

Dissolved Hydrogen Dynamics Associated with Emulsified Vegetable Oil Bioremediation of Chlorinated Ethene-Contaminated Groundwater

Frank Chapelle, Jim Landmeyer

U.S. Geological Survey

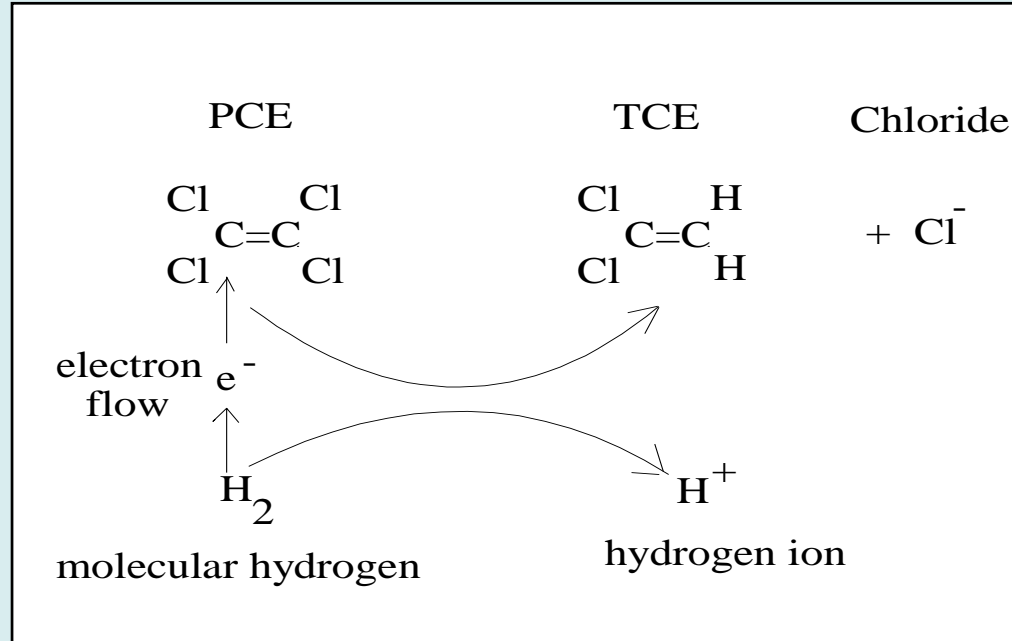


Mike Singletary, John Schoolfield

NAVFAC Southeast



Molecular Hydrogen (H₂) drives reductive dechlorination



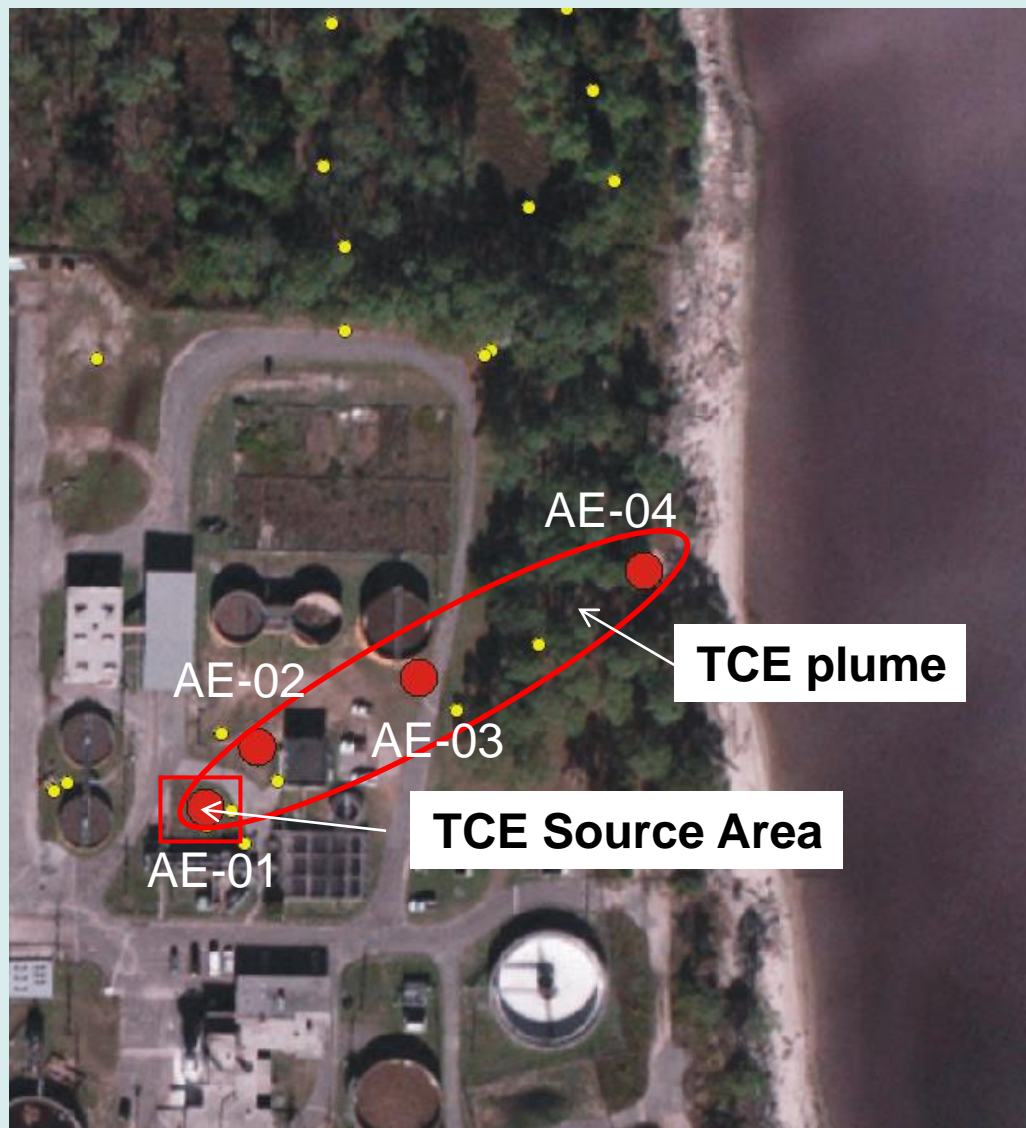
So it stands to reason that increasing H₂ concentrations by providing a fermentable substrate (veg oil) will increase dechlorination

How do H₂ concentrations respond to veg oil treatment?

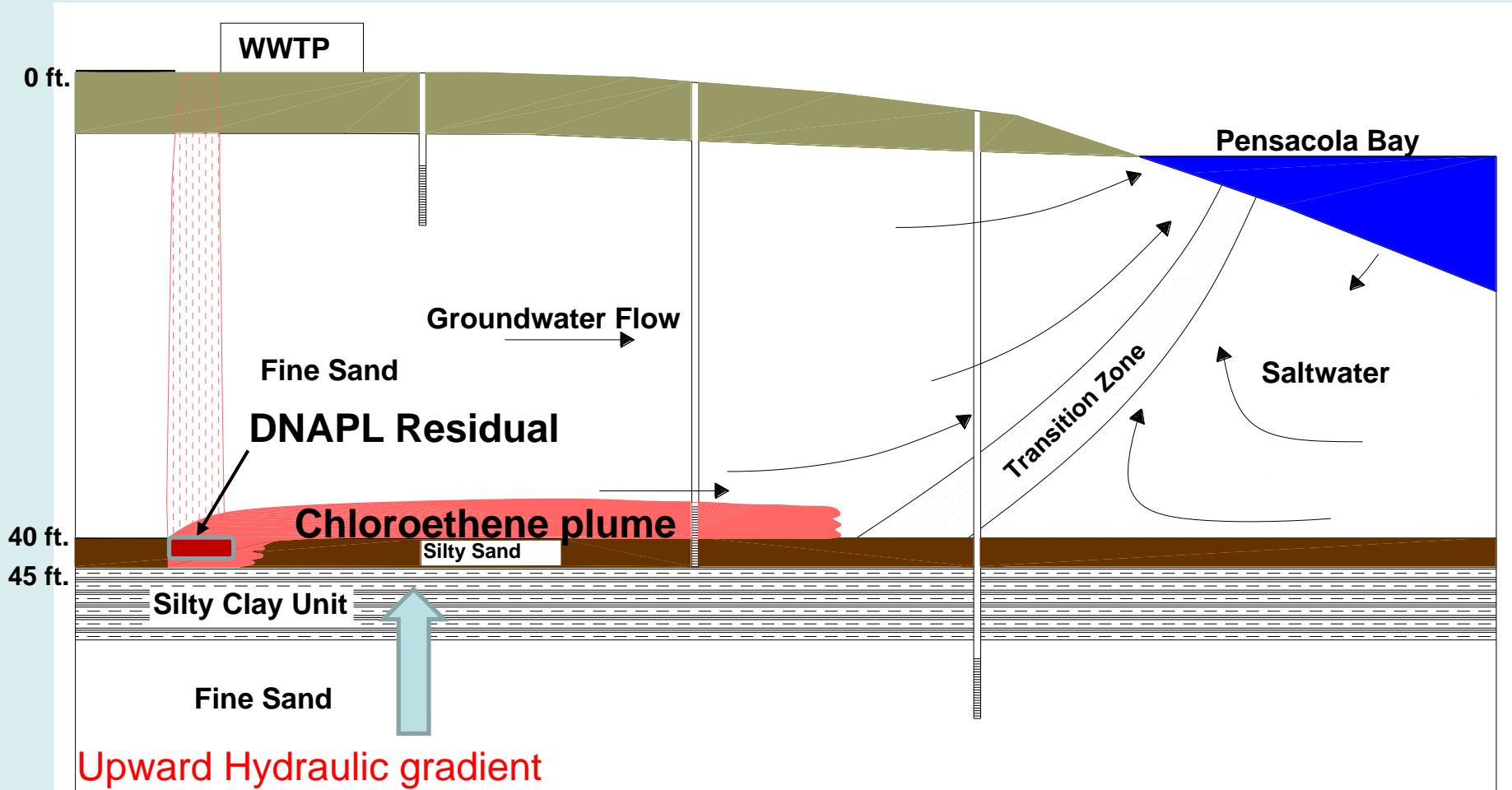
The study site is located at Naval Air Station Pensacola in Florida



Location of TCE Plume, Source Area, and Monitoring Wells

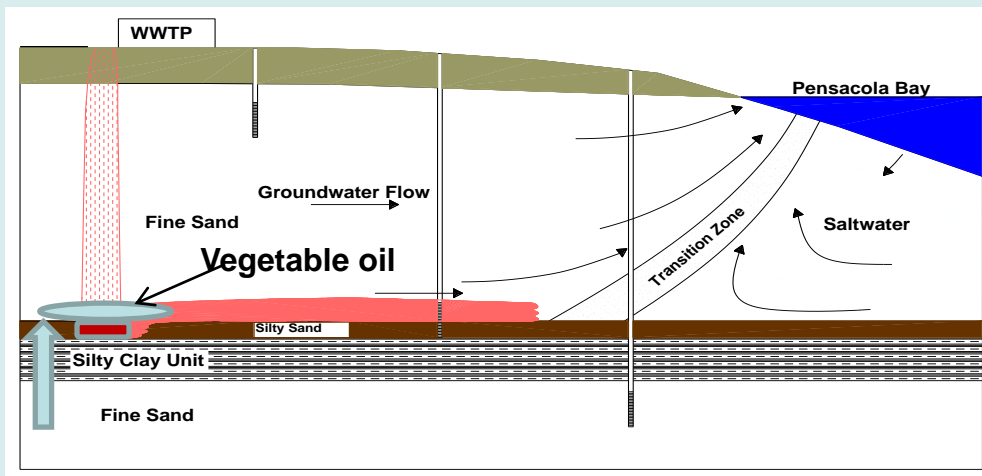


Conceptual Model



Source: Mike Singletary, NAVFAC Southeast

RADIATION STRATEGY: Emulsified vegetable oil biostimulation and MNA

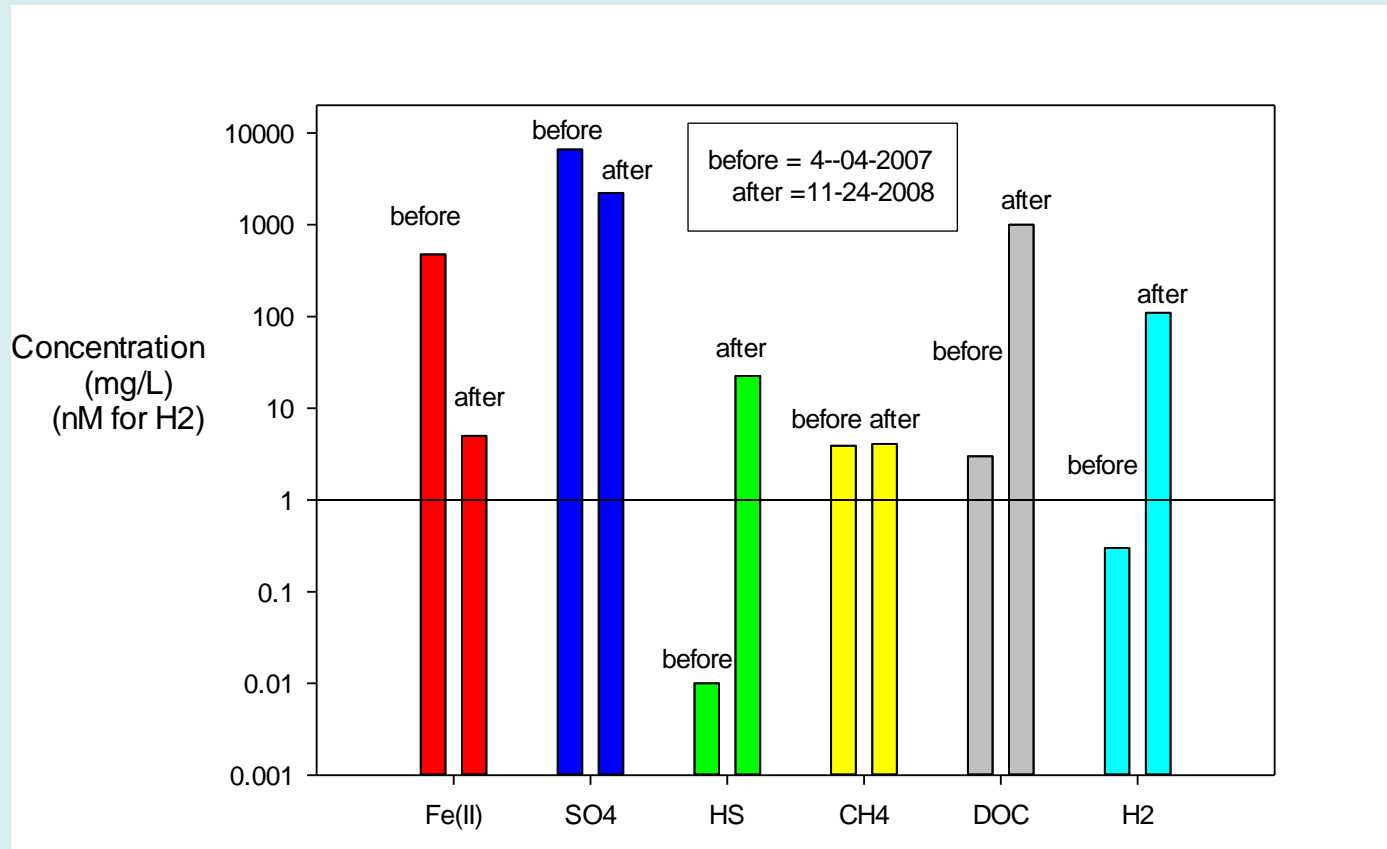


Solutions-IES, Inc. (Bob Borden)

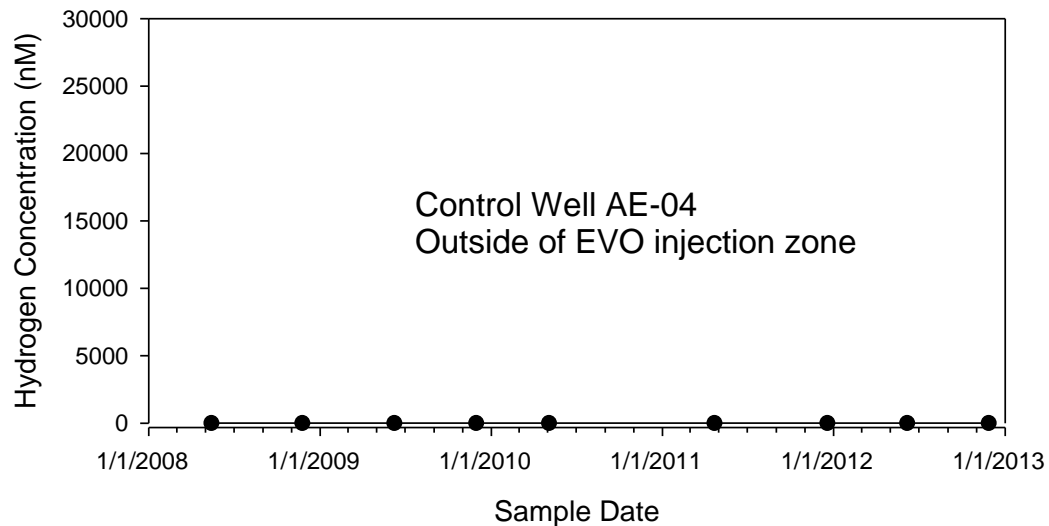
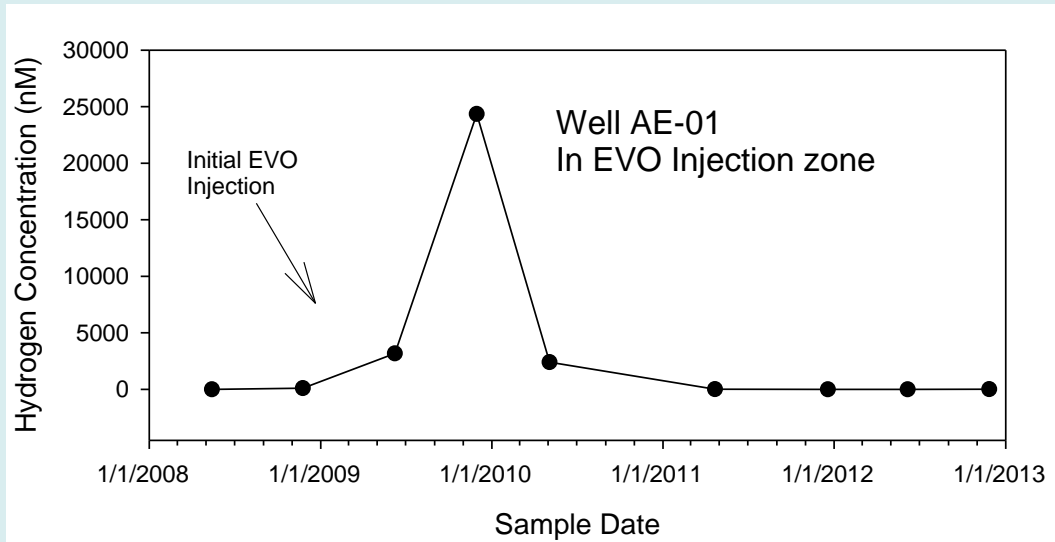
- Dilute emulsified veg oil injection
- Two pilot, one full-scale injections 2008-2010
- 18,077 gallons of AquaBupH®

So the question is, how has veg-oil biostimulation affected the biogeochemistry and TCE degradation at the site?

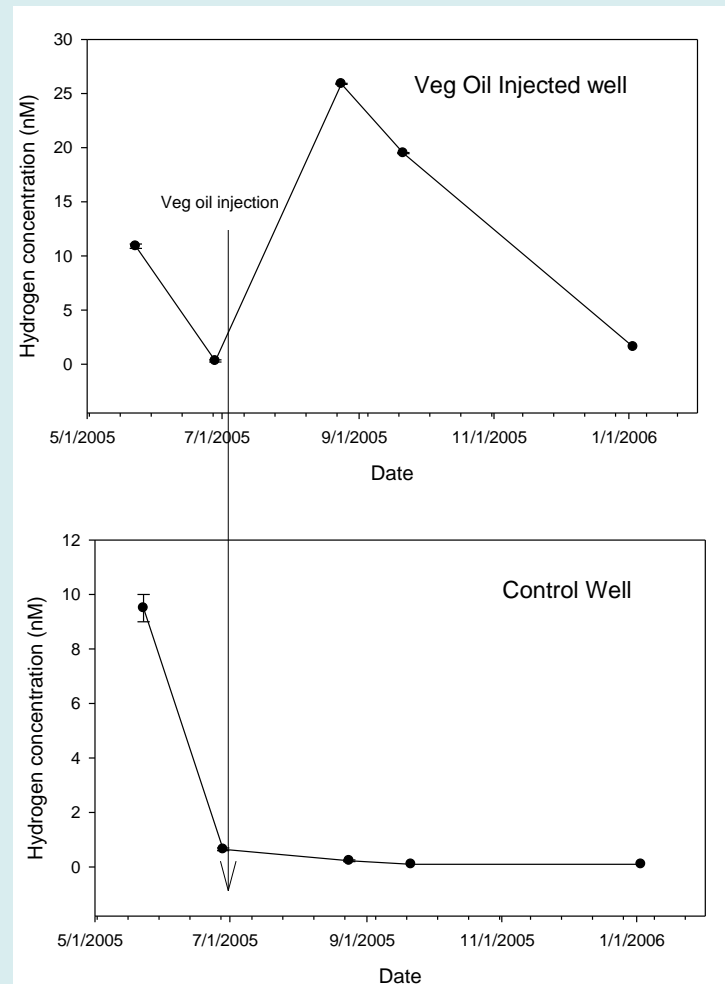
Redox Indicators before and immediately after veg oil injection at well AE-01



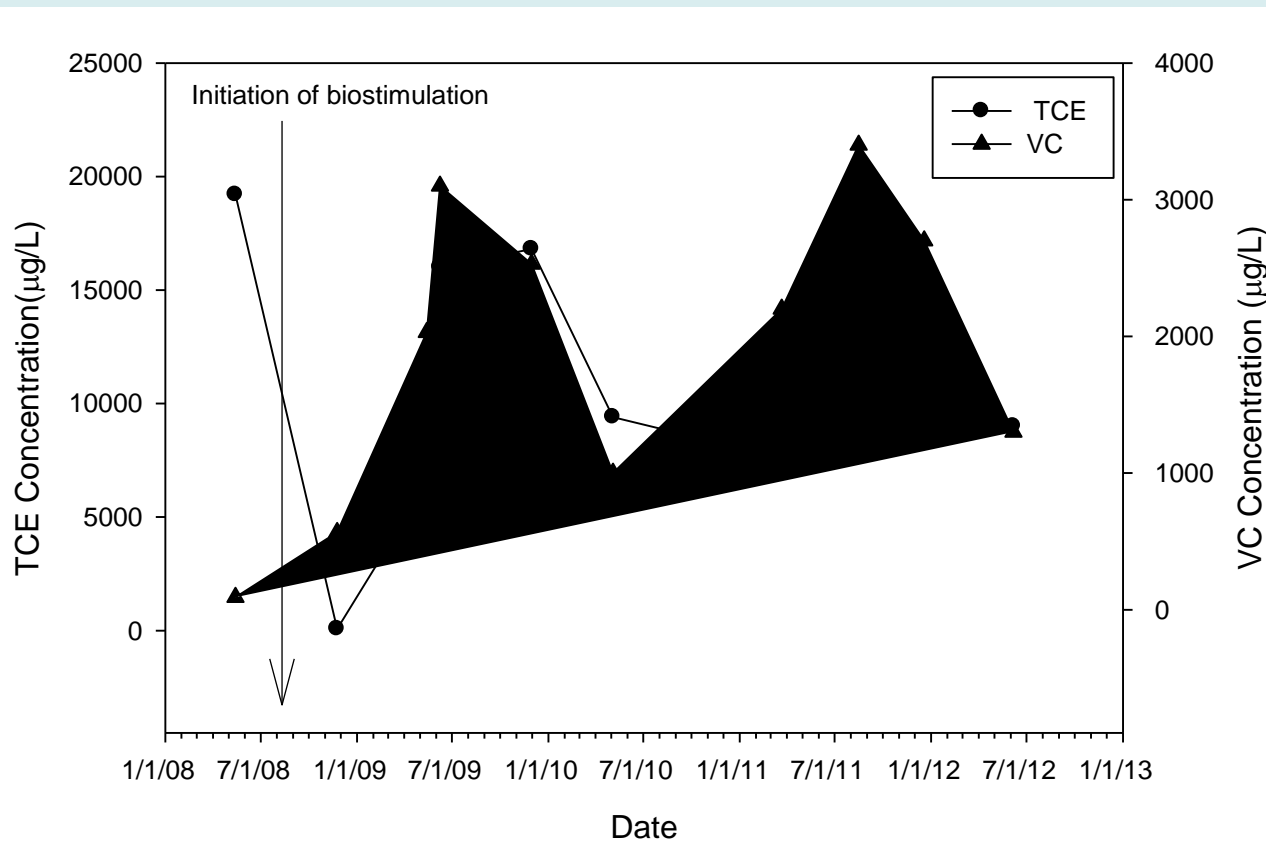
Hydrogen concentrations over time



Hydrogen concentrations over time at Naval Air Warfare Center (NJ)

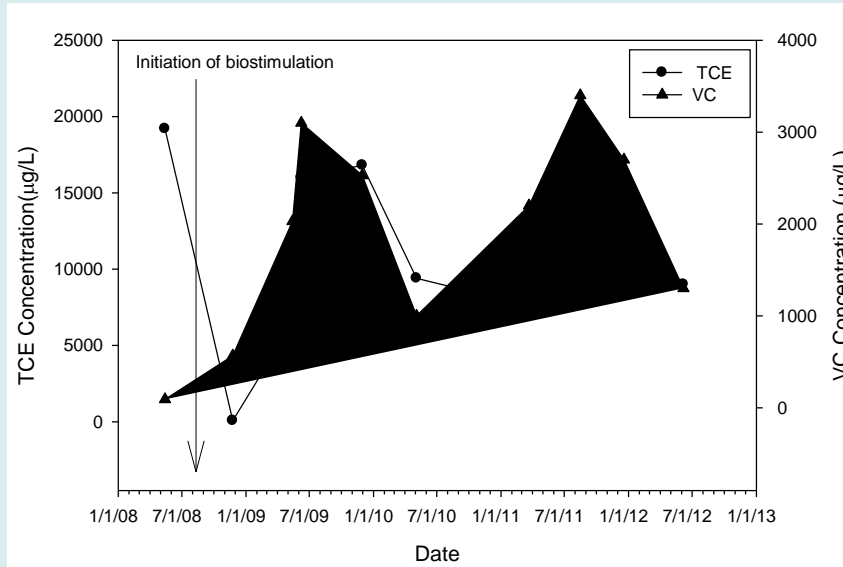


TCE and VC concentrations before and after biostimulation at Pensacola

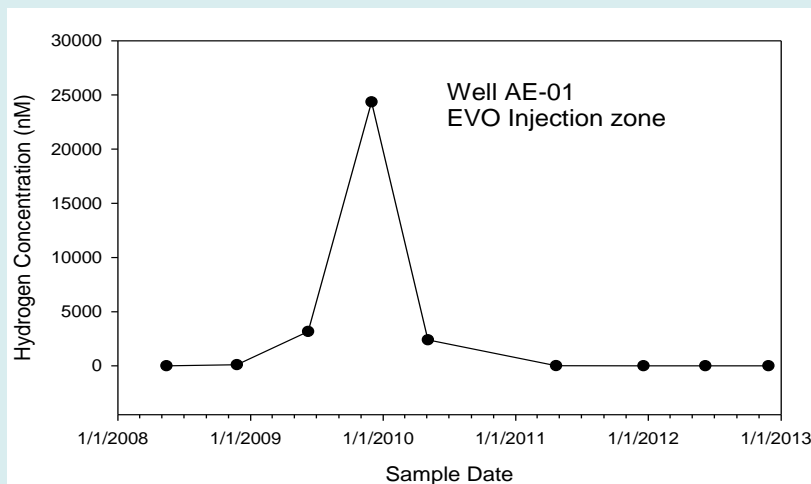


Concentrations of TCE and VC over time at well AE-01 in response to biostimulation in 2008.

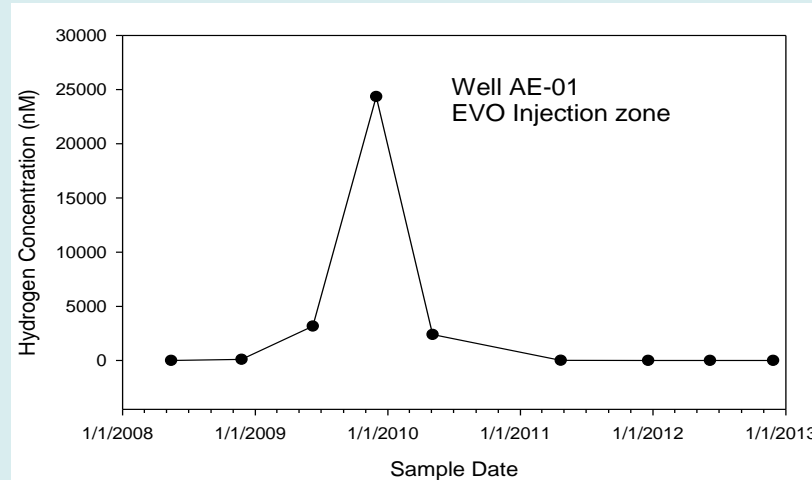
TCE and VC concentrations before and after biostimulation



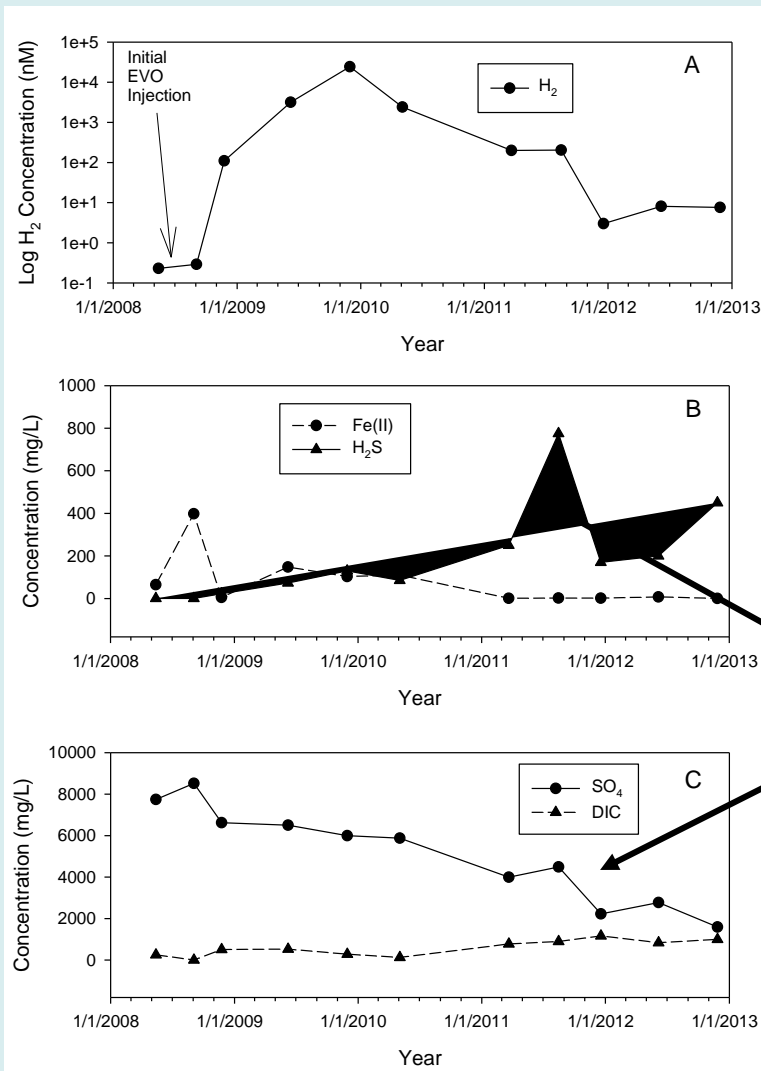
Concentrations of TCE and VC over time at well AE-01 in response to biostimulation in 2008.



Why do H₂ concentrations spike and then decline to near where they were prior to veg oil addition?



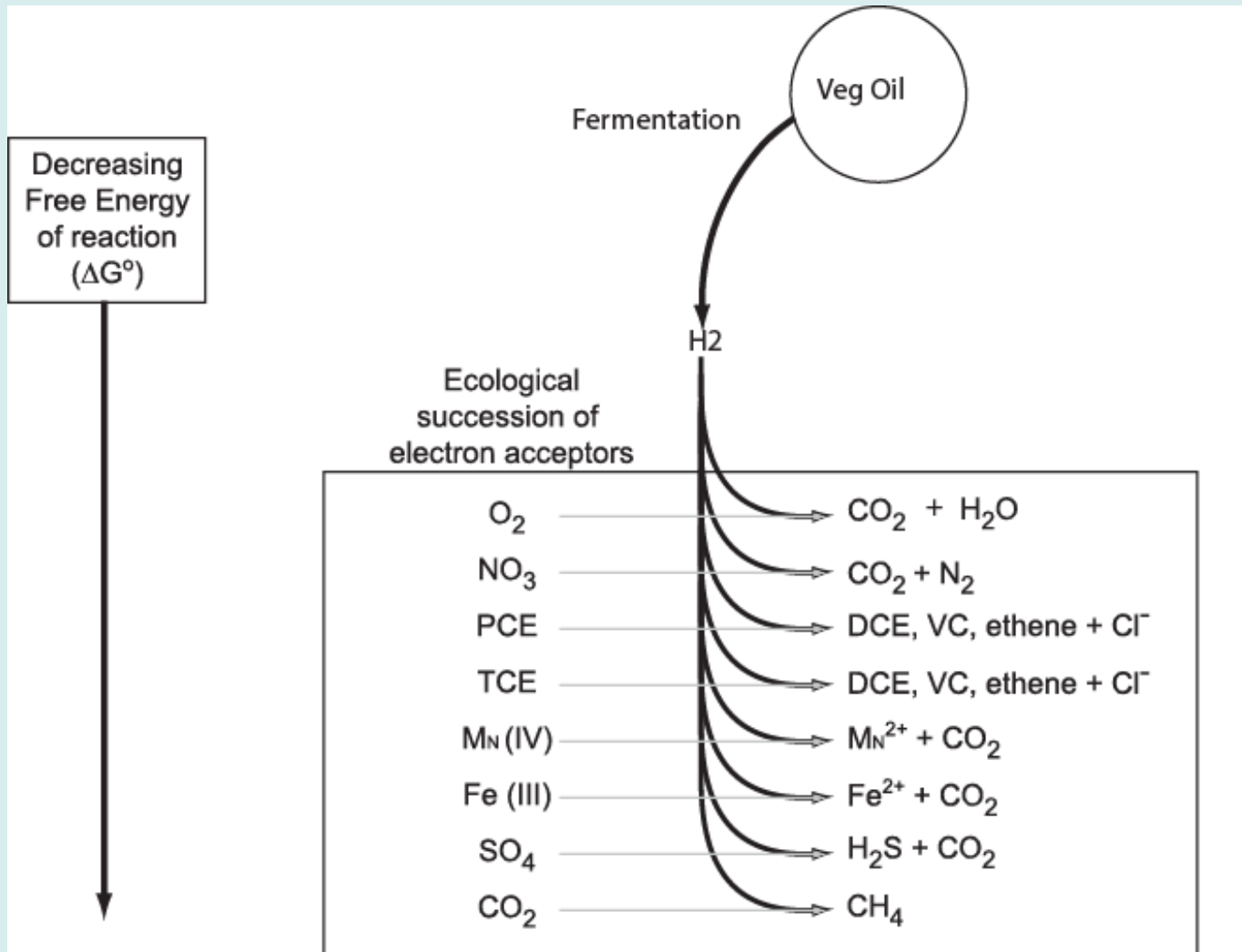
- Veg oil losing potency over time?
- Changes in microbial ecology?



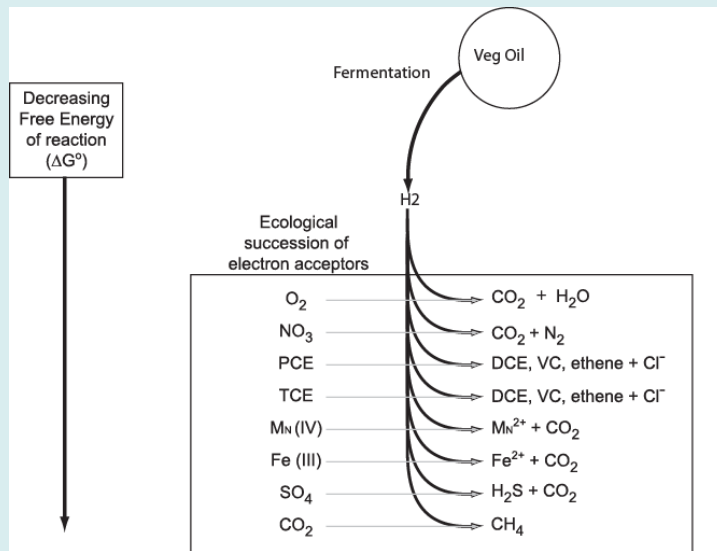
There is clear evidence of increased sulfate reduction (sulfate concentrations decrease, sulfide increases).

- Veg oil losing bioavailability over time? **Probably not!**
- Changes in microbial ecology?

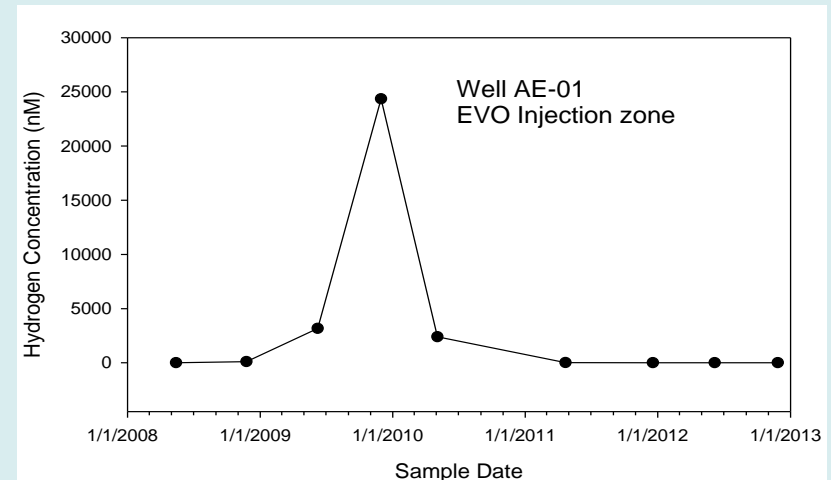
H₂ Concentrations reflect the balance between H₂ production (fermentation) and consumption (respiration)



The balance between H₂ production (fermentation) and consumption (respiration) can change over time

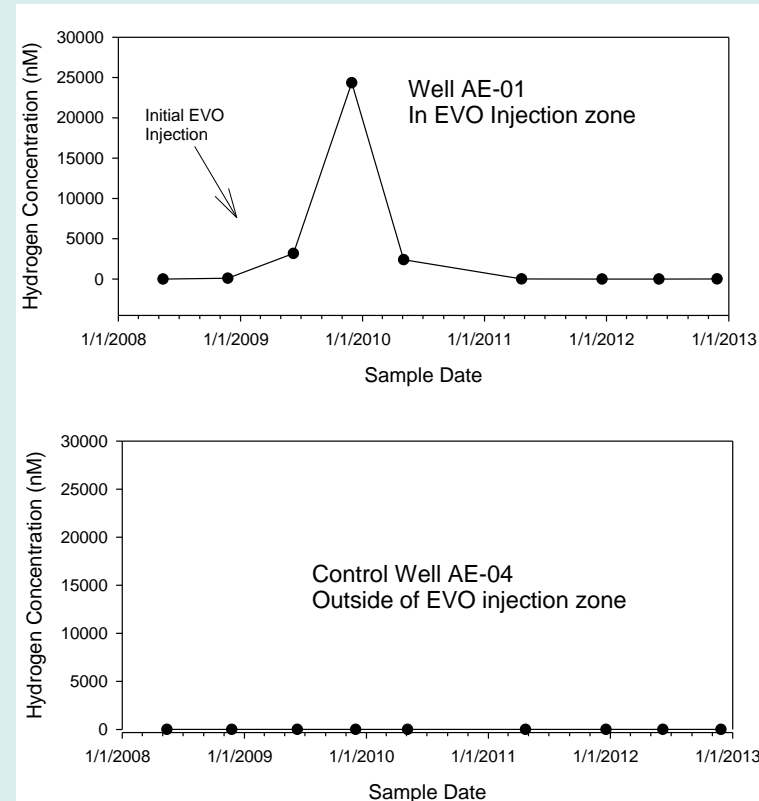


- Fermenters grow more quickly than respirers, so H₂ concentrations spike initially.
- The respirers grow more slowly, but over time they catch up, and H₂ concentrations decline.



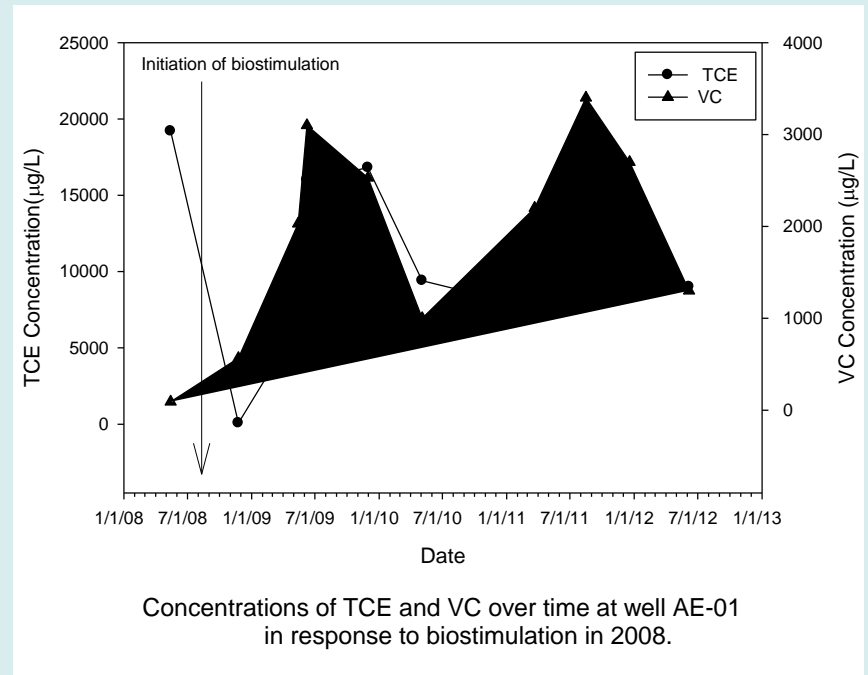
What does this say about the effectiveness of EVO treatment?

- ▶ Veg oil addition led to a significant spike in H₂ concentrations.



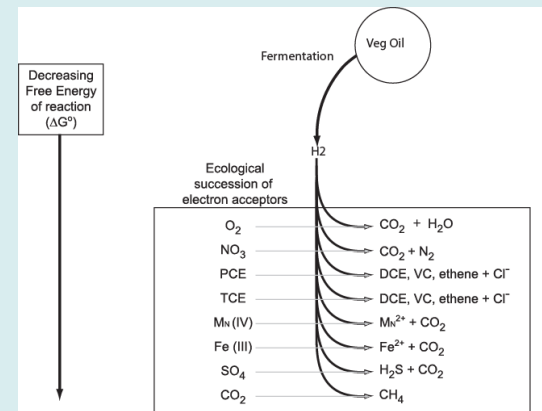
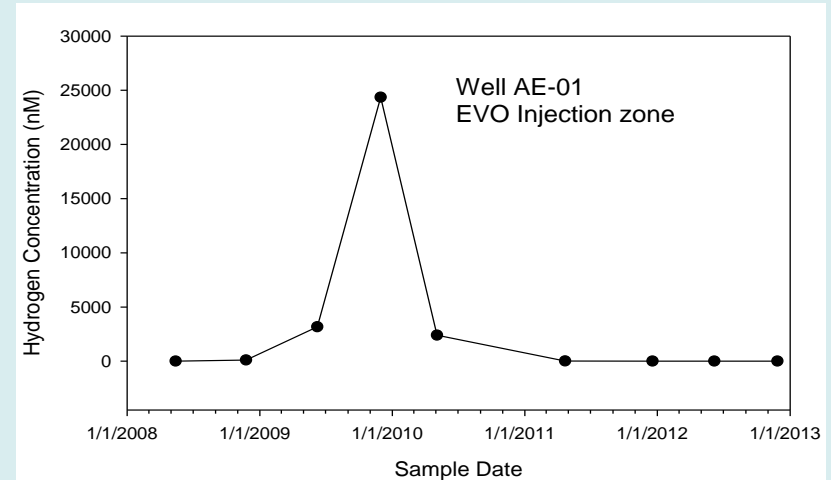
What does this say about the effectiveness of EVO treatment?

- ▶ This may have increased TCE transformation to VC.



What does this say about the effectiveness of EVO treatment?

- ▶ While H_2 concentrations have decreased as H_2 production has come into balance with H_2 consumption, they are more than adequate to support active dechlorination.



Thank You!

