Human Health Soil Quality SSTL Calculations for Threshold (Non-carcinogenic) Substances

Lead/Zinc - Town Area

Eq: HQ = { [(Ci x AF i x IR x ET i) + (Ci x AF d x DR x ET d) + (Ci x AF s x SR x ET s) + (AF g x (WG i $_{TOT}$ x GR) x ET wg)] / BW } / (TDI - EDI)

DR = FRP x TSP x IR air
TSP = [Pe x L] / [Uair x ht]
SR = [SA x M x 1E-6]

Compound	TDI	EDI	Ci	WGi site	WGi bkgd	WGi tot	THQ	BSC	AF i	AF d	AF s	AF g	Hazard Quotient	CCME (Res) (mg/kg)
Lead	**0.00357**	0.00143	**990**	6.19	1.25	2.24	1	204.2	0.3	1	0.01	0.5	1.0	140
Zinc	0.3	0	**12000**	48.76	35.23	37.93	0.2	322.8	0.8	1	0.01	0.8	0.2	200

Parameter	Definition (units)	Default Value	Reference
Ci =	Soil concentration (mg/kg)	site-specific	
WGi site =	Wild game tissue concentration (mg/kg)	site-specific	
WGi bkgd =	Background wild game tissue concentration (mg/kg)	regional	
WGi tot =	Weighted wild game tissue concentration (mg/kg)	calculated	
TDI =	reference dose - oral (mg/kg bw-day)	chemical specific	bold = CCME; underline = IRIS
EDI =	estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	chemical specific	CCME (1-4 yrs)
BW =	body weight (kg)	16.5	CCME (1-4 yrs)
THQ =	Target Hazard Quotient	chemical specific	
BSC =	background soil concentration (mg/kg)	chemical specific	Site specific
AF g =	absorption factor for gut (unitless)	chemical specific	
AF i =	absorption factor for soil (unitless)	chemical specific	
AF d =	absorption factor for lung (unitless)	chemical specific	
AF s =	absorption factor skin (unitless)	chemical specific	EPA Region 3
GR =	wild game ingestion rate (kg/day)	0.018	Richardson (1997)
IR =	soil ingestion rate (kg/day)	0.000041	calculated
DR =	soil inhalation rate (kg/day)	6.417E-09	calculated
SR =	soil dermal contact rate (kg/day)	0.000301	calculated
ET i =	exposure term for soil ingestion pathway (unitless)	1.000	Site Specific [(365 d/yr x 24 hr/d) / (365 d/yr x 24 hr/d)]
ET d =	exposure term for soil inhalation pathway (unitless)	1.000	Site Specific [(365 d/yr x 24 hr/d) / (365 d/yr x 24 hr/d)]
ET s =	exposure term for soil dermal contact pathway (unitless)	1.000	Site Specific [(365 d/yr x 24 hr/d) / (365 d/yr x 24 hr/d)]
ET wg =	exposure term for wild game ingestion pathway (unitless)	1.000	Site Specific [(365 d/yr x 24 hr/d) / (365 d/yr x 24 hr/d)]
TSP =	total suspended particulate matter in air (kg/m3)	6.9E-10	calculated
IR air =	daily inhalation rate (m3/day)	9.3	CCME (1-4 yrs)
SA =	skin surface area (cm2/day)	3010	CCME (1-4 yrs)
M =	soil to skin adherence factor (mg/cm2)	0.1	CCME (1-4 yrs)
FRP=	fraction respirable particles	1	US EPA
Pe =	particulate emission rate (kg/m2/s)	6.9E-13	Atlantic RBCA
L =	Length of soil parallel to wind (m)	1000	Site Specific
Uair =	Average wind speed (m/s)	1	Site Specific
ht =	Height of air breathing zone (m)	1	Site Specific

Human Health Soil Quality SSTL Calculations for Threshold (Non-carcinogenic) Substances

Lead/Zinc - General Mine Area

Eq: $HQ = \{ [(Ci \times AF\ i \times IR \times ET\ i) + (Ci \times AF\ d \times DR \times ET\ d) + (Ci \times AF\ s \times SR \times ET\ s) + (AF\ g \times (WG\ i_{TOT} \times GR) \times ET\ wg)] / BW \} / (TDI - EDI)$

$DR = FRP \times TSP \times IR\ air$
$TSP = [Pe \times L] / [Uair \times ht]$
$SR = [SA \times M \times 1E\text{-}6]$

Compound	TDI	EDI	Ci	WGi site	WGi bkgd	WGi tot	THQ	BSC	AF i	AF d	AF s	AF g	Hazard Quotient	CCME (Res) (mg/kg)
Lead	**0.00357**	0.00077	**3500**	11.91	1.25	3.38	1	67.9	0.3	1	0.01	0.5	1.0	140
Zinc	0.3	0	**39000**	52.99	35.23	38.78	0.2	89.7	0.8	1	0.01	0.8	0.2	200

Parameter	Definition (units)	Default Value	Reference
Ci =	Soil concentration (mg/kg)	site-specific	
WGi site =	Wild game tissue concentration (mg/kg)	site-specific	
WGi bkgd =	Background wild game tissue concentration (mg/kg)	regional	
WGi tot =	Weighted wild game tissue concentration (mg/kg)	calculated	
TDI =	reference dose - oral (mg/kg bw-day)	chemical specific	bold = CCME; underline = IRIS
EDI =	estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	chemical specific	CCME (1-4 yrs)
BW =	body weight (kg)	16.5	CCME (1-4 yrs)
THQ =	Target Hazard Quotient	chemical specific	
BSC =	background soil concentration (mg/kg)	chemical specific	Site specific
AF g =	absorption factor for gut (unitless)	chemical specific	
AF i =	absorption factor for soil (unitless)	chemical specific	
AF d =	absorption factor for lung (unitless)	chemical specific	
AF s =	absorption factor skin (unitless)	chemical specific	EPA Region 3
GR =	wild game ingestion rate (kg/day)	0.018	Richardson (1997)
IR =	soil ingestion rate (kg/day)	0.00008	CCME (1-4 yrs)
DR =	soil inhalation rate (kg/day)	6.417E-09	calculated
SR =	soil dermal contact rate (kg/day)	0.000301	calculated
ET i =	exposure term for soil ingestion pathway (unitless)	0.164	Site Specific [(60 d/yr x 24 hr/d) / (365 d/yr x 24 hr/d)]
ET d =	exposure term for soil inhalation pathway (unitless)	0.164	Site Specific [(60 d/yr x 24 hr/d) / (365 d/yr x 24 hr/d)]
ET s =	exposure term for soil dermal contact pathway (unitless)	0.164	Site Specific [(60 d/yr x 24 hr/d) / (365 d/yr x 24 hr/d)]
ET wg =	exposure term for wild game ingestion pathway (unitless)	1.000	Site Specific [(365 d/yr x 24 hr/d) / (365 d/yr x 24 hr/d)]
TSP =	total suspended particulate matter in air (kg/m3)	6.9E-10	calculated
IR air =	daily inhalation rate (m3/day)	9.3	CCME (1-4 yrs)
SA =	skin surface area (cm2/day)	3010	CCME (1-4 yrs)
M =	soil to skin adherence factor (mg/cm2)	0.1	CCME (1-4 yrs)
FRP=	fraction respirable particles	1	US EPA
Pe =	particulate emission rate (kg/m2/s)	6.9E-13	Atlantic RBCA
L =	Length of soil parallel to wind (m)	1000	Site Specific
Uair =	Average wind speed (m/s)	1	Site Specific
ht =	Height of air breathing zone (m)	1	Site Specific

Human Health Soil Quality SSTL Calculations for Threshold (Non-carcinogenic) Substances

Cadmium - Town Area

Eq: HQ = { [(Ci x AF i x IR x ET i) + (Ci x AF d x DR x ET d) + (Ci x AF s x SR x ET s) + (AF g x (WG i $_{TOT}$ x GR) x ET wg)] / BW } / (TDI - EDI)

DR = FRP x TSP x IR air
TSP = [Pe x L] / [Uair x ht]
SR = [SA x M x 1E-6]

Compound	TDI	EDI	Ci	WGi site	WGi bkgd	WGi tot	THQ	BSC	AF i	AF d	AF s	AF g	Hazard Quotient	CCME (Res) (mg/kg)
Cadmium	0.001	0.0004633	**1100**	2.49	0.08	0.56	1	0.71	0.1	1	0.01	0.1	1.0	140

Parameter	Definition (units)	Default Value	Reference
Ci =	Soil concentration (mg/kg)	site-specific	
WGi site =	Wild game tissue concentration (mg/kg)	site-specific	
WGi bkgd =	Background wild game tissue concentration (mg/kg)	regional	
WGi tot =	Weighted wild game tissue concentration (mg/kg)	calculated	
TDI =	reference dose - oral (mg/kg bw-day)	chemical specific	CCME
EDI =	estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	chemical specific	CCME (1-4 yrs)
BW =	body weight (kg)	16.5	CCME (1-4 yrs)
THQ =	Target Hazard Quotient	chemical specific	
BSC =	background soil concentration (mg/kg)	chemical specific	Site specific
AF g =	absorption factor for gut (unitless)	chemical specific	
AF i =	absorption factor for soil (unitless)	chemical specific	
AF d =	absorption factor for lung (unitless)	chemical specific	
AF s =	absorption factor skin (unitless)	chemical specific	EPA Region 3
GR =	wild game ingestion rate (kg/day)	0.018	Richardson (1997)
IR =	soil ingestion rate (kg/day)	0.000041	calculated
DR =	soil inhalation rate (kg/day)	6.417E-09	calculated
SR =	soil dermal contact rate (kg/day)	0.000301	calculated
ET i =	exposure term for soil ingestion pathway (unitless)	1.000	Site Specific [(365 d/yr x 24 hr/d) / (365 d/yr x 24 hr/d)]
ET d =	exposure term for soil inhalation pathway (unitless)	1.000	Site Specific [(365 d/yr x 24 hr/d) / (365 d/yr x 24 hr/d)]
ET s =	exposure term for soil dermal contact pathway (unitless)	1.000	Site Specific [(365 d/yr x 24 hr/d) / (365 d/yr x 24 hr/d)]
ET wg =	exposure term for wild game ingestion pathway (unitless)	1.000	Site Specific [(365 d/yr x 24 hr/d) / (365 d/yr x 24 hr/d)]
TSP =	total suspended particulate matter in air (kg/m3)	6.9E-10	calculated
IR air =	daily inhalation rate (m3/day)	9.3	CCME (1-4 yrs)
SA =	skin surface area (cm2/day)	3010	CCME (1-4 yrs)
M =	soil to skin adherence factor (mg/cm2)	0.1	CCME (1-4 yrs)
FRP=	fraction respirable particles	1	US EPA
Pe =	particulate emission rate (kg/m2/s)	6.9E-13	Atlantic RBCA
L =	Length of soil parallel to wind (m)	1000	Site Specific
Uair =	Average wind speed (m/s)	1	Site Specific
ht =	Height of air breathing zone (m)	1	Site Specific

Human Health Soil Quality SSTL Calculations for Threshold (Non-carcinogenic) Substances

Cadmium - General Mine Area

Eq: $HQ = \{ [(Ci \times AF\ i \times IR \times ET\ i) + (Ci \times AF\ d \times DR \times ET\ d) + (Ci \times AF\ s \times SR \times ET\ s) + (AF\ g \times (WG\ i_{TOT} \times GR) \times ET\ wg)] / BW \} / (TDI - EDI)$

$DR = FRP \times TSP \times IR\ air$

$TSP = [Pe \times L] / [Uair \times ht]$

$SR = [SA \times M \times 1E\text{-}6]$

Compound	TDI	EDI	Ci	WGi site	WGi bkgd	WGi tot	THQ	BSC	AF i	AF d	AF s	AF g	Hazard Quotient	CCME (Res) (mg/kg)
Cadmium	0.001	0.0004633	**3900**	4.52	0.08	0.97	1	0.71	0.1	1	0.01	0.1	1.0	14

Parameter	Definition (units)	Default Value	Reference
Ci =	Soil concentration (mg/kg)	site-specific	
WGi site =	Wild game tissue concentration (mg/kg)	site-specific	
WGi bkgd =	Background wild game tissue concentration (mg/kg)	regional	
WGi tot =	Weighted wild game tissue concentration (mg/kg)	calculated	
TDI =	reference dose - oral (mg/kg bw-day)	chemical specific	CCME
EDI =	estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	chemical specific	CCME (1-4 yrs)
BW =	body weight (kg)	16.5	CCME (1-4 yrs)
THQ =	Target Hazard Quotient	chemical specific	
BSC =	background soil concentration (mg/kg)	chemical specific	Site specific
AF g =	absorption factor for gut (unitless)	chemical specific	
AF i =	absorption factor for soil (unitless)	chemical specific	
AF d =	absorption factor for lung (unitless)	chemical specific	
AF s =	absorption factor skin (unitless)	chemical specific	EPA Region 3
GR =	wild game ingestion rate (kg/day)	0.018	Richardson (1997)
IR =	soil ingestion rate (kg/day)	0.00008	CCME (1-4 yrs)
DR =	soil inhalation rate (kg/day)	6.417E-09	calculated
SR =	soil dermal contact rate (kg/day)	0.000301	calculated
ET i =	exposure term for soil ingestion pathway (unitless)	0.164	Site Specific [(60 d/yr x 24 hr/d) / (365 d/yr x 24 hr/d)]
ET d =	exposure term for soil inhalation pathway (unitless)	0.164	Site Specific [(60 d/yr x 24 hr/d) / (365 d/yr x 24 hr/d)]
ET s =	exposure term for soil dermal contact pathway (unitless)	0.164	Site Specific [(60 d/yr x 24 hr/d) / (365 d/yr x 24 hr/d)]
ET wg =	exposure term for wild game ingestion pathway (unitless)	1.000	Site Specific [(365 d/yr x 24 hr/d) / (365 d/yr x 24 hr/d)]
TSP =	total suspended particulate matter in air (kg/m3)	6.9E-10	calculated
IR air =	daily inhalation rate (m3/day)	9.3	CCME (1-4 yrs)
SA =	skin surface area (cm2/day)	3010	CCME (1-4 yrs)
M =	soil to skin adherence factor (mg/cm2)	0.1	CCME (1-4 yrs)
FRP=	fraction respirable particles	1	US EPA
Pe =	particulate emission rate (kg/m2/s)	6.9E-13	Atlantic RBCA
L =	Length of soil parallel to wind (m)	1000	Site Specific
Uair =	Average wind speed (m/s)	1	Site Specific
ht =	Height of air breathing zone (m)	1	Site Specific

Human Health Soil Quality Site-Specific Threshold Limit Calculations for Non-Threshold (carcinogenic) Substances

Cadmium - Inhalation exposure, Town Area

Eq: SQG adult = [TR x BW] / [(AF d x DR x ET d x SFi)] + [BSC]

Eq age-adj: SQG adj = [TR x ATc] / [(AF d x DRadj*TSP x EF d x SFi)] + [BSC]

DR = FRP x TSP x IR air

SR = [SA x M x 1E-6]

Compound	SFi 1/mg/kg-d	BSC mg/kg	AF d	SQC-adult (mg/kg)	SQC-adjusted (mg/kg)	CCME (mg/kg)	CHECK: IILCR Cs = 4.74
Cadmium	4.3E+01	0.71	1	443	**368**	14	1.29E-08

Parameter	Definition (units)	Default Value	Reference
SF i =	inhalation slope factor [1/(mg/kg-day)]	chemical specific	Health Canada
TR =	target risk	1.00E-06	CCME
BW =	body weight (kg)	70.7	CCME
BSC =	background soil concentration	chemical specific	Ontario Typical Range - rural parkland
AF d =	absorption factor for lung (unitless)	chemical specific	US EPA
DR =	soil inhalation rate (kg/day)	1.1178E-08	calculated
ET d =	exposure term for soil inhalation pathway (unitless)	0.334	Site Specific (24 hrs/d x 122 d/yr x 70 yrs) / (24 hrs/d x 365 d/yr x 70 yrs)
IR air =	daily outdoor inhalation rate, outdoor (m3/day)	16.2	CCME
TSP =	ambient total suspended particulate matter in air (kg/m3)	6.9E-10	calculated
DRadj =	age adjusted soil inhalation rate (m3-yr/kg-d)	19.3	Age adjusted (0-0.5 yrs) + (0.5-5 yrs) + (5-11 yrs) + (12-19 yrs) + (20-70 yrs)
EF d =	exposure frequency for soil inhalation (d/yr)	122	Site Specific 122 d/yr x (24 hrs/d / 24 hrs/d)
ATc =	averaging time for carcinogens (d)	25550	CCME

Human Health Soil Quality SSTL Calculations for Non-Threshold (carcinogenic) Substances

Cadmium - Inhalation exposure, General Mine Area

Eq: SQG adult = [TR x BW] / [(AF d x DR x ET d x SFi)] + [BSC]

Eq age-adj: SQG adj = [TR x ATc] / [(AF d x DRadj*TSP x EF d x SFi)] + [BSC]

DR = FRP x TSP x IR air

SR = [SA x M x 1E-6]

Compound	SFi	BSC	AF d	SQC-adult	SQC-adjusted	CCME	CHECK: IILCR
	1/mg/kg-d	mg/kg		(mg/kg)	(mg/kg)	(mg/kg)	Cs = 5.75
Cadmium	4.3E+01	0.71	1	900	**748**	14	7.69E-09

Parameter	Definition (units)	Default Value	Reference
SF i =	inhalation slope factor [1/(mg/kg-day)]	chemical specific	Health Canada
TR =	target risk	1.00E-06	CCME
BW =	body weight (kg)	70.7	CCME
BSC =	background soil concentration	chemical specific	Ontario Typical Range - rural parkland
AF d =	absorption factor for lung (unitless)	chemical specific	US EPA
DR =	soil inhalation rate (kg/day)	1.1178E-08	calculated
ET d =	exposure term for soil inhalation pathway (unitless)	0.164	Site Specific (24 hrs/d x 60 d/yr x 70 yrs) / (24 hrs/d x 365 d/yr x 70 yrs)
IR air =	daily outdoor inhalation rate, outdoor (m3/day)	16.2	CCME
TSP =	ambient total suspended particulate matter in air (kg/m3)	6.9E-10	calculated
DRadj =	age adjusted soil inhalation rate (m3-yr/kg-d)	19.3	Age adjusted (0-0.5 yrs) + (0.5-5 yrs) + (5-11 yrs) + (12-19 yrs) + (20-70 yrs)
EF d =	exposure frequency for soil inhalation (d/yr)	60	Site Specific 60 d/yr x (24 hrs/d / 24 hrs/d)
ATc =	averaging time for carcinogens (d)	25550	CCME