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# Cost and Performance Summary Report

## Mulch Biowall at Offutt Air Force Base, Nebraska

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### Summary Information [1]

A pilot-scale test of a permeable reactive biowall was completed in August 2000 at Offutt Air Force Base (AFB) near Omaha, NE. The pilot test took place at a site used between 1942 and 1945 to manufacture military aircraft. The resulting ground-water contamination consists of a 3,000-ft plume with trichloroethene (TCE) concentrations reaching 2.2 mg/L where the biowall was installed.

### Timeline [1]

Date(s)	Activity
August 2000	Pilot-test of mulch biowall completed
July 2001	Full-scale biowall installed

### Factors That Affected Technology Cost or Performance - Matrix Characteristics [1]

Listed below are the key matrix characteristics for this technology and the values measured for each during site characterization.

The aquifer matrix in the test area is an alluvial silt and clay, with ground water located approximately 6 ft below ground surface. Hydrologic testing indicated that the underlying 30-ft aquifer has an average flow velocity of 84 ft/yr, a gradient of 0.01 ft/ft, and a hydraulic conductivity of 3.5 ft/day.

Parameter	Value
Soil Classification:	Alluvial silt and clay
Hydraulic Conductivity:	3.5 ft/day
Hydraulic Gradient:	0.01 ft/ft
Average Flow Velocity:	84 ft/yr
Depth to Groundwater:	Approximately 6 ft bgs

### Treatment Technology Description [1]

Field tests were conducted to determine the efficacy of organic mulch as a source of electrons for promoting biological reductive dechlorination of ground water contaminated with TCE.

Mulch was selected as the electron donor for the biowall due to evidence of reductive dechlorination occurring under an adjacent agricultural field where the soil contains a high level of naturally occurring organic carbon. The

low costs associated with obtaining mulch also were considered. Mulch was generated onsite using shredded trees and leaves, and mixed with coarse sand in a 50:50 by volume ratio to enhance the permeability and stability of the biowall. Using a continuous trencher, a 1 ft-thick wall was installed and filled simultaneously to a length of 100 ft and depth of 23 ft.

This treatment method relies on the flow of groundwater under a natural hydraulic gradient through the biowall to promote contact with slowly-dissolving organic matter. Degradation of the substrate by microbial processes in the subsurface provides a number of breakdown products, including metabolic acids. The breakdown products and metabolic acids produced by degradation of mulch in a saturated subsurface environment provide secondary electron donors or fermentable substrates for hydrogen generation, the primary electron donor used in reductive dechlorination. During reductive dechlorination, TCE is sequentially reduced to cis-1,2-dichloroethene (DCE), vinyl chloride, and ethene.

### Performance Information [1]

Performance of the biowall was monitored using two upgradient, four downgradient, and two control wells. These wells were sampled in five events over a 31-month period.

Sampling results indicated depressed oxygen concentrations and oxygen-reduction potentials due to the consumption of organic matter and oxygen by aerobic bacteria. Nitrate and sulfate levels also declined. Methane production was observed, providing further evidence of the establishment of reducing conditions. Over 31 months of treatment, the mean TCE removal 20 ft downgradient of the biowall was approximately 70%. Upgradient TCE concentrations were variable (0.3-2.1 mg/L), but downgradient TCE concentrations were consistently between 0.2 and 0.6 mg/L (Figure 1). After 5 months of treatment, the mean ratio of DCE to TCE downgradient of the wall increased over 2 orders of magnitude relative to upgradient conditions. The DCE:TCE ratio subsequently declined but TCE removal continued without the accumulation of vinyl chloride. The control plot showed no decrease in TCE concentrations.

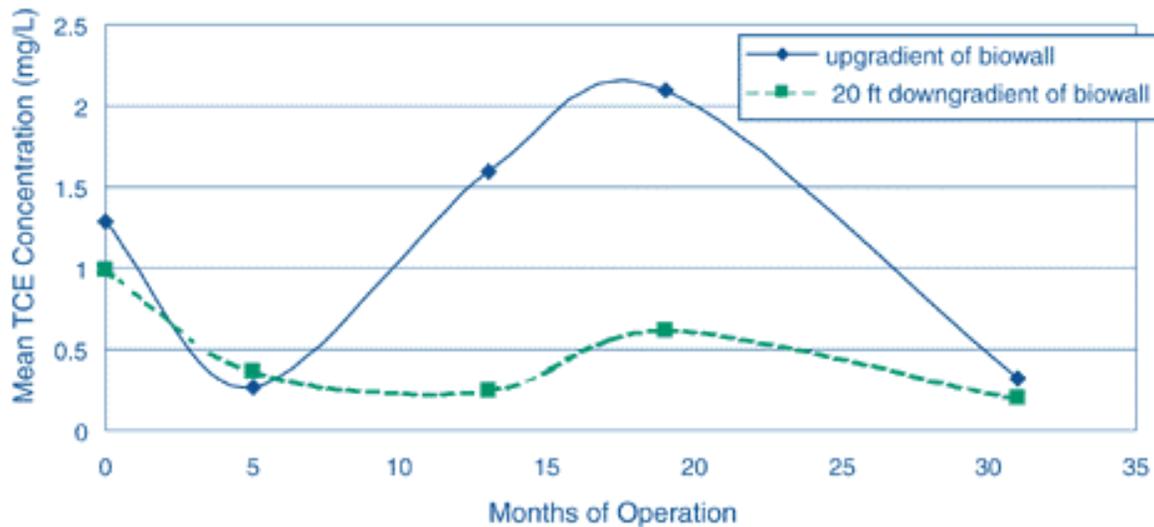


Figure 1. Average TCE Concentrations [1]

#### Cost Information [1]

The cost to install the pilot biowall at Offutt AFB was \$360/linear ft. Longer biowalls may be installed for less than \$200 / linear ft. If not generated onsite (at no cost), mulch for applications at other sites is estimated to cost approximately \$20/yd<sup>3</sup>.

#### Observations and Lessons Learned [1]

Mulch biowalls installed using continuous trenchers are appropriate at sites with shallow ground water where the plume extends less than 30 ft below ground surface. Performance data from the pilot test indicated that the biowall is a low-maintenance, cost-effective, in-situ treatment wall technology. Based on these results, a full-scale 500-ft biowall was installed at Offutt AFB in July 2001. In addition, AFCEE is seeking implementation of biowalls at two additional Air Force sites.

Additional performance data for this technology will be collected over the next two years during full-scale operations at Offutt AFB. Prior studies by others indicate that a mulch-based biowall may last approximately 10 years.

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**References**

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1. EPA. Technology News and Trends. 2002. Mulch Biowall Used to Treat TCE-Contaminated Groundwater. Contributed by James Gonzales and Jerry Hansen, AFCEE; Philip Cork, Offutt AFB; and Carol Aziz, Groundwater Services Inc. July.