

Derivation of Exposure Based Release Limits For Effluents

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Introduction

Approach for considering environmental effects in setting effluent release limits

- Exposure Based Release Limits (EBRLs)
- Useful for planning purposes
- Process:
 - Define environment and levels of protection
 - Predictive model used to estimate water and sediment quality and environmental fate
 - Back-calculate effluent quality



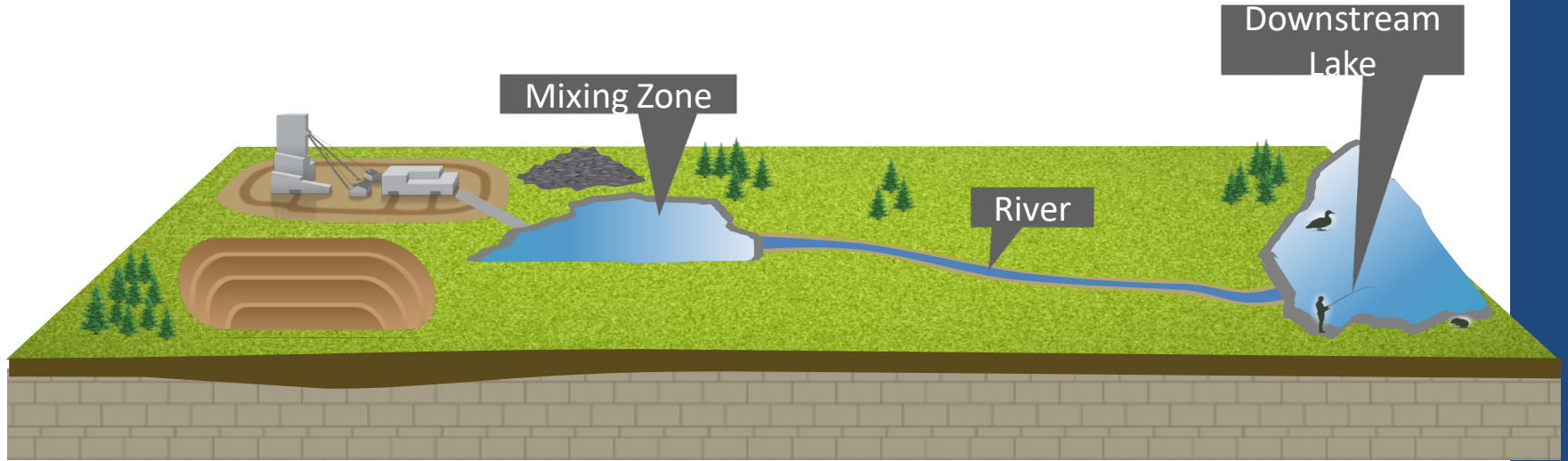
Conceptual Site Model (CSM)

First step:

- Characterize the receiving environment
- Constituents of interest
- Define receptors (aquatic, terrestrial)



Hypothetical Site



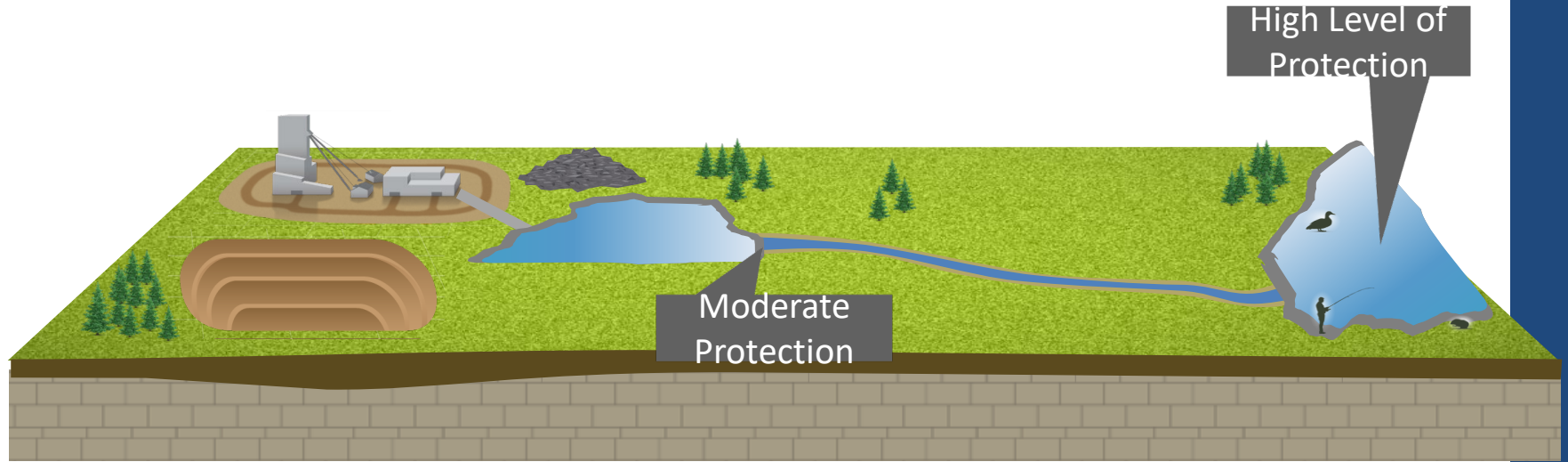
Key Considerations

1. Receptors, Locations and Endpoints

- Regulatory compliance
- Various receptors - trophic levels and dietary niches
- Different levels of protection at points in the environment



Hypothetical Site



Levels of Protection - Example

- Aquatic receptors and Species Sensitivity Distributions (SSDs)
 - Distributions of toxicity values for multiple species
 - CCME uses SSDs to set water quality guidelines
 - Chloride
 - 5% protection level
 - 120 mg/L = CWQG

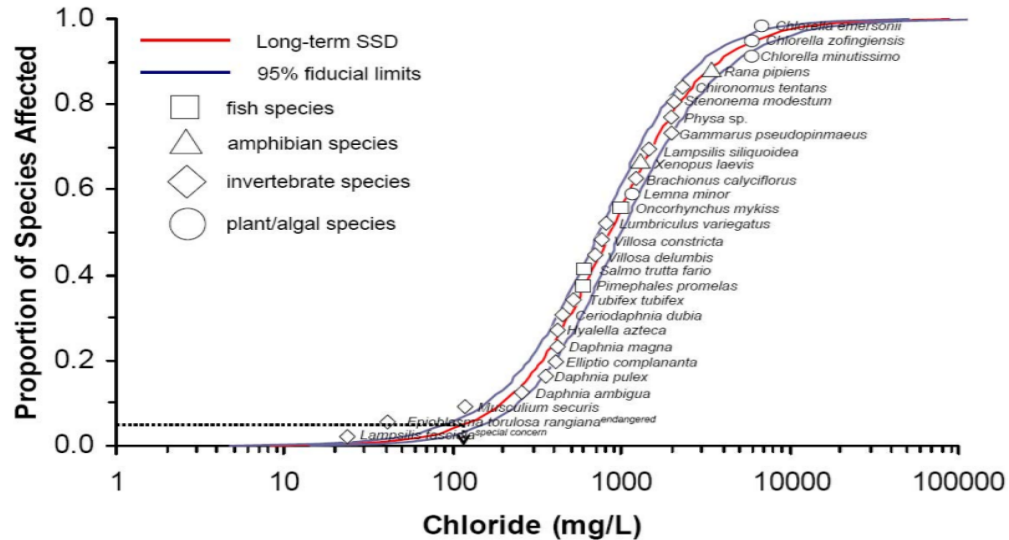
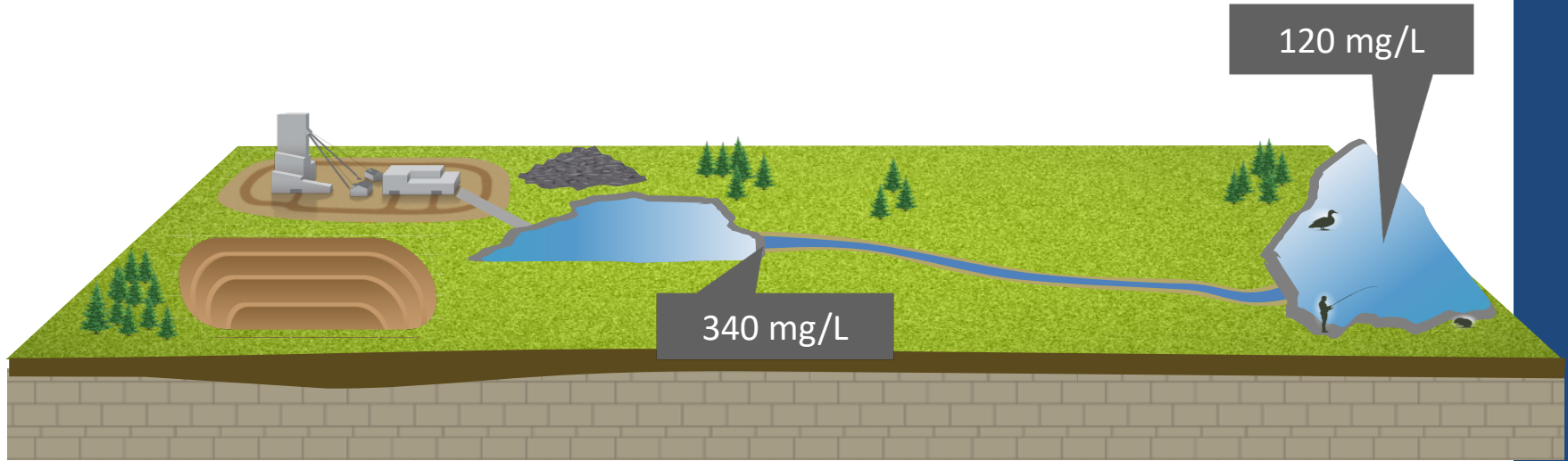


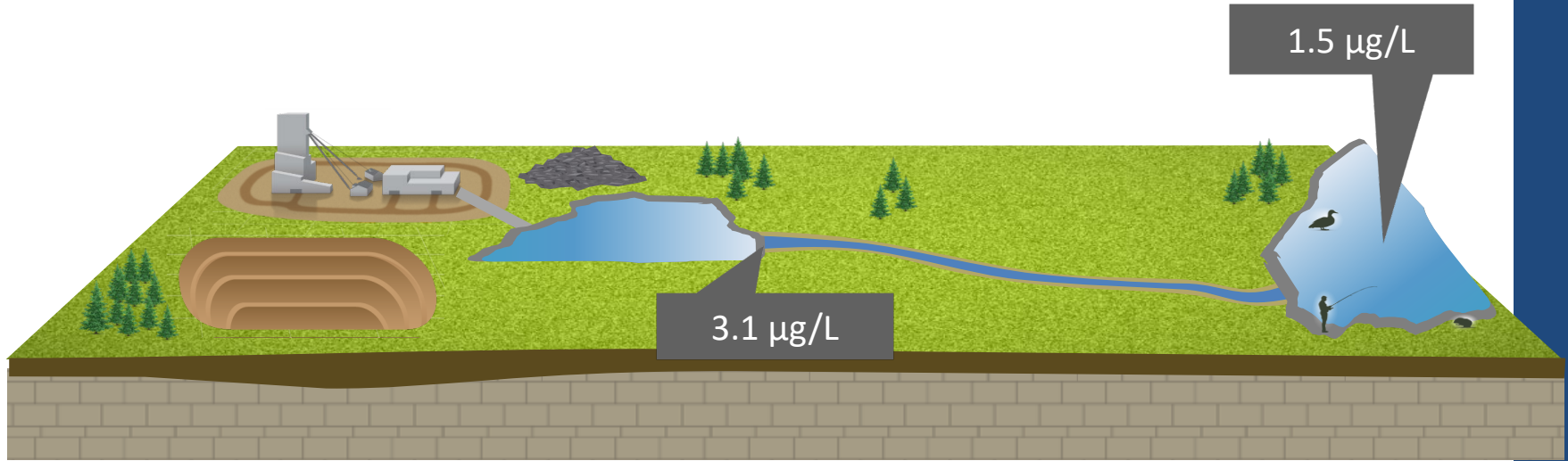
Figure 2. SSD of long-term no- and low-effect endpoint toxicity data for the chloride ion in freshwater (where mussels are present) derived by fitting the Logistic model to the logarithm of acceptable data for 28 aquatic species versus Hazen plotting position (proportion of species affected). The arrow at the bottom of the graph denotes the 5th percentile and the corresponding long-term Canadian Water Quality Guideline value.



Example - Chloride



Example - Selenium

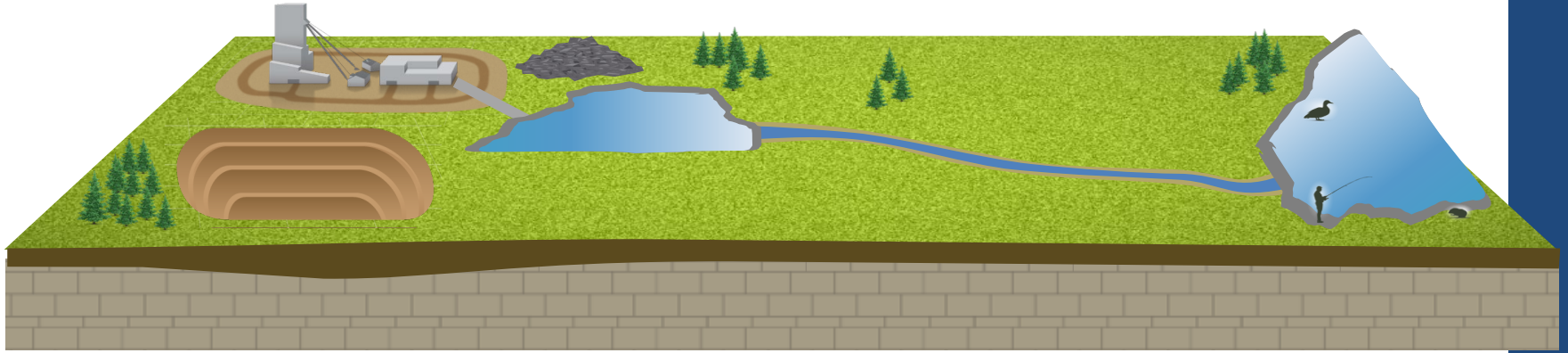


Protection of aquatic biota:

- River – 3.1 µg/L US EPA for lotic
- Lake – 1.5 µg/L US EPA for lentic



Others



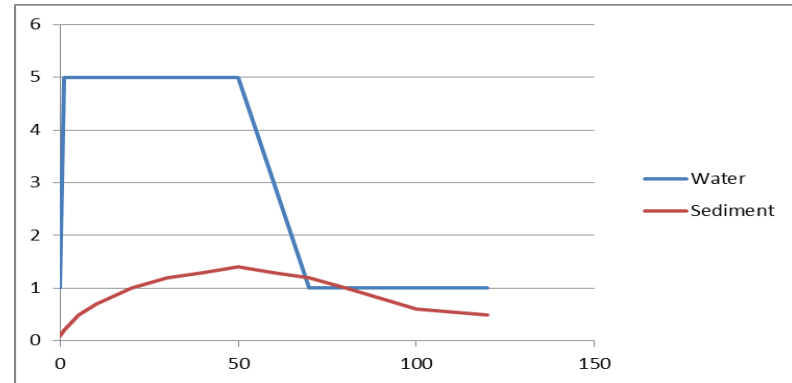
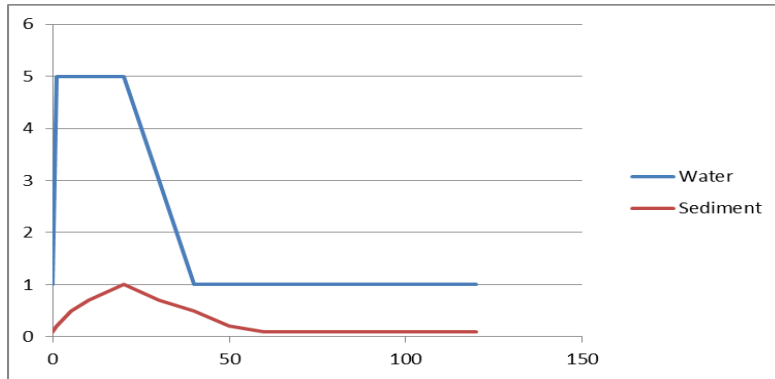
- Wildlife (species at risk?)
- Human health (use can vary widely depending on downstream land use and contaminants)



Considerations

2. Timeframe and Duration

- Current, Future, Post-Closure
- Influence of historical releases



Considerations

3. Confidence

- Upper bound
- Expected value

4. Averaging Time

- Short-term exposure
- Monthly composite

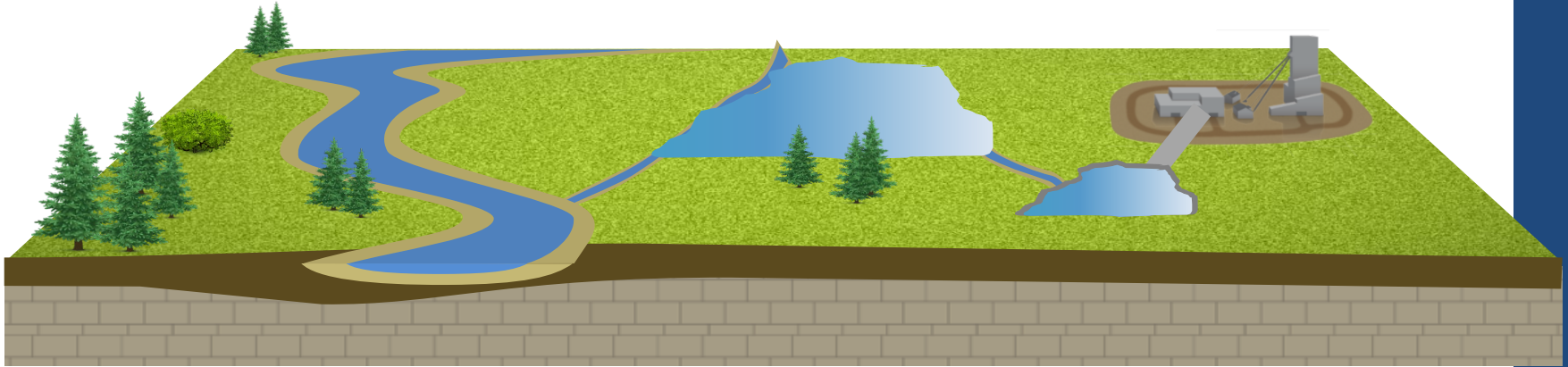


Stakeholder Consultation

- Stakeholders such as:
 - Regulatory agencies
 - Indigenous groups
 - Local populations and land users
 - Operator (corporate objectives and liabilities)
- Consult on:
 - Land use
 - Confidence
 - Levels of protection at different locations



Stakeholder Consultation



Example

- Chloride and Selenium at the Hypothetical Site we have been discussing
- Already discussed locations and endpoints
- Next: Predictive modelling.



Predictive Modelling: Contaminant Dispersion



- Constituent loads from external sources as an input
 - Seepage/groundwater loads from waste rock/tailings/etc.
 - Effluent discharge



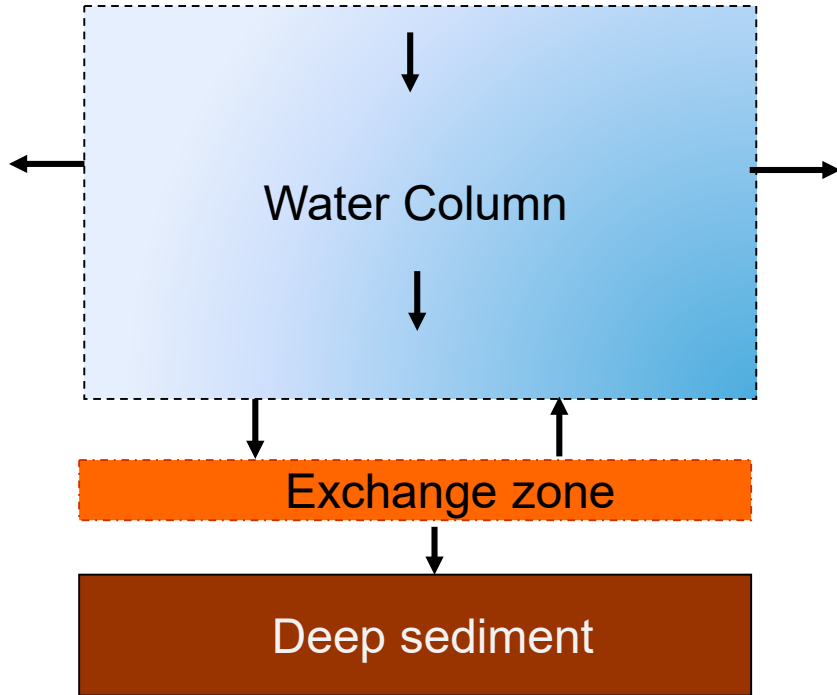
Predictive Modelling: Contaminant Dispersion



- Horizontal Transport Processes
 - Movement through watershed systems
 - Dispersive transport within large waterbodies



Predictive Modelling: Contaminant Dispersion



- Vertical Transport Processes

Processes in water column

- Settling

Processes in water & sediment

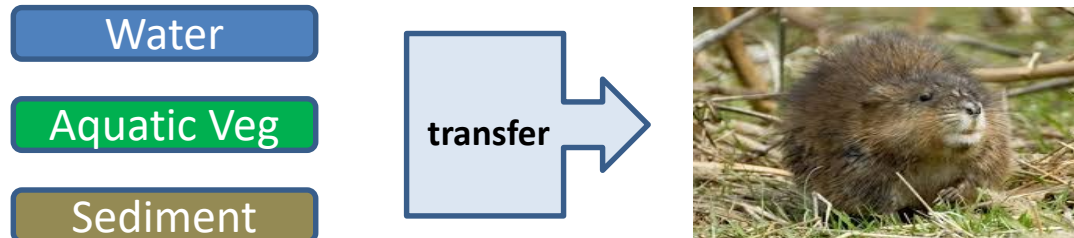
- Diffusive transport
(water column / sediment pore water)
- Kinetics of transformation
(formation / decay)

Processes in sediment

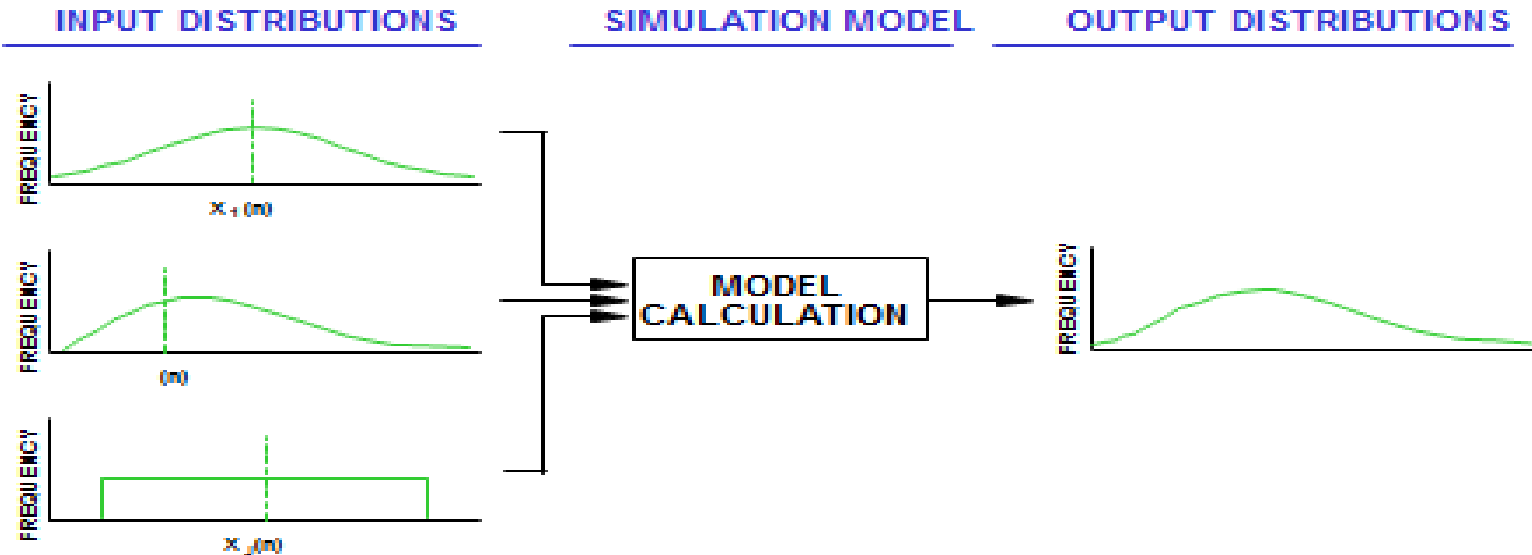
- Adsorption
- Dissolution / precipitation
- Burial

Predictive Modelling: Pathways

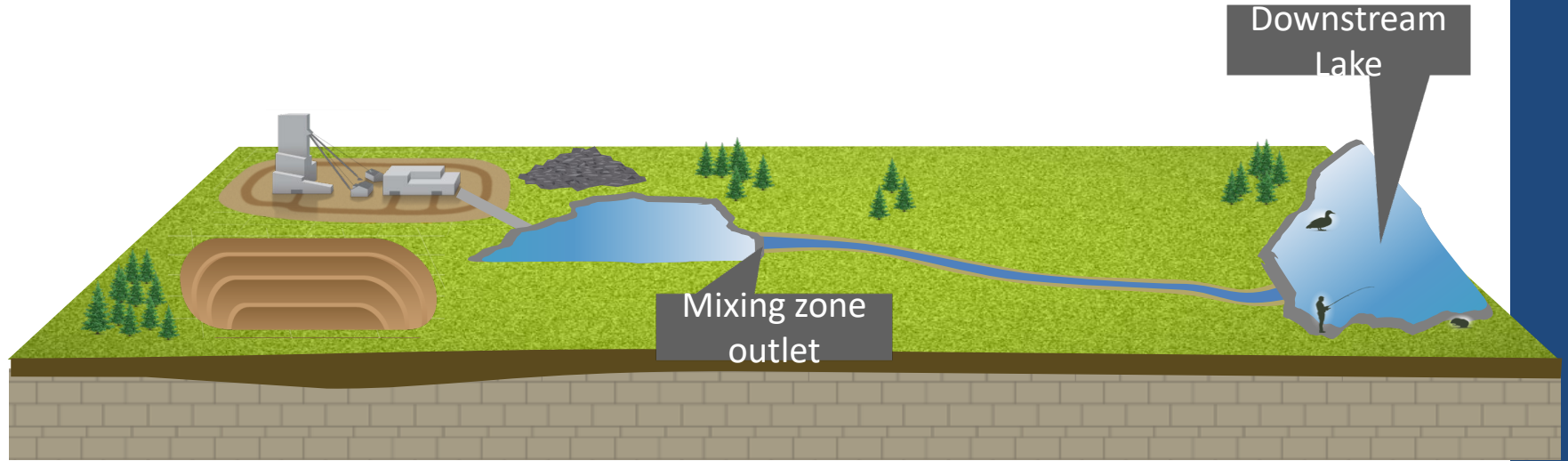
- Aquatic environment
 - Transfer to fish, aquatic vegetation, benthic invertebrates, etc.
- Terrestrial environment
 - Food chain transfer to ecological receptors of various trophic levels



Uncertainty - distributions

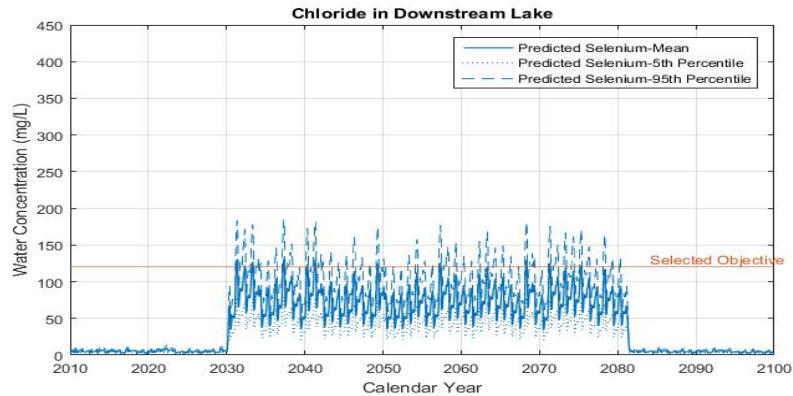
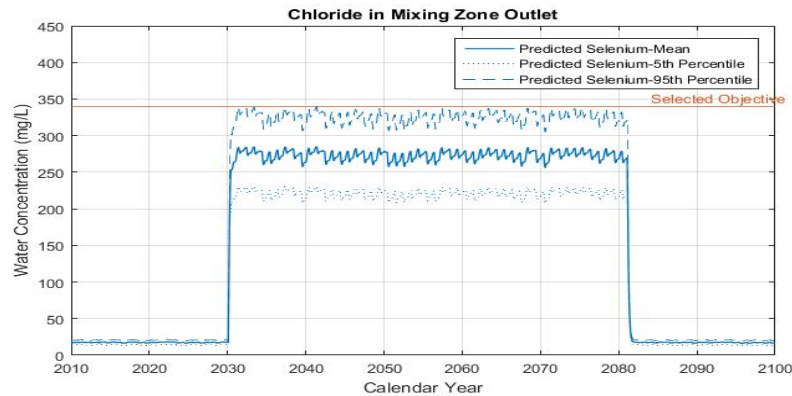


Hypothetical Site



Predicted Concentrations – Chloride

Meets Mixing Zone Outlet Constraint



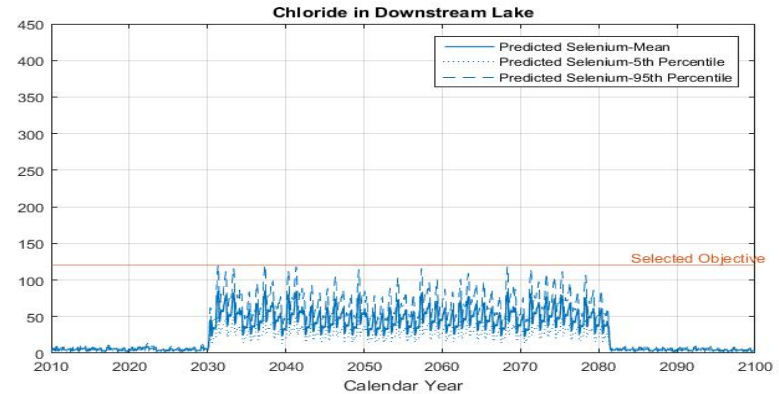
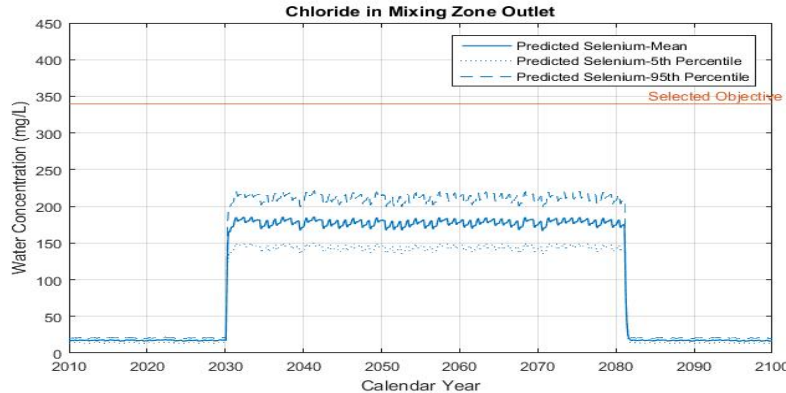
Corresponding Chloride Load: 10,050 kg/d

- 570 kg/d from Open Pit seepage
- 9,480 kg/d from operations



Predicted Concentrations – Chloride

Meets Downstream Lake Constraint



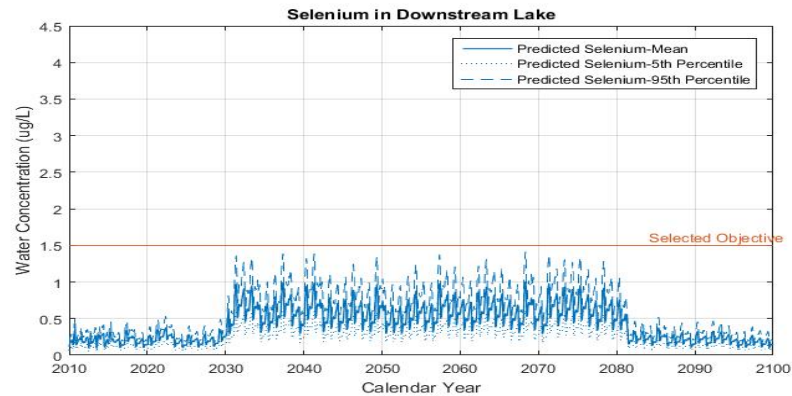
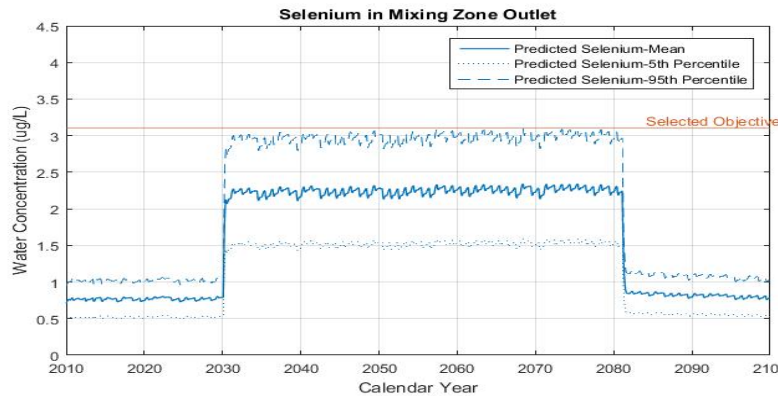
Corresponding Chloride Load: 6,540 kg/d

- 570 kg/d from Open Pit seepage
- 5,970 kg/d from operations



Predicted Concentrations – Selenium

Meets Mixing Zone Outlet Constraint

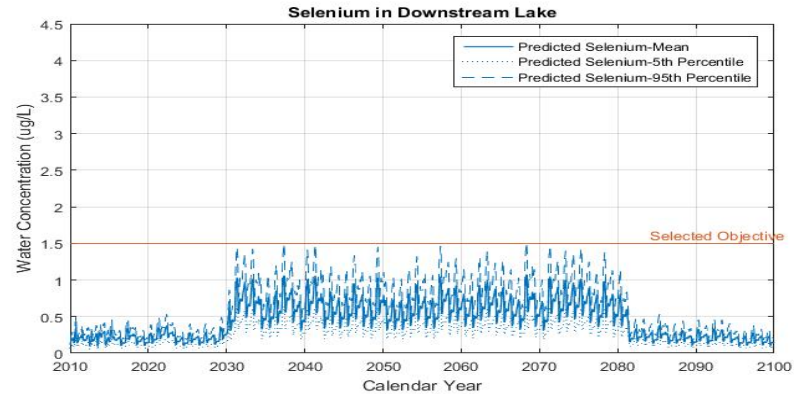
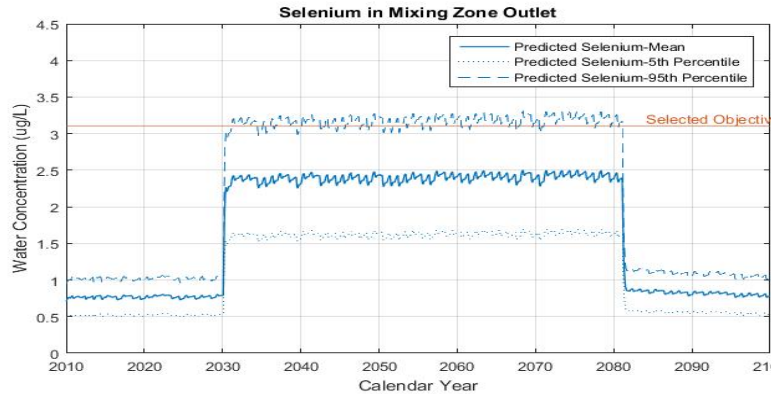


Corresponding Selenium Load: 97 g/d



Predicted Concentrations – Selenium

Meets Downstream Lake Constraint

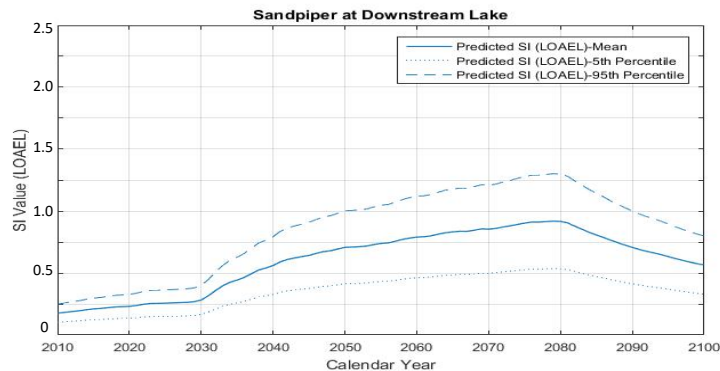
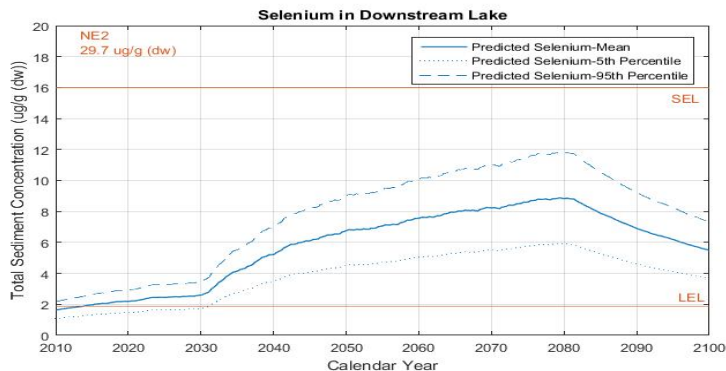


Corresponding Selenium Load: 104 g/d



Predicted Concentrations – Selenium Other Components

Meets Downstream Lake Constraint



Selenium at 97 g/d

Example

- Sensitivity to different factors
 - Receptors and endpoints
 - Duration of effluent releases
 - Characterisation of other potential load contributions
- Requires a predictive model
 - Site-specific
 - Use current and historical (if/when available) environmental concentrations
 - Understanding of other loads (historical, other sources/operations)



Use

- By the facility operator for planning purposes in the determination of Effluent Quality Criteria
 - Other considerations:
 - regulatory limits
 - technology-based release limits
 - pollution prevention
 - cost-benefit analysis
- Trigger level to initiate further action



Summary

- EBRL – Exposure Based Release Limit
- Can be useful for operators
 - Used for planning - target treatment levels, trigger levels for further action, regulatory compliance
- Requires
 - Understanding of receiving environment
 - Appropriate receptors and endpoints - consultation
 - Predictive modelling





Questions?