



The Perils of Hazard-Based Chloride Guidelines

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Presentation Objectives:

- Promote systemic thinking of hazards versus risk
- Promote discussions
 - Between rightsholders, regulators, risk managers, consultants, etc.

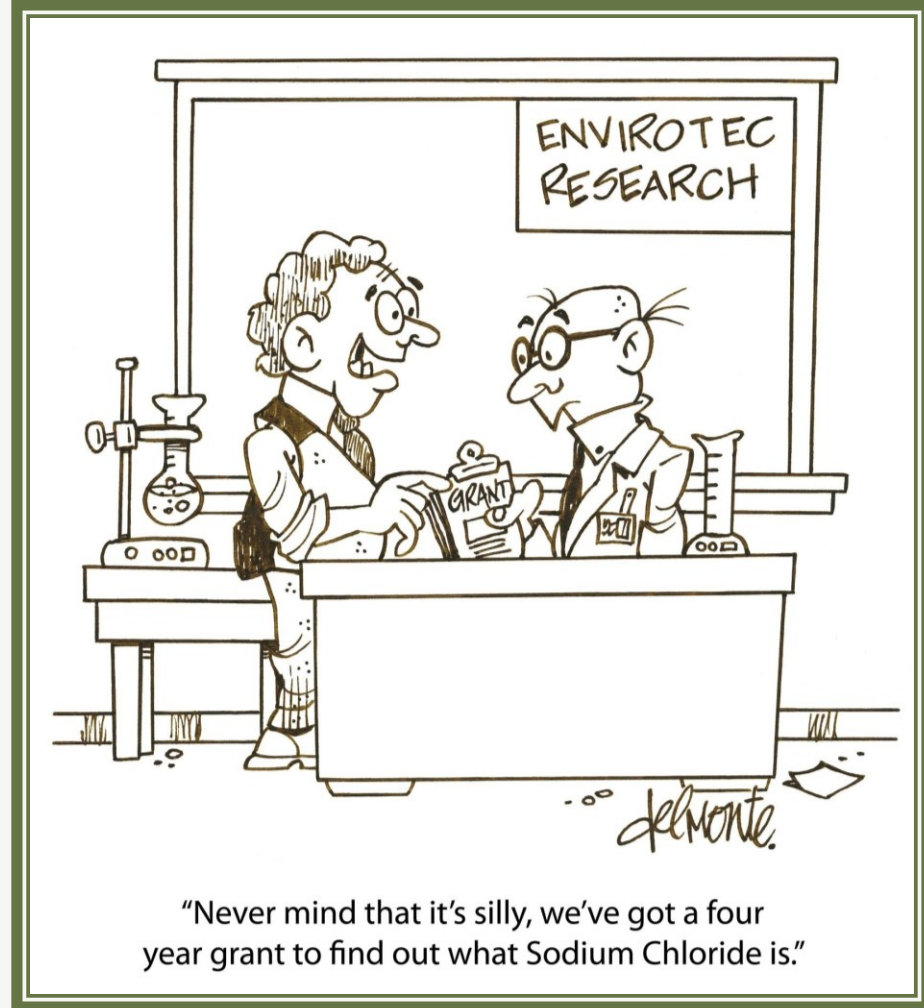
Presentation is Not Intended to:

- Provide prescriptive recommendations
- Drive change for updates regulatory policy framework
- Precede the current regulatory framework



Outline

- Hazard vs. Risk
- Chloride Groundwater Guidelines (ecological)
 - Freshwater Aquatic Life
 - Irrigation
- Opportunities to Incorporate Risk into Chloride Guidelines





Hazard Vs. Risk





Hazard Versus Risk

Hazard

- Intrinsic
- Constant
- Independent

$$HQ = \frac{\textit{Chemical Concentration}}{\textit{TRV}}$$

Risk

- *Probability* Dependent
- Dose Dependent
 - Dose makes the poison
- Context Dependent

$$RQ = \frac{\textit{Predicted Environmental Concentration}}{\textit{TRV}}$$

Hazard vs. Risk

Hazard

A Hazard is something that has the potential to harm you

vs.

Risk

Risk is the likelihood of a hazard causing harm



Exposure (pathway) is required to have risk

SHARK



A shark in the sea is a hazard



Swimming with a shark is a risk

LIGHTNING



Lightning is a hazard



Standing under a tree during a thunderstorm is a risk

Image Reference: [EFSA](https://www.efsa.europa.eu/)



What is Risk

- The *probability* of something occurring
- Ecological Risk Assessment:
 - A process that evaluates the *likelihood* that adverse effects may occur or are occurring as a result of exposure to one or more stressors
 - *Inherent Uncertainties*
 - **A tool to support decision making**
- *Not the same as a hazard*

Risk Assessment Paradigm



"A risk assessment is like a prisoner, if you torture it long enough, it will confess to anything" ~William Ruckelshaus



Risk Venn Diagram +



Must Have
Probability



Regulatory Management Considerations

Pros of Hazard-Based Management

- Focused on intrinsic chemical properties and can identify issues before exposure (risk mitigation)
- Useful for when exposure levels vary
- Simplifies regulatory framework
- Ensures protection of the most sensitive receptor
- Less site characterization data
- Easier risk communication

Pros of Risk-Based Management

- Considers probability of exposure and exposure pathways
- Generally, less conservatism than hazard-based guidelines
- Considerations for site-specific conditions



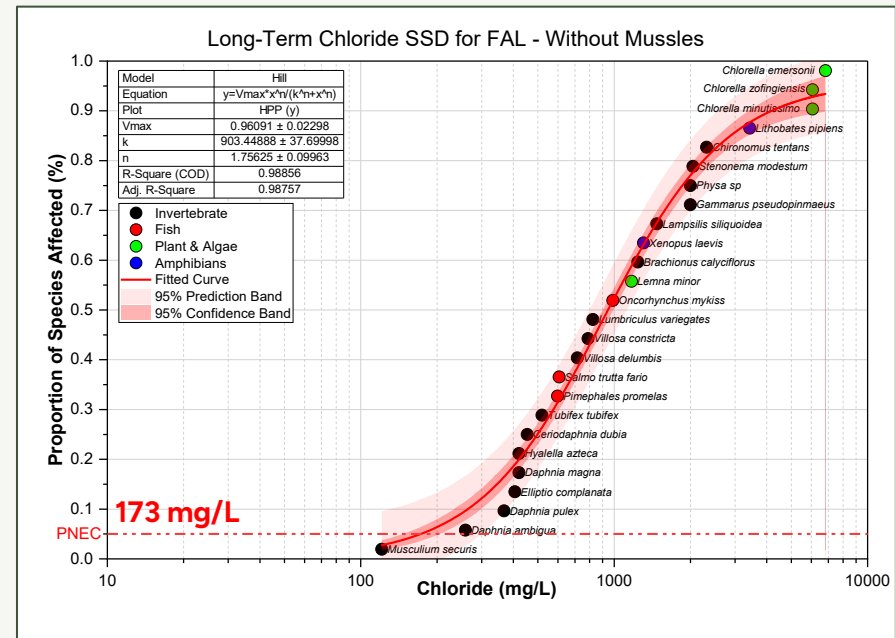
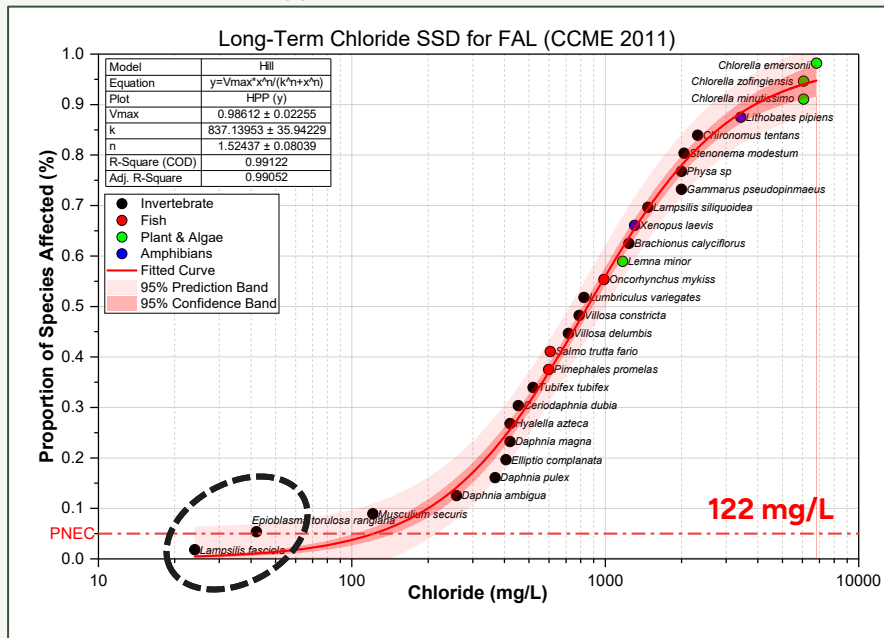
Groundwater Chloride Guideline Discussion





Aquatic Life Chloride Guidelines

- Updated in 2011 ([CCME 2011](#))
- A Type A Guideline, based on an SSD ([CCME 2007](#))
 - PNEC (HC₀₅)
- Consideration for TMFs
 - Equilibrium Environmental



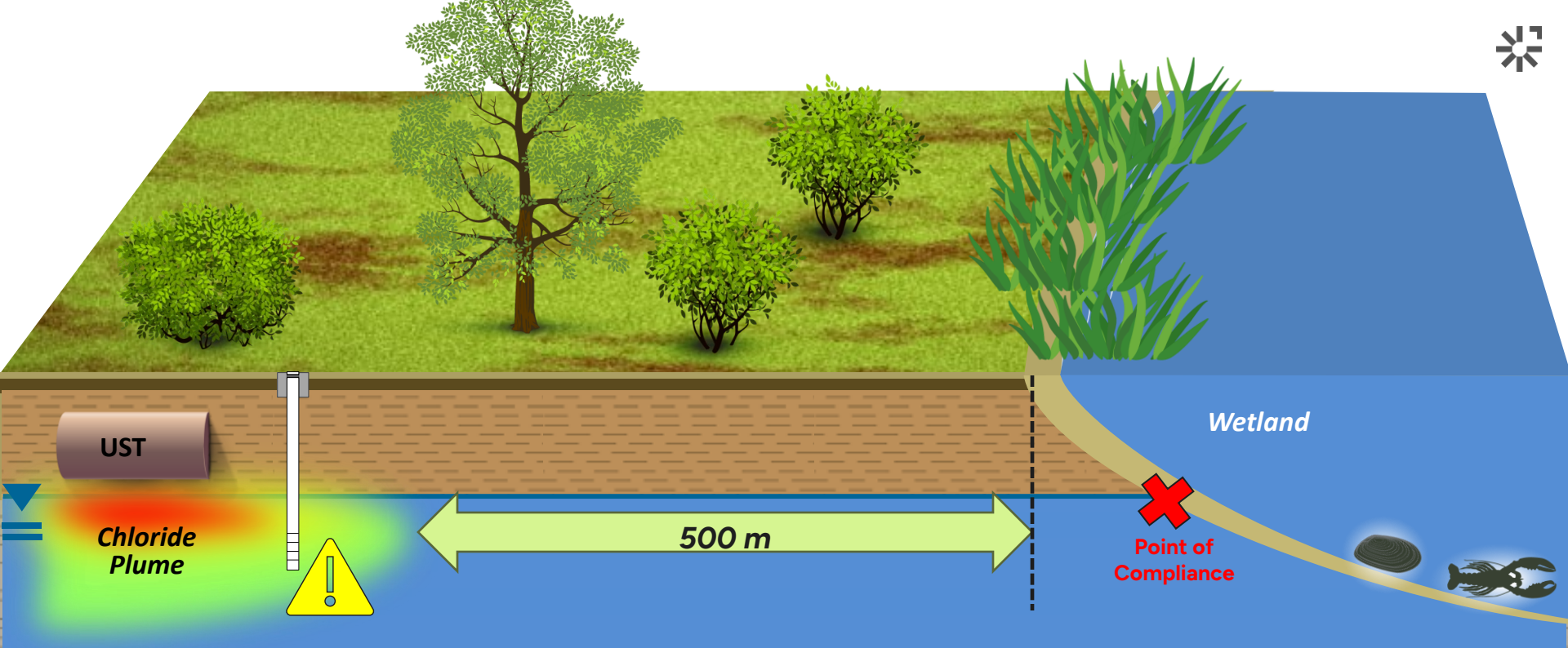


Are Chloride Guidelines Hazard-Based?

- Guidelines to protect aquatic life receptors are being applied to groundwater when there isn't necessarily an exposure pathway
 - Chloride as well as other chemicals/xenobiotics
 - Assumes exposure
 - *What is the probability?*



Must Have
Probability



Groundwater Velocity Calculated to be <0.1 m/year

Not to scale



Irrigation Watering Guidelines

- Guidelines are categorized based on crop types

Endpoint	Chloride Guideline	Crop
Foliar Damage	100 to 178 mg/L	Almonds, Apricots, Plums
Foliar Damage	178 to 355 mg/L	Grapes, Peppers, Potatoes, Tomatoes
Foliar Damage	355 to 710 mg/L	Alfalfa, Barley, Corn, Cucumbers
Foliar Damage	>710 mg/L	Cauliflower, Cotton, Safflower, Sesame, Sorghum, Sugar Beets, Sunflowers
Root Stocks	180 to 600 mg/L	Stone Fruit
Root Stocks	710 to 960 mg/L	Grapes
Cultivars	110 to 180 mg/L	Strawberries
Cultivars	230 to 460 mg/L	Grapes
Cultivars	250 mg/L	Boysenberries, Blackberries, Raspberries



Origin of Chloride Irrigation Watering Guidelines

Chloride irrigation guidelines are based on CCREM 1987
Quote from CCME 1993



“Since the publication of Canadian Water Quality Guidelines (CCREM 1987) by the Canadian Council of Resource and Environment Ministers (now the Canadian Council of Ministers of the Environment [CCME]), **a number of concerns have been raised regarding the approach used to derive guidelines for irrigation**”. (CCME 1993, p. 3)



Should Probability be Considered for Irrigation?

- Is it feasible to irrigate from a shallow aquifer?
 - If there isn't insufficient yield to support a PWA, can the aquifer actually be used for irrigation?
- What areas of the Prairie Provinces irrigate from aquifers?
- Considerations for the construction of a dugout
 - Surface water dilution



Image Reference: [Linked Here](#)



Opportunities to Incorporate Risk into Tier 1 Chloride Guidelines





Considerations for Incorporating Risk into Guidelines

- Fit for Purpose
 - Tier 1 Endpoints
 - Delineation
- Still must have the ability to develop Tier 2 and Tier 3 Endpoints
- Tier 1 Endpoints inherently include conservative assumptions
 - “All Models are Wrong, Some Are Useful”
~George Box
- Considerations for:
 - Exposure
 - Probability
- PNG045 includes considerations

$$\text{Chloride}_{\text{soil}} = \text{Chloride}_{\text{Groundwater}} \left(K_d + \frac{\phi_w + \phi_a H'}{\rho_b} \right)$$

Where:

Chloride_{soil} = soil chloride concentration (mg/kg)

Chloride_{Groundwater} = groundwater chloride concentration (mg/L)

K_d = soil-water partition coefficient (litres per kilogram). Value is 0

ϕ_w = water-filled soil porosity ($L_{\text{water}}/L_{\text{soil}}$)

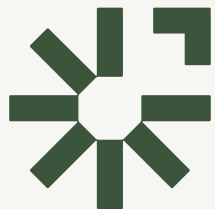
ϕ_a = air-filled soil porosity ($L_{\text{air}}/L_{\text{soil}}$)

H' = Henry's law constant. Value is 0

ρ_b = bulk density (grams per cubic centimetre [g/cm^3])



Questions/
Discussion



Making
Sustainability
Happen

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List of Acronyms

- HC_{05} – hazard concentration associated with a 5% adverse effect in an SSD
- HQ – Hazard quotient
- PNEC – predicted no effect concentration
- RQ – Risk quotient
- SSD – species sensitivity distribution
- TMF – toxicity modifying factor
- TRV – toxicological reference value



References

- Canadian Council of Ministers of the Environment. (1993). *Protocols for deriving water quality guidelines for the protection of agricultural water uses: Irrigation and livestock water*. CCME. <https://ccme.ca/en/res/protocols-for-deriving-water-quality-guidelines-for-the-protection-of-agricultural-water-uses-irrigation-and-livestock-water-en.pdf>
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