RTDF Permeable Reactive Barriers (PRB)
Action Team Meeting
Albuquerque, New Mexico
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In Situ Remediation with Solid Organic Substrate and ZVI (*i.e.* EHC™)

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OUTLINE

- What is EHC?
- Site Background
- Laboratory Results – ZVI and EHC
- Pilot Design
- Injection Methods

What is EHC™?

- EHC™ is a solid material that provides:
  - Controlled-release solid carbon
  - Micro-scale zero valent iron (ZVI)
  - Major, minor, and micronutrients
- "Second Generation" development of Dr. Alan Seech's patents, which first lead to DARAMEND® soil bioremediation technology.

What is EHC™?

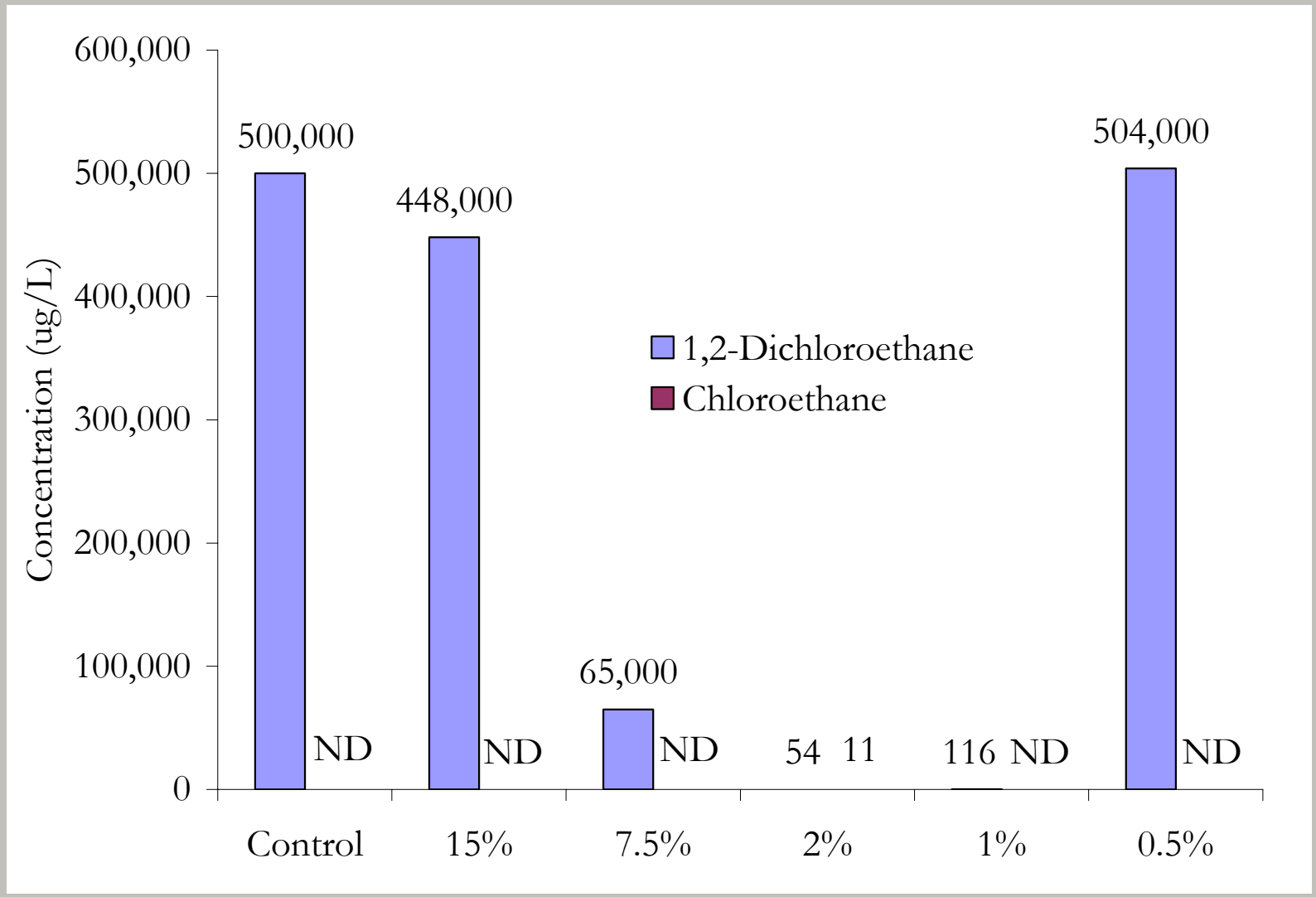
How does it work?

- Combines biological treatment of contaminant and direct reduction using ZVI.
- Increase in pH from the oxidation of Fe is offset by the release of acids from the fermentation of the carbon?
- Does not require direct contact between EHC and targeted contaminant.
- Controlled-release carbon expected to remain effective for 3 to 5 years depending on carbon source and processing methods.

List of Treatable Contaminants

- **EHC™ is highly effective in the treatment of**
  - **CT, CF, DCM (Methylene Chloride)**
  - **Chloroethanes, including 1,2-DCA and 1,1-DCA**
  - **Chloroethenes**
  - **Perchlorate**
  - **Pentachlorophenol**
  - **Chlorinated pesticides**
  - **Organic explosives compounds**

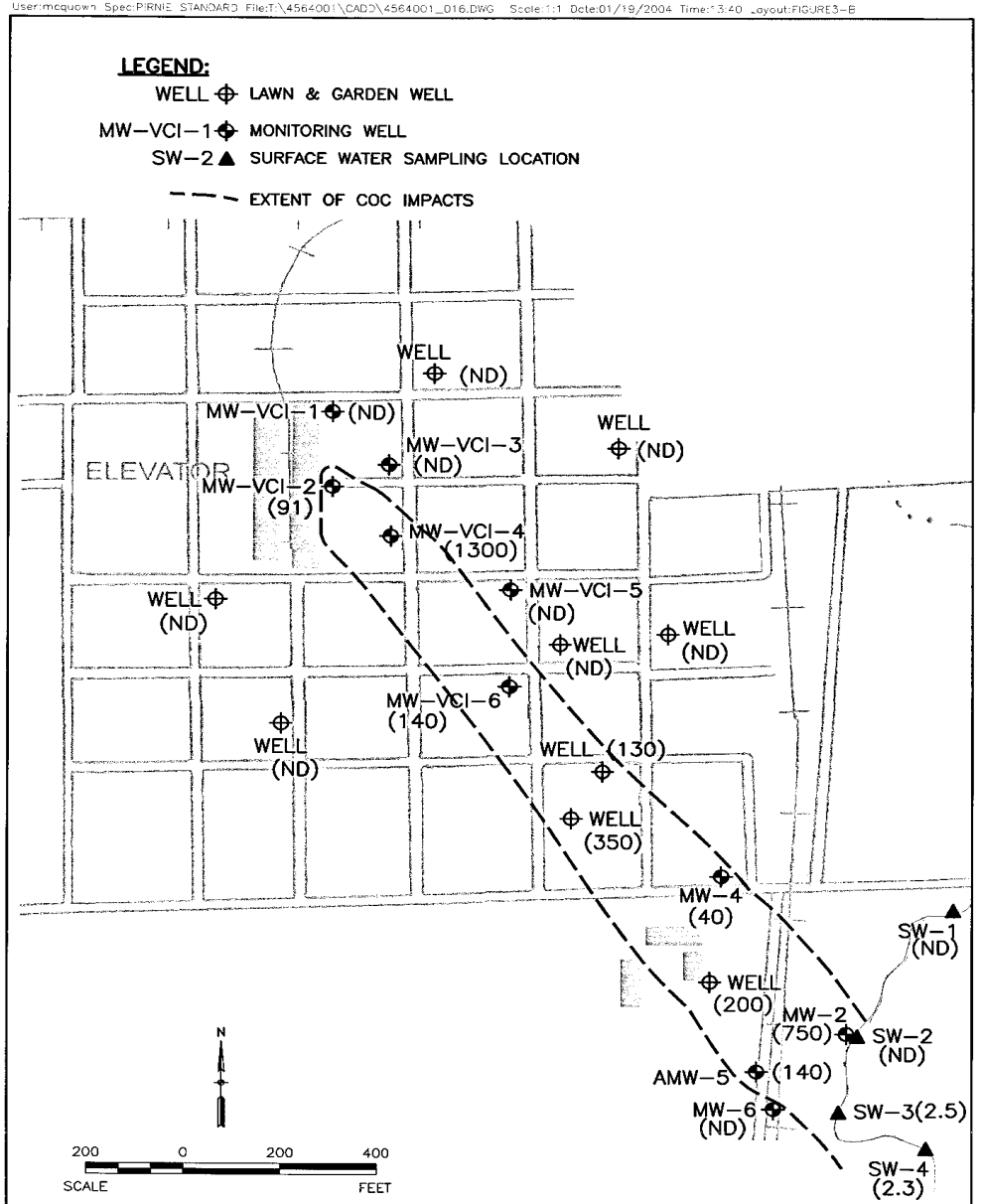
Effect of EHC Application Rate on 1,2-Dichloroethane and Chloroethane



Site Summary

- **Active grain storage facility (silo) midwest USA**
- **CT concentrations as high as 4,000 ppb in source area.**
- **Dissolved CT impacts observed in creek, *ca*. 2,000 ft down gradient.**
- **Residential irrigation wells impacted by CT and CF.**

User:mcquown Spec:PIRNIE_STANDARD File:T:\4564001\CADD\4564001_016.DWG Scale:1:1 Date:01/19/2004 Time:13:40 Layout:FIGURE3-B



MALCOLM PIRNIE

2003 CARBON TETRACHLORIDE CONCENTRATIONS
SCALE: AS SHOWN

MALCOLM PIRNIE, INC.
AUGUST, 2003
FIGURE 3

Project Goals

- **Reduce concentrations of CT and its catabolites in ground water to Risk-Based Standards down gradient of the Site**
- **Minimize or eliminate impact on creek**
- **Diminish the potential for consumption of impacted groundwater**
- **Strive for site closure from environmental perspective**

Bench-Scale Studies
Dispersed EHC Configuration

- 400 ml glass columns
- Site soil dispersed with Low (0.5 to 0.7% wgt) or High (2.2 to 3.7% wgt) EHC products
- Flow rate 150 ml/day = 1.3 d HRT
- Velocity = 24 cm/day

Bench-Scale Studies
EHC PRB Configuration

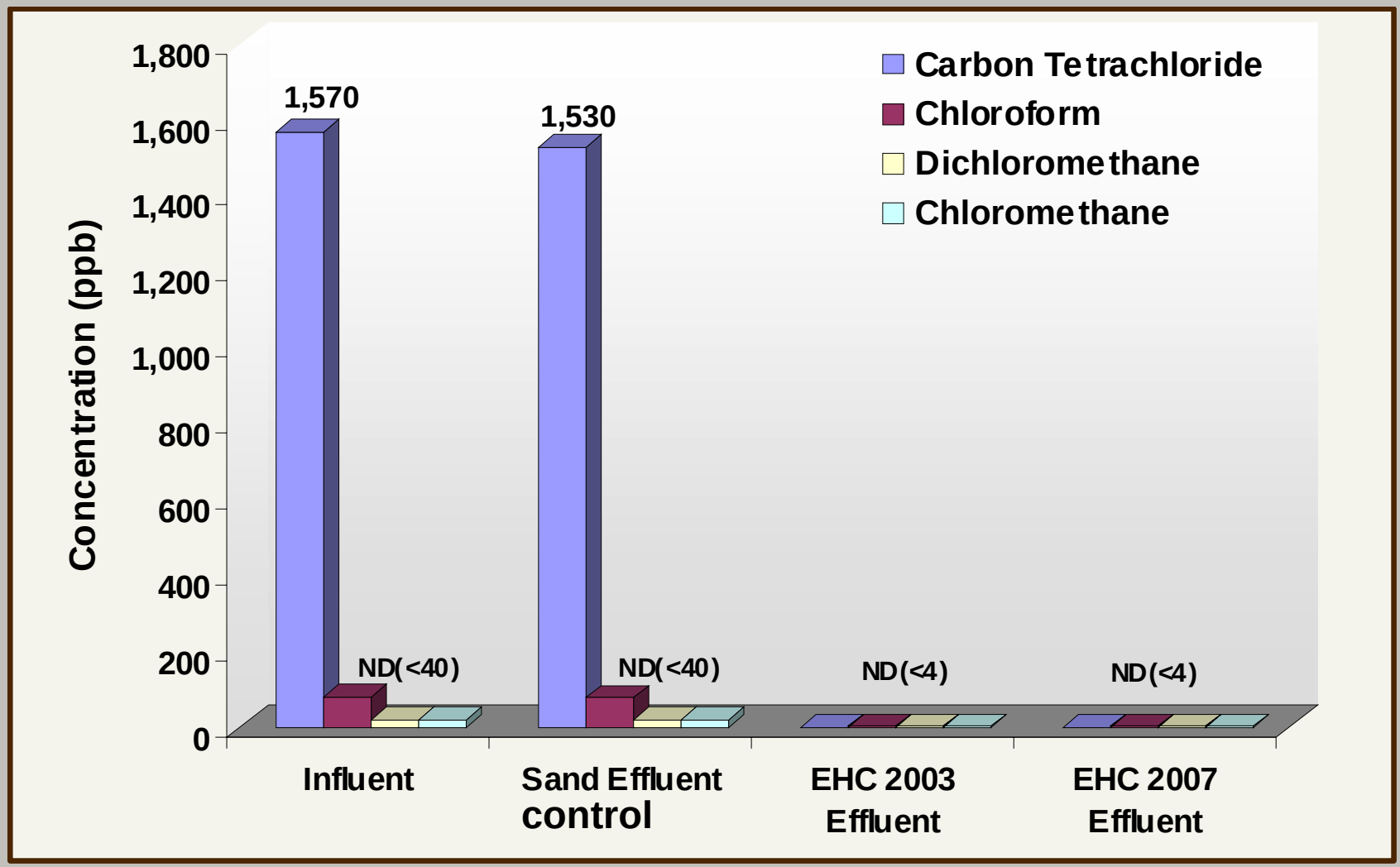
- **Plexiglass columns 50 cm long x 5 cm diam with 15 to 37% mass EHC products and medium grained clean sand**

- **1.5 m long x 10 cm diam PVC "attenuation" columns containing site soil**

- **Flow rate 150 ml/day = 50 hr and 20 d HRT, respectively**

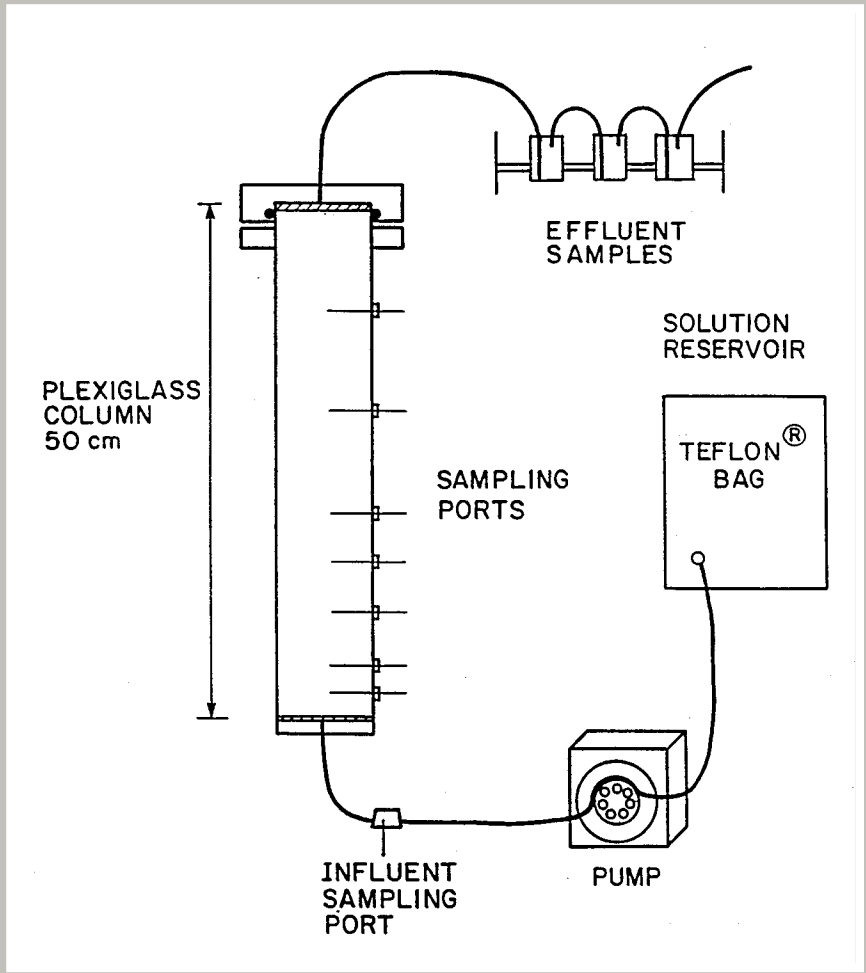
- **Velocity = 24 cm/day in reactive column; 6 cm/day in attenuation**

Dispersed EHC Columns Provided Most Effective Treatment

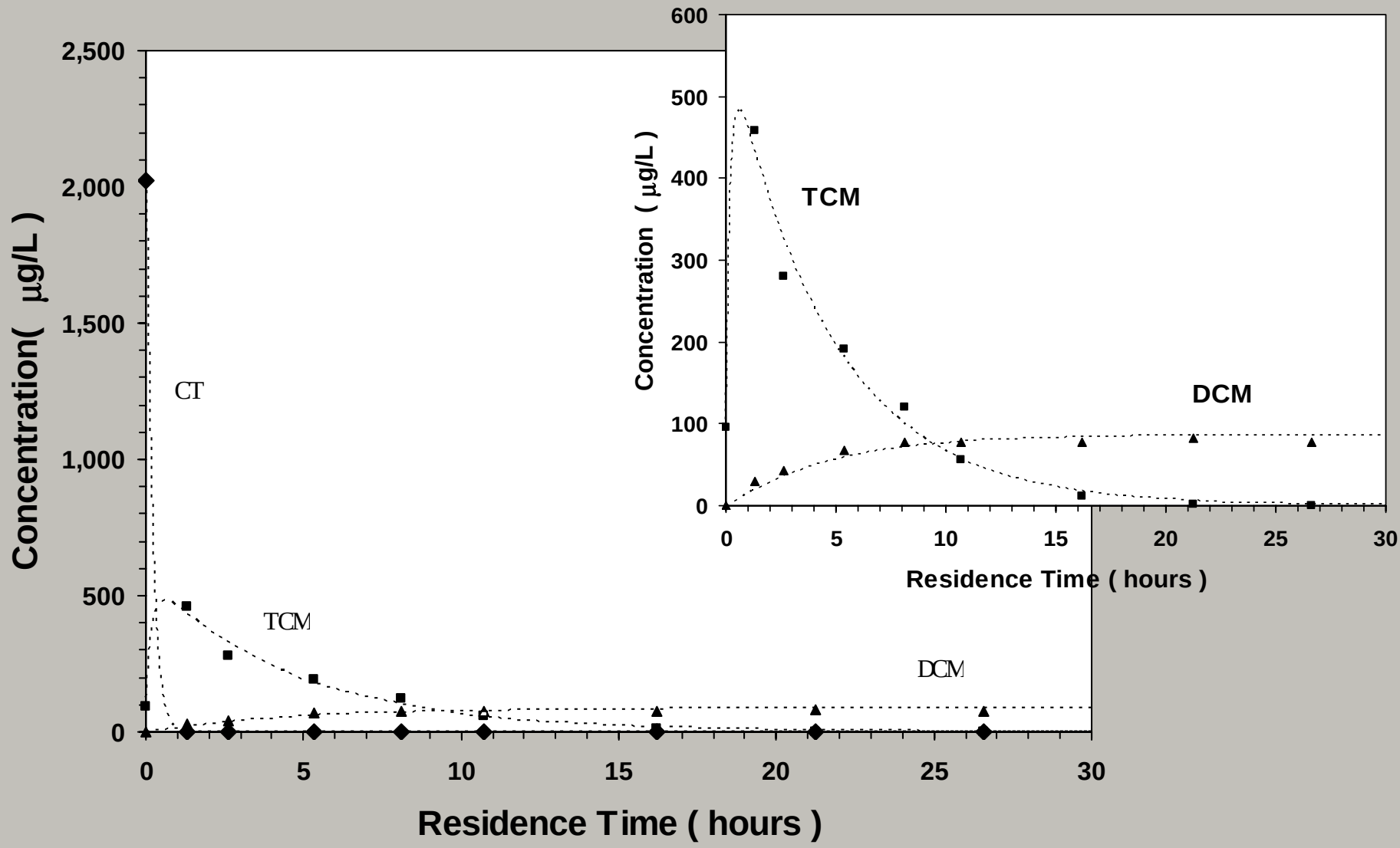


Bench-Scale Studies
ZVI Only (ETI)

- One column 50 cm long x 3.8 cm diam
- 100% granular iron (Connelly CC-1004, –8 to +50 US Standard Mesh)
- Velocity of 45 cm/day = 27 hr HRT
- Sample ports 2.5, 5, 10, 15, 20, 30 and 40 cm from inlet



RESULTS
ZVI Only (ETI)

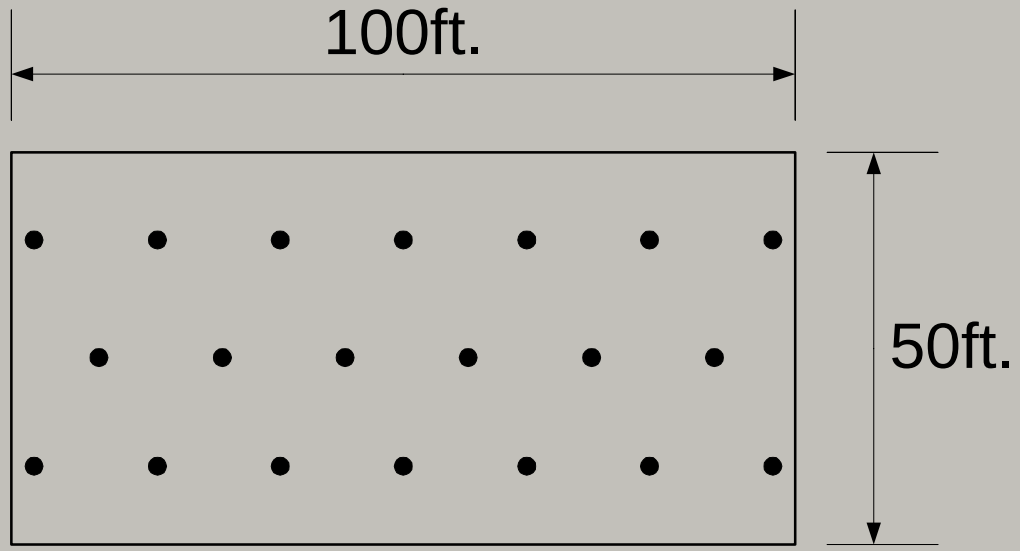


Pilot Test Design

- Client chose to pilot EHC for source zone treatment
- Target treatment area: 100’ x 50’ x 10’ thick (from 30’ to 40’ depth)
- EHC application rate of 1% based on results of bench testing
- Hydraulic fracturing proposed

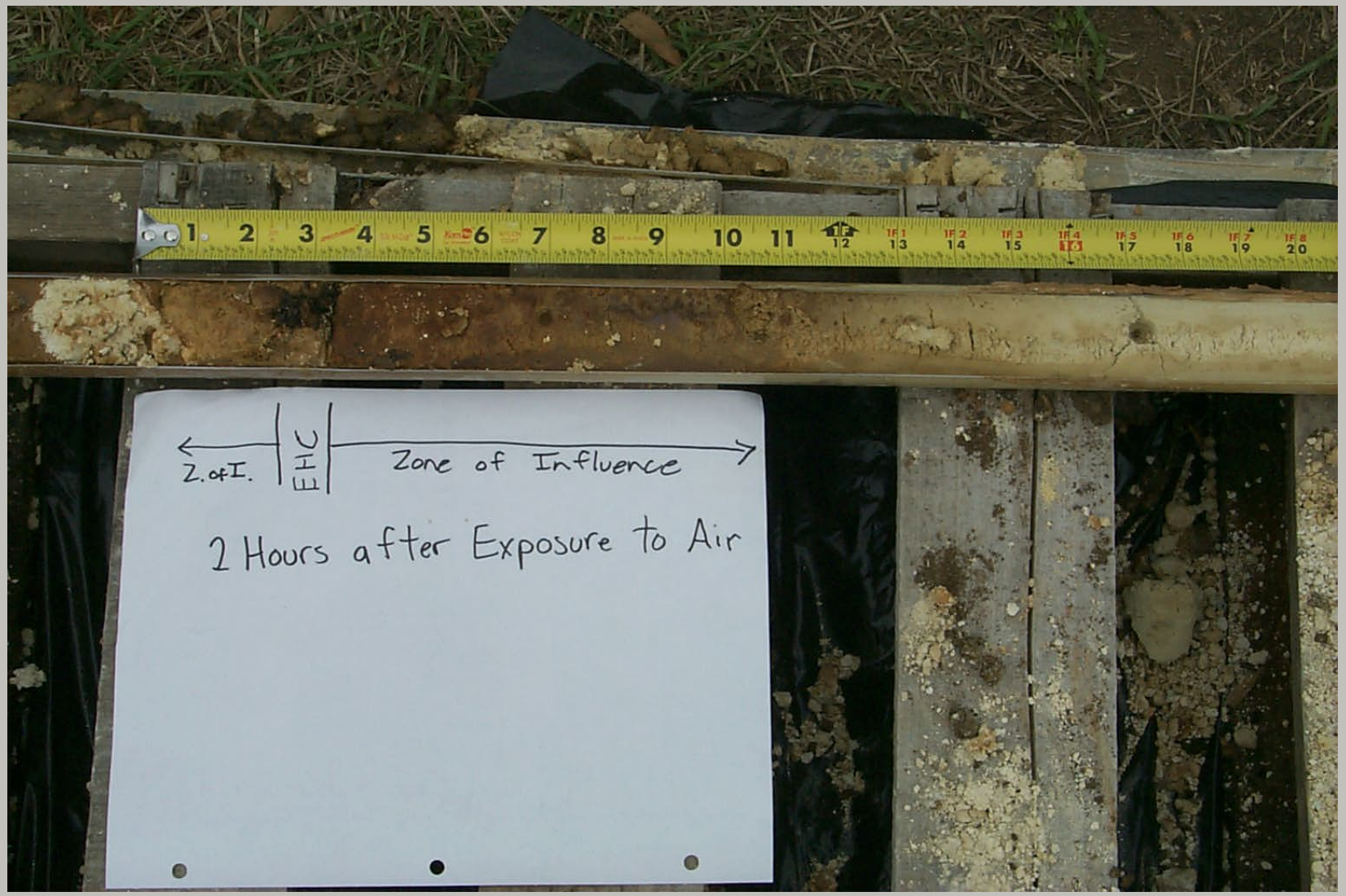
Injection Details

- 20 injection points at approx 10 ft spacings
- Three layers per location
- 1,000 lbs of EHC per injected layer



Injection Methods
Hydraulic Fracturing

EHC™ Zone of Influence around Fracture



Injection Methods
Direct Injection

Injection Methods
Pneumatic Injection and High Pressure Water Jetting

- **Pneumatic injection using pressurized nitrogen and dry EHC media feed. May provide higher initial energy near injection borehole.**

- **High pressure water jetting being researched for the injection of EHC slurry at very high pressures and velocities (University of Missouri-Rolla)**

Contact Information

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