABS	Gastro-intestinal absorption fraction	unitless	Chemical-specific

Equation 4

Nonresidential Non-carcinogenic Ingestion-Dermal Human Health-based Criteria

$$ID_{nc} = \frac{THQ * AT * ED * BW}{(EF * ED * 10^{-6}\,kg/mg) * [(\frac{1}{RfD_O} * IR) + (\frac{1}{RfD_D} * SA * AF * ABS_d)]}$$

Parameter	Definition	Units	Default
ID_{nc}	Non-carcinogenic ingestion-dermal human health-based criterion	mg/kg	Chemical-specific
THQ	Target hazard quotient	unitless	1

AT	Averaging time	days/year	365
ED	Exposure duration	years	25
BW	Body weight-adult	kg	80
EF	Exposure frequency- outdoor worker	days/year	225
RfD_O	Oral reference dose	mg/kg-day	Chemical-specific
IR	Soil ingestion rate- outdoor worker	mg/day	100
RfD_D	Dermal reference dose	mg/kg-day	Chemical-specific
SA	Skin surface area- worker	cm^2/day	3,527
AF	Soil adherence factor-worker	mg/cm^2	0.12
ABS_d	Dermal absorption fraction	unitless	Chemical-specific

Where:

(Equation 4.1)

$$RfD_D = RfD_O * GIABS$$

Parameter	Definition	Units	Default
RfD_D	Dermal reference dose	mg/kg-day	Chemical-specific
RfD_O	Oral reference dose	mg/kg-day	Chemical-specific
GIABS	Gastro-intestinal absorption fraction	unitless	Chemical-specific

2.3. Mutagenic Mode of Action

Some contaminants have been determined to have a mutagenic mode of action or early lifetime exposure component. Mutagenicity refers to the capacity to induce or increase the rate of genetic change. For the ingestion-dermal exposure pathway, the affected contaminants include several polycyclic aromatic hydrocarbons, trichloroethene and vinyl chloride.

While the Department's Site Remediation and Waste Management Program (SRWMP) supports the protection against cancer risks from early-life exposure in the context of the baseline risk assessment and its associated screening levels, as existing policy, the SRWMP does not include the mutagenic mode of action in the development of its soil or indoor air remediation standards. By regulation, the Department's standards are based on a conservative 10^{-6} risk level for carcinogenic compounds, which is protective of any additional risks incurred from early life exposure. The SRWMP will continue to review this issue as more information becomes available and may consider it for future amendments to the *Remediation Standards*, N.J.A.C. 7:26D.

2.4. Hierarchy for Toxicity Source Information

The toxicity information used to generate SRS for the ingestion-dermal exposure pathway 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 Amendments to the New Jersey Safe Drinking Water Act (P.L. 1983, c. 443)
2. USEPA's Integrated Risk Information System (IRIS, 2018a)
3. Other potential sources including USEPA's National Center for Environmental Assessment's (NCEA) Provisional Peer-Reviewed Toxicity Values (PPRTV) (USEPA, 2018e), USEPA's Health Effects Assessment Summary Tables (HEAST, 1997), California Environmental Protection Agency's (CalEPA, 2018) toxicity values, and the Agency for Toxic Substances and Disease Registry's (ATSDR) minimal risk levels (MRLs) may be considered (ATSDR, 2018).

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, N.J.A.C. 7:9C, and Surface Water Quality Standards, N.J.A.C. 7:9B. To maintain consistency with other State standards, the Department has used the A-280 contaminant toxicity information as the first source of toxicity information (first tier) for the development of soil ingestion-dermal absorption standards. Supporting documentation for A-280 toxicity information can 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 IRIS database (second tier) which provides regularly updated, peer reviewed reference doses and slope factors. (USEPA, 2018a).

For contaminants that do not have A-280 or IRIS toxicity values, the Department referred to its third preference of toxicity information (third tier), which was from a variety of sources, including but not limited to: the USEPA NCEA, which develops PPRTVs; the USEPA's HEAST; CalEPA; and the ATSDR. If toxicity information from multiple third tier sources existed, then the Department reviewed all available information and selected the most scientifically sound information in order to develop the SRS for the ingestion-dermal exposure pathway.

In some instances, the Department developed toxicity factors from the primary scientific literature if toxicity information was not available from any of the above sources, or if a toxicity factor was warranted by new scientific information. The reference dose for tertiary butyl alcohol was developed internally by the Department and used as the basis for soil remediation standards for the ingestion-dermal exposure pathway (NJDEP 1997b).

In addition, for some contaminants, toxicity information from a lower tier source was used in lieu of toxicity information from a higher tier source if it was determined that the lower tier toxicity information was derived using better scientific information. The toxicity information the Department used to develop the SRS for the ingestion-dermal exposure pathway are presented in **Table A-4** of this document and N.J.A.C. 7:26D Appendix 11, Table 1. The footnotes to both these tables also provide details of when a lower tier source was used in lieu of a higher tier source.

2.5. Route-to-Route Extrapolation

Oral toxicity factors have been developed for some contaminants using studies that relate health effects to inhalation exposure in the absence of sufficient oral based studies. Historically, the USEPA and the Department implemented route-to-route extrapolation when there was no toxicity information available for the exposure pathway under evaluation. However, subsequent USEPA RAGS Part F states performing route-to-route extrapolation may be inappropriate when data from one route of exposure is substituted for another without consideration of the pharmacokinetic differences between the routes of exposure (USEPA, 2009).

Consequently, the Department decided not to do such extrapolation to develop standards without specific contaminant-based justification. As a result, toxicity factors based on route-to-route extrapolation have been evaluated by the Department and their use restricted. Route-to-route extrapolation based toxicity factors may be used when the values have been developed after a more extensive evaluation of the potential effects of route of exposure (such as through the use of Physiologically Based Pharmacokinetic (PPBK) modeling) in the generation of the toxicity values. The footnotes to **Table A-4** of this document and N.J.A.C. 7:26D, Appendix 11, Table 1 provide details for those oral toxicity factors in which route-to-route extrapolation was applied and whether its use was supported with PBPK modeling.

2.6. Group C Carcinogen Policy

The Department has a policy for the development of remediation standards for contaminants classified as Group C carcinogens, which are defined as Possible Human Carcinogens by the USEPA under the 1986 guidelines, or Suggestive Carcinogens under the 2005 guidelines (USEPA 1986 and 2005). Group C carcinogen contaminants 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). The Department uses this policy to develop Departmental health-based standards including remediation standards, drinking water health-based maximum contaminant levels, ground water quality criteria, and human health-based surface water quality criteria.

Under this Department policy, remediation standards for contaminants classified as Group C carcinogens under the 1986 guidelines or suggestive carcinogens under the 2005 guidelines that have carcinogenic toxicity information (slope factor for the ingestion-dermal exposure pathway) are developed as a carcinogen (Group A or B) using a target cancer risk of one excess human cancer in one million (1×10^{-6} target cancer risk). For those contaminants that do not have available carcinogenic toxicity information, the Department developed a remediation standard using non-carcinogenic toxicity information (RfD for the ingestion-dermal exposure pathway), but the Department applied an added uncertainty factor of 10 to account for potential carcinogenic effects not addressed by the non-carcinogenic toxicity information.

There are 14 contaminants classified as Group C carcinogens under the 1986 guidelines or suggestive carcinogens under the 2005 guidelines for which SRS for the ingestion-dermal exposure pathway were developed. **Table A-4** of this document and N.J.A.C. 7:26D Appendix 11, Table 1 identify the contaminants which are classified as Group C carcinogens, the toxicity factors in which a 10-fold safety factor adjustment must be applied to the RfD when calculating a standard, and the New Jersey Drinking Water Quality Institute (NJDWQI) RfDs that already incorporate a 10-fold safety factor adjustment.

2.7. Exposure Parameters

Exposure parameters recommended by the USEPA Superfund program (USEPA 2014) are used as input parameters for the calculation of the residential and nonresidential SRS for the ingestion-dermal exposure pathway. The input parameters reflect reasonable maximum exposure (RME) under the applicable land use scenarios. USEPA defines the RME as the highest exposure that is reasonably expected to occur at a site (USEPA 1989). The exposure parameters, along with the applicable equations, are presented in Section 2.2 of this document.

2.8. Calculations

Carcinogenic and non-carcinogenic ingestion-dermal human health-based criteria for residential and nonresidential land use are calculated for the listed contaminants following the above procedures, where applicable toxicity information is available (**Tables A-1 and A-2**). The human health-based criteria for the applicable land use scenarios are determined as the lesser of the carcinogenic or non-carcinogenic based value.

In deriving the SRS for the ingestion-dermal exposure pathway, the Department applied the rounding rules contained in the American Society for Testing and Materials (ASTM) Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications (ASTM E29-13). For example, in applying ASTM E29-13:

- If the first number beyond the second significant figure is *less than* five, then the second significant figure remains the same, while the remaining numbers are dropped. For example, if 4.438 is rounded to two significant figures, the result is 4.4.
- If the first number beyond the second significant figure is *greater than* five, then the second significant figure increases by one and the remaining numbers are dropped. For example, if 4.668 is rounded to two significant figures, the result is 4.7.
- If the first number beyond the second significant figure is five and there are other non-zero numbers beyond the five, then the second significant increases by one and the

remaining numbers are dropped. For example, if 4.6534 is rounded to two significant figures, the result is 4.7

- If the first number beyond the second significant figure is five, and there are no numbers beyond this five (except zeros), then the second significant figure is rounded to the closest even number. For example, if 4.55 is rounded to two significant figures, then the result is 4.6; and when 4.65 is rounded to two significant figures, the result is also 4.6.

The resulting residential and nonresidential ingestion-dermal human health-based criteria are presented in **Tables A-1 and A-2**.

2.9. Chemical-Specific Information

2.9.1. 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 RfD. A 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.

Since 1994, the USEPA Office of Land and Emergency Management (OLEM) has recommended the use of the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) to support clean up decisions at current and future anticipated residential sites (USEPA 1994a). The IEUBK model is used to predict a geometric mean blood lead level in young children (birth to 7 years) that are exposed to lead from several sources of exposure (air, water, soil, dust, and diet) and routes and to limit the probability to less than a five percent chance of exceeding a target blood lead level.

In May 2021, USEPA revised several default model input exposure parameters (soil and dust ingestion rate, water consumption, water lead concentration, inhalation rate, and dietary lead) resulting in the release of IEUBK Version 2. In addition, the USEPA OLEM issued its national updated residential soil lead guidance incorporating the use of IEUBK Version 2 and revised target blood lead levels on January 17, 2024. OLEM updated the residential soil lead regional screening level (RSL) and removal management level (RML) for the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) Corrective Action Program. When evaluating residential sites with soil lead contamination, OLEM recommends EPA Regions use a residential soil lead RSL and RML of 200 mg/kg. However, if an additional source of lead is identified (for example, lead water service lines, lead-based paint, nonattainment areas of the lead National Ambient Air Quality Standard), then EPA Regions should use a RSL of 100 mg/kg. USEPA uses RSLs as screening tools to help identify and define areas that need further evaluation in the risk assessment process. RMLs are screening tools used to help prioritize and define areas that may pose the greatest threat to human health.

Prior to the release of OLEM's updated residential soil lead guidance, USEPA's residential soil lead RSL and RML were both 400 mg/kg, which was equivalent to the Department's former residential soil remediation standard for the ingestion-dermal exposure pathway for lead. This value was derived using USEPA's IEUBK Version 1 Model for lead in children. In USEPA's 1994 *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities*, USEPA adopted 10 micrograms of lead per deciliter of blood (µg/dL) as the 95th percentile target blood lead level of concern to derive a residential lead soil screening level. Using the 1994 guidance and the IEUBK Version 1 Model, USEPA established the 400 mg/kg residential soil lead RSL and RML.

The science on lead has evolved and demonstrates that a target blood lead level of 10 µg/dL is not protective of childhood exposures to lead. USEPA's 2013 Integrated Science Assessment for Lead found "clear evidence of cognitive function decrements in young children (4 to 11 years old) with mean or group blood lead levels measured at various life stages and time periods between 2 and 8 µg/dL." The 2020 Agency for Toxic Substances and Disease Registry's Toxicological Profile for Lead found "supporting evidence that exposures to lead may produce effects on cognitive function in populations whose blood lead levels are well below 5 µg/dL and may extend to levels below 1 µg/dL." The OLEM recommended RSLs of 200 mg/kg and 100 mg/kg based on predicted values using IEUBK Version 2, with 95th percentile target blood lead levels of 5 µg/dL and 3.5 µg/dL, respectively, to result in geometric mean blood lead levels (2.3 µg/dL and 1.7 µg/dL, respectively). Based on the revisions to the IEUBK input parameters and the OLEM updated residential soil lead guidance, the Department is using IEUBK Version 2 with the 5 µg/dL 95th percentile target blood level to update the residential SRS for the ingestion-dermal exposure pathway from 400 mg/kg to 200 mg/kg, consistent with current USEPA guidance. This update became effective on May 6, 2024, pursuant to N.J.A.C. 7:26D-7.2(a)4.

The Adult Lead Methodology (ALM) is used by the Department to develop the nonresidential lead SRS of 800 mg/kg. The ALM describes a process for assessing risks associated with nonresidential adult exposures to lead in soil by relating soil lead intake to blood lead concentrations in women of child-bearing age. The methodology further relates the estimated maternal adult blood lead level to the estimated fetal blood lead concentration. The Technical Review Workgroup (TRW) for lead developed an interim ALM guidance (USEPA, 1996b), followed by *Recommendations of the TRW for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil* (USEPA 2003).

The USEPA ALM 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 µg/dL is utilized in the lead methodology. At this time, quantifying uptake from dermal exposure to soil-borne lead is not recommended in the methodology due to the uncertainty in assigning a dermal absorption fraction that would apply to the numerous inorganic forms of lead typically found in environmental settings.

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) includes two input parameters used in the USEPA ALM. The values for the baseline blood lead concentration ($PbB_{adult,0}$) and the geometric standard deviation among adults ($GSD_{i,adults}$) are based on national information obtained from the NHANES III study. The 800 mg/kg soil lead level is the concentration associated with the protection of the most sensitive population after consideration of the available national data. USEPA's *Lead at Superfund Sites: Frequent Questions from Risk Assessors on the Adult Lead Methodology,* cites the use of the 800 mg/kg value as a cleanup goal protective for all subpopulations (USEPA, 2018c). The Department therefore is using the above USEPA methodology and the resulting cleanup goal of 800 mg/kg as the nonresidential SRS for lead.

The nonresidential SRS for lead of 800 mg/kg 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.

The Department recognizes that the USEPA Office of Land and Emergency Management released in May 2017, *Transmittal of Update to the Adult Lead Methodology’s Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameters (OLEM Directive 9285.6-56)*, which provided updates to the default baseline blood lead concentration and geometric standard deviation input parameters for the ALM using 2009-2014 NHANES data. It is also acknowledged that in light of USEPA updates to the residential soil lead guidance and target blood lead levels, updates to the nonresidential lead guidance may be forthcoming. However, currently soil lead updates are limited to the residential land use scenario only and the USEPA RSL and RML Tables continue to use 800 mg/kg (industrial) for lead (USEPA 2018b and 2018d), which is based on a 10 µg/dL target blood lead level and the combined phases of the NHANES III data. Due to these inconsistencies, the Department decided to retain the 2008 (former) lead nonresidential SRS for the ingestion-dermal exposure pathway at this time and keep the standard consistent with the USEPA national screening and removal management levels. The Department will continue to evaluate the science and USEPA policies involving lead to determine if a future update to the lead nonresidential SRS for the ingestion-dermal exposure pathway is necessary.

2.9.2. Arsenic

The Brownfield Act at N.J.S.A. 58:10B-12g(4) requires that SRS are health-based, but may not be lower than regional natural background levels in New Jersey for any particular contaminant. Based on an evaluation of a New Jersey statewide survey of background levels of inorganic contaminants in soil (Sanders, 2003) in relation to the proposed health-based standards, the Department determined that arsenic is usually present in New Jersey soils at levels higher than the health-based standard. The Department has selected a state-wide regional natural background SRS for arsenic of 19 mg/kg based on the 95th percentile of arsenic concentrations found in the different geographic provinces throughout New Jersey.

While the Department is proposing a statewide SRS for arsenic, the Department recognizes there is a wide variation in background concentrations of arsenic that exist across the State. In those instances where the person responsible for conducting the remediation believes that naturally occurring levels of arsenic are greater than 19 mg/kg at a site, a site-specific background determination can be conducted as part of the remediation. The procedures to determine background levels of contaminants in soil on a site-specific basis are outlined in the *Technical Requirements for Site Remediation* at N.J.A.C.7:26E-3.8 and in the *Technical Guidance for Site Investigation of Soil, Remedial Investigation of Soil, and Remedial Action Verification Sampling for Soil*, March 2015, Version 1.2 (https://www.nj.gov/dep/srp/guidance/#si_ri_ra_soils).

2.9.3. Polycyclic Aromatic Hydrocarbons (PAHs)

For the seven chemicals classified as carcinogenic PAHs, USEPA published the *Provisional Guidance for Quantitative Risk Assessment of PAHs* (USEPA, 1993b) which recommends a relative potency factor (RPF) approach for individual PAHs. This approach uses information from the scientific literature to determine the carcinogenic potency of several PAHs relative to benzo(a)pyrene (BaP). BaP is the only PAH with extensive chronic dose-response data that is routinely assayed and detected in soils contaminated with PAH mixtures. These relative potencies are used to modify BaP's cancer slope factor to calculate equivalent concentrations for each of the other PAHs. The approach is very similar to the TEF approach used for dioxins.

Compound	RPF
Benzo(a)pyrene	1.0
Benz(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Chrysene	0.001
Dibenz(a,h)anthracene	1.0
Indeno(1,2,3-c,d)pyrene	0.1

Oral slope factors for the carcinogenic PAHs normalized to BaP using the RPF approach range from 1 $(mg/kg/d)^{-1}$ for BaP to 0.001 $(mg/kg/d)^{-1}$ for chrysene **(see Table A-4).**

2.9.4. 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, 1997a) 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 MCL, ground water, surface water and soil standards. The health-based ingestion-dermal criteria for PCBs reflect this recommendation.

2.9.5. Chromium

No SRS for the ingestion-dermal exposure pathway for chromium will be developed at this time.

2.9.6. Extractable Petroleum Hydrocarbons

For details on the derivation of the SRS for extractable petroleum hydrocarbons (EPH), please refer to N.J.A.C. 7:26D and the *Evaluation of EPH in Soil Technical Guidance*, https://www.nj.gov/dep/srp/guidance/#eph_soil.

2.9.7. 2,3,7,8 – Tetrachlorodibenzo-*p*-dioxin

The term dioxin is often used to refer to a mixture of polychlorinated dioxin and furan compounds that are similar in structure and toxicity. The toxicity of the mixture is assessed in relation to the presence of a particular congener, that of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD, also referred to as "dioxin"), and considered the most toxic among the related congeners. Environmental investigations performed during the late 1970's and early 1980's led to the discovery of this contaminant in biotic and abiotic media near certain types of industrial facilities whose activities involved either dioxin-forming operations or used raw materials which contained chlorinated dioxins and furan congeners as inherent contaminants. Not intentionally produced, dioxins were discovered as unwanted byproducts of several different industrial processes involving chlorinated compounds, including, specialty chemical manufacturing with chlorinated benzenes, chlorinated phenols, and related compounds often used for herbicide and pesticide production, incomplete combustion of plastics and other chlorine-based materials, pulp and paper mill operations involving chlorine-based bleaching, and metal smelting processes (USEPA, 1980 & 2001). Overtime, improvements in manufacturing processes greatly reduced the presence of this group of contaminants in manufactured products. However, dioxins remain a significant contaminant of concern due to the existence of legacy dioxin soil and sediment contamination from former industrial discharges and its high degree of persistence, toxicity and bioaccumulation in the environment, along with its propensity for biomagnification up through the food chain.

Dioxin and dioxin-like compounds are among the most toxic synthetic compounds known to exist due to a broad spectrum of toxic effects, for both cancer risk and non-cancer impacts, attributable to dioxin exposure at low doses in many types of organisms, including humans, and especially sensitive life stages of mammals, fish and birds (USEPA, 1993a; USEPA, 2000; White and Birnbaum 2009). Dioxin is a known human carcinogen and, due to hormone- like actions, may illicit significant non-cancer impacts in areas of reproductive and developmental toxicity, nervous system toxicity, immune system toxicity, cardiovascular system impacts and hepatatoxicity (White and Birnbaum, 2009). At high doses, dioxin also causes a serious skin disorder known as Chloracne (USEPA, 2001). Toxic effects of dioxin are primarily initiated through a common biochemical mechanism known as the Aryl hydrocarbon Receptor (AhR), whereby dioxin and dioxin-like compounds interfere with the normal functioning of this biological system in vertebrates.

In 1991, due to the known high toxicity of this contaminant category and its increased discovery at numerous hazardous waste sites across the country, the USEPA initiated the Dioxin Reassessment Project. The purpose of the Dioxin Reassessment has been to promote dialogue and collaboration among national and international experts in the field of dioxin toxicity, using the best scientific information as it became available, for evaluation of both cancer risk and non-cancer effects. A primary objective was to develop an improved understanding of the underlying biological mechanisms of dioxin's toxicity and to develop appropriate methods and tools for use in risk assessment and risk management decisions involving dioxin contamination.

Historically, in the absence of either a Federal or State SRS for dioxin, the Department used a dioxin soil action level of 1 µg/kg (ppb) for residential (unrestricted) use sites and levels of between 5 – 20 µg/kg (ppb) for nonresidential (restricted use) sites. These action levels were originally based on a 1984 risk evaluation performed by the Centers for Disease Control (CDC) within the US Department of Health and Human Services (USHHS), to assist the USEPA with remedial action decisions associated with the Times Beach Dioxin Superfund site in the State of Missouri (USHHS-CDC 1984). Subsequently, recognizing the great need for consistent remedial guidance to States and Regions while the Dioxin Reassessment project was underway, the USEPA issued these levels as formal guidance for evaluation of dioxin soil contamination nationwide at both CERCLA and RCRA sites (USEPA 1998).

An early recommendation of the Dioxin Reassessment project was the need to incorporate the concept of dioxin as a mixture of similar congeners when performing dioxin exposure assessments. As a result, in 1998 through a special meeting of experts at the World Health

Organization (WHO), congener-specific toxic equivalency factors (TEFs) were developed for a subset of the tetra- through octa-polychlorinated dioxins (7 congeners) and furans (10 congeners) considered of most concern due to their related toxicity to 2,3,7,8,-TCDD (Van den Berg, M., et.al., 1998). The selected 17 congeners all have chlorine molecules attached in the same 2,3,7,8-pattern as the reference compound, 2,3,7,8,-TCDD. The use of TEFs to develop the "toxic equivalence" (TEQ) of a mixture of dioxin-like compounds in a sample, to 2,3,7,8,-TCDD, is commonly referred to as the sample TCDD-TEQ. This concept has been refined over the years and is widely accepted and used by public health institutions and governments throughout the USA and the world (Van den Berg, M., et. al., 2006; USEPA 2010).

In 1998, and again in 2008, the ATSDR recommended the use of an initial dioxin soil screening level of 50 pg/kg (ppt) for residential use sites (ATSDR, 2008), referred to as an Environmental Media Evaluation Guide (EMEG). An EMEG represents a level not expected to cause adverse non-carcinogenic health effects. The NJDEP Site Remediation Program has recommended using this EMEG as an initial screening level for sites suspected of dioxin contamination while the Dioxin Reassessment work continued, and with the understanding that dioxin toxicity science was potentially leading towards these lower levels.

In February 2012, as a result of the Dioxin Reassessment, the USEPA published an oral RfD of 0.7 pg/kg-day for 2,3,7,8-TCDD for non-cancer effects (USEPA 2012) in IRIS. The published RfD was based on two human epidemiologic studies in which one study revealed neurological developmental effects based on neonatal exposure and the other study revealed impaired reproductive development based on early childhood exposure. The Department's SRS for 2,3,7,8-TCDD are based on the IRIS oral RfD of 0.7 pg/kg-day and derived in a similar manner as other SRS using the ingestion-dermal exposure scenario equation and application of standard default exposure parameters. The resulting SRS for the ingestion-dermal exposure pathway are 51 pg/kg (ppt) for residential use sites and 810 pg/kg (ppt) for nonresidential use sites.

With regard to cancer-based toxicity, studies have resulted in development of several cancer slope factors over the years by different public health institutions (ATSDR, HEAST, CalEPA, USEPA) for use in risk assessment and similar purposes. These cancer slope factors are considered Tier 3 toxicity values. Through USEPA's Dioxin Reassessment project, the evaluation of dioxin cancer potency continues and is expected to conclude through future issuance of an updated, final cancer potency slope factor in IRIS. Until that time, the Department will base its SRS for 2,3,7,8-TCDD on the February 2012 oral RfD in IRIS.

3. Soil Remediation Standards for the Ingestion-Dermal Exposure Pathway

3.1. Determination of Soil Remediation Standards for the Ingestion-Dermal Exposure Pathway

The residential and nonresidential SRS for the ingestion-dermal exposure pathway are determined as the higher of the calculated human health-based criteria, the contaminants' analytical reporting limit (RL), or natural background level in soil. The human health-based criteria default to the analytical RL when higher, since a contaminant's analytical RL is the lowest concentration reliably able to be detected by a laboratory using the applicable analytical method. The health-based criteria default to soil background levels since the Brownfield Act at N.J.S.A. 58:10B-12g(4) requires that SRS are health based, but may not be lower than frequently detected regional natural background levels in New Jersey. The residential and nonresidential SRS for the ingestion-dermal exposure pathway, along with whether the standard is based on the analytical RL or soil background level are presented in **Tables A-1 and A-2**.

4. Alternative Remediation Standards for Soil for the Ingestion-Dermal Exposure Pathway

The Department will review proposals for alternative remediation standards (ARS) for soil on a site-by-site basis and render a decision on the acceptability of the proposal for the site. The *Alternative Remediation Standards Technical Guidance for Soil for the Ingestion-Dermal and Inhalation Exposure Pathways* (https://www.nj.gov/dep/srp/guidance/) provides technical guidance to support the development of an ARS for soil for the ingestion-dermal and inhalation exposure pathways. Guidance is provided to identify when and how to calculate a site-specific ARS for soil and supplements N.J.A.C 7:26D-8, Appendix 6 and Appendix 7. The document does not cover interim SRS or updated SRS based on new toxicity data (N.J.A.C. 7:26D-6 and 7). USEPA references and other sources that may be helpful to investigators for developing ARS for soil and supporting assumptions used in ARS calculations are also provided in the technical guidance.

In particular, the above referenced document provides:

- Background on the default SRS for the ingestion-dermal and inhalation exposure pathways to help investigators identify when an ARS for soil may or may not be appropriate to support site remedial decisions;
- ARS for soil options that require prior approval by the Department, including guidance and examples of appropriate exposure factors for deriving an ARS for soil using alternative land use scenarios (active recreational land use, passive recreational land use, restricted access areas, and infrequent access areas);
- ARS for soil options for child and adult lead models that require prior approval by the Department and interim policy;
- ARS for soil options for the inhalation exposure pathway that do not require prior approval from the Department, including depth range, soil organic carbon content, and fraction of vegetative cover;
- Information regarding the Department's calculator used for developing and submitting an ARS for soil; and
- Information on the application, documentation, and review process (in the case of prior approval) of an ARS for soil request.

The above ARS document may be accessed at https://www.nj.gov/dep/srp/guidance/.

5. Interim Soil Remediation Standards for the Ingestion-Dermal Exposure Pathway

Interim SRS for the ingestion-dermal exposure pathway may be developed in the absence of available SRS for contaminants of concern at a site. The procedures set forth at N.J.A.C. 7:26D Appendix 2 and outlined in this document, as applicable, are used to develop interim SRS for the ingestion-dermal exposure pathway provided appropriate toxicity information is available for the contaminants. Consistent with N.J.A.C.7:26D-6, the person responsible for conducting the remediation may request that the Department develop an interim soil remediation standard and shall use only a Department developed interim soil remediation standard. Contacts for technical questions regarding the development of interim SRS can be found at http://www.nj.gov/dep/srp/srra/srra_contacts.htm.

References

ASTM. Testing and Materials. Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications (ASTM E29-13).

ATSDR. Agency for Toxic Substances and Disease Registry. 2008. Update to the ATSDR Policy Guideline for Dioxins and Dioxin-Like Compounds in Residential Soil. http://www.atsdr.cdc.gov/substances/dioxin/policy/Dioxin_Policy_Guidelines.pdf

ATSDR. Agency for Toxic Substances and Disease Registry. 2018. Minimal Risk Levels for Hazardous Substances. https://wwwn.cdc.gov/TSP/MRLS/mrlsListing.aspx

ATSDR. Agency for Toxic Substances and Disease Registry. 2020. Toxicological Profile for Lead. https://www.atsdr.cdc.gov/toxprofiles/tp13.pdf

CAL EPA. California Environmental Protection Agency. 2018. Toxicity Criteria Database. https://oehha.ca.gov/chemicals

NJDEP. New Jersey Department of Environmental Protection. 1997a. Draft Recommendations for Revisions to New Jersey Risk Assessment for PCBs. April 25, 1997.

NJDEP. New Jersey Department of Environmental Protection. 1997b. Interim Specific Criterion for Tertiary Butyl Alcohol. Memorandum dated September 12, 1997.

NJDWQI. New Jersey Drinking Water Quality Institute. 1987. Maximum Contaminant Level Recommendation for Hazardous Contaminants in Drinking Water, Appendix B, Health-Based Maximum Contaminant Level Support Documents.

NJDWQI. New Jersey Drinking Water Quality Institute. 1994. Maximum Contaminant Level Recommendation for Hazardous Contaminants in Drinking Water, Appendix A, Health-Based Maximum Contaminant Level Support Documents and Addenda.

Sanders, P.F. 2003. Ambient Levels of Metals in New Jersey Soils. https://www.state.nj.us/dep/dsr/research/ambient-levels-metal.pdf

Stern, A.H., 1996. Derivation of a Target Concentration of Pb in Soil Based on Elevation of Adult Blood Pressure, Risk Analysis, 16-2, 201-209.

U.S. Environmental Protection Agency (USEPA).1980. Dioxins, EPA-600/2-80-197.

U. S. Environmental Protection Agency (USEPA). 1986. Guidelines for Carcinogen Risk Assessment. http://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=54933&CFID=52936938&CFTOKEN=51704777

U.S. Environmental Protection Agency (USEPA). 1989. Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part A, Baseline Risk Assessment). Office of Emergency and Remedial Response, Washington, DC. EPA/540/1-89/002.

U.S. Environmental Protection Agency (USEPA). 1991. Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (HHEM), Part B, Development of Risk-Based Preliminary Remediation Goals. Office of Emergency and Remedial Response, Washington, DC. OERR 9285.7-01B. NTIS PB92-963333.

U.S. Environmental Protection Agency (USEPA). 1993a. Interim Report on Data and Methods for Assessment of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Risks to Aquatic Life and Associated Wildlife, EPA/600/R-93/055.

U.S. Environmental Protection Agency (USEPA). 1993b. Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons. Office of Research and Development. EPA/600/R-93/089.

U.S. Environmental Protection Agency (USEPA). 1994a. Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children. Office of Solid Waste and Emergency Response, Washington, DC. OSWER 9285.7-15-1.

U.S. Environmental Protection Agency (USEPA). 1994b. Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. Office of Solid Waste and Emergency Response, Washington, DC. OSWER 9355.4-12.

U.S. Environmental Protection Agency (USEPA). 1996a. Soil Screening Guidance: Technical Background Document. Office of Emergency and Remedial Response, Washington, DC. EPA/540/R-96/128. NTIS PB96-963502.

U.S. Environmental Protection Agency (USEPA). 1996b. Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil, USEPA Technical Workgroup for Lead.

U.S. Environmental Protection Agency (USEPA). 1996c. Cancer dose-response assessment and application to environmental mixtures. EPA/600/P-96/001F. Office of Research and Development, National Center for Environmental Assessment, Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1997. Health Effects Assessment Summary Tables (HEAST): Annual Update, FY 1997. Office of Research and Development, Office of Emergency and Remedial Response, Washington, DC. NTIS PB97-921199.

U.S. Environmental Protection Agency (USEPA). 1998. Approach for Addressing Dioxin in Soil at CERCLA and RCRA Sites, OSWER 9200-4.26.

U.S. Environmental Protection Agency (USEPA). 2000. EPA's Dioxin Reassessment (External Review Draft), Submitted to the Science Advisory Board (SAB). EPA/600/P-00/001.

U.S. Environmental Protection Agency (USEPA). 2001. EPA Information Sheet 2, Dioxin: Scientific Highlights from Draft Reassessment (2000).

U.S. Environmental Protection Agency (USEPA). 2002a. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Draft Final, OSWER 9355.4-24.

U.S. Environmental Protection Agency (USEPA). 2002b. Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phase I and II of the National Health and Nutrition Evaluation Survey (NHANES III). Office of Solid Waste and Emergency Response. OSWER 9285.7-52.

U.S. Environmental Protection Agency (USEPA). 2003. Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. Technical Review Workgroup for Lead. EPA-540-R-03-001.

U.S. Environmental Protection Agency (USEPA). 2004. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final, EPA/540/R/99/005, OSWER 9285.7-02EP.

U. S. Environmental Protection Agency (USEPA). 2005. Guidelines for Carcinogen Risk Assessment. https://www.epa.gov/risk/guidelines-carcinogen-risk-assessment

U.S Environmental Protection Agency (USEPA). 2009. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment, Final, EPA-540-R-070-002, OSWER 9285.7-82.

U.S. Environmental Protection Agency (USEPA). 2010. Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-p-dioxin and Dioxin-like Compounds. https://www.epa.gov/sites/production/files/2013-09/documents/tefs-for-dioxin-epa-00-r-10-005-final.pdf

U.S. Environmental Protection Agency (USEPA). 2011. Exposure Factors Handbook: 2011 Edition. EPA/600/R-090/052F.

U.S. Environmental Protection Agency (USEPA). 2012. EPA's Reanalysis of Key Issues Related to Dioxin Toxicity and Response to NAS Comments, Volume 1, In Support of Summary Information on the Integrated Risk Information System (IRIS). https://cfpub.epa.gov/ncea/iris/iris_documents/documents/supdocs/dioxinv1sup.pdf

U.S. Environmental Protection Agency (USEPA). 2013. Integrated Science Assessment for Lead EPA/600/R-10/075F. https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=255721

U.S. Environmental Protection Agency (USEPA). 2014. Memorandum: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120.4-12.

U.S. Environmental Protection Agency (USEPA). 2017. Update of the Adult Lead Methodology's Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameter. OLEM Directive 9285.6-56.

U.S. Environmental Protection Agency (USEPA). 2018a. Integrated Risk Information System (IRIS). https://www.epa.gov/iris

U.S. Environmental Protection Agency (USEPA). 2018b. Regional Screening Levels (Users Guide November 2018). https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide

U.S. Environmental Protection Agency (USEPA). 2018c. Lead at Superfund Sites: Frequent Questions from Risk Assessors on the Adult Lead Methodology. https://www.epa.gov/superfund/lead-superfund-sites-frequent-questions-risk-assessors-adult-lead-methodology#screening%20value

U.S. Environmental Protection Agency (USEPA). 2018d. Regional Removal Management Levels for Chemicals. https://www.epa.gov/risk/regional-removal-management-levels-chemicals-rmls

U.S. Environmental Protection Agency (USEPA). 2018e. Provisional Peer Reviewed Toxicity Values. https://www.epa.gov/pprtv

U.S. Environmental Protection Agency (USEPA). 2021. Overview of Changes of the IEUBK Model Software from IEUBKwin version 1.1 build 11 to IEUBKwin version 2.0 build 1.63. https://semspub.epa.gov/work/HQ/400710.pdf

U.S. Environmental Protection Agency (USEPA) 2024. Updated Residential Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. https://semspub.epa.gov/work/HQ/100003435.pdf

U.S. Health and Human Services – Center for Environmental Health Centers for Disease Control. 1984. Health Implications of 2,3,7,8-Tetrachlorodibenzodioxin (TCDD) Contamination of Residential Soil. Journal of Toxicology and Environmental Health, 14:47-93. https://semspub.epa.gov/work/06/80360.pdf

Van den Berg, M., et.al. 1998. Toxic Equivalency Factors (TEFs) for PCBs, PCDDs, PCDFs for Humans and Wildlife. Environmental Health Perspectives, Volume 106, Number 12. http://www.cerc.usgs.gov/pubs/center/pdfDocs/90970.pdf

Van den Berg, M., et.al. 2006. The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicological Sciences 93 (2):223-241. http://www.who.int/foodsafety/chem/2005_WHO_TEFs_ToxSci_2006.pdf

White, S.S and Birnbaum, L.S. 2009. An Overview of the Effects of Dioxins and Dioxin-Like Compounds on Vertebrates, as Documented in Human and Ecological Epidemiology. Journal of Environmental Science and Health Part C, 27:197-211. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2788749/pdf/nihms150859.pdf

APPENDIX A

TABLES

Table A-1
Soil Remediation Standards for the Ingestion-Dermal Exposure Pathway - Residential (mg/kg)
(All numeric values are rounded to two significant figures)

Contaminant	CAS No.	Residential Carcinogenic Ingestion-Dermal Human Health-based Criterion	Residential Noncarcinogenic Ingestion-Dermal Human Health-based Criterion	Reporting Limit	Soil Remediation Standard Ingestion-Dermal – Residential
Acenaphthene	83-32-9	NA	3,600	0.17	3,600
Acetone (2-Propanone)	67-64-1	NA	70,000	0.010	70,000
Acetophenone	98-86-2	NA	7,800	0.33	7,800
Aldrin	309-00-2	0.041	2.3	0.0017	0.041
Aluminum (total)	7429-90-5	NA	78,000	20	78,000
Anthracene	120-12-7	NA	18,000	0.17	18,000
Antimony (total)	7440-36-0	NA	31	1.0	31
Arsenic (total)	7440-38-2	0.43	22	0.50	19[1]
Atrazine	1912-24-9	NA	220	0.33	220
Barium (total)	7440-39-3	NA	16,000	5.0	16,000
Benzaldehyde	100-52-7	170	7,800	0.33	170
Benzene	71-43-2	3.0	310	0.0050	3.0
Benzo(a)anthracene (1,2-Benzanthracene)	56-55-3	5.1	NA	0.17	5.1
Benzo(a)pyrene	50-32-8	0.51	18	0.17	0.51
Benzo(b)fluoranthene (3,4-Benzofluoranthene)	205-99-2	5.1	NA	0.17	5.1
Benzo(k)fluoranthene	207-08-9	51	NA	0.17	51
Beryllium	7440-41-7	NA	160	0.50	160
1,1'-Biphenyl	92-52-4	87	39,000	0.17	87
Bis(2-chloroethoxy)methane	111-91-1	NA	190	0.17	190
Bis(2-chloroethyl)ether	111-44-4	0.63	NA	0.33	0.63
Bis(2-ethylhexyl)phthalate	117-81-7	39	1,300	0.17	39
Bromodichloromethane (Dichlorobromomethane)	75-27-4	11	1,600	0.0050	11
Bromoform	75-25-2	88	1,600	0.0050	88
Bromomethane (Methyl bromide)	74-83-9	NA	110	0.0050	110
2-Butanone (Methyl ethyl ketone) (MEK)	78-93-3	NA	47,000	0.010	47,000
Butylbenzyl phthalate	85-68-7	290	13,000	0.17	290
Cadmium	7440-43-9	NA	71	0.50	71
Caprolactam	105-60-2	NA	32,000	0.33	32,000
Carbon disulfide	75-15-0	NA	NA	0.0050	NA

Carbon tetrachloride	56-23-5	7.6	310	0.0050	7.6
Chlordane (alpha and gamma forms summed)	57-74-9	0.27	36	0.0017	0.27
4-Chloroaniline	106-47-8	2.7	250	0.17	2.7
Chlorobenzene	108-90-7	NA	510	0.0050	510
Chloroethane (Ethyl chloride)	75-00-3	NA	NA	0.0050	NA
Chloroform	67-66-3	NA	780	0.0050	780
Chloromethane (Methyl chloride)	74-87-3	NA	NA	0.0050	NA
2-Chloronaphthalene	91-58-7	NA	4,800	0.17	4,800
2-Chlorophenol (o-Chlorophenol)	95-57-8	NA	390	0.17	390
Chrysene	218-01-9	510	NA	0.17	510
Cobalt (total)	7440-48-4	NA	23	0.50	23
Copper (total)	7440-50-8	NA	3,100	1.0	3,100
Cyanide	57-12-5	NA	47	0.50	47
Cyclohexane	110-82-7	NA	NA	0.0050	NA
4,4'-DDD (p,p'-TDE)	72-54-8	2.3	NA	0.0033	2.3
4,4'-DDE (p,p'-DDX)	72-55-9	2.0	NA	0.0033	2.0
4,4'-DDT	50-29-3	1.9	37	0.0033	1.9
Dibenz(a,h)anthracene	53-70-3	0.51	NA	0.17	0.51
Dibromochloromethane (Chlorodibromomethane)	124-48-1	8.3	1,600	0.0050	8.3
1,2-Dibromo-3-chloropropane	96-12-8	0.87	16	0.0050	0.87
1,2-Dibromoethane (Ethylene dibromide)	106-93-4	0.35	700	0.0050	0.35
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	NA	6,700	0.0050	6,700
1,3-Dichlorobenzene (m-Dichlorobenzene)	541-73-1	NA	6,700	0.0050	6,700
1,4-Dichlorobenzene (p-Dichlorobenzene)	106-46-7	NA	780	0.0050	780
3,3'-Dichlorobenzidine	91-94-1	1.2	NA	0.33	1.2
Dichlorodifluoromethane (Freon 12)	75-71-8	NA	16,000	0.0050	16,000
1,1-Dichloroethane	75-34-3	120	16,000	0.0050	120
1,2-Dichloroethane	107-06-2	5.8	NA	0.0050	5.8
1,1-Dichloroethene (1,1-Dichloroethylene)	75-35-4	NA	11	0.0050	11
1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	156-59-2	NA	780	0.0050	780
1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	156-60-5	NA	1,300	0.0050	1,300

2,4-Dichlorophenol	120-83-2	NA	190	0.17	190
1,2-Dichloropropane	78-87-5	19	3,100	0.0050	19
1,3-Dichloropropene (total)	542-75-6	7.0	2,300	0.0050	7.0
Dieldrin	60-57-1	0.034	3.2	0.0033	0.034
Diethylphthalate	84-66-2	NA	51,000	0.17	51,000
2,4-Dimethylphenol	105-67-9	NA	1,300	0.17	1,300
Di-n-butyl phthalate	84-74-2	NA	6,300	0.17	6,300
2,4-Dinitrophenol	51-28-5	NA	130	0.33	130
2,4-Dinitrotoluene/2,6-Dinitrotoluene (mixture)	25321-14-6	0.80	NA	0.17	0.80
Di-n-octyl phthalate	117-84-0	NA	630	0.33	630
1,4-Dioxane	123-91-1	7.0	2,300	0.067	7.0
Endosulfan I and Endosulfan II (alpha and beta) (summed)	115-29-7	NA	470	0.0033	470
Endrin	72-20-8	NA	19	0.0033	19
Ethylbenzene	100-41-4	NA	7,800	0.0050	7,800
Extractable Petroleum Hydrocarbons (Category 1)	various	NA	5,300[3]	80	5,300[3]
Extractable Petroleum Hydrocarbons (Category 2)	various	NA	Sample-specific[4]	80	Sample-specific[4]
Fluoranthene	206-44-0	NA	2,400	0.33	2,400
Fluorene	86-73-7	NA	2,400	0.17	2,400
alpha-HCH (alpha-BHC)	319-84-6	0.086	510	0.0017	0.086
beta-HCH (beta-BHC)	319-85-7	0.30	NA	0.0017	0.30
Heptachlor	76-44-8	0.15	39	0.0017	0.15
Heptachlor epoxide	1024-57-3	0.076	1.0	0.0017	0.076
Hexachlorobenzene	118-74-1	0.43	63	0.17	0.43
Hexachloro-1,3-butadiene	87-68-3	8.9	78	0.17	8.9
Hexachlorocyclopentadiene	77-47-4	NA	470	0.33	470
Hexachloroethane	67-72-1	17	55	0.17	17
n-Hexane	110-54-3	NA	NA	-[7]	NA
2-Hexanone	591-78-6	NA	390	0.010	390
Indeno(1,2,3-cd)pyrene	193-39-5	5.1	NA	0.17	5.1
Isophorone	78-59-1	570	13,000	0.17	570
Isopropylbenzene	98-82-8	NA	7,800	0.0050	7,800
Lead (total)	7439-92-1	NA	NA	0.50	200[5]
Lindane (gamma-HCH)(gamma-BHC)	58-89-9	0.57	21	0.0017	0.57
Manganese (total)	7439-96-5	NA	1,900	0.50	1,900
Mercury (total)	7439-97-6	NA	23	0.10	23
Methoxychlor	72-43-5	NA	320	0.017	320
Methyl acetate	79-20-9	NA	78,000	0.0050	78,000

Methylene chloride (Dichloromethane)	75-09-2	50	470	0.0050	50
2-Methylnaphthalene	91-57-6	NA	240	0.17	240
4-Methyl-2-pentanone (MIBK)	108-10-1	NA	NA	0.010	NA
2-Methylphenol (o-cresol)	95-48-7	NA	320	0.33	320
4-Methylphenol (p-cresol)	106-44-5	NA	630	0.33	630
Methyl tert-butyl ether (MTBE)	1634-04-4	NA	780	0.0050	780
Naphthalene	91-20-3	NA	2,500	0.17	2,500
Nickel (total)	7440-02-0	NA	1,600	0.50	1,600
4-Nitroaniline	100-01-6	27	250	0.33	27
Nitrobenzene	98-95-3	NA	160	0.17	160
N-Nitrosodi-n-propylamine	621-64-7	0.078	NA	0.17	0.17[2]
N-Nitrosodiphenylamine	86-30-6	110	NA	0.17	110
2,2'-oxybis (1-chloropropane)	108-60-1	NA	3,100	0.33	3,100
Pentachlorophenol	87-86-5	1.0	250	0.33	1.0
Phenol	108-95-2	NA	19,000	0.33	19,000
Polychlorinated biphenyls (PCBs)	1336-36-3	0.25	NA	0.030	0.25
Pyrene	129-00-0	NA	1,800	0.17	1,800
Selenium (total)	7782-49-2	NA	390	2.5	390
Silver (total)	7440-22-4	NA	390	0.50	390
Styrene	100-42-5	NA	16,000	0.0050	16,000
Tertiary butyl alcohol (TBA)	75-65-0	NA	1,400	0.10	1,400
1,2,4,5-Tetrachlorobenzene	95-94-3	NA	23	0.17	23
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6	NA	0.000051	0.0000010	0.000051[6]
1,1,2,2-Tetrachloroethane	79-34-5	3.5	1,600	0.0050	3.5
Tetrachloroethene (PCE) (Tetrachloroethylene)	127-18-4	330	470	0.0050	330
2,3,4,6-Tetrachlorophenol	58-90-2	NA	1,900	0.17	1,900
Toluene	108-88-3	NA	6,300	0.0050	6,300
Toxaphene	8001-35-2	0.49	NA	0.17	0.49
1,2,4-Trichlorobenzene	120-82-1	NA	780	0.0050	780
1,1,1-Trichloroethane	71-55-6	NA	160,000	0.0050	160,000
1,1,2-Trichloroethane	79-00-5	12	310	0.0050	12
Trichloroethene (TCE) (Trichloroethylene)	79-01-6	15	39	0.0050	15
Trichlorofluoromethane (Freon 11)	75-69-4	NA	23,000	0.0050	23,000
2,4,5-Trichlorophenol	95-95-4	NA	6,300	0.20	6,300
2,4,6-Trichlorophenol	88-06-2	49	63	0.20	49
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon TF)	76-13-1	NA	NA	0.0050	NA

1,2,4-Trimethylbenzene	95-63-6	NA	780	0.076	780
Vanadium (total)	7440-62-2	NA	390	2.5	390
Vinyl chloride	75-01-4	0.97	230	0.0050	0.97
Xylenes (total)	1330-20-7	NA	12,000	0.0050	12,000
Zinc (total)	7440-66-6	NA	23,000	1.0	23,000

NA – Not applicable because appropriate toxicological information is not available

[1] Standard is based on natural background
[2] Standard set at reporting limit

[3] Special calculation for EPH – see Appendix 2 of N.J.A.C. 7:26D

[4] Sample-specific calculation using EPH calculator – see Appendix 2 of N.J.A.C. 7:26D

[5] Standard based on the Integrated Exposure Uptake Biokinetic (IEUBK) model for lead in children

[6] This standard is used for comparison to site soil data that have been converted to sample-specific TCDD-TEQ values through application of the Toxicity Equivalence Factor Methodology (USEPA 2010) and using the WHO 2005 Mammalian Toxic Equivalency Factors (TEFs)

[7] Although n-Hexane does not have a specific reporting limit, quantification is required to be less than the applicable remediation standard

Table A-2
Soil Remediation Standards for the Ingestion-Dermal Exposure Pathway - Nonresidential (mg/kg)
(All numeric values are rounded to two significant figures)

Contaminant	CAS No.	Nonresidential Carcinogenic Ingestion-Dermal Human Health-based Criterion	Nonresidential Noncarcinogenic Ingestion-Dermal Human Health-based Criterion	Reporting Limit	Soil Remediation Standard Ingestion-Dermal – Nonresidential
Acenaphthene	83-32-9	NA	50,000	0.17	50,000
Acetone (2-Propanone)	67-64-1	NA	1,200,000	0.010	NA[1]
Acetophenone	98-86-2	NA	130,000	0.33	130,000
Aldrin	309-00-2	0.21	39	0.0017	0.21
Aluminum (total)	7429-90-5	NA	1,300,000	20	NA[1]
Anthracene	120-12-7	NA	250,000	0.17	250,000
Antimony (total)	7440-36-0	NA	520	1.0	520
Arsenic (total)	7440-38-2	2.1	350	0.50	19[2]
Atrazine	1912-24-9	NA	3,200	0.33	3,200
Barium (total)	7440-39-3	NA	260,000	5.0	260,000
Benzaldehyde	100-52-7	910	130,000	0.33	910
Benzene	71-43-2	16	5,200	0.0050	16
Benzo(a)anthracene (1,2-Benzanthracene)	56-55-3	23	NA	0.17	23
Benzo(a)pyrene	50-32-8	2.3	250	0.17	2.3
Benzo(b)fluoranthene (3,4-Benzofluoranthene)	205-99-2	23	NA	0.17	23
Benzo(k)fluoranthene	207-08-9	230	NA	0.17	230
Beryllium	7440-41-7	NA	2,600	0.50	2,600
1,1'-Biphenyl	92-52-4	450	650,000	0.17	450
Bis(2-chloroethoxy)methane	111-91-1	NA	2,700	0.17	2,700
Bis(2-chloroethyl)ether	111-44-4	3.3	NA	0.33	3.3
Bis(2-ethylhexyl)phthalate	117-81-7	180	18,000	0.17	180
Bromodichloromethane (Dichlorobromomethane)	75-27-4	59	26,000	0.0050	59
Bromoform	75-25-2	460	26,000	0.0050	460
Bromomethane (Methyl bromide)	74-83-9	NA	1,800	0.0050	1,800
2-Butanone (Methyl ethyl ketone) (MEK)	78-93-3	NA	780,000	0.010	780,000
Butylbenzyl phthalate	85-68-7	1,300	180,000	0.17	1,300
Cadmium	7440-43-9	NA	1,100	0.50	1,100
Caprolactam	105-60-2	NA	460,000	0.33	460,000
Carbon disulfide	75-15-0	NA	NA	0.0050	NA

Carbon tetrachloride	56-23-5	40	5,200	0.0050	40
Chlordane (alpha and gamma forms summed)	57-74-9	1.4	550	0.0017	1.4
4-Chloroaniline	106-47-8	13	3,600	0.17	13
Chlorobenzene	108-90-7	NA	8,400	0.0050	8,400
Chloroethane (Ethyl chloride)	75-00-3	NA	NA	0.0050	NA
Chloroform	67-66-3	NA	13,000	0.0050	13,000
Chloromethane (Methyl chloride)	74-87-3	NA	NA	0.0050	NA
2-Chloronaphthalene	91-58-7	NA	67,000	0.17	67,000
2-Chlorophenol (o-Chlorophenol)	95-57-8	NA	6,500	0.17	6,500
Chrysene	218-01-9	2,300	NA	0.17	2,300
Cobalt (total)	7440-48-4	NA	390	0.50	390
Copper (total)	7440-50-8	NA	52,000	1.0	52,000
Cyanide	57-12-5	NA	780	0.50	780
Cyclohexane	110-82-7	NA	NA	0.0050	NA
4,4'-DDD (p,p'-TDE)	72-54-8	11	NA	0.0033	11
4,4'-DDE (p,p'-DDX)	72-55-9	11	NA	0.0033	11
4,4'-DDT	50-29-3	9.5	580	0.0033	9.5
Dibenz(a,h)anthracene	53-70-3	2.3	NA	0.17	2.3
Dibromochloromethane (Chlorodibromomethane)	124-48-1	43	26,000	0.0050	43
1,2-Dibromo-3-chloropropane	96-12-8	4.5	260	0.0050	4.5
1,2-Dibromoethane (Ethylene dibromide)	106-93-4	1.8	12,000	0.0050	1.8
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	NA	110,000	0.0050	110,000
1,3-Dichlorobenzene (m-Dichlorobenzene)	541-73-1	NA	110,000	0.0050	110,000
1,4-Dichlorobenzene (p-Dichlorobenzene)	106-46-7	NA	13,000	0.0050	13,000
3,3'-Dichlorobenzidine	91-94-1	5.7	NA	0.33	5.7
Dichlorodifluoromethane (Freon 12)	75-71-8	NA	260,000	0.0050	260,000
1,1-Dichloroethane	75-34-3	640	260,000	0.0050	640
1,2-Dichloroethane	107-06-2	30	NA	0.0050	30
1,1-Dichloroethene (1,1-Dichloroethylene)	75-35-4	NA	180	0.0050	180
1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	156-59-2	NA	13,000	0.0050	13,000

1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	156-60-5	NA	22,000	0.0050	22,000
2,4-Dichlorophenol	120-83-2	NA	2,700	0.17	2,700
1,2-Dichloropropane	78-87-5	98	52,000	0.0050	98
1,3-Dichloropropene (total)	542-75-6	36	39,000	0.0050	36
Dieldrin	60-57-1	0.16	46	0.0033	0.16
Diethylphthalate	84-66-2	NA	730,000	0.17	730,000
2,4-Dimethylphenol	105-67-9	NA	18,000	0.17	18,000
Di-n-butyl phthalate	84-74-2	NA	91,000	0.17	91,000
2,4-Dinitrophenol	51-28-5	NA	1,800	0.33	1,800
2,4-Dinitrotoluene/2,6-Dinitrotoluene (mixture)	25321-14-6	3.8	NA	0.17	3.8
Di-n-octyl phthalate	117-84-0	NA	9,100	0.33	9,100
1,4-Dioxane	123-91-1	36	39,000	0.067	36
Endosulfan I and Endosulfan II (alpha and beta) (summed)	115-29-7	NA	7,800	0.0033	7,800
Endrin	72-20-8	NA	270	0.0033	270
Ethylbenzene	100-41-4	NA	130,000	0.0050	130,000
Extractable Petroleum Hydrocarbons (Category 1)	various	NA	75,000[3]	80	75,000[3]
Extractable Petroleum Hydrocarbons (Category 2)	various	NA	Sample-specific[4]	80	Sample-specific[4]
Fluoranthene	206-44-0	NA	33,000	0.33	33,000
Fluorene	86-73-7	NA	33,000	0.17	33,000
alpha-HCH (alpha-BHC)	319-84-6	0.41	7,300	0.0017	0.41
beta-HCH (beta-BHC)	319-85-7	1.4	NA	0.0017	1.4
Heptachlor	76-44-8	0.81	650	0.0017	0.81
Heptachlor epoxide	1024-57-3	0.40	17	0.0017	0.40
Hexachlorobenzene	118-74-1	2.3	1,000	0.17	2.3
Hexachloro-1,3-butadiene	87-68-3	47	1,300	0.17	47
Hexachlorocyclopentadiene	77-47-4	NA	7,800	0.33	7,800
Hexachloroethane	67-72-1	91	910	0.17	91
n-Hexane	110-54-3	NA	NA	-[7]	NA
2-Hexanone	591-78-6	NA	6,500	0.010	6,500
Indeno(1,2,3-cd)pyrene	193-39-5	23	NA	0.17	23
Isophorone	78-59-1	2,700	180,000	0.17	2,700
Isopropylbenzene	98-82-8	NA	130,000	0.0050	130,000
Lead (total)	7439-92-1	NA	NA	0.5	800[5]
Lindane (gamma-HCH)(gamma-BHC)	58-89-9	2.8	330	0.0017	2.8
Manganese (total)	7439-96-5	NA	31,000	0.50	31,000
Mercury (total)	7439-97-6	NA	390	0.10	390
Methoxychlor	72-43-5	NA	4,600	0.017	4,600
Methyl acetate	79-20-9	NA	1,300,000	0.0050	NA[1]

Methylene chloride (Dichloromethane)	75-09-2	260	7,800	0.0050	260
2-Methylnaphthalene	91-57-6	NA	3,300	0.17	3,300
4-Methyl-2-pentanone (MIBK)	108-10-1	NA	NA	0.010	NA
2-Methylphenol (o-cresol)	95-48-7	NA	4,600	0.33	4,600
4-Methylphenol (p-cresol)	106-44-5	NA	9,100	0.33	9,100
Methyl tert-butyl ether (MTBE)	1634-04-4	NA	13,000	0.0050	13,000
Naphthalene	91-20-3	NA	34,000	0.17	34,000
Nickel (total)	7440-02-0	NA	26,000	0.50	26,000
4-Nitroaniline	100-01-6	130	3,600	0.33	130
Nitrobenzene	98-95-3	NA	2,600	0.17	2,600
N-Nitrosodi-n-propylamine	621-64-7	0.36	NA	0.17	0.36
N-Nitrosodiphenylamine	86-30-6	520	NA	0.17	520
2,2'-oxybis(1-chloropropane)	108-60-1	NA	52,000	0.33	52,000
Pentachlorophenol	87-86-5	4.4	3,200	0.33	4.4
Phenol	108-95-2	NA	270,000	0.33	270,000
Polychlorinated biphenyls (PCBs)	1336-36-3	1.1	NA	0.030	1.1
Pyrene	129-00-0	NA	25,000	0.17	25,000
Selenium (total)	7782-49-2	NA	6,500	2.5	6,500
Silver (total)	7440-22-4	NA	6,500	0.50	6,500
Styrene	100-42-5	NA	260,000	0.0050	260,000
Tertiary butyl alcohol (TBA)	75-65-0	NA	23,000	0.10	23,000
1,2,4,5-Tetrachlorobenzene	95-94-3	NA	390	0.17	390
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6	NA	0.00081	0.0000010	0.00081[6]
1,1,2,2-Tetrachloroethane	79-34-5	18	26,000	0.0050	18
Tetrachloroethene (PCE) (Tetrachloroethylene)	127-18-4	1,700	7,800	0.0050	1,700
2,3,4,6-Tetrachlorophenol	58-90-2	NA	27,000	0.17	27,000
Toluene	108-88-3	NA	100,000	0.0050	100,000
Toxaphene	8001-35-2	2.3	NA	0.17	2.3
1,2,4-Trichlorobenzene	120-82-1	NA	13,000	0.0050	13,000
1,1,1-Trichloroethane	71-55-6	NA	2,600,000	0.0050	NA[1]
1,1,2-Trichloroethane	79-00-5	64	5,200	0.0050	64
Trichloroethene (TCE) (Trichloroethylene)	79-01-6	79	650	0.0050	79
Trichlorofluoromethane (Freon 11)	75-69-4	NA	390,000	0.0050	390,000
2,4,5-Trichlorophenol	95-95-4	NA	91,000	0.20	91,000
2,4,6-Trichlorophenol	88-06-2	230	910	0.20	230

1,1,2-Trichloro-1,2,2-trifluoroethane (Freon TF)	76-13-1	NA	NA	0.0050	NA
1,2,4-Trimethylbenzene	95-63-6	NA	13,000	0.076	13,000
Vanadium (total)	7440-62-2	NA	6,500	2.5	6,500
Vinyl chloride	75-01-4	5.0	3,900	0.0050	5.0
Xylenes (total)	1330-20-7	NA	190,000	0.0050	190,000
Zinc (total)	7440-66-6	NA	390,000	1.0	390,000

NA – Not applicable because appropriate toxicological information is not available

[1] – Standard not applicable because calculated health-based criterion exceeds one million mg/kg

[2] Standard is based on natural background

[3] Special calculation for EPH– see Appendix 2 of N.J.A.C. 7:26D

[4] Sample-specific calculation using EPH calculator – see Appendix 2 of N.J.A.C. 7:26D

[5] Standard based on the Adult Lead Methodology (ALM)

[6] This standard is used for comparison to site soil data that have been converted to sample-specific TCDD-TEQ values through application of the Toxicity Equivalence Factor Methodology (USEPA 2010) and using the WHO 2005 Mammalian Toxic Equivalency Factors (TEFs)

[7] Although n-Hexane does not have a specific reporting limit, quantification is required to be less than the applicable remediation standard

Table A-3
Benchmarks Supporting Ingestion-Dermal Absorption Standards

Chemical	CAS No.	Dermal Absorption Fraction (ABS_d)	Dermal Slope Factor (CSF_D)	Dermal Reference Dose (RfD_D)	Gastro-intestinal Absorption Fraction (GIABS)
Acenaphthene	83-32-9	0.13		0.06	1
Acetone (2-Propanone)	67-64-1			0.9	1
Acetophenone	98-86-2			0.1	1
Aldrin	309-00-2		17	0.00003	1
Aluminum (total)	7429-90-5			1	1
Anthracene	120-12-7	0.13		0.3	1
Antimony (total)	7440-36-0			0.00006	0.15
Arsenic (total)	7440-38-2	0.03	1.5	0.0003	1
Atrazine	1912-24-9	0.1		0.0035	1
Barium (total)	7440-39-3			0.014	0.07
Benzaldehyde	100-52-7		0.004	0.1	1
Benzene	71-43-2		0.23	0.004	1
Benzo(a)anthracene (1,2-Benzanthracene)	56-55-3	0.13	0.1		1
Benzo(a)pyrene	50-32-8	0.13	1	0.0003	1
Benzo(b)fluoranthene (3,4-Benzofluoranthene)	205-99-2	0.13	0.1		1
Benzo(k)fluoranthene	207-08-9	0.13	0.01		1
Beryllium	7440-41-7			0.000014	0.007
1,1'-Biphenyl	92-52-4		0.008	0.5	1
Bis(2-chloroethoxy)methane	111-91-1	0.1		0.003	1
Bis(2-chloroethyl)ether	111-44-4		1.1		1
Bis(2-ethylhexyl)phthalate	117-81-7	0.1	0.014	0.02	1
Bromodichloromethane (Dichlorobromomethane)	75-27-4		0.062	0.02	1
Bromoform	75-25-2		0.0079	0.02	1
Bromomethane (Methyl bromide)	74-83-9			0.0014	1
2-Butanone (Methyl ethyl ketone) (MEK)	78-93-3			0.6	1
Butylbenzyl phthalate	85-68-7	0.1	0.0019	0.2	1
Cadmium	7440-43-9	0.001		0.000025	0.025
Caprolactam	105-60-2	0.1		0.5	1
Carbon disulfide	75-15-0				1
Carbon tetrachloride	56-23-5		0.091	0.004	1
Chlordane (alpha and gamma forms summed)	57-74-9	0.04	2.3	0.0005	1
4-Chloroaniline	106-47-8	0.1	0.2	0.004	1
Chlorobenzene	108-90-7			0.0065	1
Chloroethane (Ethyl chloride)	75-00-3				1
Chloroform	67-66-3			0.01	1
Chloromethane (Methyl chloride)	74-87-3				1
2-Chloronaphthalene	91-58-7	0.13		0.08	1
2-Chlorophenol (o-Chlorophenol)	95-57-8			0.005	1

Chemical	CAS No.	Dermal Absorption Fraction (ABS_d)	Dermal Slope Factor (CSF_D)	Dermal Reference Dose (RfD_D)	Gastro-intestinal Absorption Fraction (GIABS)
Chrysene	218-01-9	0.13	0.001		1
Cobalt (total)	7440-48-4			0.0003	1
Copper (total)	7440-50-8			0.04	1
Cyanide	57-12-5			0.0006	1
Cyclohexane	110-82-7				1
4,4'-DDD (p,p'-TDE)	72-54-8	0.1	0.24		1
4,4'-DDE (p,p'-DDX)	72-55-9		0.34		1
4,4'-DDT	50-29-3	0.03	0.34	0.0005	1
Dibenz(a,h)anthracene	53-70-3	0.13	1		1
Dibromochloromethane (Chlorodibromomethane)	124-48-1		0.084	0.02	1
1,2-Dibromo-3-chloropropane	96-12-8		0.8	0.0002	1
1,2-Dibromoethane (Ethylene dibromide)	106-93-4		2	0.009	1
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1			0.086	1
1,3-Dichlorobenzene (m-Dichlorobenzene)	541-73-1			0.086	1
1,4-Dichlorobenzene (p-Dichlorobenzene)	106-46-7			0.01	1
3,3'-Dichlorobenzidine	91-94-1	0.1	0.45		1
Dichlorodifluoromethane (Freon 12)	75-71-8			0.2	1
1,1-Dichloroethane	75-34-3		0.0057	0.2	1
1,2-Dichloroethane	107-06-2		0.12		1
1,1-Dichloroethene (1,1-Dichloroethylene)	75-35-4			0.00014	1
1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	156-59-2			0.01	1
1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	156-60-5			0.017	1
2,4-Dichlorophenol	120-83-2	0.1		0.003	1
1,2-Dichloropropane	78-87-5		0.037	0.04	1
1,3-Dichloropropene (total)	542-75-6		0.1	0.03	1
Dieldrin	60-57-1	0.1	16	0.00005	1
Diethylphthalate	84-66-2	0.1		0.8	1
2,4-Dimethylphenol	105-67-9	0.1		0.02	1
Di-n-butyl phthalate	84-74-2	0.1		0.1	1
2,4-Dinitrophenol	51-28-5	0.1		0.002	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		0.01	1
1,4-Dioxane	123-91-1		0.1	0.03	1
Endosulfan I and Endosulfan II (alpha and beta) (summed)	115-29-7			0.006	1
Endrin	72-20-8	0.1		0.0003	1
Ethylbenzene	100-41-4			0.1	1
Fluoranthene	206-44-0	0.13		0.04	1
Fluorene	86-73-7	0.13		0.04	1
alpha-HCH (alpha-BHC)	319-84-6	0.1	6.3	0.008	1

Chemical	CAS No.	Dermal Absorption Fraction (ABS_d)	Dermal Slope Factor (CSF_D)	Dermal Reference Dose (RfD_D)	Gastro-intestinal Absorption Fraction (GIABS)
beta-HCH (beta-BHC)	319-85-7	0.1	1.8		1
Heptachlor	76-44-8		4.5	0.0005	1
Heptachlor epoxide	1024-57-3		9.1	0.000013	1
Hexachlorobenzene	118-74-1		1.6	0.0008	1
Hexachloro-1,3-butadiene	87-68-3		0.078	0.001	1
Hexachlorocyclopentadiene	77-47-4			0.006	1
Hexachloroethane	67-72-1		0.04	0.0007	1
n-Hexane	110-54-3				1
2-Hexanone	591-78-6			0.005	1
Indeno(1,2,3-cd)pyrene	193-39-5	0.13	0.1		1
Isophorone	78-59-1	0.1	0.00095	0.2	1
Isopropylbenzene	98-82-8			0.1	1
Lead (total)	7439-92-1				1
Lindane (gamma-HCH)(gamma-BHC)	58-89-9	0.04	1.1	0.0003	1
Manganese (total)	7439-96-5			0.024	1
Mercury (total)	7439-97-6			0.000021	0.07
Methoxychlor	72-43-5	0.1		0.005	1
Methyl acetate	79-20-9			1	1
Methylene chloride (Dichloromethane)	75-09-2		0.014	0.006	1
2-Methylnaphthalene	91-57-6	0.13		0.004	1
4-Methyl-2-pentanone (MIBK)	108-10-1				1
2-Methylphenol (o-cresol)	95-48-7	0.1		0.005	1
4-Methylphenol (p-cresol)	106-44-5	0.1		0.01	1
Methyl tert-butyl ether (MTBE)	1634-04-4			0.01	1
Naphthalene	91-20-3	0.13		0.041	1
Nickel (total)	7440-02-0			0.0008	0.04
4-Nitroaniline	100-01-6	0.1	0.02	0.004	1
Nitrobenzene	98-95-3			0.002	1
N-Nitrosodi-n-propylamine	621-64-7	0.1	7		1
N-Nitrosodiphenylamine	86-30-6	0.1	0.0049		1
2,2'-oxybis(1-chloropropane)	108-60-1			0.04	1
Pentachlorophenol	87-86-5	0.25	0.4	0.005	1
Phenol	108-95-2	0.1		0.3	1
Polychlorinated biphenyls (PCBs)	1336-36-3	0.14	2		1
Pyrene	129-00-0	0.13		0.03	1
Selenium (total)	7782-49-2			0.005	1
Silver (total)	7440-22-4			0.0002	0.04
Styrene	100-42-5			0.2	1
Tertiary butyl alcohol (TBA)	75-65-0			0.018	1
1,2,4,5-Tetrachlorobenzene	95-94-3			0.0003	1
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6	0.03		7E-10	1

Chemical	CAS No.	Dermal Absorption Fraction (ABS_d)	Dermal Slope Factor (CSF_D)	Dermal Reference Dose (RfD_D)	Gastro-intestinal Absorption Fraction (GIABS)
1,1,2,2-Tetrachloroethane	79-34-5		0.2	0.02	1
Tetrachloroethene (PCE) (Tetrachloroethylene)	127-18-4		0.0021	0.006	1
2,3,4,6-Tetrachlorophenol	58-90-2	0.1		0.03	1
Toluene	108-88-3			0.08	1
Toxaphene	8001-35-2	0.1	1.1		1
1,2,4-Trichlorobenzene	120-82-1			0.01	1
1,1,1-Trichloroethane	71-55-6			2	1
1,1,2-Trichloroethane	79-00-5		0.057	0.004	1
Trichloroethene (TCE) (Trichloroethylene)	79-01-6		0.046	0.0005	1
Trichlorofluoromethane (Freon 11)	75-69-4			0.3	1
2,4,5-Trichlorophenol	95-95-4	0.1		0.1	1
2,4,6-Trichlorophenol	88-06-2	0.1	0.011	0.001	1
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon TF)	76-13-1				1
1,2,4-Trimethylbenzene	95-63-6			0.01	1
Vanadium (total)	7440-62-2			0.00013	0.026
Vinyl chloride	75-01-4		0.72	0.003	1
Xylenes (total)	1330-20-7			0.15	1
Zinc (total)	7440-66-6			0.3	1

Blanks indicate that no information is available.

Table A-4
Soil Ingestion-Dermal Toxicity Factors

Contaminant	CAS No.	Soil Ingestion-dermal Recommendation	Soil Ingestion-dermal Toxicity Factor(s)
Acenaphthene	83-32-9	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1994) 0.06 mg/kg-day ABS 0.13
Acetone	67-64-1	IRIS RfD	IRIS RfD (2003) 0.9 mg/kg-day
Acetophenone	98-86-2	IRIS RfD	IRIS RfD (1989) 0.1 mg/kg-day
Aldrin	309-00-2	IRIS Slope Factor (SF) IRIS RfD	IRIS SF (1993) 17 (mg/kg-day)-1 IRIS RfD (1988) 0.00003 mg/kg-day
Aluminum	7429-90-5	PPRTV RfD	PPRTV RfD (2006) 1.0 mg/kg-day
Anthracene	120-12-7	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1993) 0.3 mg/kg-day ABS 0.13
Antimony	7440-36-0	IRIS RfD with a gastrointestinal absorption fraction (GIABS)	IRIS RfD (1991) 0.0004 mg/kg-day GIABS 0.15
Arsenic	7440-38-2	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)	IRIS SF (1998) 1.5 (mg/kg-day)-1 IRIS RfD (1993) 0.0003 mg/kg-day ABS 0.03
Atrazine	1912-24-9	IRIS RfD with a dermal absorption fraction (ABS) and a Group C carcinogen factor	IRIS RfD (1993) 0.035 mg/kg-day ABS 0.1 Group C carcinogen factor of 10
Barium	7440-39-3	IRIS RfD with a gastrointestinal absorption fraction (GIABS)	IRIS RfD (2005) 0.2 mg/kg-day GIABS 0.07
Benzaldehyde	100-52-7	PPRTV Slope Factor (SF) IRIS RfD	PPRTV SF (2015 4E-03 (mg/kg-day)-1 IRIS RfD (1988) 0.1 mg/kg-day
Benzene	71-43-2	NJDWQI Slope Factor (SF) IRIS RfD[1]	NJDWQI SF (1994) 0.23 (mg/kg-day)-1 IRIS RfD (2003) 0.004 mg/kg-day
Benzo(a)anthracene	56-55-3	IRIS Slope Factor (SF) (benzo(a)pyrene - adjusted for benzo(a)anthracene) with a dermal absorption fraction (ABS)	IRIS SF (2017) 1.0E-01(mg/kg-day)-1 (adjusted for benzo(a)anthracene) ABS 0.13

Benzo(a)pyrene	50-32-8	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)	IRIS SF (2017) 1.0E+00 (mg/kg-day)-1 IRIS RfD (2017) 3.0E-4 mg/kg-day ABS 0.13
Benzo(b)fluoranthene	205-99-2	IRIS Slope Factor (SF) (benzo(a)pyrene - adjusted for benzo(b)fluoranthene) with a dermal absorption fraction (ABS)	IRIS SF (2017) 1.0E-01 (mg/kg-day)-1 (adjusted for benzo(b)fluoranthene) ABS 0.13
Benzo(k)fluoranthene	207-08-9	IRIS Slope Factor (SF) (benzo(a)pyrene - adjusted for benzo(k)fluoranthene) with a dermal absorption fraction (ABS)	IRIS SF (2017) 1.0E-02(mg/kg-day)-1 (adjusted for benzo(k)fluoranthene) ABS 0.13
Beryllium	7440-41-7	IRIS RfD with a gastrointestinal absorption fraction (GIABS)	IRIS RfD (1998) 0.002 mg/kg-day GIABS 0.007
1,1'-Biphenyl	92-52-4	IRIS Slope Factor (SF) IRIS RfD	IRIS SF (2013) 0.008 (mg/kg-day)-1 IRIS RfD (2013) 0.5 mg/kg-day
Bis(2-chloroethoxy) methane	111-91-1	PPRTV RfD with a dermal absorption fraction (ABS)	PPRTV RfD (2006) 0.003 mg/kg-day ABS 0.1
Bis(2-chloroethyl) ether	111-44-4	IRIS Slope Factor (SF)	IRIS SF (1994) 1.1 (mg/kg-day)-1
Bis(2-ethylhexyl) phthalate	117-81-7	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)	IRIS SF (1993) 0.014 (mg/kg-day)-1 IRIS RfD (2013) 0.02 mg/kg-day ABS 0.1
Bromodichloromethane	75-27-4	IRIS Slope Factor (SF) IRIS RfD	IRIS SF (1993) 0.062 (mg/kg-day)-1 IRIS RfD (1991) 0.02 mg/kg-day
Bromoform	75-25-2	IRIS Slope Factor (SF) IRIS RfD	IRIS SF (1991) 0.0079 (mg/kg-day)-1 IRIS RfD (1991) 0.02 mg/kg-day
Bromomethane	74-83-9	IRIS RfD	IRIS RfD (1991) 0.0014 mg/kg-day
2-Butanone	78-93-3	IRIS RfD[2]	IRIS RfD (2003) 0.6 mg/kg-day
Butylbenzylphthalate	85-68-7	PPRTV Slope Factor (SF) with a dermal absorption fraction (ABS)	PPRTV SF (2002) 0.0019 (mg/kg-day)-1 IRIS RfD (2013)

		IRIS RfD with a dermal absorption fraction (ABS) and a Group C carcinogen factor	0.2 mg/kg-day ABS 0.1 Group C carcinogen factor of 10
Cadmium	7440-43-9	IRIS RfD with a dermal absorption fraction (ABS) and gastrointestinal absorption fraction (GIABS)	IRIS RfD (1994) 0.001 mg/kg-day ABS 0.001 GIABS 0.025
Caprolactam	105-60-2	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1988) 0.5 mg/kg-day ABS 0.1
Carbon disulfide	75-15-0	No ingestion-based toxicity factors are available	None
Carbon tetrachloride	56-23-5	NJDWQI Slope Factor (SF) IRIS RfD	NJDWQI SF (1994) 0.091 (mg/kg-day)-1 IRIS RfD (2011) 0.004 mg/kg-day
Chlordane (alpha plus gamma mixture)	57-74-9	NJDWQI Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)	NJDWQI SF (2001) 2.3 (mg/kg-day)-1 IRIS RfD (1998) 0.0005 mg/kg-day ABS 0.04
4-Chloroaniline	106-47-8	PPRTV Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)	PPRTV SF (2008) 0.2 (mg/kg-day)-1 IRIS RfD (1995) 0.004 mg/kg-day ABS 0.1
Chlorobenzene	108-90-7	NJDWQI RfD	NJDWQI RfD (1994) 0.0065 mg/kg-day
Chloroethane	75-00-3	No ingestion-based toxicity factors are available	None
Chloroform	67-66-3	IRIS RfD[3]	IRIS RfD (2001) 0.01 mg/kg-day
Chloromethane	74-87-3	No ingestion-based toxicity factors are available	None
2-Chloronaphthalene	91-58-7	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1990) 0.08 mg/kg-day ABS 0.13
2-Chlorophenol	95-57-8	IRIS RfD	IRIS RfD (1993) 0.005 mg/kg-day
Chrysene	218-01-9	IRIS Slope Factor (SF) (benzo(a)pyrene – adjusted for chrysene) with a dermal absorption fraction (ABS)	IRIS SF (2017) 1.0E-03 (mg/kg-day)-1 (adjusted for chrysene) ABS 0.13
Cobalt	7440-48-4	PPRTV RfD	PPRTV RfD (2008) 0.0003 mg/kg-day
Copper	7440-50-8	HEAST RfD	HEAST RfD (1997) 0.04 mg/kg-day
Cyanide	57-12-5	IRIS RfD	IRIS RfD (2010) 0.0006 mg/kg-day

Cyclohexane	110-82-7	No ingestion-based toxicity factors are available	None
4,4'-DDD	72-54-8	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS)	IRIS SF (1988) 0.24 (mg/kg-day)-1 ABS 0.1
4,4'-DDE	72-55-9	IRIS SF	IRIS SF (1988) 0.34 (mg/kg-day)-1
4,4'-DDT	50-29-3	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)	IRIS SF (1991) 0.34 (mg/kg-day)-1 IRIS RfD (1996) 0.0005 mg/kg-day ABS 0.03
Dibenz(a,h)anthracene	53-70-3	IRIS Slope Factor (SF) (benzo(a)pyrene – adjusted for dibenz(a,h)anthracene) with a dermal absorption fraction (ABS)	IRIS SF (2017) 1.0E+00 (mg/kg-day)-1 (adjusted for dibenz(a,h)anthracene) ABS 0.13
Dibromochloromethane	124-48-1	IRIS Slope Factor (SF) IRIS RfD and a Group C carcinogen factor	IRIS SF (1992) 0.084 (mg/kg-day)-1 IRIS RfD (1991) 0.02 mg/kg-day Group C carcinogen factor of 10
1,2-Dibromo-3-chloropropane	96-12-8	PPRTV Slope Factor (SF) PPRTV RfD	PPRTV SF (2006) 0.8 (mg/kg-day)-1 PPRTV RfD (2006) 0.0002 mg/kg-day
1,2-Dibromoethane	106-93-4	IRIS Slope Factor (SF) IRIS RfD	IRIS SF (2004) 2.0 (mg/kg-day)-1 IRIS RfD (2004) 0.009 mg/kg-day
1,2-Dichlorobenzene	95-50-1	NJDWQI RfD	NJDWQI RfD (1994) 0.086 mg/kg-day
1,3-Dichlorobenzene	541-73-1	NJDWQI RfD	NJDWQI RfD (1994) 0.086 mg/kg-day
1,4-Dichlorobenzene	106-46-7	NJDWQI RfD with a Group C carcinogen factor[4]	NJDWQI RfD (1994) 0.01 mg/kg-day (RfD includes Group C Carcinogen factor adjustment of 10)
3,3'-Dichlorobenzidine	91-94-1	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS)	IRIS SF (1993) 0.45 (mg/kg-day)-1 ABS 0.1
Dichlorodifluoromethane	75-71-8	IRIS RfD	IRIS RfD (1995) 0.2 mg/kg-day
1,1-Dichloroethane	75-34-3	CalEPA Slope Factor (SF) PPRTV RfD[5]	CalEPA SF (1992) 0.0057 (mg/kg-day)-1 PPRTV RfD (2006) 0.2 mg/kg-day
1,2-Dichloroethane	107-06-2	NJDWQI Slope Factor (SF)[6]	NJDWQI SF (1994) 0.12 (mg/kg-day)-1

1,1-Dichloroethene	75-35-4	NJDWQI RfD with a Group C carcinogen factor	NJDWQI RfD (1994) 0.00014 mg/kg-day (RfD includes Group C Carcinogen factor adjustment of 10)
cis-1,2-Dichloroethene	156-59-2	NJDWQI RfD	NJDWQI RfD (1994) 0.01 mg/kg-day
trans-1,2-Dichloroethene	156-60-5	NJDWQI RfD	NJDWQI RfD (1994) 0.017 mg/kg-day
2,4-Dichlorophenol	120-83-2	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1988) 0.003 mg/kg-day ABS 0.1
1,2-Dichloropropane	78-87-5	PPRTV Slope Factor (SF) PPRTV RfD	PPRTV SF (2016) 0.037 (mg/kg-day)-1 PPRTV RfD (2016) 0.04 mg/kg-day
1,3-Dichloropropene (cis and trans)	542-75-6	IRIS Slope Factor (SF) IRIS RfD	IRIS SF (2000) 0.1 (mg/kg-day)-1 IRIS RfD (2000) 0.03 mg/kg-day
Dieldrin	60-57-1	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)	IRIS SF (1993) 16 (mg/kg-day)-1 IRIS RfD (1990) 0.00005 mg/kg-day ABS 0.1
Diethylphthalate	84-66-2	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1993) 0.8 mg/kg-day ABS 0.1
2,4-Dimethylphenol	105-67-9	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1990) 0.02 mg/kg-day ABS 0.1
Di-n-butylphthalate	84-74-2	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1990) 0.1 mg/kg-day ABS 0.1
2,4-Dinitrophenol	51-28-5	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1991) 0.002 mg/kg-day ABS 0.1
2,4-Dinitrotoluene /2,6-Dinitrotoluene (mixture)	25321-14-6	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS)	IRIS SF (1990) 0.68 (mg/kg-day)-1 ABS 0.1
Di-n-octylphthalate	117-84-0	PPRTV RfD with a dermal absorption fraction (ABS)	PPRTV RfD (2012) 0.01 mg/kg-day ABS 0.1
1,4-Dioxane	123-91-1	IRIS Slope Factor (SF) IRIS RfD	IRIS SF (2013) 0.1 (mg/kg-day)-1 IRIS RfD (2010) 0.03 mg/kg-day
Endosulfan I and Endosulfan II (alpha and beta)	115-29-7	IRIS RfD	IRIS RfD (1994) 0.006 mg/kg-day
Endrin	72-20-8	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1991) 0.0003 mg/kg-day ABS 0.1

Ethylbenzene	100-41-4	IRIS RfD[7]	IRIS RfD (1991) 0.1 mg/kg-day
Fluoranthene	206-44-0	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1993) 0.04 mg/kg-day ABS 0.13
Fluorene	86-73-7	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1990) 0.04 mg/kg-day ABS 0.13
alpha-HCH (alpha-BHC)	319-84-6	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) ATSDR RfD with a dermal absorption fraction (ABS)	IRIS SF (1993) 6.3 (mg/kg-day)-1 ATSDR RfD (2013) 0.008 mg/kg-day ABS 0.1
beta-HCH (beta-BHC)	319-85-7	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) and Group C carcinogen factor	IRIS SF (1993) 1.8 (mg/kg-day)-1 ABS 0.1 Group C carcinogen factor of 10
Heptachlor	76-44-8	IRIS Slope Factor (SF) IRIS RfD	IRIS SF (1993) 4.5 (mg/kg-day)-1 IRIS RfD (1991) 0.0005 mg/kg-day
Heptachlor epoxide	1024-57-3	IRIS Slope Factor (SF) IRIS RfD	IRIS SF (1993) 9.1 (mg/kg-day)-1 IRIS RfD (1991) 0.000013 mg/kg-day
Hexachlorobenzene	118-74-1	IRIS Slope Factor (SF) IRIS RfD	IRIS SF (1996) 1.6 (mg/kg-day)-1 IRIS RfD (1991) 0.0008 mg/kg-day
Hexachloro-1,3-butadiene	87-68-3	IRIS Slope Factor (SF) PPRTV RfD with a Group C carcinogen factor	IRIS SF (1991) 0.078 (mg/kg-day)-1 PPRTV RfD (2007) 0.001 mg/kg-day Group C carcinogen factor of 10
Hexachlorocyclopentadiene	77-47-4	IRIS RfD	IRIS RfD (2001) 0.006 mg/kg-day
Hexachloroethane	67-72-1	IRIS Slope Factor (SF) IRIS RfD	IRIS SF (2011) 0.04 (mg/kg-day)-1 IRIS RfD (2003) 0.0007 mg/kg-day
n-Hexane	110-54-3	No ingestion-based toxicity factors are available[17]	None
2-Hexanone	591-78-6	IRIS RfD	IRIS RfD (2009) 0.005 mg/kg-day
Indeno(1,2,3-cd) pyrene	193-39-5	IRIS Slope Factor (SF) (benzo(a)pyrene – adjusted for indeno(1,2,3-cd)pyrene) with a dermal absorption fraction (ABS)	IRIS SF (2017) 1.0E-01(mg/kg-day)-1 (adjusted for indeno(1,2,3-

			cd)pyrene) ABS 0.13
Isophorone	78-59-1	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS) and a Group C carcinogen factor	IRIS SF (1992) 0.00095 (mg/kg-day)-1 IRIS RfD (2003) 0.2 mg/kg-day ABS 0.1 Group C carcinogen factor of 10
Isopropylbenzene	98-82-8	IRIS RfD	IRIS RfD (1997) 0.1 mg/kg-day
Lead	7439-92-1	USEPA IEUBK model for children USEPA ALM for adults	IEUBK (2021) Children ALM (1996) Adults
Lindane (gamma-HCH) (gamma-BHC)	58-89-9	CalEPA Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)	CalEPA SF (1992) 1.1 (mg/kg-day)-1 IRIS RfD (1988) 0.0003 mg/kg-day ABS 0.04
Manganese	7439-96-5	EPA RSL RfD	EPA RSL RfD (2018) 0.024 mg/kg-day
Mercury	7439-97-6	IRIS RfD with a gastrointestinal absorption fraction (GIABS)	IRIS RfD (1995) 0.0003 mg/kg-day GIABS 0.07
Methoxychlor	72-43-5	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1991) 0.005 mg/kg-day ABS 0.1
Methyl acetate	79-20-9	HEAST RfD	HEAST RfD (1997) 1.0 mg/kg-day
Methylene chloride	75-09-2	NJDWQI Slope Factor (SF) IRIS RfD	NJDWQI SF (1994) 0.014 (mg/kg-day)-1 IRIS RfD (2011) 0.006 mg/kg-day
2-Methylnaphthalene	91-57-6	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (2003) 0.004 mg/kg-day ABS 0.13
4-Methyl-2-pentanone	108-10-1	No ingestion-based toxicity factors are available	None
2-Methylphenol	95-48-7	IRIS RfD with a dermal absorption fraction (ABS) and a Group C carcinogen factor	IRIS RfD (2008) 0.05 mg/kg-day ABS 0.1 Group C carcinogen factor of 10
4-Methylphenol	106-44-5	ATSDR RfD with a dermal absorption fraction (ABS) and a Group C carcinogen factor	ATSDR RfD (2013) 0.1 mg/kg-day ABS 0.1 Group C carcinogen factor of 10
Methyl tert-butyl ether (MTBE)	1634-04-4	NJDWQI RfD with a Group C carcinogen factor[8]	NJDWQI RfD (1994) 0.01 mg/kg-day (RfD includes Group C

			Carcinogen factor adjustment of 10)
Naphthalene	91-20-3	NJDWQI RfD with a dermal absorption fraction (ABS) and a Group C carcinogen factor	NJDWQI RfD (1994) 0.041 mg/kg-day ABS 0.13 (RfD includes Group C Carcinogen factor adjustment of 10)
Nickel	7440-02-0	IRIS RfD with a gastrointestinal absorption fraction (GIABS)	IRIS RfD (1996) 0.02 mg/kg-day GIABS 0.04
4-Nitroaniline	100-01-6	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) PPRTV RfD with a dermal absorption fraction (ABS)	PPRTV SF (2009) 0.02 (mg/kg-day)-1 PPRTV RfD (2009) 0.004 mg/kg-day ABS 0.1
Nitrobenzene	98-95-3	IRIS RfD	IRIS RfD (2009) 0.002 mg/kg-day
N-Nitroso-di-n-propylamine	621-64-7	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS)	IRIS SF (1993) 7.0 (mg/kg-day)-1 ABS 0.1
N-Nitrosodiphenylamine	86-30-6	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS)	IRIS SF (1993) 0.0049 (mg/kg-day)-1 ABS 0.1
2,2'-Oxybis(1-choloropropane)	108-60-1	IRIS RfD	IRIS RfD (1991) 0.04 mg/kg-day
Pentachlorophenol	87-86-5	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)	IRIS SF (2010) 0.4 (mg/kg-day)-1 IRIS RfD (2010) 0.005 mg/kg-day ABS 0.25
Phenol	108-95-2	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (2002) 0.3 mg/kg-day ABS 0.1
Polychlorinated biphenyls (PCBs)	1336-36-3	NJDWQI Slope Factor (SF) with a dermal absorption fraction (ABS)	NJDWQI SF (1994) 2 (mg/kg-day)-1 ABS 0.14
Pyrene	129-00-0	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1993) 0.03 mg/kg-day ABS 0.13
Selenium	7782-49-2	IRIS RfD	IRIS RfD (1991) 0.005 mg/kg-day
Silver	7440-22-4	IRIS RfD with a gastrointestinal absorption fraction (GIABS)	IRIS RfD (1996) 0.005 mg/kg-day GIABS 0.04
Styrene	100-42-5	IRIS RfD	IRIS RfD (1990) 0.2 mg/kg-day
Tertiary butyl alcohol (TBA)	75-65-0	NJDEP RfD with a Group C carcinogen factor	NJDEP RfD (1997) 0.018 mg/kg-day (RfD includes Group C Carcinogen factor adjustment of 10)

1,2,4,5-Tetrachlorobenzene	95-94-3	IRIS RfD	IRIS RfD (1991) 0.0003 mg/kg-day
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (2012) 7E-10 mg/kg-day ABS 0.03
1,1,2,2-Tetrachloroethane	79-34-5	IRIS Slope Factor (SF) IRIS RfD[9]	IRIS SF (2010) 0.2 (mg/kg-day)-1 IRIS RfD (2010) 0.02 mg/kg-day
Tetrachloroethene (PCE)	127-18-4	IRIS Slope Factor (SF) IRIS RfD[10]	IRIS SF (2012) 0.0021 (mg/kg-day)-1 IRIS RfD (2012) 0.006 mg/kg-day
2,3,4,6-Tetrachlorophenol	58-90-2	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1992) 0.03 mg/kg-day ABS 0.1
Toluene	108-88-3	IRIS RfD	IRIS RfD (2005) 0.08 mg/kg-day
Toxaphene	8001-35-2	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS)	IRIS SF (1991) 1.1 (mg/kg-day)-1 ABS 0.1
1,2,4-Trichlorobenzene	120-82-1	IRIS RfD[11]	IRIS RfD (1996) 0.01 mg/kg-day
1,1,1-Trichloroethane	71-55-6	IRIS RfD[12]	IRIS RfD (2007) 2 mg/kg-day
1,1,2-Trichloroethane	79-00-5	IRIS Slope Factor (SF) IRIS RfD with a Group C carcinogen factor[13]	IRIS SF (1994) 0.057 (mg/kg-day)-1 IRIS RfD (1994) 0.004 mg/kg-day Group C carcinogen factor of 10
Trichloroethene (TCE)	79-01-6	IRIS Slope Factor (SF)[14] IRIS RfD	IRIS SF (2011) 0.046 (mg/kg-day)-1 IRIS RfD (2011) 0.0005 mg/kg-day
Trichlorofluoromethane	75-69-4	IRIS RfD	IRIS RfD (1992) 0.3 mg/kg-day
2,4,5-Trichlorophenol	95-95-4	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1988) 0.1 mg/kg-day ABS 0.1
2,4,6-Trichlorophenol	88-06-2	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) PPRTV RfD with a dermal absorption fraction (ABS)	IRIS SF (1994) 0.011 (mg/kg-day)-1 PPRTV RfD (2007) 0.001 mg/kg-day ABS 0.1
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	No ingestion-based toxicity factors are available[15]	None
1,2,4-Trimethylbenzene	95-63-6	IRIS RfD	IRIS RfD (2016) 0.01 mg/kg-day

Vanadium	7440-62-2	EPA RSL RfD with a gastrointestinal absorption fraction (GIABS)	EPA RSL RfD (2018) 0.005 mg/kg-day GIABS 0.026
Vinyl Chloride	75-01-4	IRIS Slope Factor (SF) IRIS RfD[16]	IRIS SF (2000) 0.72 (mg/kg-day)-1 IRIS RfD (2000) 0.003 mg/kg-day
Xylenes	1330-20-7	NJDWQI RfD	NJDWQI RfD (1994) 0.15 mg/kg-day
Zinc	7440-66-6	IRIS RfD	IRIS RfD (2005) 0.3 mg/kg-day

[1] Both the NJDWQI slope factor and IRIS RfD for benzene are based on a route-to-route conversion of an inhalation study, which was determined to be acceptable by USEPA as substantiated by additional evaluation including physiologically-based pharmacokinetic modeling.

[2] Although a NJDWQI RfD for 2-butanone exists, it is based on an inhalation route-to-route conversion. The Department's Site Remediation and Waste Management Program policy does not allow, except where warranted, for the development of soil remediation standards based on route-to-route conversion of toxicity factors. This policy conforms with USEPA policy concerning route-to-route conversion of toxicity factors.

[3] Although a CalEPA slope factor for chloroform exists, USEPA believes there is a threshold effect for cancer. As such, an RfD based soil remediation standard is protective of both cancer and non-cancer health endpoints.

[4] Although a CalEPA Slope Factor for 1,4-dichlorobenzene exists, there are questions about the study used to develop the slope factor. As such, the Department has decided not to develop an ingestion-dermal soil remediation standard for 1,4-dichlorobenzene using this slope factor.

[5] Although a NJDWQI RfD for 1,1-dichloroethane exists, it is based on an inhalation route-to-route conversion. The Department's Site Remediation and Waste Management Program policy does not allow, except where warranted, for the development of soil remediation standards based on route-to-route conversion of toxicity factors. This policy conforms with USEPA policy concerning route-to-route conversion of toxicity factors.

[6] Although a PPRTV RfD for 1,2-dichloroethane exists, it is listed as an Appendix value. PPRTV Appendix values are based on a study(s) that has flaws as determined by USEPA. It is the Department's Site Remediation and Waste Management Program policy not to use PPRTV Appendix values to develop soil remediation standards.

[7] Although a CalEPA slope factor for ethylbenzene exists, it is based on an inhalation route-to-route conversion. The Department's Site Remediation and Waste Management Program policy does not allow, except where warranted, for the development of soil remediation standards

based on route-to-route conversion of toxicity factors. This policy conforms with USEPA policy concerning route-to-route conversion of toxicity factors.

[8] Although a CalEPA slope factor for methyl tert-butyl ether exists, there are questions about the study used to develop the slope factor. As such, the Department has decided not to develop an ingestion-dermal soil remediation standard for methyl tert-butyl ether using this slope factor.

[9] Although a NJDWQI RfD for 1,1,2,2-tetrachloroethane exists, the Department has decided to use an IRIS RfD to develop a non-cancer-based ingestion-dermal soil remediation standard as the IRIS RfD is based on a newer toxicology assessment.

[10] Although a NJDWQI slope factor for tetrachloroethene exists, the Department has decided that the existing IRIS Slope Factor is a scientifically better toxicity value to develop a cancer-based ingestion-dermal soil remediation standard. The IRIS slope factor uses the newest PBPK models (extrapolating from an inhalation unit risk factor to an oral slope factor). An ingestion-dermal soil remediation standard for tetrachloroethene can also be developed using an IRIS RfD. The RfD uses the newest PBPK models (extrapolating from an inhalation RfC to oral RfD).

[11] Although a NJDWQI RfD for 1,2,4-trichlorobenzene exists, it is based on an inhalation route-to-route conversion. The Department ‘s Site Remediation and Waste Management Program policy does not allow, except where warranted, for the development of soil remediation standards based on route-to-route conversion of toxicity factors. This policy conforms with USEPA policy concerning route-to-route conversion of toxicity factors. In addition, a USEPA PPRTV slope factor for 1,2,4-trichlorobenzene is available, however the Slope Factor is based on a controversial mouse liver tumor study that many researchers have dismissed. The Department has decided not to develop an ingestion-dermal soil remediation standard based on the PPRTV slope factor.

[12] Although a NJDWQI RfD for 1,1,1-trichloroethane exists, it is based on an inhalation route-to-route conversion. The Department’s Site Remediation and Waste Management Program policy does not allow, except where warranted, for the development of soil remediation standards based on route-to-route conversion of toxicity factors. This policy conforms with USEPA policy concerning route-to-route conversion of toxicity factors.

[13] Although a NJDWQI slope factor for 1,1,2-trichloroethane exists, the Department determined that the IRIS slope factor is a scientifically better toxicity value to develop a cancer-based ingestion-dermal soil remediation standard.

[14] Although a NJDWQI slope factor for trichloroethene exists, the Department determined that the IRIS slope factor is a scientifically better toxicity value to develop a cancer-based ingestion-dermal soil remediation standard. The IRIS slope factor uses the newest PBPK models (extrapolating from an inhalation unit risk factor to an oral slope factor).

[15] Although an IRIS RfD for 1,1,2-Trichloro-1,2,2-trifluoroethane exists, it is based on an inhalation route-to-route conversion. The Department's Site Remediation and Waste Management Program policy does not allow, except where warranted, for the development of soil remediation standards based on route-to-route conversion of toxicity factors. This policy conforms with USEPA policy concerning route-to-route conversion of toxicity factors.

[16] Although a- NJDWQI slope factor exists for vinyl chloride, the Department determined that the IRIS slope factor is a scientifically better toxicity value to develop a cancer-based ingestion – dermal soil remediation standard.

[17] Although a NJDWQI RfD (1994) for n-hexane exists, it is based on an inhalation route-to-route conversion. The Department's Site Remediation and Waste Management Program policy does not allow, except where warranted, for the development of soil remediation standards based on route-to-route conversion of toxicity factors. This policy conforms with USEPA policy concerning route-to-route conversion of toxicity factors.

<u>References</u>

ALM – Adult Lead Methodology
ATSDR – Agency for Toxic Substances and Disease Registry
CalEPA – California Environmental Protection Agency
EPA RSL – United States Environmental Protection Agency Regional Screening Levels Tables
HEAST – Health Effects Assessment Summary Tables
IEUBK – Integrated Exposure Uptake Biokinetic Model for Lead
IRIS – Integrated Risk Information System
NJDEP – New Jersey Department of Environmental Protection
NJDWQI – New Jersey Drinking Water Quality Institute
PPRTV – Provisional Peer Reviewed Toxicity Values for Superfund