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FINAL MONTHLY ACTIVITIES REPORT MOBILE ENHANCED MULTI-PHASE EXTRACTION MILLINGTON SUPPACT TN

7/9/1999

BAT ASSOCIATES, INC.

MONTHLY ACTIVITIES REPORT

MOBILE ENHANCED MULTI-PHASE EXTRACTION (MEME) AT THE NAVAL EXCHANGE SERVICE STATION; NAVAL SUPPORT ACTIVITY MID-SOUTH, MILLINGTON, TENNESSEE

FACILITY I.D. No. 0-791718

FINAL July 9, 1999

Prepared by:

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BAT PROJECT NO. 983019

TABLE OF CONTENTS

1.3 MEME Technology Employed

BAT utilized Enhanced Fluid Recovery (EFR™), a mobile variation of what is commonly referred to as multi-phase extraction, dual-phase extraction, and vacuum enhanced recovery. This technology is a remediation method that utilizes high vacuum pressures and flow rates to remove multiple phase (i.e. vapor, absorbed, dissolved, and free phase) volatile organic compounds (VOCs) from the subsurface. It utilizes high vacuum and high flow rates simultaneously connected to monitoring or recovery wells.

The MEME simultaneously removes vapors, free product, and groundwater from the subsurface. It volatizes adsorbed and free phase VOCs through a process similar to soil vapor extraction, but with much higher vacuum and radius of influence. MEME can also treat adsorbed phase VOCs existing in the "smear zone" (i.e. the zone of seasonal or climatic groundwater fluctuation) that act as a source for dissolved phase VOCs. MEME dewaters and exposes the smear zone to the effects of 'high rate" soil vapor extraction. MEME also introduces oxygen to the vadose zone and saturated zones, thereby enhancing aerobic biodegradation.

2.0 SUMMARY OF RESULTS

This MEME is the eighth event that has been conducted at this site. Six previous events were conducted January 15-16, 1998 (initial event), January 29-30, 1998 (second event), January 19, 1999 (third event), February 10, 1999 (fourth event), March 15, 1999 (fifth event), April 15, 1999 (sixth event), and May 17, 1999 (seventh event).

Separate phase hydrocarbons (SPH) were not detected prior to, or upon completion of, conducting the June 18, 1999 MEME event. SPH has also not been detected during the previous seven MEME events. This MEME event was performed for a duration of eight hours at ten extraction points, consisting of the initial three hours at monitoring wells MEM-2, MEM-8, MEM-13, and MEM-14, the ensuing three hours at MEM-1, MEM-3, MEM-7, and MEM-12, and the final two hours at MEM-6 and B-3.

The first and second events were conducted over two days consisting of eight hours at wells MEM-1, MEM-2, MEM-3, MEM-7, MEM-8, MEM-12, MEM-13, and MEM-14 on the first day, and eight hours at wells MEM-6 and B3 on the second day. The third event was conducted for eight hours consisting of the initial six hours at monitoring well MEM-1, MEM-2, MEM-3, MEM-7, MEM-8, MEM-12, MEM-13, and MEM-14 and the final two hours at MEM-6 and B-3. The fourth, fifth, sixth, and seventh events were conducted in the same configuration and for the same duration as this eighth event.

2.1 Petroleum Hydrocarbons Removed

A calculated total of 582 pounds of carbon (approximately equivalent to 834 pounds of petroleum hydrocarbons - 138 equivalent gallons of gasoline) were removed during this MEME event. This recovered mass/volume of petroleum hydrocarbons represents an increase from the removal achieved during the seventh event (i.e. a calculated total of 687 pounds of petroleum hydrocarbons - approximately 113 equivalent gallons of gasoline), and is within the range of removals achieved during previous events (i.e. calculated total of 499 to 3,704 pounds of petroleum hydrocarbons - approximately 82 to 611 equivalent gallons of gasoline). A combined total of 10,356 pounds of petroleum hydrocarbons (approximately 1,708 gallons of gasoline) have been recovered during the eight MEME events conducted at this site.

A summary of petroleum hydrocarbons removed to date is shown in Table 1.

TABLE 1
Summary of Petroleum Hydrocarbons Removed

MEME Event Number	MEME Event Date	Petroleum Hydrocarbons Removed (lbs.)	Equivalent Gasoline Removed (gal.)
1*	January 15 and 16, 1998	905	149
2*	January 29 and 30, 1998	581	95
3	January 19, 1999	3,704	611
4	February 10, 1999	1,307	216
5	March 15, 1999	1,839	304
6	April 15, 1999	499	82
7	May 17, 1999	687	113
8	June 18, 1999	834	138
Total Removed To Date		**10,356**	**1,708**

*Performed by others

The carbon removal rate ranged from 1.8 to 314 pounds per hour during this MEME event. The removal rate decreased from 314 to 65 pounds per hour during the initial three hours of extraction from wells MEM-2, MEM-8, MEM-13, and MEM-14. Upon commencement of extraction from wells MEM-1, MEM-3, MEM-7, and MEM-12, the carbon removal rate initially increased to 92 pounds per hour and generally decreased to 45 pounds per hour during the ensuing three hours of extraction. Upon commencement of extraction from MEM-6 and B-3, the carbon removal rate decreased from 5.2 to 1.8 pounds per hour during the initial 1.5 hours and increased to 2.2 pounds per hour during the final 0.5 hour of this event. These removal rates ranged higher than those achieved during the seventh event (i.e. 1.7 to 113 pounds per hour) and are within the lower range of those achieved during previous events (i.e. 0.7 to 1,192 pounds per hour).

2.2 Offgas Concentrations

Offgas concentrations ranged from 400 to 82,000 ppm during this MEME event. Offgas concentrations decreased from 82,000 to 18,000 ppm during the initial three hours of extraction from MEM-2, MEM-8, MEM-13, and MEM-14. Upon commencement of extraction from MEM-1, MEM-3, MEM-7, and MEM-12, offgas concentrations generally decreased from 26,000 to 10,000 ppm during the ensuing three hours of extraction. Upon commencement of extraction from wells MEM-6 and B-3, the offgas concentrations increased from 1,600 to 1,800 ppm during the initial 0.25

hour and ranged from 400 to 1,000 ppm during the final 1.75 hours of this event. These offgas concentrations encompass the range of concentrations recorded during the seventh event (i.e. 120 to >100,000 ppm).

2.3 Flow Rates

Flow rates attained during this MEME event ranged from 367 to 587 CFM (174 to 274 dry standard CFM). The flow rates increased from 367 to 477 CFM duirng the initial one hour of this event and remained stable at 477 CFM during the ensuing two hours of extraction from MEM-1, MEM-3, MEM-7, and MEM-14. During the ensuing three hours of extraction from MEM-1, MEM-3, MEM-7, and MEM-12, the flow rates ranged from 550 to 587 CFM. Upon commencement of extraction from MEM-6 and B-3, the flow rates were stable at 403 CFM during the final two hours of this event. These flow rates ranged higher than those recorded during the seventh event (i.e. 293 to 440 CFM) and are within the lower range of those recorded during previous events (i.e. 236 to 1,100 CFM).

2.4 Extraction Wellhead Vacuum Readings

The range of vacuum readings recorded at the extraction wells during this MEME event are detailed in the field data sheets (Appendix A) and are summarized in Table 2 below.

TABLE 2
Summary of Sixth Event Vacuum Readings

Extraction Well Location	Vacuum Reading (in. of mercury)
MEM-1	9 to 10
MEM-2	15
MEM-3	15
MEM-6	15 to 17
MEM-7	6
MEM-8	11
MEM-12	12 to 13
MEM-13	14 to 15
MEM-14	14 to 15
B-3	10

Differential pressures were recorded during this event at wells MEM-3 and MEM-6 to assess the vacuum induced by MEME in the vadose zone. Differential pressure data are detailed in Appendix A.

Groundwater levels were recorded during this event to determine drawdown of the aquifer during the MEME and is detailed below.

Monitoring Well	Maximum Change	Nearest Extraction Well (Approx. Distance)
MEM-3	0.00 inches of water	MEM-14 (50 feet)
MEM-6	-0.80 inches of water	B-2 (75 feet)

2.5 Groundwater Disposal

Approximately 928 gallons of liquid (SPH was not detected in the vacuum truck tank upon conclusion of MEME activities) were removed during this MEME and off loaded to an on-base oil/water separator at the direction of the NSA environmental personnel.

2.6 Conclusions and Recommendations

Eight MEME events and four groundwater sampling events have been conducted at the site to date. Sampling was conducted April 11, 1996 (initial sampling event), March 3, 1998 (second event), September 4, 1998 (third event), and February 25, February 26, and March 1, 1999 (fourth event). A fifth sampling event is scheduled for mid-July 1999. Only the fourth sampling event has been conducted in conjunction with seven MEME events performed by BAT.

Twenty-one wells were sampled for benzene, toluene, ethyl benzene, and xylenes (BTEX), total BTEX, and total petroleum hydrocarbons-gas range organics (TPH-GRO). Of the wells sampled, ten wells (MEM-1, MEM-2, MEM-3, MEM-6, MEM-7, MEM-8, MEM-12, MEM-13, MEM-14, and MEM-B3) are included in the monthly MEME application.

Analytical data from past sampling events show a trend that indicates the MEME application is effective in reducing the levels of dissolved BTEX and total TPH constituents in the groundwater (Table 3). However, in the ten wells used for the MEME, the petroleum contaminants are still above the established TDEC "non-drinking water" classification cleanup levels (0.070 ppm for benzene and 1.0 ppm for TPH) for groundwater.

BAT recommends continuing with the MEME remediation technology on the ten wells that are above TDEC cleanup levels through the tenth MEME event (scheduled for August 2, 1999). At that time, additional data from the fifth sampling event will be available. That data can then be compared with past data from groundwater sampling and MEME events in order to gain a better understanding of the effectiveness of MEME activities over the past six months. In conjunction with the final scheduled MEME event, BAT will examine the possibilities for the need of more aggressive technologies versus the current MEME application.

TABLE 3
Analytical Data For The Initial And Fourth Groundwater Sampling Events

Well Number	Benzene (mg/L)		TPH-GRO (mg/L)	
	Initial Event	Fourth Event	Initial Event	Fourth Event
MEM-757-1	11.0	10.2	44.6	17.7
MEM-757-2	14.0	13.4	26.1	12.9
MEM-757-3	2.62	0.949	13.8	1.48
MEM-757-6	2.74	1.42	13.9	2.32
MEM-757-7	0.315	0.869	4.75	4.07
MEM-757-8	2.01	7.93	13.3	6.28
MEM-757-12	0.7	11.0	31.3	14.8
MEM-757-13	16.4	8.30	51.6	7.15
MEM-757-14	0.082	10.8	5.93	16.0
MEM-757-B3	0.397	0.130	6.12	2.74
TDEC "Non-drinking Water" Classification Cleanup Levels	0.070 ppm		1.0 ppm	

APPENDIX A

MEME FIELD DATA SHEETS

EFR® FIELD DATA SHEET

Client: BAT Env. | Facility Name: NEX (Navy Exchange) Auto Part/Fuel Lock | Facility ID#: 0-791718 | Event #: 8

Facility Address: 757 Old Navy Road, Millington, Tennessee | Technician: Lewis | Date: 6/18/99

Extraction Well(s)	Start Time (hh:mm)	End Time (hh:mm)	Interval Time (min)	Extraction Well-head Vacuum (in. Hg)											Offgas Velocity (ft/min)	Total Flow (CFM)	Stack Gas Temp. (° F)	Total Flow (DSCFM)	Offgas Concentrations			Rate of Carbon Removal (lbs/hour)	Total Carbon Removed (pounds)
				Inlet	MEM-1	MEM-2	MEM-3	MEM-6	MEM-7	MEM-8	MEM-12	MEM-13	MEM-14	B-3					Initial PPM_V	Ending PPM_V	Average PPM_V		
MEM-2,8,13,14	7:00	7:15	15	20	-	15	-	-	-	11	-	15	15	-	2,000	367	80	354	82,000	76,000	79,000	314	78
"	7:15	7:30	15	20	-	15	-	-	-	11	-	15	14	-	2,200	403	120	357	76,000	72,000	74,000	296	74
"	7:30	7:45	15	19	-	15	-	-	-	11	-	15	14	-	2,400	440	140	354	72,000	30,000	51,000	202	51
"	7:45	8:00	15	18	-	15	-	-	-	11	-	14	14	-	2,600	477	160	323	30,000	28,000	29,000	105	26
"	8:00	8:30	30	18	-	15	-	-	-	11	-	14	14	-	2,600	477	160	323	28,000	26,000	27,000	98	49
"	8:30	9:00	30	18	-	15	-	-	-	11	-	14	14	-	2,600	477	160	323	26,000	22,000	24,000	87	43
"	9:00	9:30	30	18	-	15	-	-	-	11	-	14	14	-	2,600	477	160	323	22,000	18,000	20,000	72	36
"	9:30	10:00	30	18	-	15	-	-	-	11	-	15	14	-	2,600	477	160	323	18,000	18,000	18,000	65	33
MEM-1,3,7,12	10:00	10:15	15	17	9	-	15	-	6	-	12	-	-	-	3,000	550	160	372	26,000	18,000	22,000	92	23
"	10:15	10:30	15	17	9	-	15	-	6	-	12	-	-	-	3,000	550	160	372	18,000	12,000	15,000	63	16
"	10:30	11:00	30	18	10	-	15	-	6	-	12	-	-	-	3,200	587	160	397	12,000	18,000	15,000	67	33
"	11:00	11:30	30	18	10	-	15	-	6	-	12	-	-	-	3,200	587	160	397	18,000	14,000	16,000	71	36
"	11:30	12:00	30	17	10	-	15	-	6	-	13	-	-	-	3,200	587	160	397	14,000	14,000	14,000	62	31
"	12:00	12:30	30	17	10	-	15	-	6	-	13	-	-	-	3,000	550	160	372	14,000	10,000	12,000	50	25
"	12:30	13:00	30	17	10	-	15	-	6	-	13	-	-	-	3,200	587	160	397	10,000	10,000	10,000	45	22
MEM-6;B-3	13:00	13:15	15	20	-	-	-	17	-	-	-	-	-	10	2,200	403	160	273	1,600	1,800	1,700	5.2	1.3
"	13:15	13:30	15	18	-	-	-	16	-	-	-	-	-	10	2,200	403	160	273	1,800	1,000	1,400	4.3	1.1
"	13:30	14:00	30	17	-	-	-	15	-	-	-	-	-	10	2,200	403	160	273	1,000	400	700	2.1	1.1
"	14:00	14:30	30	18	-	-	-	15	-	-	-	-	-	10	2,200	403	160	273	400	760	580	1.8	0.9
"	14:30	15:00	30	18	-	-	-	15	-	-	-	-	-	10	2,200	403	160	273	760	700	730	2.2	1.1

Vacuum Truck Information

Subcontractor:	NB Env.
Invoice No.:	
Truck Operator:	Young
Truck No.:	KingVac VK-39
Vacuum Pump Type:	Liquid Ring
Tank Capacity:	2,561
Stack I.D. (inches):	5.8
Calibration Gas:	500 ppm Hexane
Molecular Weight:	75 g/mole

Well No.	Breather Port (CFM)	Stinger Depth (feet)
MEM-1	0 (closed)	10
MEM-2	0 (closed)	10
MEM-3	0 (closed)	10
MEM-6	14	10
MEM-7	0 (closed)	10
MEM-8	0 (closed)	10
MEM-12	0 (closed)	10
MEM-13	0 (closed)	10
MEM-14	0 (closed)	10
B-3	0 (closed)	10

Recovery/Disposal Information

Total Gal. of Liquid:	928
Disposal Facility:	*
Manifest No.:	*
Total Lbs. of Carbon (Offgas):	582
Cum. Lbs. Carbon Removed:	7,353
Lbs. Hydrocarbons Removed:	834
Cum. Lbs. Hydrocarbons:	10,356
Equiv. Gal. Removed:	138
Cum. Equiv. Gal. Removed:	1,708

ECOVAC SERVICES

Comments: * Offloaded extracted liquid to an on-site oil/water separator

EFR® EVENT GAUGING DATA

Client: BAT Env.	Facility Name: NEX (Navy Exchange) Auto Part/Fuel Lock	Facility ID#: 0-791718	Event #: 8
Facility Address: 757 Old Navy Road, Millington, Tennessee		Technician: Lewis	Date: 6/18/99

Well Designation	Well Diameter (inches)	Total Depth (feet)	Before EFR® Event			After EFR® Event			Depth to Liquid Change (feet)
			Depth to SPH (feet)	Depth to Water (feet)	SPH Thickness (feet)	Depth to SPH (feet)	Depth to Water (feet)	SPH Thickness (feet)	
MEM-1	4		-	5.56	0.00	-	9.90	0.00	-4.34
MEM-2	4		-	3.65	0.00	-	10.20	0.00	-6.55
MEM-3	4		-	5.13	0.00	-	9.80	0.00	-4.67
MEM-6	4		-	3.95	0.00	-	10.00	0.00	-6.05
MEM-7	4		-	4.78	0.00	-	9.80	0.00	-5.02
MEM-8	4		-	5.33	0.00	-	16.10	0.00	-10.77
MEM-11	4		-	5.40	0.00	-	5.46	0.00	-0.06
MEM-12	4		-	4.63	0.00	-	11.30	0.00	-6.67
MEM-13	4		-	4.90	0.00	-	10.80	0.00	-5.90
MEM-14	6		-	4.85	0.00	-	10.40	0.00	-5.55
MEM-16	6		Blocked by construction						
B-3	4		-	5.95	0.00	-	9.90	0.00	-3.95
B-4	4		Blocked by construction						

ECOVAC SERVICES

Comments:

Differential Pressure and Groundwater Drawdown Data Recorded During EFR®
Event No. 8 (June 18, 1999)
NEX (Navy Exchange) Auto Part/Fuel Lock
757 Old Navy Road
Millington, Tennessee

DIFFERENTIAL PRESSURE DATA

		Well Designation:	
		MEM-3	MEM-6
Nearest Extraction Well:		MEM-14	MEM-2
(Approx. Distance):		(50 feet)	(75 feet)
Time	Elapsed Time	Differential Pressure Readings (inches of water):	
7:30	0.5 hr.	0.00	-0.25
8:00	1.0 hr.	0.00	-0.28
8:30	1.5 hrs.	0.00	-0.25
9:00	2.0 hrs.	0.00	-0.42
10:00	3.0 hrs.	0.00	-0.80
11:00	4.0 hrs.	0.00	-0.44
12:00	5.0 hrs.	0.00	-0.64
Maximum Change:		0.00	-0.80