Equations Used to Derive Target Level (TL) Concentrations

Groundwater Ingestion

A. Carcinogenic Chemicals of Concern (COCs)

(1) Category I:

$$C = \frac{TR * BW * AT_c * 365}{SFo * IRw * EF * ED * A}$$

(2) Category II:

$$C = \frac{TR_{II-III} * BW * AT_c * 365}{SFo * IRw * EF * ED * A}$$

(3) Category III:

$$C = \frac{TR_{II-III} * BW * AT_c * 365}{SFo * IR_{w-III} * EF * ED_{III} * A}$$

(4) Future Groundwater Ingestion:

$$C = \frac{TR_f * BW * AT_c * 365}{SFo * MLE}$$

B. Non-carcinogenic COC

(1) Category I & II:

$$C = \frac{HQ * RfD_o * BW * AT_n * 365}{IRw * EF * ED * A}$$

(2) Category III:

$$C = \frac{HQ * RfD_o * BW * AT_{n-III} * 365}{IR_{w-III} * EF * ED_{III} * A}$$

(3) Future Groundwater Ingestion:

$$C = \frac{HQ * RfD_o * BW * AT_{n-III} * 365}{MLE}$$

Equations Used to Derive Target Level (TL) Concentrations

Groundwater Protective Soil Concentration

$$C = \frac{C_{category} * 100(\beta * K_d + \theta_w + \theta_a * H')}{\beta}$$

Saturated Soil Concentration

$$C = \frac{S * (\beta * Kd + \theta w + \theta a * H')}{\beta}$$

Health-Based Soil Concentration

A. Resident Soil; Pathway – Ingestion and Vapor Inhalation.

$$VF_r = \frac{LS * V * DH}{A_{HB}} * \frac{\sqrt{3.14 * \alpha * T}}{2 * Dei * \theta * Kas * CF_u{}^{-1}}$$

where

$$\alpha = \frac{Dei * \theta}{\theta + \rho s(1-\theta)/Kas}$$

$$PEF = \frac{LS * V * DH * 3600}{A_{HB}} * \frac{CF_u}{0.036(1-G) * (Um/Ut)^3 * F(x)}$$

(1) Carcinogenic COC:

$$C = \frac{TR * BW * AT_c * 365}{EF\left[\left(BW * SF_o * CF_w * IF_{soil.adj}\right) + \left(SF_i * ED * IR_a * \left(\frac{1}{VF_r} + \frac{1}{PEF}\right)\right)\right]}$$

(2) Non-carcinogenic COC:

$$C = \frac{HQ * BW.C * AT_{n.C} * 365}{ED.C * EF * \left[\left(\frac{1}{RfD_o} * CF_w * IR_{soil.C}\right) + \left(\frac{1}{RfD_i} * IR_a * \left(\frac{1}{VF_r} + \frac{1}{PEF}\right)\right)\right]}$$

Equations Used to Derive Target Level (TL) Concentrations

B. Commercial/Industrial Worker Soil; Pathway – Ingestion and Vapor Inhalation.

$$VF_i = \frac{LS*V*DH}{A_{HB}} * \frac{\sqrt{3.14*\alpha*T_{C/I}}}{2*Dei*\theta*Kas*CF_u^{-1}}$$

where

$$\alpha = \frac{Dei*\theta}{\theta+\rho s(1-\theta)/Kas}$$

*PEF – Refer to Resident Soil; Pathway – Ingestion and Vapor Inhalation.

(1) Carcinogenic COC:

$$C = \frac{TR*BW*AT_c*365}{ED_w*EF_w[(SF_o*CF_w*IR_{sw})+(SF_i*IR_{a.w}\left(\frac{1}{VF_i}+\frac{1}{PEF}\right)]}$$

(2) Non-carcinogenic COC:

$$C = \frac{HQ*BW*AT_{nw}*365}{ED_w*EF_w*[\frac{CF_w}{RfD_o}*IR_{sw}+\frac{IR_{a.w}}{RfD_i}*\left(\frac{1}{VF_i}+\frac{1}{PEF}\right)]}$$

Construction Worker

A. Soil; Pathway – Ingestion, Vapor Inhalation, and Dermal Contact.

$$VF_{const} = \frac{L*V_{exc}*DH}{A_{const.soil}} * \frac{\sqrt{3.14*\alpha*T_{const}}}{2*Dei*\theta*Kas*CF_u^{-1}}$$

where

$$\alpha = \frac{Dei*\theta}{\theta+\rho s(1-\theta)/Kas}$$

$$PEF_{const} = \frac{L*V_{exc}*DH*3600}{A_{const.soil}} * \frac{CF_u}{0.036(1-G)*(Um/Ut)^3*F(x)} = 9*10^8$$

Equations Used to Derive Target Level (TL) Concentrations

(1) Carcinogenic COC:

$$C = \frac{TR * BW * AT_c * 365}{ED_{const.s} * EF_{const}[(SF_o * CF_w * IR_s) + (SF_i * IR_{a.w}\left(\frac{1}{VF_{const}} + \frac{1}{PEF_{const}}\right) + (SF_d * CF_w * SA_s * AF * ABS_d)]}$$

(2) Non-carcinogenic COC:

$$C = \frac{HQ * BW * AT_{n.const-s} * 365}{ED_{const.s} * EF_{const}[\frac{CF_w * IR_s}{RfD_o} + \frac{IR_{a.w}}{RfD_i}\left(\frac{1}{VF_{const}} + \frac{1}{PEF_{const}}\right) + \frac{CF_w}{RfD_d} * SA_s * AF * ABS_d]}$$

B. Groundwater; Pathway – Vapor Inhalation and Dermal Contact.

NOTE: The number C [calculated in (1) – (2) below] shall be divided by C_{avg} [calculated in (3) below] to obtain the target number.

If $t_{event.const} < t^*$, $Z = 2K_p\sqrt{6\tau_{event}\frac{t_{event.const}}{\pi}}$

If $t_{event.const} > t^*$, $Z = K_p(\frac{t_{event.const}}{1+B} + 2\tau_{event}\frac{1+3B}{1+B})$

(1) Carcinogens:

$$C_o = \frac{TR * BW * AT_c * 365}{EF_{const.} * ED_{const.w} * (IR_{a.w} * K_{ws} * CF_v * SF_i * \frac{A_{const.water}}{L * V_{exc} * \mathrm{DH}} + EV * SA_{const} * Z * SF_d * CF_{wat}{}^{-1})}$$

(2) Non-carcinogens:

$$C_o = \frac{HQ*BW*AT_{n.const-w}*365}{EF_{const.}*ED_{const.w}*(\frac{IRa.w*K_{ws}*CF_v*A_{const.water}}{RfD_i*L*V_{exc}*DH}+\frac{EV*SA_{const}*Z*CF_{wat}{}^{-1}}{RfD_d})}$$

(3) For all COCs, the equations for C_{avg} are:

$$C_{avg} = \frac{C_o}{\left[b*\tau+\left(\frac{b}{a}-1\right)(e^{-a*\tau}-1)\right]/a*\tau}$$

$$a = \frac{K_{ws}}{d} + \frac{3*D_{wat}}{w*l} + \frac{D_{wat}}{d_{cm}*l} + \frac{K*i}{w}$$

$$b = \frac{K*i}{w} + \frac{3*D_{wat}}{w*l} + \frac{D_{wat}}{d_{cm}*l}$$

Irrigation Well

Assumptions: Lawn watering duration and frequency are two hours every three days from March 1 to October 31, 82 events per year.

A. Residential Irrigation well: Located on Residential properties; Pathways – Groundwater Ingestion, Dermal Contact, and Vapor Inhalation.

(a) Incidental Ingestion.

(1) Carcinogens:

$$C_{ing} = \frac{TR_{IW}*AT_c*365}{SF_o*EF_{Iw}*IR_{IW.}}$$

(2) Non-carcinogens:

$$C_{ing} = \frac{HQ*RfD_o*BW.C*AT_{n.}C*365}{EF_{Iw}*ED.C*IR_{IW.}C}$$

Equations Used to Derive Target Level (TL) Concentrations

(b) Incidental Dermal Contact – As with Soil, ABS_{GI} is only adjusted if $ABS_{GI} < 0.5$, otherwise set $ABS_{GI} = 1$, $SF_d = SF_o$ and $RfD_d = RfD_o$.

(1) Carcinogens:

$$DA_{event.AgeAdj}\ (mg/cm^2\text{-event}) = \frac{TR_{IW} * AT_c * 365}{SF_o * (EV_{IW} * ED.C * EF_{IW} * \frac{SA.C}{BW.C} + EV_{IW} * ED_{.AgeAdj} * EF_{IW} * \frac{SA}{BW})}$$

If $t_{event.AgeAdj} < t^*$:

$$C_{derm} = \frac{DA_{event.AgeAdj}}{2 * FA * K_p * \sqrt{\frac{6 * \tau_{event} * t_{event.AgeAdj}}{\pi}}} * CF_{wat}$$

If $t_{event.AgeAdj} > t^*$ (all carcinogens' $t_{event.AgeAdj}$ are $< t^*$, the equation does not apply):

$$C_{derm} = \frac{DA_{event.AgeAdj} * CF_{wat}}{FA * K_p (\frac{t_{event.AgeAdj}}{1+B} + 2 * (\tau_{event}) \frac{1+3B+3B^2}{(1+B)^2})}$$

(2) Non-carcinogens:

$$DA_{event.}C = \frac{HQ * RfD_o * AT_n.C * 365 * BW.C}{EV_{IW} * ED.C * EF_{IW.} * SA.C}$$

If $t_{event} < t^*$:

$$C_{derm} = \frac{DA_{event.}C * CF_{wat}}{2 * FA * K_p * \sqrt{\frac{6 * \tau_{event} * t_{event}}{\pi}}}$$

If $t_{event} > t^*$ (Acetone, Formaldehyde, and Methyl Ethyl Ketone):

$$C_{derm} = \frac{DA_{event.}C * CF_{wat}}{FA * K_p (\frac{t_{event}}{1+B} + 2 * (\tau_{event}) \frac{1+3B+3B^2}{(1+B)^2})}$$

(c) Vapor Inhalation.

Assumptions: A receptor is standing on the lawn for two hours per event immediately after watering.

$$D_A\ (cm^2/s) = \frac{\theta_{as}^{3.33} D_{air} H' + \theta_{ws}^{3.33} D_{wat}}{[\theta_{ws} + K_d \rho_b + \theta_{as} H'] \theta_T^2}$$

and

$$E\ (mg/cm^2/s\ per\ mg/L,\ in\ water) = \frac{2 * C_w}{1000} \sqrt{\frac{D_A}{\pi * t}}$$

(1) Carcinogens:

$$C_{inh} = \frac{TR_{IW} * AT_c * 365 * V * W_{iw} * DH}{URF * CF_{air} * EF_{IW-inh} * ED * E * A_{IW}}$$

(2) Non-carcinogens:

$$C_{inh} = \frac{RfC * HQ * AT_n * 365 * V * W_{iw} * DH}{EF_{IW-inh} * ED * E * A_{IW}}$$

(d) Total Combined Concentration.

$$C\ (mg/L) = \frac{1}{\frac{1}{C_{ing}} + \frac{1}{C_{derm}} + \frac{1}{C_{inh}}}$$

B. Commercial Irrigation Well: Located on Commercial properties; Pathways – Dermal Contact and Vapor Inhalation.

(a) Ingestion – NA.

(b) Incidental Dermal Contact.

(1) Carcinogens:

$$DA_{event}\ (mg/cm^2\text{-event}) = \frac{TR_{IW} * AT_c * 365 * BW}{SF_o * EV_{IW} * ED_w * EF_{IW} * SA}$$

If $t_{event} <= t^*$:

$$C_{derm} = \frac{DA_{event} * CF_{wat}}{2 * FA * K_p * \sqrt{\frac{6 * \tau_{event} * t_{event}}{\pi}}}$$

If $t_{event} > t^*$ (Benzene only):

$$C_{derm} = \frac{DA_{event} * CF_{wat}}{FA * K_p (\frac{t_{event}}{1+B} + 2 * (\tau_{event}) \frac{1+3B+3B^2}{(1+B)^2})}$$

(2) Non-carcinogens:

$$DA_{event}\ (mg/cm^2\text{-event}) = \frac{HQ * RfD_o * AT_{nw} * 365 * BW}{EV_{IW} * ED_w * EF_{IW} * SA}$$

If $t_{event} < t^*$:

$$C_{derm} = \frac{DA_{event} * CF_{wat}}{2 * FA * K_p * \sqrt{\frac{6 * \tau_{event} * t_{event}}{\pi}}}$$

If $t_{event} > t^*$ (Acetone, Formaldehyde, and Methyl Ethyl Ketone):

$$C_{derm} = \frac{DA_{event} * CF_{wat}}{FA * K_p (\frac{t_{event}}{1+B} + 2 * (\tau_{event}) \frac{1+3B+3B^2}{(1+B)^2})}$$

Equations Used to Derive Target Level (TL) Concentrations

(c) Vapor Inhalation.

Assumptions: Pathways – Groundwater Ingestion, Dermal Contact, and Vapor Inhalation.

(1) Carcinogens:

$$C_{inh} = \frac{TR_{IW} * AT_c * 365 * V * W_{iw} * DH}{URF * CF_{air} * EF_{IW-inh} * ED_w * E * A_{IW}}$$

(2) Non-carcinogens:

$$C_{inh} = \frac{RfC * HQ * AT_{nw} * 365 * V * W_{iw} * DH}{EF_{IW-inh} * ED_w * E * A_{IW}}$$

(d) Total Combined Concentration.

$$C\ (mg/L) = \frac{1}{\frac{1}{C_{derm}} + \frac{1}{C_{inh}}}$$

Equations Used to Derive Target Level (TL) Concentrations

Table 1. Parameters, Definitions, and Units for Equations Used to Derive Target Concentrations

Parameters	Definition	Units
A	Absorption Factor	1 (Refer to Groundwater Ingestion Pathway)
A_{HB}	Area of Contamination for Residential or Commercial/Industrial Properties	1,500,000 cm^2 for VF_i or VF_r 150 m^2 for PEF
$A_{const.soil}$	Area of Excavation Floor and four (4) walls	1,087,000 cm^2 for VF_{const} or 108.7 m^2 for PEF_{const}
$A_{const.water}$	Area of Excavation Floor for Construction Worker	22.3 m^2
A_{IW}	Area of Irrigation	9,000,000 cm^2
ABS_{GI}	Gastrointestinal Absorption Fraction	COC-specific, (unitless)
ABS_d	Dermal Adsorption Factor	COC-specific, (unitless)
AF	Soil to Skin Adherence Factor (Worker)	0.12 mg/cm^2-event
AT_c	Averaging Time for Carcinogens	70 years
AT.C	Child Averaging Time for Carcinogens	6 years
AT_n	Averaging Time for Non-Carcinogens	30 years
$AT_{n\text{-}III}$	Averaging Time for Non-Carcinogens in Category III Groundwater	9 years
$AT_{n.const\text{-}s}$	Averaging Time for Soil to Construction Worker	0.24 years
$AT_{n.const\text{-}w}$	Averaging Time for Groundwater to Construction Worker	0.06 years
AT_n.C	Child Averaging Time for Non-Carcinogens	6 years
AT_{nw}	Worker Averaging Time for Non-Carcinogens	25 years
B	Relative Contribution of Permeability Coefficient $(B = K_p\frac{\sqrt{MW}}{2.6})$	COC-specific, cm/hour
BW	Adult Body Weight	70 kg
BW.C	Child Body Weight	15 kg
C	Calculated Concentration	mg/kg (soil) or mg/L (water)
C_o	Initial Dissolved COC Concentration	1 mg/L
C_{avg}	Average Dissolved COC Concentration, Over Time τ	COC-specific, mg/L
C_{carc}	Calculated Default Concentration for Carcinogens	mg/kg (soil) or mg/L (water)
$C_{category}$	Plan A Default Number for each Groundwater Category	COC-specific, mg/L
C_{nc}	Calculated Concentration for Non-Carcinogens	mg/kg (soil) or mg/L (water)

Equations Used to Derive Target Level (TL) Concentrations

Table 1. Parameters, Definitions, and Units for Equations Used to Derive Target Concentrations (cont.)

Parameters	Definition	Units
C_{derm}	Calculated Concentration for Dermal Contact	mg/L
C_{inh}	Calculated Concentration for Vapor Inhalation	mg/L
C_{ing}	Calculated Concentration for Groundwater Ingestion	mg/L
C_w	Groundwater Concentration in Irrigation Well Exposure	1 mg/L
CF_{air}	Conversion Factor	1,000 µg/mg
CF_u	Unit Conversion Factor	1,000 g/kg
CF_v	Volume Conversion Factor	1,000 L/m^3
CF_w	Weight Conversion Factor	10^{-6} kg/mg
CF_{wat}	Conversion Factor	1,000 cm^3/L
d	Depth of Water in the Excavation Pit	1 m
d_{cm}	Depth of Water in the Excavation Pit	100 cm
d_e	Effective Diameter of Excavation Pit $(d_e = \sqrt{\frac{4*Aconst.water}{\pi}})$	5.3285 m
D_A	Apparent Diffusivity	COC-specific, cm^2/sec
D_{air}	Diffusion Coefficient in Air	COC-specific, cm^2/sec
D_{ei}	Effective Diffusivity $(D_{ei} = D_{air}*\theta^{0.33})$	COC-specific, cm^2/sec
D_{wat}	Diffusion Coefficient in Water	COC-specific, cm^2/sec
D_{ether}	Diffusivity of Ether in Water	$8.5*10^{-6}$ cm^2/sec
$DA_{event.AgeAdj}$	Dermal Absorbed Dose per event for Age Adjust Exposure	mg/(cm^2-event)
$DA_{event.}C$	Dermal Absorbed Dose per event for Child Exposure	mg/(cm^2-event)
DA_{event}	Dermal Absorbed Dose per event for Commercial/Industrial Worker	mg/(cm^2-event)
DH	Diffusion Height or Air-Mixing Zone Height	2 m
E	Emission Rate	COC-specific, (mg/cm^2/sec per mg/L, in water)
ED	Exposure Duration	30 years
ED_{III}	Exposure Duration for Category III Groundwater	9 years
$ED_{.AgeAdj}$	Age Adjust Exposure Duration	24 years
ED.C	Child Exposure Duration	6 years

Equations Used to Derive Target Level (TL) Concentrations

Table 1. Parameters, Definitions, and Units for Equations Used to Derive Target Concentrations (cont.)

Parameters	Definition	Units
ED_w	Commercial/Industrial Worker Exposure Duration	25 years
$ED_{const.s}$	Construction Worker Exposure Duration (Soil)	12 weeks
$ED_{const.w}$	Construction Worker Exposure Duration (Water)	3 weeks
EF	Exposure Frequency	350 days/year
EF_{const}	Construction Worker's Exposure Frequency	5 days/week
EF_{IW}	Irrigation Well Exposure Frequency	82 days/year
$EF_{IW\text{-}inh}$	Irrigation Well Inhalation Exposure Frequency (2 hours/event for 82 events/year)	6.83333 days/year
EF_w	Worker's Exposure Frequency	250 days/year
EV	Exposure Event for Groundwater to Construction Work	2 events/day
EV_{IW}	Exposure Event for Dermal Contact with Water from Irrigation Well	1 event/day
FA	Chemical Specific Adsorbed, Default Conservatively set to 1	1 (unitless)
F(x)	Function Dependent on U_m/U_t	0.0497 (unitless)
G	Fraction of Vegetative Cover	0
H'	Dimensionless Henry's Law Constant	COC-specific (cm^3-H_2O/cm^3-air)
H	Excavation Height	2 m
HQ	Hazard Quotient	1
i	Hydraulic Gradient	0.025 (unitless)
$IF_{soil.adj}$	Age-Adjusted Soil Ingestion Rate	114 (mg-year)/(kg-day)
IR_a	Vapor Inhalation Rate for Resident	15 m^3/day
$IR_{a.w}$	Vapor Inhalation Rate for Worker	20 m^3/day
IR_{IW}	Incidental Ingestion Rate of Groundwater from Irrigation Well	0.4 (L-year)/(kg-day)
$IR_{IW.}C$	Child Incidental Ingestion Rate of Groundwater from Irrigation Well	0.32 (L-year)/(kg-day)
IR_s	Construction Work Soil Ingestion Rate	480 mg/day
$IR_{soil.}C$	Child Soil Ingestion Rate	200 mg/day
IR_{sw}	Worker Soil Ingestion Rate	50 mg/day
IR_w	Daily Adult Water Ingestion Rate	2 liters/day
$IR_{w\text{-}III}$	Daily Adult Water Ingestion Rate for Category III Groundwater	1.4 liters/day
K	Hydraulic Conductivity	$1.7*10^{-4}$(cm/sec)

Equations Used to Derive Target Level (TL) Concentrations

Table 1. Parameters, Definitions, and Units for Equations Used to Derive Target Concentrations (cont.)

Parameters	Definition	Units
K_{as}	Soil-Air Partition Coefficient $(K_{as} = \frac{H'}{K_d})$	COC-specific (g-soil/cm^3-air)
K_d	Soil-Water Partition Coefficient $(k_d = K_{oc} * f_{oc})$	COC-specific (cm^3-H_2O/g-soil)
K_{oc}	Soil Organic Carbon-Water Partition Coefficient	COC-specific (cm^3-H_2O/g-Carbon)
K_p	Dermal Permeability Coefficient $(\text{Log}K_p = 0.66\text{Log}K_{ow}\text{-}2.8\text{-}0.0056*MW)$	COC-specific, cm/hour
K_{ow}	Octanol-Water Partition Coefficient	COC-specific (cm^3-H_2O/cm^3-Octanol)
K_{ws}	Overall Mass Transfer Coefficient $K_{ws} = \frac{2.78*10^{-6}*(\frac{D_{wat}}{D_{ether}})^{\frac{2}{3}}*4.82*10^{-3}*V_{exc}{}^{0.78}*(\frac{\rho_G*D_{air}}{U_G})^{0.67}*d_e{}^{-0.11}*H'}{2.78*10^{-6}*(\frac{D_{wat}}{D_{ether}})^{\frac{2}{3}}+4.82*10^{-3}*V_{exc}{}^{0.78}*(\frac{\rho_G*D_{air}}{U_G})^{0.67}*d_e{}^{-0.11}*H'}$	COC–specific, m/sec
l	Characteristic Length for Diffusion	30.48 cm
L	Length or Width of Excavation	4.7 m
LS	Length of Contamination Area	21 m
MLE	Most Likely Exposure (1.4 L/day*235 days/year*9 years)	2,961 Liters
MW	Molecular Weight	COC-specific, g/mole
PEF	Particulate Emission Factor	$2.917*10^{10}$ m^3/kg
PEF_{const}	Particulate Emission Rate in Construction Work Scenario	$9.0*10^8$ m^3/kg
RfC	Inhalation Reference Concentration	COC-specific, mg/m^3
RfD_d	Dermal Reference Dose $RfD_d = RfD_o$ when $ABS_{GI} > 50\%$; otherwise $RfD_d = RfD_o * ABS_{GI}$	COC-specific, mg (kg-day)
RfD_i	Inhalation Reference Dose $(RfD_i = \frac{RfC*20}{70})$	COC-specific, mg/(kg-day)
RfD_o	Oral Reference Dose	COC-specific, mg/(kg-day)
S	Pure Compound Solubility in Water	COC-specific, mg/L
SA	Adult Skin Area	18,000 cm^2
SA_{const}	Construction Worker Skin Area for Groundwater Contact	6,170 cm^2

Equations Used to Derive Target Level (TL) Concentrations

Table 1. Parameters, Definitions, and Units for Equations Used to Derive Target Concentrations (cont.)

Parameters	Definition	Units
SA_s	Construction Worker Skin Area for Soil Contact	3,300 cm^2
SA.C	Child Skin Area	6,600 cm^2
SF_d	Dermal Cancer Slope Factor $SF_d = SF_o$ when $ABS_{GI} > 50\%$; otherwise $SF_d = SF_o/ABS_{GI}$	COC-specific, $mg/(kg\text{-}day)^{-1}$
SF_i	Inhalation Cancer Slope Factor $(SF_i = \frac{URF*1000*70}{20})$	COC-specific, $mg/(kg\text{-}day)^{-1}$
SF_o	Oral Cancer Slope Factor	COC-specific, $mg/(kg\text{-}day)^{-1}$
τ	Exposure Interval (3 weeks for Groundwater to Construction Worker)	1.8144*106 seconds
τ_{event}	Lag Time $(\tau_{event} = 0.105*10^{0.0056*MW})$	COC-specific, hour/event
t	Exposure Interval for Vapor Inhalation After Watering	7,200 seconds
t_{event}	Exposure Duration in Irrigation Well Scenario – Assume sufficiently warm (>70^{0}F) for 60 of the 82 events and 1-hour sprinkler play time (RME bathing time, USEPA RAGS Part E, 2001)	0.73 hours/event (60*1)/82 = 0.73
$t_{event.AgeAdj}$	Exposure Duration for Resident Contact with Water from Irrigation Well for Age Adjust, $t_{event.AgeAdj} = \frac{0.73*6+0.42*24}{30}$	0.48 hours/event
$t_{event.const}$	Exposure Duration for Construction Worker	2 hours/event
t*	Time to Reach Steady-State If B ≤ 0.6, $t^* = 2.4*\tau_{event}$ If B > 0.6, $t^* = 6*\tau_{event}*\{[\frac{2(1+B)^2}{\pi} - \frac{1+3B+3B^2}{3(1+B)}] - \sqrt{[\frac{2(1+B)^2}{\pi} - \frac{1+3B+3B^2}{3(1+B)}]^2 - [\frac{1+3B+3B^2}{3(1+B)}]^2}\}$	COC-specific, hour
T	Resident Soil Vapor Exposure Interval	$9.4608*10^8$ seconds
$T_{C/I}$	Commercial/Industrial Worker Soil Vapor Exposure Interval	$7.844*10^8$ seconds
T_{const}	Construction Worker Soil Vapor Exposure Interval	$3.78432*10^8$ seconds
TR	Life-time Cancer Risk for Category I Groundwater and Soil	10^{-6} (Class A & B COC) & 10^{-5} (Class C COC)
$TR_{II\text{-}III}$	Life-time Cancer Risk for Category II and III Groundwater	10^{-5} (Class A & B COC) & 10^{-4} (Class C COC)
TR_{IW}	Life-time Cancer Risk for Irrigation Well	10^{-5}

Equations Used to Derive Target Level (TL) Concentrations

Table 1. Parameters, Definitions, and Units for Equations Used to Derive Target Concentrations (cont.)

Parameters	Definition	Units
TR_f	Life-time Cancer Risk for Future Exposure	10^{-4}
V	Wind Speed in Mixing Zone	2.25 m/sec
V_{exc}	Wind Speed in the Excavation Pit	0.225 m/sec
U_g	Viscosity of Air	$1.81*10^{-4}$ g/(cm*s)
U_m	Mean Annual Wind Speed	4.5 m/sec
U_t	Equivalent Threshold Value of Wind	12.8 m/sec
URF	Inhalation-unit Risk Factor	COC-specific, $m^3/\mu g$
VF_i	Soil-to-Air Volatilization Factor for Commercial/Industrial Worker	COC-specific, m^3/kg
VF_r	Soil-to-Air Volatilization Factor for Resident	COC-specific, m^3/kg
VF_{const}	Soil-to-Air Volatilization Factor for Construction Worker	COC-specific, m^3/kg
w	Width of Excavation Pit	470 cm
W_{iw}	Width of Lawn	30 m
Z	Dermal Factor	COC-specific, cm/event
β	Dry Soil Bulk Density	1.7225 g/cm3
θ	Total Soil Porosity	0.35 (unitless)
θ_a	Volumetric Air-Content of Soil	0.22 (unitless)
θ_w	Volumetric Water-Content of Soil	0.13 (unitless)
θ_{as}	Volumetric Air-Content of Top Soil (Lawn)	0.1 (unitless)
θ_{ws}	Volumetric Water-Content of Top Soil Immediately after Irrigation	0.4 (unitless)
θ_T	Total Soil Porosity of Top Soil (Lawn)	0.5 (unitless)
ρ_b	Dry Soil Bulk Density for Lawn Soil	1.67 g/cm3
ρ_g	Density of Air	1.2*10-3 g/cm3
ρ_s	Soil Particle Density	2.65 g/cm3
f_{oc}	Fraction of Organic Carbon in Soil	0.002 (unitless)
$f_{oc.iw}$	Fraction of Organic Carbon in Lawn Soil	0.02 (unitless)