1 Groundwater Remediation Strategies and Case Study

Valerie Panek - Hydrogeolgist
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)
- Timeframe for Cleanup (what acceptable/practical?)

- Risk (reliability, what if it doesn't work? new problems?)
- Available Technologies (Pilot phase or accepted practice)
- Applicable to constituent of interest??

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
  - Bioslurping
  - 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

12 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

13 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
  - 1984-1996 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

14 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 I and II, Ginkgo flow tops are water-bearing zones (flow west)
- Nearest municipal well one mile east of site in Sand Hollow I
- 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

15 Shallow Aquifer

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

16 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

- Denitrification
- Sulfate reduction
- Methanogenesis
- Iron III reduction

- Actual travel distances of dissolved constituents << theoretical

17 ❑ **So What???**