Results of the Kinston Jetted PRB and Source Treatment

Steve Shoemaker - DuPont Corp. Remediation Group
Rich Landis - DuPont Engineering

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RTDF Permeable Reactive Barriers Workgroup
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- John Vogan, Envirometal Technologies
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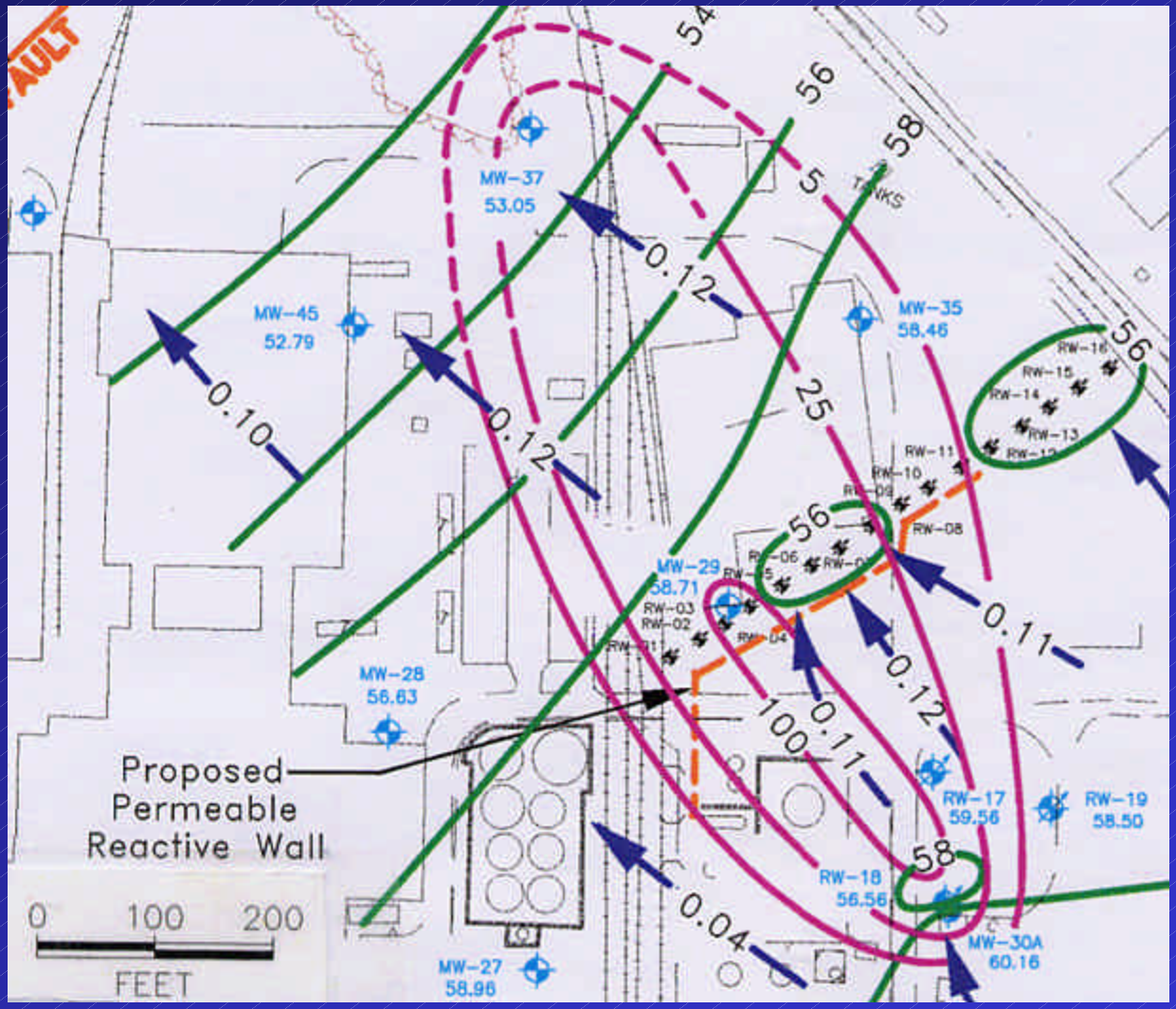
- Numerous other DuPont participants

Topics to be Covered

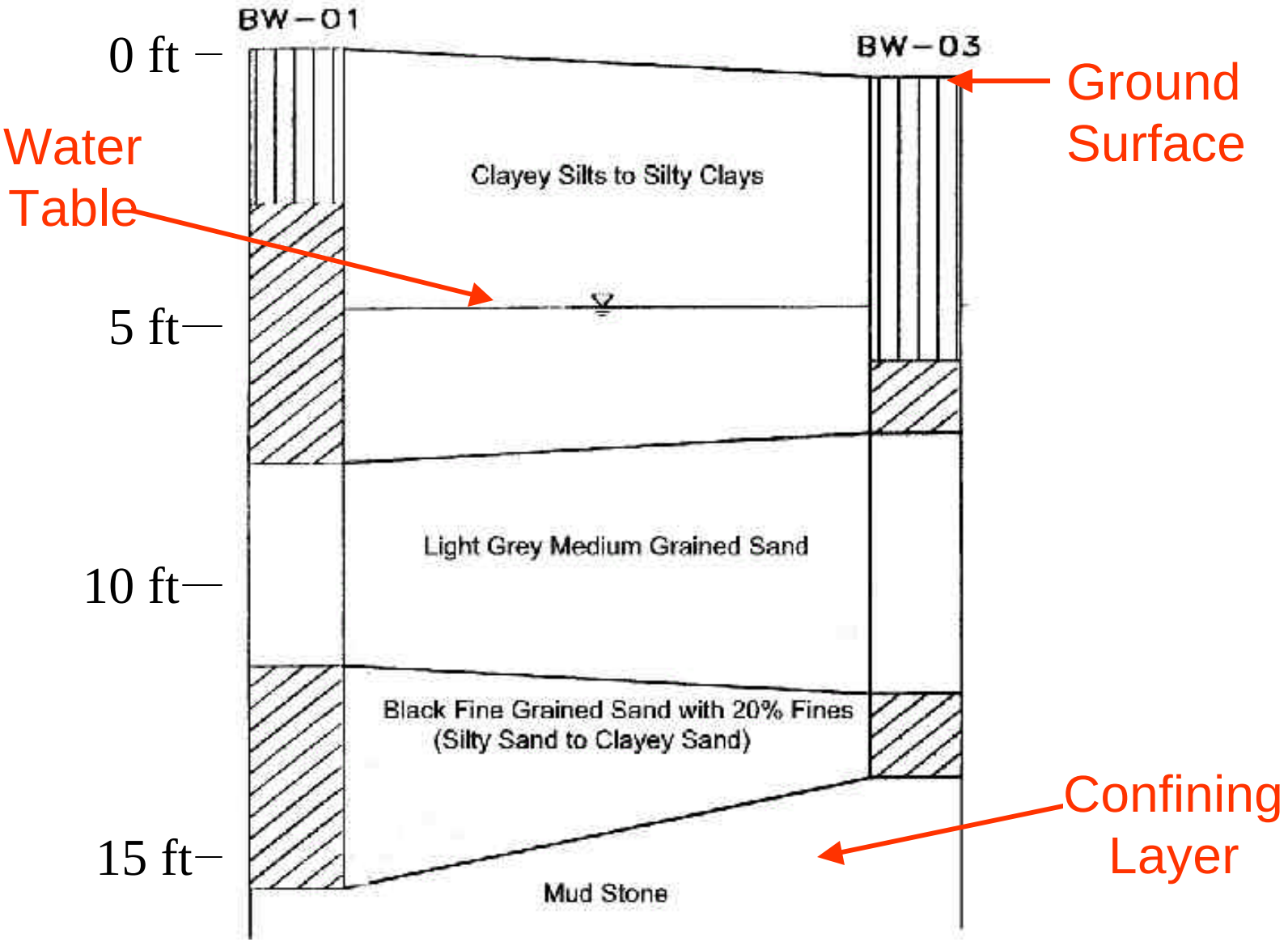
- Problem Definition
- Remedial Objectives
- Remedial Approach
- Jetting of Permeable Reactive Wall
- Field Demonstration of ZVI Source Treatment
- Results

DuPont Kinston Plant (NC)

Map of Impacted Area

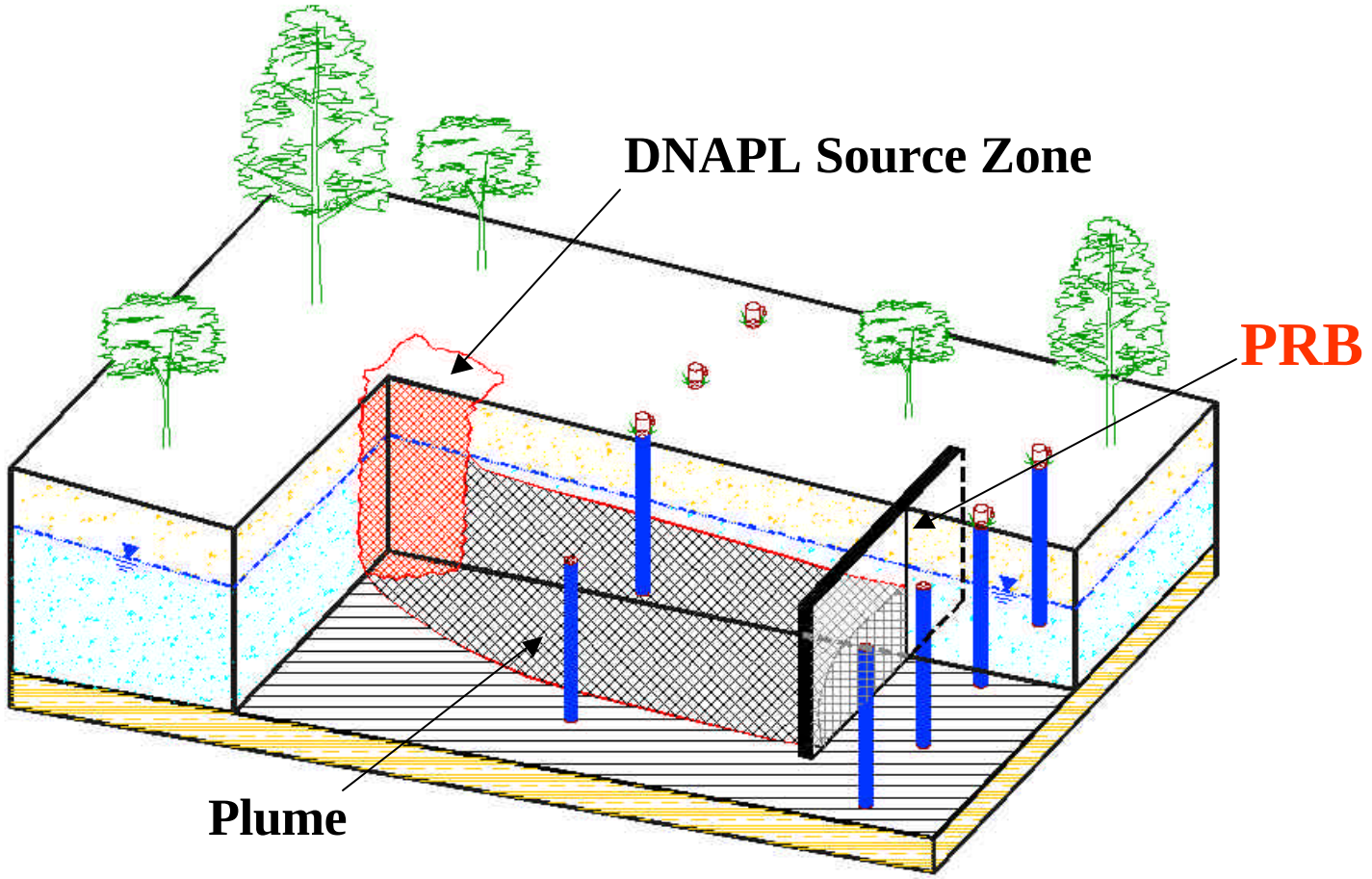


Geologic Cross Section



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**

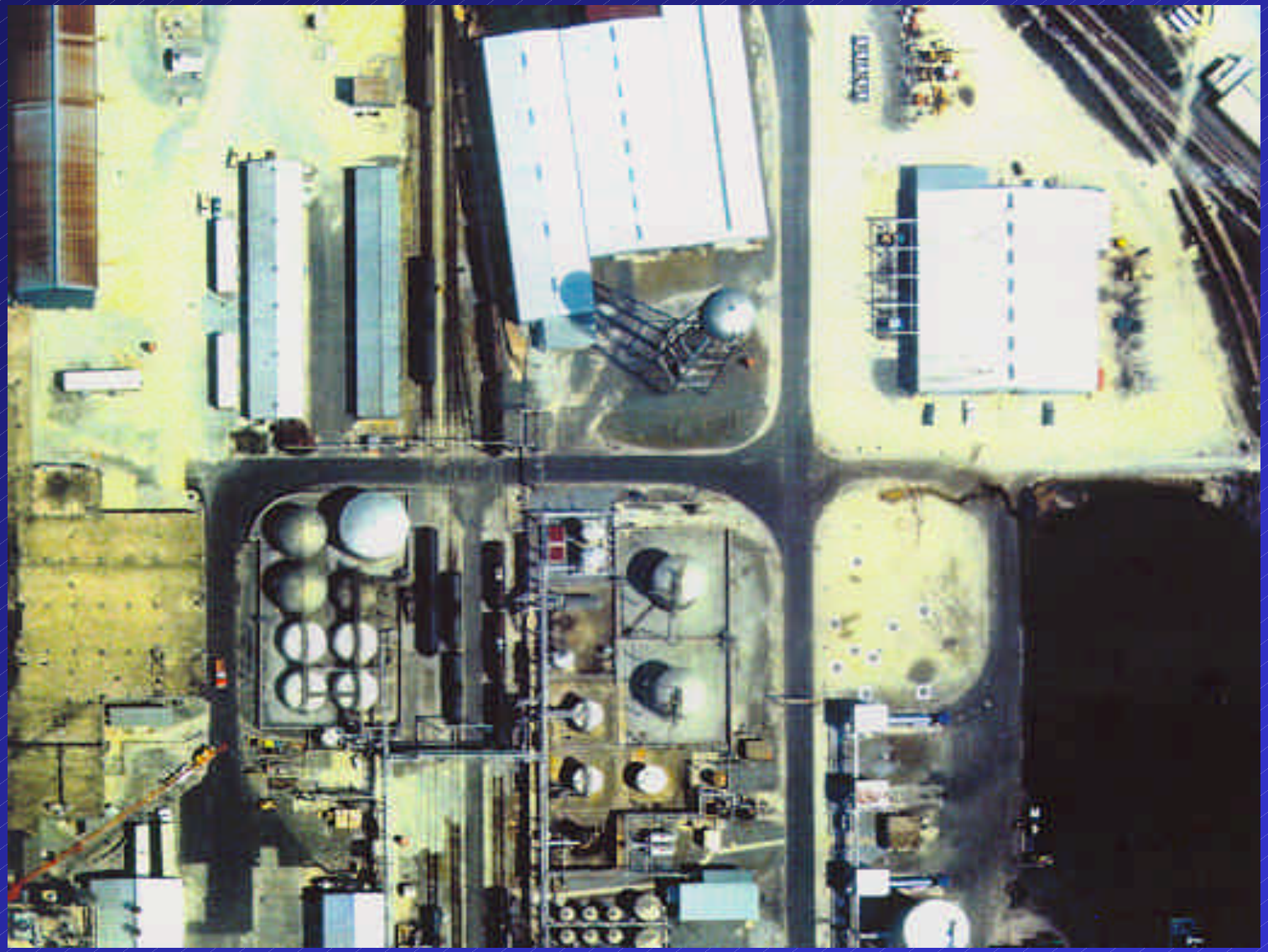


Chlorinated Solvent Plume
Problem Definition and Remedial Approach

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.

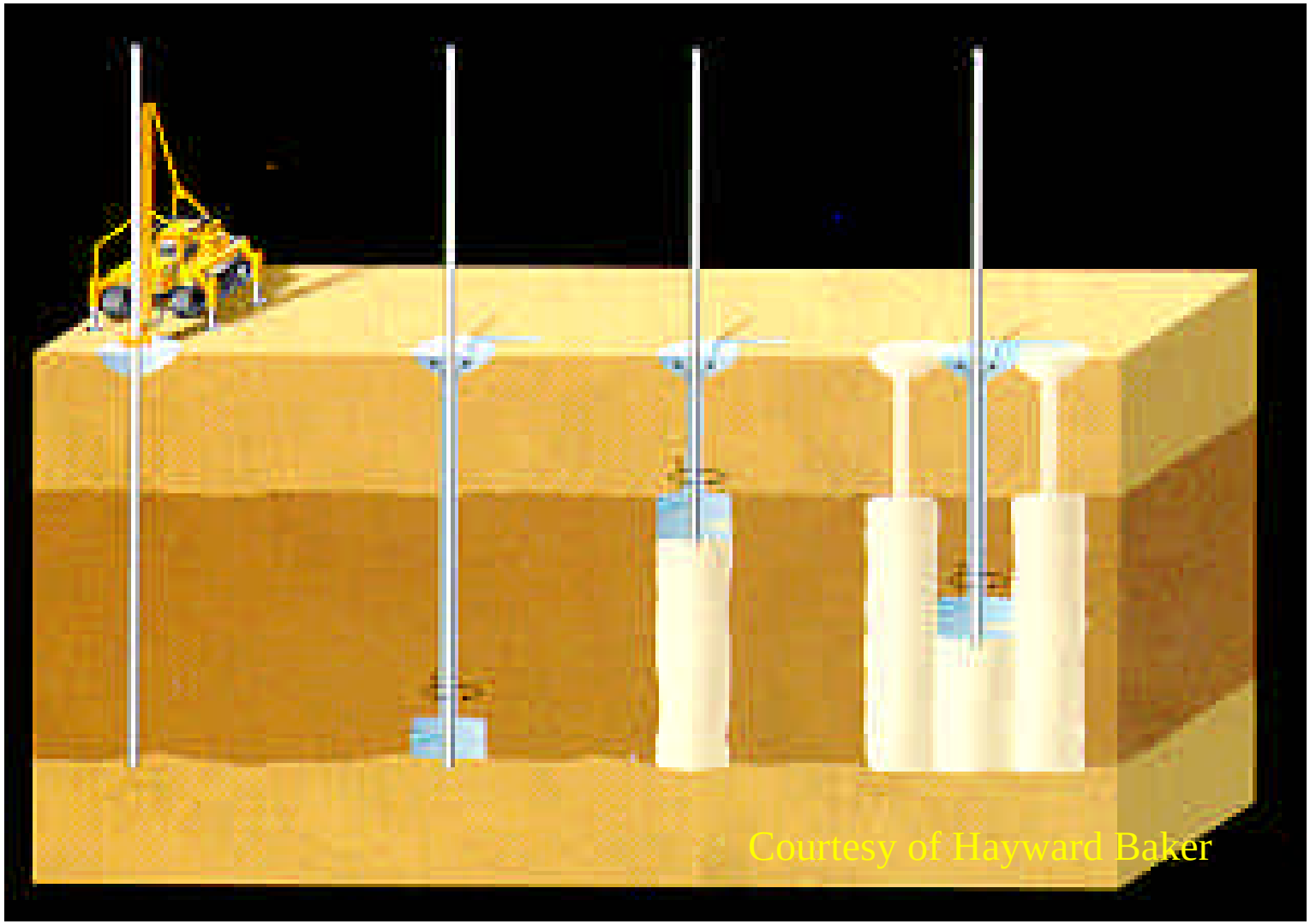
High Pressure Jetting

- 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

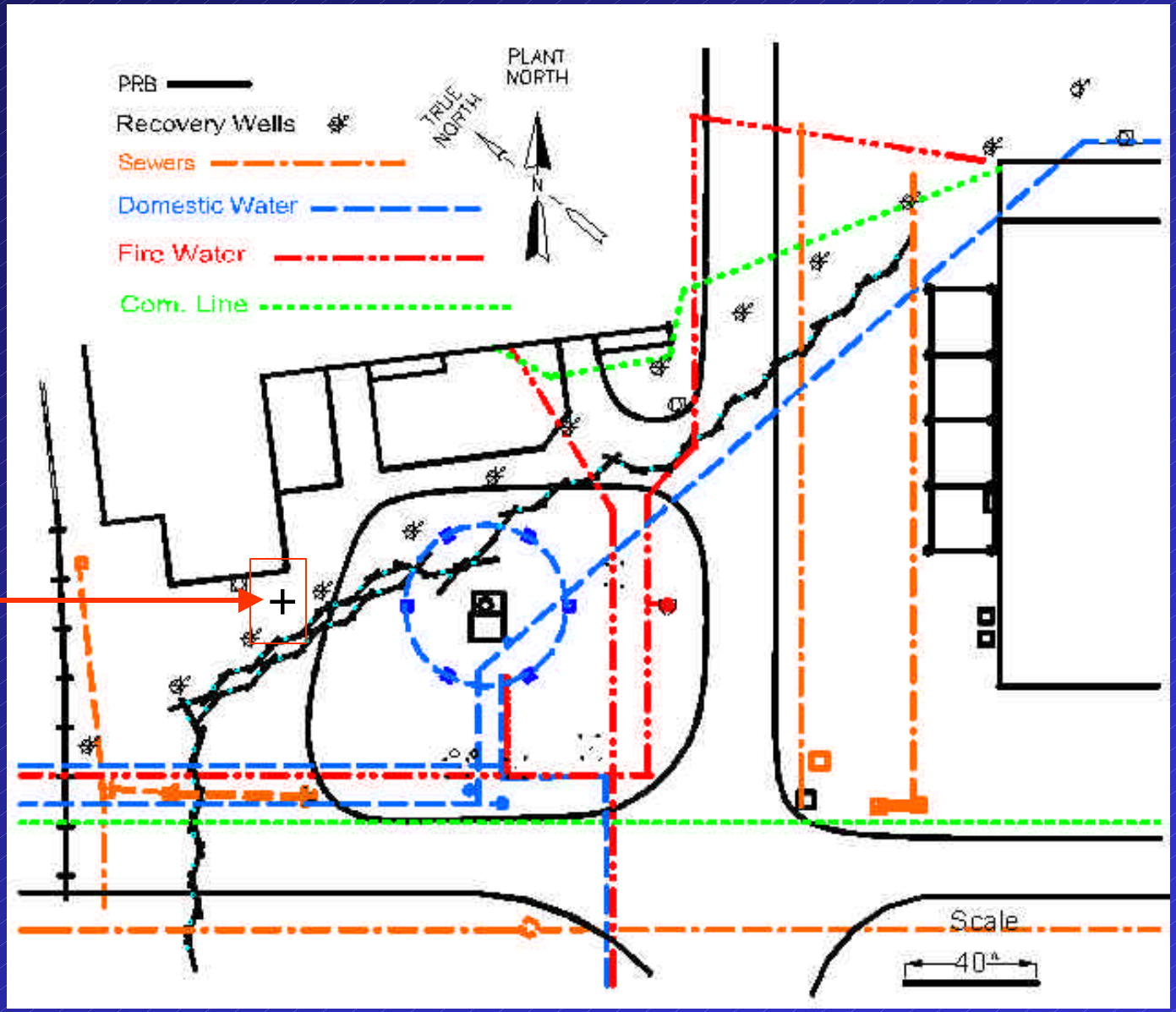
Jetting Process



Columnar Emplacement

Panel Emplacement

Plan View of PRB Alignment

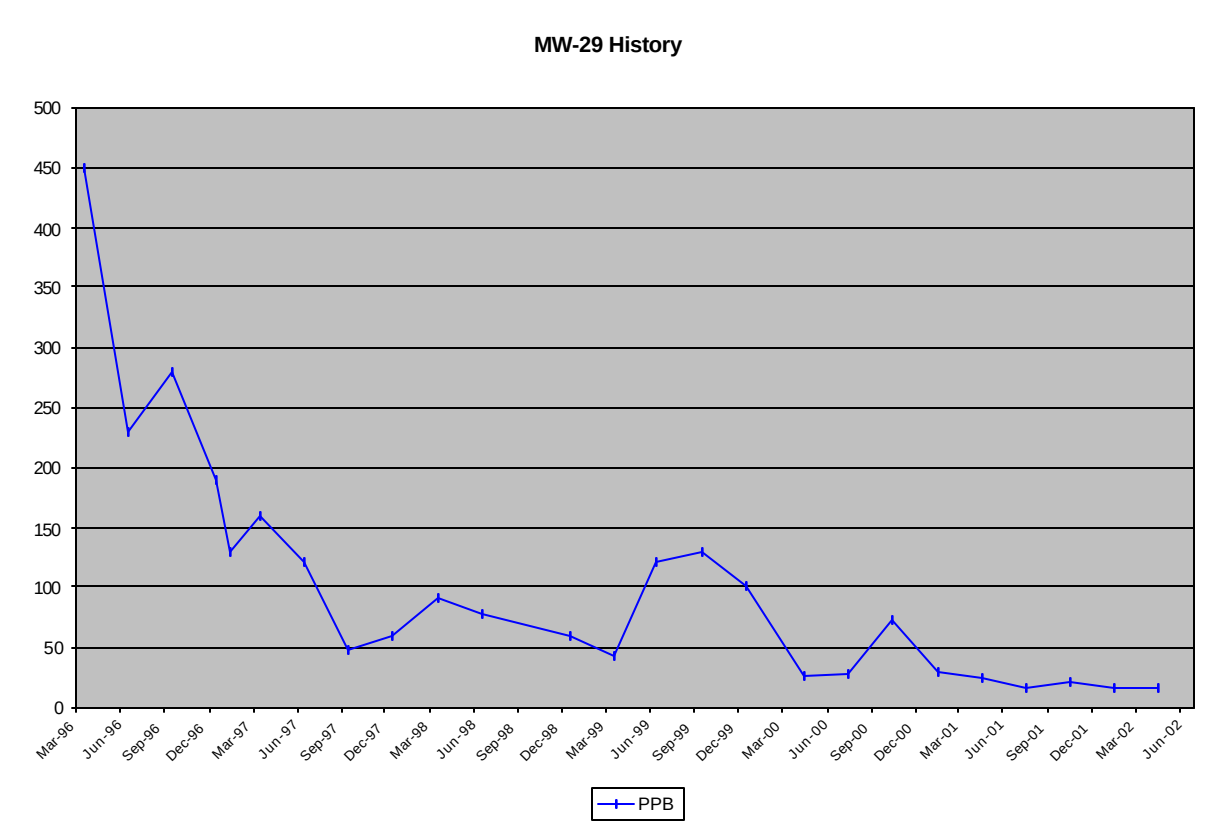


Highlights of Kinston PRB

- 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)

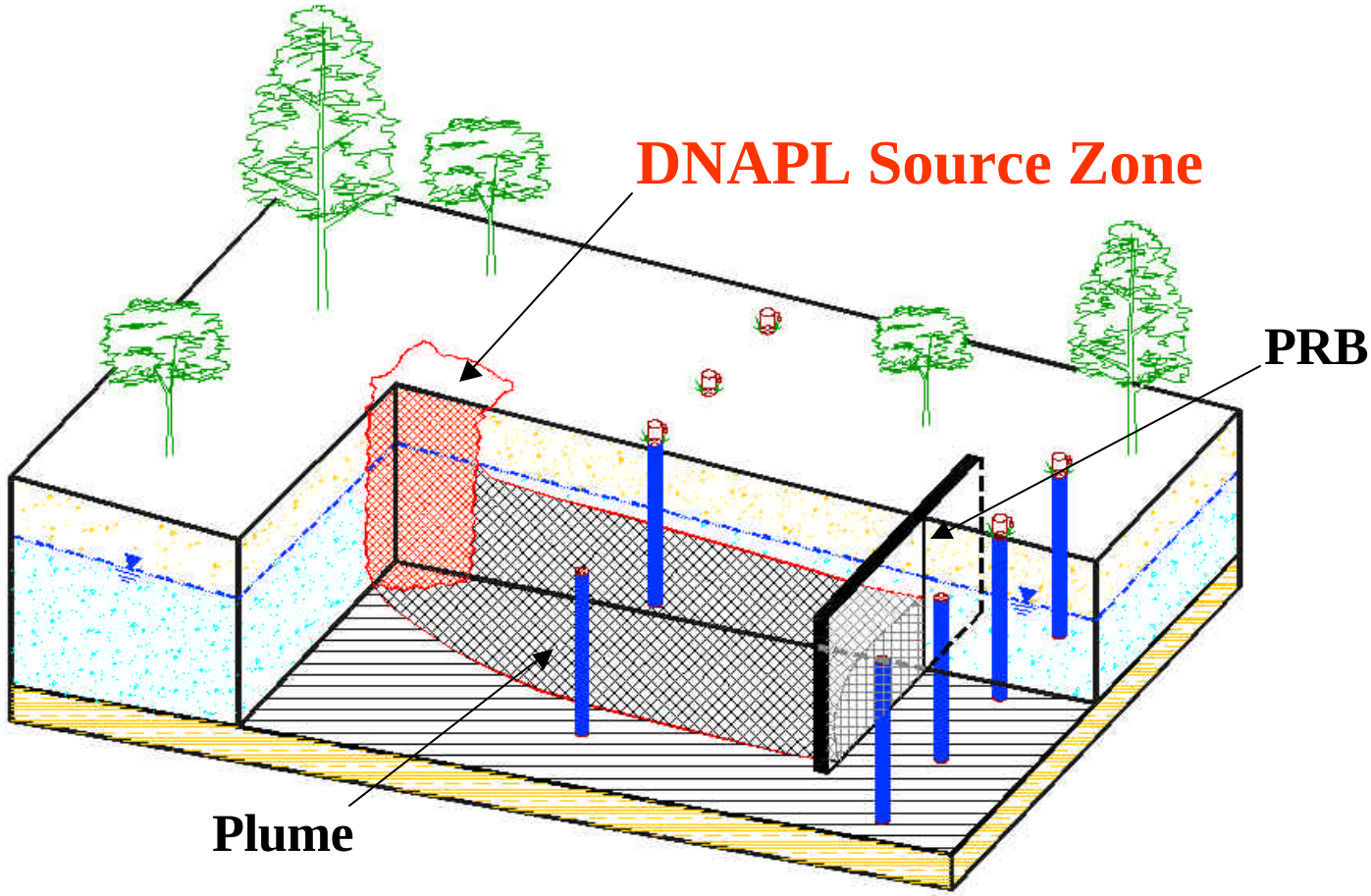
Jetted PRB Conclusions

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



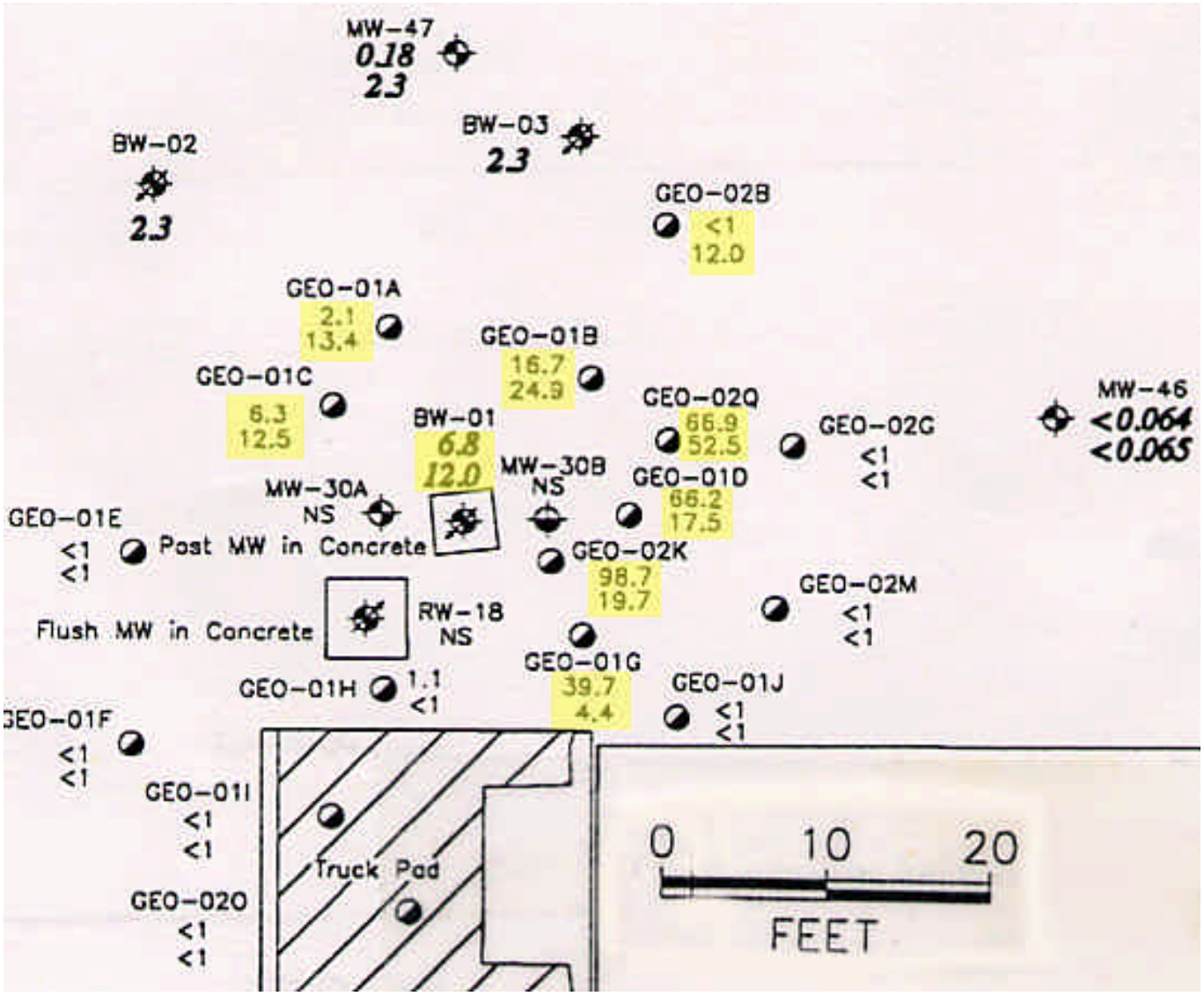
TCE in MW-29

- P&T shut down permanently in August 2001



Chlorinated Solvent Plume
Problem Definition and Remedial Approach

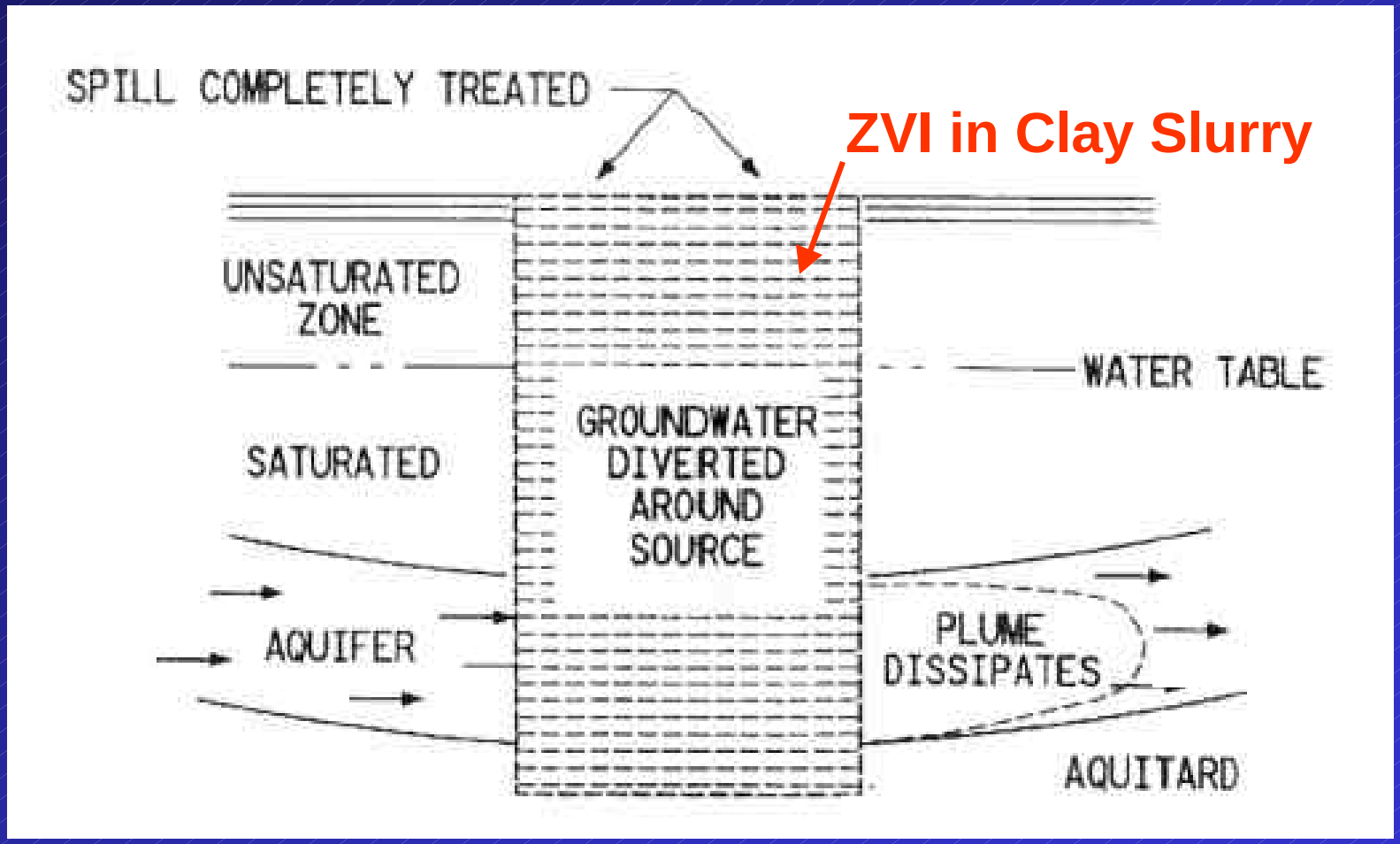
Source Zone Concentration Map



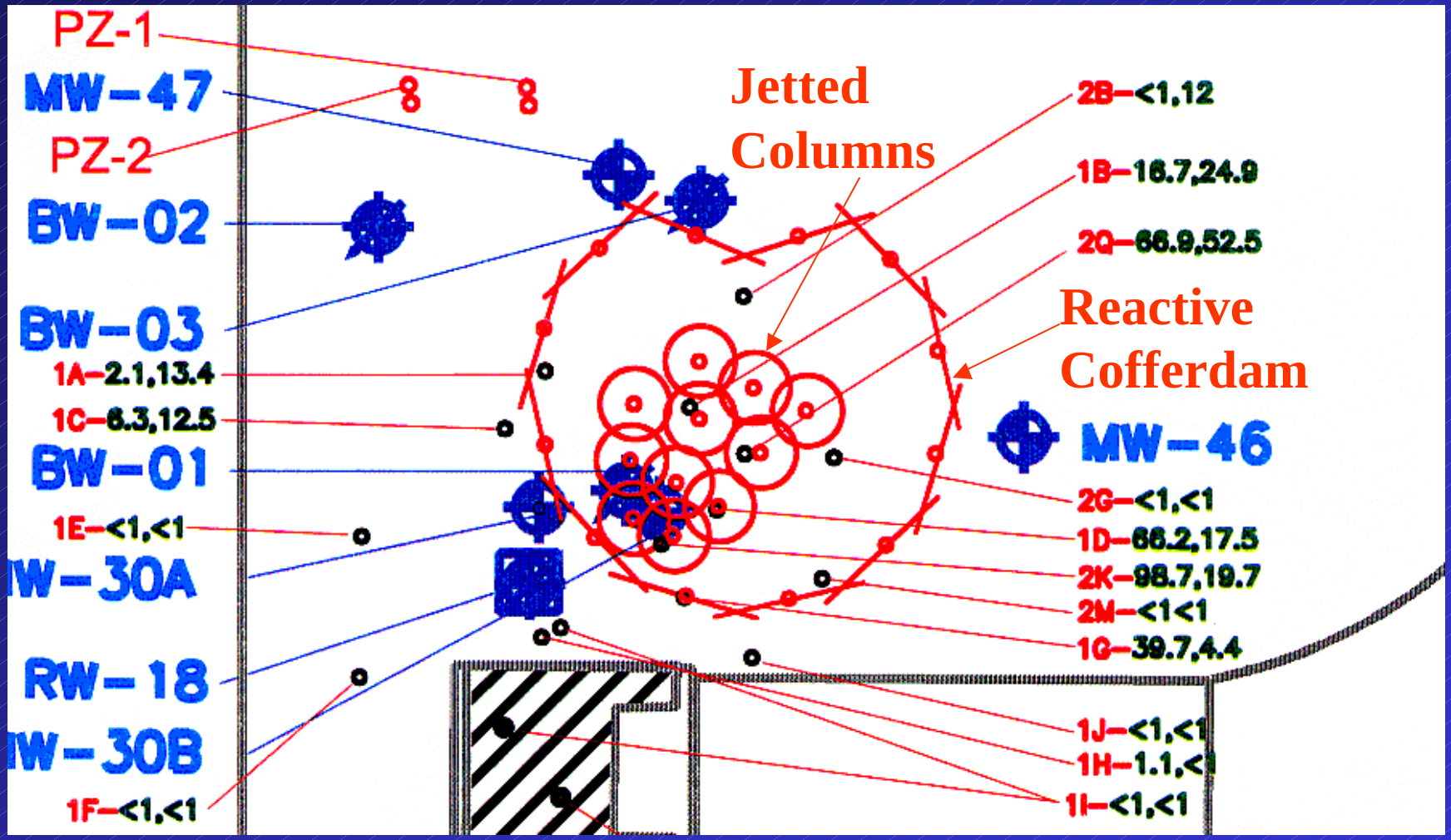
Source Zone Characteristics

- **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



Source Zone Concentration Map



Source Zone Jetting Parameters

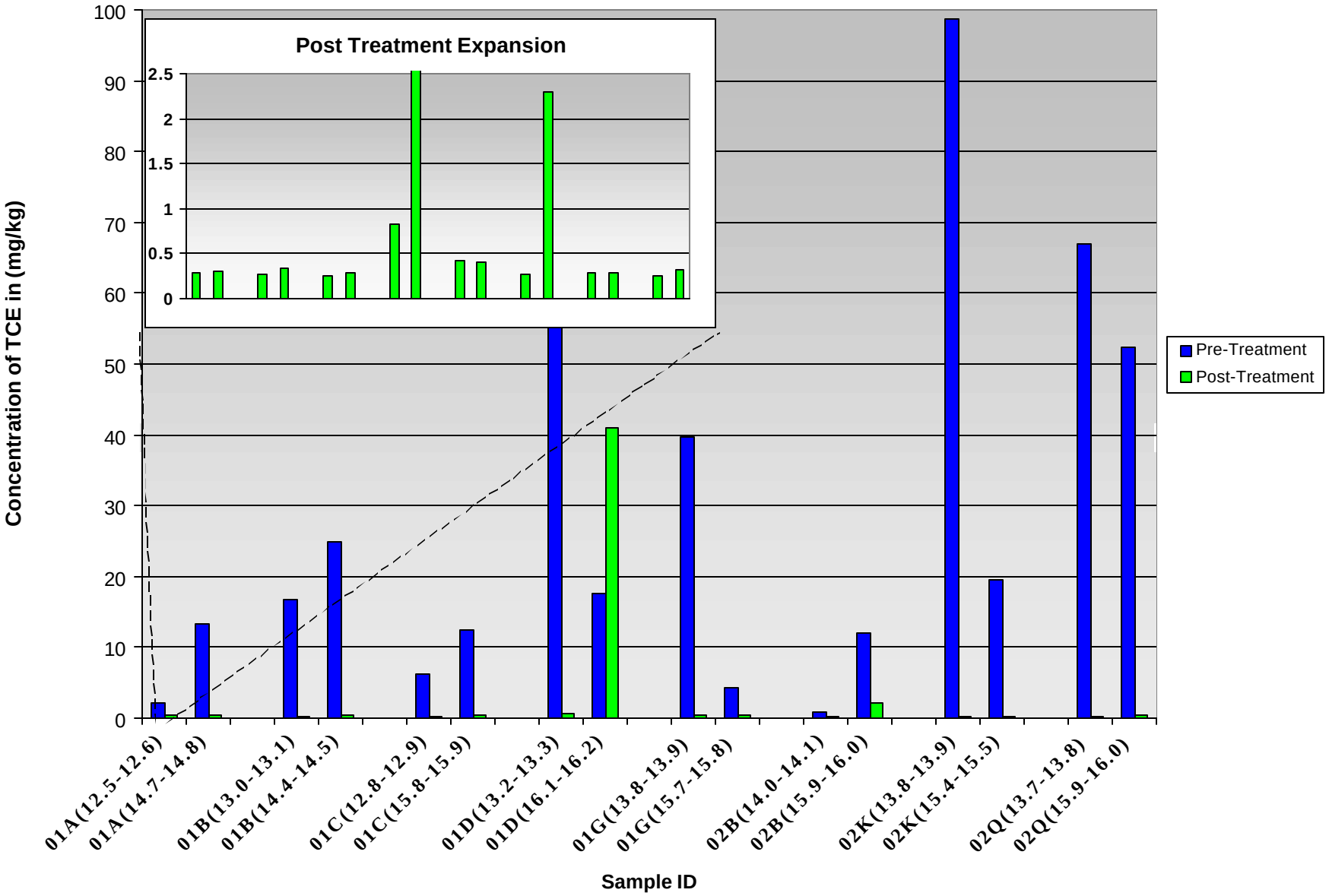
Primary Treatment - Jetted Columns

- 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

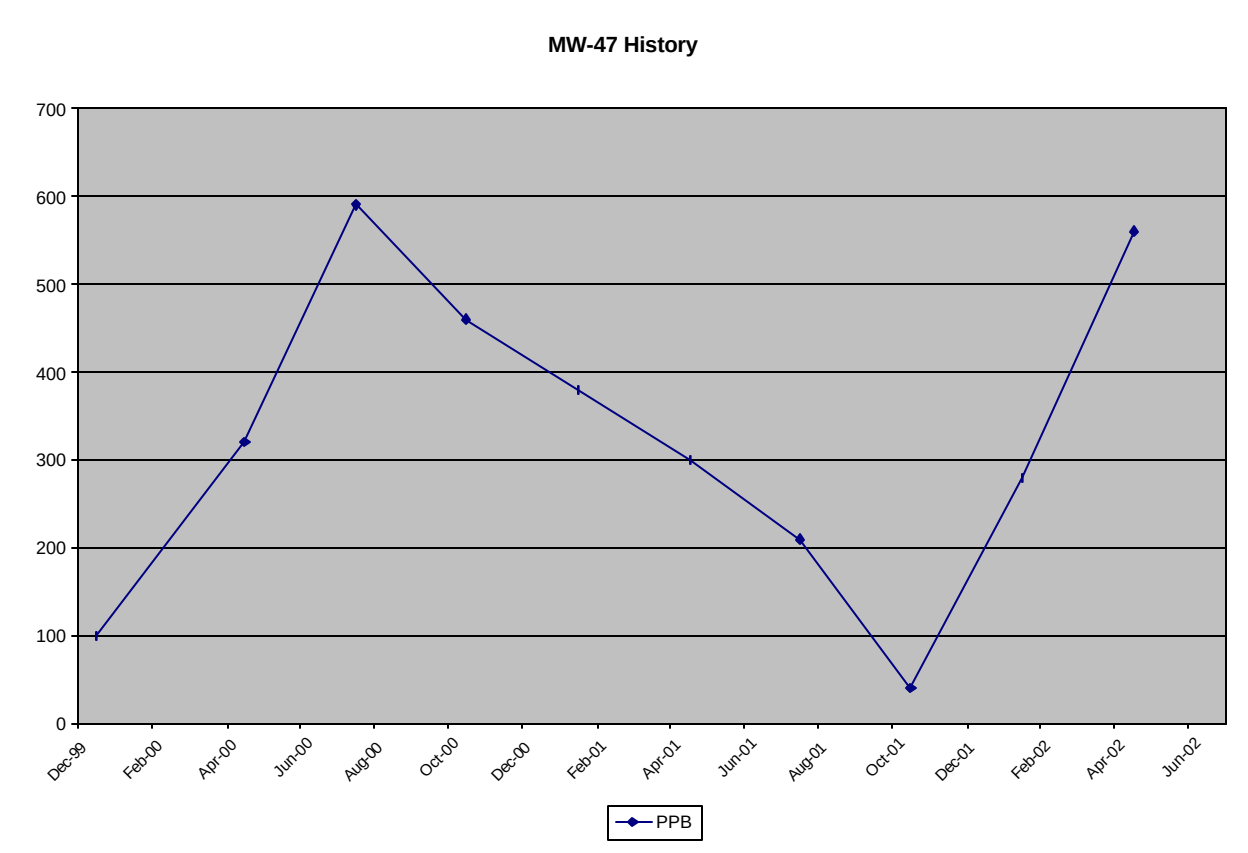
- Low K reactive thin wall cofferdam jetted around source area (95% clay with 5% ZVI)

Treatment Compasion of Source Zone Analytical Results



GW Monitoring Near Source

- Concentrations remain unstable after 3 yrs



TCE in MW-47

- 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”