Global BioSciences, Inc.

# Petroleum Pollutants Case Study

## Service Station / Winthrop, Massachusetts

In December 2001, GBI began injecting butane to remediate petroleum contamination at a gasoline service station located in Winthrop, MA. The source of the contamination was a release resulting from a leak in a product line associated with a UST that occurred in 1998. At that time, product was removed via an ORS product recovery well, and product recovery tank, and 500 yards of contaminated soil were excavated and removed from the site. A soil vapor extraction system (SVES) was then installed and operated for 18 months before being shut down in 2001, due to the high cost of monthly carbon canister replacement for the SVES and the system's inability to treat Site groundwater.

The area of environmental concern is limited to the station and an adjoining property to the west, with a total area covering approximately 2400 $ft^2$. The depth to groundwater at the site is approximately 7 to 8 feet below ground surface. The site is paved and underlain by silty sand with some gravel and clay. Groundwater flow direction is southwesterly across the property toward a surface water body and wetlands, approximately 300 feet away. The subject site and adjacent properties are zoned as a commercial area and are not situated within a Current Drinking Water Source Area.

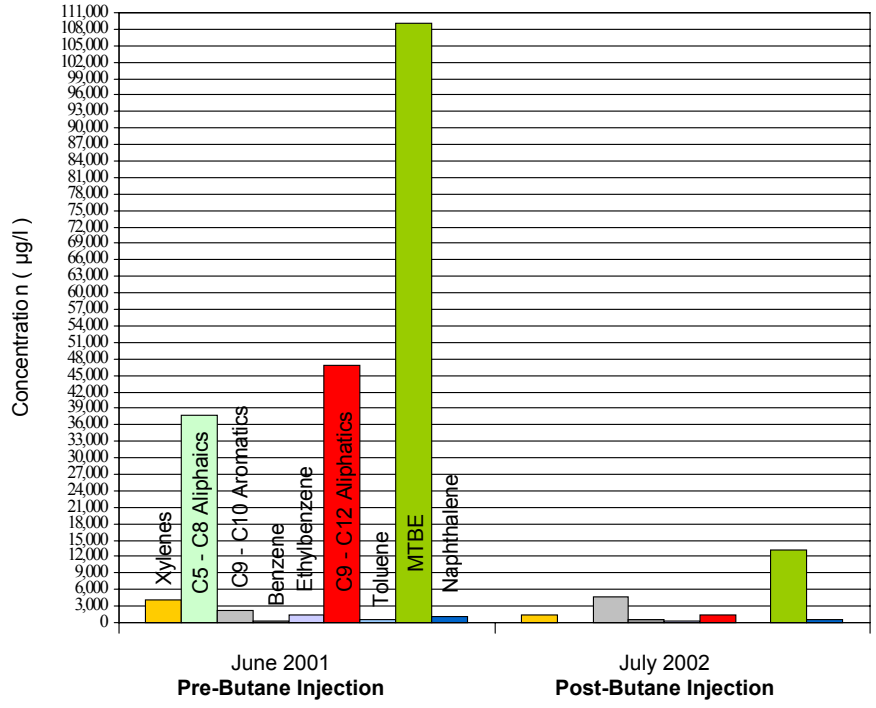
The area is serviced by the MWRA and the groundwater is classified as GW-2 and GW-3.

In November 2001, GBI installed the Butane Biostimulation treatment system, including a total of 7 injection wells, to cut off plume migration under a DEP approved Immediate Response Action Plan Modification. The SVES system previously installed at the site was converted to a Butane Bioventing™ System for in-situ treatment of soil vapor without carbon and is being operated concurrently with the Butane Biostimulation groundwater treatment system. The Butane Bioventing System is being used to control potential migration of VOCs from the treatment area into adjacent buildings and to further distribute butane and oxygenate the soils for enhanced microbial degradation of petroleum compounds in the capillary fringe and vadose zones.

Ground water sampling results for four wells are presented here. Three wells are downgradient of the source area, VW-1, VW-2, and VW-3, within the butane treatment zone. Upgradient well VW-6, previously believed to be outside the butane zone of influence, has also shown reduction in contaminant concentrations post butane injection.

## Butane Biostimulation Technologies™

### VW–2 Groundwater Test Data



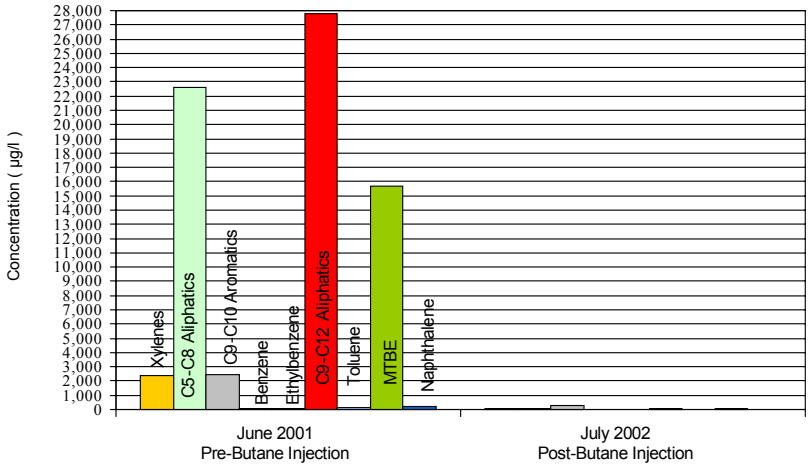

### Results

**June 2001**
**(Pre-Butane Injection)**
Xylenes = 4,090 ppb
**C5-C8 Aliphatics = 37,600 ppb**
C9-C10 Aromatics < 5500 ppb
Benzene < 500 ppb
Ethylbenzene = 1,510 ppb
**C9-C12 Aliphatics = 46,900 ppb**
Toluene = 504 ppb
**MTBE = 109,000 ppb**
Naphthalene < 2,000 ppb

**July 2002**
**(Post Butane Injection)**
Xylenes = 1,331 ppb
C5-C8 Aliphatics < 500
**C9-C10 Aromatics = 4,710 ppb**
Benzene = 551 ppb
Ethylbenzene = 271 ppb
**C9-C12 Aliphatics = 1,500 ppb**
Toluene = 44.3 ppb
MTBE = 13,100 ppb
Naphthalene = 435 ppb

*Non-detects graphed as one half MDL*
*Bold values exceed GW-2 and/or GW-3*

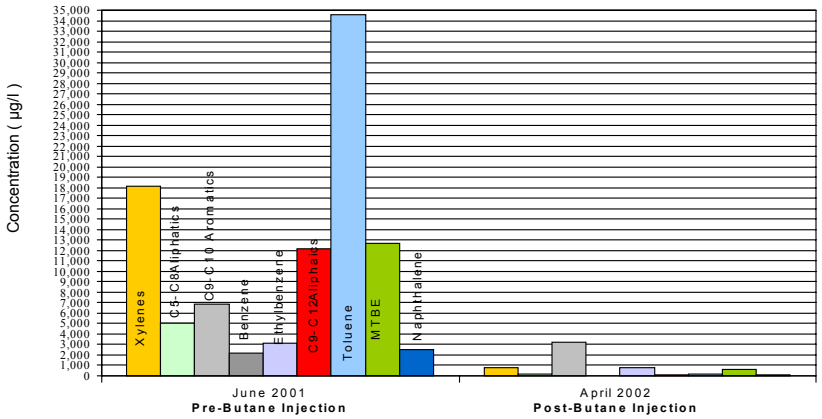
## VW-1 Groundwater Test Data




*All concentrations expressed in ( µg/l )*

| VW-1 | June 2001 Pre-Butane Injection | July 2002 Post -Butane Injection |
|---|---|---|
| Xylenes | 2404 | 40.9 |
| C5-C8 Aliphatics | **22,600** | ND |
| C9-C10 Aromatics | 2,440 | 303 |
| Benzene | <100 | 5.2 |
| Ethylbenzene | <100 | 5.4 |
| C9-C12 Aliphatics | **27,800** | ND |
| Toluene | 120 | ND |
| MTBE | 15,700 | 103 |
| Naphthalene | <400 | 29.3 |

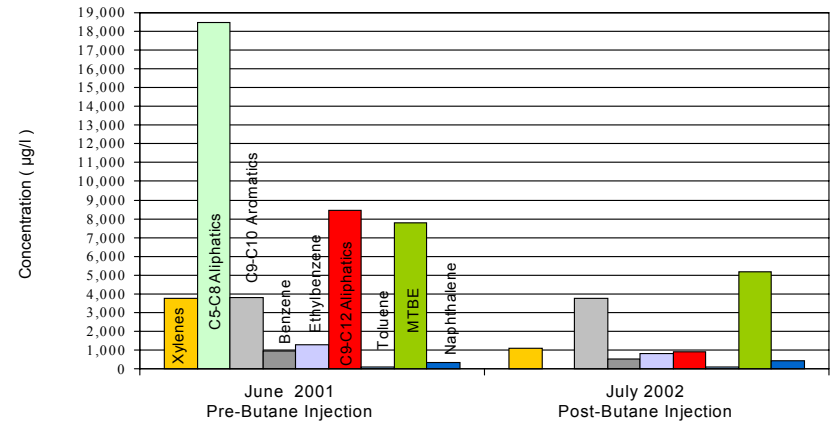
## VW-3 Groundwater Test Data




| VW-3 | June 2001 Pre-Butane Injection | April 2002 Post-Butane Injection |
|---|---|---|
| Xylenes | **18,110** | 753 |
| C5-C8 Aliphatics | <10,000 | <400 |
| C9-C10 Aromatics | <13,750 | 3,220 |
| Benzene | **2,170** | <50 |
| Ethylbenzene | 3,130 | 771 |
| C9-C12 Aliphatics | **12,200** | <150 |
| Toluene | **34,600** | 182 |
| MTBE | 12,700 | 587 |
| Naphthalene | <5000 | <200 |

*** VW-3 was dry for July 2002 sampling event**

## VW-6 Groundwater Test Data




| VW-6 | June 2001 Pre-Butane Injection | July 2002 Post– Butane Injection |
|---|---|---|
| Xylenes | 3,740 | 1073 |
| C5-C8 Aliphatics | **18,500** | ND |
| C9-C10 Aromatics | 3,800 | 3,740 |
| Benzene | 942 | 513 |
| Ethylbenzene | 1,260 | 799 |
| C9-C12 Aliphatics | **8,470** | 888 |
| Toluene | 85.8 | 116 |
| MTBE | 7,800 | 5170 |
| Naphthalene | 332 | 418 |

*Bold values exceed GW-2 and/or GW-3 Standards.*