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ANALYSIS OF AMBIENT MONITORING DATA IN THE VICINITY OF OPEN TIRE FIRES

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FINAL REPORT

ANALYSIS OF THE AMBIENT MONITORING DATA

IN THE VICINITY OF OPEN TIRE FIRES

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PREFACE

Although EPA has identified many of the major contaminants from uncontrolled tire fires and their emission concentrations under experimental conditions, real-world contaminant concentrations have not been evaluated. This report documents the collection of air monitoring data, much of which is unpublished, from 22 actual tire fire emergencies. An exploratory analysis revealed that several types of summary statistics may be appropriate, if the air monitoring data were divided into those measurements taken at less than 1000 feet from the edge of the tire fire and those taken at greater than 1000 feet.

This report is organized into three major components: Executive Summary, Detailed Report, and Appendices. Each of the components, along with its intended audience, is described in the following paragraphs.

Executive Summary

The Executive Summary includes a tabular listing and a brief explanation of air concentrations for 17 contaminant analytes. It is intended to be useful to public officials such as fire marshals who are responsible for planning for, or responding to, tire fire incidents. The median concentrations of these 17 analytes and their lower and upper confidence intervals can be used as a source profile or "fingerprint" of actual concentrations at a fire.

The 90th percentile values for 17 tire fire emission constituents may be useful for determining chronic or subchronic risks from these specific contaminants. A comprehensive risk assessment cannot be completed using these 17 analyte concentrations because emissions of literally hundreds of potentially toxic air contaminants from uncontrolled tire fires have significant public health implications. Most notably, none of the 17 analytes can be used as surrogates for known tire fire air contaminants such as the polycyclic aromatic hydrocarbons and heavy metals.

Detailed Report

The Detailed Report provides a description of the methods used to acquire, organize, and evaluate the air monitoring data. The results of the data evaluation are presented, and conclusions are discussed. It is intended to be useful to health officials interested in developing exposure assessments and potentially evaluating health risks associated with air pollution from tire fires.

Appendices

The Appendices contain detailed information about the data handling procedures, computer database system, data quality assurance/quality control efforts, and a listing of references and resources. The intended audience is scientists interested in using the database system for additional research.

The collected data are available in a computer database that may be used to identify particular characteristics of tire fire incidents affecting contaminant concentrations.

TABLE OF CONTENTS

Section **Page Number**

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

(Intended to be useful to public officials such as fire marshals, who are responsible for planning for, or responding to, tire fire incidents)

EXECUTIVE SUMMARY

Literally hundreds of air contaminants are released from uncontrolled tire fires that may have significant public health implications. Although EPA has identified many of the major contaminants and their emission concentrations under experimental conditions (Ryan, 1989 and U.S. EPA, 1989), actual contaminant concentrations have not previously been evaluated. Air monitoring data from 22 actual tire fire emergencies, many unpublished, have been collected, evaluated, and documented in this report.

The evaluation of the collected data focused on defining the "representative" or "typical" concentrations of contaminants that were measured at many of the tire fire incidents. These concentrations will be made available for use by public officials, such as fire marshals, to determine evacuation areas. A tire fire incident can be compared with previous incidents by comparing the "typical" concentrations with site-specific air monitoring data or air dispersion modeling results.

A variety of exploratory data analyses were completed. A large number of air monitoring sites were located close to the tire fires. Therefore, a natural division in the data was determined to occur at 1000 feet from the tire fires. Contaminant concentrations appeared to decrease rapidly with increasing distance from tire fires, although this rapid decrease may be only an artifact of the sampling distances typically chosen at tire fire incidents.

The exploratory analysis revealed that several types of summary statistics may be appropriate, if the air monitoring data were divided into those measurements taken at less than or equal to 1000 feet from the edge of the tire fire and those taken at greater than 1000 feet. These summary statistics are included in Table 1 and Table 2. In these tables, column "N" gives the number of measurements available for an analyte. Column "Fires" shows the number of tire fire incidents where these measurements were taken. It should be noted that these summary statistics are intended to provide typical contaminant concentrations and some measures of the variability across the various site conditions represented by the 22 different tire fire incidents. The median, along with its upper and lower 90 percent confidence limits, represents the contaminant concentrations typically found at tire fire incidents. The 90th percentile values for 17 analytes and isomers may be useful for determining subchronic (less than 90 days) exposures to these specific contaminants. Note that the 90th percentile is different from the 90 percent upper confidence limit. The 90th percentile means that of all the measurements taken at the 22 tire fire incidents, 90 percent are less than this value. The "maximum" concentration is included, although it may represent only measurements of very short duration and may not be useful in determining subchronic exposures. Acute exposures, such as those experienced by firefighters, are not addressed by the summary statistics in Tables 1 and 2.

Note that eight of the analytes have a median value of zero. These analytes all contain chlorine. If these analytes are measured at a tire fire incident, they may represent air emissions from sources other than the burning tires.

Table 1. Summary Statistics ("Fingerprint") (≤ 1000 Feet)

			Units of $\mu g/m^3$					
Analyte	N	Fires	Median	90% LCL[1]	90% UCL[1]	"a"[2]	90th Pcnt[3]	Max
Benzene	101	21	121	33	525	17	6375	79693
Toluene	94	21	220	38	527	16	3766	206753
Styrene	86	14	85	20	174	15	2320	2705
Xylenes[4]	41	9	17	0	607	11	1424	3809
m,p-Xylene	30	6	76	1	282	9	912	999
o-Xylene	49	10	35	1	109	12	336	564
Methylene Chloride	39	10	8	0	89	10	565	836
Chloroform	33	9	42	0	197	9	533	1085
Ethylbenzene	57	12	49	0	204	12	502	1477
Trichloroethene[4]	45	11	0	0	41	11	425	881
1,1,2-Trichoroethane	33	7	0	0	82	9	316	542
1,1,1-Trichoroethane	43	12	0	0	10	11	39	817
1,1-Dichloroethane	26	10	0	0	0	8	16	42
Chlorobenzene	33	11	0	0	0	9	2	11
Trichloroethane[4]	17	7	0	0	1	7	1	1
Carbon Tetrachloride	31	10	0	0	0	9	0	44
Tetrachloroethene	28	9	0	0	0	9	0	0

[1] The 90 percent confidence limits lower and upper as determined for the median
[2] Where a is the number of data values from the median to the upper and to the lower 90 percent confidence limits [derived from cumulative binomial probability table in Wonnacott (Wiley 1985)]
[3] The analytes in this table are arranged in order of 90th percentile (except for the o-xylene isomer)
[4] Contains mixed isomers

Table 2. Summary Statistics ("Fingerprint") (>1000 feet)

			Units of $\mu g/m^3$					
Analyte	N	Fires	Median	90% LCL[1]	90% UCL[1]	"a"[2]	90th Pcnt[3]	Max
Styrene	45	5	1	0	16	11	554	2705
Ethylbenzene	18	5	3	0	172	7	172	1390
Toluene	45	10	5	1	37	11	156	634
Benzene	47	10	4	0	29	11	67	524
Xylene[4]	20	4	0	0	0	7	4	20
m,p-Xylene	28	3	2	1	9	9	14	999
o-Xylene	38	6	1	1	5	10	13	521
Chlorobenzene	29	5	1	0	1	9	1	1
1,1,1-Trichloroethane[4]	30	5	1	0	1	9	1	7
Trichloroethane[4]	34	4	1	0	1	10	1	3
Carbon Tetrachloride	8	4	0	0	0	4	0	0
Trichloroethene[4]	6	4	0	0	18	3	0	18
1,1-Dichloroethane	7	3	0	0	0	3	0	0
1,1,2-Trichloroethane	6	2	0	0	0	3	0	0
Chloroform	3	3	0	0	0	1	0	0
Methylene Chloride	14	3	0	0	0	6	0	660
Tetrachloroethene	8	4	0	0	0	4	0	0

[1] The lower and upper 90 percent confidence limits as determined for the median

[2] Where a is the number of data values from the median to the 90th percentile [derived from cumulative binomial probability table in Wonnacott (Wiley 1985)]

[3] The analytes in this table are arranged in order of 90th percentile (except for the xylene isomer)

[4] Contains mixed isomers

DETAILED REPORT

(Intended to be useful to health officials interested in developing exposure assessments)

1.0 INTRODUCTION

1.1 Impetus

The U.S. generates about 240 million tires per year. This estimate does not include tires which are retreaded or reused secondhand. Approximately 170 to 204 million of those 240 million used tires are either landfilled or stockpiled. Such disposal methods pose significant environmental problems, including promoting breeding grounds for insects and rodents and causing landfill/scrapyard fires.

Since 1988, EPA's Air Risk Information Support Center (Air RISC) has received 14 requests for information on the emissions, human exposures, and health risks associated with open and uncontrolled tire burning. Five requests were also received by EPA's Control Technology Center (CTC) since October 1991. Between 1971 and 1986, approximately 170 tire fires of various sizes were documented in the U.S. Reporting systems for tire fires are improving and a query of the National Fire Incidence Reporting System for the year 1988 revealed hundreds of incidents of various sizes in the 25 States that contributed to the Reporting System that year. These fires can be very large and involve well over one million tires each. The Scrap Tire Management Council considered tire fires enough of a concern to sponsor a seminar in Washington, D.C. in late 1991 for fire marshals from across the country. Publications addressing tire fires are listed in Appendix F (References) and Appendix G (Bibliography).

1.2 Background

Initially, EPA investigated emissions data from an experimental tire burn for their applicability to estimating air concentrations at uncontrolled tire fires. In addition, unpublished information regarding monitoring data from uncontrolled tire fire incidents and other experimental tire fires were identified. Thirty-one tire fire incidents were identified in which some air monitoring was conducted. The available air monitoring data for tire fire incidents were then collected, summarized, and evaluated in order to draw general conclusions concerning exposures to nearby populations at various distances from the tire fires. This report documents these tasks and provides summary statistics on 17 analytes that were common to many of the tire fire incidents. Eight of these 17 analytes have median concentrations of zero. The 17 analytes were all gases, specifically volatile organic compounds (VOCs). Known tire fire emissions also include particulate matter containing polycyclic aromatic hydrocarbons (PAHs) and heavy metals. Particulate matter was collected at very few tire fire incidents and is not addressed in this report.

The color of the smoke plume may be an indicator of contaminant constituents and relative concentrations, although plume color information was not typically available. Sometimes plume color may be inferred or determined from concentration of elemental carbon (carbon black). These data are available for the Hagersville tire fire incident.

2.0 DATA ANALYSIS

2.1 Approach

The primary objective of this analysis is to estimate contaminant air concentrations at a given distance from a "typical" tire fire based on the compilation of available information from tire fire incidents in the United States. Contaminant concentration data from a total of 22 separate incidents are included in this analysis out of 31 incidents initially identified. The numbering system for the 22 data sets is arbitrary and retains the original numbering system of the 31 incidents as they are recorded in the database. Data from 9 sites were not included because of duplication, severely limited or compromised concentration data, or unavailability of data.

The purpose of the data analysis is to appropriately characterize the nature and distribution of the available data and arrive at a suitable description of contaminant levels at varying distances from the fire boundary. This characterization may be applied to tire fires in general, to the extent that reasonable comparisons can be made among the fires represented in the database. For example, if there were large differences in the concentration ranges for various fires, it would be important to characterize these separately and attempt to account for the causes of any differences. While there was large variability in concentrations at individual fires, this degree of variability was evident across all fires. The large number of fires included in the analysis helps to ensure that the results are adequately representative of such incidents in general.

A rigorous analysis of the data that attempts to quantitatively establish the relationship between the samples available and "true" contaminant levels was not possible. Such a treatment could only be attempted following an exhaustive analysis of the multiple sources of variability inherent in an uncontrolled burn and where measurements were obtained systematically. Sources of variability include fire size, fire duration, meteorological conditions, terrain effects, and combustion conditions such as site size and shape, storage area, mixed refuse, and fire fighting activities. A summary of tire fire incident characteristics is included in Table 2-1. Further analysis should examine the impact of different sources of variability on those factors that influence pollutant concentrations emitted from a given fire.

The tire fire incidents of larger size and longer duration had larger and possibly higher quality data sets. The greater density of data from these fires gives them more weight in the results than other fires. This does not necessarily compromise the representativeness of the analysis since the data quality from the larger data sets is expected to be higher. Phil Campagnia (Campagnia, personal communication 1992) of EPA's Emergency Response Office noted that the more recent tire fire incidents (especially 1990 to present) have higher quality air monitoring data than fires occurring a decade ago because of improved and standardized monitoring procedures.

As this analysis attempts to determine "typical" concentration levels across a variety of incidents, the data were not segregated to eliminate potential sources of variability. The concern was that such data segregation would limit the analysis to the few fires where large data sets are available. Efforts were made to incorporate as much of the available data as possible.

The most significant step taken to aggregate the largest possible data sets for the analysis was the combination of downwind, variable, and missing wind directions. A large proportion of concentration data were associated with missing or variable wind directions. For example, 50 of the 162 available data points for benzene were associated with an unknown wind direction and 31 were associated with variable winds. The graphical analyses show no strong dependence of concentration on wind direction. An analysis of variance (ANOVA) also shows no dependence of concentration on wind direction; however, the ANOVA is not truly appropriate, without a log-transformation, given the strongly skewed distribution of the data.

Table 2-1. Tire Fire Incident Characteristics

INCIDENT LOCATION (NUMBER)	# OF TIRES AT SITE	% OF TIRES BURNED	# OF TIRES BURNED	BURN DURATION (DAYS)	SITE SIZE (ACRES)	FIRE SIZE (ACRES)	PILE HEIGHT (FEET)	PILE CONFIGURATION
Fairbanks, TX (31)	NA	NA	NA	NA	50	5	12	NA
Norfolk, VA (8)	NA	NA	NA	26	5	NA	NA	NA
Batesville, AR (9)	NA	NA	NA	NA	NA	NA	NA	NA
Danville, PA (14)	NA	NA	NA	NA	NA	NA	NA	NA
Jonesville, NC (12)	20	NA	NA	4	NA	NA	NA	NA
Tacoma, WA (28)	1,000	NA	NA	NA	NA	NA	NA	NA
Chadbourn, NC (26)	90,000	100	90,000	1	NA	NA	7	ENCLOSURE
Spencer, MA (17)	200,000	NA	NA	5	12	NA	10	SHALLOW PIT
Minden, IA (30)	300,000	98	294,000	2	NA	NA	30	PIT
Wawina, MN (23)	500,000	65	325,000	3	2	1	15	RANDOM FLAT PILES
Wakefield, VA (7)	625,000	60	375,000	3	4	3	10	PIT
Webber, UT (3)	700,000	NA	NA	5	2	NA	30	HEAPS
Andover, MN(24)	800,000	50	400,000	2	NA	NA	17	RANDOM FLAT PILES
Everett, WA (2)	1,000,000	75	750,000	60	NA	NA	10	WIND ROWS
St. Amable, Quebec (21)	2,000,000	45	900,000	3	55	55	65	WIND ROWS
Level Cross, NC (6)	3,000,000	60	1,800,000	14	7	7	9	HEAPS
Belchertown, MA (18)	4,250,000	NA	NA	40	NA	NA	NA	NA
Winchester, VA (5)	5,000,000	NA	NA	270	NA	5	NA	NA
Catskill, NY (4)	5,000,000	NA	NA	NA	NA	NA	NA	NA
Danville, NH(15)	5,000,000	NA	NA	14	NA	NA	NA	HEAPS
Somerset, WI (20)	6,000,000	33	2,000,000	5	25	20	5	CONICAL HEAPS
Hagersville, Ontario (1)	14,000,000	99	13,860,000	17	12	12	20	HEAPS

NA = Not available in database system

Incident locations appear in this table in order of least to greatest number of tires burned.

It may be reasonably assumed that the missing wind directions represent downwind measurements based on the air monitoring strategies typically employed at the fires. Wind direction was not recorded. Although there is a general lack of knowledge of how wind direction data were obtained, it cannot be assumed that the variable wind direction data do not represent a downwind measurements at the time the samples were obtained. Upwind data are excluded from the analysis since the goal is to characterize concentrations downwind from the fire. Upwind data represent a relatively small proportion of the samples. More detailed analyses should investigate further the role of wind direction.

The data were segregated in the analysis based on distance from the fire boundary. A distance of 1000 feet proved to be a useful point at which to separate samples collected "near" the fire versus samples collected "far" from the fire. The majority of the data were collected at the fire boundary (zero distance) or at distances less than 1000 feet. Concentrations typically drop off very rapidly within the first 1000 feet and very slowly thereafter. A 1000-foot radius is also useful, from a public health perspective, in defining an area of increased exposure.

Seventeen analytes were monitored at six or more sites. Based on data availability, these contaminants were divided into two groups. Group 1 consists of the three analytes (benzene, toluene, and styrene) that were monitored at most of the incidents. This group has a larger number of data points. Group 2 consists of 14 analytes that were monitored at several incidents. The initial data exploration focused on Group 1 analytes; however, the Group 2 analytes exhibit similar distributions and rates of decrease with distance. Much of the data presentation is based on Group 1 analytes because the larger data sets provide a better overall view of the data and are more robust statistically. Table 2-2 shows the data availability and the number of fires represented for the contaminants considered.

2.2 Data Analysis

Table 2-2. Group Statistics

Contaminant	Measurement	
	Data Points	Number of Fires
Group 1		
Benzene	148	21
Toluene	139	21
Styrene	131	14
Group 2		
Xylene[1]	61	9
m,p-Xylene[1]	58	6
o-Xylene	87	10
Methylene Chloride	53	10
Chloroform	36	9
Ethylbenzene	75	12
Trichloroethene	51	11
Trichloroethane[2]	51	7
1,1,2-Trichloroethane	39	7
1,1,1-Trichloroethane	73	12
1,1-Dichloroethane	33	10
Chlorobenzene	62	11
Carbon Tetrachloride	39	10
Tetrachloroethene	36	9

[1] - Isomers of xylene considered as one analyte

[2] - Isomers and combined trichloroethane considered as one analyte

2.2.1 Comparison of Contaminant Concentrations Across Sites

The available measurements for the Group 1 contaminants are illustrated in Figures 2-1 through 2-6 for distances less than and greater than 1000 feet. The data are plotted on a log scale to provide a view of the large range of values and with zero concentrations plotted as 0.01 $\mu g/m^3$ since the logarithm of zero is undefined.

These figures include data for all wind directions (including upwind). Both low and high concentrations are recorded for each wind direction. It is not reasonable to assume, on this basis, that wind direction plays no role in concentration levels at a sampling location. Rather, it is more likely that the wind direction information does not accurately reflect conditions at the sites.

Data typically span three to four orders of magnitude for most of the incidents. On this basis, it seemed justifiable at this stage to aggregate concentration levels across sites in the analysis. This does not preclude further examination of individual fires in a more refined analysis. Group 2 concentration levels exhibit similar ranges.

For benzene and toluene, concentrations within 1000 feet of the fire are generally about one to two orders of magnitude greater than concentrations greater than 1000 feet from the fire. Styrene concentrations are lower overall than those for benzene and toluene; however, the difference in concentration for distances less than and greater than 1000 feet is also about one to two orders of magnitude.

2.2.2 Distribution of Contaminant Concentrations

The concentration distributions for all analytes are skewed right. The median is close to the lower end of the concentration range, with relatively few measurements representing very high concentrations. This is typical of air monitoring data in general, which are often characterized by a log-normal distribution. For example, 134 of 162 benzene measurements are below 1000

Figure 2-1. Benzene Concentration (Distance ≤1000 feet)

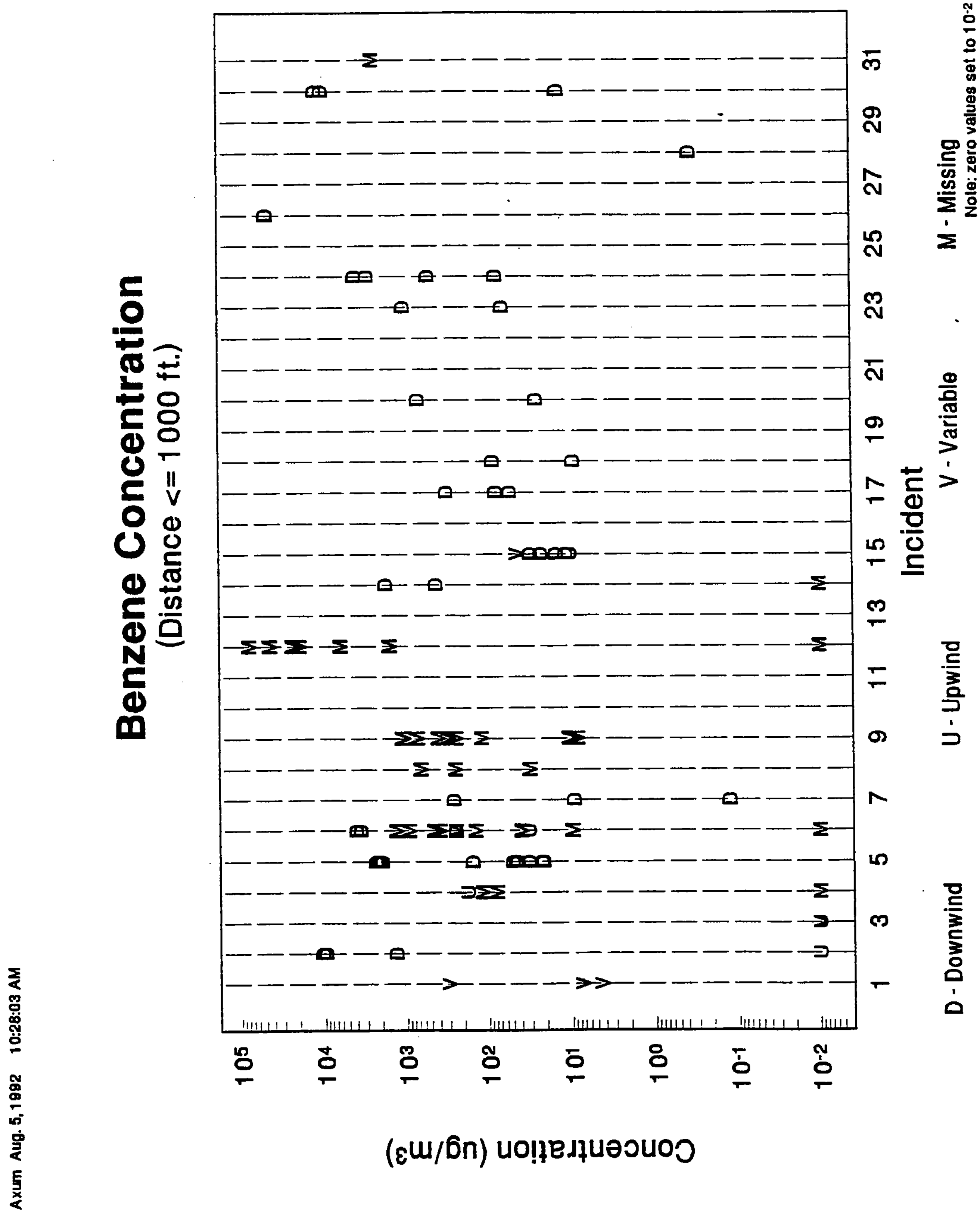


Figure 2-2. Benzene Concentration (Distance >1000 feet)

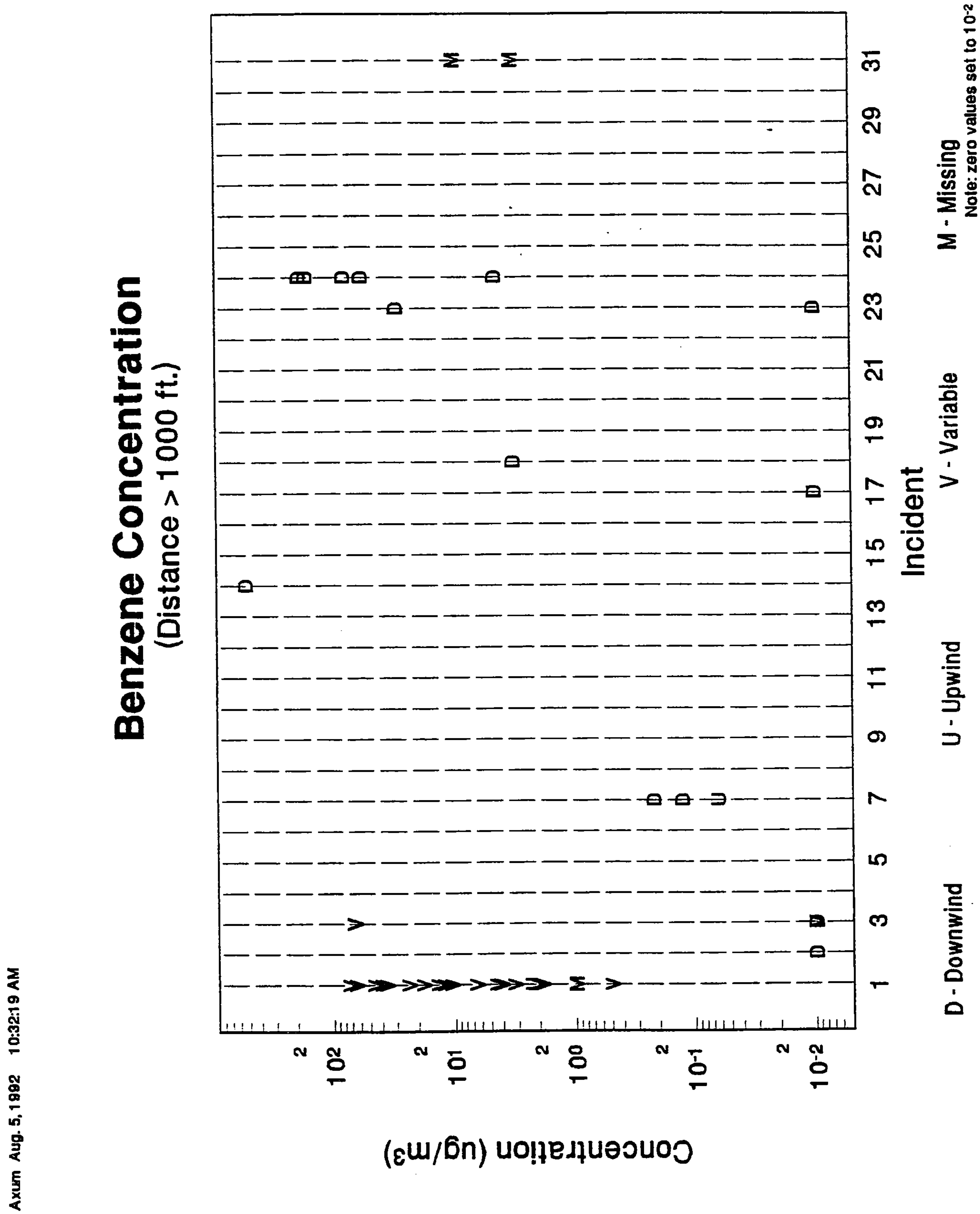


Figure 2-3. Toluene Concentration (Distance ≤1000 feet)

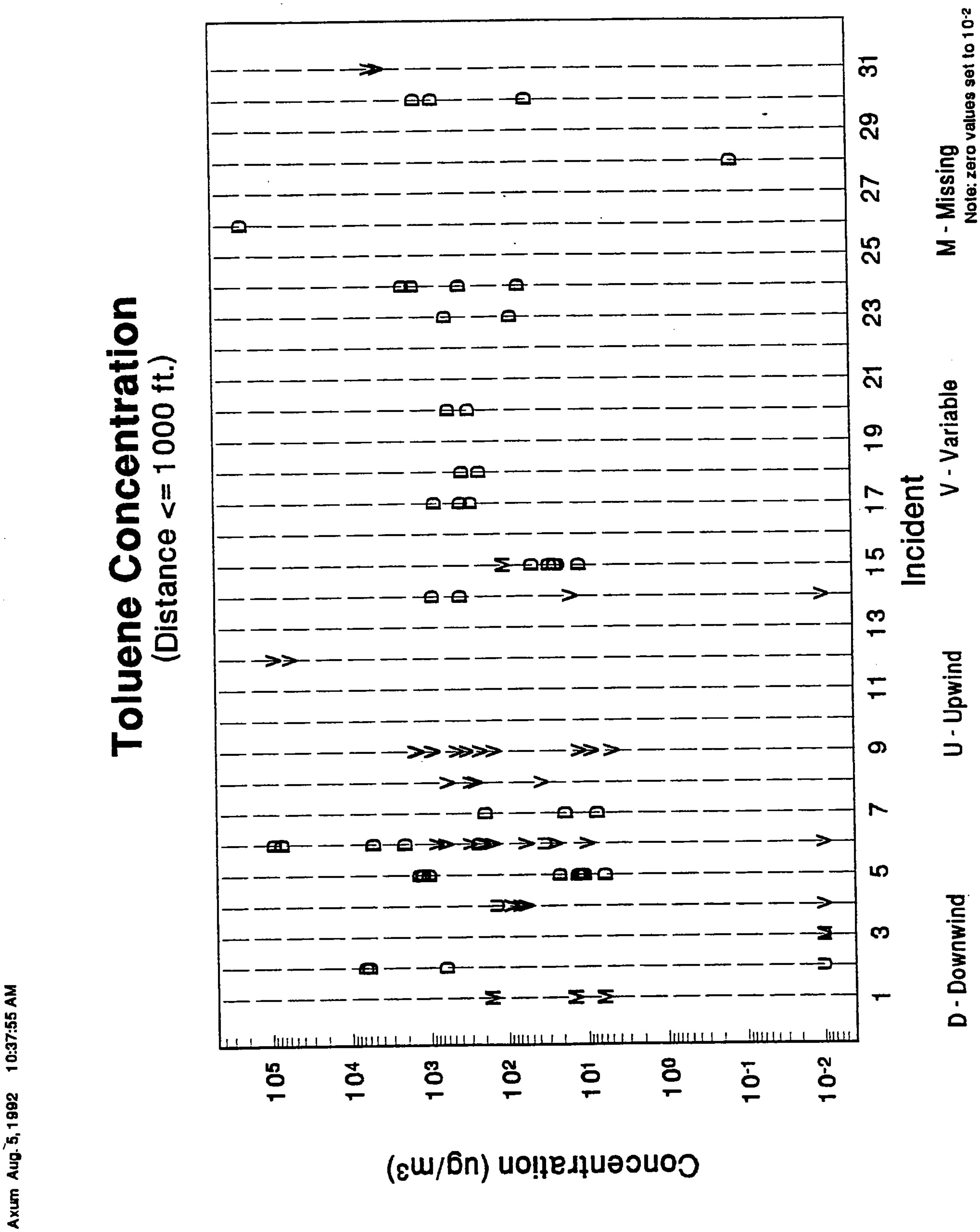


Figure 2-4. Toluene Concentration (Distance >1000 feet)

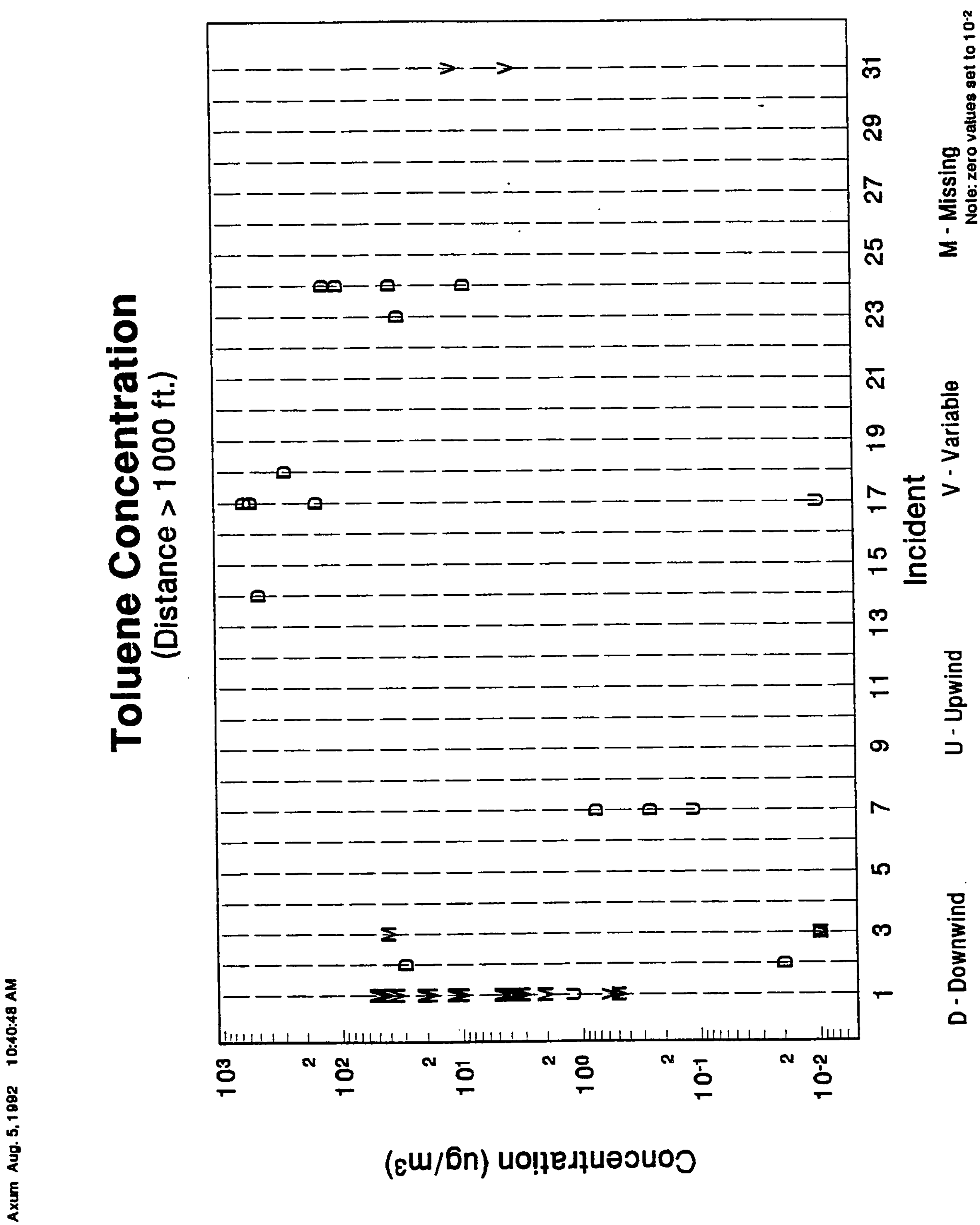


Figure 2-5. Styrene Concentration (Distance ≤ 1000 feet)

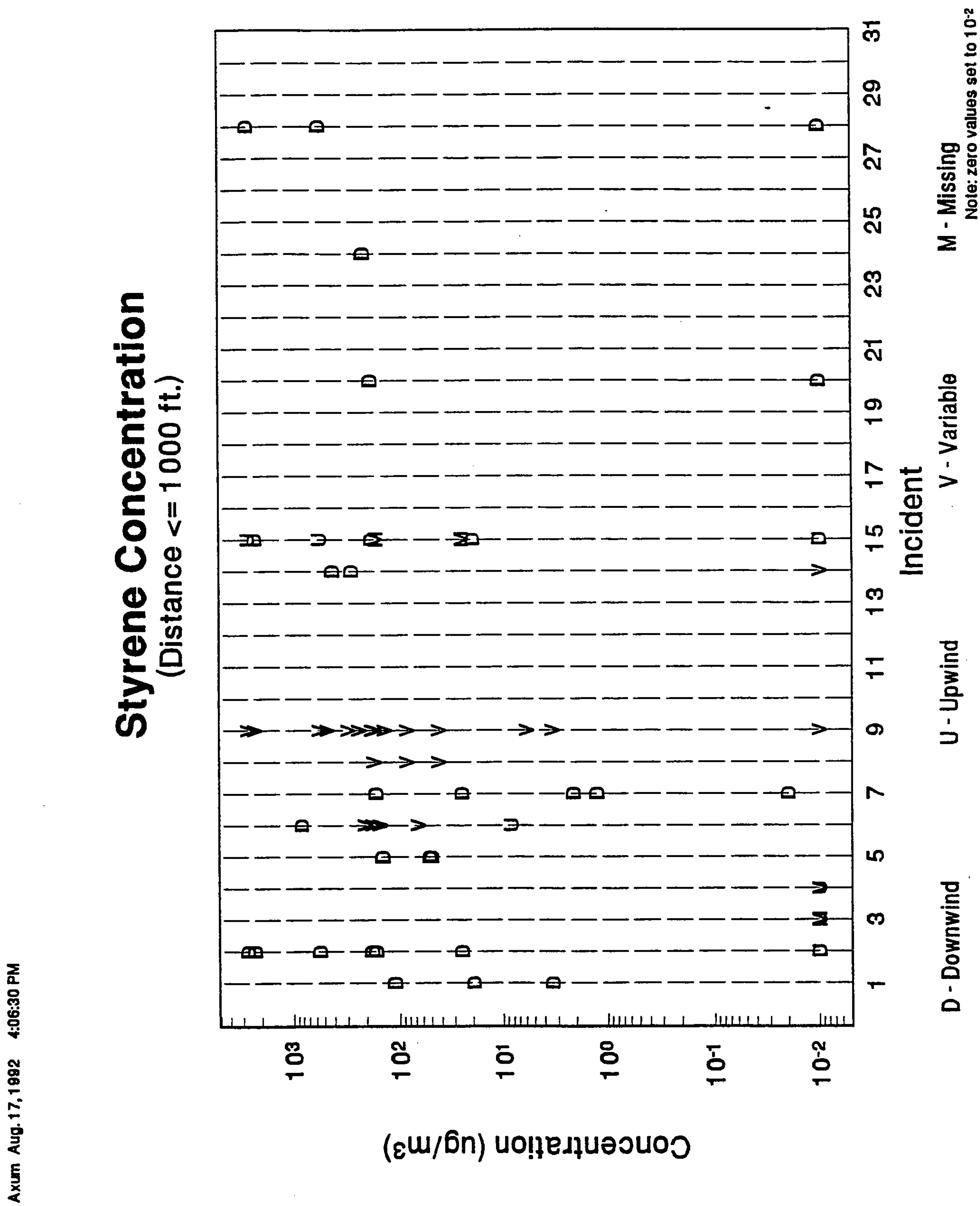
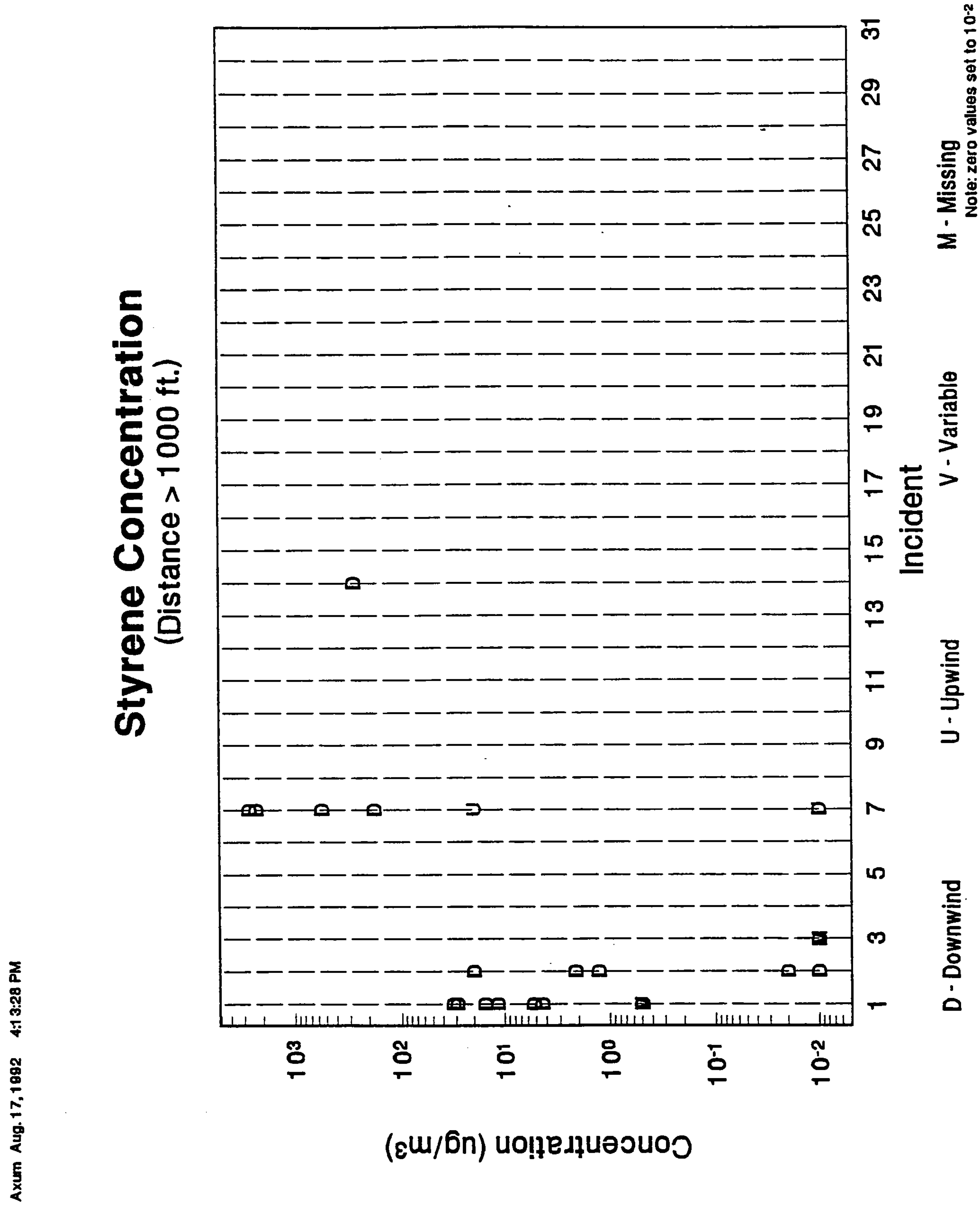


Figure 2-6. Styrene Concentration (Distance >1000 feet)



$\mu g/m^3$. Of the 134 below 1000 $\mu g/m^3$, 106 are below 100 $\mu g/m^3$, and 65 of those 106 are below 10 $\mu g/m^3$. Based on this initial survey of the data, histograms were produced for Group 1 contaminants in the two distance categories. Data beyond the 90th percentile are excluded from the histograms for clarity. These histograms are presented in Figures 2-7 through 2-12. A non-distributional approach (i.e., non-parametric) was selected to describe the data rather than justify a distributional model.

2.2.3 Analysis of Contaminant Concentrations By Distance

For some analytes, data at varying distances greater than 1000 feet (up to 20,000 feet) were sufficient to examine the rate of decrease of contaminant concentrations with distance beyond 1000 feet. For data collected within 1000 feet from the fire, the rate of decrease with distance cannot be quantified because so much of the data were collected at the fire boundary. The concentration data were not spread over a wide enough range of distances to perform a curve fitting exercise for this component of the data. Figure 2-13 shows a scatter plot of distance versus concentration for benzene for all distances available.

The initial hypothesis was that the concentration of contaminants decreased with increasing distance from the tire fire boundary. Graphical analysis suggested that a linear relationship may exist between distance and the logarithm of concentration, at least for distances greater than 1000 feet (see Figure 2-13). A least squares line was fit to the log transformed concentration data to obtain a formula for the rate of decrease with distance. In order to obtain a reasonable fit, some data editing was required. It was noted that zero concentrations were recorded across a broad range of distances. Since these data were not representative of the decrease noted in the graphical analysis, they were deleted for the purpose of obtaining a reasonably representative least squares line. It is likely that the zero concentration data are an artifact of sampling and analytical methods that were unable to detect the relatively low concentrations at greater distances.

Figures 2-14 through 2-16 illustrate the results of this curve fitting exercise for Group 1 contaminants at distances greater than 1000 feet. In each case, the slope of the fitted line is very

Figure 2-7. Benzene Concentration Distribution (≤1000 feet)

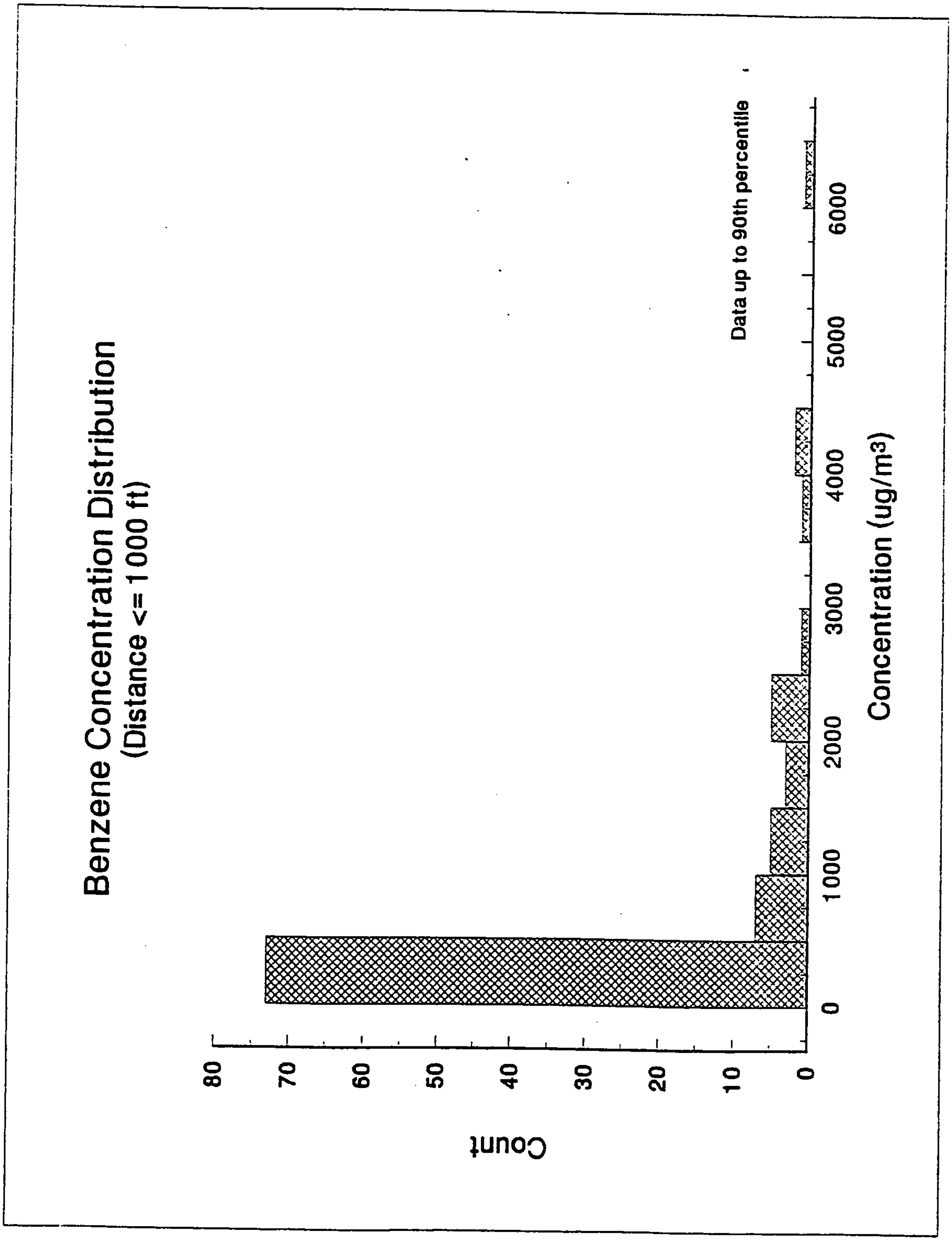


Figure 2-8. Benzene Concentration Distribution (>1000 feet)

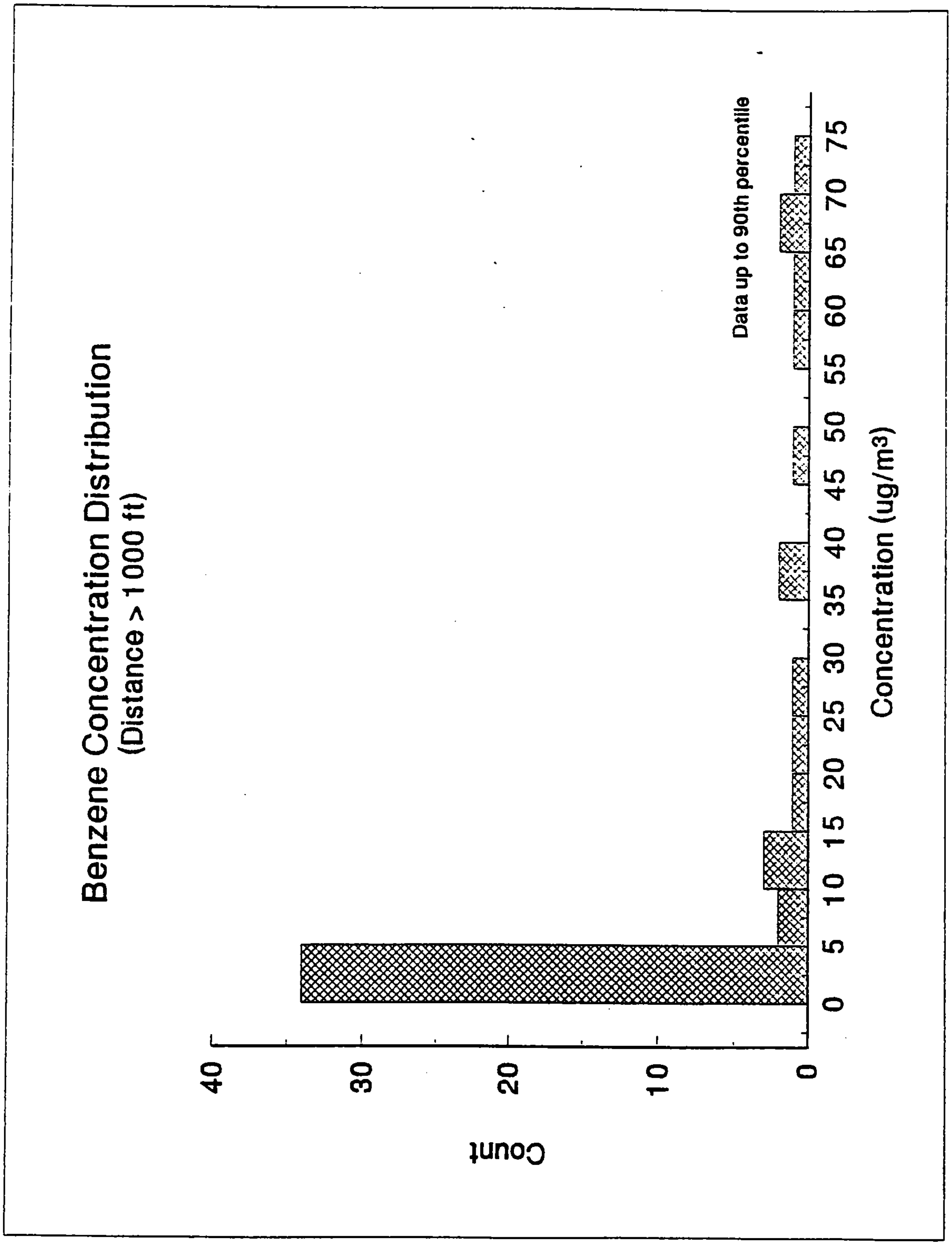


Figure 2-9. Toluene Concentration Distribution (≤1000 feet)

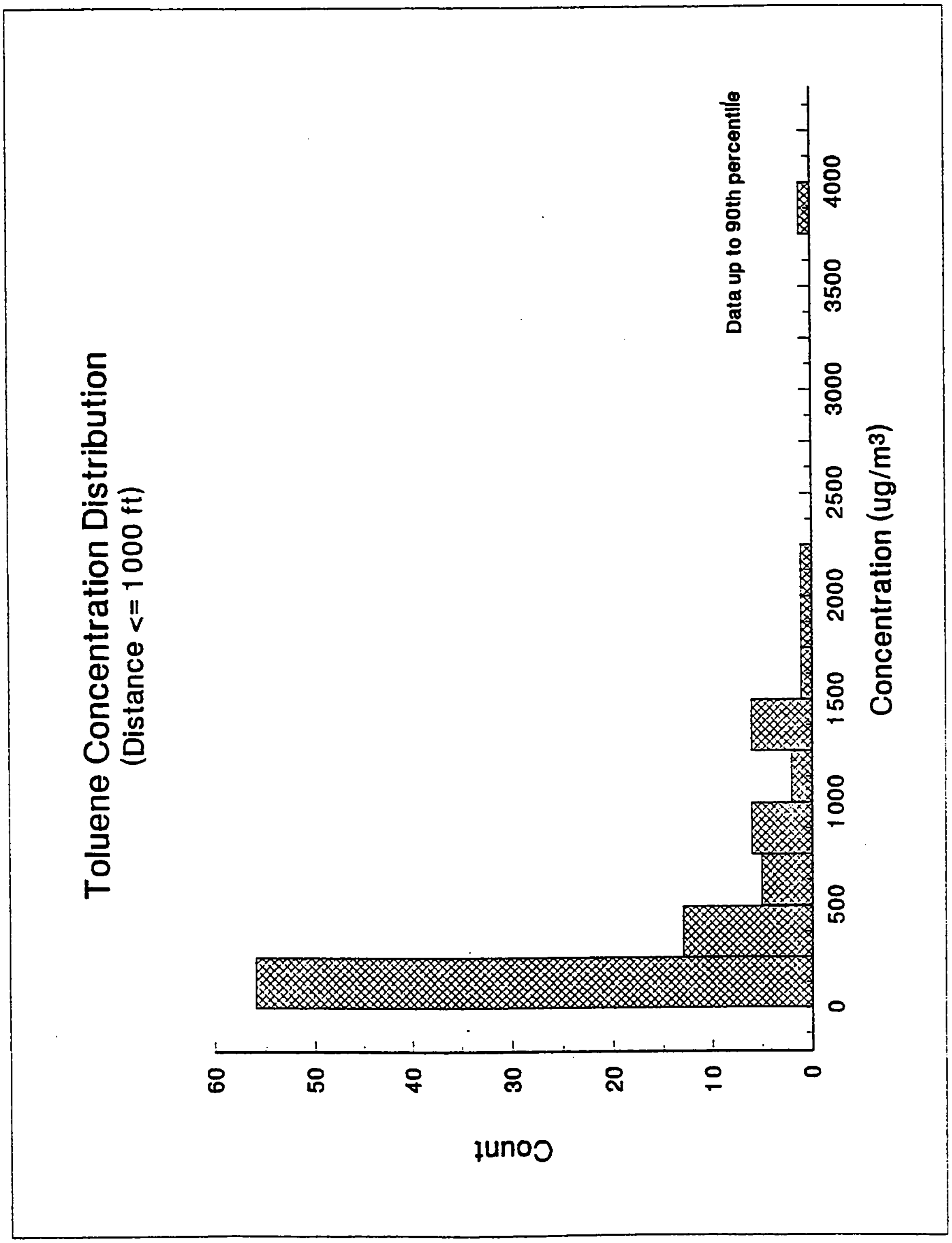


Figure 2-10. Toluene Concentration Distribution (>1000 feet)

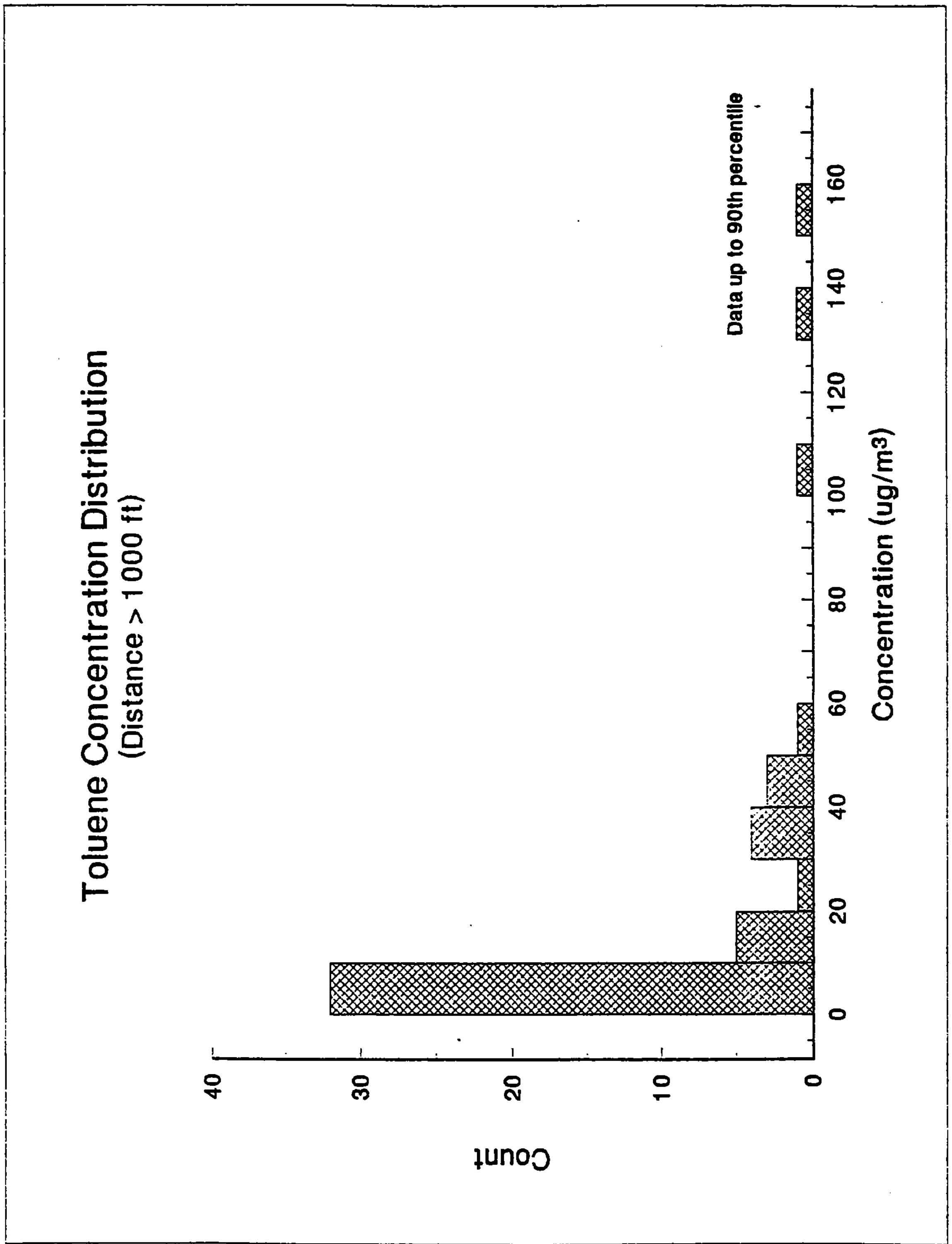


Figure 2-11. Styrene Concentration Distribution (≤1000 feet)

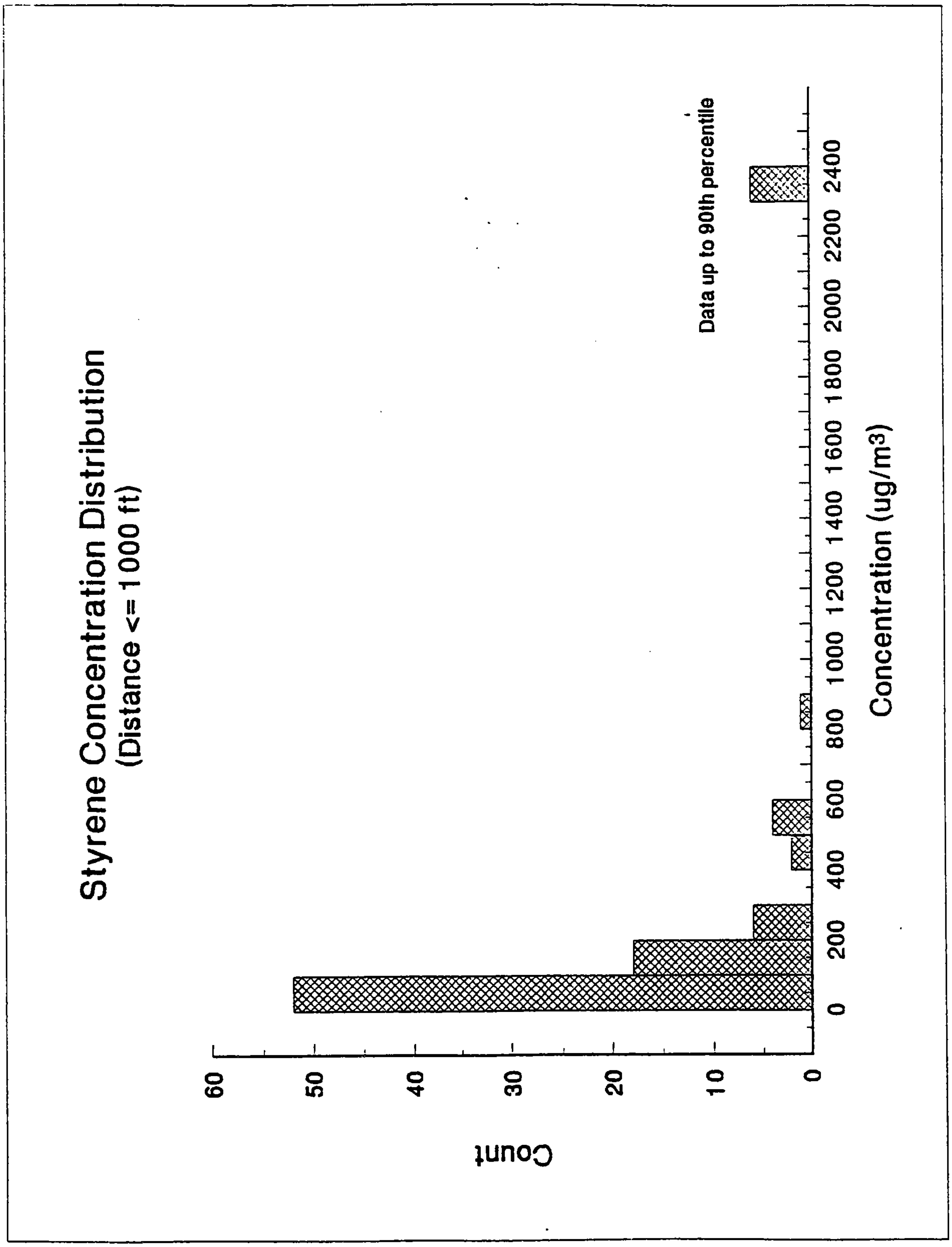


Figure 2-12. Styrene Concentration Distribution (>1000 feet)

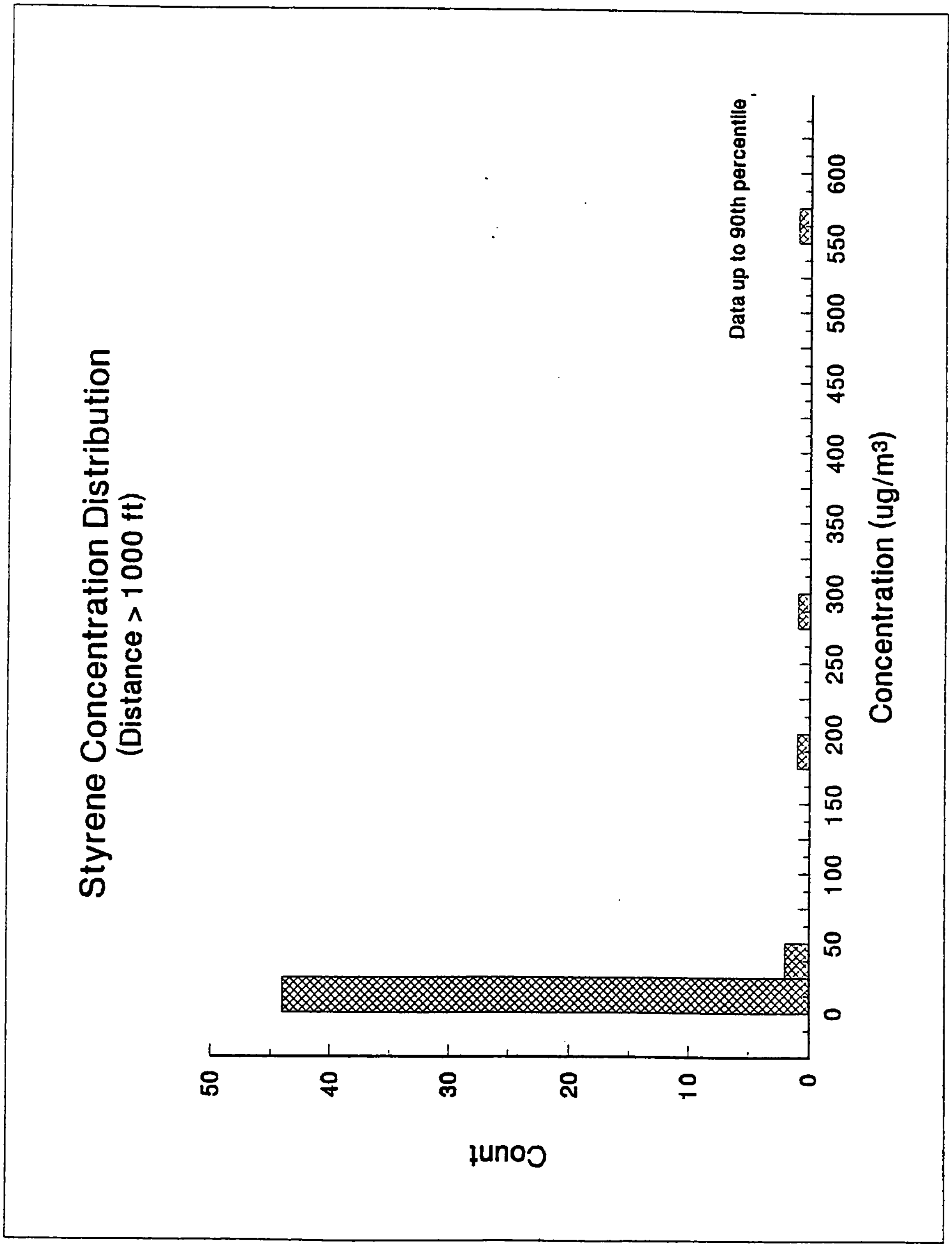
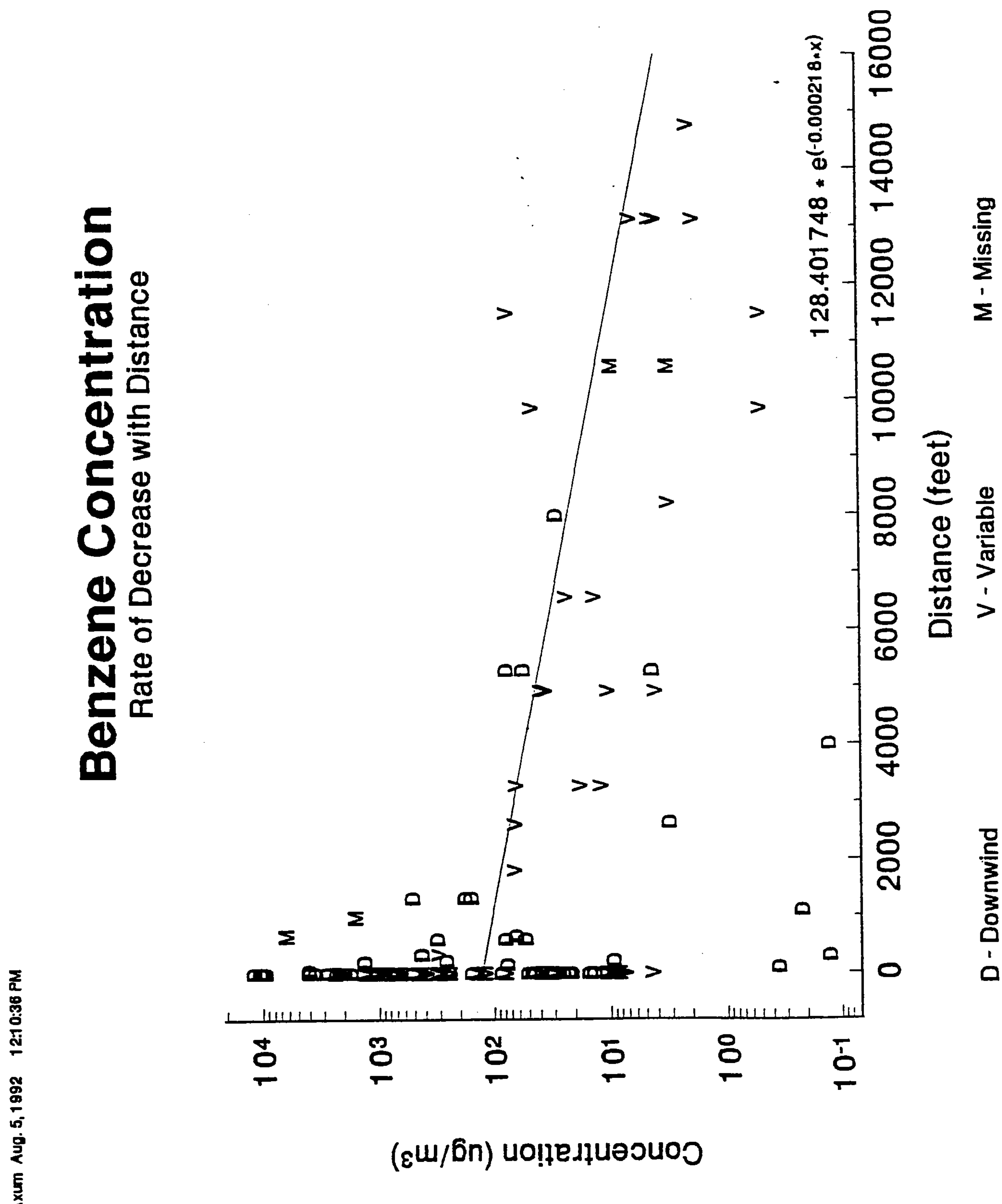


Figure 2-13. Benzene Concentration (Rate of Decrease with Distance)



similar (about -0.0001). While it is reasonable to assume that contaminant levels continue to decrease with distance, it cannot be demonstrated that the slope is different from zero given the high degree of variability in the concentration data. In other words, the rate of decrease beyond 1000 feet is very slow, and the data cannot support that it is different from zero. This is, at least partly, a result of combining data from different fires into a single analysis. Other sources of variability, as previously discussed, may also be important.

From a practical standpoint, it is not very useful to apply the formulas obtained from the curve fitting to obtain estimates of concentration at a given distance. The data do not strongly support doing so and the rate of decrease is so slow that the difference in concentration between any two distances beyond 1000 feet is insignificant as a practical matter.

For practical purposes, a single statistic should adequately characterize contaminant levels beyond 1000 feet. The "average" (some suitable central tendency) concentration level for all samples collected at more than 1000 feet from the fire is representative (within some confidence limits) of the concentration at any distance from the fire greater than 1000 feet. In addition, a reasonably conservative estimate of the maximum expected value (e.g., maximum, second highest value, or 90th percentile) can be obtained for any distance over 1000 feet as the likely maximum expected value for all distances over 1000 feet.

Wind direction information was preserved in the scatter plots in order to further examine whether concentrations appear to be dependent on recorded wind direction. The plots do not show any clear distinction between concentration levels for downwind, missing, and variable wind directions.

Figure 2-14. Benzene Concentration (Rate of Decrease at >1000 feet)

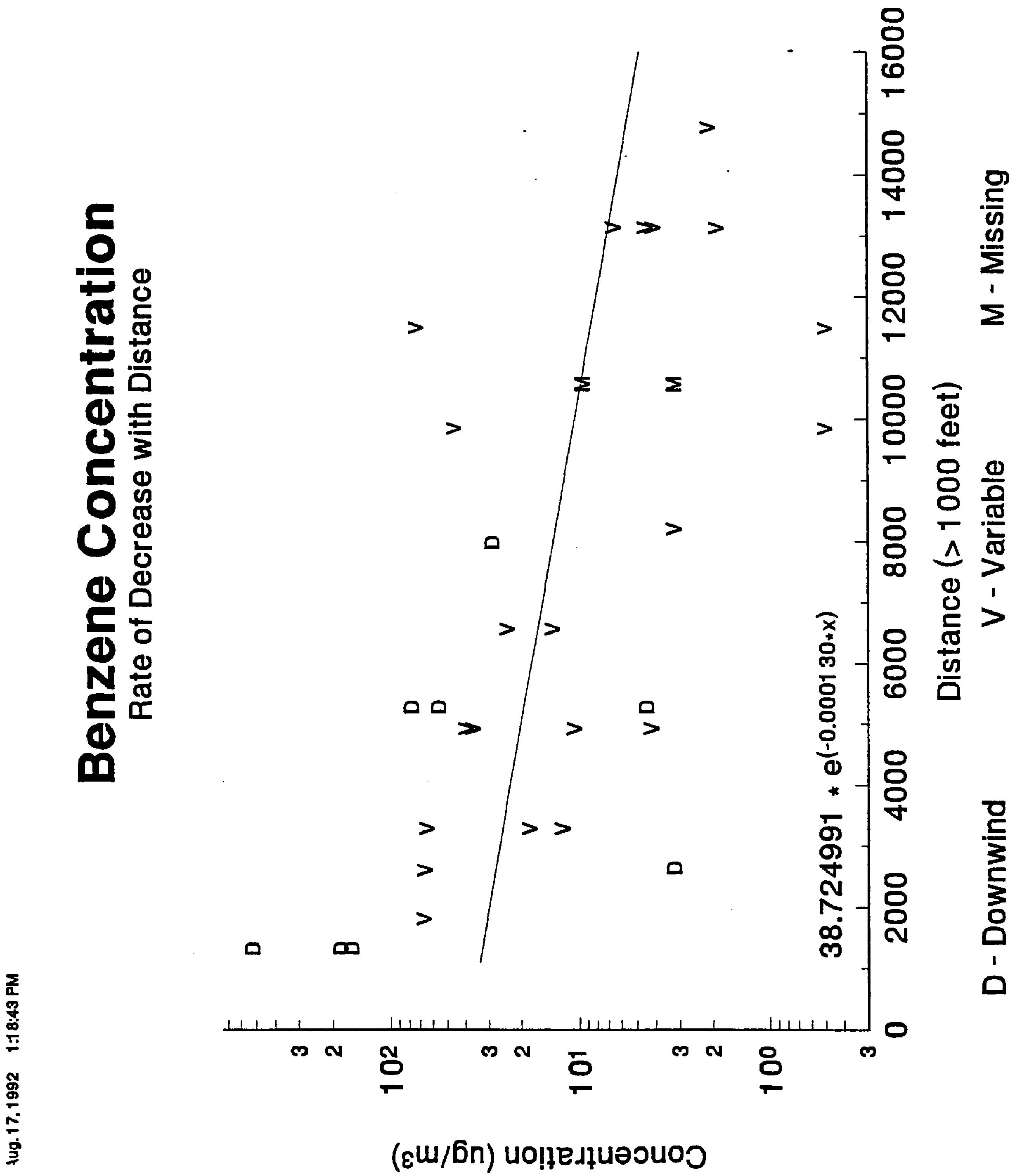


Figure 2-15. Toluene Concentration (Rate of Decrease at >1000 feet)

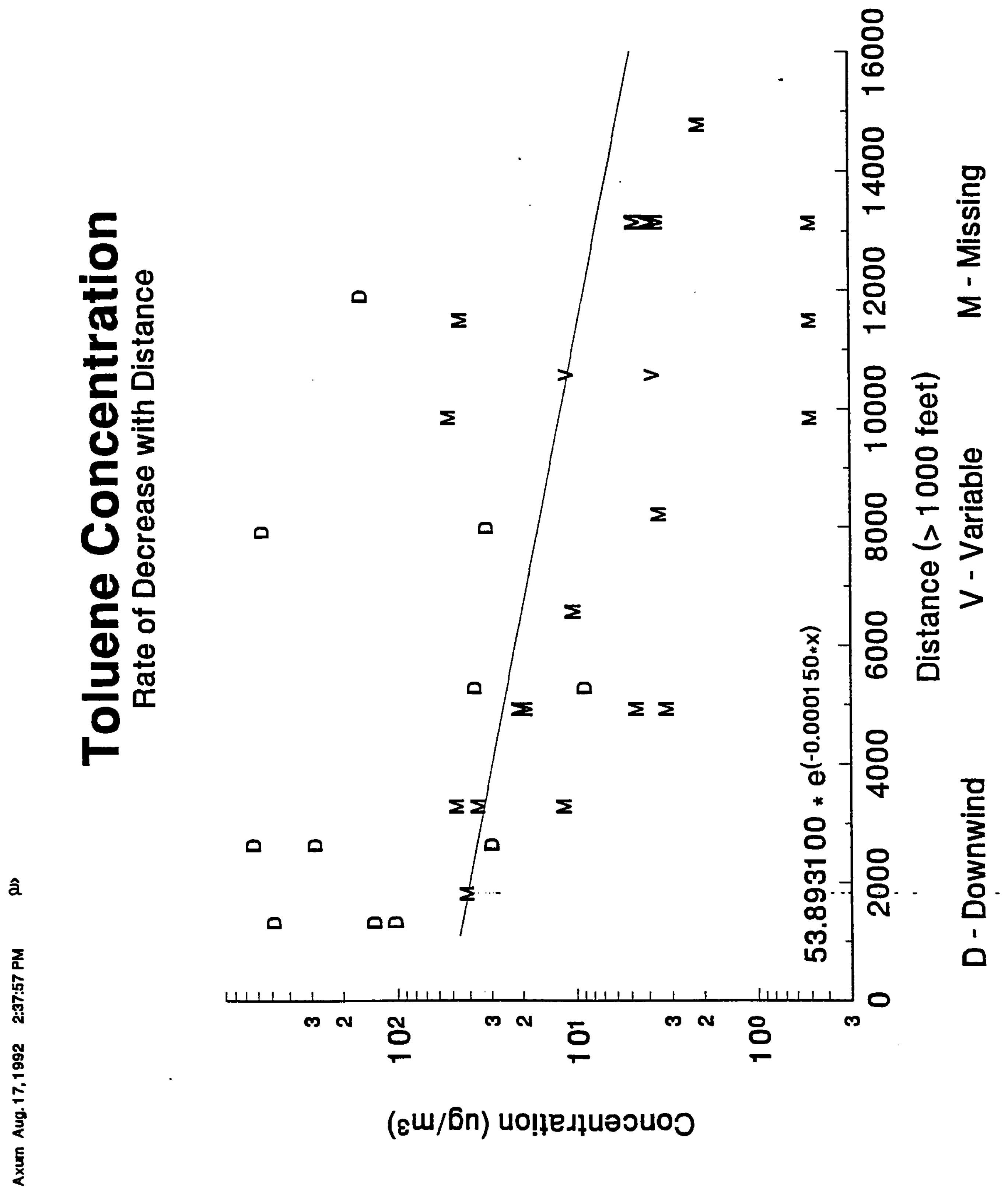
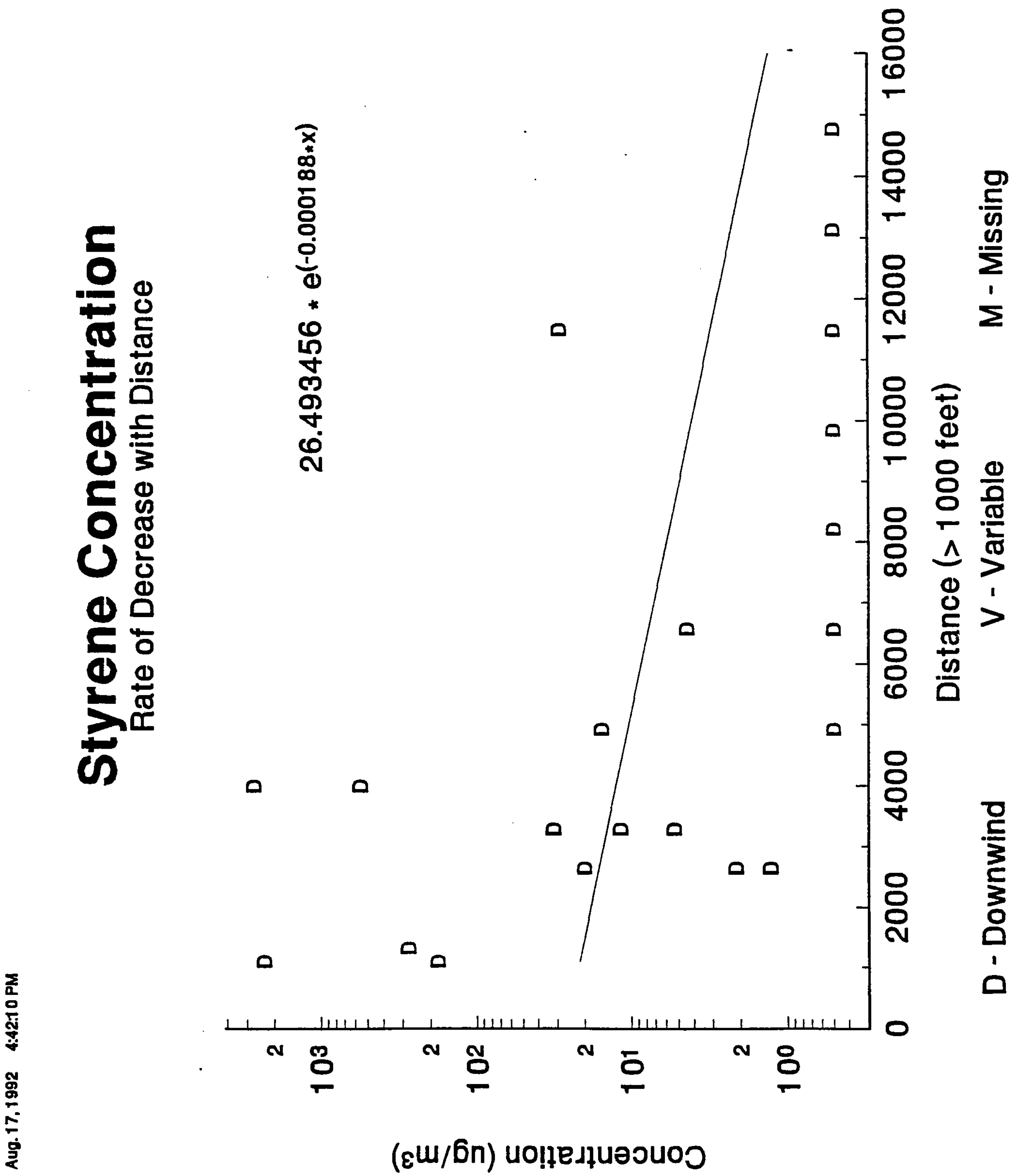


Figure 2-16. Styrene Concentration (Rate of Decrease at >1000 feet)



3.0 DISCUSSION AND CONCLUSIONS

3.1 Data Summary

Because a distributional model has not been established for the data value, non-parametric statistics (median, confidence limits, about the median, 90th percentile, and maximum) were selected to describe contaminant concentrations at distances less than and greater than 1000 feet.

The summary statistics derived for the 17 contaminants are presented in Tables 3-1 and 3-2 for distances less than 1000 feet and greater than 1000 feet, respectively. Based on experience with the distribution of the data, the median serves as a reasonable measure of central tendency. Upper and lower 90 percent confidence limits were established to provide a range of uncertainty about the median. These limits were calculated so that the skewed distribution was adequately represented without using highly sophisticated methods.

Both the upper and lower confidence limits are determined by counting up and down from the median the number of data points specified by **a**, where **a** is chosen so that the probability that the true median falls within the confidence limits is approximately 90 percent. This is based on the probability that a given number of points will fall to one side or the other of the median. Since the "true" median represents the middle of the population, the probability that a given point will fall on one side of the median versus the other is 50 percent. Thus, the problem is identical to determining the likelihood of obtaining more than a given number of heads in **N** coin tosses. The number of "heads" is one half of the sample size plus one half of the confidence interval (**N/2+a**). To simplify computation, the normal approximation to the binomial distribution is used for N greater than 12. For N less than 12, intervals are calculated based on the binomial distribution using a table of cumulative binomial probabilities found in Wonnacott (Wiley 1985).

While the median, with its associated confidence limits, characterizes the central tendency of the data, maximum expected values are more important from a public health perspective. The

Table 3-1. Summary Statistics ("Fingerprint") (Distance ≤1000 Feet)

			Units of $\mu g/m^3$					
Analyte	N	Fires	Median	90% LCL[1]	90% UCL[1]	"a"[2]	90th Pcnt[3]	Max
Benzene	101	21	121	33	525	17	6375	79693
Toluene	94	21	220	38	527	16	3766	206753
Styrene	86	14	85	20	174	15	2320	2705
Xylenes[4]	41	9	17	0	607	11	1424	3809
m,p-Xylene	30	6	76	1	282	9	912	999
o-Xylene	49	10	35	1	109	12	336	564
Methylene Chloride	39	10	8	0	89	10	565	836
Chloroform	33	9	42	0	197	9	533	1085
Ethylbenzene	57	12	49	0	204	12	502	1477
Trichloroethene[4]	45	11	0	0	41	11	425	881
1,1,2-Trichoroethane	33	7	0	0	82	9	316	542
1,1,1-Trichoroethane	43	12	0	0	10	11	39	817
1,1-Dichloroethane	26	10	0	0	0	8	16	42
Chlorobenzene	33	11	0	0	0	9	2	11
Trichloroethane[4]	17	7	0	0	1	7	1	1
Carbon Tetrachloride	31	10	0	0	0	9	0	44
Tetrachloroethene	28	9	0	0	0	9	0	0

[1] The 90 percent confidence limits lower and upper as determined for the median
[2] Where a is the number of data values from the median to the upper and to the lower 90 percent confidence limits [derived from cumulative binomial probability table in Wonnacott (Wiley 1985)]
[3] The analytes in this table are arranged in order of 90th percentile (except for the o-xylene isomer)
[4] Contains mixed isomers

Table 3-2. Summary Statistics ("Fingerprint") (Distance > 1000 Feet)

			Units of $\mu g/m^3$					
Analyte	N	Fires	Median	90% LCL[1]	90% UCL[1]	"a"[2]	90th Pcnt[3]	Max
Styrene	45	5	1	0	16	11	554	2705
Ethylbenzene	18	5	3	0	172	7	172	1390
Toluene	45	10	5	1	37	11	156	634
Benzene	47	10	4	0	29	11	67	524
Xylene[4]	20	4	0	0	0	7	4	20
m,p-Xylene	28	3	2	1	9	9	14	999
o-Xylene	38	6	1	1	5	10	13	521
Chlorobenzene	29	5	1	0	1	9	1	1
1,1,1-Trichloroethane[4]	30	5	1	0	1	9	1	7
Trichloroethane[4]	34	4	1	0	1	10	1	3
Carbon Tetrachloride	8	4	0	0	0	4	0	0
Trichloroethene[4]	6	4	0	0	18	3	0	18
1,1-Dichloroethane	7	3	0	0	0	3	0	0
1,1,2-Trichloroethane	6	2	0	0	0	3	0	0
Chloroform	3	3	0	0	0	1	0	0
Methylene Chloride	14	3	0	0	0	6	0	660
Tetrachloroethene	8	4	0	0	0	4	0	0

[1] The lower and upper 90 percent confidence limits as determined for the median
[2] Where a is the number of data values from the median to the 90th percentile [derived from cumulative binomial probability table in Wonnacott (Wiley 1985)]
[3] The analytes in this table are arranged in order of 90th percentile (except for the xylene isomer)
[4] Contains mixed isomers

maximum values, however, tend to be extremely high for some analytes in this data set (especially benzene and toluene) and may not provide a reasonable estimate of the maximum concentration likely to occur. Such extreme concentrations seem to occur very rarely, and probably do not persist for long periods. These extreme values may not, in fact, represent ambient air concentrations at all. Other factors such as measurement or data recording errors might be found to be responsible where such errors might still persist in the database. While it is important, at this stage, to retain all values in the analysis, it may be reasonable to use the 90th percentile as a surrogate for the maximum value. The 90th percentile occurs more frequently than the extreme values and is less likely to be later identified as an erroneous value.

3.2 Data Comparisons

Of the hundreds of potential tire fire air pollutants, only the 17 analytes shown in Tables 3-1 and 3-2 were common to many of the air monitoring efforts at tire fire incidents. To estimate concentrations for more than the 17 analytes, the relative concentrations of the 17 analytes were used as source profiles or "fingerprints." The fingerprints included both median and 90 percent upper confidence limits (90% UCL).

These fingerprints were compared to the Hagersville data set because it is the most comprehensive of those available from tire fire incidents. Only the Hagersville analytes that showed decreasing concentrations over distance were considered in this fingerprint match, and only values above the detection limit were used in calculating average concentrations for Hagersville analytes. The results of the match are shown in Figures 3-1 and 3-2 for distances less than 1000 feet and distances greater than 1000 feet, respectively. The Hagersville data set had five analytes (ethyl benzene, xylene, styrene, toluene, and benzene) in common with Tables 3-1 and 3-2. The m,p-xylene and o-xylene data from Tables 3-1 and 3-2 were summed to give the xylene values shown in Figures 3-1 and 3-2.

For distances less than 1000 feet, the average Hagersville values were comparable to the median fingerprint, with the largest discrepancy being about 2.5-fold for toluene. The 90% UCL of the fingerprint was much higher than the maximum values of the common Hagersville analytes. A fingerprint match was not obvious using the Hagersville data for distances greater than 1000 feet.

In addition, data common to the Hagersville incident and the EPA simulated open burning (Ryan, 1989 and U.S. EPA, 1989) are compared in Figures 3-3 and 3-4. These figures include data for analytes not in the fingerprint of 17 common analytes, but which were measured at both Hagersville and the simulated burn. The average concentrations for these simulated-burn analytes were greater than the Hagersville data with the exception of trimethyl benzene (TMB). "Spikes" of TMB occurred at several monitoring distances at the Hagersville incident, suggesting that sources other than the tire fire may have contributed.

3.3 Preliminary Conclusions

The Group 1 contaminants (benzene, toluene, and styrene) measured at the most fires, are represented by a relatively large number of measurements, and exhibit the highest overall concentrations.

While it seems reasonable to aggregate data across different incidents, further study is needed to resolve the impact of individual fires on the combined analysis. Additional effort is also needed to characterize the impact of variables other than distance and wind direction on contaminant levels. The recorded wind direction data do not seem to have a strong relationship to concentration. This may be due to inaccuracies and variations in recording practices. Principal component analysis may be useful for further clarifying the relationships among analytes and the characteristics of the tire fire incidents and monitoring parameters.

The concentration distributions show that there are many more cases of low concentrations for each analyte at distances of both less than and greater than 1000 feet. It may be reasonable to describe the distribution as log-normal. If so, the geometric mean would be the appropriate measure of central tendency.

For each analyte, concentrations appear to decrease very rapidly at first, and then very slowly with increasing distance from the fire boundary. This may be an artifact of the monitoring distances typically chosen at tire fire incidents.

The data can be reasonably summarized by statistics for measurements taken at less than and greater than 1000 feet from the fire boundary. At less than 1000 feet, the data are clustered at or near the fire boundary. At greater than 1000 feet, the rate of decrease is so gradual, that, within confidence limits, a single statistic can describe concentration levels at any given distance.

The initial efforts to compare the Hagersville data at for distances of less than 1000 feet with the fingerprint suggests that the Hagersville data may be useful in estimating tire fire pollutant concentrations. The data collected during the EPA simulated open burning study appears to show much higher concentrations of various analytes than the data collected at actual tire fire incidents. Using the Hagersville data set, it may be possible to derive analyte-specific or analyte-group factors to convert the simulated burn data to "real world" conditions at distances less than 1000 feet.

Figure 3-1. Hagersville vs. Fingerprint Data (Distances ≤ 1000 Feet)

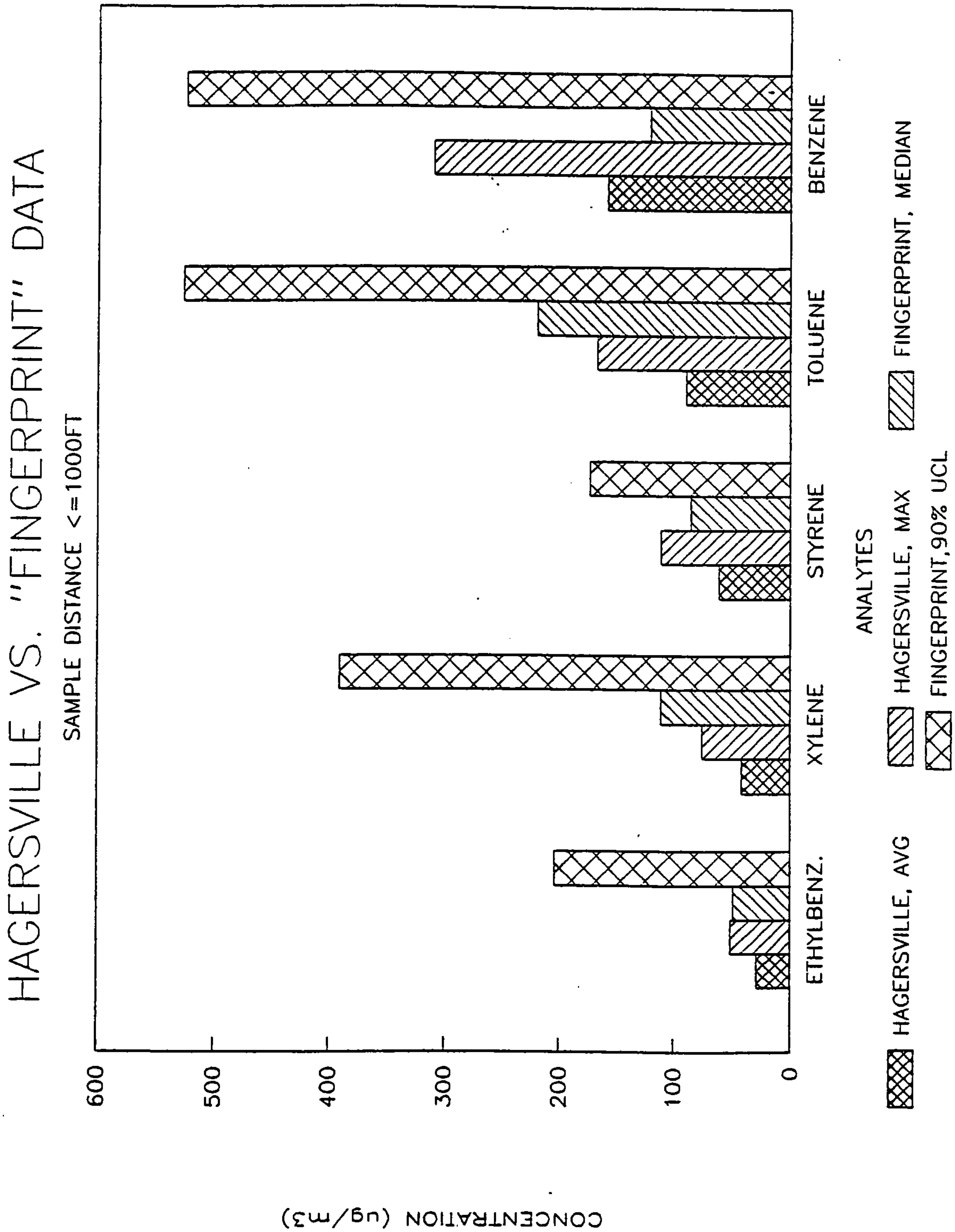


Figure 3-2. Hagersville vs. Fingerprint Data (Distance > 1000 Feet)

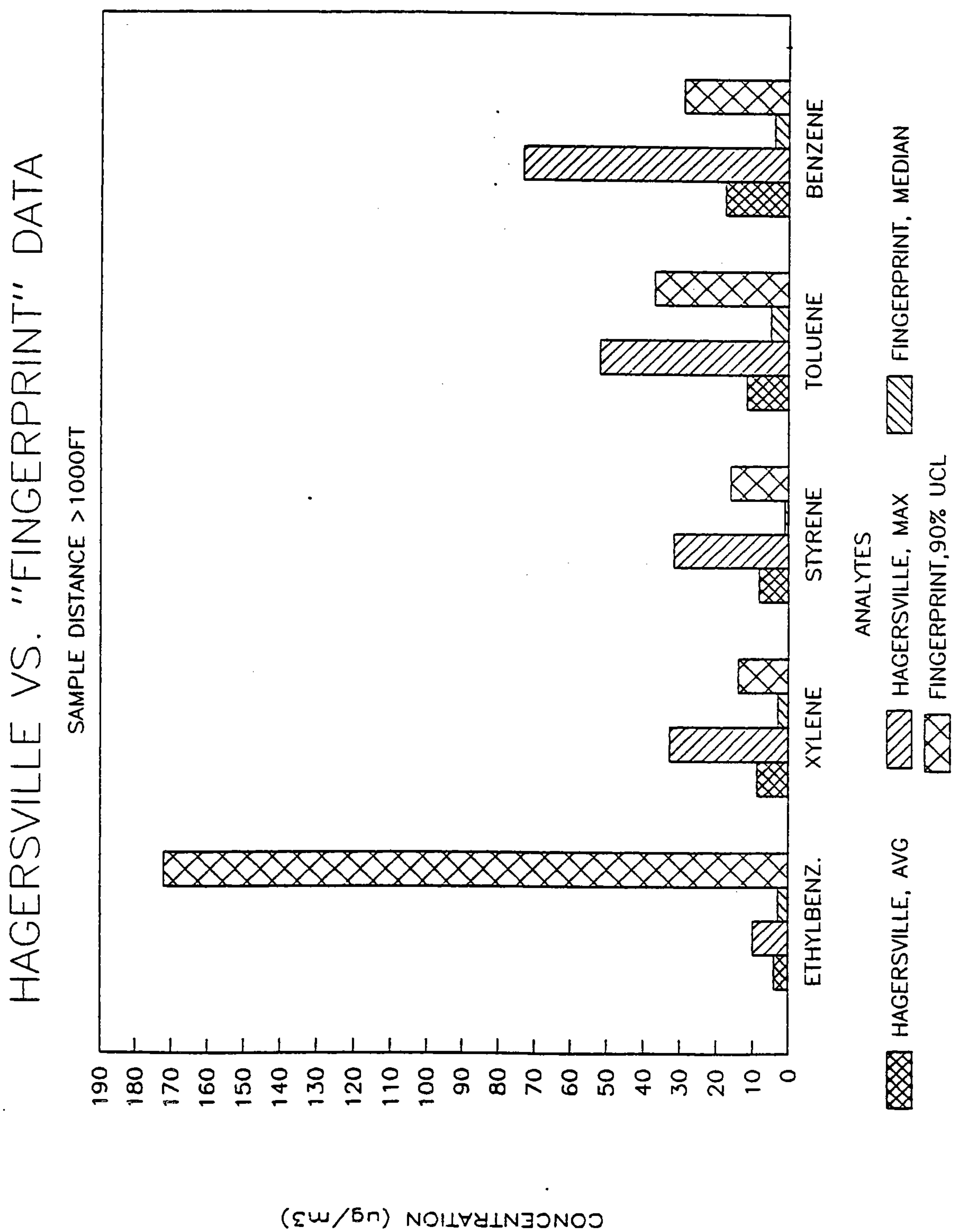


Figure 3-3. Hagersville vs. Simulated Burn Data (Distance ≤ 1000 Feet)

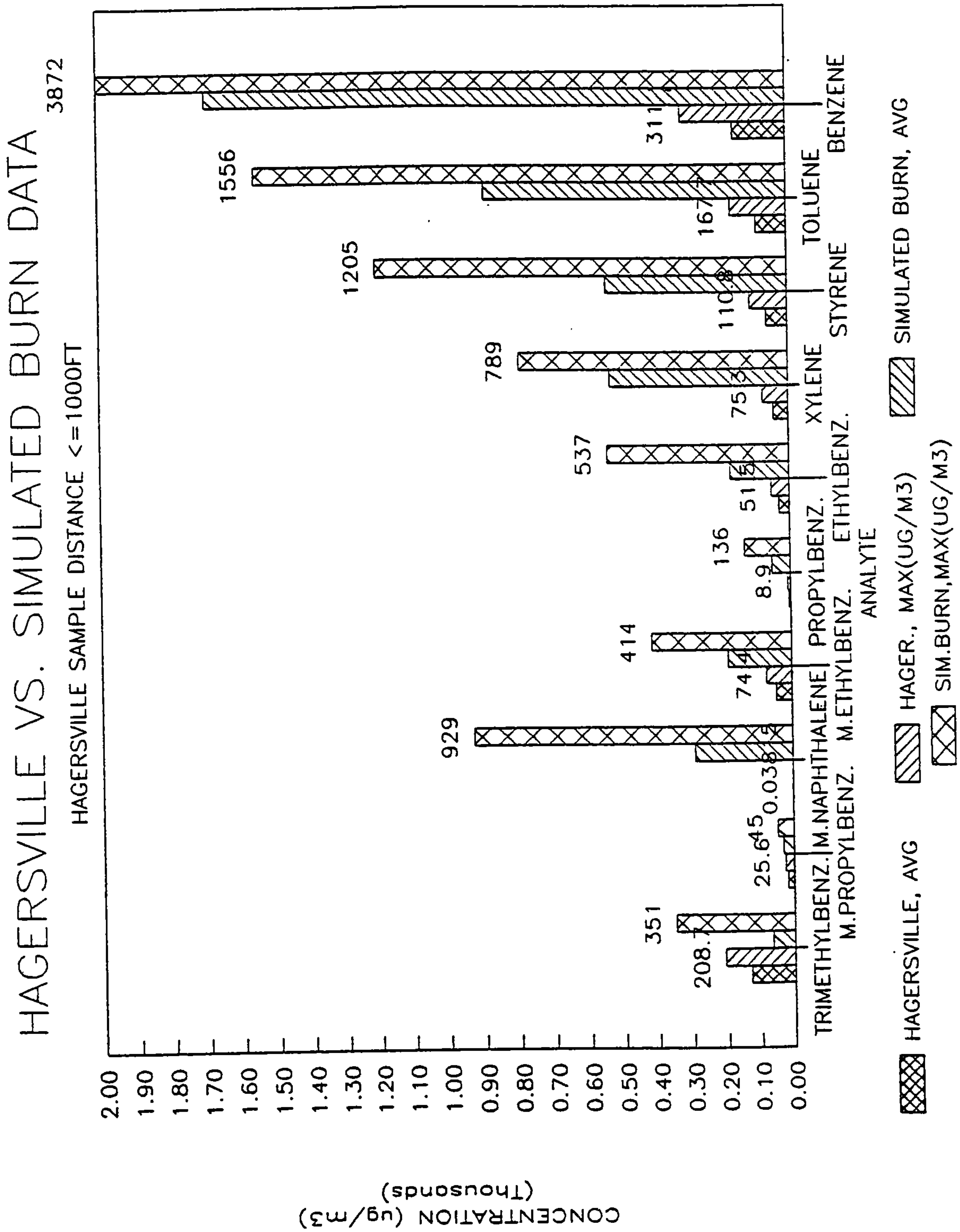
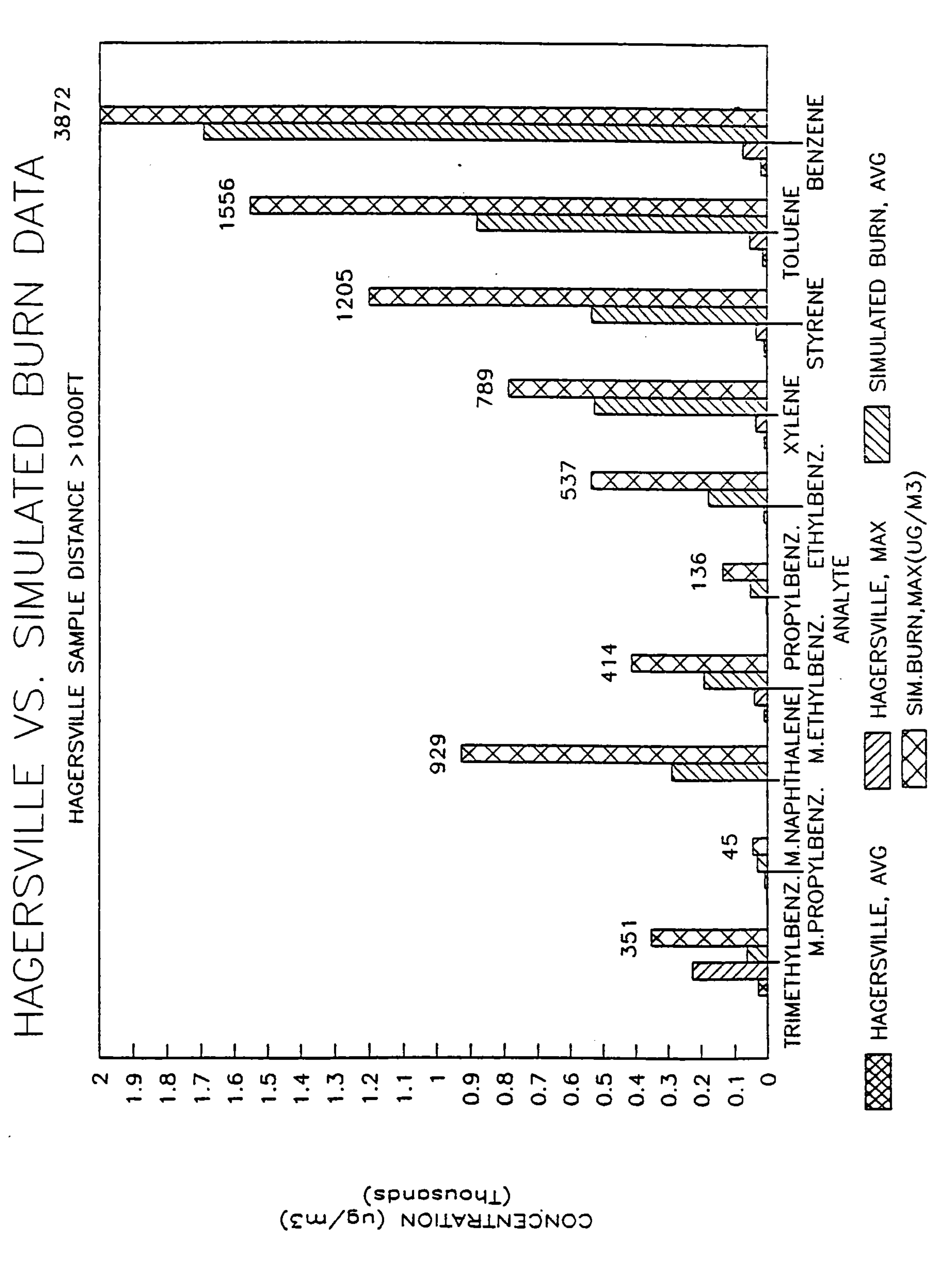


Figure 3-4. Hagersville vs. Simulated Burn Data (Distance > 1000 Feet)



APPENDIX A
DATA ACQUISITION

(Intended to be useful for scientists interested in using the database system for additional research.)

APPENDIX A. DATA ACQUISITION

A.1 Data Sources

The tire fire incidents with air monitoring data were identified through telephone conversations and written correspondence with persons identified by the Air RISC Hotline the EPA Emergency Response Office in Edison, NJ; State and local staff in air pollution and solid wastes offices in all 50 States; and a number of other government agencies, universities and business groups.

A.2 Definition of Data Requirements

In consultation with air monitoring and dispersion modeling staff, a listing of information was produced that would be useful in evaluating the air monitoring data. This listing of site characteristics that may influence contaminant concentrations included monitoring distance from the fire, fire size and duration, and topographical and meteorological conditions. During telephone conversations with the site contacts, the type and format of information available was listed. This site contact information was used to determine the level of detail that could be expected. A preliminary database system was written, consisting of about 50 topics. The preliminary database system was then revised in several iterations reviewed by three site contacts.

A.3 Receipt of Data

Tire fire incident information typically consisted of brief reports, laboratory data sheets, and handwritten notes compiled from telephone conversations with tire fire incident contacts. Inventory and follow-up actions were tracked using a computer file. Follow-up telephone conversations usually provided additional information, although many fields in a given record could not be completed. Air monitoring data sets for 22 tire fire incidents were entered into the database system. The original numbering system is retained throughout this report; therefore, the numbering of the 22 tire fire incidents is not consecutive. We were not able to locate what we believe to be a large air monitoring data set for the Denver, Colorado tire fire incident that occurred on June 11, 1987. The tire fire incidents in the database and summary of the number of analytes and the number of contaminant measurements for each incident are shown in Table A-1.

A.4 Sampling and Analytical Methods

The sampling and analytical methods used for determining airborne concentrations of analytes at tire fire incidents were considered in the decision whether to enter data into the database system. For example, analytical equipment used to measure the actual concentrations of analytes in a given volume of sample must have acceptable detection limits and employ appropriate standards. For most of these incidents, sufficient information pertaining to the type of sampling and analytical equipment used at each of the tire fire incidents was available. This information in presented in Table A-2.

Table A-1. Incident Information and Summary of Contaminant Measurements in Database System

Tire Fire Data Set - Login Sheet				
ID #	Tire Fire Incident (name)	Tire Fire Incident Date	Unique Analytes[1]	Total Measurements[2]
1	Hagersville, Ontario, Canada	2/12/90	100	3821
2	Everett, WA	9/24/84	25	116
3	Webber, Ogden, UT	8/4/86	19	284
4	Catskill, NY	2/26/89	28	162
5	Rhinehart (Winchester), VA	10/31/83	12	143
6	Level Cross, NC	6/12/89	69	384
7	Wakefield, VA	3/20/91	18	246
8	Norfolk, VA	11/4/83	4	16
9	Batesville, AR	3/31/87	7	78
12	Jonesville, NC	7/4/90	8	20
14	Danville, PA	9/13/89	41	234
15	Danville, NH	10/31/84	8	48
17	Spencer, MA	2/13/86	6	18
18	Belchertown, MA	7/27/86	3	9
20	Somerset, WI	10/20/86	18	115
21	St. Amable, Quebec, Canada	5/16/90	2	6
23	Wawina, MN	4/19/89	17	108
24	Andover, MN	2/8/89	6	53
26	C&J Tire (Chadbourn), NC	11/24/88	2	2
28	Tacoma, WA (test burn)	1988	30	35
30	Minden (McKee Farm), IA	6/21/89	15	49
31	Fairbanks (N.Houston), TX	6/4/89	3	12
Total				5959

[1] The count of analytes includes various isomers of an analyte.
[2] Total measurements include measurements with values of zero.

Table A-2. Sampling and Analysis Methods Used at Each Tire Fire Incident

ID#	Tire Fire Incident (name)	Sampling Equipment/ Type Sampling Media Used	Analysis Method Used
1	Hagersville, Ontario, Canada	VOCs - XAD thermal desorption cartridges; PAHs - modified hi-volume particulate sampler with glass fiber filter cartridge	GC/MS
2	Everett, WA	Gillian pump/charcoal and Tenax tubes for sampling VOCs	GC/MS - Liquid Chromatography (EPA Method 610)
3	Webber, Ogden, UT	Gillian Pump/charcoal tube and 2 stage silica gel tubes for sampling VOCs - Cellulose particulate filters for sampling particulates	NIOSH procedures - #127 (charcoal tubes), #173 (particulate filters) and #168 (silica gel tubes)
4	Catskill, NY	Could not determine sampling instrument used/carbon tubes for sampling various hydrocarbons	GC/FID using NIOSH procedures #1501 (aromatic hydrocarbons), #1500 (BP 36°-126° hydrocarbons) and 1003 (halogenated hydrocarbons)
5	Rhinehart (Winchester), VA	Could not determine sampling instrument(s) used/3-stage silica gel tubes (aromatic amines); carbon/Tenax/chro-mosorb tubes (organic vapors); mixed cellulose ester filters (MCEF) (for particulates)	Analytical procedures for the carbon and silica gel tubes included NIOSH P&CAM - 168 (aromatic amines) and NIOSH P&CAM-127 (organic vapors); GC/MS used for Tenax tubes; AAS used to analyze MCEF
6	Level Cross, NC	Gillian pump/Tenax and carbon tubes	GC/MS
7	Wakefield, VA	Grab sample using VOC canisters for sampling VOCs; hi-volume particulate sampler using glass fiber filters for sampling particulates	GC/MS for analyzing VOC concentrations; ICAP for analyzing for particulates
8	Norfolk, VA	Could not determine sampling instrument used/charcoal tubes	GC/MS
9	Batesville, AR	Could not determine sampling instrument used/Tenax and silica gel tubes	GC/MS

ID#	Tire Fire Incident (name)	Sampling Equipment/ Type Sampling Media Used	Analysis Method Used
12	Jonesville, NC	Miran spectrophotometer; Drager tubes; bag samples	GC for analyzing bag samples; other analytical methods used could not be determined
14	Danville, PA	Sampling pump/charcoal tubes for sampling VOCs	GC/MS
15	Danville, NH	Tenax tubes for sampling VOCs	GC/MS
17	Spencer, MA	Evacuated bottle; battery pump used with Tenax and Drager tubes - for sampling VOCs	GC/MS
18	Belchertown, MA	Evacuated bottle for sampling VOCs	GC/MS
20	Somerset, WI	Gillian pump/Tenax or charcoal tubes for sampling VOCs; Tedlar bags for gases; Gillian pump/particulate filters for sampling airborne metals	GC/MS/HPLC used to analyze Tenax and charcoal tubes for volatile and semi-volatile organic compounds; gas analyzer used to analyze Tedlar bag samples for concentrations of SO_2; could not determine method used for metals analysis
21	St. Amable, Quebec, Canada	Hi-volume sampler/polyurethane filters	GC/MS
23	Wawina, MN	Drager tubes and Tedlar bags	GC/MS for analyzing VOC samples taken using tedlar bags; could not determine method used to analyze the drager tubes
24	Andover, MN	Tedlar bags for sampling VOCs	Capillary GC/ion MS
26	C&J Tire (Chadbourn), NC	Hand bellows pump/Drager tubes for sampling for benzene and toluene	Method of analysis could not be determined
28	Tacoma, WA (test burn)	Low-volume sampler/charcoal tubes for sampling VOCs	GC/MS
30	Minden (McKee Farm), IA	6-liter vacuum canisters used to sample VOCs	Method of analysis could not be determined

ID#	Tire Fire Incident (name)	Sampling Equipment/ Type Sampling Media Used	Analysis Method Used
31	Fairbanks (N. Houston), TX	Vacuum pump/CMS tubes to sample for VOCs	GC/ITD [concentrations of VOCs were reported as quantitative estimates of benzene since an appropriate standard was not available in the field]

NOTE:
AAS - atomic adsorption spectroscopy
CMS - chromosorb
FID - flame ionization detection
GC/MS - gas chromatography/mass spectroscopy
HPLC - high pressure liquid chromatography
ICAP - inductively coupled argon plasma spectroscopy
ITD - ion trap detector
NIOSH - Natinal Institute of Occupational Safety and Health
VOC - volatile organic compound

APPENDIX B

DATA SET HANDLING PROCEDURES

MEMORANDUM

To: Dan Bowman
Marilyn Bulman
Ritchie Buschow
Ken Jones
Nancy Rohr
project file

Date:Monday 4 May 92

From:Bill Mitchell

Subject: Tire Fire Data Handling Procedures (Updated: 4 May 92)

TIRE FIRE WORK ASSIGNMENT

DATA SET HANDLING PROCEDURES

Updated: 4 May 92
20 changes(**) since 1 April 92;
5 changes(*) since 30 March 92.
(This document replaces all project modifications completed before 4 May 92.)

General Procedures:

All files and diskettes are stored in file cabinet drawer in Bill Mitchell's and Marilyn Bulman's Quadrangle offices. When removing a file or diskette, sign and date the check-out form.

Handwritten entry of a data set:

1. Current updates of the hard copies of the data base system "screens" are in the project file cabinet drawer. Use only these "screens".

2. Obtain the entire data set file, including the 2 diskettes, for a given tire fire incident.

** 3. Obtain "tire fire incident identification number "incident name" from the Tire Fire Login Sheet. This "Sheet" is a Lotus 1-2-3 file in [Scratch] named "LOGIN.WK3".

4. Review the ten conversions on the incident diskettes. These ten appear to be the most common conversions, although additional ones may be required. New conversions must be checked by a second person before use. After confirming the accuracy of the conversion, the second person should date and initial the print-out containing the conversions. This print-out should then be filed in a file folder labeled "Conversions" (there is one "Conversions" folder for each tire fire incident). When unit conversions are necessary, perform conversions using appropriate conversion files on the "primary" incident diskette. Save files to both the "primary" and the "backup" diskettes.

* 5. When writing conversions on a "screen" hard copy, make two columns and write the data units at the top of each column. Enter the data from the original document in the first column and the converted data in the second column.

* 6. Use the "Phone Conversation Record" forms and keep detailed telephone conversation notes when talking to tire fire incident contacts. These notes are kept in the project files.

** 7. The complete re-entry of data sets for the Everett, Chadbourn (C&J Tire) and the Somerset tire fire incidents must be completed by a second Alliance staff member.

8. All incident data sets must be handwritten and reviewed before computer entry except for several very large data sets such as Rhinehart (Winchester) and Hagersville.

* 9. Questions?: Ask Bill or Marilyn or use Everett and Level Cross incidents as examples. If a modification to these procedures is needed, use a "project modification" form.

Computer entry of data set into dBase system:

1. Refer to **Specific Procedures...**

2. Set "confirm" to on.

3. Leave field blank if no data is available.

4. Save files to both diskettes frequently.

Specific Procedures

"Tire Fire Incident Identification" database:

1. Obtain <u>tire fire incident identification #</u> <u>incident name</u> from the Tire Fire Login Sheet. This "Sheet" is a Lotus 1-2-3 file in [Scratch]

named "LOGIN.WK3". Some tire fire incidents may have had two or more separate teams monitoring air concentrations, with two or more discrete sets of sampling data. Each incident is given only one Incident ID#, even if there is more than one set of data and more than one contact organization, person, and phone number. The additional contacts and contact phone numbers should be entered into the "Comments" data base. The data sets are distinguished from each other by assigning different MONCRIS #s for the monitoring instruments. (Be sure to note on the Data Set Source Sheet the Instrument ID #s to facilitate tracking these separate data sets.)

** 2. One of three entries should be used in the "Complete?" field: "Y" (Yes), "N" (No), and "M" (Minimal). Some incidents do not have data for fields in the data bases or the time needed to seek out these data is excessive. If you think you have a "Minimal" data set, first explain this to Bill and then determine if the following "M" information is available:

<u>Screen</u>	<u>Field</u>
INCIDENT IDENTIFICATION	Complete? = <u>M</u> Incident ID # Incident Name Total Tires
FIRE FIGHTING DATA	none
ENVIRONMENTAL SITE DATA	none
MONITORING INSTRUMENT DATA	Instrument ID Instrument's Site-to-instrument Wind Orientation Instrument Distance from Fire Boundary
SAMPLED ANALYTE DATA	Analyte Detect Flag Air Concentration
BIBLIOGRAPHY	none

COMMENTS none

2. Write the name of a contact person who is easily accessible by telephone, knowledgeable about the air monitoring and the incident location.

"Site Data Available for Incident" database:

1. A "y" is entered in the Information Available field if quantitative data or specific descriptions are available (e.g. hourly wind speed measurements or symptom questionnaires.

"Fire Fighting Activity Data"

** If more than one fire-fighting activity was used, list first the one that was most used. Also list the fire fighting activity types and the dates they were used in the "Comments" data base.

"Monitoring Instrument Data"

1. Because of space limitations, when assigning a Monitoring Instrument ID, use this hierarchy:
   a. try to match instrument ID with that used in the original document,
   b. assign an arbitrary number (i.e. 1,2,3...),
   c. assign an arbitrary number followed by an abbreviation of "chemical grouping" used in the original document.

2. In the following order, write at least four descriptive words separated by commas in Monitoring Instrument Description that address:
   a. collection device (e.g. Gillian pump)

b. collection media (e.g. Tenax tube)

c. analytical method (e.g. GCMS)

** d. quality concerns (i.e. y,n or ?). If "n" is entered, explain in "Comments" data base (e.g. potentially: clogged filter, absorption tube breakthrough, lab contaminant)

** 3. Use of the Monitoring Instrument Compass Direction From Tire Fire Center field is optional.

** 4. Use only "up", "down" or "variable" in the Monitoring Instrument Site-To-Instrument Wind Orientation. Indicate plume color, if known, in "Comments".

** 5. Write in first the Monitoring Instrument Site Terrain feature that is judged by the documentation to most significantly affect contaminant air concentrations. If including more than one feature, separate with commas. Use only the following features "Depression", "hilltop", "slope", "level", "large surface water","buildings","trees".

** 6. If a monitoring instrument is used for sampling on more than one day at the same location, assign the instrument a different monitoring instrument ID# for each day. If the location of a monitoring instrument is changed, assign a new Monitoring Instrument ID #.

"Specific Sampled Analyte Data":

** 1. Review all documentation and select the most appropriate documents containing the incident air monitoring data set. The "data set source" form should be attached to copies of the data set before these materials are stored in the project file cabinet. Enter data quality concerns in the "Comments" data base.

2. Use appropriate conversion spreadsheets on the incident diskettes.

3. If there are two or more chemical air concentrations for one analyte at a given Monitoring Instrument ID # (e.g. 9 a.m. and 3 p.m. sampling times), assign an arbitrary Sample Num for each (i.e. 1,2,3...).

** 4. Only concentrations for specific analytes should be entered into the data base. Documents containing data for analyte "groupings" such as Total Suspended Particulates (TSP), Polynuclear Aromatic Hydrocarbons (PAHs or PNAs), Volatile Organic Compounds (VOCs) should be entered and filed in the Bibliography. The data collected using non-specific field instruments such as an Organic Vapor Analyzer (OVA) or a Flame Ionization Detector (FID) should also be listed in the "Comments" database and documents filed in the Bibliography.

* 5. In general, only target analytes should be included in a data set although if only a few non-target analytes are included in the data summary of an original document the following procedure should be followed: If two or more specific analytes are a "group" and are assigned a single air concentration, write each analyte on a separate line and write the air concentration divided by the number of analytes in the "group".

6. If a specific analyte appears in a data subset for a given monitoring instrument (i.e. same instrument, date and time), assign a separate Sample Num for each.

** 7. Enter only air concentration numeric values. If an analyte air concentration is listed ND (not detected), BTL (below detection limit) or 0, leave SAMAIR field blank.

** 8. For each tire fire, label a file folder "Data Sets" If the data set is small, place photocopies of data used in the tire fire database in the file folder and attach a blank "Data Set Source Sheet" form. If the data set is unreasonably large to photocopy, fill out a "Data Set Source Sheet" form and place it in the "Data Set" folder.

"Comments":

The "Comments" data base is used to record any information that may be important in interpreting the <u>air concentration</u> data but does not have a specific field. Examples include:

1. Smoke plume characteristics (e.g. color, opaqueness, height)
2. References for selected data set
** 3. Brief description of analytical methods
** 4. Brief data quality summary. Summarize information concerning quality of data entered into the data base. Include comments about clogged filters, absorption tube breakthrough, lab contamination, lapsed holding times.
5. Synonyms for the tire fire incident
* 6. If used, the name of the air dispersion model
** 7. If modeling was done to estimate non-target compounds, make a note in the "Comments" section.
** 8. Listing of fire fighting activity types and the dates they were used <u>if</u> they affected air sampling data.
** 9. If in-vitro assays were performed during a tire fire, make a note in the "Comments" section.
** 10. List additional Site Contact persons and phone numbers.
** 11. List data "groupings" available such as Total Suspended Particulates (TSP).

"Bibliography":

1. Organize hard copies of documents as follows and enter into "Bibliography" data base:

a. Publications
b. Stand-alone reports

c. Series of memos, letters, workplans, analytical reports (may also be included as a "Stand-alone") that address a particular issue.

** d. Newspaper articles (group all articles into a file folder labeled "Newspaper Articles" and staple a "Bibliography" screen to them.

2. Since Book, Magazine, or Journal Title and Article Title fields have a 50 character limit, use common abbreviations and "...".

3. Attach a hard copy of the "Bibliography" screen to the document before filing.

APPENDIX C

DATABASE CONSTRUCTION

APPENDIX C. DATABASE CONSTRUCTION

C.1 Background

Initially, TRC identified 31 tire fire incidents were identified in which air monitoring data had been collected for up to 100 pollutants. None of these data were available in machine-readable form. A database system was developed, based on the information gathered during telephone conversations with contacts for several tire fire incidents.

C.2 Purpose

The purpose of the database system for this work assignment was to facilitate the efficient and accurate entry of data, and to provide a flexible method to summarize and evaluate the data.

C.3 System Requirements

The following assumptions were made in selecting an adequate database system: data entry would be performed by secretarial staff using existing hardware, data could be accessed by EPA staff using existing software on nominal "PC" hardware, and data could be exported to Lotus 1-2-3 or Axum for analysis.

C.4 System Design

The database software selected was dBaseIV version 1.1. A database "system" was constructed using dBaseIV to accommodate both the data entry and data summary requirements consisting of seven database files and a total of 65 fields. The files are linked by common fields, and only one data entry is needed for a field common to two or more of the seven database files. The fields were designed to facilitate the correct entry of data, including a limited number of characters for each field, multiple choice fields, and a data entry enhancement so that a pollutant name needed to be entered (and spelled correctly) only once, even though the pollutant appeared in many of the tire fire incident data sets. In addition, a menu item was included to allow the data entry operator to stop before completing a record and finish the record at another time. Although dBaseIII+ currently is more widely used within EPA than dBaseIV, dBaseIV includes better data querying capabilities among multiple database files. A set of the field specifications for the seven database files is included in Appendix D of this report.

C.5 System Use

Data entry was performed using the system developed by TRC. Depending on how complicated the data interpretation process was for a given tire fire incident, data entry consisted of either writing the information on forms and subsequently completing the computer entry, or directly entering the data into the computer database system. Data summaries were prepared using dBase queries. The queries producing useful information were made into new databases and exported to Lotus 1-2-3 version 3.1 or Axum version 1.0.

C.6 System Limitations

The specific procedures for correct entry of data into the database system were documented for use by data entry staff. These data handling procedures are included in Appendix B of this report. The database system was not designed to perform unit conversions (e.g., ppm to $\mu g/m^3$). Instead, Lotus 1-2-3 spreadsheets were used to perform and document any necessary conversions.

APPENDIX D

DATABASE SYSTEM SPECIFICATIONS

DATABASE STRUCTURE: C:\TIRE\TF_DATA\INCIDENT.DBF

Number of records: 22
Date of last update: 07/29/92

FIELD	FIELD NAME	TYPE	WIDTH	DEC	INDEX
1	INCNUM	N	3		Y
2	INCNAME	C	50		N
3	INCDATE	D	8		N
4	AGENCY	C	50		N
5	AGSAL	C	4		N
6	AGLAST	C	20		N
7	AGFIRST	C	15		N
8	AGMI	C	1		N
9	AGPHONE	C	10		N
10	CITY	C	20		N
11	COUNTY	C	20		N
12	ST_OR_PROV	C	3		N
13	COUNTRY	C	20		N
14	TIRENUM	N	10		N
15	BURNPCT	N	3		N
16	BURNDUR	N	5		N
17	SITESIZE	N	8	3	N
18	FIRESIZE	N	8	3	N
19	PILEHT	N	3		N
20	PILECONF	C	15		N
21	TIREOIL	N	10		N
22	BURNMAT	C	30		N
23	INCFLG	C	1		N
TOTAL			318		

DATABASE STRUCTURE: C:\TIRE\TF_DATA\HAGER1.DBF

Number of records: 7
Date of last update: 04/06/92

FIELD	FIELD NAME	TYPE	WIDTH	DEC	INDEX
1	SAMANAL	C	40		N
2	SAMAIR	N	19	13	N
3	MONDIS	N	6		N
TOTAL			66		

DATABASE STRUCTURE: C:\TIRE\TF_DATA\MONITOR.DBF

Number of records: 341
Date of last update: 07/29/92

FIELD	FIELD NAME	TYPE	WIDTH	DEC	INDEX
1	INCNUM	N	3		Y
2	MONCRIS	C	5		Y
3	MONDES	C	40		N
4	MONDIR	C	4		N
5	MONDIS	N	6		N
6	MONHT	N	3		N
7	MONWIND	C	8		N
8	MONTER	C	50		N
TOTAL			120		

DATABASE STRUCTURE: C:\TIRE\TF_DATA\ANALYTE.DBF

Number of records: 5697
Date of last update: 07/30/92

FIELD	FIELD NAME	TYPE	WIDTH	DEC	INDEX
1	INCNUM	N	3		N
2	SAMANAL	C	40		Y
3	SAMDATE	D	8		N
4	SAMNUM	N	3		N
5	MONCRIS	C	5		N
6	SAMFLG	C	1		N
7	SAMAIR	N	19	13	Y
8	SAMDUR	N	5	2	N
9	SAMVOL	N	6	4	N
10	SAMWND	C	4		N
11	SAMWNS	N	3		N
12	SAMTEMP	N	3		N
TOTAL			101		

DATABASE STRUCTURE: C:\TIRE\TF_DATA\FIREFITE.DBF

Number of records: 21
Date of last update: 09/14/92

FIELD	FIELD NAME	TYPE	WIDTH	DEC	INDEX
1	INCNUM	N	3		Y
2	FITETYP	C	30		N
3	FITEDATE	D	8		N
4	FITEDUR	N	5		N
TOTAL			47		

DATABASE STRUCTURE: C:\TIRE\TF_DATA\ENVDATA.DBF

Number of records: 147
Date of last update: 04/09/93

FIELD	FIELD NAME	TYPE	WIDTH	DEC	INDEX
1	INCNUM	N	3		N
2	DATATYPE	C	4		N
3	DATAVAIL	C	1		N
4	DATALAST	C	20		N
5	DATAFIRST	C	15		N
6	DATAMI	C	1		N
7	DATPHONE	C	10		N
TOTAL			55		

DATABASE STRUCTURE: C:\TIRE\TF_DATA\COMMENT.DBF

Number of records: 13
Date of last update: 09/14/92

FIELD	FIELD NAME	TYPE	WIDTH	DEC	INDEX
1	INCNUM	N	3		Y
2	INCCOM	M	10		N
TOTAL			14		

DATABASE STRUCTURE: C:\TIRE\TF_DATA\BIBLIO.DBF

Number of records: 23
Date of last update: 04/09/93

FIELD	FIELD NAME	TYPE	WIDTH	DEC	INDEX
1	INCNUM	N	3		Y
2	BIBLST	C	20		N
3	BIBFST	C	15		N
4	BIBMI	C	1		N
5	BIBTIT	C	50		N
6	BIBART	C	50		N
7	BIBVOL	N	3		N
8	BIBPAG	N	4		N
9	BIBDATE	D	8		N
TOTAL			155		

DATABASE STRUCTURE: C:\TIRE\TF_DATA\ANALLIST.DBF

Number of records: 154
Date of last update: 07/16/92

FIELD	FIELD NAME	TYPE	WIDTH	DEC	INDEX
1	SAMANAL	C	40		Y
TOTAL			41		

DATABASE STRUCTURE: C:\TIRE\TF_DATA\ENVLIST.DBF

Number of records: 7
Date of last update: 04/06/92

FIELD	FIELD NAME	TYPE	WIDTH	DEC	INDEX
1	ENV_TYPE	C	4		Y
2	DESC	C	15		N
TOTAL			20		

APPENDIX E

QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

APPENDIX E. QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

E.1 Introduction

The data acquired for this project represent a wide variety of data collection, analysis, and Quality Assurance/Quality Control (QA/QC) methods. Data were not entered into the database if the site contact person or a site report author stated that the data were incorrect or misleading. Data from non-specific monitoring methods, such as field-survey instruments, were also not included. In addition, a QA/QC program was designed to minimize the potential for errors in entering data from the original reports to the database system and to detect errors if they occurred. The QA/QC program consisted of the following elements:

- Data "manifest" sheet: This sheet was used to keep track of the data sets including: data receipt date, handwritten data entry date, computer data entry date, and a listing of incomplete items.

- Double-entry procedure: Values from fields in the monitoring instrument and analyte databases for three data sets were entered into separate database files by two people. The files were then compared and differences were evaluated. Differences resulted from ambiguities in the original reports (i.e. different interpretations by two data entry people), different interpretations in the data entry procedures, or incorrect data entry.

- Calculation checks: Tire fire data required several unit conversions to be made. An audit was done that compared the data received to the data entered. Unit conversions were performed using a formula in a computer spreadsheet.

The three data sets used for the double entry procedure were for the Belchertown, Spencer, and Everett tire fires. The Belchertown data set contained 9 separate analyte records, the Spencer data set contained 18 records, and the Everett data set contained 96 records, for a total of 123 analyte records. Each analyte record had 19 data entry fields. Three of these fields, SAMNUM (Sample Number), MONCRIS (Monitoring Instrument Identification), and MONTER (Monitoring Instrument Location Terrain), were not included in the double-entry procedure because the values for these fields were arbitrary. Thus, 16 data entry fields were available for double entry. The 16 data entry fields could be evaluated using two general categories. The first category included six of the "minimal" fields that were required for a data set to be entered into the database system and an additional "field," record omission, to indicate when the double entries differed by an entire record. The second category included the 10 fields of ancillary information that were not available for many of the data sets. The total number of data entered in these fields for the three tire fire incidents was 1,968 (123 analyte records times 16 data entry fields). A simple QA/QC procedure was used to check all three double-entered data sets. A separate printout was generated for each double-entered data set, the printouts were then compared and any differences noted.

E.2 Preliminary Results and Discussion

The following is a description of data fields and types of differences found during the QA/QC check. Only data fields with multiple differences are discussed.

- Record Omission. Record omissions occurred 31 times, 11 as data entry and 20 as data interpretation. The data entry differences occurred when a data entry operator missed a value in the original report. Data interpretation differences occurred when one data entry operator entered sample blanks and another did not. All 20 differences were in the Everett fire data set. One of the Everett data sets was completed eight months before the second data set and there were changes in procedure between the two entry periods.

- Sample Flag (SAMFLG). Two data entry people had interpreted the purpose of the sample flag field differently. The original purpose of the sample flag field was to enter one-half the detection limit for all samples in which a contaminant was not detected and enter "No" in SAMFLG. The strategy was not used in the data analysis presented in this report (i.e., we were no longer interested in values below the detection limit).

- Sample Air Concentration (SAMAIR). The differences in values were actually errors and represented incorrect units for values at or below the detection limit. No errors were found in values above the detection limit. In particular, the sample air concentration data for the Everett tire fire were checked.

Table E-1 is a summary of the double-entry differences. The two categories of database fields are listed across the top; "minimum" fields are shaded and ancillary fields are unshaded. The tire fire name and types of differences are given along the side of the table. The two types of differences are data interpretation and data entry. Data interpretation differences occurred because the data presentation in the original report was ambiguous. For example, monitoring instrument height might be given in the original report as "2-3 feet." One data entry person would enter "2 feet" while another entered "3 feet." Data entry differences occurred when one data entry person incorrectly entered data or neglected to enter data.

There were a total of 425 differences between the double entries of the three data sets, resulting in a 22 percent difference rate for the three data sets. The differences by data set were 2 percent for Belchertown, 9 percent for Spencer, and 26 percent for Everett. The differences noted in "record omissions" and the sample flag fields often do not represent true or important differences since, in many cases, the differences involved sample blanks and analyte detections given as "below detection limit" or "0" which were not significant for the analyses performed in this report. The four remaining fields with any differences had a 6 percent difference rate. Of particular concern are the 10 data entry differences in the sample air field. These differences were only for values reported for the Everett tire fire at the detection limit but not for values above the detection limits. The incorrect values were actually reported in mg/m^3 instead of $\mu g/m^3$.

Table E-1. QA/QC Preliminary Results

	RECORD OMISSION	INCNUM	SAMANAL	SAMDATE	SAMNUM	SAMFLG	SAMAIR	SAMDUR	SAMVOL	SAMWND	SAMWNS	SAMTEMP	MONDES	MONDIR	MON DIS	MON HT	MON WIND	TOTAL	DIFF RATE MIN.	DIFF RATE TOT.
Belchertown, MA																			6%	2%
Data Interpretation																		**0**		
Data Entry															3			**3**		
Spencer, MA																			4%	9%
Data Interpretation													1		1	16	1	**19**		
Data Entry	1	1											4					**7**		
Everett, WA																			19%	26%
Data Interpretation	20																	**20**		
Data Entry	10					59	10		11	96	83	96			12			**377**		
Total Count	31	1				59	10		11	96	83	96	5		16	16	1	**425**	16%	22%
Difference Type	3	1				1	1		1	1	1	1	2		3	1	1			
Total without Omission Record and SAMFLG																			6%	19%

E.3 Preliminary Conclusions

The potential error rate was less than the 6 percent difference rate identified by comparing the three double-entered data sets. In particular, additional QA/QC efforts addressed the unconverted values within the sample air field. In general, 90 to 95 percent of the differences were readily identifiable and correctable.The results of the double-entry process suggest that there is a greater likelihood of differences in data entered in the larger data sets. Potentially, some of these differences could be errors. The records for the analytes used in the exploratory data analysis were checked in the following QA/QC procedure:

- Checked data field SAMFLG against SAMAIR. If there was a concentration given in SAMAIR, then SAMFLG should say yes, and vice versa. Also checked for patterns in SAMAIR numbers. Looked for unexpected values.

- To reduce record omissions, double checked analyte list versus data entries. Counted sources and verified analyte numbers.

- Checked one SAMAIR value from each data set for proper units for values at or below the detection limit.

E.4 QA/QC Procedure for Random Checks

QA/QC checks were performed on each of the five tire fire incidents which contained more than 200 records in the database. Table E-2 shows the type and number of data checked. A random number table was used to determine the order for checking each of the incidents, as well as randomly selecting which records to review. For each of the five incidents, the data submitted with the documentation (i.e., "the raw data") for each of the incidents were checked against the entries made in the database.

QA/QC notations were made on the database master printout. These notations were made as follows:

- A slash mark (-) was made in the left margin next to each randomly chosen record using red ink.

- The entire entry line for each randomly chosen record was highlighted with a yellow marker.

- Potential differences noted in a given field(s) for each record checked was circled with a pencil (i.e., first pass).

- For each potential difference in a given field, the original data for that particular incident were double-checked to determine if it was an actual difference (i.e., second pass).

- If an actual difference was noted during the second pass, the corrected value was noted in red ink on the master printout next to the error, and an arrow was drawn from the notation to the field for which the correction would be made.

Table E-2. Recommended QA/QC Checks

Database[1]	Fields	Total Records	QC Checks Records	Total Values	QC Checks[2] Values
BIBLIO	9	23	1	207	9
FIREFITE	4	21	1	84	4
ENVDATA	7	147	8	1,029	56
COMMENTS	2	13	1	26	2[3]
INCIDENT	23	22	1	506	23
MONITOR	8	341	17	2,728	136
ANALYTE	12	5967	250	71,604	3,000
	65	6534	279	76,184	3,230

(1) Data sets (*i.e.*, tire fire incidents) are randomly selected for QA/QC check except for ANALYTE which will be performed on the analytes used in the exploratory data analysis.

(2) QC checks comprise approximately 5% of all database data.

(3) Additional checks for omissions are suggested in the nine data sets for which there are no COMMENTS records.

In some instances, additional differences between the raw data and information entered into the database were noted as a result of this procedure. In such cases, the differences noted in these records were obvious as a result of checks performed on the randomly chosen records.

Although the procedure involved checking approximately 5 percent of the entire database, differences found in any additional records were noted.

E.5 QA/QC Procedure for the Everett, Washington Tire Fire Incident

In addition to the random QA/QC checks performed on the five tire fire incidents containing greater than 200 analyte records, an additional QC check was performed on the Everett, Washington tire fire incident analyte database to ensure that analyte concentrations recorded at or below the applicable detection limit were not entered into the database. This QC check was necessary due to a change made in the data entry procedure which occurred during the data gathering phase of the project. In general, the procedural change required that data at one-half and below the detection limit not be entered into the SAMAIR database field for each analyte record contained in the database.

As such, the analyte database for the Everett, Washington tire fire incident was checked using this procedure. The Everett database was chosen to undergo this QC check due to the complications involved in extracting the analyte data from the documentation received on this incident.

The results of this QC check were as follows:

- Concentrations for styrene and xylene contained in the incident documentation were presented as a single value. As such, concentrations for both of these analytes were entered into the database at one-half the value contained in the documentation. As a result, double entries for styrene were noted.

- Double entry for naphthalene was noted in the database. For this double entry, a different concentration value was entered into the database. The reason behind this double entry is not known.

- The Everett database contained 67 records which had analyte concentrations (i.e., in the SAMAIR field) below the detection level. Of these 67 analyte records (or 67 fields), the detection limit value was recorded in a total of 8 analyte fields (as opposed to leaving the field blank). The reasons for these noted differences can be attributed to the change in procedure as previously explained. In addition, for

MONCRIS #1, a concentration value for methylene chloride was recorded. This difference was observed since there were no detectable concentrations for methylene chloride noted for any of the samples taken.

- Of the 8 analyte fields containing values at the detection limit, 6 of the corresponding SAMFLG fields (i.e., detectable data) were noted as yes. Two additional SAMFLG fields which had corresponding undetectable concentrations were entered as "yes."

- No analyte data were entered for Benzo[a]pyrene for sample station # 9 (MONCRIS #9). It should be noted that the sample # 9 data were taken by a sampling team other than the team which took the other 8 samples during the tire fire incident.

For all differences noted above, the appropriate changes to the database were made.

E.6 Final Conclusions

The actual error rate discovered during the final random QA/QC check of the data from the tire fire incidents with greater than 200 records was approximately 4 percent. The QA/QC of the Everett, Washington data also resulted in an error rate of 4 percent. The results of the checks are presented in Table E-3.

Table E-3. QA/QC Final Results

	Errors	Records Checked	Error Rate
Everett, WA			
Double Entry Analyte	4 1	116	4%
Level Cross, NC			
Date of Sample	1	20	5%
Wakefield, VA	0	12	0%
Danville, PA	0	12	0%
Hagersville, Ontario, Canada			
Sample Air Concentration	8	190	4%
Webber, UT	0	14	0%
TOTAL	14	364	4%

APPENDIX F

REFERENCES

APPENDIX F. REFERENCES

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APPENDIX G
A TIRE FIRE BIBLIOGRAPHY

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APPENDIX H

ACKNOWLEDGMENTS

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