Groundwater Remediation Strategies and Case Study
Valerie Panek - Hydrogeologist
CH2M HILL
May 15, 2001

2 Introduction
- General Discussion of Groundwater Remediation Strategies
- Related Case Study
  - Focus on Point-Source contamination
- Consultant's Point of View

3 Topics of Discussion
- Groundwater use in Oregon
- Remediation Strategies:
  + Framework
  + Specific Remediation Methods/Technologies
- Case Study

4 Groundwater use in Oregon
- 13% of water used in Oregon (1995)
- Supplies drinking water to 90% of rural residents
- Irrigation
- Industry
- Recharge and baseflow to lakes, streams and wetlands

5 Typical Events Cycle
- Initial Assessment(s)
  + Identify nature and extent of problem, "source" area
- Remedial Investigation
  + Identify potential migration pathways, receptors, and effects
    + Fate & transport - model
    + Groundwater Beneficial Use Assessment
    + Current and Likely Land Use
    + Human Health and Ecological Risk Assessments
  + Feasibility Study
- Remedial Action

6 Remedy Selection
Considerations
- Site Conditions (will it work given site geology, gw chemistry, etc)
- Regulatory (e.g., strategy dictated by ROD)
- Client Expectations (innovative vs. traditional approach)
- Costs (where is $ coming from, reasonable vs benefits?)
- Benefits (effectiveness, full cleanup or to "acceptable" level)
- Timeframes for Cleanup (what acceptable/practical?)

Groundwater Remediation Strategies and Case Studies
7 Ground Water Treatment Technologies
   • Active vs Passive
   • Biological, Chemical, Physical
   • Extract, Destruct, Immobilize
   • Combination

8 Ground Water Treatment Technologies
   • In-situ Biological Treatment
     • Co-metabolic Treatment
     • Enhanced Bioremediation
     • Natural Attenuation
     • Phytoremediation
   • Ex-Situ Biological Treatment
     • Bioreactors
     • Constructed Wetlands

9 Ground Water Treatment Technologies
   • In-Situ Physical / Chemical Treatment
     • Air Sparging
     • Biosurping
     • Dual Phase Extraction
     • Fluid/Vapor Extraction
     • Hot Water or Steam Flushing/Stripping
     • Hydrofracturing
     • In-Well Air Stripping
     • Passive/Reactive Treatment Walls
     • Injection of ORC, HRC, Peroxide, etc.

10 Ground Water Treatment Technologies
    • Ex-Situ Physical/Chemical Treatment
      • Air Stripping
      • Granulated Activated Carbon (GAC)/Liquid Phase Carbon Adsorption
      • Ion Exchange
      • Precipitation/Coagulation/ Flocculation
      • Separation
      • Sprinkler Irrigation
      • Ultraviolet Oxidation

11 Ground Water Treatment Technologies
    • Containment
      • Deep Well Injection
      • Groundwater Pumping
      • Slurry Walls

Groundwater Remediation Strategies and Case Studies
Case Study
- Superfund Site - Tie Treating Plant in The Dalles, OR
  - Creosote (free product) found in shallow soils and deeper basalt water-bearing zones
  - Dissolved creosote constituents (PAHs) in groundwater
  - Selected dual-phase extraction system (pump creosote and water) as remedy for shallow aquifer
  - Hydraulic containment system installed at site boundary
  - Monitored Natural Attenuation with institutional controls selected as remedy for deep zone

Case Study
- Tie-treating Plant
  - 1922 Begin operations
  - 1938 Ponds shown on air photos
  - 1957 Water supply well drilled but not used "tasted oily"
  - 1967-70 DEQ received reports of oil release into Columbia River
  - 1971 Pipeline plugged with concrete
  - 1980 Ponds Abandoned
  - 1984-1995 EPA involvement, site investigations, NPL, etc., RI, FS
  - 1996 Record of Decision
  - 1996 Pilot DNAPL Recovery Test
  - 1999 Implementation of Hydraulic Containment System and DNAPL Recovery System in shallow aquifer

Hydrogeologic Setting
- Columbia River
  - Upper 25 feet unconsolidated silty sand water-bearing zone, flows north toward river
  - Underlain by Columbia River Basalt Flows: Sentinel Gap, Sand Hollow 1 and 2, Ginigo flow tops are water-bearing zones (flow west)
  - Nearest municipal well one mile east of site in Sand Hollow 1
  - Designated Critical Groundwater Area (withdrawals from aquifer closely monitored by OWRD)
  - Creosote density - present on top of Sentinel Gap
  - Poor well construction may have allowed creosote to migrate to deeper zone

Shallow Aquifer
- Dual phase extraction system with reinjection of water increases hydraulic gradients to extraction wells $$\Rightarrow$$ enhanced recovery
- Hydraulic containment system "captures" creosote and dissolved plume, preventing offsite migration

Monitored Natural Attenuation Program (Intrinsic Biodegradation) - Deep Aquifer
- Demonstrated that contaminant concentrations are stable or decreasing
- Groundwater sampling data supported aerobic degradation (loss of oxygen, creation of by-products) of PAHs

Groundwater Remediation Strategies and Case Studies
• Denitrification
• Sulfate reduction
• Methanogenesis
• Iron III reduction
• Actual travel distances of dissolved constituents << theoretical

17 □ So What???