



## INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

*We Protect Hoosiers and Our Environment.*

*Mitchell E. Daniels Jr.*  
Governor

*Thomas W. Easterly*  
Commissioner

100 North Senate Avenue  
Indianapolis, Indiana 46204  
(317) 232-8603  
Toll Free (800) 451-6027  
[www.idem.IN.gov](http://www.idem.IN.gov)

February 4, 2010

### **Interim RISC Nondefault Recreational Closure Levels**

In 2007 IDEM was asked to develop closure levels for a recreational soil direct contact exposure scenario. IDEM produced a nondefault table of recreational closure levels and has made it available upon request for use on an interim basis pending their incorporation into a revised version of the Risk Integrated System of Closure (RISC) Technical Guide nonrule policy.<sup>1</sup> In response to the increasing demand for this interim table, this document provides the table of closure levels and documentation of the methodology and inputs used to create it.<sup>2</sup> Other site-specific approaches and nondefault closure levels for recreational areas or facilities may be submitted for IDEM's consideration.

The interim nondefault recreational surface soil closure levels may be used to evaluate most recreational areas and facilities including: parks, trails, walkways, sports complexes and open areas where adults, adolescents and/or children gather to enjoy recreational activities. These closure levels are not intended for use in children's playground areas where swing sets and other playground equipment concentrate and localize the activities of young children. IDEM recommends that due to the sensitivity of this subpopulation that RISC residential soil direct contact levels be used to evaluate playground areas.

Other important notes regarding the table:

- The recreational closure levels use RISC industrial soil direct contact levels as a cap in order to protect park employees.
- For mutagenic carcinogens, the recreational soil direct contact levels were calculated using age dependent adjustment factors as described in the 2005 US EPA document "Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens." The following compounds are considered to be mutagenic carcinogens: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene and indeno(1,2,3-cd)pyrene.
- Contamination of subsurface soil and ground water are still subject to appropriate residential or industrial closure levels or risk-based remediation objectives.

---

<sup>1</sup> The RISC Technical Guide project is in progress and IDEM still plans to incorporate guidance and a table of default values for the recreational soil direct contact exposure scenario. IDEM is seeking the input of stakeholders on this topic as part of the nonrule policy development process and will provide additional opportunity for public comment before finalizing this guidance.

<sup>2</sup> Since 2007 a few different versions of the table have been released to correct errors or make other small changes. The methodology for all previous versions of this interim table is the same as that provided in this document, but some inputs varied.

### Interim RISC Nondefault Recreational Closure Level Equations

Eq. 1 – Recreational Soil Direct Contact Level (Non-Carcinogen)	$C_{rec\_sdc} = \frac{THQ \times BW_{ad} \times AT_{ad\_nc} \times 365^{d/yr}}{ED_{ad} \times EF_{ad\_rec} \left[ \frac{(IngR_{s\_ad} + (SA_{ad} \times M_{ad} \times ABS))}{RfD_o \times 1,000,000^{mg/kg}} + \frac{InhR_{ad}}{RfD_i} \left( \frac{1}{VF} + \frac{1}{PEF} \right) \right]}$				
	Symbol	Parameter	Value	Units	Source
	$C_{rec\_sdc}$	Recreational Soil Direct Contact Level (Non-Carcinogen)	CS	mg/kg	IDEM
	THQ	Target Hazard Quotient	1	unitless	EPA(1991a)
	$BW_{ad}$	Body Weight – Adolescent	39	kg	IDEM ref. EPA(1997)
	$AT_{ad\_nc}$	Averaging Time – Adolescent Non-Carcinogen	10	yr	IDEM
	$ED_{ad}$	Exposure Duration – Adolescent	10	yr	IDEM
	$EF_{ad\_rec}$	Exposure Frequency – Adolescent Recreational	104	d/yr	IDEM
	$IngR_{s\_ad}$	Ingestion Rate – Soil Adolescent	150	mg/d	IDEM
	$SA_{ad}$	Exposed Skin Surface Area – Adolescent	5000	cm <sup>2</sup>	IDEM ref. EPA(2004)
	$M_{ad}$	Soil-to-Skin Adherence Factor – Adolescent	0.2	mg/cm <sup>2</sup> -d	IDEM ref. EPA(2004)
	ABS	Dermal Absorption Fraction	CS	unitless	EPA(2004)
	$RfD_o$	Reference Dose – Chronic Oral Exposure	CS	mg/kg-d	IDEM(H)
	$InhR_{ad}$	Inhalation Rate – Adolescent	13.4	m <sup>3</sup> /d	IDEM ref. EPA(1997)
	$RfD_i$	Reference Dose – Chronic Inhalation Exposure	CS	mg/kg-d	IDEM(H)
VF	Volatilization Factor	CS	m <sup>3</sup> /kg	EPA(1996)	
PEF	Particulate Emission Factor	1.32x10 <sup>9</sup>	m <sup>3</sup> /kg	EPA(1996)	

$C_{rec\_sdc} = \frac{TR \times AT_{ca} \times 365 \frac{d}{yr}}{\frac{SF_o (IngF_{rec\_s\_ca} + (SFS_{rec\_s\_ca} \times ABS))}{1,000,000 \frac{mg}{kg}} + InhF_{rec\_s\_ca} \times SF_i \left( \frac{1}{VF} + \frac{1}{PEF} \right)}$				
Symbol	Parameter	Value	Units	Source
$C_{rec\_sdc}$	Recreational Soil Direct Contact Level (Carcinogen)	CS	mg/kg	IDEM ref. EPA(1991a)
TR	Target Risk	$10^{-5}$	unitless	IDEM
$AT_{ca}$	Averaging Time – Carcinogen	70	yr	EPA(1991b)
$SF_o$	Cancer Oral Slope Factor	CS	$(mg/kg-d)^{-1}$	IDEM(H)
$IngF_{rec\_s\_ca}$	Ingestion Age-Adjusted Factor – Recreational Soil (Carcinogen) <i>See Equation 4</i>	11500	mg/kg	IDEM ref. EPA(1991a)
$SFS_{rec\_s\_ca}$	Dermal Age-Adjusted Factor – Recreational Soil (Carcinogen) <i>See Equation 6</i>	49500	mg/kg	IDEM ref. EPA(1991a)
ABS	Dermal Absorption Fraction	CS	unitless	EPA(2004)
$InhF_{rec\_s\_ca}$	Inhalation Age-Adjusted Factor – Recreational Soil (Carcinogen) <i>See Equation 8</i>	957	$m^3/kg$	IDEM ref. EPA(1991a)
$SF_i$	Cancer Inhalation Slope Factor	CS	$(mg/kg-d)^{-1}$	IDEM(H)
VF	Volatilization Factor	CS	$m^3/kg$	EPA(1996)
PEF	Particulate Emission Factor	$1.32 \times 10^9$	$m^3/kg$	EPA(1996)

Eq. 2 – Recreational Soil Direct Contact Level (Carcinogen)

$C_{rec\_sdc} = \frac{TR \times AT_{ca} \times 365^{d/yr}}{SF_o \left( \frac{IngF_{rec\_s\_mc} + (SFS_{rec\_s\_mc} \times ABS)}{1,000,000^{mg/kg}} \right) + InhF_{rec\_s\_mc} \times SF_i \left( \frac{1}{VF} + \frac{1}{PEF} \right)}$				
Symbol	Parameter	Value	Units	Source
$C_{rec\_sdc}$	Recreational Soil Direct Contact Level (Mutagenic Carcinogen)	CS	mg/kg	IDEM ref. EPA(2005)
TR	Target Risk	$10^{-5}$	unitless	IDEM
$AT_{ca}$	Averaging Time – Carcinogen	70	yr	EPA(1991b)
$SF_o$	Cancer Oral Slope Factor	CS	$(mg/kg-d)^{-1}$	IDEM(H)
$IngF_{rec\_s\_mc}$	Ingestion Age-Adjusted Factor – Recreational Soil (Mutagen) <i>See Equation 5</i>	45500	mg/kg	IDEM ref. EPA(2005)
$SFS_{rec\_s\_mc}$	Dermal Age-Adjusted Factor – Recreational Soil (Mutagen) <i>See Equation 7</i>	176000	mg/kg	IDEM ref. EPA(2005)
ABS	Dermal Absorption Fraction	CS	unitless	EPA(2004)
$InhF_{rec\_s\_mc}$	Inhalation Age-Adjusted Factor – Recreational Soil (Mutagen) <i>See Equation 9</i>	2970	$m^3/kg$	IDEM ref. EPA(2005)
$SF_i$	Cancer Inhalation Slope Factor	CS	$(mg/kg-d)^{-1}$	IDEM(H)
VF	Volatilization Factor	CS	$m^3/kg$	EPA(1996)
PEF	Particulate Emission Factor	$1.32 \times 10^9$	$m^3/kg$	EPA(1996)

Eq. 3 – Recreational Soil Direct Contact Level (Mutagenic Carcinogen)

Eq. 4 – Recreational Soil Ingestion Age-Adjusted Factor	$IngF_{rec\_s\_ca} = \frac{ED_{ch} \times EF_{ch\_rec} \times IngR_{s\_ch}}{BW_{ch}} + \frac{ED_{ad} \times EF_{ad\_rec} \times IngR_{s\_ad}}{BW_{ad}} + \frac{(ED_a - (ED_{ch} + ED_{ad})) \times EF_{a\_rec} \times IngR_{s\_a}}{BW_a}$				
	Symbol	Parameter	Value	Units	Source
	IngF <sub>rec_s_ca</sub>	Ingestion Age-Adjusted Factor – Recreational Soil	11500	mg/kg	IDEM ref. EPA(1991a)
	ED <sub>ch</sub>	Exposure Duration – Child	6	yr	EPA (1991b)
	EF <sub>ch_rec</sub>	Exposure Frequency – Child Recreational	75	d/yr	IDEM
	IngR <sub>s_ch</sub>	Ingestion Rate – Soil Child	200	mg/d	EPA(1991b)
	BW <sub>ch</sub>	Body Weight – Child	15	kg	EPA(1991b)
	ED <sub>ad</sub>	Exposure Duration – Adolescent	10	yr	IDEM
	EF <sub>ad_rec</sub>	Exposure Frequency – Adolescent Recreational	104	d/yr	IDEM
	IngR <sub>s_ad</sub>	Ingestion Rate – Soil Adolescent	150	mg/d	IDEM
	BW <sub>ad</sub>	Body Weight – Adolescent	39	kg	IDEM ref. EPA(1997)
	ED <sub>a</sub>	Exposure Duration – Adult	30	yr	EPA (1991b)
	EF <sub>a_rec</sub>	Exposure Frequency – Adult Recreational	75	d/yr	IDEM
	IngR <sub>s_a</sub>	Ingestion Rate – Soil Adult	100	mg/d	EPA(1991b)
BW <sub>a</sub>	Body Weight – Adult	70	kg	EPA(1991b)	

<b>Eq. 5 – Recreational Soil Ingestion Age-Adjusted Factor (Mutagen)</b>	$IngF_{rec\_s\_mc} = \frac{2yr \times EF_{ch\_rec} \times IngR_{s\_ch} \times 10}{BW_{ch}} + \frac{4yr \times EF_{ch\_rec} \times IngR_{s\_ch} \times 3}{BW_{ch}} + \frac{10yr \times EF_{ad\_rec} \times IngR_{s\_ad} \times 3}{BW_{ad}} + \frac{14yr \times EF_{a\_rec} \times IngR_{s\_a} \times 1}{BW_a}$				
	<b>Symbol</b>	<b>Parameter</b>	<b>Value</b>	<b>Units</b>	<b>Source</b>
	IngF <sub>rec_s_mc</sub>	Ingestion Age-Adjusted Factor – Recreational Soil (Mutagen)	45500	mg/kg	IDEM ref. EPA(2005)
	EF <sub>ch_rec</sub>	Exposure Frequency – Child Recreational	75	d/yr	IDEM
	IngR <sub>s_ch</sub>	Ingestion Rate – Soil Child	200	mg/d	EPA(1991b)
	BW <sub>ch</sub>	Body Weight – Child	15	kg	EPA(1991b)
	EF <sub>ad_rec</sub>	Exposure Frequency – Adolescent Recreational	104	d/yr	IDEM
	IngR <sub>s_ad</sub>	Ingestion Rate – Soil Adolescent	150	mg/d	IDEM
	BW <sub>ad</sub>	Body Weight – Adolescent	39	kg	IDEM ref. EPA(1997)
	EF <sub>a_rec</sub>	Exposure Frequency – Adult Recreational	75	d/yr	IDEM
	IngR <sub>s_a</sub>	Ingestion Rate – Soil Adult	100	mg/d	EPA(1991b)
	BW <sub>a</sub>	Body Weight – Adult	70	kg	EPA(1991b)

$SFS_{rec\_s\_ca} = \frac{ED_{ch} \times EF_{ch\_rec} \times SA_{ch} \times M_{ch}}{BW_{ch}} + \frac{ED_{ad} \times EF_{ad\_rec} \times SA_{ad} \times M_{ad}}{BW_{ad}} + \frac{(ED_a - (ED_{ch} + ED_{ad})) \times EF_{a\_rec} \times SA_a \times M_a}{BW_a}$				
Symbol	Parameter	Value	Units	Source
$SFS_{rec\_s\_ca}$	Dermal Age-Adjusted Factor – Recreational Soil	49500	mg/kg	IDEM ref. EPA(1991a)
$ED_{ch}$	Exposure Duration – Child	6	yr	EPA(1991b)
$EF_{ch\_rec}$	Exposure Frequency – Child Recreational	75	d/yr	IDEM
$SA_{ch}$	Exposed Skin Surface Area – Child	2800	cm <sup>2</sup>	EPA(2004)
$M_{ch}$	Soil-to-Skin Adherence Factor – Child	0.2	mg/cm <sup>2</sup> -d	EPA(2004)
$BW_{ch}$	Body Weight – Child	15	kg	EPA(1991b)
$ED_{ad}$	Exposure Duration – Adolescent	10	yr	IDEM
$EF_{ad\_rec}$	Exposure Frequency – Adolescent Recreational	104	d/yr	IDEM
$SA_{ad}$	Exposed Skin Surface Area – Adolescent	5000	cm <sup>2</sup>	IDEM ref. EPA(2004)
$M_{ad}$	Soil-to-Skin Adherence Factor – Adolescent	0.2	mg/cm <sup>2</sup> -d	IDEM ref. EPA(2004)
$BW_{ad}$	Body Weight – Adolescent	39	kg	IDEM ref. EPA(1997)
$ED_a$	Exposure Duration – Adult	30	yr	EPA(1991b)
$EF_{a\_rec}$	Exposure Frequency – Adult Recreational	75	d/yr	IDEM
$SA_a$	Exposed Skin Surface Area – Adult	5700	cm <sup>2</sup>	EPA(2004)
$M_a$	Skin Adherence Factor – Adult	0.07	mg/cm <sup>2</sup> -d	EPA(2004)
$BW_a$	Body Weight – Adult	70	kg	EPA(1991b)

Eq. 6 – Recreational Soil Dermal Age-Adjusted Factor

Eq. 7 – Recreational Soil Dermal Age-Adjusted Factor (Mutagen)	$SFS_{rec\_s\_m} = \frac{2yr \times EF_{ch\_rec} \times SA_{ch} \times M_{ch} \times 10}{BW_{ch}} + \frac{4yr \times EF_{ch\_rec} \times SA_{ch} \times M_{ch} \times 3}{BW_{ch}} + \frac{10yr \times EF_{ad\_rec} \times SA_{ad} \times M_{ad} \times 3}{BW_{ad}} + \frac{14yr \times EF_{a\_rec} \times SA_a \times M_a \times 1}{BW_a}$				
	Symbol	Parameter	Value	Units	Source
	SFS <sub>rec_s_m</sub>	Dermal Age-Adjusted Factor – Recreational Soil (Mutagen)	176000	mg/kg	IDEM ref. EPA(2005)
	EF <sub>ch_rec</sub>	Exposure Frequency – Child Recreational	75	d/yr	IDEM
	SA <sub>ch</sub>	Exposed Skin Surface Area – Child	2800	cm <sup>2</sup>	EPA(2004)
	M <sub>ch</sub>	Soil-to-Skin Adherence Factor – Child	0.2	mg/cm <sup>2</sup> -d	EPA(2004)
	BW <sub>ch</sub>	Body Weight – Child	15	kg	EPA(1991b)
	EF <sub>ad_rec</sub>	Exposure Frequency – Adolescent Recreational	104	d/yr	IDEM
	SA <sub>ad</sub>	Exposed Skin Surface Area – Adolescent	5000	cm <sup>2</sup>	IDEM ref. EPA(2004)
	M <sub>ad</sub>	Soil-to-Skin Adherence Factor – Adolescent	0.2	mg/cm <sup>2</sup> -d	IDEM ref. EPA(2004)
	BW <sub>ad</sub>	Body Weight – Adolescent	39	kg	IDEM ref. EPA(1997)
	EF <sub>a_rec</sub>	Exposure Frequency – Adult Recreational	75	d/yr	IDEM
	SA <sub>a</sub>	Exposed Skin Surface Area – Adult	5700	cm <sup>2</sup>	EPA(2004)
	M <sub>a</sub>	Skin Adherence Factor – Adult	0.07	mg/cm <sup>2</sup> -d	EPA(2004)
	BW <sub>a</sub>	Body Weight – Adult	70	kg	EPA(1991b)

Eq. 8 – Recreational Soil Inhalation Age-Adjusted Factor	$InhF_{rec\_s\_ca} = \frac{ED_{ch} \times EF_{ch\_rec} \times InhR_{ch}}{BW_{ch}} + \frac{ED_{ad} \times EF_{ad\_rec} \times InhR_{ad}}{BW_{ad}} + \frac{(ED_a - (ED_{ch} + ED_{ad})) \times EF_{a\_rec} \times InhR_a}{BW_a}$				
	Symbol	Parameter	Value	Units	Source
	InhF <sub>rec_s_ca</sub>	Inhalation Age-Adjusted Factor – Recreational Soil	957	mg/kg	IDEM ref. EPA(1991a)
	ED <sub>ch</sub>	Exposure Duration – Child	6	yr	EPA(1991b)
	EF <sub>ch_rec</sub>	Exposure Frequency – Child Recreational	75	d/yr	IDEM
	InhR <sub>ch</sub>	Inhalation Rate – Child	10	m <sup>3</sup> /d	EPA(1991b)
	BW <sub>ch</sub>	Body Weight – Child	15	kg	EPA(1991b)
	ED <sub>ad</sub>	Exposure Duration – Adolescent	10	yr	IDEM
	EF <sub>ad_rec</sub>	Exposure Frequency – Adolescent Recreational	104	d/yr	IDEM
	InhR <sub>ad</sub>	Inhalation Rate – Adolescent	13.4	m <sup>3</sup> /d	IDEM ref. EPA(1997)
	BW <sub>ad</sub>	Body Weight – Adolescent	39	kg	IDEM ref. EPA(1997)
	ED <sub>a</sub>	Exposure Duration – Adult	30	yr	EPA(1991b)
	EF <sub>a_rec</sub>	Exposure Frequency – Adult Recreational	75	d/yr	IDEM
	InhR <sub>a</sub>	Inhalation Rate – Adult	20	m <sup>3</sup> /d	EPA(1991b)
BW <sub>a</sub>	Body Weight – Adult	70	kg	EPA(1991b)	

<b>Eq. 9 – Recreational Soil Inhalation Age-Adjusted Factor (Mutagen)</b>	$InhF_{rec\_s\_mc} = \frac{2yr \times EF_{ch\_rec} \times InhR_{ch} \times 10}{BW_{ch}} + \frac{4yr \times EF_{ch\_rec} \times InhR_{ch} \times 3}{BW_{ch}} + \frac{10yr \times EF_{ad\_rec} \times InhR_{ad} \times 3}{BW_{ad}} + \frac{14yr \times EF_{a\_rec} \times InhR_{a} \times 1}{BW_{a}}$				
	Symbol	Parameter	Value	Units	Source
	InhF <sub>rec_s_mc</sub>	Inhalation Age-Adjusted Factor – Recreational Soil (Mutagen)	2970	m <sup>3</sup> /kg	IDEM ref. EPA(2005)
	EF <sub>ch_rec</sub>	Exposure Frequency – Child Recreational	75	d/yr	IDEM
	InhR <sub>ch</sub>	Inhalation Rate – Child	10	m <sup>3</sup> /d	EPA(1991b)
	BW <sub>ch</sub>	Body Weight – Child	15	kg	EPA(1991b)
	EF <sub>ad_rec</sub>	Exposure Frequency – Adolescent Recreational	104	d/yr	IDEM
	InhR <sub>ad</sub>	Inhalation Rate – Adolescent	13.4	m <sup>3</sup> /d	IDEM ref. EPA(1997)
	BW <sub>ad</sub>	Body Weight – Adolescent	39	kg	IDEM ref. EPA(1997)
	EF <sub>a_rec</sub>	Exposure Frequency – Adult Recreational	75	d/yr	IDEM
	InhR <sub>a</sub>	Inhalation Rate – Adult	20	m <sup>3</sup> /day	EPA(1991b)
BW <sub>a</sub>	Body Weight – Adult	70	kg	EPA(1991b)	

**Source Key Reference**

- EPA(1991a) Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Interim. Office of Emergency and Remedial Response. EPA/540/R-92/003.
- EPA(1991b) Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual Supplemental Guidance “Standard Default Exposure Factors.” Interim Final. Office of Emergency and Remedial Response Toxics Integration Branch. OSWER Directive 9285.6-03.
- EPA(1996) Soil Screening Guidance: Technical Background Document. Office of Solid Waste and Emergency Response. EPA/540/R95/128.
- EPA(1997) Exposure Factors Handbook. National Center for Environmental Assessment, Office of Research and Development.
- EPA(2004) Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005.
- EPA(2005) Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. Risk Assessment Forum. EPA/630/R-30/003F.
- IDEM This value was reached through professional judgment by IDEM. Please contact IDEM for more information.
- IDEM(H) This value was reached through use of the hierarchies set forth earlier in the RISC Technical Guidance Document, Appendix 1. The recreational soil direct contact levels were calculated with the same physical, chemical and toxicological values published in the 2006 version of Appendix 1.
- IDEM ref. This value was reached through professional judgment by IDEM using methodology described in the referenced EPA document. Please contact IDEM for more information.

## Interim RISC Nondefault Recreational Closure Levels

Contaminant	CAS	Soil								
		Soil Attenuation Capacity <sup>1</sup>	Soil Saturation (Csat) <sup>2</sup>	Cons. Soil Direct <sup>3</sup>		Industrial Soil Direct <sup>3</sup>		Rec. Soil Direct <sup>3</sup>		Nondefault Closure Level
		mg/kg	mg/kg	mg/kg		mg/kg		mg/kg		mg/kg
Acenaphthene	83-32-9	6000		50000	NC	24000	NC	29000	NC	6000
Acenaphthylene	208-96-8	6000		5900	NC	2800	NC	3500	NC	2800
Acetochlor	34256-82-1	6000		18000	NC	9800	NC	11000	NC	6000
Acetone (2-Propanone)	67-64-1	6000	200000	230000	NC	51000	NC	93000	NC	6000
Acrolein	107-02-8	6000	50000	3.5	NC	0.64	NC	1.3	NC	0.64
Aldrin	309-00-2	6000		27	NC	0.8	C	0.91	C	0.8
Anthracene	120-12-7	6000		250000	NC	120000	NC	150000	NC	6000
Antimony and compounds	7440-36-0	10000		460	NC	620	NC	340	NC	340
Arsenic	7440-38-2	10000		320	NC	20	C	13	C	13
Atrazine	1912-24-9	6000		2800	C	63	C	71	C	63
Barium	7440-39-3	10000		220000	NC	230000	NC	160000	NC	10000
Benzene	71-43-2	6000	590	560	NC	14	C	24	C	14
Benzo(a)anthracene	56-55-3	6000		790	C	15	C	5.1	MC	5.1
Benzo(a)pyrene	50-32-8	6000		79	C	1.5	C	0.51	MC	0.51
Benzo(b)fluoranthene	205-99-2	6000		790	C	15	C	5.1	MC	5.1
Benzo(k)fluoranthene	207-08-9	6000		7900	C	150	C	51	MC	51
Benzoic acid	65-85-0	6000		1000000	NC	1000000	NC	1000000	NC	6000
Benzyl Alcohol	100-51-6	6000	8800	270000	NC	150000	NC	160000	NC	6000
Beryllium and compounds	7440-41-7	10000		2300	NC	2900	NC	1700	NC	1700
Bis(2-chloro-1-methylethyl) ether	108-60-1	6000	550	5200	C	61	C	95	C	61
Bis(2-Chloroethyl)ether	111-44-4	6000	4000	280	C	3	C	4.8	C	3
Bis(2-ethylhexyl)phthalate	117-81-7	6000	10000	18000	NC	980	C	1100	C	980
Bromodichloromethane	75-27-4	6000	2100	2100	C	17	C	31	C	17
Bromoform(tribromomethane)	75-25-2	6000	1200	7700	NC	580	C	890	C	580
n-Butanol	71-36-3	6000	16000	2700	NC	490	NC	970	NC	490
Butylbenzylphthalate	85-68-7	6000	310	180000	NC	98000	NC	110000	NC	310
Cadmium	7440-43-9	10000		590	NC	990	NC	450	NC	450

Contaminant	CAS	Soil								
		Soil Attenuation Capacity <sup>1</sup>	Soil Saturation (Csat) <sup>2</sup>	Cons. Soil Direct <sup>3</sup>		Industrial Soil Direct <sup>3</sup>		Rec. Soil Direct <sup>3</sup>		Nondefault Closure Level
		mg/kg	mg/kg	mg/kg		mg/kg		mg/kg		mg/kg
Carbazole	86-74-8	6000		31000	C	690	C	780	C	690
Carbon disulfide	75-15-0	6000	480	6200	NC	1200	NC	2300	NC	480
Carbon tetrachloride	56-23-5	6000	520	38	NC	5.2	C	9.5	C	5.2
Chlordane	12789-03-6	6000		510	NC	68	C	53	C	53
p-Chloroaniline	106-47-8	6000		3600	NC	2000	NC	2200	NC	2000
Chlorobenzene	108-90-7	6000	310	2600	NC	510	NC	980	NC	310
Chloroethane	75-00-3	6000	3000	16000	C	120	C	230	C	120
Chloroform	67-66-3	6000	2300	650	C	4.7	C	8.7	C	4.7
2-Chloronaphthalene	91-58-7	6000		71000	NC	39000	NC	44000	NC	6000
2-Chlorophenol	95-57-8	6000	22000	2200	NC	580	NC	980	NC	580
Chromium III <sup>4</sup>	16065-83-1	10000		1000000	NC	1000000	NC	1000000	NC	10000
Chromium VI <sup>4</sup>	18540-29-9	10000		3400	NC	650	C	1200	C	650
Chrysene	218-01-9	6000		79000	C	1500	C	510	MC	510
Copper	7440-50-8	10000		46000	NC	62000	NC	34000	NC	10000
Cyanide, Free <sup>5</sup>	57-12-5	6000		23000	NC	31000	NC	17000	NC	6000
Cyclohexane	110-82-7	6000	69	51000	NC	9300	NC	18000	NC	69
DDD	72-54-8	6000		2200	NC	120	C	82	C	82
DDE	72-55-9	6000		2200	C	86	C	58	C	58
DDT	50-29-3	6000		540	NC	86	C	58	C	58
Dibenzo(a,h)anthracene	53-70-3	6000		79	C	1.5	C	0.51	MC	0.51
Dibenzofuran	132-64-9	6000		1800	NC	980	NC	1100	NC	980
1,2-Dibromoethane	106-93-4	6000	1400	59	C	0.49	C	0.88	C	0.49
Dibutyl phthalate	84-74-2	6000	760	89000	NC	49000	NC	55000	NC	760
1,2-Dichlorobenzene	95-50-1	6000	220	18000	NC	3900	NC	7200	NC	220
1,3-Dichlorobenzene	541-73-1	6000	230	2200	NC	890	NC	1200	NC	230
1,4-Dichlorobenzene	106-46-7	6000		8000	C	73	C	130	C	73
3,3-Dichlorobenzidine	91-94-1	6000		1400	C	31	C	35	C	31
1,1-Dichloroethane	75-34-3	6000	1400	8600	NC	1700	NC	3200	NC	1400
1,2-Dichloroethane	107-06-2	6000	2000	150	NC	5.8	C	11	C	5.8

Contaminant	CAS	Soil								
		Soil Attenuation Capacity <sup>1</sup>	Soil Saturation (Csat) <sup>2</sup>	Cons. Soil Direct <sup>3</sup>		Industrial Soil Direct <sup>3</sup>		Rec. Soil Direct <sup>3</sup>		Nondefault Closure Level
		mg/kg	mg/kg	mg/kg		mg/kg		mg/kg		mg/kg
1,1-Dichloroethylene	75-35-4	6000	930	2200	NC	410	NC	800	NC	410
cis-1,2-Dichloroethylene	156-59-2	6000	1000	750	NC	140	NC	280	NC	140
trans-1,2-Dichloroethylene	156-60-5	6000	2100	1200	NC	230	NC	450	NC	230
2,4-Dichlorophenol	120-83-2	6000		2700	NC	1500	NC	1600	NC	1500
2,4-Dichlorophenoxyacetic acid (2,4-D)	94-75-7	6000		9100	NC	5200	NC	5600	NC	5200
1,2-Dichloropropane	78-87-5	6000	830	99	NC	7.2	C	13	C	7.2
1,3-Dichloropropene	542-75-6	6000	1000	290	NC	16	C	28	C	16
Dieldrin	60-57-1	6000		39	C	0.86	C	0.97	C	0.86
Diethylphthalate	84-66-2	6000	840	710000	NC	390000	NC	440000	NC	840
N,N Dimethylformamide	68-12-2	6000	200000	26000	NC	5800	NC	11000	NC	5800
2,4-Dimethylphenol	105-67-9	6000		18000	NC	9800	NC	11000	NC	6000
Dimethylphthalate	131-11-3	6000	1100	1000000	NC	1000000	NC	1000000	NC	1100
2,4-Dinitrophenol	51-28-5	6000		1800	NC	980	NC	1100	NC	980
Dinitrotoluene mixture	25321-14-6	6000		890	NC	20	C	23	C	20
Di-n-octyl phthalate	117-84-0	6000	3300	36000	NC	20000	NC	22000	NC	3300
Endosulfan	115-29-7	6000		5300	NC	2900	NC	3300	NC	2900
Endrin	72-20-8	6000		270	NC	150	NC	160	NC	150
Ethyl acetate	141-78-6	6000	25000	290000	NC	69000	NC	120000	NC	6000
Ethylbenzene	100-41-4	6000	160	29000	NC	6800	NC	12000	NC	160
Ethylene glycol	107-21-1	6000	200000	1000000	NC	570000	NC	780000	NC	6000
Fluoranthene	206-44-0	6000		33000	NC	16000	NC	20000	NC	6000
Fluorene	86-73-7	6000		33000	NC	16000	NC	20000	NC	6000
alpha-HCH(alpha-BHC)	319-84-6	6000		120	C	4	C	3	C	3
beta-HCH(beta-BHC)	319-85-7	6000		200	NC	12	C	10	C	10
gamma-HCH(Lindane)	58-89-9	6000		310	NC	19	C	15	C	15
Heptachlor	76-44-8	6000		140	C	2.9	C	3.4	C	2.9
Heptachlor epoxide	1024-57-3	6000		12	NC	1.5	C	1.7	C	1.5
Hexachloro-1,3-butadiene	87-68-3	6000	350	270	NC	150	NC	160	NC	150
Hexachlorobenzene	118-74-1	6000		390	C	8.6	C	9.7	C	8.6

Contaminant	CAS	Soil								
		Soil Attenuation Capacity <sup>1</sup>	Soil Saturation (Csat) <sup>2</sup>	Cons. Soil Direct <sup>3</sup>		Industrial Soil Direct <sup>3</sup>		Rec. Soil Direct <sup>3</sup>		Nondefault Closure Level
		mg/kg	mg/kg	mg/kg		mg/kg		mg/kg		mg/kg
Hexachlorocyclopentadiene	77-47-4	6000	720	5300	NC	2900	NC	3300	NC	720
Hexachloroethane	67-72-1	6000		660	NC	240	NC	340	NC	240
n-Hexane	110-54-3	6000	100	1200	NC	220	NC	440	NC	100
Indeno(1,2,3-cd)pyrene	193-39-5	6000		790	C	15	C	5.1	MC	5.1
Isophorone	78-59-1	6000	3500	180000	NC	14000	C	16000	C	3500
Isopropylbenzene (Cumene)	98-82-8	6000	42	9900	NC	1900	NC	3700	NC	42
Lead <sup>6</sup>	7439-92-1	10000		970	O	1300	O	400	O	400
Mercury and compounds	7487-94-7	10000		340	NC	470	NC	260	NC	260
Methoxychlor	72-43-5	6000		4400	NC	2500	NC	2700	NC	2500
Methyl bromide (bromomethane)	74-83-9	6000	3700	69	NC	13	NC	25	NC	13
Methyl ethyl ketone (MEK)	78-93-3	6000	28000	260000	NC	70000	NC	120000	NC	6000
Methyl tertiary butyl ether (MTBE)	1634-04-4	6000	11000	65000	C	650	C	1100	C	650
4-Methyl-2-pentanone (MIBK)	108-10-1	6000	8700	64000	NC	29000	NC	36000	NC	6000
Methylene chloride	75-09-2	6000	3000	22000	C	200	C	340	C	200
2-Methylnaphthalene	91-57-6	6000		3300	NC	1600	NC	2000	NC	1600
3-Methylphenol (m-cresol)	108-39-4	6000	6100	44000	NC	25000	NC	27000	NC	6000
4-Methylphenol (p-cresol)	106-44-5	6000		4400	NC	2500	NC	2700	NC	2500
2-Methylphenol(o-cresol)	95-48-7	6000		39000	NC	17000	NC	22000	NC	6000
Metolachlor	51218-45-2	6000	420	130000	NC	74000	NC	82000	NC	420
Naphthalene	91-20-3	6000		17000	NC	8000	NC	9800	NC	6000
Nickel, soluble salts	various	10000		23000	NC	31000	NC	17000	NC	10000
2-Nitroaniline	88-74-4	6000		2700	NC	1500	NC	1600	NC	1500
Nitrobenzene	98-95-3	6000	690	440	NC	250	NC	270	NC	250
N-Nitrosodi-n-propylamine	621-64-7	6000	2500	89	C	2	C	2.2	C	2
N-Nitrosodiphenylamine	86-30-6	6000		18000	NC	2800	C	3200	C	2800
PCBs (polychlorinated biphenyls) <sup>7</sup>	1336-36-3	6000		16	NC	5.3	C	6.9	C	5.3
Pentachlorophenol	87-86-5	6000		3800	C	54	C	89	C	54
Phenanthrene	85-01-8	6000		2500	NC	1200	NC	1500	NC	1200
Phenol	108-95-2	6000		230000	NC	96000	NC	130000	NC	6000

Contaminant	CAS	Soil								
		Soil Attenuation Capacity <sup>1</sup>	Soil Saturation (Csat) <sup>2</sup>	Cons. Soil Direct <sup>3</sup>		Industrial Soil Direct <sup>3</sup>		Rec. Soil Direct <sup>3</sup>		Nondefault Closure Level
		mg/kg	mg/kg	mg/kg		mg/kg		mg/kg		mg/kg
n-Propylbenzene	103-65-1	6000	300	10000	NC	2200	NC	4100	NC	300
Propylene glycol monomethyl ether	107-98-2	6000	200000	440000	NC	150000	NC	220000	NC	6000
Pyrene	129-00-0	6000		25000	NC	12000	NC	15000	NC	6000
Selenium	7782-49-2	10000		5700	NC	7800	NC	4300	NC	4300
Silver	7440-22-4	10000		5700	NC	7800	NC	4300	NC	4300
Styrene	100-42-5	6000	550	68000	NC	16000	NC	29000	NC	550
1,1,1,2-Tetrachloroethane	630-20-6	6000	1200	7400	C	67	C	120	C	67
1,1,2,2-Tetrachloroethane	79-34-5	6000	1200	960	C	8.7	C	15	C	8.7
Tetrachloroethylene (PCE)	127-18-4	6000	120	660	NC	16	C	29	C	16
Thallium (and compounds)	7440-28-0	10000		80	NC	110	NC	60	NC	60
Toluene	108-88-3	6000	310	49000	NC	16000	NC	25000	NC	310
Toxaphene	8001-35-2	6000		560	C	12	C	14	C	12
1,2,4-Trichlorobenzene	120-82-1	6000	1100	8900	NC	4900	NC	5500	NC	1100
1,1,1-Trichloroethane	71-55-6	6000	640	34000	NC	6700	NC	13000	NC	640
1,1,2-Trichloroethane	79-00-5	6000	1300	600	NC	15	C	27	C	15
Trichloroethylene (TCE) <sup>8</sup>	79-01-6	6000	630	210	NC	24	C	14	C	14
Trichlorofluoromethane	75-69-4	6000	970	6900	NC	1300	NC	2500	NC	970
2,4,5-Trichlorophenol	95-95-4	6000		89000	NC	49000	NC	55000	NC	6000
2,4,6-Trichlorophenol	88-06-2	6000		89	NC	49	NC	55	NC	49
2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)	93-76-5	6000		8900	NC	4900	NC	5500	NC	4900
1,2,4-Trimethylbenzene	95-63-6	6000	430	920	NC	170	NC	340	NC	170
1,3,5-Trimethylbenzene	108-67-8	6000	90	380	NC	68	NC	140	NC	68
Vinyl acetate	108-05-4	6000	4200	7600	NC	1400	NC	2700	NC	1400
Vinyl chloride (chloroethene) <sup>9</sup>	75-01-4	6000	930	500	C	6.4	C	4.8	C	4.8
Xylene mixed (total)	1330-20-7	6000	170	4800	NC	890	NC	1800	NC	170
Zinc	7440-66-6	10000		340000	NC	470000	NC	260000	NC	10000

### Footnotes

1. The RISC default Soil Attenuation Capacity (SAC) value is 6,000 mg/kg for surface soil and 2,000 mg/kg for subsurface soil. The subsurface value should be used for subsurface soil contamination. It is possible to raise the SAC value based on the organic carbon content in the soil, and the user is referred to the non-default chapter for further information.
2. Certain chemicals that are considered liquids at soil temperatures have calculated soil saturation levels. The soil saturation level, or "Csat" value, is an indicator of the possibility there is free product present. An assumption of the soil direct contact calculations is that free product is not present. In cases where the Csat value is lower than any other soil calculated value the Csat value becomes the default closure level. If the user does not think free product exists at the site but has concentrations that exceed Csat, but not other closure levels, then they should contact the IDEM site manager in order to verify there is no free product.
3. Each soil direct pathway column in the closure level tables has a "C" or "MC" or "NC" next to the value. This designation indicates whether the numerical value is the result of calculation from a carcinogenic endpoint, a mutagenic carcinogenic endpoint or a non-carcinogenic endpoint. Knowing the carcinogenic or non-carcinogenic designation is necessary when performing additivity. Sometimes the endpoints may be different for different receptors. Many compounds are calculated using endpoints from both carcinogenic and non-carcinogenic toxicity information, and the system used to calculate the default closure level selects the lowest endpoint.
4. Total chromium concentrations must be assumed to be 100% chromium VI unless a species-specific ratio evaluation of chromium VI to chromium III is made.
5. Cyanide values apply to "free" cyanide only. The closure levels are not applicable to copper cyanide and other complexed cyanides. The physical constants used in the calculation of the free cyanide closure levels are based on hydrogen cyanide (non-complexed, ionic cyanide). Total cyanide concentrations may not be representative of, and in fact may over estimate, free cyanide concentrations.
6. The recreational soil direct contact level for lead is assumed to be equal to the residential direct contact level.  
Lead values were calculated using:  
The 1994 Integrated Exposure Uptake Biokinetic Model (see EPA/540/R-93/081, PB-963510), The Methodology for Assessing Risks Associated with Adult Exposure to Lead in Soil SRC-GLD-F0162-209-Draft-7/21/96, Review of the Methodology for Establishing Risk-Based Remediation Goals for Commercial Areas of the California Gulch Site, USEPA, Technical Review Workgroup for Lead, October 26, 1995 for industrial and construction exposures.
7. PCBs are assumed to be a mixture, and that Aroclor 1016 and 1254 are present.
8. IDEM developed and adopted default slope factors for TCE of  $0.1 \text{ (mg/kg-day)}^{-1}$  as the residential oral slope factor,  $0.034 \text{ (mg/kg-day)}^{-1}$  as the industrial oral slope factor, and  $0.054 \text{ (mg/kg-day)}^{-1}$  as the residential inhalation slope factor,  $0.018 \text{ (mg/kg-day)}^{-1}$  as the industrial inhalation slope factor, in 2006. Please see the 2006 IDEM document "A Regulatory Approach for Deriving Trichloroethylene Cancer Potency Estimates for Use in the Development of Health Based Remediation Closure Levels" on the RISC website for more information. The recreational soil direct contact level in this table was calculated using the residential toxicity values.
9. Vinyl chloride calculations are based on two different sets of slope factors. The industrial and construction soil direct contact levels use  $0.75 \text{ (mg/kg-d)}^{-1}$  for the oral slope factor and  $0.016 \text{ (mg/kg-day)}^{-1}$  for the inhalation slope factor. The recreational soil direct contact level uses  $1.5 \text{ (mg/kg-d)}^{-1}$  for the oral slope factor and  $0.031 \text{ (mg/kg-day)}^{-1}$  for the inhalation slope factor. The values derived for industrial and construction levels are recommended for lifetime exposure beginning at adulthood. For exposures beginning at birth an additional twofold safety factor is recommended. This has been taken into account when deriving the soil direct contact level for recreational areas.