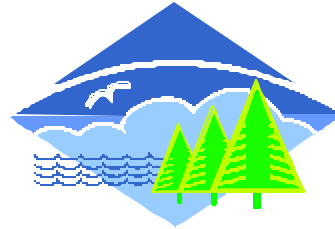


Reclamation and Remediation Framework for Upstream Oil and Gas Sites



Walter Ceroici
Alberta Environment

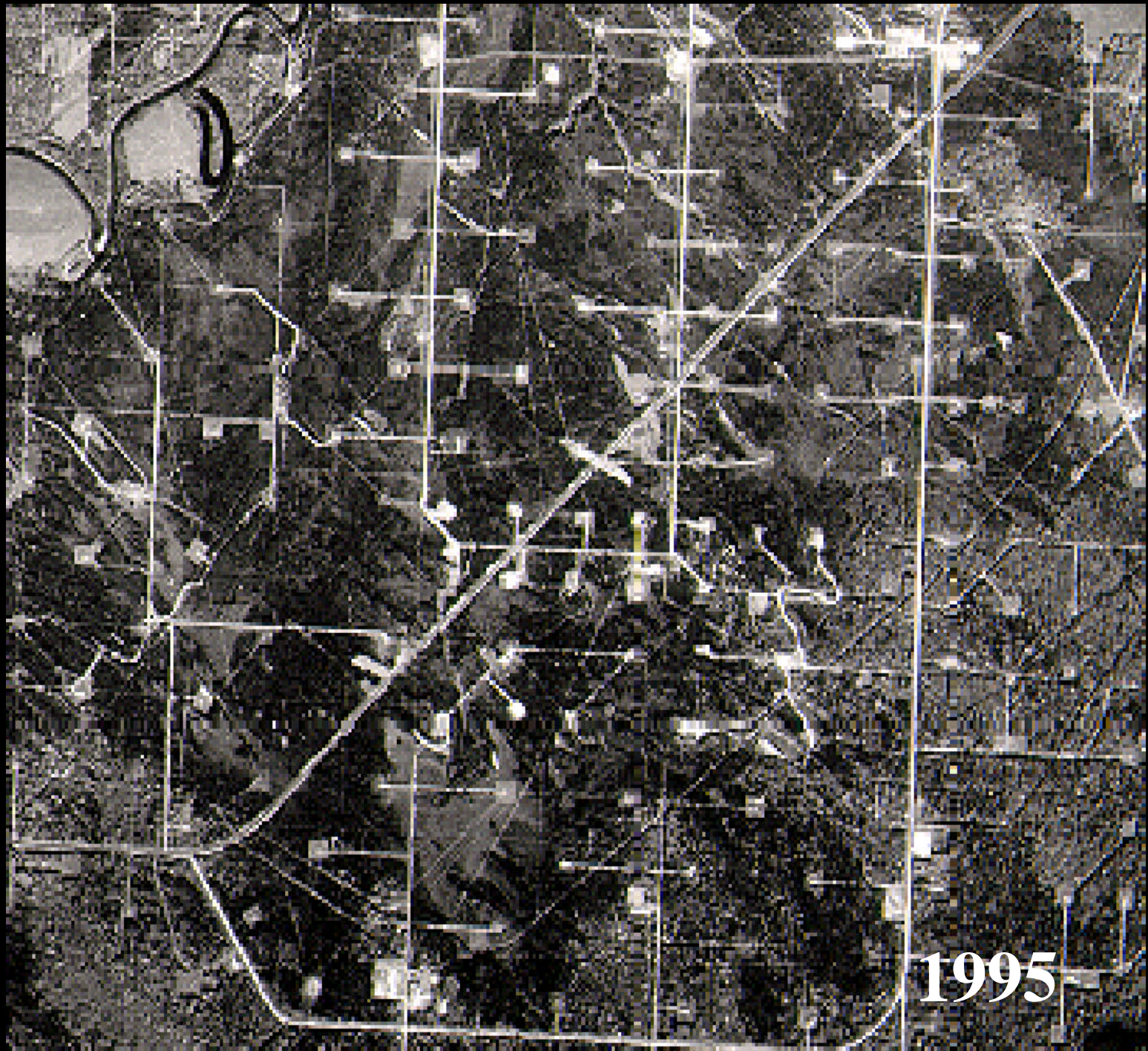
Upstream Oil and Gas Facilities

Include:

- All wells licensed by the EUB
- pipelines, flowlines and associated equipment
- satellites, batteries, metering stations,
- gas plants
- oil production sites



1945



1995

Contaminants at Upstream Facilities

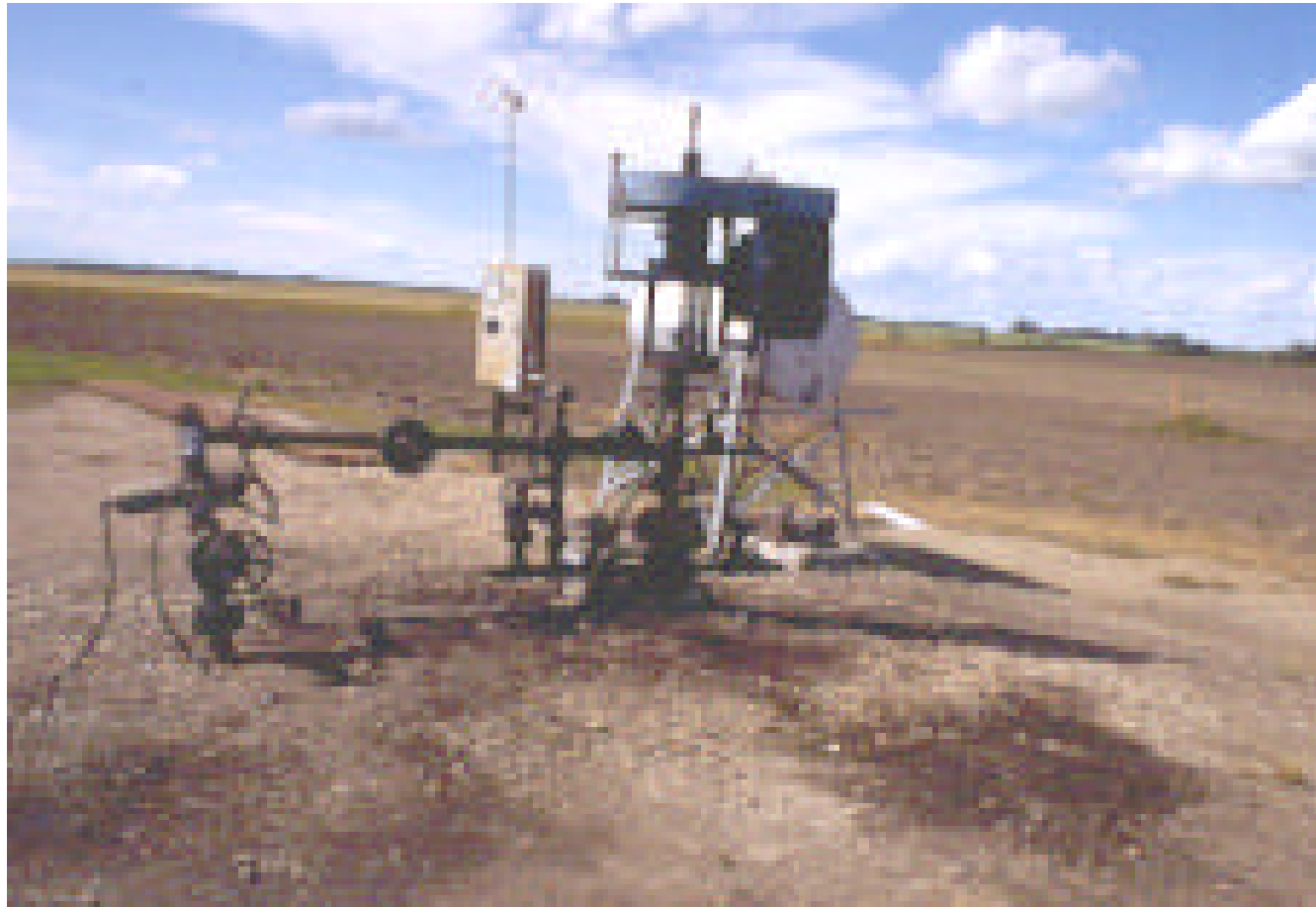


Hydrocarbons

Salt

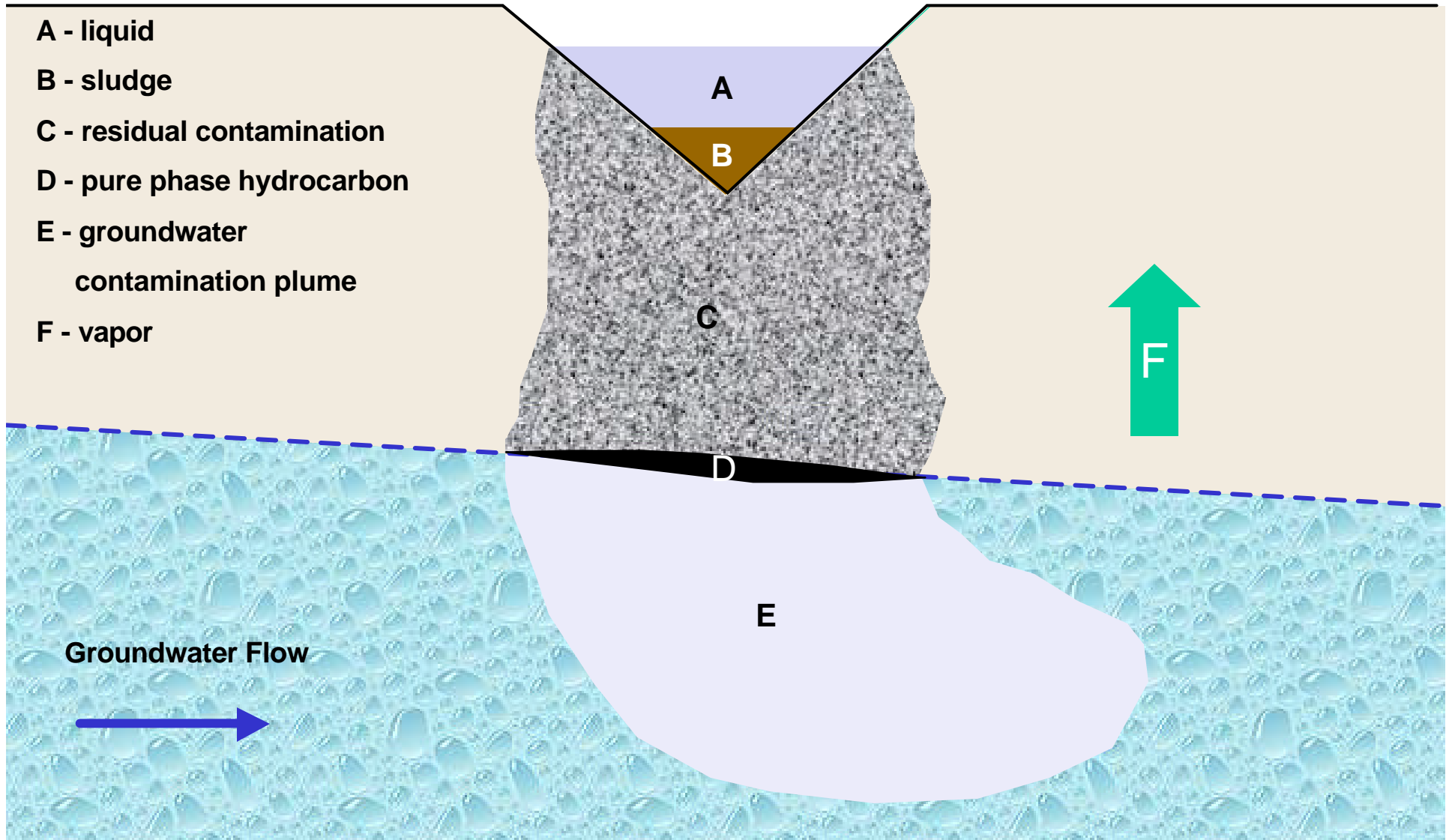
Process Chemicals

Herbicides





Contamination at Upstream Sites



Remediation

- remediation options include:
 - removal (considered oilfield waste - EUB)
 - treatment in place
 - containment
- remediation a challenge due:
 - to fine-grained nature of subsurface materials in Alberta
 - variety of contaminants
- remediation can take a long time

EPEA Requirements

- EPEA requires an operator to:
 - address any contamination
 - reclaim
- an RC issued when site is properly reclaimed
- allows for lease cancellation
- the RC documents surface conditions:
 - soil quality
 - grade restoration
 - retention of soil organic matter
 - vegetative cover
- in practice, RC not used to address contamination

Historical Management

- Operator carries out remedial work prior to surface reclamation
- soil contamination evaluated against Alberta Tier 1 criteria or site-specific risk-based criteria
- groundwater use protection
- Documentation? Closure?

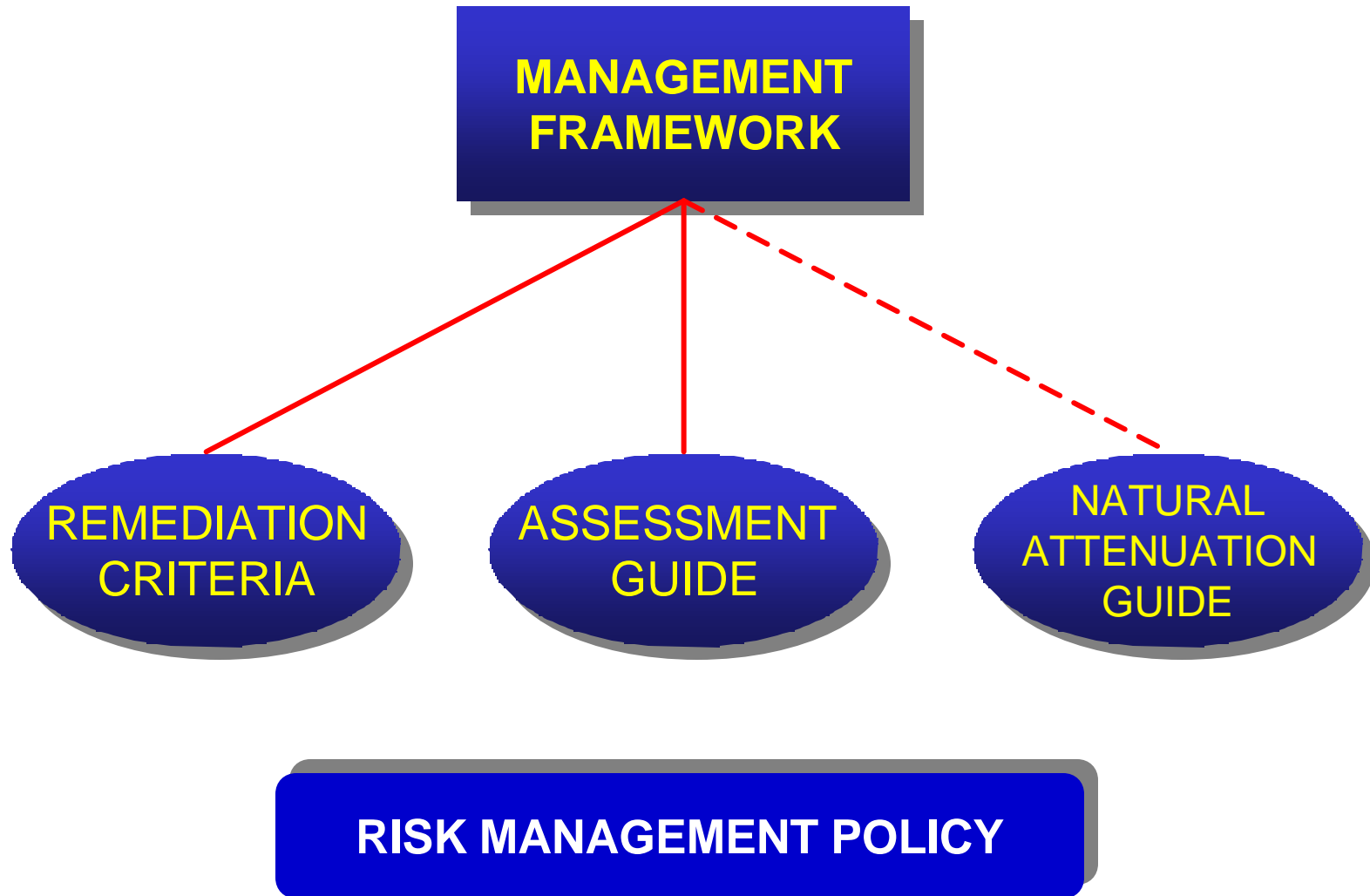
Relationship Between Reclamation and Remediation

- Uncertain due to lack of science-based criteria for assessment
- To clarify, the following tools developed as part of a framework:
 - Phase I ESA
 - Salt Management Guide
 - CWS PHC

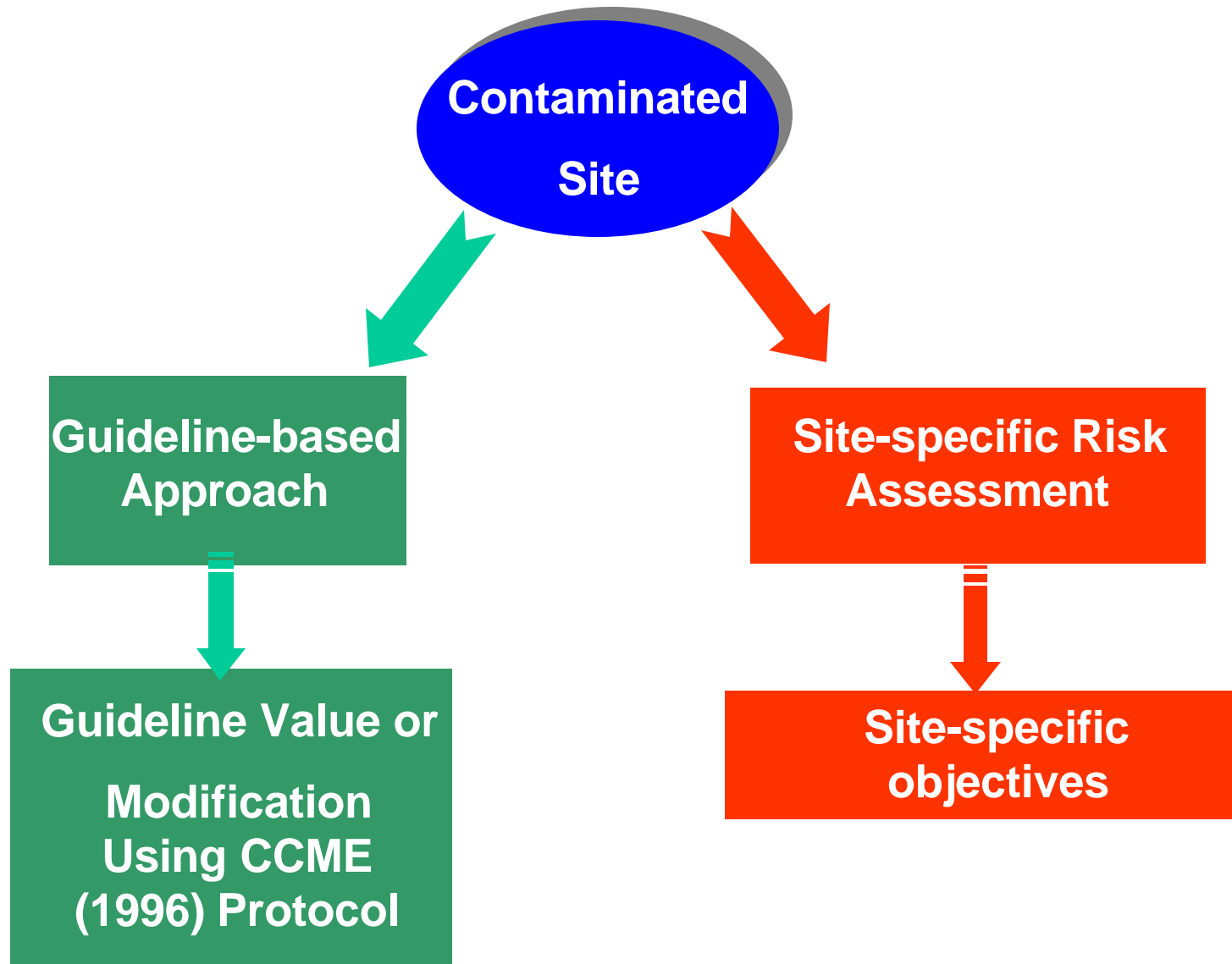
Stakeholder Perspectives

- Landowner seeks speedy recovery of land use without limitation
- AENV seeking complete reclamation and remediation at highest proportion of sites
- industry seeking:
 - greater certainty in process and outcome
 - recognition that **natural attenuation** can play a role in site remediation

Proposed Management Framework

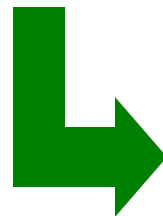


Remediation Objectives



Remediation Objectives

- Alberta Tier 1
- CCME (1991) Interim Criteria
- CCME (1999) Environmental Quality Guidelines
- CCME (2000) Petroleum Hydrocarbon Standard
- other

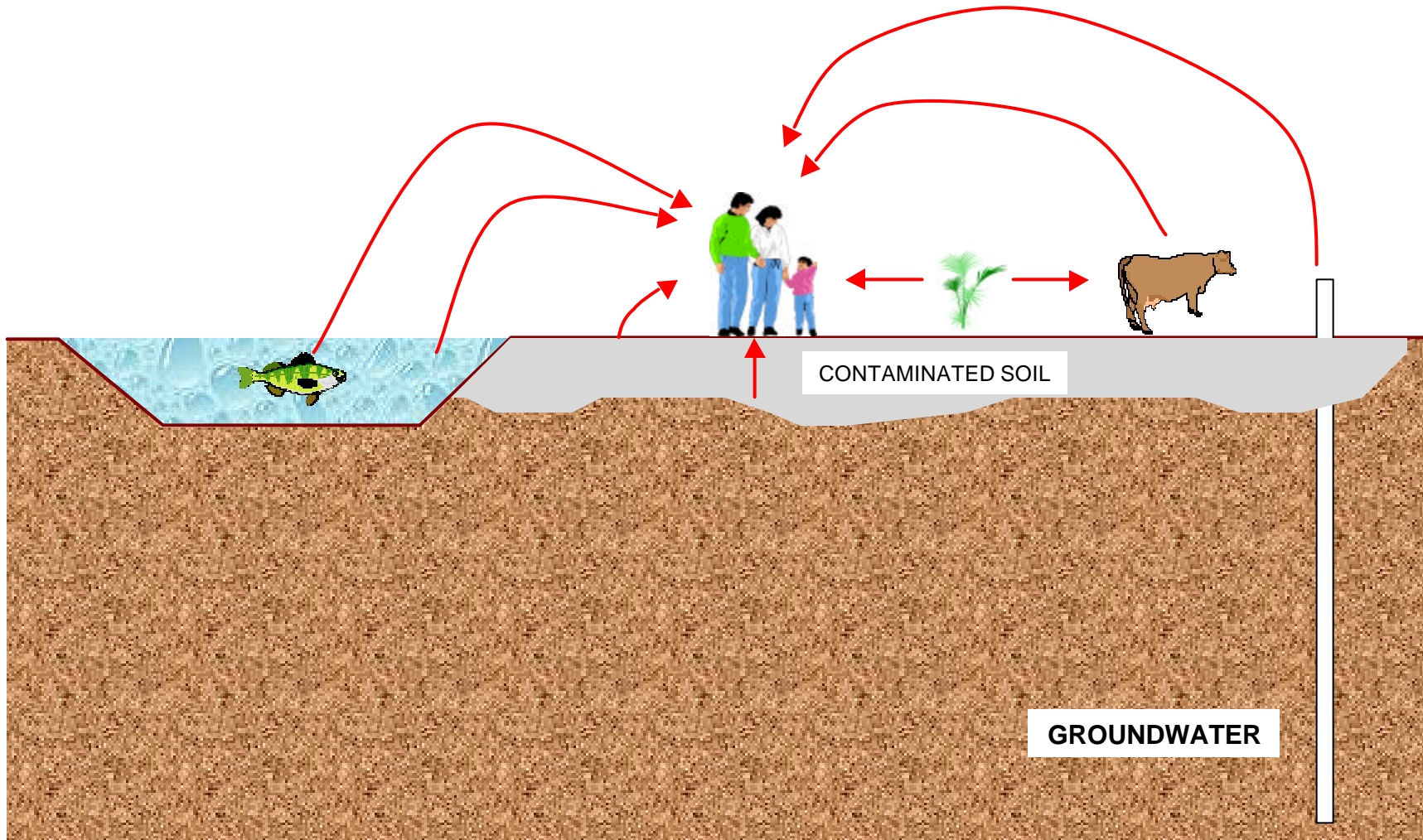


“Alberta Soil Quality Guidelines”

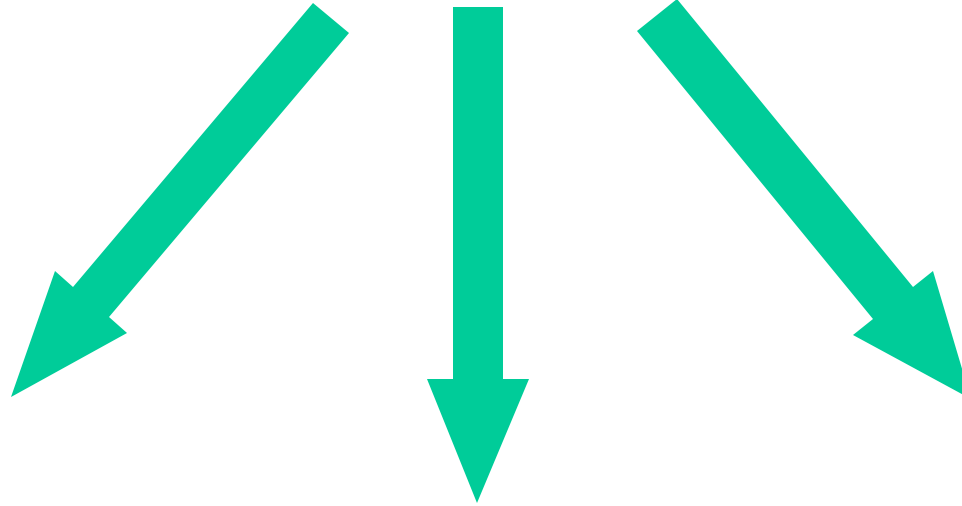
Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil

- Remedial standard to address PHC releases to soil and groundwater
- Alberta chairs national Development Committee
- Risk-based, 3-tiered standard for four land uses
- Consensus multistakeholder development process
- Endorsed by Ministers in May 2001 -- Alberta implementation in 2001 field season
- CCME national workshop - May 10 and 11

Exposure Pathways



Management Framework Options



Unconditional
Closure

Conditional
Closure

Deferred
Closure

- objective is protection of human health and environment

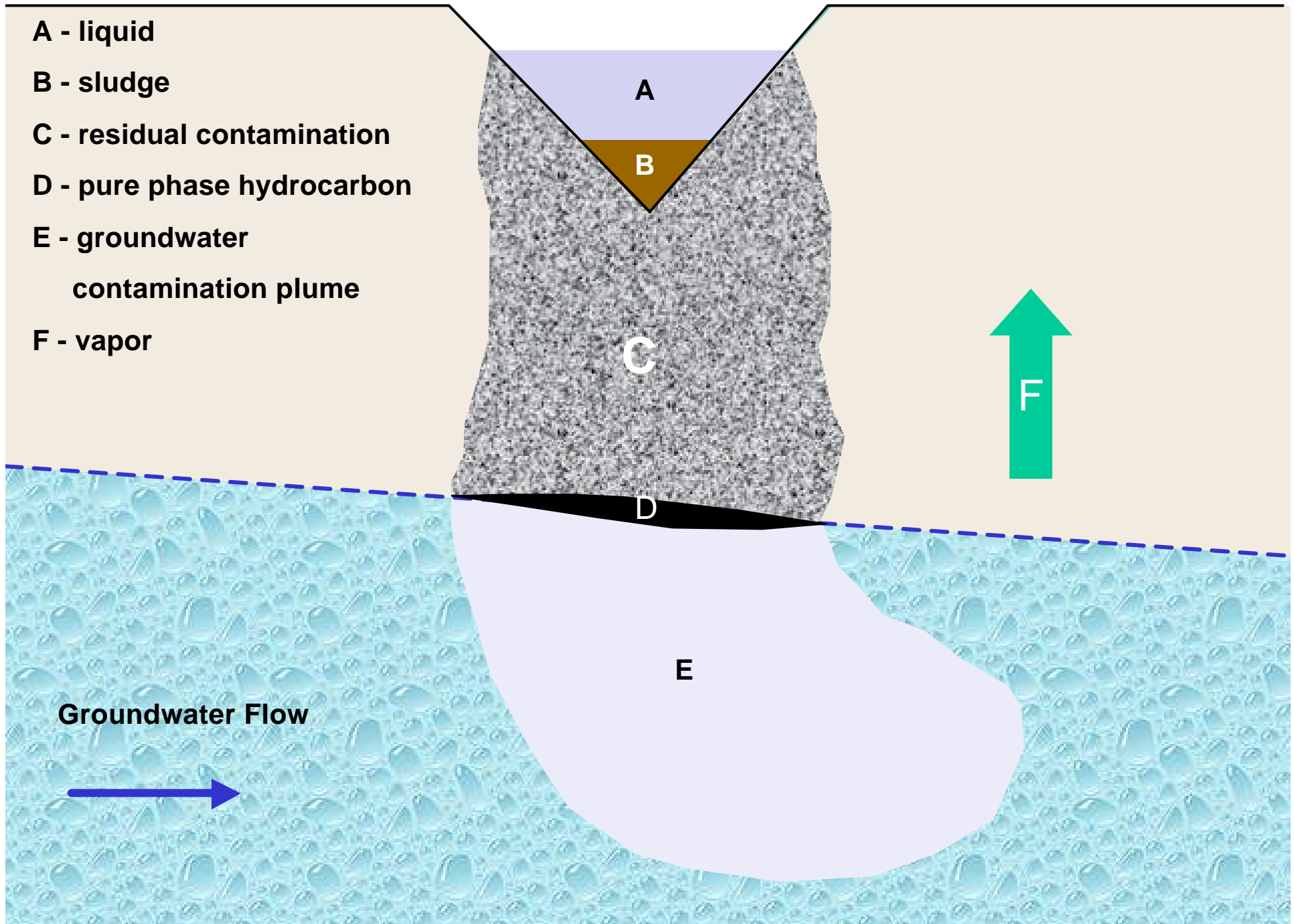
Unconditional Closure (~80% of sites)

- Contamination does not limit uses of land or water
- Reclamation Certificate issued - lease terminated
- liability period for reclamation
- ongoing operator liability for contamination

Conditional Closure (~18% of sites)

An option when:

- practical barriers to remediation
- natural attenuation can reasonably be expected to perform
- landowner agrees to co-manage any risks
- contamination sources removed to greatest extent possible



Land Reclamation Complete

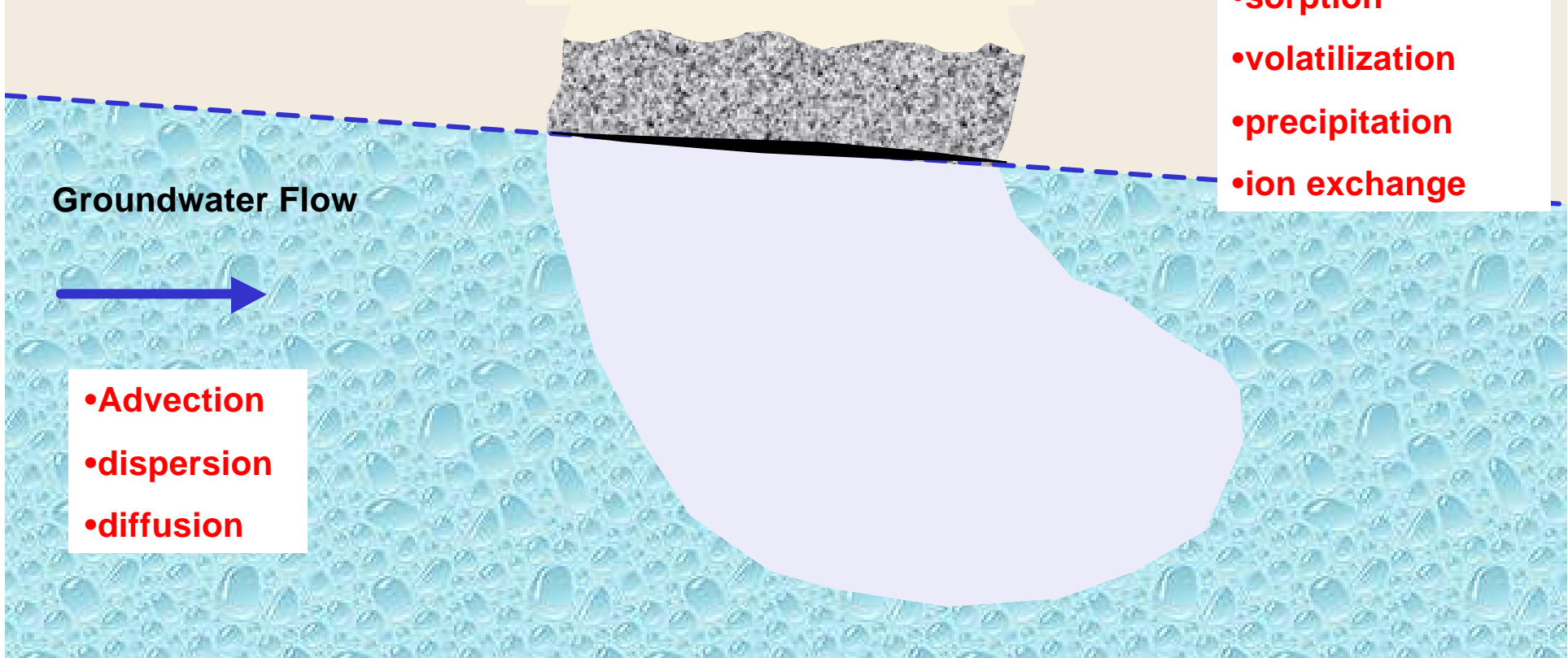
Possible subsurface use limitations

- Attenuation:**
- biodegradation
 - sorption
 - volatilization
 - precipitation
 - ion exchange

Groundwater Flow



- Advection
- dispersion
- diffusion



Conditional Closure - Benefits

- Landscape disruption minimized
- landowner regains use of surface more quickly
- total remediation costs reduced

Uncertainty: Accuracy and precision of predicted natural attenuation.

Additional work required

Deferred Closure (~ 2% of sites)

- Active risk management makes surface reclamation impossible
- operator manages risks so as to prevent adverse effect
- agreements may be required to ensure operator has care and control
- ultimate goal remains certification

Site Assessment Guide

- Consistent with the CSA Phase 1 guide
- Phase 1 ESA guideline
 - historical air photo review
 - corporate file review
 - interviews
 - field inspection
- objective to standardize Phase 1 ESAs
- provides assurance to landowners and regulators that contamination issues have been assessed

Salt Contamination Guideline

- Salt contamination caused by a wide variety of industrial activities
- guideline intended to provide:
 - regulatory advice
 - assessment and remediation guidance
- one year trial period complete

Conclusions

- Framework is an important step in implementing CWS
- Additional work and stakeholder consultation required on:
 - conditional closure option
 - further development of remediation objectives
 - acknowledging remediation closure
 - natural attenuation guideline
- looking for your input

