USING EMULSIFIED EDIBLE OIL SUBSTRATE FOR *IN SITU* BIOREMEDIATION OF A TCE SOURCE AREA

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Tarheel Army Missile Plant

(U.S. Army Environmental Command)

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Award-Winning Project

2007 National Ground Water Association

Outstanding Ground Water Project Award

(Remediation – Below Median Cost)

"The Three-Month Success Story Solves a 10-Year Problem at the Tarheel Army Missile Plant"

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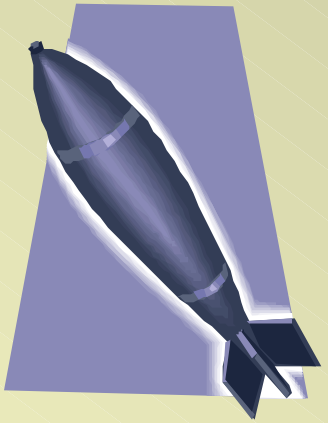
Site Activities

- Government (Army)-Owned, Contractor Operated Facility in Burlington, North Carolina
- 50-year history of defense-related activities (1944-1992)
  - Missile electronics manufacturing and maintenance
  - Fuel and solvent storage



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Site History

- 1993: Soil and groundwater contamination discovered: primarily BTEX and TCE
- 1995: AS/SVE
- 1999: Pump & Treat
- 2003: Army wanted to sell property
- 2004: Solutions-IES was retained to perform bioremediation pilot test to address TCE source area

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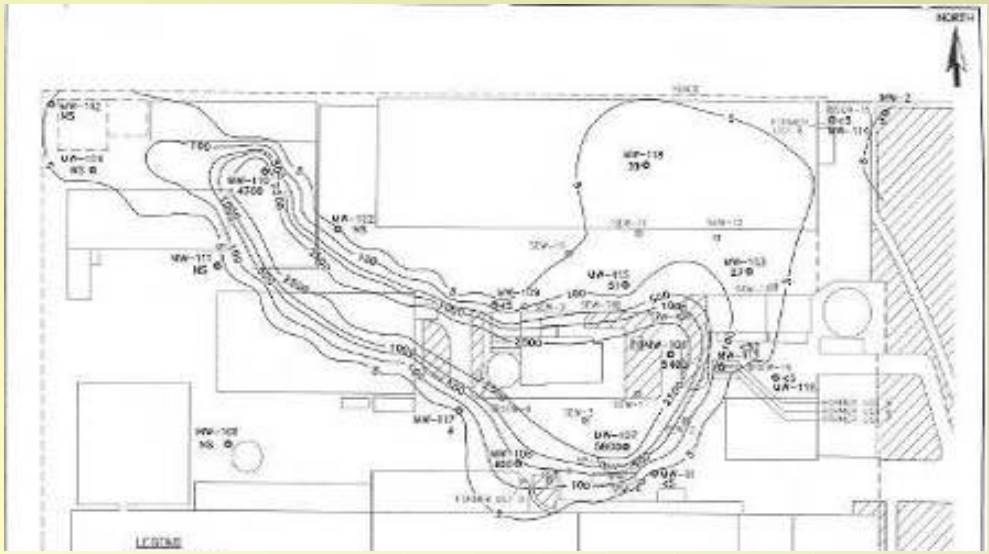
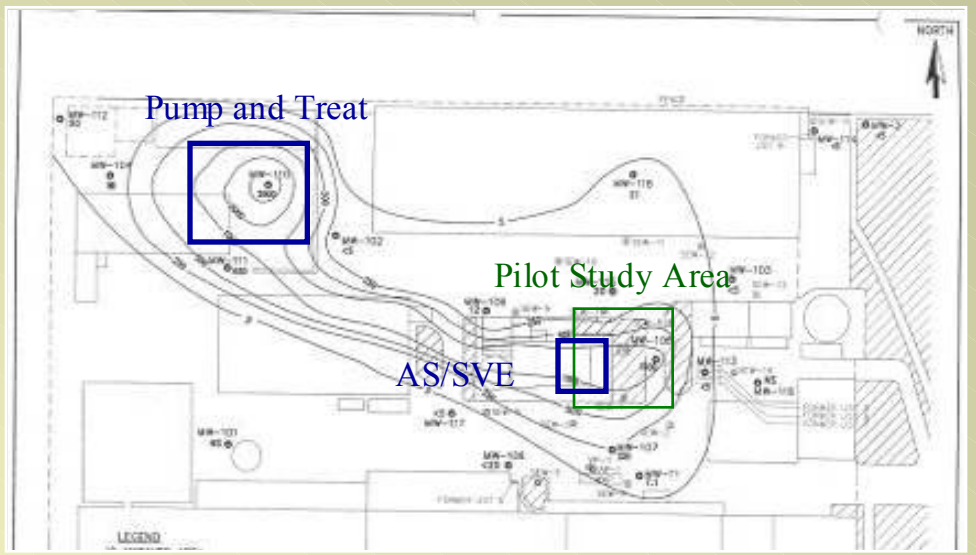
TCE in Groundwater

1995



Borrowed from Roy F. Weston, Inc., November 21, 1994.

2003



Borrowed from Weston Solutions, Inc., July 2003.

Groundwater Flow Direction

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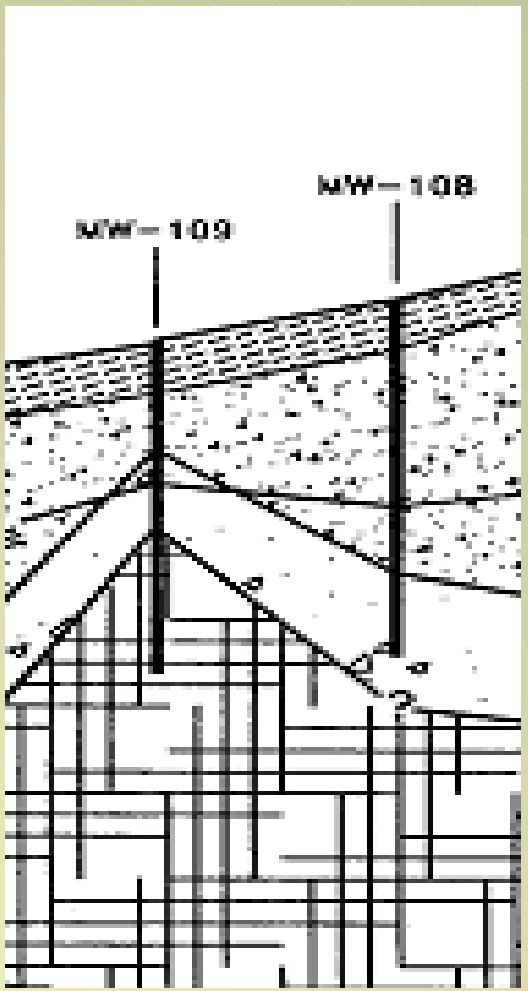
Site Conditions

- Geology/Hydrogeology
  - Clayey residual soils, low permeability
  - Groundwater velocity ~ 24 ft/yr
  - Bedrock 12 to 30 feet bgs
  - Depth to groundwater ~ 6-12 ft bgs
- Contaminants/Chemistry
  - Oxidative subsurface conditions due to AS
  - Chlorinated solvents up to 2.5 mg/L
  - No NAPL



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Bioremediation Strategy

- Install a grid of injection wells
- Inject an emulsified oil substrate
  - EOS® from EOS Remediation, Inc.
- Verify adequate distribution of emulsion
- Monitor GW geochemistry

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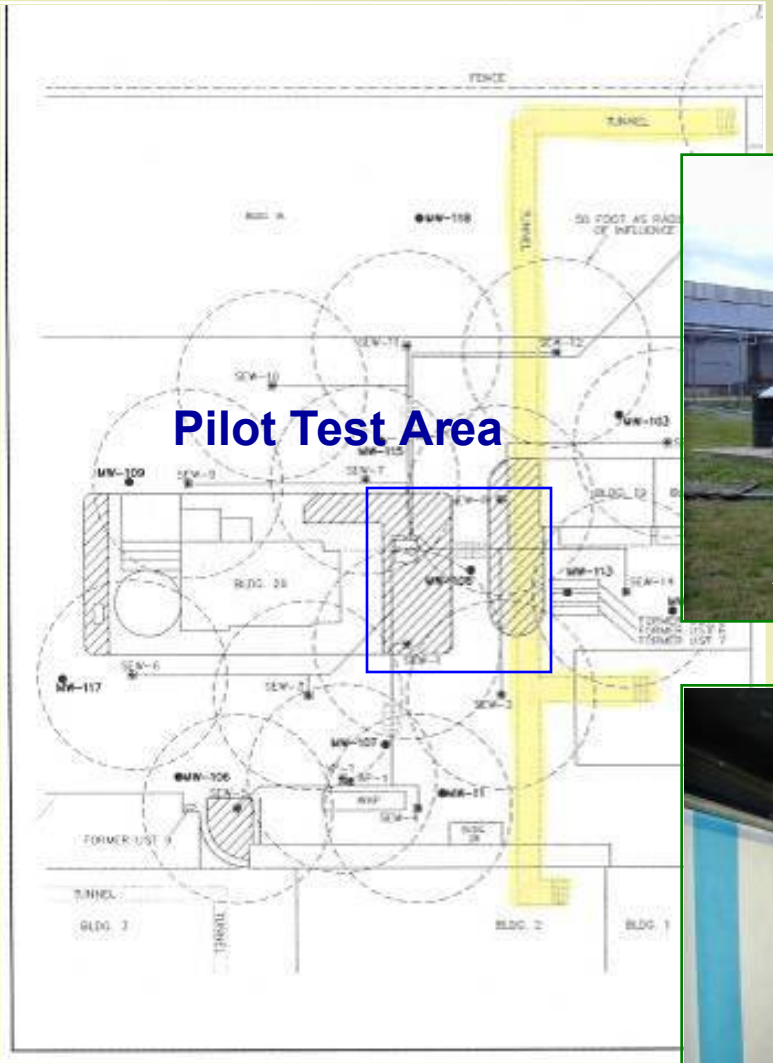
Engineering Challenges



- Extensive Infrastructure
  - Concrete
  - Tunnel
  - AS/SVE System
- Oxygenated Conditions

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Injection Optimization

- Issues
  - Low permeability
  - Expensive drilling
  - Tunnel influence on groundwater
  - Shallow groundwater table
- Solutions
  - Limited number of injection points
  - Recirculated groundwater to enhance EOS distribution and eliminate mounding
  - Developed a model to simulate injection and optimize injection locations

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Groundwater Recirculation

- Worked closely with NCDENR to re-circulate contaminated groundwater as “chase” water
- Obtained UIC permit
- Connected well pair recirculation piping below grade

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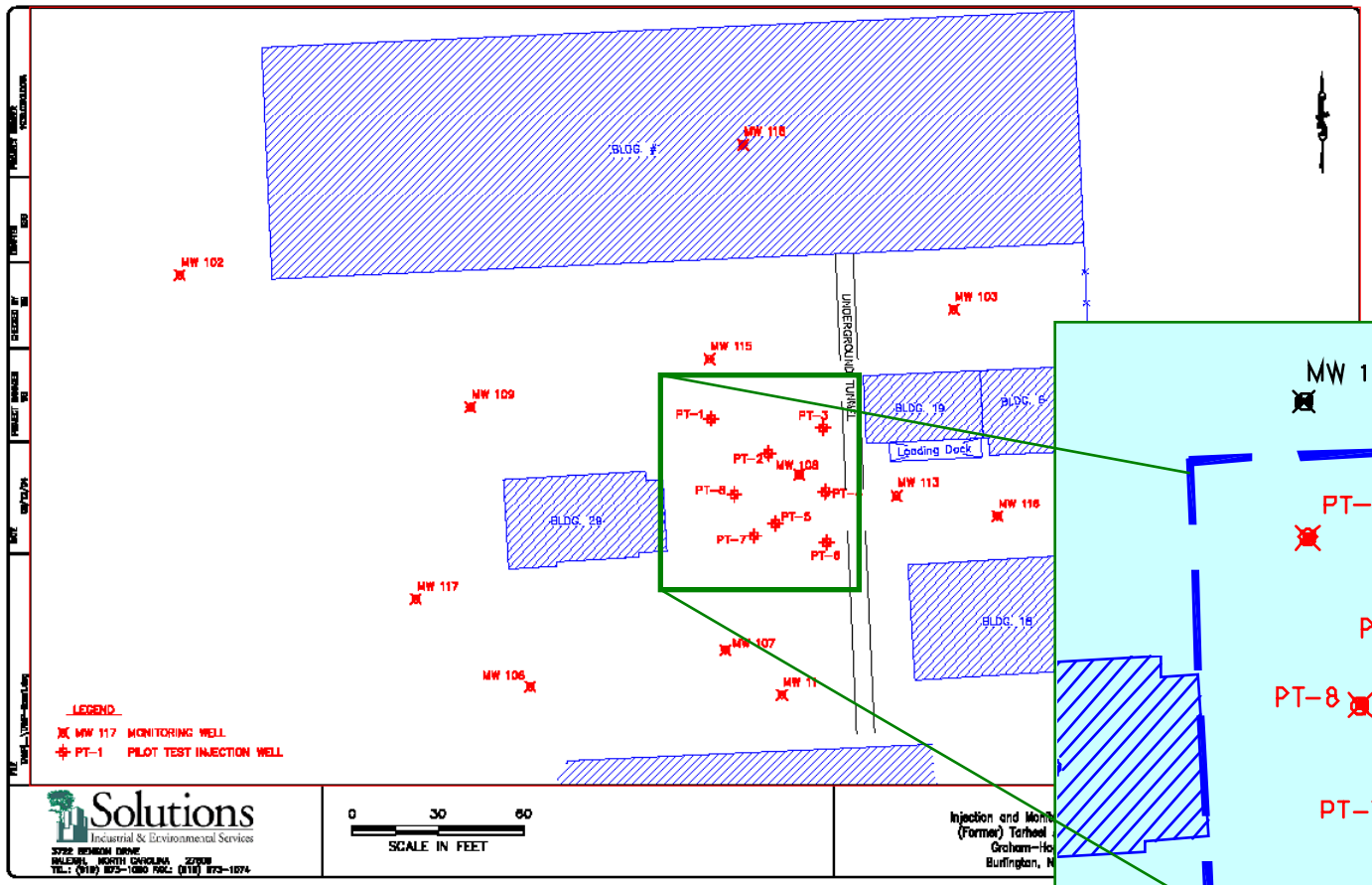
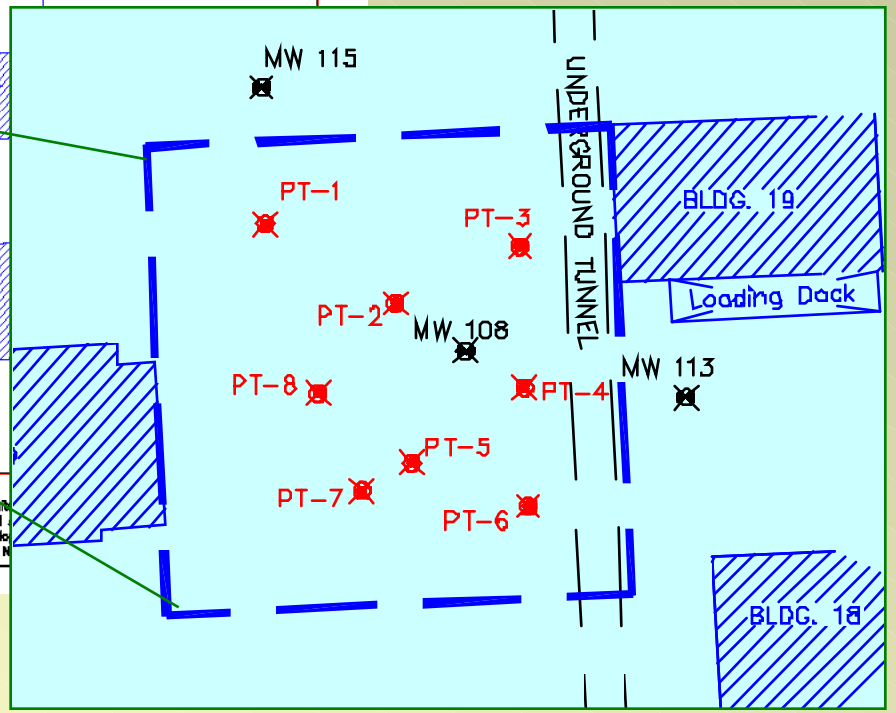
Treatment Area

Targeted a 100 ft x 100 ft x 10 ft source area



- 8 6-in wells
- 10-ft screens
- 30-35 ft apart
- 4 well pairs



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Two-Phase Injection

- Phase 1: Injection with groundwater recirculation

EOS® **Groundwater**

- EOS® sorbs to aquifer material
- Phase 2: A second injection with reversed sequence 3 months later

Groundwater **EOS®**

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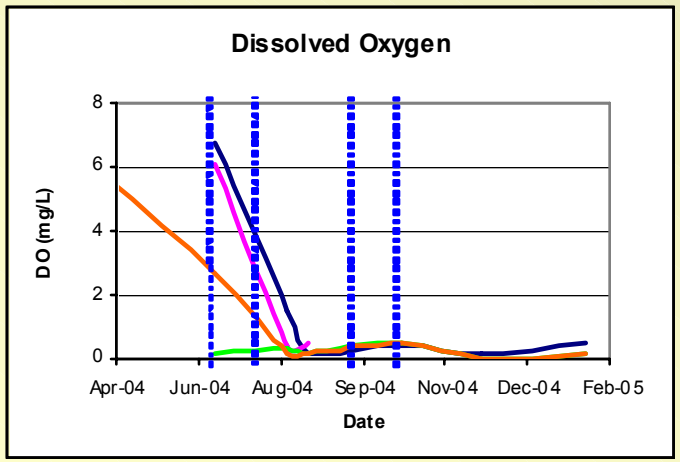
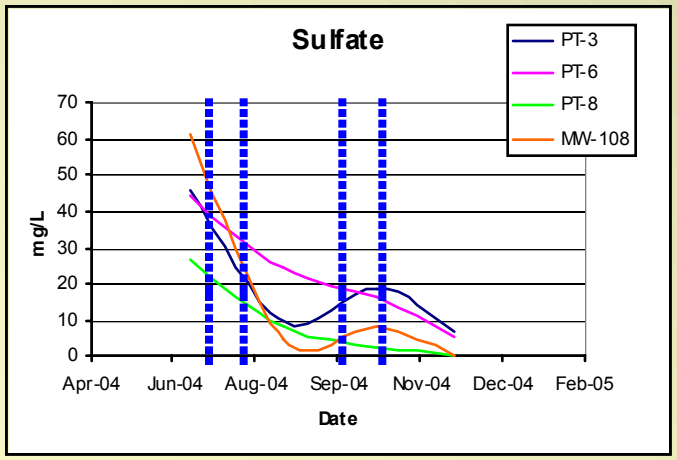
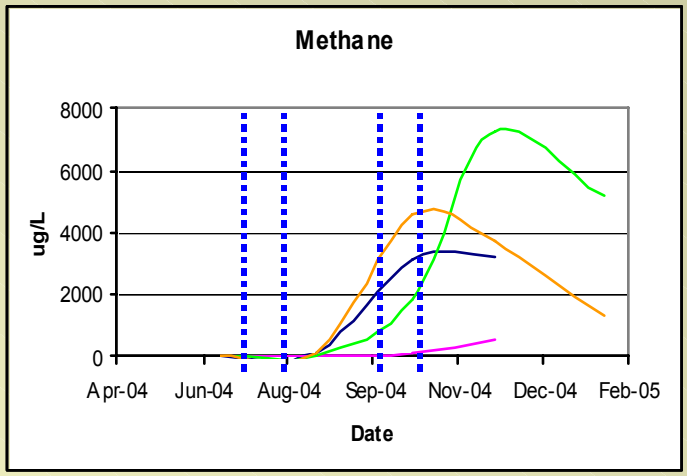
Results

- Optimum aquifer geochemistry established in 1 month
  - Anaerobic reducing conditions







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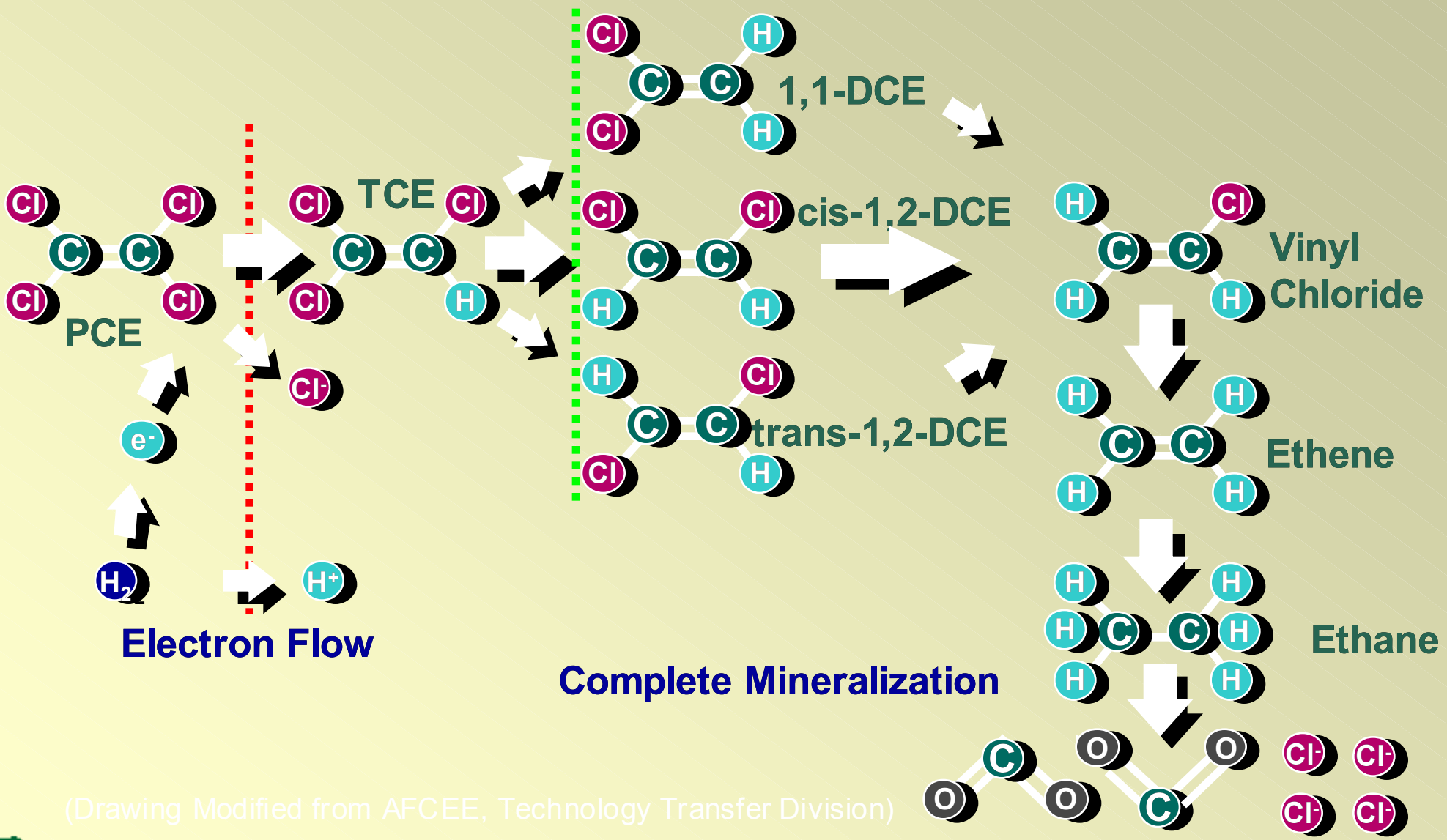
Anaerobic Reductive Dechlorination of Chlorinated Ethenes



(Drawing Modified from AFCEE, Technology Transfer Division)

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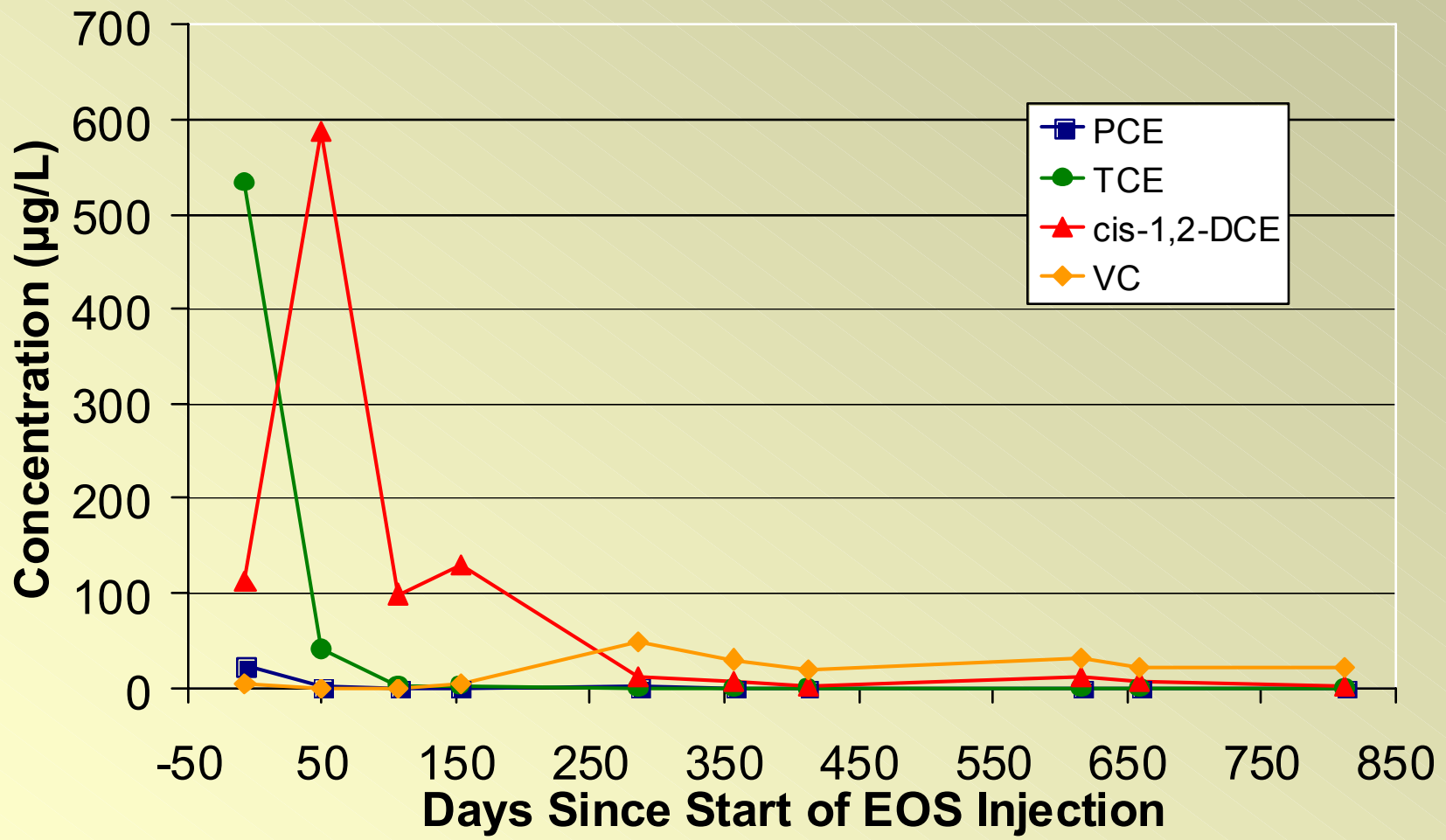
Average Chlorinated Ethenes in the Pilot Test Area

TCE successfully reduced to below the detection limit



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Conclusions

- EOS® effectively distributed throughout treatment area.
- Within 1 month, favorable geochemistry for reductive dechlorination was established.
- TCE was quickly eliminated in the PT area.
- PT treatment met sitewide remediation goals within 3 months – not an anticipated outcome for a PT.
- Army sold property.

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Successful Site Transfer

- One of 11 properties successfully transferred to a non-government entity using Government's Early Transfer Authority (ETA)

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Overall Success

- Traditional methods were ineffective with chlorinated solvents.
  - 10 years AS/SVE
- Innovative *in situ* technologies are proven to be efficient and cost-effective when site characteristics are considered.
  - met remediation goals in 3 months using an Emulsified Edible Oil Substrate

Army Chemical Review (July 2005):

"New Technology Helps Mother Nature Expedite Cleanups"

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