

Table 1. Soil Invertebrate Tissue Quality due to Uptake from Soil Contact

COPC	Uptake Model*	Csoil	Cfood dwt	Cfood wwt	Reference
Copper	Cinvert dwt = 0.515 x Csoil	229	117.94	18.87	USEPA 2007a
Arsenic	ln(B) = 0.706*ln(Cs)-1.44	35.1	2.98	0.48	USEPA 2007a
Naphthalene	Cinvert dwt = 4.4 x Csoil	10.5	46.20	7.39	USEPA 2007a
Soil Sample Moisture (%)		84			

Note: Uptake model from USEPA 2007

Table 2. Receptor Characteristics for Dusky Shrew

Variable	Units	Value
Body Wt	kg	1.50E-02
Food Ingestion	kg/d	9.00E-03
Soil Ingestion	kg/d	1.17E-03
Water Ingestion	L/d	3.30E-03
Habitat Range	ha	3.90E-01
Diet Preference	(proportion)	100% soil invertebrates

Table 3. Dose Calculation

		Copper	Arsenic	Naphthalene
3a. Soil Ingestion	$\frac{DR_s = C_s \times IR_s \times BIO_{oral}}{BW} =$	1.79E+01	2.74E+00	8.19E-01
Where: DRs = estimated dose from ingestion of COPC in soil (mg/Kg bw-day) IRs = soil ingestion rate (kg/day) Cs = COPC concentration in soil (mg/kg) BIOoral = bioavailability of COPC in soil BW = body weight (kg)				
3b. Food Ingestion	$\frac{DR_f = C_f \times IR_f \times BIO_{food}}{BW}$	1.13E+01	2.86E-01	4.44E+00
Where: DRs = estimated dose from ingestion of COPC in food (mg/kg bw-day) IRs = food ingestion rate (kg/day) Cs = COPC concentration in soil (mg/kg) BIOoral = bioavailability of COPC in food BW = body weight (kg)				
3c. Total Dose Rate = DR_s + DR_f		2.92E+01	3.02E+00	5.25E+00
4. Risk Estimation				
Toxicity Reference Value (mg/(kg-d) *)		5.6	1.04	10
Hazard Quotient (deterministic, based on NOEL)		5.21E+00	2.91E+00	5.25E-01

* Note:

TRV for Copper and Arsenic taken from USEPA ECOSsl as NOEL

TRV for Naphthalene taken from US Soils Reclamation TRV (NOEL) Data Base

Toxicity Assessment: Question #1

In an experiment, it is determined that Chemical X causes hepatic necrosis according to the table below:

Dose (mg/kg bw/day)	Number of animals (out of 30) with hepatic necrosis
0	0
5	0
20	0
50	7
200	15

What would be the NOEL for Chemical X? What would be the LOEL for Chemical X? Assuming this is the most relevant study and that an uncertainty factor of 100 is applicable, what would be the TDI?

Answer to Question #1

- NOEL is the highest dose that no observable effects were found
 - NOEL = 20 mg/kg bw/day
- LOEL is the highest dose that no observable effects were found
 - LOEL = 50 mg/kg bw/day

Answer to Question #1

- $TDI = \frac{NOEL}{\text{Uncertainty factor}}$
 $= \frac{20 \text{ mg/kg bw/day}}{100}$
 $= 0.2 \text{ mg/kg bw/day}$

Toxicity Assessment: Question #2

Chemical Y has been determined to be a genotoxic carcinogen with an estimated carcinogenic potency (q_1^*) of $0.00001 \text{ } (\mu\text{g/kg body weight/day})^{-1}$. Chemical Z has also been determined to be a genotoxic carcinogen with an estimated carcinogenic potency (q_1^*) of $0.001 \text{ } (\mu\text{g/kg body weight/day})^{-1}$.

Which is the more carcinogenic substance?

What would be the Risk Specific Dose for a target cancer risk of one-in-one hundred thousand for each of these chemicals?

Answer to Question #2

- Two ways of answering this:
 - The greater the slope factor, the more carcinogenic the substance
 - The lower the RsD, the more carcinogenic the substances
- So, the question can be answered by comparing slope factors or by comparing RsDs

Answer to Question #2

- RsD for a 1×10^{-5} risk can be calculated as

$$\text{RsD} = \frac{\text{Target Cancer Risk}}{\text{Slope Factor}}$$

$$\begin{aligned} \text{For Chemical Y, RsD} &= \frac{1 \times 10^{-5}}{1 \times 10^{-5} \text{ (ug/kg bw/d)}^{-1}} \\ &= 1 \text{ ug/kg bw/d} \end{aligned}$$

$$\begin{aligned} \text{For Chemical Z, RsD} &= \frac{1 \times 10^{-5}}{1 \times 10^{-3} \text{ (ug/kg bw/d)}^{-1}} \\ &= 0.01 \text{ ug/kg bw/d} \end{aligned}$$

Answer to Question #2

- So, Chemical Z has both a greater slope factor and lower RsD than Chemical Y
- Thus, Chemical Z is considered to be more potent than Chemical Y

Risk Characterization: Group Exercise

Assume that trespassers access a site at a rate of 1 hour per day, 7 days per week. While at the site, the trespasser is exposed to:

- arsenic at a dose rate of 1 ug/kg bw/day
- naphthalene at an outdoor air concentration of 30 ug/m³

Using the previously provided US EPA TRVs, what would be the risks from arsenic and naphthalene for a person spending:

- 1 year trespassing at the site?
- 10 years trespassing at the site?

Answer to Risk Characterization Group

Exercise: Arsenic

Firstly, it is necessary to estimate cancer risks for arsenic and non-cancer risks for naphthalene and arsenic (although it is unlikely that arsenic non-cancer risks would drive the risk assessment).

For arsenic cancer risks, the arsenic dose rate is 1 ug/kg bw/day when the person is at the site. Cancer risks can be estimated as the exposures amortized over the lifetime. Consequently, the risks will be dependent upon how many years of exposure that a person may receive.

Incremental Lifetime Cancer Risk (ILCR) can be estimated as:

$$\text{ILCR} = \frac{\text{Daily Annual Exposure} \times \text{Number of Years Present} \times \text{Slope Factor}}{\text{Number of Years in a Lifetime}}$$

Answer to Risk Characterization Group

Exercise: Arsenic

For 1 year trespassing at the site, the risks can be estimated as:

$$\text{ILCR} = \frac{1 \text{ ug/kg bw/d} \times 1 \text{ year} \times 1.5 \times 10^{-3} (\text{ug/kg bw/d})^{-1}}{80 \text{ years}^*}$$

$$\text{ILCR} = 1.9 \times 10^{-5}$$

For 10 years trespassing at the site, the risks can be estimated as:

$$\text{ILCR} = \frac{1 \text{ ug/kg bw/d} \times 10 \text{ years} \times 1.5 \times 10^{-3} (\text{ug/kg bw/d})^{-1}}{80 \text{ years}^*}$$

$$\text{ILCR} = 1.9 \times 10^{-4}$$

* Health Canada guidance may sometimes be interpreted as amortizing over the adult lifestage only (or 61 years)

Answer to Risk Characterization Group

Exercise: Naphthalene

For evaluation of the non-cancer risks from naphthalene, the risk estimates can be amortized on a weekly basis; however, the risk estimates cannot mathematically adjust a 1 year exposure versus a 10 year exposure. Thus, the same risk is estimated for both trespassing scenarios.

Since the TRV is provided as an air concentration estimate, there is no reason to estimate the dose rate.

Hazard Quotient (HQ) values can be estimated as:

$$\text{HQ} = \frac{\text{Air Concentration} \times \text{Hours per Day at the Site} \times \text{Days per Week at the Site}}{\text{Reference Concentration} \times 24 \text{ hours} \times 7 \text{ days}}$$

$$\text{HQ} = \frac{30 \text{ ug/m}^3 \times 1 \text{ hour} \times 7 \text{ days}}{3 \text{ ug/m}^3 \times 24 \text{ hours} \times 7 \text{ days}}$$

$$= 0.42$$