SVE and Groundwater Containment at OU1, Shaw AFB

Site Background

Operable Unit 1 (OU1) is comprised of four IRP sites (SS-04, OT-05, ST-14, and Area C). This section focuses on the SVE system located at the OU1 POL yard, the OU1 Area A Interim Response groundwater containment/treatment system, and the Interim Response Area C groundwater containment system (product recovery system) all operating within OU1. The Area B VEP and Area C biosparging systems at OU1 are not addressed in this report. Soil and groundwater contamination within OU1 is presented in Figures 9, 10, and 11.

Contaminants in Soil

- The contaminant of concern at the POL yard is JP-4 jet fuel with an estimated area of 30,000 sq. feet of contaminated soil.

Contaminants in Groundwater

- An estimated 400,000 gallons of JP-4 free product and other petroleum hydrocarbons are present in the groundwater at OU1.
- A dissolved phase plume extends over an are of approximately 47 acres.

Lithology

- Soils are typically sand and silts, followed by confining clay layer at approximately 70 to 80 feet bgs.
- Groundwater depths range from 20-40 feet bgs at OU1.

Technologies at OU1

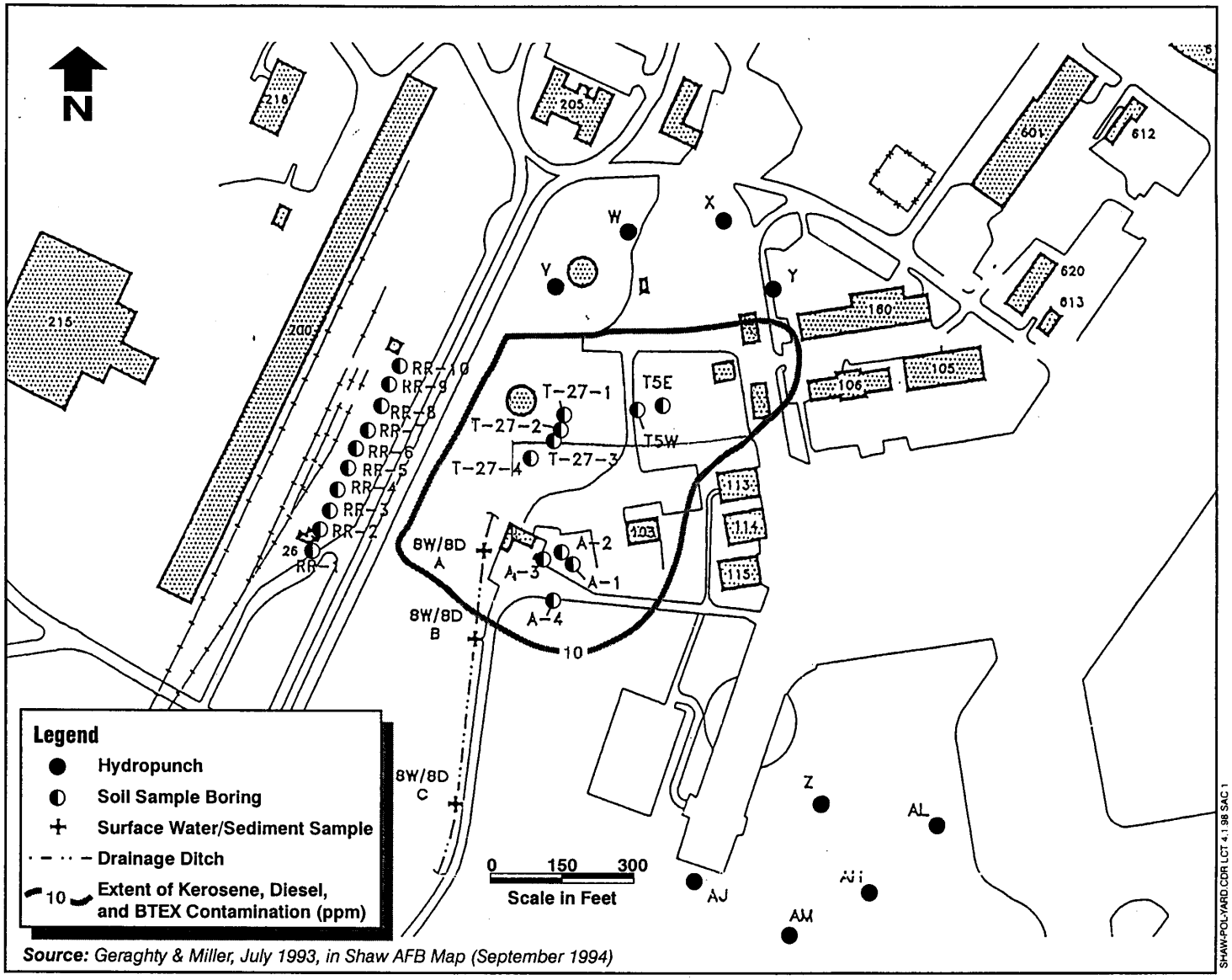
- Soil – The contaminated soil at the POL yard (Area A) is being removed by an SVE system.
- Groundwater – Groundwater containment within OU1 (Area A) was performed by the Interim Response OU1 Area A fuel recovery and a groundwater treatment system.
- Groundwater – Area C interim response passive free product recovery remedial action system operated from 1995 to 1997.

SVE System Details

- The SVE system at the POL yard operates at 18 inches of Hg.
- The SVE system consists of 30 vacuum extraction wells; four vacuum monitoring wells; three SVE vacuum blowers; an oil and water separator; and two thermal Catalytic Oxidation units.
- In December 1996, five VEP wells (used to remediate free-phase product and dissolved-phase groundwater) located in Area B were connected to the SVE system.
- Extracted vapor was treated with Thermal Oxidation (ThermOx) from December 1995 until December 1997. Catalytic Oxidation (CatOx) is now used for vapor treatment.
- The system was shut down in August 1997 to evaluate the cause of the toxicity test failure for the treated effluent.

Groundwater Containment System Details

- The Interim Response Area A groundwater containment system consisted of nine recovery wells and was designed to treat approximately 75 gallons per minute (gpm) of contaminated groundwater.
- The Interim Response Area A system consisted of a product recovery system, a groundwater recovery system, iron pretreatment, entrained oil removal, solids removal, a packed air stripper, and discharged the treated effluent into the sanitary sewer treatment system.
- The groundwater treatment system and free product recovery system upgrade was completed in May 1997.
- Free product recovery system was upgraded with dual-phase recovery pumps, an oil/water separator, an equalization tank, and two skid-mounted shallow tray air stripper units.



Source: *Geraghty & Miller, July 1993, in Shaw AFB Map (September 1994)*

Figure 9. Soil Contamination OU1 POL Yard, Shaw AFB

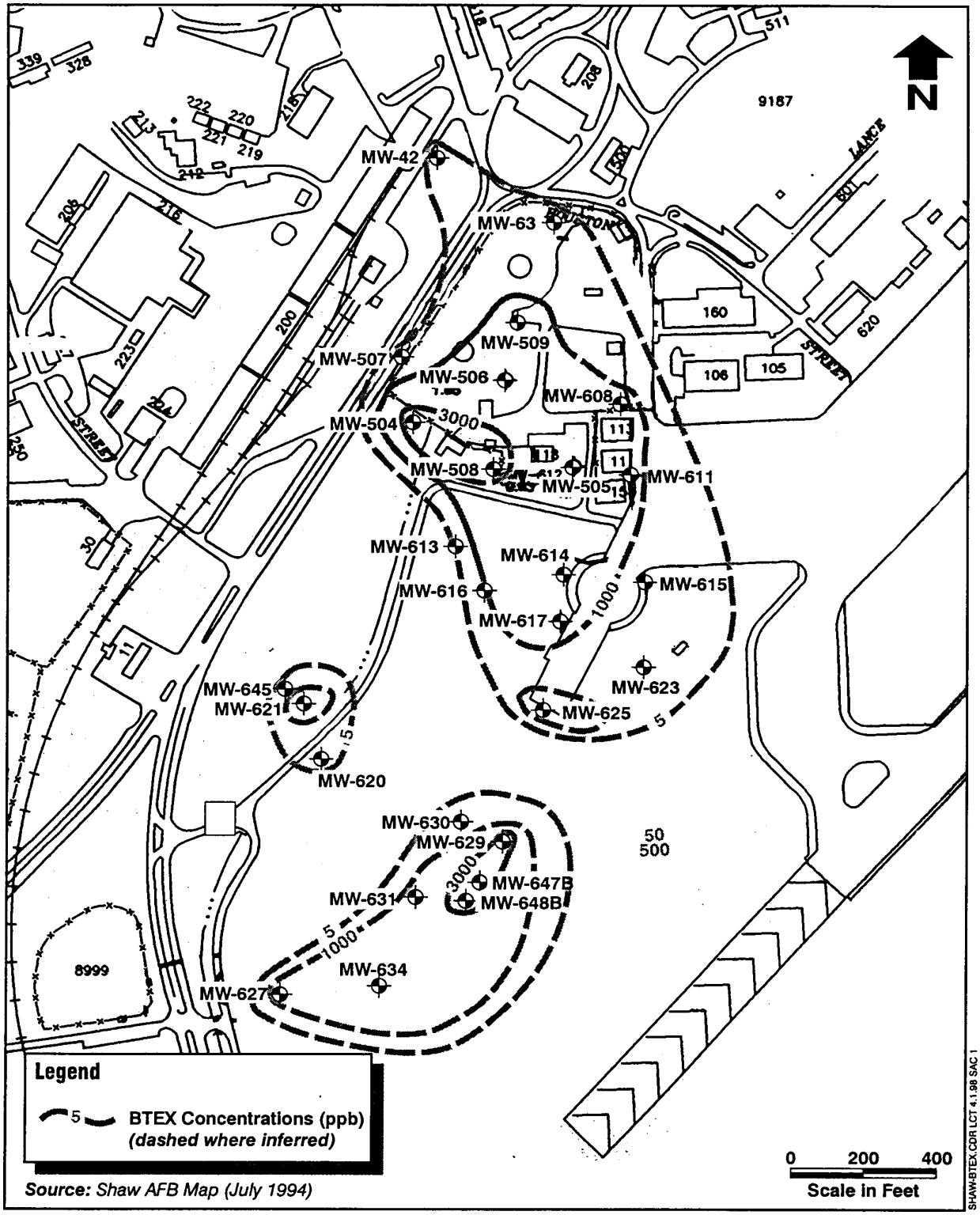


Figure 10. Distribution of Total Dissolved BTEX Concentrations in the Shallow Aquifer at OU1, Shaw AFB

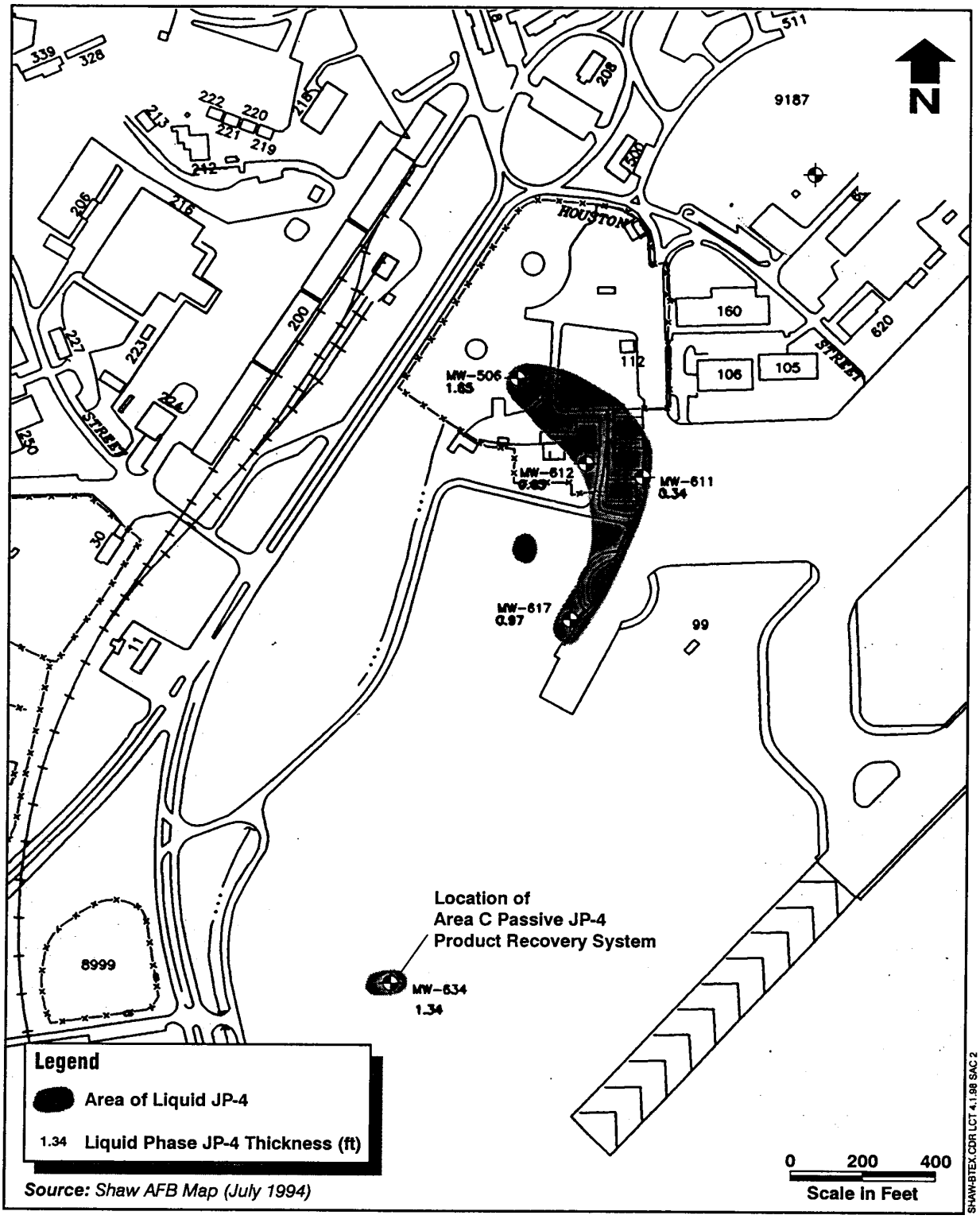


Figure 11. Free Phase JP-4 Distribution in Groundwater at OU1, Shaw AFB

- The interim response Area C passive groundwater containment system consisted of one recovery well (MW-634).
- The Area C system was modified to a full-scale system with five extraction wells in September 1997.

Operation Period

- The SVE system at the POL Yard began operation in December 1995 and is still operating.
- The Interim Response Area A system began operation in 1989 and was shut down in November 1996.
- The Interim Response Area C system begun operation in April 1995 and was operated until it was upgraded in September 1997.

Total Capital Costs

- The estimated capital costs for the SVE system at the POL yard (Area A) was $1,800,000.
- The estimated capital costs for the Interim Response Area A groundwater treatment system was $980,000.
- The estimated capital costs for the Interim Response Area C system was $650,000.

Total O&M Costs

- The cumulative O&M costs for the SVE system at the POL yard were $568,500 (January 1996 through July 1997).
- The cumulative O&M costs for the Interim Response Area A JP-4 product recovery system were $995,500 (February 1992 through April 1996).
- Total cumulative O&M costs for the Area C system from June 1995 through August 1996 were $33,000.

Cost and Performance of SVE at OU1 POL Yard

SVE Operational Objectives

The objective of SVE is typically to remove contamination in the soil as cost-effectively as possible to prevent contamination of surrounding soil and groundwater.

Cost for Operation

Figure 12 illustrates the curves of O&M costs for the SVE at the OU1 POL yard. The monthly O&M costs range from $18,000 to $57,500. Total O&M costs after nineteen months of operation were $568,500.

Contaminant Removal

Figure 13 illustrates curves of the contaminant removal rates of JP-4 jet fuel for the SVE system at the OU1 POL yard. Contaminant removal rates ranged from 2,560 to 94,800 lbs per month. Total contaminant removal after nineteen months of operation was 518,250 lbs. of JP-4. By August 1996, the curve representing the cumulative removal rate began to flatten, indicating that the removal rate was decreasing and a system evaluation for reducing operating cost was warranted.

In 1997, pulsing of the SVE system was performed to reduce operating cost and enhancing system performance (Shaw AFB, 1997). The cumulative removal rates began to increase in January of 1997, indicating that the pulsing of the SVE system increased system performance.

After the system upgrade in May 1997, the curve indicates an increase in cumulative and monthly removal rates. This may be attributed to the combined vapor flow from the addition of extraction wells after the system upgrade.

Correlation of Costs and Contaminant Removal

Figures 14 and 15 illustrate the relationship between the O&M costs and the removal rates for the SVE system at the OU1 POL yard.

Figure 14 illustrates the curve of the cumulative O&M cost and the cumulative contaminant removal. In the month of August 1996 the curve started to steepen as the cost per unit of contaminant removal rises. However, after modification of the operations of the SVE system in 1997 and the addition of Area B extraction wells in December 1996 the curve flattened as the cost per unit of contaminant removal decreased.

In December 1997, a CatOx unit was installed to reduce vapor treatment cost. It is recommended that the data be re-evaluated following operation of CatOx unit to determine if the system objectives are being met.

Figure 15 illustrates the curves of the monthly and cumulative cost per unit of contaminant removal over the operation time of the technology. The monthly curve illustrates the cost per unit of contaminant removal in each month. The cumulative curve illustrates that the average cost per unit of contaminant removal after nineteen months of operation time (September 1997) was $1.09/pound of JP-4.

Cost and Performance of OU1 Area A Groundwater Containment

Groundwater Containment Operational Objectives

Groundwater containment systems are most often used to protect downgradient areas threatened by a contaminant plume. The objective of the free product source removal is typically to remove liquid-phase contamination as quickly and cost-effectively as possible to prevent continued contamination of surrounding soil and groundwater, while the objective of groundwater containment for dissolved phase contaminants is to operate efficiently over a relatively long period of time. The emphasis for free product removal is that the mass of contaminants are cost effectively removed, where as the emphasis for dissolved phase groundwater containment is whether containment was cost effectively achieved.

Data on whether groundwater containment is being achieved at each site is not available.

Therefore, this report will only present the efficiency of contaminant removal for groundwater containment sites. However, each dissolved phase site should be evaluated to determine if the plume is cost effectively being contained.

Cost for Operation

Figure 16 illustrates the curves of the O&M costs for the Area A groundwater containment system at OU1. The monthly O&M costs range from $674 to $90,100. Total O&M costs after four years of operation were $995,500.

Contaminant Removal

Figures 17 and 18 illustrates curves of the removal rates of dissolved JP-4 jet fuel and JP-4 free product at the Interim Response Area A groundwater containment system at OU1. Monthly removal rates of dissolved JP-4 fuel ranged from 0 to 10.7 gallons. Monthly removal rates of JP-4 free product ranged from 0 to 9,980 gallons. Total contaminant removal after 4 years of operation was 171 gallons of dissolved JP-4 jet fuel and 114,340 gallons of JP-4 free product. By January 1996, both curves representing the cumulative removal rates had flattened, indicating that the removal rates were negligible. The Interim Response Area A system was shut down in November 1996 because the operating objectives were no longer being met.

In May 1997 the OU1 groundwater treatment plant began treating extracted groundwater from both Area A and Area C wells. The combined Area A free product recovery system recovered 960 lbs and 1,920 lbs of free product during July and August 1997, respectively. A total of 5.6 lbs of dissolved contaminants were removed during these two months. The cumulative cost per pound recovered for these two months was $0.22/pound.

Correlation of Costs and Contaminant Removal

Figures 19 and 20 illustrate curves of the relationship between the O&M costs and the removal rates for the Interim Response Area A groundwater containment system at OU1.

Figure 19 illustrates curves of the cumulative O&M cost relative to contaminant removal. By late 1995, the curve had steepened as the cost per unit of contaminant removal rose exponentially. The Interim Response Area A system was shut down in November 1996 because the operating objectives were no longer being met.

Figure 20 illustrates the monthly and cumulative cost per unit of contaminant removal over the operation time of the technology. The monthly curve represents the cost per gallon of JP-4 removal in each month. The cumulative curve illustrates that the average cost per unit of contaminant removal was $8.69/gallon of JP-4 after 4 years of operation time.

Cost and Performance of Groundwater Containment at OU1 Area C

Groundwater Containment with Free Product Source Removal Operational Objectives

The objective of free product source removal is typically to remove liquid-phase contamination as quickly and cost-effectively as possible to prevent continued contamination of surrounding soil and groundwater. The emphasis for free product removal is that the mass of contaminants is cost effectively removed.

Cost for Operation

Figure 21 illustrates curves of the O&M costs for the interim response groundwater containment system at Site Area C. The monthly O&M costs range from $437 to $6,187. Total O&M costs after 1.4 years of operation were $33,000.

Contaminant Removal

Figure 22 illustrates the removal rate of JP-4 free product at the interim response groundwater containment system at Area C. Monthly removal rates of JP-4 free product ranged from 266 to 2,145 gallons. Total contaminant removal after 1.4 years (April 1995 through August 1996) of operation was 12,766 gallons of JP-4 free product. By August 1996, the curve representing the cumulative removal rate had not yet begun to flatten, indicating that the removal rate was still adequate for this system's performance and it's operational objectives were being met.

In September 1997, the Area C system was modified to a full scale system.

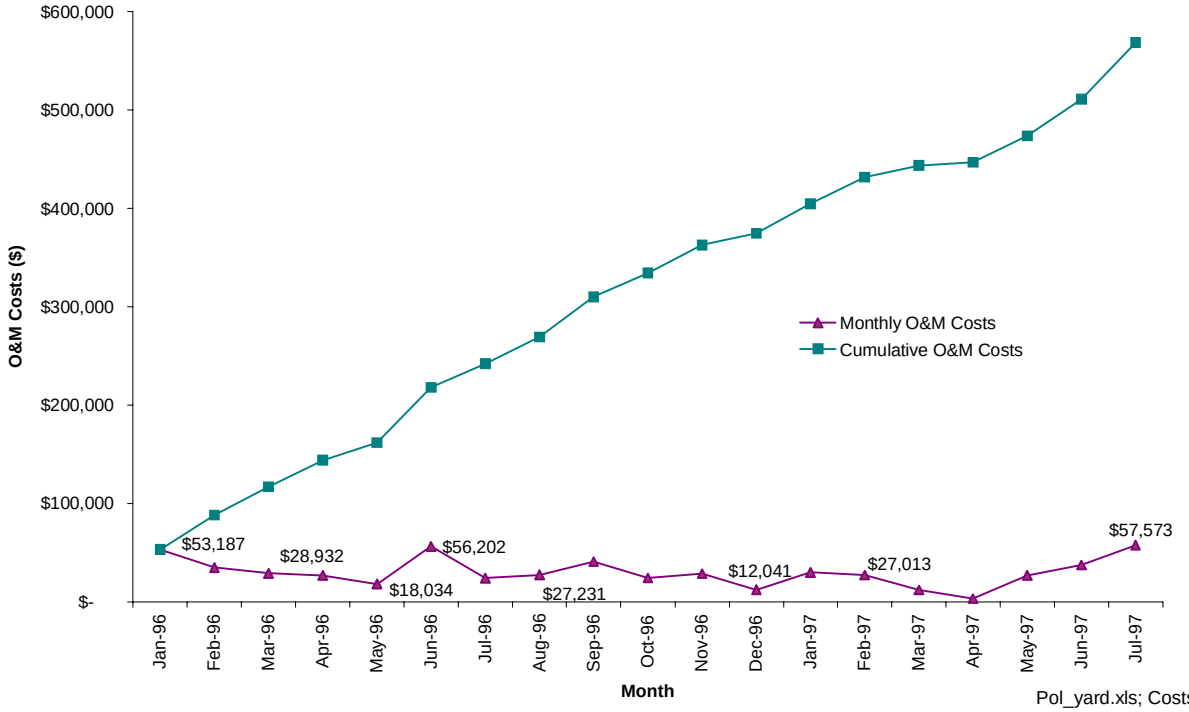
Correlation of Costs and Contaminant Removal

Figures 23 and 24 illustrate the relationship between the O&M costs and the removal rates for the groundwater containment system at Area C.

Figure 23 illustrates the cumulative O&M cost relative to the cumulative contaminant removal. As of August 1996, this curve had not steepened. In August 1996, the passive groundwater containment system was operating efficiently for this system's performance and the operational objectives were being met.

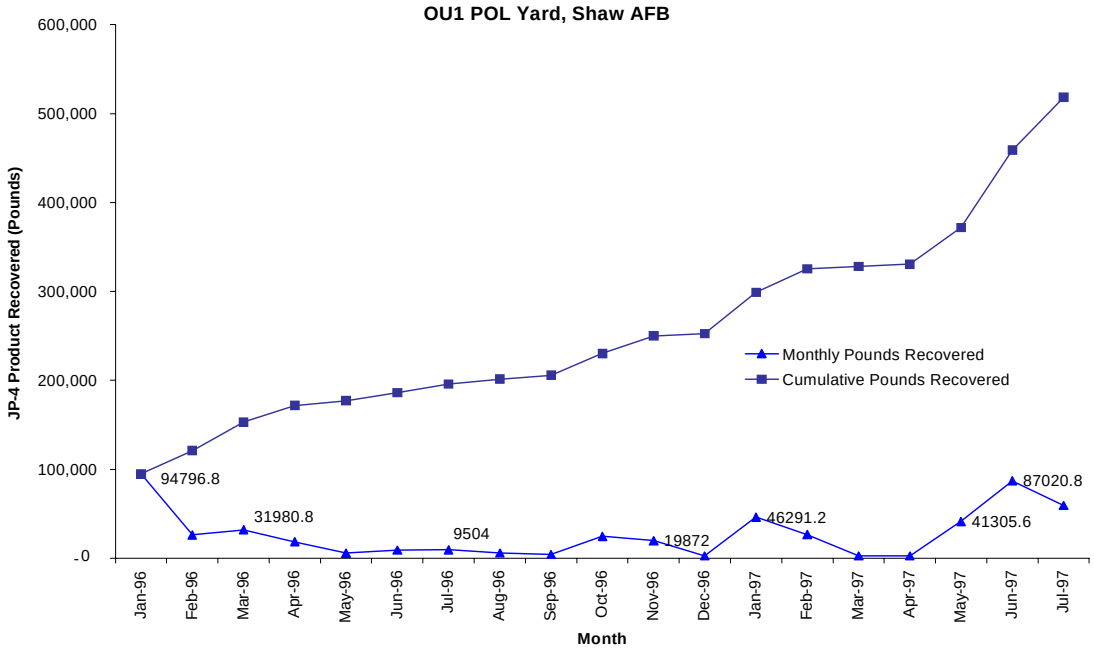
Figure 24 illustrates the monthly as well as the cumulative cost per unit of contaminant removal over the operation time of the technology. The first curve illustrates the cost per gallon of JP-4 removal in each month. The cumulative curve illustrates that the average cost per unit of contaminant removal was $2.59/gallon of JP-4 after 1.4 years of operation time.

Figure 12
Monthly and Cumulative O&M Costs vs. Time
OU1 POL Yard, Shaw AFB



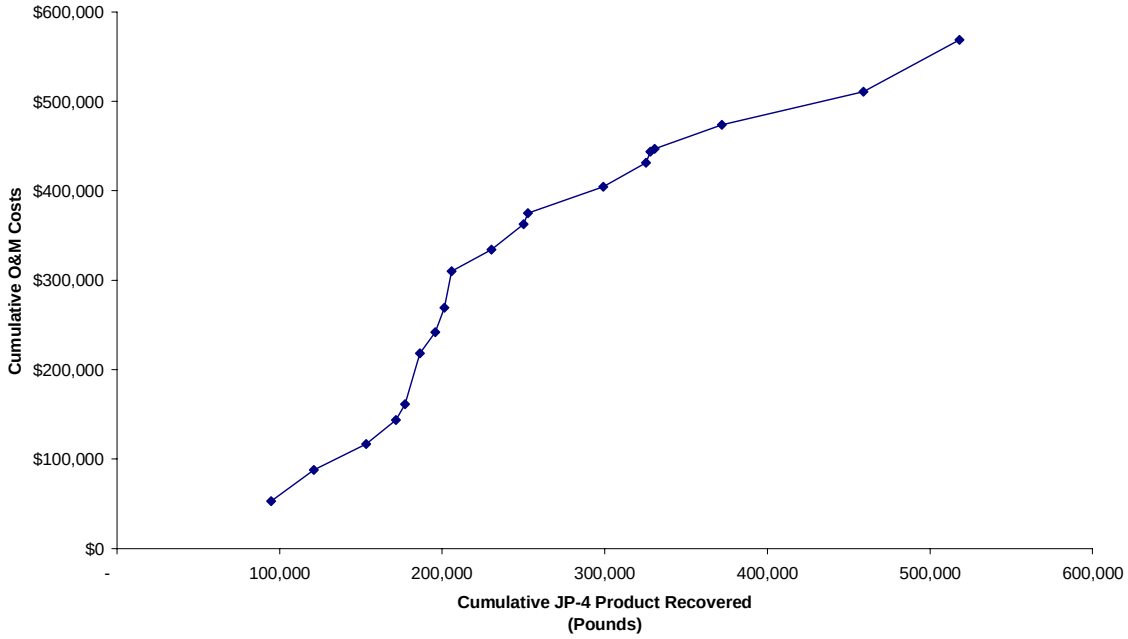
Pol_yard.xls; Costs

Figure 13
Cumulative and Monthly JP-4 Product Recovered vs. Time
OU1 POL Yard, Shaw AFB



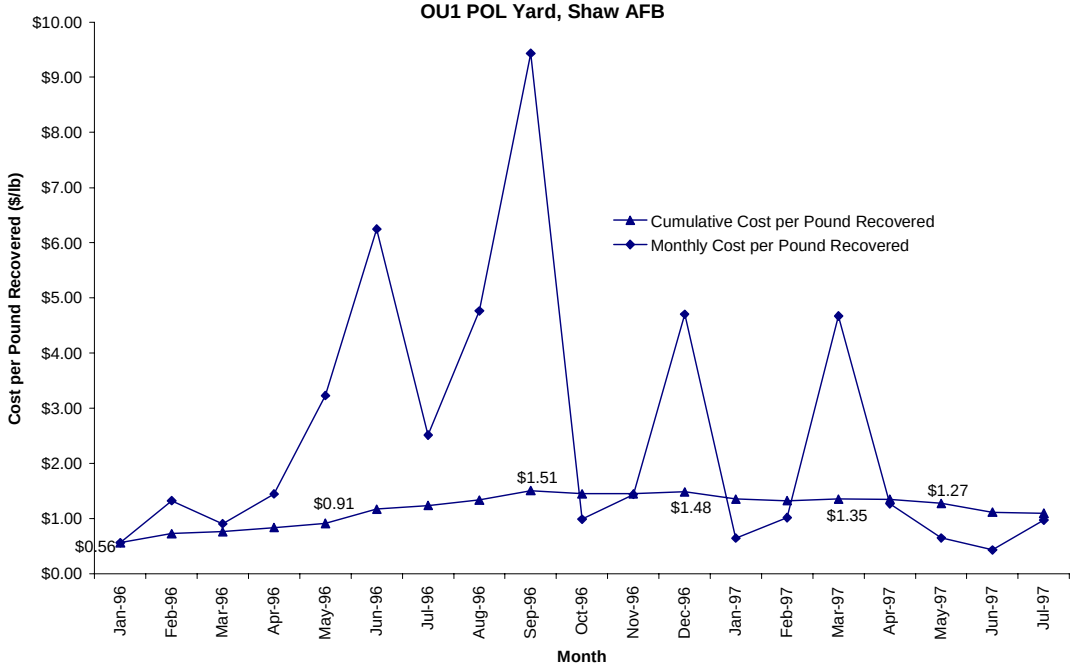
Pol_yard.xls; Mass Recovered

Figure 14
Cumulative O&M Costs vs. Cumulative JP-4 Product Recovered
OU1 POL Yard, Shaw AFB



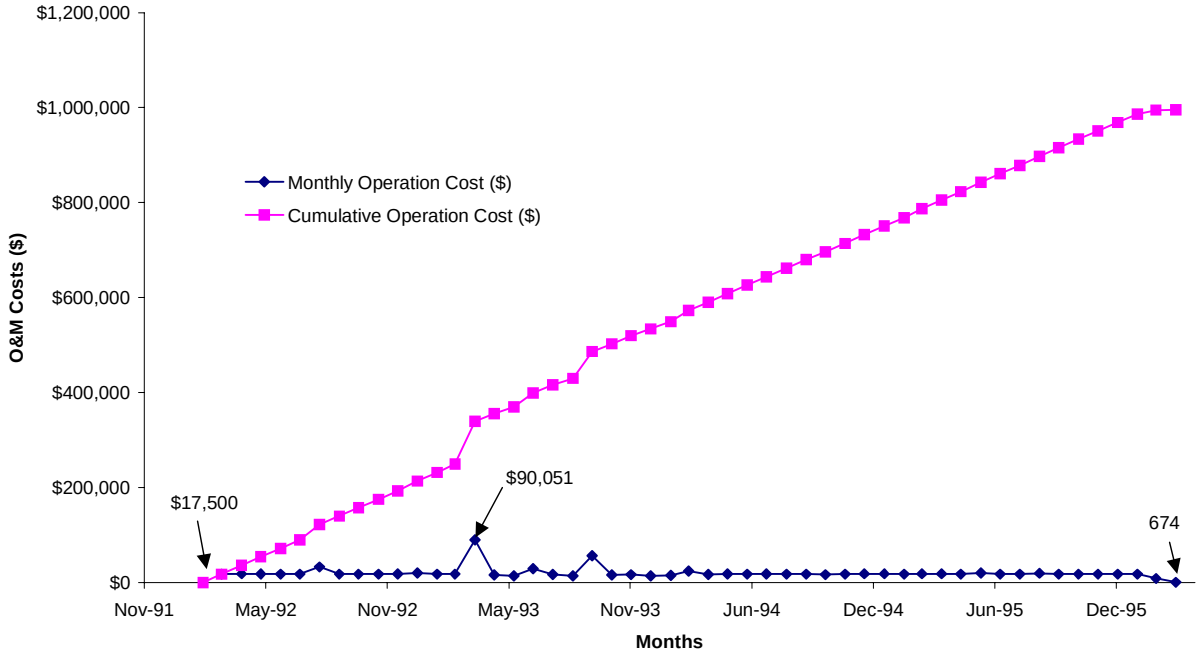
Pol_yard.xls; Costs vs Mass

Figure 15
Monthly and Cumulative O&M Cost per Pound vs. Time
OU1 POL Yard, Shaw AFB



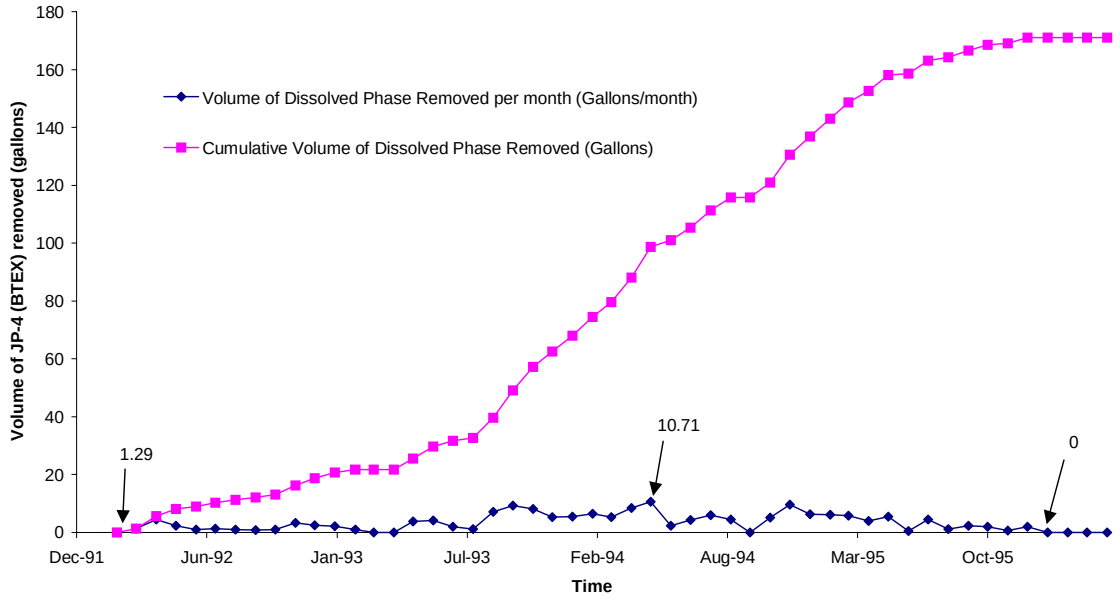
Pol_yard.xls; Cost per Pound vs Time

Figure 16
Monthly and Cumulative O&M Costs vs. Time
Dissolved JP-4 and JP-4 Free Product Combined
OU1 Area A, OU1, Shaw AFB



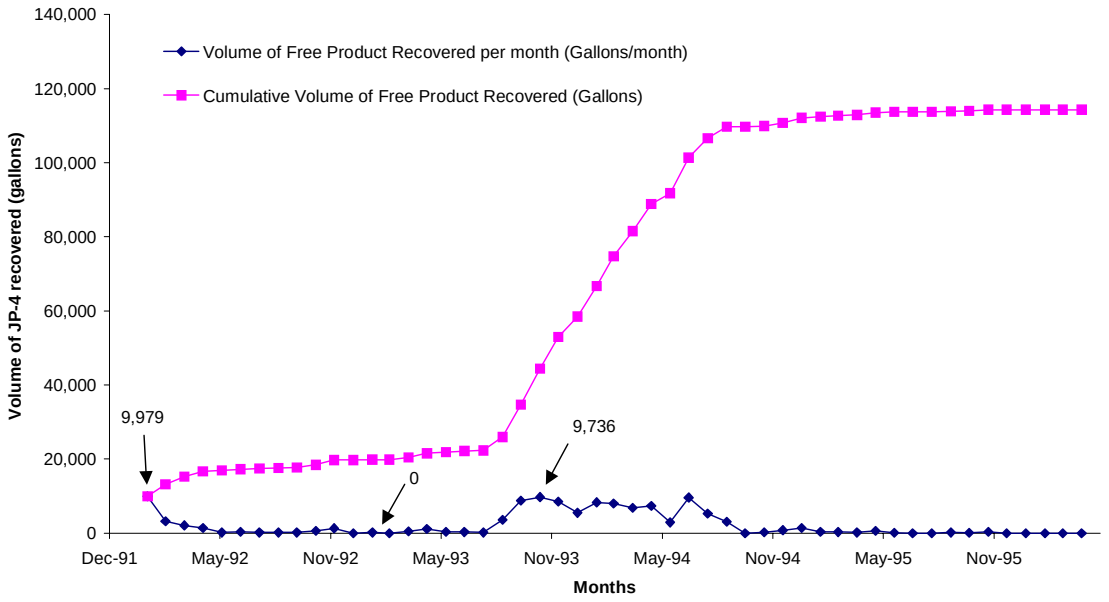
Rawou1.xls; O&M

Figure 17
Monthly & Cumulative JP-4 Removal vs. Time
Dissolved Product (BTEX)
OU1 Area A, Shaw AFB



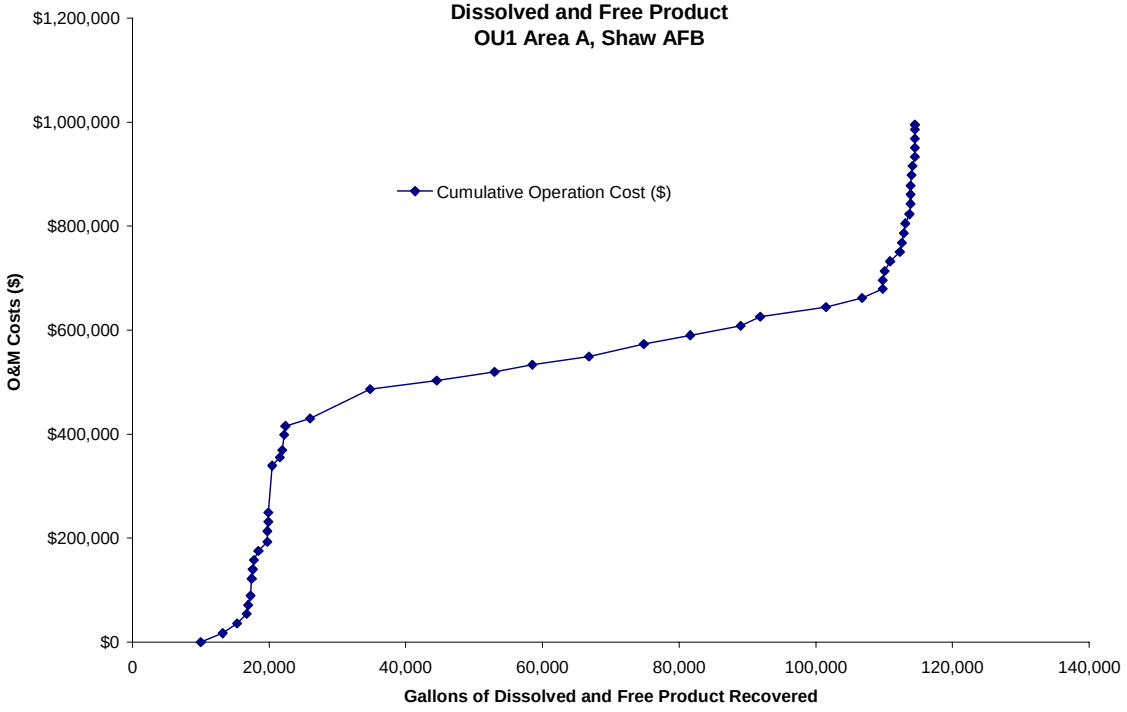
Rawou1; diss vol vs. time

Figure 18
Monthly & Cumulative Volume of JP-4 Recovered vs. Time
OU1 Area A, Shaw AFB
Free Product



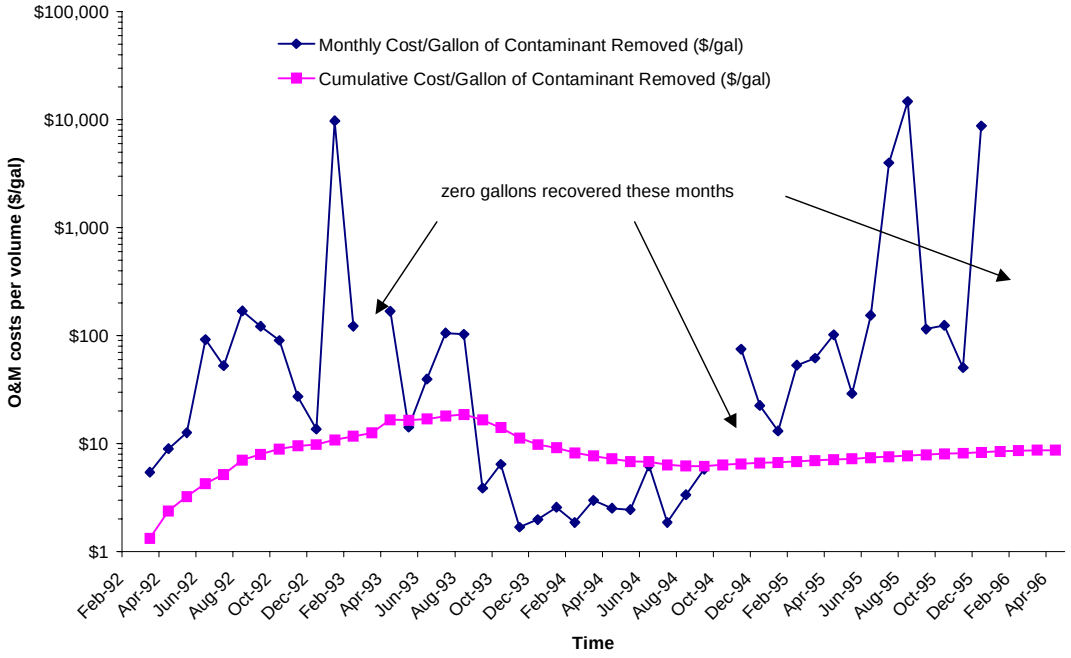
Rawou1.xls; volvs.time

Figure 19
Cumulative O&M costs vs. Volume Recovered
Dissolved and Free Product
OU1 Area A, Shaw AFB



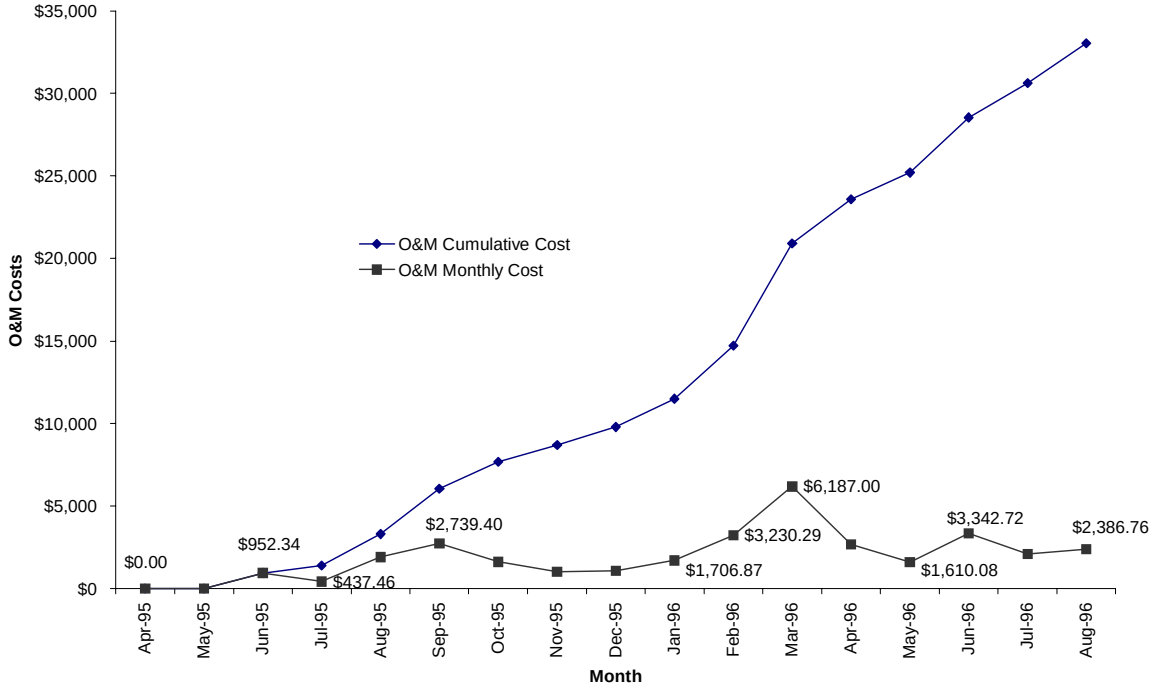
Rawou1.xls; cum & vs vol

Figure 20
Monthly & Cumulative O&M costs per Volume vs. Time
Dissolved and Free Product Combined (JP-4)
OU1 Area A, Shaw AFB



Rawou1.xls; $ per gal vs time

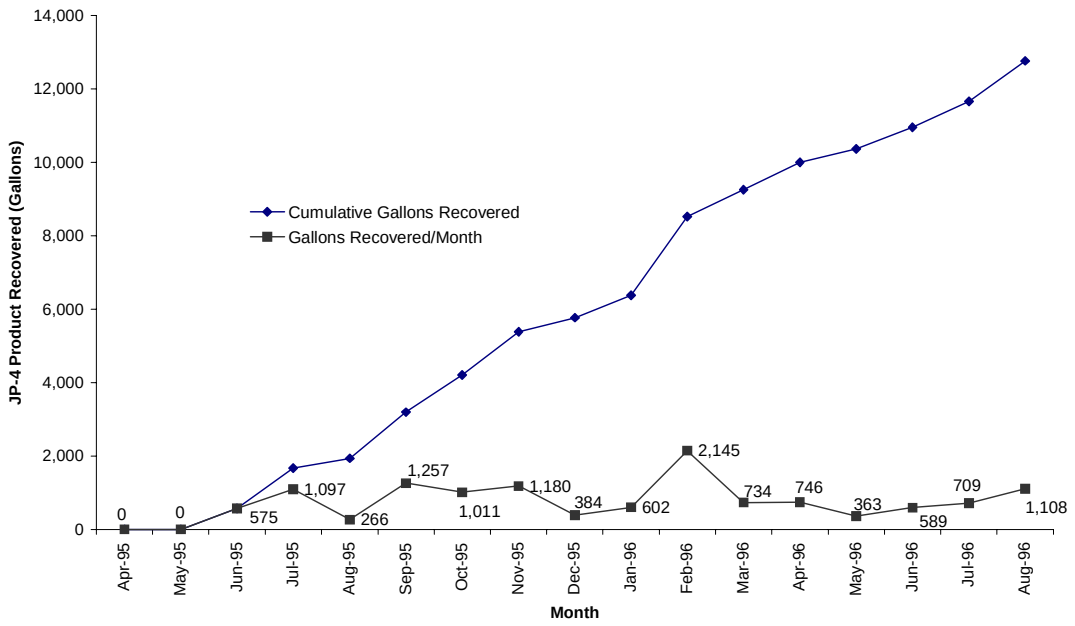
Figure 21
Monthly and Cumulative O&M Costs vs. Time
OU1 Area C, Shaw AFB



Note: Initial O/M costs of $1,359.27 were allocated to the months of June and July 1995.

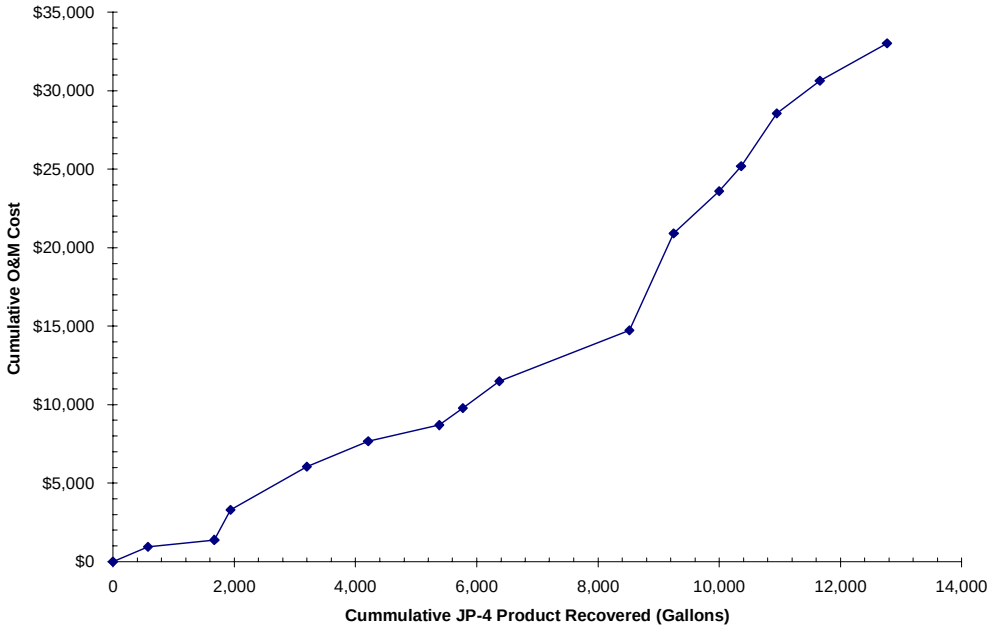
Revss15.xls; Cumulative Cost Per Month

Figure 22
Cumulative and Monthly JP-4 Product Recovered vs. Time
OU1 Area C, Shaw AFB



Revss15.xls; Cumulative Gallons Recovered

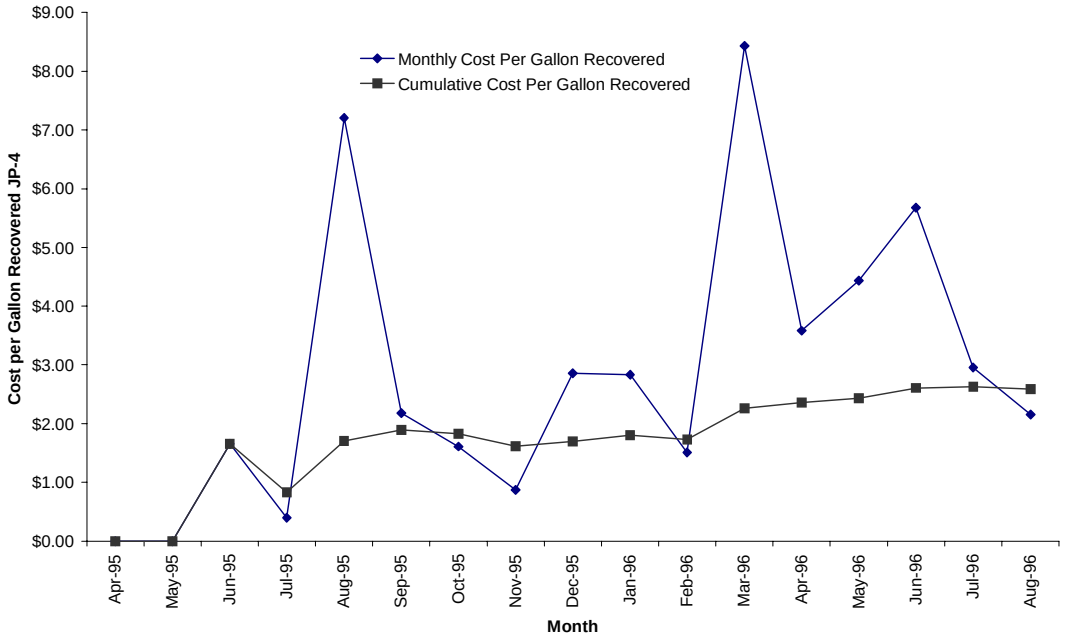
Figure 23
Cummulative O&M Cost vs. Cummulative JP-4 Recovered
OU1 Area C, Shaw AFB



Note: Initial O/M costs of $1,359.27 were allocated to the months of June and July 1995.

Revss15.xls; Cumm OM vs Recovered

Figure 24
Monthly and Cummulative O&M Cost Per Gallon of JP-4 Recovered vs. Time
OU1 Area C, Shaw AFB



Note: Initial O/M costs of $1,359.27 were allocated to the months of June and July 1995.

Revss15.xls; Cost per Gallon

APPENDIX A

Detailed Cost and Performance Data Tables

BTEX/JP4 REMOVAL RATES VIA AN SVE SYSTEM
OU1 POL YARD
SHAW AFB

DATE	# OF DAYS	MONTHLY BTEX/JP4 REMOVED (Gallons)	Monthly Pounds Recovered	CUMM. REMOVED (Gallons)	Cumulative Pounds Recovered	ACTUAL BTEX/JP4 REMAINING	Monthly O&M Costs	ACT. MONTHLY COST/GALLON	Cumulative O&M Costs	ACTUAL CUMULATIVE COST/GALLON	Monthly Cost per Pound Recovered	Cumulative Cost per Pound Recovered
Dec-95	0	0		0		91780						
Jan-96	31	14812	94796.8	14812	94796.8	76968	$53,187	$3.59	$53,187	$3.59	$0.56	$0.56
Feb-96	59	4114	26329.6	18926	121126.4	72854	$34,862	$8.47	$88,049	$4.65	$1.32	$0.73
Mar-96	90	4997	31980.8	23923	153107.2	67857	$28,932	$5.79	$116,982	$4.89	$0.90	$0.76
Apr-96	120	2900	18560	26823	171667.2	64957	$26,825	$9.25	$143,806	$5.36	$1.45	$0.84
May-96	151	872	5580.8	27695	177248	64085	$18,034	$20.68	$161,840	$5.84	$3.23	$0.91
Jun-96	181	1405	8992	29100	186240	62680	$56,202	$40.00	$218,042	$7.49	$6.25	$1.17
Jul-96	212	1485	9504	30585	195744	61195	$23,904	$16.10	$241,946	$7.91	$2.52	$1.24
Aug-96	243	893	5715.2	31478	201459.2	60302	$27,231	$30.49	$269,176	$8.55	$4.76	$1.34
Sep-96	273	677	4332.8	32155	205792	59625	$40,873	$60.37	$310,049	$9.64	$9.43	$1.51
Oct-96	304	3819	24441.6	35974	230233.6	55806	$24,124	$6.32	$334,173	$9.29	$0.99	$1.45
Nov-96	334	3105	19872	39079	250105.6	52701	$28,528	$9.19	$362,701	$9.28	$1.44	$1.45
Dec-96	365	400	2560	39479	252665.6	84460	$12,041	$30.10	$374,742	$9.49	$4.70	$1.48
Jan-97	396	7233	46291.2	46712	298956.8	77227	$29,903	$4.13	$404,645	$8.66	$0.65	$1.35
Feb-97	424	4145	26528	50857	325484.8	73082	$27,013	$6.52	$431,658	$8.49	$1.02	$1.33
Mar-97	455	400	2560	51257	328044.8	72682	$11,953	$29.88	$443,611	$8.65	$4.67	$1.35
Apr-97	485	400	2560	51657	330604.8	72282	$3,246	$8.12	$446,857	$8.65	$1.27	$1.35
May-97	516	6454	41305.6	58111	371910.4	65828	$26,772	$4.15	$473,629	$8.15	$0.65	$1.27
Jun-97	546	13597	87020.8	71708	458931.2	52231	$37,271	$2.74	$510,900	$7.12	$0.43	$1.11
Jul-97	577	9269	59321.6	80977	518252.8	42962	$57,573	$6.21	$568,473	$7.02	$0.97	$1.10

JP-4 Product Recovery, Free-Product/Dissolved Phase Pumping with Air Stipping
OU1 Area A
Shaw Air Force Base

Date of Product Recovery	Total Volume of contaminants Recovered per month (Gallons/month)	Cumulative Total Volume of contaminants recovered (Gallons)	Monthly Operation Cost ($)	Cumulative Operation Cost ($)	Monthly Cost/Gallon of Contaminant Removed ($/gal)	Cumulative Cost/Gallon of Contaminant Removed ($/gal)	Influent Concentration of BTEX (ug/L)
Feb-92	9,979.00	9,979.00		$0.00			
Mar-92	3,221.29	13,200.29	$17,500.00	$17,500.00	$5.43	$1.33	651
Apr-92	2,091.40	15,291.69	$18,797.00	$36,297.00	$8.99	$2.37	3224
May-92	1,422.33	16,714.02	$17,924.00	$54,221.00	$12.60	$3.24	1943
Jun-92	189.96	16,903.98	$17,500.00	$71,721.00	$92.12	$4.24	4598
Jul-92	336.31	17,240.29	$17,718.00	$89,439.00	$52.68	$5.19	3158
Aug-92	193.94	17,434.23	$32,797.00	$122,236.00	$169.11	$7.01	3873
Sep-92	145.79	17,580.02	$17,726.00	$139,962.00	$121.59	$7.96	3194
Oct-92	196.00	17,776.02	$17,719.00	$157,681.00	$90.40	$8.87	4304
Nov-92	646.27	18,422.29	$17,719.00	$175,400.00	$27.42	$9.52	5080
Dec-92	1,312.42	19,734.71	$17,910.00	$193,310.00	$13.65	$9.80	4190
Jan-93	2.10	19,736.81	$20,477.00	$213,787.00	$9,750.95	$10.83	6351
Feb-93	145.99	19,882.80	$17,828.00	$231,615.00	$122.12	$11.65	5084
Mar-93	0.00	19,882.80	$17,719.00	$249,334.00		$12.54	
Apr-93	536.00	20,418.80	$90,051.00	$339,385.00	$168.01	$16.62	
May-93	1,152.75	21,571.55	$16,300.00	$355,685.00	$14.14	$16.49	4904
Jun-93	354.17	21,925.72	$14,016.00	$369,701.00	$39.57	$16.86	3012
Jul-93	276.91	22,202.63	$29,199.00	$398,900.00	$105.45	$17.97	1883
Aug-93	166.07	22,368.70	$17,061.00	$415,961.00	$102.73	$18.60	1637
Sep-93	3,614.04	25,982.74	$13,958.00	$429,919.00	$3.86	$16.55	4968
Oct-93	8,781.30	34,764.04	$56,606.00	$486,525.00	$6.45	$14.00	4459
Nov-93	9,744.16	44,508.20	$16,369.00	$502,894.00	$1.68	$11.30	4802
Dec-93	8,495.31	53,003.51	$16,793.00	$519,687.00	$1.98	$9.80	3436
Jan-94	5,503.46	58,506.97	$14,162.00	$533,849.00	$2.57	$9.12	4735
Feb-94	8,292.47	66,799.44	$15,451.00	$549,300.00	$1.86	$8.22	3731
Mar-94	8,029.27	74,828.71	$23,975.00	$573,275.00	$2.99	$7.66	3701
Apr-94	6,813.40	81,642.11	$17,142.00	$590,417.00	$2.52	$7.23	3996
May-94	7,350.71	88,992.82	$17,959.00	$608,376.00	$2.44	$6.84	4730
Jun-94	2,866.25	91,859.07	$17,850.00	$626,226.00	$6.23	$6.82	1837
Jul-94	9,616.33	101,475.40	$17,949.00	$644,175.00	$1.87	$6.35	2717
Aug-94	5,287.97	106,763.37	$17,696.00	$661,871.00	$3.35	$6.20	4101
Sep-94	3,059.43	109,822.80	$17,691.00	$679,562.00	$5.78	$6.19	2472
Oct-94	0.00	109,822.80	$16,600.00	$696,162.00		$6.34	
Nov-94	235.23	110,058.03	$17,682.00	$713,844.00	$75.17	$6.49	3796
Dec-94	819.57	110,877.60	$18,488.00	$732,332.00	$22.56	$6.60	4141
Jan-95	1,407.37	112,284.97	$18,381.00	$750,713.00	$13.06	$6.69	3048
Feb-95	331.02	112,615.99	$17,609.00	$768,322.00	$53.20	$6.82	4127
Mar-95	299.74	112,915.73	$18,528.00	$786,850.00	$61.81	$6.97	4316
Apr-95	180.94	113,096.67	$18,407.00	$805,257.00	$101.73	$7.12	3477
May-95	615.51	113,712.18	$17,850.00	$823,107.00	$29.00	$7.24	3127
Jun-95	130.51	113,842.69	$20,128.00	$843,235.00	$154.23	$7.41	4143
Jul-95	4.42	113,847.11	$17,625.00	$860,860.00	$3,987.56	$7.56	3560
Aug-95	1.19	113,848.30	$17,591.00	$878,451.00	$14,782.35	$7.72	725
Sep-95	168.29	114,016.59	$19,387.00	$897,838.00	$115.20	$7.87	1017
Oct-95	141.92	114,158.51	$17,722.00	$915,560.00	$124.87	$8.02	622
Nov-95	350.56	114,509.07	$17,722.00	$933,282.00	$50.55	$8.15	365
Dec-95	2.00	114,511.07	$17,438.00	$950,720.00	$8,719.00	$8.30	3254
Jan-96	0.00	114,511.07	$17,722.00	$968,442.00		$8.46	
Feb-96	0.00	114,511.07	$17,722.00	$986,164.00		$8.61	
Mar-96	0.00	114,511.07	$8,682.00	$994,846.00		$8.69	
Apr-96	0.00	114,511.07	$674.00	$995,520.00		$8.69	

JP-4 Product Recovery, Free-Product
OU1 Area A
Shaw Air Force Base

Date of Product Recovery	Volume of Free Product Recovered per month (Gallons/month)	Cumulative Volume of Free Product Recovered (Gallons)
Feb-92	9,979	9,979
Mar-92	3,220	13,199
Apr-92	2,087	15,286
May-92	1,420	16,706
Jun-92	189	16,895
Jul-92	335	17,230
Aug-92	193	17,423
Sep-92	145	17,568
Oct-92	195	17,763
Nov-92	643	18,406
Dec-92	1,310	19,716
Jan-93	0	19,716
Feb-93	145	19,861
Mar-93	0	19,861
Apr-93	536	20,397
May-93	1,149	21,546
Jun-93	350	21,896
Jul-93	275	22,171
Aug-93	165	22,336
Sep-93	3,607	25,943
Oct-93	8,772	34,715
Nov-93	9,736	44,451
Dec-93	8,490	52,941
Jan-94	5,498	58,439
Feb-94	8,286	66,725
Mar-94	8,024	74,749
Apr-94	6,805	81,554
May-94	7,340	88,894
Jun-94	2,864	91,758
Jul-94	9,612	101,370
Aug-94	5,282	106,652
Sep-94	3,055	109,707
Oct-94	0	109,707
Nov-94	230	109,937
Dec-94	810	110,747
Jan-95	1,401	112,148
Feb-95	325	112,473
Mar-95	294	112,767
Apr-95	177	112,944
May-95	610	113,554
Jun-95	130	113,684
Jul-95	0	113,684
Aug-95	0	113,684
Sep-95	166	113,850
Oct-95	140	113,990
Nov-95	350	114,340
Dec-95	0	114,340
Jan-96	0	114,340
Feb-96	0	114,340
Mar-96	0	114,340
Apr-96	0	114,340

JP-4 Product Recovery, Dissolved Phase
OU1 Area A
Shaw Air Force Base

Date of Product Recovery	Volume of Dissolved Phase Removed per month (Gallons/month)	Mass of Dissolved Phase (JP-4) Removed per month (lbs/month)*	Cumulative Volume of Dissolved Phase Removed (Gallons)	Cumulative Mass of Dissolved Phase (JP-4) Removed (lbs)*
Feb-92			0.00	
Mar-92	1.29	8.26	1.29	8.26
Apr-92	4.40	28.16	5.69	36.42
May-92	2.33	14.91	8.02	51.33
Jun-92	0.96	6.14	8.98	57.47
Jul-92	1.31	8.38	10.29	65.86
Aug-92	0.94	6.02	11.23	71.87
Sep-92	0.79	5.06	12.02	76.93
Oct-92	1.00	6.40	13.02	83.33
Nov-92	3.27	20.93	16.29	104.26
Dec-92	2.42	15.49	18.71	119.74
Jan-93	2.10	13.44	20.81	133.18
Feb-93	0.99	6.34	21.80	139.52
Mar-93	0.00	0.00	21.80	139.52
Apr-93	0.00	0.00	21.80	139.52
May-93	3.75	24.00	25.55	163.52
Jun-93	4.17	26.69	29.72	190.21
Jul-93	1.91	12.22	31.63	202.43
Aug-93	1.07	6.85	32.70	209.28
Sep-93	7.04	45.06	39.74	254.34
Oct-93	9.30	59.52	49.04	313.86
Nov-93	8.16	52.22	57.20	366.08
Dec-93	5.31	33.98	62.51	400.06
Jan-94	5.46	34.94	67.97	435.01
Feb-94	6.47	41.41	74.44	476.42
Mar-94	5.27	33.73	79.71	510.14
Apr-94	8.40	53.76	88.11	563.90
May-94	10.71	68.54	98.82	632.45
Jun-94	2.25	14.40	101.07	646.85
Jul-94	4.33	27.71	105.40	674.56
Aug-94	5.97	38.21	111.37	712.77
Sep-94	4.43	28.35	115.80	741.12
Oct-94	0.00	0.00	115.80	741.12
Nov-94	5.23	33.47	121.03	774.59
Dec-94	9.57	61.25	130.60	835.84
Jan-95	6.37	40.77	136.97	876.61
Feb-95	6.02	38.53	142.99	915.14
Mar-95	5.74	36.74	148.73	951.87
Apr-95	3.94	25.22	152.67	977.09
May-95	5.51	35.26	158.18	1,012.35
Jun-95	0.51	3.26	158.69	1,015.62
Jul-95	4.42	28.29	163.11	1,043.90
Aug-95	1.19	7.62	164.30	1,051.52
Sep-95	2.29	14.66	166.59	1,066.18
Oct-95	1.92	12.29	168.51	1,078.46
Nov-95	0.56	3.58	169.07	1,082.05
Dec-95	2.00	12.80	171.07	1,094.85
Jan-96	0.00	0.00	171.07	1,094.85
Feb-96	0.00	0.00	171.07	1,094.85
Mar-96	0.00	0.00	171.07	1,094.85
Apr-96	0.00	0.00	171.07	1,094.85

*The density of JP-4 used is 6.4 lb/gal at 60F density of JP-4 6.40
(U.S. EPA, 1996, Compilation of Air Pollution Emission Factors (AP-42) - Volume 1: Stationary Point and Area Sources, 5th Ed.)

JP-4 Free Product Recovery
at OU1 Area C
Shaw Air Force Base

Cost Per Gallon For Free Product Recovery Interim Remedial Action System At MW-634 O&M Cost

Month	Gallons Recovered/Month	Cumulative Gallons Recovered	O&M Monthly Cost	O&M Cumulative Cost	Monthly Cost Per Gallon Recovered	Cumulative Cost Per Gallon Recovered
Apr-95	0	0	$0.00	$0.00	$0.00	$0.00
May-95	0	0	$0.00	$0.00	$0.00	$0.00
Jun-95	575	575	$952.34	$952.34	$1.66	$1.66
Jul-95	1,097	1,672	$437.46	$1,389.80	$0.40	$0.83
Aug-95	266	1,938	$1,916.60	$3,306.40	$7.21	$1.71
Sep-95	1,257	3,195	$2,739.40	$6,045.80	$2.18	$1.89
Oct-95	1,011	4,206	$1,628.10	$7,673.90	$1.61	$1.82
Nov-95	1,180	5,386	$1,025.80	$8,699.70	$0.87	$1.62
Dec-95	384	5,770	$1,096.60	$9,796.30	$2.86	$1.70
Jan-96	602	6,372	$1,706.87	$11,503.17	$2.84	$1.81
Feb-96	2,145	8,517	$3,230.29	$14,733.46	$1.51	$1.73
Mar-96	734	9,251	$6,187.00	$20,920.46	$8.43	$2.26
Apr-96	746	9,997	$2,671.30	$23,591.76	$3.58	$2.36
May-96	363	10,360	$1,610.08	$25,201.84	$4.44	$2.43
Jun-96	589	10,949	$3,342.72	$28,544.56	$5.68	$2.61
Jul-96	709	11,658	$2,096.85	$30,641.41	$2.96	$2.63
Aug-96	1,108	12,766	$2,386.76	$33,028.17	$2.15	$2.59

Note: Initial O/M costs of $1359.27 were allocated to the months of June and July 1995.

This Page Intentionally Left Blank