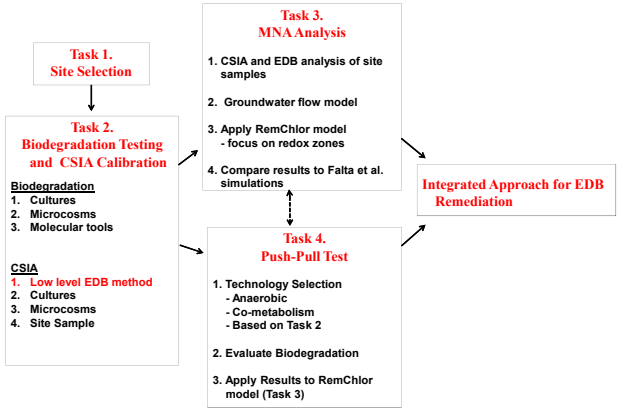
Monitored Natural Attenuation and Biostimulation for In Situ Treatment of 1,2-Dibromoethane (EDB)

Objectives

The objectives of this ESTCP-funded project are (1) to evaluate, quantify, and verify rates of EDB natural attenuation in groundwater, and (2) to determine if biostimulation can be used to enhance EDB degradation rates when monitored natural attenuation (MNA) appears insufficient to protect critical receptors. The project will use compound-specific stable isotope analysis (CSIA) to estimate EDB degradation rates in groundwater at Kirtland AFB Bulk Fuels Facility under widely differing geochemical conditions, ranging from highly reducing to oxic. These data will provide critical insights into the extent to which this compound naturally biodegrades *in situ* via anaerobic biological pathways, abiotic mechanisms and aerobic biodegradation. Plume-wide isotope values, geochemical parameters, and concentration data will be combined with a groundwater flow model to generate and validate a MNA model for EDB at the site. We also will test the efficacy of using aerobic co-metabolic (or anaerobic) biostimulation to enhance EDB removal where natural attenuation processes are insufficient. ***Development and validation of critical MNA parameters and bioremediation options for EDB will result in a better understanding of the fate of EDB at KAFB and allow an informed selection of an appropriate remedial option for the site.***

Study Design



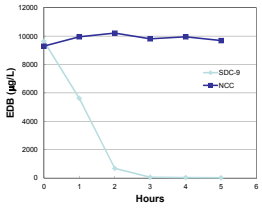
Task 2. Treatability Testing and CSIA Calibration

1. Demonstrate biodegradation to MCL
   - Anaerobic (SDC-9 and microcosms)
   - Co-metabolic (propanotrophs, ethanotrophs, methanotrophs, pure cultures and microcosms)
   - Biogeochemical (FeS, Microscosms [$FeCl_3$])
2. Determine isotope fractionation factors (ε)
   - Lab cultures
   - Microcosms
   - FeS

Questions: Can EDB be degraded to MCL levels? Which biodegradation mechanism is most effective? Is biogeochemical degradation important?

EDB Degradation by Test Strains

SDC-9™



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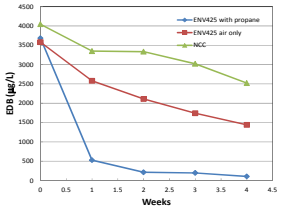

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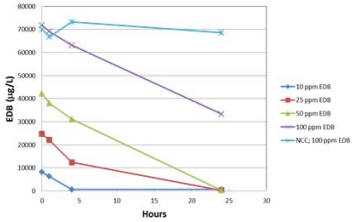


Laboratory cultures are currently being analyzed by CSIA to determine isotope fractionation during biodegradation

1,2-EDB								
Date	Time (weeks)	Killed Control	Live Control	Biostimulation	Bioaugmentation	Ethane	Methane	Propane
6/4/2014	0	21 ± 0.2	22 ± 0.5	22 ± 1.6	21 ± 0.7	21 ± 1.6	21 ± 0.2	21 ± 1.1
7/3/2014	4	20 ± 1.6	21 ± 2.0	20 ± 0.4	0 ± 0.0	21 ± 0.8	20 ± 0.1	20 ± 1.1
8/4/2014	9							
9/4/2014	13							
10/4/2014	17							
11/4/2014	22							

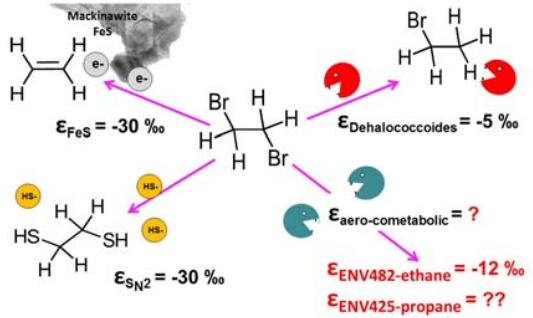
Microcosms studies are underway to evaluate in situ bioremediation of EDB at KAFB. EDB was rapidly degraded in microcosms augmented with the SDC-9 culture.

Task 2. CSIA Calibration

1. Verify and improve sensitivity of CSIA analysis for EDB
   - Pre-concentration
     - Verify method
     - Verify accuracy and reproducibility
   - Establish minimum sample size (microcosms)
2. CSIA analysis of microcosms
3. CSIA analyze site samples

Questions: Can CSIA be used at low EDB concentration? Can CSIA distinguish degradation mechanisms?

Biotic and Abiotic Pathways Leading to Isotope Fractionation of EDB



Task 4. Push-Pull Test for Active Treatment

1. Select best treatment alternative (from Task 2)
   - Assume propane biosparging
2. Pre-condition aquifer
   - 2 to 3 substrate additions
3. Perform activity measurement
   - May require water from nearby location
   - Measure degradation rate
   - EDB conc., CSIA, substrates

Questions: Can we treat EDB to MCL? Can CSIA be used to estimate extent of degradation in situ?