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*Measurement of Surface Emission Flux Rates
for Volatile Organic Compounds
at Technical Area 54*

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MEASUREMENT OF SURFACE EMISSION FLUX RATES FOR VOLATILE ORGANIC COMPOUNDS AT TECHNICAL AREA 54

by

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ABSTRACT

The survey described in this report was conducted to estimate the mass of volatile organic compounds venting to the atmosphere from active and inactive waste disposal sites at Technical Area 54. A large number of nonintrusive passive sample collection devices were placed on the ground surface for 72 hours to characterize an area of approximately 150 acres. Results provided an indication of the boundary location of the known volatile organic plume, plume constituents, and isolated high concentration areas. The data from this survey enhanced existing data from a limited number of monitor wells currently used for plume surveillance. Results indicate that the estimated mass emission to the atmosphere is orders of magnitude lower than what is considered a small flux rate at a spill site or a Resource Conservation and Recovery Act landfill and is far below the threshold limit established by the State of New Mexico as an air quality concern.

1.0 INTRODUCTION

This report presents the results of the Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) to estimate volatile organic compound (VOC) emission from material disposal areas (MDAs) in Technical Area (TA) 54 at Los Alamos National Laboratory (Laboratory) (Figure 1-1). The report includes site history, environmental setting, data analysis and assessment approach, quality assurance and quality control results, specific results, conclusions, and recommendations.

1.1 General Site History

TA-54 is located on Mesita del Buey between Pajarito Canyon and Cañada del Buey (Figure 1-2); the environmental setting is described in Appendix A. During the late 1950s and after review by the Laboratory, the US Atomic Energy Commission, and the US Geological Survey, portions of the mesa (MDAs G, H, J, and L) (Figure 1-2) were opened for disposal of Laboratory-derived waste. MDA G, situated on the eastern end of the mesa, was the first site to open, and development of MDAs H, J, and L followed. The nature of the materials disposed of at each of the MDAs is documented in "Operable Unit 1148 Data Report" (IT Corporation 1992). Historical records stated and previous investigations (Trent 1990) determined that

large volumes of VOCs were disposed of in the pit, impoundments, and shafts at MDA L. VOCs were also disposed of in some pits and shafts at MDA G.

1.1.1 MDA G

MDA G is a 65-acre site with 32 pits and 174 shafts (Figure 1-3). Pits vary in size but, in general, are 200 ft by 60 ft and are mainly about 25 to 40 ft deep; a few are 60 ft deep. Shafts are typically 6 ft in diameter and 60 ft deep. The site first received waste in 1957 and, in earlier years, received a variety of waste types, including some liquid hazardous and mixed wastes. It continues to be an active site and is the Laboratory's main facility for disposal of solid low-level radioactive wastes and storage of transuranic and mixed waste. Only three pits are currently receiving low-level radioactive waste, and one is receiving asbestos waste; the remainder have been closed, capped with a layer of crushed tuff, and are not visible on the surface. Many shafts are currently receiving wastes; waste types include those that require special packaging (e.g., tritium), special handling (e.g., highly activated metals), or segregation [e.g., polychlorinated biphenyl (PCB) contaminated waste]. A review of disposal records established that VOCs were disposed of in certain pits and shafts (IT Corporation 1992). The history of disposal practices at MDA G and old photographs from Laboratory archives

Figure 1-1. Location of Los Alamos National Laboratory.

are contained in "History and Environmental Setting of LASL Near-Surface Land Disposal Facilities for Radioactive Waste (Areas A, B, C, D, E, F, G, and T)" (Rogers 1977).

Vapor transport is known to have occurred in the vadose zone in the vicinity of MDA G based on the presence of VOCs in four existing vapor monitoring wells located within the MDA (Trent 1990). Gas samples are collected from selected ports of these monitoring wells as part of an ongoing quarterly monitoring program at MDAs G and L.

1.1.2 MDA H

MDA H is a 0.3-acre site containing nine vertical shafts used for disposal of Laboratory classified waste,

including weapon component mock-up shapes, detonators, papers, and items contaminated with tritium (Figure 1-4). Each shaft is 6 ft in diameter and 60 ft deep. When disposed waste came to within 6 ft of the surface, the shaft was capped with a 3-ft-thick concrete plug, overlain by 3 ft of crushed tuff, and seeded over (with the exception of shaft 9, which does not as yet have a concrete plug). MDA H was used from 1960 to 1986 and is no longer active.

During the drilling of shaft 8 in 1969, tritiated water vapor was discovered at a depth of 40 ft. Subsequent investigation determined that tritium was measurable in soil vapor and in the tissue of surrounding trees and shrubs. Tritium is the only chemical known to have migrated from the shafts. No documentation was found of any accidents or surface spills.

1.1.3 MDA J

MDA J is a 2.7-acre facility that includes six pits and four shafts (Figure 1-5). The site was opened in 1961. Barium sand, disposed of in pits, composes the majority of

the waste buried there. Only about 4% of the disposed material can be classified as hazardous waste (IT Corporation 1992). Currently, the MDA is used for the disposal of administratively controlled waste (i.e., nonhazardous materials). Three of the pits and shafts 3 and 4 are active; others are closed and covered with crushed tuff. Surface sites at MDA J include a small land-farming project for the aeration of soil contaminated with petroleum products, a storage area for containers of asbestos awaiting shipment to a licensed off-site disposal area, and two drum-storage areas.

1.1.4 MDA L

MDA L is a 2.5-acre facility that was used for subsurface disposal of liquid hazardous wastes between the late

Figure 1-2. Locations of Pajarito Canyon, Cañada del Buey, and TA-54 MDAs.

Figure 1-3. Location map of shafts, pits, and trenches at MDA G.

1950s and 1985 (Figure 1-6). Wastes were disposed of in 1 pit (A), 3 impoundments (B, C, and D), and 34 shafts; all are inactive and covered. The pit was 12 ft deep, the impoundments were 10 ft deep, and most shafts were 60 ft deep. The dates of use and capacity for the pit, impoundments, and shafts are listed in Table 1-1 (LANL 1992). The site is currently used for hazardous waste storage (chemical, mixed, and PCB) and treatment. Early disposal activities resulted in a subsurface VOC vapor plume that extends beyond the facility boundary. The plume is monitored on a quarterly basis in numerous monitoring wells.

1.2 Objective of Study

The objective of this investigation was to determine the extent of vapor phase VOCs migrating to the surface. The investigation was part of the Phase 1 characterization performed by Field Unit 5 of the Laboratory's Environmental Restoration Project and is described in the RFI work plan for Operable Unit 1148 (LANL 1992). The field-sampling activities consisted of passive collection of soil-gas samples at the ground surface at numerous locations within and around the four MDAs; the Quadrel EMFLUX (trace gas detection system) was used for collection.

2.0 SAMPLE-COLLECTION AND ANALYTICAL METHODS

2.1 Sample-Collection Devices and Procedure

The Quadrel EMFLUX system is a passive, nonintrusive device that allows simultaneous measurements at many sample locations and a cumulative measurement at each sample location. A cumulative measurement minimizes variations resulting from meteorological conditions and diurnal soil-gas emission. To determine periods of high soil-gas emissions (for collecting samples), Quadrel Services used a computer-based

Figure 1-6. Location map of inactive subsurface pit, shafts, and impoundments at MDA L.

model that calculated the crustal effects of gravity, which influences vertical soil-gas velocities.

The sample collection device includes a stainless steel shell, a stainless steel support stake, and a cartridge filled with approximately 100 milligrams of adsorbent material (Figure 2-1). The perimeter of the collection shell was sealed to the ground surface for approximately 72 hours to sorb VOCs in the soil gas. The actual time of exposure of the cartridges was recorded. Following the exposure, the cartridges were placed in closed glass containers and shipped to Maryland Spectral Services, a commercial analytical laboratory, for analysis.

Soil-gas samples were collected during two surveys. During the first survey, samples were collected at MDAs G, J, and L. During the second survey, soil-gas samples

TABLE 1-1
DATES OF USE AND CAPACITY OF INDIVIDUAL PITS AND SHAFTS, MDA L

Pit, Impoundment, or Shaft	Start Date of Use ^a	End Date of Use ^a	Dimensions (ft)	Total Capacity of Pit or Shaft (ft)
A ^b	1950s	12/78	200 x 12 x 12 ^c	28,800
B ^d	1/79	6/85	10 x 20 x 10	2000
C ^d	7/85	12/86	10 x 20 x 10	2000
D ^d	1972	1984	10 x 20 x 10	2000
1 ^e	4/80	8/83	3 x 60 ^f	424
2	2/75	6/79	3 x 60	424
3	2/75	10/78	3 x 60	424
4	2/75	4/80	3 x 60	424
5	2/75	5/77	3 x 60	424
6	6/75	5/79	4 x 60	754
7	6/75	5/79	3 x 60	424
8	6/75	5/79	3 x 60	424
9	6/75	5/79	3 x 60	424
10	6/75	5/79	3 x 60	424
11	1/78	6/79	8 x 60	3016
12	1/78	6/79	4 x 60	754
13	6/79	4/82	8 x 60	3016
14	6/79	4/82	3 x 60	424
15	6/79	4/82	3 x 60	424
16	6/79	4/82	3 x 60	424
17	6/79	4/82	3 x 60	424
18	6/79	5/80	8 x 60	3016
19	4/80	4/82	8 x 60	3016
20	3/82	8/83	3 x 60	424
21	3/82	12/85	3 x 60	424
22	3/82	8/83	3 x 60	424
23	4/82	2/84	4 x 60	754
24	4/82	3/84	4 x 60	754
25	9/82	4/85	6 x 60	1696
26	9/82	2/84	6 x 60	1696
27	1/83	1/85	4 x 60	754
28	1/82	4/85	4 x 60	754
29	12/83	7/84	6 x 65	1838
30	12/83	4/84	6 x 65	1838
31	12/83	8/84	6 x 61	1725
32	3/84	8/84	4 x 15	188
33	3/84	1/85	6 x 65	1838
34	2/85	4/85	6 x 63	1781

a. Dates are from J. Mascarenas (IT Corporation 1991).

b. Pit

c. Dimensions for the pit and impoundments are width x length x depth.

d. Impoundments

e. Shafts are numbers 1 through 34.

f. Dimensions for the shafts are diameter x depth.

Figure 2-1. The EMFLUX sample collection device.

were also collected at MDA H. The first survey occurred from August 26 through August 31, 1993, and the second survey occurred from August 15 through August 19, 1994. Measurements were taken in the same time period to allow comparison of analytical results. A total of 366 locations were sampled, and the samples included 366 field samples, 18 duplicate field samples, 26 ambient-air control samples (field blanks), and 4 trip blanks. The trip blanks were collected in and around the boundaries of MDAs G, J, and L.

2.2 Analytical Method

Maryland Spectral Services analyzed the cartridges for VOCs using a modified Environmental Protection Agency (EPA) SW-846 method 8240 (EPA 1994) that utilized thermal desorption of the EMFLUX cartridge. The cartridge was immersed in 5 milliliters of water spiked with the internal and surrogate standards; this was followed by gas chromatography/mass spectrometry (GC/MS) analysis to obtain the mass of each compound in each cartridge. The soil-gas VOC emission flux rates were subsequently calculated based on the mass of the VOCs detected, the subtended area of the collector shell, the time of collection, and the adsorbent recovery factors. The following equation was used.

$$F = \frac{C}{ATR} ,$$

where

- F = emission flux rate (ng/m²/min.),
- C = compound mass (ng),
- A = subtended area of EMFLUX collector shell (m²),
- T = time of collection (min.), and
- R = adsorbent recovery factor (decimal fraction).

3.0 SURFACE AND SUBSURFACE ENVIRONMENTAL CONDITIONS DURING SAMPLING PERIODS

This section includes a discussion of environmental conditions at the surface and in the subsurface during the sample collection period. Surface conditions were recorded at a meteorological station located at TA-54, and subsurface conditions were recorded from monitor wells near MDA L. Location of the meteorological tower is shown on Figure 1-2. A brief discussion is first given on subsurface soil-gas transport and pressure measurement.

3.1 Subsurface Soil-Gas Transport and Pressure Measurements

Transport of subsurface soil-gas is influenced by the following factors:

- atmospheric pressure variations;
- earth tides;
- wind shear;
- matrix characteristics, including permeability, porosity, moisture content, and homogeneity-fracture density;
- plant roots and burrowing rodents; and
- air-density differences near the surface.

At TA-54, the upper 400 ft or so of the matrix is composed of fractured volcanic ash layers with varying air permeability and water content. Profiles for permeability and moisture in the stratigraphic units of a representative vertical borehole are shown in Figure 3-1. Permeability values range between near zero and greater than 3 D. However, values up to 172 D have been measured in boreholes drilled at an angle to the

Figure 3-1. Profiles for permeability and moisture in stratigraphic units.

vertical plane. Presumably, the larger values were taken near a fracture. Canyon walls on the north and south side of TA-54 provide an increase in exposed surface to the atmosphere; therefore, there is greater potential for gas exchange than in flat terrain. Because the aspect ratio (mesa width to canyon wall height) ranges between about two and eight, the path for soil-gas migration in the mesa may have a significant horizontal component.

Monitor wells at TA-54 are equipped with ports ranging between 7 ft and 300 ft below the mesa top. Selected ports have pressure transducers located at the surface so that measurements do not reflect hydrostatic pressure effects. Early measurements were recorded on a four-hour interval with a strip-chart recorder; later an automated data logger was incorporated to record measurements on an hourly interval. The hourly interval was subsequently changed to a 45-min. interval to optimize analytical methods in determining frequency content (Neeper 1994) from pressure profiles. Based on the average air density at Los Alamos (Bowen 1990), the hydrostatic distribution is about 2.9 mb per 100 ft of elevation.

3.2 Survey I Sampling Period, August 26 through August 31, 1993

3.2.1 Environmental Conditions During Sample Collection

Sample plots of weather data at a central station operated by the Laboratory (Stone 1995) are shown in Appendix B, and a summary of maximum and minimum values and changes in atmospheric pressure, temperature, wind speed, humidity, and precipitation is presented in Table 3-1.

During Survey I, fluctuations in atmospheric pressure were normal for a period without large synoptic storms. A maximum value of 808.0 mb was recorded on August 26, and a minimum value of 798.8 mb was recorded on August 29. The diurnal average variation was 4.1 mb. Precipitation was recorded on all but the last day of the sampling period. The largest amount of precipitation (3.07 cm) was recorded on the first day, and less than 1 cm was recorded on the following days. The total amount of precipitation during the sampling period was 5.4 cm and was expected to have a minimal

TABLE 3-1
SUMMARY OF WEATHER STATISTICS DURING SURVEY I, 1993

	August 26	August 27	August 28	August 29	August 30	August 31
Atmospheric Pressure (mb)						
Diurnal Max.	808.0	807.4	805.8	802.4	805.8	807.1
Diurnal Min.	803.3	804.6	801.6	798.8	800.3	803.2
Diurnal Variation	4.7	2.8	4.2	3.6	5.5	3.9
Avg. Diurnal Variation	4.1					
Avg. Diurnal Max.	806.1					
Avg. Diurnal Min.	802.0					
Temperature (°C)						
Diurnal Max.	27.6	20.8	21.2	19.9	23.2	19.1
Diurnal Min.	11.0	13.6	12.8	10.0	8.3	10.2
Diurnal Variation	16.6	7.2	8.5	9.9	14.9	8.9
Avg. Diurnal Variation	10.2					
Avg. Diurnal Max.	21.9					
Avg. Diurnal Min.	11.0					
Relative Humidity (%)						
Diurnal Max.	96	96	96	96	96	91
Diurnal Min.	30	57	53	62	41	53
Diurnal Change	66	39	43	34	55	38
Avg. Diurnal Variation	46					
Avg. Diurnal Max.	95					
Avg. Diurnal Min.	49					
Precipitation (cm)						
Daily Amount	3.07	0.686	0.864	0.381	0.432	0.00
Total Precipitation	5.43					
Wind Speed (m/s)						
Diurnal Avg.	2.4	1.6	1.8	1.7	2.3	3.1
Gust	9.8	12.5	7.6	9.4	9.3	8.0
Avg. Wind Speed	2.16					
Avg. Gust	9.43					

effect on soil-gas emissions to the atmosphere. The relative humidity was above normal with an average daily maximum of 95% and average daily minimum of 49%. The maximum temperature was 27.6°C, and the minimum was 10.0°C. Temperature fluctuations were relatively small with a diurnal average variation of 10.2°C. The average wind speed during this period was 2.2 m/s, and the average gust was 9.4 m/s.

3.2.2 Subsurface Pressure Variations

Subsurface soil-gas pressure and atmospheric pressure were monitored at well 54-2022 (Figure 3-2)

by the Environmental Restoration Project. Data acquired during this survey apparently came from a faulty or misconnected sensor, so there is no direct information about subsurface pressures during this time. Figure 3-3 shows the atmospheric pressure measurements digitized at four-hour intervals from a strip chart record. No data were available from late on August 30 through August 31 because of equipment malfunction. The atmospheric pressures are slightly lower than those reported by the central station (Stone 1995) because the surface elevation at well 54-2022 is higher than that of the central station.

Figure 3-2. Location of monitor wells near MDA L at TA-54.

Figure 3-3. Atmospheric pressure variation at monitor well 54-2022 during Survey I.

According to the Quadrel computer-based model of earth tides, this period was favorable for surface sampling. The atmospheric pressure generally declined during the survey period. This is favorable for surface sampling because the subsurface pressure variation lags behind the atmospheric variation, forcing pore gas toward the surface.

3.3 Survey II Sampling Period, August 15 through August 19, 1994

3.3.1 Environmental Conditions During Sample Collection

A summary of maximum and minimum values of and changes in atmospheric pressure, temperature, wind speed, humidity, and precipitation is listed in Table 3-2.

TABLE 3-2
SUMMARY OF WEATHER STATISTICS DURING SURVEY II, 1994

	August 15	August 16	August 17	August 18	August 19
Atmospheric Pressure (mb)					
Diumal Max.	809.5	806.1	806.8	807.0	806.0
Diumal Min.	804.5	802.6	803.4	803.4	801.8
Diumal Variation	5.0	3.5	3.4	3.6	4.2
Avg. Diumal Variation	3.9				
Avg. Diumal Max.	807.1				
Avg. Diumal Min.	803.1				
Temperature (°C)					
Diumal Max.	22.7	31.3	31.1	31.8	29.5
Diumal Min.	12.8	10.5	12.3	12.5	13.4
Diumal Variation	9.9	20.8	18.8	19.3	16.1
Avg. Diumal Variation	17.0				
Avg. Diumal Max.	29.3				
Avg. Diumal Min.	12.3				
Relative Humidity (%)					
Diumal Max.	96	95	81	70	75
Diumal Min.	48	11	13	18	27
Diumal Change	48	84	68	52	48
Avg. Diumal Variation	60				
Avg. Diumal Max.	83.4				
Avg. Diumal Min.	23.4				
Precipitation (cm)					
Daily Amount	.0510	.025	0.0	0.0	0.0
Total Precipitation	.0762				
Wind Speed (m/s)					
Diumal Avg.	2.5	2.4	2.4	2.5	2.6
Gust	8.6	8.8	22.9	13.5	11.9
Avg. Wind Speed	2.5				
Avg. Gust	13.1				

Atmospheric pressure reached a maximum of 809.5 mb on August 15 and a minimum of 801.8 mb on August 19. The diurnal average pressure variation was 3.9 mb. Minimal amounts of precipitation (0.076 cm) were recorded on August 15 and 16. The relative humidity was high (95% and 96%) during the first two days of the sampling period and then dropped to the lower 70s. The minimum values ranged between 48% and 84%. The maximum temperature was 31.8°C, and the minimum was 10.5°C. The average diurnal temperature fluctuation was 17.0°C. Wind speed averaged 2.5 m/s, and gusts averaged 13.1 m/s.

3.3.2 Subsurface Pressure Variations

Changes in subsurface soil-gas pressure and atmospheric pressure were monitored at TA-54 by the Environmental Restoration Project. Coincident measurements of atmospheric pressure and pressure at 12 ports ranging between 37.5 ft and 338 ft below the surface were recorded at well 54-1004 (Neeper and Limback, unpublished) (Figure 3-2). Measurements

were taken at 45-minute intervals and recorded with an automated data logger. A plot displaying pressure profiles for the atmosphere and the subsurface is shown in Figure 3-4.

During the sample collection period, atmospheric pressure was generally lower than subsurface pressure. Atmospheric pressure was lowest during each midafternoon and highest in the early morning. During the afternoon of August 16, atmospheric pressure reached its lowest value during the sampling period. At this time, a distinct pressure gradient developed with atmospheric pressure at its lowest and subsurface pressure increasing with depth. These conditions provide excellent flow potential for soil gas from the subsurface to the surface, and according to the Quadrel computer-based model, this period was a favorable time for surface sampling.

3.4 Summary

During both sample collection periods the following conditions were observed.

Figure 3-4. Surface and subsurface pressure variations during Survey II (monitor well 54-1004).

- There were no unusually large fluctuations in barometric pressure or temperature.
- Wind speed was low; therefore, wind shear effects were small.
- There was light precipitation during Survey I, but it was expected to have little effect on normal gas exchange with the atmosphere.
- Subsurface pressure measurements indicated a flow potential toward the surface.

4.0 RESULTS

During the first survey, sample collection devices were placed on the mesa top above waste disposal sites, and 257 field locations, identified as 54-15000 through 54-15256 (Quadrel 1993), were sampled. In addition to the field samples, there were 12 duplicate, 26 ambient-air control, and 4 trip blank samples. On Thursday, August 26, sample collection devices were deployed at MDAs J and L and in subareas G1 and G2 within MDA G (Figure 4-1). Devices in subareas G3 through G8 were deployed the following day. The devices deployed on August 26 were retrieved on Monday, August 30, and devices deployed on August 27 were collected on Tuesday, August 31. Data

validation was performed on some Survey I samples; results are in Appendix C.

During the second survey, most sample collection devices were placed on the north- and south-facing slopes of Mesita del Buey near the disposal areas, and some were placed on the mesa top. A total of 109 sample locations, identified as 54-15261 through 54-15369 (Quadrel 1994), were sampled. There were also six duplicate samples. The collection devices were deployed on Monday, August 15, and retrieved on Friday, August 19.

Sample locations are shown in Figures 4-2 through 4-4. Solid circles designate Survey I locations; solid triangles designate Survey II locations. A small number of sample location markers were destroyed by ongoing construction before surveying; these locations are approximate and are represented by a clear triangle.

Analytical results are presented in two forms: tables (Appendix D) and bubble plots (Appendix E). A single compound is presented on each plot for each MDA. Note that MDAs H and J are combined. Results below the quantitation level are represented with a clear triangle at the sample location. The emission rate is

Figure 4-1. Location map of subareas at MDA G.

Figure 4-2. Sample locations at MDA G.

represented with a circle at each of the sample locations; the area of the circle is proportional to the magnitude of the measured emission rate.

Bubble plots were chosen to display the results because of the immediate visual impact. The subsurface matrix is nonhomogeneous, and the use of other display methods, which require interpolation between locations (e.g., contour plots), may give misleading indications, especially in uneven terrain. The results for 1,1,1-trichloroethane (the most prevalent compound) at MDAs G, H, J, and L are shown in Figures 4-5 through 4-7. Bubble plots for other compounds, including tetrachloroethylene, trichloroethylene, 1,1,2-trichlorotrifluoroethane (Freon 113), 1,1-dichloroethylene, and 1,1-dichloroethane, are shown in figures in Appendix E.

5.0 DISCUSSION OF RESULTS AND ESTIMATES OF EMISSION RATES

The rate of natural venting of VOCs from the matrix to the atmosphere has been estimated for each of the MDAs and is discussed in the following sections. The mass-flow emission rates were determined by taking

the mean emission rates for locations and multiplying the result by the surface area affected. At MDA L, emission rates were determined for two regions: the area near the disposal sites and the area away. These areas are shown in Figure 5-1. At MDA G, mass-flow emission rates were determined for each of the eight subareas. Dimensions taken just beyond the locations where compounds were not detected were used to calculate surface area.

5.1 MDA L

At MDA L, sample locations were grouped into two areas: near the disposal sites and away. The area encompassing the plume was 43 acres (1100 ft x 1700 ft). Dimensions for the plume were based on a distance of 50 ft beyond the sample locations where compounds were not detected. Ten acres were near the disposal sites (900 ft x 500 ft). The area away from the disposal sites is greater by a factor of three than the area near the disposal sites.

A total of 102 locations, 70 in Survey I and 32 in Survey II, were sampled in and around MDA L (Figure 4-3). Sampling above the pit, impoundments, and shafts in the eastern region of MDA L was hampered because

Figure 4-3. Sample locations at MDAs H and J.

the surface is covered with asphalt. Several samples were taken above shafts in the western region. This surface has since been covered with asphalt.

5.1.1 Discussion of Results

Twenty compounds were detected; 12 were chlorinated compounds, and the remaining 8 were benzene toluene ethylbenzene xylene (BTEX) compounds. The most prevalent were trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane, each detected in more than 90% of the samples. The maximum emission rates for these three compounds were larger than the maximums of other compounds by more than one order of magnitude. The compound 1,1,2-trichlorotrifluoroethane (Freon 113) was detected in 70% of the samples. Chloromethane, 1,1-dichloroethylene, carbon tetrachloride, and 1,2-dichloropropane were detected in 13 to 24% of the samples. Chlorobenzene, 1,2-

dichloroethane, 1,1-dichloroethane, and chloroform were detected in less than 5% of the samples. BTEX compounds were detected at relatively low emission rates. The dominant BTEX compound was toluene, which was present in 41% of the samples. Benzene was detected in 36% of the samples and mixed xylenes in 9%. Ethylbenzene was detected in a single sample at slightly above the quantitation level. Other compounds detected included acetone, present in 70% of samples, and 2-butanone, present in 6% of samples. Bromobenzene and n-propyl benzene were each detected once with emission rates slightly above the quantitation level. A complete list of analytical results is presented in Appendix D.

Bubble plots indicate the following:

- Values for surface emission rates of 1,1,1-trichloroethane and trichloroethylene are highest near shafts on the west side.

Figure 4-4. Sample locations at MDA L.

- The compound 1,1,1-trichloroethane has the highest mean emission rate and is more widespread than trichloroethylene and tetrachloroethylene. This may be because of its high vapor pressure and low vapor density. The compound 1,1,1-trichloroethane has a high diffusivity coefficient.
- Emission rates decrease, with a jagged-shaped profile, as distance from the disposal sites increases. This may be a result of the nonhomogeneous nature of the matrix, namely the large number of fractures.
- Emission rates for trichloroethylene are highest along the fence line just north of impoundments B and C. This agrees with results from core samples taken beneath the pit and impoundments.
- Trichloroethylene appears to be confined to the northern portion of the mesa with only small

detections south of MDA L and no detections on the mesa's southern slope.

- For most compounds, emission rates decrease toward the canyon. There appears to be an anomaly in the emission gradient for 1,1-dichloroethylene on the northern canyon slope in the eastern region of MDA L, where emissions were greater toward the canyon.
- There were several sporadic detections of 1,1-dichloroethylene above the shafts on the west side and on the mesa's northern slope.
- Emissions are virtually nondetectable 400 ft away from the MDA L boundary.

5.1.2 Estimate of Mass Emission Rates

The mass emission rate of compounds released to the atmosphere by natural venting was estimated by multiplying the mean emission rate for each compound

Figure 4-5. Distribution of 1,1,1-trichloroethane in soil vapor at TA-54, MDA G.

Figure 4-6. Distribution of 1,1,1-trichloroethane in soil vapor at TA-54, MDAs H and J.

Figure 4-7. Distribution of 1,1,1-trichloroethane in soil vapor at TA-54, MDA L.

by the surface area in each region, then summing the values for the compounds. These estimates are expected to be higher than the actual emissions because the potential for soil-gas flow reverses itself periodically.

At MDA L, the mass emission rate of all compounds to the atmosphere is estimated to be 70 lb./yr. The emission rates in the two areas (near and away) were comparable, with 42.1 and 27.9 lb./yr., respectively. However, the distribution of compounds was dramatically different. Near the disposal sites, 20 compounds were detected. Four compounds, 1,1,1-trichloroethane, tetrachloroethene, trichloroethene, and 1,1,2-trichloro-trifluoroethane (Freon 113), make up more than 90% of those compounds detected. Compounds with a low gas diffusivity coefficient and high specific gravity (greater than one) were more prevalent near the disposal sites; most of the

tetrachloroethene (91.9%) and trichloroethene (85.8%) was detected there. Ten compounds were detected in the area away from the disposal sites. Compounds with higher vapor pressure and low specific gravity (terms contributing to a large diffusivity coefficient, such as 1,1,2-trichloro-trifluoroethane (Freon 113) and 1,1,1-trichloroethane, were more widespread and present in larger proportion there. These results give an indication of the migration capability of the different compounds in the subsurface environment. Estimated values for mean flux rates and mass venting to the atmosphere for each compound are summarized in Table 5-1. The distribution of compounds naturally venting to the atmosphere is represented on Figure 5-2.

5.2 MDA G

At MDA G, 245 locations were sampled, 174 during Survey I and 71 during Survey II (Figure 4-2). These

Figure 5-1. Areas near and away from the disposal pits at MDA L.

locations do not include any samples taken within the proposed expansion zone, an undisturbed area between the MDA L boundary and the old MDA G entrance, located approximately 150 ft west of pit 37. Most sample locations were near inactive waste disposal pits and shafts. The ground surface is relatively bare; only a small percentage is covered with asphalt and buildings. Because MDA G is a large area, it was divided into eight subareas designated as G1 through G8, as shown in Figure 4-1; a summary of subarea dimensions and calculations is listed in Table 5-2. The total surface area encompassing the vapor plume at MDA G is about 98 acres.

5.2.1 Discussion of Results

Fourteen analytes were detected; chlorinated compounds dominated the list. The compound 1,1,1-trichloroethane was detected in 97% of all samples and had a median emission rate of one order of magnitude larger than the median value of the next highest

compound detected, tetrachloroethylene. Tetrachloroethylene, trichloroethylene, and 1,1,2-trichloro-trifluoroethane (Freon 113) were present in 88%, 66%, and 52% of all samples, respectively, and had relatively low emission rates compared to 1,1,1-trichloroethane. Other chlorinated compounds detected included 1,1-dichloroethylene, chloromethane, and 1,1-dichloroethane, which were present in 21%, 6.1%, and 5.3% of all samples, respectively. Compounds detected in less than 1% of samples included trichlorofluoromethane (Freon 11) and methylene chloride. Nonchlorinated compounds detected in less than 14% of all samples include acetone, toluene, and benzene. There was a single detection each of carbon disulfide and mixed xylenes at low emission rates.

By far the largest emission rates occur at the east end in subareas G5 and G6. Further discussion of the mass emission rates for the various compounds is given in the following section. From the bubble plots, we can see that the compound levels are relatively small near

TABLE 5-1
SURFACE EMISSIONS AT MDA L

Compound	Near Disposal Sites			Away From Disposal Sites			Combined	
	m/A (ng/min./m ²)	% (A/sum A)	m (lb./yr)	m/A (ng/min./m ²)	% (A/sum A)	m (lb./yr)	% of Total	Total m (lb./yr)
Acetone	20.5	24.0	1.0	15.6	76.0	3.1	5.9	4.1
Benzene	1.4	7.8	0.1	4	92.2	0.8	1.2	0.9
Bromobenzene	0.02	0.2	0.0	2.2	99.8	0.4	0.6	0.4
2-Butanone	0.67	100	0.03	0	0.0	0.0	0.05	0.03
Carbon tetrachloride*	1.1	100	0.1	0	0.0	0.0	0.1	0.1
Chlorobenzene	1.1	100	0.1	0	0.0	0.0	0.1	0.1
Chloroform*	0.05	100	0.002	0	0.0	0.0	0.003	0.002
Chloromethane	2	21.1	0.1	1.8	78.9	0.4	0.7	0.5
1,2-Dichloroethane*	1.2	100	0.1	0	0.0	0.0	0.1	0.1
1,1-Dichloroethane	0.16	100	0.01	0	0.0	0.0	0.01	0.01
1,1-Dichloroethylene*	6.7	100	0.3	0	0.0	0.0	0.5	0.3
1,2-Dichloropropane	0.8	100	0.04	0	0.0	0.0	0.1	0.04
Ethylbenzene	0.02	100	0.001	0	0.0	0.0	0.001	0.001
n-Propylbenzene	0.04	100	0.002	0	0.0	0.0	0.003	0.002
Tetrachloroethylene*	259.3	91.9	12.6	5.5	8.1	1.1	19.5	13.7
Toluene	1.3	28.9	0.1	0.77	71.1	0.2	0.3	0.2
1,1,1-Trichloroethane	289.1	48.2	14.0	74.8	51.8	15.1	41.5	29.1
Trichloroethylene*	233	85.8	11.3	9.3	14.2	1.9	18.8	13.2
1,1,2-trichloro-trifluoroethane (Freon 113)	51	34.4	2.5	23.4	65.6	4.7	10.3	7.2
Xylene	0.16	3.4	0.0	1.1	96.6	0.2	0.3	0.2
Sum of Compounds	869.6	60.2	42.1	138.5	39.8	27.9	100	70.0

* Listed as a carcinogen in 40 CFR, Part 264, Subpart S, Appendix A.

the facility boundaries and below the quantitation limit at distances greater than 250 ft away from the facility fence line.

Waste disposal began in pits at the eastern end of MDA G then progressed toward the west. Compounds disposed of in pits 1 and 2 (east end), which were closed by 1963, are rich with 1,1,1-trichloroethane and trichloroethylene, solvents that were used during this time period. As the use of these solvents became more restricted, new solvents, such as the Freons, became available. In the more recent disposal pits, Freons are more prevalent and older solvents are less prevalent.

The gradient in mass emission concentration of compounds across the mesa top shows a time line.

5.2.2 Estimate of Mass Emission Rates

The mass emission rate of compounds vented to the atmosphere at MDA G was estimated to be 103 lb./yr. The compound 1,1,1-trichloroethane made up 74% of the mass emission rate; 1,1,1-trichloroethane, tetrachloroethene, and 1,1,2-trichloro-trifluoroethane (Freon 113) made up 92% of the total. The remaining 13 compounds were detected at low emission rates, 8 contributed less than 1% to the total.

The highest mean emission rate for all compounds combined was detected in subarea G5; it accounted for 37% of the total. The next highest mean emission rate was in subarea G6; it accounted for 21% of the total. Subareas G5 and G6 compose about 20% of the surface area at MDA G and vent approximately 60% of the VOCs. Each of the remaining six subareas contain less than 12% of the total emissions, and the lowest rates are in subareas G2 and G7, each with about 4% of the total. Estimates in subarea G4 may be biased on

the high side because disposal sites occupy about half the subarea, and only a small number of samples were taken in the unoccupied subarea. Mean emission rates and estimates for mass venting to the atmosphere for each compound are summarized in Table 5-3, and a graphical representation of these values is shown in Figure 5-3.

5.3 MDAs J and H

At MDAs J and H, the waste disposal sites were generally used for administrative waste; therefore, emission rates were expected to be low. A total of 19 locations were sampled, 14 at MDA J and 5 at MDA H.

Figure 5-2. Distribution of compounds venting to the atmosphere at MDA L.

5.3.1 Discussion of Results

Seven compounds were detected at levels slightly above the quantitation level. The compound 1,1,1-trichloroethane was detected most often and had the highest value of 14.6 ng/min./m² near pit 3. Other values were minimal.

5.3.2 Estimate of Mass Emission Rates

A small number of compounds were detected at very low emission rates. This resulted in a combined estimated release to the atmosphere of a few tenths of a pound per year at these sites. Because some of the compounds were detected in the method blank samples, the presence of these compounds at MDAs J and H is suspect.

TABLE 5-2
SUBAREA CALCULATIONS AT MDA G

Subarea	Dimensions (ft)	Area (acres)	% of Total Area
G1	1400 x 600	19.3	5.1
G2	600 x 600	8.3	8.5
G3	500 x 900	10.3	10.5
G4	1200 x 800	22.0	22.4
G5	500 x 800	9.2	9.4
G6	900 x 500	10.3	10.5
G7	600 x 500	6.9	7.0
G8	700 x 700	11.2	11.4

TABLE 5-3
SURFACE EMISSIONS AT MDA G

	Acetone	Benzene	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	1,1-Dichloroethane	1,1-Dichloroethylene	Methylene Chloride	Tetrachloroethylene	Toluene	1,1,1-Trichloroethane	Trichloroethylene	Trichlorofluoromethane (Freon 11)	1,1,2-trichloro-trifluoroethane (Freon 113)	Xylene	Sum Of Compounds
G1	m/A (ng/mln./m ³)	2.6	0.1	0	0	0	0	0	0	5.5	0.26	53.7	0.79	0	16.2	0	79.2
	% of total in G1	3.3	0.1	0	0	0	0	0	0	6.9	0.3	67.8	1	0	20.5	0	100
	% (A/sum A)	29.9	43.4	0	0	0	0	0	0	4.2	0.7	6.6	3	0	21.1	0	—
G2	m (lb./yr.)	0.24	0.01	0	0	0	0	0	0	0.50	0.0	4.85	0.07	0	1.46	0	7.2
	m/A (ng/mln./m ³)	3.7	0.15	0	0.3	0	0	0	0	4.0	0.2	59.1	0.69	0	36.3	0	104.4
	% of total in G2	3.5	0.14	0	0.3	0	0	0	0	3.81	0.2	56.6	0.66	0	34.8	0	100
G3	% (A/sum A)	18.2	27.9	0	100	0	0	0	0	1.31	0.24	3.11	1.12	0	20.3	0	—
	m (lb./yr.)	0.1	0.01	0	0	0	0	0	0	0.2	0.01	2.3	0.03	0	1.4	0	4.0
	m/A (ng/mln./m ³)	1.84	0	0	0	0	2.08	0	9.52	11.5	0.1	177.2	1.12	0.64	36.8	0.0	240.8
G4	% of total in G3	0.76	0	0	0	0	0.86	0	3.95	4.76	0.04	73.6	0.47	0.27	15.3	0.0121	100
	% (A/sum A)	11.3	0	0	0	0	50.0	0	14.0	4.7	0.3	11.7	2.1	100	25.7	0	—
	m (lb./yr.)	0.09	0	0	0	0	0.1	0	0.46	0.55	0.01	8.58	0.05	0.03	1.78	0.001	11.7
G4	m/A (ng/mln./m ³)	0.89	0	0.85	0	0	0.27	0	0.31	25.1	0.03	46.1	3.56	0	12.6	0	89.8
	% of total in G4	0.99	0	0.94	0	0	0.3	0	0.35	28	0.03	51.4	3.97	0	14.1	0	100
	% (A/sum A)	11.7	0	100	0	0	116	0	0.91	22.1	0.09	6.5	15.5	0	18.8	0	—
	m (lb./yr.)	0.09	0	0.09	0	0	0.03	0	0.03	2.6	0	4.76	0.37	0	1.3	0	9.3

TABLE 5-3 (concluded)

		Acetone	Benzene	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	1,1-Dichloroethane	1,1-Dichloroethylene	Methylene Chloride	Tetrachloroethylene	Toluene	1,1,1-Trichloroethane	Trichloroethylene	Trichlorofluoromethane (Freon 11)	1,1,2-trichloro-trifluoroethane (Freon 113)	Xylene	Sum Of Compounds
G5	m/A(ng/mln./m³)	1.56	0	0	0	0	0.45	3.89	51.7	8.92	64.3	72.4	667	4.45	0	0.63	0	875
	% of total in G5	0.18	0	0	0	0	0.05	0.45	5.91	1.02	7.35	8.27	76.2	0.51	0	0.07	0	100
	% (A/sum A)	8.53	0	0	0	0	81.5	84.7	67.9	100	23.6	97.4	39.0	8.1	0	0.39	0	
	m(lb./yr.)	0.07	0	0	0	0	0.02	0.2	2.23	0.38	2.77	3.12	28.7	0.19	0	0.03	0	37.7
G6	m/A(ng/mln./m³)	0.21	0	0	0	0	0.12	0.64	8.48	0	58.6	0.08	385	10.2	0	6.25	0	470
	% of total in G6	0.045	0	0	0	0	0.02	0.14	1.81	0	12.5	0.02	82	2.18	0	1.33	0	100
	% (A/sum A)	1.304	0	0	0	0	23.3	15.5	12.5	0	24.2	0.1	25.3	20.8	0.0	4.4	0	—
	m(lb./yr.)	0.01	0	0	0	0	0.01	0	0.41	0	2.84	0	18.6	0.5	0	0.3	0	22.7
G7	m/A(ng/mln./m³)	4.26	0.09	0	0	0	2.26	0	4.41	0	21.2	0.53	63.7	33.2	0	2.78	0	132.4
	% of total in G7	3.22	0.07	0	0	0	1.71	0	3.33	0	16	0.40	48.1	25.1	0	2.1	0	100
	% (A/sum A)	17.5	14.5	0	0	0	30	0	4.34	0	5.83	0.53	2.8	45.0	0	1.3	0	—
	m(lb./yr.)	0.14	0	0	0	0	0.07	0	0.14	0	0.68	0.02	2.06	1.07	0	0.09	0	4.3
G8	m/A(ng/mln./m³)	0.26	0.06	0	0	0	0.10	0.24	0	0	31	0.20	71.4	1.99	0	10.7	0	116
	% of total in G8	0.23	0.05	0	0	0	0.09	0.2	0	0	26.8	0.18	61.6	1.71	0	9.25	0	100
	% (A/sum A)	1.75	14.3	0	0	0	100	4.3	0	0	13.9	0.34	5.12	4.40	0	8.15	0	—
	m(lb./yr.)	0.01	0	0	0	0	0.01	0.01	0	0	1.63	0.01	3.76	0.11	0	0.57	0	6.1
All G Sum of m(lb./yr.)		0.79	0.02	0.09	0.01	0.01	0.23	0.2	3.28	0.04	11.7	3.2	73.6	2.38	0.03	6.93	0.001	103

Figure 5-3. Distribution of compounds venting to the atmosphere at MDA G.

5.4 Comparison Of Sample Results From Monitoring Wells and Quadrel Surveys

Several soil-gas monitoring wells are located at MDAs G and L, as shown in Figure 3-2. Some wells were drilled vertically, and others were drilled at an angle; they range between 80 and 300 ft in depth. Sampling ports were installed at several depths in each well. Soil-gas samples are currently taken on a quarterly basis to satisfy EPA requirements for plume surveillance. Soil-gas sample analysis is performed by two methods. In the first method, a predetermined volume of soil gas, drawn at specified sampling ports, flows through two parallel carbo-sieve cartridges, where the compounds are captured. Volumetric flow through one of the cartridges is greater, usually by a factor of 10, to increase the dynamic range for detection. The cartridges are then analyzed for 48 EPA-listed compounds at a fixed laboratory; thermal desorption (TD) GC/MS methods are used for the analyses. In the second method, soil-gas samples are drawn from the sampling ports with a vacuum pump/iron lung set-up and captured in a Tedlar bag. Shortly after being drawn, the soil gas from the bag is analyzed in the field for specific target compounds by photoacoustic radiometry methods. The target compounds were previously

identified from TDGC/MS analysis. Because the photoacoustic radiometer utilizes seven optical filters, one for each compound, it must be precalibrated for each compound. The two methods of analysis are complementary; in the first a wide range of compounds can be detected and target compounds identified. The second method allows for the target compounds to be detected in the field quickly, accurately, and at a very low cost.

Sample analysis results (Solli 1995) for two monitor wells in MDA L and two in MDA G were compared with sample analysis results from collection devices located in the areas of the four wells. Only results from fixed analytical laboratories were used for comparison. Because only select ports are used for fixed laboratory analysis, results were used from ports ranging between 42 and 120 ft in depth. A summary of the

compounds detected and their respective contaminant magnitude is listed in Table 5-4. Direct comparison of the magnitude of the numbers is not valid because the measurement taken in the wells corresponds to an analyte density, i.e., analyte mass per unit of gas volume, and the measurement taken with the surface samples correspond to an emission flux rate. However, comparison can be made of the compounds detected and their relative strength. Typical compound vertical profiles for monitor wells at MDAs L and G are shown in Figure 5-4. Both methods detected the same dominant compounds, 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene. Monitor wells at MDA L detected moderate levels of methylene chloride, whereas the surface sample collection devices did not.

6.0 CONCLUSIONS AND FUTURE WORK

The compound 1,1,1-trichloroethane, tetrachloroethylene, trichloroethylene, and 1,1,2-trichloro-trifluoroethane (Freon 113) were the compounds most commonly detected during this survey, with 1,1,1-trichloroethane being most widespread. At MDA L, a previously undetected high concentration area of trichloroethylene was identified.

TABLE 5-4
COMPARISON OF RESULTS FROM MONITOR WELLS AND SURFACE SAMPLES

Compound	Material Disposal Area L				Material Disposal Area G			
	Well 54-2012 ^a (d=42 ft) ^b	Surface Sample 54-15030 ^c	Well 54-2002 ^a (d=120 ft) ^b	Surface Sample 54-15057 ^c	Well 54-2010 ^a (d=95 ft) ^b	Surface Sample 54-15122 ^c	Well 54-2009 ^a (d=92 ft) ^b	Surface Sample 54-15159 ^c
1,1,1-Trichloroethane	530(1)	354.4	260(1)	15	120(1)	0.7	270(1)	418
1,1-Dichloroethane	80	ND ^d	1.9	ND	1.8	ND	3.5	ND
1,1-Dichloroethylene	54	ND	18	ND	3.6	ND	9.2	22.2
1,2-Dichloroethane	27	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	ND	1.6	ND	ND	ND	ND	ND
2-Butanone	ND	ND	ND	5.4	ND	ND	ND	ND
Acetone	ND	10.9	ND	10.5	1.1	ND	ND	ND
Benzene	1.5	2.1	ND	ND	ND	ND	ND	ND
Chloroform	15	ND	3.4	ND	ND	ND	ND	ND
Chlorobenzene	ND	3.9	ND	ND	ND	ND	ND	ND
Chloromethane	ND	ND	ND	ND	ND	8.4	ND	8.6
Dichlorodifluoromethane	6.2	ND	3.1	ND	1.2	ND	ND	ND
Methylene chloride	410(1)	ND	100	ND	ND	ND	ND	ND
Tetrachloroethylene	41	398.1	25	14.6	1.4	.9	2	25
Toluene	6.5	1.7	45	ND	ND	1.6	ND	ND
Trichloroethylene	170(1)	630.2	45	18.9	5.7	0.8	4.5	2.5
Trichlorofluoromethane ^e	43	ND	19	ND	3.6	ND	ND	ND
1,1,2-Trichloro-trifluoroethane ^f	12	9.1	22	4.3	8.8	ND	ND	ND
Xylene	ND	ND	ND	ND	ND	0.7	ND	ND

- a. Units are in mg/L.
b. d = depth.
c. Units are in ng/m²/min.
d. ND = not determined. The result is below the quantitation limit.
e. Freon 11
f. Freon 113

Figure 5-4. Typical compound vertical profiles for monitor wells at MDAs G and L.

A handful of other compounds was detected at much lower levels (Table 6-1). Compounds were detected over and near the disposal sites with small amounts detected on the canyon walls and virtually none detected on adjacent canyon bottoms.

From this survey, an estimate for the total mass rate of compounds naturally vented to the atmosphere was as follows:

- 70 lb./yr. at MDA L,
- 103 lb./yr. at MDA G, and
- nearly zero emissions at MDAs H and J.

The emission flux rate value for the single highest measurement within all the MDAs at TA-54 is an order of magnitude lower than what is considered a small flux rate ($<100 \mu\text{g}/\text{min}/\text{m}^2$) at a spill site or a RCRA landfill. The largest mean emission rate at any subarea is at least two orders of magnitude lower. The estimated total mass of VOCs naturally vented to the atmosphere in all MDAs is lower by a factor of several hundred than

the threshold limit established by the State of New Mexico as an air quality concern.

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TABLE 6-1
COMPOUNDS DETECTED AT LOW LEVELS

Compound	Area G	Areas J and H	Area L
Acetone	x	x	x
Benzene	x	x	x
Bromobenzene			x
2-Butanone			x
Carbon disulfide	x		
Carbon tetrachloride	x		x
Chlorobenzene		x	x
Chloroform	x	x	x
Chloromethane	x	x	x
1,2-Dichloroethane			x
1,1-Dichloroethane	x	x	x
1,1-Dichloroethylene	x	x	x
1,2-Dichloropropane			x
Ethylbenzene			x
Methylene chloride	x		
n-Propylbenzene			x
Tetrachloroethylene	x		x
Toluene	x	x	x
1,1,1-Trichloroethane	x	x	x
Trichloroethylene	x	x	x
Trichlorofluoromethane (Freon 11)	x		
1,1,2-Trichloro-trifluoroethane (Freon 113)	x	x	x
Xylene (total)		x	x

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APPENDIX A

ENVIRONMENTAL SETTING

The environmental setting of the Los Alamos National Laboratory (Laboratory) is described in Section 2.4 of the "Installation Work Plan for Environmental Restoration" (LANL 1995). A discussion of the environmental setting, including climate, geology, hydrology, and a conceptual hydrogeologic model for the area and its surroundings, is presented in the Operable Unit 1148 Resource Conservation and Recovery Act facility investigation work plan (LANL 1992), and a summary is presented in the following sections.

A.1 Climate

Technical Area (TA) 54 has a semiarid, temperate mountain climate (Bowen 1990). Annual average precipitation at a weather station at Material Disposal Area (MDA) G is about 14 in.; approximately 40% of this occurs as brief, intense thunderstorms during July and August. Snowfall is greatest from December through March; heavy snowfall is infrequent during other months. Surface water runoff can occur during summer thunderstorms, frontal storms, and snowmelt periods, but the majority of runoff and the resultant erosion probably occurs during the summer thunderstorm period. The predominant wind direction at MDA G is from the south-southwest; however, a more easterly, downslope component from the Jemez Mountains is common at night. Many of the strongest winds occur in the spring. Summer afternoon temperatures at TA-54 range typically between 70°F and 90°F, and typical winter temperatures range between 30°F and 50°F in the daytime and 15°F to 25°F at night.

A.2 Geology

A.2.1 Geologic Setting

A detailed discussion of the geology of the entire Los Alamos area is located in Section 2.5.1 of the installation work plan (IWP) (LANL 1995). A summary of the geology of the area surrounding the MDAs is presented below.

Mesita del Buey, a 100- to 140-ft-high mesa, is underlain by the Bandelier Tuff, a series of volcanic ash flows that originate from the Valles caldera located in the Jemez Mountains west of the Laboratory. The mesa

stratigraphy is composed of the Tshirege Member of the tuff (Figure A-1). Unit 2 of Broxton et al. (in preparation) is the uppermost unit, and Units 1v and 1g are exposed on the mesa sides. The lower mesa sides and the adjacent canyon bottoms within Pajarito Canyon and Cañada del Buey are covered with colluvium and alluvium that eroded from the tuff and soils that formed on the mesa top and canyon walls.

Figure A-1. Representative geologic cross section across Mesita del Buey in vicinity of MDA G. Units 1g, 1v, and 2 are the Tshirege Member of the Bandelier Tuff.

At Mesita del Buey, the Bandelier Tuff varies from a nonwelded to a moderately welded texture. The mesa top is composed of moderately welded tuff that hosts the disposal pits and shafts. There are only thin (~1 ft) soils on the mesa top. The mesa soil and tuff support a piñon-juniper woodland with a variety of grasses and cactus. The larger piñon trees can have some roots that extend to a depth of 60 ft.

A.2.2 Soils

A discussion of the soils in the Los Alamos area is located in Section 2.5.1.3 of the IWP (LANL 1995). Soils in the area surrounding the MDAs are discussed below.

The soils on the mesa top at TA-54 were mapped by Nyhan et al. (1978). The soil is composed of

disintegrated tuff (phenocrysts and phenocryst fragments, devitrified glass, and minor lithic fragments). Most areas at the MDAs, however, have been heavily disturbed by grading, excavation, and other activities, and many are paved with asphalt. Chemically, mesa top materials at the MDAs probably include a combination of crushed Unit 2 tuff, some soils, and various materials, such as asphalt and road gravel, imported to the mesa.

Young sediments along the channels consist primarily of fine- to coarse-grained sands, silts, and some clays; there is little or no soil development in the channels. Channel sediments are derived from the mesa top materials, the tuff from the sides of the mesa, and colluvium and soils from the mesa sides. The relative contribution of these various sources to the channel sediments is unknown.

A.3 Hydrology

The hydrology of the Pajarito Plateau is summarized in Section 2.5.2 of the IWP (LANL 1995). Site-specific conditions are summarized below.

A.3.1 Surface Water

No perennial streams occur at TA-54 or in the adjacent canyons, although intermittent stream flow is common in Pajarito Canyon. Surface water runoff from the MDAs occurs primarily during intense summer thunderstorms; runoff also results from rain accompanying frontal storms in other seasons and from snowmelt. This intermittent surface runoff drains along many separate channels into Pajarito Canyon and Cañada del Buey. Runoff from MDA H drains south along a shallow mesa top channel before emptying into a tributary of Pajarito Canyon. Runoff from MDAs J and L discharges to the north into a tributary of Cañada del Buey. At MDA G, the mesa top drainage divide is located on the north side of the mesa, and most of the surface runoff flows to the south around closed disposal pits and shafts into a series of canyon-wall embayments along Pajarito Canyon. Additional runoff flows from the east and north sides of MDA G into channels that empty into Cañada del Buey. Figure A-2 shows the topography of the area.

Figure A-2. Topography of TA-54.

A.3.2 Groundwater

Depths to the main aquifer beneath Laboratory land have been compiled by Purtymun (1984). At Mesita del Buey, the depth ranges between about 1040 ft in the vicinity of MDA H and 900 ft beneath eastern MDA G. PM-2, located in Pajarito Canyon, is the measurement well nearest TA-54. Host rocks for the aquifer beneath TA-54 are thought to be sedimentary fanglomerates, conglomerates, and sandstones beneath thick basaltic volcanic flows. There has been no drilling to the main aquifer under TA-54.

Extensive shallow drilling, particularly the geological characterization drilling in the mid-1980s (Kearl et al. 1986), encountered no perched aquifers within the Tshirege Member of the Bandelier Tuff. More recent and deeper drilling beneath MDA L by the Environmental Restoration Project encountered thin (less than 10 ft) moist intervals of rock at depths of approximately 260 ft, 370 ft, 490 ft, and 520 ft from the mesa top. Intervals in the deep basalts (490 ft and 520 ft) can be described as wet, although repeated attempts to sample water were unsuccessful because of the lack of available water volume. The presence of deep and moist or wet intervals requires more study, but the data suggest that thick or laterally extensive perched aquifers are not present beneath Mesita del Buey to depths of at least 500 ft. There are no springs or seeps on Mesita del Buey.

REFERENCES

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APPENDIX B WEATHER DATA

TA-54 (1996 MSL) DAY 243

AUGUST 31, 1993

TA-54 (1996 MSL) DAY 227

AUGUST 15, 1994

TA-54 (1996 MSL) DAY 227

AUGUST 15, 1994

APPENDIX C DATA ASSESSMENT

Data validation was performed on 15 of the 257 field samples collected during the first survey of the study because 15 sample results in Contract Laboratory Program (CLP) data packages were available. These 15 field samples were chosen before the volatile organic compound (VOC) analysis; thus they are not biased. The analytical results for all other samples (with the exception of three) were presented in CLP Form I format, which shows only the amount of compound detected for each cartridge. Analytical results for samples 54-15009 and 54-15079 were lost because of malfunctioning laboratory equipment, and data for sample 54-15195A could not be obtained because sample integrity was lost during transportation.

The analyses of the samples collected in the first survey were completed on September 18, 1993. Because no holding time for soil-gas samples has been established by the Environmental Protection Agency (EPA), the

completion of the analyses was considered satisfactory.

C.1 Organic Analysis

Samples were analyzed using a modified EPA SW-846 Method 8240 (EPA 1994). The modification included thermal desorption of the cartridge through 5 ml of water spiked with the internal and surrogate standards before analysis according to the EPA method. Cartridges were analyzed for the CLP target compound list and 15 other VOCs. Table C-1 shows which VOCs samples were analyzed for.

Data from the 15 field samples were reviewed according to EPA guidelines for organic data review (EPA 1994). Several deficiencies were noted in the data package. Compounds commonly found as laboratory solvents, such as methylene chloride, carbon disulfide, trichlorofluoromethane, 2-hexanone, benzene, 1,2-dichlorobenzene, and 1,4-dichlorobenzene, were found

TABLE C-1
VOCs INCLUDED IN THE SOIL-GAS SAMPLE ANALYSIS

Acetone	1,3-Dichlorobenzene	4-Methyl-2-Pentanone
Benzene	1,4-Dichlorobenzene	Methylene chloride
Bromobenzene	Dichlorodifluoromethane	n-Propylbenzene
Bromoform	1,2-Dichloroethane	Tetrachloroethylene
Bromomethane	1,1-Dichloroethane	Toluene
2-Butanone	1,1-Dichloroethylene	1,1,1-Trichloroethane
Carbon disulfide	1,2-Dichloroethene (total)	1,1,2-Trichloroethane
Carbon tetrachloride	1,3-Dichloropropane	Trichloroethylene
Chlorobenzene	2,2-Dichloropropane	Trichlorofluoromethane (Freon 11)
Chloroethane	1,2-Dichloropropane	1,1,2-Trichloro-trifluoroethane (Freon 113)
Chloroform	trans-1,3-Dichloropropene	1,2,4-Trimethylbenzene
Chloromethane	cis-1,3-Dichloropropene	1,3,5-Trimethylbenzene
Dibromomethane	1,1-Dichloropropene	Vinyl Chloride
1,2-Dichlorobenzene	Ethylbenzene	Xylene (total)

in the laboratory method blanks. Therefore, the results for these compounds may be biased high. The chloromethane results may also be biased high because of the low relative response factors observed in the initial and continuing calibrations.

Seven of the fifteen sample results reviewed showed amounts of 1,1,1-trichloroethane, trichloroethene, and tetrachloroethene that exceeded the linear range of the calibration standards. The exact amount of compounds in the samples could not be determined because of the nature of the sample collection and analysis setup, which did not allow dilution or reanalysis of the sample. There was one occasion when the laboratory reduced the electron multiplier voltage between sample analyses to minimize the saturation effect of the detector. Consequently, the peak area counts for the internal standards did not meet the lower acceptance criteria established by the EPA, thus increasing the uncertainty of the results. There were occasions when the recovery

of one surrogate standard exceeded the acceptance criteria, thus biasing sample results to be high.

Review of the data for the 257 field samples showed that significant amounts of compounds, including 1,1,1-trichloroethane, toluene, and xylene, were found in the ambient-air control samples. The amount was already subtracted from the field sample results before VOC emission flux rates were determined.

Despite the minor problems described above, no significant error was found associated with the soil-gas results. Therefore, all soil-gas data are considered useable and valid to determine the extent of VOC contamination at these material disposal areas.

REFERENCE

EPA (US Environmental Protection Agency), "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review," EPA540/R-94/012, Washington, DC (February 1994).

* ND denotes flux rate was not determined because the result is below the quantitation limit. All values reported represent the net flux rate with contaminant from the field blanks subtracted.

Sample Area			Emission Flux Rate (ng/m ² /min.)																
G-1	Sample ID/Location		Acetone	Benzene	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	1,1-Dichloroethane	1,1-Dichloroethylene	Methylene chloride	Tetrachloroethylene	Toluene	1,1,1-Trichloroethane	Trichloroethylene	Trichlorofluoromethane (Freon 11)	1,1,2-Trichloro-trifluoroethane (Freon 113)	Xylene	
	54-15082	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10.1	ND	9.1	1.2	ND	ND	ND	
G-2	54-15083	ND	ND	ND	ND	ND	ND	3.8	ND	ND	ND	58.4	ND	129.2	1.3	11.5	45.8	ND	
	54-15084	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.4	ND	20.6	1.0	ND	ND	ND	
	54-15085	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.5	ND	12.1	1.7	ND	7.2	ND	
	54-15086	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13.4	ND	ND	10.8	ND	
	54-15087	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.3	ND	ND	ND	ND	
	54-15088	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	29.5	1.8	ND	15.7	ND	
	54-15089	7.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.9	ND	542.4	2.6	ND	109.5	ND	
	54-15090	ND	1.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	66.7	4.2	ND	40.0	ND	
54-15132	10.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.0	ND	ND	ND	ND		
G-2	54-15091	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.9	ND	ND	ND	ND	
	54-15092	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	34.0	ND	ND	30.4	ND	
	54-15093	5.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.1	1.2	85.5	0.8	ND	25.4	ND	
	54-15094	ND	1.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.1	ND	ND	ND	ND	
	54-15095	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.7	ND	ND	ND	ND	
	54-15096	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.8	ND	20.2	ND	ND	23.7	ND	

TABLE D-1 (continued)

Sample Area		Emission Flux Rate (ng/m ² /min.)															
Sample ID/Location		Acetone	Benzene	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	1,1-Dichloroethane	1,1-Dichloroethylene	Methylene chloride	Tetrachloroethylene	Toluene	1,1,1-Trichloroethane	Trichloroethylene	Trichlorofluoromethane (Freon 11)	1,1,2-Trichloro-trifluoroethane (Freon 113)	Xylene
G-2	54-15097	10.1	ND	ND	ND	ND	ND	ND	ND	ND	2.2	ND	34.4	3.0	ND	134.5	ND
	54-15098	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.6	ND	7.9	2.5	ND	ND	ND
	54-15099	11.6	ND	ND	3.2	ND	ND	ND	ND	ND	23.4	1.0	374.8	1.3	ND	137.4	ND
	54-15100	8.6	ND	ND	ND	ND	ND	ND	ND	ND	1.0	ND	53.2	ND	ND	25.7	ND
G-3	54-15133	4.9	ND	ND	ND	ND	ND	ND	ND	ND	1.7	ND	26.0	ND	ND	22.3	ND
	54-15101	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12.4	ND	ND	17.0	ND
	54-15102	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	60.4	2.5	ND	16.9	ND
	54-15103	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.2	ND	163.9	5.6	ND	47.8	ND
	54-15104	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.9	ND	130.0	2.8	ND	24.3	ND
	54-15105	ND	ND	ND	ND	ND	ND	ND	ND	ND	34.3	ND	249.8	0.8	ND	78.5	ND
	54-15106	ND	ND	ND	ND	ND	ND	ND	9.0	ND	10.7	ND	143.8	ND	ND	4.4	ND
	54-15107	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.5	ND	405.2	2.6	ND	21.2	ND
	54-15108	ND	ND	ND	ND	ND	ND	ND	100.6	ND	4.1	ND	372.8	1.3	ND	83.8	ND
	54-15109	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.8	ND	43.5	ND	ND	28.0	ND
	54-15110	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.8	ND	65.4	2.8	ND	6.7	ND
	54-15111	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.7	ND	104.6	ND	ND	38.3	ND
	54-15112	4.7	ND	ND	ND	ND	ND	ND	ND	ND	17.4	ND	215.1	ND	ND	37.2	ND
54-15113	ND	ND	ND	ND	ND	ND	ND	ND	ND	48.7	ND	129.2	ND	ND	15.8	ND	
54-15114	ND	ND	ND	ND	ND	ND	ND	ND	ND	21.7	ND	541.6	0.8	ND	30.9	ND	

TABLE D-1 (continued)

Sample Area		Emission Flux Rate (ng/m ² /min.)															
G-3	Sample ID/Location	Acetone	Benzene	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	1,1-Dichloroethane	1,1-Dichloroethylene	Methylene chloride	Tetrachloroethylene	Toluene	1,1,1-Trichloroethane	Trichloroethylene	Trichlorofluoromethane (Freon 11)	1,1,2-Trichloro-trifluoroethane (Freon 113)	Xylene
	54-15115	ND	ND	ND	ND	ND	19.8	ND	ND	ND	26.7	0.9	200.8	ND	ND	7.5	ND
G-4	54-15116	5.8	ND	ND	ND	ND	ND	ND	50.9	ND	2.6	ND	306.1	2.3	ND	63.1	ND
	54-15117	ND	ND	ND	ND	ND	ND	ND	10.7	ND	11.6	ND	35.6	1.9	ND	15.7	ND
	54-15118	7.5	ND	ND	ND	ND	ND	ND	ND	ND	81.8	ND	151.9	ND	15.4	77.9	ND
	54-15119	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.9	ND	175.7	ND	ND	21.3	ND
	54-15120	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.0	ND	166.3	ND	ND	22.0	ND
	54-15121	ND	ND	ND	ND	ND	11.1	ND	ND	ND	0.9	ND	12.9	ND	ND	ND	ND
	54-15122	ND	ND	ND	ND	ND	8.4	ND	ND	ND	0.9	1.6	0.7	0.8	ND	ND	0.7
	54-15123	ND	ND	ND	ND	ND	10.7	ND	ND	ND	1.0	ND	6.5	ND	ND	ND	ND
	54-15124	17.2	ND	ND	ND	ND	ND	ND	17.0	ND	3.0	ND	450.9	2.3	ND	193.7	ND
	54-15125	5.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.2	ND	ND	ND	ND	ND
	54-15126	5.0	ND	ND	ND	ND	ND	ND	ND	ND	4.5	1.2	13.8	ND	ND	10.2	ND
	54-15127	5.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.0	ND	ND	ND	ND
	54-15128	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.7	ND	ND	7.4	ND
	54-15134	8.9	ND	ND	ND	ND	ND	ND	ND	ND	30.0	ND	202.6	13.8	ND	71.3	ND
	54-15135	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.4	ND	20.5	0.7	ND	4.5	ND
G-4	54-15136	17.7	1.8	ND	ND	ND	ND	ND	ND	ND	ND	0.8	ND	ND	ND	ND	ND
	54-15238	5.6	ND	ND	ND	ND	ND	ND	ND	ND	1.5	0.6	4.3	ND	ND	4.5	ND
	54-15239	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.4	ND	41.4	ND	ND	9.1	ND

TABLE D-1 (continued)

Sample Area	Sample ID/Location	Emission Flux Rate (ng/m ² /min.)															
		Acetone	Benzene	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	1,1-Dichloroethane	1,1-Dichloroethylene	Methylene chloride	Tetrachloroethylene	Toluene	1,1,1-Trichloroethane	Trichloroethylene	Trichlorofluoromethane (Freon 11)	1,1,2-Trichloro-trifluoroethane (Freon 113)	Xylene
G-4	54-15240	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.0	ND	9.2	ND	ND	ND	ND
	54-15240D	ND	ND	18.6	ND	ND	ND	ND	ND	ND	2.0	ND	6.4	ND	ND	ND	ND
	54-15241	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.3	ND	2.1	ND	ND	ND	ND
	54-15242	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.9	ND	11.5	ND	ND	4.2	ND
	54-15243	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.9	ND	55.8	ND	ND	18.4	ND
	54-15244	ND	ND	ND	ND	ND	ND	ND	6.9	ND	1.8	ND	11.7	ND	ND	ND	ND
	54-15245	ND	ND	ND	ND	ND	ND	ND	ND	ND	195.5	ND	39.3	ND	ND	5.0	ND
	54-15246	ND	ND	ND	ND	ND	ND	ND	ND	ND	33.2	ND	87.6	1.0	ND	16.3	ND
	54-15247	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.3	ND	ND	15.5	ND	ND	ND
	54-15248	ND	ND	ND	ND	ND	ND	ND	ND	ND	174.8	ND	61.5	14.0	ND	8.7	ND
	54-15249	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.2	ND	73.3	29.3	ND	8.0	ND
	54-15250	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	45.0	0.7	ND	6.4	ND
	54-15251	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.2	ND	98.3	ND	ND	13.5	ND
	54-15252	ND	ND	ND	ND	ND	ND	ND	ND	ND	20.1	ND	2.7	2.0	ND	ND	ND
54-15253	ND	ND	ND	ND	ND	ND	ND	ND	ND	19.8	ND	ND	ND	ND	ND	ND	
54-15254	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.8	ND	3.3	1.3	ND	ND	ND	
54-15255	ND	ND	ND	ND	ND	ND	ND	ND	ND	12.6	ND	150.8	ND	ND	61.1	ND	
54-15256	5.1	ND	ND	ND	ND	5.9	ND	ND	ND	16.4	ND	87.2	ND	ND	34.1	ND	
G-5	54-15151	5.4	ND	ND	ND	ND	ND	3.3	305.1	ND	13.4	ND	870.8	5.8	ND	6.1	ND

TABLE D-1 (continued)

Sample Area		Emission Flux Rate (ng/m ² /min.)															
G-5	Sample ID/Location	Acetone	Benzene	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	1,1-Dichloroethane	1,1-Dichloroethylene	Methylene chloride	Tetrachloroethylene	Toluene	1,1,1-Trichloroethane	Trichloroethylene	Trichlorofluoromethane (Freon 11)	1,1,2-Trichloro-trifluoroethane (Freon 113)	Xylene
	54-15152	ND	ND	ND	ND	ND	ND	ND	13.0	ND	19.7	ND	806.0	3.0	ND	ND	ND
	54-15153	ND	ND	ND	ND	ND	ND	ND	ND	ND	117.4	ND	555.9	6.7	ND	ND	ND
	54-15154	ND	ND	ND	ND	ND	ND	7.4	149.8	ND	64.2	ND	1414.5	7.0	ND	ND	ND
	54-15155	ND	ND	ND	ND	ND	ND	ND	189.3	ND	27.2	ND	943.5	1.4	ND	ND	ND
	54-15156	ND	ND	ND	ND	ND	ND	ND	21.2	ND	152.6	ND	429.7	5.8	ND	ND	ND
	54-15157	17.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.9	ND	ND	ND	ND	ND
	54-15158	6.5	ND	ND	ND	ND	ND	ND	ND	ND	3.4	ND	137.0	2.9	ND	ND	ND
	54-15159	ND	ND	ND	ND	ND	8.6	ND	22.2	ND	25.0	ND	418.4	2.5	ND	ND	ND
	54-15160	ND	ND	ND	ND	ND	ND	3.1	ND	ND	98.7	ND	594.4	4.4	ND	ND	ND
	54-15160D	ND	ND	ND	ND	ND	ND	3.6	39.7	ND	146.5	ND	961.9	13.7	ND	ND	ND
	54-15161	ND	ND	ND	ND	ND	ND	12.2	47.6	ND	23.2	ND	1860.1	7.3	ND	ND	ND
	54-15162	ND	ND	ND	ND	ND	ND	12.8	45.1	ND	38.5	ND	1689.1	4.7	ND	ND	ND
	54-15163	ND	ND	ND	ND	ND	ND	4.3	48.9	ND	216.4	ND	752.6	8.3	ND	ND	ND
	54-15164	ND	ND	ND	ND	ND	ND	6.1	82.2	ND	371.1	ND	716.5	3.0	ND	ND	ND
	54-15165	ND	ND	ND	ND	ND	ND	ND	11.7	8.9	43.3	ND	533.6	9.9	ND	ND	ND
	54-15166	ND	ND	ND	ND	ND	ND	ND	ND	8.0	7.9	ND	92.4	3.4	ND	ND	ND
	54-15167	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.9	ND	45.8	2.0	ND	ND	ND
	54-15168	ND	ND	ND	ND	ND	ND	ND	8.9	ND	39.2	ND	215.6	6.9	ND	ND	ND
54-15185	ND	ND	ND	ND	ND	ND	ND	27.7	ND	ND	ND	1210.4	ND	ND	5.8	ND	

TABLE D-1 (continued)

Sample Area		Sample ID/Location	Emission Flux Rate (ng/m ² /min.)														
			Acetone	Benzene	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	1,1-Dichloroethane	1,1-Dichloroethylene	Methylene chloride	Tetrachloroethylene	Toluene	1,1,1-Trichloroethane	Trichloroethylene	Trichlorofluoromethane (Freon 11)	1,1,2-Trichloro-trifluoroethane (Freon 113)
G-6	54-15169	ND	ND	ND	ND	ND	ND	ND	ND	ND	123.8	ND	468.5	56.7	ND	3.5	ND
	54-15170	ND	ND	ND	ND	ND	ND	12.2	18.3	ND	174.2	ND	1990.4	11.0	ND	8.6	ND
	54-15170D	ND	ND	ND	ND	ND	ND	17.7	24.6	ND	192.9	ND	2235.0	11.4	ND	10.5	ND
	54-15171	ND	ND	ND	ND	ND	ND	ND	ND	ND	156.9	ND	328.7	2.5	ND	5.6	ND
	54-15172	ND	ND	ND	ND	ND	ND	ND	ND	ND	61.0	ND	333.7	0.7	ND	6.5	ND
	54-15173	ND	ND	ND	ND	ND	ND	ND	ND	ND	20.5	ND	620.3	2.4	ND	20.5	ND
	54-15174	4.9	ND	ND	ND	ND	ND	ND	ND	ND	9.8	ND	1009.7	5.8	ND	13.8	ND
	54-15175	ND	ND	ND	ND	ND	ND	ND	ND	ND	54.8	ND	470.4	34.8	ND	7.9	ND
	54-15176	ND	ND	ND	ND	ND	ND	ND	ND	ND	183.4	ND	375.2	6.4	ND	10.1	ND
	54-15177	ND	ND	ND	ND	ND	ND	ND	ND	ND	60.2	ND	629.7	2.9	ND	11.3	ND
	54-15178	ND	ND	ND	ND	ND	ND	ND	ND	ND	84.8	ND	330.2	1.4	ND	ND	ND
	54-15179	ND	ND	ND	ND	ND	ND	ND	ND	ND	128.9	ND	248.1	1.0	ND	ND	ND
	54-15180	ND	ND	ND	ND	ND	ND	ND	ND	ND	35.8	ND	66.5	ND	ND	ND	ND
	54-15180D	ND	ND	ND	ND	ND	6.0	ND	ND	ND	34.1	0.8	29.2	ND	ND	ND	ND
	45-5181	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.6	ND	83.1	1.8	ND	9.2	ND
	54-15182	ND	ND	ND	ND	ND	ND	ND	ND	ND	83.0	ND	181.0	ND	ND	3.5	ND
	54-15183	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.6	ND	146.3	ND	ND	ND	ND
	54-15184	ND	ND	ND	ND	ND	ND	ND	ND	ND	54.9	ND	316.3	63.4	ND	ND	ND
	54-15186	ND	ND	ND	ND	ND	ND	3.1	ND	ND	55.3	ND	935.5	11.3	ND	13.8	ND

TABLE D-1 (continued)

Sample Area	Sample ID/Location	Emission Flux Rate (ng/m ² /min.)															
		Acetone	Benzene	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	1,1-Dichloroethane	1,1-Dichloroethylene	Methylene chloride	Tetrachloroethylene	Toluene	1,1,1-Trichloroethane	Trichloroethylene	Trichlorofluoromethane (Freon 11)	1,1,2-Trichloro-trifluoroethane (Freon 113)	Xylene
G-6	54-15187	ND	ND	ND	ND	ND	ND	ND	12.8	ND	42.5	ND	708.4	7.0	ND	11.3	ND
	54-15188	ND	ND	ND	ND	ND	ND	ND	ND	11.9	11.9	ND	67.2	1.7	ND	ND	ND
	54-15189	ND	ND	ND	ND	ND	ND	ND	ND	40.4	40.4	ND	443.3	10.9	ND	4.2	ND
	54-15190	ND	ND	ND	ND	ND	ND	ND	17.6	ND	41.3	ND	479.8	13.7	ND	7.2	ND
	54-15191	ND	ND	ND	ND	ND	ND	ND	26.4	ND	122.7	ND	563.5	13.3	ND	9.3	ND
	54-15192	ND	ND	ND	ND	ND	ND	ND	23.5	ND	148.6	ND	650.7	30.6	ND	10.3	ND
	54-15193	ND	ND	ND	ND	ND	ND	ND	27.5	ND	7.6	ND	588.8	5.5	ND	8.2	ND
	54-15194	ND	ND	ND	ND	ND	ND	ND	55.9	ND	37.9	ND	748.8	17.4	ND	22.8	ND
	54-15195	ND	ND	ND	ND	ND	ND	ND	171.9	ND	15.3	ND	62.7	10.9	ND	5.1	ND
	54-15196	ND	ND	ND	ND	ND	ND	ND	7.4	ND	1.8	ND	140.2	3.1	ND	4.0	ND
	54-15197	ND	ND	ND	ND	ND	ND	ND	12.2	ND	9.3	ND	347.2	14.4	ND	7.3	ND
	54-15198	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.2	ND	124.9	ND	ND	ND	ND
	54-15199	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.5	ND	17.5	1.8	ND	ND	ND
	54-15200	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.3	ND	326.8	9.1	ND	8.8	ND
54-15200D	ND	ND	ND	ND	ND	ND	ND	76.7	ND	2.0	ND	475.6	4.8	ND	18.0	ND	
54-15201	ND	ND	ND	ND	ND	ND	ND	7.9	ND	1.7	ND	222.2	3.7	ND	9.1	ND	
54-15202	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.8	ND	65.3	2.1	ND	5.2	ND	
54-15203	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.6	ND	88.5	0.7	ND	3.9	ND	
54-15204	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.5	ND	19.2	1.6	ND	ND	ND	

TABLE D-1 (continued)

Sample Area		Emission Flux Rate (ng/m ² /min.)															
G-6	Sample ID/Location	Acetone	Benzene	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	1,1-Dichloroethane	1,1-Dichloroethylene	Methylene chloride	Tetrachloroethylene	Toluene	1,1,1-Trichloroethane	Trichloroethylene	Trichlorofluoromethane (Freon 11)	1,1,2-Trichloro-trifluoroethane (Freon 113)	Xylene
	54-15205	ND	ND	ND	ND	ND	ND	ND	21.9	ND	2.2	ND	241.7	5.3	ND	ND	ND
G-7	54-15206	ND	ND	ND	ND	ND	ND	ND	15.6	ND	12.6	ND	155.7	35.5	ND	8.5	ND
	54-15207	ND	ND	ND	ND	ND	ND	ND	7.9	ND	354.7	2.8	567.6	51.9	ND	ND	ND
	54-15208	ND	ND	ND	ND	ND	ND	ND	13.6	ND	1.2	ND	329.9	1.6	ND	10.2	ND
	54-15209	ND	ND	ND	ND	ND	ND	ND	9.6	ND	7.5	ND	118.6	1.7	ND	ND	ND
	54-15210	ND	ND	ND	ND	ND	ND	ND	ND	ND	26.8	ND	199.5	4.3	ND	6.7	ND
	54-15211	ND	ND	ND	ND	ND	ND	ND	ND	ND	370.2	ND	138.3	9.1	ND	6.3	ND
	54-15212	ND	ND	ND	ND	ND	ND	ND	ND	ND	64.9	ND	172.8	6.3	ND	5.1	ND
	54-15213	ND	ND	ND	ND	ND	ND	ND	ND	ND	52.2	ND	91.2	4.8	ND	4.2	ND
	54-15214	ND	ND	ND	ND	ND	ND	ND	ND	ND	36.8	ND	9.1	1.8	ND	ND	ND
	54-15215	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.2	ND	127.0	2.8	ND	6.0	ND
G-7	54-15221	ND	ND	ND	ND	ND	ND	ND	72.4	ND	22.3	0.7	488.0	45.7	ND	13.2	ND
	54-15138	6.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.7	ND	ND	ND	ND
	54-15139	6.2	ND	ND	ND	ND	3.6	ND	ND	ND	1.8	ND	ND	0.9	ND	ND	ND
	54-15140	19.5	ND	ND	ND	ND	ND	ND	ND	ND	3.2	3.2	33.4	15.8	ND	ND	ND
	54-15140D	29.4	1.5	ND	ND	ND	ND	ND	ND	ND	8.3	3.9	74.9	37.1	ND	ND	ND
	54-15141	ND	ND	ND	ND	ND	ND	ND	ND	ND	94.9	ND	17.5	202.6	ND	ND	ND
	54-15142	ND	ND	ND	ND	ND	ND	ND	ND	ND	101.6	ND	19.6	67.2	ND	ND	ND
54-15143	6.9	ND	ND	ND	ND	ND	ND	17.7	ND	5.0	ND	297.1	78.9	ND	ND	ND	

TABLE D-1 (continued)

Sample Area		Emission Flux Rate (ng/m ² /min.)																
Sample ID/Location		Acetone	Benzene	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	1,1-Dichloroethane	1,1-Dichloroethylene	Methylene chloride	Tetrachloroethylene	Toluene	1,1,1-Trichloroethane	Trichloroethylene	Trichlorofluoromethane (Freon 11)	1,1,2-Trichloro-trifluoroethane (Freon 113)	Xylene	
G-7	54-15144	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.7	ND	176.4	16.0	ND	9.9	ND	
	54-15145	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0	ND	8.7	ND	ND	ND	ND	
	54-15146	ND	ND	ND	ND	ND	ND	ND	ND	ND	40.5	ND	32.9	ND	ND	ND	ND	
	54-15147	ND	ND	ND	ND	ND	ND	ND	ND	ND	30.9	ND	151.2	ND	ND	ND	ND	
	54-15148	ND	ND	ND	ND	ND	ND	ND	41.4	ND	9.0	1.3	107.2	2.0	ND	14.9	ND	
	54-15149	ND	ND	ND	ND	ND	ND	ND	11.4	ND	ND	ND	12.2	1.3	ND	ND	ND	
	54-15150	ND	ND	ND	ND	ND	10.7	ND	ND	ND	3.7	ND	60.0	10.6	ND	4.5	ND	
	54-15216	ND	ND	ND	ND	ND	ND	ND	ND	ND	55.1	ND	15.4	74.1	ND	4.1	ND	
	54-15217	ND	ND	ND	ND	ND	ND	ND	ND	ND	10.0	ND	135.3	23.9	ND	5.9	ND	
	54-15218	ND	ND	ND	ND	ND	21.8	ND	ND	ND	1.4	ND	24.6	ND	ND	5.1	ND	
	54-15219	ND	ND	ND	ND	2.4	ND	ND	ND	ND	10.5	ND	63.4	7.1	ND	10.1	ND	
	54-15220	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.7	ND	63.4	2.7	ND	12.6	ND	
G-8	54-15220D	ND	1.3	ND	ND	ND	ND	ND	ND	ND	1.8	ND	56.0	3.0	ND	7.9	ND	
	54-15222	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.1	ND	29.6	ND	ND	10.5	ND	
	54-15129	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.0	ND	1.0	ND	ND	ND	ND	
	54-15130	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.5	ND	2.9	2.3	ND	ND	ND	
	54-15137	ND	ND	ND	ND	ND	ND	ND	ND	ND	21.9	1.2	54.2	2.2	ND	3.4	ND	
	54-15223	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.1	ND	ND	ND	ND	
	54-15224	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.9	0.9	7.6	ND	ND	4.2	ND	

TABLE D-1 (concluded)

Sample Area		Sample ID/Location	Emission Flux Rate (ng/m ² /min.)															
G-8			Acetone	Benzene	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	1,1-Dichloroethane	1,1-Dichloroethylene	Methylene chloride	Tetrachloroethylene	Toluene	1,1,1-Trichloroethane	Trichloroethylene	Trichlorofluoromethane (Freon 11)	1,1,2-Trichloro-trifluoroethane (Freon 113)	Xylene
54-15225		ND	ND	ND	ND	ND	ND	ND	ND	ND	7.4	ND	12.5	ND	ND	ND	ND	ND
54-15226		ND	ND	ND	ND	ND	ND	ND	ND	ND	26.3	ND	2.1	1.3	ND	ND	ND	ND
54-15227		ND	ND	ND	ND	ND	ND	ND	ND	ND	17.7	ND	11.7	ND	ND	ND	ND	ND
54-15228		ND	ND	ND	ND	ND	ND	ND	ND	ND	71.0	ND	612.1	ND	ND	ND	42.5	ND
54-15229		ND	ND	ND	ND	ND	ND	ND	ND	ND	5.9	ND	38.3	ND	ND	ND	ND	ND
54-15230		ND	ND	ND	ND	ND	ND	ND	ND	ND	25.2	ND	270.2	12.9	ND	ND	32.1	ND
54-15231		ND	ND	ND	ND	ND	ND	ND	ND	ND	6.5	ND	269.4	ND	ND	ND	27.4	ND
54-15232		6.0	ND	ND	ND	ND	ND	ND	ND	ND	204.4	0.7	35.7	ND	ND	ND	12.0	ND
54-15233		ND	ND	ND	ND	ND	ND	ND	ND	ND	75.2	ND	26.5	1.5	ND	ND	ND	ND
54-15234		ND	ND	ND	ND	ND	5.5	ND	ND	ND	25.7	1.9	11.0	11.8	ND	ND	9.1	ND
54-15235		ND	ND	ND	ND	ND	ND	ND	ND	ND	6.7	ND	2.1	2.4	ND	ND	ND	ND
54-15236		ND	ND	ND	ND	ND	ND	ND	ND	ND	96.3	ND	32.1	ND	ND	ND	33.6	ND
54-15237		ND	ND	ND	ND	ND	ND	ND	ND	ND	4.7	ND	5.6	0.9	ND	ND	ND	ND

TABLE D-2
SURVEY I RESULTS FOR MDA J

Emission Flux Rate (ng/m ² /min.)							
Sample ID/Location	Acetone	Benzene	Chloromethane	Tetrachloroethylene	1,1,1-Trichloroethane	Trichloroethylene	1,1,2-Trichloro- trifluoroethane (Freon 113)
54-15069	11.8	ND*	ND	ND	ND	ND	ND
54-15070	ND	ND	ND	ND	1.1	ND	ND
54-15071	17.2	8.0	ND	ND	6.0	6.7	ND
54-15072	6.0	3.9	2.3	ND	12.1	1.6	ND
54-15073	11.7	7.8	ND	ND	3.1	ND	ND
54-15074	27.5	10.8	ND	ND	ND	ND	ND
54-15075	5.4	5.1	2.1	2.0	ND	0.7	ND
54-15076	5.2	ND	4.3	ND	14.6	2.6	5.7
54-15077	14.7	5.7	4.5	ND	14.2	ND	8.2
54-15078	ND	ND	ND	ND	ND	ND	ND
54-15080	6.3	ND	ND	ND	ND	ND	ND
54-15080D	ND	5.4	ND	ND	ND	ND	ND
54-15081	ND	ND	ND	ND	ND	2.5	ND

* ND = not determined. The result is below the quantitation limit.

TABLE D-3
SURVEY I RESULTS FOR MDA L

Sample ID/Location		Emission Flux Rate (ng/m ² /min.)																		
		Acetone	Benzene	Bromobenzene	2-Butanone	Carbon Tetrachloride	Chlorobenzene	Chloroform	Chloromethane	1,2-Dichloroethane	1,1-Dichloroethane	1,1-Dichloroethylene	1,2-Dichloropropane	Ethylbenzene	n-Propylbenzene	Tetrachloroethylene	Toluene	1,1,1-Trichloroethane	Trichloroethylene	1,1,2-Trichloro-trifluoroethane (Freon 113)
54-15000	15.9	ND*	ND	ND	ND	ND	ND	ND	ND	ND	9.2	ND	ND	ND	39.3	1.2	510.8	302.7	28.8	ND
54-15001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	30.2	0.8	1.0	80.8	ND	ND
54-15002	ND	6.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.1	ND	ND	ND	ND	ND
54-15003	ND	1.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	204.4	ND	6.3	3.7	ND	ND
54-15004	7.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	233.4	1.0	4.3	14.3	ND	ND
54-15005	31.5	1.7	ND	ND	ND	6.5	ND	8.8	ND	ND	ND	3.2	ND	ND	473.4	4.0	130.3	213.5	14.6	1.1
54-15006	9.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	10.7	11.3	ND	ND	218.7	1.7	290.6	233.5	42.9	ND
54-15007	21.2	ND	ND	ND	2.5	ND	ND	ND	ND	ND	ND	8.9	ND	ND	194.3	1.7	477.0	212.5	171.9	ND
54-15008	85.9	1.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.0	ND	ND	148.7	13.2	390.4	59.4	57.9	ND
54-15010	69.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.1	ND	ND	99.0	4.3	140.8	39.8	60.7	1.8
54-15011	7.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	177.8	3.7	211.8	85.7	28.2	2.5
54-15012	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	210.5	0.9	189.0	126.9	20.8	ND
54-15013	15.7	ND	ND	ND	ND	ND	ND	2.0	ND	ND	ND	ND	ND	ND	519.6	4.8	31.8	110.9	ND	0.9
54-15014	7.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	424.5	2.3	125.4	114.6	12.4	ND
54-15015	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	303.0	1.1	220.5	68.2	28.3	ND
54-15016	10.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	52.1	ND	360.5	289.2	19.1	ND
54-15017	308.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.8	4.1	17.1	30.9	ND	ND

* ND = not determined. The result was below the quantitation limit.

Sample ID/Location		Emission Flux Rate (ng/m ² /min.)																			
		Acetone	Benzene	Bromobenzene	2-Butanone	Carbon Tetrachloride	Chlorobenzene	Chloroform	Chloromethane	1,2-Dichloroethane	1,1-Dichloroethane	1,1-Dichloroethylene	1,2-Dichloropropane	Ethylbenzene	n-Propylbenzene	Tetrachloroethylene	Toluene	1,1,1-Trichloroethane	Trichloroethylene	1,1,2-Trichloro-trifluoroethane (Freon 113)	Xylene
54-15018	8.1	1.5	ND	ND	ND	ND	ND	ND	11.2	ND	11.9	ND	ND	ND	ND	163.5	1.6	710.1	354.7	17.2	ND
54-15019	15.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	17.9	ND	ND	ND	ND	6.8	ND	888.7	46.8	54.8	ND
54-15020	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.3	ND	10.4	13.5	ND	ND
54-15020D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	19.4	ND	147.0	70.1	ND	ND
54-15021	ND	ND	ND	ND	ND	ND	ND	2.1	ND	ND	ND	ND	ND	ND	ND	17.1	1.3	457.3	100.7	15.2	ND
54-15022	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	138.6	1.0	2.8	57.4	ND	ND
54-15023	5.7	ND	ND	ND	ND	ND	ND	4.5	ND	ND	ND	ND	ND	ND	ND	61.5	ND	222.5	274.4	7.6	ND
54-15024	49.8	ND	ND	ND	ND	9.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	114.1	ND	715.2	557.4	184.7	ND
54-15025	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	38.2	ND	90.0	249.4	3.7	ND
54-15026	ND	ND	ND	ND	ND	ND	ND	3.6	ND	ND	ND	ND	ND	ND	ND	17.1	0.9	27.0	18.0	ND	ND
54-15027	6.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.9	ND	ND	ND	ND	49.5	ND	316.2	254.7	6.3	ND
54-15028	19.6	ND	ND	ND	ND	4.6	ND	ND	5.8	3.4	26.0	ND	ND	ND	ND	169.0	0.7	863.3	407.2	58.2	ND
54-15029	12.2	ND	ND	ND	ND	ND	ND	9.0	ND	ND	ND	ND	ND	ND	ND	22.2	ND	255.0	150.2	27.6	ND
54-15030	10.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	150.9	1.5	354.4	479.8	ND	ND
54-15030D	10.9	2.1	ND	ND	ND	3.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	398.1	1.7	250.3	630.2	9.1	ND
54-15031	36.6	7.1	1.1	ND	15.4	51.4	2.8	ND	47.1	5.2	140.7	ND	1.1	ND	ND	673.3	18.8	1057.0	4517.9	478.6	0.8
54-15032	5.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	12.8	ND	ND	ND	ND	70.8	ND	58.5	309.9	7.2	ND
54-15033	16.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	336.9	ND	347.6	277.2	62.7	ND
54-15034	ND	ND	ND	ND	ND	ND	ND	8.0	ND	ND	ND	ND	ND	ND	ND	531.9	ND	38.5	50.9	5.2	ND

TABLE D-3 (continued)
Emission Flux Rate (ng/m²/min.)

Sample ID/Location	Acetone	Benzene	Bromobenzene	2-Butanone	Carbon Tetrachloride	Chlorobenzene	Chloroform	Chloromethane	1,2-Dichloroethane	1,1-Dichloroethane	1,1-Dichloroethylene	1,2-Dichloropropane	Ethylbenzene	n-Propylbenzene	Tetrachloroethylene	Toluene	1,1,1-Trichloroethane	Trichloroethylene	1,1,2-Trichloro- trifluoroethane (Freon 113)	Xylene
54-15035	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	769.6	ND	263.1	130.8	41.6	ND
54-15036	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1364.4	ND	34.2	25.9	4.3	ND
54-15037	ND	3.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1275.2	ND	99.2	60.7	12.1	ND
54-15038	19.0	ND	ND	ND	ND	ND	ND	4.0	ND	ND	ND	ND	ND	ND	2000.0	ND	207.4	202.3	25.0	ND
54-15039	22.5	ND	ND	ND	4.4	ND	ND	5.5	ND	ND	ND	3.4	ND	ND	1503.0	ND	516.0	538.8	51.8	ND
54-15040	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.0	ND	ND	255.8	ND	165.9	196.8	27.5	ND
54-15040D	15.1	ND	ND	ND	5.6	ND	ND	ND	ND	ND	ND	4.0	ND	ND	328.7	ND	607.7	373.7	175.7	ND
54-15041	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.5	ND	ND	92.4	1.1	103.7	76.7	22.7	ND
54-15042	10.9	9.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	93.7	1.2	17.3	24.6	7.4	ND
54-15043	10.1	3.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	148.2	ND	156.7	28.3	78.2	ND
54-15044	13.4	10.5	ND	ND	ND	ND	ND	2.1	ND	ND	ND	ND	ND	ND	70.5	ND	199.2	94.9	33.9	ND
54-15045	48.4	12.0	ND	ND	7.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	33.9	ND	1027.3	115.3	668.4	ND
54-15046	9.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.9	ND	58.6	7.0	ND	ND
54-15047	104.7	2.8	ND	14.6	4.8	ND	ND	30.5	ND	ND	ND	ND	ND	2.0	41.7	0.8	1190.1	200.5	60.9	1.1
54-15048	65.7	10.1	ND	ND	11.2	ND	ND	24.7	ND	ND	120.9	ND	ND	ND	147.9	ND	1829.3	624.4	119.8	ND
54-15049	9.9	4.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	25.4	1.4	288.7	27.4	72.5	ND
54-15050	6.7	4.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.5	ND	188.4	3.5	83.5	ND
54-15051	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	18.0	ND	ND
54-15052	ND	4.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.1	ND	ND	319.5	ND	58.6	17.4	4.6	ND

TABLE D-3 (concluded)

Sample ID/Location		Emission Flux Rate (ng/m ² /min.)																		
	Acetone	Benzene	Bromobenzene	2-Butanone	Carbon Tetrachloride	Chlorobenzene	Chloroform	Chloromethane	1,2-Dichloroethane	1,1-Dichloroethane	1,1-Dichloroethylene	1,2-Dichloropropane	Ethylbenzene	n-Propylbenzene	Tetrachloroethylene	Toluene	1,1,1-Trichloroethane	Trichloroethylene	1,1,2-Trichloro-trifluoroethane (Freon 113)	Xylene
54-15053	26.6	8.6	ND	ND	ND	ND	ND	5.6	ND	ND	ND	ND	ND	ND	21.7	1.7	63.3	24.0	ND	ND
54-15054	23.9	6.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.3	ND	66.6	7.1	13.6	ND
54-15055	14.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	39.4	ND	98.0	37.4	128.8	ND
54-15056	ND	ND	ND	5.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.0	ND	9.6	3.6	ND	ND
54-15057	10.5	ND	ND	5.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14.6	ND	15.0	18.9	4.3	ND
54-15058	13.1	5.4	ND	ND	ND	ND	ND	2.3	ND	ND	ND	ND	ND	ND	8.1	ND	168.7	27.4	85.9	ND
54-15059	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.1	ND	ND	7.3	ND	ND
54-15060	11.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.2	1.1	ND	ND
54-15060D	15.4	11.2	ND	ND	ND	ND	ND	5.8	ND	ND	ND	ND	ND	ND	ND	ND	4.1	ND	ND	ND
54-15061	15.5	4.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12.6	ND	ND	5.5	ND	ND
54-15062	9.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.5	ND	177.6	19.8	41.6	ND
54-15063	56.9	12.1	ND	37.7	ND	ND	ND	15.9	ND	ND	ND	ND	ND	ND	2.4	1.0	16.2	5.8	ND	ND
54-15064	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.2	ND	ND
54-15065	23.2	12.6	ND	ND	ND	ND	ND	6.7	ND	ND	ND	ND	ND	ND	ND	ND	132.9	1.7	39.5	ND
54-15066	1.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.0	ND	118.3	ND	49.4	ND
54-15067	13.2	8.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.9	ND	49.1	1.5	11.5	ND
54-15068	13.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.4	ND	ND	ND	ND
54-15131	30.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.6	ND	ND	ND	ND

**TABLE D-4
SURVEY II RESULTS FOR MDA G**

Sample Location ID	1,1,1-Trichloroethane	Trichloroethylene	Tetrachloroethylene	Toluene	Acetone	Methylene Chloride	1,1-Dichloroethene	1,1,2-Trichloro-trifluoroethane (Freon 113)	1,1-Dichloroethane	Chlorobenzene	Total Xylenes	Chloroform
54-15264	51.6	ND*	3.3	ND	ND	ND	8	ND	ND	ND	ND	ND
54-15265	23.8	ND	1.2	0.8	ND	ND	ND	4.3	ND	ND	ND	ND
54-15266	2.6	ND	0.9	7.7	18.1	ND	ND	ND	ND	ND	1.1	ND
54-15267	15.5	ND	ND	0.7	ND	ND	ND	ND	ND	ND	ND	ND
54-15268	7.5	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND
54-15269	ND	ND	ND	3.1	6	ND	ND	ND	ND	ND	ND	ND
54-15271	35.3	ND	11.6	1.8	ND	ND	7.1	ND	ND	ND	ND	ND
54-15272	ND	ND	ND	1.3	9	ND	ND	ND	ND	ND	ND	ND
54-15273	4	ND	2.2	6.7	9.1	8.2	ND	ND	ND	ND	ND	ND
54-15274	13.9	ND	2.7	1.5	ND	ND	ND	ND	ND	ND	ND	ND
54-15275	ND	ND	ND	ND	27.4	ND	ND	ND	ND	ND	ND	ND
54-15276	93.5	ND	16	ND	ND	ND	7	ND	ND	ND	ND	ND
54-15277	39.2	ND	10.3	ND	ND	ND	ND	ND	ND	ND	ND	ND
54-15278	19.8	ND	4.4	0.8	ND	ND	ND	ND	ND	ND	ND	ND
54-15279	5.9	ND	1.1	2.2	5.1	ND	ND	ND	ND	ND	ND	ND
54-15292	81.5	0.7	49.1	ND	ND	ND	12.9	ND	ND	ND	ND	ND
54-15293	52	ND	19.8	0.8	ND	ND	ND	ND	ND	ND	ND	ND

* ND = not determined. The result is below the quantitation limit.

TABLE D-4 (continued)

Sample Location ID	1,1,1-Trichloroethane	Trichloroethylene	Tetrachloroethylene	Toluene	Acetone	Methylene Chloride	1,1-Dichloroethene	1,1,2-Trichloro-trifluoroethane (Freon 113)	1,1-Dichloroethane	Chlorobenzene	Total Xylenes	Chloroform
54-15294	4.4	ND	2.2	7.6	15.1	ND	ND	ND	ND	ND	0.9	ND
54-15295	158.7	1.1	26.2	8.6	33.1	ND	ND	ND	7.9	ND	ND	ND
54-15296	2.6	ND	1	1	ND	ND	ND	ND	ND	ND	ND	ND
54-15297	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
54-15298	ND	ND	ND	0.8	ND	ND	ND	ND	ND	ND	ND	ND
54-15298D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
54-15299	5	ND	ND	ND	7.3	ND	ND	ND	ND	ND	ND	ND
54-15300	21.8	2.6	73	ND	ND	ND	25.6	ND	ND	ND	ND	ND
54-15301	6.6	ND	3.5	4.1	8.8	ND	ND	ND	ND	ND	ND	ND
54-15302	47.7	ND	10.6	5.1	4.9	ND	6.9	ND	ND	ND	ND	ND
54-15303	8.8	ND	5.2	ND	ND	ND	ND	ND	ND	ND	ND	ND
54-15304	2.6	ND	0.8	7.2	13.2	ND	ND	ND	ND	ND	ND	ND
54-15305	403.1	5	212.8	0.9	ND	ND	68.9	ND	4.9	ND	ND	ND
54-15305D	381.9	5	62.7	1.2	ND	ND	82.2	ND	4.6	ND	ND	ND
54-15306	126.6	ND	42.6	7.2	ND	ND	42.5	ND	ND	ND	ND	ND
54-15307	42.1	ND	10.7	0.8	ND	ND	10.8	ND	ND	ND	ND	ND
54-15308	37.8	ND	5.8	1.1	ND	ND	12.1	ND	ND	ND	ND	ND
54-15309	24.5	ND	3.3	0.7	ND	ND	8.8	ND	ND	ND	ND	ND

TABLE D-4 (continued)

Sample Location ID	1,1,1-Trichloroethane	Trichloroethylene	Tetrachloroethylene	Toluene	Acetone	Methylene Chloride	1,1-Dichloroethene	1,1,2-Trichloro-trifluoroethane (Freon 113)	1,1-Dichloroethane	Chlorobenzene	Total Xylenes	Chloroform
54-15310	51.9	1	5.6	1.7	ND	ND	16.5	ND	ND	ND	ND	ND
54-15311	10.7	ND	0.8	1.3	ND	ND	ND	ND	ND	ND	ND	ND
54-15312	1.8	ND	ND	2	ND	ND	ND	ND	ND	ND	ND	ND
54-15281	219.3	5.4	67.3	ND	ND	ND	28.7	ND	ND	ND	ND	ND
54-15282	107.4	ND	23.4	1.5	ND	ND	21.7	ND	ND	ND	ND	ND
54-15283	181.7	1.6	57.5	ND	ND	ND	119.2	ND	ND	ND	ND	ND
54-15284	174.4	0.8	62.9	ND	ND	ND	35.4	ND	ND	ND	ND	ND
54-15285	147.6	3	396.9	0.8	ND	ND	11.2	ND	ND	ND	ND	ND
54-15286	120.3	1.9	37	ND	ND	ND	18.3	ND	ND	ND	ND	ND
54-15287	227.8	9.5	55.8	ND	ND	ND	13	ND	ND	ND	ND	ND
54-15288	213.7	6.9	106.7	ND	ND	ND	82.5	ND	ND	ND	ND	ND
54-15289	231.7	5.4	228	ND	ND	ND	11.8	ND	ND	ND	ND	ND
54-15290	28.4	1.1	31	1.2	6.8	ND	ND	ND	ND	ND	ND	ND
54-15291	81.7	2.3	205.4	0.8	ND	ND	12.4	ND	ND	ND	ND	ND
54-15318	55	ND	55.8	2.9	7.2	ND	8.5	ND	ND	ND	ND	ND
54-15319	427.1	6.3	134.1	5.9	ND	10.2	218.8	4	ND	ND	ND	ND
54-15320	6.9	ND	4	6.3	20.1	ND	ND	ND	ND	ND	ND	ND
54-15321	37	ND	5.7	2.8	ND	9.9	27.1	ND	ND	ND	ND	ND
54-15322	ND	ND	ND	1.21	7.2	11.1	ND	ND	ND	ND	1.6	ND

Sample Location ID	1,1,1-Trichloroethane	Trichloroethylene	Tetrachloroethylene	Toluene	Acetone	Methylene Chloride	1,1-Dichloroethene	1,1,2-Trichloro-trifluoroethane (Freon 113)	1,1-Dichloroethane	Chlorobenzene	Total Xylenes	Chloroform
54-15313	196.3	15.3	48.4	0.8	ND	ND	27.5	6.4	ND	ND	ND	ND
54-15314	129.4	2.2	13.1	2.6	4.9	10.5	27.8	3.7	ND	ND	ND	ND
54-15315	6.8	ND	1.5	8.2	12.6	ND	ND	ND	ND	ND	ND	ND
54-15316	3.9	ND	ND	1	ND	ND	ND	ND	ND	ND	ND	ND
54-15317	ND	ND	ND	4.1	5.9	ND	ND	ND	ND	ND	3.4	ND
54-15317D	ND	ND	ND	0.9	ND	9.9	ND	ND	ND	ND	ND	ND
54-15323	19.6	ND	11.6	6.2	ND	10.7	ND	4	ND	ND	ND	ND
54-15324	3.7	ND	7.8	2.5	ND	ND	ND	ND	ND	ND	ND	ND
54-15325	3	ND	6.9	1.6	ND	ND	ND	ND	ND	ND	ND	ND
54-15326	ND	ND	ND	1	ND	7.9	ND	ND	ND	ND	ND	ND
54-15327	ND	ND	ND	4.8	ND	8.3	ND	ND	ND	ND	ND	ND
54-15328	ND	ND	ND	4.2	ND	17	ND	ND	ND	ND	ND	ND
54-15329	ND	ND	ND	2.4	4.9	ND	ND	ND	ND	ND	ND	ND
54-15330	ND	ND	ND	7.8	6.1	ND	ND	ND	ND	ND	ND	ND
54-15331	ND	ND	ND	ND	ND	8.5	ND	ND	ND	ND	ND	ND
54-15332	ND	ND	ND	1	ND	7.9	ND	ND	ND	ND	ND	ND
54-15263	9	3.6	68.2	ND	ND	ND	ND	13.7	ND	ND	ND	ND
54-15262	39.9	2.1	41	ND	ND	ND	ND	16.7	ND	ND	ND	ND
54-15261	83	ND	34.3	ND	ND	ND	ND	12.5	ND	ND	ND	ND
54-15270	167.2	ND	98.4	ND	5.5	ND	10	7.6	ND	ND	ND	ND

TABLE D-4 (concluded)

TABLE D-5
SURVEY II RESULTS FOR MDAs J AND H

MDA		Sample Location	1,1,1-Trichloroethane	Trichloroethylene	Tetrachloroethylene	Toluene	Acetone	Methylene Chloride	1,1-Dichloroethene	1,1,2-Trichloro-trifluoroethane (Freon 113)	1,1-Dichloroethane	Chlorobenzene	Total Xylenes	Chloroform
J	54-15333		3.6	ND*	ND	4.3	ND	ND	ND	ND	ND	ND	ND	ND
	54-15334		ND	ND	ND	ND	5.3	ND	ND	ND	ND	ND	ND	ND
	54-15335		ND	ND	ND	ND	7.5	ND	ND	ND	ND	ND	ND	ND
	54-15336		ND	ND	ND	ND	8.1	ND	ND	ND	ND	ND	ND	ND
	54-15337		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
H	54-15338		ND	ND	ND	ND	9.1	ND	ND	ND	ND	ND	ND	ND

* ND = not determined. The result was below the quantitation limit.

TABLE D-6
SURVEY II RESULTS FOR MDA L

Subgroup	Location Id	1,1,1-Trichloroethane	Trichloroethylene	Tetrachloroethylene	Toluene	Acetone	Methylene Chloride	1,1 Dichloroethene	1,1,2-Trichloro-trifluoroethane (Freon 113)	1,1 Dichloroethane	Chlorobenzene	Xylene	Chloroform
L1	54-15339	32.3	ND*	3.2	ND	6.9	ND	ND	ND	ND	ND	ND	ND
	54-15340	8.1	4	5	2.8	ND	ND	17.1	ND	ND	ND	ND	ND
	54-15341	4.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	54-15342	ND	ND	ND	ND	7.7	ND	ND	ND	ND	ND	ND	ND
L2	54-15343	33.5	ND	5.7	0.8	ND	ND	ND	ND	ND	ND	ND	ND
	54-15344	34.9	7	15	ND	ND	ND	ND	ND	ND	ND	ND	ND
	54-15345	10.4	2.2	4	ND	ND	ND	ND	ND	ND	ND	ND	ND
	54-15346	2.9	ND	1.1	ND	ND	ND	ND	ND	ND	ND	ND	ND
	54-15347	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	54-15347D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	54-15348	8.4	1.7	13.8	1.5	11.9	ND	ND	ND	ND	ND	ND	ND
L3	54-15349	19.3	4.3	10.3	ND	5	ND	ND	ND	ND	ND	ND	ND
	54-15350	2.8	0.7	1.9	ND	ND	ND	ND	ND	ND	ND	ND	ND
	54-15351	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	54-15352	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
L4	54-15353	12.2	1.7	1.3	ND	ND	ND	ND	ND	ND	ND	ND	ND
	54-15354	ND	ND	ND	2.6	16.8	ND	ND	ND	ND	ND	ND	ND
	54-15355	ND	ND	ND	ND	5.8	ND	ND	ND	ND	ND	ND	ND
L5	54-15356	51.6	25.9	76.1	1.8	7.3	ND	ND	5.4	ND	ND	ND	ND
	54-15357	86	38.9	47.1	1	ND	ND	14.3	17.8	ND	ND	ND	ND
	54-15358	15.9	3.3	4.6	1	ND	16.8	10.5	ND	ND	ND	ND	ND
L6	54-15359	42.4	89.5	142.4	9.1	ND	ND	12.1	4.5	ND	ND	0.8	ND
	54-15360	305.5	217.4	155	3.6	6.5	ND	30.8	50.4	ND	ND	ND	ND
	54-15361	22.8	16.8	13.5	3.2	ND	10.5	52.4	7.9	ND	ND	ND	ND
	54-15362	ND	ND	ND	2.2	ND	8.2	ND	ND	ND	ND	ND	ND
	54-15362D	ND	ND	ND	1	ND	8.9	ND	ND	ND	ND	ND	ND
L7	54-15363	213.1	318.4	168.4	2.3	ND	ND	46.8	6.4	ND	ND	ND	ND
	54-15364	11.3	30.7	22.8	6.6	ND	ND	29.3	ND	ND	ND	ND	ND
	54-15365	60.4	19.6	23.9	3.5	ND	ND	16.4	4.3	ND	ND	ND	ND
	54-15366	ND	ND	ND	1.7	ND	16.5	ND	ND	ND	ND	ND	ND
L8	54-15368	5.8	ND	ND	ND	5.7	18.3	60.8	3.8	ND	ND	ND	ND
	54-15267	61.9	6	4.5	4.1	ND	8.8	13.5	ND	ND	ND	ND	ND
	54-15280	16.9	3.4	2.3	4.5	ND	ND	ND	ND	ND	ND	ND	ND
L9	54-15369	829.1	692.5	1064	ND	13.4	ND	28.6	106.2	3.1	2.2	ND	ND
	54-15369D	755.8	500.8	979.8	ND	16.9	ND	19.7	107.7	3.5	1.3	ND	1.8

* ND = not determined. The result was below the quantitation limit.

APPENDIX E BUBBLE PLOTS

Figure E-1. Distribution of tetrachloroethylene in soil vapor at TA-54, MDA G.

Figure E-2. Distribution of tetrachloroethylene in soil vapor at TA-54, MDAs H and J.

Figure E-3. Distribution of tetrachloroethylene in soil vapor at TA-54, MDA L.

Figure E-4. Distribution of trichloroethylene in soil vapor at TA-54, MDA G.

Figure E-5. Distribution of trichloroethylene in soil vapor at TA-54, MDAs H and J.

Figure E-6. Distribution of trichloroethylene in soil vapor at TA-54, MDA L.

Figure E-7. Distribution of 1,1,2-trichloro-trifluoroethane (Freon 113) in soil vapor at TA-54, MDA G.

Figure E-8. Distribution of 1,1,2-trichloro-trifluoroethane (Freon 113) in soil vapor at TA-54, MDAs H and J.

Figure E-9. Distribution of 1,1,2-trichloro-trifluoroethane (Freon 113) in soil vapor at TA-54, MDA L.

Figure E-10. Distribution of 1,1-dichloroethylene in soil vapor at TA-54, MDA G.

Figure E-11. Distribution of 1,1-dichloroethylene in soil vapor at TA-54, MDAs H and J.

Figure E-12. Distribution of 1,1-dichloroethylene in soil vapor at TA-54, MDA L.

Figure E-13. Distribution of 1,1-dichloroethane in soil vapor at TA-54, MDA G.

Figure E-14. Distribution of 1,1-dichloroethane in soil vapor at TA-54, MDAs H and J.

Figure E-15. Distribution of 1,1-dichloroethane in soil vapor at TA-54, MDA L.