SEP 09 '96 09:47AM ENV MGMNT/ GRNDWATER WASTE TEAM P.1/9

Post-It™ brand fax transmittal memo 7671	# of pages ▸ 9
To EVA Chu	From CURT PECK
Co. ACHCS	Co. CRTC
Dept.	Phone # 510-242-7086
Fax # 337-9335	Fax # -242-1380

MEMORANDUM

2/5/97 - verbal approval of wp with some minor changes - RA expected ~ 3/15/97

September 6, 1996
Richmond, California

Risk Evaluation Workplan - Proposal
Former Chevron Service Station #9-1723
9757 San Leandro Blvd., Oakland California

Mr. Phil Briggs:
San Ramon, CA

STID# 44667

This Risk Evaluation Workplan is submitted to fulfill a request made in a July 26, 1996 letter from Eva Chu of the Alameda County Health Care Services Agency (ACHCS) to Phil Briggs, Chevron Products Company. The ACHCS review of additional site data indicated that this site would be an appropriate candidate for a Risk Based Corrective Action (RBCA) evaluation and Chevron Research and Technology Company (CRTC) proposes to conduct this evaluation. The evaluation is intended to develop site specific target levels (SSTL's) in soil and groundwater for the fuel hydrocarbons benzene, ethylbenzene, toluene and xylene (BETX) based on a commercial worker exposure risk scenario at this site. The RBCA evaluation will not include TPH-gas as it is not a single compound with specific chemical and physical parameters. Use of default values will be discussed with and approved by ACHCS prior to implementing this workplan. It is the intention of CRTC to work closely with ACHCS in developing appropriate site characteristic and risk levels prior to performing this evaluation. The CRTC Toxicology group will participate in the development of the SSTL's and risk evaluation for this site.

It is proposed that the Groundwater Services Inc. (GSI) Tier 2 RBCA Tool Kit software package be used to determine site SSTL's for the $1x10^{-4}$ risk range. The GSI Tool Kit is based on the American Society of Testing and Materials (ASTM) RBCA standard E-1739-95. Site specific soil and groundwater data from previous site investigations and groundwater monitoring events will be used to define 95% UCL concentrations for both soil and groundwater to be used in the calculations of the SSTL's. Site specific input parameters will also be used where applicable. Absent site specific data, GSI RBCA default values for model input parameters will be used and noted where appropriate. Commercial worker exposure scenarios would include the enclosed-space inhalation of soil and groundwater vapors and worker dermal exposure to subsurface (>3 feet) soil contamination. The ingestion of groundwater is not a likely exposure pathway as the drinking water in the area is supplied by a municipal water purveyor and the nearby water supply wells are for industrial purposes only.

use 10^{-5}

Do not use geometric mean use arithmetic

Available Site Data

A review of site data indicates that site specific data can be developed for:

1) Groundwater concentration from monitoring wells MW-5, MW-6 and MW-8. ok

2) Depth to groundwater will be determined as the average depth to groundwater based on the last 4 quarters of monitoring data from wells MW-5, -6 and -8. ok

3) Site soil concentrations at the 5 foot, 10 foot and 15 foot intervals from GTI 4/96 site investigation Soil Borings SB-1 through SB-23. ok This is below GW elevation

future + current scenario

Curt is going to get back.

(1) Redo the soil samples + GW for indoor pathway around building

(2)

(1) → Do RMMP since soil - indoor did not pass - (taking all conc

(2) Excavate soil + resample

(3) Soil Gas → ~~they~~ know this.

Changes: 0.5 hr → 2/3/97

(1) calc Risk using 10⁻⁵

(2) Do not use geometic mean for UCL → Use arithmetic

(3) capillary zone should be determined using data data for site.

(4) GW conc. should be averaged from each well for 4 qtrs, then the 3 wells avg conc can be averaged.

4) Site soil bulk density, soil moisture, porosity and Total Organic Carbon will be calculated from the physical parameters measured in SB-3, SB-8, SB-10, SB-20 and SB-21 during the GTI 4/96 site investigation. ok

5) The site lithology has been characterized as clays and clayey sands based on boring log interpretation. ok

Estimated Site Parameters

1) The capillary zone will be estimated at 10% of the depth to groundwater. ok base on depth to water

2) Default parameters for the calculation of vapor inhalation from soil (VFsesp) and groundwater (VFwesp) to enclosed space will be based on the E-1739-95 Table X2.6 attached. These calculations will be generated by the GSI software and checked by hand calculations. ok

3) Chemical specific properties of the BETX compounds will be taken from the E-1739-95 Table X2.7. ok

It is anticipated that additional parameter selection will be necessary to complete this evaluation and ACHCS will be involved in the development of these additional values. This workplan could be implemented within 45 days of acceptance by the ACHCS.

Please contact me at 242-7086 with comments or questions.

Curtis A Peck

Curtis A. Peck
Lead Hydrogeologist

the inhalation of airborne chemicals resulting from the volatilization of chemicals from surficial soils follow guidance given in Ref (26) for inhalation of airborne chemicals.

X2.6.6 A conceptual model for the volatilization of chemicals from surficial soils to outdoor air is depicted in Fig. X2.3. For simplicity, the relationship between outdoor air and surficial soil concentrations is represented in Tables X2.2 and X2.3 by the "volatilization factor" VF_{ss} [(mg/m^3-air)/(mg/kg-soil)] defined in Table X2.5. It is based on the following assumptions:

X2.6.6.1 Uniformly distributed chemical throughout the depth 0—*d* (cm) below ground surface,

X2.6.6.2 Linear equilibrium partitioning within the soil matrix between sorbed, dissolved, and vapor phases, where

TABLE X2.5 Volatilization Factors (VF_i), Leaching Factor (LF_{sw}), and Effective Diffusion Coefficients (D_i^{eff})

Symbol	Cross-Media Route (or Definition)	Equation
VF_{wesp}	Ground water — enclosed-space vapors	$VF_{wesp}\left[\frac{(mg/m^3\text{-air})}{(mg/L\text{-}H_2O)}\right] = \frac{H\left[\frac{D_{ws}^{eff}/L_{GW}}{ER\,L_B}\right]}{1+\left[\frac{D_{ws}^{eff}/L_{GW}}{ER\,L_B}\right]+\left[\frac{D_{ws}^{eff}/L_{GW}}{(D_{crack}^{eff}/L_{crack})\eta}\right]} \times 10^3 \frac{L}{m^3}$ [A]
VF_{wamb}	Ground water — ambient (outdoor) vapors	$VF_{wamb}\left[\frac{(mg/m^3\text{-air})}{(mg/L\text{-}H_2O)}\right] = \frac{H}{1+\left[\frac{U_{air}\delta_{air}L_{GW}}{WD_{ws}^{eff}}\right]} \times 10^3 \frac{L}{m^3}$ [B]
VF_{ss}	Surficial soils — ambient air (vapors)	$VF_{ss}\left[\frac{(mg/m^3\text{-air})}{(mg/kg\text{-soil})}\right] = \frac{2W\rho_s}{U_{air}\delta_{air}}\sqrt{\frac{D_s^{eff}H}{\pi[\theta_{ws}+k_s\rho_s+H\theta_{as}]\tau}} \times 10^3 \frac{cm^3\text{-}kg}{m^3\text{-}g}$ [C] or: $VF_{ss}\left[\frac{(mg/m^3\text{-air})}{(mg/kg\text{-soil})}\right] = \frac{W\rho_s d}{U_{air}\delta_{air}\tau} \times 10^3 \frac{cm^3\text{-}kg}{m^3\text{-}g}$; whichever is less[D]
VF_p	Surficial soils — ambient air (particulates)	$VF_p\left[\frac{(mg/m^3\text{-air})}{(mg/kg\text{-soil})}\right] = \frac{P_e W}{U_{air}\delta_{air}} \times 10^3 \frac{cm^3\text{-}kg}{m^3\text{-}g}$ [E]
VF_{samb}	Subsurface soils — ambient air	$VF_{samb}\left[\frac{(mg/m^3\text{-air})}{(mg/kg\text{-soil})}\right] = \frac{H\rho_s}{[\theta_{ws}+k_s\rho_s+H\theta_{as}]\left(1+\frac{U_{air}\delta_{air}L_S}{D_s^{eff}W}\right)} \times 10^3 \frac{cm^3\text{-}kg}{m^3\text{-}g}$ [F]
VF_{sesp}	Subsurface soil — enclosed-space vapors	$VF_{sesp}\left[\frac{(mg/m^3\text{-air})}{(mg/kg\text{-soil})}\right] = \frac{\frac{H\rho_s}{[\theta_{ws}+k_s\rho_s+H\theta_{as}]}\left[\frac{D_s^{eff}/L_S}{ER\,L_B}\right]}{1+\left[\frac{D_s^{eff}/L_S}{ER\,L_B}\right]+\left[\frac{D_s^{eff}/L_S}{(D_{crack}^{eff}/L_{crack})\eta}\right]} \times 10^3 \frac{cm^3\text{-}kg}{m^3\text{-}g}$ [A]
LF_{sw}	Subsurface soils — ground water	$LF_{sw}\left[\frac{(mg/L\text{-}H_2O)}{(mg/kg\text{-soil})}\right] = \frac{\rho_s}{[\theta_{ws}+k_s\rho_s+H\theta_{as}]\left(1+\frac{U_{gw}\delta_{gw}}{IW}\right)} \times 10^0 \frac{cm^3\text{-}kg}{L\text{-}g}$ [B]
D_s^{eff}	Effective diffusion coefficient in soil based on vapor-phase concentration	$D_s^{eff}\left[\frac{cm^2}{s}\right] = D^{air}\frac{\theta_{as}^{3.33}}{\theta_T^2} + D^{wat}\frac{1}{H}\frac{\theta_{ws}^{3.33}}{\theta_T^2}$ [A]
D_{crack}^{eff}	Effective diffusion coefficient through foundation cracks	$D_{crack}^{eff}\left[\frac{cm^2}{s}\right] = D^{air}\frac{\theta_{acrack}^{3.33}}{\theta_T^2} + D^{wat}\frac{1}{H}\frac{\theta_{wcrack}^{3.33}}{\theta_T^2}$ [A]
D_{cap}^{eff}	Effective diffusion coefficient through capillary fringe	$D_{cap}^{eff}\left[\frac{cm^2}{s}\right] = D^{air}\frac{\theta_{acap}^{3.33}}{\theta_T^2} + D^{wat}\frac{1}{H}\frac{\theta_{wcap}^{3.33}}{\theta_T^2}$ [A]
D_{ws}^{eff}	Effective diffusion coefficient between ground water and soil surface	$D_{ws}^{eff}\left[\frac{cm^2}{s}\right] = (h_{cap}+h_v)\left[\frac{h_{cap}}{D_{cap}^{eff}}+\frac{h_v}{D_s^{eff}}\right]^{-1}$ [A]
C_s^{sat}	Soil concentration at which dissolved pore-water and vapor phases become saturated	$C_s^{sat}\left[\frac{mg}{kg\text{-soil}}\right] = \frac{S}{\rho_s} \times [H\theta_{as}+\theta_{ws}+k_s\rho_s] \times 10^0 \frac{L\text{-}g}{cm^3\text{-}kg}$ [F]

[A] See Ref (29).
[B] See Ref (30).
[C] See Ref (31).
[D] Based on mass balance.
[E] See Ref (32).
[F] See Ref (33).

TABLE X2.6 Soil, Building, Surface, and Subsurface Parameters Used in Generating Example Tier 1 RBSLs

NOTE—See X2.10 for justification of parameter selection.

Parameters	Definitions, Units	Residential	Commercial/Industrial
d	lower depth of surficial soil zone, cm	100 cm	100 cm
D^{air}	diffusion coefficient in air, cm²/s	chemical-specific	chemical-specific
D^{wat}	diffusion coefficient in water, cm²/s	chemical-specific	chemical-specific
ER	enclosed-space air exchange rate, L/s	0.00014 s^{-1}	0.00023 s^{-1}
f_{oc}	fraction of organic carbon in soil, g-C/g-soil	0.01	0.01
H	henry's law constant, (cm^3-H_2O)/(cm^3-air)	chemical-specific	chemical-specific
h_{cap}	thickness of capillary fringe, cm	5 cm	5 cm
h_v	thickness of vadose zone, cm	295 cm	295 cm
I	infiltration rate of water through soil, cm/years	30 cm/year	30 cm/year
k_{oc}	carbon-water sorption coefficient, cm^3-H_2O/g-C	chemical-specific	chemical-specific
k_s	soil-water sorption coefficient, cm^3-H_2O/g-soil	$f_{oc} \times k_{oc}$	$f_{oc} \times k_{oc}$
L_B	enclosed-space volume/infiltration area ratio, cm	200 cm	300 cm
L_{crack}	enclosed-space foundation or wall thickness, cm	15 cm	15 cm
L_{GW}	depth to ground water = $h_{cap} + h_v$, cm	300 cm	300 cm
L_S	depth to subsurface soil sources, cm	100 cm	100 cm
P_e	particulate emission rate, g/cm²-s	6.9×10^{-14}	6.9×10^{-14}
S	pure component solubility in water, mg/L-H_2O	chemical-specific	chemical-specific
U_{air}	wind speed above ground surface in ambient mixing zone, cm/s	225 cm/s	225 cm/s
U_{gw}	ground water Darcy velocity, cm/year	2500 cm/year	2500 cm/year
W	width of source area parallel to wind, or ground water flow direction, cm	1500 cm	1500 cm
δ_{air}	ambient air mixing zone height, cm	200 cm	200 cm
δ_{gw}	ground water mixing zone thickness, cm	200 cm	200 cm
η	areal fraction of cracks in foundations/walls, cm²-cracks/cm²-total area	0.01 cm²-cracks/cm²-total area	0.01 cm²-cracks/cm²-total area
θ_{acap}	volumetric air content in capillary fringe soils, cm³-air/cm³-soil	0.038 cm³-air/cm³-soil	0.38 cm³-air/cm³-soil
θ_{acrack}	volumetric air content in foundation/wall cracks, cm³-air/cm³ total volume	0.26 cm³-air/cm³ total volume	0.26 cm³-air/cm³ total volume
θ_{as}	volumetric air content in vadose zone soils, cm³-air/cm³-soil	0.26 cm³-air/cm³-soil	0.26 cm³-air/cm³-soil
θ_T	total soil porosity, cm³/cm³-soil	0.38 cm³/cm³-soil	0.38 cm³/cm³-soil
θ_{wcap}	volumetric water content in capillary fringe soils, cm³-H_2O/cm³-soil	0.342 cm³-H_2O/cm³-soil	0.342 cm³-H_2O/cm³-soil
θ_{wcrack}	volumetric water content in foundation/wall cracks, cm³-H_2O/cm³ total volume	0.12 cm³-H_2O/cm³ total volume	0.12 cm³-H_2O/cm³ total volume
θ_{ws}	volumetric water content in vadose zone soils, cm³-H_2O/cm³-soil	0.12 cm³-H_2O/cm³-soil	0.12 cm³-H_2O/cm³-soil
ρ_s	soil bulk density, g-soil/cm³-soil	1.7 g/cm³	1.7 g/cm³
τ	averaging time for vapor flux, s	7.88×10^8 s	7.88×10^8 s

the partitioning is a function of constant chemical- and soil-specific parameters,

X2.6.6.3 Diffusion through the vadose zone,

X2.6.6.4 No loss of chemical as it diffuses towards ground surface (that is, no biodegradation), and

X2.6.6.5 Steady well-mixed atmospheric dispersion of the emanating vapors within the breathing zone as modeled by a "box model" for air dispersion.

X2.6.7 In the event that the time-averaged flux exceeds that which would occur if all chemical initially present in the surficial soil zone volatilized during the exposure period, then the volatilization factor is determined from a mass balance assuming that all chemical initially present in the surficial soil zone volatilizes during the exposure period.

X2.7 *Subsurface Soils—Inhalation of Outdoor Vapors:*

X2.7.1 In this case chemical intake is a result of inhalation of outdoor vapors which originate from hydrocarbons contained in subsurface soils located some distance below ground surface. Here the goal is to determine the RBSL for subsurface soils that corresponds to the target RBSL for outdoor vapors in the breathing zone, as given in X2.2. If the selected target vapor concentration is some value other than

TABLE X2.7 Chemical-Specific Properties Used in the Derivation Example Tier 1 RBSLs

Chemical	CAS Number	M_w, g/mol	H, L-H_2O/L-air	D^{air}, cm²/s	D^{wat}, cm²/s	log(K_{oc}), L/kg	log(K_{ow}), L/kg
Benzene	71-43-2	78[A]	0.22[A]	0.093[A]	1.1×10^{-5} [A]	1.58[A]	2.13[A]
Toluene	108-88-3	92[A]	0.26[A]	0.085[A]	9.4×10^{-6} [D]	2.13[A]	2.65[A]
Ethyl benzene	100-41-4	106[A]	0.32[A]	0.076[A]	8.5×10^{-6} [D]	1.98[A]	3.13[A]
Mixed xylenes	1330-20-7	106[A]	0.29[A]	0.072[D]	8.5×10^{-6} [D]	2.38[A]	3.26[A]
Naphthalene	91-20-3	128[A]	0.049[A]	0.072[D]	9.4×10^{-6} [A]	3.11[A]	3.28[A]
Benzo(a)pyrene	50-32-8	252[C]	5.8×10^{-8} [B]	0.050[D]	5.8×10^{-6} [D]	5.59[E]	5.98[B]

Chemical	CAS Number	SF_o, kg-day/mg	SF_i, kg-day/mg	RfD_o, mg/kg-day	RfD_i, mg/kg-day
Benzene	71-43-2	0.029[F]	0.029[F]	...	...
Toluene	108-88-3	...	...	0.2[F]	0.11[F]
Ethyl benzene	100-41-4	...	...	0.1[F]	0.29[F]
Mixed xylenes	1330-20-7	...	...	2.0[F]	2.0[F]
Naphthalene	91-20-3	...	...	0.004[G]	0.004[G]
Benzo(a)pyrene	50-32-8	7.3[F]	6.1[F]	...	...

[A] See Ref (34).
[B] See Ref (35).
[C] See Ref (7).
[D] Diffusion coefficient calculated using the method of Fuller, Schettler, and Giddings, from Ref (11).
[E] Calculated from K_{ow}/K_{oc} correlation: $\log(K_{oc}) = 0.937 \log(K_{ow}) - 0.006$, from Ref (17).
[F] See Ref (2).
[G] See Ref (3).

TABLE X2.3 Equations Used to Develop Example Tier 1 Risk-Based Screening Level (RBSLs) Appearing in "Look-Up" Table X2.1—Noncarcinogenic Effects[A]

NOTE—See Tables X2.4 through X2.7 for definition of parameters.

Medium	Exposure Route	Risk-Based Screening Level (RBSL)
Air	inhalation[B]	$RBSL_{air}\left[\frac{\mu g}{m^3\text{-}air}\right] = \dfrac{THQ \times RfD_i \times BW \times AT_n \times 365 \frac{days}{years} \times 10^3 \frac{\mu g}{mg}}{IR_{air} \times EF \times ED}$
Ground water	ingestion (potable ground water supply only)[B]	$RBSL_w\left[\frac{mg}{L\text{-}H_2O}\right] = \dfrac{THQ \times RfD_o \times BW \times AT_n \times 365 \frac{days}{years}}{IR_w \times EF \times ED}$
Ground water[C]	enclosed-space (indoor) vapor inhalation[D]	$RBSL_w\left[\frac{mg}{L\text{-}H_2O}\right] = \dfrac{RBSL_{air}\left[\frac{\mu g}{m^3\text{-}air}\right]}{VF_{wesp}} \times 10^{-3} \frac{mg}{\mu g}$
Ground water[C]	ambient (outdoor) vapor inhalation[D]	$RBSL_w\left[\frac{mg}{L\text{-}H_2O}\right] = \dfrac{RBSL_{air}\left[\frac{\mu g}{m^3\text{-}air}\right]}{VF_{wamb}} \times 10^{-3} \frac{mg}{\mu g}$
Surficial soil	ingestion of soil, inhalation of vapors and particulates, and dermal contact[D]	$RBSL_s\left[\frac{\mu g}{kg\text{-}soil}\right] = \dfrac{THQ \times BW \times AT_n \times 365 \frac{days}{years}}{EF \times ED\left(\dfrac{\left(10^{-6} \cdot \frac{kg}{mg} \times (IR_{soil} \times RAF_o + SA \times M \times RAF_d)\right)}{RfD_o} + \dfrac{(IR_{air} \times (VF_{ss} + VF_p))}{RfD_i}\right)}$ For surficial and excavated soils (0 to 1 m)
Subsurface soil[C]	ambient (outdoor) vapor inhalation[D]	$RBSL_s\left[\frac{mg}{kg\text{-}soil}\right] = \dfrac{RBSL_{air}\left[\frac{\mu g}{m^3\text{-}air}\right]}{VF_{samb}} \times 10^{-3} \frac{mg}{\mu g}$
Subsurface soil[C]	enclosed space (indoor) vapor inhalation[D]	$RBSL_s\left[\frac{mg}{kg\text{-}soil}\right] = \dfrac{RBSL_{air}\left[\frac{\mu g}{m^3\text{-}air}\right]}{VF_{sesp}} \times 10^{-3} \frac{mg}{\mu g}$
Subsurface soil[C]	leaching to ground water[D]	$RBSL_s\left[\frac{mg}{kg\text{-}soil}\right] = \dfrac{RBSL_w\left[\frac{mg}{L\text{-}H_2O}\right]}{LF_{sw}}$

[A] Note that all RBSL values should be compared with thermodynamic partitioning limits, such as solubility levels, maximum vapor concentrations, and so forth. If a RBSL exceeds the relevant partitioning limit, this is an indication that the selected risk or hazard level will never be reached or exceeded for that chemical and the selected exposure scenario.

[B] Screening levels for these media based on other considerations (for example, aesthetic, background levels, environmental resource protection, and so forth) can be derived with these equations by substituting the selected target level for $RBSL_{air}$ or $RBSL_w$ appearing in these equations.

[C] These equations are based on Ref (28).

[D] These equations simply define the "cross-media partitioning factors," VF_{ij} and LF_{sw}.

X2.4 *Ground Water—Inhalation of Outdoor Vapors:*

X2.4.1 In this case chemical intake is a result of inhalation of outdoor vapors which originate from dissolved hydrocarbons in ground water located some distance below ground surface. Here the goal is to determine the dissolved hydrocarbon RBSL that corresponds to the target RBSL for outdoor vapors in the breathing zone, as given in Tables X2.3 and X2.4. If the selected target vapor concentration is some value other than the RBSL for inhalation (that is, odor threshold or ecological criterion), this value can be substituted for the $RBSL_{air}$ parameter appearing in the equations given in Tables X2.2 and X2.3.

X2.4.2 A conceptual model for the transport of chemicals from ground water to ambient air is depicted in Fig. X2.1. For simplicity, the relationship between outdoor air and dissolved ground water concentrations is represented in Tables X2.2 and X2.3 by the "volatilization factor," VF_{wamb} [(mg/m³-air)/(mg/L-H_2O)], defined in Table X2.5. It is based on the following assumptions:

X2.4.2.1 A constant dissolved chemical concentration in ground water,

X2.4.2.2 Linear equilibrium partitioning between dissolved chemicals in ground water and chemical vapors at the ground water table,

X2.4.2.3 Steady-state vapor- and liquid-phase diffusion through the capillary fringe and vadose zones to ground

TABLE X2.4 Exposure Parameters Appearing in Tables X2.2 and X2.3

Parameters	Definitions, Units	Residential	Commercial/Industrial
AT_c	averaging time for carcinogens, years	70 years	70 years[A]
AT_n	averaging time for noncarcinogens, years	30 years	25 years[A]
BW	adult body weight, kg	70 kg	70 kg[A]
ED	exposure duration, years	30 years	25 years[A]
EF	exposure frequency, days/years	350 days/year	250 days/year[A]
IR_{soil}	soil ingestion rate, mg/day	100 mg/day	50 mg/day[A]
IR_{air}-indoor	daily indoor inhalation rate, m^3/day	15 m^3/day	20 m^3/day[A]
IR_{air}-outdoor	daily outdoor inhalation rate, m^3/day	20 m^3/day	20 m^3/day[A]
IR_w	daily water ingestion rate, L/day	2 L/day	1 L/day[A]
LF_{sw}	leaching factor, (mg/L-H_2O)/(mg/kg-soil)—see Table X2.5	chemical-specific	chemical-specific
M	soil to skin adherence factor, mg/cm^2	0.5	0.5[B]
RAF_d	dermal relative absorption factor, volatiles/PAHs	0.5/0.05	0.5/0.05[B]
RAF_o	oral relative absorption factor	1.0	1.0
$RBSL_i$	risk-based screening level for media i, mg/kg-soil, mg/L-H_2O, or µg/m^3-air	chemical-, media-, and exposure route-specific	chemical-, media-, and exposure route-specific
RfD_i	inhalation chronic reference dose, mg/kg-day	chemical-specific	chemical-specific
RfD_o	oral chronic reference dose, mg/kg-day	chemical-specific	chemical-specific
SA	skin surface area, cm^2/day	3160	3160[A]
SF_i	inhalation cancer slope factor, $(mg/kg\text{-}day)^{-1}$	chemical-specific	chemical-specific
SF_o	oral cancer slope factor, $(mg/kg\text{-}day)^{-1}$	chemical-specific	chemical-specific
THQ	target hazard quotient for individual constituents, unitless	1.0	1.0
TR	target excess individual lifetime cancer risk, unitless	for example, 10^{-6} or 10^{-4}	for example, 10^{-6} or 10^{-4}
VF_i	volatilization factor, (mg/m^3-air)/(mg/kg-soil) or (mg/m^3-air)/(mg/L-H_2O)—see Table X2.5	chemical- and media-specific	chemical- and media-specific

[A] See Ref (27).
[B] See Ref (28).

surface,

X2.4.2.4 No loss of chemical as it diffuses towards ground surface (that is, no biodegradation), and

X2.4.2.5 Steady well-mixed atmospheric dispersion of the emanating vapors within the breathing zone as modeled by a "box model" for air dispersion.

X2.4.3 Should the calculated $RBSL_w$ exceed the pure component solubility for any individual component, ">S" is entered in the table to indicate that the selected risk level or hazard quotient cannot be reached or exceeded for that compound and the specified exposure scenario.

X2.5 *Ground Water—Inhalation of Enclosed-Space (Indoor) Vapors:*

X2.5.1 In this case chemical intake results from the inhalation of vapors in enclosed spaces. The chemical vapors originate from dissolved hydrocarbons in ground water located some distance below ground surface. Here the goal is to determine the dissolved hydrocarbon RBSL that corresponds to the target RBSL for vapors in the breathing zone, as given in Tables X2.2 and X2.3. If the selected target vapor concentration is some value other than the RBSL for inhalation (that is, odor threshold or ecological criterion), this value can be substituted for the $RBSL_{air}$ parameter appearing in the equations given in Tables X2.2 and X2.3.

X2.5.2 A conceptual model for the transport of chemicals from ground water to indoor air is depicted in Fig. X2.2. For simplicity, the relationship between enclosed-space air and dissolved ground water concentrations is represented in Tables X2.2 and X2.3 by the "volatilization factor" VF_{wesp} [(mg/m^3-air)/(mg/L-H_2O)] defined in Table X2.5. It is based on the following assumptions:

X2.5.2.1 A constant dissolved chemical concentration in ground water,

X2.5.2.2 Equilibrium partitioning between dissolved chemicals in ground water and chemical vapors at the ground water table,

X2.5.2.3 Steady-state vapor- and liquid-phase diffusion through the capillary fringe, vadose zone, and foundation cracks,

X2.5.2.4 No loss of chemical as it diffuses towards ground surface (that is, no biodegradation), and

X2.5.2.5 Steady, well-mixed atmospheric dispersion of the emanating vapors within the enclosed space, where the convective transport into the building through foundation cracks or openings is negligible in comparison with diffusive transport.

X2.5.3 Should the calculated $RBSL_w$ exceed the pure component solubility for any individual component, ">S" is entered in the table to indicate that the selected risk level or hazard quotient cannot be reached or exceeded for that compound and the specified exposure scenario.

X2.6 *Surficial Soils—Ingestion, Dermal Contact, and Vapor and Particulate Inhalation:*

X2.6.1 In this case it is assumed that chemical intake results from a combination of intake routes, including: ingestion, dermal absorption, and inhalation of both particulates and vapors emanating from surficial soil.

X2.6.2 Equations used to estimate intake resulting from ingestion follow guidance given in Ref (26) for ingestion of chemicals in soil. For this route, it has been assumed that surficial soil chemical concentrations and intake rates remain constant over the exposure duration.

X2.6.3 Equations used to estimate intake resulting from dermal absorption follow guidance given in Ref (26) for dermal contact with chemicals in soil. For this route, it has been assumed that surficial soil chemical concentrations and absorption rates remain constant over the exposure duration.

X2.6.4 Equations used to estimate intake resulting from the inhalation of particulates follow guidance given in Ref (26) for inhalation of airborne chemicals. For this route, it has been assumed that surficial soil chemical concentrations, intake rates, and atmospheric particulate concentrations remain constant over the exposure duration.

X2.6.5 Equations used to estimate intake resulting from