APPENDIX A – MtBE Treatment Profiles – Summary of Available Data
Technologies for Treating MtBE and Other Fuel Oxygenates
EPA 542-R-04-009; May 2004

NOTES:
* Site name and location corresponds to that in the on-line database.
** For ongoing projects, final MTBE concentration shown is the most current available concentration.
*** Other technologies involved and cost for the use of selected technology shown only when provided in the available source materials.
**** Reflects content of database as of January 2003

Table A-1. Summary of Operating and Performance Information for Selected Projects – Air Sparging

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Air Sparging Only Projects									
Creek & Davidson, Site N: Bulk Terminal, WI	• Groundwater • >25 ft of fine to medium sand	Full	January 1996 - present/ On-going (data through June 2000)	• 28 air sparging wells • 40 cfm • Vendor: NA	NA	NA	NA	NA	Total Cost: $280,000 Capital Cost: 250,000 O&M Cost: $20,000/ No other technologies
Fountain Inn Exxon Fountain Inn, SC	• Groundwater	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	10,227	NA	NA	NA	Total Cost: $164,096/ No other technologies
Hess Station #40234 West Columbia, SC	• Groundwater	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	999	NA	NA	NA	Total Cost: $81,210/ No other technologies
Jim's Variety Shop Pageland, SC	• Groundwater	Full	Not Provided/ On-going (data through May 2002)	• Configuration not provided • Vendor: NA	10,242	NA	NA	NA	Total Cost:$107,428 / Free Product Recovery
NY 1-9012898	• Soil	Full	Not Provided/ On-going (data through May 2002)	• Configuration not provided • Vendor: NA	12,000	NA	6,000	50	Total Cost: $20,536/ No other technologies
Service Station, FL - B Pensacola, FL	• Groundwater • Sandy soil with a sand aquifer	Full	March 1994 - July 1994/ Completed	• 5 air sparging wells with 35 ft spacing • 8 scfm • Well pulsed on a daily cycle • Vendor: NA	230	NA	5	98	NA
Service Station, MA – C, MA	• Groundwater • Fine to medium sand	Full	Not Provided/ On-going (data through March 2001)	• 6 air sparging wells with 30 to 40 ft spacing • 5 scfm with continuous flow • Vendor: NA	215	NA	115	47	NA
Service Station, ME - A Sebato, ME	• Groundwater and soil • Fine sand & silt with a fine sand aquifer	Full	April 1994 - October 1995/ Completed	• 7 air sparging wells with 25 to 35 ft spacing • 5 to 10 scfm with continuous flow • Vendor: NA	62,000	NA	16	>99	NA

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Service Station, NM - A Albuquerque, NM	• Groundwater • Gravelly sand, with a gravel/sand aquifer • Depth to water: 40 ft	Full	June 1993 - January 1995/ Completed	• 9 air sparging wells with 40 to 50 ft spacing • 6 to 10 scfm with a continuous flow • Vendor: NA	1,600	NA	27	98	NA
Site CO-A Denver, CO	• Groundwater	Pilot	1996-1998/ On-going (data through March 2000)	• Horizontal air sparging trenches backfilled with pea gravel • Vendor: NA	8,000	NA	NA	NA	NA
Speedway #239 Georgetown, SC	• Groundwater	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	49	NA	NA	NA	Total Cost: $72,570/ No other technologies
Velta's Exxon #4-3594 North Charleston, SC	• Groundwater	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	5,111	NA	NA	NA	Total Cost: $259,000/ No other technologies
Wilson's Country Store Blacksburg, SC	• Groundwater	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	135	NA	NA	NA	Total Cost: $345,000/ No other technologies
Air Sparging with Soil Vapor Extraction Projects									
Bob's Suprette Clover, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	35,773	NA	NA	NA	Total Cost: $199,957/ SVE
By-Pass Quick Stop Bennetsville, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	12	NA	NA	NA	Total Cost: $357,000/ SVE
Convenience Mart Wilmington, NC	• Soil and groundwater	Full	May 1997 to Present/ On-going (data through December 2003)	• 2 vapor extraction wells & density driven convection (DDC) • Groundwater recirculation wells: 10 DDC wells • Vendor: Coastal Environmental Services (CESCO) and Wasatch	2,483	NA	2	>99	NA/ SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Crawford's Country Store Abbeville, SC	• Soil and groundwater	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	20,553	NA	NA	NA	Total Cost: $117,000 / SVE and Free Product Recovery
Creek & Davidson, Site M: Bulk Terminal, CO	• Groundwater and soil • 14-30 ft of sand	Full	February 1994 - present/ On-going (data through June 2000)	• Configuration not provided • 7 horizontal air sparging wells • 500 cfm • 23 vapor extraction wells • Vendor: NA	NA	NA	NA	NA	NA/ SVE with catalytic oxidation for off-gas
Eaddy Brothers Hemmingway, SC	• Groundwater and soil • Silty clays with inter-fingered thin clayey-sand lenses • Depth to water: 18 ft	Full	June 1999 - Present/ On-going (data through March 2001)	• 10 vertical air sparging wells, each 26 ft deep with 5 ft well screens • Vendor: NA	5,110,000	80	1,400	>99	Total Cost: $197,715/ SVE with thermal oxidation
EZ Mart Spartanburg, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	5,132	NA	NA	NA	Total Cost: $401,121/ SVE
E-Z Serve #8618 Charleston, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	808	NA	NA	NA	Total Cost: $335,000/ SVE
Former Gasoline Dispensing Facility Yarmouth, MA	• Groundwater and soil • Silty sand fill ranging from 1 to 5 feet below grade; underlain by 5 feet of fine sand, which is underlain by coarse sand to greater than 62 feet below grade • Depth to water: 5 ft	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • 5 air sparging wells • 4 vapor extraction wells • Vendor: NA	4,100	70	44	99	Total Cost: $653,500 / SVE
Former Livingstons Exxon Charleston, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	21	NA	NA	NA	Total Cost: $26,988/ SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Jennings Exxon Orangeburg, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	36	NA	NA	NA	Total Cost: $98,800/ SVE
Kansas A1-095-40139 Hugoton, KS	• Groundwater and soil • 1-21 silt/clay • 21-39 ft bgs sand • 39-44 silt/clay • 44-56 ft bgs sand • 56-105 ft bgs sand/gravel	Full	October 1999 - present/ On-going (data through July 2001)	• 17 air sparging wells • 6 soil vapor extraction wells • Vendor: NA	510	NA	3	>99	NA/ SVE
Kansas A2-078-40106 Sylvia, KS	• Groundwater and soil • 0-5 ft bgs sand • 5-12 ft bgs clay • 12-50 ft bgs sand • Depth to water: 12 ft	Full	January 2001 - present/ On-going (data through July 2001)	• 12 air sparging wells • 13 soil vapor extraction wells • Vendor: NA	NA	NA	NA	NA	NA/ SVE
Kansas A6-026-40102 Ellis, KS	• Groundwater • 1-12 ft bgs clay • 12-14 ft bgs sand • Depth to water: 7 ft	Full	October 2000 - present/ On-going (data through July 2001)	• 8 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	46.3	NA	47.7	Increase	NA/ SVE
Kansas U1-029-00122 Dodge City, KS	• Groundwater and soil • 0-6 ft bgs sand • 6-12 ft bgs silt/clay • 12-44 ft bgs sand • Depth to water: 17 ft	Full	July 2000 - present/ On-going (data through July 2001)	• 11 air sparging wells • 12 soil vapor extraction wells • Vendor: NA	4,340	NA	18,400	Increase	NA/ SVE
Kansas U1-029-00755 Offerley, KS	• Groundwater and soil • 0-19 bgs silt/clayy • 19-26 bgs sand • Depth to water: 21 ft.	Full	June 2000 - December 2000/ On-going (data through July 2001)	• Configuration not provided • Vendor: NA	755	NA	542	28	NA/SVE
Kansas U1-029-00890 Dodge City, KS	• Groundwater and soil • 0-23 ft bgs silt • 23-50 ft bgs sand	Full	August 1998 - present/ On-going (data through July 2001)	• 6 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	383	NA	74	81	NA/ SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Kansas U1-029-10316 Dodge City, KS	• Groundwater and soil • 0-20 ft bgs silt/clay • 20-35 ft bgs m/c sand • 35-45 ft bgs c sand-gravel • Depth to water: 22 ft	Full	February 1998 - present/ On-going (data through July 2001)	• 3 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	360	NA	100	72	NA/ SVE
Kansas U1-035-00354 Cimarron, KS	• Groundwater and soil • 1-33 silt/clay • 33-37 sand • 37-40 sand/gravel • Depth to water: 28 ft	Full	March 2000 - present/ On-going (data through July 2001)	• 5 air sparging wells • 6 soil vapor extraction wells • Vendor: NA	280	NA	46	84	NA/ SVE
Kansas U1-035-10120 Cimarron, KS	• Groundwater and soil • 1-45 ft bgs silt • 45-55 ft bgs sand • Depth to water: 45 ft	Full	March 1999 - present/ On-going (data through July 2001)	• 7 air sparging wells • 3 soil vapor extraction wells • Vendor: NA	92,000	NA	2,700	97	NA/ SVE
Kansas U1-076-488 Pratt, KS	• Groundwater and soil • 1-19 ft bgs silt • 19-30 ft bgs sand • 19-35 ft bgs silt/silt • 35-55 ft bgs sand/silt • Depth to water: 41 ft	Full	April 1998 - February 2001/ On-going (data through July 2001)	• 8 air sparging wells • 8 soil vapor extraction wells • Vendor: NA	105	NA	ND	NA	NA/ SVE
Kansas U1-076-896 Luka, KS	• Groundwater and soil • 1-23 ft bgs silt/silt • 23-48 ft bgs silt • 48-50 ft bgs sand • 50-55 ft bgs silt • Depth to water: 50 ft	Full	May 2000 - present/ On-going (data through July 2001)	• 6 air sparging wells • 14 soil vapor extraction well • Vendor: NA	NA	NA	115	NA	NA/ SVE
Kansas U1-086-0910 Scott City, KS	• Groundwater and soil • 0.5 - 65 ft bgs silt clay • 65 - 80 ft bgs m/c sand • 80 - 120 ft bgs sandy clay • 120 - 160 ft bgs m/c sand • Depth to water: 135 ft	Full	January 2000 - present/ On-going (data through July 2001)	• 3 air sparging wells • 5 soil vapor extraction wells • Vendor: NA	69,100	NA	NA	NA	NA/ SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Kansas U1-086-10822 Scott City, KS	• Groundwater and soil • 0.5-65 ft bgs silt clay • 65-80 ft bgs m/c sand • 80-120 ft bgs sandy clay • 120-160 ft bgs m/c sand	Full	January 2000 - present/ On-going (data through July 2001)	• 4 air sparging wells • 6 soil vapor extraction wells • Vendor: NA	21,600	NA	NA	NA	NA/ SVE
Kansas U2-087-01212 Wichita, KS	• Groundwater and soil • 1-5 clay ft bgs • 5-30 ft bgs sand • Depth to water: 14 ft	Full	September 1999 - April 2001/ On-going (data through July 2001)	• 8 air sparging wells • 3 soil vapor extraction wells • Vendor: NA	1,560	NA	1,454	93	NA/ SVE
Kansas U5-057-00856 Peabody, KS	• Groundwater and soil • 0-30 ft bgs silt/clay • 30-40 ft bgs shale • Depth to water: 11 ft	Full	November 2000 - February 2001/ On-going (data through July 2001)	• 1 air sparging well • 3 soil vapor extraction wells • Vendor: NA	4,840	NA	4,840	0	NA/ SVE
Kansas U6-026-00066B Hays, KS	• Groundwater and soil • 1-35 ft bgs clay • 35-50 ft bgs sand • Depth to water: 33 ft	Full	November 1998 - February 2001/ On-going (data through July 2001)	• 5 air sparging well • 1 soil vapor extraction wells • Vendor: NA	3,500	NA	140	96	NA/ SVE
Kansas U1-093-11583 Greenfield, KS	• Groundwater and soil • 1-8 ft bgs clay • 8-50 ft bgs sand • Depth to water: 18 ft	Full	October 2000 - present/ On-going (data through July 2001)	• 11 air sparging wells • 3 soil vapor extraction wells • Vendor: NA	255	NA	<250	2	NA/ SVE
Kansas U1-093-11814 Macksville, KS	• Groundwater and soil • 1-15 ft bgs clay • 15-35 ft bgs sand • Depth to water: 19 ft	Full	September 1999 - present/ On-going (data through July 2001)	• 7 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	100	NA	108	Increase	NA/ SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Kansas U1-095-428 Hugoton, KS	• Groundwater and soil • 1-26 ft bgs silt/clay • 26-38 ft bgs sand • 38-40 ft bgs clay • 40-57 ft bgs sand • 57-60 ft bgs silt • 60-90 ft bgs sand/gravel • 90-95 ft bgs silt/sand • 95-100 ft bgs sand/gravel • Depth to water: 86 ft	Full	October 1999 - present/ On-going (data through July 2001)	• 3 air sparging wells • 2 soil vapor extraction wells • Vendor: NA	21,000	NA	ND	99	NA/ SVE
Kansas U1-102-0802 Marienthal, KS	• Groundwater and soil • 0.5 – 30 ft bgs silt • 30 – 75 ft bgs f/m sand • 75 - 95 ft bgs silt • 95 - 150 ft bgs sand • Depth to water: 128 ft	Full	May 2000 - present/ On-going (data through July 2001)	• 8 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	22,300	NA	1,850	92	NA/ SVE
Kansas U2 087 0288 Wichita, KS	• Groundwater and soil • 0.5 – 25 ft bgs sand/silt/clay • 25 - 42 ft bgs f/c sand • 42 - 45+, ft bgs sand/gravel	Full	November 2000 - present/ On-going (data through July 2001)	• 9 air sparging wells • 3 soil vapor extraction wells • Vendor: NA	2,770	NA	46	NA	NA/ SVE
Kansas U2-078-01344 Hutchinson, KS	• Groundwater and soil • 0-5 ft bgs clay • 5-6 ft bgs silt • 6-25 ft bgs silt/sand • Depth to water: 13 ft	Full	September 2000 - present/ On-going (data through July 2001)	• 3 air sparging wells • 2 soil vapor extraction wells • Vendor: NA	3,580	NA	74	98	NA/ SVE
Kansas U2-087-1061 Wichita, KS	• Groundwater and soil • 1-7 ft bgs silt/clay • 7-25 ft bgs sand • Depth to water: 11 ft	Full	April 1994 - October 1997/ On-going (data through July 2001)	• 4 air sparging wells • 2 soil vapor extraction wells • Vendor: NA	355	NA	ND	NA	NA/ SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Kansas U2-087-10943 Wichita, KS	• Groundwater and soil • 1-8 ft bgs clay • 8-43 ft bgs sand • 43 ft bgs shale • Depth to water: 11 ft	Full	January 2000 - present/ On-going (data through July 2001)	• 7 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	8,850	NA	6	>99	NA/ SVE
Kansas U2-087-11161 Wichita, KS	• Groundwater and soil • 0-20 ft bgs clay w/sand • Depth to water: 13 ft	Full	March 2001 - present/ On-going (data through July 2001)	• 8 air sparging wells • 7 soil vapor extraction wells • Vendor: NA	72.5	NA	NA	NA	NA/ SVE
Kansas U2-087-1232 Wichita, KS	• Groundwater and soil • 0-12 ft bgs silt • 12-50 ft bgs sand • Bedrock ft bgs 50 ft	Full	January 1997 - present/ On-going (data through July 2001)	• 6 air sparging wells • 8 soil vapor extraction wells • Vendor: NA	1,250	NA	98	92	NA/ SVE
Kansas U2-087-1236 Park City, KS	• Groundwater and soil • 0-12 ft bgs silt • 12-50 ft bgs sand • Bedrock 50 ft bgs	Full	October 1997 - present/ On-going (data through July 2001)	• 4 air sparging wells • 5 soil vapor extraction wells • Vendor: NA	NA	NA	1,060	NA	NA/ SVE
Kansas U2-087-989 Andale, KS	• Groundwater and soil • 1-29 ft bgs silt/silt • 29-55 ft bgs (TD) sand • Depth to water: 45 ft	Full	September 1997- present/ On-going (data through July 2001)	• 3 air sparging wells • 8 soil vapor extraction wells • Vendor: NA	128	NA	ND	>99	NA/ SVE
Kansas U4-044-1120 Grantville, KS	• Groundwater and soil • 1-11ft bgs silt/clay • 11-34 ft bgs silt • 34-46 ft bgs sand • Depth to water: 27 ft	Full	June 1994 - February 1999/ Completed (data through July 2001)	• Configuration not provided • 4 air sparging wells • 8 soil vapor extraction wells • Vendor: NA	337	NA	ND	NA	NA/ SVE
Kansas U4-044-1275 Grantville, KS	• Groundwater and soil • 1-11 ft bgs silt/clay • 11-34 ft bgs silt • 34-46 ft bgs sand • Depth to water: 27 ft	Full	June 1996 - February 1999/ On-going (data through July 2001)	• 4 air sparging wells • 8 soil vapor extraction wells • Vendor: NA	95	NA	ND	NA	NA/ SVE
Kansas U5-014-535 Clay Center, KS	• Groundwater and soil • 26-45 ft bgs sand	Full	November 1997 - present/ On-going (data through July 2001)	• 2 air sparging wells • 2 soil vapor extraction wells • Vendor: NA	25	NA	ND	NA	NA/ SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Kansas U5-031-00650 Junction City, KS	• Groundwater and soil • 0-24 ft bgs clay • 22-42 ft bgs sand • 42-49 silt-clay • Depth to water: 38 ft	Full	August 2000 - present/ On-going (data through July 2001)	• 5 air sparging wells • 5 soil vapor extraction wells • Vendor: NA	500	NA	120	76	NA/ SVE
Kansas U5-031-590 Junction City, KS	• Groundwater and soil • 0-9 ft bgs silt • 9-40 ft bgs sand	Full	November 1997 - November 2000/ On-going (data through July 2001)	• 3 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	3,871	NA	ND	>99	NA/ SVE
Kansas U5-080-291 Alden, KS	• Groundwater and soil • 1-5 ft bgs clay • 5-20 ft bgs sand • 20-27 ft bgs gravel • Depth to water: 9 ft	Full	November 1999 - present/ On-going (data through July 2001)	• 4 air sparging wells • 2 soil vapor extraction wells • Vendor: NA	46	NA	47	Increase	NA/ SVE
Kansas U6-005-10039 Ellinwood, KS	• Groundwater and soil • 1-11ft bgs sand-clay • 11-TD ft bgs sand/sand • Depth to water: 13 ft	Full	June 1998 - present/ On-going (data through July 2001)	• 2 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	5,600	NA	77	99	NA/ SVE
Kansas U6-005-10086 Ellinwood, KS	• Groundwater and soil • 1-10 ft bgs clay, silty • 10-TD ft bgs sand	Full	January 1999 - present/ On-going (data through July 2001)	• 6 air sparging wells • 3 soil vapor extraction wells • Vendor: NA	194 (Site reported that start up sampling is suspicious)	NA	252	Increase	NA/ SVE
Kansas U6-005-12657 Ellinwood, KS	• Groundwater and soil • 1-10 ft bgs clay, silt • 10-TD ft bgs f-c sand • Depth to water: 12 ft	Full	July 2000 - April 2001/ On-going (data through July 2001)	• 2 air sparging wells • 3 soil vapor extraction wells • Vendor: NA	27.7	NA	ND	>99	NA/ SVE
Kansas U6-005-278 Ellinwood, KS	• Groundwater and soil • 1-9 ft bgs clay • 10-TD ft bgs sand • Depth to water: 11 ft	Full	October 1998 - present/ On-going (data through July 2001)	• 3 air sparging wells • 8 soil vapor extraction wells • Vendor: NA	232	NA	26	89	NA/ SVE
Kansas U6-005-649 Ellinwood, KS	• Groundwater and soil • 1-10 ft bgs clay, sand-clay • 10-TD sand/sand • Depth to water: 12 ft	Full	March 1997 - present/ On-going (data through July 2001)	• 2 air sparging wells • 3 soil vapor extraction wells • Vendor: NA	190	NA	190	0	NA/ SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Kansas U6-020-628 Oberlin, KS	• Groundwater and soil • Silt/silt to 35 ft bgs • Depth to water: 18 ft	Full	April 1996 - present/ On-going (data through July 2001)	• 2 soil vapor extraction wells • Vendor: NA	127	NA	189	Increase	NA/ • SVE • Excavation
Kansas U6-026-00066B Hays, KS	• Groundwater and soil • 1-35 ft bgs clay • 35-50 ft bgssand • Depth to water: 33 ft	Full	November 1998 - February 2001/ On-going (data through July 2001)	• 5 air sparging wells • 1 soil vapor extraction wells • Vendor: NA	3,350	NA	140	96	NA/ • SVE • Excavation
Kansas U6-026-274 Ellis, KS	• Groundwater and soil • 1-8 ft bgs silt/silt • 8-15 ft bgs silt • 15-20 ft bgs sand/silt • Depth to water: 9 ft	Full	August 2000 - present/ On-going (data through July 2001)	• 5 air sparging wells • 5 soil vapor extraction wells • Vendor: NA	8,140	NA	6,430	20	NA/ SVE
Kansas U6-032-513 Quinter, KS	• Groundwater and soil • 0-28 ft bgs clay • 28-52 ft bgs sand/sand • 52-95 ft bgs silt/sand • Depth to water: 75 ft	Full	December 1996 - present/ On-going (data through July 2001)	• 11 air sparging wells • 14 soil vapor extraction wells • Vendor: NA	280	NA	15.1	97	NA/ SVE
Kansas U6-055-295 Oakley, KS	• Groundwater and soil • 0-67 ft bgs silt/clay • 67-85 ft bgs sand • 85-110 ft bgs silt/clay • 110 ft bgs sand	Full	June 1996 - present/ On-going (data through July 2001)	• 11 air sparging wells • 16 soil vapor extraction wells • Vendor: NA	9,158	NA	55.6	>99	NA/ SVE
Kansas U6-068-0015 Ness City, KS	• Groundwater and soil • 0.5 - 22 ft bgs clay/silt-clay • 22 – 34 ft bgs sand/clay • 34 - 44 ft bgs gravel f/c sand • Depth to water: 33 ft	Full	January 2000 - present/ On-going (data through July 2001)	• 4 air sparging wells • 3 soil vapor extraction wells • Vendor: NA	97	NA	45.3	53	NA/ SVE
Kansas U6-068-559 Ness City, KS	• Groundwater and soil • 1-35 or 40 ft bgs silt/silt • 35/40 ft bgs silty sand • Depth to water: 32 ft	Full	November 1998 - April 2001/ On-going (data through July 2001)	• 11 air sparging wells • 15 soil vapor extraction wells • Vendor: NA	<250	NA	ND	>99	NA/ SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Kansas U6-091-221 Selden, KS	• Groundwater and soil • 83-118 ft bgs sand/sand • 118-147 ft bgs sand, clay • Depth to water: 125 ft	Full	February 1999 - present/ On-going (data through July 2001)	• 4 air sparging wells • 12 soil vapor extraction wells • Vendor: NA	5.32	NA	ND	>99	NA/ SVE
Kansas U6-097-386 Oakley, KS	• Groundwater and soil • 1-50 ft bgs silt/clay • 50-90 ft bgs sand/ clay/ sand/ gravel • Depth to water: 80 ft	Full	October 1999 - January 2001/ On-going (data through July 2001)	• 8 air sparging wells • 15 soil vapor extraction wells • Vendor: NA	666	NA	ND	>99	NA/ SVE
Kansas U6-097-617 Colby, KS	• Groundwater and soil • 1-46 ft bgs silt/clay • 46-76 ft bgs sand • 76-81clay • 81-130 sand/clay sand • Depth to water: 102 ft	Full	September 1998 - present/ On-going (data through July 2001)	• 7 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	426	NA	236	45	NA/ SVE
Kwik Fill #17 Dillon, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	NA	NA	NA	NA	Total Cost: $130,000/ SVE
Muffler Palace Lake Tahoe, CA	• Groundwater and soil	Full	January 1999 - present/ On-going (data through April 2000)	• Configuration not provided • Vendor: NA	58	NA	13	78	NA/ SVE with GAC
NY 1-9008339	• Soil	Full	Not Provided/ On-going (data through May 2002)	• Remediation consists of air sparging (oxygen) with soil vapor extraction and soil excavation • Vendor: NA	58,000		28	>99	Total Cost: $201,900/ SVE
NY 1-9108813	• Soil	Full	Not provided/ On-going (data through May 2002)	• Configuration not provided • Vendor: NA	17,000	NA	930	95	Total Cost: $246,933/ SVE
Rotten Robbie Lake Tahoe, CA	• Groundwater and soil	Full	June 1995 - present/ On-going (data through April 2000)	• Configuration not provided • Vendor: NA	5	NA	437	Increase	NA/ SVE with GAC

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Ryder Commercial Leasing Greenville, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	49	NA	NA	NA	Total Cost: $256,000/ SVE
SCDOT Newberry Maintenance Facility Newberry, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	12	NA	NA	NA	Total Cost: $175,000/ SVE
Scotchman #60 Myrtle Beach, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	3,204	NA	NA	NA	Total Cost: $137,000/ SVE
Service Station, NY - C Bayshore, NY	• Groundwater and soil	Full	Not Provided/ On-going (data through May 2002)	• Horizontal air sparging: 3 bundles of wells with 22 air sparging points • Radius of influence of 27 ft at 20 cfm • 2 bundles with 10 soil vapor extraction points utilizing directional drilling; radius of influence of 40 ft at 50 cfm • Vendor: J.N.M. Environmental Inc.	110	NA	NA	NA	NA/ SVE
Site KS - A Park City, KS	• Groundwater	Full	October 1997 - Present/ On-going (data through March 2001)	• Configuration not provided • Vendor: NA	285,000	NA	72,100	75	Cost for all technologies combined: Total Cost: $143,500 O&M Cost $14,700/ SVE with GAC
Site KS - B Rush Center, KS	• Groundwater and soil	Full	January 1996 - Present/ On-going (data through March 2001)	• Two oxygen release compound barriers • Vendor: NA	191,000	NA	47,000	75	Cost for all technologies combined: Total Cost: $1,051,000 Assessment Cost: $74,000 Capital Cost: 984,983 O&M Cost: $16,500/ SVE
Southern Gas Service Travelers Rest, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	NA	NA	NA	NA	Total Cost: $192,250/ SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Speedway #617 Rock Hill, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	16	NA	NA	NA	Total Cost: $269,380/ SVE
Terrible Herbst Gas Station, Lake Tahoe, CA	• Groundwater and soil	Full	November 1995 - present/ On-going (data through April 2000)	• Configuration not provided • Vendor: NA	296	NA	240	19	NA/ SVE
Air Sparging with Pump and Treat Projects									
Amoco Petroleum Pipeline	• Groundwater • 10 to 29 ft of interbedded sand and gravel overlies a silty clay glacial till unit • Free product present in an approximate 6-acre area	Full	Not Provided/ On-going (NA)	• 4 pump and treat extraction wells installed in two phases (1988 and 1992) at depths up to 28 ft bgs • Extraction rates of 50 and 100 gallons per minute • Extracted water is treated with one 20,000 pound GAC vessels • 30 air sparging wells • Vendor: Residuals Management Technology, Inc.	NA	380	NA	NA	Capital Cost: $672,000/ Pump and treat
Chevron Service Station #90071 Lake Tahoe, CA	• Groundwater and soil	Full	December 1992 - May 1998/ Completed	• Configuration not provided • Vendor: NA	11,000	NA	2,070	81	NA/ • Pump and treat, Granular activated carbon (GAC) • Excavation
Meyers Beacon Lake Tahoe, CA	• Groundwater	Full	May 1998 - present/ Completed	• Configuration not provided • Vendor: NA	1,200	NA	18	99	NA/ Pump and Treat with GAC
Moss Chevron Lake Tahoe, CA	• Groundwater	Full	May 1999 - present/ On-going (data through April 2000)	• Configuration not provided • Vendor: NA	8,700	NA	8,700	0	NA/ Pump and treat with GAC
Air Sparging with Soil Vapor Extraction and Pump and Treat Projects									
Exxon Service Station, Smithtown, NY	• Groundwater and soil	Full	April 2001 - Present/ On-going (data through September 2001)	• 300 cfm • Vendor: Geological Services Corp.	150,000	NA	NA	NA	NA/ • Excavation •Pump and treat (complete) • SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
E-Z Serve #8639 Spartanburg, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	36	NA	NA	NA	Total Cost: $380,000/ • SVE • Pump and treat
Gate #311 Cheraw, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	5,111	NA	NA	NA	Total Cost: $184,250/ • SVE • Pump and treat
Green Sea Grocery Green Sea, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	15	NA	NA	NA	Total Cost: $327,000/ • SVE • Pump and treat • Free product recovery
Kansas U1-029-230 Dodge City, KS	• Groundwater and soil • 0-23 ft bgs silt • 23-50 ft bgs sand	Full	1995 - January 2001/ On-going (data through July 2001)	• 21 air sparging wells • 11 soil vapor extraction wells • Vendor: NA	15	NA	ND	NA	NA/ • SVE • Pump and Treat
Kansas U6-005-00268 Great Bend, KS	• Groundwater and soil • 1-8 ft bgs clay • 8-27 ft bgs sand • 27-48 ft bgs clay • Depth to water: 10 ft	Full	November 1994 - January 1998/ Completed	• Configuration not provided • 7 air sparging wells • 8 Soil vapor extraction wells • Vendor: NA	390	NA	4.8	99	NA/ SVE
Morris Variety Shop Bluffton, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	33	NA	NA	NA	Total Cost: $435,000/ • SVE • Pump and treat
NY 1-8504473	• Soil and groundwater	Full	Not provided/ On-going (data through May 2002)	• Configuration not provided • Vendor: NA	22,000	NA	1,600	93	Total Cost: $567,140/ • SVE • Pump and treat • Excavation
NY 1-8900312, NY	• Soil and groundwater	Full	Not provided/ On-going (data through May 2002)	• Configuration not provided • Vendor: NA	4,000	NA	567	86	NA/ • SVE • Pump and treat • Bioremediation
NY 1-8910209, NY	• Soil and groundwater	Full	Not provided/ On-going (data through May 2002)	• Configuration not provided • Vendor: NA	9,999	NA	8	99	Total Cost: $96,350/ • SVE • Pump and treat • Excavation

Selected MtBE Treatment Projects

Source: www.clu-in.org/products/mtbe

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
NY 1-9003951, NY	• Soil and groundwater	Full	Not provided/ On-going (data through May 2002)	• Configuration not provided • Vendor: NA	7,900	NA	ND	>99	Total Cost: $410,616/ • SVE • Pump and treat • Excavation
Perfection Connection Lake Tahoe, CA	• Groundwater and soil	Full	October 1991 - November 1995/ Completed	• Configuration not provided • Vendor: NA	5	NA	2	60	NA/ • Excavation and aeration of the soil • SVE • Pump and treat: GAC
Pit Stop Service Station Baldwin, NY	• Groundwater	Full	1996 - Present/ On-going (data through September 2001)	• 300 cfm • 2 groundwater extraction, combined flow rate of 30 gpm, air stripper • Vendor: J.N.M. Environmental Inc.	NA	NA	NA	NA	NA/ • SVE with catalytic oxidizer • Pump and treat
SaveWay #2 Hartsville, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	270	NA	NA	NA	Total Cost: $284,178/ • SVE • Pump and treat
Scotchman #171 North Charleston, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	20	NA	NA	NA	Total Cost: $300,000/ • SVE • Pump and treat
Service Station MA-E Palmer, MA	• Soil and groundwater • 15 to 20 ft of sand and gravel over 70 to 80 ft of interbedded fine sand and silt • Bedrock is found at 90 to 150 ft below ground surface	Full	1996-1997/ Completed	• Site reported that no action was taken until 2 months after the initial gasoline spill in 1989 • The initial effort included the installation of three recovery wells to capture and remove the floating product • The remediation system installed was a soil • Vendor: NA	NA	NA	NA	NA	Total Cost: $12 million (anticipated)/ • SVE • Pump and treat

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Service Station, MA - B Cape Cod, MA	• Groundwater and soil • 5 ft of fill over fine to coarse sand • Depth to water: 3-7 ft	Full	August 1990 - October 1996/ Completed	• 5 air sparging wells • 2 groundwater extraction well; treated by air stripping then two 2,000# carbon canisters. Effluent water sent to an on-site recharge and town storm sewer. • Off gas treatment via two 200# carbon canisters • 5 vapor extraction wells • Vendor: NA	2,600	70	3	>99	NA/ • Pump and Treat • SVE
Tahoe Tom's, Lake Tahoe, CA	• Groundwater and soil	Full	September 1998 - present/ On-going (data through April 2000)	• Configuration not provided • Vendor: NA	52,100	NA	760,000	Increase	NA/ • Pump and treat with air striping • SVE with GAC
USA Petroleum Lake Tahoe, CA	• Groundwater	Full	November 1997 - Present/ On-going	• Configuration not provided • Vendor: NA	31,000	NA	270	>99	NA/ • Pump and treat • SVE with GAC
Air Sparging with Other Technologies Projects									
Al's Ski Run Chevron Lake Tahoe, CA	• Groundwater and soil	Full	July 1995 - Present/ On-going (data through March 2001)	• Configuration not provided • Vendor: NA	260	NA	27	90	NA/ • Pump and treat • Dual vapor extraction (DVE) • In-situ oxidation using hydrogen peroxide
Beene Site, Dallas, TX	• Groundwater and soil • Clay with minor silts throughout the soil column	Full	12 months/ Completed	• Biosparging using ambient surface air, coupled with vadose zone vacuum extraction • Air sparging to volatilize contaminants, with in-situ aerobic bioremediation • Spacing between air injection points varied • 12 sparge wells • Vendor: Billings & Associates Inc.	44,386	NA	NA	NA	NA/ • In-situ bioremediation • SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Bloom Site, Bloomfield, NM	• Groundwater and soil • Fine to medium sands with occasional silt stringers of irregular thickness	Full	24 months/ Completed	• Biosparging using ambient surface air, coupled with vadose zone vacuum extraction • Air sparging to volatilize contaminants, with in-situ aerobic bioremediation • Spacing between air injection points varied • 13 sparge wells • Vendor: Billings & Associates Inc.	4,151	NA	NA	NA	NA/ • In-situ bioremediation • SVE
Canon Site, Canon City, CO	• Groundwater and soil • Multilayered lithology with silts and clays intermixed in the upper 7.9 to 9.9 ft • Medium to coarse grained sands are found to a depth of approximately 20 ft • From 20 to 24.6 ft a coarse sand and cobble bed is encountered	Full	12 months/ Completed	• Biosparging using ambient surface air, coupled with vadose zone vacuum extraction • Air sparging to volatilize contaminants, with in-situ aerobic bioremediation • Spacing between air injection points varied • 6 air sparge wells • Vendor: Billings & Associates Inc.	13,633	NA	NA	NA	NA/ • In-situ bioremediation • SVE
Herrera Site, Albuquerque, NM	• Groundwater and soil • Subsurface is composed of primarily alluvial sands of medium to fine grain with intermittent thin silt layers	Full	24 months/ Completed	• Biosparging using ambient surface air, coupled with vadose zone vacuum extraction • Air sparging to volatilize contaminants, with in-situ aerobic bioremediation • Spacing between air injection points varied • 17 air sparge wells • Vendor: Billings & Associates Inc.	17,323	NA	NA	NA	NA/ • In-situ bioremediation • SVE
Port Hueneme - A Oxnard, CA	• Groundwater	Bench	Not Provided/ On-going (data through May 2001)	• Configuration not provided • Vendor: NA	10,000	NA	25	>99	NA/ Ex-situ bioremediation: Injection of MC-100 & SC-100

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Port Hueneme - C Oxnard, CA	• Groundwater	Pilot	October 1999 - Present/ On-going (data through October 2001)	• 3 air sparging wells - two sparged with oxygen, one with Strain PM1 • Vendor: NA	6,000	NA	10	>99	NA/ *In-situ* bioremediation with Strain PM1& biostimulation of native microbial populations
Scotchman #94 Florence, SC	• Groundwater and soil • Clayey sands, and sandy clays, with a hard clay layer at approximately 10 ft • Depth to water: 23 ft	Full	March 1999 - Present/ On-going (data through March 2001)	• 28 air sparging wells in seven groups • 5 extraction wells • Vendor: NA	87,000	2,495	7,410	91	Total Cost: $383,000/ • Multi-phase extraction • SVE
Tahoe Boat Company, CA	• Groundwater	Full	August 1995 - April 1999/ Completed	• Configuration not provided • Vendor: NA	55	NA	79	Increase	NA/ Multi-phase extraction with GAC
Tuba Site, Tuba City, AZ	• Groundwater and soil: • Medium to fine sands to a subsurface depth of approximately 20 ft	Full	Three months/ Completed	• Biosparging using ambient surface air, coupled with vadose zone vacuum extraction • Air sparging to volatilize contaminants, with in-situ aerobic bioremediation • Spacing between air injection points varied • 9 air sparge wells • Vendor: Billings & Associates Inc.	7,938	NA	NA	NA	NA/ *In-situ* bioremediation
Upgradient Water Supply Well, CA - H Lake Tahoe, CA	• Groundwater • Silty to clayey sand • Depth to water: 5 ft	Full	Not Provided/ On-going (data through May 2000)	• 4 air sparging wells • Fed by C-Sparging TM (ozone/air injection with a pulsing pump) • Vendor: NA	6	NA	ND	NA	NA/ In-situ chemical oxidation:oxidative curtain (bubble fence)

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Air Sparging	MtBE Concentration (µg/L)			MtBE % Reduction	Cost for Air Sparging/ Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Vagabond Site, Socorro, NM	• Groundwater and soil • Medium sands with occasional silt	Full	6 months/ Completed	• Biosparging using ambient surface air, coupled with vadose zone vacuum extraction • Air sparging to volatilize contaminants, with in-situ aerobic bioremediation • Spacing between air injection points varied • 18 air sparge wells • Vendor: Billings & Associates Inc.	5,135	NA	NA	NA	NA/ • *In-situ* bioremediation • SVE
Young's Food Store #51 Johnsonville, SC	• Groundwater	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	NA	NA	NA	NA	Total Cost: $135,000/ *In-situ* bioremediation

Abbreviations:

bgs	below ground surface	lbs/day	pounds per day	L	liter
cfm	cubic feet per minute	scfm	standard cubic feet per minute	Ft	foot
gpm	gallons per minute	yd^3	cubic yards	ft^2	square ft
NA	not available	g	grams	ft^3	cubic ft
ND	not detected	psi	pounds per square inch	TD	total depth
m/yr	meters per year	kg	kilograms	ug/L	micrograms per liter
ft/day	ft per day				

Table A-2. Summary of Operating and Performance Information for Selected Projects – Soil Vapor Extraction

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Soil Vapor Extraction Only Projects									
Branchville Texaco Service Station Branchville, SC	• Soil	Full	NA / On-going (data through January 2002)	• Off-gas treatment: thermal oxidation • Type of SVE, configuration, and additives not provided	NA	NA	NA	NA	Total Cost: $84,300 Capital Cost: $84,300/ No other technologies
Creek & Davidson, Site G: Service Station, CA	• Soil • 10-15 ft clay over sand & gravel	Full	May 1994 - June 1996/ Completed	• 700 cfm • 5 vapor extraction wells • Vendor: NA	8,900	NA	21	>99	Total Cost: $140,000 Capital Cost: $100,000 O&M Cost: $18,000/ No other technologies
Dollar Hill Shell Service Station Lake Tahoe, CA	• Soil	Full	May 1995 - March 1997/ Completed	• Type of SVE, configuration, and additives not provided	48	NA	ND	>99	NA
Kansas U2-087-1018 Andale, KS	• Soil • 1-35 ft silty clay with occasional sand • Depth to water: 19 ft	Full	January 1997-present/ On-going (data through July 2001)	• 4 vapor extraction wells • Vendor: NA	850	NA	65	92	NA
Kansas U6-077-231 Atwood, KS	• Soil • 1-18 ft silt/clay • 18-50 ft sand/sand gravel • Depth to water: 12 ft	Full	February 1994 - present/ On-going (data through July 2001)	• 8 vapor extraction wells • Vendor: NA	480	NA	93	91	NA
Kansas U5-014-10314 Clay Center, KS	• Soil • 0-18 ft silt/clay • 18-45 ft sand • Depth to water: 31 ft	Full	November 1996 - present/ On-going (data through July 2001)	• 2 vapor extraction wells • Vendor: NA	11	NA	ND	>99	NA
Kansas U1-029-049 Dodge City, KS	• Soil • 0-23 ft silt • 23-50 ft sand	Full	June 1997 - present/ On-going (data through July 2001)	• 8 vapor extraction wells • Vendor: NA	22	NA	ND	>99	NA
Kansas U1-029-574 Dodge City, KS	• Soil • 1-17 ft silt/clay • 17-45 ft fine to medium sand • Depth to water: 37 ft	Full	April 1996 - present/ On-going (data through July 2001)	• 6 vapor extraction wells • Vendor: NA	1,400	NA	12	>99	NA
Kansas U6-091-345 Goodland, KS	• Soil • 0-42 ft silt	Full	June 1993 - present/ On-going (data	• 5 vapor extraction wells • Vendor: NA	270	NA	1.92	>99	NA

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
	• 42-57 ft clay • 57-144 ft sand w/clay • 144-188 ft clay/sand • 188-216 ft sand • Depth to water: 188 ft		through July 2001)						
Kansas U6-032-00734 Grinnell, KS	• Soil • 1-35 ft silt • 35-40 ft silt/clay • 40-50 ft silt • 50-80 ft sand • 80-88 ft clay • 88-107 ft sand • Depth to water: 88 ft	Full	October 1999 - present/ On-going (data through July 2001)	• 2 vapor extraction wells • Possible on-going release • Vendor: NA	175	NA	21.5	88	NA
Kansas U1-042-269 Hanston, KS	• Soil • 0-31 ft silt/clay • 31-42 ft sand • 35-42 ft sand • Depth to water: 35 ft	Full	1996 - March 1998/ Completed	• 6 vapor extraction wells • Vendor: NA	6,900	NA	3,200	54	NA
Kansas U6-068-00207 Ness City, KS	• Soil • 1-28 ft clay • 28-33 ft sand • 33-46 ft clay/sand • Depth to water: 41 ft	Full	July 1996 - present/ On-going (data through July 2001)	• 8 vapor extraction wells • Vendor: NA	280	NA	868	Increase	NA
Kansas U1-076-101 Pratt, KS	• Soil • 1-25 ft clay • 25-36 ft sand • 36-51 ft clay • 51-67 ft sand • Depth to water: 45 ft	Full	1996 - present/ On-going (data through July 2001)	• 3 vapor extraction wells • Request to add air sparging • Vendor: NA	49	NA	15	69	NA
Kansas U6-083-194 Rush Center, KS	• Soil • 0-20 ft silt/clay • 20-45 ft fine to medium sand • 45-70 ft sand	Full	January 1997 - present/ On-going (data through July 2001)	• 16 vapor extraction wells • Vendor: NA	191,000	NA	99,800	48	NA
Kansas U1-041-399 Santanta, KS	• Soil • 0-70 ft clay	Full	1993 - present/ On-going (data through	• 2 vapor extraction wells • Site reported ready for closure	460	NA	ND	>99	NA

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
	• 70-140 ft sand • 140-260 ft clay/sand • 260-300 ft sand • 0-26 ft silt/clay		July 2001)	• Vendor: NA					
Kansas U1-086-341 Scott City, KS	• Soil • 1-25 ft silt/clay • 25-50 ft silt/clay/sand • 50-65 ft sand • 65-83 ft silt/clay • 83-134 ft sand-sand/silt • Depth to water: 123 ft	Full	December 1997 - present/ On-going (data through July 2001)	• 4 vapor extraction wells • Deep site requires additional time for SVE • Vendor: NA	63	NA	4	94	NA
Kansas A4-058-40127 Summerfield, KS	• Soil • 0-21 ft silt/clay • Depth to water: 12 ft	Full	Unknown - present/ On-going (data through July 2001)	• Type of SVE, configuration, and additives not provided	NA	NA	450	NA	NA/ Excavation
Ken's Service Center Dillion, SC	• Soil	Full	NA/ On-going (data through January 2002)	• Type of SVE, configuration, and additives not provided	NA	NA	NA	NA	Total Cost: $37,830 Capital Cost: $37,830/No other technologies
North Tahoe P.U.D. Maintenance (National Avenue) Lake Tahoe, CA	• Soil	Full	June 1995 - present/ On-going (data through April 2000)	• Type of SVE, configuration, and additives not provided	40	NA	4.5	89	NA/ Excavation
Unocal Service Station #3553 Lake Tahoe, CA	• Soil	Full	May - September 1994/ Completed	• Type of SVE, configuration, and additives not provided	NA	NA	1,800	NA	NA/No other technologies
Soil Vapor Extraction with Air Sparging Projects									
Bob's Suprette Clover, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	35,773	NA	NA	NA	Total Cost: $199,957/ SVE
By-Pass Quick Stop Bennetsville, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	12	NA	NA	NA	Total Cost: $357,000/ SVE
Convenience Mart Wilmington, NC	• Soil and groundwater	Full	May 1997 to Present/ On-going (data through December 2003)	• 2 vapor extraction wells & density driven convection (DDC) • Groundwater recirculation wells: 10 DDC wells • Vendor: Coastal Environmental	2,483	NA	2	>99	NA/ SVE

Selected MtBE Treatment Projects Source: www.clu-in.org/products/mtbe

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
				Services (CESCO) and Wasatch					
Crawford's Country Store Abbeville, SC	• Soil and groundwater	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	20,553	NA	NA	NA	Total Cost: $117,000 / SVE and Free Product Recovery
Creek & Davidson, Site M: Bulk Terminal, CO	• Groundwater and soil • 14-30 ft of sand	Full	February 1994 - present/ On-going (data through June 2000)	• Configuration not provided • 7 horizontal air sparging wells • 500 cfm • 23 vapor extraction wells • Vendor: NA	NA	NA	NA	NA	NA/ SVE with catalytic oxidation for off-gas
Eaddy Brothers Hemmingway, SC	• Groundwater and soil • Silty clays with inter-fingered thin clayey-sand lenses • Depth to water: 18 ft	Full	June 1999 - Present/ On-going (data through March 2001)	• 10 vertical air sparging wells, each 26 ft deep with 5 ft well screens • Vendor: NA	5,110,000	80	1,400	>99	Total Cost: $197,715/ SVE with thermal oxidation
EZ Mart Spartanburg, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	5,132	NA	NA	NA	Total Cost: $401,121/ SVE
E-Z Serve #8618 Charleston, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	808	NA	NA	NA	Total Cost: $335,000/ SVE
Former Gasoline Dispensing Facility Yarmouth, MA	• Groundwater and soil • Silty sand fill ranging from 1 to 5 feet below grade; underlain by 5 feet of fine sand, which is underlain by coarse sand to greater than 62 feet below grade • Depth to water: 5 ft	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • 5 air sparging wells • 4 vapor extraction wells • Vendor: NA	4,100	70	44	99	Total Cost: $653,500 / SVE
Former Livingstons Exxon Charleston, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	21	NA	NA	NA	Total Cost: $26,988/ SVE
Jennings Exxon Orangeburg, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	36	NA	NA	NA	Total Cost: $98,800/ SVE
Kansas A1-095-40139	• Groundwater and soil • 1-21 silt/clay	Full	October 1999 - present/ On-going	• 17 air sparging wells • 6 soil vapor extraction wells	510	NA	3	>99	NA/ SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Hugoton, KS	• 21-39 ft bgs sand • 39-44 silt/clay • 44-56 ft bgs sand • 56-105 ft bgs sand/gravel		(data through July 2001)	• Vendor: NA					
Kansas A2-078-40106 Sylvia, KS	• Groundwater and soil • 0-5 ft bgs sand • 5-12 ft bgs clay • 12-50 ft bgs sand • Depth to water: 12 ft	Full	January 2001 - present/ On-going (data through July 2001)	• 12 air sparging wells • 13 soil vapor extraction wells • Vendor: NA	NA	NA	NA	NA	NA/ SVE
Kansas A6-026-40102 Ellis, KS	• Groundwater • 1-12 ft bgs clay • 12-14 ft bgs sand • Depth to water: 7 ft	Full	October 2000 - present/ On-going (data through July 2001)	• 8 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	46.3	NA	47.7	Increase	NA/ SVE
Kansas U1-029-00122 Dodge City, KS	• Groundwater and soil • 0-6 ft bgs sand • 6-12 ft bgs silt/clay • 12-44 ft bgs sand • Depth to water: 17 ft	Full	July 2000 - present/ On-going (data through July 2001)	• 11 air sparging wells • 12 soil vapor extraction wells • Vendor: NA	4,340	NA	18,400	Increase	NA/ SVE
Kansas U1-029-00755 Offerley, KS	• Groundwater and soil • 0-19 bgs silt/clayy • 19-26 bgs sand • Depth to water: 21 ft.	Full	June 2000 - December 2000/ On-going (data through July 2001)	• Configuration not provided • Vendor: NA	755	NA	542	28	NA/SVE
Kansas U1-029-00890 Dodge City, KS	• Groundwater and soil • 0-23 ft bgs silt • 23-50 ft bgs sand	Full	August 1998 - present/ On-going (data through July 2001)	• 6 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	383	NA	74	81	NA/ SVE
Kansas U1-029-10316 Dodge City, KS	• Groundwater and soil • 0-20 ft bgs silt/clay • 20-35 ft bgs m/c sand • 35-45 ft bgs c sand-gravel • Depth to water: 22 ft	Full	February 1998 - present/ On-going (data through July 2001)	• 3 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	360	NA	100	72	NA/ SVE
Kansas U1-035-00354 Cimarron, KS	• Groundwater and soil • 1-33 silt/clay • 33-37 sand • 37-40 sand/gravel • Depth to water: 28 ft	Full	March 2000 - present/ On-going (data through July 2001)	• 5 air sparging wells • 6 soil vapor extraction wells • Vendor: NA	280	NA	46	84	NA/ SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Kansas U1-035-10120 Cimarron, KS	• Groundwater and soil • 1-45 ft bgs silt • 45-55 ft bgs sand • Depth to water: 45 ft	Full	March 1999 - present/ On-going (data through July 2001)	• 7 air sparging wells • 3 soil vapor extraction wells • Vendor: NA	92,000	NA	2,700	97	NA/ SVE
Kansas U1-076-488 Pratt, KS	• Groundwater and soil • 1-19 ft bgs silt • 19-30 ft bgs sand • 19-35 ft bgs silt/silt • 35-55 ft bgs sand/silt • Depth to water: 41 ft	Full	April 1998 - February 2001/ On-going (data through July 2001)	• 8 air sparging wells • 8 soil vapor extraction wells • Vendor: NA	105	NA	ND	NA	NA/ SVE
Kansas U1-076-896 Luka, KS	• Groundwater and soil • 1-23 ft bgs silt/silt • 23-48 ft bgs silt • 48-50 ft bgs sand • 50-55 ft bgs silt • Depth to water: 50 ft	Full	May 2000 - present/ On-going (data through July 2001)	• 6 air sparging wells • 14 soil vapor extraction well • Vendor: NA	NA	NA	115	NA	NA/ SVE
Kansas U1-086-0910 Scott City, KS	• Groundwater and soil • 0.5 - 65 ft bgs silt clay • 65 - 80 ft bgs m/c sand • 80 - 120 ft bgs sandy clay • 120 - 160 ft bgs m/c sand • Depth to water: 135 ft	Full	January 2000 - present/ On-going (data through July 2001)	• 3 air sparging wells • 5 soil vapor extraction wells • Vendor: NA	69,100	NA	NA	NA	NA/ SVE
Kansas U1-086-10822 Scott City, KS	• Groundwater and soil • 0.5-65 ft bgs silt clay • 65-80 ft bgs m/c sand • 80-120 ft bgs sandy clay • 120-160 ft bgs m/c sand	Full	January 2000 - present/ On-going (data through July 2001)	• 4 air sparging wells • 6 soil vapor extraction wells • Vendor: NA	21,600	NA	NA	NA	NA/ SVE
Kansas U2-087-01212 Wichita, KS	• Groundwater and soil • 1-5 clay ft bgs • 5-30 ft bgs sand • Depth to water: 14 ft	Full	September 1999 - April 2001/ On-going (data through July 2001)	• 8 air sparging wells • 3 soil vapor extraction wells • Vendor: NA	1,560	NA	1,454	93	NA/ SVE
Kansas U5-057-00856 Peabody, KS	• Groundwater and soil • 0-30 ft bgs silt/clay • 30-40 ft bgs shale • Depth to water: 11 ft	Full	November 2000 - February 2001/ On-going (data through July 2001)	• 1 air sparging well • 3 soil vapor extraction wells • Vendor: NA	4,840	NA	4,840	0	NA/ SVE
Kansas U6-026-	• Groundwater and soil	Full	November 1998 -	• 5 air sparging well	3,500	NA	140	96	NA/ SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
00066B Hays, KS	• 1-35 ft bgs clay • 35-50 ft bgs sand • Depth to water: 33 ft		February 2001/ On-going (data through July 2001)	• 1 soil vapor extraction wells • Vendor: NA					
Kansas U1-093-11583 Greenfield, KS	• Groundwater and soil • 1-8 ft bgs clay • 8-50 ft bgs sand • Depth to water: 18 ft	Full	October 2000 - present/ On-going (data through July 2001)	• 11 air sparging wells • 3 soil vapor extraction wells • Vendor: NA	255	NA	<250	2	NA/ SVE
Kansas U1-093-11814 Macksville, KS	• Groundwater and soil • 1-15 ft bgs clay • 15-35 ft bgs sand • Depth to water: 19 ft	Full	September 1999 - present/ On-going (data through July 2001)	• 7 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	100	NA	108	Increase	NA/ SVE
Kansas U1-095-428 Hugoton, KS	• Groundwater and soil • 1-26 ft bgs silt/clay • 26-38 ft bgs sand • 38-40 ft bgs clay • 40-57 ft bgs sand • 57-60 ft bgs silt • 60-90 ft bgs sand/gravel • 90-95 ft bgs silt/sand • 95-100 ft bgs sand/gravel • Depth to water: 86 ft	Full	October 1999 - present/ On-going (data through July 2001)	• 3 air sparging wells • 2 soil vapor extraction wells • Vendor: NA	21,000	NA	ND	99	NA/ SVE
Kansas U1-102-0802 Marienthal, KS	• Groundwater and soil • 0.5 – 30 ft bgs silt • 30 – 75 ft bgs f/m sand • 75 - 95 ft bgs silt • 95 - 150 ft bgs sand • Depth to water: 128 ft	Full	May 2000 - present/ On-going (data through July 2001)	• 8 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	22,300	NA	1,850	92	NA/ SVE
Kansas U2 087 0288 Wichita, KS	• Groundwater and soil • 0.5 – 25 ft bgs sand/silt/clay • 25 - 42 ft bgs f/c sand • 42 - 45+, ft bgs sand/gravel	Full	November 2000 - present/ On-going (data through July 2001)	• 9 air sparging wells • 3 soil vapor extraction wells • Vendor: NA	2,770	NA	46	NA	NA/ SVE
Kansas U2-078-01344 Hutchinson, KS	• Groundwater and soil • 0-5 ft bgs clay • 5-6 ft bgs silt	Full	September 2000 - present/ On-going (data through July	• 3 air sparging wells • 2 soil vapor extraction wells • Vendor: NA	3,580	NA	74	98	NA/ SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
	• 6-25 ft bgs silt/sand • Depth to water: 13 ft		2001)						
Kansas U2-087-1061 Wichita, KS	• Groundwater and soil • 1-7 ft bgs silt/clay • 7-25 ft bgs sand • Depth to water: 11 ft	Full	April 1994 - October 1997/ On-going (data through July 2001)	• 4 air sparging wells • 2 soil vapor extraction wells • Vendor: NA	355	NA	ND	NA	NA/ SVE
Kansas U2-087-10943 Wichita, KS	• Groundwater and soil • 1-8 ft bgs clay • 8-43 ft bgs sand • 43 ft bgs shale • Depth to water: 11 ft	Full	January 2000 - present/ On-going (data through July 2001)	• 7 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	8,850	NA	6	>99	NA/ SVE
Kansas U2-087-11161 Wichita, KS	• Groundwater and soil • 0-20 ft bgs clay w/sand • Depth to water: 13 ft	Full	March 2001 - present/ On-going (data through July 2001)	• 8 air sparging wells • 7 soil vapor extraction wells • Vendor: NA	72.5	NA	NA	NA	NA/ SVE
Kansas U2-087-1232 Wichita, KS	• Groundwater and soil • 0-12 ft bgs silt • 12-50 ft bgs sand • Bedrock ft bgs 50 ft	Full	January 1997 - present/ On-going (data through July 2001)	• 6 air sparging wells • 8 soil vapor extraction wells • Vendor: NA	1,250	NA	98	92	NA/ SVE
Kansas U2-087-1236 Park City, KS	• Groundwater and soil • 0-12 ft bgs silt • 12-50 ft bgs sand • Bedrock 50 ft bgs	Full	October 1997 - present/ On-going (data through July 2001)	• 4 air sparging wells • 5 soil vapor extraction wells • Vendor: NA	NA	NA	1,060	NA	NA/ SVE
Kansas U2-087-989 Andale, KS	• Groundwater and soil • 1-29 ft bgs silt/silt • 29-55 ft bgs (TD) sand • Depth to water: 45 ft	Full	September 1997- present/ On-going (data through July 2001)	• 3 air sparging wells • 8 soil vapor extraction wells • Vendor: NA	128	NA	ND	>99	NA/ SVE
Kansas U4-044-1120 Grantville, KS	• Groundwater and soil • 1-11ft bgs silt/clay • 11-34 ft bgs silt • 34-46 ft bgs sand • Depth to water: 27 ft	Full	June 1994 - February 1999/ Completed (data through July 2001)	• Configuration not provided • 4 air sparging wells • 8 soil vapor extraction wells • Vendor: NA	337	NA	ND	NA	NA/ SVE
Kansas U4-044-1275 Grantville, KS	• Groundwater and soil • 1-11 ft bgs silt/clay • 11-34 ft bgs silt • 34-46 ft bgs sand	Full	June 1996 - February 1999/ On-going (data through July 2001)	• 4 air sparging wells • 8 soil vapor extraction wells • Vendor: NA	95	NA	ND	NA	NA/ SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
	• Depth to water: 27 ft								
Kansas U5-014-535 Clay Center, KS	• Groundwater and soil • 26-45 ft bgs sand	Full	November 1997 - present/ On-going (data through July 2001)	• 2 air sparging wells • 2 soil vapor extraction wells • Vendor: NA	25	NA	ND	NA	NA/ SVE
Kansas U5-031-00650 Junction City, KS	• Groundwater and soil • 0-24 ft bgs clay • 22-42 ft bgs sand • 42-49 silt-clay • Depth to water: 38 ft	Full	August 2000 - present/ On-going (data through July 2001)	• 5 air sparging wells • 5 soil vapor extraction wells • Vendor: NA	500	NA	120	76	NA/ SVE
Kansas U5-031-590 Junction City, KS	• Groundwater and soil • 0-9 ft bgs silt • 9-40 ft bgs sand	Full	November 1997 - November 2000/ On-going (data through July 2001)	• 3 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	3,871	NA	ND	>99	NA/ SVE
Kansas U5-080-291 Alden, KS	• Groundwater and soil • 1-5 ft bgs clay • 5-20 ft bgs sand • 20-27 ft bgs gravel • Depth to water: 9 ft	Full	November 1999 - present/ On-going (data through July 2001)	• 4 air sparging wells • 2 soil vapor extraction wells • Vendor: NA	46	NA	47	Increase	NA/ SVE
Kansas U6-005-10039 Ellinwood, KS	• Groundwater and soil • 1-11ft bgs sand-clay • 11-TD ft bgs sand/sand • Depth to water: 13 ft	Full	June 1998 - present/ On-going (data through July 2001)	• 2 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	5,600	NA	77	99	NA/ SVE
Kansas U6-005-10086 Ellinwood, KS	• Groundwater and soil • 1-10 ft bgs clay, silty • 10-TD ft bgs sand	Full	January 1999 - present/ On-going (data through July 2001)	• 6 air sparging wells • 3 soil vapor extraction wells • Vendor: NA	194 (Site reported that start up sampling is suspicious)	NA	252	Increase	NA/ SVE
Kansas U6-005-12657 Ellinwood, KS	• Groundwater and soil • 1-10 ft bgs clay, silt • 10-TD ft bgs f-c sand • Depth to water: 12 ft	Full	July 2000 - April 2001/ On-going (data through July 2001)	• 2 air sparging wells • 3 soil vapor extraction wells • Vendor: NA	27.7	NA	ND	>99	NA/ SVE
Kansas U6-005-278 Ellinwood, KS	• Groundwater and soil • 1-9 ft bgs clay • 10-TD ft bgs sand • Depth to water: 11 ft	Full	October 1998 - present/ On-going (data through July 2001)	• 3 air sparging wells • 8 soil vapor extraction wells • Vendor: NA	232	NA	26	89	NA/ SVE

Selected MtBE Treatment Projects Source: www.clu-in.org/products/mtbe

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Kansas U6-005-649 Ellinwood, KS	• Groundwater and soil • 1-10 ft bgs clay, sand-clay • 10-TD sand/sand • Depth to water: 12 ft	Full	March 1997 - present/ On-going (data through July 2001)	• 2 air sparging wells • 3 soil vapor extraction wells • Vendor: NA	190	NA	190	0	NA/ SVE
Kansas U6-020-628 Oberlin, KS	• Groundwater and soil • Silt/silt to 35 ft bgs • Depth to water: 18 ft	Full	April 1996 - present/ On-going (data through July 2001)	• 2 soil vapor extraction wells • Vendor: NA	127	NA	189	Increase	NA/ • SVE • Excavation
Kansas U6-026-274 Ellis, KS	• Groundwater and soil • 1-8 ft bgs silt/silt • 8-15 ft bgs silt • 15-20 ft bgs sand/silt • Depth to water: 9 ft	Full	August 2000 - present/ On-going (data through July 2001)	• 5 air sparging wells • 5 soil vapor extraction wells • Vendor: NA	8,140	NA	6,430	20	NA/ SVE
Kansas U6-032-513 Quinter, KS	• Groundwater and soil • 0-28 ft bgs clay • 28-52 ft bgs sand/sand • 52-95 ft bgs silt/sand • Depth to water: 75 ft	Full	December 1996 - present/ On-going (data through July 2001)	• 11 air sparging wells • 14 soil vapor extraction wells • Vendor: NA	280	NA	15.1	97	NA/ SVE
Kansas U6-055-295 Oakley, KS	• Groundwater and soil • 0-67 ft bgs silt/clay • 67-85 ft bgs sand • 85-110 ft bgs silt/clay • 110 ft bgs sand	Full	June 1996 - present/ On-going (data through July 2001)	• 11 air sparging wells • 16 soil vapor extraction wells • Vendor: NA	9,158	NA	55.6	>99	NA/ SVE
Kansas U6-068-0015 Ness City, KS	• Groundwater and soil • 0.5 - 22 ft bgs clay/silt-clay • 22 – 34 ft bgs sand/clay • 34 - 44 ft bgs gravel f/c sand • Depth to water: 33 ft	Full	January 2000 - present/ On-going (data through July 2001)	• 4 air sparging wells • 3 soil vapor extraction wells • Vendor: NA	97	NA	45.3	53	NA/ SVE
Kansas U6-068-559 Ness City, KS	• Groundwater and soil • 1-35 or 40 ft bgs silt/silt • 35/40 ft bgs silty sand • Depth to water: 32 ft	Full	November 1998 - April 2001/ On-going (data through July 2001)	• 11 air sparging wells • 15 soil vapor extraction wells • Vendor: NA	<250	NA	ND	>99	NA/ SVE
Kansas U6-091-221 Selden, KS	• Groundwater and soil • 83-118 ft bgs sand/sand	Full	February 1999 - present/ On-going	• 4 air sparging wells • 12 soil vapor extraction wells	5.32	NA	ND	>99	NA/ SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
	• 118-147 ft bgs sand, clay • Depth to water: 125 ft		(data through July 2001)	• Vendor: NA					
Kansas U6-097-386 Oakley, KS	• Groundwater and soil • 1-50 ft bgs silt/clay • 50-90 ft bgs sand/ clay/ sand/ gravel • Depth to water: 80 ft	Full	October 1999 - January 2001/ On-going (data through July 2001)	• 8 air sparging wells • 15 soil vapor extraction wells • Vendor: NA	666	NA	ND	>99	NA/ SVE
Kansas U6-097-617 Colby, KS	• Groundwater and soil • 1-46 ft bgs silt/clay • 46-76 ft bgs sand • 76-81clay • 81-130 sand/clay sand • Depth to water: 102 ft	Full	September 1998 - present/ On-going (data through July 2001)	• 7 air sparging wells • 4 soil vapor extraction wells • Vendor: NA	426	NA	236	45	NA/ SVE
Kwik Fill #17 Dillon, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	NA	NA	NA	NA	Total Cost: $130,000/ SVE
Muffler Palace Lake Tahoe, CA	• Groundwater and soil	Full	January 1999 - present/ On-going (data through April 2000)	• Configuration not provided • Vendor: NA	58	NA	13	78	NA/ SVE with GAC
NY 1-9008339	• Soil	Full	Not Provided/ On-going (data through May 2002)	• Remediation consists of air sparging (oxygen) with soil vapor extraction and soil excavation • Vendor: NA	58,000		28	>99	Total Cost: $201,900/ SVE
NY 1-9108813	• Soil	Full	Not provided/ On-going (data through May 2002)	• Configuration not provided • Vendor: NA	17,000	NA	930	95	Total Cost: $246,933/ SVE
Rotten Robbie Lake Tahoe, CA	• Groundwater and soil	Full	June 1995 - present/ On-going (data through April 2000)	• Configuration not provided • Vendor: NA	5	NA	437	Increase	NA/ SVE with GAC
Ryder Commercial Leasing Greenville, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	49	NA	NA	NA	Total Cost: $256,000/ SVE
SCDOT Newberry Maintenance Facility Newberry, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	12	NA	NA	NA	Total Cost: $175,000/ SVE
Scotchman #60	• Groundwater and soil	Full	Not Provided/ On-	• Configuration not provided	3,204	NA	NA	NA	Total Cost: $137,000/

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Myrtle Beach, SC			going (data through January 2002)	• Vendor: NA					SVE
Service Station, NY - C Bayshore, NY	• Groundwater and soil	Full	Not Provided/ On-going (data through May 2002)	• Horizontal air sparging: 3 bundles of wells with 22 air sparging points • Radius of influence of 27 ft at 20 cfm • 2 bundles with 10 soil vapor extraction points utilizing directional drilling; radius of influence of 40 ft at 50 cfm • Vendor: J.N.M. Environmental Inc.	110	NA	NA	NA	NA/ SVE
Site KS - A Park City, KS	• Groundwater	Full	October 1997 - Present/ On-going (data through March 2001)	• Configuration not provided • Vendor: NA	285,000	NA	72,100	75	Cost for all technologies combined: Total Cost: $143,500 O&M Cost $14,700/ SVE with GAC
Site KS - B Rush Center, KS	• Groundwater and soil	Full	January 1996 - Present/ On-going (data through March 2001)	• Two oxygen release compound barriers • Vendor: NA	191,000	NA	47,000	75	Cost for all technologies combined: Total Cost: $1,051,000 Assessment Cost: $74,000 Capital Cost: 984,983 O&M Cost: $16,500/ SVE
Southern Gas Service Travelers Rest, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	NA	NA	NA	NA	Total Cost: $192,250/ SVE
Speedway #617 Rock Hill, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	16	NA	NA	NA	Total Cost: $269,380/ SVE
Terrible Herbst Gas Station, Lake Tahoe, CA	• Groundwater and soil	Full	November 1995 - present/ On-going (data through April 2000)	• Configuration not provided • Vendor: NA	296	NA	240	19	NA/ SVE
Soil Vapor Extraction with Air Sparging and Pump and Treat Projects									
Exxon Service Station, Smithtown, NY	• Groundwater and soil	Full	April 2001 - Present/ On-going (data through	• 300 cfm • Vendor: Geological Services Corp.	150,000	NA	NA	NA	NA/ • Excavation •Pump and treat

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
			September 2001)						(complete) • SVE
E-Z Serve #8639 Spartanburg, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	36	NA	NA	NA	Total Cost: $380,000/ • SVE • Pump and treat
Gate #311 Cheraw, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	5,111	NA	NA	NA	Total Cost: $184,250/ • SVE • Pump and treat
Green Sea Grocery Green Sea, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	15	NA	NA	NA	Total Cost: $327,000/ • SVE • Pump and treat • Free product recovery
Kansas U1-029-230 Dodge City, KS	• Groundwater and soil • 0-23 ft bgs silt • 23-50 ft bgs sand	Full	1995 - January 2001/ On-going (data through July 2001)	• 21 air sparging wells • 11 soil vapor extraction wells • Vendor: NA	15	NA	ND	NA	NA/ • SVE • Pump and Treat
Kansas U6-005-00268 Great Bend, KS	• Groundwater and soil • 1-8 ft bgs clay • 8-27 ft bgs sand • 27-48 ft bgs clay • Depth to water: 10 ft	Full	November 1994 - January 1998/ Completed	• Configuration not provided • 7 air sparging wells • 8 Soil vapor extraction wells • Vendor: NA	390	NA	4.8	99	NA/ SVE
Morris Variety Shop Bluffton, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	33	NA	NA	NA	Total Cost: $435,000/ • SVE • Pump and treat
NY 1-8504473	• Soil and groundwater	Full	Not provided/ On-going (data through May 2002)	• Configuration not provided • Vendor: NA	22,000	NA	1,600	93	Total Cost: $567,140/ • SVE • Pump and treat • Excavation
NY 1-8900312, NY	• Soil and groundwater	Full	Not provided/ On-going (data through May 2002)	• Configuration not provided • Vendor: NA	4,000	NA	567	86	NA/ • SVE • Pump and treat • Bioremediation
NY 1-8910209, NY	• Soil and groundwater	Full	Not provided/ On-going (data through May 2002)	• Configuration not provided • Vendor: NA	9,999	NA	8	99	Total Cost: $96,350/ • SVE • Pump and treat • Excavation

Selected MtBE Treatment Projects

Source: www.clu-in.org/products/mtbe

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
NY 1-9003951, NY	• Soil and groundwater	Full	Not provided/ On-going (data through May 2002)	• Configuration not provided • Vendor: NA	7,900	NA	ND	>99	Total Cost: $410,616/ • SVE • Pump and treat • Excavation
Perfection Connection Lake Tahoe, CA	• Groundwater and soil	Full	October 1991 - November 1995/ Completed	• Configuration not provided • Vendor: NA	5	NA	2	60	NA/ • Excavation and aeration of the soil • SVE • Pump and treat: GAC
Pit Stop Service Station Baldwin, NY	• Groundwater	Full	1996 - Present/ On-going (data through September 2001)	• 300 cfm • 2 groundwater extraction, combined flow rate of 30 gpm, air stripper • Vendor: J.N.M. Environmental Inc.	NA	NA	NA	NA	NA/ • SVE with catalytic oxidizer • Pump and treat
SaveWay #2 Hartsville, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	270	NA	NA	NA	Total Cost: $284,178/ • SVE • Pump and treat
Scotchman #171 North Charleston, SC	• Groundwater and soil	Full	Not Provided/ On-going (data through January 2002)	• Configuration not provided • Vendor: NA	20	NA	NA	NA	Total Cost: $300,000/ • SVE • Pump and treat
Service Station MA-E Palmer, MA	• Soil and groundwater • 15 to 20 ft of sand and gravel over 70 to 80 ft of interbedded fine sand and silt • Bedrock is found at 90 to 150 ft below ground surface	Full	1996-1997/ Completed	• Site reported that no action was taken until 2 months after the initial gasoline spill in 1989 • The initial effort included the installation of three recovery wells to capture and remove the floating product • The remediation system installed was a soil • Vendor: NA	NA	NA	NA	NA	Total Cost: $12 million (anticipated)/ • SVE • Pump and treat
Service Station, MA - B Cape Cod, MA	• Groundwater and soil • 5 ft of fill over fine to coarse sand • Depth to water: 3-7 ft	Full	August 1990 - October 1996/ Completed	• 5 air sparging wells • 2 groundwater extraction well; treated by air stripping then two 2,000# carbon canisters. Effluent water sent to an on-site recharge and town storm sewer. • Off gas treatment via two 200# carbon canisters	2,600	70	3	>99	NA/ • Pump and Treat • SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
				• 5 vapor extraction wells • Vendor: NA					
Tahoe Tom's, Lake Tahoe, CA	• Groundwater and soil	Full	September 1998 - present/ On-going (data through April 2000)	• Configuration not provided • Vendor: NA	52,100	NA	760,000	Increase	NA/ • Pump and treat with air striping • SVE with GAC
USA Petroleum Lake Tahoe, CA	• Groundwater	Full	November 1997 - Present/ On-going	• Configuration not provided • Vendor: NA	31,000	NA	270	>99	NA/ • Pump and treat • SVE with GAC
Soil Vapor Extraction with In Situ Bioremediation Projects									
Turtle Bayou Easement Area Turtle Bayou, TX	• Soil • Gulf coast sediments- intermittent sand, silt, and clay to 30 ft • Permeability of 10-30 cm/sec	Full	June 1996 - present/ On-going (data through June 2000)	• SVE with thermal oxidation is complete • 30 extraction wells • Vendor: NA	NA	NA	NA	NA	Cost for all technologies combined: $4,600,000 Capital Cost: $1,000,000 Site reported power and fuel are major cost elements/ • *In situ* thermal desorption (Complete) • Excavation (Complete) • *In situ* bioremediation for naphthalene (On-going)
Soil Vapor Extraction with In Situ Chemical Oxidation Projects									
Former Service Station, PA-A, Bucks County, PA	• Soil and Ground water • Groundwater - unconfined aquifer approximately 15 ft thick • Soil - heterogeneous, overlying weathered schist	Full	9 months/ Completed	• Process Type: dual phase extraction, followed by four months of ozone sparging. The ozone sparging was conducted through a series of nested, sparge points at 2 scfm with an ozone dose of 2.5 lbs/day • SVE applied with (11) 9 ft deep vapor extraction wells, and groundwater extraction using total phase extraction technology and traditional groundwater pumping. Extracted and treated groundwater was re-injected to the subsurface, upgradient of the impacted area • Vendor: Resource Control	17,000	2,900	31	<99	Total Cost: $146,000 Capital Cost: $90,000 O&M Cost: $56,000/ *In Situ* Chemical Oxidation

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
				Corporation					
Site MA-F, Concord, MA	• Soil and groundwater	Full	July 2000 - Present / On-going (data through 2001)	• Process type: Oxy Vac, a patented process of combining in situ oxidation with vacuum extraction dual phase extraction, or air sparging • Hydrogen peroxide injection points and a network of SVE wells to extract off gasses from the in situ oxidation • As of December 2000, six injections • Vendor: NA	3,400	NA	70	98	NA/ *In Situ* Chemical Oxidation
Soil Vapor Extraction with Other Technologies									
Beene Site, Dallas, TX	• Groundwater and soil • Clay with minor silts throughout the soil column	Full	12 months/ Completed	• Biosparging using ambient surface air, coupled with vadose zone vacuum extraction • Air sparging to volatilize contaminants, with in-situ aerobic bioremediation • Spacing between air injection points varied • 12 sparge wells • Vendor: Billings & Associates Inc.	44,386	NA	NA	NA	NA/ • In-situ bioremediation • SVE
Bloom Site, Bloomfield, NM	• Groundwater and soil • Fine to medium sands with occasional silt stringers of irregular thickness	Full	24 months/ Completed	• Biosparging using ambient surface air, coupled with vadose zone vacuum extraction • Air sparging to volatilize contaminants, with in-situ aerobic bioremediation • Spacing between air injection points varied • 13 sparge wells • Vendor: Billings & Associates Inc.	4,151	NA	NA	NA	NA/ • In-situ bioremediation • SVE
Canon Site, Canon City, CO	• Groundwater and soil • Multilayered lithology with silts and clays intermixed in the upper 7.9 to 9.9 ft	Full	12 months/ Completed	• Biosparging using ambient surface air, coupled with vadose zone vacuum extraction • Air sparging to volatilize contaminants, with in-situ aerobic	13,633	NA	NA	NA	NA/ • In-situ bioremediation • SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
	• Medium to coarse grained sands are found to a depth of approximately 20 ft • From 20 to 24.6 ft a coarse sand and cobble bed is encountered			bioremediation • Spacing between air injection points varied • 6 air sparge wells • Vendor: Billings & Associates Inc.					
Creek & Davidson, Site H: 275 Gallon, VT	• Soil and groundwater • 5-15 ft of sandy soils with private wells nearby	Full	August 1994 - present/ On-going (data through June 2000)	• 100 cfm • 1 vapor extraction well • 1 groundwater extraction well • 3 gpm • Vendor: NA	2,720	NA	NA	NA	Cost for all technologies combined: $212,000 Capital Cost: $166,500 O&M Cost: $28,000 / Pump and treat
Creek & Davidson, Site I: Service Station, MA	• Soil and groundwater • 5 to 12 ft of sand and gravel with private wells nearby	Full	October 1995 - present/ On-going (data through June 2000)	• Off-Gas Treatment: GAC and catalytic oxidation • 120 cfm • 3 vapor extraction wells • Pumping at 5 gpm • Vendor: NA	5,000	NA	NA	NA	Cost for all technologies combined: $160,000 Capital Cost: $80,000 O&M Cost: $80,000/ Pump and treat
Creek & Davidson, Site J: Service Station, MA	• Soil and groundwater • 10-18 ft of sand & gravel	Full	June 1990 - present/ On-going (data through June 2000)	• Off-gas treatment: GAC and a catalytic oxidation • 100 cfm • 3 vapor extraction wells • 2 gpm with 1 groundwater extraction well • Vendor: NA	34,440	NA	NA	NA	Cost for all technologies combined: $624,000 Capital Cost: $430,000 O&M Cost: $33,000/ Pump and treat with GAC
Creek & Davidson, Site K: Service Station, NJ	• Soil and groundwater • Silt & sand over sand/gravel with municipal and private wells nearby	Full	November 1991 - present/ On-going (data through June 2000)	• Off-gas treatment: catalytic oxidation • 100 cfm • 7 vapor extraction wells • 0.5 gpm with 4 recovery wells • Vendor: NA	56,000	NA	NA	NA	Cost for all technologies combined: $339,000 Capital Cost: $130,000 O&M Cost: $36,000/ Pump and treat
Creek & Davidson, Site L: UST Service Station, MA	• Soil and groundwater	Full	November 1991 - present/ On-going (data through June 2000)	• Off-gas treatment: catalytic oxidation • 21 gpm with 1 groundwater extraction well, air stripper (with an air-to-water ratio of >155:1) • 60 cfm • 4 vapor extraction wells	2,290	NA	NA	NA	Cost for all technologies combined: $216,000 Capital Cost: $150,000 O&M Cost: $33,000/ Pump and treat

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
				• 7-18 cfm with 7 sparge wells • Vendor: NA					
Delta Service Station Lindenhurst, NY	• Soil and groundwater	Full	NA/ On-going (data through September 2001)	• Off-Gas Treatment: catalytic oxidizer • 200 cfm • 3 recovery wells pumping at 30 gpm each with a 4'x 36' air stripper • Vendor: Environmental Assessment and Remediation	10,000	NA	NA	NA	NA/ Pump and treat
Kansas U1-029-342 Dodge City, KS	• Soil and groundwater • 0-23 ft silt • 23-45 ft sand	Full	1993 - 1998/ Completed	• 5 vapor extraction wells • 2 groundwater extraction wells • Vendor: NA	NA	NA	ND	NA	NA/ Pump and treat
Herrera Site, Albuquerque, NM	• Groundwater and soil • Subsurface is composed of primarily alluvial sands of medium to fine grain with intermittent thin silt layers	Full	24 months/ Completed	• Biosparging using ambient surface air, coupled with vadose zone vacuum extraction • Air sparging to volatilize contaminants, with in-situ aerobic bioremediation • Spacing between air injection points varied • 17 air sparge wells • Vendor: Billings & Associates Inc.	17,323	NA	NA	NA	NA/ • In-situ bioremediation • SVE
Kansas U6-005-402 Great Bend, KS	• Soil and groundwater • 0 - 2 ft sand/clay • 2 - 12 ft fine to medium sand • 12-20 ft sand/gravel • Depth to water: 10 ft	Full	February 1994 - present/ On-going (data through July 2001)	• 3 vapor extraction wells • 1 groundwater extraction well • Vendor: NA	79	NA	ND	>99	NA/ Pump and treat
Kansas U6-026-390 Hays, KS	• Soil and groundwater • 1-40 ft silt/clay • 40-70 ft sand • Depth to water: 28 ft	Full	August 1996 - present/ On-going (data through July 2001)	• 8 recovery wells • 7 groundwater extraction wells • Vendor: NA	25,000	NA	1,942	92	NA/ Pump and treat
Milford Chevron, Milford, UT	• Soil and groundwater • Groundwater plume is about 25 fbg and at least 220,000 ft²	Pilot	August 2001 – Present/ On-going (data through July 2002)	• Remediation consists of groundwater pump and treat with reinjection, coupled with soil vapor extraction. An oil water separator was added to the treatment system	49,000	NA	NA	NA	NA

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
				once operation began. The site also reported removal of 40 tons of contaminated soil and hand-baled free product when contamination was initially discovered in 1991. Air sparging had been considered but not selected as a remedial technology for this site. • Vendor: NA					
NY 1-8900312, NY	• Soil and groundwater	Full	Not provided/ On-going (data through May 2002)	• Configuration not provided • Vendor: NA	4,000	NA	567	86	NA/ • SVE • Pump and treat • Bioremediation
NY 1-8300526, NY	• Soil and groundwater	Full	NA/ On-going (data through May 2002)	• Type of SVE, configuration, and additives not provided	120	NA	ND	>99	Total Cost: $380,834/ • Pump and treat • Soil excavation
Service Station, MO - A Jerico Springs, MO	• Soil and groundwater • Sandy clay with sandstone at a depth of 17 in-20 ft bgs • 7,000 tons of soil excavated	Full	NA/ On-going (data through October 2001)	• Treated with a standard oil/water separator, then a liquid/liquid separator and EC-300 organoclay/carbon media and carbon activated filters • Vendor: Environmental Process Systems Inc.	7,762	NA	354	95	NA/ • Pump and treat • Excavation
Scotchman #94 Florence, SC	• Groundwater and soil • Clayey sands, and sandy clays, with a hard clay layer at approximately 10 ft • Depth to water: 23 ft	Full	March 1999 - Present/ On-going (data through March 2001)	• 28 air sparging wells in seven groups • 5 extraction wells • Vendor: NA	87,000	2,495	7,410	91	Total Cost: $383,000/ • Multi-phase extraction • SVE
Service Station, NH - B	• Soil and groundwater • 4-8 ft of sandy fill over 2-13 ft of till • Fractured bedrock at 10-15 ft bgs • The hydraulic gradient is 30ft/1,000 ft • Depth to water: 15 ft	Full	September 1996 - January 2000/ Completed	• Screened to bedrock at 7.5 gpm; groundwater pumped and treated with a standard oil/water separator, followed by an equalization tank, a particulate filter, and an air stripper (7 HP and 1,000 scfm) • 11 vertical & 4 horizontal vapor extraction wells • Removed 3 USTs, 860 tons of soil,	1,000,000	NA	200	>99	NA/ • Pump and treat • Excavation

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Soil Vapor Extraction	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Soil Vapor Extraction/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
				and 27,000 gallons of groundwater • Vendor: ENSR					
Site CA-T Mammoth, CA	• Soil and groundwater	Full	NA/ On-going (data through March 2000)	• 4 extraction wells with a total flow rate of 32 gpm • Water is pumped into a 2,500-gal batch tank and then into a boiler tank to increase the temperature from 40° to 70° • Water is treated with BIO-GAC and a low profile air stripper, followed by GAC polishing • Air stripper has a maximum flow rate of 50 gpm and 2,400 ft^3pm max air flow rate • Vendor: NA	333,000	NA	NA	NA	NA/ • Pump and treat with GAC • Air stripping with GAC off-gas treatment, and BIO-GAC
Tuba Site, Tuba City, AZ	• Groundwater and soil: • Medium to fine sands to a subsurface depth of approximately 20 ft	Full	Three months/ Completed	• Biosparging using ambient surface air, coupled with vadose zone vacuum extraction • Air sparging to volatilize contaminants, with in-situ aerobic bioremediation • Spacing between air injection points varied • 9 air sparge wells • Vendor: Billings & Associates Inc.	7,938	NA	NA	NA	NA/ *In-situ* bioremediation
Vagabond Site, Socorro, NM	• Groundwater and soil • Medium sands with occasional silt	Full	6 months/ Completed	• Biosparging using ambient surface air, coupled with vadose zone vacuum extraction • Air sparging to volatilize contaminants, with in-situ aerobic bioremediation • Spacing between air injection points varied • 18 air sparge wells • Vendor: Billings & Associates Inc.	5,135	NA	NA	NA	NA/ • *In-situ* bioremediation • SVE

Abbreviations:

bgs - below ground surface
cfm – cubic feet per minute
gpm – gallons per minute
NA - not available
ND - Not detected
M/yr – meters per year
ft/day – feet per day
lbs/day - pounds per day
yd^3 - cubic yards
g – grams
psi – pounds per square inch
kg - kilograms
L – liter
fbg - feet below grade
ft – feet
ft^2 - square feet
ft^3 – cubic feet
ug/L - micrograms per liter

Table A-3. Summary of Operating and Performance Information for Selected Projects – Multi-phase Extraction

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Multi Phase Extraction (MPE)	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for MPE/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
MPE Only Projects									
Eight Service Stations MD – A, MD	• Groundwater and soil • 4 of the sites are located in the Coastal Plain Province, characterized by alluvial sands, silts, and clay • The other 4 sites are located in the Piedmont Province and are characterized by saprolites of schist and gneiss	Full	1990 - 1997 (varies by site)/Completed	• The remediation system used was vapor extraction and groundwater extraction (VE/GE). • The number of VE and GE wells varies between 2 and 17 depending on the site • VE systems generate an average air flow ranging from 4.6 to 18.5 SCFM • GW systems operate at an average pumping rate of 0.11 to 0.3 gpm • Vendor: NA	6,139	NA	791	87	NA
JFK International Airport (Hydroxyl System), Jamaica City, NY	• Groundwater	Full	November 1999 – Present/ On-going (data through May 2002)	• Process type: and total fluid extraction (TFE) and advanced oxidation technology (AOT) • Twenty gpm of groundwater were extracted using multi-phase and TFE systems • The system consists of two 8' x 40' weather-proof, skid mounted modules located at an active airport gate • The first module provides oil-water separation, suspended solids reduction and emulsion-breaking • The second module is a combined AOT and biological treatment system for removal of dissolved organics • The AOT uses ozone and hydrogen peroxide to treat MTBE, resulting in acetone as a byproduct • An attached-growth bioreactor is used to biodegrade the acetone to reach an effluent quality standard of 50 µg/L for acetone • A major capacity upgrade of the	100,000	50	50	>99	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Multi Phase Extraction (MPE)	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for MPE/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				initial system was completed in May 2002, doubling the treatment capacity • Vendor: Hydroxyl Systems Inc.					
Kings Beach Swiss Mart, Lake Tahoe, CA	• Groundwater and soil	Full	September 1999 – Present / On-going (data through March 2001)	• Type of MPE configuration not provided • Vendor: NA	32,000	0.5	2,300	93	Remediation cost: $130,000/ No other technologies
Site CA – AA, Antioch, CA	• Groundwater • Depth to groundwater: 37	Pilot	NA/ On-going (data through May 2000)	• Process type: Bubblex, a patented method that simultaneously extracts vapor and water using a high vacuum • Remediation used a 500 cfm capacity catalytic oxidizer to treat extracted soil vapor • A positive displacement blower capable of 150 in of water column was used to apply 110 in of water column vacuum to the wellhead and extraction pipe • The vapor flow rate was 140 cfm and the water flow rate was 0.5 gpm • Vendor: Tait Environmental Management, Inc.	NA	NA	NA	NA	NA
Site CA – X, Lawndale, CA	• Groundwater • Depth to groundwater: 15	Pilot	30 minutes/ Completed	• Process type: Bubblex, a patented method that simultaneously extracts vapor and water using a high vacuum • Remediation used a positive displacement blower with 200 in of water column; vacuum capacity was used to extract water and vapor • Average water removal rate was 6 gpm • Average vapor flow rate was 87 cfm • Vendor: Tait Environmental Management, Inc.	11	NA	NA	NA	NA
Site CA – Y, Los Angeles, CA	• Groundwater • Depth to groundwater: 43	Pilot	10 minutes/ Completed	• Process type: Bubblex, a patented method that simultaneously extracts vapor and water using a high vacuum • Vendor reported use of a super	NA	NA	NA	NA	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Multi Phase Extraction (MPE)	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for MPE/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				sucker (vacuum truck) attached to a Bubblex extraction pipe which was placed in the well creating 3 ft of water drawdown in the well and extracting water and vapor at the same time • The total duration of the test was ten minutes • The test was performed with 80 in of water column vacuum applied to the wellhead and the Bubblex modified extraction pipe • The estimated vapor flow rate was 50 cfm and the water flow rate was less than 1 gpm • Vendor: Tait Environmental Management, Inc.					
Site CA – Z, Yorba Linda, CA	• Groundwater • Depth to groundwater: 34	Pilot	NA/ On-going (data through May 2000)	• Process type: Bubblex, a patented method that simultaneously extracts vapor and water using a high vacuum • Vendor reported use of a super sucker (vacuum truck) to apply 80 in of water vacuum applied to the wellhead and extraction pipe • Site reported 80 in of water column vacuum applied to the wellhead, a vapor flow rate of approximately 50 cfm, and a water flow rate of 1.3 gpm • Vendor: Tait Environmental Management, Inc.	NA	NA	NA	NA	NA
Site CA –W, Los Angeles, CA	• Groundwater • Depth to groundwater: 38	Full	NA/ On-going (data through May 2000)	• Process type: Bubblex, a patented method that simultaneously extracts vapor and water using a high vacuum • Bubblex, a two phase extraction system using a thermal catalytic oxidizer to treat extracted vapor, and two 500 lb GAC units was used • Average vacuum at the wellhead was	NA	NA	NA	NA	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Multi Phase Extraction (MPE)	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for MPE/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				108" of water column • Water flow rate was less than 1 gpm, and the vapor flow rate was 190 cfm • Vendor: Tait Environmental Management, Inc.					
Sparks Solvents/Fuel Site, Sparks, NV	• Groundwater	Full	October 1995 – Present/ On-going (data through March 2001)	• Process type: granular activated carbon (GAC)/fluidized bed reactor containing GAC • Total of 29 multi-phase extraction wells • Influent flow rate is 370 gpm with a retention time of 8 minutes • Vendor: NA	2,400	NA	55	98	NA
MPE with Air Sparging Projects									
Scotchman #94, Florence, SC	• Groundwater and soil • Clayey sands, and sandy clays, with a hard clay layer at approximately 10 ft • Depth to groundwater: 23 ft	Full	March 1999 – Present/ On-going (data through March 2001)	• The groundwater treatment system includes a multi-phase extraction system consisting of five extraction wells with an air sparging system on site • Number of air sparging wells: 28 • Vendor: NA	87,000	2,495	7,410	94	Remediation cost: $383,000/ No other technologies
Tahoe Boat Company, Lake Tahoe, CA	• Groundwater • Size of MTBE plume was 150 ft by 100 ft by 15 ft	Full	August 1995 - April 1999/ Completed	• Process type: multi-phase extraction with granular activated carbon (GAC) • Air sparging was later used to further treat contamination • Vendor: NA	55	NA	79	increase	NA
MPE with In-Situ Chemical Oxidation Projects									
Former Bulk Terminal, NY – B, NY	• Groundwater and soil • Area of contamination over 20 acres	Full	February 1998 – Unknown/ On-going (data through September 2000)	• Ozone was injected into the subsurface by combining air with the discharge from two ozone generators and sparging it through an existing 380 ft horizontal well • The air/ozone mixture was delivered to both ends of the horizontal well. The ozone sparge system was operated in conjunction with dual-phase extraction	160	NA	40	75	NA/ Dual vapor extraction with air sparging

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Multi Phase Extraction (MPE)	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for MPE/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				• Vendor: Resource Control Corporation					
Jet Thru Gas and Car Wash, Lake Tahoe, CA	• Groundwater and soil	Full	September 1996 – Present/ On-going (data through March 2001)	• In-situ oxidation reported use of hydrogen peroxide • Vendor: NA	790	0.5	1,500	increase	NA/ • Dual vapor extraction with air sparging • Air sparging with GAC polishing

Abbreviations:
gpm – gallons per minute
scfm – standard cubic feet per minute
cfm – cubic feet per minute
ft³ - cubic feet
µg/L – micrograms per liter
ft – feet

Table A-4. Summary of Operating and Performance Information for Selected Projects – Bioremediation

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Bioremediation	MTBE Concentration (µg/L)			MtBE % Reduction	Cost for Bioremediation/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
In Situ Bioremediation Only Projects									
Abandoned Service Station, MA - D, Boston, MA	• Soil and groundwater • Area of soil contamination approximately 1,000 yd^3 • Area of groundwater contamination approximately 100 ft x 700 ft at 10 to 20 ft	Full	NA/ Completed	• Process type: In-situ Aerobic bioremediation and natural attenuation • Tank and soil removal were performed for source control • Vendor: Lyondell Chemical Company	2,500	NA	NA	NA	Total cost: $400,000/ Excavation
Active Gas Station, CA – I, San Luis Obispo, CA	• Groundwater • Groundwater flow is south toward a creek at an average gradient of 0.1 ft/ft	Pilot	August 2000-January 2001 / Completed	• Process type: Iso-Gen • Aerobic bioremediation • 2 Iso-Gen wells (4-inch PVC wells) • Vendor: Environmental H2O L.L.C.	33,000	NA	NA	42 to 89	Total cost: $270,000 Monitoring: $20,000/ No Other Technologies
Active Gas Station, NV-B Las Vegas, NV	• Groundwater • Groundwater is semi-confined in predominately clayey sediments with lesser amounts of sand and caliche • Groundwater flow direction is toward the east-northeast at an average gradient of 0.038 ft/ft	Pilot	One month/ Completed	• Process type: Iso-Gen process • The Iso-Gen process generates high concentrations of dissolved oxygen (DO) in groundwater using an in-well electrolytic process • Process dissociates water into hydrogen and oxygen • Vendor: Environmental H2O L.L.C	2,700	NA	2,000	26	NA
Active Gas Station, NV-C, Las Vegas, NV	• Groundwater • Soils consists of interbedded lenses of clay, sand, gravel, and caliche • Depth to groundwater: 19.77 to 22.72 ft bgs • The groundwater is semi-confined in predominantly clayey sediments with lesser amounts of sand	Pilot	October 2000 – November 2000/ Completed	• Process type: Iso-Gen process • The Iso-Gen process generates high concentrations of dissolved oxygen (DO) in groundwater using an in-well electrolytic process • Process dissociates water into hydrogen and oxygen • Vendor: Environmental H2O L.L.C	2,300	NA	NA	NA	NA

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Bioremediation	MTBE Concentration (µg/L)			MtBE % Reduction	Cost for Bioremediation/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Active Fuel Terminal, CA – K, San Jose, CA	• Groundwater • Clay and silt to depths of approximately 5 to 25 ft bgs underlain to depths of approximately 20 to 30 ft bgs by an extensive coarse grained unit of poor to well graded sand, with gravel	Pilot	January 2000/ On-going (data through June 2001)	• Process type: Iso-Gen applied to 5 existing wells • Aerobic bioremediation • Vendor: Environmental H2O L.L.C.	35,000	NA	50	99	Total cost (estimated): $190,000 to $385,000 (based on 16 Iso-Gen units and 12 to 24 month clean-up period/ No Other Technologies
Active Service Station, FL - A	• Groundwater	Full	April 1996 - July 1996/ Completed	• Process type: ORC© in three, 3-in diameter boreholes • 7-ft column of slurry per borehole • 21 lbs of ORC© per borehole • Aerobic bioremediation • Vendor: Regenesis	15	NA	ND	>99	ORC© cost: $614/ No other technologies
Adjacent Operating Unit in Chemical Plant, Channelview, TX	• Groundwater	Full	Unknown/ On-going (data through March 2001)	• Aerobic (oxygen addition) to the subsurface • Vendor: Lyondell Chemical Company	10,000	NA	NA	NA	Total cost: $150,000/ No other technologies
Bessinger's Gulf, Barnwell, SC	• Groundwater	Full	Unknown/ On-going (data through January 2002)	• Type of bioremediation, configuration, and additives not provided • Vendor: NA	21	NA	NA	NA	Total cost: $138,000/ No other technologies
Bull Convenience Market, Conway, SC	• Groundwater	Full	Unknown/ On-going (data through February 2002)	• Type of bioremediation, configuration, and additives not provided • Vendor: NA	10,223	NA	NA	NA	Total cost: $217,500/ No other technologies
Chemical Plant, TX - D, Pasadena, TX	• Soil and groundwater • Plume of contaminated soil approximately 100 ft by 600 ft	Full	Unknown/ On-going (data through March 2001)	• Aerobic circulating bioremediation with natural attenuation • Vendor: Lyondell Chemical Company	60,000	NA	NA	NA	Total cost: $400,000/ No other technologies
Cordray's Grocery, Ravenal, SC	• Soil and groundwater	Full	April 1998/ On-going (data through March 2001)	• Excavation of soil • Process type: Injection ORC© • Aerobic (oxygen addition) • Vendor: Regenesis	239	NA	NA	NA	Total cost: $21,000/ Excavation

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Bioremediation	MTBE Concentration (µg/L)			MtBE % Reduction	Cost for Bioremediation/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Crossroads Grocery, Westminster, SC	• Groundwater	Full	Unknown/ On-going (data through January 2002)	• Type of bioremediation, configuration, and additives not provided • Vendor: NA	10,442	NA	NA	NA	Total cost: $139,506/ No other technologies
Davis 66, Chester, SC	• Groundwater	Full	Unknown/ On-going (data through January 2002)	• Type of bioremediation, configuration, and additives not provided • Vendor: NA	10,221	NA	NA	NA	Total cost: $148,740/ No other technologies
Department of Defense Housing Facility (DoDHF), Novato, CA	• Soil and groundwater	Bench	150 days/ Completed	• Soil and groundwater samples collected from two locations (N1 and N2) • Aerobic, anaerobic, and cometabolic (propane and butane biodegradation mechanisms) were investigated without nitrate addition • Results proved that oxygen addition cometabolic air-sparging proved to be best technology for this site • Vendor: Environmental Technology	10,000	NA	N1- ND	N2- 39	NA
Former UST Area of a Service Station, SC - B, Beaufort, SC	• Groundwater • Aquifer and vadose zone composed of well-sorted sand grains, with <0.01% natural sedimentary organic matter, underlain by a regional confining clay unit • The groundwater velocity is 33 m/yr • Plume extends from the UST area, to 755 ft downgradient	Pilot	January 1999/ On-going (data through September 2000)	• Process type: ORC© • 18 boreholes on 1.7 ft centers injected with ORC© slurry • Aerobic oxygen source added • Vendor: Regenesis	30,000	NA	5,000	83	NA
Gladden's Grocery, Chester, SC	• Groundwater	Full	Unknown/ On-going (data through January 2002)	• Type of bioremediation, configuration, and additives not provided • Vendor: NA	15,335	NA	NA	NA	Total cost: $87,434/ No other technologies

Selected MtBE Treatment Projects Source: www.clu-in.org/products/mtbe

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Bioremediation	MTBE Concentration (µg/L)			MtBE % Reduction	Cost for Bioremediation/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Hanna Magic Car Wash, Lake Tahoe, CA	• Groundwater	Full	August 1997 - unknown/ Completed	• Process type: ORC© • Aerobic (oxygen addition) • Excavation • Vendor: NA	<5	NA	8	Increase	NA/ Excavation
Hess #40245, Columbia, SC	• Groundwater	Full	Unknown/ On-going (data though January 2002)	• Configuration not provided • Vendor: Not Specified	41	NA	NA	NA	Total cost: $114,000/ No other technologies
Hess 9403, Brookville, FL	• Groundwater	Full	February 1995 - January 2000/ Completed	• Injection of proprietary mixture into the vadose and saturated zones at an average depth of 85 ft • Vendor: BioWorld Innovations	440	35	5	92	Total cost: <$50,000/ No other technologies
Huck's Country Express, Conway, SC	• Groundwater	Full	Unknown/ On-going (data through January 2002)	• Type of bioremediation, configuration, and additives not provided • Vendor: NA	20,449	NA	NA	NA	Total cost: $91,660/ No other technologies
Industrial Site, NH - A	• Groundwater • Groundwater velocity is 0.2 to 0.3 ft/day • The plume was approximately 20 ft by 120 ft by 20 ft contained in a fractured bedrock aquifer	Full	Unknown/ Completed (data through January 2000)	• Process type: ORC© • Aerobic (oxygen addition) • Injection of 678 lbs of ORC© applied by slurry injection via a Geoprobe • Reported concentrations from three downgradient sentinel wells • Vendor: Regenesis	140	NA	19	>63	ORC cost: $6,000/ No other technologies
Industrial Site, NJ - A	• Groundwater • Contaminant plume located in coarse gravel • Groundwater flow velocity estimated 0.04 ft/day • Plume area approximately 275 ft by 8 ft	Full	Unknown/ Completed (data through January 2000)	• Process type: ORC© • Aerobic (oxygen addition) • ORC© barrier constructed within a trench; ORC© socks placed into two rows spaced on 12 ft centers in trench; and ORC socks changed after 3 months • Single row of 5 wells installed along the up gradient edge of the trench • Vendor: Regenesis	1,570	NA	1,160	26	NA

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Bioremediation	MTBE Concentration (µg/L)			MtBE % Reduction	Cost for Bioremediation/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Kansas U6-026-10985, Ellis, KS	• Groundwater • Clay, silt and sand	Full	August 2000/ On-going (data through July 2001)	• Process type: ORC© injection • Additional trenching and back fill and SVE/AS installation planned for summer, 2001 • Aerobic (oxygen addition) • Vendor: Regenesis	1,400	NA	980	30	NA/ Excavation
Kelly's Olanta, SC	• Groundwater	Full	Unknown/ On-going (data through January 2002)	• Type of bioremediation, configuration, and additives not provided • Vendor: NA	23,999	NA	NA	NA	Total cost: $49,547/ No other technologies
Main Street Shell, Conway, SC	• Groundwater	Full	Unknown/ On-going (data through January 2002)	• Type of bioremediation, configuration, and additives not provided • Vendor: NA	10	NA	NA	NA	Total cost: $83,540/ No other technologies
Master Shell, Winnsboro, SC	• Groundwater	Full	Unknown/ On-going (data through January 2002	• Type of bioremediation, configuration, and additives not provided • Vendor: NA	283	NA	NA	NA	Total cost: $236,600/ No other technologies
Michigan Integrated Remediation Technology Laboratory, Oscoda, MI	• Groundwater • Medium to fine grained sand and gravel approximately 60 ft thick • This formation is underlain by silts and clays several hundred ft thick.	Pilot	10 months/ completed	• Two permeable reactive barriers (PRB), a whey barrier and an oxygen release compound (ORC) barrier, were used to study the fate and transport of MTBE during 1998-1999 • Vendor: NA	NA	NA	NA	NA	NA
Off-Site Area, UT - A	• Groundwater • Clayey silts and silty sands clay, poorly graded gravels	Pilot	September 2000 - November 2000/ Completed	• Process type: Iso-Gen technology • Iso-Gen technology was applied to 1 6-in diameter existing well (EW-2) located on the leading edge of the MTBE plume • Monitoring points are all 1 inch in diameter • Aerobic bioremediation • Vendor: Environmental H2O L.L.C.	3,600	NA	1,300	64	NA

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Bioremediation	MTBE Concentration (µg/L)			MtBE % Reduction	Cost for Bioremediation/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Operating Service Station, NJ - B	• Soil and groundwater • Fine to medium sands	Pilot	Unknown/ On-going (data through June 2001)	• Strain ENV425 in slurry injected into three existing air sparging wells • Cometabolic propane added, will mineralize to CO2 after growth on propane • Vendor: Envirogen Inc.	NA	NA	NA	NA	NA
Port Hueneme - B, Oxnard, CA	• Groundwater	Pilot	120 days/ Completed	• Aerobic and cometabolic oxygenated and bioaugmented barrier containing a high activity ether oxygenate-degrading mixed culture (MC-100) and a single culture MTBE-degrading isolate (SC-100) • Three test plot biobarriers (10-20 ft wide) were developed in the 10-20 bgs aquifer zone were intermittently sparged with air or oxygen • The three plots were: 1) MC 100 plus air, 2) SC 100 plus air, and 3) SC-100 plus oxygen • Vendor: Equilon	2,000	NA	1-25	99	NA/ Air sparging
Port Hueneme - D, Oxnard, CA	• Soil and groundwater • Sandy at depths of 10-20 ft bgs • The upper aquifer is bounded by a clay aquitard at about 20 ft bgs	Full	Fall 2000/ On-going (data through July 2002)	• 500 ft wide biobarrier • Aerobic degradation by the injection of oxygen, air, mixed culture (MC 100), & single culture (SC 100) • System components: 240 CFH oxygen generator, 252 gas injection wells, 174 ground water monitoring wells, 25 satellite gas storage tanks, & a control system • Vendor: NA	>1,000	NA	<0.005	>99	NA, however a comparison cost to a pump and treat system in operation at the site suggests a <$50 million savings over the projected lifetime of the site
Racetrac #306 West Columbia, SC	• Groundwater	Full	Unknown/ On-going (data through January 2002)	• Type of bioremediation, configuration, and additives not provided • Vendor: NA	5,113	NA	NA	NA	Total cost: $180,000/ No other technologies

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Bioremediation	MTBE Concentration (µg/L)			MtBE % Reduction	Cost for Bioremediation/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Rural Area Disposal Area, TX - B, Liberty, TX	• Soil and groundwater • Intermittent sand, silt, silty-clay to 30", some permeable lenses • Plume area 300' X 400'	Full	Unknown/ Completed	• In-situ aerobic bioremediation • Vendor: NA	3,000	NA	NA	NA	Total cost: $5,700,000/ • Excavation and ex-situ bioremediation • Incineration or landfill of free-phase soils • Soil washing • Aquifer flushing with surfactants
Service Station, CT - A	• Groundwater • Fine to medium-grained sand with traces of silt and gravel • Estimated 1,000 yd³ of contaminated soil and groundwater	Full	October 1997-March 1999/ Completed	• Process type: DO-IT • DO-IT process was applied by retrofitting an existing horizontal air sparging trench and vertical vapor extraction wells • Vendor: NA	6,000	70	1,500	75	Total cost: $95,000/ Air sparging, SVE
Service Station, CA - B	• Groundwater	Full	Unknown/ On-going (data through Spring 2001)	• BioRemedy system- oxygen injection combined with injection of a mixed culture of MTBE-degrading microbes • Aerobic bioremediation oxygen and microbes become "biobarrier" that the MTBE plume flows through • Eighteen oxygen-injection well points-perpendicular to groundwater flow direction at 5 ft spacing • Vendor: NA	>20,000	NA	NA	NA	NA
Service Station, CA - D	• Groundwater • Sandy silt with intermittent clayey silt and silty sand	Full	May 1997 - December 1997/ Completed	• Process type: ORC© • 2,550 lbs of ORC© injected as a slurry via Geoprobe • Aerobic biodegradation of BTEX and MTBE • Vendor: Regenesis	48,000	NA	33,000	32	NA

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Bioremediation	MTBE Concentration (µg/L)			MtBE % Reduction	Cost for Bioremediation/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Service Station, CA - E	• Groundwater • Soil consists of silts and clays to 20 ft bgs; silty, fine-grained sands to medium-grained sands in the saturated zone	Full	Unknown/ On-going (data through March 2001)	• Process type: ORC© • 150 lbs of ORC© were injected at the down-gradient property boundary • 2 direct push bore holes at a depth of 28 ft • Additional 750 lbs was injected within the source area • Aerobic degradation with oxygen addition • Vendor: Regenesis	2,200	NA	2,300	Increase	NA
Service Station, CT - B	• Groundwater	Full	May 2000 - January 2001/ Completed	• Process type: BioRemedy system • Aerobic oxygen and microbes injected using a "biobarrier" • Oxygen injection wells installed on 5 ft centers at two depths • Vendor: Shell Global Solutions	100,000	NA	1,100	99	NA/ Pump and treat
Service Station, NY - E, Clifton Park, NY	• Soil and groundwater • 5 - 8 ft alluvial sands, underlain by low permeability clay extending to bedrock • Groundwater: sand layer, with a saturated thickness of 4 - 5 ft, gradient changes 0.11 ft/ft	Full	579 days/ Completed	• Process type: Patented oxygen injection system • Aerobic degradation with oxygen addition at 90-95% • Oxygen concentrations of up to 40 mg/L injected • 7 injection points with injection pressure of 2 psi per point • Vendor: NA	2,800	50	30	99	O&M Cost: $30,000/ No other technologies
Service Station, PA - C	• Groundwater/ • Silty sand aquifer	Full	6 months/ Completed	• Process type: ORC© • Injection of 540 lbs of ORC© as a slurry via Geoprobe. • Aerobic degradation with oxygen addition • Vendor: Regenesis	15,000	NA	12,500	17	NA

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Bioremediation	MTBE Concentration (µg/L)			MtBE % Reduction	Cost for Bioremediation/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Service Station, WI - A	• Groundwater • Silt and clay • Plume covered an area of 160 ft by 200 ft by 13 ft	Full	14 months/ Completed	• Process type: ORC© • Tank removed for source control • 2,000 lbs ORC© added as backfill amendment • Aerobic degradation with oxygen addition • Injected via push points around the dispenser island for perimeter containment • Vendor: Regenesis	5,800	NA	7,000	Increase	Total cost: $221,750/ Excavation
Service Station, WI - B, Lake Geneva, WI	• Groundwater	Full	Unknown/ On-going (data through March 2001)	• Process 1,700 lbs ORC© slurry injected into the backfill of the excavated area using a Geoprobe© • Aerobic degradation with oxygen addition • 37 different locations • Vendor: Regenesis	1,800	NA	<2	99	NA
Site MA - A	• Soil and groundwater	Bench	Unknown/ Completed	• Cometabolic butane injecting into contaminated area • Different bacteria co-oxidize chlorinated solvents while growing at the expense of butane • Vendor: NA	10,000	NA	<1	99	NA
Site NY - F	• Soil and groundwater • Silty clay and clay overlying sand and gravel • 5,000 ft² X 30 ft, a soil volume of 10,000 ft³ • Groundwater volume of 50,000 ft³	Full	3 years/ On-going (data through June 2001)	• Process type: Patented oxygen pulse injection system • 18 injection points • Aerobic degradation with oxygen addition / advection • Vendor: Matrix Environmental Technology	870,000	10	42,000	95	Remediation capital: $35,000 O&M cost: $68,000/ Pump and treat (used prior to bioremediation)

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Bioremediation	MTBE Concentration (µg/L)			MtBE % Reduction	Cost for Bioremediation/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Site PA - B	• Groundwater • Fractured bedrock	Pilot	Unknown/ On-going (data through June 2001)	• Aerobic • Hydrogenophaga flava (ENV735), a bacterial isolate that grows on MTBE as its sole food source • Strain ENV735 injected into aquifer using modified push-pull approach in conjunction with oxygen in-well injection • Vendor: Envirogen Inc.	NA	NA	NA	NA	NA
Site SC - C, SC	• Soil and groundwater	Full	July 1999 - January 2000/ Completed	• Cometabolic treatment consists of low-pressure injection of a slurry of facultative bacteria, nutrients, and co-substrate into the vadose, saturated, and smear zone soils, and groundwater • Vendor: NA	229	NA	3	99	NA
Sunoco Service Station, MA	• Soil and groundwater • 10 ft below ground surface: Brown fine to medium sand and fine to coarse gravel • 15 bgs: dark brown peat with silt. 20 - 25 bgs: light gray silt and clay	Full	October 2000 - January 2001/ Completed	• 2,000 yd^3 of soil was excavated from the site • Butane-utilizing bacteria existed at the site • 12 injection wells • Two butane injection panels • Cometabolic • Vendor: Global Biosciences	370	NA	12	97	NA/ Excavation
South Beach Marine, SC	• Groundwater • The soil at the site consists of silty fine sands and clays	Full	May 1999/ On-going (data through March 2001)	• Microbial solution pumped into temporary bore holes and wells at 5-20 psi • Three injections of 150-700 gal of solution • Vendor: NA	3,140	40	41	99	Total cost: $63,500/ No other technologies
Speedway #226, North Charleston, SC	• Groundwater	Full	Unknown/ On-going (January 2002)	• Type of bioremediation, configuration, and additives not provided • Vendor: NA	10	NA	NA	NA	Total cost: $312,000/ No other technologies
Traveland of Orangeburg, Orangeburg, SC	• Groundwater	Full	Unknown/ On-going (data through January 2002)	• Type of bioremediation, configuration, and additives not provided • Vendor: NA	21	NA	NA	NA	Total cost: $58,990/ No other technologies

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Bioremediation	MTBE Concentration (µg/L)			MtBE % Reduction	Cost for Bioremediation/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Underground Storage Tank, NY - G, Medina, NY	• Groundwater • The surficial geology is silty sand overlaying bedrock • Treatment zone is 18,000 ft² with a maximum depth of 12 ft • Soil volume of 210,000 ft³ • Groundwater volume of 126,000 ft³	Full	Unknown/ Completed	• Process type: Patented oxygen pulse injection system • 18 injection points • Aerobic degradation with oxygen addition • Vendor: Matrix Environmental Technology	1,800	50	40	>98	Capital cost: $40,000 O&M cost: $15,000/ Pump and treat (used prior to bioremediation)
Underground Storage Tank, TN - A, Chatanooga, TN	• Soil and groundwater • Groundwater beneath the site is located in a tight clay soil horizon • 1,500 yd³ of soil at the site were impacted by contamination • Plume covers approximately 16,000 ft²	Full	July 1998/ On-going (data through March 2001)	• Process type: DO-IT system • Aerobic • Injected oxygenated water, nutrients and treatment products • The system consisted of 3 extraction wells, 2 vertical injection wells, and 3 horizontal injection wells • Vendor: NA	5,000	NA	90	>98	Startup cost: $30,000/ No other technologies
U.S. Coast Guard (USCG) Support Center, Elizabeth City, NC	• Groundwater	Full	Unknown-2000/ Completed	• Process type: ORC© • Aerobic • Source area treated with 18 injection points of a slurry suspension of 16 kg of ORC and 48 L of water • The plume portion treated 13 injection points of 10 kg of ORC and 30 L of water • Vendor: Regenesis	NA	NA	NA	NA	NA
Vandenberg Air Force Base, Lompoc, CA	• Groundwater	Pilot	August 1999/ On-going (data through March 2001)	• Three configurations for aerobic oxygen addition: release wells, release panel, and permeable trench • Vendor: University of Waterloo	420	NA	2	>99	NA
Young's Food Store #51, Johnsonville, SC	• Groundwater	Full	Unknown/ On-going (data through January 2002)	• Type of bioremediation, configuration, and additives not provided • Vendor: NA	NA	NA	NA	NA	Total cost: $135,000/ NA

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Bioremediation	MTBE Concentration (µg/L)			MtBE % Reduction	Cost for Bioremediation/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
In Situ Bioremediation Projects with Air Sparging and or SVE Projects									
Beene Site, Dallas, TX	• Soil and groundwater • Clay with minor silts throughout the soil column	Full	12 months/ Completed	• Remediation consisted of biosparging using ambient surface air, coupled SVE • Biosparging consisted of air sparging to volatilize contaminants, with in situ aerobic bioremediation • 12 air sparging wells with spacing between 10 to 20 ft • Aerobic bioremediation • Vendor: Billings & Associates, Inc.	44,386	NA	NA	NA	NA/ Air sparging with SVE
Bloom Site, Bloomfield, NM	• Soil and groundwater • Fine to medium sands with occasional silt stringers of irregular thickness	Full	24 months/ Completed	• Biosparging using ambient surface air, coupled with SVE • Biosparging consisted of air sparging to volatilize contaminants, with in situ aerobic bioremediation • 13 air sparging wells with spacing between 10 to 20 ft • Aerobic bioremediation • Vendor: Billings & Associates, Inc.	4,151	NA	NA	NA	NA/ Air sparging with SVE
Canon Site, Canon City, CO	• Soil and groundwater • Silts and clays intermixed in the upper 7.9 to 9.9 ft • Medium to coarse grained sands, coarse sand and cobble bed	Full	12 months/ Completed	• Biosparging using ambient surface air, coupled with SVE • Biosparging consisted of air sparging to volatilize contaminants, with in situ aerobic bioremediation • 26 air sparging wells with spacing between 10 to 20 ft • Aerobic bioremediation • Vendor: Billings & Associates, Inc.	13,633	NA	NA	70	NA/ Air sparging with SVE
Herrera Site, Albuquerque, MN	• Soil and groundwater • Alluvial sands of medium to fine grain with intermittent thin silt layers	Full	24 months/ Completed	• Biosparging using ambient surface air, coupled with SVE • Biosparging consisted of air sparging to volatilize contaminants, with in situ aerobic bioremediation • 17 air sparging wells with spacing between 10 ft to 20 ft • Vendor: Billings & Associates, Inc.	17,323	NA	NA	NA	NA/ Air sparging with SVE

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Bioremediation	MTBE Concentration (µg/L)			MtBE % Reduction	Cost for Bioremediation/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Tuba Site, Tuba City, AZ	• Soil and groundwater • Medium to fine sands to a subsurface depth of approximately 20 ft	Full	3 months/ Completed	• Process type: biosparging using ambient surface air, coupled SVE • Biosparging consisted of air sparging to volatilize contaminants, with in situ aerobic bioremediation • 9 air sparging wells with spacing of 10 to 20 ft • Air injection pumps were all rotary-lobe positive displacement units • Vendor: Billings & Associates, Inc.	7,938	NA	NA	67	NA/ Air Sparging with SVE
Vagabond Site, Socorro, NM	• Soil and groundwater • Medium sands with occasional silt	Full	6 months/ Completed	• Process type: biosparging using ambient surface air, coupled SVE • Biosparging consisted of air sparging with in situ aerobic bioremediation • 18 air sparging wells with spacing between 10 to 20 ft • Air injection pumps were all rotary-lobe positive displacement units • Vendor: Billings & Associates, Inc.	5,135	NA	NA	38	NA/ Air sparging with SVE
In Situ Bioremediation with Pump and Treat Projects									
Shell Service Station, Tahoe City, CA	• Groundwater • Plume was 200 ft by 300 ft by 20ft	Full	April 1999/ On-going (data through March 2000)	• Type of bioremediation, configuration, and additives not provided • Vendor: NA	22,300	NA	8,500	62	NA/ Pump and treat (groundwater extraction and treatment with granular activated carbon)
In-Situ Bioremediation with Multiple Technologies									
NY 1-8900312	• Soil and groundwater	Full	Unknown/ On-going (data through May 2002)	• Configuration not provided • Vendor NA	4,000	NA	567		Total Cost: $99/ • Air sparging with SVE • Pump and treat
Ex-Situ Bioremediation									

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Bioremediation	MTBE Concentration (µg/L)			MtBE % Reduction	Cost for Bioremediation/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Lawrence Livermore National Laboratory, Livermore, CA	• Soil and groundwater	Bench	Unknown/ Completed	• Microcosms created using sediment and groundwater-supplemented with MTBE • Evaluated aerobic and anaerobic microcosms and the use of various amendments • Vendor: NA	420	NA	<5	>99	NA
Los Angeles County Joint Water Pollution Control Plant, Carson City, CA	• Groundwater	Bench	Unknown/ Completed	• Bacterial strain PM1 was isolated from an MTBE-degrading mixed culture enriched from a compost biofilter • PM1 was grown at 25 degrees Celsius in 250 mL bottles containing 50 mL of a mineral salts medium, using either MTBE or benzene as a sole source of carbon and energy • When grown on MTBE, MTBE was initially added at aqueous concentrations of 20 to 100 mg/L • When some growth was observed in the bottles as indicated by an increase in turbidity, the concentration of MTBE was increased to 500 mg/L • Once MTBE was nearly degraded (typically within 4 days), cells were harvested by centrifuging the culture suspension at 2,800 rpm for 20 minutes • Vendor: NA	NA	NA	NA	NA	NA

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Bioremediation	MTBE Concentration (µg/L)			MtBE % Reduction	Cost for Bioremediation/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
Port Hueneme-A, Oxnard, CA	• Groundwater	Bench	Unknown/ On-going (data through May 2001)	• Laboratory-scale microcosm study • Aerobic and cometabolic mechanisms (propane and butane as growth substrates) were investigated both with and without nitrate addition • Each microcosm contained approximately 5 g of soil and 10 mL of groundwater • Vendor: NA	10,000	NA	NA	NA	NA
Rail Loading Area and Tank Farm Area, TX - A Bayport, TX	• Soil and groundwater • Silty sand and silty clay to 30 ft bgs; subsoils are consistent	Full	Unknown/ On-going (data through March 2001)	• Remediation consisted of excavation • Removal of shallow soils and ex situ bioremediation/land treatment of soils followed by land filling • Planned groundwater remediation • Vendor: Lyondel	1,200	NA	NA	NA	Total cost: $420,000/ Excavation
Stormwater Basin, TX - E Houston, TX	• Soil and groundwater • Intermittent silts, fine sand, clay to aquitard at 30 ft bgs; variable permeability	Full	Unknown/ On-going (data through March 2001)	• Approximately 2 ft of soils below the bottom of the basin affected • Use of a slurry phase bioremediation for sludges • Natural attenuation for the aquifer • Vendor: NA	150	NA	10	>94	Total cost: $400,000/ No other technologies
Universidad Autonoma Metropolitana-Iztapalapa, Mexico City, Mexico	• Soil	Bench	6 days/ Completed	• A lab scale bioremediation test adapted a soil consortium (P. aeruginosa) to degrade reformulated gasoline containing MTBE • For cometabolic studies in microcosms, a mineral salt solution was added to each bottle and autoclaved • Vendor: NA	NA	NA	NA	NA	NA

Site Name, Location *	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Bioremediation	MTBE Concentration (µg/L)			MtBE % Reduction	Cost for Bioremediation/Other Technologies Involved***
					Initial	Cleanup Goal	Final**		
University of Massachusetts, Amherst, MA	• Soil	Bench	Unknown/ Completed	• Laboratory incubations were screened for the capacity to anaerobically biodegrade MTBE • MTBE degradation was stimulated in aquifer sediment that had been amended with Fe (III) oxides and humic substances • Vendor: NA	NA	NA	NA	NA	NA

Abbreviations:
bgs - below ground surface
gpm - gallons per minute
NA - not available
ND - Not detected
M/yr – meters per year
ft/day – feet per day
kg/day – kilograms per day
lbs/day - pounds per day
yd^3 - cubic yards
g – grams
gal - gallons
psi – pounds per square inch
kg - kilograms
L - liter
mL - milliliter
ft - feet
ft^2 - square feet
ft^3 – cubic feet
ug/L - micrograms per liter

Table A-5. Summary of Operating and Performance Information for Selected Projects – *In Situ* Chemical Oxidation

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for *In Situ* Chemical Oxidation	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for In Situ Chemical Oxidation/ Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
In Situ Chemical Oxidation Only Projects									
Former Maintenance and Repair Garage, NY – H, West Chester, NY	• Groundwater • Very fine to coarse sand and gravel with occasional cobbles underlain by highly weathered and decomposed fractured bedrock, ranging from 11 to 17.5 ft bgs • Depth to groundwater: 10 ft • Total contamination area approximately 20,000 ft² extending to an approximate depth of 20 ft bgs • 2 plumes were identified, a BTEX plume and a down-gradient MTBE plume	Pilot	December 1999 - December 2000/ Completed	• Process type: ISOTEC • Aerobic • ISOTEC, a chemical oxidation process that involves the injection of hydrogen peroxide and proprietary iron-based catalysts directly into or around areas of contamination in the subsurface • The field pilot program consisted of two 10-day injection events, to evaluate in-situ treatment efficiency • ISOTEC chemical reagents were injected into two separate plume areas at the site; the up-gradient BTEX plume area, as well as the down-gradient MTBE plume • Vendor: In-Situ Oxidative Technologies, Inc.	451	NA	171	62	NA
Frenchglen Mercantile, Frenchglen, OR	• Groundwater and soil • Shallow and deep aquifers • Approximately 1,300 yd³ of contaminated soil were removed	Full	April 2002 – Present/ On-going (data through April 2002)	• Current site remediation consists of in situ chemical oxidation using Fenton's Reagent and hydrogen peroxide • Injection depths range from 8-14 ft bgs and the volume of injection ranges from 25 to 495 gal total • Site reported plans to let the site "sit" for a while to measure chemical oxidation response or rebound potential • Vendor: NA	NA	NA	NA	NA	Total Cost: $260,000/ • Pump and treat • Natural attenuation
Garage, NJ – F, Island Heights, NJ	• Groundwater	Full	June 1997 - August 1998/ Completed	• Process type: ISOTEC • Aerobic • ISOTEC, a chemical oxidation process that involves the injection of hydrogen peroxide and proprietary	55.4	NA	4.8	91	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for *In Situ* Chemical Oxidation	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for In Situ Chemical Oxidation/ Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				iron-based catalysts directly into or around areas of contamination in the subsurface • Vendor: In-Situ Oxidative Technologies, Inc.					
Maintenance Garage, NY – A, Merrick, NY	• Groundwater • Depth to groundwater: 6 ft • Medium to coarse grained sand aquifer • Hydraulic conductivity was estimated at 3x10 -4 cm/sec • Total organic carbon as 1 ppm, pH of 6.6; conductance of 450 µs/cm • Groundwater flow is 0.02 ft/day • Groundwater was found to be contaminated at a depth of approximately 20 fbg • An estimated 105,000 gal of site groundwater was contaminated	Pilot	NA/ On-going (data through May 2000)	• Process type: CleanOX • CleanOX is a proprietary in-situ chemical oxidation process that involves the application of a Fenton-like chemistry to create and migrate hydroxyl radicals, which in turn degrade organic contamination • The site used three 4-inch diameter application wells in the center of the plume, a treated area of approximately 4,000 ft² • Aerobic • Vendor: ManTech Environmental Corporation	620	NA	220	65	NA
Municipal Garage, NJ	• Groundwater • Fractured shale bedrock; 27,000 gal perched aquifer • Depth to groundwater: 21 ft	NA	NA/ On-going (data through 2002)	• Process type: CleanOX • CleanOX is an in-situ process that injects the proprietary liquid chemical formulations through monitoring wells into the contaminated portion of the aquifer • The process oxidizes groundwater contaminants to carbon dioxide and water • Aerobic • Vendor: ManTech Environmental Corporation	490 - 10,290	NA	360 - 4,950		NA
Service Station, IN – A, Hobart, IN	• Groundwater and soil • Clay	Full	August 1998 – Unknown/ On-	• Process type: BiOx • BiOx is a proprietary in-situ remedial	682	NA	ND	>99	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for *In Situ* Chemical Oxidation	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for In Situ Chemical Oxidation/ Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
			going (data through June 2000)	technology that destroys organic contaminants through an oxidation process • A blend of catalysts and oxidizers (hydrogen peroxide) are injected into the groundwater or area of contamination • By-products of the process are water, carbon dioxide, and possibly chloride ions • The vertical treatment interval for this site is 5 to 15 ft bgs • Aerobic • Vendor: BioManagement Services, Inc.					
Service Station, IN – B, Hammond, IN	• Groundwater and soil • Silty sand	Full	August 1998 – Unknown/ On-going (data through June 2000)	• Process type: BiOx • BiOx is a proprietary in-situ remedial technology that destroys organic contaminants through an oxidation process • A blend of catalysts and oxidizers (hydrogen peroxide) are injected into the groundwater or area of contamination. • By-products of the process are water, carbon dioxide, and possibly chloride ions. The vertical treatment interval for this site is 4 to 11 ft bgs • Aerobic • Vendor: BioManagement Services, Inc.	1,310	NA	85	94	NA
Service Station, IN – C, Mishawaka, IN	• Groundwater and soil • Sand	Full	August 1999 – Unknown/ On-going (data through June 2000)	• Process type: BiOx • BiOx is a proprietary in-situ remedial technology that destroys organic contaminants through an oxidation process • A blend of catalysts and oxidizers (hydrogen peroxide) are injected into the groundwater or area of	17,000	NA	430	97	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for *In Situ* Chemical Oxidation	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for In Situ Chemical Oxidation/ Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				contamination • By-products of the process are water, carbon dioxide, and possibly chloride ions. The vertical treatment area for this site is 4 to 11 ft bgs • Aerobic • Vendor: BioManagement Services, Inc.					
Service Station, NJ – D, Northfield, NJ	• Groundwater • Shallow groundwater was contaminated and a petroleum product sheen was observed in several on-site wells	Pilot	NA/ On-going (data through May 2000)	• Process type: CleanOX • Chemical oxidation process that involves the application of a Fenton-like chemistry to create and migrate hydroxyl radical, which in turn degrade organic contamination • Due to the presence of floating product, the CleanOX Process was applied as a two-cycle application at the site • The site used 3 on-site application wells (in the area where the highest concentrations were detected) and 2 monitoring wells. • Aerobic • Vendor: ManTech Environmental Corporation	620	NA	11.6	98	NA
Service Station, NJ – E, North Halden, NJ	• Groundwater	Full	March 1998 - May 1998/ Completed	• Process type: ISOTEC • ISOTEC, a chemical oxidation process that involves the injection of hydrogen peroxide and proprietary iron-based catalysts (fenton's chemistry) directly into or around areas of contamination in the subsurface • Aerobic • Vendor: In-Situ Oxidative Technologies, Inc.	403,000	NA	1,430	>99	NA
Service Station, PA – D, Warminster, PA	• Groundwater	Full	August 1997 - October 1998/	• Process type: ISOTEC • ISOTEC, a chemical oxidation	50,000	NA	6.6	>99	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for *In Situ* Chemical Oxidation	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for In Situ Chemical Oxidation/ Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
			Completed	process that involves the injection of hydrogen peroxide and proprietary iron-based catalysts (fenton's chemistry) directly into or around areas of contamination in the subsurface • Aerobic • Vendor: In-Situ Oxidative Technologies, Inc.					
Shell Gas Station, South Lake Tahoe, CA	• Groundwater and soil	Full	May 1998 – Present/ On-going (data through March 2001)	• Remediation consisted of in situ chemical oxidation using hydrogen peroxide • Site also reported use of groundwater extraction • Vendor: NA	9	0.5	22	increase	NA
Spill Site (Long Island, New York), Long Island, NY	• Groundwater • Medium to coarse grained sand aquifer	Pilot	January 29, 2001 - March 30 2001/ Completed	• Process type: KVA C-Sparge system • Contaminants are destroyed in situ rather than volatilized as a vapor • Two ozone sparging points were installed at different depths in a single borehole to maximize the conical diffusion of gases into the aquifer • Monitoring wells were installed at 12 and 28 ft down gradient of the sparge points to measure the magnitude of hydraulic effect and to monitor changes in groundwater quality. • Ozone sparging was done on a continual basis for four weeks, followed by an additional three weeks of monitoring • Vendor: LFR Levine-Fricke	6,300	NA	79	99	NA
Warehousing Facility in Union County New Jersey, NJ	• Groundwater	Full	NA/ Completed	• Process type: ISOTEC • ISOTEC, a proprietary catalytic agent which delays formation of reactive hydroxyl radicals • ISOTEC reagents were introduced through six injection points in 15	6,400	70	<70	99	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for *In Situ* Chemical Oxidation	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for In Situ Chemical Oxidation/ Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				days over 3 months • Vendor: ISOTEC					
In Situ Chemical Oxidation with Air Sparging Projects									
Al's Ski Run Chevron, Lake Tahoe, CA	• Groundwater	Full	July 1995 – Present/ On-going (data through March 2001)	• Process type: in situ oxidation using hydrogen peroxide and air sparging with dual vapor extraction (DVE) • Aerobic • Vendor: NA	260	NA	27	90	NA/ Air sparging
Upgradient Water Supply Well, CA – H, Lake Tahoe, CA	• Groundwater • Soil in the vicinity of the well was silty to clayey sand • Depth to groundwater: 5 ft • The bottom of the contaminated zone was 20 ft below grade • The upgradient breadth of the plume was estimated to be about 50 ft	Full	NA/ On-going (data through May 2000)	• Process type: Bubble fence • An oxidative curtain or "bubble fence" was employed to contain an advancing MTBE plume • The bubble fence was composed of 4 dual-level sparge points fed by a Model 3600 C-sparge unit • Monitoring wells were installed upgradient and downgradient of the well • Air and ozone are injected directly into the groundwater through specifically designed spargers to create small "microbubbles" that have a very high surface area to volume ratio, therefore as they rise through the water they strip out contaminants • Aerobic • Vendor: NA	6	NA	0	>99	NA/ Air sparging
In Situ Chemical Oxidation with Multi-Phase Extraction Projects									
Former Bulk Terminal, NY – B, NY	• Groundwater and soil • Area of contamination is over 20 acres	Full	February 1998 – Unknown/ On-going (data through September 2000)	• Ozone was injected into the subsurface by combining air with the discharge from two ozone generators and sparging it through both ends of an existing 380 ft horizontal well • The ozone sparge system was operated in conjunction with dual-phase extraction from 2 adjacent horizontal wells for a pilot period of	160	NA	40	75	NA/ Multi Phase Extraction

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for *In Situ* Chemical Oxidation	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for In Situ Chemical Oxidation/ Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				seven months, prior to full scale operation in March 2000. • Groundwater and in situ soil gas were screened daily. • Upon implementation of the full-scale operation, dual-phase extraction systems ceased operation • In the future, the site reports plans to use the ozone sparging system on one well at a time, using a series of horizontal wells, without vapor extraction • Site reported the full-scale ozone-sparging system is projected to remediate the entire site (>20 acres) in a three-year period • Prior to the air sparging system, the site reported operation of several dual-phase extractions systems for a period of six months • Vendor: Resource Control Corporation					
Jet Thru Gas and Car Wash, Lake Tahoe, CA	• Groundwater and soil	Full	September 1996 – Present/ On-going (data through March 2001)	• Process type: dual vapor extraction (DVE) used with air sparging • In-situ oxidation reported use of hydrogen peroxide outside of the area influenced by DVE • Aerobic • Vendor: NA	790	0.5	1,500	increase	NA/ Air sparging with GAC polishing
In Situ Chemical Oxidation with Pump and Treat Projects									
North Texas Service Station, TX	• Soil • Soil: Low permeability soils, which are dry most of the year	Full	May 1999 - November 2000/ Completed	• Process type: The lance and pump and treat • The initial response was to recover the free phase product by a pump and treat system, resulted in pumping 32,207 gal of water and product from the tank pit and from the 4 in-place observation wells surrounding the tank hold in May 1999	475,000	NA	68,400	86	Total Cost: $55,000 - 65,000/ Pump and treat

Selected MtBE Treatment Projects Source: www.clu-in.org/products/mtbe

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for *In Situ* Chemical Oxidation	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for In Situ Chemical Oxidation/ Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				• Following this, several more extraction events were conducted recovering a total of more than 50,000 gal of water from the tank hold • Due to expense and time frame of recovery, the pump and treat system was stopped and in situ chemical oxidation using Fenton's reagent began • The delivery system injected low volumes of liquid amendments at high pressure, using a "lance." • The "lance" allowed the amendments without the need for injection wells and created micro fractures in the soil • A total of 37 drums of 33% hydrogen peroxide were injected into the tank hold for a total of about 2,000 gal • 220 gal of ferrous sulfate (12% concentration) were injected prior to the peroxide addition • The injector pressure at the nozzle was estimated to be 3,500 psi • Vendor: URS Corporation and Hill Liebert, Inc.					
In Situ Chemical Oxidation with Soil Vapor Extraction Projects									
Former Service Station, PA – A, Bucks County, PA	• Groundwater and soil • Groundwater: An unconfined aquifer approximately 15 ft thick • Soil: Heterogeneous, saprolite (sandy clay and silts) overlying weathered schist • The treatment zone is 21,600 ft² with a maximum depth of 18 ft	Full	9 months/ Completed	• Product recovery was initiated via groundwater and dual phase extraction, followed by ozone sparging • The ozone sparging was conducted at the site through a series of nested, sparge points at 2 scfm with an ozone dose of 2.5 lbs/day • The ozone sparge system was augmented with soil vapor extraction, applied with (11) 9 ft	17,000	2,900	31	100	Total Cost: $146,000 Remediation Capital: $90,000 O&M Cost: $56,000/ SVE

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for *In Situ* Chemical Oxidation	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for In Situ Chemical Oxidation/ Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				deep vapor extraction wells, and groundwater extraction using total phase extraction technology and traditional groundwater pumping • Extracted and treated groundwater was re-injected to the subsurface, upgradient of the impacted area to further enhance remedial effectiveness by flushing the contaminated area with clean water • Vendor: Resource Control Corporation					
Site MA – F, Concord, MA	• Groundwater and soil	Full	July 2000 – Present/ On-going (data through 2001)	• Process type: Oxy Vac, dual phase extraction, or air sparging • Oxy Vac, a patented process of combining in-situ oxidation with vacuum extraction, dual phase extraction, or air sparging. • Field operations consisted of several hydrogen peroxide injection points and a network of SVE wells to extract off gasses from the in-situ oxidation • As of December 2000, 6 injections of hydrogen peroxide were completed • Site reported that a bench scale test was performed prior to the design of the full-scale field application • Aerobic • Vendor: Terra Vac	3,400	70	NA	NA	NA/ SVE

Abbreviations

µg/L – micrograms per liter
fbg – feet below ground
cm/sec – centimeters per second
ft – feet
ft² - square feet
psi – pounds per square inch
gal – gallon
bgs – below ground surface
scfm – standard cubic feet per minute
lb – pound
yd³ - cubic yard

Table A-6. Summary of Operating and Performance Information for Selected Projects – Pump and Treat and Drinking Water Treatment

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
Pump and Treat Only Projects									
Barkousen Site, Turlock, CA	• Groundwater	Pilot	September 4-5, 2001/ Completed	• Process type: HiPOx • HiPOx, a continuous, in-line, at pressure, destructive advanced oxidation technology that uses hydrogen peroxide and ozone to create hydroxyl radicals that oxidize VOCs to carbon dioxide and water • HiPOx unit was used for the pilot test, with a flow rate of 3 gpm • The mobile unit was configured with 18 reactors, each equipped with an ozone injector and a static mixer • Hydrogen peroxide was injected into the contaminated water upstream from the first reactor and again at reactor 10 • On September 4 and 5, 2001 two tests were performed • Performed by pumping 20 gal of contaminated water into a drum and 65 gal into the 100 gal polypropylene HiPOx feed tank • Contaminated water was passed through the HiPOx pilot system and the effluent from the system was collected in a separate 80-gal polypropylene tank, and then pumped back through the HiPOx system • The process was repeated 22 times in order to apply the entire amount (2,700 mg/L) of ozone required to achieve the specified destruction of contaminants • No information was provided about the groundwater extraction portion of	170,000	<0.5	<0.5	>99	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				the cleanup • Vendor: Applied Process Technology, Inc.					
Beacon Station #688, Lake Tahoe, CA	• Groundwater	Full	August 1991 – Present/ On-going (data through March 2001)	• Pump and treat configuration not provided • Vendor: NA	1,400	0.5	50	96	Total Cost: $332,602/ Bioventing
Carey Avenue Site, Las Vegas, NV	• Groundwater • The affected site estimated 150 ft by 150 ft by 30 ft • Site contains approximately 1,500,000 gal of contaminated water	Pilot	NA/ Completed	• Process type: HiPOx, • HiPOx a continuous, in-line, pressurized advanced oxidation technology that uses hydrogen peroxide and ozone to create hydroxyl radicals that oxidize VOCs • Ozone and hydrogen peroxide are injected at mg/L levels into the contaminated water to be treated • The ozone is produced at 40 to 50 psig on-site from a solid state ozone generator • Pure oxygen is supplied to the ozone generator to yield high concentrations of ozone (6-10% weight in oxygen) • The injection of ozone takes place at various points along the treatment system's flow path in order to increase the effectiveness of the process and minimize by-product formation • The HiPOx unit used was a mobile unit configured with 18 reactors, each equipped with an ozone injector and a static mixer • 11 monitoring wells are installed on the site • The water flow rate for the test was 2.8 gpm • Groundwater was pumped from a well and then passed through the	50,000	20	<1	>99	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				HiPOx system five times in order to apply the total of 600 mg/L of ozone estimated to achieve the specified destruction of contaminants • Vendor: Applied Process Technology, Inc.					
Central Valley Gas Station, Turlock, CA	• Groundwater	Full	March 2002 – Present/ On-going (data through June 2002)	• Process type: HiPOx • HiPOx, a continuous, in-line, pressurized advanced oxidation technology that uses hydrogen peroxide and ozone to create hydroxyl radicals that oxidize VOCs • Ozone and hydrogen peroxide are injected at mg/L levels into the contaminated water to be treated • The ozone is produced at 40 to 50 psig on-site from a solid state ozone generator • Pure oxygen is supplied to the ozone generator to yield high concentrations of ozone (6-10 percent weight in oxygen) • The injection of ozone takes place at various points along the treatment system's flow path in order to increase the effectiveness of the process and minimize by-product formation. • Acetone is formed during the destruction of MTBE and BA and is reported to be detected at levels of up to 160 µg/L in the effluent of the HiPOx system • Site reported use of a bioreactor to remove the excess acetone from the HiPOx system effluent • Vendor: Applied Process Technology, Inc.	3,400	NA	<0.5	>99	NA
Chevron, CA – J,	• Groundwater	Full	NA/ On-going (data	• Process type: HiPOx	100,000	NA	<250	>99	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
Newark, CA	• Shallow aquifer		through June 2002)	• HiPOx, a continuous, in-line, pressurized advanced oxidation technology that uses hydrogen peroxide and ozone to create hydroxyl radicals that oxidize VOCs • Ozone and hydrogen peroxide are injected at mg/L levels into the contaminated water to be treated • The ozone is produced at 40 to 50 psig on-site from a solid-state ozone generator • Pure oxygen is supplied to the ozone generator to yield high concentrations of ozone (6-10 percent weight in oxygen) • The injection of ozone takes place at various points along the treatment system's flow path in order to increase the effectiveness of the process and minimize by-product formation • The HiPOx unit used at Newark, CA had a flow rate of 10 gpm with 5 ozone generators • The system is 8 ft by 17 ft • No information was provided about the groundwater extraction aspect of the cleanup • Vendor: Applied Process Technology, Inc.					
Christy Station, North Windham, ME	• Groundwater	Full	May - June 1998/ Completed	• Pump and treat consisted of 2 extraction wells operating at a combined 3 gpm treatment with shallow tray aeration followed by granular activated carbon • Vendor: NA	6,000	500	2	>99	Remediation Capital Cost: $60,000 O&M Cost: $11,000 (per month) Monitoring Cost: $8,000 (per month)/ No other technologies
Creek & Davidson, Site A: Service	• Groundwater • Less than 150 ft of coarse	Full	September 1980 - November 1985/	• Process type: air stripping/GAC polish	96	NA	NA	NA	Total Cost: $1,175,000 Total Capital Cost:

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
Station, NJ	sand and gravel with municipal wells nearby		Completed	• The remediation system used was pump and treat (800 gpm from 3 municipal supply wells) • The treatment system was initially GAC, but later changed to air stripping/GAC polish due to poor GAC performance • Vendor: NA					$575,000 O&M Cost: $120,000/ No other technologies
Creek & Davidson, Site B: Service Station, FL	• Groundwater • Fine sand	Full	January 1996 – Unknown/ On-going (data through June 2000)	• The remediation system used was pump and treat (8 gpm from one residential supply well) and air stripping • Vendor: NA	580	NA	NA	NA	Total Cost: $74,000 Total Capital Cost: $44,000 O&M Cost: $20,000/ No other technologies
Creek & Davidson, Site C: Service Station, FL	• Groundwater • 5 ft medium sand over limestone	Full	December 1993 – Unknown/ On-going (data through June 2000)	• The remediation system used was pump and treat (20 gpm with 3 recovery wells) with air stripping • Vendor: NA	130	NA	NA	NA	Total Cost: $137,500 Total Capital Cost: $50,000 O&M Cost: $25,000/ No other technologies
Creek & Davidson, Site E: Service Station, NJ	• Groundwater • 5 – 25 ft of silty clay over siltstone with private wells nearby	Full	May 1994 – Unknown/ On-going (data through June 2000)	• Process type: Pump and treat and GAC • The remediation system used was pump and treat (2 gpm with 5 recovery wells) • The treatment system was granular activated carbon (2 vessels in series) • Vendor: NA	1,200	NA	NA	NA	Total Cost: $180,000 Total Capital Cost: $90,000 O&M Cost: $40,000/ No other technologies
Creek & Davidson, Site F: Service Station, NJ	• Groundwater • 15 ft of silty clay over medium sand	Full	August 1993 - February 1996/ Completed	• Process type: GAC and AOP • The remediation system used was pump and treat (10 gpm with 3 recovery wells) • Site reported sporadic operation of the system • The treatment system was initially GAC, however due to poor performance it was changed to AOP • Vendor: NA	1,610	NA	NA	NA	Total Capital Cost: $230,000 O&M Cost: $430,000/ No other technologies
Ed's Auto Body, Lake Tahoe, CA	• Groundwater • Reported size of MTBE	Full	March 1999 - February 2000/ On-	• Process type: Pump and treat with GAC	110	NA	35	68	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
	plume was 80 ft by 40 ft by 25 ft		going (data through April 2000)	• Remediation at this site consisted of contaminated groundwater pumped out and treated with granular activated carbon • Vendor: NA					
Fox Gas Station, Lake Tahoe, CA	• Groundwater	Full	October 1998 - March 2000/ On-going (data through April 2000)	• Process type: Pump and treat with GAC • Remediation at this site consisted of contaminated groundwater pumped out and treated with GAC • There are SVE and air sparging systems at the site which have been deactivated • Vendor: NA	460	NA	20	96	NA
Kinder Morgan Energy Partners Site, Sparks, NV	• Groundwater • Contamination resulted from a leaking fuel pipeline	Full	October 1999 - February 2002/ Completed	• Process type: HiPOx • HiPOx, a continuous, in-line, pressurized advanced oxidation technology that uses hydrogen peroxide and ozone to create hydroxyl radicals that oxidize VOCs • Ozone and hydrogen peroxide are injected at mg/L levels into the contaminated water to be treated • The ozone is produced at 40 to 50 psig on-site from a solid state ozone generator • Site reported use of 4 ozone generators • Pure oxygen is supplied to the ozone generator to yield high concentrations of ozone (6-10 percent weight in oxygen) • The injection of ozone takes place at various points along the treatment system's flow path in order to increase the effectiveness of the process and minimize by-product formation • Site reported use of a full scale	4,000	100	<20	>99	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				HiPOx system with a flow rate of 40 gpm • The HiPOx unit has run without interruption 97.5% for 2 1/2years since operation began in 1999 • Vendor: Applied Process Technology, Inc.					
Marine Corps Air Station Military Base, Marine Corps Air Station Military Base, CA	• Groundwater	Full	February 2002 – Present/ On-going (data through June 2002)	• Process type: HiPOx • HiPOx, a continuous, in-line, at pressure, destructive advanced oxidation technology that uses hydrogen peroxide and ozone to create hydroxyl radicals that oxidize VOCs to carbon dioxide and water • Ozone and hydrogen peroxide are injected at mg/L levels into the contaminated water to be treated • The ozone is produced at 40 to 50 psig on-site from a solid state ozone generator • Pure oxygen is supplied to the ozone generator to yield high concentrations of ozone (6-10 percent weight in oxygen) • The injection of ozone takes place at various points along the treatment system's flow path in order to increase the effectiveness of the process and minimize by-product formation • Site reported use of a full scale 30 gpm unit that was expanded to operate at flow rates of 50 to 70 gpm and has been operating at 50 gpm since February 2002 • Vendor: Applied Process Technology, Inc.	35,400	13	1	>99	NA
NY 1-9513482, NY	• Groundwater	Full	NA/ On-going (data through May 2002)	• Process type: pump and treat • Vendor: NA	1,000	NA	49	95	Total Cost: $71,928/ No other technologies

Selected MtBE Treatment Projects

Source: www.clu-in.org/products/mtbe

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
Obexer's (Homewood Import), Lake Tahoe, CA	• Groundwater • Reported size of MTBE plume was 250 ft by 350 ft by 30 ft	Full	September 1997 - March 2000/ On-going (data through April 2000)	• Process type: groundwater extraction with GAC treatment of the contaminated water • The water was then reinjected through trenches • Vendor: NA	167	NA	26	84	NA
Saratoga Springs Site, Saratoga Springs, NY	• Groundwater	Pilot	1999 – Unknown/ On-going (data through December 2001)	• The system tested was an Electrochemical Peroxidation (ECP) process, which involves the use of H2O2 • Groundwater from the site was treated at a flow rate of 10 gpm over a 4 month period • Residual H2O2 was discharged into the recharge gallery, and the redox of the groundwater was modified to aerobic conditions allowing for the degradation of contaminants • Vendor: NA	NA	NA	NA	NA	NA
Service Station, CA – F, Newport Beach, CA	• Groundwater	Full	1995 – 2000/ Completed	• Process type: Initially, the treatment train consisted of a pump and treat system and oxidation with ultraviolet light and hydrogen peroxide, then remediation system was modified to replace the UV/peroxide with the HYDROX process (hydraulically induced cavitation) • The system processed and reinjected water at up to 12 gpm • The HYDROX process is an advanced oxidation technology that produces hydroxyl radicals through hydrodynamics • Vendor: Oxidation Systems Inc.	300	NA	ND	NA	NA
Site CA – BB, Healdsburg, CA	• Groundwater	Pilot	Summer 1999 – Present/ On-going (data through 2000)	• Process type: Initially, the treatment train consisted of a pump and treat system and oxidation with ultraviolet light and hydrogen peroxide, then remediation system was modified to	NA	NA	NA	NA	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				replace the UV/peroxide with the HYDROX process (hydraulically induced cavitation) • The system processed and reinjected water at up to 12 gpm • The HYDROX process is an advanced oxidation technology that produces hydroxyl radicals through hydrodynamics • Vendor: NA					
Site CA – G, CA	• Groundwater	Pilot	One year/ Completed	• Process type: Fluidized Bed Bioreactor • The system that was tested was a pilot scale Fluidized Bed Bioreactor for treatment of extracted groundwater • The bioreactor treated MTBE contaminated groundwater that also contained significant amounts of gasoline hydrocarbons and ferrous iron • Vendor: NA	NA	NA	NA	NA	NA
Site CA – M, San Diego, CA	• Groundwater	Full	NA/ On-going (data through June 2002)	• Process type: HiPOx • HiPOx, a continuous, in-line, pressurized advanced oxidation technology that uses hydrogen peroxide and ozone to create hydroxyl radicals that oxidize VOCs • Ozone and hydrogen peroxide are injected at mg/L levels into the contaminated water to be treated • The ozone is produced at 40 to 50 psig on-site from a solid state ozone generator • Pure oxygen is supplied to the ozone generator to yield high concentrations of ozone (6-10 percent weight in oxygen) • The injection of ozone takes place at	8,600	NA	<5	>99	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				various points along the treatment system's flow path in order to increase the effectiveness of the process and minimize by-product formation • Site reported use of a full scale HiPOx system with a flow rate of 10 gpm • Site treats tank farm draw down and process wastewater • Vendor: Applied Process Technology, Inc.					
Site CA – N, Chico, CA	• Groundwater	Pilot	NA/ On-going (data through June 2002)	• Process type: HiPOx • HiPOx, a continuous, in-line, pressurized advanced oxidation technology that uses hydrogen peroxide and ozone to create hydroxyl radicals that oxidize VOCs • Ozone and hydrogen peroxide are injected at mg/L levels into the contaminated water to be treated • The ozone is produced at 40 to 50 psig on-site from a solid state ozone generator • Pure oxygen is supplied to the ozone generator to yield high concentrations of ozone (6-10 percent weight in oxygen) • The injection of ozone takes place at various points along the treatment system's flow path in order to increase the effectiveness of the process and minimize by-product formation • Site reported use of a field evaluation HiPOx system with a flow rate of 1 gpm • Site treated tank farm draw down and process wastewater in an industrial	660,000	NA	2.3	>99	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				application • Vendor: Applied Process Technology, Inc.					
Site CA – O, Vacaville, CA	• Groundwater	Pilot	NA/ On-going (data through June 2002)	• Process type: HiPOx • HiPOx, a continuous, in-line, pressurized advanced oxidation technology that uses hydrogen peroxide and ozone to create hydroxyl radicals that oxidize VOCs • Ozone and hydrogen peroxide are injected at mg/L levels into the contaminated water to be treated • The ozone is produced at 40 to 50 psig on-site from a solid state ozone generator • Pure oxygen is supplied to the ozone generator to yield high concentrations of ozone (6-10 percent weight in oxygen) • The injection of ozone takes place at various points along the treatment system's flow path in order to increase the effectiveness of the process and minimize by-product formation • Site reported use of a field evaluation HiPOx system with a flow rate of 10 gpm of groundwater • Vendor: Applied Process Technology, Inc.	26,000	NA	<0.5	>99	NA
Site CA – P, Ripon, CA	• Groundwater	Pilot	NA/ On-going (data through June 2002)	• Process type: HiPOx • HiPOx, a continuous, in-line, pressurized advanced oxidation technology that uses hydrogen peroxide and ozone to create hydroxyl radicals that oxidize VOCs • Ozone and hydrogen peroxide are injected at mg/L levels into the contaminated water to be treated	8,840	NA	<5	>99	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				• The ozone is produced at 40 to 50 psig on-site from a solid state ozone generator • Pure oxygen is supplied to the ozone generator to yield high concentrations of ozone (6-10 percent weight in oxygen) • The injection of ozone takes place at various points along the treatment system's flow path in order to increase the effectiveness of the process and minimize by-product formation • Site reported use of a field evaluation HiPOx system with a flow rate of 10 gpm of groundwater • Vendor: Applied Process Technology, Inc.					
Site CA – Q, Truckee, CA	• Groundwater	Pilot	NA/ On-going (data through June 2002)	• Process type: HiPOx • HiPOx, a continuous, in-line, pressurized advanced oxidation technology that uses hydrogen peroxide and ozone to create hydroxyl radicals that oxidize VOCs • Ozone and hydrogen peroxide are injected at mg/L levels into the contaminated water to be treated • The ozone is produced at 40 to 50 psig on-site from a solid-state ozone generator • Pure oxygen is supplied to the ozone generator to yield high concentrations of ozone (6-10 percent weight in oxygen) • The injection of ozone takes place at various points along the treatment system's flow path in order to increase the effectiveness of the process and minimize by-product	5,100	NA	<0.5	>99	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				formation • Site reported use of a field evaluation HiPOx system with a flow rate of 10 gallons per minute; the HiPOx system was used as a replacement for the existing granular activated carbon/air stripper system • Vendor: Applied Process Technology, Inc.					
Site CA – R, Cambria, CA	• Groundwater	Pilot	NA/ On-going (data through June 2002)	• The treatment system is HiPOx, a continuous, in-line, pressurized advanced oxidation technology that uses hydrogen peroxide and ozone to create hydroxyl radicals that oxidize VOCs. Ozone and hydrogen peroxide are injected at mg/L levels into the contaminated water to be treated • The ozone is produced at 40 to 50 psig on-site from a solid state ozone generator • Pure oxygen is supplied to the ozone generator to yield high concentrations of ozone (6-10 percent weight in oxygen) • The injection of ozone takes place at various points along the treatment system's flow path in order to increase the effectiveness of the process and minimize by-product formation • Site reported use of a field evaluation HiPOx system with a flow rate of 10 gpm • Vendor: Applied Process Technology, Inc.	300	NA	<0.5	>99	NA
Site CA – S, Modesto, CA	• Groundwater	Pilot	NA/ On-going (data through June 2002)	• Process type: HiPOx • HiPOx, a continuous, in-line, pressurized advanced oxidation	170,000	NA	<0.5	>99	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				technology that uses hydrogen peroxide and ozone to create hydroxyl radicals that oxidize VOCs • Ozone and hydrogen peroxide are injected at mg/L levels into the contaminated water to be treated • The ozone is produced at 40 to 50 psig on-site from a solid state ozone generator • Pure oxygen is supplied to the ozone generator to yield high concentrations of ozone (6-10 percent weight in oxygen) • The injection of ozone takes place at various points along the treatment system's flow path in order to increase the effectiveness of the process and minimize by-product formation • Site reported use of a field evaluation HiPOx system with a flow rate of 10 gpm • Vendor: Applied Process Technology, Inc.					
Site CA – U, Vacaville, CA	• Groundwater	Full	NA/ On-going (data through June 2002)	• Process type: Groundwater pump and treat with air stripping using carbon adsorption or granular activated carbon (GAC) • The air stripper is a shallow tray air stripper with flow rates of 600 cfm and an estimated VOC removal rate of 2.05 lbs/hour • Vendor: North East Environmental Products, Inc.	210,000	<13	NA	NA	Capital Cost: $111,352 O&M Cost: $21,000/ No other technologies
Site CA – V, El Segundo, CA	• Groundwater • Quantity of media treated: 30 gal	Pilot	NA/ Completed	• Process type: Patented CAV-OX cavitation oxidation process • CAV-OX used hydrodynamic cavitation, ultraviolet radiation, and hydrogen peroxide to oxidize organic	3,700 - 8,000	NA	68		NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				compounds in water • The end products are water, carbon dioxide, halides, and in some cases, organic acids • In the process, a cavitation chamber induces hydrodynamic cavitation, which occurs when a liquid undergoes a dynamic pressure reduction while under constant temperature • The pressure reduction causes gas bubbles to explosively develop, grow, and then collapse • Cavitation decomposes water into extremely reactive hydrogen atoms and hydroxyl radicals, which recombine to form hydrogen peroxide and molecular hydrogen • The process uses mercury vapor lamps to generate the UV radiation • The principal oxidants in the process, hydroxyl and hydroperoxyl radicals are produced by hydrodynamic cavitation and direct photolysis of hydrogen peroxide at UV wavelengths • The remediation conducted used the CAV-OX II High Energy Pilot System and the CAV-OX Low Energy Pilot System • MTBE was mixed into 30 gal of Santa Monica, CA city water in order to determine if CAV-OX was a potential solution for further remediation in the city of Santa Monica • 60 ppm of hydrogen peroxide was added to the water before the test was begun					

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				• Vendor: Magnum Water Technology					
Site IL – A, East Alton, IL	• Groundwater	Full	NA/ On-going (data through June 2001)	• Process type: pump and treat system, with air stripping • Vendor: NA	100	NA	NA	NA	Total Cost: $1,200,000 Monitoring Cost: $300,000/ No other technologies
Site IL – B, Island Lake, IL	• Groundwater	Full	NA/ On-going (data through June 2001)	• The remediation system used was a pump and treat system, with air stripping • Vendor: NA	100	NA	NA	NA	Total Cost: $750,000 Monitoring Cost: $188,000/ No other technologies
Site ME – B, Fryeburg, ME	• Groundwater and soil • Bedrock	Full	NA/ On-going (data through January 2002)	• Remediation consisted of silt removal and a pump and treat system. Treatment also consisted of well replacement by extending the wells to another water system (aquifer) • Vendor: NA	NA	NA	NA	NA	Total Cost: $721,000 O&M Cost: $568,000 / Excavation
Site ME – C, Limington, ME	• Groundwater	Full	NA/ On-going (data through January 2002)	• Process type: pump and treat system. The system was installed at the point of entry • Vendor: NA	NA	NA	NA	NA	Total Cost: $590,000 Capital Cost: $10,000 O&M Cost: $130,000 Monitoring Cost: $120,000/ No other technologies
Site ME – D, Standish, ME	• Groundwater and soil • Bedrock: sandy glacial till consisting of coarse sand and large boulders • Seven to twelve gallons of spilled reformulated gasoline. Site reported contamination of 24 residential wells • Removal of 80 cubic yards of contaminated soil, leaving a small amount under the road in order to avoid road collapse	Full	December 1997 - December 1999/ On-going (data through January 2002)	• Process type: soil removal and pumping by point-of-entry filtration (activated carbon) on affected households • Pumping 24 private wells at a normal household usage (probably 200 gallons per day per well) for one year while efforts to extend a water main took place. • Vendor: NA	6,500	NA	25	>99	NA/ Excavation
Site ME – E,	• Groundwater	Full	NA/ On-going (data	• Process type: pump and treat system	NA	NA	NA	NA	Total Cost: $1,096,000/

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
Windham, ME	• Site reported two public water supply wells impacted		through January 2002)	• Vendor: NA					No other technologies
Site NV – A, NV	• Groundwater • Quantity of media treated: 20,000,000 gal	Full	October 1999 – Present/ On-going (data through June 2001)	• Process type: The Applied Process Technology (APT) line-pressure advanced oxidation process, HiPOx was used to reduce the concentration of MTBE after extraction and before being fed to the bio-reactor • Remediation at this site consisted of 30 groundwater extraction wells and an above ground bioreactor • The HiPOx process oxidizes organics using a combination of ozone and peroxide • The ozone is injected at line pressure of 30 to 40 psig resulting in very rapid and stoichiometric utilization of the ozone in the destruction of MTBE. A 40-gpm HiPOx unit was built and is currently in operation at the site • Vendor: Applied Process Technology	4,000	100	30	99	NA
Site NY – D, Riverhead, NY	• Groundwater	Full	March 1996 - November 1997/ Completed	• Site reported use of nine extraction and six injection wells; treatment performed in a 4 in x 30 in packed air stripping column • Vendor: NA	1,800	50	23	98	Total Cost: $500,000/ No other technologies
South Y Shell, Lake Tahoe, CA	• Groundwater • Reported size of MTBE plume was 450 ft by 250 ft by 100 ft	Full	November 1998 - January 2000/ On-going (data through April 2000)	• Remediation consisted of groundwater extraction with granular activated carbon treatment of the contaminated water • Vendor: NA	65,500	NA	21,600	67	NA
Swissmart Gas Station, Lake Tahoe, CA	• Groundwater • Reported size of MTBE plume was 200 ft by 80 ft by 60 ft	Full	December 1998 - December 1999/ On-going (data through April 2000)	• Remediation at this site consisted of a groundwater pump and treat system. The groundwater was treated with granular activated carbon and resin	70,000	NA	27,000	61	NA

Selected MtBE Treatment Projects Source: www.clu-in.org/products/mtbe

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				• Vendor: NA					
Tahoe Asphalt, Lake Tahoe, CA	• Groundwater and soil	Full	April 1998 - December 1999/ Completed	• Remediation consisted of soil excavation and contaminated groundwater pumped out and treated with granular activated carbon • Vendor: NA	NA	NA	1	NA	NA/ Excavation
Tahoe Keys Marina, Lake Tahoe, CA	• Groundwater • Reported size of MTBE plume was 20 ft by 20 ft by 15 ft	Full	October 1998 - March 2000/ On-going (data through April 2000)	• Remediation at this site consisted of contaminated groundwater pumped out and treated with granular activated carbon • Vendor: NA	2,300	NA	2.9	>99	NA
Unocal Station, Lake Tahoe, CA	• Groundwater • Reported size of MTBE plume was 100 ft by 50 ft by 16 ft	Full	December 1999 - February 2000/ On-going (data through April 2000)	• The remediation system used was a pump and treat system • Vendor: NA	53	NA	75	increase	NA
Whitefield Elementary School, ME	• Groundwater and soil	Full	NA/ On-going	• Remediation consisted of soil removal and a pump and treat system • Vendor: NA	NA	NA	NA	NA	Total Cost: $200,000 Monitoring Cost: $20,000 / Excavation
Whoa Tavern, Keno, OR	• Groundwater	Full	NA/ Completed	• Process type: HiPOx • HiPOx, a continuous, in-line, pressurized advanced oxidation technology that uses hydrogen peroxide and ozone to create hydroxyl radicals that oxidize VOCs • Ozone and hydrogen peroxide are injected at mg/L levels into the contaminated water to be treated. The ozone is produced at 40 to 50 psig on-site from a solid state ozone generator • Pure oxygen is supplied to the ozone generator to yield high concentrations of ozone (6-10 percent weight in oxygen) • The injection of ozone takes place at various points along the treatment system's flow path in order to increase the effectiveness of the process and minimize by-product	33.8	20	<0.26	99	NA

Selected MtBE Treatment Projects Source: www.clu-in.org/products/mtbe

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				formation • The HiPOx unit used was a truck-mounted unit configured with 18 reactors, each equipped with an ozone injector and a half-inch, four-element, static mixer • An on-board ozone generator supplied the ozone for the required injection; the generator consumes bottled oxygen and can generate up to 10% ozone by weight • Two tests (Test 1 & 2) were completed at the site on April 23, 2002 • Ozone dosing during Test 1 was 13.9 ppm and the hydrogen peroxide to ozone mole ratio was 1.6 • Ozone dosing for Test 2 was 14.5 ppm, and the mole ratio was 2.8. The water flow rate for both tests was 3 gpm • Vendor: Applied Process Technology, Inc.					
Pump and Treat with Air Sparging Projects									
Amoco Petroleum Pipeline, Constantine, MI	• Groundwater • Approximately 10 to 29 ft of interbedded sand and gravel overlies a silty clay glacial till unit • Cobble size sediments and sandy silt deposits are found occasionally • Soil porosity is reported at 30-40% • Groundwater flow from the site is generally to the west and southwest, discharging to drainage ditches, a pond, and	Full	October 1988 – Present/ On-going (data through NA)	• Process type: GAC • The pump and treat system consists of 4 extraction wells installed in two phases (1988 and 1992) at depths up to 28 fbg with extraction rates of 50 and 100 gpm • Extracted water is treated with one 20,000 lb GAC vessel • The recovered free product is sent to storage in aboveground tanks • In addition, site reported use of air sparging (February 1994) using 30 two-inch diameter air sparging wells with 3 ft screens, all installed to depths of 25-30 ft, and the use of two	NA	380	NA	NA	Capital Cost: $672,000/ Air sparging

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
	ultimately the St. Joseph River • Hydraulic conductivity is 0.0002 - 0.0004 cm/sec • Depth to groundwater: 10 ft • An estimated 350,000 to 2 million gal of gasoline, fuel oil, and kerosene were released to the subsurface • Quantity treated: 775 million gal of groundwater			300 scfm blowers • Air sparging is performed at an airflow rate of between 10 and 30 scfm and a pressure of 12 lb/in² at each well • Site reported manual recovery of free product from monitoring wells in November of 1987 • 30 air sparging wells • Vendor: Residuals Management Technology, Inc.					
Chevron Service Station #90071, Lake Tahoe, CA	• Groundwater and soil • Reported size of MTBE plume was 200 ft by 150 ft by 15 ft	Full	December 1992 - May 1998/ Completed	• Process type: Contaminated groundwater pumped out and treated with GAC between 1992 – 1998 • Soil was excavated in 1998 • Air sparging wells were also put into place • Vendor: NA	11,000	NA	2,070	81	NA/ Excavation Air sparging
Meyers Beacon, Lake Tahoe, CA	• Groundwater • Reported size of MTBE plume was 1000 ft by 500 ft by 60 ft	Full	May 1998 - December 1999/ Completed	• Process type: Contaminated groundwater pumped out and treated with GAC followed by discharge to a reinjection trench • Air sparging was also performed at the site • Vendor: NA	1,200	NA	18	99	NA/ Air sparging
Moss Chevron, Lake Tahoe, CA	• Groundwater • Reported size of MTBE plume was 200 ft by 100 ft by 50 ft	Full	May 1999 - February 2000/ On-going (data through April 2000)	• Process type: Contaminated groundwater pumped out and treated with GAC • The site was also treated with air sparging wells • Vendor: NA	8,700	NA	8,700	0	NA/ Air sparging
Pump and Treat with Air Sparging and Soil Vapor Extraction Projects									
Exxon and Mobil Service Stations, Smithtown, NY	• Groundwater and soil	Full	April 2001 – Present/ On-going (data through	• Exxon and Mobil service station identified as separate sources. At Exxon Station: Initially removed >	150,000	NA	NA	NA	NA/ Air sparging with SVE

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
			September 2001)	4,000 yd³ of contaminated soil, and used pump and treat for on-site contamination • Shut off pump and treat, and replaced with air sparging to treat groundwater both on and off-site • SVE/air sparge system 300 cfm • At Mobil station: On-Site pump and treat system (currently shut down awaiting modifications for TBA treatment) • Vendor: Geological Services Corp.					
E-Z Serve #8639, Spartanburg, SC	• Groundwater and soil	Full	NA/ On-going (data through January 2002)	• Process type: air sparging with vapor extraction and groundwater pumping • Vendor: NA	36	NA	NA	NA	Total Costs: $380,000/ Air sparging with SVE
Gate #311, Cheraw, SC	• Groundwater and soil	Full	NA/ On-going (data through January 2002)	• Process type: air sparging with vapor extraction, and groundwater pumping • Vendor: NA	5,111	NA	NA	NA	Total Cost: $184,250/ Air sparging with SVE
Green Sea Grocery, Green Sea, SC	• Groundwater and soil	Full	NA/ On-going (data through January 2002)	• Process type: air sparging with vapor extraction, a groundwater pump and treat system, and free product recovery • Vendor: NA	15	NA	NA	NA	Total Cost: $327,000/ Air sparging with SVE
Kansas U1-029-230, Dodge City, KS	• Groundwater and soil • 0-23' silt • 23-50' sand	Full	1995 - January 2001/ Completed	• 21 air sparging wells • 11 SVE wells	15	NA	NA	NA	NA/ Air sparging with SVE
Kansas U6-005-00268, Great Bend, KS	• Groundwater and soil • 1-8 clay • 8-27 sand • 27-48 clay • Depth to groundwater: 10 ft	Full	November 1994 - January 1998/ Completed	• 7 air sparging well • 8 SVE wells • Vendor: NA	390	NA	4.8	>98	NA/ Air sparging with SVE
Morris Variety Shop, Bluffton, SC	• Groundwater and soil	Full	NA/ On-going (data through January 2002)	• Process type: air sparging, vapor extraction, and groundwater pumping • Vendor: NA	33	NA	NA	NA	Total Cost: $435,000
NY 1-8504473, NY	• Groundwater and soil	Full	NA/ On-going (data through May 2002)	• Process type: pump and treat, air sparging with SVE, soil excavation, and natural attenuation	22,000	NA	1,600	93	Total Cost: $567,136/ • Excavation

Selected MtBE Treatment Projects

Source: www.clu-in.org/products/mtbe

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				• Vendor: NA					• Natural attenuation • Air sparging with SVE
NY 1-8910209, NY	• Groundwater and soil	Full	NA/ On-going (data through May 2002)	• Process type: air sparging with SVE, pump and treat, soil excavation, and natural attenuation. • Vendor: NA	9,999	NA	8	>99	Total Cost: $96,350/ Excavation Natural attenuation Air sparging with SVE
NY 1-9003951, NY	• Groundwater and soil	Full	NA/ On-going (data through May 2002)	• Process type: air sparging with SVE, pump and treat, soil excavation, and natural attenuation. • Vendor: NA	7,900	NA	ND	>99	Total Cost: $410,616/ Excavation Natural attenuation Air sparging with SVE
Perfection Connection, Lake Tahoe, CA	• Groundwater and soil • Reported size of MTBE plume was 100 ft by 60 ft by 20 ft	Full	October 1991 - November 1995/ Completed	• Process type: first excavation and aeration of the soil, followed by air sparging, SVE, and pump and treat with GAC • Vendor: NA	5	NA	2	60	NA/ Air sparging with SVE
Pit Stop Service Station, Baldwin, NY	• Groundwater and soil • Plume length extends from the station to a point approximately 300 ft south of the station	Full	1996 – Present/ On-going (data through September 2001)	• Two technologies, in situ SVE/air sparge system (300 cfm) with catalytic oxidizer for emissions treatment and an ex situ groundwater pump and treat system (2 recovery wells pumping at a combined flow rate of 30 gpm and a shallow air stripper with carbon for emissions treatment • Vendor: J.N.M Environmental Inc.	NA	NA	NA	NA	NA/ Air sparging with SVE
SaveWay #2, Hartsville, SC	• Groundwater and soil	Full	NA/ On-going (data through January 2002)	• Air sparging with vapor extraction, and groundwater pumping • Vendor: NA	270	NA	NA	NA	Total Cost: $284,178/ Air sparging with SVE
Scotchman #171, North Charleston, SC	• Groundwater and soil	Full	NA/ On-going (data through January 2002)	• Air sparging with vapor extraction, and groundwater pumping • Vendor: NA	2	NA	NA	NA	Total Cost: $300,000/ Air sparging with SVE
Service Station MA – E, Palmer, MA	• Groundwater and soil • 15 - 20 ft of sand and gravel over 70 - 80 ft of interbedded fine sand and silt • Bedrock is found at 90 -	Full	1996 – 1997/ Completed	• Site reported that no action was taken until 2 months after the initial gasoline spill in 1989 • The initial effort included the installation of three recovery wells to capture and remove the floating	NA	NA	NA	NA	NA/ Air sparging with SVE

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
	150 ft bgs • Depth to groundwater: 25 ft • Site reported a release of 12,000 gal of gasoline from an underground storage tank. • Shallow and deep groundwater contamination with floating product was reported • Also, site reported a downgradient groundwater plume from another source			product • The remediation system installed was a SVE system and passive aquifer oxygenation system • A fourth recovery well was installed to capture groundwater from the down gradient property • Four additional wells were installed to intercept the plume • Vendor: NA					
Service Station, MA – B, Cape Cod, MA	• Groundwater and soil • Five feet of fill over fine to coarse sand • Depth to groundwater: 7 ft	Full	August 1990 - October 1996/ Completed	• Pump and treat system • The contaminant was treated by air stripping, then later by two 2,000# carbon canisters • Effluent water was sent to an on-site recharge and then to a town storm sewer • Also, SVE (off gas treatment via two 200# carbon canisters), and air sparging were performed • 5 air sparging wells • 5 SVE wells • Vendor: NA	2,600	70	3	>99	NA/ Air sparging with SVE
Tahoe Tom's, Lake Tahoe, CA	• Groundwater • Reported size of MTBE plume was 700 ft by 500 ft by 50 ft	Full	September 1998 - January 2000/ On-going (data through April 2000)	• Groundwater pumped through a heated air stripper, with granular activated carbon polishing • This site also used air sparging and SVE wells • Vendor: NA	52,100	NA	760,000	Increase	NA/ Air sparging with SVE
USA Petroleum, Lake Tahoe, CA	• Groundwater	Full	November 1997 – Present/ On-going (data through	• Source area treated using air sparging and SVE followed by granular activated carbon	31,000	NA	270	99	NA/ Air sparging with SVE

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
			March 2001)	• Site reported use of two GAC pump and treat systems used to remediate the MTBE plume • Vendor: NA					
Pump and Treat with Soil Vapor Extraction Projects									
Creek & Davidson, Site H: 275 Gallon UST, VT	• Groundwater and soil • Five to fifteen feet of sandy soils with private wells nearby	Full	August 1994 - June 1996/ On-going (data through June 2000)	• Process type: Source Treatment and Dissolved Phase Treatment • Number of SVE wells: 1 • The remediation system used was a pump and treat system (3 gpm with 1 recovery well) and SVE (100 cfm with 1 vapor recovery well) • Vendor: NA	2,720	NA	NA	NA	Total Cost: $212,000 Capital Cost: $166,500 O&M Cost: $28,000/ SVE
Creek & Davidson, Site I: Service Station, MA	• Groundwater and soil • Five to twelve feet of sand and gravel with private wells nearby	Full	October 1995 - October 1996/On-going (data through June 2000)	• Number of SVE wells: 3 • The remediation system used was a pump and treat system (5 gpm) and SVE (120 cfm with 3 vapor recovery wells). The treatment system consisted of granular activated carbon for pump and treat and catalytic oxidation for SVE. • Vendor: NA	5,000	NA	NA	NA	Total Cost: $160,000 Capital Cost: $80,000 O&M Cost: $80,000/ SVE
Creek & Davidson, Site J: Service Station, MA	• Groundwater and soil • Ten to eighteen feet of sand and gravel	Full	June 1990 - August 1996/On-going (data through June 2000)	• Remediation consisted of pump and treat with GAC, and SVE • Number of SVE wells: 3 • The remediation system used was a pump and treat system (2 gpm with 1 recovery well) SVE (100 cfm with 3 recovery wells) • Both treatment systems used GAC • The site reported that the pump and treat system was initially changed to air stripping, but changed back to GAC • The site also reported that the SVE system used GAC and a catalytic oxidation alternately • The site reported closure for the	34,440	NA	NA	NA	Total Cost: $624,000 Capital Cost: $430,000 O&M Costs: $33,000/ SVE

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				SVE, but not for the pump and treat system • Vendor: NA					
Creek & Davidson, Site K: Service Station, NJ	• Groundwater and soil • Silt/sand over sand/gravel with municipal and private wells nearby	Full	November 1991 - August 1996/On-going (data through June 2000)	• Remediation consisted of a pump and treat system (0.5 gpm with 4 recovery wells) and SVE (100 cfm with 7 vapor extraction wells) • Site reported use of air stripping with GAC polish with the pump and treat system • Number of SVE wells: 7 • Site reported catalytic oxidation for SVE off-gas • Vendor: NA	56,000	NA	NA	NA	Total Cost: $339,000 Capital Cost: $130,000 O&M Cost: $36,000/ SVE
Creek & Davidson, Site L: UST Service Station, MA	• Groundwater and soil	Full	November 1991 - August 1996/On-going (data through June 2000)	• The remediation system used was a pump and treat system (21 gpm with 1 recovery well), SVE (60 cfm with 4 recovery wells) system, and air sparging (7-18 cfm with 7 sparge wells) • Number of SVE wells: 4 • Number of air sparging wells: 7 • The site reported that GAC was used initially with the pump and treat system, but was changed to air stripping/GAC polish • Site reported that the SVE system used catalytic oxidation and a stripper for off-gas • Vendor: NA	2,290	NA	NA	NA	Total Cost: $216,000 Capital Cost: $150,000 O&M Cost: $33,000/ SVE
Delta Service Station, Lindenhurst, NY	• Groundwater and soil • Area of contamination: Extending from the station to a point approximately 3,900 ft south-southwest of the station • The impacted soil zone is	Full	NA/On-going (data through September 2001)	• Remediation consisted of SVE system with catalytic oxidizer for emissions treatment (200 cfm) and a groundwater pump and treat system (3 recovery wells pumping at 30 gpm each with a 4' x 36' air stripper) • Vendor: Environmental Assessment and Remediation	> 10,000	NA	NA	NA	NA/ SVE

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
	approximately 50'W x 2,000'L x 6-8'thick (dissolved MTBE plume approximately 300" W x 5,000'L)								
Kansas U1-029-342, Dodge City, KS	• Groundwater and soil • 0-23 silt • 23-45 sand	Full	1993 – 1998/Completed	• Type of pump and treat configuration not provided • Number of SVE wells: 5 • Vendor: NA	NA	NA	NA	NA	NA/ SVE
Kansas U6-005-402, Great Bend, KS	• Groundwater and soil • 0 - 2 sand/clay • 2- 12 f/m sand • 12-20 sand/gravel • Depth to water: 10 ft	Full	February 1994 - November 2000/On-going (data through July 20001	• Type of pump and treat configuration not provided • Number of SVE wells: 3 • Vendor: NA	79	NA	NA	NA	NA/ SVE
Kansas U6-026-390, Hays, KS	• Groundwater and soil • 1-40 silt/clay • 40-70 sand • Depth to water: 28 ft	Full	August 1996 – present/On-going (data through July 2001)	• Type of pump and treat configuration not provided • Number of SVE wells: 8 • Vendor: NA	<2,5000	NA	1,942	92	NA/ SVE
Milford Chevron, Milford, UT	• Groundwater and soil • Area of contamination: Groundwater plume is about 25 feet below grade, and is at least 220,000 square feet in size	Pilot	August 2001 – Present/On-going (data through July 2002)	• Remediation consists of groundwater pump and treat with reinjection, coupled with SVE. • An oil water separator was added to the treatment system once operation began. The site also reported removal of 40 tons of contaminated soil and hand-baled free product when contamination was initially discovered in 1991. Air sparging had been considered but not selected as a remedial technology for this site. • Vendor: NA	49,000	NA	NA	NA	NA/ SVE
NY 1-8300526, NY	• Groundwater and soil	Full	NA/On-going (data through May 2002)	• Remediation consists of SVE, pump and treat, and soil excavation. • Vendor: NA	120	NA	0	>99	Total Cost: $380,834/ SVE
Service Station, MO – A, Jerico Springs, MO	• Groundwater and soil • Approximately 7,000 tons of dirt was excavated for source control	Full	NA/On-going (data through October 2001)	• Remediation consists of residual contamination treatment using vapor extraction and pump and treat • Initially, groundwater was pumped	7762	NA	354	95	NA/ SVE Excavation

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
	• Sandy clay with sandstone at a depth of 17" to 20 ft bgs			out and treated with a standard oil/water separator, air stripper, and carbon activated filters • The system was later supplemented with a liquid/liquid separator and EC-300 organoclay/ carbon media • The influent first encounters a solid impedance and coalescing honeycomb pack • Water is sent over a diffuser plate, through a filter media, and into a second honeycomb pack • The water then goes over three flow directional weirs and is discharged • Vendor: Environmental Process Systems Inc.					
Service Station, NH – B, Somersworth, NH	• Groundwater and soil • 4 to 8 ft of sandy fill over 2 to 13 ft of till • Fractured bedrock at 10 to 15 ft bgs • The hydraulic gradient is 30ft/1,000 ft • Stratigraphy at the disposal site generally consists of sandy fill material overlying loose glacial • Depth to water: 15 ft • Area of contamination: The area of contamination extended across five separate properties totaling approximately 70,000 square feet • Quantity of media treated: 2,100 gal	Full	November 1996 – Present/On-going (data through May 2000)	• Remediation consisted of source control was performed by the removal of 3 underground storage tanks, 860 tons of soil, and 27,000 gal of groundwater with 158 lbs of hydrocarbons, SVE (SVE) and a pump and treat system were used to treat remaining contamination • 40 gallons of LNAPLs were recovered with skimmers in 3 wells, and 80 gal through manual bailing • The SVE system consisted of fifteen 4-in wells (11 vertical, 4 horizontal). The pump and treat system was screened to bedrock at approximately 7.5 gpm total • Groundwater was pumped through an oil/water separator, followed by an equalization tank, a particulate filter, and an air stripper • The air stripper (7HP, 1,000 scfm) treated an MTBE influent up to 1,670,000 µg/L and a BTEX influent	145,000	13	9,500	93	Total Cost: $590,000 Capital Cost: $240,000 O&M Cost: $60000 Monitoring Cost: $20,000/ SVE

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				up to 439,000 µg/L. • Number of SVE wells: 11 • Number of air sparging wells: 9 • Vendor: ENSR - System Design/Operation					
Site CA – T, Mammoth, CA	• Groundwater and soil	Full	NA/On-going (data through March 2000)	• Remediation consisted of SVE and groundwater pump and treat with granular activated carbon (GAC), air stripping with GAC off-gas treatment, and biologically activated carbon (BIO-GAC) • Groundwater is pumped out of the ground using 4 extraction wells with a total flow rate of 32 gpm • The water is pumped into a 2,500-gallon batch tank and then into a boiler tank to increase the temperature from 40 degrees F to 70 degrees F • Once the temperature is increased, the water is treated with BIO-GAC and a low profile air stripper, followed by GAC polishing • The air stripper has a maximum flow rate of 50 gpm and 2,400 ft^3/min max air flow rate. • Vendor: Malcolm Pirnie Inc.	333,000	NA	NA	NA	NA/ SVE
Pump and Treat with other Technologies Projects									
North Texas Service Station, TX	• Soil • Soil: Low permeability soils, which are dry most of the year • Area of contamination consists of: 7,052 gal of gasoline were released	Full	May 1999 - November 2000/ Completed	• The initial response was to recover the free phase product by a pump and treat system, resulted in pumping 32,207 gal of water and product from the tank pit and from the four in-place observation wells surrounding the tank hold in May 1999 • Following this, several more extraction events were conducted recovering a total of more than 50,000 gal of water from the tank	475,000	NA	68,400	86	Total Cost: $55,000 - 65,000/ In situ chemical oxidation

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				hold • Due to the projected expense and time frame of recovery, the pump and treat system was stopped and in situ chemical oxidation using Fenton's reagent began • The delivery system injected low volumes of liquid amendments at high pressure, using a "lance" • The "lance" allowed the delivery of the amendments without the need for injection wells and created micro fractures in the soil • A total of 37 drums of 33% hydrogen peroxide were injected into the tank hold for a total of about 2,000 gal • 220 gal of ferrous sulfate (12% concentration) were injected prior to the peroxide addition • The injector pressure at the nozzle was estimated to be 3,500 psi • Vendor: URS Corporation and Hill Liebert, Inc.					
NY 1-8900312, NY	• Groundwater and soil	Full	NA/ On-going (data through May 2002)	• Process type: air sparging with SVE, pump and treat, and soil bioremediation. • Vendor: NA	4,000	NA	567	86	Total Cost: $99/ Bioremediation
Shell Service Station, Tahoe City, CA	• Groundwater • Reported size of MTBE plume was 200 ft by 300 ft by 20 ft	Full	April 1999 - March 2000/ On-going (data through April 2000)	• Remediation at this site consisted of in situ bioremediation in April 1999, followed by groundwater extraction and treatment with granular activated carbon in October 1999 • Vendor: NA	22,300	NA	8,500	62	NA/ In situ bioremediation
Site TX – C, Houston, TX	• Groundwater • The MTBE plume was 20 m wide, 100 m long • Area treated: 1.7 acres	Pilot	1998 – Present/ On-going (data through September 2001)	• The contaminant plume is currently being captured by a pump and treat system, and a field study was conducted using phytoremediation with poplar trees • Hybrid poplar trees (DN-34, NE-19;	46.7	NA	NA	NA	NA/ Phytoremediation

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				Hramor Nursery, Manistee, MI) were planted at the site in February 1998 over approximately 1.7 acres • The trees were planted with 6 ft centers spaced 8 ft between staggered rows to maximize the rate of canopy of development • The hybrid poplars were planted in deep-drilled 1 ft diameter holes that penetrated the clay to the sandy aquifer material • Poplar whips were planted 6-9 ft bgs with 0.5-1 ft of whip exposed above ground • The main backfilling material included a fertilizer-amended mixture of 60% sand and 40% mulch • Vendor: Equilon Enterprises, LLC					
Drinking Water Treatment Projects									
Atwood Public Water, Atwood, KS	• Drinking Water	Full	NA/On-going (data through May 2002)	• Remediation consists of two 10,000 lb granular activate carbon vessels using coconut shell carbon • System design includes using two vessels from an existing site, relining the vessels with NSF coating and installing • Vendor: NA	50	ND	ND	NA	Remediation Capital: $180,000 O&M: $15,000/No other technologies
Charnock Wellfield, Los Angeles, CA	• Drinking Water	Pilot	July 1998 - January 2000/Completed	• Process type: Advanced oxidation process (AOP) and granular activated carbon (GAC) • The AOP system tested was a UV/peroxide unit followed by GAC units operated in either series or parallel • The tower consisted of 3 UV lamps operating at 23.5 kW; peroxide dosing to concentrations of 20-60 mg/L • Aerobic	1,000	13	3	>99	Remediation Capital: $3,000,000/ No other technologies

Selected MtBE Treatment Projects Source: www.clu-in.org/products/mtbe

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				• Vendor: NA					
City of Salina Public Water Well Supply, Salina, KS	• Drinking Water	Full	NA/On-going (data through May 2002)	• Process type: Dissolved phase treatment • Remediation consists of two packed tower air strippers at the water treatment facility • Vendor: NA	10	ND	ND	NA	NA
Gasoline Dispensing Facility, Bolton, MA	• Drinking Water and soil • Silty fine sand (likely fill) from 1 to 5 fbg, underlain by fine to coarse-grained sand with some gravel • Depth to fractured metamorphic bedrock ranged from 5 to greater than 20 fbg • Depth to groundwater: 16 ft • Overburden dissolved-phase groundwater impacts over an approximate area of 100 by 200 ft • Bedrock dissolved-phase groundwater impacts detected over an approximate area of 750 by 400 ft • Total amount of soil treated: 480 tons	Full	Over 5 years/On-going (data through August 2002)	• Process type: Source treatment and dissolved phase treatment • Soil: excavation and off-site asphalt-batch treatment. • Groundwater: carbon adsorption (two - 2 ft³ vessels connected in series) for seven impacted residential water supplies • Vendor: Aquatek Filtration & Pump Service, Inc.	39	<0.5	<0.5	99	Total Cost: $118,500 Remediation Capital: $10,500/ No other technologies
Hays Public Water, Hays, KS	• Drinking Water	Full	November 1999 – Present/On-going (data through May 2002)	• The remediation system is using shallow tray air strippers to pre-treat 3 recovery wells with xylene • 13 additional wells are treated using two packed tower air strippers • Vendor: NA	10	ND	ND	NA	NA
Manhattan Public Water, Manhattan,	• Drinking Water	Full	NA/Design Phase (data through May	• The system proposed is two 20,000 lb granular activated carbon vessels	15	ND	NA	NA	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
KS			2002)	to treat up to 5 wells • The system will use bituminous coal and will treat prior to the water softening process • Vendor: NA					
Manter Public Water, Manter, KS	• Drinking Water	Full	March 1998 – Present/On-going (data through May 2002)	• Remediation consists of two 10,000 lb granular activated carbon vessels that treat one well using bituminous coal • Vendor: NA	10	ND	ND	NA	Remediation Capital: $178,000 O&M: $7,500/ No other technologies
Moscow Public Water, Moscow, KS	• Drinking Water	Full	August 1998 – Present/On-going (data through May 2002)	• Remediation consists of two 10,000 lb granular activated carbon vessels treating one well using bituminous coal • Vendor: NA	NA	NA	NA	NA	NA
Oakley Public Water, Oakley, KS	• Drinking Water	Full	December 1997 – Present/On-going (data through May 2002)	• Remediation consists of two 10,000 lb granular activated carbon vessels treating one well using bituminous coal • One change out has been needed since startup on December 11, 2001 • Vendor: NA	NA	NA	NA	NA	Remediation Capital: $240,000 O&M: $15,000/ No other technologies
Park City Public Water, Park City, KS	• Drinking Water	Full	May 2000 – Present/On-going (data through May 2002)	• Process type: Dissolved phase treatment • Remediation consists of two 20,000 lb granular activated carbon vessels with treatment enclosure • The vessels treats up to 4 wells • The system was started using coconut shell carbon for the second supply • Vendor: NA	100	ND	ND	NA	Remediation Capital: $250,000 O&M: $12,000/ No other technologies
Public Water Well Supply, KS – C, Lacrosse, KS	• Drinking Water	Full	1997 – Present/On-going (data through March 2001)	• Remediation consists of two air stripping towers (33' tall, 6' diameter) operated in series, packed with 2 in Jaeger Tri-pack • Air to water ratio is 150:1 and design flow rate is 480 gpm for MTBE	340	10	<0.2	>99	Remediation Capital: $185,000 O&M: $30,000/ No other technologies

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				concentrations of up to 1,000 µg/L • Vendor: NA					
Public Water Well Supply, NJ – C, Rockaway, NJ	• Drinking Water • Unconsolidated glacial deposit • Depth to groundwater: 200 ft	Full	1980 – Present/On-going (data through March 2001)	• Process type: GAS and GAC • Remediation consists of air stripping followed by granular activated carbon • Treated water was collected in an aluminum clear well located under the column • Water was then pumped through the GAS system • Air stripper is a countercurrent packed column, 35 ft high and 9 ft diameter with a design capacity of 1,400 gpm and an air to water ratio of 200:1 • GAC system consists of two contractors operated in parallel, each 20 ft high and 10 ft diameter • Vendor: NA	35	NA	1	97	Remediation Capital: $575,000 O&M: $100,000/ No other technologies
Santa Monica Arcadia Wellfield, Los Angeles, CA	• Drinking Water	Pilot	1996 – Present/On-going (data through May 2002)	• Process type: Dissolved phase treatment • Site reported use groundwater pump and treat for shallow and lower aquifers and well head treatment for production (drinking supply) aquifer • Vendor: NA	33,000	0.5	0.5	>99	Total Cost: $4,000,000 Remediation Capital: $1,800,000 O&M: $400,000/ No other technologies
Satanta Public Water Supply, Satanta, KS	• Drinking Water	Full	March 1997 – Present/On-going (data through May 2002)	• Process type: Dissolved phase treatment • Remediation consists of two 10,000 lb granular activated carbon vessels that treat one public supply well with bituminous coal • Vendor: NA	NA	NA	NA	NA	Remediation Capital: $220,000 O&M: $15,000/ No other technologies
South Tahoe Public Utility District (STPUD) Water Utility, Lake Tahoe,	• Groundwater • High groundwater level aquifer in unconsolidated glacial and stream	Full	February 1997 – Unknown/On-going (data through June 2001)	• Process type: HiPOx • As of February 1997, STPUD water utility abandoned 18 of 34 production wells due to detected	NA	NA	NA	NA	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Pump and Treat	MTBE Concentration (µg/L))			MTBE % Reduction	Cost for Pump and Treat/Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
CA	deposits			MTBE plumes in several parts of the aquifer • Since the detection, the existing water distribution system was improved by placing a new well in the Gardner Mountain pressure zones, investigating potential sites for a new well, and purchasing an advanced oxidation package (HiPOx) treatment plant for an onsite well (Arrowhead well #3) • GAC is also being considered for other on-site wells • Vendor: NA					

Abbreviations:
bgs - below ground surface
cfm- cubic feet per minute
gpm - gallons per minute
NA - not available
ND - Not detected
M/yr – meters per year
ft/day – ft per day
lbs/day - pounds per day
scfm- standard cubic feet per minute
yd³ - cubic yards
g – grams
psi – pounds per square inch
psig – pounds per square inch, gauge
kg - kilograms
L - liter
ft - foot
ft² - square ft
ft³ – cubic ft
TD- total depth
ug/L - micrograms per liter

Table A-7. Summary of Operating and Performance Information for Selected Projects – Phytoremediation

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Phytoremediation	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Phytoremediation/ Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
Phytoremediation Only Projects									
Active Service Station, SC – A, Beaufort, SC	• Groundwater • Shallow aquifer • MTBE plume 100 ft wide, 700 ft long	Pilot	NA/On-going (data through Spring 2001)	• Investigation consisted of monitoring mature live oak trees growing around an active gasoline station that have an extensive network of roots that extend into the shallow contaminated aquifer near a leaking underground storage tank • Vendor: NA	10,000	NA	NA	NA	NA
Base Exchange Service Station, Vandenberg Air Force Base, Lompoc, CA	• Groundwater and soil • Perched groundwater system • Remediation consisted of excavating contaminated soil and leaking USTs from the site • Following excavation, an estimated 7,800 yd^3 of impacted soil was left in place that was affecting the groundwater	Full	NA/On-going (data through June 2001)	• Investigation consisted of groundwater balance and flow was impacted by existing mature eucalyptus trees surrounding the station, confirmed by sampling groundwater, rhizosphere soil gas, leaf, and tree core samples for contaminant uptake as an indirect consequence of root system water uptake • The impact of natural attenuation was modeled using kriging and linear trend comparisons • The impact of the trees was modeled using the mathematical model PlantX • Vendor: NA	NA	NA	NA	NA	NA/Natural attenuation, excavation
Constructed Wetland System, Casper, WY	• Groundwater	Pilot	June 2001 - December 2001/Completed	• A pilot scale subsurface flow wetland was constructed at the site to test if a constructed wetland could treat recovered groundwater • The system had four treatment cells packed with sand and operated in an upward vertical flow mode • Mean hydraulic retention time was approximately 1 day and the flow rate was reported at 4 gpm • Two of the cells were subjected to	1 - 1.6	0	0.8 - 1.2	77%	NA

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Phytoremediation	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Phytoremediation/ Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				forced subsurface aeration using coarse bubble aerators • For benzene, the aerial rate constant was 200 m/yr, which was increased by 50% by aeration • Vendor: Phytokinetics, Inc.					
Kansas State University, KS	• Soil	Bench	NA/Completed	• The study was performed using alfalfa plants dosed with MTBE in channels 110 cm x 60 cm • The experimental systems were channels, some with alfalfa plants growing in soil, others unplanted soil, which MTBE containing water flowed through • MTBE concentrations in the effluent water and gaseous MTBE flux measured at the soil surface were monitored throughout the experiment • Vendor: Kansas State University	NA	NA	NA	NA	NA
Leaking Underground Storage Tank, CA – A, CA	• Groundwater • The subsurface contains bay muds and silty clay that have low hydraulic conductivity	Pilot	NA/Completed	• The California EPA SWRB evaluated the transpiration of MTBE and TBA from a row of mature Monterey pine (Pinus radiata) trees, which were located down gradient from a LUST • Vendor: NA	NA	NA	NA	NA	NA
Site TX – C, Houston, TX	• Groundwater • Area of contamination consisted of MTBE plume was 20 m wide, 100 m long • Total quantity treated: 1.7 acres	Pilot	1998 – Present/On-going (data through September 2001)	• The contaminant plume is currently being captured by a pump and treat system, and a field study was conducted using phytoremediation with poplar trees • The trees were planted with 6 ft centers spaced 8 ft between staggered rows to maximize the rate of canopy of development • The hybrid poplars were planted in deep-drilled 1 ft diameter holes that penetrated the clay to the sandy	46.7	NA	NA	NA	NA/ Pump and treat

Site Name, Location*	Description of Media Treated	Scale	Period of Operation/Status	Key Operating Parameters for Phytoremediation	MTBE Concentration (µg/L)			MTBE % Reduction	Cost for Phytoremediation/ Other Technologies involved ***
					Initial	Cleanup Goal	Final**		
				aquifer material • Poplar whips were planted 6-9 ft bgs with 0.5-1 ft of whip exposed above ground • Vendor: Equilon Enterprises, LLC					
University of Colorado, CO	• Soil	Bench	One Week/Completed	• MTBE was added to the root zones of hybrid poplar saplings growing in individual hydroponic containers at concentrations of 300 and 1600 µg/L • Vendor: University of Colorado	NA	NA	NA	NA	NA
University of Washington, WA	• Soil	Bench	Two weeks/Completed	• Hybrid poplar and eucalyptus tree seedlings growing in columns were doused with MTBE at a concentration of 5 mg/L • Vendor: University of Washington	NA	NA	NA	NA	NA

Abbreviations:
gpm – gallons per minute
m/yr – meters per year
cm - centimeter
yd³ - cubic yards
µg/L – micrograms per liter
mg/L – milligrams per liter
ft – feet
bgs – below ground surface
m – meters