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DRAFT FINAL INSTALLATION RESTORATION REMEDIAL INVESTIGATION FEASIBILITY STUDY STAGE 2 VOLUME 9 OF 9 NAS FORT WORTH TX

4/1/1989

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File: 17G
A.F.

NAVAL AIR STATION FORT WORTH JRB CARSWELL FIELD TEXAS

ADMINISTRATIVE RECORD COVER SHEET

AR File Number 39

File: 17A 1b
D.B.

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INSTALLATION RESTORATION PROGRAM
RI/FS STAGE 2

CARSWELL AFB, TEXAS

RADIAN CORPORATION
8501 MO-PAC BOULEVARD
P. O. BOX 201088
AUSTIN, TEXAS 78720-1088

APRIL 1989

FINAL DRAFT (9/87 - 9/88)
VOLUME 9: APPENDICES H-K

PREPARED FOR:

HEADQUARTERS STRATEGIC AIR COMMAND
(HQ SAC/DE)
OFFUTT AIR FORCE BASE, NEBRASKA 68113-5001

UNITED STATES AIR FORCE
OCCUPATIONAL & ENVIRONMENTAL HEALTH LABORATORY
TECHNICAL SERVICES DIVISION (USAFOEHL/TS)
BROOKS AIR FORCE BASE, TEXAS 78235-5501

20th★★★★ Anniversary

RADIAN CORPORATION

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INSTALLATION RESTORATION PROGRAM

RI/FS STAGE 2

DRAFT FINAL
VOLUME 9: APPENDICES H-K

FOR

CARSWELL AFB, TEXAS

HEADQUARTERS STRATEGIC AIR COMMAND
(HQ SAC/DE)
OFFUTT AIR FORCE BASE, NEBRASKA 68113-5001

APRIL 1989

PREPARED BY

RADIAN CORPORATION
8501 MO-PAC BOULEVARD
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AUSTIN, TEXAS 78720-1088

USAF CONTRACT NO. F33615-87-D-4023, DELIVERY ORDER NO. 0004
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USAFOEHL TECHNICAL PROGRAM MANAGER

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TECHNICAL SERVICES DIVISION (TS)
BROOKS AIR FORCE BASE, TEXAS 78235-5501

VOLUME 9

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APPENDIX H

Stage 1 Analytical Results

TABLE 4-5. RESULTS OF SOIL SAMPLE ANALYSES, LANDFILL 4, CARSWELL AFB, TEXAS

Parameter	LOCATION[1] 4A (14-15 ft)	4B (14-15 ft)	4B (19-20 ft)	4C (19-20 ft)	4C (29-30 ft)	4D (19-20 ft)	4D (29-30 ft)	4E (24-25 ft)	4E (29-30 ft) (34-35 ft)
ORGANIC COMPOUNDS (ug/g)									
Phenol	<0.1	<0.1	<0.1 (<0.1, <0.1)	0.3	0.2	0.4	<0.15	0.4	0.3
METALS (ug/g)									
Arsenic	5.7	9.4	<5.2 (<5.1, <5.3)	8.5	5.9	<5.2	<5.7	<5.2	<5.4
Barium	18.0	50.0	36.5 (34.0, 39.0)	18.0	5.5	8.6	6.2	2.8	10
Cadmium	0.32	0.54	<0.17 (<0.17, <0.17)	0.84	0.42	<0.17	<0.19	<0.17	0.38
Chromium	1.7	2.0	1.45 (1.3, 1.6)	4.8	3.7	1.5	2.5	0.44	3.2
Mercury	<0.04	<0.04	<0.04 (<0.04, <0.04)	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Lead	7.8	7.5	<6.9 (<6.8, <7.0)	8.3	<6.3	<7.0	<7.6	<7.0	<7.2
Selenium	<6.1	<6.6	<6.9 (<6.8, <7.0)	<6.0	<6.3	<7.0	<7.6	<7.0	<7.2
Silver	2.0	1.4	0.73 (0.58, 0.88)	1.8	1.5	0.83	<0.19	0.21	0.69

[1] Duplicate field sample results are reported. The average of the two analytical values is shown first, followed by the actual values in parenthesis "( )".

TABLE 4-6. RESULTS OF GROUND-WATER SAMPLE ANALYSES, LANDFILL 4, CARSWELL AFB, TEXAS

Parameter	MONITOR WELL[1] 4A Feb	4A Mar	4B Feb	4B Mar	4C Feb	4C Mar
METALS (mg/l)						
Arsenic - ICP	<0.06	<0.06 [<0.06, <0.06]	<0.06	<0.06	<0.06 [<0.06, <0.06]	<0.06
Barium	0.21	<0.035 [<0.089, 0.08]	0.4	0.87	0.40 [0.36, 0.43]	0.15
Cadmium	<0.002	<0.002 [<0.002, <0.002]	<0.002	<0.002	<0.002 [<0.002, <0.002]	<0.002
Chromium	<0.005	<0.005 [<0.005, <0.005]	<0.005	<0.005	<0.005 [<0.005, <0.005]	<0.005
Lead - ICP	<0.08	<0.08 [<0.08, <0.08]	<0.08	<0.08	<0.08 [<0.08, <0.08]	<0.08
Mercury	0.0024	<0.002 [<0.002, <0.002]	<0.005	<0.005	<0.009 [<0.003, <0.014]	<0.0002
Selenium - ICP	0.08	<0.08 [<0.08, <0.08]	<0.08	<0.08	<0.08 [<0.08, <0.08]	<0.08
Silver	<0.002	<0.002 [<0.002, <0.002]	<0.002	<0.002	<0.002 [<0.002, <0.002]	<0.002
METALS (mg/L) - RA (resampled November 1985)						
Arsenic		0.009		0.006		0.007
Lead		<0.002		<0.002		<0.002
Selenium		<0.003		<0.003		0.004
Mercury		0.0004		0.0003		0.0002
ORGANIC INDICATORS (mg/l)						
Oil & Grease	19	<1 [<1, <1]	<1	<1	21.5 [20, 23]	<1
Phenols	0.013	<0.005 [<0.005, <0.005]	0.088	<0.005	0.058 [0.1, 0.015]	<0.005
TOC	1	5 [8, 2]	1	8	9 [2, 16]	5
PESTICIDES/HERBICIDES (ug/L)	ND	ND	ND	ND	ND	ND
PURGEABLE HALOCARBONS[2] (ug/l)						
Vinyl Chloride	ND, ND	ND, ND	ND, ND	ND, ND	12.4 [12.3, 12.5]	ND, ND
Chloroethane	ND, ND	ND, ND	ND, ND	ND, ND	7.8 [7.8, 7.8]	7.3 [7.0, 7.5]
Methylene Chloride	ND, ND	ND, ND	4.2 [4.1, 4.3]	ND, ND	ND, ND	ND, ND
Trichlorofluoromethane	4.8 [8.8, 3.0]	4.5 [5.1, 3.8]	ND, ND	4.9 [5.1, 4.8]	3.3 [3.4, 3.2]	2.8 [2.0, 3.7]
1,1-Dichloroethene	3.3 [3.4, 3.1]	3.15 [3.1, 3.2]	ND, ND	ND, ND	2.8 [2.8, 2.5]	ND, ND
1,1-Dichloroethane	4.3 [4.4, 4.1]	ND, ND	ND, ND	ND, ND	ND, ND	[ND, 4.5]
1,1,1-Trichloroethane	8.1 [8.0, 8.2]	8.9 [9.2, 8.6]	3.15 [3.1, 3.2]	3.25 [3.2, 3.3]	25.1 [25.1, 25]	ND, ND
1,2-Dichloropropane	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND
Trichloroethylene	3.0 [3.0, 3.0]	3.1 [3.1, 3.1]	ND, ND	1.8 [1.8, 1.8]	ND, ND	29.5 [29.1, 29.8]
Tetrachloroethylene	2.7 [2.7, 2.7]	ND, ND	ND, ND	ND, ND	15.7 [16.3, 15.1]	18.7 [18.5, 18.8]
Chlorobenzene	ND, ND	ND, ND	ND, ND	ND, ND	2.7 2.89, 2.7]	ND, ND
1,4-Dichlorobenzene	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	8.0 [8.1, 8.9]
PURGEABLE AROMATICS[2] (ug/l)						
1,4-Dichlorobenzene	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	[5.5, ND]

(Continued)

TABLE 4-6. (Continued)

Parameter	MONITOR WELL[1] 4D Feb	4D Mar	4E Feb	4E Mar	PR Mar 7	PR Mar 26
METALS (mg/l)						
Arsenic - ICP	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Barium	0.44	0.15	0.41	0.094	0.034	0.039
Cadmium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Lead - ICP	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Mercury	0.007	0.0005	<0.0005	<0.0002	<0.0002	0.0006
Selenium -ICP	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Silver	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
METALS (mg/L) - AA (resampled November 1985)						
Arsenic		<0.003		0.004		0.003
Lead		<0.002		<0.002		<0.002
Selenium		0.003		0.004		<0.003
ORGANIC INDICATORS (mg/l)						
Oil & Grease	<1	<1	<1	<1	<1	<1
Phenols	0.043	<0.005	0.039	<0.005	<0.005	0.02
TOC	2	28	8	5	<1	<1
PESTICIDES/HERBICIDES (ug/L)	ND	ND	ND	ND	ND	ND
PURGEABLE HALOCARBONS[2] (ug/l)						
Vinyl Chloride	7.1 (7.2, 6.8)	ND, ND	ND, ND	ND, ND	ND	ND
Chloroethane	ND, ND	ND, ND	ND, ND	ND, ND	ND	ND
Methylene Chloride	ND, ND	ND, ND	ND, ND	ND, ND	ND	ND
Trichlorofluoromethane	3.5 (3.5, 3.4)	ND, ND	ND, ND	ND, ND	ND	ND
1,1-Dichloroethene	8.1 (7.9, 8.1)	ND, ND	ND, ND	ND, ND	ND	ND
1,1-Dichloroethane	ND, ND	ND, ND	ND, ND	ND, ND	ND	ND
1,1,1-Trichloroethene	ND, ND	ND, ND	ND, ND	ND, ND	ND	ND
1,2-Dichloropropane	2.3 (2.3, 2.3)	ND, ND	ND, ND	ND, ND	ND	ND
Trichloroethylene	3345 (3410, 3280)	3100 (3060, 3140)	3835 (3380, 4290)	4175 (3800, 4550)	ND	ND
Tetrachloroethylene	ND, ND	ND, ND	ND, ND	ND, ND	ND	ND
Chlorobenzene	2.6 (3.5, 3.7)	ND, ND	ND, ND	ND, ND	ND	ND
1,4-Dichlorobenzene	ND, ND	ND, ND	ND, ND	ND, ND	ND	ND
PURGEABLE AROMATICS[2] (ug/l)						
1,4-Dichlorobenzene	ND, ND	ND, ND	ND, ND	ND[3], ND[3]	ND	ND

[1] Duplicate field sample results are reported. The average of the two analytical values is shown first followed by the actual values used in parentheses "( )".

[2] Parameters shown were detected (ND = not detected.)

[3] Method 602 run at 0.01 dilution due to non-602 compound interference.

TABLE 4-7. RESULTS OF SURFACE-WATER SAMPLE ANALYSES, LANDFILL 4, CARSWELL AFB, TEXAS

Parameter	January	February
ORGANIC INDICATORS (mg/L)		
COD	4	<1
TOC	2	3
PESTICIDES/HERBICIDES (ug/L)	ND	ND
PURGEABLE HALOCARBONS (ug/L)		
Vinyl Chloride	2.3	ND
Methylene Chloride	2.7	ND
1,1,1-Trichloroethane	ND	5.0
Trichloroethylene	1.4	4.3
PURGEABLE AROMATICS (ug/L)	ND	ND

Note: Parameters shown were detected (ND = not detected).

TABLE 4-8. RESULTS OF SOIL SAMPLE ANALYSES, LANDFILL 5, CARSWELL AFB, TEXAS

Parameter	LOCATION 5A (24-25 ft)	5A (29-30 ft)	5B (4-5 ft)	5C (14-15 ft)	5C (19-20 ft)
METALS (ug/g)					
Arsenic	7.1	<5.8	<5.9	9.4	<5.9
Barium	2.8	19	70	13	4.4
Cadmium	0.47	<0.19	0.39	0.62	<0.20
Chromium	2.0	4.1	47	3.7	0.74
Lead	<7.8	<7.8	<7.9	8.4	<7.9
Mercury	0.09	0.09	0.21	0.08	<0.05
Selenium	<7.9	<7.8	<7.9	<7.7	<7.9
Silver	<0.20	1.0	0.45	0.54	<0.20
ORGANIC INDICATORS (ug/g)					
Oil & Grease	<10	10	<10	<10	<10
Phenols	0.3	<0.1	<0.1	<0.1	<0.1
PURGEABLE HALOCARBONS[1] (ug/g)					
Trans-1,2-Dichloroethene	0.024	ND	ND	0.033	0.015
Trichloroethylene	0.287	0.257	ND	0.338	0.277
PURGEABLE AROMATICS[1] (ug/g)					
Ethyl Benzene	ND	ND	ND	ND	1.070
Toluene	ND	ND	ND	0.460	ND

[1] Parameters shown were detected (ND = not detected).

TABLE 4-9. RESULTS OF GROUND-WATER SAMPLE ANALYSES, LANDFILL 5, CARSWELL AFB, TEXAS

Parameter	MONITOR WELL[1] 5A Feb	5A Mar	5B Feb	5B Mar	5C Feb	5C Mar	P1 Mar 7	P1 Mar 26
METALS (mg/l)								
Arsenic - ICP	<0.06 [<0.06, <0.06]	<0.06	<0.06	<0.06	<0.06	<0.06 [<0.06, <0.06]	<0.06	<0.06
Barium	0.185 [0.19, 0.19]	0.11	0.59	0.25	0.25	0.13 [0.13, 0.13]	0.023	0.032
Cadmium	<0.002 [<0.002, <0.002]	<0.002	<0.002	<0.002	<0.002	<0.002 [<0.002, <0.002]	<0.002	<0.002
Chromium	<0.005 [<0.005, <0.005]	<0.005	<0.005	<0.005	<0.005	<0.005 [<0.005, <0.005]	<0.005	<0.005
Lead - ICP	<0.08 [<0.08, <0.08]	<0.08	<0.08	<0.08	<0.08	<0.08 [<0.08, <0.08]	<0.08	<0.08
Mercury	0.005 [0.007, <0.003]	<0.0003	<0.0003	<0.005	<0.0002	[<0.0002, <0.0002]	0.0004	0.0002
Selenium - ICP	<0.08 [<0.08, <0.08]	<0.08	<0.08	<0.08	<0.08	<0.08 [<0.08, <0.08]	<0.08	<0.08
Silver	<0.002 [<0.002, <0.002]	<0.002	<0.002	<0.002	<0.002	<0.002 [<0.002, <0.002]	<0.002	<0.002
METALS (mg/L) - AA (resampled November 1985)								
Arsenic		0.005		0.018		0.005		<0.003
Lead		<0.002		<0.002		<0.002		<0.002
Selenium		0.003		<0.003		<0.003		<0.003
ORGANIC INDICATORS (mg/l)								
Oil & Grease	51 [59, 43]	<1 [<1, <1]	215 [220, 210]	<1	45	<1, <1	<1	<1
Phenols	0.065 [0.075, 0.055]	<0.005	0.005	<0.005	0.012	<0.005 [<0.005, <0.005]	<0.005	<0.005
TOC	1.5 [1, 2]	1	8	8	4	2, 2	<1	<1
TOX	[0.05, 1.5]	1.1 [0.85, 1.4]	0.035 [0.04, 0.03]	0.02	1.3	0.82 [1.0, 0.63]	<0.01	<0.01
PURGEABLE HALOCARBONS[2] (ug/l)								
Vinyl Chloride	ND, ND	ND, ND	131.5 [135, 128]	171.5 [165, 178]	ND, ND	ND, ND	ND	ND
Chloroethene	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND	ND
Methylene Chloride	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND	ND
Trichlorofluoromethene	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND	ND
1,1-Dichloroethene	ND, ND	ND, ND	[7.5, ND]	ND, ND	ND, ND	ND, ND	ND	ND
1,1-Dichloroethene	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND	ND
1,1,1-Trichloroethene	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND	ND
1,2-Dichloropropene	ND, ND	ND, ND	[2.6, ND]	ND, ND	ND, ND	ND, ND	ND	ND
Trichloroethene	3240 [3200, 3280]	2840 [2730, 3150]	[6.3, ND]	38.4 [38.6, 37.1]	1755 [1760, 1750]	2155 [2330, 1980]	ND	ND
Tetrachloroethylene	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND	ND
Chlorobenzene	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND	ND
PURGEABLE AROMATICS[2] (ug/l)	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND	ND

[1] Duplicate field sample results are reported. The average of the two analytical values is shown first, followed by the actual values used in parentheses "[ ]".

[2] Parameters shown were detected; other parameters not listed were scanned but not detected.

TABLE 4-10. RESULTS OF SURFACE-WATER SAMPLE ANALYSES, LANDFILL 5, CARSWELL AFB, TEXAS

Parameter	January	February
ORGANIC INDICATORS (mg/L)		
Oil & Grease	350	<1
TOC	8	12
COD	5	9
PESTICIDES/HERBICIDES (ug/L)[1]	NA	ND
PURGEABLE HALOCARBONS (ug/L)[2]		
Vinyl Chloride	ND	38.7
trans-1,2-Dichloroethene	ND	56.9
Trichloroethylene	ND	4.4
PURGEABLE AROMATICS (ug/L)	ND	ND

Notes: [1]Sample container broken during shipment. (NA = not analyzed).
[2]ND = not detected.

TABLE 4-11. RESULTS OF SOIL SAMPLE ANALYSES, WASTE BURIAL AREA (SITE 10), CARSWELL AFB, TEXAS

Parameter[1]	LOCATION				
	10A (28-30 ft)	10B (14-15 ft)	10B (28-30 ft)	10C (24-25 ft)	10C (28-30 ft)
Oil & Grease (ug/g)	<10	<10	<10	<10	<10
1,1,1-Trichloroethane (ug/g)	ND	ND	0.044	ND	ND
Trichloroethylene (ug/g)	0.014	ND	0.067	0.0151	0.021

[1]Parameters shown were detected (ND = not detected).

TABLE 4-12. RESULTS OF GROUND-WATER SAMPLE ANALYSES, WASTE BURIAL AREA (SITE 10), CARSWELL AFB, TEXAS

Parameter	MONITOR WELL[1] 10A Feb	10A Mar	10B Feb	10B Mar	10C Feb	10C Mar
ORGANIC INDICATORS (mg/l)						
Oil & Grease	270	<1	270	<1	310	<1
TOC	1	<1	2	7	5	7
TOX	0.05	1.4 (1.4, 1.4)	0.08	0.02	0.16	0.03
PURGEABLE HALOCARBONS[2] (ug/l)						
Vinyl Chloride	ND, ND	ND, ND	(8.8, ND)	ND, ND	ND, ND	ND, ND
Trichlorofluoromethane	ND, ND	ND, ND	(5.3, ND)	ND, ND	ND, ND	ND, ND
1,1-Dichloroethene	ND, ND	ND, ND	(8.8, ND)	ND, ND	ND, ND	ND, ND
Trichloroethylene	4070 (4120, 4020)	3570 (3550, 3590)	4470 (4510, 4430)	4780 (5000, 4560)	2785 (3680, 1870)	2190 (2130,2250)
Tetrachloroethylene	ND, ND	ND, ND	89.2 (36.4, 102)	43.0 (43.3, 42.7)	ND, ND	ND, ND
PURGEABLE AROMATICS[2] (ug/L)	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND

[1] Duplicate field sample results are reported. The average of the two analytical values is shown first, followed by the actual values used in parenthesis "( )".
[2] Parameters shown were detected; other parameters not listed were scanned but not detected.

TABLE 4-13. RESULTS OF SOIL SAMPLE ANALYSES, FIRE DEPARTMENT TRAINING AREA NO. 1 (SITE 11), CARSWELL AFB, TEXAS

Parameter	LOCATION[1] 11A (9-10 ft)	11B (9-10 ft)	11 C (0 ft)	11 C (2 ft)	11 C (4 ft)	11 C (6 ft)
METALS (ug/g)						
Arsenic	14	<3	<3	<3 (<3,<3)	<3	<3
Barium	<0.23	<0.23	42	39.5 (47,32)	32	20
Cadimium	<0.23	<0.2	<0.39	<0.40 (<0.39,<0.4)	<0.4	<0.39
Chromium	3.0	2.0	6.4	7.6 (7.9,7.3)	6.5	7.1
Lead	<4	<4	8	12.5 (13,12)	13	<4
Mercury	0.14	0.21	0.11	0.14 (0.08,0.19)	0.11	0.15
Selenium	9	<4	11	16.5 (17,16)	20	9
Silver	3.1	<0.18	<0.2	(<0.2,0.72)	1.6	0.74
ORGANIC INDICATORS (ug/g)						
Oil and Grease	<10	<10	100	(2200,<10)	<10	<10
Phenols	<0.1	<0.1	<0.1	<0.1 (<0.1,<10)	<0.1	<0.1
INSECTICIDES[2] (ug/g)	ND	ND	ND	ND,ND	ND	ND
HERBICIDES[2] (ug/g)	ND	ND	ND	ND,ND	ND	ND
PURGEABLE HALOCARBONS[2] (ug/g)						
Trichloroethylene	0.251	ND	0.249	ND,ND	ND	0.257
PURGEABLE AROMATICS[2] (ug/g)	ND	ND	ND	ND,ND	ND	ND

[1]Duplicate field sample results are reported. The average of the two analytical values is shown first, followed by the actual values in parenthesis "( )".
[2]Parameters shown were detected (ND = not detected).

TABLE 4-14. RESULTS OF GROUND-WATER SAMPLE ANALYSES, FIRE TRAINING AREA 1 (SITE 11), CARSWELL AFB, TEXAS

Parameter	MONITOR WELL[1] 11A Feb	11A Mar	11B Feb	11B Mar
METALS (mg/l)				
Arsenic - ICP	<0.06	<0.06	<0.06	<0.06
Barium	0.16	0.18	0.18	0.16
Cadmium	<0.002	<0.002	<0.002	<0.002
Chromium	<0.005	<0.005	<0.005	<0.005
Lead - ICP	<0.08	<0.08	<0.08	<0.08
Mercury	0.0002	0.0003	0.0005	0.0002
Selenium - ICP	<0.08	<0.08	<0.08	<0.08
Silver	<0.002	<0.002	<0.002	<0.002
METALS (mg/L) - AA (resampled November 1985)				
Arsenic		0.004		0.041
Lead		<0.002		<0.002
Selenium		<0.003		<0.003
ORGANIC INDICATORS (mg/l)				
Oil & Grease	50 [55, 45]	<1	200	<1
Phenols	0.005	<0.005	0.005	<0.005
TOC	7	7	15	14
TOX	0.075 [0.01, 0.14]	0.03	0.04	0.25 [0.27, 0.23]
HERBICIDES[2] (ug/l)				
2,4,5-T	[ND, 0.2]	ND	ND	ND
PESTICIDES[2] (ug/L)	ND, ND	ND	ND	ND
PURGEABLE HALOCARBONS[2] (ug/l)				
Trichlorofluoromethene	2.35 [2.3, 2.4]	5.1 [4.4, 5.7]	ND, ND	[ND, 3.2]
Trichloroethylene	ND, ND	ND, ND	[ND, 1.4]	[ND, 1.8]
PURGEABLE AROMATICS[2] (ug/l)				
Benzene	ND, ND	ND, ND	ND, ND	2.8 [1.5, 3.8]

[1] Duplicate field sample results are reported. The average of the two analytical values is shown first, followed by the actual values used in parenthesis "[ ]".

[2] Parameters shown were detected (ND = not detected).

TABLE 4-15. RESULTS OF SOIL SAMPLE ANALYSES, FIRE TRAINING AREA 2 (SITE 12), CARSWELL AFB, TEXAS

Parameter	LOCATION[1] 12A (19-20 ft)	12B (9-10 ft)	12B (14-15 ft)	12B (34-35 ft)	12C (24-25 ft)	12F (0 ft)	12F (2 ft)	12F (4 ft)	12F (6 ft)	12F (8 ft)
METALS (ug/g)										
Arsenic	<5.7 [<5.9, <5.5]	<5.3 [<5.5, <5.0]	<5.5	<4.8	<5.2	<3	<11 [19, <3]	<3	<3	<3
Barium	28 [26, 30]	34 [30, 38]	2.4	4.4	7.5	20	92 [84, 100]	74	59	23
Cadmium	0.28 [<0.19, 0.37]	0.45 [0.37, 0.53]	<0.16	<0.16	<0.17	<0.20	0.54 [0.69, <0.39]	<0.39	<0.39	<0.39
Chromium	4.6 [4.6, 4.6]	5.0 [4.6, 5.3]	1.4	0.84	2.5	7.6	13 [15, 11]	14	9.3	8.6
Lead	8.9 [9.6, 8.2]	10.6 [8.2, 13]	<7.3	<6.4	<7.0	18	52 [49, 54]	19	13	<4
Mercury	<0.04 [<0.04, <0.04]	<0.04 [<0.04, <0.04]	<0.04	<0.04	<0.04	0.12	0.07 [<0.05, 0.09]	0.10	<0.05	0.21
Selenium	8.6 [<7.8, 9.3]	12.2 [9.3, 15]	<7.3	<6.4	<7.0	<4	35 [38, 32]	24	17	<4
Silver	0.63 [0.69, 0.56]	0.60 [0.56, 0.63]	0.61	<0.16	<0.17	2.8	2.2 [2.7, 1.6]	1.6	1.8	0.46
ORGANIC INDICATORS (ug/g)										
Oil & Grease	<10.0, <10.0	<10.0, <10.0	700	<10	<10	17,000	13,000; 11,000	9,800	8,200	11,000
Phenols	<0.1, <0.1	<0.1, <0.1	<0.1	<0.1	<0.1	<0.1	1.5, 1.3	1.2	2.0	2.4
PURGEABLE HALOCARBONS[2,3] (ug/g)										
1,2-Dichlorobenzene	ND, ND	ND, ND	ND	ND	ND	ND	0.689 [0.699, 0.679]	1.659	1.170	0.721
1,3-Dichlorobenzene	ND, ND	ND, ND	ND	ND	ND	ND	ND, ND	0.464	0.364	0.273
1,1,2,2-Tetrachloroethane	ND, ND	ND, ND	ND	ND	ND	ND	0.273 [0.271, 0.274]	0.327	0.384	1.000
Trichloroethylene	ND, ND	ND, ND	ND	ND	ND	258	0.277 [0.276, 0.278]	0.288	0.320	0.385
Trichlorofluoromethane	ND, ND	ND, ND	ND	ND	ND	210	ND, ND	ND	ND	ND
PURGEABLE AROMATICS[2,3] (ug/g)										
Benzene	ND, ND	ND, ND	ND	ND	ND	6.44	[ND; 752.0]	ND	ND	ND
Ethyl Benzene	ND, ND	ND, ND	2.9	ND	ND	32.2	[ND, 23,700]	28.4	63.6	110.0
Toluene	ND, ND	ND, ND	1.4	ND	ND	12.2	[ND, 27,400]	36.1	84.3	134.0

[1] Duplicate field sample results are reported. The average of the two analytical values is shown first, followed by the actual values used in parenthesis "[ ]".
[2] Parameters shown were detected (ND = not detected).
[3] Method detection limits: Purgeable halocarbons - 10 ug/Kg for 12A, 12B, 12C, and 12F
Purgeable aromatics - 250 ug/Kg for 12A, 12B, 12C; 2500 ug/Kg for 12F [D], 12F [4], 12F [6], 12F [8]; 12,500 ug/Kg and 500 ug/Kg for splits of 12F [2].

TABLE 4-16. RESULTS OF GROUND-WATER SAMPLE ANALYSES, FIRE TRAINING AREA 2 (SITE 12), CARSWELL AFB, TEXAS

Parameter	MONITOR WELL[1] 12A Feb	12A Mar	12B Feb	12B Mar	12C Feb	12C Mar
METALS (mg/l)						
Arsenic - ICP	<0.06 [<0.06, <0.06]	<0.06	<0.06	<0.06	<0.06	<0.06
Barium	0.078 [0.1, 0.097]	0.11	0.14	0.16	0.18	0.18
Cadmium	<0.0002 [<0.002, <0.002]	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium	<0.0005 [<0.005, <0.005]	<0.005	<0.005	<0.005	<0.005	<0.005
Lead - ICP	<0.08 [<0.08, <0.08]	<0.08	<0.08	<0.08	<0.08	<0.08
Mercury	<0.0002 [<0.0002, <0.0002]	<0.0002	0.0003	<0.0002	<0.0002	<0.0002
Selenium - ICP	<0.08 [<0.08, <0.08]	<0.08	<0.08	<0.08	<0.08	<0.08
Silver	<0.002 [<0.002, <0.002]	<0.002	<0.002	<0.002	<0.002	<0.002
METALS (mg/L) - AA (resampled November 1985)						
Arsenic		<0.003		<0.003		0.004
Lead		<0.002		<0.002		<0.002
Selenium		<0.003		<0.003		<0.003
ORGANIC INDICATORS (mg/l)						
Oil & Grease	37.5 [41, 34]	<1	34	<1	89	<1, <1
Phenols	0.017 [0.013, 0.021]	<0.005	0.017	<0.005	0.005	0.006
TOC	<1 [<1, <1]	<1	1	<1	5	<1
TOX	<0.1 [<0.01, <0.01]	0.01	0.38	0.38	0.03	0.11, 0.10
PURGEABLE HALOCARBONS[2] (ug/L)						
Vinyl Chloride	ND, ND	ND, ND	ND, ND	ND, ND	9.0 [9.4, 8.5]	ND, ND
Trichlorofluoromethane	14.2 [12.6, 15.7]	4.0 [3.8, 4.1]	ND, ND	ND, ND	12.0 [13.3, 10.6]	ND, ND
1,1-Dichloroethene	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	2.5 [2.5, 2.5]
1,1-Dichloroethane	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	5.85 [5.9, 5.8]
1,1,1-Trichloroethane	ND, ND	2.6 [2.8, 2.8]	ND, ND	ND, ND	2.9 [2.9, 2.9]	2.9 [2.9, 2.9]
Trichloroethylene	ND, ND	2.2 [2.2, 2.2]	360 [358, 362]	190 [187, 193]	4.8 [4.8, 4.8]	5.7 [5.8, 5.6]
Tetrachloroethylene	ND, ND	2.55 [2.5, 2.6]	161.5 [159, 164]	89.6 [87, 92.2]	4.85 [4.7, 4.8]	8.4 [8.6, 8.1]
PURGEABLE AROMATICS[2] (ug/l)						
1,2-Dichlorobenzene	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	[ND, 3.9]
1,4-Dichlorobenzene	ND, ND	ND, ND	ND, ND	[2.3, ND]	ND, ND	3.6 [4.1, 3.0]

[1] Duplicate field sample results are reported. The average of the two analytical values is shown first, followed by the actual values used in parenthesis "[ ]".

[2] Parameters shown were detected; other parameters not listed were scanned but not detected.

TABLE 4-17. RESULTS OF SURFACE-WATER SAMPLE ANALYSES, FIRE TRAINING AREA 2, CARSWELL AFB, TEXAS

Parameter	January	February
METALS (mg/L)		
Arsenic	0.16	<0.06
Barium	0.29	0.15
Cadmium	0.007	<0.002
Chromium	0.017	<0.005
Lead	0.081	<0.08
Mercury	0.0003	0.0006
Selenium	<0.08	<0.08
Silver	<0.002	<0.002
ORGANIC INDICATORS (mg/L)		
Oil & Grease	84,000	1
Phenols	0.14	
TOC	50,000	86
TOX	0.63	<0.01
PURGEABLE HALOCARBONS (ug/L)		
Trichlorofluoromethane	ND	3.5
PURGEABLE AROMATICS (ug/L)	ND	ND

Note: ND = not detected.

TABLE 4-20. RESULTS OF SOIL SAMPLE ANALYSES, LANDFILL 1, CARSWELL AFB, TX

Parameter	BORING[1] 1A (4-5 ft)	1B (9-10 ft)	1B (19-20 ft)	1C (14-15 ft)	1C (24-25 ft)	1D (9-10 ft)	1D (19-20 ft)	1D (20 ft)
METALS (ug/g)								
Arsenic	<3.0	<3.0	<3.0, <3.0	<3.0	<3.0	<3.0	<3.0	11
Barium	16	40	43, 41	25	23	48	16	17
Cadmium	<0.39	<0.39	<0.40, <0.40	<0.40	<0.40	<0.39	<0.39	<0.40
Chromium	1.8	22	6.3, 6.5	4.3	5.4	5.7	6.9	8.0
Lead	<4.0	8	10, 8	<4.0	<4.0	8	5	9
Mercury	<0.05	0.13	0.10, 0.11	0.12	0.17	0.06	0.07	0.08
Selenium	<4.0	17	16, 12	10	<4.0	12	7	7
Silver	1.1	1.6	1.7, 1.4	1.4	1.4	1.0	2.1	2.1
ORGANIC COMPOUNDS (ug/g)								
Oil and Grease	71	76	210, 68	130	84	<10	85	<10
Phenols	<0.1	<0.1	<0.1, <0.1	<0.1	<0.1	<0.1	<0.1	<0.1
HERBICIDES[2] (ug/L)								
2,4-D	ND	ND	ND, ND	ND	ND	ND	D.52	ND
PESTICIDES[2] (ug/Kg)	ND	ND	ND, ND	ND	ND	ND	ND	ND
PURGEABLE HALOCARBONS[2] (ug/Kg)	ND	ND	ND, ND	ND	ND	ND	ND	ND
PURGEABLE AROMATICS[2] (ug/Kg)	ND	ND	ND, ND	ND	ND	ND	ND	ND

[1]Duplicate field samples are reported.
[2]Parameters shown were detected (ND = not detected).

TABLE 4-21. RESULTS OF GROUND-WATER SAMPLE ANALYSES, LANDFILL 1, CARSWELL AFB, TEXAS

Parameter	MONITOR WELL[1] 1A Feb	1A Mar	1B[2] Feb	1B[2] Mar	1C Feb	1C Mar	1D Feb	1D Mar
METALS (mg/L)								
Arsenic - ICP	<0.06	<0.06, <0.06	Not	<0.06	<0.06	<0.06	<0.06, <0.06	<0.06
Barium	0.34	0.21, 0.21	Sampled	0.28	0.18	0.18	0.088, 0.11	0.12
Cadmium	<0.002	<0.002, <0.002		<0.002	<0.002	<0.002	<0.002, <0.002	<0.002
Chromium	<0.005	<0.005, <0.005		<0.005	<0.005	<0.005	<0.005, <0.005	<0.005
Lead - ICP	<0.08	<0.08, <0.08		<0.08	<0.08	<0.08	<0.08, <0.08	<0.08
Mercury	0.0006	<0.0002, <0.0002		0.0008	0.0004	0.0003	<0.0002, 0.0005	<0.0002
Selenium - ICP	<0.08	<0.08, <0.08		<0.08	<0.08	<0.08	<0.08, <0.08	<0.08
Silver	<0.002	<0.002, <0.002		<0.002	<0.002	<0.002	<0.002, <0.002	<0.002
METALS (mg/L) - AA (resampled November 1986)								
Arsenic		0.012				0.006		0.006
Lead		<0.002				0.003		<0.002
Selenium		<0.003				<0.003		<0.003
ORGANIC INDICATORS (mg/L)								
Oil and Grease	170, 180	<1, <1		Not	<1	<1, <1	63, 63	<1
Phenols	0.074	<0.005, <0.005		Sampled	0.026	<0.005	0.038, 0.059	0.01
TOC	3	11, 9			3	7	7, 8	11
TOX	<0.01	0.01, 0.01			<0.01	0.03, 0.07	<0.01, <0.01	0.01
HERBICIDES[3] (ug/L)								
2,4,5-T	ND, ND	ND, ND			ND	ND, ND	ND, 0.2	ND
PESTICIDES[3]	ND, ND	ND, ND			ND	ND, ND	ND, ND	ND
PURGEABLE HALOCARBONS[3] (ug/L)								
Trichlorofluoromethane	ND, ND	3.4, 3.1		ND	ND, ND	ND, 3.1	ND, ND	3.6, 3.8
Trans-1,2-Dichloroethene	ND, ND	ND, ND		ND	0.8, 0.8	ND, ND	ND, ND	ND, ND
Trichloroethene	1.3, ND	ND, ND		ND	ND, ND	1.3, 1.4	ND, ND	ND, ND
PURGEABLE AROMATICS[3]	ND, ND	ND, ND		ND	ND, ND	ND, ND	ND, ND	ND, ND

[1] Duplicate field samples are reported.
[2] Well 1B was partially sampled due to extremely low yield of water.
[3] Parameters shown were detected (ND = not detected).

TABLE 4-22. RESULTS OF SOIL SAMPLE ANALYSES, FLIGHTLINE DRAINAGE DITCH, CARSWELL AFB, TX

Parameter	BORING 13A (0 ft)	13B (0 ft)	13B (2 ft)	13B (4 ft)	13C (0 ft)	13C (2 ft)	13C (4 ft)	13C (8 ft)
METALS (ug/g)								
Arsenic	<0.08	<0.08	<0.08, <0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Barium	1.1	1.0	0.9, 1.0	0.91	0.89	0.88	0.72	0.45
Cadmium	<0.002	0.023	<0.002, <0.002	<0.002	0.031	<0.002	<0.002	<0.002
Chromium	<0.005	0.008	0.007, <0.005	<0.005	<0.005	<0.005	<0.005	<0.008
Lead	<0.08	<0.08	<0.08, <0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Mercury	0.0003	0.0007	0.0004, 0.0003	0.0003	0.0003	0.0003	0.0016	0.0008
Selenium	<0.08	<0.08	<0.08, <0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Silver	<0.002	<0.002	<0.002, <0.002	<0.002	<0.002	<0.002	<0.002	<0.002
ORGANIC COMPOUNDS (ug/g)								
Oil and Grease	510	<10	<10, <10	<10	80	<10	<10	<10

(Continued)

TABLE 4-22. (Continued)

Parameter	BORING 13D (0 ft)	13D (2 ft)	13D (4 ft)	13D (8 ft)	13D (8 ft)	13E (0 ft)	13F (0 ft)	13F (0 ft)
METALS (ug/g)								
Arsenic	<0.08	<0.08	<0.08	<0.08	<0.08	-	-	<0.08
Barium	1.1	1.2	0.78	0.86	0.54	-	-	0.99
Cadmium	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	0.03
Chromium	<0.005	<0.005	0.014	0.008	<0.005	-	-	<0.005
Lead	<0.08	<0.08	<0.08	<0.08	<0.08	-	-	<0.08
Mercury	0.0003	0.0004	0.0004	<0.0002	0.0011	-	-	0.0016
Selenium	<0.08	<0.08	<0.08	<0.08	<0.08	-	-	<0.08
Silver	<0.002	<0.002	0.005	<0.002	<0.002	-	-	<0.002
ORGANIC COMPOUNDS (ug/g)								
Oil and Grease	650	<10	<10	<10	<10	80	30	<10

(Continued)

TABLE 4-22. (Continued)

Parameter	BORING 13F (2 ft)	13F (2 ft)	13F (4 ft)	13F (8 ft)	13F (8 ft)	13G SS	13H SS	13I SS
METALS (ug/g)								
Arsenic	-	<0.08	-	-	-	<0.08	-	0.19
Barium	-	0.94	-	-	-	0.38	-	0.37
Cadmium	-	<0.002	-	-	-	<0.002	-	0.007
Chromium	-	<0.005	-	-	-	<0.005	-	0.022
Lead	-	<0.08	-	-	-	<0.08	-	0.12
Mercury	-	0.0004	-	-	-	0.0006	-	0.13
Selenium	-	<0.08	-	-	-	<0.08	-	0.18
Silver	-	<0.002	-	-	-	<0.002	-	0.027
ORGANIC COMPOUNDS (ug/g)								
Oil and Grease	1300	50	2000	160	1400	<10	270	69

SS = Surface Sediment.

TABLE 4-23. RESULTS OF GROUND-WATER SAMPLE ANALYSES, SITE 15, CARSWELL AFB, TX

Parameter	MONITOR WELL 15A Feb	15A Mar	15B Feb	15B Mar	15C Feb	15C Mar
ORGANIC INDICATORS (mg/L)						
TOC	3	4	4	5	<1	2
HERBICIDES[1] (ug/L)	ND	ND	ND	ND	ND	ND
INSECTICIDES[1] (ug/L)						
Lindane	ND	ND	ND	ND	<0.1	ND
Endrin	ND	ND	ND	ND	<0.1	ND

[1]Parameters shown were detected (ND = not detected).

TABLE 4-24. RESULTS OF SOIL SAMPLE ANALYSES, UNNAMED STREAM (SITE 16), CARSWELL AFB, TEXAS

Depth (ft) Parameter	BORING 16D (0-2 ft)	16E (2 ft)	16E (8 ft)	16F (1 ft)	16F (9 ft)	16G (0-2 ft)
METALS (ug/g)						
Arsenic	11	9.9	6.1	<5.8	<6.1	7.0
Barium	48	85	74	45	57	58
Cadmium	0.70	0.89	0.56	0.19	<0.2	0.55
Chromium	7.1	13	8.6	4.6	5.1	5.5
Lead	19	20	13	3.6	8.4	18
Mercury	0.08	0.10	0.10	0.09	0.05	0.09
Selenium	20	41	24	9.5	9.1	16
Silver	1.2	1.2	1.2	0.56	0.82	0.8
ORGANIC COMPOUNDS (ug/g)						
Oil and Grease	44	61	240	<10	27	56
PURGEABLE AROMATICS[1] (ug/g)						
Toluene	ND	ND	ND	ND	0.540	ND
PURGEABLE HALOCARBONS[1] (ug/g)	ND	ND	ND	ND	ND	ND

[1]Parameters listed were detected (ND = not detected)

TABLE 4-25. RESULTS OF WATER SAMPLE ANALYSES, UNNAMED STREAM (SITE 16), CARSWELL AFB, TX

Parameter	GROUND WATER FROM BORINGS			SURFACE WATER[1]			
				Oil/Water Separator		Unnamed Stream	
	16A	16B	16C	Jan	Feb	Jan	Feb
METALS (mg/L)							
Arsenic - ICP	<0.06	<0.06	<0.06	0.16	<0.08	<0.06	<0.06
Barium	1.3	0.86	1.2	0.29	0.28	0.25	0.25
Cadmium	<0.002	<0.002	<0.002	0.007	<0.002	<0.002	<0.002
Chromium	<0.005	<0.005	<0.005	0.017	<0.005	<0.005	<0.005
Lead - ICP	<0.080	<0.080	<0.080	0.081	<0.08	<0.080	<0.08
Mercury	0.0004	0.0006	0.0004	0.0003	0.0004	0.0005	0.0004
Selenium - ICP	<0.080	<0.080	<0.080	<0.080	<0.08	<0.080	<0.08
Silver	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
METALS (mg/L) - AA (resampled November 1985)							
Arsenic					0.056		0.042
Lead					<0.002		<0.002
Selenium					<0.003		<0.003
ORGANIC INDICATORS (mg/L)							
Oil and Grease	940	<1	7100	640	1	<1	<1
TOC	230	1	420	200	4	4	4
TOX	0.01	<0.01	<0.01		0.01		0.04
PURGEABLE HALOCARBONS (ug/L)							
Trichlorofluoromethane	4.2	ND	ND	ND	2.9	ND	3.3
Trans-1,2-Dichloroethane	0.1	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	2.9	ND	ND	ND	ND	ND
Tetrachloroethylene	ND	ND	ND	ND	ND	ND	3.4
PURGEABLE AROMATICS (ug/L)	*[2]	high[3]	very high[3]	ND	ND	ND	ND

[1] The surface water samples were also analyzed for herbicides and pesticides, but neither was detected.
[2] Sample bottle broken during storage.
[3] Both samples 16B and 16C contained large amounts of organic contaminants, but the amounts could not be quantified due to interference.

TABLE 4-26. RESULTS OF SOIL SAMPLE ANALYSES, POL TANK FARM (SITE 17), CARSWELL AFB,TX

	BORINGS												
Depth (ft)	17A (9-10)	17A (14-15)	17B (9-10)	17B (19-20)	17C (9-10)	17C (14-15)	17D (14-15)	17E (9-10)	17E (14-15)	17F (14-15)	17G (9-10)	17G (14-15)	17H (14-15)
ORGANIC INDICATORS													
Oil and Grease (ug/g)	170	170	<10	<10	<10	<10	<10	1300	170	<10	510	<10	<10

TABLE 4-27. RESULTS OF GROUND-WATER ANALYSES, POL TANK FARM, CARSWELL AFB, TX

	BORING							
Parameter	17A	17B	17C	17D	17E	17F	17G	17H
ORGANIC INDICATORS (ug/L)								
Oil and Grease	<1*	<1*	<1*	5200	31,000	<1*	10,000	<1*
TOC	77	190	100	70	44	100	60	55
TOX	0.01	<0.01	<0.01	0.12	<0.01	0.01	<0.01	<0.01

*Value not reliable, interferance suspected in analysis.

TABLE 4-28. RESULTS OF SOIL SAMPLE ANALYSES, WEAPONS STORAGE AREA, CARSWELL AFB, TEXAS

Parameter	BORING					
	Drainage Ditch (upslope)		Drainage Ditch (downslope)		Concrete Pad	
	(1.5 ft)	(3.25 ft)	(1.5 ft)	(2.5 ft)	(1.5 ft)	(ft)
ORGANIC INDICATOR (ug/g)						
Oil & Grease	<10	<10	14	<10	<10	<10
PURGEABLE HALOCARBONS (ug/g)						
Trichloroethylene	ND	0.0619	ND	ND	ND	ND
PURGEABLE AROMATICS (ug/g)						
	ND	ND	ND	ND	ND	ND

Note: ND = not detected

TABLE 4-29. RESULTS OF GROUND-WATER SAMPLE ANALYSIS, WEAPONS STORAGE AREA, CARSWELL AFB, TEXAS

Parameter	Concentration*
Gross Alpha	3.6 (1.5)
Gross Beta	5.1 (1.8)
Total Radium	8.5 (0.9)

*Units are in pCi/L; values in parentheses represent +/-one standard deviation at 68% confidence level.

TAB

I

APPENDIX I

Soil Gas Survey

- D R A F T -

SOIL VAPOR SURVEY
CARSWELL AIR FORCE BASE
FORT WORTH, TEXAS

Report to
RADIAN CORPORATION
Austin, Texas

- D R A F T -

McClelland engineers

Report No. 0187-3559
January 5, 1988

Radian Corporation
8501 Mo-Pac Blvd.
Austin, Texas 78766

Attention: Mr. Larry French

Soil Vapor Survey
Carswell Air Force Base
Fort Worth, Texas

Submitted herein is a copy of our report of the soil vapor survey conducted at Carswell Air Force Base in Fort Worth, Texas. This work was authorized under Radian Purchase Order No. 57580, dated December 15, 1987.

It has been a pleasure working with Radian on this project. We will be calling you to discuss this report and answer any questions that you may have.

Sincerely,

McCLELLAND ENGINEERS, INC.

Robert B. Beck
Chemical Engineer

Susan T. Litherland, P.E.
Project Manager

RBB/STL/dka(8,109:186)
Copies Submitted: 3

C O N T E N T S

1.0 INTRODUCTION

McClelland Engineers conducted a soil gas sampling survey at Site 17 and the Base Service Station at Carswell Air Force Base in Fort Worth, Texas. The purpose of this effort was to investigate possible subsurface contamination with volatile organic compounds. This work was authorized under Radian Purchase Order No. 57580, dated December 15, 1987.

On December 16 through 19, McClelland Engineers analyzed a total of 58 soil vapor samples from 49 locations. Fifteen of the samples analyzed had total organic levels greater than 10 parts per million (ppm) as equivalent methane. These elevated organic levels were found primarily in the areas immediately adjacent to Tanks 1156 and 1157 at Site 17, and the underground tanks at the Base Service Station.

The remaining sections of the report discuss the field investigation and the results obtained. It is our understanding that this information will be used by Radian to aid in the selection of monitoring well locations at these sites.

2.0 FIELD INVESTIGATION

The field investigation consisted of completing soil gas sampling at 49 locations.

2.1 Approach

Soil gas sampling locations and depths were selected by Mr. Guy Childs, a representative of Radian Corporation, who was onsite during all field investigation activities. The sample location maps for Site 17 and the Base Service Station provided to us by Mr. Childs are presented in Appendix A. In general, the following activities were completed at each location:

(1) drilling through the slab, at Base Service Station locations SG6, SG7, SG8, and SG9 only;

(2) pushing the Vadose Zone Vapor Probe (VZV Probe®) to the selected sampling depth;

(3) pulling five probe and sample line volumes of soil gas through the system and venting to atmosphere (an inline flow meter was used to calculate volumes through the system);

(4) collecting a soil gas sample in a Tedlar® bag positioned in a vacuum chamber;

(5) disconnecting the Tedlar® bag from the collection system;

(6) analyzing a sample of the Tedlar® bag contents with an organic vapor analayzer/gas chromatograph (Foxboro OVA/GC Model No. 128);

(7) purging the probe and tubing with Zero Air (hydrocarbon-free air) and analyzing outlet gases to verify that the probe was clean. (This step was completed only after sampling vapors with total organic levels exceeding 10 ppm.)

Two types of field analyses were performed on the contents of the Tedlar® bag. First, a total organic vapor concentration was recorded using McClelland's OVA/GC. In the OVA mode, the OVA/GC flame ionizes organic species in the sample and creates a current. The current is converted to and displayed as ppm methane equivalent. For most samples with total organic concentrations exceeding 10 ppm, a field gas chromatograph was run. In the GC mode, the vapor sample is first passed through a column which separates the organic compounds based on their differing physical and chemical characteristics. The smaller, more volatile compounds elute faster than the larger,

less volatile compounds. As the sample exits the column, a flame ionizes the species and again a current is measured. The relative current vs time is plotted with a strip chart recorder.

2.2 Difficulties

The main difficulty encountered during this investigation was trying to draw a vapor sample from some of the tight clays at the sites. When the probe was advanced into these clays, the sample flow rate was severely reduced and in some cases the amount of sample collected was smaller than normal. Often times when in these clays, five probe volumes could not be pulled through the sampling system. An attempt was made to allow at least one probe volume through the system before a sample was collected. Samples taken during these low flow conditions were noted on the field log. In general, samples taken at these conditions had total organic levels below 10 ppm. It is not known whether these low flow values are indicative of a lack of contamination at the sample location or due to the difficulty in sampling.

A second difficulty was the limited knowledge about groundwater elevation. At some locations, the probe had to be pushed into the ground a second or third time because previous pushes were advanced into a saturated zone (possibly perched water). This required purging of the probe prior to additional sampling attempts.

3.0 RESULTS

Table 3-1 presents the total organic readings (in ppm as equivalent methane) at each location and depth. Chromatograms for samples with total organic concentrations greater than 15 ppm are presented in Appendix B along with chromatograms of jet fuel, leaded gasoline, and unleaded gasoline. The field chromatograms were compared to the standards in an attempt to evaluate the type of product present in the subsurface.

3.1 Total Organic Readings

At Site 17, samples from locations SG5, SG7, SG9, SG11, and SG13 had organic concentrations, as methane, ranging between 800 and greater than 1,000 ppm (the maximum reading on the OVA/GC). These locations are within the bermed areas of Tanks 1156 and 1157. In addition, a hydrocarbon liquid was present on the cone tip as it was retracted from the soil at location SG13. Samples from location SG1 and SG16 had 40 and 14 ppm organic concentrations. These locations are just south of the bermed areas. The sample collected at location SG20 (located between the bermed areas), had a total organic concentration greater than 1,000 ppm. The sample collected at SG29 (about 400 ft east of Tank 1157) also had a concentration exceeding 1,000 ppm.

At the Base Service Station, samples from locations SG1, SG2, SG5, SG9, and SG11, had organic concentrations ranging between 60 and greater than 1,000 ppm. Sample location SG9 is located south of the station. The other locations with high organic levels were located adjacent to and east of the station's underground storage tanks.

3.2 Gas Chromatograms

Evaluation of the type of product present in the subsurface was done by comparing the chromatograms run on the samples to those run on standards of jet fuel, leaded gasoline, and unleaded gasoline. Interpretation of the GCs was made difficult because of the low temperatures encountered during the field activities. The standards were run at room temperature before the project was begun. Although the OVA/GC was kept inside the cab of the pickup, there was a definite difference between the temperature during standard runs and that during sample runs. Colder temperatures slow the retention times of

compounds. Because of this difference in temperature, the type of product present in the subsurface was difficult to identify.

Fuel-type components were identified from the gas chromatograms run on samples from SG1, SG5, SG7, SG11, SG13, SG20, and SG29 from Site 17. The chromatograms from SG1, SG5, SG7, SG13, and SG29 compare most favorably to the jet fuel standard. The chromatogram from SG20 appears to be most similar to the standard run on leaded gasoline. The GC run on the sample from location SG13 could not be compared favorably with any of the three standards.

Fuel-type components were identified from the gas chromatograms run on samples from SG1, SG2, and SG5 at the Base Service Station. These chromatograms appeared most similar to the standard run on leaded gasoline.

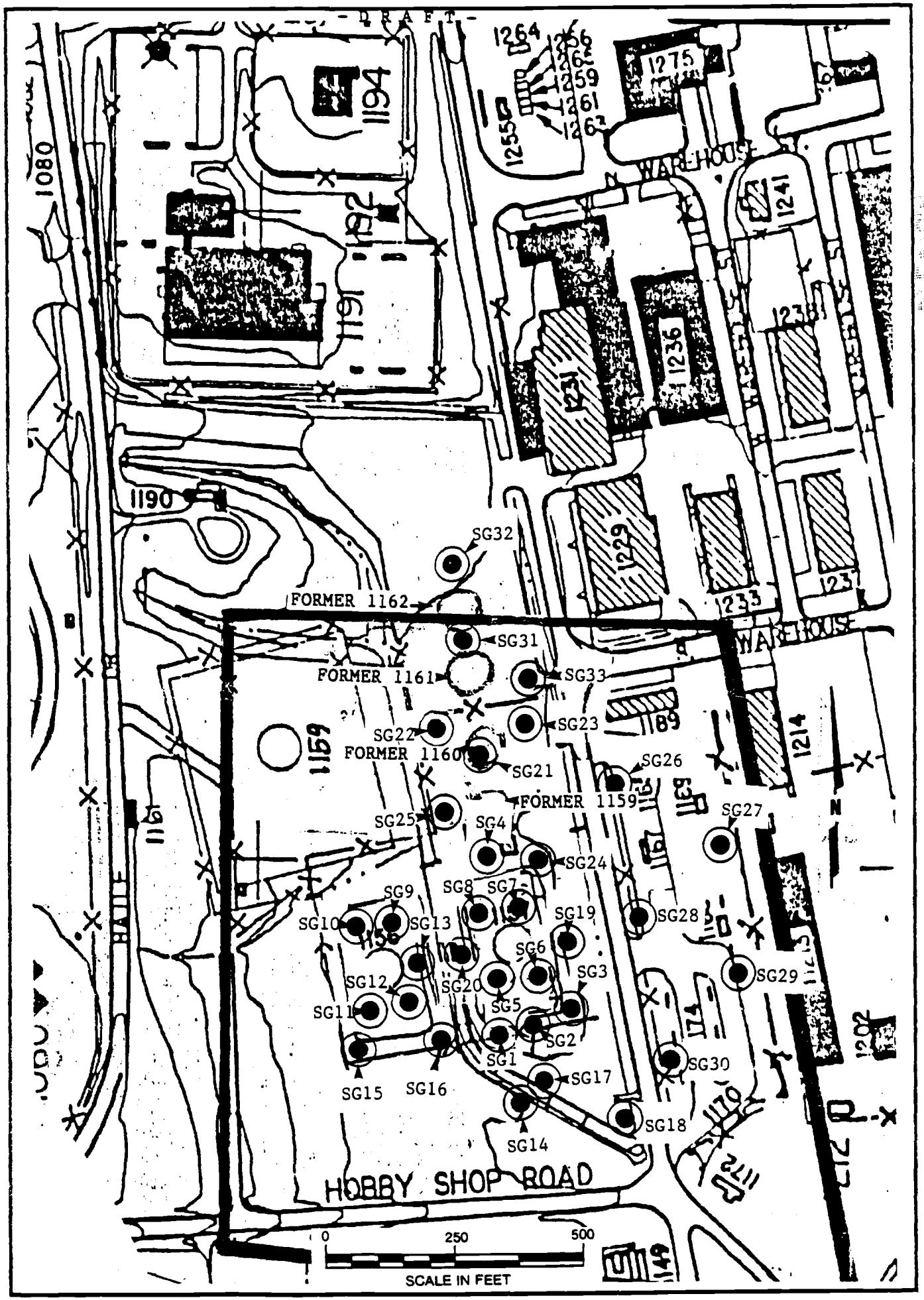
During many of the GC runs, scale switches were performed to keep the peaks from going off scale. This results in a line on the strip chart which is discontinuous. However, by performing these scale changes, it does allow for only one GC to be run per sample. This saves time and allows for more samples to be analyzed.

Table 3-1
Summary of Soil Gas Sampling Results

Location	Depth (ft)	Total Organics (ppm as methane)	Comments
Site 17-SG1	5	0	low flow
	10	40	GC run
	12	7	
Site 17-SG2	10	2.5	low flow
	13	2.3	low flow
Site 17-SG3	14	0	low flow
Site 17-SG4	14	0.5	wet probe
Site 17-SG5	5	>1,000	GC run
	12	10	
Site 17-SG6	10	4.2	surface water
Site 17-SG7	10	800	GC run
Site 17-SG8	10	0	
Site 17-SG9	10	>1,000	GC run
Site 17-SG10	10	2	low flow, probe moist
	6	3	wet probe, low flow
Site 17-SG11	10	0.5	probe moist
	8	0	closed probe
	6	>1,000	GC run
Site 17-SG12	6	9	standing water
Site 17-SG13	6	>1,000	GC run, hydrocarbon on probe
Site 17-SG14	10	8.2	low flow
Site 17-SG15	10	9	good flow
Site 17-SG16	10	14	low flow
Site 17-SG17	10	8.5	low flow
Site 17-SG18	10	9.5	low flow, wet probe
Site 17-SG19	10	7.2	
Site 17-SG20	7	>1,000	GC run
Site 17-SG21	10	6	moist probe
Site 17-SG22	9	5	moist probe
Site 17-SG23	8	9	low flow
Site 17-SG24	12	6	low flow
Site 17-SG25	8	0	good flow
Site 17-SG26	10	0.5	moist
Site 17-SG27	10	0	

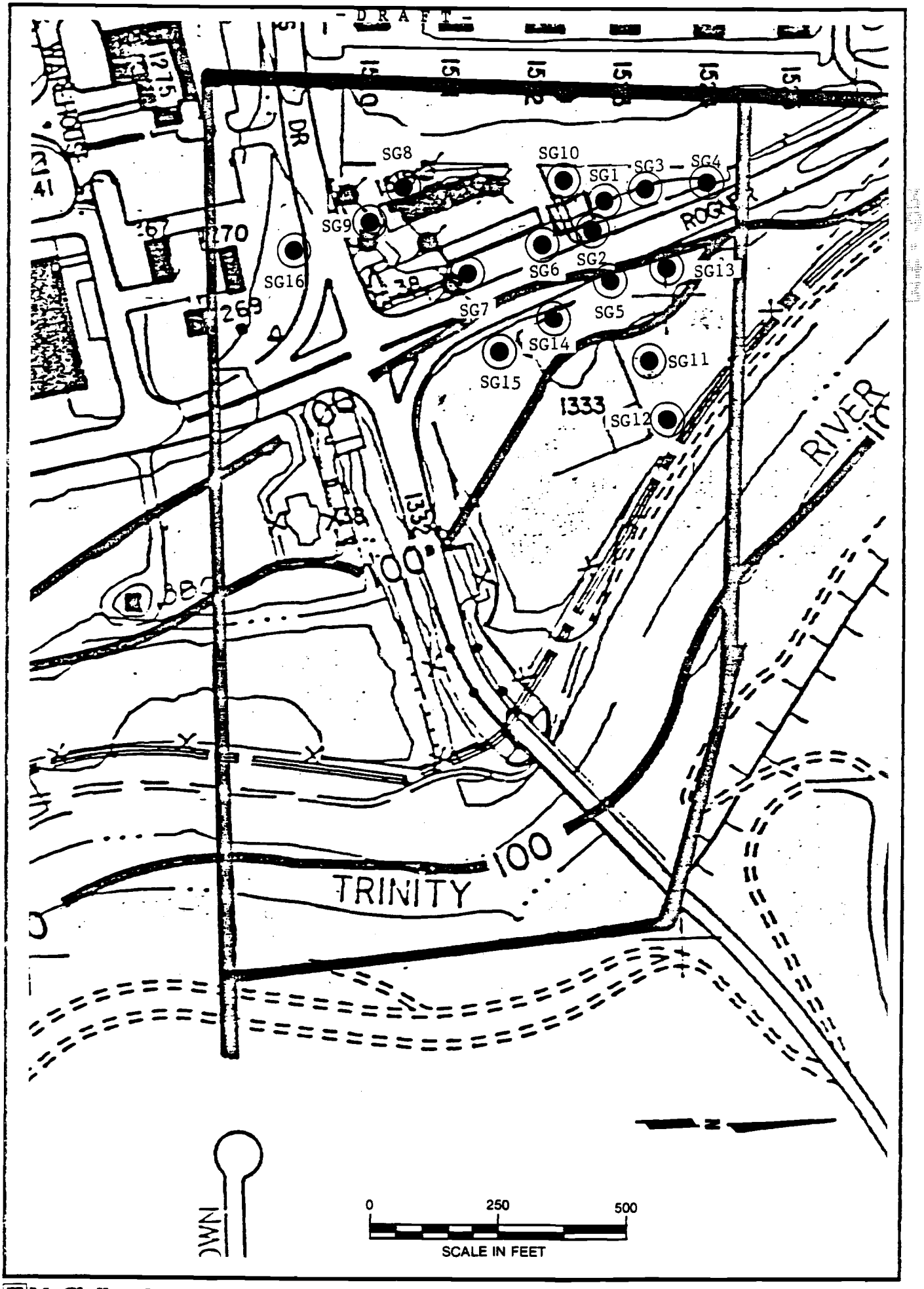
Location	Depth (ft)	Total Organics (ppm as methane)	Comments
Site 17-SG28	10	1.5	wet probe
	8	8.5	
Site 17-SG29	8	>1,000	GC run
Site 17-SG30	8	7	low flow
Site 17-SG31	6	7	low flow
Site 17-SG32	6	3	low flow
Site 17-SG33	6	2	low flow
BSS-SG1	7.5	6.2	low flow, wet probe
	5	>1,000	GC run, good flow
BSS-SG2	2.5	>1,000	GC run
BSS-SG3	5	5	low flow
BSS-SG4	2	3	high flow
BSS-SG5	5	>1,000	GC run, high flow
BSS-SG6	5	14	low flow
BSS-SG7	5	0	wet probe
BSS-SG8	5	4	
BSS-SG9	5	>1,000	GC run, high flow
BSS-SG10	6	0	
BSS-SG11	5	60	GC run, high flow
BSS-SG12	5	1	high flow
BSS-SG13	5	0	high flow
BSS-SG14	5	0	high flow
BSS-SG15	5	0	
BSS-SG16	5	0	low flow

APPENDIX A
SAMPLE LOCATION MAPS



McClelland

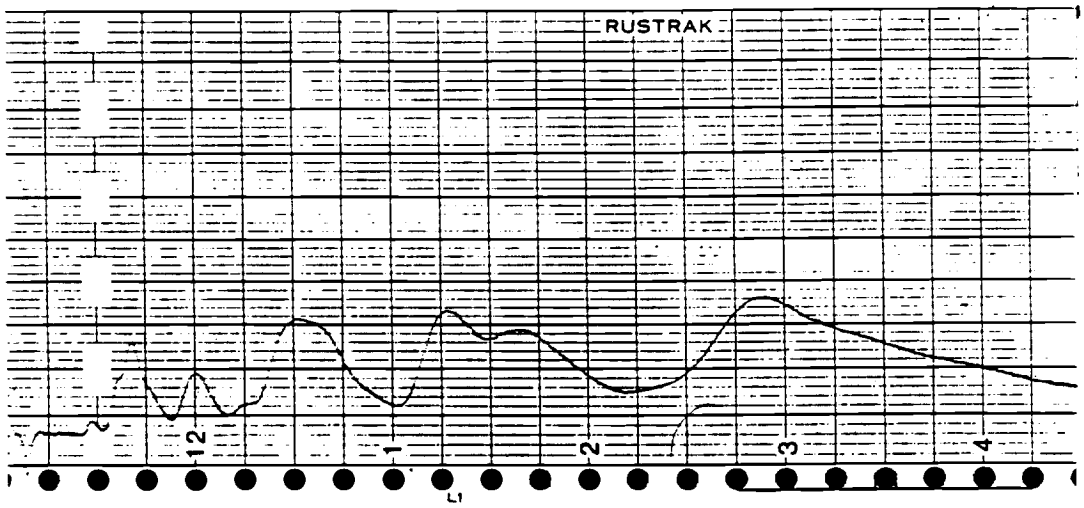
SITE 17 SAMPLING LOCATIONS



McClelland

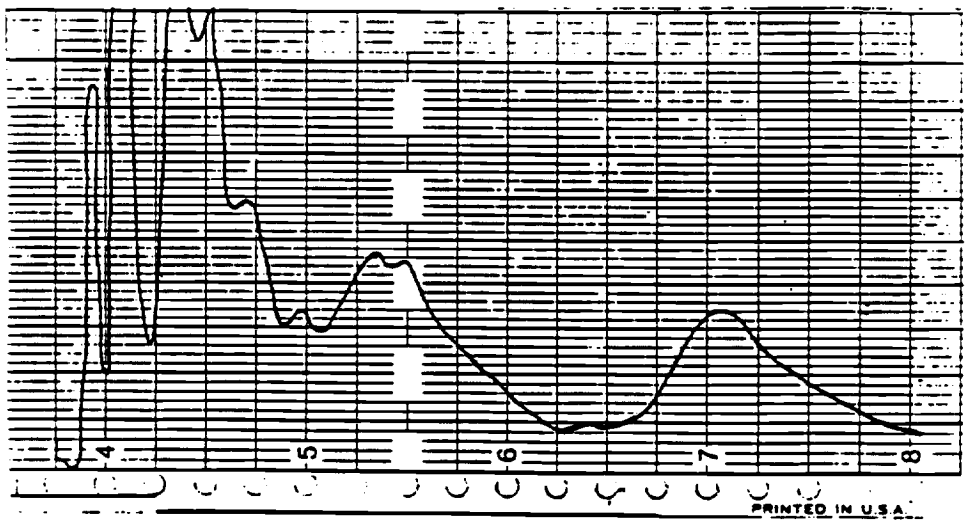
BASE SERVICE STATION SAMPLING LOCATIONS

APPENDIX B
GAS CHROMATOGRAMS



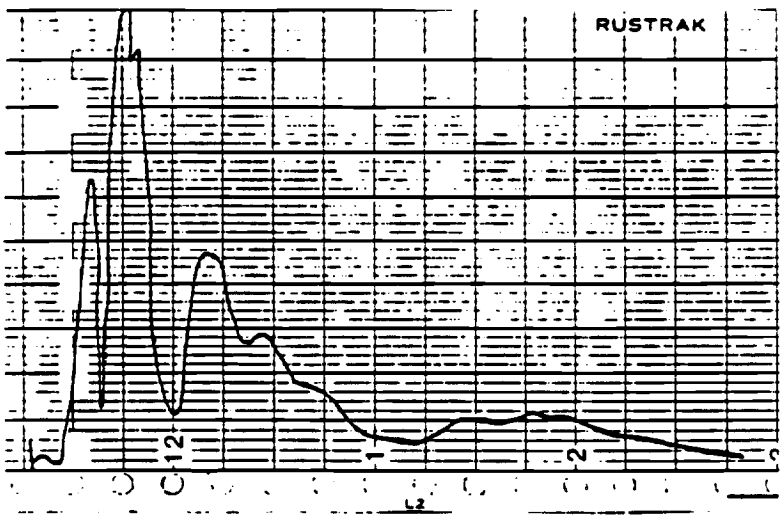
Jet Fuel
Standard

X1 Scale



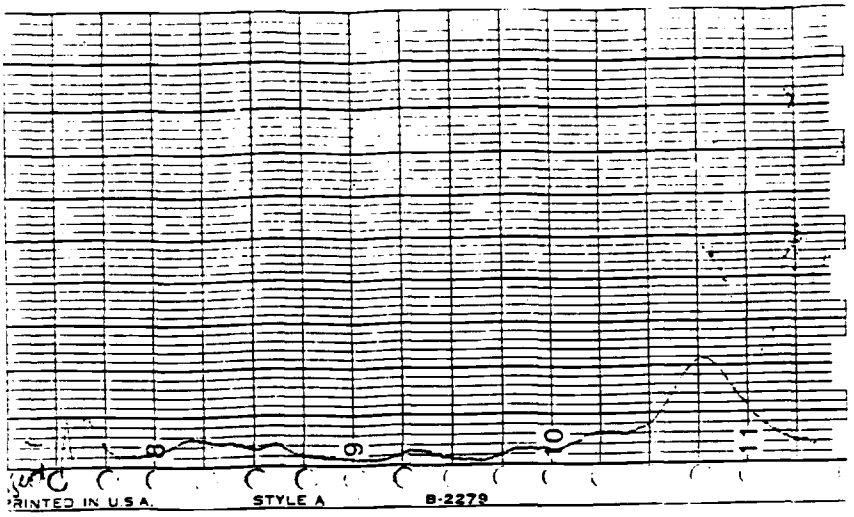
Leaded
Gasoline
Standard

X100 Scale

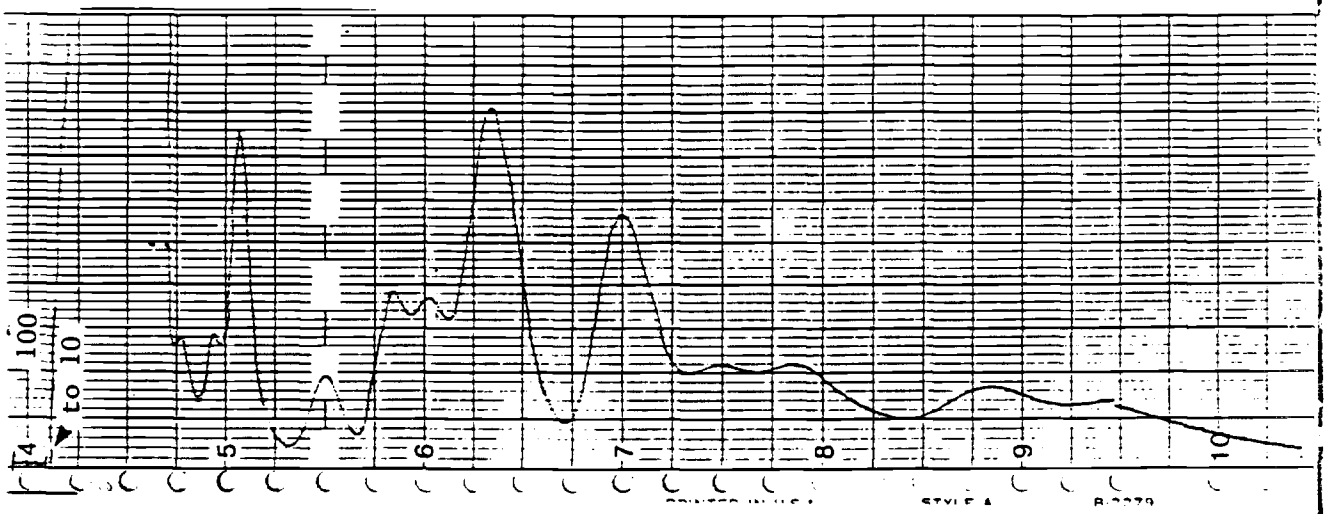


Unleaded
Gasoline
Standard

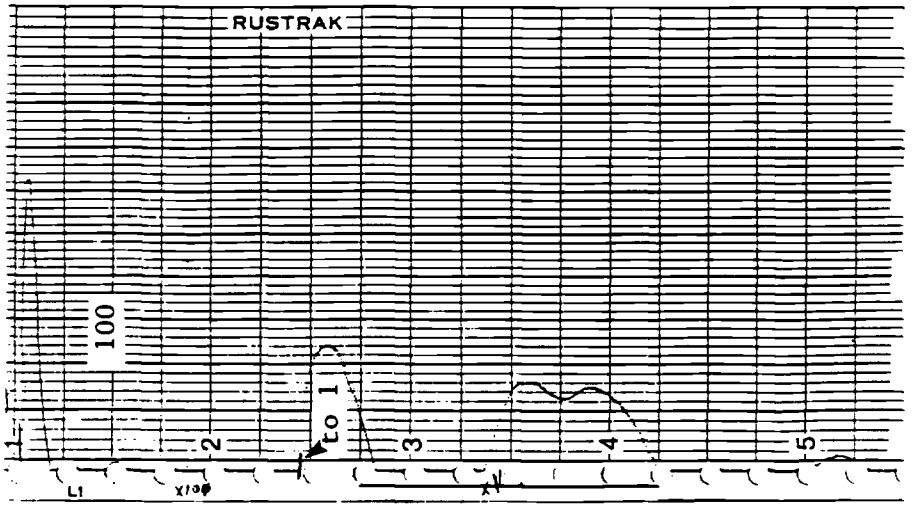
X100 Scale



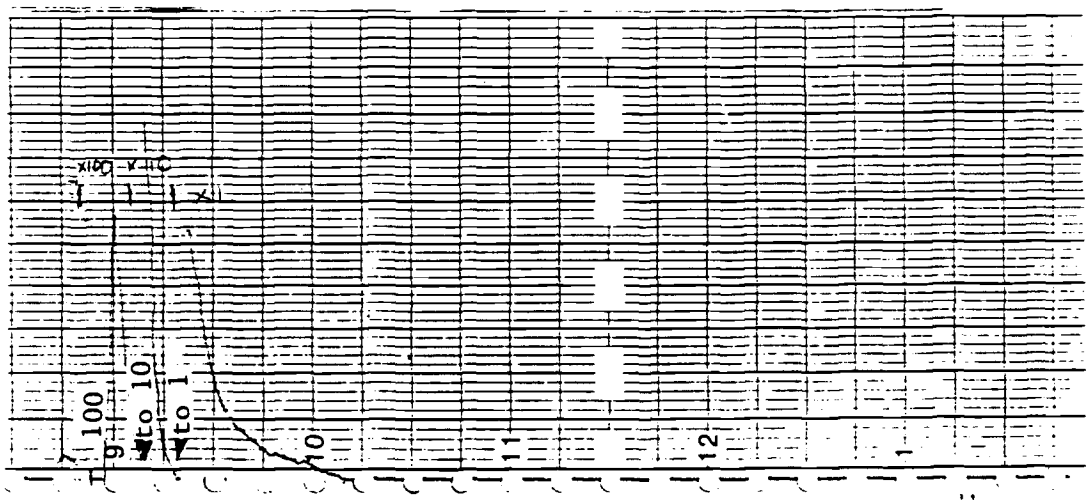
Site 17
SG1-10'
40PPM
X1 Scale



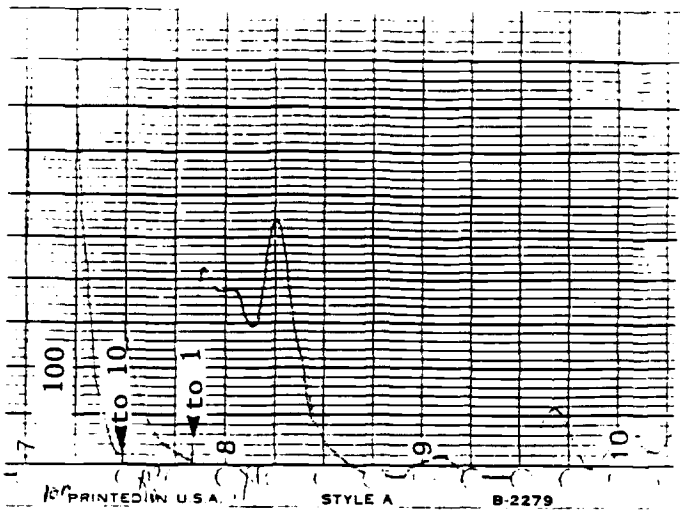
Site 17 SG5-5' >1000 PPM X10 Switch to X100 Switch to X10 Scale



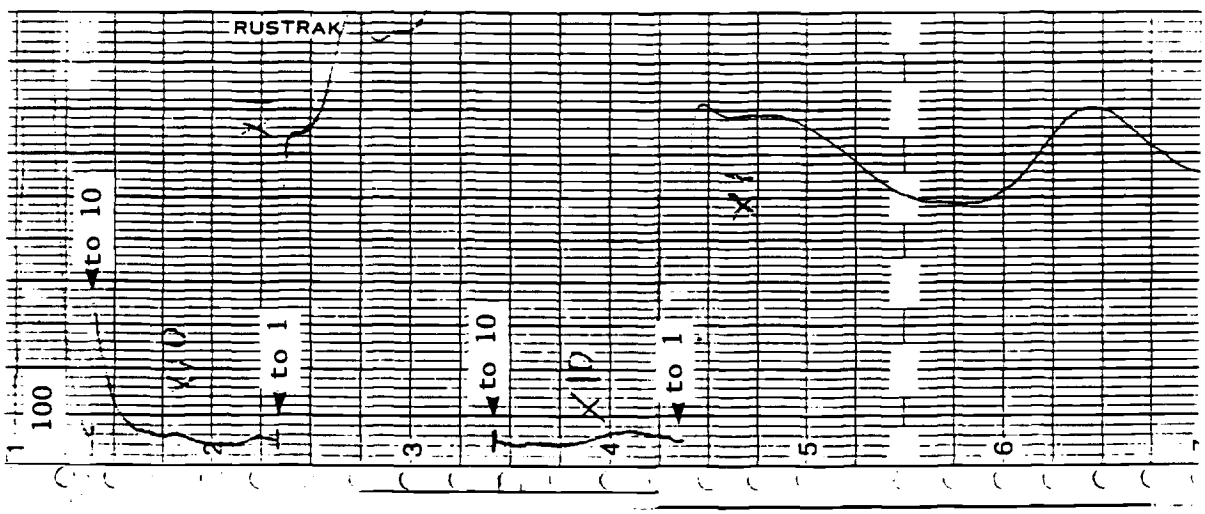
Site 17
SG7-10'
800 PPM
X100 Scale
Switch to
X1 Scale



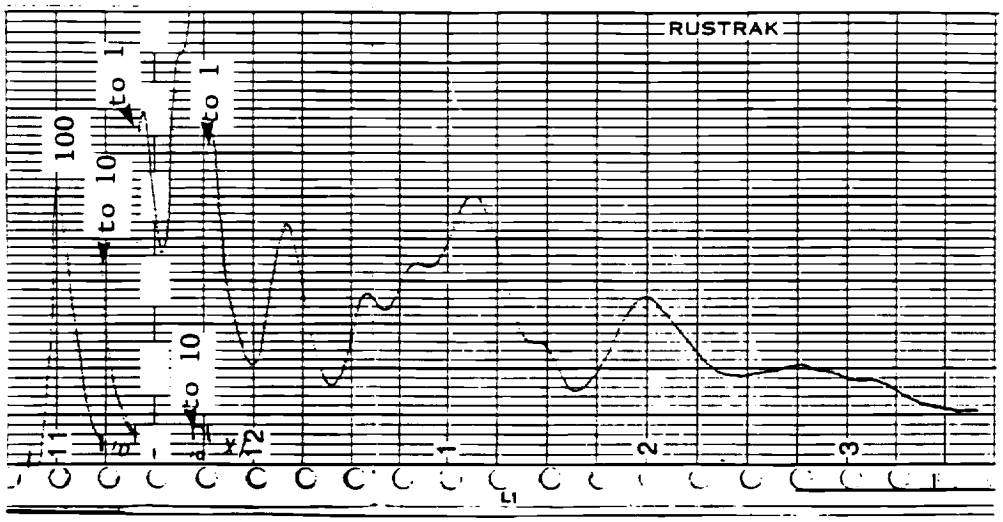
Site 17
SG9-10'
>1000 PPM
X100 Scale
Switch to
X10 Scale
Switch to
X1 Scale



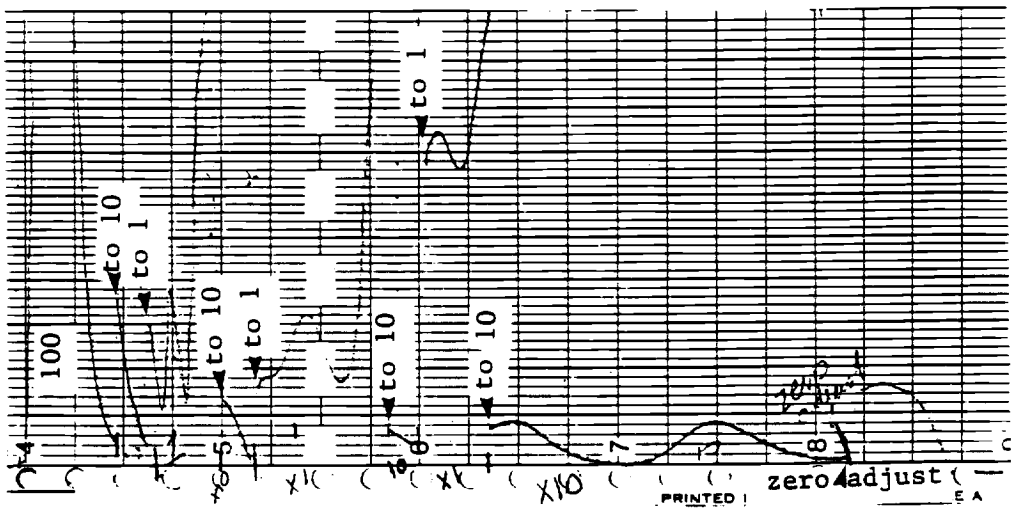
Site 17
SG11-6'
>1000 PPM
X100 Scale
Switch to
X10 Scale
Switch to
X1 Scale



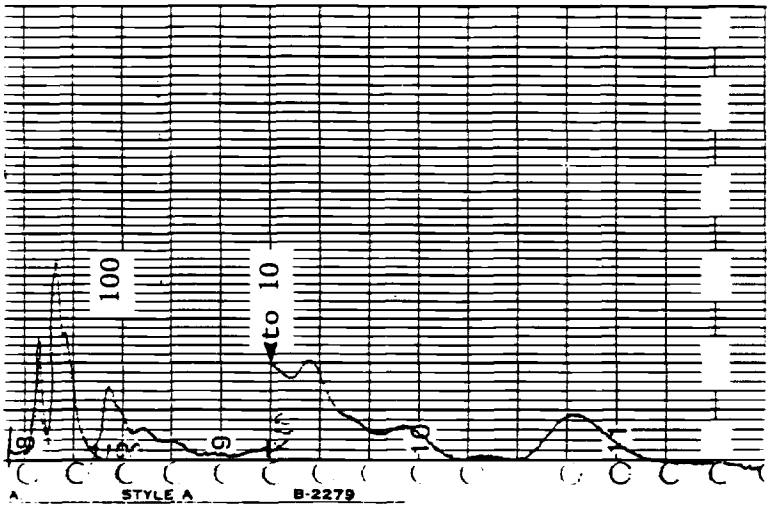
Site 17 SG13-6' >1000 PPM
X100 Scale Switch to X10 Scale Switch to X1 Scale



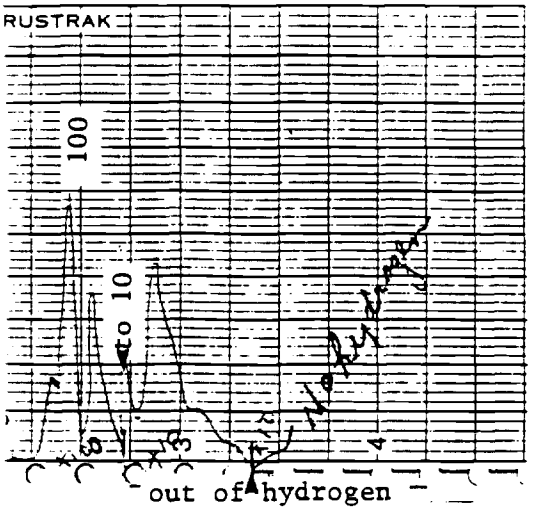
Site 17
SG20-7'
>1000 PPM
X100 Scale
Switch to
X10 Scale
Switch to
X1 Scale



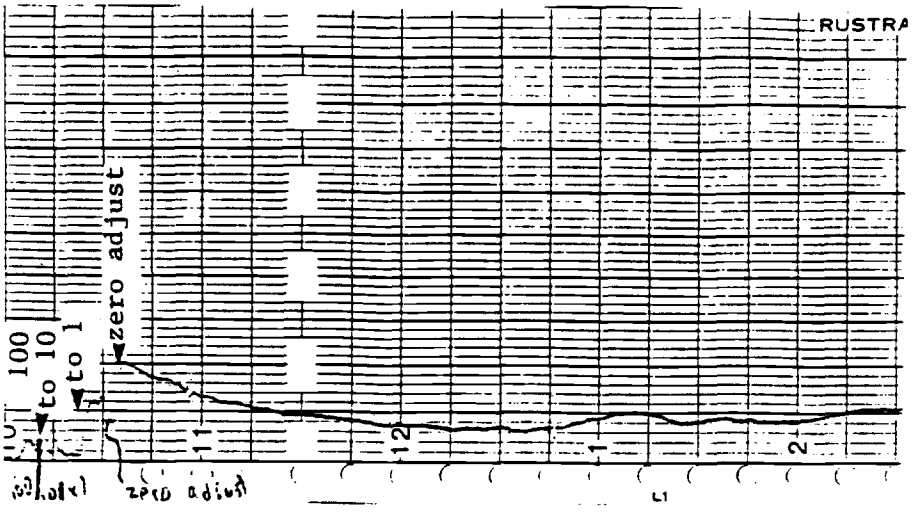
Site 17
SG29-8'
>1000 PPM
X100 Scale
Switch to
X10 Scale
Switch to
X1 Scale



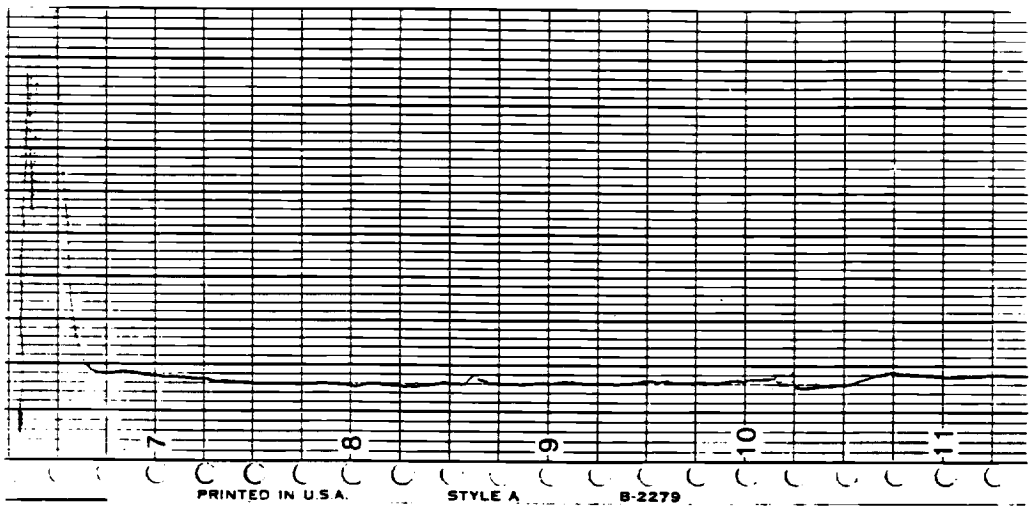
Base Service Station
SG1-5'
>1000 PPM
X100 Scale
Switch to
X10 Scale



Base Service Station
SG2-2.5'
>1000 PPM
X100 Scale
Switch to
X10 Scale



Base Service Station
SG9-5'
>1000 PPM
X100 Scale
Switch to
X10 Scale
Switch to
X1 Scale



Base Service Station

SG11-5'

60 PPM

X1 Scale

TAB

J

APPENDIX J

Risk Assessment Data

CHEMICAL AND TOXICOLOGICAL SUPPORT DATA

APPENDIX J-1. CHEMICAL AND TOXICOLOGICAL SUPPORT DATA

This appendix presents chemical and toxicological support data used in evaluating environmental transport and fate and health impacts for chemicals for which relevant data were not available in the published literature.

J-1.1 Acceptable Daily Intake Values

The risk assessment used Acceptable Intakes for Chronic Exposures (AICs) listed in the EPA Superfund Public Health Evaluation Manual (U.S. EPA, 1986) to characterize risks of noncarcinogenic effects. The AICs were recorded directly from the appropriate Health Effects Assessment (U.S. EPA, 1984a-r) or from compilations of EPA-verified reference dose (RFD) values. These verified reference doses were developed by an EPA work group chaired by the Office of Research and Development in 1985 and 1986. The actual source used for each value is referenced fully in the manual (U.S. EPA, 1986).

When an AIC was listed for either inhalation exposure or for ingestion exposure but not for both, the same value was used for both routes of exposure. AICs were not listed for either route of exposure for these indicator chemicals: arsenic, benzo(a)anthracene, benzo(a)pyrene, benzene, 1,2-dichloroethane, trichloroethene, and vinyl chloride.

Arsenic

No formal ADI has been established for arsenic. In its draft drinking water health advisory for arsenic, EPA recommends a safe drinking water concentration of 0.05 mg/l (U.S. EPA, 1985a). Assuming 100 percent gastrointestinal absorption, 2 liters of water consumed per day, and a 60 kg body weight, an informal ADI of 1.7 μg/kg/day was calculated:

$$0.0017 \text{ mg/kg/day} = \frac{0.05 \text{ mg/l} \times 2 \text{ l/day}}{60 \text{ kg}}$$

Polycyclic Aromatic Hydrocarbons Benzo(a)anthracene, Benzo(a)pyrene

Toxicological data suitable for developing an ADI for Polycyclic Aromatic Hydrocarbons (PAHs) are not available (U.S. EPA, 1984g). Also, the use of the ACGIH TLV® for cool tar pitch volatiles to estimate an ADI is inappropriate because this TLV® is not based on quantifiable toxicological effects (American Conference of Governmental Industrial Hygienists, 1987). The potential for noncarcinogenic effects associated with PAH exposure could therefore not be evaluated in terms of ADI in this assessment. There are data available, however, describing the average normal population exposure to PAH from all sources (e.g., fire, smoke, broiled foods, naturally occurring PAH). Normal exposures range between 2.7×10^{-5} to 2.7×10^{-4} mg/kg/day. The lowest value of this range was used to evaluate the significance of PAH exposures for both benzo(a)anthracene and benzo(a)pyrene.

Benzene

The ADI for chronic exposure to benzene was developed using the Lewis, Lynch and Nikiforov method which is described in "Community Exposure Levels: A Collection of Current Methods for Estimating Long-Term Protective Levels," prepared by the Chemical Manufacturers Association, May 1988.

In the study which provides the basis for calculating the long-term ADI CBA/Ca mice were exposed by inhalation to 0, 10, 25, 100 or 300 ppm of benzene for 16 weeks and observed for the remainder of their natural lives. The exposures to 100 or 300 ppm were leukemogenic. The investigator reported lymphopenia among the 25 ppm-exposed mice, but indicated doubt that the lumphopenia should be regarded as an adverse effect. The NOAEL was 25 ppm (80 mg/m^3). The ADI for long-term exposure is developed by first adjusting the pulse dose to a continuous dose for exposure hours/day and days/week and converting the concentration in air to mg/kg/day in the mouse. This gives a value of 206 mg/kg/day. This value is then adjusted by the variable factor approach.

The uncertainty factors are developed as follows:

- [S] = 1; no scaling factors were used;
- [I] = 2; is used because the sample includes sensitive individuals;
- [R] = 1; based on best potency estimates from human epidemiological data, CBA/Ca mice are more sensitive;
- [U] = 80; as follows: U_1 = 1; the results are accepted as proven in humans, U_2 = 5; there were only 16 weeks of exposure, U_3 = 4; it is not certain that 25 ppm is a true NOAEL, U_4 = 4, used to adjust for the uncertainty in estimating [I] and [R]; and
- [C] = 4; a conservative judgment due to the possible severity of the effect.

The ADI is calculated as follows:

$$\frac{206 \text{ mg/kg/day (1)}}{(2)\ (1)\ (80)\ (4)} = 0.32 \text{ mg/kg/day}$$

1,2-Dichloroethane

The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a Threshold Limit Value-Time Weighted Average (TLV-TWA) for 1,2-dichloroethane of 40 mg/m^3 (ACGIH, 1987). Adjusting for continuous exposure (from an 8 hour/day, 5 days/week exposure) and a 1,000-fold uncertainty factor to protect sensitive individuals yields an ADI of 2.7 x 10^{-3} mg/kg/day:

$$40\ mg/m^3 \times 8\ hr/24\ hr \times 5\ days/7\ days \times 20\ m^3/day \times \frac{1}{70\ kg} \times \frac{1}{1,000}$$

$$= 2.7 \times 10^{-3}\ mg/kg/day$$

Trichloroethene

The ADI for chronic exposure to trichloroethene was derived from an oral rat LD_{50} of 4,920 mg/kg (Registry of Toxic Effects of Chemical Substances) using the method proposed by Layton, Mallon, Rosenblatt, and Small, in "Derived Allowable Intakes for Systemic Toxicants Lacking Chronic Toxicity Data," Reg. Tox. and Pharm. 7, 96-112 (1987) as follows:

Rat oral LD_{50}: 4920 mg/kg

$$ADI = 4920\ mg/kg \times 5 \times 10^{-6}\ day^{-1}$$

$$= 2.46 \times 10^{-2}\ mg/kg/day$$

Vinyl Chloride

EPA has calculated an ADI for vinyl chloride of 1.3 μg/kg/day based on a lifetime feeding study in rats (U.S. EPA, 1985b; Til et al., 1983). The ADI was calculated by dividing a No Observable Adverse Effects Level (NOAEL) of 0.13 mg/kg/day by an uncertainty factor of 100. Effects observed at this dose level consisted of increased incidences of basophilic foci in the liver of male rats (Til et al., 1983).

J-1.2 Fish Bioconcentration Factors (BCFs)

The risk assessment used BCFs listed in the EPA Superfund Public Health Evaluation Manual (U.S. EPA, 1986) to evaluate human exposure to chemicals via ingestion of fish. BCFs were not listed for bis(2-ethylhexyl)phthalate, benzo(a)anthracene, or benzo(a)pyrene.

Bis(2-ethylhexyl)phthalate

A BCF was calculated for bis(2-ethylhexyl)phthalate based on a log octanol-water partition coefficient (log kow) of 4.88 (ATSDR, 1987), as follows:

$$\log kow = 4.88$$

$$\log BCF = 0.124 + 0.542 \log kow$$

$$BCF = \log^{-1} 2.77$$

$$BCF = 590$$

Benzo(a)anthracene and Benzo(a)pyrene

One study of the environmental fate of benzo(a)pyrene indicates a fish bioconcentration factor for this compound ranging from 33 to 930 (Lu, 1977). The baseline risk assessment assumed the highest value (930) for both benzo(a)pyrene and benzo(a)anthracene.

R-RAM RESULTS

APPENDIX J-2. R-RAM RESULTS

Fire Department Training Area 2 (Site 12):

- Receptor 5 - Day Care Facility
- Receptor 6 - On-Site Maximally Exposed Individual
- Receptor 7 - Off-Site Maximally Exposed Individual

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:05:29 VERSION: 42688

The Pathway Variables are:

** GENERAL **	
Risk Threshold For Burden Calc.	0.000E+00
Body Weight (kg)	7.000E+01
Alternate Exposure Period (yrs)	1.000E+01
** RESPIRATION **	
Respiration Rate (m^3/day)	2.000E+01
Particle Correction	1.000E+00
** SOIL **	
Mixing Depth (m)	1.500E-01
Soil Consumption, 70 Years (kg/day)	7.000E-05
Soil Consumption, Alt. Years (kg/day)	7.000E-05
** PLANT **	
Rec. # Used as Farm (0=Rec. Specific)	0.000E+00
Interception Fraction (*)	5.400E-02
Elimination Constant (1/day)	3.870E-02
Days Exposed (day)	6.000E+01
Edible Crop Density (kg/m^2)	2.000E+00
Cleaning Efficiency (*)	0.000E+00
Plant Consumption (kg/day)	9.050E-02
Root Vegetable Consumption (kg/day)	5.980E-02
** FISH **	
Rec. # Used as Water Body	1.000E+00
Rec. # Used as Runoff	2.000E+00
Water Surface Area (m^2)	1.424E+07
Water Flowrate (m^3/day)	6.145E+08
Sediment Flowrate (kg/day)	0.000E+00
Deposition Period	7.700E+01
Fish Consumption (g/day)	6.500E+00
** DAIRY AND BEEF **	
Rec. # Used as Dairy Pasture	3.000E+00
Rec. # Used as Dairy Feedlot	3.000E+00
Fraction of Dairy Feed From Grazing	5.000E-01
Bioconcentration Factor for Milk	5.000E+00
Rec. # Used as Beef Pasture	4.000E+00
Rec. # Used as Beef Feedlot	4.000E+00
Fraction of Beef Feed from Grazing	5.000E-01
Bioconcentration Factor for Beef	4.000E+00
Cattle Inhalation Rate (m^3/day)	1.580E+02
Fodder Exposure Period (hrs)	4.800E+01
Fodder Surface Area (m^2/day)	1.000E+00
Quantity of Fodder Exposed (kg)	3.600E+01
Water Surface Area (m^2)	8.550E+00
Water Residence Time (hr)	7.520E+00
Water Quantity in Water Tank (kg)	4.700E+03
Milk Production Rate (kg/day)	1.100E+00
Cattle Body Weight (kg)	2.400E+02

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:05:34 VERSION: 42688

Grass Interception (*)	5.700E-01
Grass Density (kg/m^2)	2.000E+00
Grass Consumption Rate (kg/day)	1.400E+01
Soil Consumption Rate (kg/day)	2.000E+00
Water Consumption Rate (kg/day)	1.500E+02
Fodder Consumption Rate (kg/day)	1.600E+01
Beef Consumption Rate (kg/day)	6.000E-03
Milk Consumption Rate (kg/day)	2.300E-02
** DERMAL **	
Skin Surface Area (cm^2)	4.170E+03
Dust on Skin (mg/cm^2/day)	5.000E-01
** MOTHERS MILK **	
Female Fat Content (kg)	1.800E+01
Infant Milk Consumption (ml/day)	8.500E+02
Infant Body Weight (kg)	5.000E+00
** DRINKING WATER **	
Rec. # Used as Reservoir	1.000E+00
Reservoir Surface Area (m^2)	1.424E+07
Water Reservoir Outflow (kg/day)	6.145E+08
Drinking Water Consumption (kg/day)	2.000E+00

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:05:36 VERSION: 42688

THE POLLUTANT SPECIFIC DATA ARE:

SYMBOL	INGEST POT.	INHALE POT.	BIOCONC	ROOT	CLASS
BENZENE	5.200E-02	2.600E-02	5.200E+00	0.00E+00	A
CHLOROFO	8.100E-02	8.100E-02	3.750E+00	0.00E+00	A
DCE	9.100E-02	3.500E-02	1.200E+00	0.00E+00	A
MC	7.500E-03	1.650E-03	5.000E+00	0.00E+00	A
TETRACE	5.100E-02	1.700E-03	3.100E+01	0.00E+00	A
TOLUENE	0.000E+00	0.000E+00	1.070E+01	0.00E+00	A
TRICE	1.100E-02	4.600E-03	1.060E+01	0.00E+00	A
VC	2.300E+00	2.500E-02	1.170E+00	0.00E+00	A
ANTIMONY	0.000E+00	0.000E+00	1.000E+00	2.00E-02	M
ARSENIC	1.500E+01	5.000E+01	4.400E+01	1.50E-03	M
BARIUM	0.000E+00	0.000E+00	1.000E+00	1.20E-02	M
BERYLLIU	0.000E+00	8.400E+00	1.900E+01	3.70E-04	M
CADMIUM	0.000E+00	6.100E+00	8.100E+01	6.40E-02	M
CHROMIUM	0.000E+00	4.100E+01	1.600E+01	5.40E-04	M
LEAD	0.000E+00	0.000E+00	4.900E+01	2.00E-03	M
NICKEL	1.190E+00	1.190E+00	4.700E+01	6.20E-03	M
SELENIUM	0.000E+00	0.000E+00	1.600E+01	6.50E-03	M
SILVER	0.000E+00	0.000E+00	3.080E+03	4.00E-02	M
CHLORDAN	1.160E+00	1.160E+00	1.400E+04	7.00E-02	M
DEHP	6.840E-04	6.840E-04	5.900E+02	3.00E-02	M
B(A)A	1.150E+01	6.100E+00	9.300E+02	1.00E-02	M
B(A)P	1.150E+01	6.100E+00	9.300E+02	1.00E-02	M

SYMBOL - Pollutant name
POTENCY - Pollutant ingestion potency slope
INHALE POT. - Pollutant inhalation potency slope
BIOCONC - Bioconcentraion factor for fish
ROOT - Root uptake factor
CLASS - 'A' Area weighted deposition flux
'M' Mass weighted deposition flux

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:05:41 VERSION: 42688

THE ELIMINATION RATE DATA ARE:

SYMBOL	SOIL	ANIMAL	MOTHERS MILK
BENZENE	1.000E+00	1.000E+00	1.000E+00
CHLOROFO	1.000E+00	1.000E+00	1.000E+00
DCE	1.000E+00	1.000E+00	1.000E+00
MC	1.000E+00	1.000E+00	1.000E+00
TETRACE	1.000E+00	1.000E+00	1.000E+00
TOLUENE	1.000E+00	1.000E+00	1.000E+00
TRICE	1.000E+00	1.000E+00	1.000E+00
VC	1.000E+00	1.000E+00	1.000E+00
ANTIMONY	1.000E+00	1.000E+00	1.000E+00
ARSENIC	1.000E+00	1.000E+00	1.000E+00
BARIUM	1.000E+00	1.000E+00	1.000E+00
BERYLLIU	1.000E+00	1.000E+00	1.000E+00
CADMIUM	1.000E+00	1.000E+00	1.000E+00
CHROMIUM	1.000E+00	1.000E+00	1.000E+00
LEAD	1.000E+00	1.000E+00	1.000E+00
NICKEL	1.000E+00	1.000E+00	1.000E+00
SELENIUM	1.000E+00	1.000E+00	1.000E+00
SILVER	1.000E+00	1.000E+00	1.000E+00
CHLORDAN	1.250E-04	1.000E+00	3.800E-04
BEHP	6.930E-02	1.000E+00	7.600E-04
B(A)A	3.470E-02	1.000E+00	1.000E-01
B(A)P	3.470E-02	1.000E+00	1.000E-01

SYMBOL - Pollutant name
SOIL - Elimination constant for soil
ANIMAL - Elimination constant for cattle
MILK - Elimination constant for mothers milk

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:05:46 VERSION: 42688

THE POPULATIONS OF THE RECEPTORS ARE:

Receptor	Population
RESERVOI	0.
RUNOFF	0.
DAIRY	0.
BEEF	0.
DAY CARE	0.
ON MAX	0.
OFF MAX	0.

Receptor - Receptor name

Population - Number of people living at receptor

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:05:47 VERSION: 42688

Unit concentrations and deposition fluxes are:

Source	Receptor	Unit Conc.	Area Dep.	Mass Dep.
SITE 12				
	RESERVOI	4.330E-02	0.000E+00	8.660E-04
	RUNOFF	2.120E+00	0.000E+00	4.240E-02
	DAIRY	7.320E-03	0.000E+00	1.460E-04
	BEEF	2.550E-03	0.000E+00	5.100E-05
	DAY CARE	6.410E-01	0.000E+00	1.280E-02
	ON MAX	1.100E+01	0.000E+00	2.200E-01
	OFF MAX	4.500E-01	0.000E+00	9.000E-03

Source - Source Identification
Receptor - Receptor Identification
Unit Conc. - Unit emission rate ground level concentration in UG/M^3/g/s
Area Dep. - Unit emission rate area weighted deposition flux in UG/M^2/s/g/s
Mass Dep. - Unit emission rate mass weighted deposition flux in UG/M^2/s/g/s

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:05:49 VERSION: 42688

Emission rate of Pollutants from all Sources is:

Source	Pollutant	Emission Rate
SITE 12		
	BENZENE	8.800E-05
	CHLOROFO	1.940E-07
	DCE	0.000E+00
	MC	3.700E-04
	TETRACE	5.200E-07
	TOLUENE	1.680E-04
	TRICE	1.050E-05
	VC	1.300E-05
	ANTIMONY	1.040E-07
	ARSENIC	1.760E-07
	BARIUM	1.390E-07
	BERYLLIU	1.050E-09
	CADMIUM	2.640E-09
	CHROMIUM	6.170E-08
	LEAD	4.760E-08
	NICKEL	5.470E-08
	SELENIUM	1.050E-07
	SILVER	1.760E-09
	CHLORDAN	0.000E+00
	BEHP	2.120E-06
	B(A)A	0.000E+00
	B(A)P	0.000E+00

Source - Source Identification
Pollutant - Pollutant Identification
Emission rate - Emission rate of each pollutant in g/s

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:05:54 VERSION: 42688

The Gastrointestinal Factors are:

Symbol	Inhal	Soil	Plant	Fish	D&B	Dermal	Water	Milk	Tissue
BENZENE	1.000	1.000	1.000	1.000	.000	.000	1.000	.000	1.000
CHLOROFO	1.000	1.000	1.000	1.000	.000	.000	1.000	.000	1.000
DCE	1.000	1.000	1.000	1.000	.000	.000	1.000	.000	1.000
MC	1.000	1.000	1.000	1.000	.000	.000	1.000	.000	1.000
TETRACE	1.000	1.000	1.000	1.000	.000	.000	1.000	.000	1.000
TOLUENE	1.000	1.000	1.000	1.000	.000	.000	1.000	.000	1.000
TRICE	1.000	1.000	1.000	1.000	.000	.000	1.000	.000	1.000
VC	1.000	1.000	1.000	1.000	.000	.000	1.000	.000	1.000
ANTIMONY	1.000	1.000	1.000	1.000	.000	.010	1.000	.000	1.000
ARSENIC	1.000	1.000	1.000	1.000	.000	.010	1.000	.000	1.000
BARIUM	1.000	1.000	1.000	1.000	.000	.010	1.000	.000	1.000
BERYLLIU	1.000	1.000	1.000	1.000	.000	.010	1.000	.000	1.000
CADMIUM	1.000	1.000	1.000	1.000	.000	.010	1.000	.000	1.000
CHROMIUM	1.000	1.000	1.000	1.000	.000	.010	1.000	.000	1.000
LEAD	1.000	1.000	1.000	1.000	.000	.010	1.000	.000	1.000
NICKEL	1.000	.100	.100	1.000	.000	.010	.100	.000	.100
SELENIUM	1.000	1.000	1.000	1.000	.000	.010	1.000	.000	1.000
SILVER	1.000	1.000	1.000	1.000	.000	.010	1.000	.000	1.000
CHLORDAN	1.000	1.000	1.000	1.000	1.000	.010	1.000	1.000	1.000
BEHP	1.000	1.000	1.000	1.000	1.000	.010	1.000	1.000	1.000
B(A)A	1.000	1.000	1.000	1.000	1.000	.010	1.000	1.000	1.000
B(A)P	1.000	1.000	1.000	1.000	1.000	.010	1.000	1.000	1.000

Symbol - Pollutant name
Inhal - Inhalation absorbtion efficiency
Soil - Soil ingestion GI factor
Plant - Plant ingestion GI factor
Fish - Fish consumption GI factor
D&B - Beef and dairy consumption GI factor
Dermal - Dermal uptake factor
Water - Water consumption GI factor
Milk - Mothers milk consumption GI factor
Tissue - GI factor for pollutants into plant tissue

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:06:00 VERSION: 42688

Acceptable Daily Intakes for all Pollutants are:

Pollutant	Inhalation ADI	Ingestion ADI
BENZENE	1.900E-02	1.900E-02
CHLOROFO	1.000E-02	1.000E-02
DCE	2.700E-03	2.700E-03
MC	6.000E-02	6.000E-02
TETRACE	2.000E-02	2.000E-02
TOLUENE	1.500E+00	3.000E-01
TRICE	2.460E-02	2.460E-02
VC	1.300E-03	1.300E-03
ANTIMONY	4.000E-04	4.000E-04
ARSENIC	1.700E-03	1.700E-03
BARIUM	1.400E-04	5.100E-02
BERYLLIU	5.000E-04	5.000E-04
CADMIUM	2.900E-04	2.900E-04
CHROMIUM	5.000E-03	5.000E-03
LEAD	4.300E-04	1.400E-03
NICKEL	1.000E-02	1.000E-02
SELENIUM	1.000E-03	3.000E-03
SILVER	3.000E-03	3.000E-03
CHLORDAN	5.000E-05	5.000E-05
BEHP	2.000E-02	2.000E-02
B(A)A	2.700E-05	2.700E-05
B(A)P	2.700E-05	2.700E-05

Pollutant - Pollutant name
Inhalation ADI - Acceptable daily intake for inhalation of pollutant
Ingestion ADI - Acceptable daily intake for ingestion of pollutant

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:07:42 VERSION: 42688

INHALATION
RECEPTOR NUMBER 5

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
BENZEN	1.612E-08	4.190E-10	1.612E-08	5.986E-11
CHLORO	3.553E-11	2.878E-12	3.553E-11	4.111E-13
MC	6.776E-08	1.118E-10	6.776E-08	1.597E-11
TETRAC	9.523E-11	1.619E-13	9.523E-11	2.313E-14
TOLUEN	3.077E-08		3.077E-08	
TRICE	1.923E-09	8.846E-12	1.923E-09	1.264E-12
VC	2.381E-09	5.952E-11	2.381E-09	8.503E-12
ANTIMO	1.905E-11		1.905E-11	
ARSENI	3.223E-11	1.612E-09	3.223E-11	2.302E-10
BARIUM	2.546E-11		2.546E-11	
BERYLL	1.923E-13	1.615E-12	1.923E-13	2.308E-13
CADMIU	4.835E-13	2.949E-12	4.835E-13	4.213E-13
CHROMI	1.130E-11	4.633E-10	1.130E-11	6.619E-11
LEAD	8.718E-12		8.718E-12	
NICKEL	1.002E-11	1.192E-11	1.002E-11	1.703E-12
SELENI	1.923E-11		1.923E-11	
SILVER	3.223E-13		3.223E-13	
BEHP	3.883E-10	2.656E-13	3.883E-10	3.794E-14
PATHWAY RISK ==>		2.694E-09		3.849E-10

SOIL
RECEPTOR NUMBER 5

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
ANTIMO	1.306E-11		1.866E-12	
ARSENI	2.210E-11	3.315E-10	3.158E-12	6.766E-12
BARIUM	1.746E-11		2.494E-12	
BERYLL	1.319E-13		1.884E-14	
CADMIU	3.315E-13		4.736E-14	
CHROMI	7.748E-12		1.107E-12	
LEAD	5.978E-12		8.540E-13	
NICKEL	6.869E-13	8.175E-13	9.813E-14	1.668E-14
SELENI	1.319E-11		1.884E-12	
SILVER	2.210E-13		3.158E-14	
BEHP	5.445E-11	3.725E-14	2.744E-11	2.681E-15
PATHWAY RISK ==>		3.324E-10		6.785E-12

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:07:43 VERSION: 42688

PLANT

RECEPTOR NUMBER 5

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
ANTIMO	3.740E-10		1.336E-10	
ARSENI	1.939E-10	2.909E-09	1.634E-10	3.502E-10
BARIUM	3.499E-10		1.572E-10	
BERYLL	9.971E-13		9.522E-13	
CADMIU	2.515E-11		5.629E-12	
CHROMI	6.000E-11		5.615E-11	
LEAD	5.566E-11		4.466E-11	
NICKEL	9.494E-12	1.130E-11	5.575E-12	9.477E-13
SELENI	1.865E-10		1.076E-10	
SILVER	1.107E-11		2.939E-12	
BEHP	4.720E-09	3.228E-12	2.892E-09	2.826E-13
PATHWAY RISK ==>		2.924E-09		3.514E-10

FISH

RECEPTOR NUMBER 5

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
ANTIMO	1.289E-12		1.289E-12	
ARSENI	9.600E-11	1.440E-09	9.600E-11	2.057E-10
BARIUM	1.723E-12		1.723E-12	
BERYLL	2.473E-13		2.473E-13	
CADMIU	2.651E-12		2.651E-12	
CHROMI	1.224E-11		1.224E-11	
LEAD	2.892E-11		2.892E-11	
NICKEL	3.187E-11	3.793E-11	3.187E-11	5.418E-12
SELENI	2.083E-11		2.083E-11	
SILVER	6.720E-11		6.720E-11	
BEHP	1.551E-08	1.061E-11	1.551E-08	1.515E-12
PATHWAY RISK ==>		1.489E-09		2.127E-10

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:07:45 VERSION: 42688

DAIRY AND BEEF

RECEPTOR NUMBER 5

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
BEHP	2.350E-11	1.607E-14	1.954E-11	1.910E-15
PATHWAY RISK ==>		1.607E-14		1.910E-15

DERMAL (CONTACT W/ SOIL)

RECEPTOR NUMBER 5

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
ANTIMO	3.890E-12		5.557E-13	
ARSENI	6.583E-12	9.875E-11	9.405E-13	2.015E-12
BARIUM	5.199E-12		7.428E-13	
BERYLL	3.928E-14		5.611E-15	
CADMIU	9.875E-14		1.411E-14	
CHROMI	2.308E-12		3.297E-13	
LEAD	1.781E-12		2.544E-13	
NICKEL	2.046E-12	2.435E-12	2.923E-13	4.969E-14
SELENI	3.928E-12		5.611E-13	
SILVER	6.583E-14		9.405E-15	
BEHP	1.622E-11	1.109E-14	8.172E-12	7.986E-16
PATHWAY RISK ==>		1.012E-10		2.066E-12

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:07:45 VERSION: 42688

DRINKING WATER
RECEPTOR NUMBER 5

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
ANTIMO	5.152E-12		7.360E-13	
ARSENI	8.719E-12	1.308E-10	1.246E-12	1.868E-11
BARIUM	6.886E-12		9.837E-13	
BERYLL	5.202E-14		7.431E-15	
CADMIU	1.308E-13		1.868E-14	
CHROMI	3.057E-12		4.367E-13	
LEAD	2.358E-12		3.369E-13	
NICKEL	2.710E-13	3.225E-12	3.871E-14	4.607E-13
SELENI	5.202E-12		7.431E-13	
SILVER	8.719E-14		1.246E-14	
BEHP	1.050E-10	7.184E-14	1.500E-11	1.026E-14
PATHWAY RISK ==>		1.341E-10		1.915E-11

MOTHERS MILK
RECEPTOR NUMBER 5

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
BEHP	1.177E-08	8.050E-12	2.488E-08	2.431E-12
PATHWAY RISK ==>		8.050E-12		2.431E-12

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:07:46 VERSION: 42688

RISK TABLE FOR RECEPTOR : 5

	PATHWAY								
POLLUTANT	INHALATION	SOIL	PLANT	FISH	DAIRY	DERMAL	WATER	HUMAN MILK	TOTAL
BENZEN	4.190E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.190E-10
CHLORO	2.878E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.878E-12
DCE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MC	1.118E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.118E-10
TETRAC	1.619E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.619E-13
TRICE	8.846E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.846E-12
VC	5.952E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.952E-11
ARSENI	1.612E-09	3.315E-10	2.909E-09	1.440E-09	0.000E+00	9.875E-11	1.308E-10	0.000E+00	6.522E-09
BERYLL	1.615E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.615E-12
CADMIU	2.949E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.949E-12
CHROMI	4.633E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.633E-10
NICKEL	1.192E-11	8.175E-13	1.130E-11	3.793E-11	0.000E+00	2.435E-12	3.225E-12	0.000E+00	6.762E-11
CHLORD	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BEHP	2.656E-13	3.725E-14	3.228E-12	1.061E-11	1.607E-14	1.109E-14	7.184E-14	8.050E-12	2.229E-11
B(A)A	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
B(A)P	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL =	2.694E-09	3.324E-10	2.924E-09	1.489E-09	1.607E-14	1.012E-10	1.341E-10	8.050E-12	7.682E-09

*** TOTAL 10.0 YR RISK ==> 9.794E-10 ***

*** TOTAL 70.0 YR RISK ==> 7.682E-09 ***

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:07:48 VERSION: 42688

Pollutant Name	Inhalation Exposure	Inhalation ADI	Safety Factor	Ingestion Exposure	Iingestion ADI	Safety Factor
BENZEN	1.61E-08	1.90E-02	1.18E+06	0.00E+00	1.90E-02	0.00E+00
CHLORO	3.55E-11	1.00E-02	2.81E+08	0.00E+00	1.00E-02	0.00E+00
DCE	0.00E+00	2.70E-03	0.00E+00	0.00E+00	2.70E-03	0.00E+00
MC	6.78E-08	6.00E-02	8.85E+05	0.00E+00	6.00E-02	0.00E+00
TETRAC	9.52E-11	2.00E-02	2.10E+08	0.00E+00	2.00E-02	0.00E+00
TOLUEN	3.08E-08	1.50E+00	4.88E+07	0.00E+00	3.00E-01	0.00E+00
TRICE	1.92E-09	2.46E-02	1.28E+07	0.00E+00	2.46E-02	0.00E+00
VC	2.38E-09	1.30E-03	5.46E+05	0.00E+00	1.30E-03	0.00E+00
ANTIMO	1.90E-11	4.00E-04	2.10E+07	3.97E-10	4.00E-04	1.01E+06
ARSENI	3.22E-11	1.70E-03	5.27E+07	3.27E-10	1.70E-03	5.19E+06
BARIUM	2.55E-11	1.40E-04	5.50E+06	3.81E-10	5.10E-02	1.34E+08
BERYLL	1.92E-13	5.00E-04	2.60E+09	1.47E-12	5.00E-04	3.41E+08
CADMIU	4.83E-13	2.90E-04	6.00E+08	2.84E-11	2.90E-04	1.02E+07
CHROMI	1.13E-11	5.00E-03	4.42E+08	8.54E-11	5.00E-03	5.86E+07
LEAD	8.72E-12	4.30E-04	4.93E+07	9.47E-11	1.40E-03	1.48E+07
NICKEL	1.00E-11	1.00E-02	9.98E+08	1.38E-10	1.00E-02	7.22E+07
SELENI	1.92E-11	1.00E-03	5.20E+07	2.30E-10	3.00E-03	1.31E+07
SILVER	3.22E-13	3.00E-03	9.31E+09	7.87E-11	3.00E-03	3.81E+07
CHLORD	0.00E+00	5.00E-05	0.00E+00	0.00E+00	5.00E-05	0.00E+00
BEHP	3.88E-10	2.00E-02	5.15E+07	3.22E-08	2.00E-02	6.21E+05
B(A)A	0.00E+00	2.70E-05	0.00E+00	0.00E+00	2.70E-05	0.00E+00
B(A)P	0.00E+00	2.70E-05	0.00E+00	0.00E+00	2.70E-05	0.00E+00

POLLUTANT - Pollutant identifier
INHALATION EXPOSURE - Exposure through inhalation of pollutant
INHALATION ADI - Inhalation Acceptable Daily Intake
INHALATION SAFETY FACTOR - ADI divided by exposure
INGESTION EXPOSURE - Exposure through all pathways other than inhalation
INGESTION ADI - Ingestion Acceptable Daily Intake
INGESTION SAFETY FACTOR - ADI divided by exposure

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:08:00 VERSION: 42688

INHALATION

RECEPTOR NUMBER 6

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
BENZEN	2.766E-07	7.191E-09	2.766E-07	1.027E-09
CHLORO	6.097E-10	4.939E-11	6.097E-10	7.055E-12
MC	1.163E-06	1.919E-09	1.163E-06	2.741E-10
TETRAC	1.634E-09	2.778E-12	1.634E-09	3.969E-13
TOLUEN	5.280E-07		5.280E-07	
TRICE	3.300E-08	1.518E-10	3.300E-08	2.169E-11
VC	4.086E-08	1.021E-09	4.086E-08	1.459E-10
ANTIMO	3.269E-10		3.269E-10	
ARSENI	5.531E-10	2.766E-08	5.531E-10	3.951E-09
BARIUM	4.369E-10		4.369E-10	
BERYLL	3.300E-12	2.772E-11	3.300E-12	3.960E-12
CADMIU	8.297E-12	5.061E-11	8.297E-12	7.230E-12
CHROMI	1.939E-10	7.950E-09	1.939E-10	1.136E-09
LEAD	1.496E-10		1.496E-10	
NICKEL	1.719E-10	2.046E-10	1.719E-10	2.923E-11
SELENI	3.300E-10		3.300E-10	
SILVER	5.531E-12		5.531E-12	
BEHP	6.663E-09	4.557E-12	6.663E-09	6.511E-13
PATHWAY RISK ==>		4.623E-08		6.604E-09

SOIL

RECEPTOR NUMBER 6

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
ANTIMO	2.245E-10		3.207E-11	
ARSENI	3.799E-10	5.698E-09	5.427E-11	1.163E-10
BARIUM	3.000E-10		4.286E-11	
BERYLL	2.266E-12		3.238E-13	
CADMIU	5.698E-12		8.140E-13	
CHROMI	1.332E-10		1.903E-11	
LEAD	1.027E-10		1.468E-11	
NICKEL	1.181E-11	1.405E-11	1.687E-12	2.867E-13
SELENI	2.266E-10		3.238E-11	
SILVER	3.799E-12		5.427E-13	
BEHP	9.359E-10	6.402E-13	4.716E-10	4.608E-14
PATHWAY RISK ==>		5.713E-09		1.166E-10

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:08:01 VERSION: 42688

PLANT

RECEPTOR NUMBER 6

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
ANTIMO	6.428E-09		2.297E-09	
ARSENI	3.333E-09	5.000E-08	2.809E-09	6.019E-09
BARIUM	6.015E-09		2.702E-09	
BERYLL	1.714E-11		1.637E-11	
CADMIU	4.323E-10		9.676E-11	
CHROMI	1.031E-09		9.651E-10	
LEAD	9.567E-10		7.676E-10	
NICKEL	1.632E-10	1.942E-10	9.581E-11	1.629E-11
SELENI	3.205E-09		1.850E-09	
SILVER	1.904E-10		5.052E-11	
BEHP	8.112E-08	5.548E-11	4.971E-08	4.858E-12
PATHWAY RISK ==>		5.025E-08		6.040E-09

FISH

RECEPTOR NUMBER 6

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
ANTIMO	1.289E-12		1.289E-12	
ARSENI	9.600E-11	1.440E-09	9.600E-11	2.057E-10
BARIUM	1.723E-12		1.723E-12	
BERYLL	2.473E-13		2.473E-13	
CADMIU	2.651E-12		2.651E-12	
CHROMI	1.224E-11		1.224E-11	
LEAD	2.892E-11		2.892E-11	
NICKEL	3.187E-11	3.793E-11	3.187E-11	5.418E-12
SELENI	2.083E-11		2.083E-11	
SILVER	6.720E-11		6.720E-11	
BEHP	1.551E-08	1.061E-11	1.551E-08	1.515E-12
PATHWAY RISK ==>		1.489E-09		2.127E-10

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:08:03 VERSION: 42688

DAIRY AND BEEF

RECEPTOR NUMBER 6

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
BEHP	2.350E-11	1.607E-14	1.954E-11	1.910E-15
PATHWAY RISK ==>		1.607E-14		1.910E-15

DERMAL (CONTACT W/ SOIL)

RECEPTOR NUMBER 6

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
ANTIMO	6.686E-11		9.552E-12	
ARSENI	1.132E-10	1.697E-09	1.616E-11	3.464E-11
BARIUM	8.937E-11		1.277E-11	
BERYLL	6.751E-13		9.644E-14	
CADMIU	1.697E-12		2.425E-13	
CHROMI	3.967E-11		5.667E-12	
LEAD	3.060E-11		4.372E-12	
NICKEL	3.517E-11	4.185E-11	5.024E-12	8.541E-13
SELENI	6.751E-11		9.644E-12	
SILVER	1.132E-12		1.616E-13	
BEHP	2.788E-10	1.907E-13	1.405E-10	1.373E-14
PATHWAY RISK ==>		1.739E-09		3.551E-11

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:08:03 VERSION: 42688

DRINKING WATER

RECEPTOR NUMBER 6

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
ANTIMO	5.152E-12		7.360E-13	
ARSENI	8.719E-12	1.308E-10	1.246E-12	1.868E-11
BARIUM	6.886E-12		9.837E-13	
BERYLL	5.202E-14		7.431E-15	
CADMIU	1.308E-13		1.868E-14	
CHROMI	3.057E-12		4.367E-13	
LEAD	2.358E-12		3.369E-13	
NICKEL	2.710E-13	3.225E-12	3.871E-14	4.607E-13
SELENI	5.202E-12		7.431E-13	
SILVER	8.719E-14		1.246E-14	
BEHP	1.050E-10	7.184E-14	1.500E-11	1.026E-14
PATHWAY RISK ==>		1.341E-10		1.915E-11

MOTHERS MILK

RECEPTOR NUMBER 6

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
BEHP	5.916E-08	4.047E-11	9.569E-08	9.350E-12
PATHWAY RISK ==>		4.047E-11		9.350E-12

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:08:04 VERSION: 42688

RISK TABLE FOR RECEPTOR : 6

POLLUTANT	INHALATION	SOIL	PLANT	FISH	DAIRY	DERMAL	WATER	HUMAN MILK	TOTAL
				PATHWAY					
BENZEN	7.191E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.191E-09
CHLORO	4.939E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.939E-11
DCE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MC	1.919E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.919E-09
TETRAC	2.778E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.778E-12
TRICE	1.518E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.518E-10
VC	1.021E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.021E-09
ARSENI	2.766E-08	5.698E-09	5.000E-08	1.440E-09	0.000E+00	1.697E-09	1.308E-10	0.000E+00	8.662E-08
BERYLL	2.772E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.772E-11
CADMIU	5.061E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.061E-11
CHROMI	7.950E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.950E-09
NICKEL	2.046E-10	1.405E-11	1.942E-10	3.793E-11	0.000E+00	4.185E-11	3.225E-12	0.000E+00	4.958E-10
CHLORD	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BEHP	4.557E-12	6.402E-13	5.548E-11	1.061E-11	1.607E-14	1.907E-13	7.184E-14	4.047E-11	1.120E-10
B(A)A	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
B(A)P	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL =	4.623E-08	5.713E-09	5.025E-08	1.489E-09	1.607E-14	1.739E-09	1.341E-10	4.047E-11	1.056E-07

*** TOTAL 10.0 YR RISK ==> 1.304E-08 ***

*** TOTAL 70.0 YR RISK ==> 1.056E-07 ***

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:08:06 VERSION: 42688

Pollutant Name	Inhalation Exposure	Inhalation ADI	Safety Factor	Ingestion Exposure	Iingestion ADI	Safety Factor
BENZEN	2.77E-07	1.90E-02	6.87E+04	0.00E+00	1.90E-02	0.00E+00
CHLORO	6.10E-10	1.00E-02	1.64E+07	0.00E+00	1.00E-02	0.00E+00
DCE	0.00E+00	2.70E-03	0.00E+00	0.00E+00	2.70E-03	0.00E+00
MC	1.16E-06	6.00E-02	5.16E+04	0.00E+00	6.00E-02	0.00E+00
TETRAC	1.63E-09	2.00E-02	1.22E+07	0.00E+00	2.00E-02	0.00E+00
TOLUEN	5.28E-07	1.50E+00	2.84E+06	0.00E+00	3.00E-01	0.00E+00
TRICE	3.30E-08	2.46E-02	7.45E+05	0.00E+00	2.46E-02	0.00E+00
VC	4.09E-08	1.30E-03	3.18E+04	0.00E+00	1.30E-03	0.00E+00
ANTIMO	3.27E-10	4.00E-04	1.22E+06	6.73E-09	4.00E-04	5.95E+04
ARSENI	5.53E-10	1.70E-03	3.07E+06	3.93E-09	1.70E-03	4.32E+05
BARIUM	4.37E-10	1.40E-04	3.20E+05	6.41E-09	5.10E-02	7.95E+06
BERYLL	3.30E-12	5.00E-04	1.52E+08	2.04E-11	5.00E-04	2.45E+07
CADMIU	8.30E-12	2.90E-04	3.50E+07	4.43E-10	2.90E-04	6.55E+05
CHROMI	1.94E-10	5.00E-03	2.58E+07	1.22E-09	5.00E-03	4.10E+06
LEAD	1.50E-10	4.30E-04	2.87E+06	1.12E-09	1.40E-03	1.25E+06
NICKEL	1.72E-10	1.00E-02	5.82E+07	1.82E-09	1.00E-02	5.50E+06
SELENI	3.30E-10	1.00E-03	3.03E+06	3.53E-09	3.00E-03	8.51E+05
SILVER	5.53E-12	3.00E-03	5.42E+08	2.63E-10	3.00E-03	1.14E+07
CHLORD	0.00E+00	5.00E-05	0.00E+00	0.00E+00	5.00E-05	0.00E+00
BEHP	6.66E-09	2.00E-02	3.00E+06	1.57E-07	2.00E-02	1.27E+05
B(A)A	0.00E+00	2.70E-05	0.00E+00	0.00E+00	2.70E-05	0.00E+00
B(A)P	0.00E+00	2.70E-05	0.00E+00	0.00E+00	2.70E-05	0.00E+00

POLLUTANT - Pollutant identifier
INHALATION EXPOSURE - Exposure through inhalation of pollutant
INHALATION ADI - Inhalation Acceptable Daily Intake
INHALATION SAFETY FACTOR - ADI divided by exposure
INGESTION EXPOSURE - Exposure through all pathways other than inhalation
INGESTION ADI - Ingestion Acceptable Daily Intake
INGESTION SAFETY FACTOR - ADI divided by exposure

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:08:18 VERSION: 42688

INHALATION

RECEPTOR NUMBER 7

POLLUTANT	70 YEARS DOSE	70 YEARS RISK	10.0 YEARS DOSE	10.0 YEARS RISK
BENZEN	1.131E-08	2.942E-10	1.131E-08	4.202E-11
CHLORO	2.494E-11	2.020E-12	2.494E-11	2.886E-13
MC	4.757E-08	7.849E-11	4.757E-08	1.121E-11
TETRAC	6.686E-11	1.137E-13	6.686E-11	1.624E-14
TOLUEN	2.160E-08		2.160E-08	
TRICE	1.350E-09	6.210E-12	1.350E-09	8.871E-13
VC	1.671E-09	4.179E-11	1.671E-09	5.969E-12
ANTIMO	1.337E-11		1.337E-11	
ARSENI	2.263E-11	1.131E-09	2.263E-11	1.616E-10
BARIUM	1.787E-11		1.787E-11	
BERYLL	1.350E-13	1.134E-12	1.350E-13	1.620E-13
CADMIU	3.394E-13	2.071E-12	3.394E-13	2.958E-13
CHROMI	7.933E-12	3.252E-10	7.933E-12	4.646E-11
LEAD	6.120E-12		6.120E-12	
NICKEL	7.033E-12	8.369E-12	7.033E-12	1.196E-12
SELENI	1.350E-11		1.350E-11	
SILVER	2.263E-13		2.263E-13	
BEHP	2.726E-10	1.864E-13	2.726E-10	2.663E-14
PATHWAY RISK ==>		1.891E-09		2.702E-10

SOIL

RECEPTOR NUMBER 7

POLLUTANT	70 YEARS DOSE	70 YEARS RISK	10.0 YEARS DOSE	10.0 YEARS RISK
ANTIMO	9.183E-12		1.312E-12	
ARSENI	1.554E-11	2.331E-10	2.220E-12	4.757E-12
BARIUM	1.227E-11		1.753E-12	
BERYLL	9.272E-14		1.325E-14	
CADMIU	2.331E-13		3.330E-14	
CHROMI	5.448E-12		7.783E-13	
LEAD	4.203E-12		6.004E-13	
NICKEL	4.830E-13	5.748E-13	6.900E-14	1.173E-14
SELENI	9.272E-12		1.325E-12	
SILVER	1.554E-13		2.220E-14	
BEHP	3.829E-11	2.619E-14	1.929E-11	1.885E-15
PATHWAY RISK ==>		2.337E-10		4.771E-12

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:08:19 VERSION: 42688

PLANT

RECEPTOR NUMBER 7

POLLUTANT	70 YEARS DOSE	70 YEARS RISK	10.0 YEARS DOSE	10.0 YEARS RISK
ANTIMO	2.630E-10		9.396E-11	
ARSENI	1.364E-10	2.045E-09	1.149E-10	2.462E-10
BARIUM	2.461E-10		1.105E-10	
BERYLL	7.011E-13		6.695E-13	
CADMIU	1.769E-11		3.958E-12	
CHROMI	4.219E-11		3.948E-11	
LEAD	3.914E-11		3.140E-11	
NICKEL	6.675E-12	7.944E-12	3.920E-12	6.663E-13
SELENI	1.311E-10		7.567E-11	
SILVER	7.787E-12		2.067E-12	
BEHP	3.318E-09	2.270E-12	2.034E-09	1.987E-13
PATHWAY RISK ==>		2.056E-09		2.471E-10

FISH

RECEPTOR NUMBER 7

POLLUTANT	70 YEARS DOSE	70 YEARS RISK	10.0 YEARS DOSE	10.0 YEARS RISK
ANTIMO	1.289E-12		1.289E-12	
ARSENI	9.600E-11	1.440E-09	9.600E-11	2.057E-10
BARIUM	1.723E-12		1.723E-12	
BERYLL	2.473E-13		2.473E-13	
CADMIU	2.651E-12		2.651E-12	
CHROMI	1.224E-11		1.224E-11	
LEAD	2.892E-11		2.892E-11	
NICKEL	3.187E-11	3.793E-11	3.187E-11	5.418E-12
SELENI	2.083E-11		2.083E-11	
SILVER	6.720E-11		6.720E-11	
BEHP	1.551E-08	1.061E-11	1.551E-08	1.515E-12
PATHWAY RISK ==>		1.489E-09		2.127E-10

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:08:21 VERSION: 42688

DAIRY AND BEEF
RECEPTOR NUMBER 7

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
BEHP	2.350E-11	1.607E-14	1.954E-11	1.910E-15
PATHWAY RISK ==>		1.607E-14		1.910E-15

DERMAL (CONTACT W/ SOIL)
RECEPTOR NUMBER 7

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
ANTIMO	2.735E-12		3.908E-13	
ARSENI	4.629E-12	6.943E-11	6.613E-13	1.417E-12
BARIUM	3.656E-12		5.223E-13	
BERYLL	2.762E-14		3.945E-15	
CADMIU	6.943E-14		9.919E-15	
CHROMI	1.623E-12		2.318E-13	
LEAD	1.252E-12		1.788E-13	
NICKEL	1.439E-12	1.712E-12	2.055E-13	3.494E-14
SELENI	2.762E-12		3.945E-13	
SILVER	4.629E-14		6.613E-15	
BEHP	1.140E-11	7.801E-15	5.746E-12	5.615E-16
PATHWAY RISK ==>		7.115E-11		1.453E-12

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:08:22 VERSION: 42688

DRINKING WATER

RECEPTOR NUMBER 7

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
ANTIMO	5.152E-12		7.360E-13	
ARSENI	8.719E-12	1.308E-10	1.246E-12	1.868E-11
BARIUM	6.886E-12		9.837E-13	
BERYLL	5.202E-14		7.431E-15	
CADMIU	1.308E-13		1.868E-14	
CHROMI	3.057E-12		4.367E-13	
LEAD	2.358E-12		3.369E-13	
NICKEL	2.710E-13	3.225E-12	3.871E-14	4.607E-13
SELENI	5.202E-12		7.431E-13	
SILVER	8.719E-14		1.246E-14	
BEHP	1.050E-10	7.184E-14	1.500E-11	1.026E-14
PATHWAY RISK ==>		1.341E-10		1.915E-11

MOTHERS MILK

RECEPTOR NUMBER 7

	70 YEARS		10.0 YEARS	
POLLUTANT	DOSE	RISK	DOSE	RISK
BEHP	1.090E-08	7.455E-12	2.358E-08	2.304E-12
PATHWAY RISK ==>		7.455E-12		2.304E-12

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:08:22 VERSION: 42688

RISK TABLE FOR RECEPTOR : 7

	PATHWAY								
POLLUTANT	INHALATION	SOIL	PLANT	FISH	DAIRY	DERMAL	WATER	HUMAN MILK	TOTAL
BENZEN	2.942E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.942E-10
CHLORO	2.020E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.020E-12
DCE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MC	7.849E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.849E-11
TETRAC	1.137E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.137E-13
TRICE	6.210E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.210E-12
VC	4.179E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.179E-11
ARSENI	1.131E-09	2.331E-10	2.045E-09	1.440E-09	0.000E+00	6.943E-11	1.308E-10	0.000E+00	5.050E-09
BERYLL	1.134E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.134E-12
CADMIU	2.071E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.071E-12
CHROMI	3.252E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.252E-10
NICKEL	8.369E-12	5.748E-13	7.944E-12	3.793E-11	0.000E+00	1.712E-12	3.225E-12	0.000E+00	5.975E-11
CHLORD	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BEHP	1.864E-13	2.619E-14	2.270E-12	1.061E-11	1.607E-14	7.801E-15	7.184E-14	7.455E-12	2.064E-11
B(A)A	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
B(A)P	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL =	1.891E-09	2.337E-10	2.056E-09	1.489E-09	1.607E-14	7.115E-11	1.341E-10	7.455E-12	5.882E-09

*** TOTAL 10.0 YR RISK ==> 7.576E-10 ***

*** TOTAL 70.0 YR RISK ==> 5.882E-09 ***

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:08:24 VERSION: 42688

Pollutant Name	Inhalation Exposure	Inhalation ADI	Safety Factor	Ingestion Exposure	Iingestion ADI	Safety Factor
BENZEN	1.13E-08	1.90E-02	1.68E+06	0.00E+00	1.90E-02	0.00E+00
CHLORO	2.49E-11	1.00E-02	4.01E+08	0.00E+00	1.00E-02	0.00E+00
DCE	0.00E+00	2.70E-03	0.00E+00	0.00E+00	2.70E-03	0.00E+00
MC	4.76E-08	6.00E-02	1.26E+06	0.00E+00	6.00E-02	0.00E+00
TETRAC	6.69E-11	2.00E-02	2.99E+08	0.00E+00	2.00E-02	0.00E+00
TOLUEN	2.16E-08	1.50E+00	6.94E+07	0.00E+00	3.00E-01	0.00E+00
TRICE	1.35E-09	2.46E-02	1.82E+07	0.00E+00	2.46E-02	0.00E+00
VC	1.67E-09	1.30E-03	7.78E+05	0.00E+00	1.30E-03	0.00E+00
ANTIMO	1.34E-11	4.00E-04	2.99E+07	2.81E-10	4.00E-04	1.42E+06
ARSENI	2.26E-11	1.70E-03	7.51E+07	2.61E-10	1.70E-03	6.51E+06
BARIUM	1.79E-11	1.40E-04	7.83E+06	2.71E-10	5.10E-02	1.88E+08
BERYLL	1.35E-13	5.00E-04	3.70E+09	1.12E-12	5.00E-04	4.46E+08
CADMIU	3.39E-13	2.90E-04	8.54E+08	2.08E-11	2.90E-04	1.40E+07
CHROMI	7.93E-12	5.00E-03	6.30E+08	6.46E-11	5.00E-03	7.75E+07
LEAD	6.12E-12	4.30E-04	7.03E+07	7.59E-11	1.40E-03	1.85E+07
NICKEL	7.03E-12	1.00E-02	1.42E+09	1.08E-10	1.00E-02	9.29E+07
SELENI	1.35E-11	1.00E-03	7.41E+07	1.69E-10	3.00E-03	1.77E+07
SILVER	2.26E-13	3.00E-03	1.33E+10	7.53E-11	3.00E-03	3.99E+07
CHLORD	0.00E+00	5.00E-05	0.00E+00	0.00E+00	5.00E-05	0.00E+00
BEHP	2.73E-10	2.00E-02	7.34E+07	2.99E-08	2.00E-02	6.69E+05
B(A)A	0.00E+00	2.70E-05	0.00E+00	0.00E+00	2.70E-05	0.00E+00
B(A)P	0.00E+00	2.70E-05	0.00E+00	0.00E+00	2.70E-05	0.00E+00

POLLUTANT - Pollutant identifier
INHALATION EXPOSURE - Exposure through inhalation of pollutant
INHALATION ADI - Inhalation Acceptable Daily Intake
INHALATION SAFETY FACTOR - ADI divided by exposure
INGESTION EXPOSURE - Exposure through all pathways other than inhalation
INGESTION ADI - Ingestion Acceptable Daily Intake
INGESTION SAFETY FACTOR - ADI divided by exposure

*** CARSWELL AFB SITE 12 (FIRE DEPT. TRAINING AREA 2) *** DATE: 9-13-1988 TIME: 1:08:26 VERSION: 42688

MAXIMUM TOTAL 10.00 YR RISK ==> 1.30E-08 ***

MAXIMUM TOTAL 70.0 YR RISK ==> 1.06E-07 ***

R-RAM TERMS

Pathway Variables

General

Risk Threshold for Burden Calc.	Level of risk below which the population burden is not calculated.
Body Weight	Average weight of people in the study group (kg).
Alternate Exposure Period	Length of exposure (in years) to emitted pollutants. R-RAM assumes a 70-year exposure period; however, an alternate exposure period can be set manually and the program will assess risks based on a different length of exposure in addition to the 70-year period.

Respiration

Respiration Rate	Total volume (in cubic meters) of air breathed per day.
Particle Correction	Percentage of particles entrained in the respiratory tract.

Soil

Mixing Depth	Depth (in meters) to which pollutants penetrate the soil through leaching and tilling.

R-RAM TERMS (Cont.)

Soil

Soil Consumption, 70 Years	Amount of soil ingested by the average individual in kg/day over a 70-year period.
Soil Consumption, Alternate Years	Amount of soil ingested by individual in kg/day over an alternate exposure period.

Plant

Rec. # Used as Farm	The number assigned to a given receptor area designated for use as a farm. If the input is 0, the site where produce is grown is receptor-specific, e.g., from backyard gardens.
Interception Fraction	The fraction of a plant's total surface area which is oriented such that it can receive deposition of airborne particles.
Elimination Constant	The inverse half-life of pollutants in plant tissue.
Days Exposed	The number of days plants are exposed to pollutants before harvest.
Edible Crop Density	The amount of edible plants grown per area of farmland (in kg/m^3).

R-RAM TERMS (Cont.)

Plant (cont.)

Cleaning Efficiency	The fraction of particles deposited on a plant which actually penetrate its surface. Cleaning Efficiency = Plant Concentration ÷ Surface Concentration.
Plant Consumption	The average amount of plants grown in the study area that are eaten by individuals in the study population (in kg/day).
Root Vegetable Consumption	The average amount of root vegetables grown in the study area that are eaten by individuals in the study population (in kg/day).

Fish

Rec. # Used as Water Body	Number of the receptor designated for use as a fishable water source.
Rec. # Used as Runoff	Number of the receptor designated as the area for runoff to the fishable water source.
Water Surface Area	The surface area (in square meters) of the fishable water source.
Water Flow Rate	The total flow rate of fishable water source (kg/day).
Sediment Flow Rate	The total flow of sediment in fishable water source (kg/day).

R-RAM TERMS (Cont.)

Fish (cont.)

Deposition Period	Water retention time in days.
Fish Consumption	Intake of fish grown in fishable water source by individuals in study population (g/day).

Dairy and Beef

Rec # Used as Dairy Pasture	Number of the receptor designated for use as a dairy pasture (for grazing).
Rec # Used as Dairy Feedlot	Number of the receptor designated for use as a dairy cattle feedlot (for confined consumption of fodder).
Fraction of Dairy Feed from Grazing	Percentage of time dairy cattle graze.
Bioconcentration Factor for Milk	Factor relating concentration of pollutant in dairy cattle to concentration in milk.
Rec. # Used as Beef Pasture	Number of the receptor designated for use as a beef cattle pasture (for grazing).
Rec. # Used as Beef Feedlot	Number of the receptor designated for use as as a beef cattle feedlot (for confined consumption of fodder).
Fraction of Beef Feed from Grazing	Percentage of time beef cattle graze.

R-RAM TERMS (Cont.)

Dairy and Beef (Cont.)

Bioconcentration Factor for Beef	Factor relating concentration of pollutant in beef cattle to concentration in edible meat.
Cattle Inhalation Rate	Breathing rate of dairy and beef cattle (m^3/day).
Fodder Exposure Period	Length of time a mass of cattle feed (fodder) is exposed to air (hours).
Fodder Surface Area	Surface area of feed (fodder) exposed to deposition processes (m^2/day).
Quantity of Fodder Exposed	Total quantity of fodder exposed to deposition processes in one day (kg).
Water Surface Area	The surface area of water in a cattle watering tank (m^2).
Water Residence Time	The length of time water sits in a watering tank (hours).
Water Quantity in Water Tank	The mass of water in a cattle watering tank (kg).
Milk Production Rate	The mass of milk (fat adjusted) produced by dairy cattle in the study area which is consumed by people in the study area (kg/day).

R-RAM TERMS (Cont.)

Dairy and Beef (Cont.)

Cattle Body Weight	The average weight of cattle in the study area (kg).
Grass Interception	The fraction of the surface area of grass which is oriented such that it can receive deposition of airborne particles.
Grass Density	The density of grass consumed by cattle (kg/m^2).
Grass Consumption rate	The mass of grass consumed by cattle each day (kg/day).
Soil Consumption	The mass of soil consumed by cattle while grazing (kg/day).
Water Consumption Rate	The amount of water consumed by cattle each day (kg/day).
Fodder Consumption Rate	The mass of fodder consumed by cattle each day (kg/day).
Beef Consumption	The average amount of locally-produced beef products consumed by individuals in the study population (kg/day).
Milk Consumption	The average amount of locally-produced dairy products consumed by individuals in the study population (kg/day).

R-RAM TERMS (Cont.)

Dermal

Skin Surface Area	The mean surface area of skin exposed to deposition (cm^2).
Dust on Skin	The average mass of dust deposited on skin surface area per day ($mg/cm^2/day$).

Mother's Milk

Female Fat Content	The average amount of fat in breast-feeding women in the population (kg).
Infant Milk Consumption	The average amount of mother's milk consumed by nursing infants each day (ml/day).
Infant Body Weight	The average weight of nursing infants in the population (kg).

Drinking Water

Rec. # Used as Reservoir	Number of the receptor designated for use as a drinking water source.
Reservoir Surface Area	The surface area of an above-ground drinking water source (m^2).
Water Reservoir Outflow	The flow rate of a drinking water source (kg/day).
Drinking Water Consumption	The average amount of water consumed by individuals in the study population (kg/day).

R-RAM TERMS (Cont.)

Pollutant Specific Data

Symbol	Pollutant identificaiton.
Ingestion Pot.	Pollutant ingestion cancer potency slope (mg/kg/day).
Inhalation Pot.	Pollutant inhalation cancer potency slope (mg/kg/day).
Bioconc.	A factor relating the concentration of a pollutant in water to its concentration in fish.
Root	The Root Uptake factor, which relates the concentration of a pollutant in soil to its concentration in plant tissue.
Class	Exposure Class. "M" designates mass weighted deposition flux; "A" designates area weighted deposition flux.

Elimination Rate Data

Symbol	Pollutant identification.
Soil	The elimination rate constant of a pollutant from soil.
Animal	The elimination rate constant of a pollutant from cattle.

R-RAM TERMS (Cont.)

Elimination Rate Data (Cont.)

Mother's Milk	The elimination rate constant of a pollutant from nursing mothers' bodies.

Populations of Receptors

Receptor	Location of impact.
Population	The total number of individuals residing in a defined receptor location.

Unit Concentrations and Deposition Fluxes

Source	Identification of an air emissions source.
Receptor	Location of impact.
Unit Conc.	Ground level concentration flux of an emitted pollutant ($\mu g/m^3/g/s$).
Area Dep.	The area-weighted, unit emission rate deposition flux ($\mu g/m^2/s/g/s$).
Mass Dep.	The mass-weighted, unit emission rate deposition flux ($\mu g/m^2/s/g/s$).

R-RAM TERMS (Cont.)

Emission Rates

Source	Identification of an air emissions source.
Pollutant	Pollutant identification.
Emission Rate	Rate at which pollutant is emitted to the air by a specified source (g/s).

Gastrointestinal Factors

Symbol	Pollutant identification.
Inhale	The fraction of a pollutant in the air which is absorbed following inhalation by humans.
Soil	The fraction of a pollutant in the soil which is absorbed following ingestion of soil by humans.
Plant	The fraction of a pollutant in plants which is absorbed following ingestion of plants by humans.
Fish	The fraction of a pollutant in fish which is absorbed following ingestion of fish by humans.
D & B	The fraction of a pollutant in dairy and beef products which is absorbed following ingestion of dairy and beef products by humans.

R-RAM TERMS (Cont.)

Gastrointestinal Factors (Cont.)

Dermal	The fraction of a pollutant in soil/dust which is absorbed during contact with human skin.
Water	The fraction of a pollutant in water which is absorbed following ingestion of water by humans.
Milk	The fraction of a pollutant in mother's milk which is absorbed following ingestion of mother's milk by infants.
Tissue	Absorption efficiency of plant tissue.

Acceptable Daily Intakes

Pollutant	Pollutant identification.
Inhalation ADI	Acceptable daily intake for inhalation of a pollutant (mg/kg/day).
Ingestion ADI	Acceptable daily intake for ingestion of a pollutant (mg/kg/day).

TAB

K

APPENDIX K

Resumes of Key Personnel

FRANCIS J. SMITH

EDUCATION:

M.S., Sanitary Engineering, Massachusetts Institute of Technology, 1954.

B.S., Civil Engineering, University of Michigan, 1950.

EXPERIENCE:

Senior Program Manager, Research and Engineering Operations, Radian Corporation, McLean, VA, 1985-Present.

Program Manager, Research and Engineering Operations, Radian Corporation, McLean, VA, 1981-1985.

Senior Associate, Occupational Health and Safety and Environmental Engineering, A.T. Kearney Management Consultants, Alexandria, VA, 1980-1981.

Acting Chief Environmental Planning, Logistics and Engineering, Headquarters USAF, Washington, DC, 1979-1980.

Chief Environmental Policy, Logistics and Engineering, Headquarters USAF, Washington, DC, 1976-1979.

Director Environmental Protection, Air Force Systems Command (AFSC), Andrews Air Force Base, MD, 1972-1976.

Chief Bioenvironmental Engineering, Headquarters Pacific Air Force, Hickam Air Force Base, HI, 1968-1972.

Similar assignments at Headquarters Alaskan Air Command, Headquarters Tactical Air Command, and at Subcommands of Strategic Air Command, 1951-1968.

Junior Industrial Waste Engineer, Lederle Division, American Cyanamide, Pearl River, NY, 1950-1951.

FIELDS OF EXPERIENCE:

Mr. Smith has had 35 years experience in all aspects of environmental engineering. This experience ranges from carrying out the routine environmental and occupational health operations at individual installations to running the environmental activities of a major federal agency. He is a registered Professional Engineer, Certified Industrial Hygienist, Certified Safety Professional and is a Diplomate of the American Academy of Environmental Engineers.

He has been the contract program manager for two prime contracts which Radian has with the USAF. Both are multi-million dollar efforts; one has had a total of 29 delivery orders and the other has had 18 thus far. The work has been

Francis J. Smith

varied but has strongly emphasized hazardous waste site investigations (USAF Installation Restoration Program (IRP) Phase II). Work has been conducted at 13 USAF installations under this contract.

Mr. Smith is program manager for the confirmation study of the Marine Corps Training Base at Quantico, Virginia. It is the second phase of the Navy Assessment and Control of Installation Pollutants (NACIP) program for the base. This phase includes three areas: verification of the existence/absence of groundwater contamination; further characterization, if needed; and preparation of remedial plans and specifications.

He was the program manager on the Air Force Engineering and Services Center basic ordering agreement. Four USAF IRP Phase I record searches were conducted under this contract. He was also the program manager for the preparation of a hazardous waste management plan, SPCC and other related environmental plans for a Naval Air Station. He manages a subcontract with a major architect-engineer firm for the provision of analytical and technical services in support of groundwater investigations.

He is a section manager in the Solid and Hazardous Waste Management Business Unit of the Research and Engineering Division. Mr. Smith assists the Radian staff in the identification of business opportunities across the seven business units that comprise Radian services. In addition, he coordinates all Radian business with DOD in the environmental and occupational health areas. He also participates in the marketing of Radian services to federal agencies and trade associations.

Since retiring from the USAF, Mr. Smith has been involved in a variety of projects including both environmental and health work. His emphasis has been on hazardous waste. These activities have included: quality review of reports; health and safety evaluation of a cement plant seeking permits to burn chemical wastes; a draft environmental impact statement (EIS) on the thermal destruction of chemical wastes; review of the treatment of photographic chemical manufacturing wastes; groundwater contamination studies; RCRA impacts; and an R&D study of truck tire noise for the National Highway Safety Transportation Agency.

He was the Certified Industrial Hygienist (CIH) and an environmental consultant for A.T. Kearney Management Consultants. In addition to the routine occupational safety and health activities he specialized in the interpretation and response to the EPA RCRA regulations.

For three of the last four years in his assignment with Headquarters USAF, he was responsible for air, land, and water pollution management programs. This included programming an average of $19 million per year. Also included were: the implementation of RCRA; the initial USAF Installation Restoration Program (IRP, equivalent to CERCLA-Superfund); management of 17 million acres of natural resources; and the National Environmental Policy Act (NEPA) environmental impact analysis program. In addition to these activities, he assumed responsibility for one year for all of Enviromental Planning. This included:

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comprehensive base planning; the Air Installation Compatibility Use Zone plans for acquiring or regulating land use near bases with high noise or accident potential; and the development of environmental methodologies.

At the Air Force Systems Command, Mr. Smith organized an office to address effects of the federal environmental laws on the Research, Development and Acquisition programs. (This office was the highest level environmental activity ever established at a USAF major command.) He directed the preparation of almost all of the EIS's issued by the USAF in this period. He was an expert witness for the federal government. One was a suit over the health hazards associated with the siting of new type radar stations in California and Massachusetts. The other pertained to an EIS for new facilities in Colorado. Additionally, he was responsible for advising on the industrial hygiene and environmental needs of Government Owned Contractor Operated (GOCO) industrial plants.

During his assignment to the Pacific Air Force, Mr. Smith provided environmental and industrial hygiene guidance to USAF activities in Korea, Japan, Taiwan, Vietnam, Thailand, Philippine Islands, Guam, Trust Territories, and Hawaii. This included the traditional areas of sanitary engineering (water supply, treatment, and distribution; waste collection, treatment, and disposal; and pest control). It also included more modern problems, such as LASER equipment calibration, maintenance, and use; handling of large volumes of herbicides; noise control; industrial hygiene; heat and cold extremes; decontamination and quarantine of equipment to prevent introduction of foreign fauna or flora into the U.S. from Asia. For four years, Mr. Smith was a member of the United States delegation to the South East Asia Treaty Organization (SEATO) Military Committee. He represented the U.S. with regard to public health engineering policies. Mr. Smith also evaluated USAF civic action programs to provide basic water and waste disposal to rural Thai villages.

Other USAF assignments in various commands provided environmental engineering and industrial hygiene support for the combat Air Force. Many of the previously mentioned activities were carried out as well as support for the current priority preventive medical activities. Some examples of the latter would be: defense against accidental release or delivery and use of chemical agents; improved water treatment plant operations; improved wastewater facilities and operations; conversion of dumps to sanitary fills; substitution of less toxic materials; and engineering control of working exposures.

CERTIFICATIONS/REGISTRATIONS AND PROFESSIONAL SOCIETIES:

Certified Industrial Hygienist by the American Board of Industrial Hygiene, 1971, No. 690
Certified Safety Professional by the Board of Safety Professionals of the Americas, 1972, No. 2103
Registered Professional Engineer, State of Massachusetts, 1963, No. 19021
Diplomat, American Academy of Environmental Engineers, 1980.

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American Industrial Hygiene Association (National and Baltimore-Washington)
American Conference of Government Industrial Hygienists
National (and Maryland) Society of Professional Engineers
American Academy of Industrial Hygiene
American Academy of Environmental Engineers
American Defense Preparedness Association
Society of Military Engineers

NELSON H. LUND

EDUCATION:

M.P.H., Environmental Health and Engineering, University of Minnesota, Minneapolis, MN, 1965.

B.S., Civil Engineering, Michigan Technological University, Houghton, MI, 1960.

Graduate (Professional Military Degree), U.S. Army Command and General Staff College, Ft. Leavenworth, KS, 1972.

EXPERIENCE:

Currently is Program Manager for several Department of Defense projects. As Program Manager he has ultimate responsibility to insure that the environmental projects for the Army, Navy, and Air Force are completed on time, within budget and to the government's complete satisfaction. He currently manages a comprehensive $3.7 million environmental program for the Omaha District, Corps of Engineers on behalf of the U.S. Air Force Tactical Air Command. He recently managed a U.S. Navy project to prepare a Hazardous Waste Management Plan and Spill Prevention, Control, and Countermeasure Plan at a large Naval Air Station/Army Depot complex. In addition he is currently the Assistant Program Manager for the U.S. Air Force Occupational Environmental Health Laboratory sponsored Installation Restoration Program being performed at several Air Force bases.

Other work at Radian has included involvement in a project to clean up a 20-acre site contaminated with pesticide. Mr. Lund participated in the complete project from initial field sampling, through the RI/FS, and concluded with his work as site engineer and construction manager during site cleanup. He has also prepared RCRA Part B closure and post closure plans for major refineries. Mr. Lund also completed design plans and specifications for an indoor hazardous waste containment facility.

Mr. Lund joined Radian Corporation in July 1984 after completing 24 years on active duty as an Environmental Engineering Program Manager with the U.S. Army. He is intimately familiar with governmental procedures and worldwide complex environmental issues.

In his last position with the Army (July 1981-July 1984) before joining Radian, Mr. Lund was the Program Manager for the Army's Hazardous Waste; Air Quality; and Water and Wastewater programs. He managed 97 engineers, scientists, technicians, and administrators providing worldwide environmental quality consultative services to all U.S. Army commands and installations as well as the Defense Logistics Agency. Services included on-site surveys and studies, document reviews, preparation of permits and plans, and review/interpretation of sampling data. Areas of specialization were: chemical agent

demilitarization support and installation restoration to the U.S. Army Toxic and Hazardous Materials Agency, hazardous and solid waste management, groundwater monitoring, drinking water and wastewater assessments, air pollution source surveillance, and ambient air evaluations. Clients received final reports advising them of their status of compliance with Federal, state, and local environmental laws. Reports included remedial action measures and treatability determinations. He also coordinated environmental actions and trends with senior governmental officials and the public sector. Mr. Lund controlled an annual budget of $6.7 million, plus an additional $1.2 million for technical equipment purchases. He also served as the Environmental Engineer Consultant to the Army Surgeon General.

From August 1978 to July 1981 Mr. Lund was assigned to Headquarters, U.S. Army, Europe, in Heidelburg, Federal Republic of Germany, where he served as the Environmental Program Manager for the U.S. Army throughout Europe and the Middle East. He managed approximately 130 environmental scientists and technicians at 15 separate locations whose work included water/wastewater quality surveillance, hazardous/solid waste treatment or disposal, industrial hygiene monitoring, and environmental noise. In addition, he was responsible for technical staff supervision of a 34-person environmental engineering consultant division. That division conducted on-site surveys to determine environmental compliance with U.S. or German laws. He also prepared quarterly training programs for engineers and scientists and met frequently with top U.S. and German government officials regarding environmental laws and future initiatives.

Before moving to Heidelberg, he was the Environmental Program Manager to the Commander of Health Services Command at San Antonio, Texas where he managed installation-level environmental health and engineering initiatives at all Army installations throughout the U.S. In that capacity, from June 1975 to August 1978, Mr. Lund managed approximately 480 environmental scientists and technicians located at 48 separate locations. Those individuals provided environmental support to their geographical area in the disciplines of water/-wastewater monitoring, hazardous/solid waste treatment or disposal, air pollution assessment, and industrial hygiene surveillance. He coordinated approximately 400 environmental engineering surveys with the Army Environmental Hygiene Agency and its respective clients. Mr. Lund also supervised the environmental health and engineering curriculum taught at the Army Academy of Health Sciences, Ft. Sam Houston, Texas.

While with the U.S. Army Environmental Hygiene Agency from July 1982 to June 1975, Mr. Lund was the Program Manager for the Army's Industrial Hygiene program. He managed 16 engineers and industrial hygienists providing worldwide industrial hygiene consultative services which encompassed on-site surveys, studies, and audits. Reports included recommendations to correct engineering deficiencies and reduce or eliminate possible health hazards. One major effort involved the in-plant and incinerator studies for the chemical agent demilitarization program at Rocky Mountain Arsenal, Colorado and later the Chemical Agent Munitions Disposal System at Tooele Army Depot, Utah. He also developed guidance for Department of the Army regarding the new

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Occupational Safety and Health Act. He also activated training courses for Army personnel to achieve proficiency in the conduct of industrial hygiene audits and assessments. Additionally, he had direct control over an annual budget of approximately $1 million.

During service with the 3d U.S. Army in Atlanta, Georgia, Mr. Lund was the Program Manager for environmental engineering operations throughout a 13-state area. These operations were staffed by approximately 140 environmental engineers, scientists, and technicians at 14 separate locations, who conducted water, wastewater, solid waste, and industrial hygiene monitoring and surveillance activities. He also manager a 10-person environmental engineering consultant service which provided on-site surveys to assess health hazards and environmental problems, prepared guidance to ensure compliance with Federal and state environmental laws, and reviewed plans and specifications for environmentally related design deficiencies.

Earlier assignments included Program Management of environmental engineering operations at various locations throughout the U.S., Europe, and Southeast Asia.

PROFESSIONAL REGISTRATIONS/CERTIFICATIONS/SOCIETIES:

Board Certified by the American Academy of Environmental Engineers.
Board Certified by the International Board of Hazard Control Managers.
Registered Professional Engineer in the states of Texas and Mississippi.
Member of the National Society of Professional Engineers.
Member of the Texas Society of Professional Engineers.
Member of the American Defense Preparedness Association

PUBLICATIONS:

Author and co-author of numerous military publications dealing with environmental engineering and pollution control projects and programs. Prepared training and doctrinal materials dealing with environmental and industrial hygiene programs for use by Army personnel. Author and co-author of several Radian reports dealing with permits, plans, and remedial actions for hazardous waste sites.

WILLIAM L. BOETTNER

EDUCATION:

Graduate studies, Geological Sciences, The University of Texas at Austin, Austin, TX, 1981-83.

B.A., Geology, The University of Texas at Austin, Austin, TX, 1977.

EXPERIENCE:

Program Manager, Radian Corporation, Austin, TX, July 1988-Present.

Project Manager, Radian Corporation, Austin, TX, May 1987-June 1988.

Staff Hydrogeologist, Radian Corporation, Austin, TX, 1986-May 1987.

Hydrogeologist, Radian Corporation, Austin, TX, 1984-1985.

Hydrogeologist, U.S. Geological Survey, Water Resources Division, Austin, TX, 1979-84.

Consulting Geologist, Roswell, New Mexico, 1978-79.

CERTIFICATION: North Carolina Licensed Geologist, No. 719; AIPG Certified Geological Scientist, No. 7129.

FIELDS OF EXPERIENCE:

As a Program Manager, Mr. Boettner's primary duties are in the fields of ground-water contamination and underground storage tanks. Earlier, Mr. Boettner was a Project Manager for Research and Engineering Operations with primary responsibility for solid and hazardous waste work for Department of Defense clients. He manages multi-disciplinary programs to ensure that technical goals are achieved and projects are completed on time, within budget and to the client's satisfaction. He is currently Program Manager for three Delivery Orders, totaling about $3 million this year, to provide technical environmental services to the U.S. Air Force under their Installation Restoration Program. Mr. Boettner is responsible for all aspects of project management, including technical design contract administration and client liaison. The programs that he manages involve large environmental investigations at Air Force bases throughout the western U.S. The multi-disciplinary investigations involve surface water, ground water, soil and air contaminant studies.

As a staff hydrogeologist at Radian, Mr. Boettner participated in a broad range of hydrogeological investigations both as a technical staff member and in a supervisory capacity. He is responsible for RCRA groundwater permitting and compliance. He provides technical representation for clients before regulatory agencies.

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William L. Boettner

As Project Director for the Phase II, Stage 2 Installation Restoration Program investigation at Hill AFB, Utah, Mr. Boettner is responsible for technical planning and management. His duties include technical design and guidance, contract management, staffing, scheduling and budget control. This project involves 25 people from 3 national offices of Radian and a budget in excess of $800,000. The project includes soil gas studies, groundwater testing and evaluation, aquifer testing and data analysis in support of remedial planning.

Mr. Boettner served as task leader for an environmental assessment and hydrogeological investigation of a petroleum pipeline break. He designed and installed monitor systems to define the extent of the leak.

Mr. Boettner served as assistant project director for an investigation of the former site of a town gasifier in the central business district of Austin, Texas. He designed and conducted the hydrological and geotechnical investigations which focused on determining the source and extent of residual by-products of coal gasification. The site contained a coal gasifier plant which operated from the 1850's to the 1930's. During the project Mr. Boettner worked on the waste characterization, remediation design, permitting and regulatory requirements.

As Field Coordinator for the McClellan AFB, Stage 2-3 Installation Restoration Program, Mr. Boettner's duties included project management, scheduling of field operations, staffing, subcontractor coordination, and technical liaison with Air Force personnel. In addition to the role of field coordinator, Mr. Boettner served as task leader for aquifer testing and evaluation. He was responsible for the design, installation, execution, and interpretation of the aquifer test, which involved the installation of 9 observation wells and 2 production wells. The test ran for 2 weeks and the interpretations will be incorporated into a flow model.

Mr. Boettner served as Project Director for an extensive geotechnical and environmental investigation for a commercial client. The investigation assessed the effectiveness of current waste management practices in protecting a major ground water system.

Mr. Boettner also served as a Task Leader for an innovative experimental field test to evaluate the in situ neutralization of a chlorinated camphene pesticide. The project involved using anaerobic microbial action to enhance natural degradation of pesticide residues under field conditions. The project continued as a full-scale remediation which resulted in clean-up of the site and subsequent commercial development.

Mr. Boettner was the Supervising Geologist for a vapor monitor well installation program at the Chevron, U.S.A./El Segundo Refinery located in Los Angeles, California. The project is an investigation of the potential extent of a hydrocarbon plume in the subsurface. The installation effort occurred under intense public and governmental scrutiny and was completed ahead of schedule.

William L. Boettner

Mr. Boettner participated as a team member in conducting field investigations of various hazardous waste sites at McClellan Air Force Base in Sacramento, California, and Cannon AFB in Clovis, New Mexico. These efforts are part of the Air Force's Installation Restoration Program (IRP) and involved the installation of monitoring wells and hazardous waste site soil sampling for chemical analysis. The results will be used to define the site hydrogeology and waste site impacts, if any, on the local ground-water system.

While a geologist at the United States Geological Survey, Mr. Boettner researched and developed a two-dimensional finite-difference model for the computer simulation of the Edwards Limestone Aquifer, a large regional aquifer in Central Texas. He collected drilling samples and performed aquifer tests to construct the conceptual framework for the ground-water simulation. Mr. Boettner presented the results of the computer model and its utility as a management tool in a Water Resources Investigation report for the U.S. Geological Survey.

Mr. Boettner conducted a 6-month hydrogeological mapping project for the U.S. Geological Survey which resulted in a field delineation of the extent of the Edwards Aquifer in Central Texas. The project developed an in-depth understanding of the contribution of the surface water drainage system to the regional and local ground water system. The final report and maps are currently being used by state and local regulatory agencies to manage the resources of the ground-water system.

In the area of mining hydrology, Mr. Boettner researched and wrote a case study for the U.S. Bureau of Mines, Bureau of Land Management and the U.S. Geological Survey on the potential impacts of lignite coal mining on the hydrologic systems of the state of Texas. The study included both the social and technical costs associated with such development along with recommendations for development within regulatory guidelines.

During studies on ground-water contamination in the Hueco Bolson Aquifer of El Paso, Texas, Mr. Boettner discovered the migration of an irrigation leachate plume. Further studies by Mr. Boettner identified the source and extent of the contamination problem. The extent of the problem was evaluated through the installation of monitoring wells both upgradient and downgradient from the leachate source. Remedial action was recommended and the contamination problem was neutralized.

As a consulting geologist in New Mexico, Mr. Boettner worked with numerous ranching and agricultural interests and small communities on studies to improve the existing ground and surface water sources as well as the installation of new water development systems.

William L. Boettner

TRAINING:

EPA-approved 40-hour course: "Safety at Hazardous Waste Sites," December 1986.

Seminar on "Groundwater Monitoring and Recovery Well Design," February 1987.

HONORARY AND PROFESSIONAL SOCIETIES:

Member, ASTM Committee D.18.21 to Establish Groundwater Standards; Subcommittee on Well Construction Standards; Subcommittee on Groundwater Data Collection Standards
National Water Well Association - Division of Ground Water Scientists and Engineers
Geological Society of America
Austin Geological Society
Member, Renewable Energy Advisory Committee, Austin City Council, 1980-81
Member, Citizens Advisory Task Force on Solid Waste Management for the City of Austin, Texas, 1983-87
Member, Rural Water Task Force, National Demonstration Water Project 1985-86

William L. Boettner

PUBLICATIONS/REPORTS:

Boettner, W.L. and others, "Installation Restoration Program Phase II - Confirmation/Quantification Stage 2, Vols. 1-14, Radian Corporation, Final Report to U.S. Air Force, July 1987.

Boettner, W.L. and D.B. Holsten, "Aquifer Testing and Evaluation, Installation Restoration Program Phase II - Confirmation/Quantification, Stage 2-3, McClellan AFB, California," Radian Corporation, Final Report to U.S. Air Force, August 1986.

Radian Staff, "Installation Restoration Program Phase II - Confirmation/-Quantification Stage 1, Cannon AFB, New Mexico," Radian Corporation, Austin, TX, June 1985.

Radian Staff, "Installation Restoration Program Phase II - Confirmation/-Quantification Stage 1, McClellan AFB, California," Radian Corporation, Austin, TX, July 1984.

Boettner, W.L. and R.M. Slade, Jr., "Computer Simulation of the Ground-Water Resources of the Edwards Aquifer in Northern Travis, Williamson and Bell Counties, Texas," U.S. Geological Survey Water Resources Investigation 86-(in press), June 1986.

Boettner, W.L., "The Hydrology of Lignite Mining in Texas - A Case Study," U.S. Bureau of Mines, Bureau of Land Management, and U.S. Geological Survey Special Publication 82-17, August 1982.

Boettner, W.L. and D.L. White, "Migration of an Irrigation Leachate Plume in the Hueco Bolson Aquifer, El Paso, Texas," U.S. Geological Survey Administrative Report, September 1981.

LAWRENCE N. FRENCH

EDUCATION:

M.A., Geological Sciences, University of Texas at Austin, 1979.

B.S., Geological Sciences, University of California at Riverside, 1975.

EXPERIENCE:

Senior Geologist, Radian Corporation, 1985-Present.

Staff Geologist, Radian Corporation, 1979-1984.

Geologist, Sargent & Lundy Engineers, Chicago, IL, 1978-1979.

REGISTRATION/CERTIFICATION:

Registered Geologist No. 3804, California
American Institute of Professional Geologists, CPGS No. 6307

FIELDS OF EXPERIENCE:

At Radian, Mr. French is involved in a variety of hydrogeologic and geologic studies. His roles in these studies range from collecting and analyzing hydrogeologic data, interpreting and reporting results of investigations, to directing interdisciplinary programs.

While assigned to Radian's Los Angeles office, Mr. French managed the soil and ground-water investigations at over 60 sites at a large petroleum refinery. His responsibilities included the management of task budgets totalling over $1 million, technical oversight of the preparation of work plans, performance of drilling and collection of soil, soil vapor, and ground-water samples, interpretation of environmental data, and preparation of reports. His role in the project included monthly presentations of these technical activities to state and local regulatory agencies. He also directed an assessment of the nature and extent of liquid hydrocarbon product on the water table, the occurrence and concentration of dissolved hydrocarbon species, and the direction and magnitude of ground-water flow under the refinery.

A RCRA groundwater detection monitoring program was designed by Mr. French for a hazardous waste management area at a large petroleum refinery in Illinois. The groundwater program, a component of a Part B application, provided for sampling and analysis of groundwater at compliance monitoring points and specified monitoring parameters. He also prepared a ground-water quality assessment document required by RCRA compliance monitoring regulations.

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At Air Force Plant 4 and Carswell AFB, Texas, Mr. French was Project Director of investigations to determine the effect of waste-disposal sites on soil, surface water, and ground-water. The programs, part of the nationwide DOD Installation Restoration Program, involved installation of monitor wells, performance of soil gas and geophysical surveys, collection and analysis of environmental samples, and interpretation of data. For the second phase of work performed at Carswell AFB, a risk assessment of the study sites is being conducted and the likely corrective measures for the remediation of ground-water and soil contamination are being evaluated. He also served as Supervising Geologist for a similar program conducted at Tinker AFB, Oklahoma.

Mr. French has also been involved in various aspects of ground-water investigations at several hazardous waste disposal sites. He served as Project Director for a study of PCB-contaminated soils at an industrial site in North Texas. The study involved sampling and analysis of near-surface soils to define the extent of PCB contamination. Remedial measures options were also identified. Mr. French also developed a ground-water monitoring plan in accordance with the Compliance Agreement between the state and the property owner. As Ground-Water Task Leader, he supervised the installation of monitoring wells at an abandoned petroleum products waste dump in Southern California. He later co-authored a technical report on the occurrence and character of ground water at the site. Mr. French also prepared technical designs and specifications for a permanent, post-remedial action ground-water monitoring network.

For a water-rights and water availability study at George AFB, California. Mr. French reviewed existing hydrogeologic data for the Mojave River alluvial channel and the regional alluvial aquifer. He is also contributing to an investigation of the source(s) of recharge to the regional aquifer by evaluating ground-water tracers in the subsurface at the base.

While employed by Sargent and Lundy Engineers, Mr. French was involved in detailed hydrologic and geologic studies for Preliminary and Final Safety Analysis Reports (PSAR and FSAR) for several nuclear power plants. The PSARs and FSARs involved detailed geologic mapping, inventory of water wells, analysis of subsurface flow, and reviews of regional geologic features. Mr. French also analyzed stratigraphic, structural, and hydrologic features at power plant sites in the Illinois Basin for a compressed air energy storage project. Mr. French directed a hydrogeologic and geologic study of potential sites for a lignite-fired electric generation station in Walker County, Texas.

HONORARY AND PROFESSIONAL SOCIETIES:

Association of Ground-Water Scientists and Engineers

Lawrence N. French

PUBLICATIONS/REPORTS:

Radian Corporation, "El Porto HLC Mitigation Evaluation (Phase 1)," report to Chevron U.S.A., Inc., September 1987.

Radian Corporation, "Remedial Investigation - Groundwater Assessment 2 Interim Report," report to Chevron U.S.A., Inc., September 1987.

Radian Corporation, "Summary Remedial Investigation Report," report to Chevron U.S.A., Inc., June 1987.

Radian Corporation, "Remedial Investigation - Category D Site Assessment," report to Chevron U.S.A., Inc., May 1987.

Radian Corporation, "Remedial Investigation - Category C Site Assessment," report to Chevron U.S.A., Inc., February 1987.

Radian Corporation, "Installation Restoration Program, Phase II - Field Evaluation, Stage 1, Air Force Plant 4, Texas," report to Air Force Occupational and Environmental Health Laboratory, December 1986.

Radian Corporation, "Remedial Investigation - Category B Site Assessment," report to Chevron U.S.A., Inc., November 1986.

Radian Corporation, "Installation Restoration Program Phase II - Field Evaluation, Stage 1, Carswell AFB, Texas," report to Air Force Occupational and Environmental Health Laboratory, October 1986.

Radian Corporation, "Remedial Investigation - Category A Site Assessment," report to Chevron U.S.A., Inc., August 1986.

Radian Corporation, "Remedial Investigation--Groundwater Assessment," report to Chevron U.S.A., Inc., July 1986.

Radian Corporation, "Installation Restoration Program Phase II - Field Evaluation, Stage 1, Tinker AFB, Oklahoma," report to Air Force Systems Command, November 1984.

Radian Corporation, "Site and Compliance Profiles of a Major DOE Facility," August 1984 (author of hazardous waste sections).

French, L.N. and J.L. Machin, "Cumulative Hydrologic Impact Assessment for McKinley Mine," Radian Corporation, Austin, TX, January 1984.

French, L.N., "Pre-Closure Evaluation of the Treated Wood Products Facility and Site C, Longview, Washington," Radian Corporation, Austin, TX, May 1983.

Little, W.M. and L.N. French, "Hydrogeologic Aspects of the McColl Site, Fullerton, California," Radian Corporation, Austin, TX, November 1982.

Lawrence N. French

French, L.N., et al., "Environmental Constraint Analysis of the Proposed Coastal Bend Coal Gasification Project," Radian Corporation, Austin, TX, August 1981.

French, L.N., "Compilation of Environmental Information for a Proposed Olefins Complex, Brazoria County, Texas," Radian Corporation, Austin, TX, July 1981 (author of Ground-Water Hydrology and Topography and Geology chapters).

White, D.M. and L.N. French, "Evaluation, Screening, and Prioritization of Candidate Gulf Coast Lignite Resource Blocks," Radian Corporation, Austin, TX, April 1981.

U.S. Bureau of Land Management, "Proposed Camp Swift Lignite Leasing (Draft and Final EIS)," Radian Corporation, Austin, TX, September 1980.

Lacy, J.C., L.N. French, and T.W. Grimshaw, "Regulation of the Hydrologic Impacts of Underground Coal Gasification," in Proc. Sixth Underground Coal Conversion Symposium, Shangri-La, OK, pp. V-79 thru V-88, July 1980.

French, L.N. and J.L. Machin, "Water Availability Appraisal for the Proposed Solvent Refined Coal-I Demonstration Plant, Daviess County, Kentucky," Radian Corporation, Austin, TX, December 1979.

GUY J. CHILDS

EDUCATION:

B.S., Geology, University of Nebraska, Lincoln, 1983.

A.A., Taft Junior College, Taft, CA, 1980.

EXPERIENCE:

Geologist, Radian Corporation, Los Angeles, CA, 1985-Present.

Wellsite Geologist, Epoch Well Logging, Inc., Bakersfield, CA, 1983-1985.

FIELDS OF EXPERIENCE:

At Radian, Mr. Childs serves as a geologist and has participated in hazardous waste investigations at a large Los Angeles area refinery. His work in the field involves a variety of sampling and data gathering activities such as sampling, subsurface soil investigations, and monitoring well installations. He has been the supervising geologist on approximately two hundred exploratory borings. He has also had responsibility for writing portions of remedial investigation workplans and reports and for preparing lithologic cross-sections of subsurface strata.

Mr. Childs also supervised the installation of monitor wells and piezometers in glacial till and sandstone bedrock at a petroleum refinery's land treatment facility in Illinois. He also conducted slug tests of the completed wells to determine the hydraulic characteristics of the glacial till.

At a site investigation on a military installation in northern California, Mr. Childs was responsible for the on-site safety during drilling activities. His work included the ambient screening for halogenated hydrocarbons, charcoal tube and draeger tube monitoring, safety audits and the enforcement of safety.

As a wellsite geologist prior to joining Radian, Mr. Childs developed oil and gas logs from exploration and production wells onshore and offshore using hydrocarbon analyzing and gas chromatographic equipment along with drill cutting analysis.

SANDRA A. SMITH

EDUCATION:

Course work in toxicology, University of Texas at Austin, 1981.

M.S., Environmental Health Science, Hunter College, City University of New York, 1976.

B.A., Biology, Duke University, 1973.

EXPERIENCE:

Senior Scientist, Radian Corporation, Austin, TX, 1985-Present.

Staff Scientist, Radian Corporation, Austin, TX, 1980-1984.

Scientist, Radian Corporation, Austin, TX, 1979-1980.

Assistant Project Manager, Fred C. Hart Associates, Inc., New York, NY, 1977-1979.

Science Instructor, Birch Wathen School, New York, NY, 1973-1975.

FIELDS OF EXPERIENCE:

At Radian, Ms. Smith is a senior environmental health scientist in the Engineering and Environmental Analysis Division. She has worked extensively in the areas of risk assessment, health effects research, toxic substances policy, and solid and hazardous waste management. She has considerable experience in regulatory, policy, and program planning for a variety of federal, state, and local government agencies and private industries.

At the present time Ms. Smith is conducting health risk assessments for a proposed waste-to-energy plant for the City of Austin and a proposed commercial hazardous waste incinerator for a private client. As a tool in the assessments, Ms. Smith is using the Radian Risk Assessment Model (R-RAM). R-RAM is a fully integrated, multimedia computer model capable of calculating exposure, dose, and risk for an unlimited number of toxic pollutant and receptor inputs and for a variety of exposure pathways, including inhalation, dermal exposure, and ingestion of contaminated vegetables, meat, milk, drinking water, and soil.

In the health effects area, Ms. Smith conducted a chemical hazard screening program to identify and summarize the reported health effects associated with the input materials and specialty chemicals used by the plastics and resins industry. This work involved the evaluation of data on approximately 500 chemicals and classification of each chemical by degree of hazard. In

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addition, Ms. Smith participated in the development of a system to screen for potential hazards associated with major industrial processes. The system incorporates scoring components for the potential for release of contaminants, the potential magnitude of release for individual contaminants, population at risk of exposure, and degree of hazard associated with individual contaminants. The system was tested using data for twenty major energy producing and/or energy consuming processes.

Ms. Smith also assessed the potential for public exposure to environmental releases from a refinery's hazardous waste impoundments. The assessment was a requirement of the Hazardous and Solid Waste Amendments of 1984.

In the area of toxic substances policy, Ms. Smith directed a program to implement the National Air Toxics Information Clearinghouse to support state and local programs for the control of non-criteria air pollutants. The Clearinghouse provides information to state and local agencies that are developing or operating programs to address toxic and potentially toxic air pollutants. She also directed a feasibility study for the Clearinghouse and the design of the automated Clearinghouse database. She continues to support the operation and maintenance of the database.

In another program, Ms. Smith was responsible for developing a scheme to apportion the costs of remedial action at a closed waste disposal site. The scheme incorporates considerations such as the quantities of waste disposed at the site by more than 200 waste generators, waste types, and the hazard potential and mobility of individual contaminants escaping from the site.

As project director of a study to assist the State of Maryland in the development of a program to control toxic air pollutants, Ms. Smith identified and analyzed alternatives for state-level air toxics control. In the same vein, she participated in the development of a seminar/workshop for state, local, and EPA Regional Office personnel on air toxics, sponsored by EPA's Manpower and Technical Information Branch. For the State of New Jersey, she directed an assessment of air program emission fee practices in fourteen states and one locality.

Other related work includes: 1) provision of supporting documentation for use in EPA's decision on whether or not to regulate polycyclic organic matter (POM) in the air; 2) analysis of the applicability of state and federal VOC and TSP regulations in the control of certain specific compounds; 3) preparation of the health effects portions for environmental assessments of proposed activities (for example, construction of a coal gasification plant, cleanup of an abandoned hazardous waste site); 4) organization and conduct of a training session on health effects of exposure to hazardous laboratory wastes for employees of the Laramie Energy Technology Center; and 5) evaluation of EPA's proposed gasoline lead-content regulations. Recently, Ms. Smith participated in a program to evaluate and compare environmental and regulatory aspects of coal and nuclear power generation alternatives. Environmental impacts and associated regulatory issues were examined for the entire chain of supply from mine through generating station for routine power generation operations.

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Also in the area of toxic substances policy, Ms. Smith participated in a study of air pollution/health effects research needs for the State of Texas. The study: (1) established the principal areas of air pollution-related health problems which are likely to be faced by Texas in the future; and (2) identified research projects whose results would help the Texas Air Control Board carry out its responsibilities to protect the health and welfare of the people as mandated by the Texas Clean Air Act.

In a related area of research, Ms. Smith assessed the requirements of the Toxic Substances Control Act (TSCA) as they apply to the products and by-products of coal liquefaction. She also participated in a program to survey industry representatives regarding the effects on the synfuels industry of compliance with TSCA.

Ms. Smith has taken part in numerous programs in the area of solid and hazardous waste management. For example, she identified and evaluated issues in the management of coal-based energy wastes for U.S. DOE. More recently, she investigated the feasibility of mine disposal of coal combustion wastes for a utility. In another project she aided in examining the potential environmental and health impacts of wastes generated by emerging energy technologies. She has also directed an analysis of the solid waste impacts of the federal program for oil and gas displacement, including an assessment of health effects resulting from increased levels of coal ash and scrubber sludge production. She assessed the need for state level financial assurance requirements for hazardous waste facilities. Prior to enactment of the 1984 RCRA amendments, she evaluated the Senate and House bills for RCRA reauthorization to identify and assess potential implications for major energy producing and energy consuming industries. Ms. Smith regularly contributes to the development of RCRA Part B applications, primarily in the area of health and safety.

Recently, she directed the preparation of an Operation Plan (California equivalent of a RCRA Part B application) for the proposed new Decontamination and Waste Treatment Facilities at Lawrence Livermore National Laboratory. The proposed facility will include an incinerator, solid and liquid waste treatment, storage facilities and radioactive decontamination facilities. At the present time she is participating in a program to develop a database for a private client which will store and retrieve information on wastes generated at the plant site. The database will contain physical and chemical data, analytical results, regulatory documentation and handling, shipping and tracking instructions. She recently completed a comprehensive assessment of record-keeping and reporting requirements to support the development of an automated information management system for a commercial multi-site hazardous waste management company.

In the field of regulatory analysis, Ms. Smith was directly involved with U.S. EPA in developing New Source Performance Standards for industrial boilers. The policy implications of these new standards involved important energy/-environment/public health issues, such as the effect of the standards on emerging coal technologies and the demand for low sulfur coals. Ms. Smith was

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responsible for identifying regulatory options and evaluating the advantages and disadvantages of each option for resolving these and other issues which emerged during development of the regulations.

Also in the area of policy and regulatory analysis, Ms. Smith participated as a major contributor in an EPA program to streamline the processes required for new non-nuclear energy facilities to acquire environmental permits and meet regulatory requirements. Research methodology included designing a data collection questionnaire, reviewing permit files at the Regional offices, and in-depth interviewing of Regional personnel involved in the permit actions. Ms. Smith and the project team have delineated the procedures involved in the most significant EPA regulatory and permit processes and defined the information requirements of these processes. The procedures and information requirements have been evaluated to identify methods for shortening the time required for the processes, reduce the required paperwork and ensure synergistic data acquisition. Ms. Smith authored a series of catalogues outlining the permitting process and information requirements for major sources of air emissions under the Prevention of Significant Deterioration (PSD) program and for hazardous waste facilities under the Resource Conservation and Recovery Act (RCRA).

At Fred C. Hart Associates, Ms. Smith was assistant project manager in charge of environmental and energy analysis in the Engineering Group. Representative project work includes an assessment of the impacts, primarily health and air quality impacts, of on-site cogeneration of electricity and thermal energy in urban areas, and an evaluation of the combined effects of air, water, and solid waste regulations on emerging coal technologies. She also participated in the development of an enforcement management system for hazardous waste regulations under RCRA and in developing outreach strategies to inform the regulated community and general public about the regulations. She was a major contributor to a study of the effects of RCRA on the utility industry, sponsored by the Electric Power Research Institute.

While studying under a U.S. Public Health Service Fellowship in environmental health, management and planning, Ms. Smith conducted research in the use of natural resource inventories to determine optimum siting for residential, commercial and industrial developments. She developed an evaluation methodology and tested the methodology by carrying out a case study of the Bridgehampton area of Suffolk County, New York.

Prior to obtaining her Master of Science degree in environmental health, Ms. Smith taught secondary level Earth Science, Physical Science and Biological Science at Birch Wathen School. She also developed and taught a course entitled "Science and Society" which studied the social implications of recent science policy and technology developments.

Sandra A. Smith

HONORARY AND PROFESSIONAL SOCIETIES:

Society for Risk Analysis
Society of Environmental Toxicology and Chemistry
National Environmental Health Association
National Solid Waste Management Association
American Planning Association

PUBLICATIONS/REPORTS:

Ms. Smith has authored or co-authored several papers in the areas of solid waste streams generated by coal-fired boilers and environmental issues in coal technology, and has been a major contributor to numerous technical reports in the areas of toxic substances policy, energy and environmental policy, and health effects of industrial developments. She is the primary author of several reports relating to the development and implementation of the National Air Toxics Information Clearinghouse, the development of state air toxics policy, and the assessment of health risks.

KATHLEEN B. ALSUP

EDUCATION:

B.S., Environmental Science, Lamar University, Beaumont, TX 1980.

EXPERIENCE:

Staff Scientist, Radian Corporation, Austin, TX, 1985-Present.

Senior Biologist, Texaco, Inc., Port Arthur, TX, 1980-1985.

Lab Technician, Sabine River Authority, Orange, TX 1979-1980.

FIELDS OF EXPERIENCE:

As a Staff Scientist in the Environmental Analysis Department at Radian, Ms. Alsup's job responsibilities include providing guidance on regulatory requirements and developing working plans primarily for solid waste issues. This includes RCRA permitting, TSCA permitting, variances, exemptions, market studies, and others. She has provided considerable amounts of input into developing permit applications, responding to Notice of Deficiencies, and reviewing draft permits. She has developed and summarized a data needs list for preparing a Part B application. She has also developed questionnaires for conducting an environmental assessment at facilities, which include the following subjects: NPDES, NSPS, PSD, TSCA, OSHA, RCRA, and CERCLA.

RCRA/TSCA Applications and Variances

- Prepared an inspection plan, a security plan, a trial burn plan, closure plans, and engineering reports for hazardous waste tanks and container storage areas at an existing chemical industrial facility. Reviewed and responded to the draft RCRA permit developed by the state agency. Prepared addenda to the Part B application for expansions to existing facilities.

- Prepared closure plans for surface impoundments and treatment facilities at a coal gasification facility.

- Prepared a waste analysis plan for a major chemical company in Texas. Also prepared required addenda to the RCRA Part B permit application which included a Tank System Report, and a Continuing Releases Report. The Tank System Report provided additional requirements for tanks as per the July 1986 revised tank requirements. The Continuing Releases Report provided additional information for Solid Waste Management Units not permitted under RCRA.

- Prepared several sections of a California Department of Health Services Operation Plan for a proposed waste treatment facility at a

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government facility. Sections included a facility description, a geology report, floodplain information, waste characterization, a contingency plan, a personnel training plan, records and reporting requirements, closure plans, and engineering reports.

- Designed and prepared a closure plan for an abandoned crop dusting air strip contaminated with pesticides.

- Prepared a contingency plan and a waste analysis plan which were incorporated into a Hazardous Waste Management Plan for a government facility. Revised an existing SPCC plan, and developed inspection plans to ensure regulatory compliance.

- Prepared a variance petition for the 50-foot buffer zone requirement for a hazardous waste storage facility in California.

- Prepared a Minimum Technology Requirement exemption request for retrofitting an aeration basin type surface impoundment with double liners. This required preparing a demonstration of significant degradation of toxic pollutants and hazardous constituents.

- Participated in conducting a market study for incineration in a particular region to assess the strength of the commercial hazardous waste marketplace. After providing quantitative justification, worked with facility management, and the design engineers to prepare a Part B application for the proposed facility.

- Prepared a Health and Safety Plan, and a SPCC plan which was incorporated into a TSCA/PCB application for a mobile incineration type facility.

- Prepared responses for several Notice of Deficiencies to RCRA Part B applications for various industries.

Regulatory Review

- Researched available quantitative data to characterize discharge streams from both tar-producing and nontar-producing coal gasification systems. Identified and summarized applicable regulations and required permits for the coal gasification industry.

- Reviewed and helped complete an NPDES permit for a pipeline terminal facility.

Site Assessments

- Prepared a site investigation report for a government facility to determine the presence of any soil contamination. The report provided analytical results, conclusions, regulatory guidelines,

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recommendations, and follow-up activities. A Quality Control Summary Report was also developed to outline the quality control practices employed during the contract work, and the reliability of data.

- Conducted a water balance study to determine if infiltration of a recreational area at a government facility had any effect on downgradient hazardous waste facilities.

- Conducted a water balance study to determine effects of irrigating collected rainfall and leachate from a commercial hazardous waste disposal facility on a meadow.

- Investigated possible causes contributing to excessive ambient air particulates and ozone concentrations occurring at a coal gasification facility.

- Prepared a ground-water monitoring program which will monitor operations from an in situ combustion oil recovery facility. The program was incorporated into an Environmental Monitoring Plan.

- Participated in obtaining socio-economic information for citing the superconducting collider in Texas.

Prior to work at Radian, Ms. Alsup worked in an environmental group at a large refinery. Her primary responsibilities were developing and implementing solid waste strategies to ensure the refinery was in compliance with RCRA. She also prepared air permits and/or exemptions for modifications to existing and new units, monitored ambient air for SO_2, monitored for fugitive emissions, participated in stack sampling, conducted odor surveys using the butanol scale, and followed the operations of an activated sludge treatment unit.

GARY L. PATTON

EDUCATION:

M.A., Zoology, University of South Florida, Tampa, FL, 1982.

B.A., Biology, University of South Florida, Tampa, FL, 1979.

EXPERIENCE:

Scientist, Quality Assurance/Statistics Group, Radian Corporation, Austin, TX, 1987-Present.

Research Assistant, Barrier Evaluation Technologies Group, Radian Corporation, Austin, TX, 1984-1987.

Science Instructor, Potomac School, Boca Raton, FL, 1982-1983.

Research Assistant, Department of Natural Rsources, Marine Sciences Division, St. Petersburg, FL, Summer 1979, Summer 1981.

FIELDS OF EXPERIENCE:

Mr. Patton currently serves as a Scientist in the Quality Assurance/ Statistical Analysis Group. As a member of this group, Mr. Patton's responsibilities include assisting with experimental design, data reduction and statistical analyses for projects conducted by Radian Corporation. His areas of experience include studies concerned with pharmaceutical bioequivalency, hazardous waste incineration, analytical method equivalence, pesticide environmental fate and protective clothing evaluation and development.
Mr. Patton's recent experience includes involvement in the following projects:

Pharmaceutical Bio-Equivalency Studies

- Statistical analysis of 2-way crossover designed studies.

Hazardous Waste Incinerator Studies

- Generation of SAS data sets for statistical analyses.
- Assist in performance and evaluation of correlation and cluster analyses designed to characterize incineration parameters.
- Assist in statistical evaluation of scrubbing mechanisms on waste incinerators.

Pesticide Environmental Fate Studies

- Manipulate and statistically analyze data sets used to determine the environmental fate of pesticides due to chemical, biological and physical degradation in soil.

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Protective Clothing Evaluation

- Conduct evaluation of protective clothing materials via permeation, penetration and degradation tests with hazardous chemicals.
- Develop methods for evaluation of raw materials used in protective clothing manufacturing, "breathable" fabrics and chemical/clothing combinations that are unsuitable for routine testing.
- Design and conduct statistical analyses to determine effects of manufacturer, thickness and lot on permeation of hazardous chemicals.
- Design and conduct statistical analyses to evaluate and improve permeation test methods and equipment.

Mr. Patton's statistical design and analysis participation is aided by theoretical and practical background in physiological, population and community ecology; environmental experimental design and analysis; and light microscopy. He also has experience with statistical packages SAS, BMDP and SPSS.

PROFESSIONAL SOCIETIES:

American Association for the Advancement of Science.

DANIEL J. RADIN

EDUCATION:

M.A., Computer Science, University of Texas, Austin, 1983.

B.A., Mathematics, University of Cincinnati, 1977.

EXPERIENCE:

Senior Staff Scientist, Group Leader, Software Applications Department, Radian Corporation, Austin, TX, March 1987 - Present (Group leader, November 1987 - Present).

Technical Staff/Database Development, Micro-Electronics and Computer Consortium (MCC), Austin, TX, 1985-1987.

Software Manager, Michael Leesley Consulting, Austin, TX, 1983-1985.

Systems programmer, Information Research Associates, Austin, TX, 1981-1983.

Systems Analyst, Cincinnati Bell, Inc., Cincinnati, OH, 1977-1980.

FIELD OF EXPERIENCE:

Mr. Radin is currently Group Leader for staff of six Application Software Engineers. He also serves as Project Director for the development of an Oil Transformer Gas Analysis software system for Hartford Steam Boiler. This system integrates the database management system Empress/32 with the expert system Rulemaster®. Mr. Radin was instrumental in the development of a preliminary database functional specification document and directed efforts of three software engineers in the detailed design of the system.

Most recently, Mr. Radin developed a QA/QC model for laboratory data which involved regular communication with QA/QC personnel in the Chemistry department. He directed the implementation of the data model for a geological sampling project on the Sun 3/160 computer using Empress/32. Mr. Radin was also involved in the development of a QA/QC enhancement of Sam which is Radian's Laboratory Information Management System (LIMS) that operates on a PC network.

Previous experience includes:

- As a member of the technical staff at Micro-Electronics and Computer Consortium (MCC), Mr. Radin developed an object-oriented distributed database management system for networking Lisp and C machines to support VLSI CAD for eleven major U.S. companies.

Daniel J. Radin

- He planned for, scheduled, and coordinated the efforts for six persons who were developing the CAD DBMS for C machines. He documented external interfaces of the DBMS for use by fifty other CAD researchers and company representatives.

- He designed, coded, tested, and integrated Lisp code on Symbolics and C code on Sun 3/160 running Unix. He also ported the platform DBMS from C under Unix to Lisp for LMI and Symbolics. Mr. Radin also developed a translator to aid in the port of the CAD DBMS in Lisp to the CAD DBMS in C.

- As Software Manager at Michael Leesley Consulting, Mr. Radin integrated efforts of 25 design software development and support professionals for the Process Plant Design System-which was targeted for the AEC industry. In this position, he supervised managers of applications, database, engineering, systems, and technical writing groups. He also monitored progress, planned weekly objectives, and investigated potential problem areas.

- Mr. Radin evaluated designs of software engineers for "C" code to run on network of Apollo color workstations. He wrote a 125-page user's view report of all releases of the Process Plant Design System. He also presented the system architecture to the client for approval and aided the chemical engineering in design of the user interface.

- As Systems programmer at Information Research Associates, Mr. Radin designed and wrote system software and implemented precompiler for evolutionary database management system. He worked three-quarter time with four other software researchers while enrolled full-time in graduate school. He specified, coded, tested, and integrated Fortran code on VAX 780 running VMS. His database management responsibilities included B-tree processor, memory management, and dynamic hashing.

- While at Cincinnati Bell, Inc., Mr. Radin worked as a Systems Analyst. He analyzed, designed, and implemented major company report system. Mr. Radin maintained and enhanced application computer programs that processed over 2000 customer orders per day.

JILL P. ROSSI

EDUCATION:

B.A. Geography, The University of Minnesota at Minneapolis, 1972.

EXPERIENCE:

Geographer, Cartographer, Policy and Environmental Analysis Division, Radian Corporation, Austin, TX, 1980-Present.

Drafting and Graphics Assistant, Dam Safety Unit, Texas Department of Water Resources, Austin, TX, 1979-1980.

Cartographer, Continental Map Inc., Austin, TX, 1978-1979.

Teaching Assistant, University College-Geology, University of Minnesota at Minneapolis, 1972.

FIELDS OF EXPERIENCE:

At Radian, Ms. Rossi is responsible for producing maps and coordinating graphics for the Environmental Analysis Division. She utilizes data from a variety of technical disciplines (geology, hydrology, noise and air monitoring, sociology, soils, and hydrogeology) to create maps which clearly and concisely illustrate the written text. Ms. Rossi has been responsible for work in the following projects:

- Develop base maps and coordinate graphics throughout an Environmental Impact Statement prepared for the U.S. Bureau of Land Management for a central Texas lignite mine;
- Develop color overlay method of mapping for site selection process of commercial waste disposal sites in Texas and southeastern Oklahoma;
- Develop a series of figures used as illustrations in a manual for the Environmental Protection Agency on Remedial Actions at Uncontrolled Hazardous Waste Sites:
- Draft maps and coordinate the graphics for an Environmental Impact Statement for a synfuels plant in Tennessee;
- Create base and thematic maps for Air Force Installation Restoration Programs (Phase I and Phase II) for the following locations: Kelly AFB, Texas; Hill AFB, Utah; Bergstrom AFB, Texas; Cannon AFB, New Mexico; England AFB, Louisiana; Tinker AFB, Oklahoma; and Reese AFB, Texas; Carswell AFB, Texas; Sheppard AFB, Texas;

Jill P. Rossi

- Map limestone deposits, lime plants, and limestone quarries in the United States by county in a series of regional maps for the Electric Power Research Institute;
- Map compliance/non-compliance with air pollution standards for all counties in the United States in a series of EPA regional maps;
- Map concentrations of selected air pollutants in the El Paso, Texas, area for a Texas Air Control Board study in a series of quarterly and annual reports;
- Prepare aerial photography history of a wood preserving plant for a commercial client which included extensive research of available aerial photography and interpretation of those photos to determine historical features of interest;
- Prepare complex permitting schedules for proposed mines, energy facilities, and hazardous waste handling facilities;
- Preparation of base and thematic maps for various feasibility studies, fatal flaw analyses, Environmental Information Documents, and Environmental Impact Statements;
- Identify, field verify, and map oil and gas development features within the Big Thicket National Preserve for the National Park Service; and
- Research of available map resources, aerial photography, remote sensing products, and mapping technologies as required by individual client needs.

While with the Texas Department of Water Resources, Ms. Rossi worked in the graphics section of the Dam Safety Unit, a federal grant program. She prepared maps and exhibits, and laid out phototypset text into camera-ready form according to standards, developed with her assistance, for the technical reports written by the engineering section.

During her employment with Continental Map Incorporated, Ms. Rossi was involved in all phases of four color map production. These included source information procurement and classification, imaging of base maps, scribing plates, cutting specialties, sizing and adhering type, designing customer copy panels, indexing streets and points of interest, photo-lab contact reproducing of base plates, and the final compositing of the four negative plates to be sent to the printer. These maps included large metroplex areas, counties, enlarged downtown sections, and simplified principle city thoroughfares.

Jill P. Rossi

While employed by the University of Minnesota as a Geology Teaching Assistant, Ms. Rossi taught geology laboratory sessions, prepared geology lab work materials, tutored students, and assisted the professors by preparing classroom presentations and grading and proctoring exams.

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