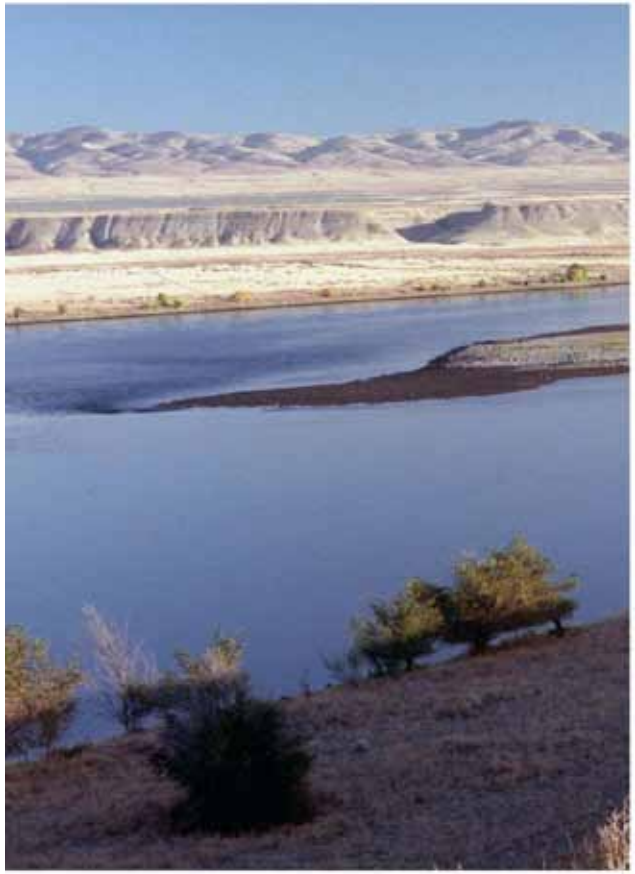
CH2MHILL
Plateau Remediation Company



General Response Action – Containment Technologies

Presented by: T. J. Simpkin/M. J. Truex

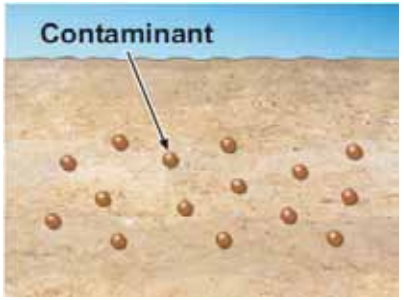
Location: Shilo Inn, Richland, Washington
Date: June 7, 2011

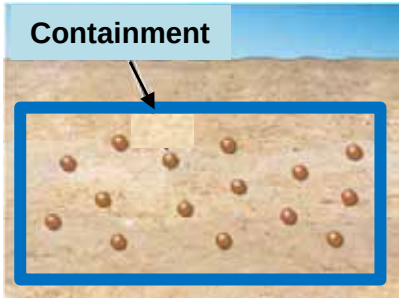
U.S. DEPARTMENT OF ENERGY

General Response Action – Containment Technologies

General Description

- Physically isolate contaminants or limit water movement through contaminated zones to slow their movement sufficiently to meet groundwater remediation goals





State of Development

- Has been applied as a remedy for waste sites, but not for the deep vadose zone

Limitations/Development Needs

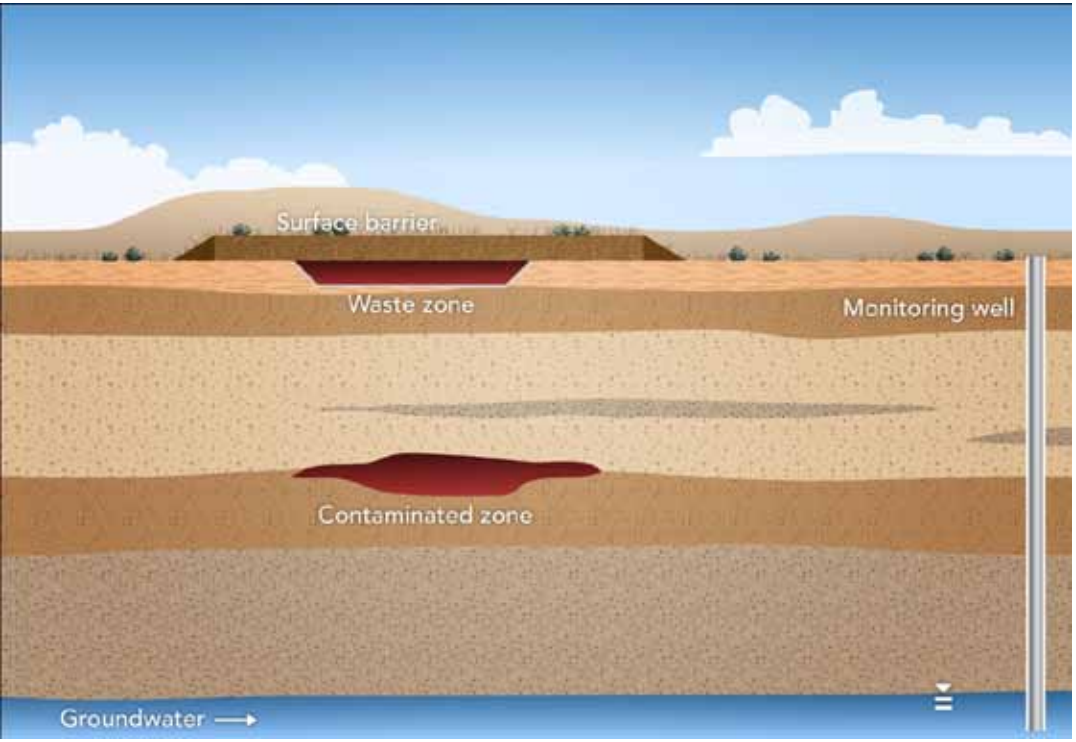
- Effectiveness as a function of depth
- Design for deep vadose zone applications

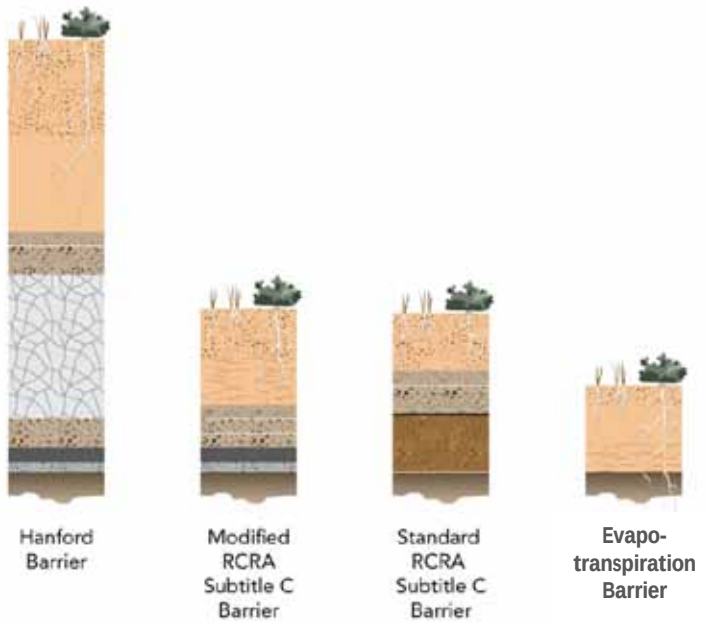
Technology – Infiltration Control Barrier

General Description

- Construction of a barrier at the surface that decreases recharge

Potential Contaminants:
- All





Technology – Infiltration Control Barrier

State of Development

- Several types of barriers have been developed, tested, and applied for waste sites

Limitations/Development Needs

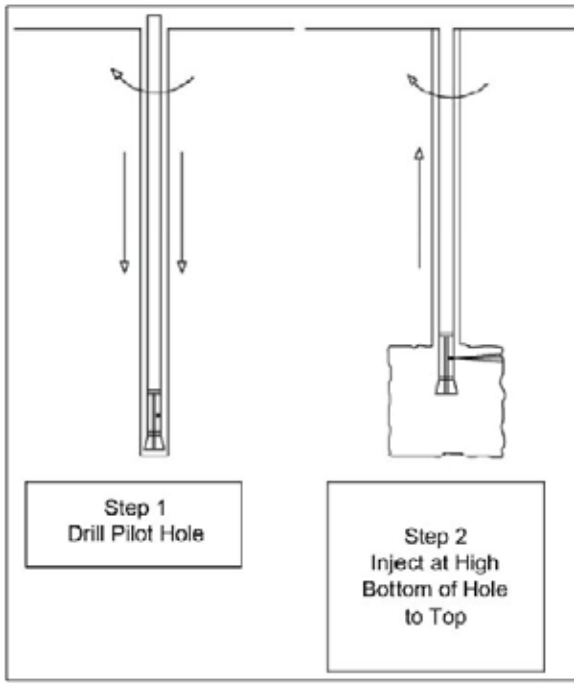
- Need evaluation of the impact of barriers for the deep vadose zone

Lab Testing Only	Field Testing Only	Limited Field Application	Remediation Ready (limited application)	Remediation Ready

Technology – Jet Grouting

General Description

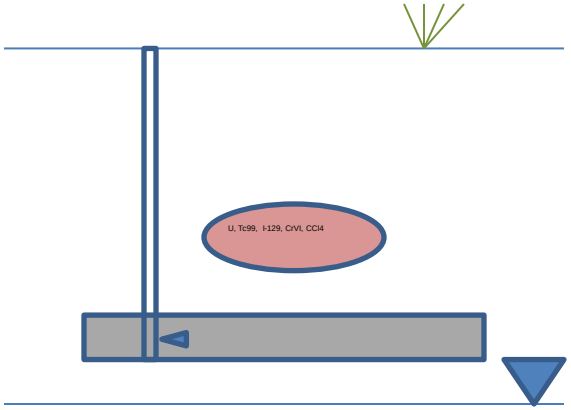
- High pressure injection of a grout slurry into soil in order to hydraulically mix the soil with the slurry
- Create lower permeability layer to reduce water infiltration, above or below contaminated media



Source: From Nicholson, 2010.

From: DOE/RL-2010-68

Potential Contaminants:
- All



Technology – Jet Grouting

State of Development

- Field scale application is fully deployable and has been performed to depths of 300 feet
- Has not been applied to large-scale sites with many radiological and chemical hazards

Limitations/Development Needs

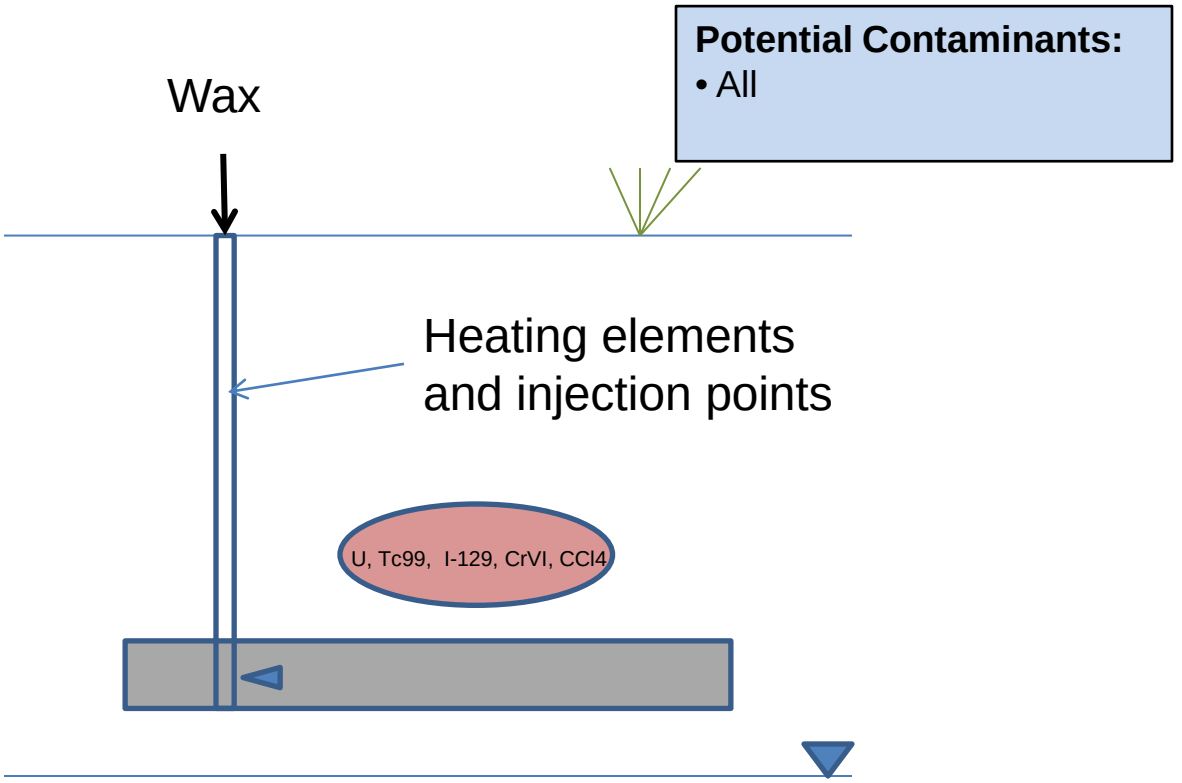
- Effective application depends on subsurface properties. Cobbles may cause gaps in coverage
- Tight spacing between injection points is generally required, so very large number of borings would be required

Lab Testing Only	Field Testing Only	Limited Field Application	Remediation Ready (limited application)	Remediation Ready

Technology – Permeation Grouting (Molten Wax Injection)

General Description

- Injection of grout (e.g. acrylamide or silicate) or molten thermoplastic wax, resulting in an impermeable material
- Molten wax is delivered by first heating the soil and then injecting the wax
- Heating methods can include conductive heating
- Create lower permeability layer to reduce water infiltration, above or below contaminated media



Technology – Permeation Grouting (Molten Wax Injection)

State of Development

- A number of tests of permeation grouting have been conducted in the DOE complex, however, not at the required depth
- Molten Wax Injection - Development has occurred over the last several years at INL in radiologically-contaminated environments

Limitations/Development Needs

- Molten wax injection requires heating prior to injection which can be energy intensive
- Tight spacing between heating elements and injection points is generally required, so a very large number of borings would be required
- Shrinkage of grout may occur under some conditions, increasing the permeability
- Long term viability is unknown

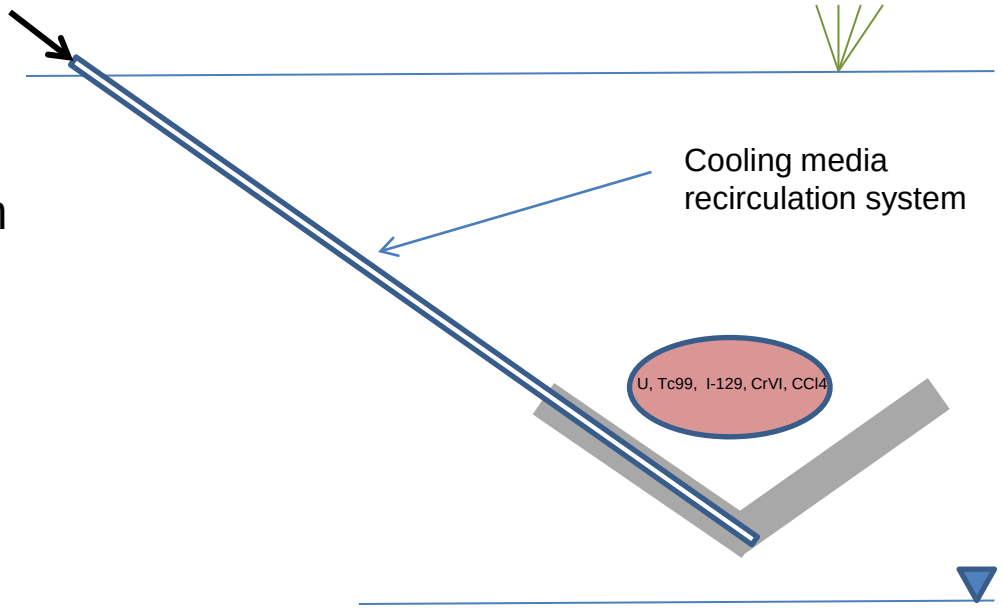
Lab Testing Only	Field Testing Only	Limited Field Application	Remediation Ready (limited application)	Remediation Ready

Technology – Soil Freezing

Potential Contaminants:
- All

General Description

- Placement of cooling media distribution systems into the soil layer below the contamination to freeze soil pore water and reduce mobilization of contaminants
- Relies on soil moisture to form ice that is the primary structural feature of the frozen soil. In arid environments, supplemental soil moisture addition may be required to form adequate ice



Technology – Soil Freezing

State of Development

- Proven application for temporary containment for dewatering during construction
- Technology is in early development and testing stages (RPP-ENV-34028). Several demonstrations have been performed at near surface depths, but not within the deep vadose zone.

Limitations/Development Needs

- Requires high moisture (or saturated conditions)
- Not permanent. Would require periodic re-freezing and would not offer passive permanence
- Energy intensive
- Tight spacing between cooling elements is generally required, so very large number of borings would be required
- Barrier integrity and long-term stability are key uncertainties

Seattle Daily Journal of Commerce

Lab Testing Only	**Field Testing Only**	Limited Field Application	Remediation Ready (limited application)	Remediation Ready