



**A Human Health Risk Assessment
Conundrum:**

**What is the Best Way to Evaluate Short-Term
Exposure at Contaminated Sites?**



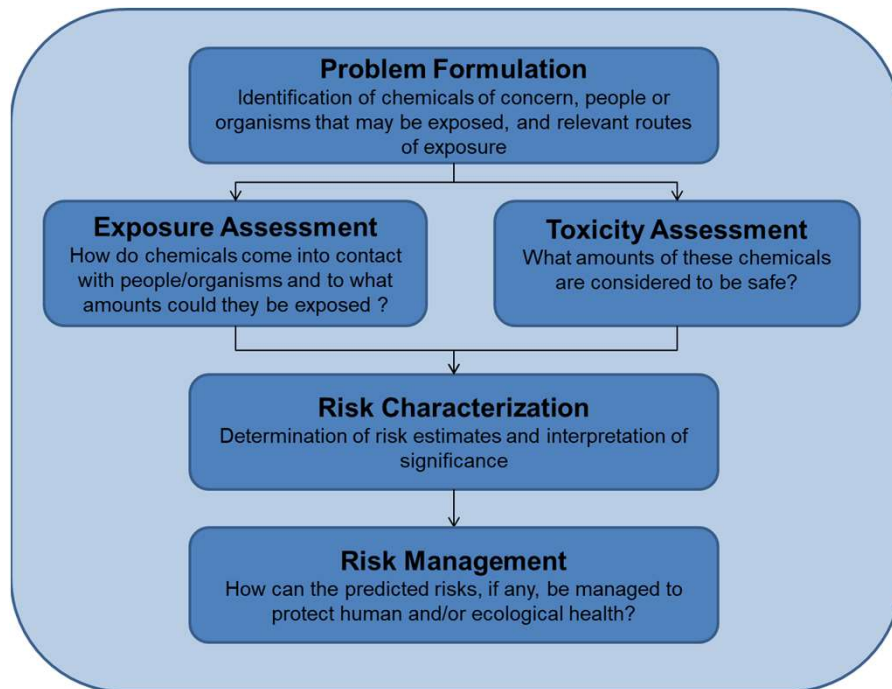
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Outline

- Overview of Issue
- Toxicological Concepts
- Potential Pitfalls
- Parting Thoughts

Overview of issue



- **Requirement** in Alberta to evaluate short-term and long-term risks
- Acute-based toxicity limits generally limited to inhalation exposures – few regulatory-derived values available
- Guidelines /Criteria based on long-term exposure

Why do Duration and Frequency Matter at Contaminated Sites?

- Regulatory guidance documents often provide default exposure assumptions - may or may not be relevant to chemical
- The assumption that people will be exposed continuously every day over a lifetime is highly conservative and not always practical
- Risks can be **over-** or **under-**estimated depending on approaches used
 - **Affects remediation target development, impacts risk management decisions**

What is The General Difference?

- **Acute**
 - Single exposure
- **Intermediate (sub-chronic)**
 - Repeated exposure
- **Chronic**
 - Repeated, long-term exposure, sometimes lifetime

BUT Exposure Time (total amount of time exposed over entire duration) can also matter



Definitions - Acute and Short-term Exposures

Definition of acute varies by agency. “Short Term” even less clear

Agency	Acute	Intermediate (sub-chronic)	Chronic
Alberta Environment	< 24-hours	> 30-days	Repeated/long-term
Health Canada	< 14-days	14- to 90-days	> 90-days
Health Canada Pesticide Management Regulatory Agency (PMRA)	< 24-hours	< 30-days (short-term) 1- to 6-months	> 6-months
US Agency for Toxic Substances and Disease Registry	< 14-days	15- to 364-days	> 365-days
US Environmental Protection Agency	< 24-hours	< 30-days (short-term) > 30-days (sub-chronic)	> 30-days (10% of human lifespan)

The Importance of Chemical-Specific Information

- **Effects can be:**
 - Concentration-dependent
 - Time-dependent
 - Time- and concentration-dependent
 - May only be relevant to *in utero* exposures or certain exposure pathways
 - Limited to a specific window of susceptibility
(e.g. teratogens, developmental toxicants)
 - Influenced by degree of absorption, the formation and activity of metabolites, and the elimination of the chemical and metabolites
 - Carcinogenic vs. non-carcinogenic, mutagenic vs. non-mutagenic, etc.

Chemical-Specific Information is Key to a Quality TRV

What Guidance is Available?

- Health Canada – guidance memorandum provided in 2016.
- Supplemental guidance proposed in 2020/2021 for Federal contaminated sites
- Limited guidance from other governmental agencies beyond having acute, intermediate (sub-chronic) or chronic toxicity reference values
- **Result of this gap:**
 - Inconsistency in approaches
 - Potential for inaccuracies in approaches used on a site-specific basis

Other Complicating Factors

- Several different potential exposures at contaminated sites
 - Regular, daily
 - Occasional or intermittent
 - Surface vs. sub-surface
- Soil ingestion
 - Representative estimates of ingestion
 - Pica children
- Potentially susceptible sub-populations



Can Short-term Effects be Assessed?

Do you have all the information?

Available TRVs of appropriate duration?

Toxicological endpoint relevant to acute exposure?

Are effects due to concentration, time or both?

Endpoint relevant to receptor?

Substance half-life(s) known?

Assumptions for exposure calculations – are they practical?

Do you have a clear understanding of how people may be exposed?

Potential Pitfalls

The chronic risks are okay so why do we even bother?

Regulatory requirement:

Alberta Tier 2 Soil and Groundwater Remediation Guidelines (2019):

- *“For all human health risk assessments, risk from acute pica events should be evaluated to determine that the assessment is protective of these events”*

Detailed HHRA has to at least consider this scenario.

Potential Pitfalls – Example 1

Incorrect Toxicological Reference Values

- Accounting for short-term, high soil ingestion events
- Pica soil ingestion rate = 5,000 mg/day
- Toddler = 16.5 kg

Potential Pitfalls – Example 1

Cadmium and Zinc

- Where do you go for short-term TRVs?
- Intermediate TRVs from ATSDR:
 - Cadmium = 0.0005 mg/kg bw/day
 - Zinc = 0.3 mg/kg bw/day

$$C_s = (TRV \times BW) \div (IR_s \times RAF_{oral} \times ET)$$

Potential Pitfalls – Example 1

Contaminant	Residential – Direct Human Soil Contact (mg/kg)	Short-term Events (mg/kg)
Cadmium	14	1.65
Zinc	10,000	990

Result: Overestimation of risk

Potential Pitfalls – Example 2

Incorrect Application of Dose Averaging

- Only applicable to certain chemicals and scenarios
- What about sites that aren't commonly used?
- Short-term exposure of lead (Pb) at a non-residential site

Single exposure per year

$$\neq \frac{1}{365}$$

Result: Underestimation of risk

Potential Pitfalls – Example 3

Unrealistic Exposure Scenario

- Contamination at depth brought to surface
- PCDD/F
 - Reproductive/developmental toxicant
- Short-term TRV selection (< 24 hrs) based on tolerable monthly intake
- WHO conclusion:
 - *“In view of the long half-lives of PCDDs, PCDFs and coplanar PCBs, [WHO] concluded that it would not be appropriate to establish an acute reference dose for these compounds.”*

Result: Erroneous risk estimate

UK Case Studies

- Examples where acute risks may exceed chronic risks
- Cyanide:
 - Old gas manufacturing plant, now parkland use
 - TRV based on LOAEL
 - Acute risks > chronic risks
- Chromium (VI)
 - Old tannery redeveloped as a primary school in the 1970s
 - Allergic contact dermatitis
 - Soil quality guideline = 80 mg/kg (note: AB resi/park guideline = 220 mg/kg)
- Both sites saw infrequent use
- Not expected at residential sites

Conclusions

- The assessment of single and short-term exposures is **not** straightforward
- Careful consideration must be given to each chemical and exposure scenario
- The use of incorrect values or assumptions can result in erroneous risk estimates and/or the calculation of guidelines that are not appropriate
- The result to the site operator/owner may be increased costs and liability

Parting Thoughts and Questions

- The development of acute or short-term TRVs for use at contaminated sites requires careful consideration of the **duration of exposure AND chemical-specific characteristics** by experts
- Small variations in methods for deriving short-term TRVs can have notable differences in the resulting values
- Are short-term risks being evaluated appropriately at your sites?



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