Advances in Sulfate Enhanced Bioremediation

Jim Cuthbertson, P.E.
Rose Connolly, P.E.
Bill Patzelt
Why Sulfate Enhancement?

Accelerates site cleanup!

In-Situ and minimally disruptive

Cost effective

“Green Technology” reduced carbon foot

Proven Results
Sulfate Application

Technical Overview
Significance of Sulfate

Sulfate reduction is the predominant electron accepting process for the degradation of hydrocarbons.
Technical Advantages of Sulfate

- Naturally Occurring
- High Solubility
- Easily Applied
- Safe
- Quick Results
Site Feasibility Evaluation

BTEX, MTBE, TPH, TBA, etc.

No Significant LPH Thickness

Effective within water saturated zone

Depleted Electron Acceptors
Case Studies

Michigan

Alabama
Constantine, MI Case Study

Site Background

- 350K to 2M gallon pipeline release 1987
- Sand to 35 ft bgs
- Groundwater@3 to 9 ft bgs
- Sulfate Enhanced Biodegradation
  - Phase I (pilot application) Nov 2010
  - Phase II (full application) Nov 2012
Phase II Application
Constantine, MI Case Study

MW-16B

MW-85

MW-44
Potterville, MI Case Study

**Phase I Application**
November 1, 2010

**Phase II Application**
November 12, 2010
Constantine, MI Case Study

Conclusions

• Enhance sulfate concentrations

• Decrease in xylene concentrations

• Decrease in benzene concentrations

• Avoided more costly remedial options

• Treated 15 acres in two days
Alabama Case Study

Site Background

- Release due to historical petroleum storage
- Clays and sands to 60 ft bgs
- Groundwater@9 to 32 ft bgs
- 30,000 gallons of sulfate solution gravity fed
- 149 injection wells covering 10 acres

- Initial application Jan/Feb 2013, Second application July 2013
Alabama Case Study – Site Map
MW-1 Alabama Site

- Sulfate, mg/L
- Volatile Concentration, ug/L
- Benzene
- 1,2,4 TMB
- Xylenes

1st Application: Jan/Feb 2013
2nd Application: July 2013
MW-9 Alabama Site

- **Volatile Concentration, ug/L**
  - Xylenes
  - 1,2,4 TMB
  - Sulfate

- **Sulfate, mg/L**

**Applications:**
- **1st Application**
  - Jan/Feb 2013
- **2nd Application**
  - July 2013
MW-21 Alabama Site

1st Application
Jan/Feb 2013

2nd Application
July 2013

Volatile Concentration, ug/L

Sulfate, mg/L

Benzene
Xylenes
1,2,4 TMB
Sulfate

Inogen
Environmental Alliance

Antea USA, Inc.
Alabama Case Study

Conclusions

• Increase sulfate concentrations
• Decrease then small rebound in xylenes concentrations
• Decrease in benzene concentrations
• Diminished demand from BTEX constituents will lead to sulfate degrading 1,2,4 trimethylbenzene
• Avoided more costly remedial options
Questions and Answers
Contact Information

For additional information please contact:
Jim Cuthbertson, Antea™Group
248-699-0259