Permeable Reactive Barriers – A Green Technology

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Permeable Reactive Barriers: Technology Update

ITRC (www.itrcweb.org) – Shaping the Future of Regulatory Acceptance

- Host organization
- Network
  - State regulators
    - All 50 states and DC
  - Federal partners

DOE DOD EPA

  - ITRC Industry Affiliates Program
  - Academia
  - Community stakeholders

- Wide variety of topics
  - Technologies
  - Approaches
  - Contaminants
  - Sites
- Products
  - Documents
    - Technical and regulatory guidance documents
    - Technology overviews
    - Case studies
  - Training
    - Internet-based
    - Classroom

PRB: Technology Update Team

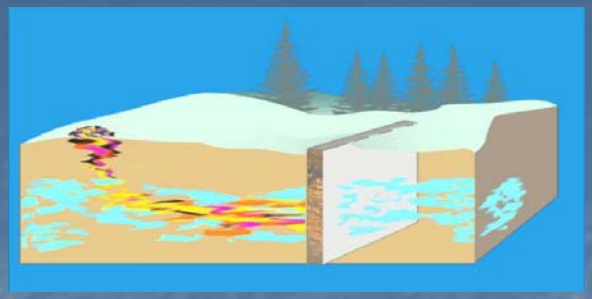
- Working with AFCEE
- Formed in 2009, projected to close in 2011
- Previous ITRC teams published documents in 1999, 2000, and 2005
- Technical Regulatory Guidance Document scheduled to be published early 2011
- Internet Based Training scheduled to begin 2011

Team Problem Statement

- Hundreds of Permeable Reactive Barriers (PRBs) have been installed to treat contaminated GW
- ITRC published an update on advances in PRB technology in 2005
- Advances have continued, including the increased use of non-iron reactive materials and new installation technologies

Focus of Today's Talk

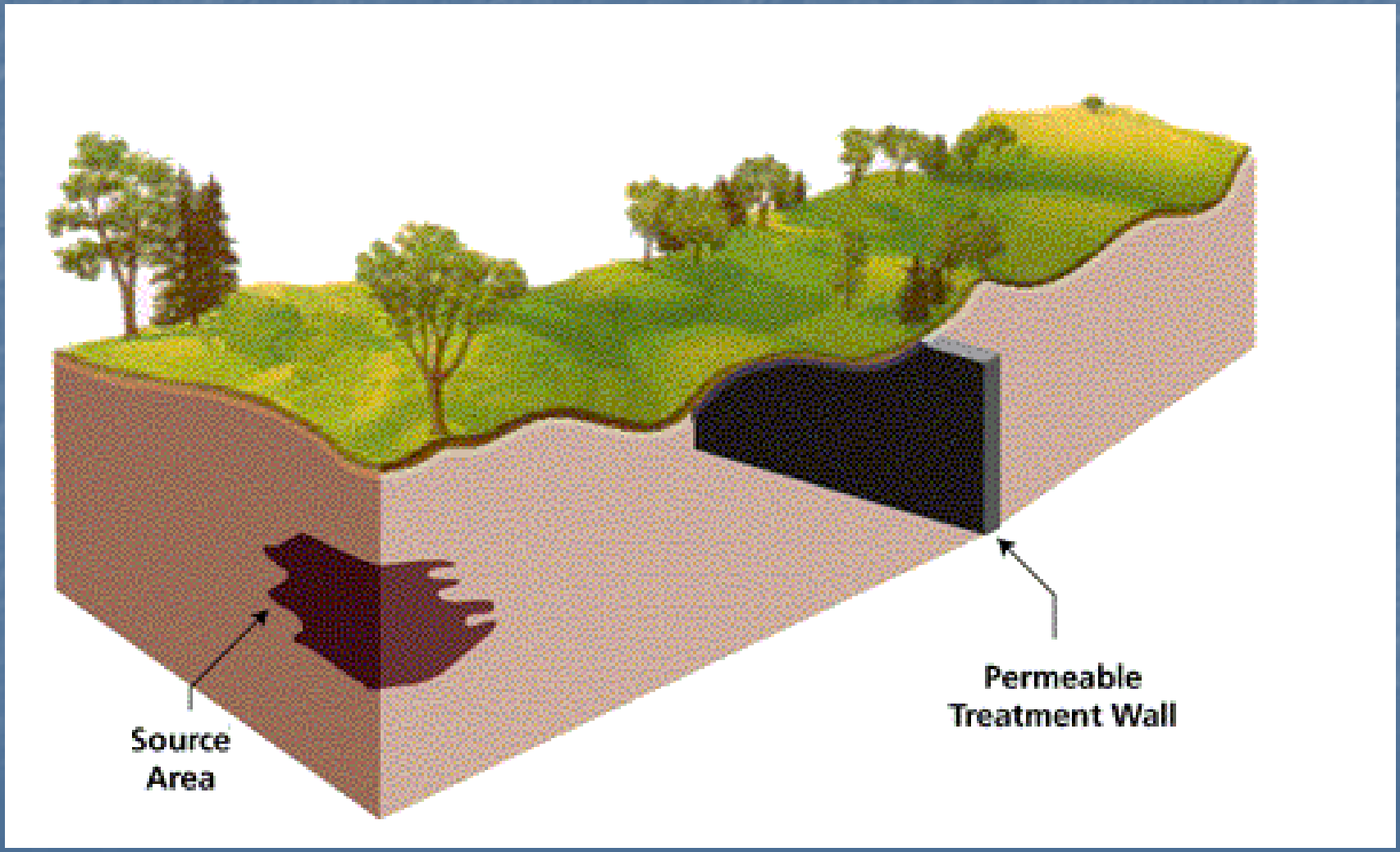
- Definitions
- Construction and Installation Methods
- Reactive Materials
- How PRBs are a "green" and sustainable remediation technology



Definitions

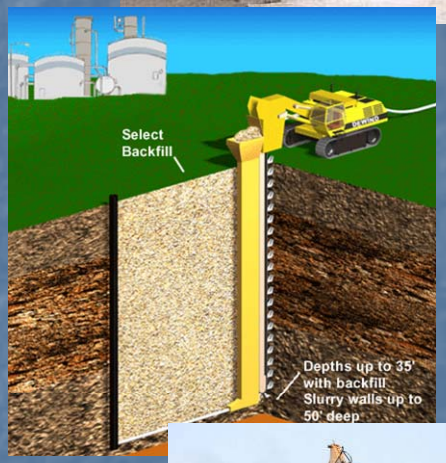
- An in-situ method for remediating contaminated ground water. It combines a passive chemical or biological treatment zone with subsurface fluid flow management. The contaminants are either degraded or retained in the barrier material, which may require periodic replacement.
- Further clarified that if injected, the reactive material must form a continuous “wall”

Permeable Reactive Barrier –
(How it functions)



Construction Methods

- Excavation
  - Conventional Trenching Techniques (supported and unsupported)
  - Continuous Trenching
  - Long-arm Excavators and Biopolymer Slurries
  - Cofferdam/Sheet Piling
  - Augured Boreholes or Caissons
  - Clamshell Excavators



Installation Methods

- Injection
  - Direct Injection
  - Pneumatic Fracturing and Injection
  - Hydraulic Fracturing and Injection
- Other Installation Methods
  - Vertical Hydrofracturing
  - Deep Soil Mixing
  - High-Pressure Jetting
  - Vibrating Beam/Tremie Tube
  - Pressure Pulse Injection

Reactive Media

- Iron-Based
  - Granular Zero-Valance Iron (ZVI)
  - Micro-Scale and Nano-Scale
  - Amorphous
- Organic Substrates
  - Mulch and Compost
  - Vegetable Oil
  - Molasses
  - HRC®

Reactive Media

- Other Mineral Media
  - Iron and Steel Furnace Slag
  - Phosphatic Compounds
  - Zeolites
  - Transformed Red Muds
- Combined Media
  - Emulsified Zero Valent Iron
  - Other Iron – Organic Combinations

Green?

PRB technology is widely considered to be a sustainable, or green, groundwater remediation method but, is it?

Green?

- The intent of a PRB system is to perform under hydraulically passive means (i.e., no energy or mechanical input for routing chemically-impacted groundwater through the PRB)
- The technology has a track record for long-term performance (>15 years) without the need for substantial maintenance
- The treatment media often consists of recycled material or “waste” material such as compost

EPA 542-F-08-002 (April, 2008)

BMP program for green remediation defines “sustainable practices” as those processes that result in cleanups that minimize the environmental and energy footprint of actions taken. Items for consideration include:

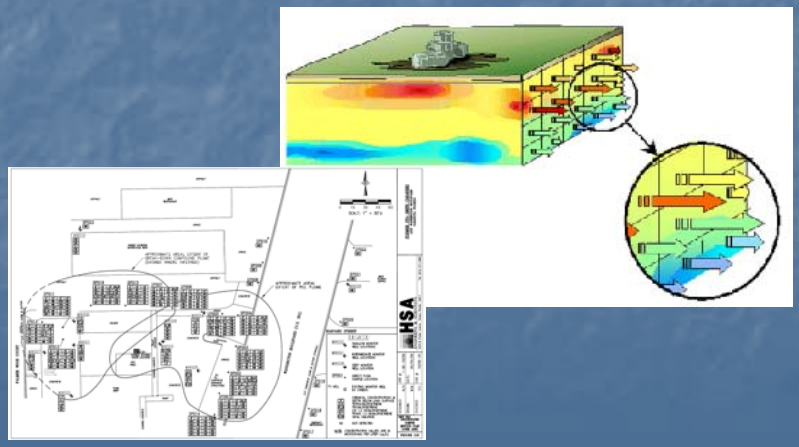
- Energy Requirements
- Air Emissions
- Water requirements and impacts on water resources
- Impacts to land and ecosystems
- Material consumption and waste generation
- Impacts on long-term stewardship to a site

Green System Values

- Design for optimum efficiency
- Use renewable resources to meet power demands
- Generate electricity from byproducts of the remediation and/or participate in power generation or purchasing partnerships based on renewable resources
- Minimize fresh water consumption and maximize water reuse during treatment
- Prevent water quality impact to nearby resources
- Reclaim treated water for beneficial use

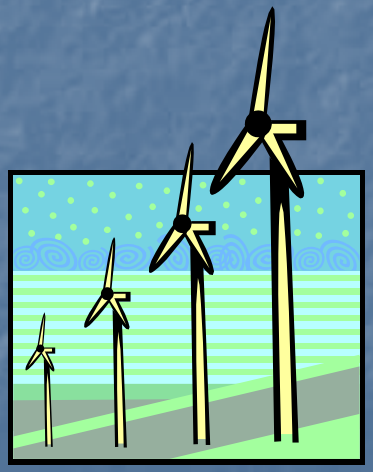
Site Characterization

- Typically the same as for other in-situ technologies
- Additional detailed subsurface characterization generally required
- General issues relating to waste minimization/ reduction



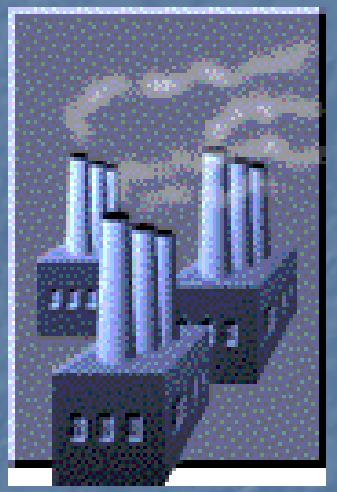
Energy Requirements

- PRB Implementation
  - PRB Materials
  - Transportation
  - Construction Process
- PRB Operation



Air Emissions

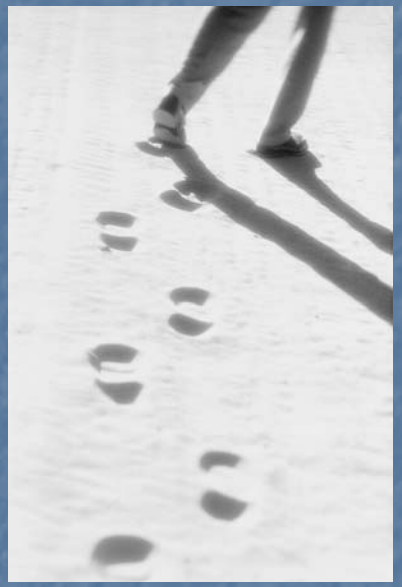
Air emission inventory for PRB use can be summarized as follows:



- PRB Material preparation – low to moderate
- PRB Construction – low to moderate
- PRB Operation – negligible
- PRB Monitoring - very low to low
- PRB Maintenance - low to potentially moderate

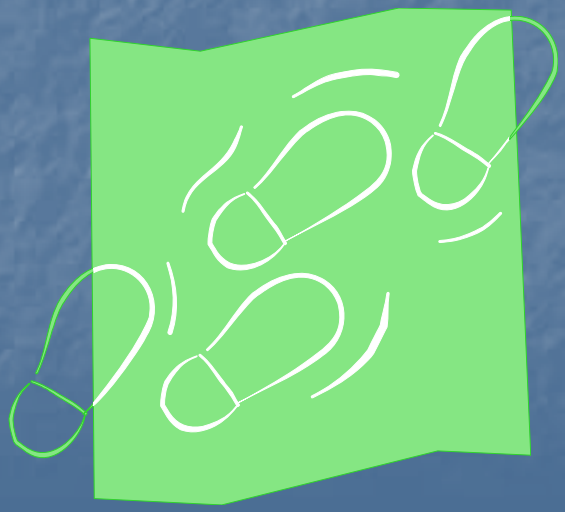
Footprint

- During construction
  - Substantial land impact
  - Limited time
- After construction (operation)
  - Negligible land footprint
  - PRB System is underground
  - MWs can be completed at grade
  - Land use restrictions minimal – no digging/excavation



Footprint

- Water resource conservation method
  - No water removed
  - All water returned to native aquifer
- Passive contaminant removal



Waste Minimization

- PRB is no different than other systems requiring excavation.
- However, PRBs can use recycled materia as their treatment media.
- Green waste that forms mulch, recycled iron that is formed into ZVI, and excess food grade bone can all be applied in PRBs.

Green?

YES!

In fact, PRBs may be considered a cornerstone of the green remediation movement!

Links :

www.itrcweb.org