Results of the Kinston Jetted PRB and Source Treatment

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Topics to be Covered

- Problem Definition
- Remedial Objectives
- Remedial Approach
- Jetting of Permeable Reactive Wall
- Field Demonstration of ZVI Source Treatment
- Results
DuPont Kinston Plant (NC)
Map of Impacted Area
Remedial Objectives

• Principal Objective: **Plume Containment**
  – migration toward creek
  – conditions unfavorable for MNA

• Secondary Objective: **Reduce Cost**
  – existing P&T system costing $100K per yr (O&M)
  – two lbs of TCE removed after five years

• Additional Objective: **Prove out source treatment using ZVI**
Chlorinated Solvent Plume

Problem Definition and Remedial Approach

DNAPL Source Zone

PRB

Plume

Chlorinated Solvent Plume
Problem Definition and Remedial Approach
Treatment Requirements

- TCE from 10 ppb to 150 ppb
- Lack of daughter products
- GW velocity ~ 0.1 ft/day
- Treatment goal: 5 ppb
- ZVI thickness needed:
  - Two inches in fringe
  - Four inches in center
Area of Concern
The Technical Challenge

- Ability to emplace a 2 to 4 inch thick PRB.
- Ability to work around utilities and minimize disruption of plant operations.
- Flexibility of the technology to work within very limited available space.
High Pressure Jetting

- Technology has been around for decades
- Primarily used to mix cement into soil to improve load-bearing capacity
- Proven capable of jetting iron into soil for PRBs
High Pressure Jetting Process

- Iron suspended in slurry-based jetting fluid
- Initiated at high pressure and flow from boreholes on roughly 6 to 10 foot centers
- Slurry is jetted through nozzle at end of drill string
- High velocity fluid stream erodes cavity in the soil
- Jetting creates columnar or panel structures in subsurface depending on drill string orientation
Jetting Process

Courtesy of Hayward Baker
Columnar Emplacement
Panel Emplacement
Plan View of PRB Alignment

MW-29
Highlights of Kinston PRB

• First application of jetting to PRB.
• Guar gum mud used as base to make pumpable slurry. Enzymes added to break guar.
• Guar gum biodegrades in situ, to create a permeable wall.
• Jetted wall approximately 2-4 inches thick.
• Peerless ZVI (-50 mesh gradation)
Jetted PRB Conclusions

- Three years of data so far - slow GW flow
- Definite TCE drop in downgradient wells

TCE in MW-29

- P&T shut down permanently in August 2001
Chlorinated Solvent Plume
Problem Definition and Remedial Approach
Source Zone Concentration Map
Source Zone Characteristics

- Source contained in ~30 foot diameter zone in upper sand
- Base of contamination at top of mudstone confining layer (15-18 ft depth).
- TCE concentrations in source soil: 25-50 ppm (ave); 99 ppm (max)
- Plume concentration in source vicinity: 50 to 60 mg/l
Remedial Approach for Treating DNAPL Source Zone

ZVI in Clay Slurry

Diagram showing the remedial approach where groundwater is diverted around the source zone, and the spill is completely treated.
Source Zone Jetting Parameters

Primary Treatment - Jetted Columns

• Treatment slurry: 95% kaolinite clay mixed with 5% Peerless ZVI (-50 mesh)
• Treatment column diameter: 5-6 feet
• Column centerline distance: 4-5 feet

Secondary Cofferdam - Interlocking Panels

• Low K reactive thin wall cofferdam jetted around source area (95% clay with 5% ZVI)
Treatment Comparison of Source Zone Analytical Results

Post Treatment Expansion

Concentration of TCE in (mg/kg)

Sample ID

01A(12.5-12.6) 01B(13.0-13.1) 01C(12.8-12.9) 01D(13.2-13.3) 01G(13.8-13.9) 02B(14.0-14.1) 02K(13.8-13.9) 02Q(14.7-14.8)
GW Monitoring Near Source

- Concentrations remain unstable after 3 yrs
- Monitoring will continue
Source Treatment Conclusions

• Jetting successful for delivering ZVI and clay into source, though intimate mixing not achieved
• Jetting carries significant fraction of target contaminant to surface with “return” (non-issue in Kinston case)
• Process removed most of source TCE
• Auger mixing should be considered for future projects -- Possible advantages: Better mixing, little or no “return”