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Applied Research for Simple Solutions to Environmental Liability Management

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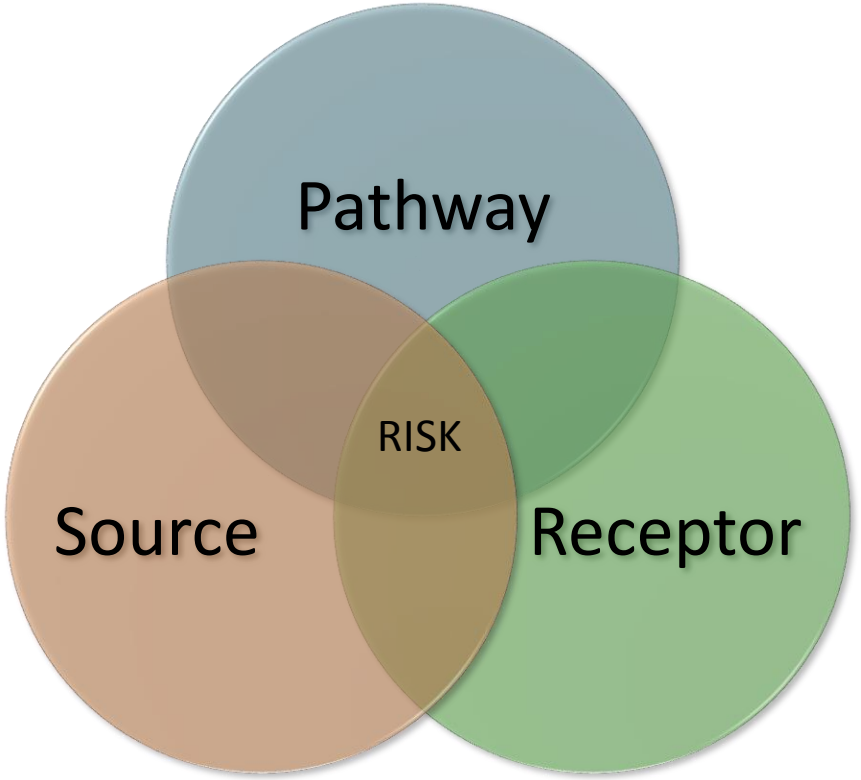
What is Risk?



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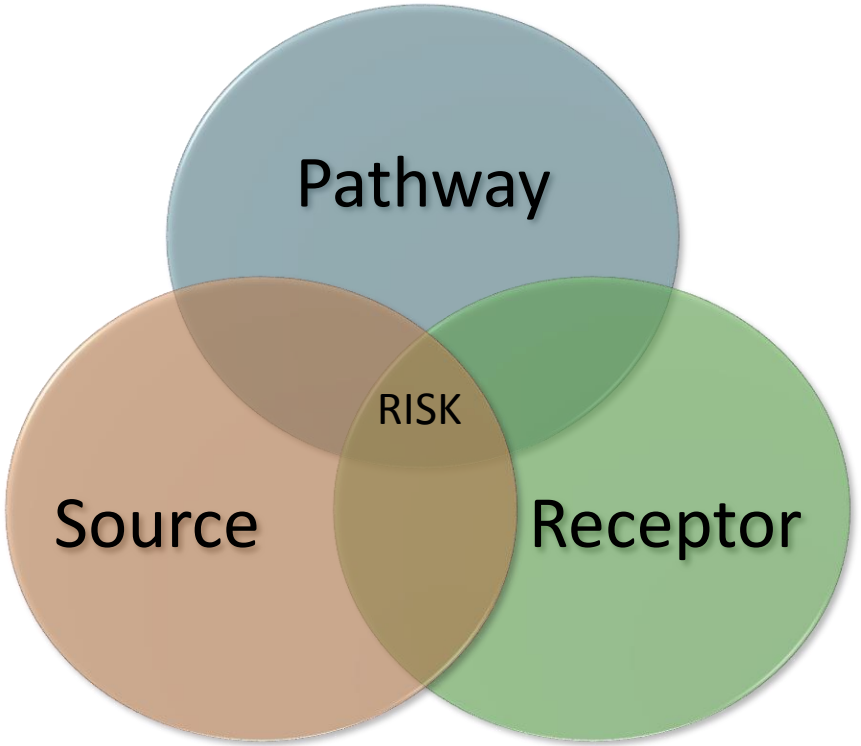
When is there no Risk?



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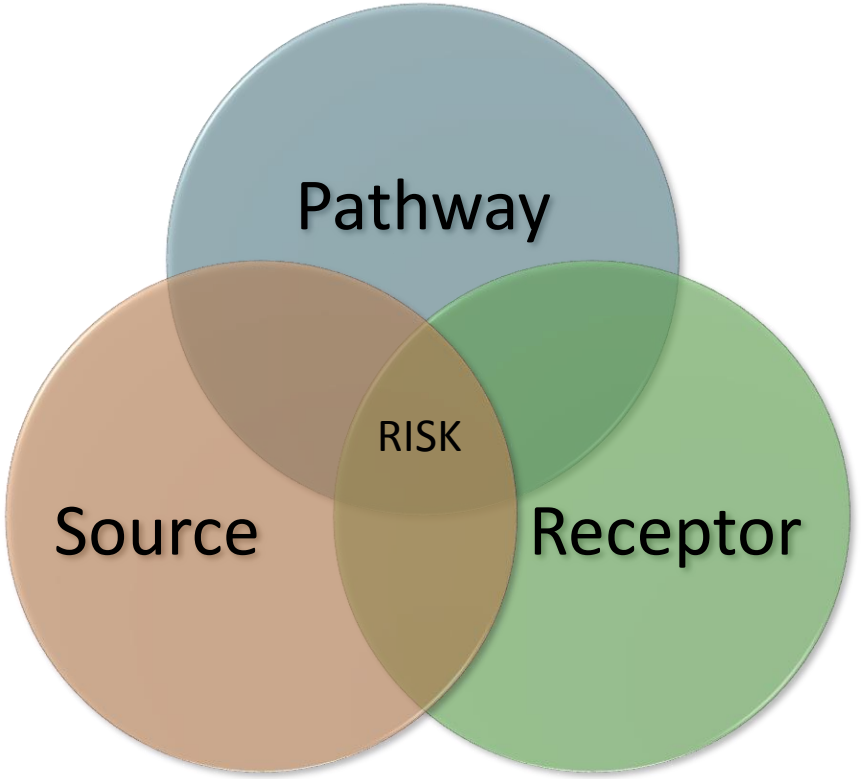
Where do our Projects Fit?



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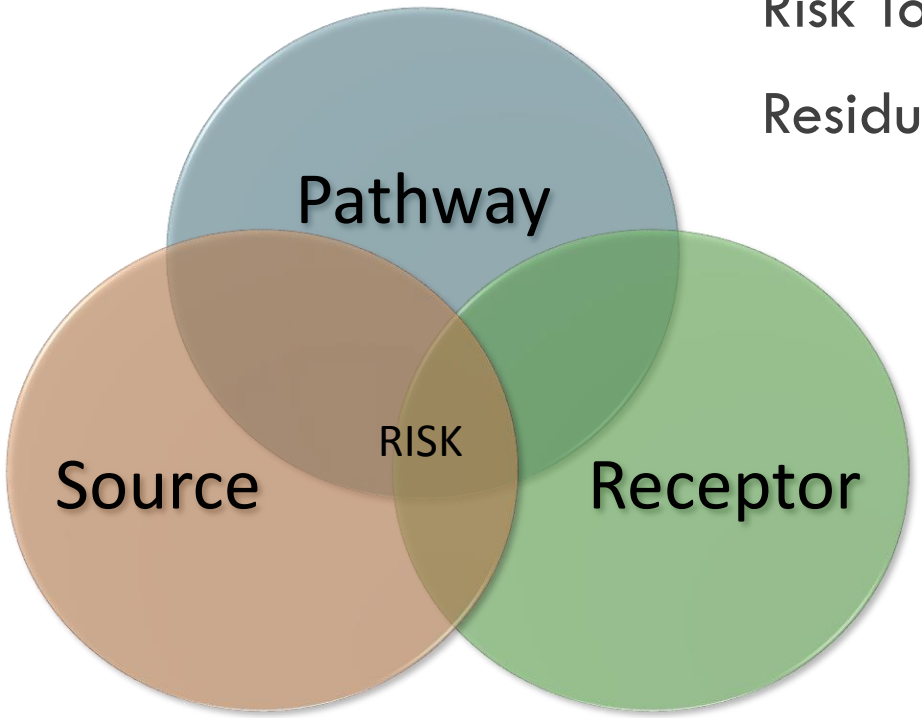
Exposure Pathway



Risk Tools

Residual Mass

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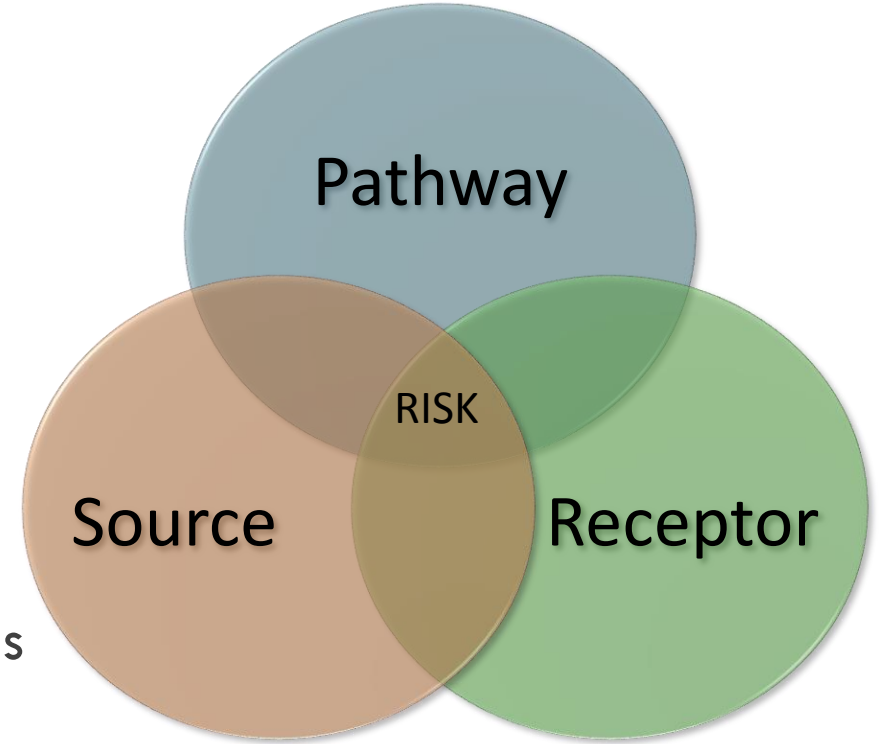
Source



Groundwater Metals

Regional Salinity Background

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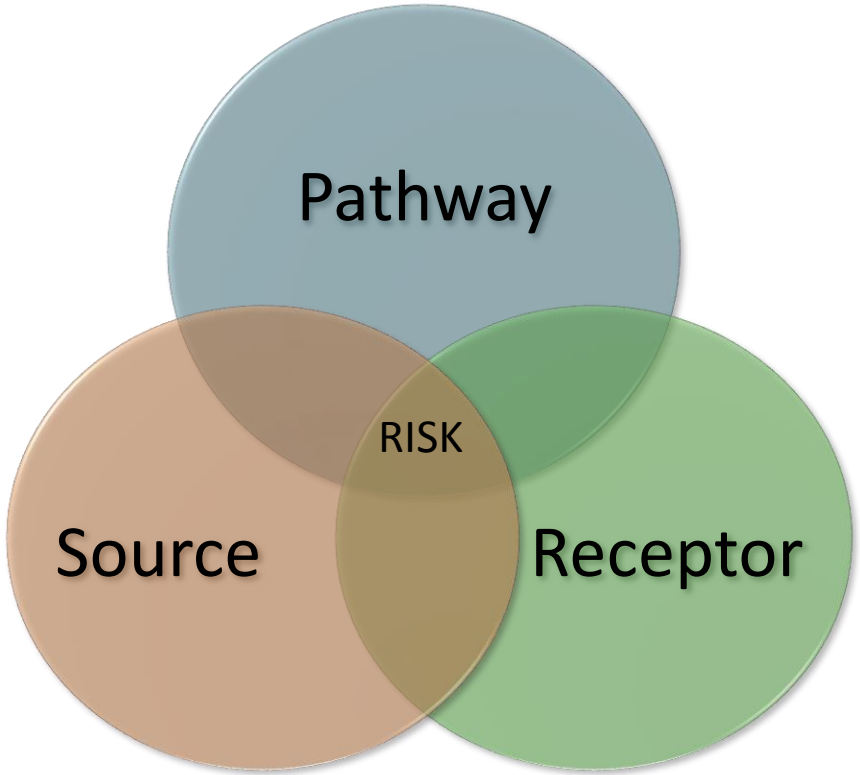
Receptor



LPR

F2/F3

NPP

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Risk Tools

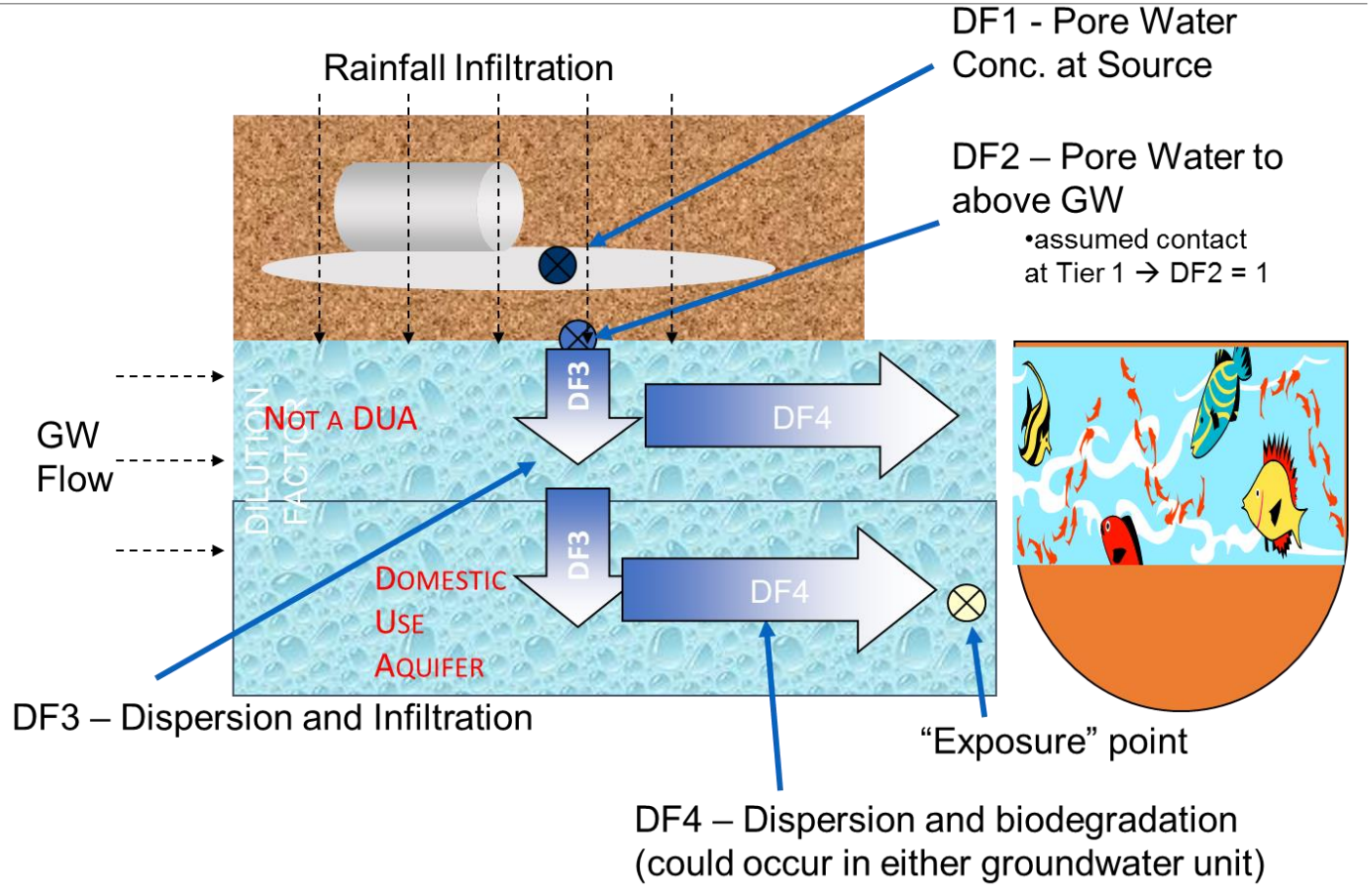
Simple sites need simple, inexpensive solutions

- Methods documented in Tier 2 guidelines aren't always the right tools
- Other simple tools have been developed, used successfully
- Project goal: document some of these tools and get formal regulatory endorsement

Risk Tools: Multi-layer groundwater model

Extension of existing Tier 2 groundwater model

- Based on shallow groundwater not being a DUA
- Vertical transport in the saturated zone



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Risk Tools

- Screening-level model for inorganics
  - Needs to consider background concentrations
- Hydrus 1D vertical transport
  - Direction of unsaturated zone movement
- Transport properties for peat

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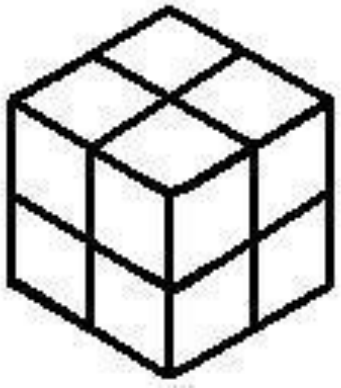
Residual Mass Model Guidance

Large, complex plumes

- Guideline-based approaches can greatly over-estimate remedial volumes
  - Assume “blocks” of constant concentration
- Numerical modelling can better estimate remediation required to protect receptors
  - Use actual contaminant distribution
- May be the only realistic approach for very complex sites

What if my plume doesn’t look like this…



…but looks more like this?

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The Regulatory Challenge

How to review SSRAs based on residual mass modelling approaches?

- Not realistic to build another model to check
- Need to identify key elements in the approach that are sufficient to ensure success

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The Project

Develop guidance for residual mass-based SSRA

- Outcome-based guidance
- Focused on:
  - Key elements that need to be demonstrated
  - What is required to successfully achieve those elements
  - Examples of acceptable and non-acceptable elements
- Provides a path for regulatory review and acceptance

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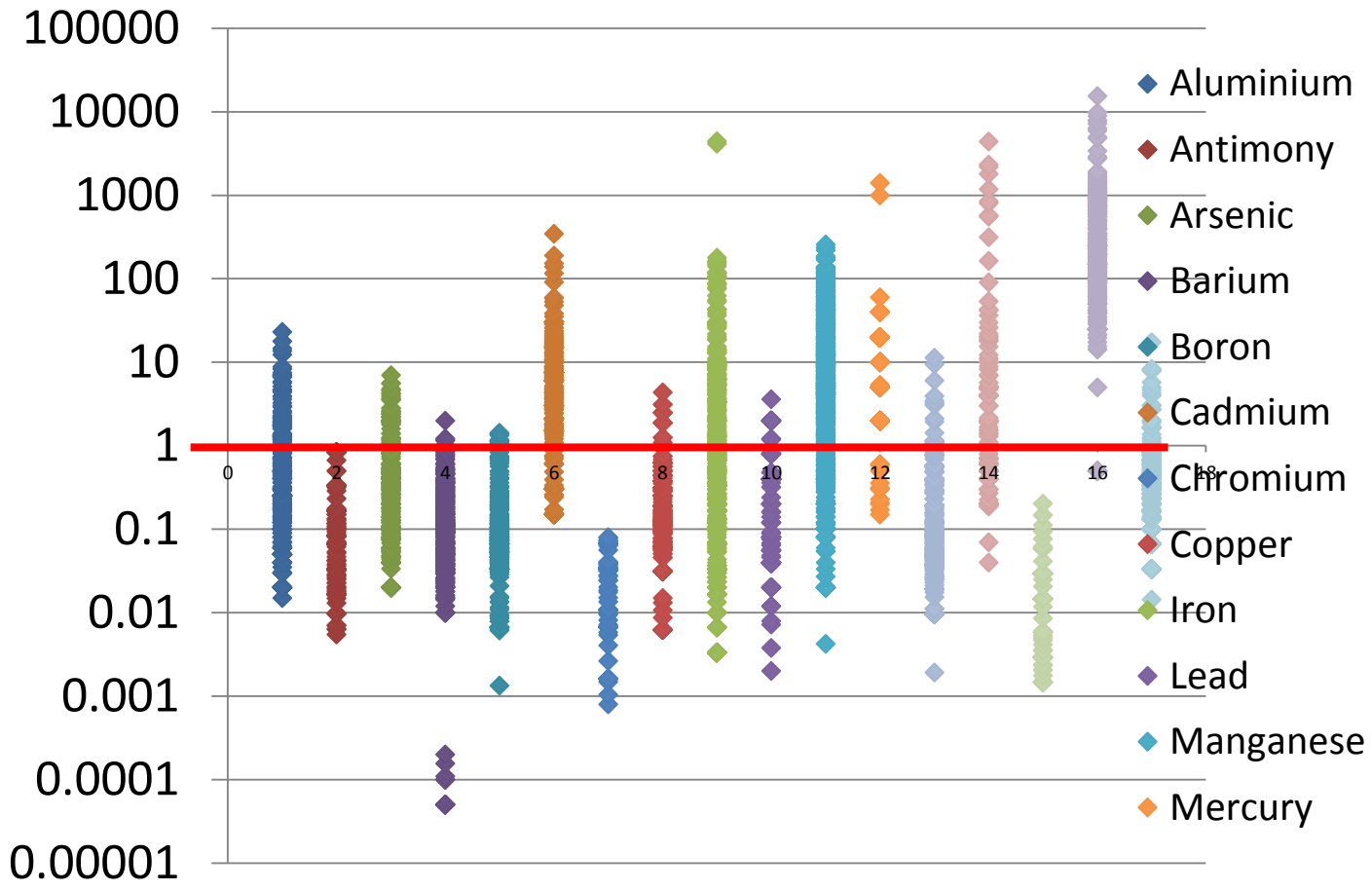
Groundwater Metals

Background metals in groundwater frequently above background

How do we determine which could be related to upstream activities?



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Considerations

Drilling mud components

Formation waters/produced water

Anaerobic biodegradation

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Tier 1 Metals Potentially Associated with Wellsites

Metal	Drilling Fluid?	Produced Water?	Hydrocarbon Degradation?
Arsenic		✓	
Barium	✓		
Boron	✓	✓	
Chromium	✓		
Copper	✓		
Iron			✓
Manganese			✓
Nickel	✓		
Selenium	✓	✓	
Zinc	✓		

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Tier 1 Groundwater Metals Likely Not Associated with Wellsites

Metal	Rationale
Aluminium	Mercury
Antimony	Silver
Cadmium	Uranium
Lead	

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Regional Background Soil Quality Assessment

1. Define a consistent procedure for assessing regional background salinity;
2. Share data between nearby sites; and,
3. Reduce assessment and remediation costs, and unnecessary remediation.

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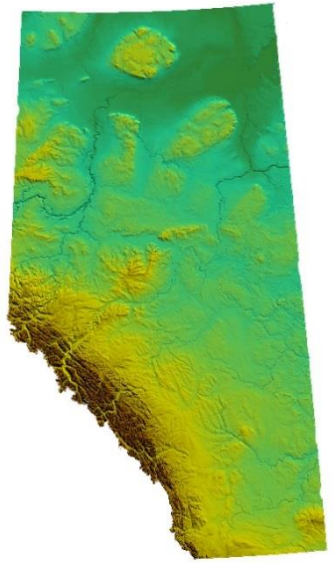
Defining Study Area

Determining where background samples will be collected to ensure that concentrations can be meaningfully compared between background sampling locations and investigation sites.

Information requirements:

- Sampling location;
- Anthropogenic inputs and activities;
- Parent material;
- Climate;
- Groundwater; and
- Slope positon.



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Background Sampling Program

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F2/F3 Management Limits

- Existing management limits developed as part of PHC Canada-wide Standard
  - Based on limited existing information
- Updated limits available for green area
- Some of the same considerations apply in other areas
- Project goal: re-examine F2 and F3 management limits based on updated science

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F2/F3 Management Limits

- Current key limitations:
  - Vapour intrusion in trenches – underlying science is limited
  - Effects on buried infrastructure – not readily quantified

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Low Probability Receptor

- Underlying concepts:
  - Remediation in the absence of an adverse effect has a net negative environmental effect
  - Some receptors considered in guidelines have an extremely low likelihood of occurring before impacts attenuate
  - If remediation is based on the protection of these “low probability” receptors, high likelihood of net negative environmental outcome

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Low Probability Receptor

- Case studies: showed considerable reduction in remediation costs, improved net environmental benefit
- Key consideration: what if that low probability receptor does occur?

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Agronomic Receptor Evaluation

Applicability of the Ecological Direct Soil Contact pathway as it relates to agronomic receptor species for the White Area of Alberta.

Establish path toward a scientifically defensible depth at which the ecological direct soil contact pathway is applicable.

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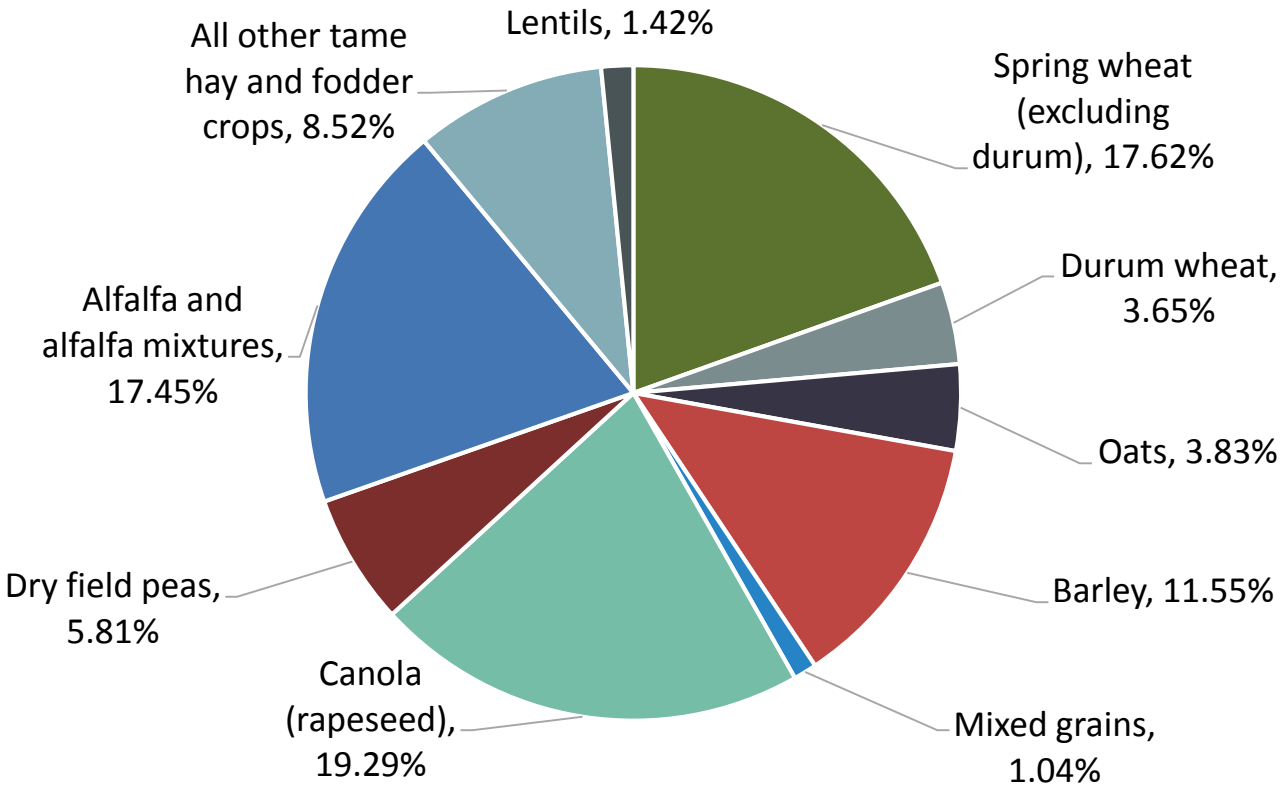
Crop Distribution in Alberta



Percentage of Total Agricultural Land used per Crop Species in Alberta Census Divisions in 2016 (20116 Statistics Canada Agriculture Census)

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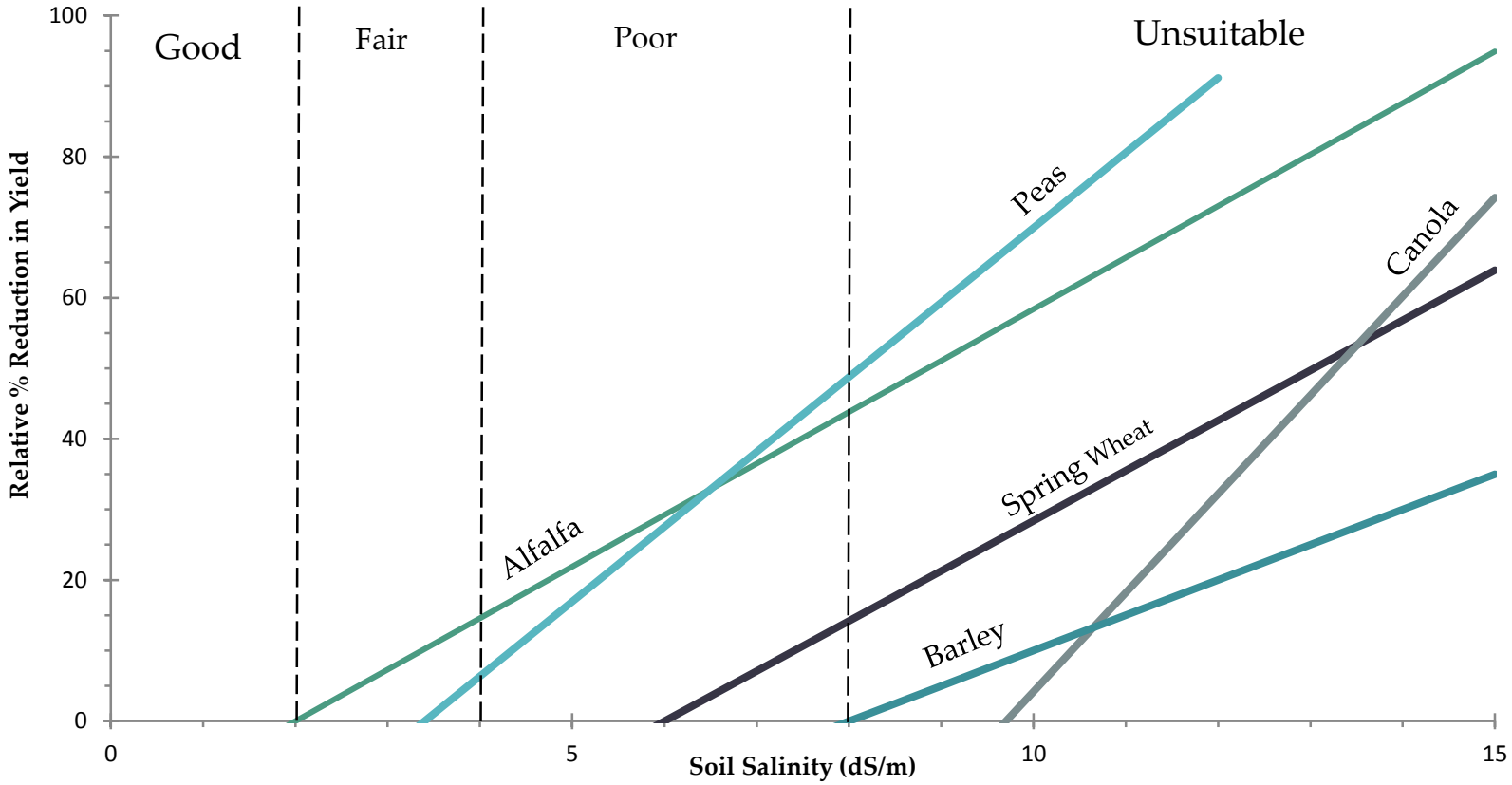
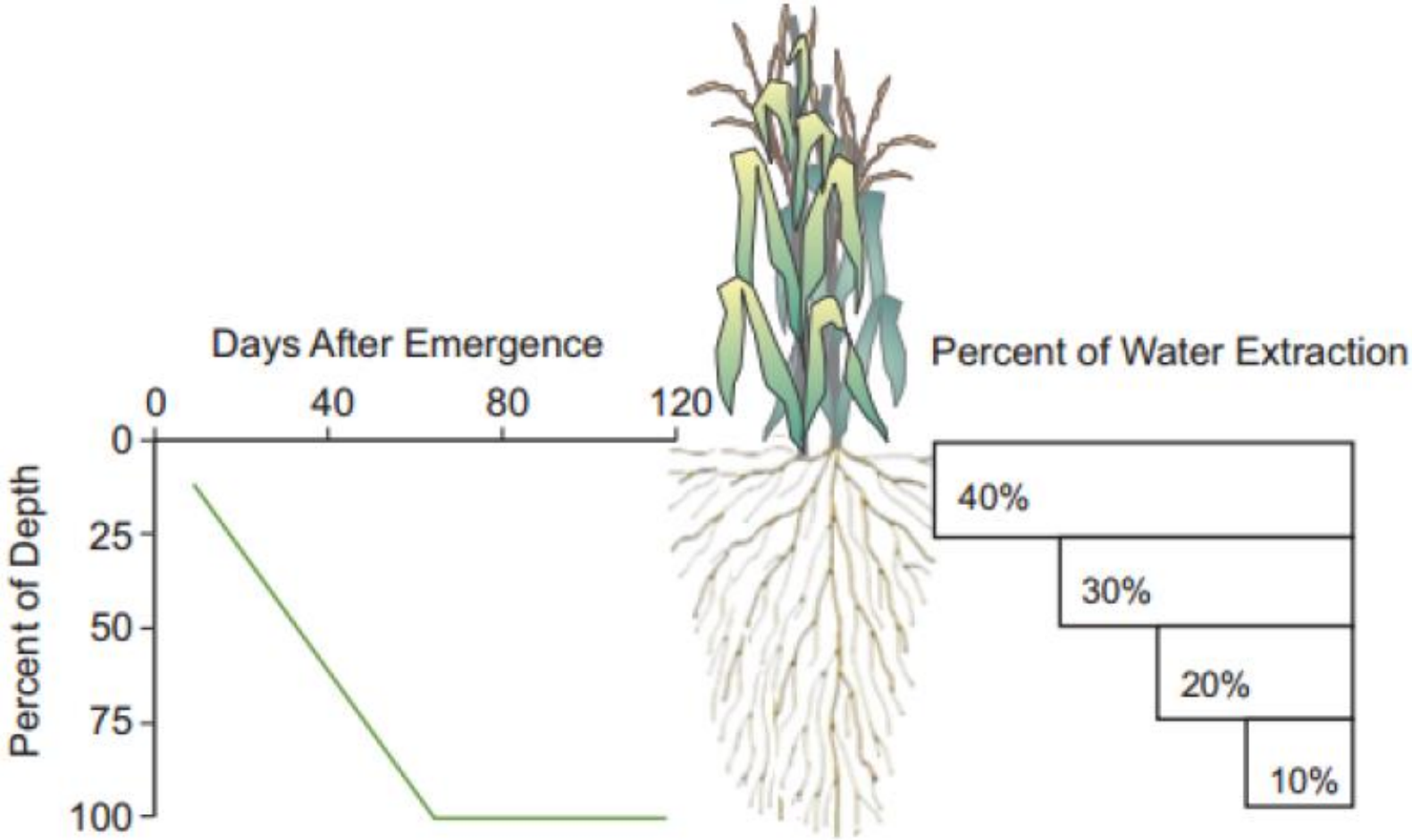
Validation



Crop sensitivity analysis for a select number of prevalent crop species in Alberta. The SCARG classification of soil suitability is represented by vertical dashed lines.

EcoContact and Effective Rooting Depth



From: Alberta Agriculture and Forestry (2016)

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Data Gaps

Knowledge Gaps	Further Work
Evidence from Alberta that microbial and invertebrate activity, exist within the rhizosphere to the depth dictated by plant rooting	Field study to define the biologically active zone
Validation of rooting depths for alfalfa in Alberta	Field study to acquire observational evidence
Effect salinity has on root structure and distribution for alfalfa	Lab/greenhouse study to the effect NaCl has on plant health (both above and below ground)

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Conclusions

New projects intended to expand the tools available for addressing environmental liability in Alberta

Consider all components of risk (source, receptor, exposure pathway)