A Review of Environmental Management Considerations for Firefighting Foams Containing Per- and Polyfluoroalkyl Substances

EnviroTech 2020
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global **environmental** and **advisory** solutions

SLR

Class B Foams

Major user groups:

- Municipal fire stations
- Flammable liquid storage and processing
- Oil refineries, terminals and bulk storage
- Airports and military installations

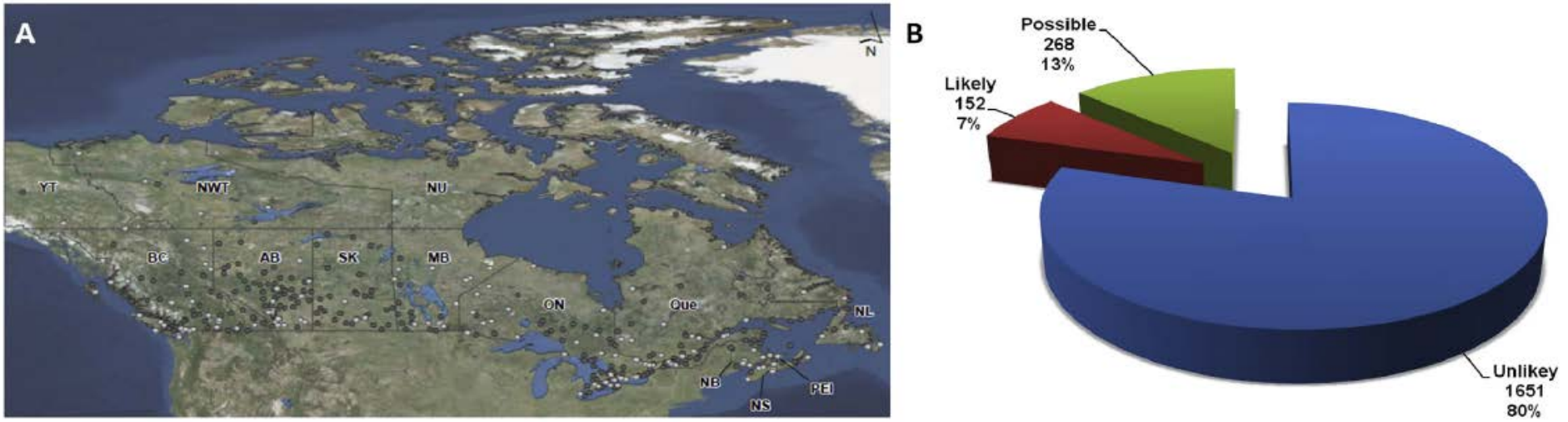


Fig. 3. (A) Map of Canada depicting airports locations likely contaminated with PFAS (light gray dots) and possibly contaminated with PFAS (dark gray dots). (B) Classification summary for potential PFAS contamination at Canadian airports.

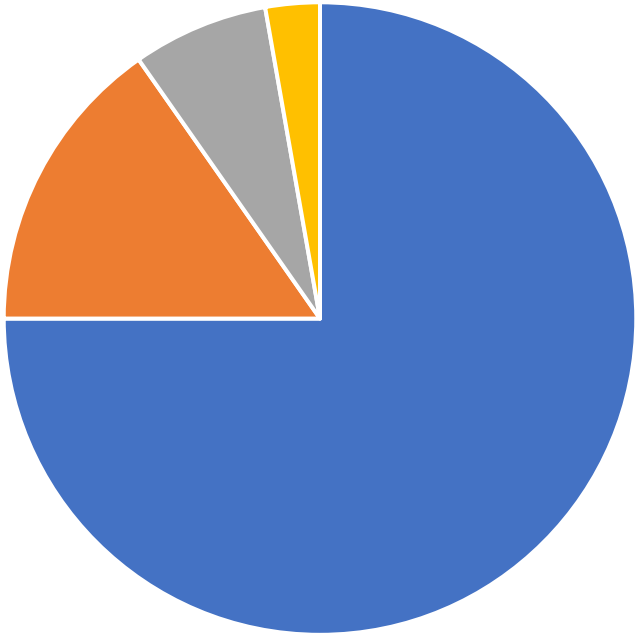
Class B Foams - Types

Fluorinated Foams (contain PFAS)	Fluorine-free Foams (no PFAS)
• **Aqueous film-forming foam (AFFF):** legacy PFOS AFFF, legacy flurotelomer AFFF, modern flurotelomer AFFF	• Protein foam
• Alcohol-resistant AFFF (AR-AFFF)	• Alcohol-resistant protein foam (AR-P)
• Film-forming fluoroprotein (FFFP)	• Synthetic fluorine-free foam (FFF)
• Alcohol-resistant film-form fluoroprotein foam (AR-FFFP)	• Synthetic alcohol-resistant fluorine-free foam (AR-FFF)
• Fluoroprotein foam (FP)	
• Alcohol-resistant fluoroprotein foam (FPAR)	

Source: ITRC, 2020. Aqueous Film-Forming Foam. April 2020.

Class B Foams – Composition

- **Solvents** (water, glycol ethers, alcohols, etc.) ~50-90%
- **Modifiers, stabilizers, additives** (e.g., salts, corrosion inhibitors, biocides, etc.) ~1-20%
- **Non-fluorinated surfactants** ~1%-20%
- **PFAS** ~1%-20%

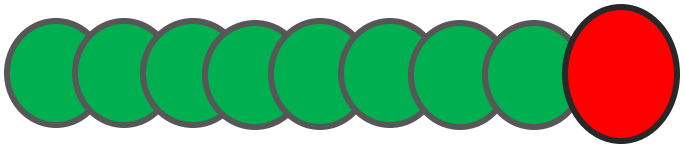


What are PFAS?

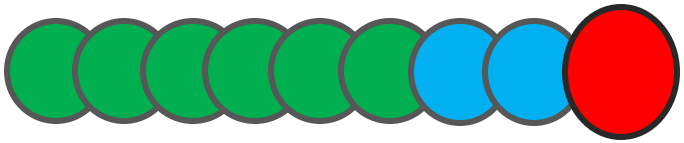
- Currently 4,700 man-made chemicals
- Contain one or more fully fluorinated alkyl moieties

$$(C_nF_{2n+1})$$

- **Per**fluoroalkyl = fully fluorinated carbon chain

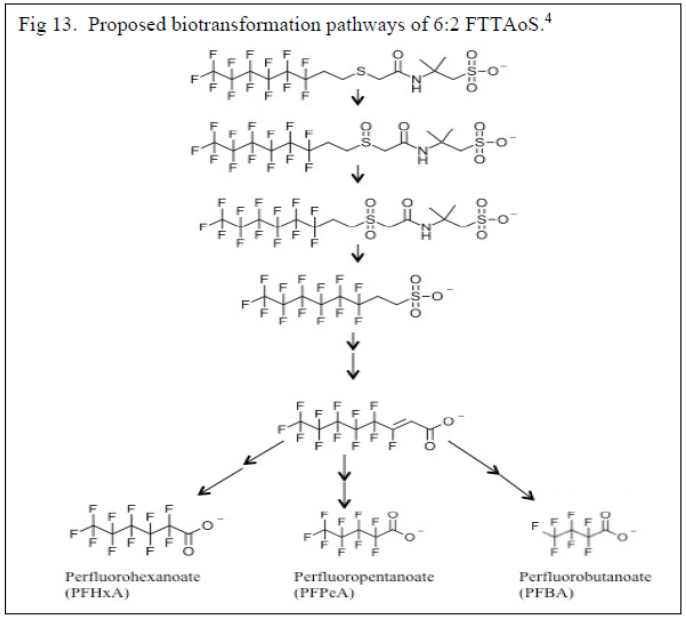


- **Poly**fluoroalkyl = partially fluorinated carbon chain



PFAS Precursors and Transformation Products

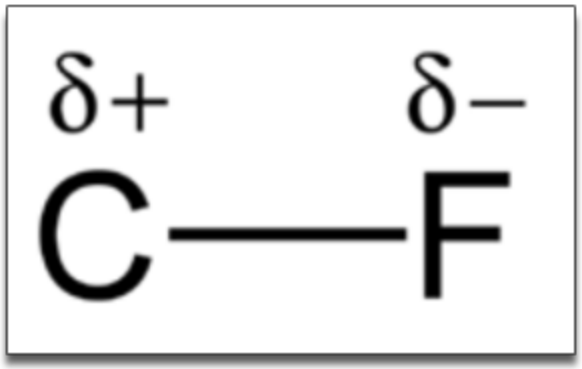
- Numerous classes of PFAS present in AFFF (anionic, cationic, zwitterionic surfactants)
- Precursors transform to terminal PFAS

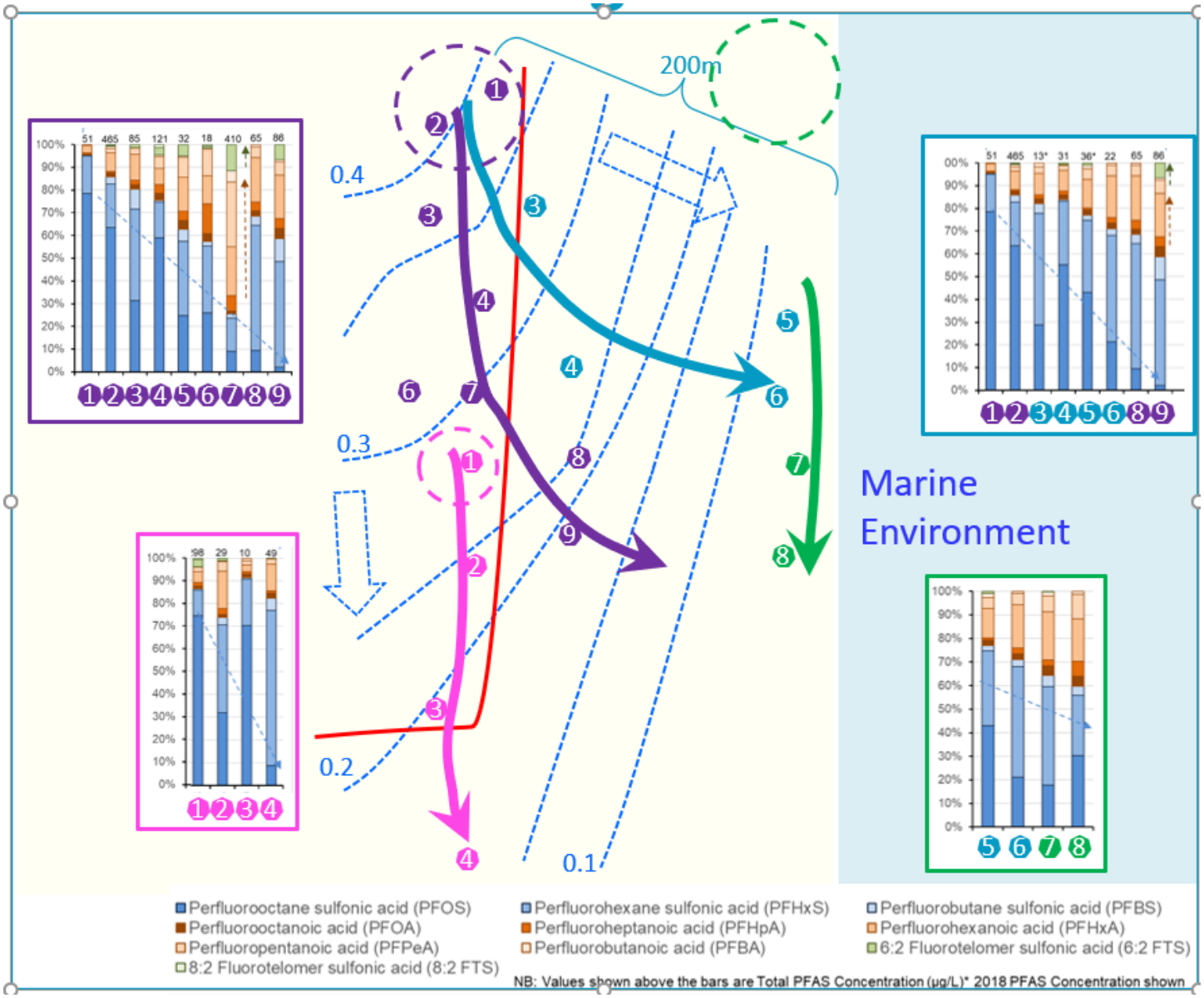


Field, J., D. Sedlak and L. Alvarez-Cohen, 2017. Final Report: Characterization of the Fate and Biotransformation of Fluorochemicals in AFFF-Contaminated Groundwater at Fire/Crash Testing Military Sites. SERDP Project ER-2128. April 2017.

PFAS concerns…

- **Persistent** – fully fluorinated part doesn't break down in nature
- **Bioaccumulative** – some PFAS accumulate in tissues of higher trophic level biota
- **Toxic** – known human and ecological health effects
- **Mobile** – contaminant plumes can be large




200m
0.4
0.3
0.2
0.1
Marine Environment
Perfluorooctane sulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluoropentanoic acid (PFPeA)
8:2 Fluorotelomer sulfonic acid (8:2 FTS)
Perfluorohexane sulfonic acid (PFHxS)
Perfluoroheptanoic acid (PFHpA)
Perfluorobutanoic acid (PFBA)
Perfluorobutane sulfonic acid (PFBS)
Perfluorohexanoic acid (PFHxA)
6:2 Fluorotelomer sulfonic acid (6:2 FTS)
NB: Values shown above the bars are Total PFAS Concentration (µg/L)* 2018 PFAS Concentration shown

Regulatory Considerations

International

- **Stockholm Convention on POPs (PFOS, PFOA) (PFHxS under review)**
- **Basel Convention requirements (PFOS in waste)**

Federal

- **CEPA listed toxic substances (PFOS, PFOA, LC-PFCAs)**
- CCME draft guidelines (soil and groundwater) for PFOS
- ECCC FEQGs (surface water and tissue) for PFOS
- HC MACs (PFOS, PFOA) and DWSVs (nine PFAS)

Western Canada

- British Columbia, CSR soil standards (PFBS and PFOS), and groundwater (PFOA and PFOS)
- Alberta, Expect Tier 1 guidelines to be updated after release of CCME PFOS guidelines.
- Saskatchewan and Manitoba: No updates, to apply CCME.

AFFF Management Considerations

- Develop a foam environmental management plan!

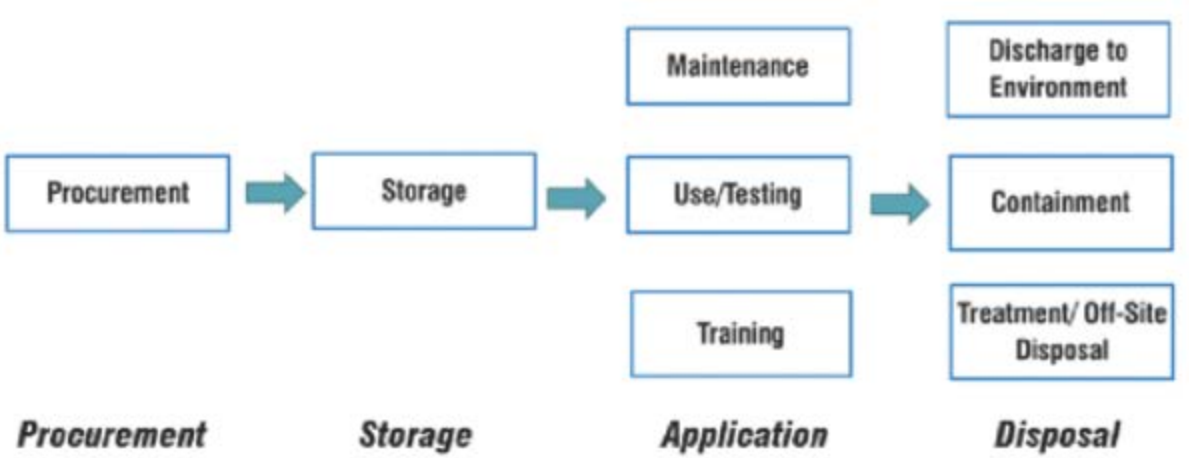


Figure 4-1. AFFF life cycle stages.

Source: Transportation Research Board. The National Academies of Science, Engineering & Medicine. 2017. Use and Potential Impacts of AFFF Containing PFASs at Airports. Research Report 173.

Procurement

- Protection of human lives and infrastructure is the priority
- When comparing products consider:
    - Efficacy
    - Operating conditions
    - Industry requirements

Billy Bishop Toronto City Airport

Procurement – Environmental Considerations

- Evaluate chemical formulations
  - Information Sources: product sheet, MSDS, information shared via NDAs
- Review available toxicity data (ingredients & mixtures)

MATERIAL SAFETY DATA SHEET - 9 SECTIONS

SECTION 1 - PRODUCT INFORMATION

Product Name
Product Use
Manufacturer's Name
Physical and Mailing Address
Emergency Contact Phone Number

WHMIS Classification (optional)

Supplier's Name
Physical and Mailing Address
Emergency Contact Phone Number

SECTION 2 - HAZARDOUS INGREDIENTS

Hazardous Ingredients (very specific)

SECTION 3 - PHYSICAL DATA

Physical State (What does it look like? Is it a liquid, gas, or solid?)
What happens to it under a variety of circumstances? (i.e. heat, freezing, dropping, etc.)
Flammability and how to extinguish. Includes a wide variety of details concerning how easily this product

SECTION 4 - FIRE AND EXPLOSION DATA

will ignite / explode and how to deal with it.
How stabile is this product?

How it reacts under various conditions.

SECTION 5 - REACTIVITY DATA

Incompatibility with other substances.

Hazardous Decomposition Products

Information about how the product affects and enters the body. Immediate affect. Long term toxic affect.

SECTION 6 - TOXICOLOGICAL PROPERTIES

Exposure limits. In summery, immediate and long term affects to the human body.

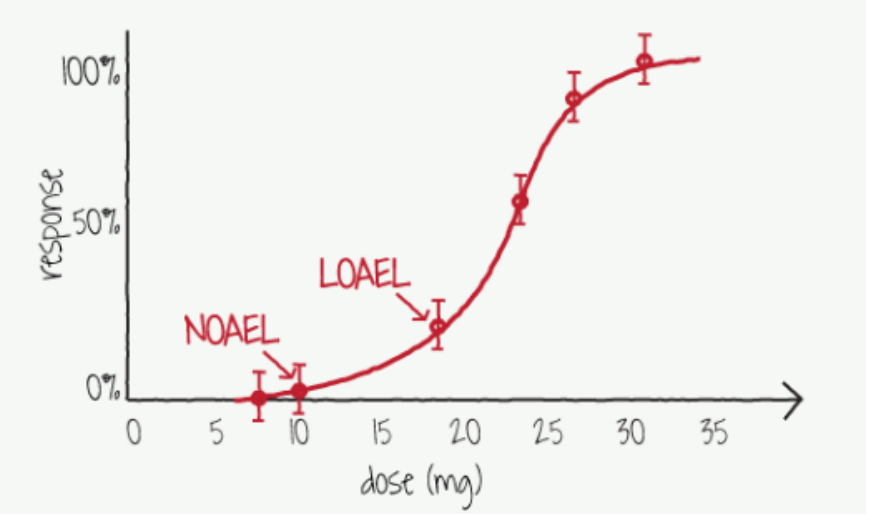
SECTION 7 - PREVENTIVE MEASURES

Personal Protective Gear; ventilation, etc.; leak and spill info; waste disposal; handling and storage; special shipping instructions

SECTION 8 - FIRST AID MEASURES

Information for immediate first aid treatment. Usually always ends with "contact a Doctor"

SECTION 9 - PREPARATION INFORMATION / *Who prepared this and contact info*

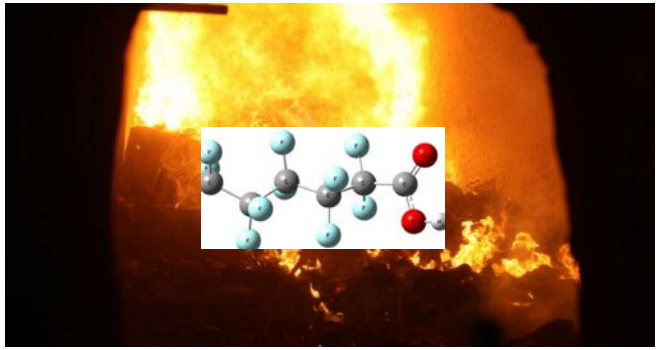


Procurement - Recommendations

- Evaluate feasibility of fluorine-free foams
- Use a multi-foam approach if possible (e.g., fluorinated + F3 + Class A)
- Be critical of donated or older products!

Storage & Handling

- Proper labeling, storage and isolation of products
- Routine inspection/maintenance of pre-charged systems
- Decontamination procedures
- Disposal at proper facilities

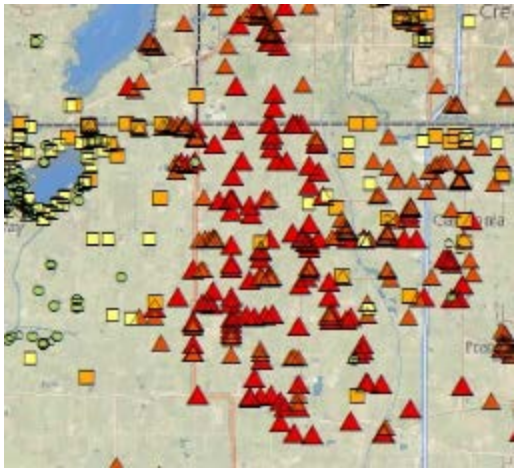


Training & Testing

- Training with water or PFAS-free training foams
- Training at specialized facilities
- Non-discharge testing

Preparation for Release

- Scenario planning (all potential emergencies or releases)
- Maintain complete and accurate inventories of containment supplies
- Map out key exposure routes, preferential pathways and receptors

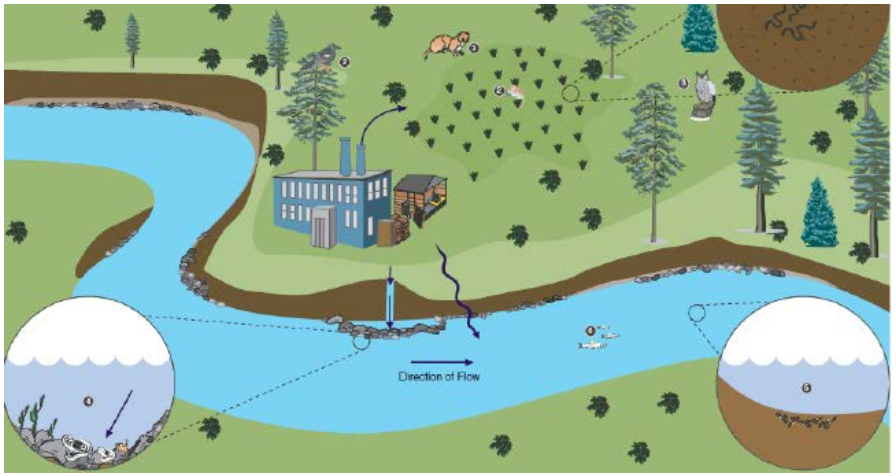


Product Release and Emergency Response

- Rapid response to contain foam and impacted water
- Photo documentation of foam dispersal and runoff routes
- Maintain accurate record of release events
- Prompt excavation of foam impacted media
- Water treatment units
- Immediate testing of groundwater monitoring wells

Site Assessment Considerations

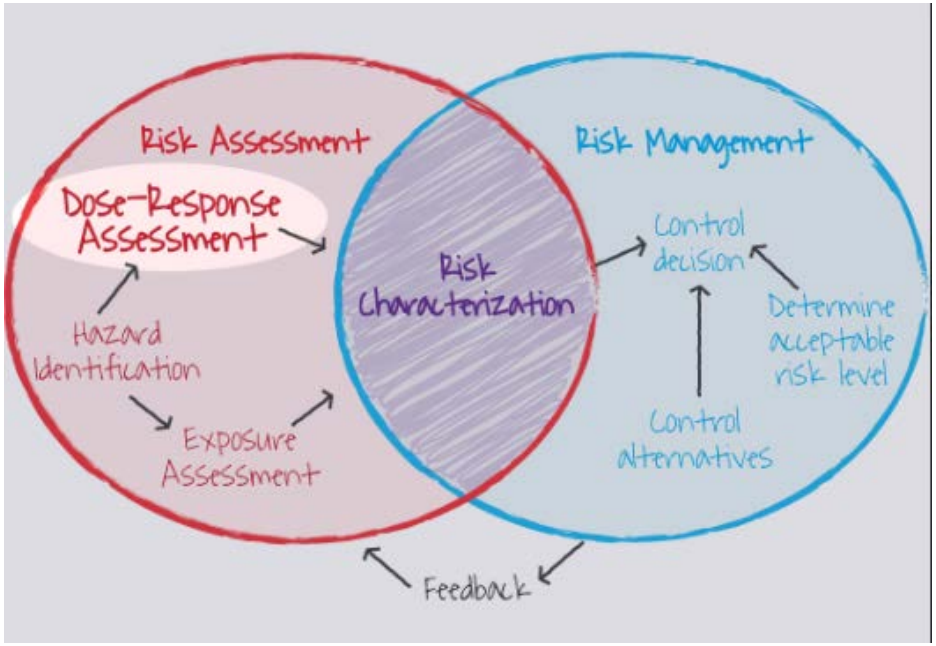
- Development of strong CSMs
- Know your receptors
- Awareness of adjacent sources / background
- Sampling procedures and precautions
- Awareness of analytical tools (e.g., TOP and TOF)



Source: CCME. 2020. Ecological Risk Assessment Guidance.

Remediation and Risk Management Considerations

- Remediation is a rapidly developing but expensive frontier
- Risk assessment uncertainties



Thank you!

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