Innovative Remediation Technology for Soil & Groundwater Contamination at Sites Containing MTBE and other Pollutants

Global BioSciences, LLC

Butane Biological Processes

- *Metabolism* - bacterial cells receive energy from the degradation processes (i.e. of butane and other petroleum hydrocarbons)

  - *good for petroleum degradation*

- *Cometabolism* - bacteria growing on a particular food source (butane) produce enzymes that degrade a second substrate (MTBE) (bacteria do not gain energy from the cometabolic process)

Good for MTBE and chlorinated solvents degradation

Proven Effective Removal of...

- MTBE
- Chlorinated Solvents
- Pesticides
- PCBs
- Petroleum Hydrocarbons
- Gasoline
- PAHs
- 1,4-Dioxane
- Aromatics

- *And a variety of other pollutants*

GBI: Environmental Remediation

- Simpler and more efficient remediation of soil and groundwater
  - Proprietary butane technology
  - Stimulates indigenous soil and groundwater bacteria
  - Enzymes produced degrade contaminants *in-situ*
  - No soil excavation or disposal required
  - Proven track-record; technology of choice in several states
  - Cleans multiple common contaminants

Butane Injection System

Skid Size: 4 x 4 x 6 (feet)

Butane Injection System

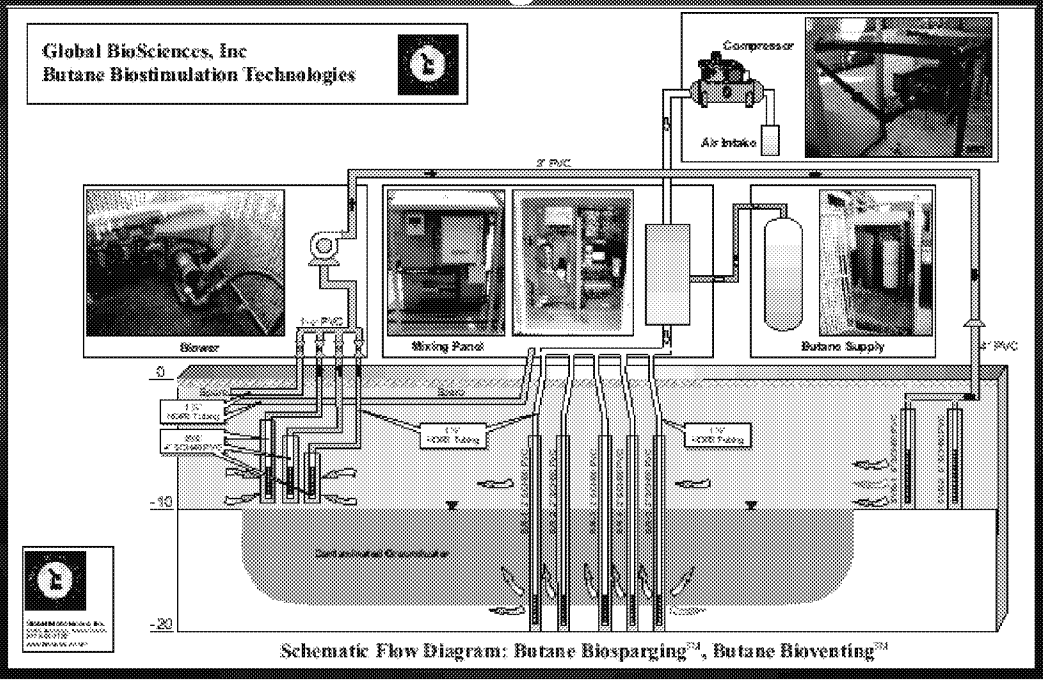
Skid built into shed to provide comfortable work space for on-site workers

Portable Injection Hardware for Small Sites

- Portability or mobility allows hot-spot treatment and butane treatment at small release Sites.
- Flexibility permits soil and groundwater treatment in tightly settled or built-up areas by utilizing existing monitoring wells as butane injection wells.
- For hot-spot treatment, the mobile butane treatment system will significantly lower capital costs for injection well installation.
- Dramatically lowers remediation costs for small sites.

Delivery System Flow Diagram

Note: Activated carbon has been removed from process stream – large cost savings to client



Schematic Flow Diagram: Butane Biosparging™, Butane Bioventing™

Process Currently Accepted by...

- US Environmental Protection Agency (for Superfund Site remediation)
- Massachusetts Department of Environmental Protection
- Florida Department of Environmental Protection
- Pennsylvania Department of Environmental Protection
- Iowa Department of Natural Resources

Acceptance in other states highly likely (never rejected)

EPA/ROD/R07-01/516
2001

EPA Superfund
Record of Decision:

GENERAL MOTORS S.C.
EPA ID: IAD000686899
OU 01
SIOUX CITY, IA
06/14/2001

1.2 Statement of Basis and Purpose

This decision document presents the selected remedial action for GM/AC site located in Sioux City, Iowa. The remedial action was chosen by the Iowa Department of Natural Resources (DNR) in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) 40 C.F.R. Part 300.

This decision is based on the documents and information contained in the Administrative Record for the site. The U.S. Environmental Protection Agency concurs with the selected remedy for this site.

U.S. EPA Contaminated Site Cleanup Information (CLU-IN)

Search Result from the March 2003 Issue

Note: At the time these abstracts were archived all links were functional. Many may subsequently be broken as the referred site is pulled down. We intentionally keep the original abstracts as a record. Please excuse any inconvenience this may cause.

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A BIOREMEDIATION CASE STUDY: BUTANE BIOSTIMULATION FOR THE REMEDIATION OF PETROLEUM CONTAMINANTS

Begley, J.F. (Global BioSciences, Inc., North Attleboro, MA); J. Longo (Horsley & Witten, Inc., Sandwich, MA); F.A. Perriello (Global BioSciences, Inc., North Attleboro, MA), and G. DiCesare. The 16th Annual International Conference on Contaminated Soils, Sediments and Water, 21-24 October 2002. University of Massachusetts at Amherst. Northeast Regional Environmental Health Center, Univ. of Massachusetts, Amherst. CD-ROM, 2002

Butane Biostimulation Technology(TM), a remediation system developed by Global BioSciences (GBI) of North Attleborough, MA, was applied to clean up a fuel oil-contaminated site in Fairhaven, MA. The system achieved ground-water cleanup goals within seven months of startup. The patented butane bioremediation process stimulates naturally occurring butane-utilizing bacteria to metabolize and cometabolize pollutants. In the Butane Biosparging(TM) treatment system, butane and air are introduced into the ground water via a specialized gas delivery system, the Butane Injector 2000(TM). This system injects low volumes of butane gas at a predetermined rate into the air stream from an air compressor. The butane/air mixture is distributed into the ground water via a set of injection wells. The butane dissolves into the ground water and provides a food source for butane- and petroleum-degrading bacteria. Along with increased dissolved oxygen, the butane stimulates increased biomass and treatment by direct metabolism of hydrocarbons and cometabolism of more recalcitrant compounds, such as MTBE. Above the water table, the Butane Bioventing(TM) system degrades contaminants in the unsaturated zone. The system provides soil treatment by circulating butane and air through the contaminated area and promoting the growth of butane-utilizing bacteria. Contact: Global BioSciences, Inc., 508-643-7122, info@biobutane.com.

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- Cleanup News
- Demonstrations/ Feasibility Studies
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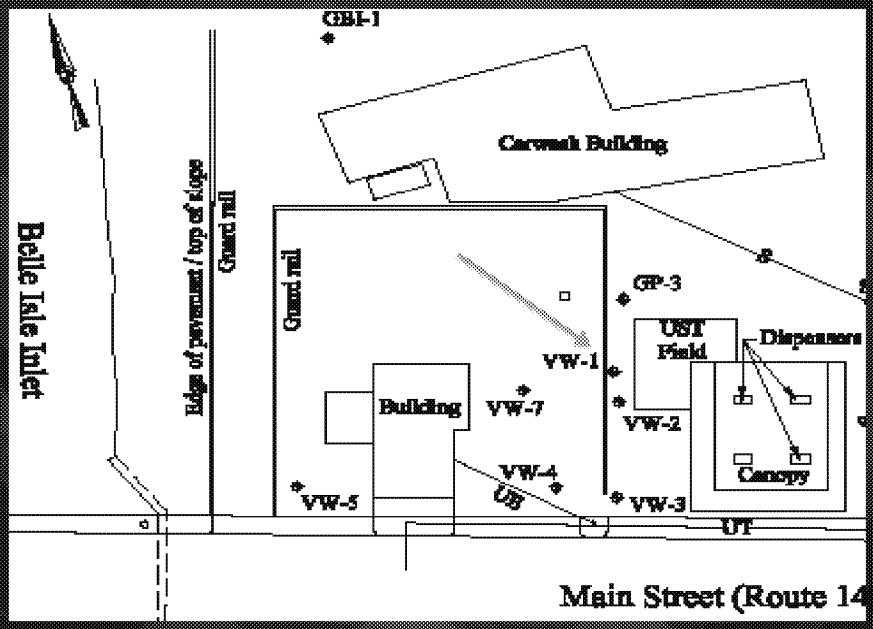
Butane Safety

- Butane distribution system mixes butane with air prior to injecting the mix into the soil
- Concentrations generated in the subsurface with the butane injector are less than 0.01% of the LEL for butane in air
- Typically butane gas is used in shaving cream cans and also used in food products
- Local fire departments typically require a permit to store Butane
- Excess butane (C_4H_{10}) in soil/groundwater decomposes into CO_2, H_2O, and other inert species in 2-3 days
- Fugitive emissions are *never* generated as a result of the process

Case Studies

- MTBE
- Chlorinated Solvents

Mobil Gasoline Station in Winthrop, MA



Mobil Gasoline Station in Winthrop, MA

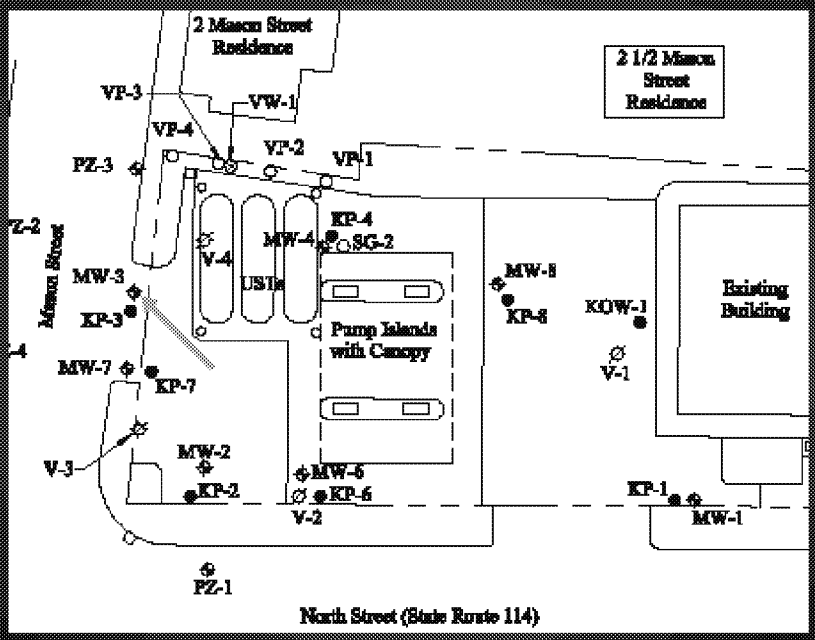
Mobil Gasoline Station in Winthrop, MA

Time Period	Start-up	+ 7 Months
Parameters		
VPH (ug/L)	VW-1	VW-1
Methyl tert-butyl ether (MBTE)	16,000	103
Benzene	<300	5.2
Toluene	<300	<5.0
Ethylbenzene	<300	5.4
Xylenes	<300	40.9
Naphthalene	<300	27.7
C_5-C_8 Aliphatic Hydrocarbons	<500	<40
C_9-C_{12} Aliphatic Hydrocarbons	930	<15
C_9-C_{10} Aromatic Hydrocarbons	<500	303

System start-up date 12/12/2001

System operation was terminated on November 10, 2003; Site is undergoing post-remedial monitoring

Citgo Gasoline Station in Salem, MA



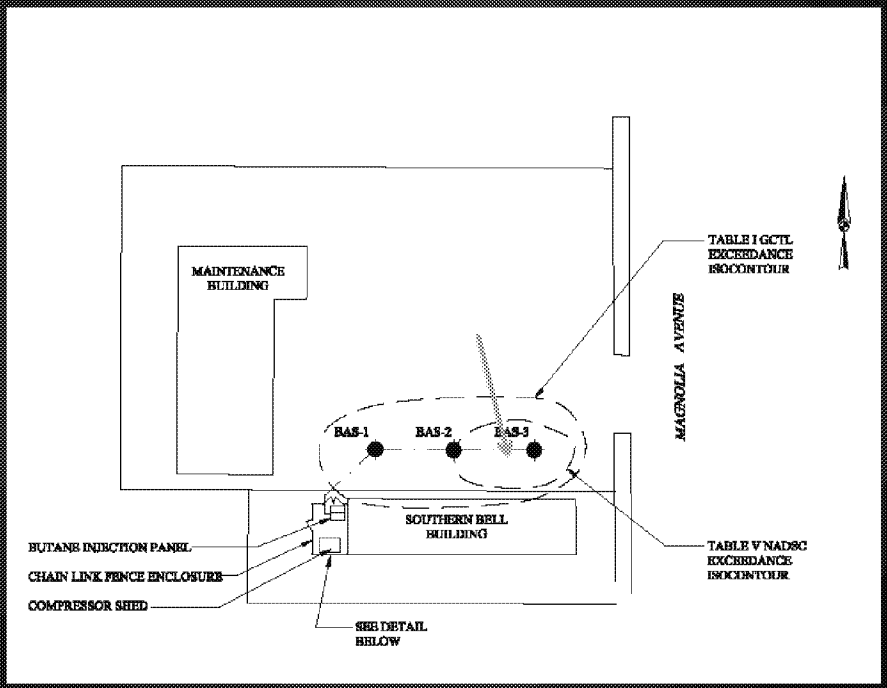
Citgo Gasoline Station in Salem, MA

Citgo Gasoline Station in Salem, MA

Time Period	Start-up	+ 6 Months
Parameters		
VPH (ug/L)	MW-3	MW-3
Methyl tert-butyl ether (MBTE)	206,000	4,090
Benzene	787	<5.0
Toluene	211	<5.0
Ethylbenzene	66.3	<5.0
Xylenes	322	<5.0
Naphthalene	58	<20
C_5-C_8 Aliphatic Hydrocarbons	<8,000	<40
C_9-C_{12} Aliphatic Hydrocarbons	897	<15
C_9-C_{10} Aromatic Hydrocarbons	935	<55

System start-up date 12/2/2002.

DPW Maintenance Facility in Keystone Heights, Florida

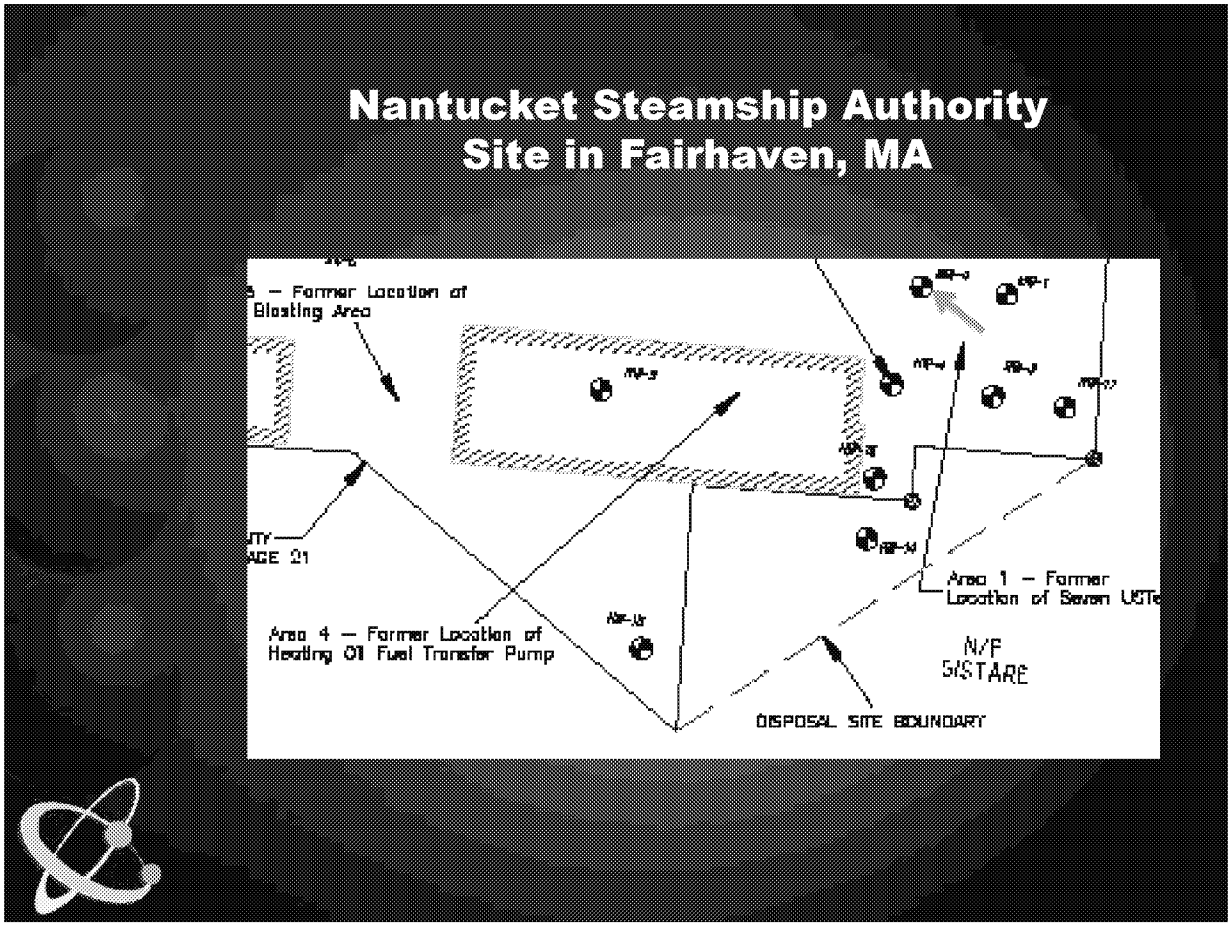


DPW Maintenance Facility in Keystone Heights, Florida

DPW Maintenance Facility in Keystone Heights, Florida (Silty-Clay Soils)

Time Period	Start-up	+ 4 Months
Parameters		
VPH (ug/L)	MW-2	MW-2
Methyl tert-butyl ether (MBTE)	4.0	<1.0
Benzene	3.0	<1.0
Toluene	83	<1.0
Ethylbenzene	387	<1.0
Xylenes	1,190	<1.0
Naphthalene	92	<1.0

System start-up date 4/4/2002; System operation was terminated on 3/4/2003; First Site closed in Florida using butane technology



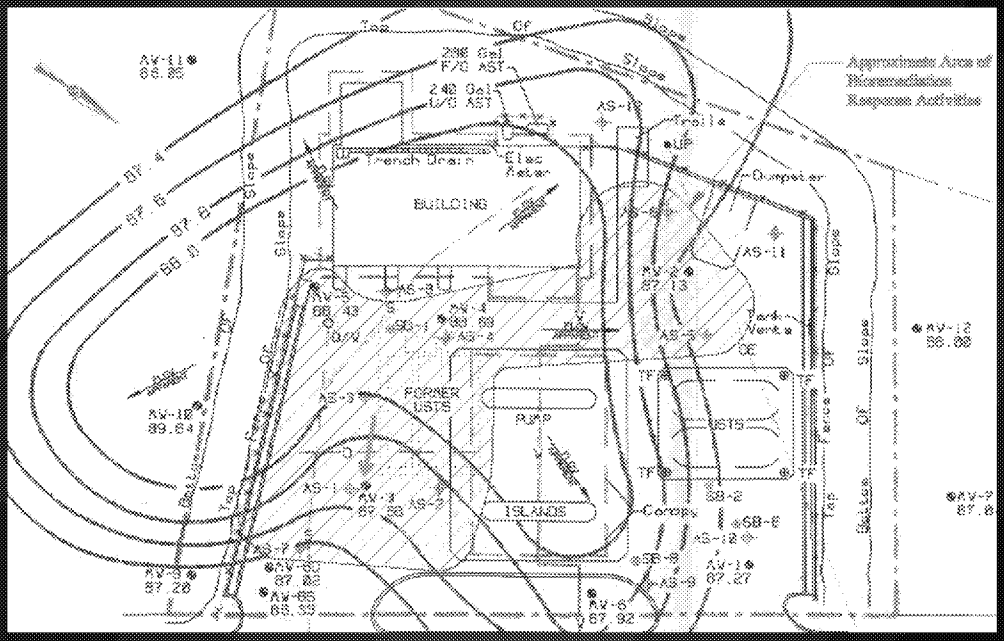
Nantucket Steamship Authority Site in Fairhaven, MA

Nantucket Steamship Authority Site in Fairhaven, MA

Time Period	Start-up	+ 6 Months
Parameters		
VPH and EPH (ug/L)	MW-4	MW-4
C_5-C_8 Aliphatic Hydrocarbons	54	<40
C_9-C_{12} Aliphatic Hydrocarbons	830	<15
C_9-C_{10} Aromatic Hydrocarbons	1,200	583
C_9-C_{18} Aliphatic Hydrocarbons	19,000	<100
C_{19}-C_{36} Aliphatic Hydrocarbons	2,400	<100
C_{11}-C_{22} Aromatic Hydrocarbons	30,000	<100

System start-up date December, 2001; System operation was terminated in June 2002

Sunoco Gasoline Station in Canton, MA



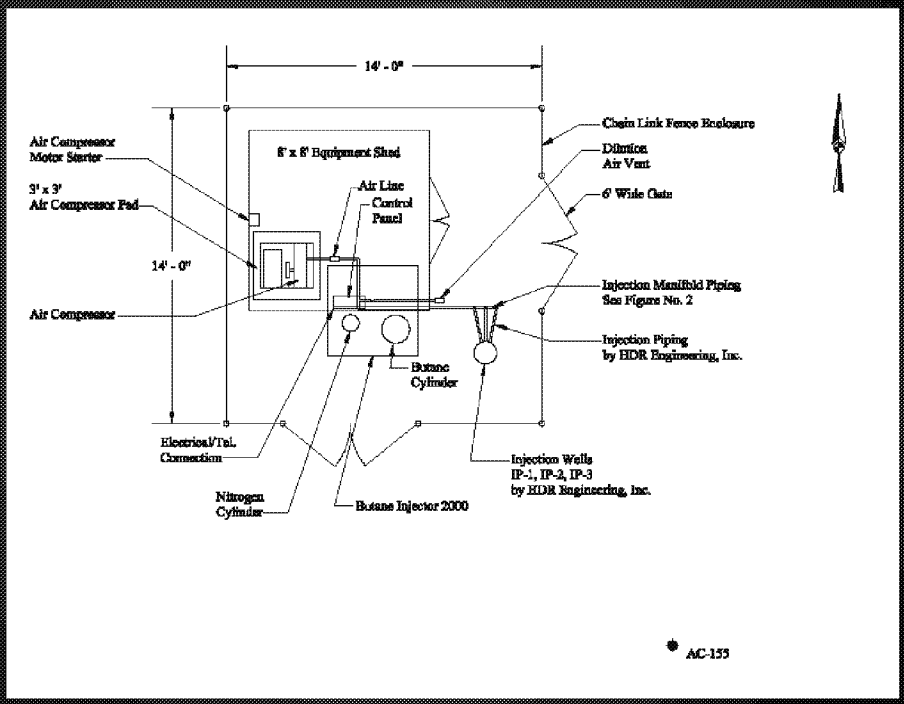
Sunoco Gasoline Station in Canton, MA

Sunoco Gasoline Station in Canton, MA

Time Period	Start-up	+11 Months
Parameters		
VPH (ug/L)	MW-3	MW-3
Methyl tert-butyl ether (MBTE)	370	52
Benzene	850	<5.0
Toluene	830	<5.0
Ethylbenzene	380	<5.0
Xylenes	2,000	<5.0
Naphthalene	110	<10
C_5-C_8 Aliphatic Hydrocarbons	1,900	<50
C_9-C_{12} Aliphatic Hydrocarbons	660	<50
C_9-C_{10} Aromatic Hydrocarbons	1,700	<50

System start-up date 11/10/2000; System operation was terminated on 10/29/2002; Site closed after one year of post-remedial monitoring

Butane Remediation of TCA/TCE in Sioux City, IA



Butane Remediation of TCA/TCE

Butane Remediation of TCA/TCE

Sampling Date	2/14/2001	4/11/2001
Parameters	Before	After
VOCs (ug/L)	AC-155	
1,1,1-Trichloroethane	7,160	0.7
1,1,2-Trichloroethane	0	0
1,1-Dichloroethane	5,170	1.6
1,1-Dichloroethene	1,400	0
1,2-Dichloroethane	0	0
cis-1,2-Dichloroethene	5,720	3.5
Tetrachloroethene	0	0
Trichloroethene	1,400	0
Vinyl Chloride	0	0

Project in Sioux City, Iowa for General Motors Corporation

Injection Hardware is Simple, Safe And Code Compliant

- Hardware design is rugged, simple, and safety certified (UL Listed)
- Hardware has approval from State Fire Marshals
- Injection system complies with federal, state and local laws and regulations pertaining to compressed gas delivery and storage
- Single injection panel (6-14 wells) covers ~ 1-2 acre area

Butane Biostimulation Summary

- Simple, rapid, effective for a wide variety of environmental pollutants
- Cost-effective and readily adaptable to large or small clean-ups
- No soil excavation or disposal necessary (very minimal surface disruption)
- Subsurface bacterial populations return to background levels after process is stopped
- Proven track-record, acceptance growing
- Enormous market opportunity

Thank You!

- www.GlobalBioSciencesllc.org