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AN IMPLEMENTATION PLAN FOR SUSPENDED PARTICULATE MATTER IN THE PHOENIX AREA
VOLUME I - AIR QUALITY ANALYSIS

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

AN IMPLEMENTATION PLAN FOR SUSPENDED PARTICULATE MATTER IN THE PHOENIX AREA
VOLUME I. AIR QUALITY ANALYSIS

by

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EPA Project Officer: Dallas Safriet

Prepared for

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1.0 INTRODUCTION

Under contract to the Environmental Protection Agency, TRW Environmental Engineering has developed control strategies for total suspended particulates in the Phoenix area. The methodology developed for Phoenix has been extended into a general guidelines document for application to areas with fugitive dust problems. This report is the first of four technical support documents prepared for the project. The report concerns a review of air quality data in the Phoenix area, including a monitoring site survey, statistical analysis of aerometric data, and discussion of apparent relationships between total suspended particulate levels and meteorology.

The support document is organized into six sections. The present section serves as a general introduction and provides a summary of major findings and conclusions. Section 2 consists of a general description of the Phoenix area, in terms of the topography, climatology and meteorology, population, land use, and economy. The discussion provides a qualitative indication of factors that may be related to the total suspended particulate problem.

Section 3 presents an evaluation of the siting of particulate monitoring stations in the Phoenix area. The section includes a discussion of the general notions of siting criteria and "useful" representativeness. Based on a field survey of the monitoring sites, a station by station description of the environment at each monitoring site is documented. Both the local environment immediately around the monitor and the general area around the site are considered. Finally, the representativeness of air quality measured at each of the monitoring sites is evaluated, and the utility of the data obtained at the sites is assessed.

Section 4 summarizes the hi-vol particulate data for the Phoenix area. The section begins with a brief discussion of statistical methods. These methods are then employed to establish particulate level distributions at the various stations and to compute expected annual geometric means and yearly 24 hour maxima. The expected values are compared to observed annual means and maxima and the discrepancies are explained.

Section 5 provides an assessment of the spatial pattern of suspended particulate levels. Categories of monitoring sites are classified geographically and environmentally and related to concentration regimes. The apparent influence of local sources on spatial distribution of ambient particulate levels is discussed.

Section 6 investigates the apparent relationships between suspended particulate levels and meteorology. Observed particulate concentrations are correlated to various meteorological variables such as wind speed, rainfall and rainfall frequency, temperature, and mixing height. Seasonal patterns of particulate levels and the associated seasonal meteorology are investigated. Daily meteorology and particulate concentrations are studied. Finally, the meteorological circumstances associated with specific particulate episodes are evaluated.

1.1 CONCLUSIONS

- Air quality at most of the monitor sites is influenced by local sources of fugitive soil dust. However, air quality at these sites appears to be representative of the general area because the sites are subject to the same type of local sources characteristic of the general area. In a few cases, particulate levels at the monitor are site specific, and may not represent the general area. In cases where the significance of the site specific sources is indeterminate, the utility of the particulate measurements there is doubtful.

- While there is no clear spatial pattern for particulate concentrations in the Phoenix area, there is a distinct pattern in the concentration by type of local environment. Six types of site environments can be identified. (Section 5.0). Measured concentrations conform roughly to a limited range for each of the identified site categories.
- The National Ambient Primary Air Quality Standards are exceeded at all monitoring sites except the remote Carefree Airport station. The expected maximal 24 hour values are generally higher than the measured values. Due to the rather limited number of samples collected from the monitoring network, the computed expected values should be used to characterize maximal levels at the monitoring sites.
- Seasonal patterns of particulate concentrations vary markedly from year to year, but are consistent from station to station. The seasonal patterns fluctuate considerably due to variations in seasonal meteorology from year to year, particularly with respect to rainfall. Given a normal rainfall for each quarter, it appears that particulate levels will be highest in the winter season, and least during the early summer.
- Measured levels of suspended particulates are inversely proportional to rainfall frequency for any given season of the year. This relationship is less sensitive to rainfall frequency in the winter months than in the warmer summer months.

The apparent relationship between measured levels of particulate and wind speed varies among the monitor station categories. Because of differences in local source strengths, the relative contribution of wind blown dust and dust arising from human activities to the ambient total dust level changes from station to station. In areas where limited human activities occur, and where there are substantial soil surfaces susceptible to wind erosion, ambient particulate levels are proportional to wind speed. At stations where local dust emissions result primarily from human activity, concentrations are observed to be inversely proportional to wind speed (except when dust storms occur).

1.2 RECOMMENDATIONS

For the purpose of control strategy formulation, a number of environments have been identified for consideration. Each of these environmental categories experiences a different regime of suspended particulate levels. In the rural environments, wind blown dust is a major contributor to high particulate levels, while in the city regions, dust arising from human activity appears to contribute to higher levels. Distinctions should be made among the different source environments in the formulation and evaluation of control strategies.

In developing a source-receptor model, it will be necessary to account for meteorological influences on both emission levels and particulate concentrations. The spatial variation of the various contributing sources, both in the general area, and in the area immediately surrounding the monitors (receptors), must be carefully resolved and incorporated into the source receptor model.

The dramatic effect of certain meteorological variations on suspended particulate levels provides insights into potentail source control mechanisms. Potential actions which would render surface soils less susceptible to wind erosion, short term and long term, should be studied.

2.0 GENERAL DESCRIPTION OF THE STUDY REGION

The study region should consist of an area which includes those emission sources having impact on the suspended particulate levels around Phoenix, and which includes important topographical boundaries affecting local meteorology. As such, the study region is explicitly formulated as the project proceeds and as distribution and extent of emission sources surrounding the Phoenix area are documented. Based on the location of Phoenix, it is initially clear that most of Maricopa County will comprise the major portion of the study region.

Figure 2-1 illustrates the orientation of Maricopa county within Arizona, and Figure 2-2 presents a map of the county.

The following sections of this chapter contain a general description of the characteristics of the study region, including its topography, climatology and meteorology, population, land use and economy.

2.1 TOPOGRAPHY

The topographical features of Maricopa County are illustrated in Figure 2-3. The map indicates that most of the County is situated in a broad flat valley, the Salt River Valley, which slopes downward to the southwest from an elevation of approximately 2,000 feet to a few hundred

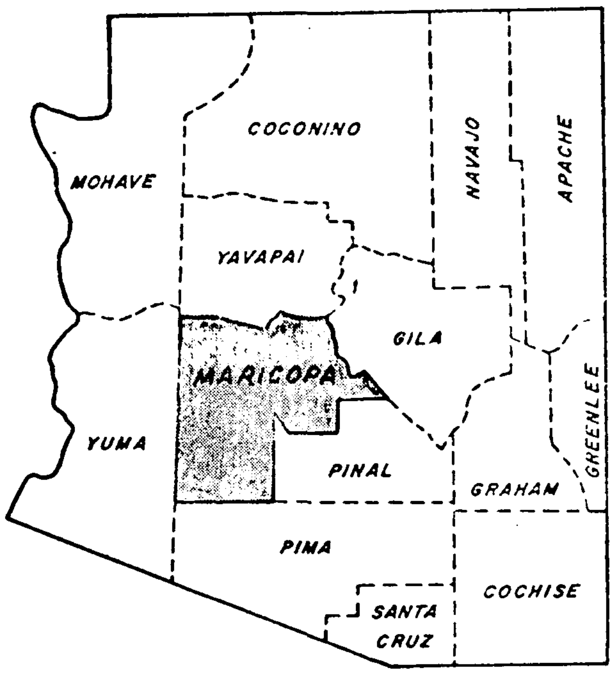


Figure 2-1. State of Arizona

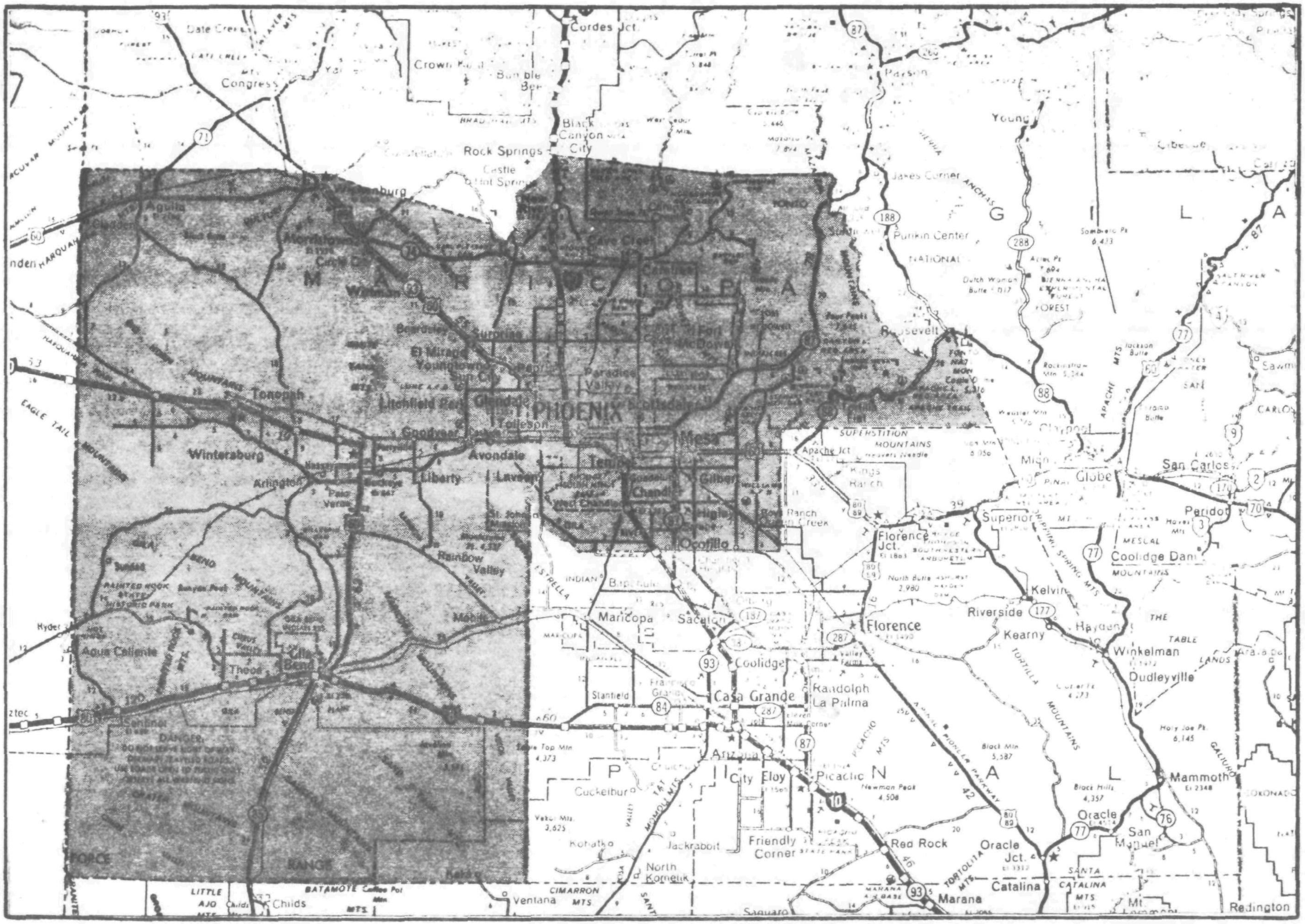
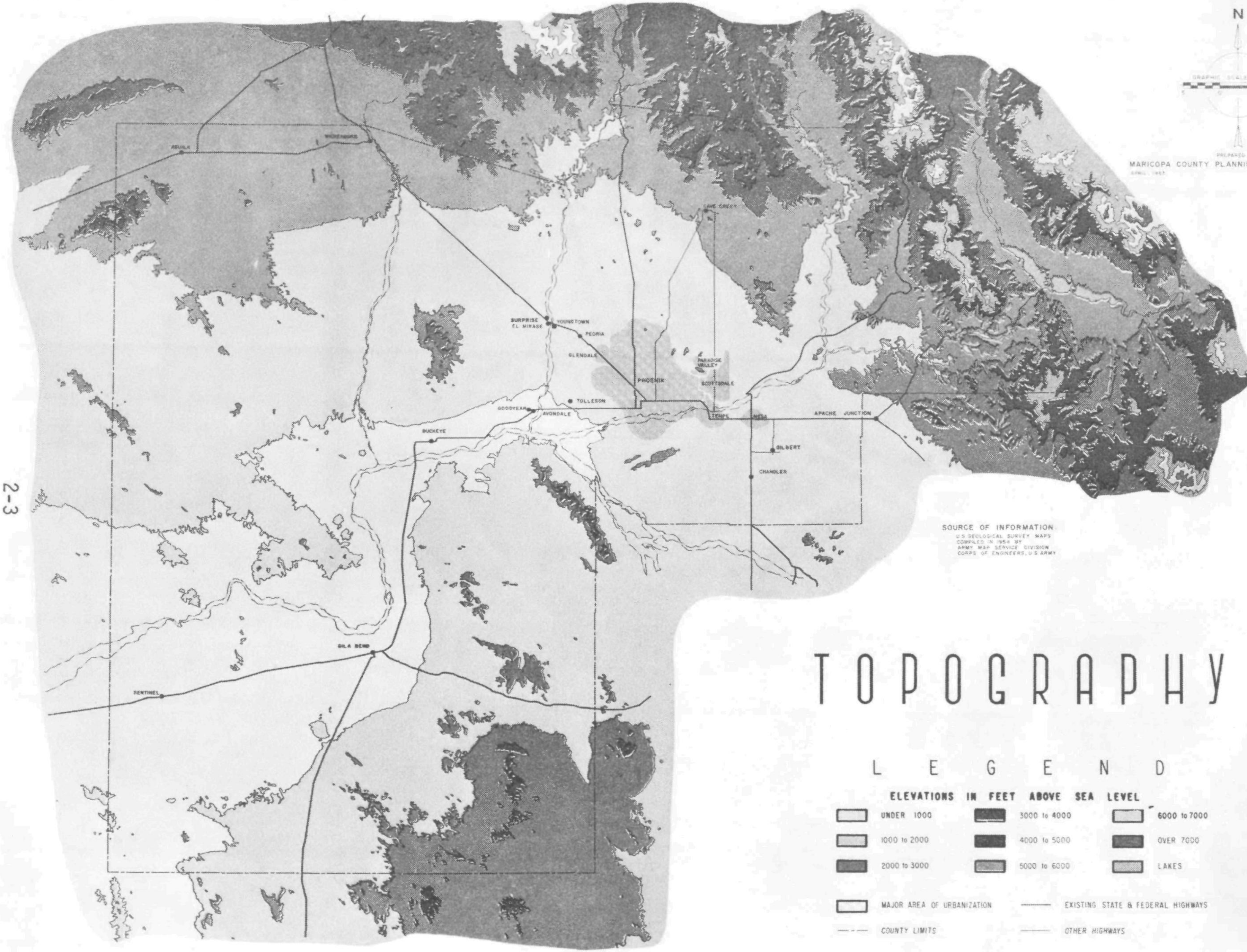


Figure 2-2. Maricopa County, Arizona


N
GRAPHIC SCALE IN MILES
5 0 5 10
PREPARED BY
MARICOPA COUNTY PLANNING AND ZONING DEPT
CAVE CREEK
SURPRISE
EL MIRAGE
YOUNGTOWN
PEORIA
GLENDALE
PHOENIX
PARADISE VALLEY
SCOTTSDALE
TOLLESON
GOODYEAR
AVONDALE
TEMPE
MESA
APACHE JUNCTION
GILBERT
CHANDLER
BUCKEYE
GILA BEND
SENTINEL
SOURCE OF INFORMATION
U.S. GEOLOGICAL SURVEY MAPS
COMPILED IN 1954 BY
ARMY MAP SERVICE DIVISION
CORPS OF ENGINEERS, U.S. ARMY
TOPOGRAPHY
LEGEND
ELEVATIONS IN FEET ABOVE SEA LEVEL
UNDER 1000
1000 to 2000
2000 to 3000
3000 to 4000
4000 to 5000
5000 to 6000
6000 to 7000
OVER 7000
LAKES
MAJOR AREA OF URBANIZATION
EXISTING STATE & FEDERAL HIGHWAYS
COUNTY LIMITS
OTHER HIGHWAYS

feet above sea level. Sharply rising mountains are located to the north and the southeast of the valley and numerous other mountains are scattered throughout. The northeast portion of the County contains the McDowell, Goldfield, Superstition and the Mazatzal Mountains which rise sharply in some places to be above 7,000 feet, while the southeast portion contains the Maricopa, Sand Tank and Sauceda Mountains which rise slightly above 3,000 feet. The County is characterized by extreme variations in elevation ranging from the Four Peaks Mountain on the northeast border at 7,645 feet above sea level to the Gila River Bed on the west county boundary line at 436 feet above sea level. Most of the urban activities are concentrated on a relatively flat plain in the Phoenix Metropolitan area. Seventy-eight percent of the County land area has a general slope of less than ten percent. The topography has played an important role in the agricultural activities of the County by permitting dams and reservoirs to be established in the mountain areas which are used to irrigate the floor of the valley. Some additional discussion of topographical features is contained in section 2.5 which describes the County's existing land use.[1]

2.2 CLIMATOLOGY AND METEOROLOGY

The climate in Phoenix may be characterized as desert-like with low annual rainfall and low relative humidity. The following is a summary of the salient climatological characteristics of the region obtained from the National Oceanic and Atmospheric Administration.[2]

Daytime temperatures in the region are high in the summer months, beginning in June and extending through August. The autumn season, beginning in the latter part of September, is characterized by sudden changes in temperature. The change from the heat of summer to the mild winter temperatures usually occurs in October. The normal temperature change from the beginning to the end of October is the greatest of any month of the year in central Arizona. By November, the mild winter season is established in the Salt River Valley region. During the winter months the temperature is marginal for some types of crops, such as citrus. Areas with milder temperatures around the edges of the valley are utilized by these crops. However, the entire valley is subject to occasional hard freezes. During the spring temperatures are warm during the day and mild in the evening. Average monthly temperatures recorded between 1935 and 1974 are contained in Table 2-1.

TABLE 2-1. AVERAGE MONTHLY TEMPERATURES IN PHOENIX

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1935	53.8	57.9	57.6	69.4	74.1	87.2	92.0	88.4	84.6	72.6	57.2	54.3	70.9
1936	52.8	56.4	64.6	73.1	81.7	90.3	93.2	91.1	83.6	73.2	61.5	53.2	72.9
1937	43.2	54.7	59.9	67.6	78.6	85.3	91.8	92.2	86.9	74.8	62.3	56.9	71.2
1938	52.6	54.4	57.8	66.6	78.7	83.4	88.3	88.2	84.4	69.7	53.2	53.6	69.2
1939	57.7	47.0	61.0	70.2	77.5	84.6	92.0	90.3	82.0	69.4	62.5	55.5	70.2
1940	54.6	55.2	63.6	69.5	80.8	89.1	92.0	91.3	85.0	72.7	57.7	55.6	72.3
1941	53.3	57.2	56.4	61.6	74.5	80.6	88.6	86.2	79.2	66.4	60.0	52.3	68.2
1942	52.4	51.0	57.0	64.8	73.4	83.2	91.8	87.2	83.3	70.6	61.9	54.5	69.3
1943	51.7	57.6	53.2	70.7	77.5	83.6	91.0	87.4	84.0	71.1	59.4	52.4	70.8
1944	49.9	51.6	56.0	64.2	74.2	79.6	88.0	92.5	83.0	73.2	56.6	51.0	68.2
1945	50.4	54.6	55.8	65.4	75.1	81.2	91.1	89.6	83.9	73.8	57.6	49.9	69.0
1946	49.6	52.0	60.8	72.4	75.8	86.2	90.1	88.3	83.8	66.4	54.3	53.5	69.5
1947	48.5	58.1	62.7	68.2	78.8	82.7	92.9	88.8	86.2	72.7	55.0	49.2	70.4
1948	51.6	57.4	56.3	69.2	74.4	94.2	91.0	91.4	85.6	73.6	54.9	51.1	69.8
1949	43.7	51.8	59.1	70.6	76.0	85.3	90.4	87.6	86.1	68.5	64.4	51.3	69.6
1950	49.7	58.9	62.6	72.5	76.0	94.9	90.5	90.3	82.2	78.3	64.2	57.5	72.3
1951	51.9	55.1	60.7	67.8	75.7	83.0	92.5	87.2	83.2	71.9	58.6	52.1	70.1
1952	51.4	54.2	55.4	57.8	79.6	84.5	89.7	90.9	85.8	76.8	57.1	51.0	70.4
1953	54.5	53.3	61.5	64.6	70.9	85.0	90.6	89.3	84.1	71.6	61.5	49.3	69.9
1954	52.3	61.1	58.3	71.5	78.2	94.7	91.3	86.4	86.2	74.9	64.6	54.0	72.1
1955	48.7	50.3	61.4	66.7	75.4	93.7	86.7	86.0	82.9	75.7	59.1	55.8	69.5
1956	56.0	50.9	61.6	64.1	76.9	86.9	87.9	85.8	84.6	69.7	57.2	53.3	69.8
1957	54.0	61.4	51.8	65.5	72.9	87.1	91.4	98.0	83.2	70.6	56.4	55.0	70.7
1958	53.0	58.0	57.0	66.7	81.3	89.1	93.6	92.7	86.4	75.6	61.4	56.0	72.7
1959	53.3	53.9	63.6	73.5	76.3	90.2	94.0	86.1	83.3	72.7	60.9	53.4	72.0
1960	48.5	51.5	65.1	70.4	77.8	90.0	92.4	89.7	85.9	70.6	60.5	50.5	71.1
1961	54.2	55.6	57.6	69.2	75.6	88.6	91.7	86.6	80.4	69.6	57.1	52.3	70.2
1962	51.5	55.7	56.0	72.3	73.5	83.1	90.2	91.7	84.3	71.6	61.9	55.0	70.6
1963	48.4	60.2	51.0	65.8	85.0	81.7	92.0	87.1	85.1	75.2	61.9	51.8	71.0
1964	46.7	49.3	56.5	69.2	73.7	82.6	90.6	85.2	80.9	74.9	55.5	52.0	67.8
1965	52.7	52.4	56.1	63.4	71.8	79.0	91.0	89.0	79.2	73.8	62.1	52.9	68.6
1966	48.2	49.7	61.7	69.8	80.1	86.8	93.0	90.9	82.9	70.9	60.5	52.0	70.5
1967	50.7	55.7	62.8	62.4	75.1	81.1	91.6	91.0	84.8	73.5	63.9	48.2	70.1
1968	52.4	59.7	59.9	66.7	76.6	86.2	90.2	85.5	83.6	72.7	59.2	49.5	70.3
1969	54.9	53.0	55.9	58.5	78.3	84.2	93.1	94.4	84.1	69.5	67.1	54.3	71.5
1970	52.1	60.2	59.5	64.7	79.6	88.1	93.0	92.5	87.7	69.1	61.4	50.6	71.4
1971	52.2	56.3	63.8	64.5	73.7	85.3	94.9	89.5	85.6	69.3	59.7	51.2	70.5
1972	51.4	59.1	70.4	71.4	78.3	87.8	94.4	89.9	84.8	71.9	55.1	52.1	72.5
1973	51.2	57.5	56.4	67.2	80.7	88.1	93.5	93.4	84.7	74.4	60.8	55.4	72.0
1974	54.0	56.7	64.5	70.5	80.2	92.2	92.4	91.2	87.2	75.9	61.5	50.6	73.1
RECORD													
MEAN	51.6	55.5	60.9	67.8	76.0	85.2	90.8	89.0	83.5	71.7	59.6	52.4	70.3
MAX	65.0	69.1	74.7	83.0	91.9	101.5	104.1	101.8	97.7	86.8	74.6	65.8	84.7
MIN	38.1	41.8	46.2	52.5	60.0	68.6	77.5	76.1	69.2	56.5	45.0	38.9	55.9

Sunshine in the area averages 86 percent of the possible amount, ranging from a minimum monthly average of 77 percent in January and December to a maximum of 94 percent in June. During the winter, skies are sometimes cloudy, but clear skies predominate. During the spring, skies are also predominantly clear. During July and August, there is often considerable afternoon cloudiness associated with cumulous clouds building up over the nearby mountains.

The valley floor is generally free of wind. During the spring months southwest and west winds predominate and are associated with the passage of low pressure troughs. During the thunderstorm season local gusty winds often occur, usually flowing from an easterly direction. Throughout the year there are periods, often several days in length, in which winds remain under 10 miles an hour.

There are two separate rainfall seasons in the region. The first occurs during the winter months from November to March when the area is subjected to occasional storms from the Pacific Ocean. Although this is considered a rainfall season, there can be periods of a month or more when practically no precipitation occurs. Snowfall occurs very rarely in the Salt River Valley, while light snows occasionally fall in the higher mountains surrounding the valley. The second rainfall period occurs during July and August when Arizona is subjected to widespread thunderstorm activity which varies in intensity and location. The spring and fall months are generally dry, although precipitation in substantial amounts has fallen on occasion during every month of the year. Precipitation and snowfall recorded between 1935 and 1974 are contained in Tables 2-2 and 2-3, respectively.

TABLE 2-2. MONTHLY PRECIPITATION IN PHOENIX

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1935	0.95	3.14	1.39	0.39	0.14	[illegible]	0.93	1.27	1.37	0.13	0.56	0.39	10.33
1936	0.80	1.01	0.50	0.14	T	T	2.47	0.32	0.49	0.13	0.35	2.12	8.29
1937	0.83	0.76	1.54	T	0.04	T	[illegible]	0.05	1.17	T	0.00	0.41	5.37
1938	0.51	0.68	0.77	0.02	T	0.36	[illegible]	0.97	T	0.00	0.03	1.62	5.01
1939	0.27	0.59	0.11	0.11	0.00	0.00	0.77	[illegible]	4.23	0.10	0.47	T	7.83
1940	0.01	0.51	T	0.34	T	T	[illegible]	[illegible]	1.47	1.05	0.79	3.94	8.18
1941	0.97	2.02	4.14	2.12	1.31	T	[illegible]	[illegible]	1.67	0.52	1.15	1.06	16.26
1942	0.35	0.21	0.29	0.69	[illegible]	[illegible]	[illegible]	[illegible]	1.07	[illegible]	T	0.29	4.87
1943	0.64	0.34	0.59	0.05	[illegible]	0.02	[illegible]	4.91	0.78	[illegible]	0.00	1.42	9.03
1944	0.37	2.23	0.95	0.49	0.34	[illegible]	[illegible]	1.07	0.23	0.33	1.12	1.28	3.70
1945	1.01	[illegible]	0.79	T	0.00	0.00	1.31	0.58	T	0.53	0.00	0.44	4.76
1946	1.14	0.15	0.07	0.02	0.00	0.00	1.50	2.41	2.47	0.15	0.82	0.83	9.38
1947	0.05	0.13	T	T	0.32	T	T	1.10	0.34	1.04	0.59	0.45	3.00
1948	0.00	1.31	0.14	T	T	0.08	0.91	1.41	T	0.60	0.55	0.69	4.15
1949	1.71	0.12	0.35	0.18	0.07	0.33	0.44	2.46	0.99	0.82	0.31	0.92	6.74
1950	0.41	1.15	0.24	T	T	0.11	0.76	2.37	0.49	0.00	0.04	0.03	3.62
1951	1.55	0.29	1.44	1.02	0.20	T	1.25	5.55	0.33	0.52	0.73	0.64	12.77
1952	0.56	1.49	2.27	1.94	0.00	0.05	[illegible]	1.11	0.23	0.96	3.04	0.68	[illegible]
1953	0.23	0.53	0.74	0.02	0.71	T	0.89	[illegible]	0.00	T	0.07	0.07	3.56
1954	0.69	0.58	1.27	0.02	0.11	0.02	0.36	0.55	0.44	0.12	T	0.01	4.31
1955	2.41	0.09	T	T	0.07	0.95	[illegible]	1.60	T	0.13	0.05	0.18	9.82
1956	0.57	0.64	0.08	0.33	T	0.01	0.92	[illegible]	0.02	0.06	0.00	0.01	2.92
1957	1.57	0.21	0.53	0.12	0.43	0.26	0.72	1.85	[illegible]	2.06	0.02	0.23	7.60
1958	0.07	1.15	1.94	0.69	0.05	0.05	1.31	1.72	1.24	0.50	0.16	0.00	8.12
1959	0.21	0.69	0.09	0.05	T	T	[illegible]	1.31	[illegible]	1.75	0.43	3.44	8.40
1960	0.85	0.04	0.57	0.01	T	T	0.25	1.82	0.12	[illegible]	T	0.67	3.39
1961	0.23	0.01	0.41	T	T	T	[illegible]	1.11	0.22	[illegible]	0.12	0.65	4.43
1962	1.20	0.83	0.50	0.00	T	0.17	[illegible]	0.25	0.39	T	0.03	0.48	3.90
1963	0.57	1.16	0.37	0.39	T	[illegible]	[illegible]	[illegible]	T	[illegible]	[illegible]	T	7.26
1964	0.22	0.01	0.37	0.10	T	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.09	6.00
1965	1.22	0.97	1.39	1.35	0.14	0.91	[illegible]	[illegible]	[illegible]	0.27	1.92	3.19	11.19
1966	0.35	0.94	0.34	T	T	1.22	[illegible]	[illegible]	[illegible]	0.25	[illegible]	0.52	7.27
1967	0.24	0.07	0.43	0.08	0.05	[illegible]	[illegible]	[illegible]	[illegible]	0.67	1.27	3.96	8.34
1968	0.19	1.20	1.04	T	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.35	0.91	0.59	6.57
1969	1.37	0.78	0.54	0.03	0.24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.45	0.54	6.94
1970	T	0.30	2.24	T	T	[illegible]	[illegible]	1.02	2.34	0.44	0.07	0.26	7.63
1971	0.22	0.35	T	0.13	T	[illegible]	[illegible]	2.39	1.97	0.27	T	1.47	3.59
1972	0.00	T	T	T	T	[illegible]	[illegible]	[illegible]	0.28	[illegible]	[illegible]	[illegible]	[illegible]
1973	0.13	1.34	1.69	[illegible]	[illegible]	T	[illegible]	T	0.06	[illegible]	[illegible]	[illegible]	4.01
1974	0.57	0.07	1.37	0.01	0.00	[illegible]	0.94	1.15	1.07	2.12	0.44	0.59	3.18
RECORD MEAN	0.75	0.73	0.64	0.34	0.12	0.11	0.91	1.04	0.78	0.51	0.60	0.87	7.44

TABLE 2-3. MONTHLY SNOWFALL IN PHEONIX

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1935-36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1936-37	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0
1937-38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1938-39	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.6
1939-40	0.0	0.0	0.0	0.0	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1940-41	0.0	0.0	0.0	0.0	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1941-42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1942-43	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0
1943-44	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0
1944-45	0.0	0.0	0.0	0.0	0.0	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0
1945-46	0.0	0.0	0.0	0.0	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1946-47	0.0	0.0	[illegible]	0.0	0.0	[illegible]	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0
1947-48	[illegible]	0.0	[illegible]	0.0	0.0	0.0	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0
1948-49	[illegible]	0.0	0.0	0.0	0.0	0.0	[illegible]	[illegible]	0.0	T	0.0	0.0	T
1949-50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1950-51	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	T
1951-52	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1952-53	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1953-54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1954-55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1955-56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1956-57	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1957-58	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1958-59	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1959-60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1960-61	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1961-62	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	T
1962-63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1963-64	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1964-65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1965-66	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1966-67	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1967-68	0.0	[illegible]	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	0.0	T
1968-69	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	0.0	T
1969-70	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1970-71	0.0	0.0	0.0	0.0	0.0	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1971-72	0.0	0.0	[illegible]	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1972-73	0.0	[illegible]	[illegible]	0.0	[illegible]	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0
1973-74	[illegible]	0.0	0.0	0.0	0.0	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0
1974-75	0.0	[illegible]	0.0	0.0	[illegible]	[illegible]							
RECORD MEAN	0.0	0.0	0.0	0.0	0.0	T	T	T	0.0	T	0.0	0.0	T

2.3 POPULATION

Historical and projected population levels for Maricopa County are listed in Table 2-4. The County has been growing rapidly since 1940 with most of the growth occurring in the Phoenix urban area.

TABLE 2-4.

POPULATION ESTIMATES
MARICOPA COUNTY

Year	Population	Percent Change
1940	186,193	----
1950	331,770	78.2
1960	663,510	100.0
1970	969,425	46.1
1975	1,362,000*	
1980	1,713,000*	
1985	2,069,000*	
1990	2,425,000*	

Source: Maricopa Association of Governments

* projected population

In 1970, 89.7 percent of the population resided in incorporated cities and towns within the County. A population estimate prepared by the Maricopa Planning and Zoning Department indicated that the population increased from 969,425 in 1970 to approximately 1,180,000 in 1973, an increase of over 21 percent.

Table 2-5 contains a listing of population data by districts for 1970 and 1974. The data for 1974 were compiled from a survey conducted in October 1974.[3] Districts are comprised of aggregations of census tracts as illustrated in Figure 2-4. These data illustrate the distribution of population throughout the County and the concentration in the Phoenix urban area. It should be noted that a special census is presently being conducted in Maricopa County and the preliminary results indicated that these population estimates may be somewhat overestimated.

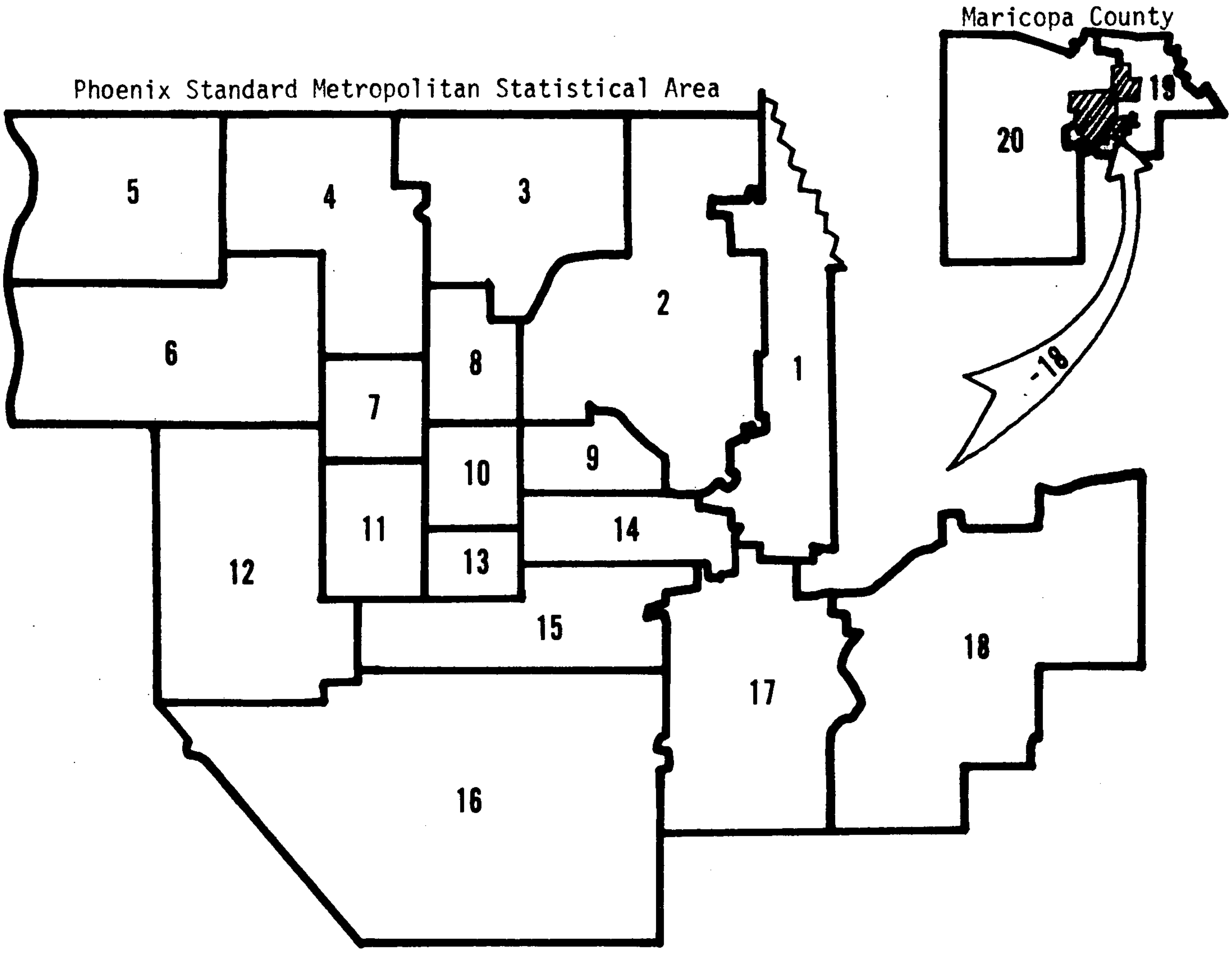


Figure 2-4. Population Districts

TABLE 2-5

POPULATION ESTIMATED BY DISTRICTS

District	1970 Population[a]	Estimated 1974 Population[b]
1	69,085	94,000
2	34,570	48,000
3	41,340	70,000
4	57,614	102,000
5	21,170	43,000
6	38,494	69,000
7	51,962	65,000
8	49,943	62,000
9	42,320	47,000
10	48,480	49,000
11	48,755	54,000
12	55,146	82,000
13	34,635	33,000
14	50,935	59,000
15	37,143	38,000
16	45,497	62,000
17	68,523	101,000
18	70,963	108,000
19	44,763	82,000
20	58,087	86,000
Total	969,425	1,294,000

a. U.S. Census

b. Arizona Republic and Phoenix Gazette Survey

2.4 LAND USE

Maricopa County comprises approximately 9,226 sq. miles of land area. The County's existing land use is illustrated in Figure 2-5. Area and percentage breakdowns by land use category are given below in Table 2-6.[4]

TABLE 2-6

EXISTING GENERAL LAND USE
MARICOPA COUNTY

Land Use	Area In Square Miles	Percent of Total County Area
Urban Development	323 sq. mi.	3.5%
Agricultural Areas	882	9.6
Major Park and Recreation Areas	1,305	14.1
Airports and Military Res.	1,260	13.7
Mountains and Desert	5,456	59.1
TOTAL COUNTY AREA	9,226 sq. mi.	100.0%

Source: Maricopa County Planning Department

The presently urbanized areas, those developed for residential, commercial, public or industrial purposes, occupy 323 square miles or 3.5 percent of the total land area. Most of this urbanized area is concentrated in the Phoenix Urban Area which contains 90 percent of the total county population while occupying approximately 307 square miles or 3.3 percent of the total land area. The average population density for the urban area based on 1970 population was 4.4 persons per acre. The Phoenix Urban Area includes the major incorporated cities of Phoenix, Scottsdale, Tempe, Mesa and Glendale and the unincorporated area of Sun City.

The central urbanized area is surrounded by small pockets of urban development, particularly in the agricultural area to the west and southeast of Phoenix. Included are Chandler and Gilbert in the southeast portion of the County; Avondale, Goodyear, Litchfield Park, Tolleson and Cashion in the west central portion; Buckeye, Gila Bend and Wickenburg in the western portion; and Cave-Creek-Carefree to the north.

Approximately 882 square miles or 9.6 percent of the total land area of Maricopa County is used for agricultural purposes. The major portion of agricultural development surrounds the Phoenix Urban Area and extends from

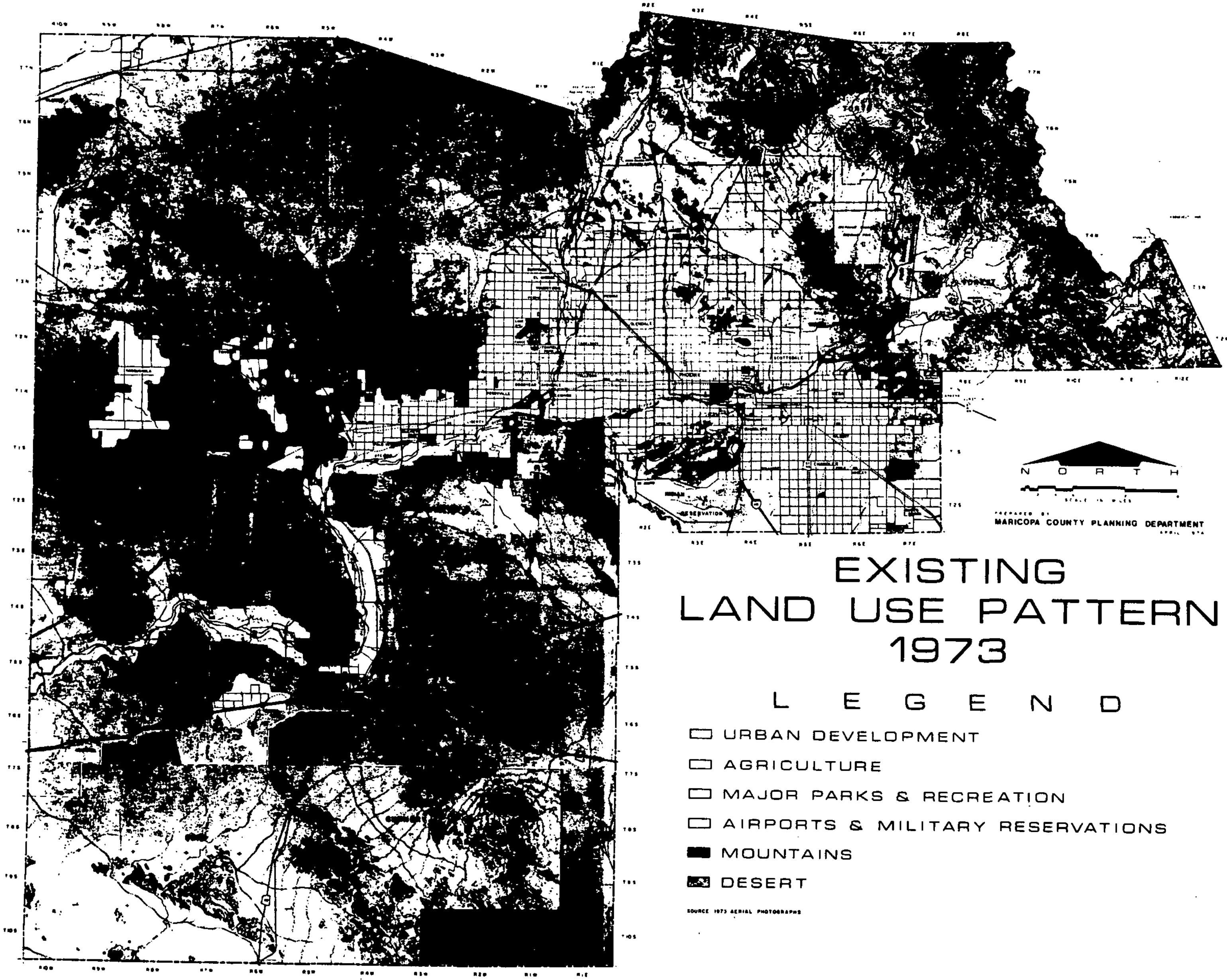


Figure 2-5. Land Use in Maricopa County

Pinal County on the east to the White Tank Mountains and the Buckeye area on the west. Other smaller agricultural areas are dispersed throughout the county mostly along drainage channels. Agriculture, which is sustained in the county by a major irrigation system, is an important component of the county's economy, second only to manufacturing as a source of income. Agricultural land use, however, has declined considerably in recent decades because of urban expansion, changes in water conditions and other economic factors. Although agricultural land use is increasing in the western portions of the County, it has not kept pace with the agricultural land developed in the Phoenix Urban Area. Table 2-7 shows the total cropped acreage from 1950 to 1972.

TABLE 2-7

AGRICULTURE CROP AREA
Maricopa County

Year	Total Cropped Area (Acres)
1950	535,000
1955	485,000
1960	523,863
1965	481,120
1970	462,710
1971	442,635
1972	442,600

Source: "Arizona Agricultural", Annual Bulletin of Cooperative Extension Service Agricultural Experiment Station, University of Arizona.

Park and recreational land uses occupy an estimated 1,306 square miles or 14.1 percent of the total County land area. Included are County and municipal park systems and Tonto National Forest.

Airports and military installations occupy 1,260 square miles or 13.7 percent of the total land area in Maricopa County. Most recent estimates indicate that there are 40 airports (12 municipal and 28 private) currently located in Maricopa County* in addition to Sky Harbor Airport, which is the only general aviation airport in the County, and eight other

* Personal communication with the staff of the Maricopa Association of Governments

municipal airports. There are two major military air bases in the County: Williams Air Force Base, located nine miles east of Chandler, and Luke Air Force Base, located ten miles west of Glendale. The largest military installation is the Gila Bend Bombing and Gunnery Range in the southwestern part of the County.

Mountainous and desert areas cover approximately 5,456 square miles or 59.1 percent of the total land area in Maricopa County. All of the County falls within the desert region of the Basin and Range Geological Province, except for the extreme northeastern portion. There are approximately 640 square miles, or 6.9 percent of the total land area, of mountainous areas in the County outside of areas designed for other primary uses (i.e., parks and recreation). Desert areas cover 4,816 square miles or 52.2 percent of the total County land area. Desert soils vary from very thin, rocky and gravel type soils on the steeper slopes adjacent to the mountainous dreds, to thick sandy and clay-like loams towards the major drainage channels.

2.5 ECONOMY

Personal income, manufacturing, agriculture and tourism are the major sources of income in Maricopa County. Income from these four sectors in 1974 is listed in Table 2-8. Forecasts for 1975 are also included in the table. Income trends in manufacturing, agriculture and tourism are illustrated in Figure 2-6, which shows manufacturing to be the leading source of income (excluding personal income). According to the Arizona Department of Economic Security, a total of 1408 manufacturing establishments were operating in 1974 in Maricopa County. They are listed by industry in Table 2-9.

TABLE 2-8

INCOME BY MAJOR SECTOR
MARICOPA COUNTY

Sector	1974 Income (millions of dollars)	1975 Forecast (millions of dollars)
Personal Income	6,080	6,635
Manufacturing Value Added	1,725	1,846
Agriculture	409	434
Tourism	340	348

Source: Inside Phoenix - 1975

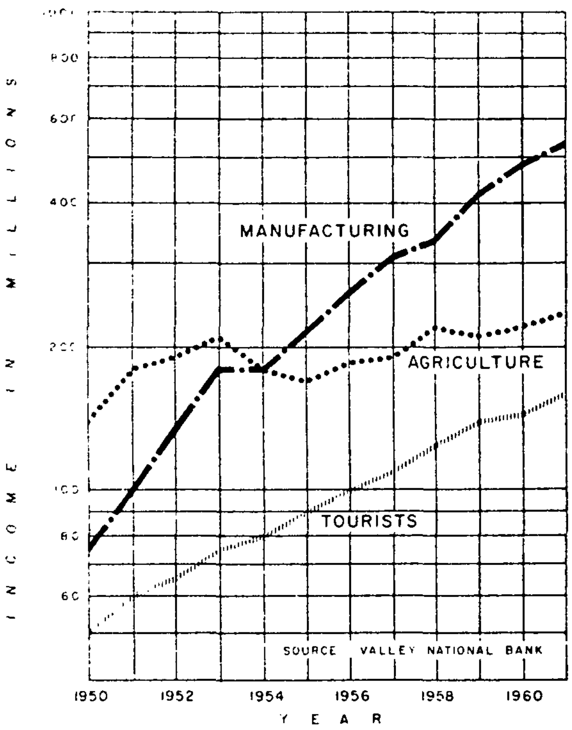


Figure 2-6. Economic Trends

TABLE 2-9
MANUFACTURING ESTABLISHMENTS

Industry	Number of Plants	Industry	Number of Plants
ordnance	2	leather	10
food	104	stone, clay, glass	82
apparel	43	primary metal	30
lumber	62	fabricated metal	167
furniture	60	machinery	182
paper	14	elec. machinery	88
printing	223	trans. equipment	130
chemicals	45	instruments	28
petroleum	7	miscellaneous	62
rubber and plastic	68	TOTAL	1408

Second to manufacturing, agriculture is the major source of income in Maricopa County. As mentioned in section 2.5, a significant, though declining, amount of land is used in the County for agriculture. In 1972, 442,600 acres or approximately 7 percent of the County's total land area was in use as cropland, orchards, vineyards, pasturelands, or fallow cropland. This represents a decline of 21 percent from 1950 when 535,000 acres were in agricultural use. Table 2-10 contains a summary of agricultural statistics for the County including acreages in use by crop, yields and products (where available).

The soil, climate and irrigation system in the County make it possible for farmers to grow and market seasonal crops the year round. Gross receipts from the sale of agricultural products in 1974 were $441 million, split between crops and livestock. A breakdown of these receipts by product is given in Table 2-11.

Total employment in the County in 1970 and 1975 by industry is listed in Table 2-12. Between 1970 and 1975, total employment has grown significantly, increasing approximately 30 percent from 371,200 to 484,400. Agriculture was the only sector in which employment declined (9 percent). The highest percentage increases occurred in trade, finance, insurance, real estate and service industries.

TABLE 2-10

AGRICULTURAL STATISTICS
MARICOPA COUNTY

CROP	ACRES 1/			YIELD PER HARVESTED ACRE				PRODUCTION			
	1972	1973	1974	Unit	1972	1973	1974	Unit	1972	1973	1974
FIELD CROPS											
Upland cotton 2/	101,200	99,100	151,650	Lb.	1,128	1,122	1,348	Bale	238,100	231,550	425,900
American Pima cotton 2/	8,800	7,500	8,100	Lb.	688	695	711	Bale	12,620	10,850	12,000
Alfalfa hay	100,000	100,000	95,000	Ton	6.2	6.8	6.9	Ton	620,000	684,000	655,500
All other hay	12,100	12,000	11,900	Ton	2.65	2.49	2.50	Ton	32,100	29,820	29,800
Safflower	17,100	11,900	7,700	Lb.	2,550	2,090	2,400	Ton	21,800	12,450	9,250
Sugarbeets	6,760	7,890	4,590	Ton	22.8	22.8	25.5	Ton	153,900	180,050	117,000
Barley											
Planted all purposes	60,000	60,000	50,000	[redacted]				[redacted]			
Harvested for grain	45,000	52,000	43,200	Lb.	3,600	3,890	3,740	Ton	81,000	101,090	80,870
Sorghum											
Planted all purposes	33,600	30,000	32,000	[redacted]				[redacted]			
Harvested for grain	30,300	29,000	29,500	Lb.	3,640	3,420	3,700	Ton	55,150	49,530	54,520
Wheat											
Planted all purposes	69,000	84,000	74,000	[redacted]				[redacted]			
Harvested for grain	58,000	78,000	71,000	Lb.	4,200	4,320	4,200	Ton	121,800	168,480	149,100
Corn											
Planted all purposes	7,700	7,000	5,800	[redacted]				[redacted]			
Harvested for grain	4,000	500	1,000	Lb.	3,700	3,420	3,470	Ton	7,390	850	1,740
VEGETABLES AND MELONS											
Lettuce	12,330	10,100	8,350	Cwt.	174	153	220	Thou. Cwt.	2,140	1,545	1,837
Cantaloups	970	1,730	1,500	Cwt.	90	132	142	Thou. Cwt.	87	229	213
Carrots 3/	2,800	2,750	1,940	Cwt.	132	83	147	Thou. Cwt.	370	229	285
Dry onions	1,130	1,400	1,200	Cwt.	483	519	500	Thou. Cwt.	551	726	600
Watermelons	2,950	3,000	1,450	Cwt.	211	130	187	Thou. Cwt.	623	390	271

CITRUS, DECIDUOUS FRUIT, PECANS

CROP	1973	1974	1975
	Acres in groves or orchards		
Oranges	11,880	11,600	11,970
Grapefruit	6,230	7,040	7,170
Lemons	2,920	3,120	3,050
Other citrus	3,020	3,030	2,810
Grapes	2,828	2,895	2,910
Peaches	475	475	475
Nectarines	205	205	205
Plums	420	420	560
Apricots	135	135	135
Apples	—	—	—
Pecans	750	1,420	1,420

LIVESTOCK PRODUCTION AND MARKETINGS

ITEM	1972	1973	1974
Eggs produced (Thou.)	83,804	83,468	81,200
Milk produced (Thou. Lbs.)	568,000	651,000	721,000
Cattle marketed from feedlots (Number)	345,000	304,000	274,000

Source: Maricopa County Agricultural Statistics - 1974, Arizona Crop and Livestock Reporting Service.

TABLE 2-11

RECEIPTS FROM AGRICULTURAL PRODUCTS

Product	1974 Sales (millions of dollars)	Percent of Total
Livestock	110.2	25
Cotton	110.2	25
Dairy Products	49.1	13
Alfalfa	29.2	6
Lettuce	17.5	4
Wheat	14.3	3
Potatoes	11.1	3
Citrus	7.9	2
Other	81.4	19
	441.0	100

Source: Maricopa County Agricultural Statistics 1974

TABLE 2-12

TOTAL EMPLOYMENT
MARICOPA COUNTY

Industry	Employment 1970	Employment 1975	Percent Change
Agriculture	12,000	11,000	-9
Manufacturing	70,900	71,100	1
Mining and Quarrying	300	400	33
Contract Construction	21,300	29,200	37
Transportation, Communications Public Utilities	17,700	23,900	35
Trade	81,000	113,600	40
Finance Insurance and Real Estate	22,800	32,200	41
Services & Miscellaneous	55,000	82,000	49
Government	48,200	82,400	34
Other[a]	32,000	39,000	22
TOTAL	371,200[b]	484,400[c]	

Source: Arizona Department of Economic Security

[a] includes self employed

[b] unadjusted total. Total employment adjusted for commuting, multiple job holding and labor management disputes = 363,800.

[c] unadjusted total. Total employment adjusted for commuting, multiple job holding and labor management disputes = 474,400.

3.0 MONITOR SITE SURVEY

This section provides an evaluation of the siting of each of the particulate monitoring stations in Phoenix. The evaluations were developed following a detailed monitor site survey in which the description of the environment of each monitor site was documented. This included an investigation of previous and existing emission sources in the locale, as well as physical descriptions of the monitoring sites. These descriptions were used to estimate the representativeness of each of the monitor sites, and to establish the utility of data obtained there.

The siting evaluation is organized into 2 sections. In section 3.1, the general notions of siting criteria and "useful" representativeness are discussed. This includes methodology for the assessment of the potential utility of air quality data from a given site. Section 3.2 provides a summary of a siting evaluation performed for the Phoenix Hi-Vol monitoring network.

3.1 General Discussion

Many decisions concerning air program planning are dependent upon the placement of the sensors used to measure air quality. Because ambient pollutant levels often vary substantially throughout a planning area, it is evident that contrasting siting procedures can result in totally different air quality characterizations. These differences have important implications for the nature of planning decisions for air quality standards and implementation programs.

Suitable resources rarely exist to site the number of sensors needed for comprehensive description of spatial air quality variations. Instead, a limited number of air monitors are generally placed at "representative sites" selected as characteristic of air quality levels in the immediate area. This notion of representativeness is, of course, approximate, since the emission sources (and hence the air quality) in or around any single locale, are generally far from homogenious. However, there are degrees of homogeneity and practical considerations dictate that monitors should be sited in areas where the source homogeneity is not too divergent. An exception to this siting procedure consists of the case where it is desired that a monitor be source oriented to be representative of maximal concentrations arising from a single source or a "hot spot". However, representativeness of this kind is fiction also, since a single siting will provide the desired measurement only under a single set of temporal and meteorological conditions.

In addition to difficulties associated with siting of monitors to be representative of a given area, there is a problem concerning the determination of the areas which should be represented in the network. Generally, it is desirable to select those areas suspected to incur high exposure levels of ambient pollutants. The precise location of such areas is often unclear. For one thing, these locations may vary from day to day, or from year to year. This is because of normal variations in important air quality determinants such as meteorology and emission levels, and because of changes which occur in the environment (i.e. sources and source locations).

Ultimately, a monitoring network cannot possibly satisfy all siting criteria. However, the network can still be very useful. This utility can be assured when an understanding of the representativeness of the monitors, is fully developed. One means of developing this understanding is the site survey.

In conducting the site surveys, the geographic range of representativeness of the monitor is estimated by observation of local sources and topography surrounding the monitor. Figures 3-1 through 3-3 illustrate some potential source orientations with respect to monitor stations. In Figure 3-1, the monitor is located in a rather homogenious field of sources, and unless the sensor is subject to distorting local phenomena, the measurements should be representative of the general area. In Figure 3-2, the monitor is source oriented in an uneven field of sources, and measurements there may only be representative of a very limited space around the sensor. In Figure 3-3, the monitor is representative of the shaded region of area source emissions.

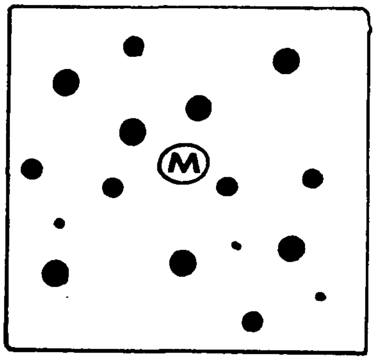


Figure 3-1. Monitor in Homogenious Field of Point Sources. Representation of General Area.

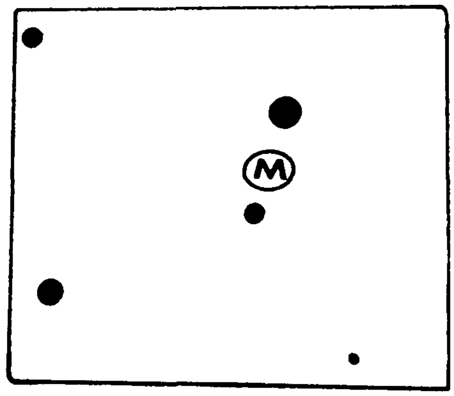


Figure 3-2. Monitor in Inhomogenious Field of Point Sources. Site Specific Representativeness.

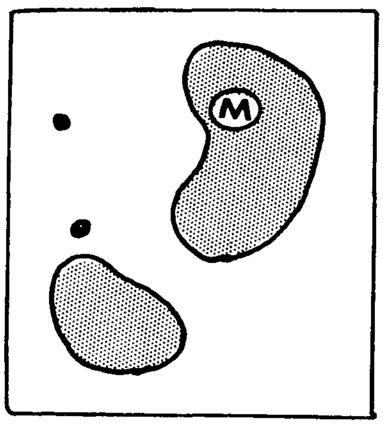


Figure 3-3. Monitor in Field of Area Sources (shaded). Site Specific Representativeness.

A major issue in the representativeness of any monitor (such as that in the examples above) concerns the placement of the sensor with respect to sources and topography immediately adjacent to the site. If the sensor is placed directly in an emissions plume, the measurements derived from the sensor will be dominated by this local source. If the source is well described and can be quantitatively assessed, the domination of measurements may also be assessed and the readings recorded by the monitor may serve as indicators for air quality nearby. However, it is more desirable that the sensor be placed in areas where source emissions are relatively mixed and spatial variations in concentrations are less dramatic. This is particularly the case when the local influences next to the monitor are not easily described, and their accountability in the measurements is indeterminant. In addition to source orientation, local influences by topography can be important. A sensor located next to physical obstructions (i.e. too close to ground, next to a wall) can fail to sense the desired pollutant concentrations because ambient air streamlines are directed away from the site.

In summary, the air quality measured at a given monitor may be representative of either a broad or confined area. In either case, if the relationship of air quality at the sensor site to air quality at other nearby points can be understood, the monitor is representative in a useful way. If it is not possible to estimate or assume this relationship with some certainty, the measurements obtained at the monitor are of limited utility. Site surveys can provide the information necessary for these appraisals.

3.2 SITING EVALUATION

Figure 3-4 shows the location of the various hi-Vol monitoring sites in Maricopa County. All monitors but the Arizona State Station are operated by the Maricopa County Air Pollution Control. The history of the various sites is varied. Many of the stations have been sampling for a limited time, having been established as recently as 1974. Other stations were established several years before the period of interest of the current study. During the sampling history of some stations, significant changes

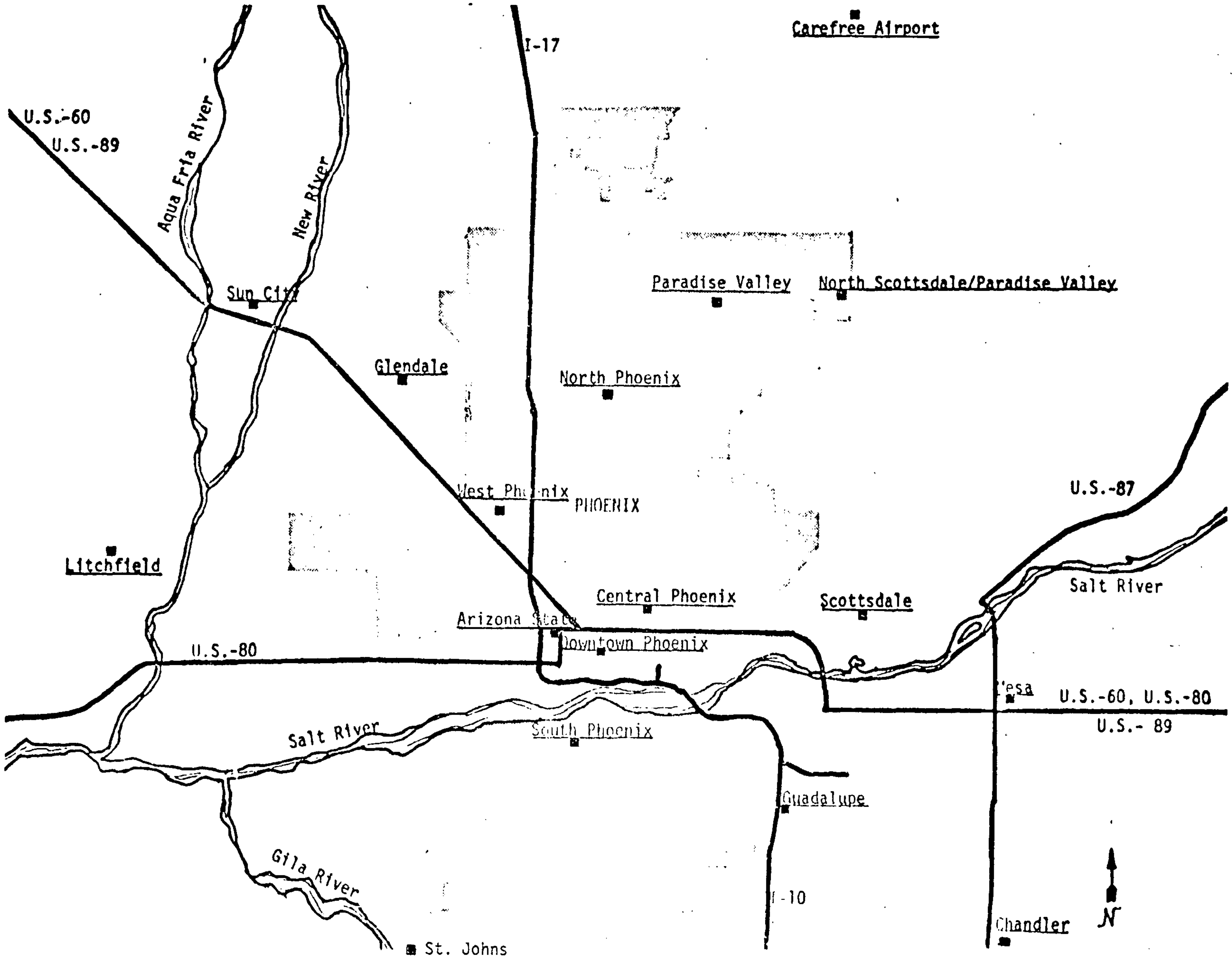


Figure 3-4 Location of Hi-Vol Monitors in Phoenix Area.

in the surrounding environment have affected air quality levels and representativeness at the monitor site. The present status of representativeness for the various stations has been investigated in a recent site survey conducted in November of 1975. The survey included judgments regarding historical and future characterizations of the sites as well. Table 3-1 identifies each of the monitor sites addressed in the site survey.

There are several variations in the site locations and monitor placement. These concern the height of sampler, the type and orientation of sources near the monitor, the characterization of the general area in which the monitor is located, historical and forecasted environmental changes at the site, and the representativeness of the monitor site. Table 3-2 provides a summary of the survey's pertinent findings for each of the sites.

One of the most obvious differences in the various monitor sitings concerns the elevation of the sensor above ground level. Seven of the sites included monitors at elevations of five feet above ground, four from ten to fifteen feet, and the remaining six at 20 to 25 feet. It was not clear without further analysis (to be undertaken in a subsequent task) the significance of these differences on observed levels of suspended particulates. For sites located in general areas containing fugitive dust sources, monitor elevation may prove a significant issue, due to tendency of fugitive dust particles to distribute unevenly as a function of vertical height. Moreover, since fugitive dust is the primary source of region-wide suspended particulates, the elevation issue is important (in varying degrees) at all the monitor sites. Ultimately, air quality data should probably be adjusted to a common level of representativeness before control strategy formulations can reasonably commence. This concept will be discussed in the emissions diffusion modeling task.

The majority of the monitor sites are placed within a residential community. Only two sites differ: the Carefree Site, which is remote, and the Downtown Phoenix Site, located in a commercial area. Because there are few urban areas in Phoenix, most of the sites are located in

TABLE 3-1. HI-VOL MONITOR SITES IN PHOENIX AREA

1.	Central Phoenix Station 03-0600-002(G) 1845 E. Roosevelt, Phoenix	Lat: 33° 27' 30" N Long: 112° 02' 30" W UTM Northing: 3702388 UTM Easting: 403195
2.	South Phoenix Station 03-0600-013 4732 S. Central Ave., Phoenix	Lat: 33° 24' 15" N Long: 112° 04' 10" W UTM Northing: 3692438 UTM Easting: 00400550
3.	Arizona State Station 03-0600-014 1740 W. Adams, Phoenix	Lat: 33° 26' 56" N Long: 112° 05' 48" W UTM Northing: 3701424 UTM Easting: 00398076
4.	Glendale Station 03-0320-001 Glendale Community College 6000 W. Olive, Glendale	Lat: 33° 33' 45" N Long: 112° 11' 15" W UTM Northing: 3710058 UTM: Easting: 00389772
5.	West Phoenix Station 03-0600-006 Grand Canyon College 3300 W. Camelback, Phoenix	Lat: 33° 29' 16" N Long: 112° 09' 49" W UTM Northing: 3705772 UTM Easting: 391897
6.	North Phoenix Station 03-0600-004 601 E. Butler, Phoenix	Lat: 33° 33' 12" N Long: 112° 03' 49" W UTM Northing: 3712940 UTM Easting: 401263
7.	North Scottsdale/Paradise Valley Station 03-0740-004 13665 No. Scottsdale Rd., Scottsdale	Lat: 33° 36' 15" N Long: 111° 55' 40" W UTM Northing: 3719250 UTM Easting: 414500
8.	Scottsdale Station 03-0740-003 2857 N. Miller Rd., Scottsdale	Lat: 33° 28' 50" N Long: 111° 55' 10" W UTM Northing: 3704651 UTM Easting: 00414885

TABLE 3-1. HI-VOL MONITOR SITES IN PHOENIX AREA (continued)

9.	Mesa Station 03-0460-002 3rd Place & Center, Mesa	Lat: 33° 25' 30" N Long: 111° 49' 45" W UTM Northing: 3698514 UTM Easting: 422913
10.	Downtown Phoenix Site 03-0600-010 500 S. 3rd Ave., Phoenix	Lat: 33° 26' 38" N Long: 112° 04' 45" W UTM Northing: 3700819 UTM Easting: 399692
11.	St. John's Site 03-0440-011 St. John's Indian School	Lat: 33° 17' 25" N Long: 112° 10' 10" W UTM Northing: 3683881 UTM Easting: 391110
12.	Sun City Site 03-0790-002 10401 Thunderbird Blvd., Sun City	Lat: 33° 36' 30" N Long: 112° 17' 00" W UTM Northing: 3719270 UTM Easting: 380940
13.	Paradise Valley Pump Site 03-0570-002 3546 E. Sweetwater Rd., Paradise Valley	Lat: 33° 36' 15" N Long: 112° 00' 10" W UTM Northing: 3718521 UTM Easting: 406964
14.	Carefree Airport Site 03-0440-006 Carefree, Arizona	Lat: 33° 49' 05" N Long: 110° 53' 50" W UTM Northing: 3742146 UTM Easting: 416964
15.	Chandler Site 03-0120-001 250 E. Commonwealth, Chandler	Lat: 33° 18' 30" N Long: 111° 50' 14" W UTM Northing: 3685585 UTM Easting: 422035
16.	Guadalupe Site 03-0440-008 Encinas Rd., vacant pump station	Lat: 33°22' 00" N Long: 110° 57' 37" W UTM Northing: 3692151 UTM Easting: 410665
17.	Litchfield Station 03-0440-009 Litchfield & Villa Nuera Rds., Litchfield	Lat: 33° 29' 30" N Long: 112° 21' 30" W UTM Northing: 3702423 UTM Easting: 00373811

Source: Maricopa County Health Department, Bureau of Air Pollution Control

TABLE 3-2. SITE SURVEY SUMMARY

MONITOR SITE	CHARACTERIZATION OF GENERAL AREA	ELEVATION OF MONITOR ABOVE GROUND	SITE SPECIFIC SOURCES	SOURCES IN GENERAL AREA	REPRESENTATIVENESS	IMPACT OF ENVIRONMENTAL CHANGES AT SITE	UTILITY OF MONITOR DATA	OBSERVED TSP IN 1975
1. St. Johns	Rural/residential. Indian Reservation in open desert.	15 ft.	Soil dust from unpaved roads, residence yards, and open fields.	Soil dust from unpaved roads.	Site Specific	Not significant	Useful as indicator, but significance of site and specific sources must be determined.	145
2. Litchfield Park	Suburban/residential. Relatively new community with substantial growth in progress.	10 ft.	Soil dust from unpaved roads, disturbed open fields, construction-excavation activities.	Soil dust from unpaved roads, disturbed open field, construction-excavation activities. Soil dust from open fields.	Area-Wide	Previous changes are representative of areawide trends and probably have not affected areawide representativeness.	Useful representation of air quality for the general area.	139*
3. Sun City	Suburban/residential	25 ft.	Soil dust from disturbed open fields. Motor vehicle exhaust, entrained dust from paved roads.	Soil dust from disturbed open fields, entrained dust from paved roads.	Area-Wide	Future development will intensify local fugitive sources, then towards completion, reduce them.	Useful representation of air quality for the general area.	88*
4. Glendale	Surburan-rural/residential-agricultural	20 ft.	Motor vehicle exhaust in parking lot, entrained dust from paved roads.	Power plant 1/2 mile SW of site. Agricultural fields, and disturbed fields, and disturbed vacant lots, entrained dust from paved roads.	Area-Wide	Not significant.	Useful representation of air quality for the general area.	101
5. West Phoenix	Suburban/residential	5 ft.	None significant.	Soil dust from open fields.	Area-Wide	Not significant	Useful representation of air quality for the general area.	--
6. North Phoenix	Suburban/residential	5 ft.	Soil dust from unpaved roadways and unpaved parking lots, entrained dust from paved roads.	Soil dust from unpaved roadways and vacant lots, entrained dust from paved roads.	Site Specific	Not significant	Doubtful if significance of site specific source can be determined. Measurements may have to be deleted from data base.	121
7. Paradise	Suburban/residential Considerable new development in progress	5 ft	Soil dust from disturbed open fields, unpaved excavation and construction activities, entrained dust from paved roads.	Soil dust from disturbed open fields, excavation and construction, and unpaved roads. Entraineddust from paved roads.	Area-Wide	Construction activity near site in late 1974 may have resulted in site specific representation of air quality	Useful representation of air quality for the general area.	184
8. North Scottsdale/ Paradise Valley	Rural/residential-Commercial	5 ft.	Soil dust from disturbed open fields.	Soil dust from disturbed open fields, excavation and construction, and unpaved roads. Entrained dust from paved roads.	Area-Wide	Not significant	Useful representation of air quality for the general area.	149
9. Carefree	Remote	5 ft.	Soil dust from disturbed desert ground.	Soil dust from disturbed desert ground.	Area-Wide	Not significant	Useful representation of air quality for the general area.	42
10. Scottsdale	Suburban/residential	15 ft.	Motor vehicle exhaust. entrained dust from paved roads.	Entrained dust from paved roads.		Previously an unpaved driveway and parking lot may have resulted in slightly higher levels of particulates.	Useful representation of air quality for the general area.	115
11. South Phoenix	Urban/residential-Commercial	36 ft.	Soil dust from residence yards, unpaved road shoulders, and open fields. Motor exhaust from parking lots and Central Ave. Entrained dust from paved roads.	Soil dust from residence yards, unpaved road shoulders, and open fields. Motor vehicle exhaust, entrained dust from paved roads.	Area-Wide	Not significant	Useful representation of air quality for the general area.	144
12. Guadalupe	Rural/residential	5 ft	Soil dust from residence yards, disturbed vacant lots, entrained dust from paved roads.	Soil dust from residence yards, open fields, disturbed vacant lots, entrained dust from paved roads.	Area-Wide	Not significant	Useful representation of air quality for the general area.	173
13. Chandler	Suburban/residential-	21 ft.	Soil dust from open fields, unpaved roads and parking lots, from open fields, agricultural property, entrained dust from paved roads.	Soil dust from open fields, unpaved roads and parking lots, and agricultural property, entrained dust from paved roads.	Area-Wide	Municipal landscaping activities in recent years may have limited representativeness to a site specific characterization.	Useful representation of general area at present. Previous potential levels measured in 1973 are probably somewhat higher than general area trend.	119*
14. Mesa	Suburban/residential-Commercial	5 ft.	Soil dust from unpaved roadways and parking lots, soil yards, entrained dust from paved roads.	Soil dust from unpaved parking lots and roadways, disturbed vacant lots, entrained dust from paved roads.	Site Specific	Not significant	Doubtful if significance of specific sources can be determined and if air quality data can be useful.	117
15. Downtown Phoenix	Urban/Commercial	23 ft.	Soil dust from unpaved roads and parking areas, motor vehicle exhaust, entrained dust from paved roads.	Soil dust from unpaved roads and parking areas, motor vehicle exhaust, entrained dust from paved roads.	Site Specific	Not significant	Doubtful if significance of specific source can be determined and if air quality data can be useful.	200*
16. Arizona State	Suburban/residential	15 ft.	Soil dust from vacant lots, open fields, and excavation/construction activities. Motor vehicle exhaust, entrained dust from paved roads.	Soil dust from vacant lots, open fields, escavation/construction activities, motor vehicle exhaust, entrained dust from paved roads.	Area-Wide	Site specific construction occurring earlier (1973) may have affected area-wide representativeness of monitor.	Useful representation of air quality for the general area.	169
17. Central Phoenix	Urban/residential	22 ft.	Soil dust from vacant fields, residence yards, and road shoulders, Motor vehicle exhaust, entrained dust from paved roads.	Soil dust from vacant fields, residence yards, and road shoulders. Motor vehicle exhaust, entrained dust from paved roads.	Area-Wide	Not significant.	Useful representation of air quality for the general area.	112

suburban or rural areas. The communities in some of these areas are long-established, while others are relatively new and presently undergoing substantial growth trends.

Almost all of the monitor sites appear to experience fugitive soil dust as the most significant site-specific source of suspended particulates. Soil dust sources in the vicinity of the various monitors varies substantially, in magnitude and type. Generally, soil dust is most apt to be generated in areas where there is substantial activity on soil surfaces. Soil dust particles are emitted by the actual activity (i.e., vehicle travel, pedestrian, excavation) or are suspended by wind after being disturbed by these activities. Numerous acres of soil surfaces are exposed throughout the Phoenix area, and are subject to constant activity and suspension influences. These surfaces consist of vacant lots, open fields, unpaved road shoulders, residence yards, unpaved roads, excavation piles, and agricultural lands. Dust which is deposited from these sources on other surfaces (e.g. paved roads) may be considered as another source. When suspended, this source is known as "entrained dust".

Consistent with the specific site environment, the most significant sources of suspended particulates in the general areas encircling the monitor sites is soil dust. These sources are generally similar to those characterizing the specific site, both in type, and apparent magnitude and distribution. Hence, air quality at most of the sites is representative of both site specific sources as well as the area-wide sources. However, four of the sites do appear to be representative of only site specific air quality. At the St. Johns Site, the monitor appears to be located in a hotspot of fugitive dust activity which is unrepresentative of the otherwise remote and mostly undisturbed soil of the general area. At North Phoenix, the site is subject to soil dust raised by vehicle traffic on an unpaved alleyway 30 feet from the monitor. Although the general area contains several such unpaved alleyways, the proximity of the monitor to the site-specific source limits this location to a site specific representativeness. The same type of problem occurs at the Mesa Site. An unpaved vehicle accessway, and disturbed soil surfaces under and encircling the monitor, appears to create a site specific air quality which is non-representative of the general area. At the Downtown Phoenix Site, unpaved vehicle accessways and unpaved parking areas contribute suspended dust loadings to the nearby monitor sensor. These loadings do not appear to be representative, in magnitude and distribution of emission sources throughout the general area.

On the basis of the site reviews, the utility of the monitor data appears to be in doubt from only four sites. These sites are Downtown Phoenix, Mesa, St. Johns, and North Phoenix. It is doubtful if the significance of the fugitive sources near the monitor at these sites may be definitively estimated. If the effect of the local sources can be determined, it may be possible to factor out the local influence of these sources, permitting the monitor to act as a useful indicator of area-wide air quality. The potential utility of these problem sites will be explored in later tasks concerning analysis of fugitive emissions and diffusion modeling of these sources.

Appendix A contains the station by station monitor site descriptions. Each description is organized into two parts. In the first part, the locale in the immediate vicinity of the sensor is characterized. Site inspections, photography, and local interviews form the basis for the characterization. Emission sources are identified, and obstructions and topography around the monitor are discussed. Relevant changes which have occurred (or are forecast) in the site environment are considered. In the second part, the representativeness of the monitor in expressing air quality of the local area is assessed, and the implications of this assessment for the utility of air quality measurements from the sites is evaluated.

4.0 STATISTICAL DISTRIBUTIONS OF HI-VOL MONITORING DATA

This section presents and analyzes the statistical distributions of Hi-Vol data from monitoring sites in the Phoenix study region. The data are from seventeen monitoring sites for the years 1973 to 1975. The analysis attempts to derive distributions typical of 1975, the base year for the implementation planning phase of this project. Monitoring data are used for three years, rather than one year, to provide a larger number of samples for estimating the statistical distributions.

Section 4.1 briefly discusses the nature and extent of the monitoring data. Section 4.2 describes the statistical methodology which is used. The method basically involves fitting log normal distributions to the data. Section 4.3 summarizes the annual geometric means and expected 24 hour maximal values that are derived from the data. These expected values are compared with yearly measured values in Section 4.4.

4.1 AVAILABLE HI-VOL MONITORING DATA

Hi-Vol monitoring data were available from two data sources for the air quality review: 1) the National Aerometric Data Bank (Raw Data Listing), from which 1973 through 1974 data were obtained, and 2) the Maricopa County Health Department, Bureau of Air Pollution Control, from which 1975 data were obtained. These Hi-Vol data, representing 24-hour averages of suspended particulate matter measured every six days (60 samples per year), were available for seventeen monitoring locations. These monitoring sites were adequately distributed throughout the Phoenix area; the locations of the sites are shown in Figure 4-1.

The duration of the overall sampling periods during 1973 to 1975 was not consistent among all of the stations. For instance, only fifteen of the seventeen monitoring stations provided some data for 1975. The overall sampling period for each station is documented in Section 4.3.

4.2 METHODS FOR STATISTICAL ANALYSIS OF HI-VOL DATA

Routine Hi-Vol monitoring data typically represent 24 hour samples of particulate air quality. Since particulate concentrations vary with

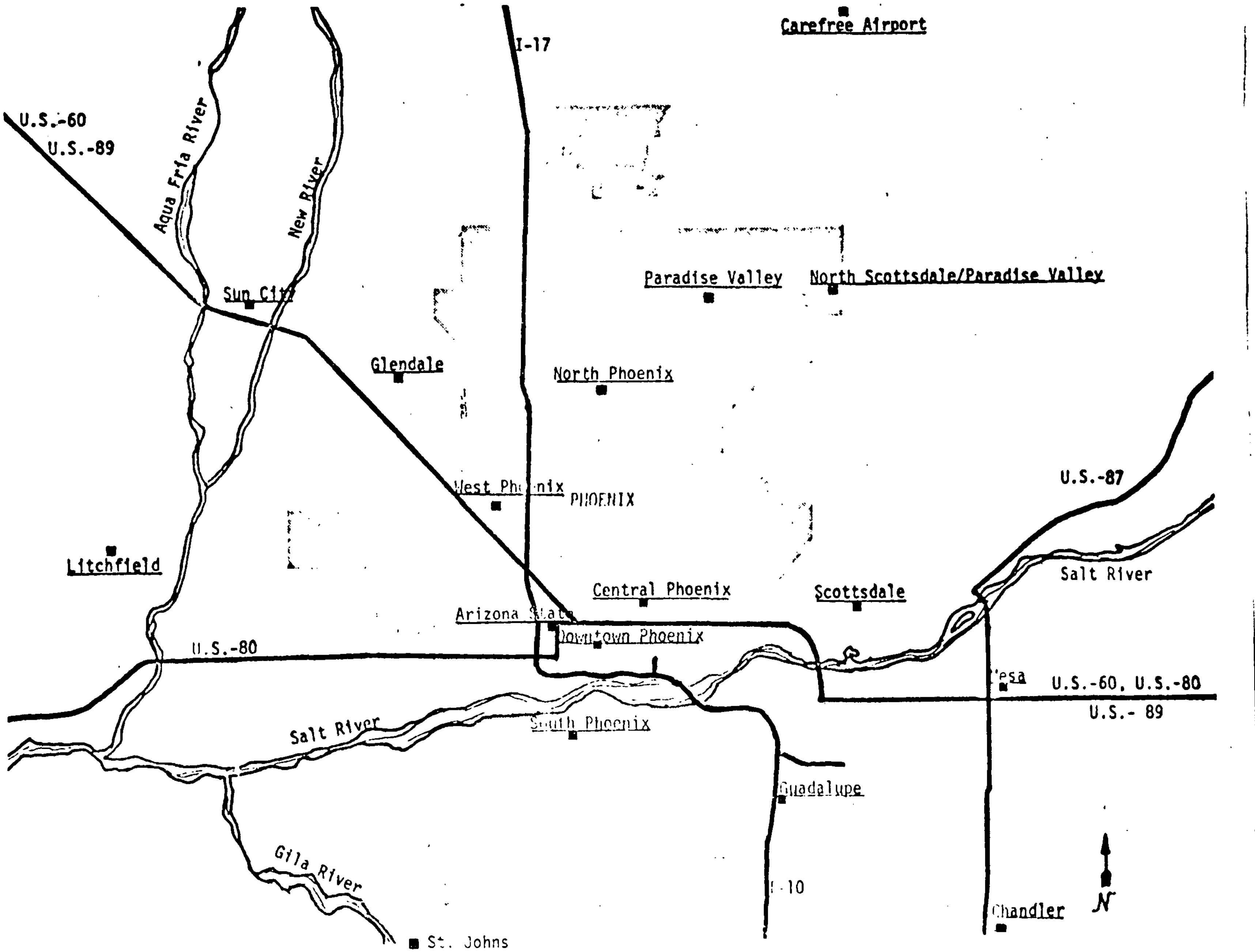


Figure 4-1. Hi-Vol Monitoring Sites Within the Phoenix Area.

time due to meteorological variance and emission fluctuations, the Hi-Vol samples from any location occur in the form of a statistical distribution. National Ambient Air Quality Standards for suspended particulate matter, summarized in Table 4-1, have been established for two parameters of this distribution, the yearly maximal 24 hour value and the annual geometric mean. In comparing monitoring data to the NAAQS, statistical analyses should be performed to account for the stochastic nature of the data.

In this report, plots of the data on log-probability paper will be used as the basic statistical methodology. A straight line on log-probability paper represents a log-normal frequency distribution, the case where the logarithms of the data form a normal or Gaussian distribution. Aerometric data form "one-tailed" distributions (no data occur less then zero), and these distributions generally approximate the shape of a log-normal curve[5]. It is not expected that all air quality data will have a perfect log-normal frequency distribution, and deviations from log-normality will be reflected in a curved line on log-probability paper. A study of the curvature of actual air quality distributions indicates that it is a result of certain meteorological parameters and is also related to the type of source (i.e., area source or point source)[6].

TABLE 4-1. NATIONAL AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATE MATTER.

	Annual Geometric Mean	Maximum: Not to be exceeded more than once a year
Primary Standard	75 $\mu g/m^3$	260 $\mu g/m^3$ for 24 hours
Secondary Standard	60 $\mu g/m^3$*	150 $\mu g/m^3$ for 24 hours

*Guideline for attainment of 24 hour Secondary Standard.

A typical frequency distribution of suspended particulate data (Hi-Vol sampling data) is illustrated by the histogram in Figure 4-2. A log-normal distribution of this data is represented by the superimposed line on that histogram. The same data plotted on log-probability paper (with a probability scale on the abscissa) is illustrated in Figure 4-3.

Two statistical parameters are utilized to characterize a log-normal distribution: the geometric mean (m_g) and the standard geometric deviation (s_g). For a number of individual observations of size "n", these are defined below:

$$m_g = \exp\left(\frac{\sum \ln c}{n}\right) \qquad (1)$$

and

$$s_g = \exp\left[\frac{\sum(\ln c - \ln m_g)^2}{n}\right]^{0.5} \qquad (2)$$

where: m_g = geometric mean,

exp= the base of natural logarithms, 2.718,

$\sum \ln c$ = the summation of the natural logarithms of the individual concentrations measured,

n = the number of individual concentrations measured,

and s_g= standard geometric deviation.

The arithmetic mean (m), geometric mean (m_g), standard deviation (s), and standard geometric deviation (s_g) for a log-normal distribution are related as follows:

$$s_g = \exp\left[\ln^{0.5}\left(\frac{s^2}{m^2} + 1\right)\right] \qquad (3)$$

$$m_g \doteq \frac{n}{\exp\left(0.5 \ln^2 s_g\right)} \qquad (4)$$

or, taking the logarithms of the terms:

$$\ln m_g = \ln m - 0.5 \ln^2 s_g \qquad (5)$$

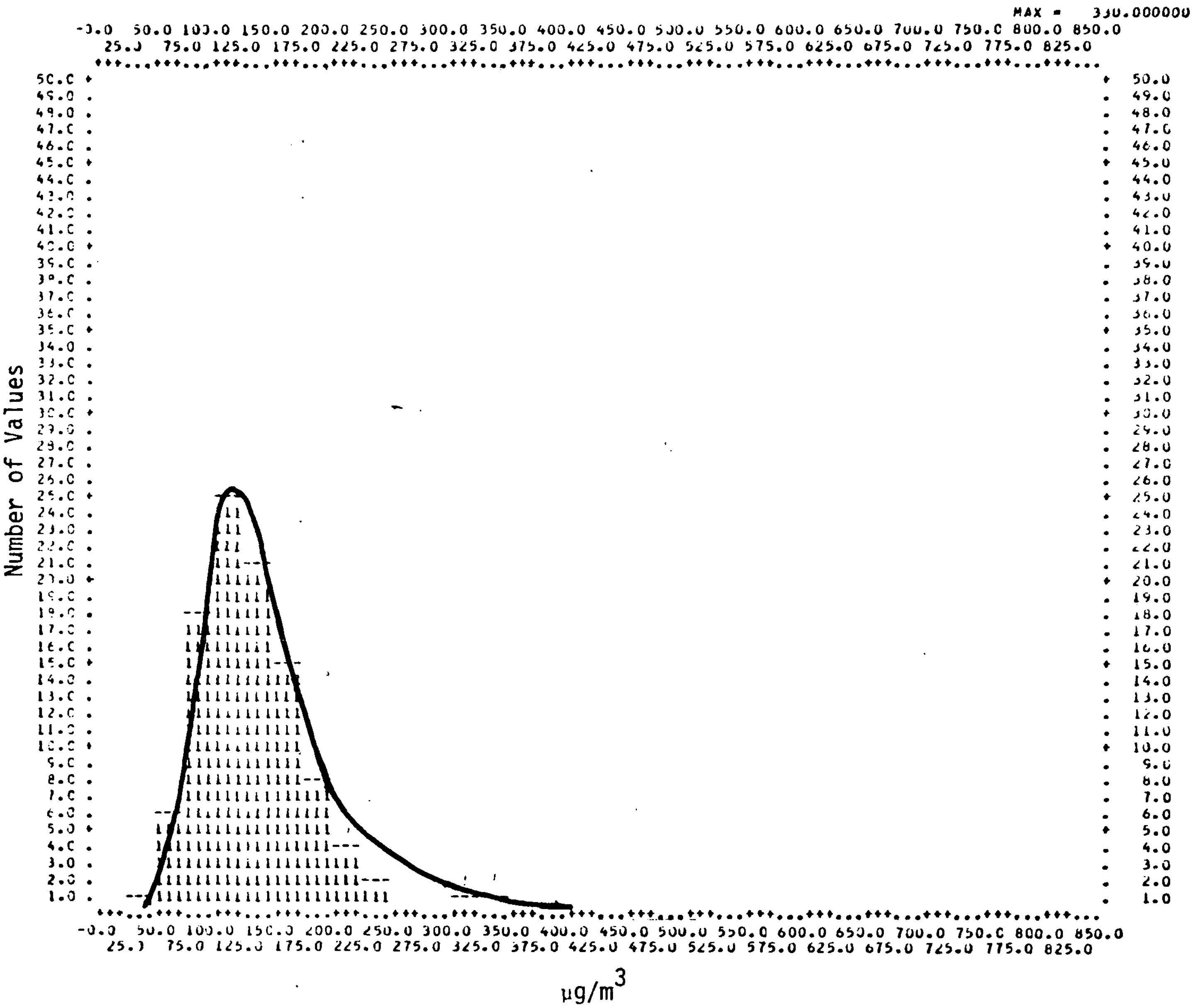


Figure 4-2. Frequency Distribution of 24 Hour Suspended Particulates at Mesa Site ($\mu g/m^3$). February 1974 through December 1975.

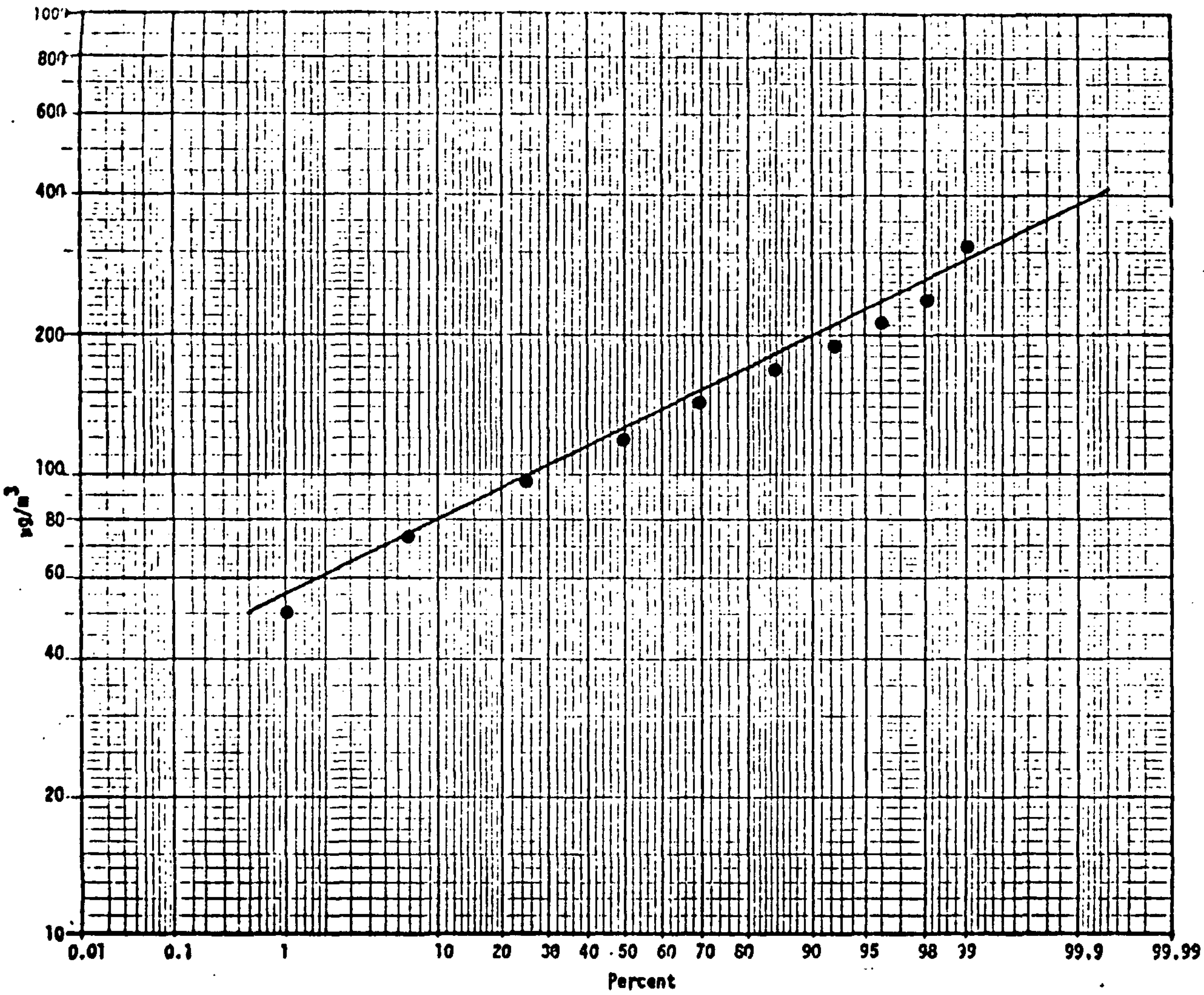


Figure 4-3. Cumulative Frequency Distribution Plot of Suspended Particulate Levels. Mesa Site-- February 1974 through December 1975.

For a log-normal plot such as Figure 4-3, the equation of the best fit straight line has the following form:

$$\ln c = \ln m_g + z \ln s_g \qquad (6)$$

$$\text{or} \qquad c = m_g \, s_g^{\,z} \qquad (7)$$

where c = individual concentrations measured,

and z = number of standard deviations that "c" occurs away from the geometric mean.

For accumulative frequency distribution, the 84th percentile concentration value and the 16th percentile point are represented by one standard deviation, $z = \pm 1$. The geometric mean (m_g) is represented by the 50th percentile value (i.e., $z = 0$). Therefore,

$$m_g = c_{50\%} \qquad (8)$$

$$\text{and} \quad \ln c_{84\%} = \ln m_g + (1) \ln (s_g), \qquad (9)$$

$$\text{or} \quad s_g = \frac{c_{84\%}}{c_{50\%}} = \frac{c_{84\%}}{m_g}. \qquad (10)$$

The expected maximum value for a number of samples can be calculated utilizing equation (7), where the "z-value" is dependent on the frequency with which the expected maximum value occurs. An empirical equation for calculating the plotting position frequency for any point other than the median, is as follows[7]:

$$f = 100\% \; \frac{r - 0.4}{n} \qquad (11)$$

where f = the plotting position frequency, in percent,

r = the rank order (e.g., highest, second, third, fourth, etc.,) and

n = the number of samples.

Using a normal error table, the frequency determines the statistical "z-value" associated with the number of deviations from the median [3]. The"z-values" used in calculating the expected maximum concentration for 60, 70, 90, and 365 samples per year are 2.33, 2.38, 2.47, and 2.94 respectively. These values for "z" may be obtained very readily from a "z-curve", which is plotted with "plotting-position frequency" (equation (11)) as the abscissa and "number of standard deviations from median" (z-value) on the ordinate[8].

4.3 FREQUENCY DISTRIBUTIONS OF SUSPENDED PARTICULATE LEVELS AND CALCULATION OF MAXIMAL 24-HOUR LEVELS

Cumulative frequency distributions of Hi-Vol data, plotted on log-probability paper, are presented for the seventeen sites in Figures 4-4 through 4-20. The order of the figures is as follows:

Figure 4-4	Central Phoenix	Figure 4-12	Mesa
4-5	South Phoenix	4-13	Downtown Phoenix
4-6	Arizona State	4-14	St. John's
4-7	Glendale	4-15	Sun City
4-8	West Phoenix	4-16	Paradise Valley
4-9	North Phoenix	4-17	Carefree
4-10	North Scottsdale/ Paradise Valley	4-18	Chandler
4-11	Scottsdale	4-19	Guadalupe
		4-20	Litchfield

In each case, a log-normal distribution (straight line) has been fit to the data. This distribution is defined by the geometric mean (m_g) and geometric standard deviation (s_g) calculated from the Hi-Vol data. An alternative presentation of the data, histograms of the frequency distributions, can be found in Appendix B.

In most cases, the data in Figures 4-4 through 4-20 approximate a log-normal distribution (straight line) fairly well. However, in three cases (Scottsdale, Downtown Phoenix, and Guadalupe), there is substantial curvature to the data. For these three sites there appears to be a leveling off of the highest values as compared to the log-normal distributions. The log-normal distribution might considerably overestimate maximal value for these sites. In these three cases, a separate (dashed) line has been drawn to fit the upper portions of the distribution. The dashed lines should provide more realistic predictions of expected maximal values.

Table 4-2 summarizes the parameters of the log-normal distributions that are fit to the data from each site. Table 4-2 presents the annual geometric mean, geometric standard deviation, and cumulative frequency distribution for the log-normal lines. Table 4-2 also presents the

CUMULATIVE FREQUENCY DISTRIBUTION PLOT OF 24-HOUR SUSPENDED PARTICULATE VALUES

Figure 4-4.

Central Phoenix Site 1/73-12/75

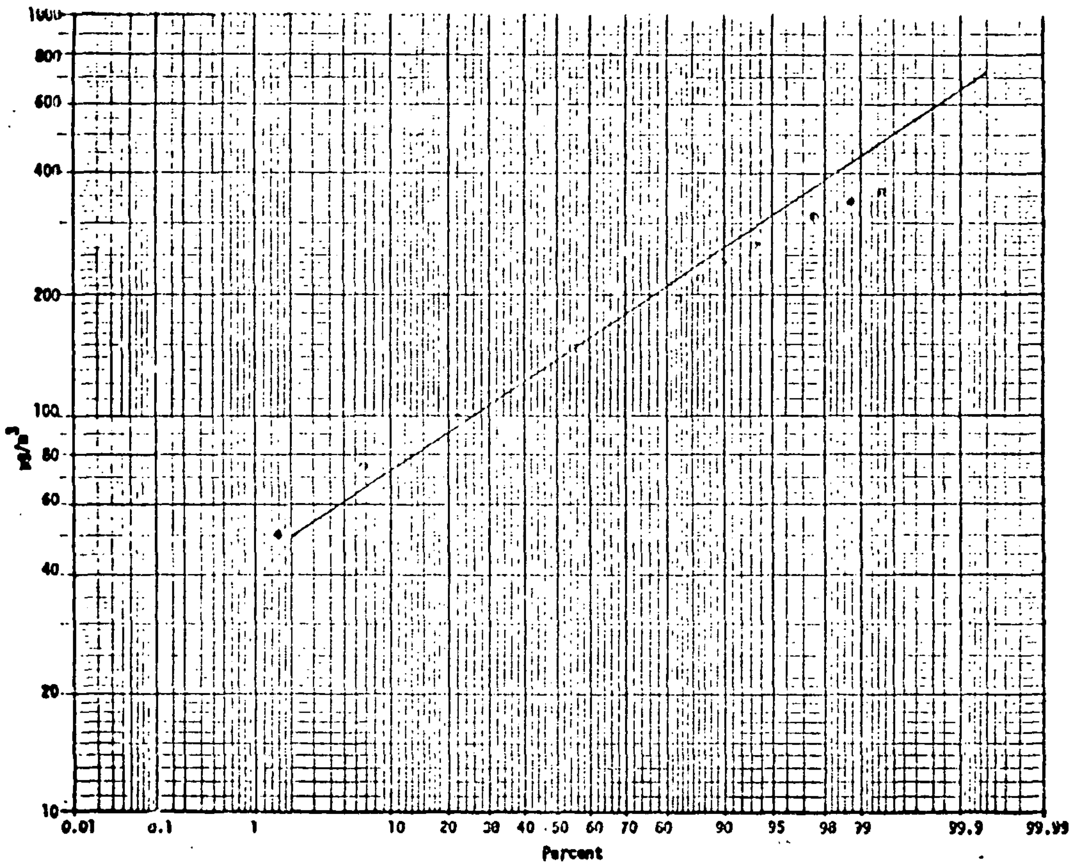


Figure 4-5.

South Phoenix Site 4/74-12/75

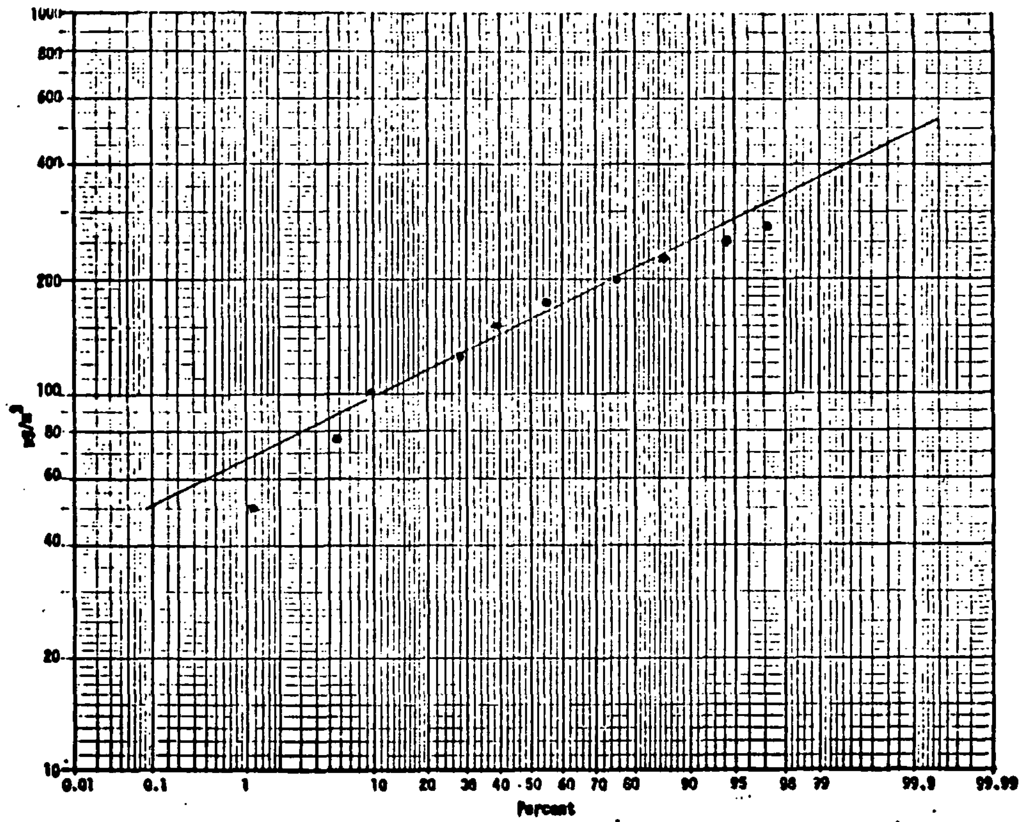


Figure 4-6.

Arizona State Site 6/74-12/74

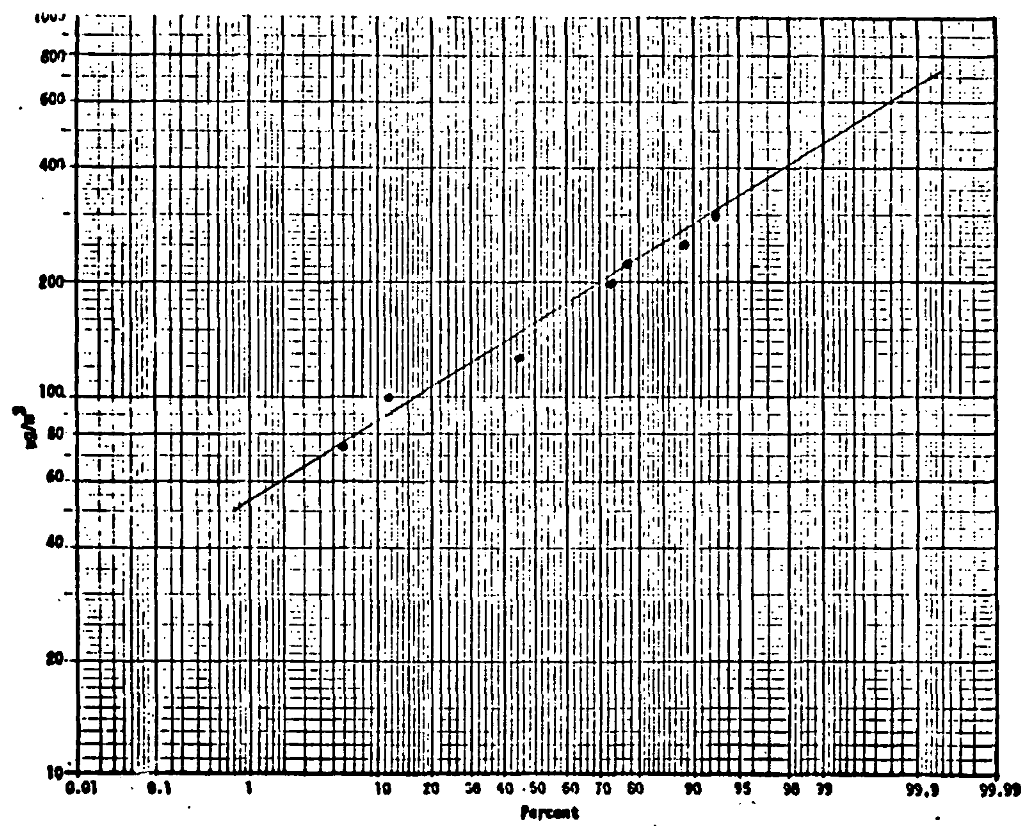


FIGURE 4-7.

Glendale Site 7/74-12/75

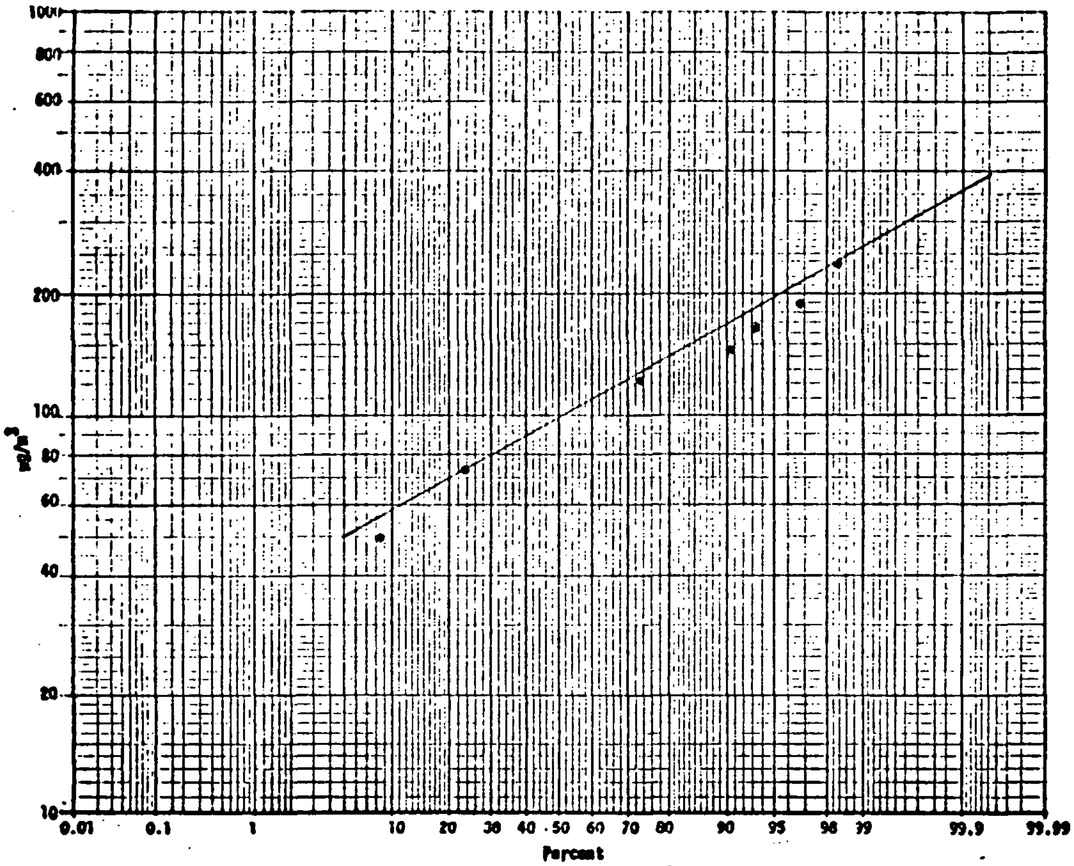
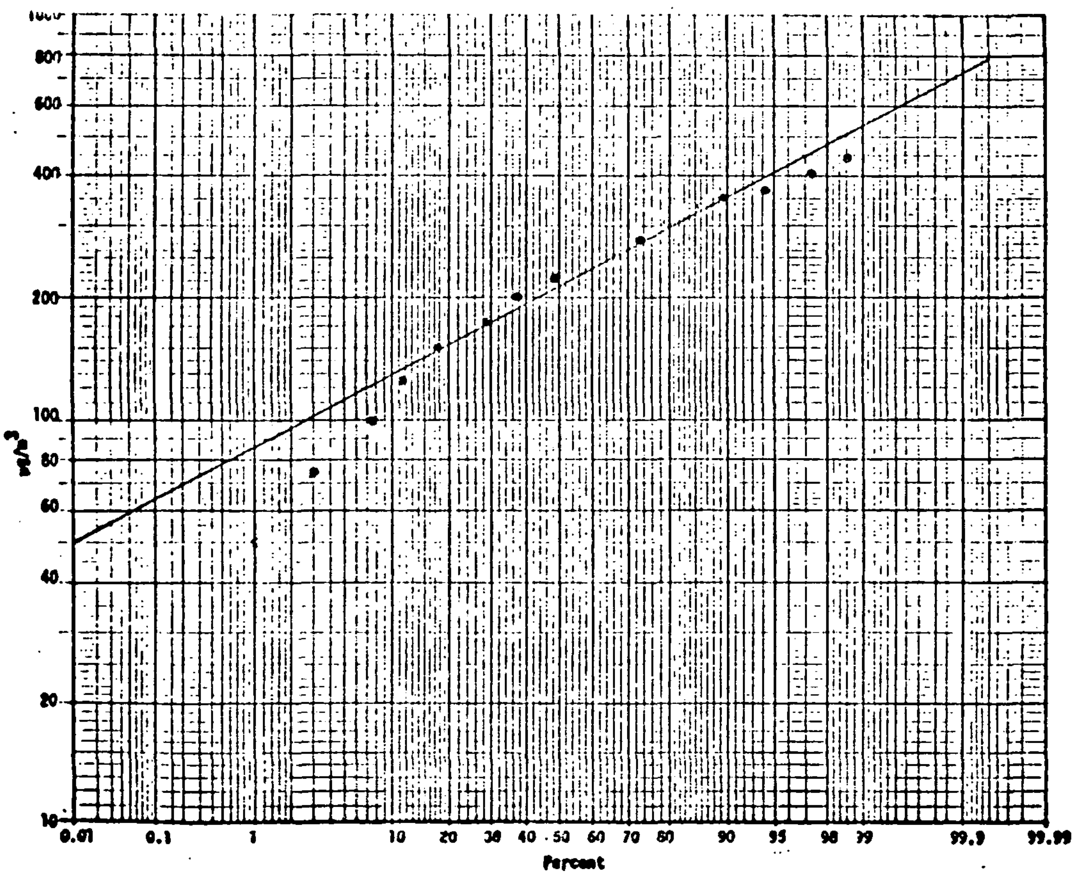


FIGURE 4-8.

West Phoenix Site 1/73-1,2,3,5/74



CUMULATIVE FREQUENCY DISTRIBUTION PLOT OF 24-HOUR SUSPENDED PARTICULATE VALUES

Figure 4-9.

North Phoenix Site 1/73-12/75

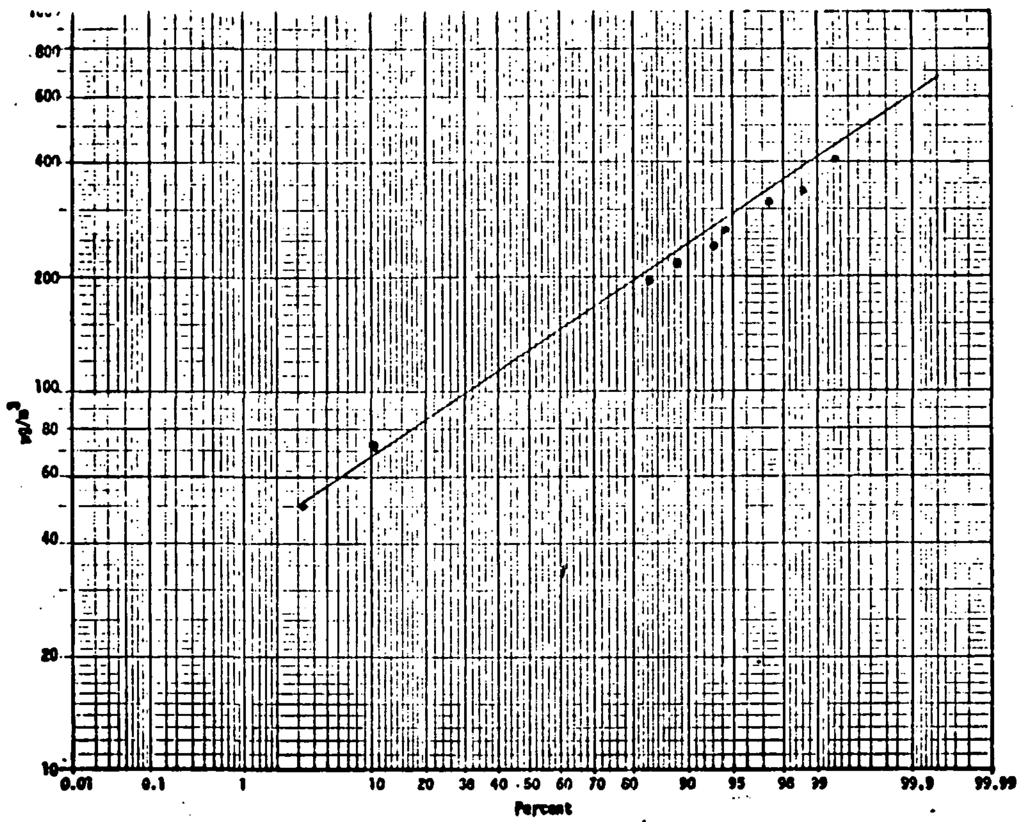
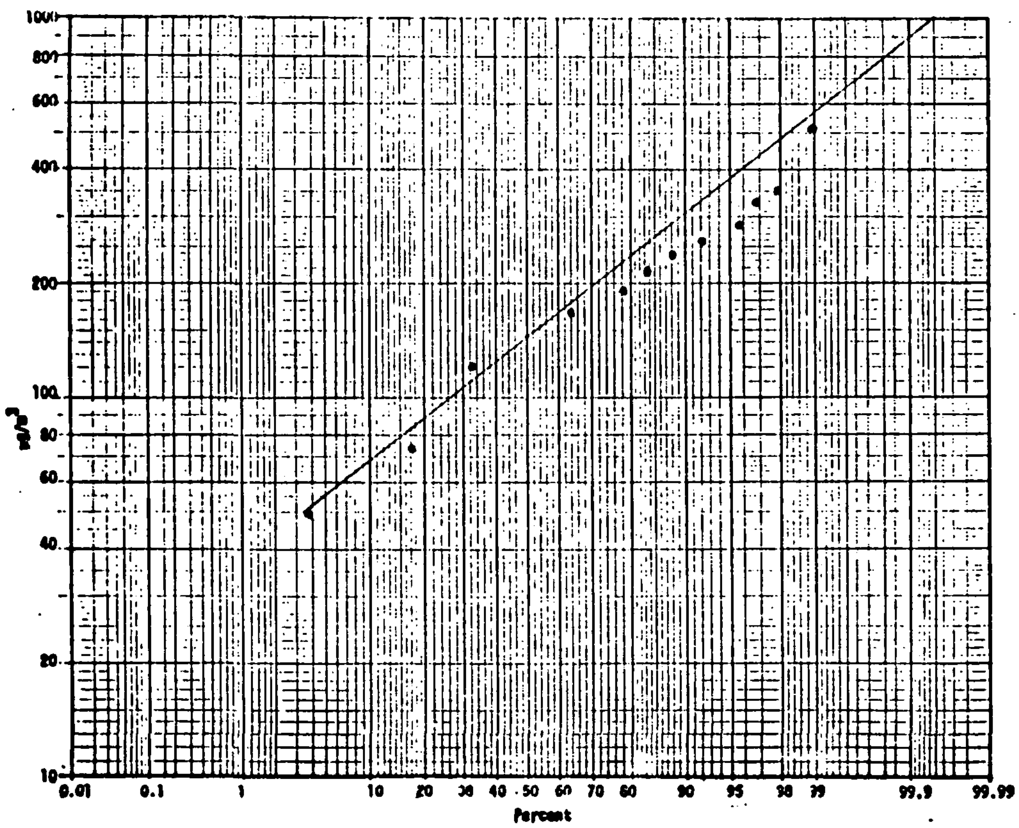


Figure 4-10.

North Scottsdale/Paradise Valley Site 4/74-12/75



CUMULATIVE FREQUENCY DISTRIBUTUION PLOT OF 24-HOUR SUSPENDED PARTICULATE VALUES

Figure 4-11.

Scottsdale Site 8/74-12/75

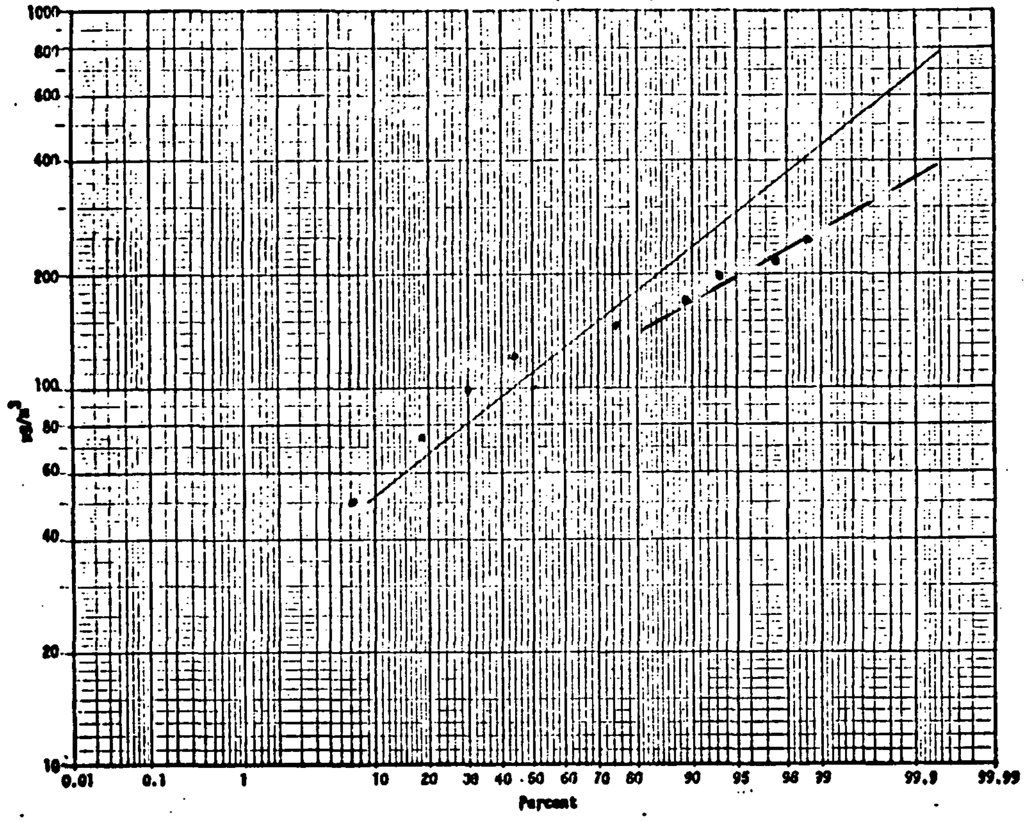
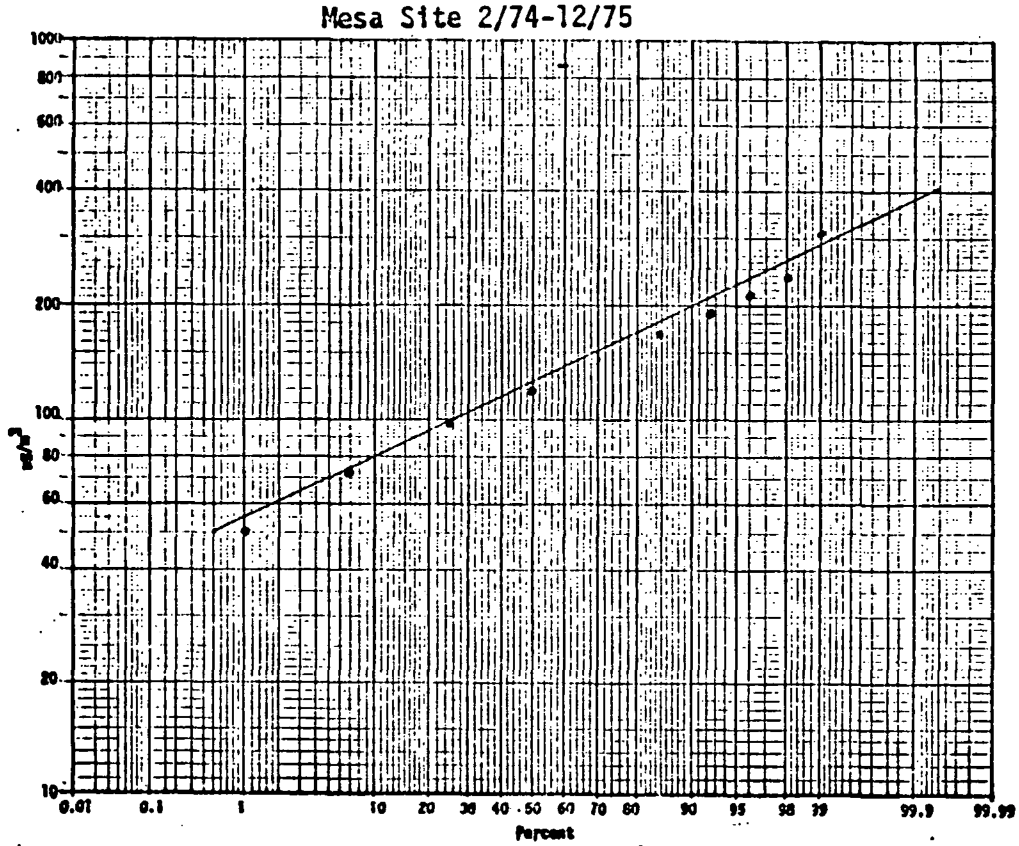


Figure 4-12.

Mesa Site 2/74-12/75



CUMULATIVE FREQUENCY DISTRIBUTUION PLOT OF 24-HOUR SUSPENDED PARTICULATE VALUES

Figure 4-13.

Downtown Phoenix Site 6/73-2/75

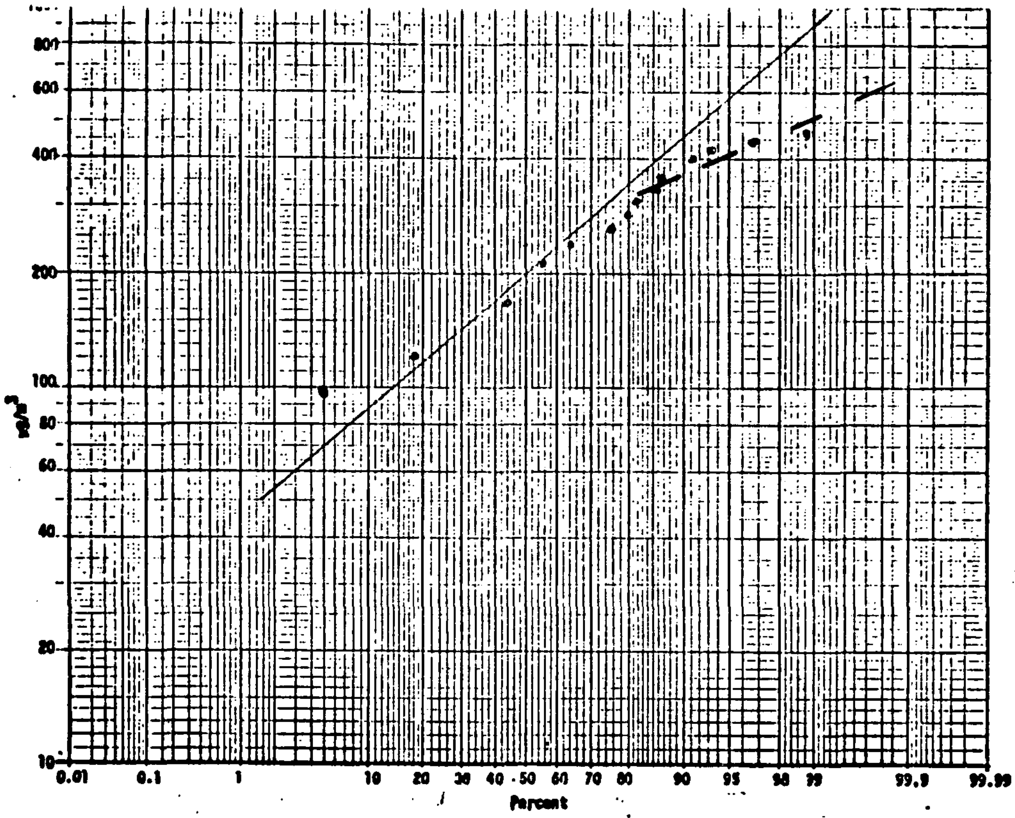
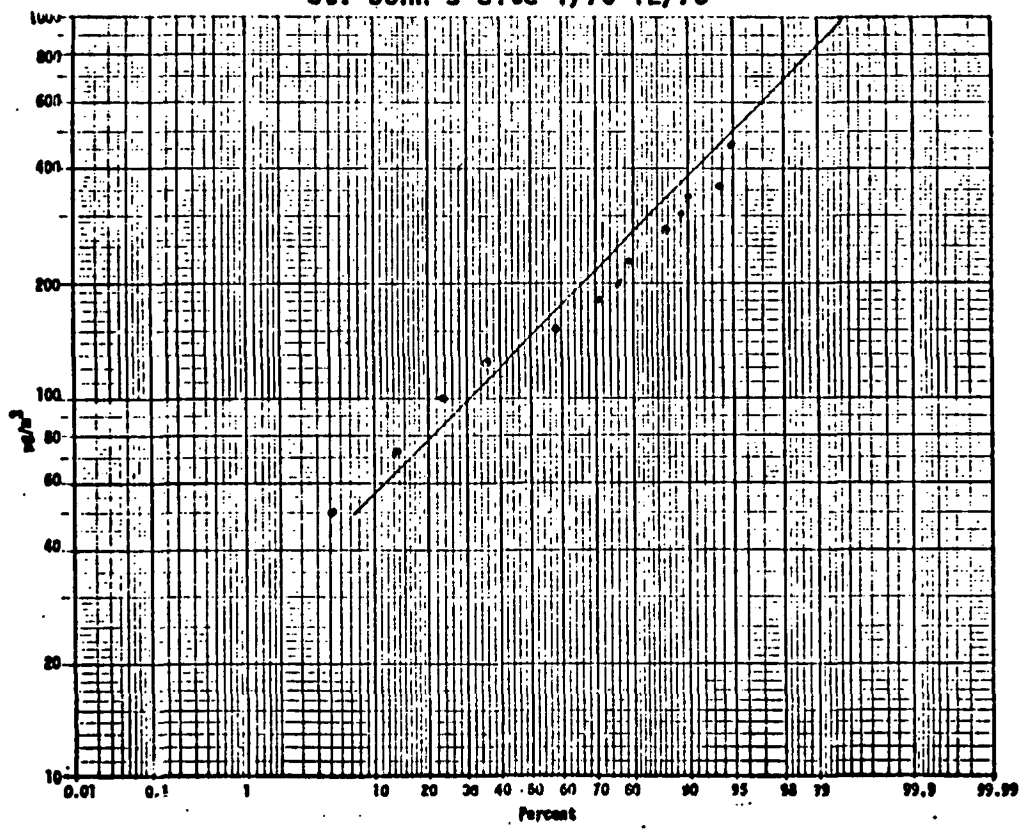


Figure 4-14.

St. John's Site 1/75-12/75



CUMULATIVE FREQUENCY DISTRIBUTION PLOT OF 24-HOUR SUSPENDED PARTICULATE VALUES

Figure 4-15.

Sun City Site 7/73-3/75

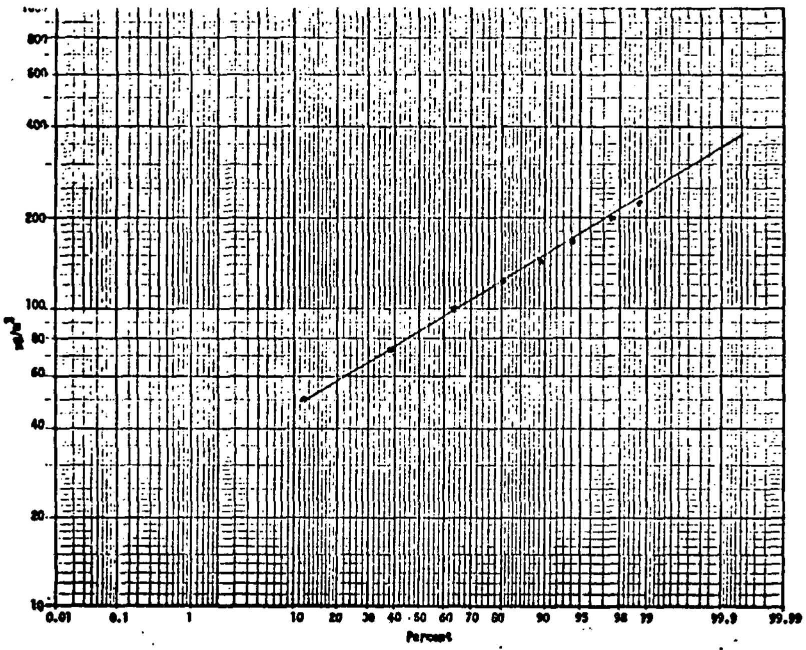


Figure 4-16.

Paradise Valley Site 6/73-3/75

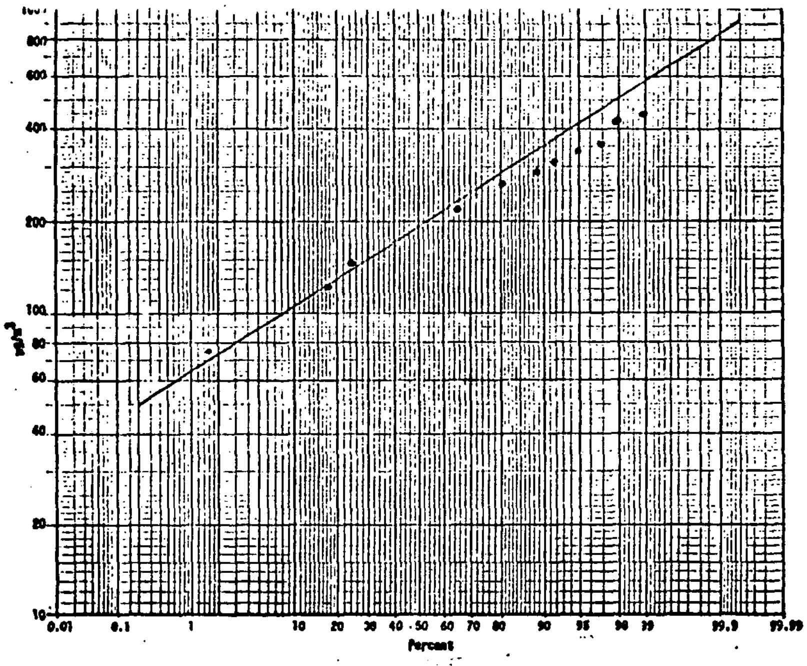


Figure 4-17.
Carefree Site 6/73-12/75

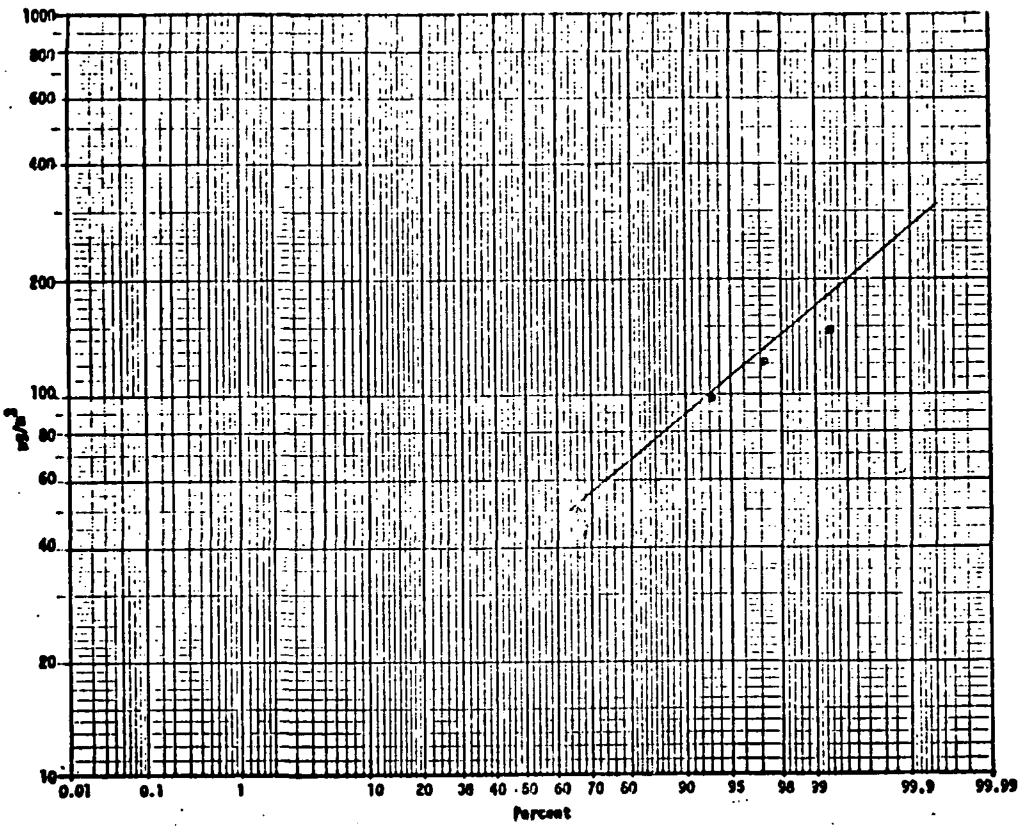
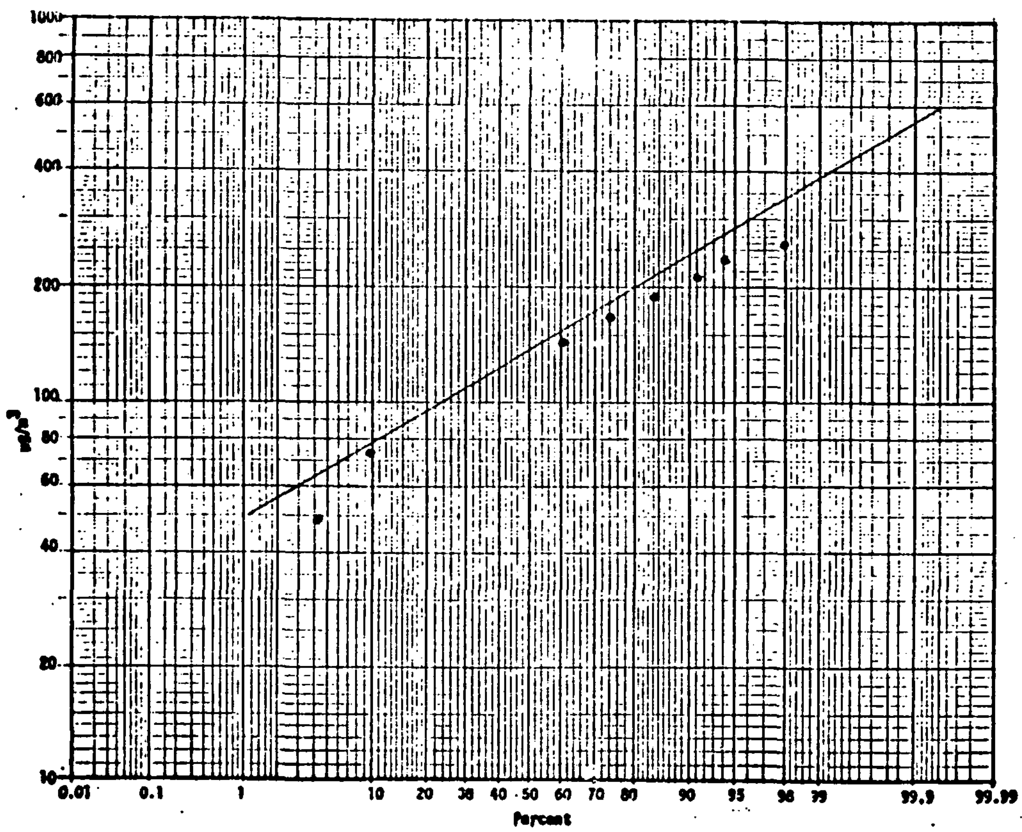


Figure 4-18.
Chandler Site 6/73-3/75



CUMULATIVE FREQUENCY DISTRIBUTION PLOT OF 24-HOUR SUSPENDED PARTICULATE VALUES

Figure 4-19.

Guadalupe 1/74-12/75

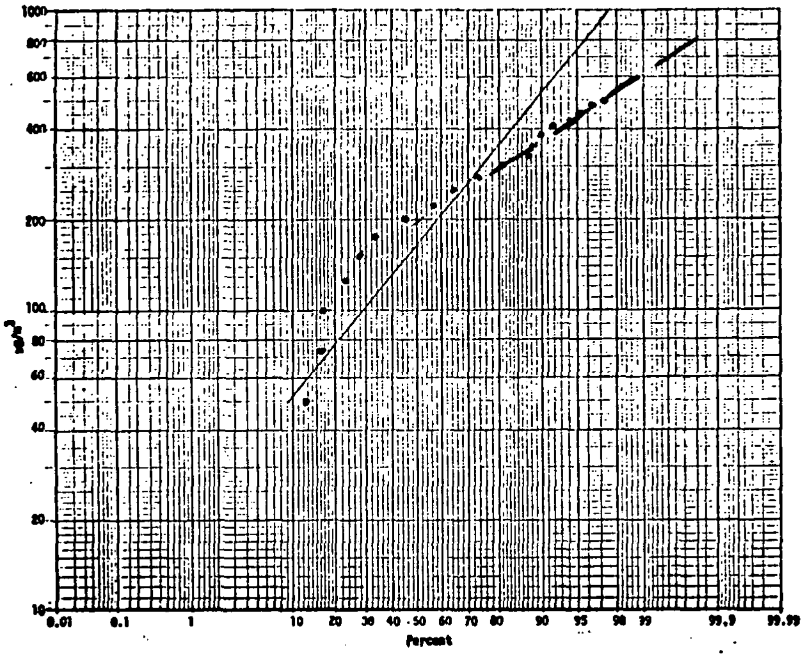


Figure 4-20.

Litchfield Site 2/75-6/75

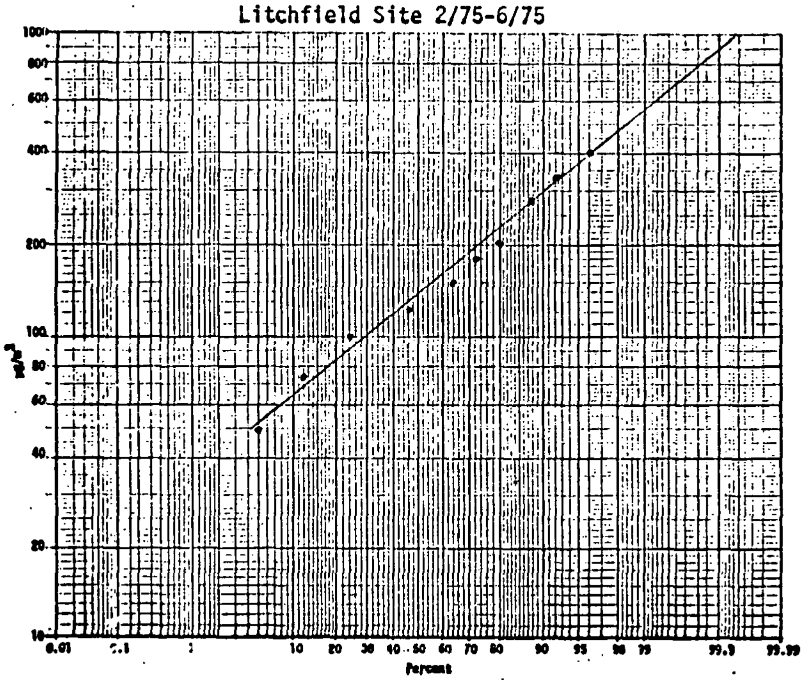


TABLE 4-2

CUMULATIVE FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE

Central Phoenix 1/73 - 12/75		South Phoenix 4/74 - 12/75	
Less than or equal to this value ($\mu g/m^3$)	Cumulative Percent	Less than or equal to this value ($\mu g/m^3$)	Cumulative Percent
50	2.0	50	<0.1
100	26.0	100	7.0
150	57.0	150	37.0
200	77.0	200	66.0
250	88.5	250	85.0
300	94.0	300	94.0
350	97.0	350	97.2
400	98.3	400	99.0
450	99.1		
m_g = 139 s_g = 1.59 c_{365} = 543		m_g = 170 s_g = 1.45 c_{365} = 463	

TABLE 4-2 (continued)

CUMULATIVE FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE

Arizona State 6/74 - 12/74		Glendale 7/74 - 12/75		West Phoenix 1/73 - 1,2,3,5/74	
Less than or equal to this value (μg/m³)	Cumulative Percent	Less than or equal to this value (μg/m³)	Cumulative Percent	Less than or equal to this value (μg/m³)	Cumulative Percent
50	0.7	50	15.0	50	<0.1
100	16.5	100	51.0	100	2.5
150	46.0	150	84.0	150	19.0
200	70.0	200	95.5	200	44.0
250	84.5	250	98.7	250	66.0
300	92.0	300	99.6	300	81.0
350	95.9			350	90.0
400	97.8			400	94.5
450	98.8			450	97.0
500	99.3			500	98.5
				550	99.2
m_g = 155		m_g = 97		m_g = 210	
s_g = 1.59		s_g = 1.54		s_g = 1.56	
c_{60} = 458		c_{60} = 264		c_{60} = 593	
c_{365} = 608		c_{365} = 344		c_{365} = 777	

TABLE 4-2 (continued)

CUMULATIVE FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE

Mesa 2/74 - 12/75		Downtown Phoenix * 6/73 - 2/75		St. John's 1/75 - 12/75	
Less than or equal to this value ($\mu g/m^3$)	Cumulative Percent	Less than or equal to this value ($\mu g/m^3$)	Cumulative Percent	Less than or equal to this value ($\mu g/m^3$)	Cumulative Percent
50	0.5	50	1.6	50	7.5
100	25.0	100	14.0	100	31.0
150	69.0	150	33.0	150	52.0
200	90.0	200	50.0	200	66.0
250	97.0	250	64.0	250	77.0
300	99.2	300	74.0	300	87.0
		350	(88) 82.0	350	88.0
		400	(94) 86.0	400	91.0
		450	(97) 90.0	450	93.5
		500	(98.8) 92.2	500	95.0
		550	(99.4) 94.2	550	96.0
		600	(99.7) 95.5	600	97.0
		700	(99.9^+) 97.3	700	98.1
		800	(99.9^+) 98.4	800	98.8
		900	(99.9^+) 99.0	900	99.2
m_g = 124		m_g = 199		m_g = 145	
s_g = 1.45		s_g = 1.78		s_g = 2.11	
c_{60} = 295		c_{60} = 763 (509)		c_{60} = 827	
c_{365} = 370		c_{365} = 1085 (619)		c_{365} = 1304	

* Values in parenthesis based on distribution of highest values only.

TABLE 4-2 (continued)

CUMULATIVE FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE

North Phoenix 1/73 - 12/75		North Scottsdale/Paradise Valley 4/74 - 12/75		Scottsdale * 8/74 - 12/75	
Less than or equal to this value ($\mu g/m^3$)	Cumulative Percent	Less than or equal to this value ($\mu g/m^3$)	Cumulative Percent	Less than or equal to this value ($\mu g/m^3$)	Cumulative Percent
50	3.0	50	3.5	50	9.0
100	31.0	100	26.0	100	44.0
150	62.0	150	52.0	150	70.0
200	81.0	200	71.0	200	(95) 84.5
250	91.0	250	82.5	250	(98.6) 92.0
300	95.5	300	89.5	300	(99.6) 95.5
350	97.8	350	93.5	350	(99.9) 97.5
400	98.8	400	95.9	400	(99.9^{+}) 98.5
450	99.4	450	97.3	450	(99.9^{+}) 99.2
		500	98.3		
		550	98.9		
		600	99.2		
m_g = 127		m_g = 143		m_g = 109	
s_g = 1.65		s_g = 1.75		s_g = 1.79	
c_{60} = 408		c_{60} = 528		c_{60} = 425 (253)	
c_{365} = 554		c_{365} = 743		c_{365} = 606 (323)	

* Values in parenthesis based on distribution of highest values only.

TABLE 4-2 (continued)

CUMULATIVE FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE

Sun City 7/73 - 3/75		Paradise Valley 6/73 - 3/75		Carefree 6/73 - 12/75	
Less than or equal to this value (μg/m^3)	Cumulative Percent	Less than or equal to this value (μg/m^3)	Cumulative Percent	Less than or equal to this value (μg/m^3)	Cumulative Percent
50	12.0	50	0.2	50	64.0
100	64.0	100	8.3	100	93.0
150	90.0	150	30.0	150	98.3
200	97.0	200	54.0	200	99.5
250	99.2	250	71.0	250	98.4
300	97.5	300	83.0		
		350	90.0		
		400	94.0		
		450	96.5		
		500	97.9		
		550	98.7		
		600	99.2		
m_g = 84		m_g = 191		m_g = 41	
s_g = 1.55		s_g = 1.61		s_g = 1.84	
c_{60} = 233		c_{60} = 578		c_{60} = 169	
c_{365} = 305		c_{365} = 773		c_{365} = 244	

TABLE 4-2 (continued)

CUMULATIVE FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE

Chandler 6/73 - 3/75		Guadalupe * 1/74 - 12/75			Litchfield 2/75 - 6/75	
Less than or equal to this value ($\mu g/m^3$)	Cumulative Percent	Less than or equal to this value ($\mu g/m^3$)		Cumulative Percent	Less than or equal to this value ($\mu g/m^3$)	Cumulative Percent
50	1.1	50		9.0	50	4.1
100	24.0	100		29.0	100	29.0
150	58.0	150		46.0	150	56.0
200	80.0	200		59.0	200	73.0
250	91.0	250		68.0	250	84.0
300	96.0	300	(81)	75.0	300	90.0
350	98.3	350	(88)	80.0	350	94.0
400	99.2	400	(93)	83.5	400	96.0
450		450	(95.5)	86.5	450	97.5
		500	(97.2)	89.0	500	98.4
		550	(98.4)	90.8	550	98.9
		600	(98.9)	92.0	600	99.3
		700	(99.5)	94.3		
		800	(99.8)	95.9		
		900	(99.9)	96.9		
		1000	(99.9^+)	97.5		
m_g = 136		m_g = 162			m_g = 139	
s_g = 1.56		s_g = 2.5			s_g = 1.8	
c_{60} = 384		c_{60} = 1373 (620)			c_{60} = 546	
c_{365} = 504		c_{365} = 2400 (835)			c_{365} = 782	

* Values in parenthesis based on distribution of highest values only.

expected maximal values, C_{60} and C_{365}, for each site. The value, C_{60}, is the expected maximum assuming that 60 samples per year are taken, while C_{365} is an estimate of the maximum value that would occur if sampling were performed every day. For Scottsdale, Downtown Phoenix, and Guadalupe, the maximal values and upper end of the cumulative frequency distribution that are based on the dashed lines are given in parentheses.

4.4 COMPARISON OF EXPECTED SUSPENDED PARTICULATE VALUES WITH YEARLY MEASURED VALUES

Section 4.3 presented frequency distributions of suspended particulate levels and determined expected annual geometric means and maximal 24-hour levels based on data for the 1973 to 1975 period. This section checks these expected values for consistency with the measured values of individual years.

Table 4-3 compares expected and actual geometric means for the seventeen monitoring sites. The comparison indicates that actual geometric means each year are generally consistent with the expected values. The agreement is surprisingly good in light of the fact that several stations provide only a few months of data for certain years. Actual values for 1973 are all higher than the expected values based on three years of data. This may indicate that the meteorology in 1973 was condusive to high particulate levels, or possibly, that emission controls reduced particulate levels after 1973. The expected values at each site except one (Carefree) indicate violation of the primary and secondary NAAQS.

The expected maximal 24-hour values (C_{60}) are based on data for the period 1973 through 1975 and on the assumption that sampling is performed sixty days per year. Table 4-4 compares these expected values with the maximal and second highest values measured each year.* The expected maximal 24-hour values are generally higher than measured

* The expected values for Scottsale, Downtown Phoenix, and Guadalupe are based on the distribution fit to the highest measured values.

TABLE 4-3

ANNUAL GEOMETRIC MEANS FOR HI-VOL STATIONS

Monitoring Station	1973	1974	1975	Expected Annual**
Central Phoenix	144	168	112	139
South Phoenix	186	179	144	170
Arizona State	-----	156	-----	156
Glendale	-----	92 *	101	97
West Phoenix	215	178 *	-----	210
North Phoenix	135	124	121	127
North Scottsdale/Paradise Valley	-----	137	149	143
Scottsdale	-----	94 *	115	110
Mesa	-----	132	117	124
Downtown Phoenix	250	178	200 *	199
St. John's	-----	-----	145	145
Sun City	117	71	88. *	84
Paradise Valley	198	189	184	191
Carefree Airport	56	33	42	41
Chandler	156	131	119 *	136
Guadalupe	-----	149	173	162
Litchfield	-----	-----	139 *	139

* Less than 6 months of hi-vol data.
**Based on data available for each monitoring station during 1973 through 1975.

TABLE 4-4

MAXIMUM EXPECTED AND MEASURED 24-HOUR SUSPENDED PARTICULATE CONCENTRATIONS ($\mu g/m^3$)

Monitoring Station	Maximum Expected 24-Hour Concentration (c_{60})*	Yearly Observed 24-Hour Concentration 1973 Highest	1973 2nd Highest	1974 Highest	1974 2nd Highest	1975 Highest	1975 2nd Highest
Central Phoenix	409	337	335	351	324	399	287
South Phoenix	369	480	456	287	252	293	252
Arizona State	458	---	---	460	295	---	---
Glendale	264	---	---	139	138	262	231
West Phoenix	593	450	423	279	244	---	---
North Phoenix	408	439	423	321	251	343	335
North Scottsdale/Paradise Valley	528	---	---	328	258	1083	532
Scottsdale	253**	---	---	168	153	281	234
Mesa	295	---	---	330	322	235	228
Downtown Phoenix	508**	482	459	480	454	338	262
St. John's	827	---	---	---	---	1916	1082
Sun City	233	224	223	164	133	193	153
Paradise Valley	578	459	439	351	345	842	173
Carefree Airport	169	144	123	91	78	277	138
Chandler	384	355	274	372	261	245	209
Guadalupe	620**	---	---	556	535	540	420
Litchfield	546	---	---	---	---	519	379

*Based on data available for each monitoring station during 1973 through 1975.
** Based on distribution of highest values only.

maximal values. This is demonstrated in Table 4-5 which compares the expected maxima to the average of the yearly measured maxima. Table 4-5 also reveals the probable reason for the discrepancy. As shown on the right hand side of the table, the average number of samples per year during the years of measurement is generally less then 60 samples per year and often as low as 20 to 30 samples per year. The low number of samples per year is due, in part, to the fact that some of the monitors operated for only a few months during certain years. It is not surprising that the measured maxima, often based on less than 60 samples per year, are generally lower than the expected values for C_{60}. The low number of samples in certain of the years should be a warning against using actual measured maxima to characterize the expected maximal levels at the monitoring sites.

TABLE 4-5

COMPARISON OF MAXIMUM EXPECTED 24-HOUR VALUES WITH AVERAGE YEARLY MAXIMAL VALUES ($\mu g/m^3$)

Monitoring Station	Maximum Expected 24-Hour Concentration (C_{60})*	Average of Yearly Maximal Values	Monitoring Period	Average Number of Samples Per Year in Years Monitored
Central Phoenix	409	362	1/73 to 12/75	56
South Phoenix	369	353	1/73 to 12/75	41.0
Arizona State	458	460**	6/74 to 12/74	25
Glendale	264	201	7/74 to 12/75	30.5
West Phoenix	593	365	1/73 to 5/74	34.5
North Phoenix	408	368	1/73 to 12/75	52
North Scottsdale/Paradise Valley	528	706	4/74 to 12/75	43
Scottsdale	253 **	225	8/74 to 12/75	35.5
Mesa	295	283	2/74 to 12/75	51.5
Downtown Phoenix	508 ***	433	6/73 to 2/75	29.3
St. John's	827	1916**	1/75 to 12/75	58
Sun City	233	194	7/73 to 3/75	28
Paradise Valley	578	551	6/73 to 3/75	31
Carefree Airport	169	171	6/73 to 12/75	47
Chandler	384	324	6/73 to 3/75	33
Guadalupe	620 ***	548	1/74 to 12/75	52.5
Litchfield	546	519**	1/75 to 12/75	18

* Based on data available for each monitoring station during 1973 through 1975.
** Only one annual maximum value measured.
***Based on distribution of highest values only.

5.0 SPATIAL DISTRIBUTION OF SUSPENDED PARTICULATE LEVELS

The previous chapter derived expected annual geometric mean and expected 24-hour maximal Hi-Vol levels for seventeen sites in Phoenix based on data for 1973-1975. The present chapters analyze the spatial distributions of the suspended particulate levels. The spatial distributions of expected annual geometric mean levels and expected 24-hour levels are shown in Figures 5-1 and 5-2, respectively. These figures reveal that suspended particulate levels do not follow a consistent overall spatial pattern among the seventeen sites. It does not seem meaningful to attempt to draw isolines to the data. The lack of an overall spatial pattern is evidence that localized sources play an important role in determining the spatial distribution of TSP levels. The analysis below will attempt to explain (in a qualitative way) the station to station variance in TSP levels by analyzing the sources surrounding the various stations.

The survey of monitoring sites (Section 3.0) revealed a variety of different local sources may surround any of the sites. The significant local sources affecting air quality at any of the sites are fugitive dust sources. Emissions from these sources arise from human activity (motor vehicles on unpaved roadways or open fields, agricultural activities on farmland, construction and excavation) and from erosion of disturbed soils susceptible to suspension. The nature of the sources is generally related to the type of development in which the monitor is located. For example, many sites which were placed in rural residential areas were surrounded by numerous vacant fields and unpaved roads. Construction activities are frequent in such areas, and much of the soil surface area is generally disturbed and susceptible to suspension by wind. By contrast, other sites which were placed in rural residential areas were surrounded by fully improved property from which fugitive dust sources were non-apparent. Based on the site review, a plausible source categorization of the monitoring site environments is presented in Table 5-1. Six site categories are identified. The expected and observed annual and

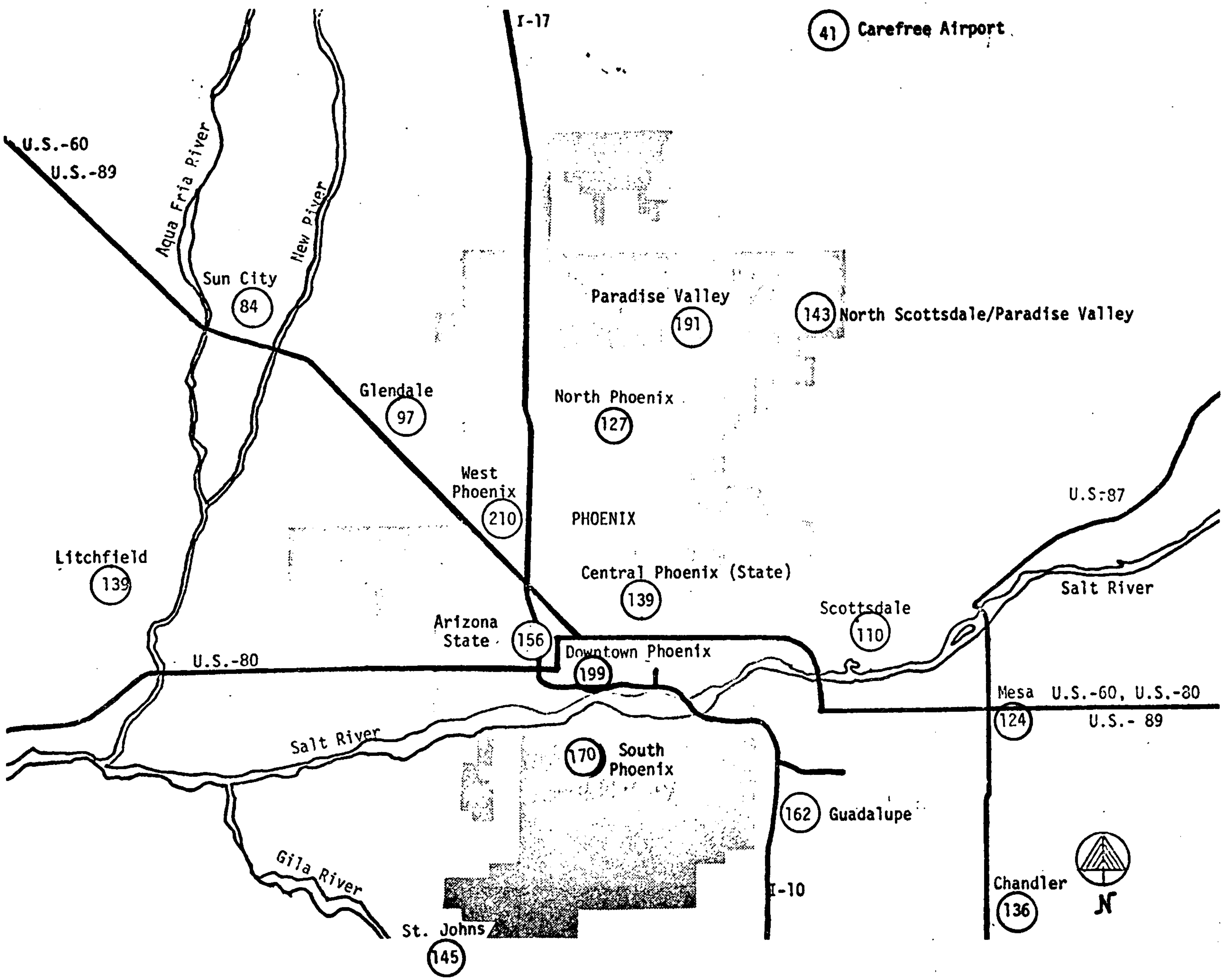


Figure 5-1. Expected Annual Geometric Means
for Suspended Particulate Monitoring Sites.

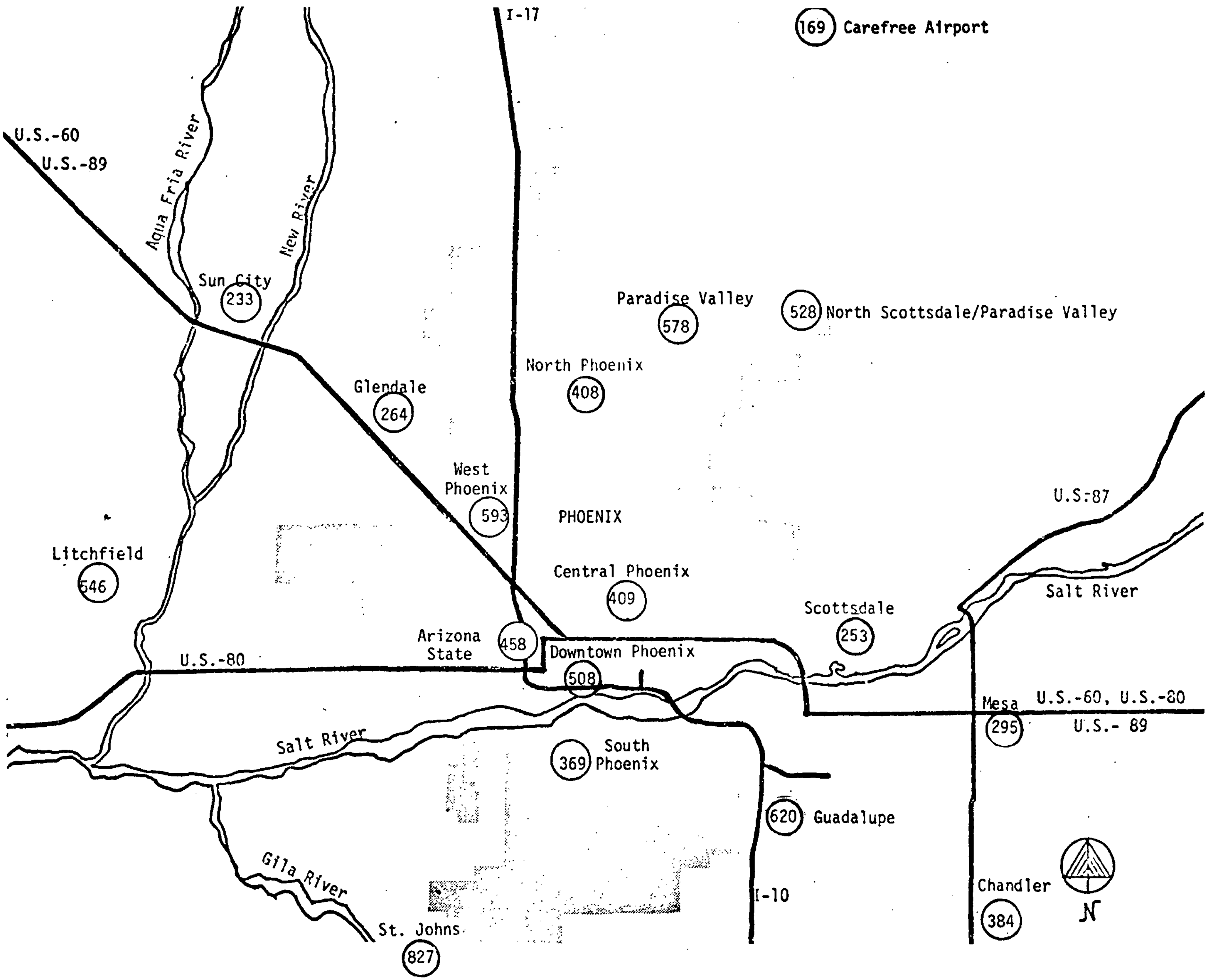


Figure 5-2. Expected Maximal 24 Hour Suspended Particulate Levels at Monitoring Sites.

TABLE 5-1. CATEGORIZATION OF SOURCE ENVIRONMENTS SURROUNDING PARTICULATE MONITORING SITES IN PHOENIX AREA

SITE ENVIRONMENT CATEGORY	STATION	EXPECTED ANNUAL GEOMETRIC MEAN	EXPECTED MAXIMAL 24-HOUR LEVEL	OBSERVED MAXIMAL 24-HOUR LEVEL (1973-1975)
Central City/ Residential-Commercial Surrounded by Fugitive Sources.	Downtown Phoenix	199	508	482
	South Phoenix	170	369	480
Central City/ Residential No Sources.	West Phoenix	210	593	450
	Arizona State	156	458	460
	Central Phoenix	139	409	399
Rural/Residential Surrounded by Fugitive Sources	Paradise Valley	191	578	842
	Guadalupe	162	620	556
	St. Johns	145	827	1916
	N. Scottsdale/Paradise	143	528	1083
Suburban/Residential Surrounded by Fugitive Sources.	Chandler	136	384	372
	N. Phoenix	127	408	439
	Mesa	124	295	330
Rural/Residential No Sources.	Scottsdale	110	253	281
	Glendale	97	264	262
	Sun City	84	233	224
Remote	Carefree	41	169	277

maximum 24-hour value of total particulates is also listed. It is seen that the magnitude of the ambient particulate levels is closely related to the site category. Concentrations appear to conform to a limited regime for each of the identified site environments. Annual expected particulate levels are highest for the sites in the residential-commercial city areas surrounded by fugitive sources (i.e., unpaved alleyways and unimproved residence yards composed of dust soil surfaces). Sites in the residential central city areas, are also characterized by high expected annual particulate levels. The descending order of the remaining categories by concentration level is somewhat intuitive, and, as shown in Table 5-1, rather clearly defined. Hence, it is clear that while there is probably no clear pattern of particulate concentration by geographic distribution, there is at least a pattern by type of local environment. This pattern is rather consistent by season, as will be shown by the seasonal analysis in Section 6.0. However it will be shown later that for any given episode day, air quality at a certain category of sites may be more affected than at others. For example, it appears that the rural/residential sites surrounded by fugitive sources are inclined to be affected concurrently during particulate episode days, while levels for the rest of the Phoenix area are affected to a far lesser degree. This is also supported by the expected regime of maximal 24-hour levels at these sites. The 24-hour maximal forecasts are higher than the other site categories despite the fact the annual average at these sites is relatively medium ranged. This occurs because of the different effects which meteorology exerts on both the dispersion and generation of particulate emissions at the different site categories in the basin.

6.0 THE RELATIONSHIP BETWEEN METEOROLOGY AND SUSPENDED PARTICULATE LEVELS

In areas where the suspended particulate levels originate primarily from fugitive dust sources, meteorology is a determinant of source emission rates as well as the rate of dispersion of the particles once airborne. The effect of meteorology on suspended particulate levels is demonstrated by analysis of empirical data in the following sections. Section 6.1 consists of an evaluation of seasonal patterns of particulate levels and the associated seasonal meteorology affecting the levels. Section 6.2 concerns the analysis of daily meteorology and air quality data to isolate effects of single meteorological parameters on air quality. Section 6.3 provides a summary of the meteorological circumstances associated with particulate episodes and other days of interest.

6.1 SEASONAL PATTERNS OF TOTAL PARTICULATE CONCENTRATIONS

Figure 6-1 illustrates typical annual meterology for the Phoenix area. Climatic changes appear to concide roughly with the calendar quarters of the year. Two distinct rainfall seasons occur. One of these seasons occurs from November to March, and the other from July to September. Temperature variation is steady throughout the year, peaking in July and reaching a minimum in January. Atmospheric mixing heights parellel the temperature variation. Average summer maximum mixing height is approximately 3200 meters, while in the winter it averages to 1300 meters. Surface wind in the Phoenix area is relatively mild, and does not vary substantially throughout the year.

Figure 6-2 provides a summary of indicators for meteorology in the Phoenix area on a quarterly basis for the study period 1973-1975. While mean temperature and average wind speed for these years very nearly parallel historical patterns of the area, rainfall and rainfall frequency are quite variable for any given year. Depending on the significance of rainfall as a determinant of total particulate concentrations, any given year may exhibit a seasonal pattern of particulate levels quite unlike the overall historical seasonal average. This characteristic variation of

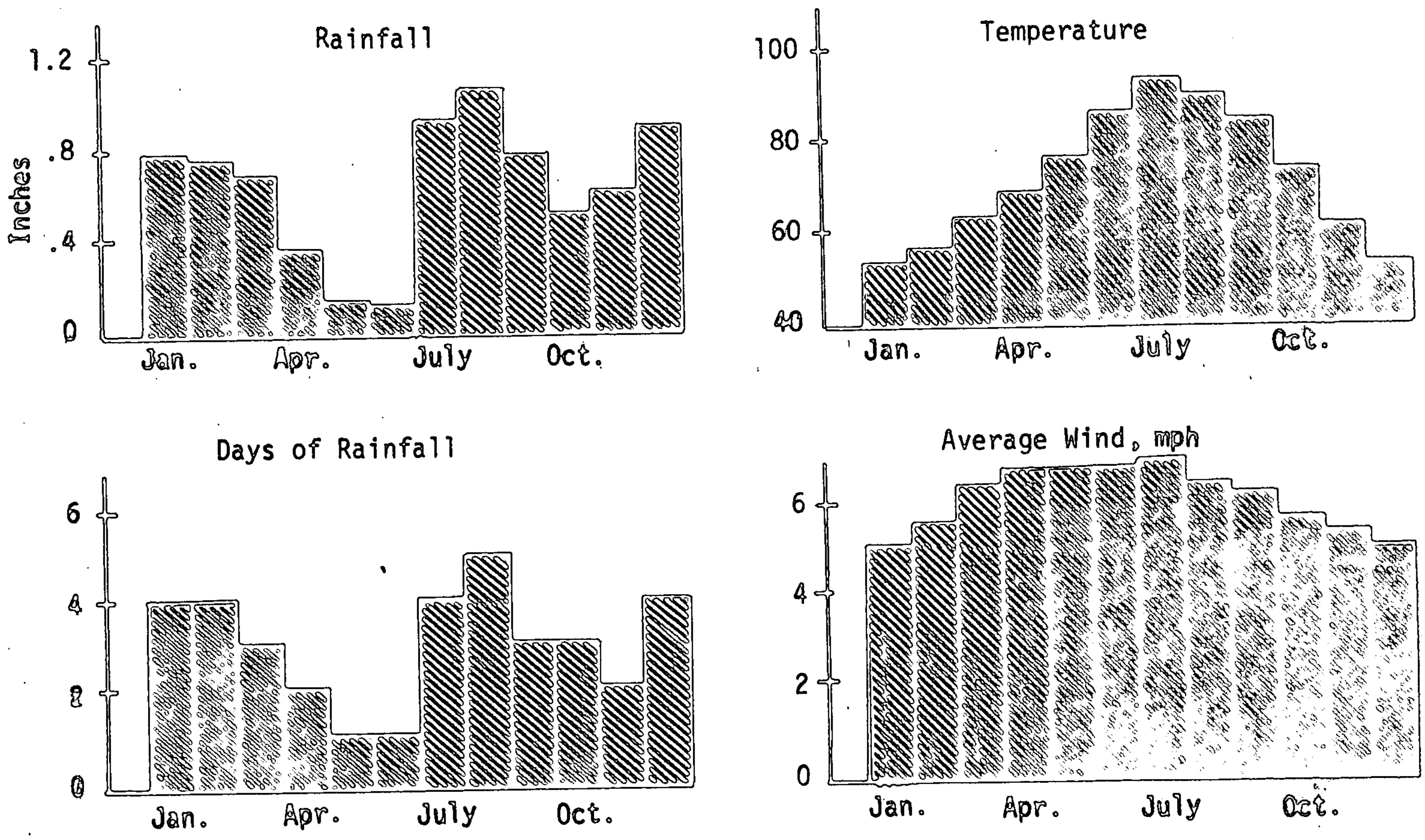


Figure 6-1. Historical Annual Meteorology of Phoenix[9].

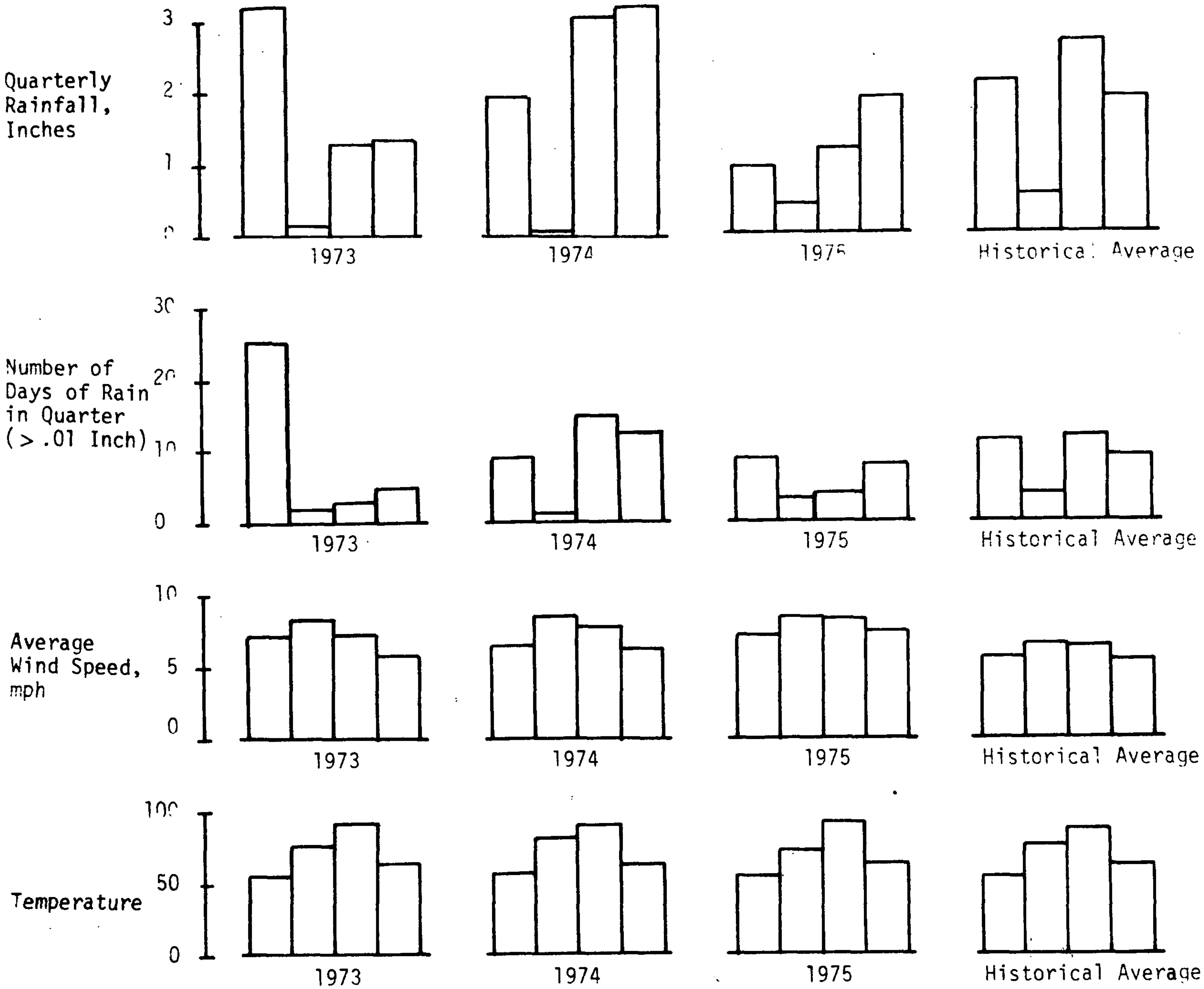


Figure 6-2. Quarterly Meteorology for the Phoenix Area, 1973, 1974, 1975 and Historical Averages

rainfall as a somewhat independent variable should facilitate analysis of the significance of its effect on total particulate levels by season.

Figure 6-3 presents the quarterly averages of concentrations of suspended particulates at the various Hi-vol monitoring sites throughout the Phoenix area. These quarterly plots were compiled to provide an indication of the seasonal distribution of particulate levels, and to investigate apparent relationships between these concentrations and the quarterly meteorology for the same periods. The seasonal patterns and magnitudes fluctuate considerably from year to year due to: 1) variations in seasonal meteorology, 2) statistical limitations involving the relatively few number of Hi-vol measurements conducted each quarter. An obvious additional limitation in the plots of Figure 6-3 involves the frequency of data gaps. Complete data for the three year study period (1973-1975) is available for only three of the 17 monitoring stations. Still the data do show that:

- Concentrations of total particulates do not appear to exibit a consistent seasonal pattern (from year to year) at any of the stations.
- For any of the three years of the study period, there is a consistent seasonal pattern from station to station.

The apparent relationship between quarterly total suspended particulate levels and quarterly meteorology is suggested by the plots of Figure 6-2 and 6-3. The variation of quarterly values of total particulates appear to be related to quarterly rainfall. This trend is summarized in the matrix of Table 6-1. In 1973, levels of total particulates were greatest during the forth quarter when rainfall was unseasonably low compared to other quarters. In 1974, highest levels of particulates were recorded during the second quarters. In 1975, the pattern is less distinct. Rainfall was unseasonably low in the first quarter, but no station experienced a quarterly high during this period. Rainfall during the fourth quarter was relatively normal, but several stations experienced quarterly highs during this period. Given a normal meteorology for each quarter, it appears that particulate levels will

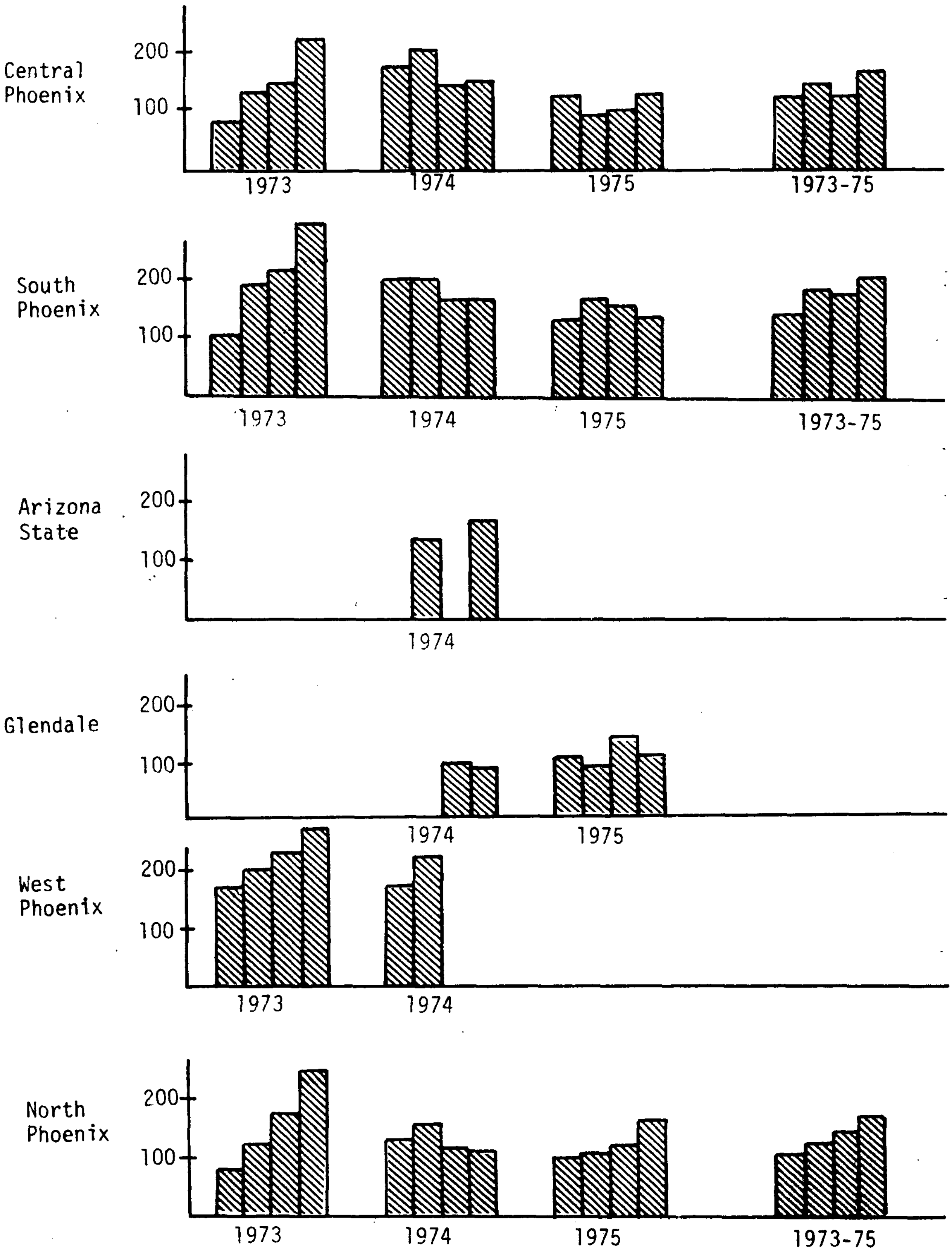


Figure 6-3. Total Particulate Quarterly Averages, $\mu g/m^3$

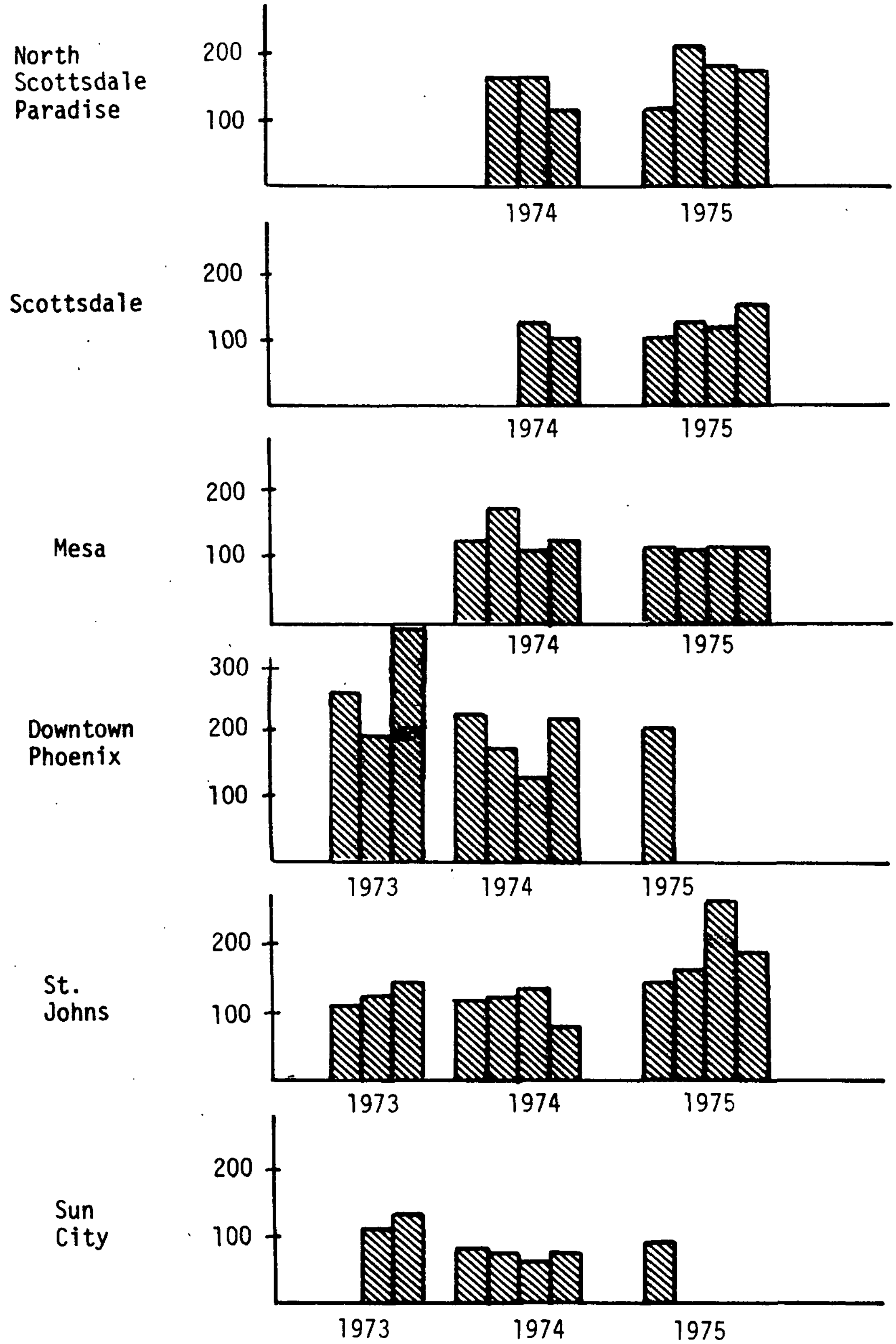


Figure 6-3. (continued) Total Particulate Quarterly Averages, $\mu g/m^3$.

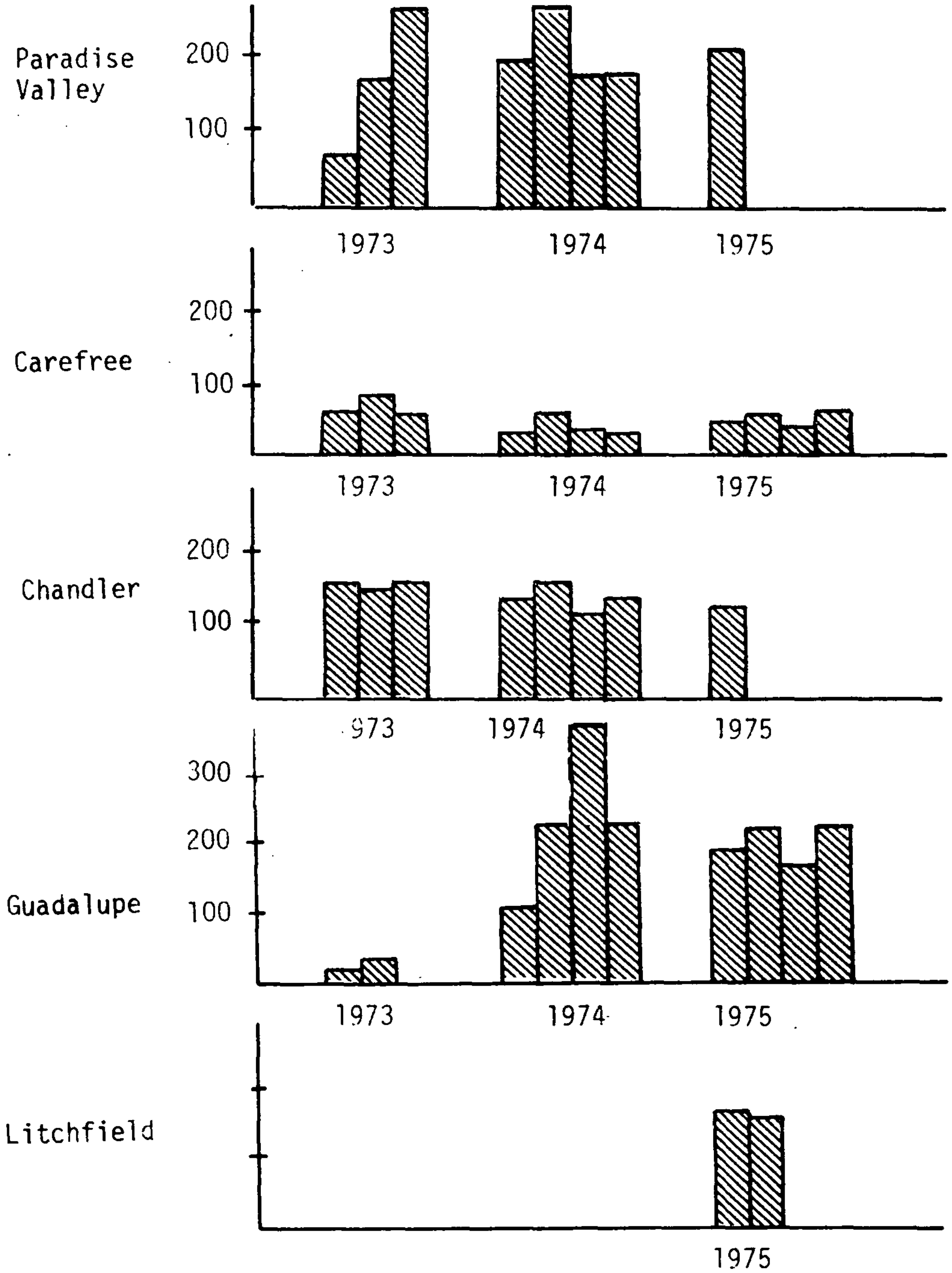


Figure 6.3. (continued) Total Particulate Quarterly Averages, μg/m^3.

TABLE 6-1. SEASONAL PATTERN OF TOTAL PARTICULATE LEVELS IN THE PHOENIX AREA

YEAR	QUARTER OF HIGHEST TSP	ASSOCIATED METEOROLOGY	QUARTER OF LOWEST TSP	ASSOCIATED METEOROLOGY
1973	4th quarter. (4 out of 4 complete cases, probable for 4 more, and only 2 known exceptions).	Unseasonably low rainfall. Lowest quantity wind speed average. Normal temperature.	1st quarter. (4 out of 4 complete cases.)	Greatest rainfall of all quarters in study period. Normal temperature and wind speed.
1974	2nd quarter. (7 out of 8 complete cases).	Very little rainfall compared to other quarters. Highest quarterly wind speed.	3rd and 4th quarters. (6 of 8 complete cases).	Greater than normal rainfall. Normal temperature and wind speed.
1975	4th quarter. (5 out of 10 complete cases).	Rainfall less than usual. Normal temperature.	No clear pattern.	--

be highest in the fourth quarter. The description of this seasonal trend is obscured in the plots of Figure 6-3 due to the highly variable nature of rainfall and its apparent effect on particulate levels. Other meteorological parameters exhibited normal seasonal values for the period of interest.

The available air quality data for the period 1973-75 is relatively incomplete and does not permit a singular approach for the diagnosis of seasonal patterns. However, the data may be treated in several ways to illustrate some of the more dramatic patterns which are apparent. Since rainfall frequency is one of the most variable meteorological parameters over a given quarter, it was appropriate that it be investigated as an independent variable in total TSP levels. Figure 6-4 shows the variation of TSP with rainfall frequency for specific quarters of the year at four stations in Phoenix. Data from all other stations in the Phoenix area were incomplete from any given quarter throughout the 1973 to 1975 period, hence, only a limited number of data points could be assembled as normalized

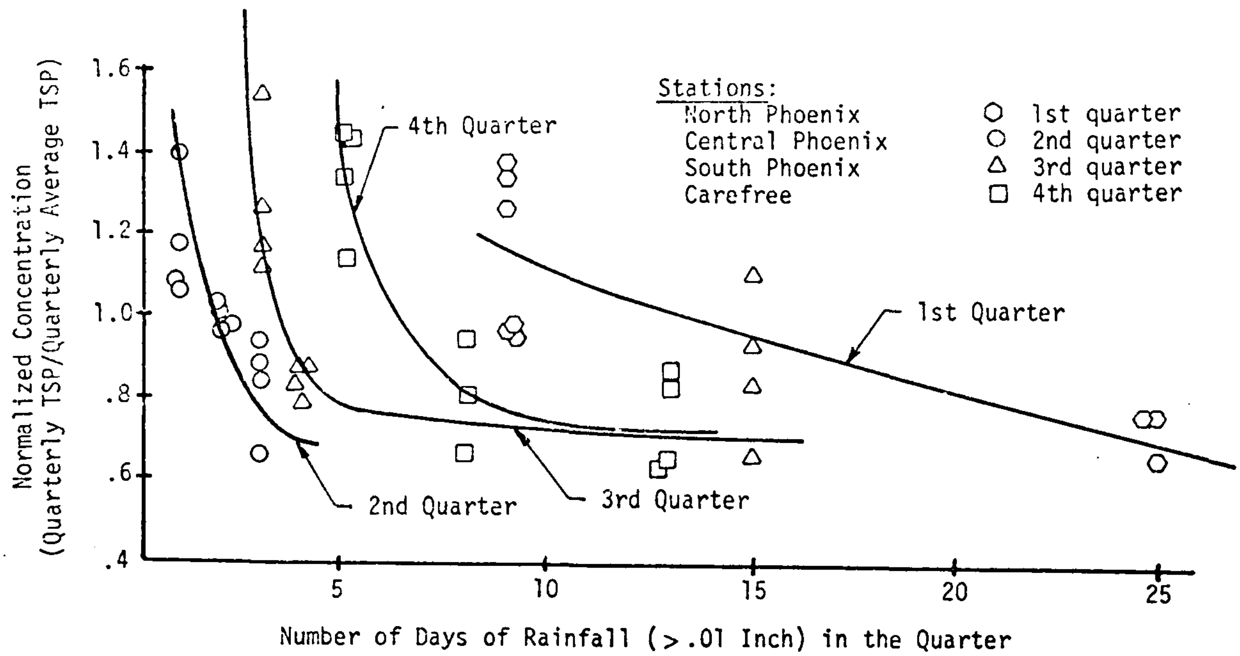


Figure 6-4. Variation of Total Particulate Level with Quarterly Rainfall Frequency

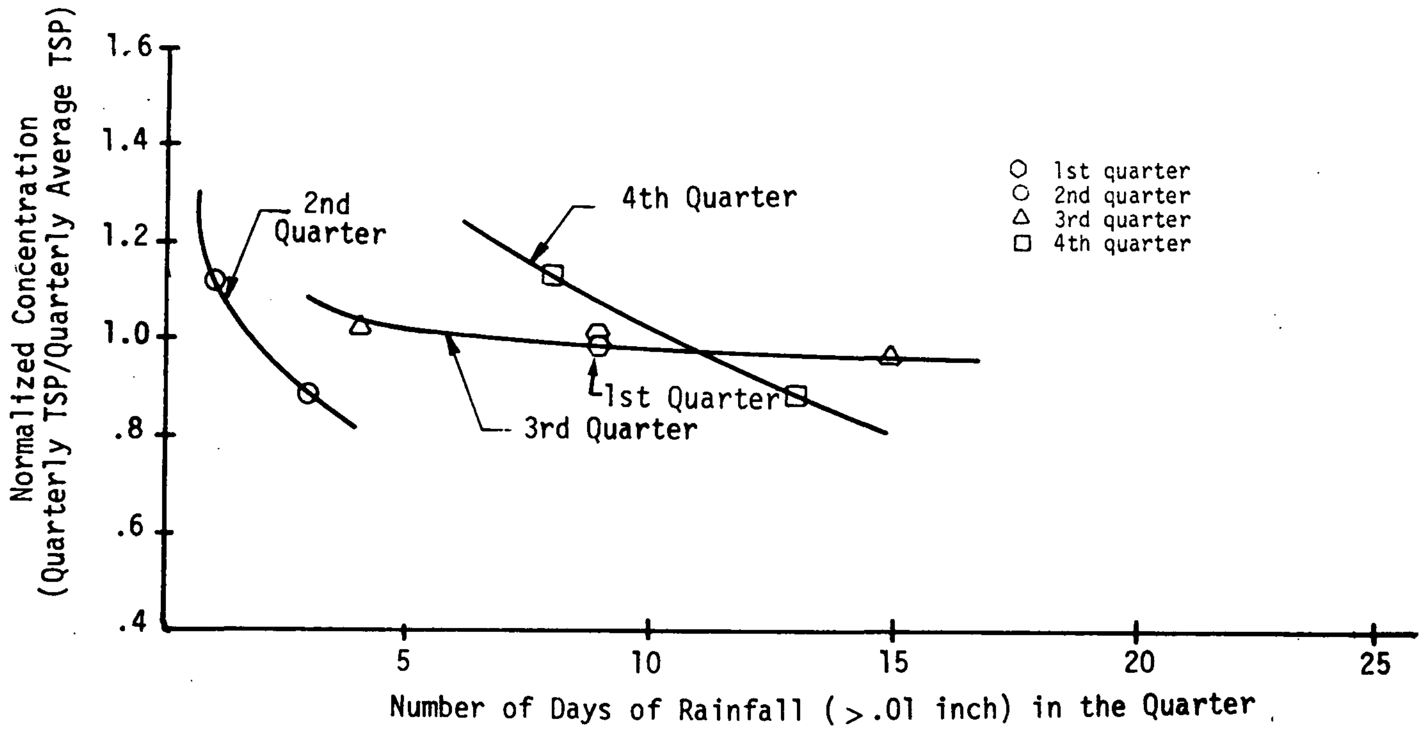


Figure 6-5. Variation of Total Particulate Levels with Quarterly Rainfall Frequency (all Stations Measuring for One or More Quarters in 1974 & 1975 Were Included in the Averages).

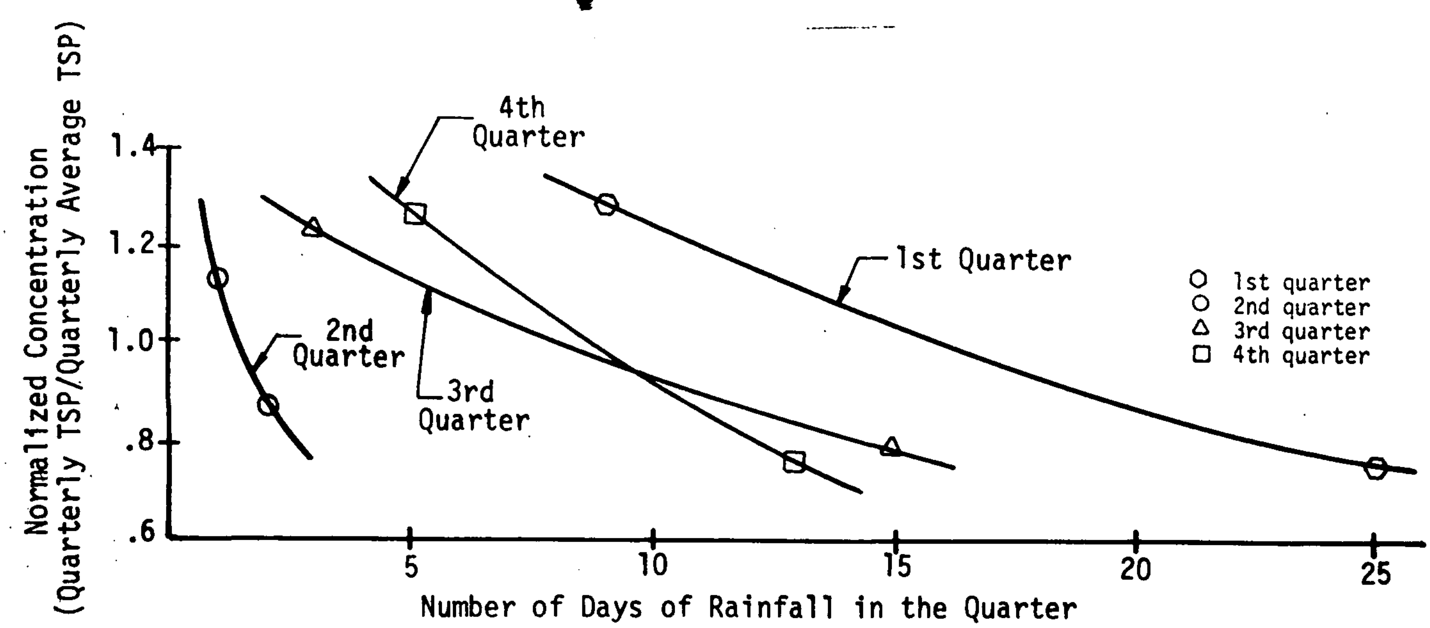


Figure 6-6. Variations of Total Particulate Levels with Quarterly Rainfall Frequency (all Stations Measuring for One or More Quarters in 1973 & 1974 were Included in the Averages).

concentration values on the plot. The same type of plot is shown in Figure 6-5, but for normalized concentrations of quarters in 1974 and 1975, a period for which data was available (partially or totally) for 13 of the 17 monitoring stations addressed in the study. Figure 6-6 is a similar plot, assembled to relate the pattern shown by measurements when they are only available for the years 1973 and 1974. Each of the plots suggest the following relationships:

- Measured levels of suspended particulates are inversely proportional to rainfall frequency for any given season of the year.
- Levels of suspended particulates appear to be less sensitive to rainfall frequency in the winter months than in the warmer summer periods. Relatively small changes in rainfall frequency are associated with dramatic changes in TSP levels for the months of the second quarter.

It should be remembered that the plots illustrate relative effects between TSP and rainfall. However, Figure 6-7 shows that the magnitude of of suspended particulate concentrations varies with rainfall in different

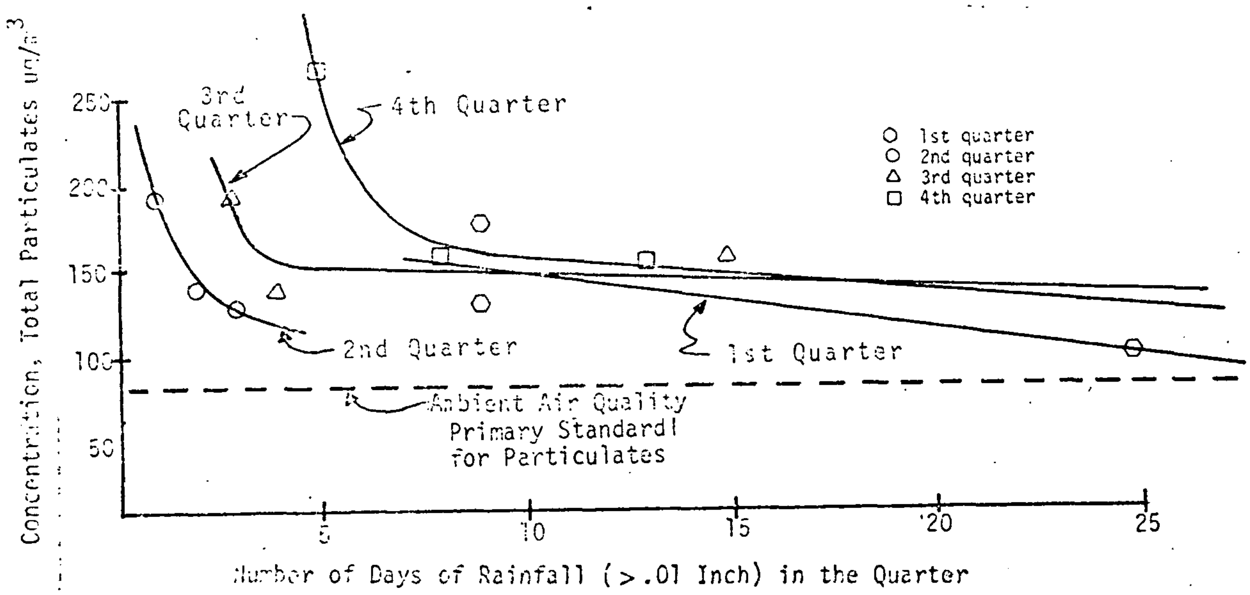


Figure 6-7. Average Quarterly Levels of Total Particulates versus Rainfall Frequency for all Stations Measuring Throughout 1973, 74 and 75.

seasons in a similar pattern. The plot is based on the averages of the quarterly levels of TSP for the stations measured throughout the 1973 to 1975 period. The plot shows:

- Levels of TSP are generally highest in the fourth and first quarters for a given number of rainfall days in a quarter.
- Levels of TSP are the least during the second quarter, but increase to levels comparable to wintertime values during periods of minimal precipitation.
- TSP concentrations are relatively the same in all but the second quarter when rainfall frequency increases to more than about 8 days per quarter.
- While rainfall appears to exert a significant influence on particulate levels, the data indicate (for the stations shown in Figure 6-7) that only very unusually high rainfall frequencies will cause ambient air to conform to the federal air quality standards.

The apparent relationships described above are confirmed by statistical treatment of the quarterly data. Table 6-2 presents a correlation matrix for observed meteorology and particulate levels at two of the Hi-Vol stations measuring throughout the study period. The statistical correlation of particulate concentration with rainfall frequency and average wind speed are both significant. Considering the number of variables which can influence ambient particulate levels (i.e., source activity variations, wind direction variations, previous day carry-over, etc.) and which are not accounted for in the correlation analysis, the value of the correlation coefficients is surprisingly good. Concentration is shown to be inversely related to both rainfall frequency and wind speed. This finding is consistent with known facts about particulate origins and meteorology in the Phoenix area. Rainfall, even at the infrequent intervals experienced in the Phoenix area, plays an important role in the suspension potential of fugitive dust sources. Because fugitive dust comprises the major portion of suspended particulate loadings in Phoenix [10, 11], rainfall exerts an important effect on overall ambient particulate concentrations. The dependence of dust concentration on

TABLE 6-2 CORRELATION MATRIX FOR QUARTERLY METEOROLOGY AND QUARTERLY PARTICULATE CONCENTRATION

CENTRAL PHOENIX

	TSP Concentration	Days of Rain	Total Rain	Temp.
Days of Rain	-.36			
Total Rain	-.20	.87		
Temperature	-.05	-.47	-.29	
Wind Speed	-.41	-.34	-.51	.60

NORTH PHOENIX

	TSP Concentration	Days of Rain	Total Rain	Temp.
Days of Rain	-.44			
Total Rain	-.24	.87		
Temperature	.03	-.47	-.29	
Wind Speed	-.40	-.34	-.51	.60

wind speed is not as clearly intuitive. While it is evident that diffusion of fugitive dust due to human activity (agricultural plowing, vehicle traffic on unpaved roads, excavation and construction) is hastened by higher wind speed, it is also clear that emissions of fugitive dust caused by wind action will increase with wind. The relative magnitude of wind blown fugitive emissions versus dust emissions resulting directly from human activity, and the effect of pollutant dispersion by wind under the atmospheric mixing layer are joint determinants of the resultant concentrations. The result of the statistical analysis reveals that in the Phoenix area, the most severe seasonal particulate concentrations are apparently caused by fugitive dust arising from human activities during periods when wind speeds are minimal. A cause-effect relationship such as that shown in Figure 4-8 is suggested. Emissions from human activity are portrayed as increasing slightly under the influence of wind speed while wind blown emissions steadily increase. The net effect of these separate contributions to ambient suspended particulate levels is a concentration which diminishes with increasing wind speed until wind reaches a level at which dust storms begin to develop.

Because of local effects, the relative contribution of wind blown dust and dust arising from human activities to the ambient total dust level may change from station to station. For example, in areas where limited human activities occur, and where there are substantial soil surfaces susceptible to wind erosion, the ambient particulate loadings may rise to higher levels at only moderate wind speeds. Table 6-3 summarizes particulate concentrations at different stations for quarterly periods in which rainfall was not appreciably different. It was desirable to choose periods for which the rainfall was at higher levels, to avoid the apparent sensitivity of the concentrations to small changes in rainfall, and it was necessary to choose among the quarters of lower rainfall amounts. Despite the strong expected effect of rainfall the data show there are certain monitoring sites for which increased wind speed results in increased levels of total particulates. These sites appear to comprise two of the station categories identified in Section 5.0; they are 1) re-

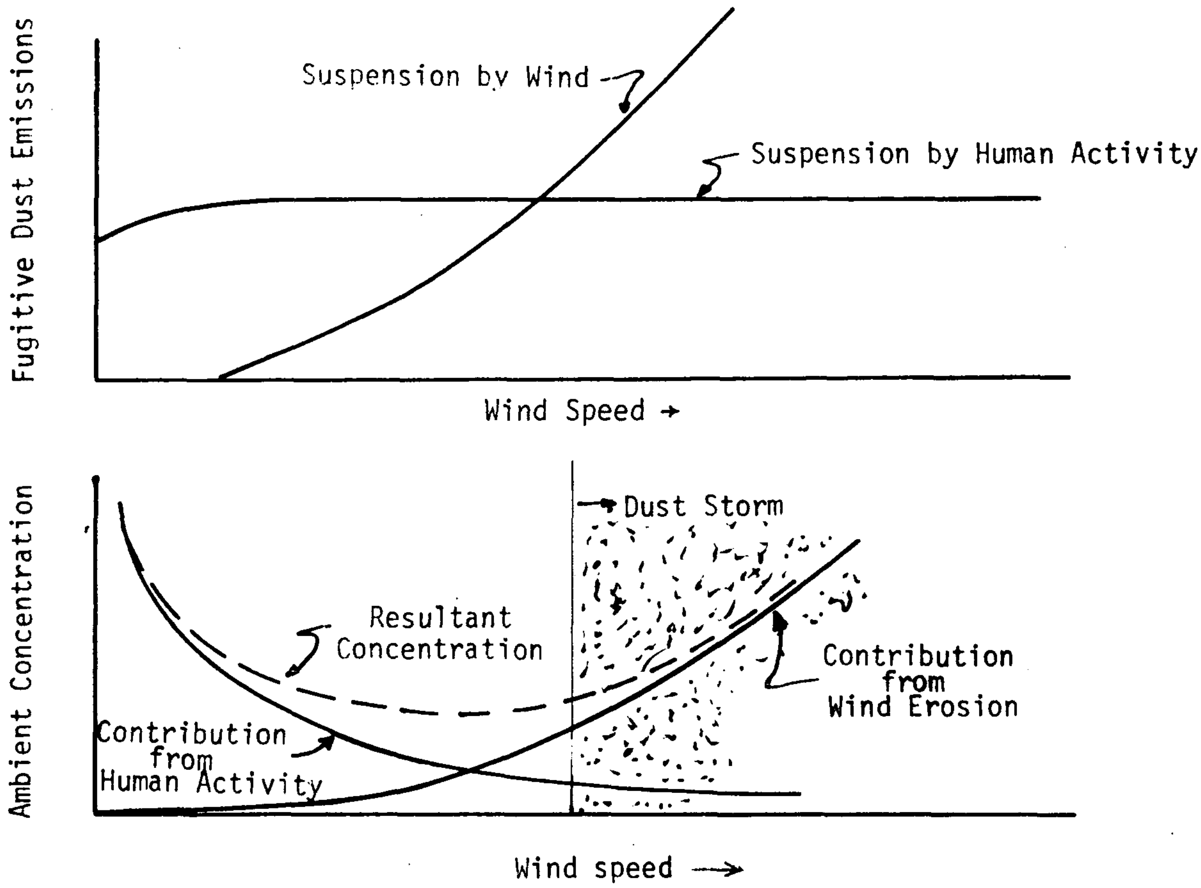


Figure 6-8. Effect of Wind Speed on Ambient Suspended Particulate Levels

TABLE 6-3. EFFECT OF WIND SPEED ON TOTAL PARTICULATE CONCENTRATIONS FOR VARIOUS HI-VOL STATIONS IN PHOENIX AREA.

Average Wind Speed	Year and Quarter	Number of days of rain	Forecasted Relative Ranking of Concentrations[1]	Concentration of Total Particulates, ug/m^3								Comments on Rain Effects
				Central Phoenix	South Phoenix	North Phoenix	Mesa	Downtown Phoenix	St. Johns	Paradise Valley	Carefree	
6.6	1974, 1st Qtr.	9	High	187	207	140	143	241	134	208	32	Quarterly rainfall is equivalent in each year, not a factor in variations.
7.2	1975, 1st Qtr.	9	Low	137	139	107	127	216	137	225	49	
7.2	1973, 3rd Qtr.	3	High	152	224	193			141		81	Concentration is quite sensitive to rainfall in this range.
8.3	1975, 3rd Qtr.	4	Low	108	164	136			296		43	
5.8	1973, 4th Qtr.	5	High	238	315	261			155		54	Concentration is quite sensitive to rainfall in this range.
7.3	1975, 4th Qtr.	8	Low	143	147	168			205		60	
6.3	1974, 4th Qtr.	13	High	156	177	118	144		94		30	Concentration is not very sensitive to rainfall in this range.
7.3	1975, 4th Qtr.	8	Low	143	147	168	125		205		60	

NOTES:

1. The forecast is based on the assumption that concentration is inversely related to wind speed and rainfall. In the last case considered, rainfall change from 1974 to 1975 is significant but expected to exert a small effect on concentration, because of the absolute numbers involved (see Figure 6-4), hence, wind speed is expected to be the determining influence on concentration change.
2. The circled concentrations indicate those values which did not conform to the forecasted effect of wind speed. For these cases an opposite relationship seems indicated: concentration is directly related to wind speed.

mote sites, and 2) rural/residential surrounded by fugitive sources. The significance of wind blown dust at these stations is consistent with the station category descriptions. Each of the stations is surrounded by field soils which may be more likely suspended by wind erosion than by the relatively infrequent human activity there.

6.2 ANALYSIS OF DAILY AIR QUALITY AND METEOROLOGY DATA

The analysis of seasonal air quality data (Section 6.1) showed that ambient concentrations of particulates were significantly related to both rainfall and wind speed, and that the extent of this dependence appeared to vary by season (due to variation of other influence factors such as type and levels of source emissions, and other meteorological parameters). The seasonal relationships were also seen to vary somewhat by monitoring site location. This present section will include additional investigation into the apparent effects which meteorology exerts on suspended particulate levels. The investigation will concern the analysis of the daily air quality and meteorology data.

Figure 6-9 illustrates the apparent effect of rainfall drought on total ambient particulate levels. No attempt has been made to factor out the effects of other influence factors in the plot, and it is possible that the effect of rainfall as indicated by the plot is yet more distinct than shown. However, the mere summarization of daily measurements and meteorology in Figure 6-9 demonstrates the apparent significance of rainfall for suspended particulates. For each of the five stations (representing the different site categorires classified in Section 5.0), particulate levels are seen to increase dramatically with the first 15 to 20 days of absence of rain. After twenty days without rain, the effect of increased drought does not generally appear to appreciably alter ambient concentrations, until periods of 60 to 80 days absence of rain have occurred. After 60 to 80 days, suspended particulate levels begin to increase steadily.

The effect of wind was also investigated by simple plotting approaches including the observations of concentrations associated with various wind

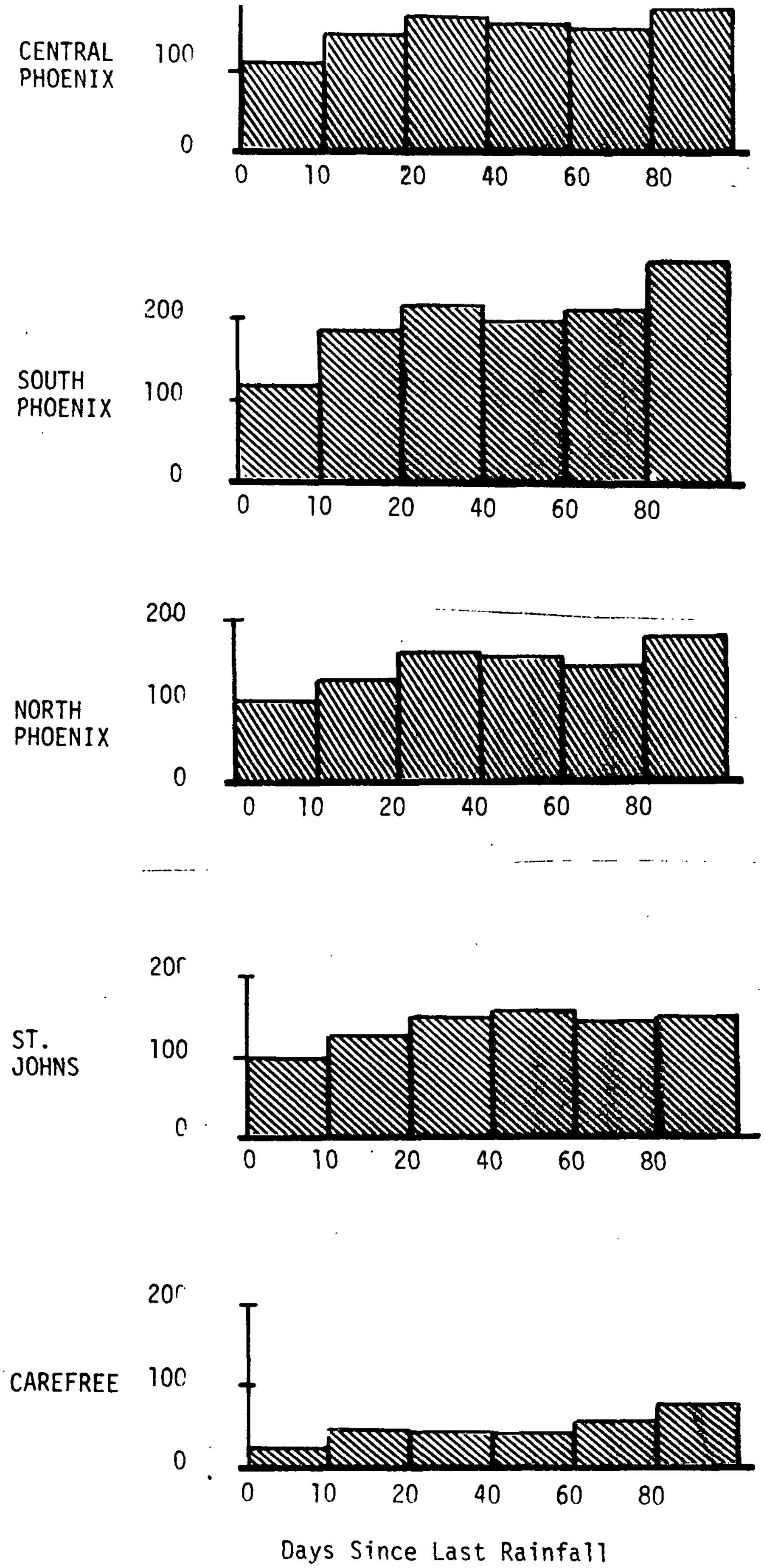


Figure 6-9. Ambient Concentration of Particulates Versus Number of Days Since Last Rainfall (1973-1975)

speed ranges. An attempt was made to sort out measurements recorded on days for which rain had occurred in the past 10 days, since this effect would tend to negate probable wind effects. The information gained by plotting the measurements was not consistent, and apparently there are too many other factors obscuring whatever effects the average wind speed might exert on particulate levels on a daily measurement basis. These other factors include variation in wind speed by monitoring site location, variation in wind direction (affecting transport of particulates in varying patterns for a given average wind speed), variation of the mixing height and other meteorological influences.

Because of the noise level inherent in analysis of the daily air quality and meteorology data, the information was treated statistically by assessing the significance of the meteorological factors by stepwise regression analysis. Table 6-4 shows the correlation matrix of suspended particulate levels and meteorological parameters produced by the statistical analysis. Among the meteorology parameters concentration is correlated most strongly to the absence of rainfall in four of the five cases investigated (the cases were selected to be representative of the Hi-vol monitoring site categories identified in Section 5.0). In most of the cases, rainfall of the past five days correlates to concentration to a far lesser extent than rainfall absence. The magnitude of the correlation coefficients are probably surprisingly good, considering that the number of significant physical variables actually known to effect ambient total particulates is substantial.

The other important meteorological variable which appears to be significant (Table 6-4) is wind speed. The strength of this correlation varies from station to station, and also varies in sign. In the Civic area at Central Phoenix and South Phoenix, wind appears to have a "clearing" effect on suspended particulates. However, in the surburban, rural, and remote site categories represented by North Phoenix, St. Johns, and Carefree, particulate concentrations correlate positively to wind speed,

TABLE 6-4. CORRELATION MATRIX FOR 24-HOUR HI-VOL MEASUREMENTS AND ASSOCIATED METEOROLOGY.

CENTRAL PHOENIX

	RAIN	DAYS SINCE	WIND	TEMP.	CONCN.	PREV.CONCN.
RAIN	1.000	-.263	.024	-.100	-.197	-.039
DAYS SINCE		1.000	-.024	.268	.435	.395
WIND			1.000	.308	-.169	-.181
TEMP.				1.000	-.012	-.059
CONCN.					1.000	.483
PREV.CONCN.						1.000

SOUTH PHOENIX

	RAIN	DAYS SINCE	WIND	TEMP.	CONCN.	PREV.CONCN.
RAIN	1.000	-.254	.059	-.101	-.295	-.067
DAYS SINCE		1.000	-.054	.338	.639	.597
WIND			1.000	.257	-.318	-.190
TEMP.				1.000	.191	.147
CONCN.					1.000	.515
PREV.CONCN.						1.000

NORTH PHOENIX

	RAIN	DAYS SINCE	WIND	TEMP.	CONCN.	PREV.CONCN.
RAIN	1.000	-.268	.040	-.074	-.166	.020
DAYS SINCE		1.000	-.051	.278	.412	.346
WIND			1.000	.303	.119	-.139
TEMP.				1.000	.179	.057
CONCN.					1.000	.219
PREV.CONCN.						1.000

ST. JOHNS

	RAIN	DAYS SINCE	WIND	TEMP.	CONCN.	PREV.CONCN.
RAIN	1.000	-.246	-.053	-.065	-.128	.020
DAYS SINCE		1.000	.125	.323	.124	.099
WIND			1.000	.366	.261	.014
TEMP.				1.000	.164	.156
CONCN.					1.000	.007
PREV. CONCN.						1.000

CAREFREE

	RAIN	DAYS SINCE	WIND	TEMP.	CONCN.	PREV.CONCN.
RAIN	1.000	-.252	-.053	-.037	-.305	.014
DAYS SINCE		1.000	.057	.218	.388	.434
WIND			1.000	.376	.377	.336
TEMP.				1.000	.338	.259
CONCN.					1.000	.364
PREV.CONCN.						1.000

NOTES:
1. RAIN refers to total rainfall in the past five days.
2. DAYS SINCE indicates days since rain (≥ .01 inch).
3. PREV. CONCN. is the concentration of previous measurement (six days prior).

and particulate levels are seen to increase when wind speed increases. This conclusion is generally consistent with that derived from the seasonal analysis (Section 6.1). Of all the stations investigated, the remote site of Carefree exhibited the greatest statistical correlation with wind speed. This site is removed from local source influences and wind may increase particulate levels by 1) suspending soil by the natural process of wind erosion, and 2) transporting pollution from more active source areas. In the rural regions where there are generally substantial areas of disturbed soil surfaces, the effect of increased wind on local soil erosion may be substantial.

In some cases, the variance of concentrations can be partly explained by formulating another independent variable - the previous concentration. Incorporating this variable in the analysis would account for the effect of "carry over" of particulate concentrations from one day to the next. However, the drawback to inclusion of this variable as a carryover background are: 1) the previous concentration is probably largely an expression of the previous meteorology and thus may effectively only be correlating the previous meteorology to that of the day of interest, and 2) measurements are performed at 6-day intervals and hence it is doubtful that the "previous" measured concentration will reflect background potential for a concentration measured 6 days later. Table 6-4 shows that the previous concentration correlated with concentration relatively consistently among the test cases examined. Only concentrations at St. Johns showed insignificant correlation to previous recorded levels.

The importance of the different variables (as determined by regression analysis) in explaining the variation of concentrations is summarized in Table 6-5. Absence of rain and wind speed are either first or second in importance in four of the five cases tested. In one case (Central Phoenix), the regression analysis identified previous concentration as first in importance. However, as expected, this variable was not rated important in the remaining cases. The value of R^2 in Table 6-5 shows that in three of the five test cases, 30% or better of the concentration variation could be explained by the meteorological parameters identified as candidate determinants. At North Phoenix, only 19% of the variation

TABLE 6-5. REGRESSION ANALYSIS FOR 24 HOUR PARTICULATE AND METEOROLOGY VARIABLES. EQUATIONS FOR CONCENTRATION AND EXPLANATION OF VARIANCE.

	CENTRAL PHOENIX		SOUTH PHOENIX		NORTH PHOENIX		ST. JOHNS		CAREFREE	
VARIABLE	Coef.	R^2	Coef.	R^2	Coef.	R^2	Coef.	R^2	Coef.	R^2
Rain (last 5 days)			-45.3	0.02(3)					-22.3	0.04(3)
No. Days Concentration	0.585	0.07(1)	1.43	0.41(1)	0.992	0.17(1)			0.276	0.15(1)
Wind Speed			- 9.54	0.08(2)	5.02	0.02(2)	23.7	0.07	3.89	0.13(2)
Temperature									0.268	0.02(4)
Previous Concentration	0.370	0.23(1)	0.167	0.02(4)						
Constant	79.8		200.		80.7		-11.4		-5.25	
R^2		0.30		0.52		0.19		0.07		0.34

NOTE:

1. Number in parantheses are orders of importance of independent variables.
2. The level of confidence that an equation coefficient is not zero is 90% when $R^2 \geq .10$.

was explained, and at St. Johns, there is a very low confidence level that the effect of any of the variables is significant. This is perhaps not surprising, since it is known that the Hi-vols at St. Johns and North Phoenix are subject to site specific fugitive dust sources and micro meteorology which may obscure the physical relationship between area-wide meteorology and concentrations in the general area of the site.

The regression equations yielded by the regression analysis summarized in Table 6-5 may be used to approximate probable seasonal variation in concentrations at the various stations. Figure 6-10 illustrates the variation of concentration at the South Phoenix monitor as a function of rainfall absence there. The various lines drawn among the historical data on the plot are based on the regression equation

$$\text{CONCN} = 200 + 1.43\ (\text{DAYS SINCE RAIN}) - 9.54\ (\text{WIND}) - 45.3\ (\text{RAIN LAST 5 DAYS}) + .167\ (\text{PREVIOUS CONCN})$$

and on the seasonal averages of variables for 1973 to 1975. The calculated seasonal variation is consistent with the findings of Section 6.1 and the plot of Figure 6-7. Winter meteorology in the fourth quarter appears to provide conditions conducive to the highest values of particulate concentrations, while the meteorology of the second quarter tends to the lowest concentrations.

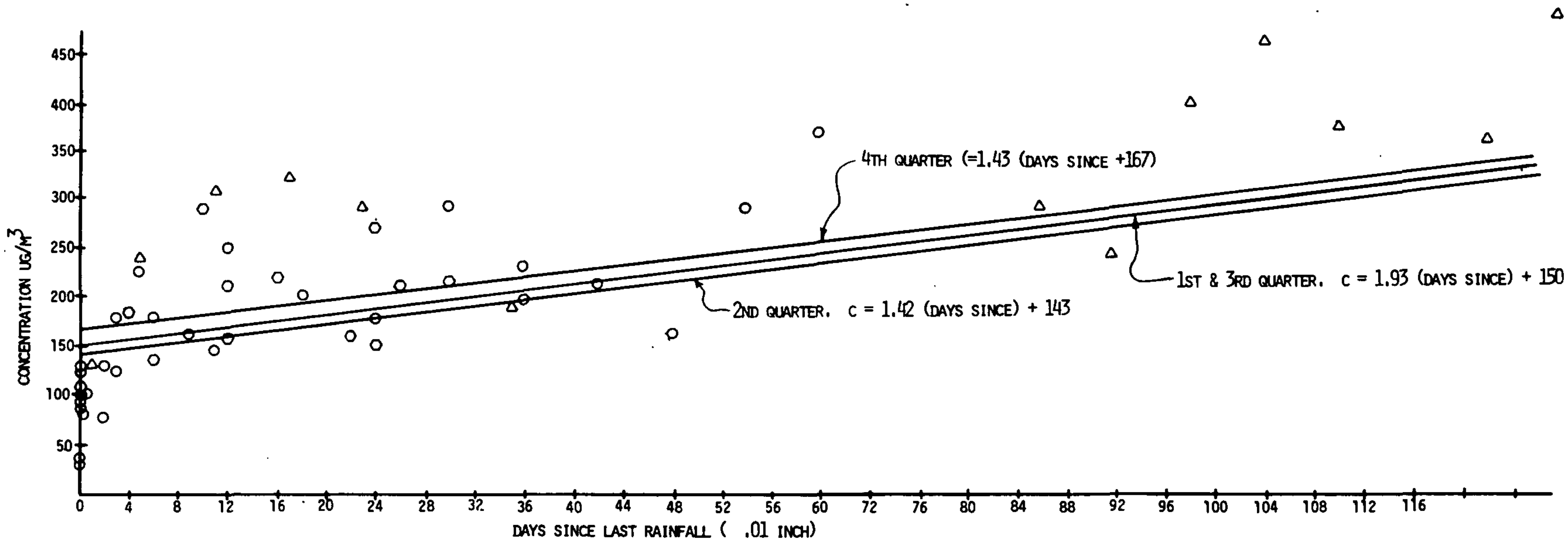


Figure 6-10. Effect of Rainfall Drought on Suspended Particulate Levels at South Phoenix Station, Actual Observations and Regression Predictions.

6.3 ANALYSIS OF PARTICULATE EPISODES

Table 6-6 presents a summary of meteorology and concentration distribution in the Phoenix area for nine of the most severe particulate episodes occuring in the 1973-1975 period. Hi-vol measurements are listed for the four stations experiencing the highest particulate concentrations. The category of the source environment at each station is indicated by number and is consistent with the station classification derived in Section 3.0. Meteorological data provided include parameters discussed earlier in Section 6.1 and 6.2, as well as resultant wind direction and magnitude.

Table 6-6 shows that most episodes occur in the winter months. This is consistent with conclusions of the previous sections that seasonal particulate levels are generally highest in the winter months. However, four of the nine episode cases listed occurred from March to August. The meteorology and ambient particulate distribution associated with the episodes appears to establish two clear patterns. In the wintertime, when low wind speeds and low mixing heights limit dispersion of particulate emissions, high ambient concentrations generate consistently at the city monitoring sites (categories 1 and 2), and often at Paradise Valley (category 3). Particulate levels also increase at other stations throughout the Phoenix region, but generally to a lesser degree. For the episodes occurring from March to August, particulate concentrations are observed to be highest for the rural and surburban residential areas (category 3 and 4). During these episodes strong wind gusts were measured from the Southeast or West, and resultant and average wind speed during the day was appreciably greater than normal. This behavior is entirely consistent with the findings of the previous sections.

A very plausible explanation for the two distinct patterns exibited during the various episodes concerns the emission source origins:

- Human activity, which is most densely focused in the city area, is responsible for suspension of substantial fugitive emissions. These emissions are of higher density than those released at the rural sites, and this is reflected by the higher concentrations produced during the stable atmospheric conditions of winter.

TABLE 6-6. PARTICULATE EPISODES IN PHOENIX AREA, 1973-1975

STATION CATEGORY	DATE & STATIONS	CONCENTRATION ug/m^3	MIXING HEIGHT (Meters)	NO. OF DAYS SINCE RAIN	AVERAGE WIND SPEED (MPH)	RESULTANT WIND DIR. AND MAGNITUDE.	TEMP.	GENERAL COMMENTS ON WEATHER
	November 12, 1973							
1	Downtown Phoenix	513	253	120	6.0	5.1	70	haze most of day. Maximum wind speed 13 mph.
3	Paradise Valley	439						
2	West Phoenix	364						
4	Chandler	355						
	November 18, 1973							
1	Downtown Phoenix	458	394	126	9.8	3.9	63	Partly cloudy & thunderstorms and wind gusts to 36mph beginning at night.
4	North Phoenix	439						
2	West Phoenix	389						
2	Central Phoenix	337						
	January 17, 1974							
1	Downtown Phoenix	480	108	9	4.3	4.1	58	Haze much of day. Maximum wind speed 13 mph.
3	Paradise Valley	351						
2	West Phoenix	279						
4	Chandler	261						
	June 16, 1974							
4	Chandler	372	5888	75	10.9	6.1	98	Clear. Wind gusts from SE at 43 mph.
4	Mesa	330						
2	Central Phoenix	322						
1	Downtown Phoenix	239						
	November 13, 1974							
1	Downtown Phoenix	454	352	11	3.7	1.9	64	Cloudy much of day. Maximum wind speed 13 mph.
3	Paradise Valley	255						
1	South Phoenix	252						
2	Central Phoenix	234						
	December 19, 1974							
2	Arizona State	460	261	14	5.3	2.2	54	Clear. Maximum wind speed 12 mph.
1	Downtown Pheonix	353						
3	Paradise Valley	260						
2	Central Phoenix	234						
	March 25, 1975							
3	Paradise Valley	842	NA	11	12.2	4.6	66	Partly cloudy. Wind gusts from west at 35 mph.
3	Litchfield	379						
3	St Johns	346						
3	N Scotts/Paradise	295						
	June 17, 1975							
3	N Scotts/Paradise	1083	NA	69	11.4	4.8	88	Clear. Wind gusts from West at 35 mph.
3	St Johns	798						
3	Litchfield	519						
4	North Phoenix	248						
	August 10, 1975							
3	St Johns	456	NA	25	12.4	6.3	96	Partly Cloudy. Wind gusts from SE at 47 mph.
4	North Phoenix	343						
2	Central Phoenix	287						
5	Glendale	262						

NA = not available

* Station Category:
1 = Central City/residential commercial surrounded by fugitive sources.
2 = Central City/residential, no source in immediate surroundings.
3 = Rural/residential, surrounded by fugitive sources.
4 = Surburban/residential, surrounded by fugitive sources.
5 = Rural/residential, no sources immediately nearby.
6 = Remote

- Because vast expanses of agricultural land, unpaved roads, and unimproved (but disturbed) soil surfaces surround the rural sites, suspension of dust by soil wind erosion is very likely a dominant factor affecting high particulate levels during gusty winds in the rural areas. Soil erosion by wind is of less consequence in the more developed areas.

The importance of local sources in concentrations recorded at the monitoring sites is also suggested by considering wind direction at the site. For example, it can be seen that Chandler, normally one of the cleaner ambient environments (category 4), exhibits some of the region's highest particulate concentrations whenever wind originates from the East. This is consistent with the results of the monitor site survey, which revealed appreciable fugitive dust sources to the East of the site. Mesa is similarly exposed to easterly sources, as is represented in the June 16 episode. Caution should be exercised interpreting the significance of stations ranked in Table 6-6. Inconsistencies apparent in the station listing are often due to the fact certain monitors were not operating on the day of the episode. The recording pattern for the various stations is somewhat erratic, but it should not obscure the conclusions formulated above.

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APPENDIX A

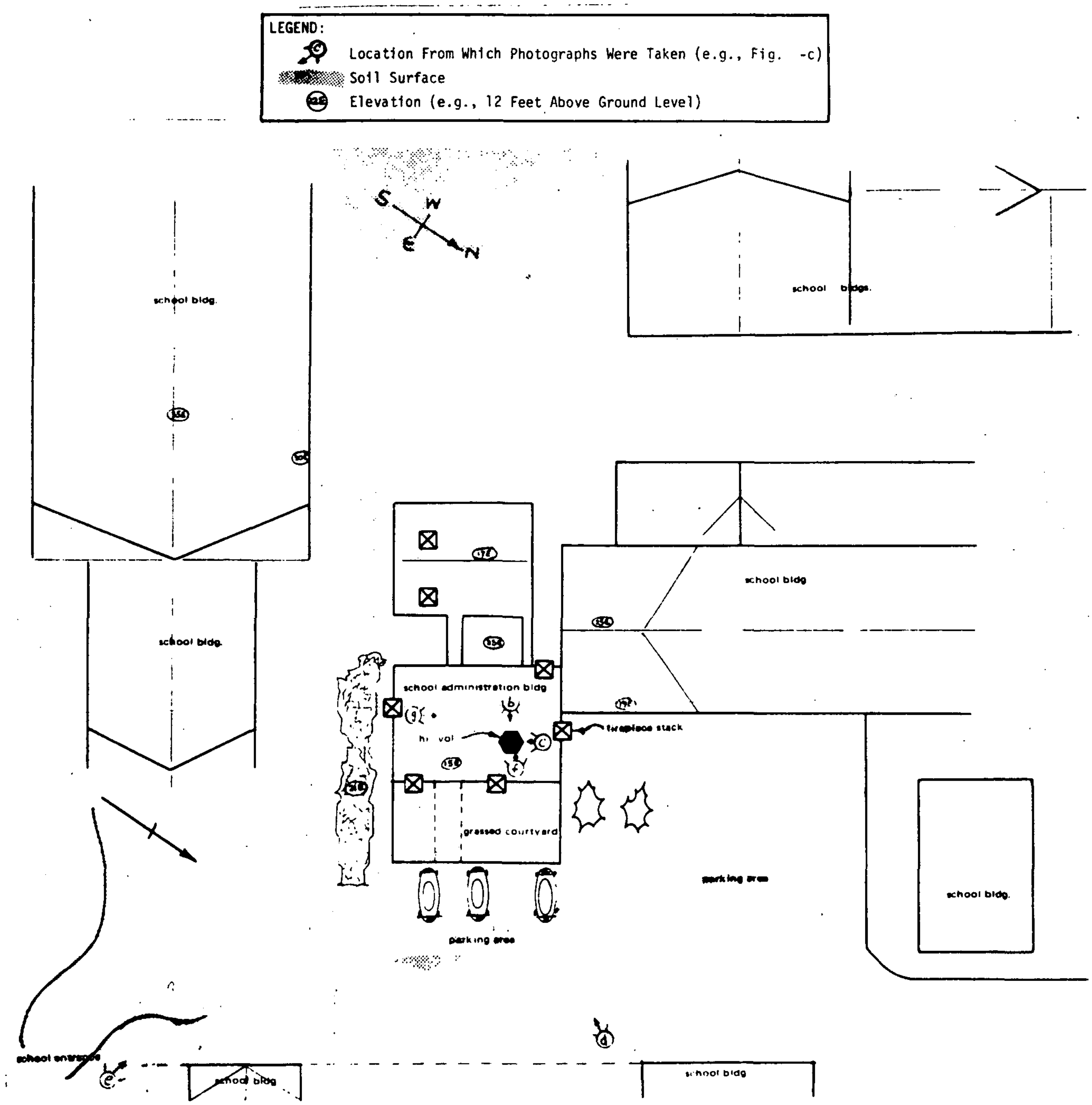
MONITOR SITE REVIEW

A-1. St. Johns

Site Specific Environment

The plot description of Figure A-1a provides an orientation for structures, objects, and emission sources in the immediate vicinity of the Hi-Vol at the St. Johns site. The Hi-Vol is located on the rooftop of the St. Johns Indian School administration building. The roof is approximately 15 feet above ground level, and the sampler is mounted on a conventional stand 1-1/2 feet above the flat tarpaper rooftop (see Figure A-1b). The sampler has adequate vertical clearance with all nearby objects to the east, north and northwest, but there are potentially significant vertical barriers to wind movement from the southeast, south, and southwest. The largest building on the school campus is about 70 feet directly south of the Hi-Vol, and rises at its peak to an elevation of 20 feet above the Hi-Vol sampler (see Figure A-1c). A small rooftop room rises 8 feet above the Hi-Vol sampler only 12 feet to the southwest (Figure A-1f). Air movement from the west is obstructed by a school building which rises 8 feet above the sampler (Figure A-1g). A thick hedge of trees rises 4 feet above the Hi-Vol to the northeast (Figure A-1c and A-1d). These obstacles, in addition to the high elevation of the sampler above ground, are apt to prevent dust levels experienced at ground level from being measured by the rooftop sampler.

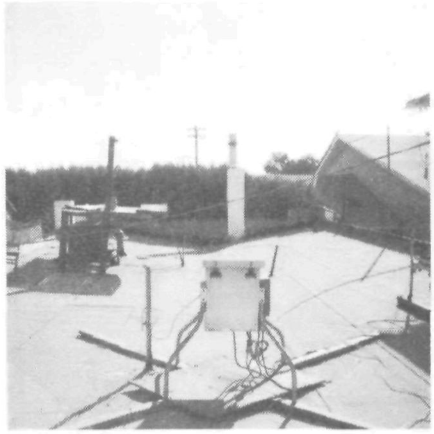
The most significant local source of particulates consists of fugitive dust. The suspension of this dust is related to vehicle activity and other activities which disturb the ground surface sufficiently to permit suspension of soil by wind. Almost all activity in the immediate vicinity of the St. Johns School occurs on soil surfaces. Parking lots and roadways are unpaved. Most walkways are unpaved and most yards (residential and school) consist of dirt fields. The composition of the roadways parking lots, and open fields is generally hardpack with a fine dust powder cover. Except for tall groups of trees, there is very little vegetation in the area. During the day of the survey site visit, a slight 5 to 10 mph breeze from the northwest was blowing loose paper and occasionally dust clouds off of vehicle parking lots and open ground and yard



(a)

Figure A-1. St. John's Site

b



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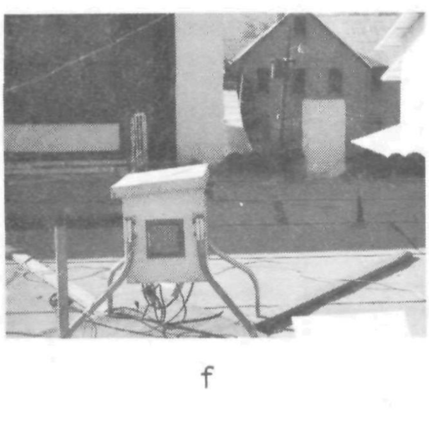

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g

Figure A-1 (Continued). St. John's Site.

areas. Dust clouds were frequently observed in the parking lot sourrouding the entrance side (northeast) of the school administration building This parking lot merges with the main school entrances, and is used intermittently throughout the day. The dust clouds arising from the adjacent parking lot and roadway, both from vehicle activity and wind erosion, are apt to affect measurements of the Hi-Vol monitor significantly, especially when prevailing winds are northerly.

Local sources other than fugitive dust probably have minor effect on the Hi-Vol measurements. Bus and automobile exhausts are emitted in the parking lot adjacent and below the monitor. No commercial activities are conducted in the area. The numerous fireplace vents which exit on the roof where the Hi-Vol is located have not been used for several years (since the school was equipped with gas and electric heating). A stove vent exits at the southeast end of the roof, but only limited breakfast cooking for a few persons is conducted over this vent.

There have been very few changes in the environment of the Hi-Vol site which would have significantly affected air quality measurements. No development has occurred near the monitor site for more than 15 years. However, a new single level school building is presently being erected approximately 700 feet east of the site. The parking area near the monitor is gravelled annually to reduce dust levels and to prevent erosion. No deliberate efforts are implemented (i.e. surface wetting) to diminish dust levels on a continual basis.

Representativeness of Monitor

Based on the review of sources at the site and in the general area, the monitor siting is probably generally representative of air quality at the community of the Gila River Indian Reservation near the school, but not representative of the general area. The small community surrounding the school is a hotspot for fugitive dust source activity, and the monitor is centered in this activity. The rural area outside the small community is characterized by vast expanses of undisturbed desert terrain and less traffic activity.

Definitive representativeness of the monitor site is limited by two principal factors. First, the monitor is sheltered by obstructions to the south, so that particulate levels measured under prevailing southerly winds may tend to be slightly lower than levels at most points within the community. Second, the elevation of the sampler is inappropriate to represent typical ground level exposures.

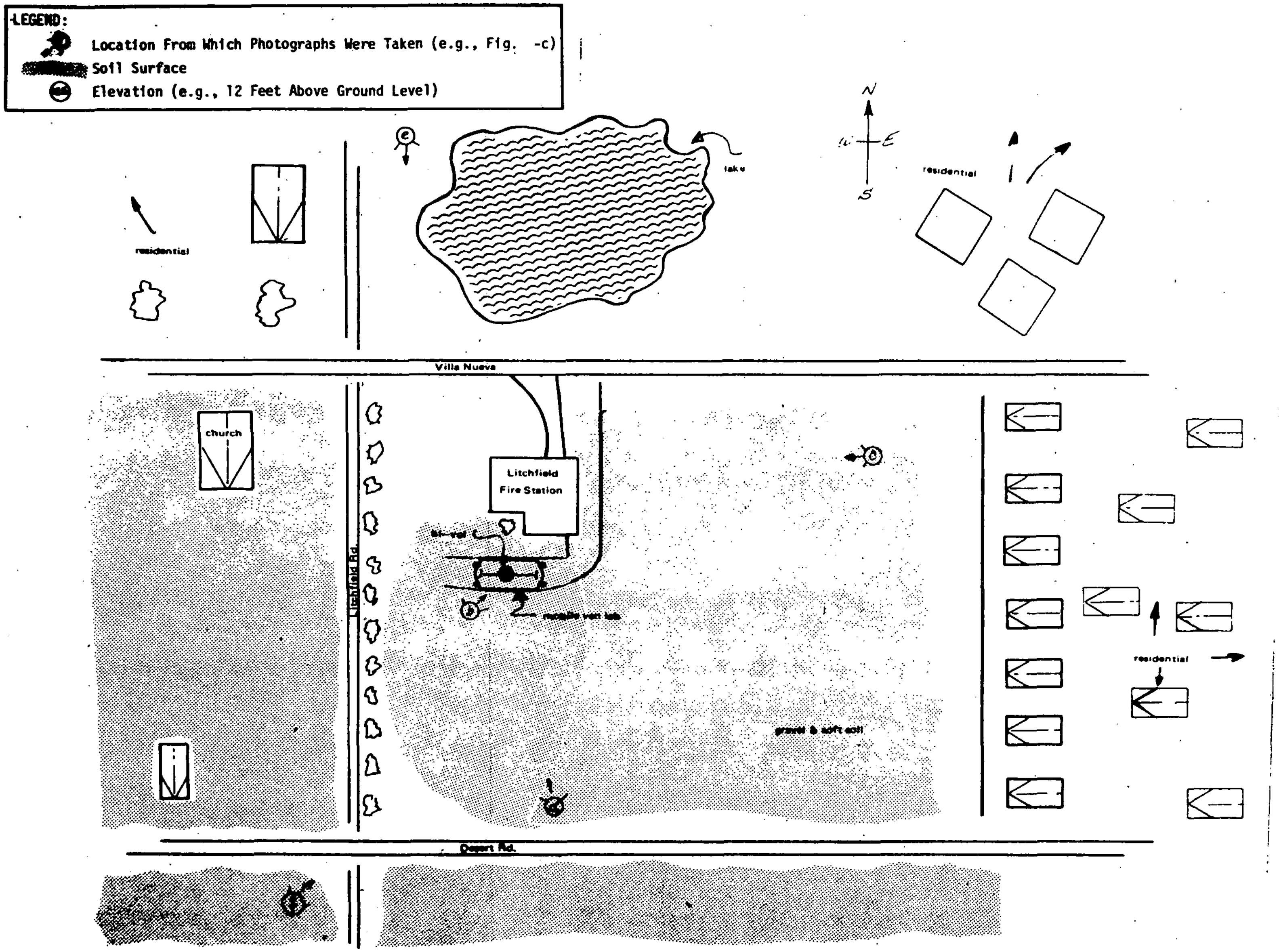
The effect of historical changes in the monitor environment (i.e. source activity, new structures, new or deleted sources) and on the representativeness of the air quality measurements may be considered negligible. There is no immediate plan which would affect significant environmental changes to alter this situation in the future (1980 and 1985).

A.2 Litchfield Park

Site Specific Environment

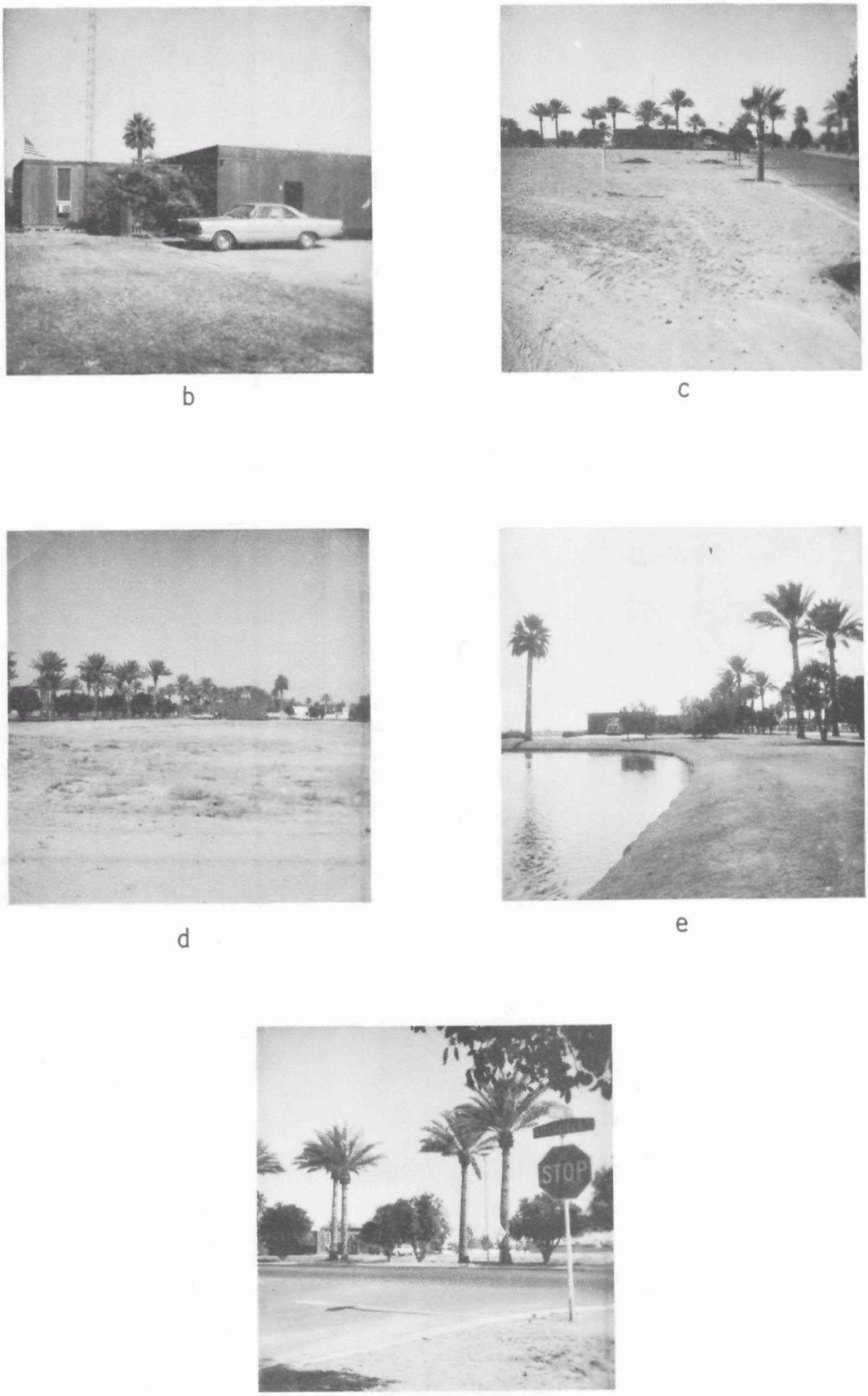
The plot description of Figure A-2a shows the orientation of structure, objects, and emission sources in the immediate vicinity of the Hi-Vol when it was located at the Litchfield Site. The Maricopa County Air Pollution Control mobile laboratory station was stationed behind the Litchfield Park Fire Station for 6 months during early 1975. The Hi-Vol sampler was located approximately 10 feet above ground atop the mobile laboratory van. Figure A-2b shows a sedan in the position where the van was parked during the period of air quality measurements. The sampler has adequate vertical clearance with all nearby objects to the east, west and south. The fire station rises slightly above the monitor (approximately 1 foot), obstructing air movement from the north.

The area immediately surrounding the monitor site typifies the general area. There is a mix of open fields and new residential housing developments. To the west, new homes and a church characterize recent construction, some of which took place during the Hi-Vol sampling period



(a)

Figure A-2. Litchfield Park Site.



b c d e f

Figure A-2 (Continued). Litchfield Park Monitor Site.

in 1975. To the east there is about 400 feet of open field (Figure A-2c) followed by a residential development constructed in recent years. To the south (Figure A-2d) are large expanses of open fields, and to the north (Figure A-2e) substantical residential development has occurred for several blocks.

The most conspicuous local source of ambient particulates is fugitive dust. This dust becomes suspended by vehicle activity and other activities which disturb the ground sufficiently to loosen the soil permitting suspension of the soil particles by wind. To the west, new construction during the sampling period included earth-moving and grading operations, and resulted in loose soil cover (yet to be planted) around the new buildings (see immediate foreground of Figure A-2f). These open earth areas are presently used as parking areas for residents as well as construction laborers still working in the area. The open field (to the south and east) on which the fire station is located has been graded and coarse gravel has been mixed with the surface layer (see Figure A-2c). The driveway and parking space of the mobile van is composed of a similar surface mix. The grading operation was conducted preparatory to eventual residential development expected to occur on this property in the near term. While these earth activities occurred prior to the monitoring period, they have resulted in a loose soil cover in the empty lot, which is additionally disturbed by occasional vehicle traffic. In other open fields extending to the south, there are numerous unpaved roadways and frequent traffic. Subtantial dust clouds were observed behind vehicles traveling on these roads. Also frequent dust clouds were observed to result solely from the effect of wind (approximately 10 to 15 mph during the site visit) on the dust cover in these open fields near the monitor site. It is probable that these local dust clouds significantly affect measurements at the Litchfield site, especially during southerly and easterly winds.

Local sources other than fugitive dust probably have negligible effect on the Hi-Vol measurements. Vehicular exhausts are emitted from light traffic on Litchfield Road approximately 100 feet from the site. The fire station is equipped with electric utilities and houses only one fire truck. The truck and station are operated by a single attendant.

Numerous changes are occurring in the environment surrounding the site. These changes would have significant impact on dust levels at the monitor over the past few years and in future years. The period of sampling at the site reflects the status of the environment during only a short term in 1975. As development continues according to the general plan, the site characterization should be modified if additional sampling is to be conducted there.

Representativeness of Monitor

Based on the review of sources at the site and in the general area, it appears that air quality measured at the monitor site is representative of both site specific and area-wide levels of suspended particulates. The monitor is subject to wind blown dust from the adjacent open field and from more distant open fields and unpaved roads to the south. However, open fields are typical of this area, being spaced intermittently among blocks of new residential development. The monitor is placed at the boundary between residential dwellings and undeveloped property. Except for slight over-representation of either open field dust or residential development resulting from certain prevailing wind directions air quality at the monitor site is presently generally representative of the area. During the period of sampling (Feb to June, 1975)it is possible that construction activities (i.e. earth moving operations) west of the station resulted in significant dust levels causing high readings at the monitor on certain occasions. This possibility should be considered in addressing inconsistencies in particulate levels measured at the Litchfield station relative to regular trends demonstrated by other stations in the monitoring network. In the future, projected development occurring near the Litchfield Site (by 1980 and 1985) should incur significant impact on dust levels there. Air quality at the site would probably be non-representative of the general area during the intensive development periods on property immediately adjacent to the site. However, in the far term as the community and air quality of Litchfield becomes more homogenious after development, it is evident that air quality at the monitor site will ultimately evolve to be more definitively representative of the general area.

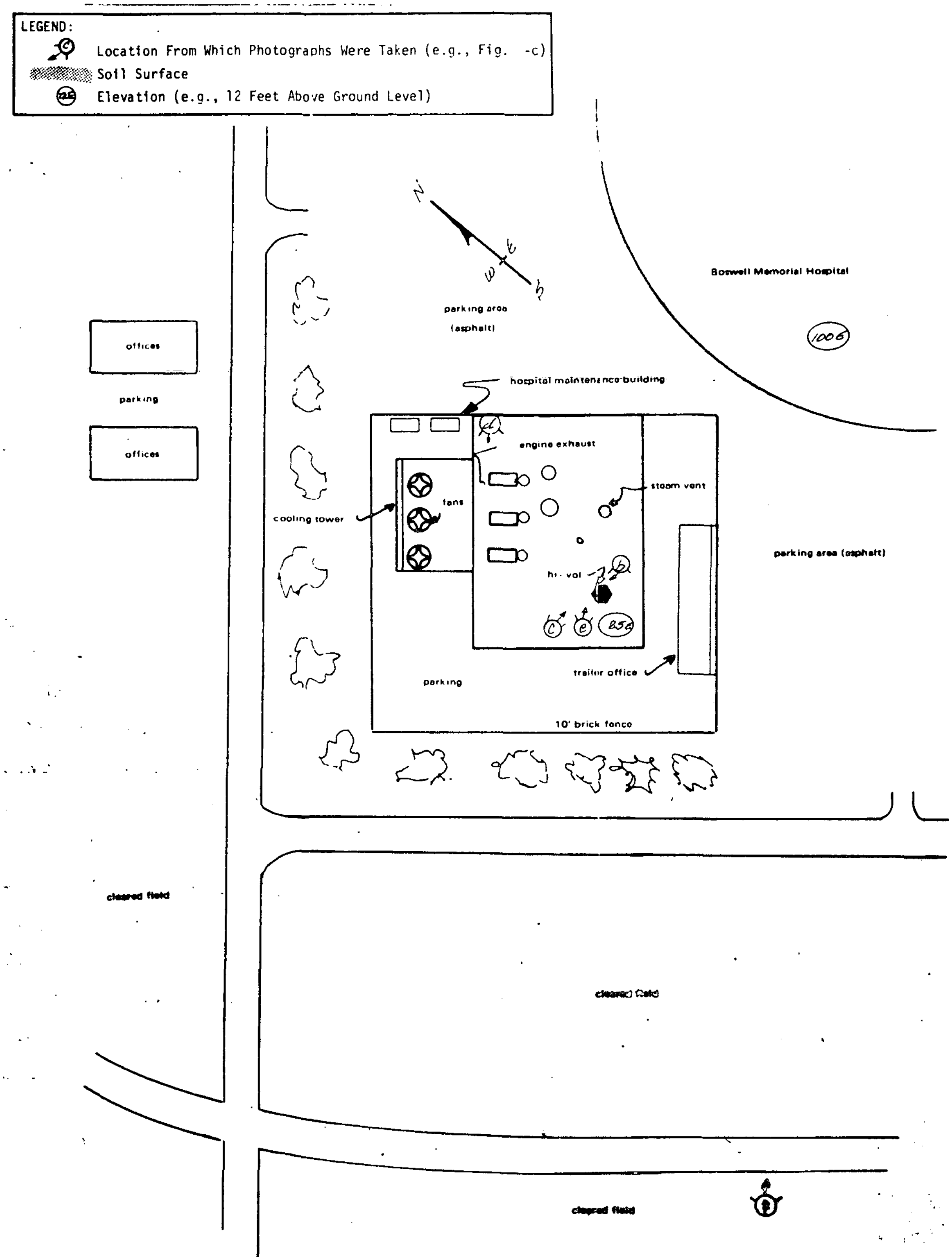
A.3 Sun City

Site Specific Environment

The plot description of Figure A-3a shows the orientation of structures, objects, and emission sources in the immediate vicinity of the Hi-Vol at the Sun City Site. The Hi-Vol is located on the rooftop of the Boswell Memorial Hospital utility building at the northwest corner of the hospital complex. The rooftop surface on which the monitor is located measures approximately 180 by 60 feet, and is surrounded by paved parking areas which extend several hundred feet to the southeast and northeast and about 50 feet to the northwest and southwest (See Figure A-3a). The roof of the utility building is approximately 25 feet above ground level, and the Hi-Vol is mounted on a conventional stand about 1 1/2 feet above the flat tarpaper rooftop (Figure A-3b). The monitor has adequate vertical clearance with all nearby objects in every direction, although the main hospital building may cause some obstruction of air movement from the east. The hospital rises approximately 80 feet above the monitor site (Figure A-3c).

The area immediately surrounding the monitor consists of a mix of parking lots, commercial buildings, and undeveloped open fields. The region slightly beyond is comprised primarily of residential dwellings.

In general, the most significant local source of ambient particulates may be fugitive dust. This dust would result from suspension of soil particles by wind in open fields adjacent to the monitor. Vehicle traffic on these fields is infrequent, and major portions of the field area were characterized by a firm crust surface. Portions of these vacant areas were also populated by a sparce grass growth. This growth is cleared from the fields annually by earth-scraping equipment. The fields are watered down during this operation to minimize dust levels. While much of the surface of the fields appeared undisturbed, substantial portions of the vacant fields were observed to consist of loose soil dust resulting apparently from occasional vehicle activity. On the day of the site visit,



(a)

Figure A-3. Sun City Site.

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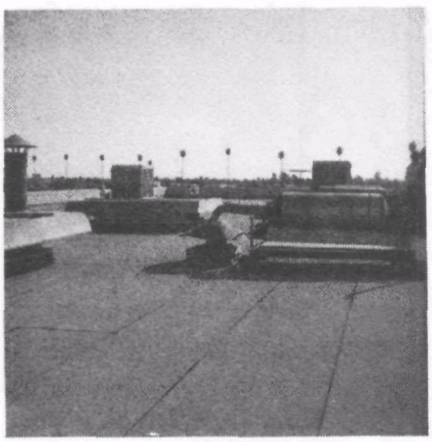

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Figure A-3 (Continued). Sun City Site.

a 15 to 20 mph wind from the south was observed to be generating occasional dust clouds in the vacant lots.

Dust entrained by motor vehicles traveling over paved roads and parking lots near the monitor may also be a significant local source of TSP. Dust loadings on nearby streets are probably relatively high due to the vast areas of exposed earth adjacent to these streets.

Local sources other than fugitive dust probably exert only minor influence on suspended particulate levels at the monitor site. Several vent outlets emerge from the rooftop (see Figure A-3d and A-3e). Many of the smaller outlets serve simply as ventilation outlets for air in the utility rooms below. Discussions with the hospital maintenance manager indicated there are only rare instances when activities inside the building (i.e. accidental fire, sawdust spillage) might produce substantial particulate concentrations, and these occurrences would be short-lived. The larger vents emerging from the roof emit exhausts from large engines and boilers in the utility building. All the engines and boilers burn natural gas and therefore emit a clear exhaust of minimal particulate concentration. The monitor is located about 40 feet south of the nearest engine exhaust vent and approximately 45 feet from the nearest steam vent. The most significant conventional emission source affecting the Hi-Vol measurements may consist of motor vehicle exhaust on streets and parking lots immediately surrounding the utility building.

During the period which the monitor has been sampling at the Sun City Site (since July 1974), there have been relatively few changes in the immediate environment. The open field southwest and northwest of the monitor are cleared of brush annually, resulting in periodic disturbance of the soil and vunerability to natural suspension of soil particles by wind. Future plans for the open fields adjacent to the hospital and beyond include additional commercial development. Significant local fugitive sources immediately adjacent to the monitor will ultimately vanish by 1985.

Representativeness of Monitor

Based on the review of sources at the site and in the general area, air quality measured at the monitor site is apparently representative of both site specific and area wide levels of suspended particulates. There are no significant point sources in the area, and area and fugitive dust sources appear to be rather evenly distributed, both at the site and in the general area.

The elevation of the monitor is inappropriate to represent typical ground level exposures. This limitation should be considered in the subsequent adjusting of air quality data such that it is representative of ground level values.

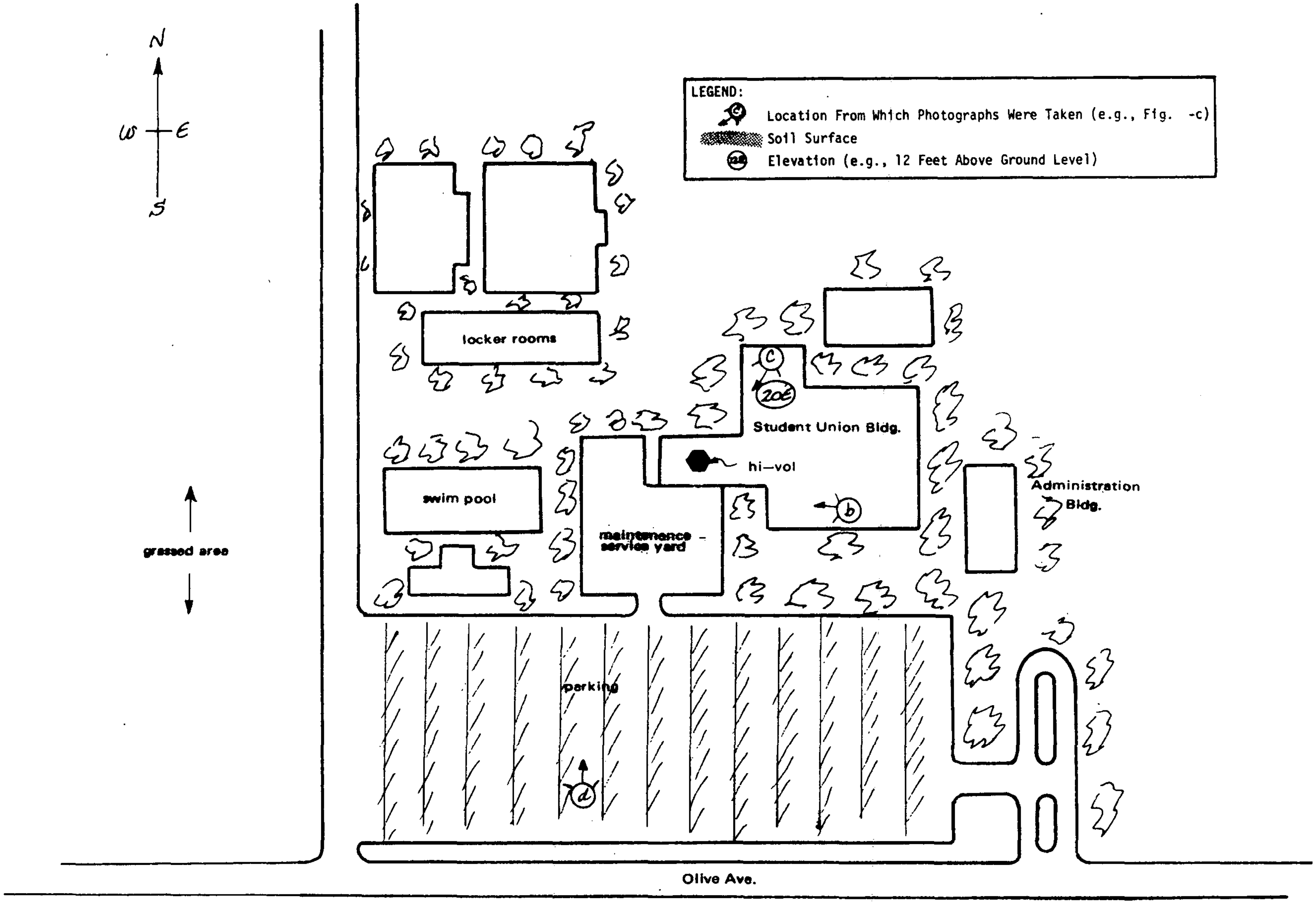
In the future, projected development occurring near the Sun City site may have significant impact on dust levels there. Air quality at the site of the monitor will be somewhat non-representative of the general area during the development period on the open fields adjacent the site. In the far term, development on these open fields should reduce fugitive dust levels at the monitor, but because overall development is expected throughout the general area, air quality at the monitor will remain representative of that in the general area.

A.4 Glendale

Site Specific Environment

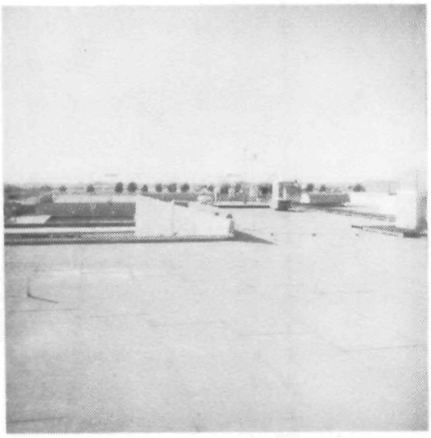
The plot description of Figure A-4a shows the orientation of structures, objects, and emission sources in the immediate vicinity of the Hi-Vol on the rooftop of the Glendale Community College student union building on the south side of the campus. The roof is about 20 feet above ground level, and the Hi-Vol is mounted on a conventional stand and a wood pedestal about 1-1/2 feet above the flat tarpaper roof surface (Figure A-4b). The monitor has adequate clearance with nearby objects in every direction.

The area immediately surrounding the monitor site consists of a mix of paved parking lots, one level school building, and grassed campus yards. To the south and west of the monitor is a paved maintenance yard, used for storage of maintenance vehicles and equipment. Beyond this maintenance yard to the south is the main parking lot (Figure A-4d), which extends about 600 feet to Olive Street. Beyond the maintenance yard to the west is the college swim pool and associated structures. North and East of the monitor are grassed areas and other school buildings.



(a)

Figure A-4. Glendale Site.



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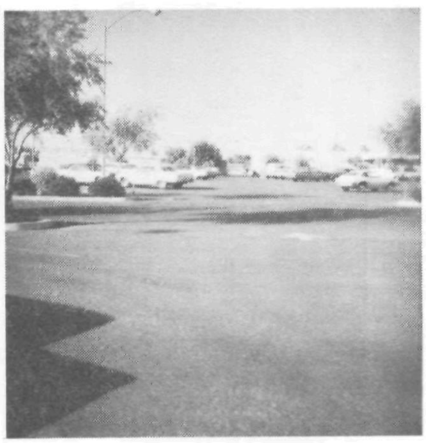

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Figure A-4 (Continued). Glendale Site.

There are no major conspicuous sources of particulate emissions in the immediate vicinity of the monitor. The monitor is located several feet from any roof vents, and these exhaust only the ambient air inside the rooms of the student union building. Fugitive dust sources are not apparent as all areas nearby are paved or grassed. Activities in the maintenance yard below are characterized mainly by equipment storage and parts supplies operations. The most significant source of ambient particulates near the monitor are motor vehicles in the campus parking lot and on adjacent roadways. This source may significantly impact air quality at the monitor when the prevailing air movement is from the south and school is in session.

During the period which the monitor has been sampling at the Glendale site (since July 1974), there have been no changes in the adjacent environment which would have significantly affected air quality measurements at the sensor.

Representativeness of Monitor

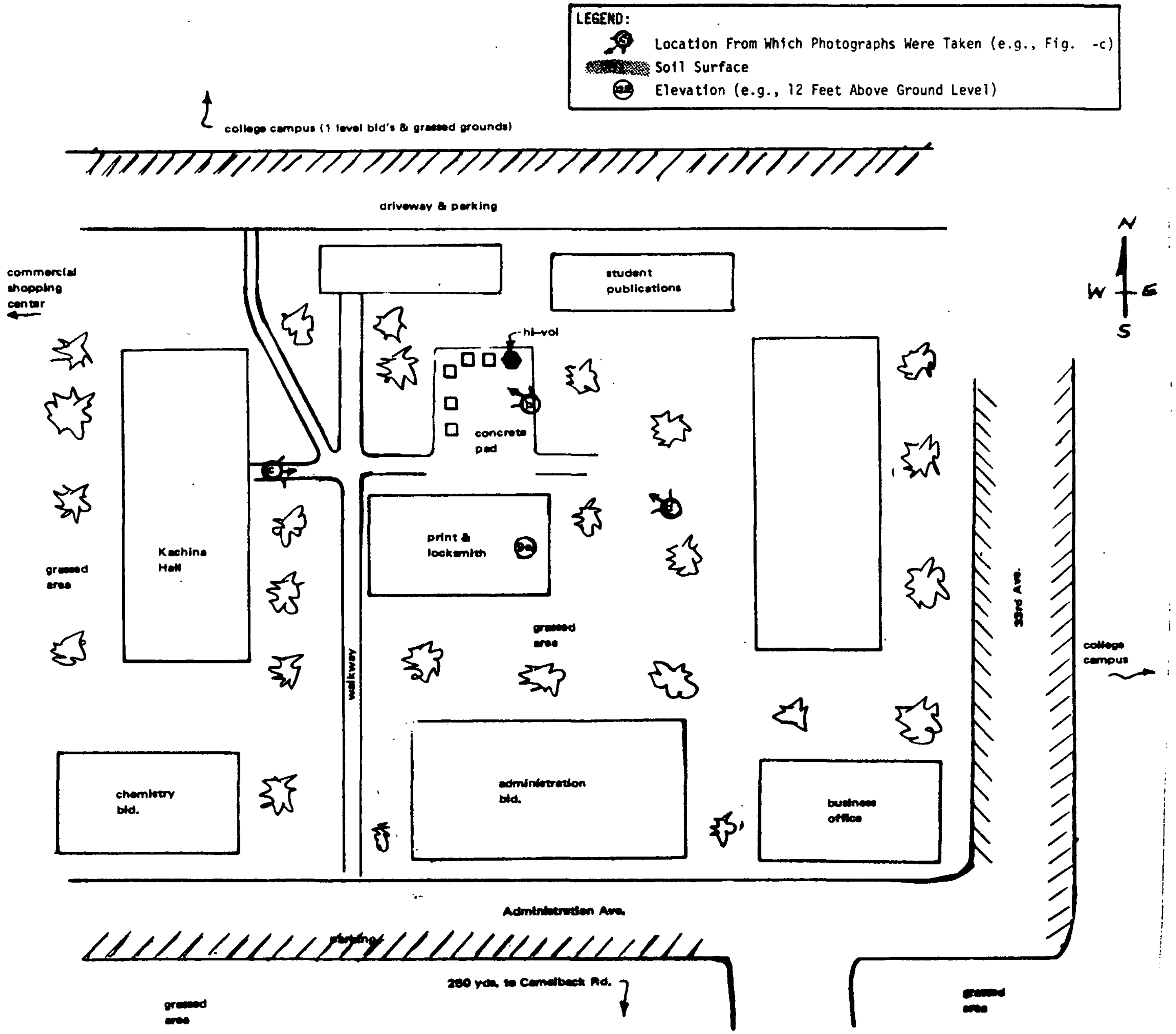
Generally, the air quality at the monitor may be considered representative of the general area. However, because the monitor is located in a residential portion of an area comprised of both agricultural and residential land use, air quality at the site may tend to be somewhat unrepresentative of the effect of fugitive dust emissions from open agriculture fields. Still, some of these agricultural lands are located relatively nearby (see Figure A-4a), and fugitive dust arising from the soil surfaces would be represented at the monitor during southwesterly air movement.

Two principal factors may distract the general representativeness of the monitor air quality readings. First, emissions from a power plant located approximately 1/2 mile southwest of the monitor may cause significant increases in the readings of suspended particulates when southeasterly winds are prevalent. Second, the elevation of the sampler is inappropriate to represent typical ground level exposures.

A-5 West Phoenix

Site Specific Environment

The plot description of Figure A-5a shows the orientation of structures, objects, and emission sources in the immediate vicinity of the Hi-Vol at the West Phoenix site. The Hi-Vol is located on a concrete slab (see Figure A-5b) in the center of the Grand Canyon College campus, between the printing



(a)

Figure A-5. West Phoenix Site.

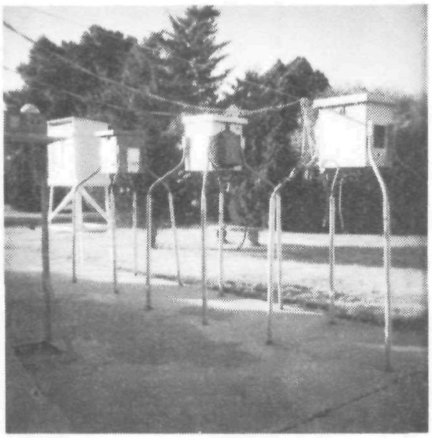


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Figure A-5 (Continued). West Phoenix Site.

and publications buildings. The Hi-Vol is elevated by a standard mount approximately 5 feet above the concrete platform. The site is also used to station other atmospheric sampling devices, including other Hi-Vols present (for a short term experiment by EPA) at the time the survey was conducted. The monitor appears to have adequate clearance with all nearby verticial objects. Although the buildings on either side of the site may provide some restriction to air movement, this would not be important since there are no sources immediately in the vicinity to be affected. Overall particulate levels would be well mixed in the vicinity of the monitor.

The area immediately surrounding the monitor site consists of a mixture of small one level school buildings, paved parking lots, and grassed campus yards. Twenty feet to the south of the monitor is the school print and locksmith building (Figure A-5c). To the east, west, and north of the site are grassed campus yards, and beyond that are modest one level school buildings. Parking areas are located around the perimeter of the small campus, and are characterized by single rows of parking spaces along the shoulder of the vehicle access ways.

There are no significant sources of particulate emissions immediately adjacent to the monitor. Operations in the nearby school buildings involve classroom instruction. The use of printing equipment and other materials in the classrooms does not result in emissions of particulates. Fugitive dust sources are not apparent as all areas adjacent to the monitor are paved or grassed. The effect of periodic campus yard maintenance (i.e., cutting of grass) on Hi-Vol measurements is unclear. However, microscopy and composition analysis of the filters indicate the organic component of the filter deposits rarely exceed more than 5 mg/m^3. Motor vehicle traffic on the college access ways is limited and would have insignificant effect on air quality at the monitor.

During the past three years of sampling at the West Phoenix site, there have been no significant developments on the school campus which would have influenced air quality at the monitor.

Representativeness of Monitor

Based on the review of sources at the site and in the general area, it appears that air quality measured at the monitor site is representative of both site specific and area - wide levels of suspended particulates. There are no major point sources in the general area, and area and fugitive dust sources are rather evenly distributed. This distribution is represented at the specific site, where although there are no fugitive sources on the campus, the campus is relatively small such that open fields adjacent to the campus (sources of fugitive dust) are a potential influence on air quality at the monitor.

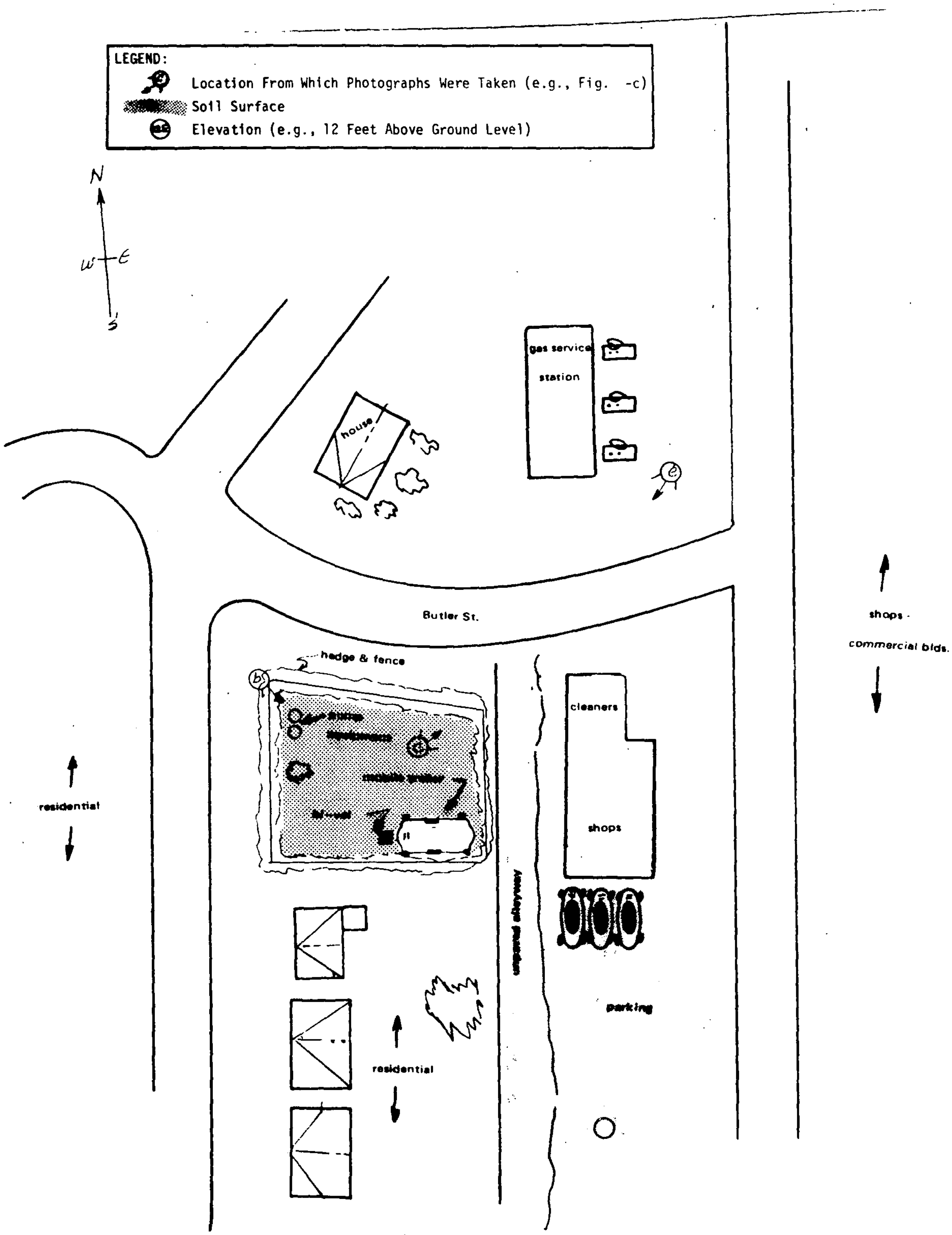
The effect of historical changes in the monitor environment (i.e., source activity, new structures, deleted sources) and on the representativeness of the air quality measurements may be considered negligible. Future development on nearby vacant lots could incur significant impact on dust levels measured at the monitor. Air quality at the site would probably be non-representative of the area during the intensive development periods on property immediately adjacent to the site. However, in the far term, as the community and air quality of West Phoenix becomes more homogenious after development, it is evident that air quality at the monitor site will ultimately evolve to be more definitively representative of the general area.

A-6 North Phoenix

Site Specific Environment

The plot description of Figure A-6a shows the orientation of structures, objects, and emission sources in the immediate vicinity of the Hi-Vol at the North Phoenix site. The Hi-Vol is located within the confine of a water pump substation. It is mounted on a conventional stand approximately 5 feet above the gravel/soil surface of the enclosure (Figure A-6b). Horizontal air movement to the monitor is slightly obstructed by a 10 foot hedge of Oleander bushes which circles the substation perimeter.

The area immediately surrounding the monitor typifies the general area. There is a mix of residential dwellings, commercial buildings, unpaved parking lots, and paved and unpaved roadways. To the south of the utility



(a)

Figure A-6. North Phoenix Site.

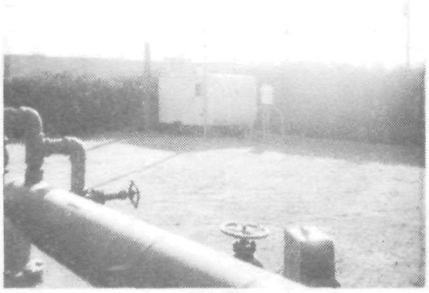


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Figure A-6 (Continued). North Phoenix Site.

enclosure is a private residence. The east is bordered by a gravel/dirt alleyway (Figure 3-11d) serving as access to unpaved parking lots for adjacent commercial buildings. The north and west utility boundaries are joined by asphalt roadways, and beyond that, private residences.

The most conspicous local source of ambient particulates is fugitive dust. This dust becomes suspended by vehicle activity and by wind action. Dust clouds raised by traffic on the unpaved alleyway east of the site have caused complaints by adjacent residents. One resident claims that clothesline wash is soiled by dust generated off the alleyway and unpaved parking lots. Fallout dust from these activities was apparent on nearby surfaces (i.e., leaves of the hedge surrounding the substation). Another source of suspended particulates is entrained dust arising from dust loadings on nearby paved streets. A less significant source of particulates at the site is motor vehicle exhaust resulting from commercial activity east of the site. No significant point sources were identified within this shopping center.

Discussions with local residents revealed that no major changes have occurred to the environment adjacent the site in the past few years. Commercial activity nearby has not altered appreciably, and residential development occurred several years before the sampling period of interest. Initiative for paving of the alleyway has been discouraged because of associated financial assessments which must be borne by adjacent homeowners.

Representativeness of the Monitor

Air quality measured at the monitor appears to be representative of site specific levels of air quality, but not representative of the general area. The monitor is subject to dust loadings created by vehicle activity on the alleyway immediately adjacent to the site. While unpaved alleyways are typical of the general area and undoubtedly contribute significantly to overall particulate levels throughout the area, the contribution diminishes rapidly with distance from the source. Locations in close proximity to the dust source will experience substantial deposits of settleable particulates from the fallout. It is clear, therefore, that a monitor placed only 30 feet from the alleyway is representative only of the site specific levels of suspended particulates. The definitiveness of this representation is limited. For one thing, the monitor is sheltered by vegetation, and the effect of this obstruction varies for different meteorology. Also, the source generation rate is unknown. Alleyway counts and parking lot usage data are necessary to attain a more definite characterization of the monitor representativeness, and to assess the potential utility of air quality data obtained there.

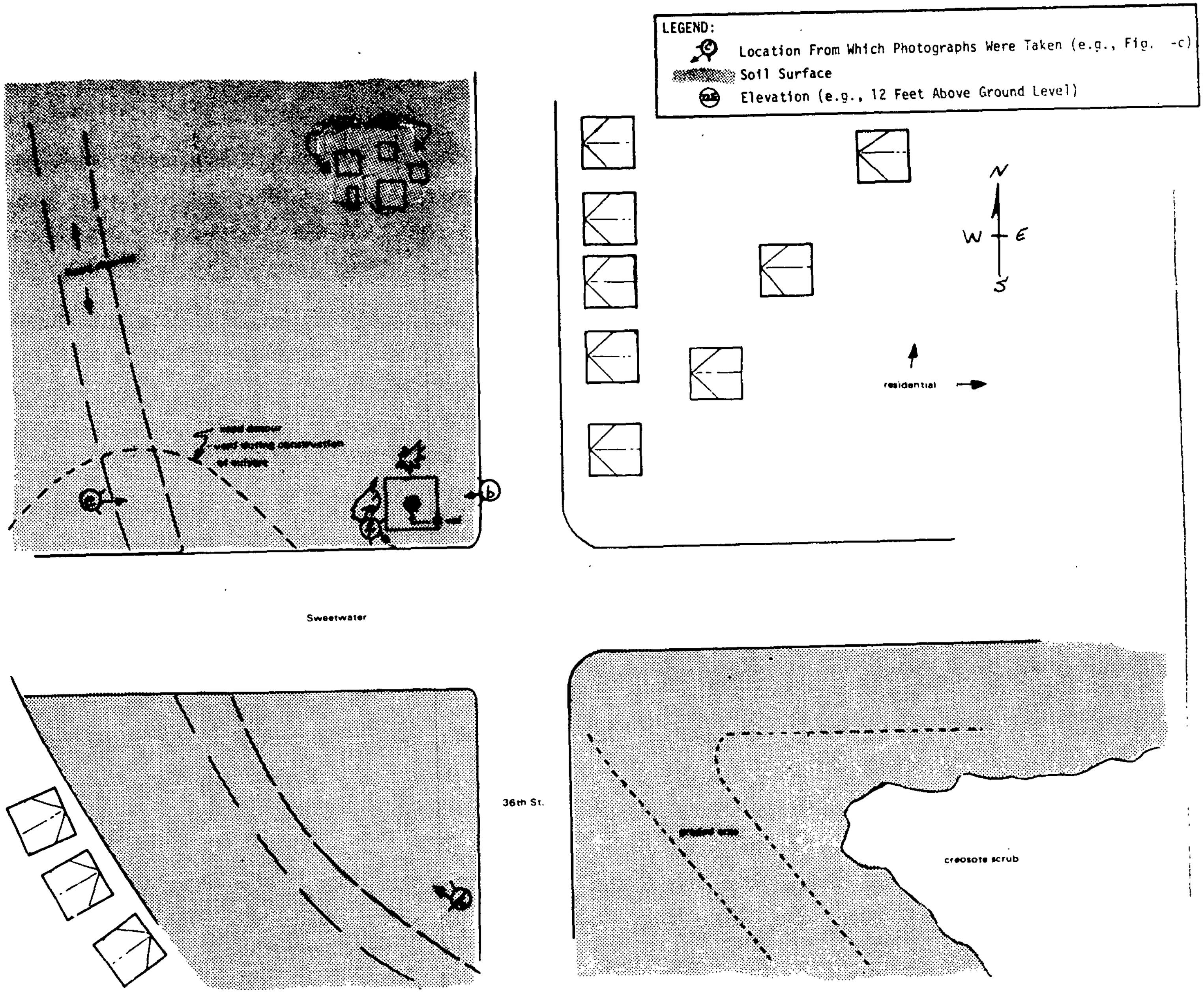
A.7 Paradise Valley

Site Specific Environment

The plot description of Figure A-7a shows the orientation of structures, objects, and emission sources in the immediate vicinity of the Hi-Vol at the Paradise Valley site. The Hi-Vol is located inside a fenced enclosure on an open field at the intersection of 36th Street and Sweetwater (Figure A-7b). The monitor is mounted on a conventional stand five feet above ground, and has unobstructed clearance in all directions.

The area immediately surrounding the monitor site typifies the general area. There is a predominance of open fields separated by new housing developments. To the north of the monitor is an open field of soft soil and creosote scrub. About 400 feet from the monitor in this field are various makeshift enclosures and stables for horses. The area immediately west and south of the monitor consists of an open field of soft soil (Figure A-7e). A flood channel runs through this field under a bridge on Sweetwater Road. The open field terminates several hundred yards beyond the channel at a new residential community. To the east accross 36th Street are several blocks of residential dwellings (Figure A-7e). To the southeast, across the intersection from the monitor, is a large open field which has been graded and excavated in preparation of future development to occur there (Figure A-7f). The field is covered in many places by creosote scrub, but is baren and bears a soft dust surface in the remaining portions.

The only significant local source of particulates is fugitive dust. The suspension of this dust is related to vehicle activity (on unpaved and paved roads) and activities which disturb the soil surfaces sufficiently to permit suspension of soil by wind. The open fields of the area are covered by a soft soil dust which is easily suspended by winds. Thick layers of dust were observed on the adjacent homes and automobiles. Residents confirmed that dust is a constant nuisance in the area.



(a)

Figure A-7. Paradise Valley Site.

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Figure A-7 (Continued). Paradise Valley Site.

Local dust sources are also created by construction and excavation activities in the area. Numerous earth shaping activities have occurred in the previous two years in the area. This activity was associated with a new residential development southwest of the monitor and the construction of the flood channel bridge (late 1974) approximately 200 feet west of the monitor. The bridge construction required the routing of traffic onto a temporary detour through the open field. Residents reported observing dust clouds frequently during this construction activity.

The general plan for the area involves continued residential development for the next several years. This development will have significant impact on dust levels at the monitor. The site characterization should be reviewed periodically to assess the changes in local source influences.

Representativeness of Monitor

It appears that air quality measured at the monitor is representative of both site specific and area-wide levels of suspended particulates. The general area is dominated by open fields and unpaved roads. The monitor location is directly representative of exposures experienced around these open fields. It is possible that nearby construction activities and resulting disturbance of soil surfaces in open fields have been unduly represented at the monitor site in the past two years, however, such activity is typical in the general area because of the substantial development currently underway.

The manner in which future development occurs may affect changes in the monitor representativeness. For example, intensive development immediately around the monitor could render the monitor as representative of only the site specific air quality. During construction, dust producing operations may raise levels to extreme levels at the monitor, while after development has been completed, dust levels might be reduced below previous values. Unless development takes place with this same intensity throughout the general area it is clear that air quality at the monitor site would no longer be representative of the general area. Because of the substantial level of residential growth forecast for the area around the Paradise Valley Hi-Vol site, the representativeness of the monitor should be periodically reevaluated.

A.8 North Scottsdale/Paradise Valley

<u>Site Specific Environment</u>

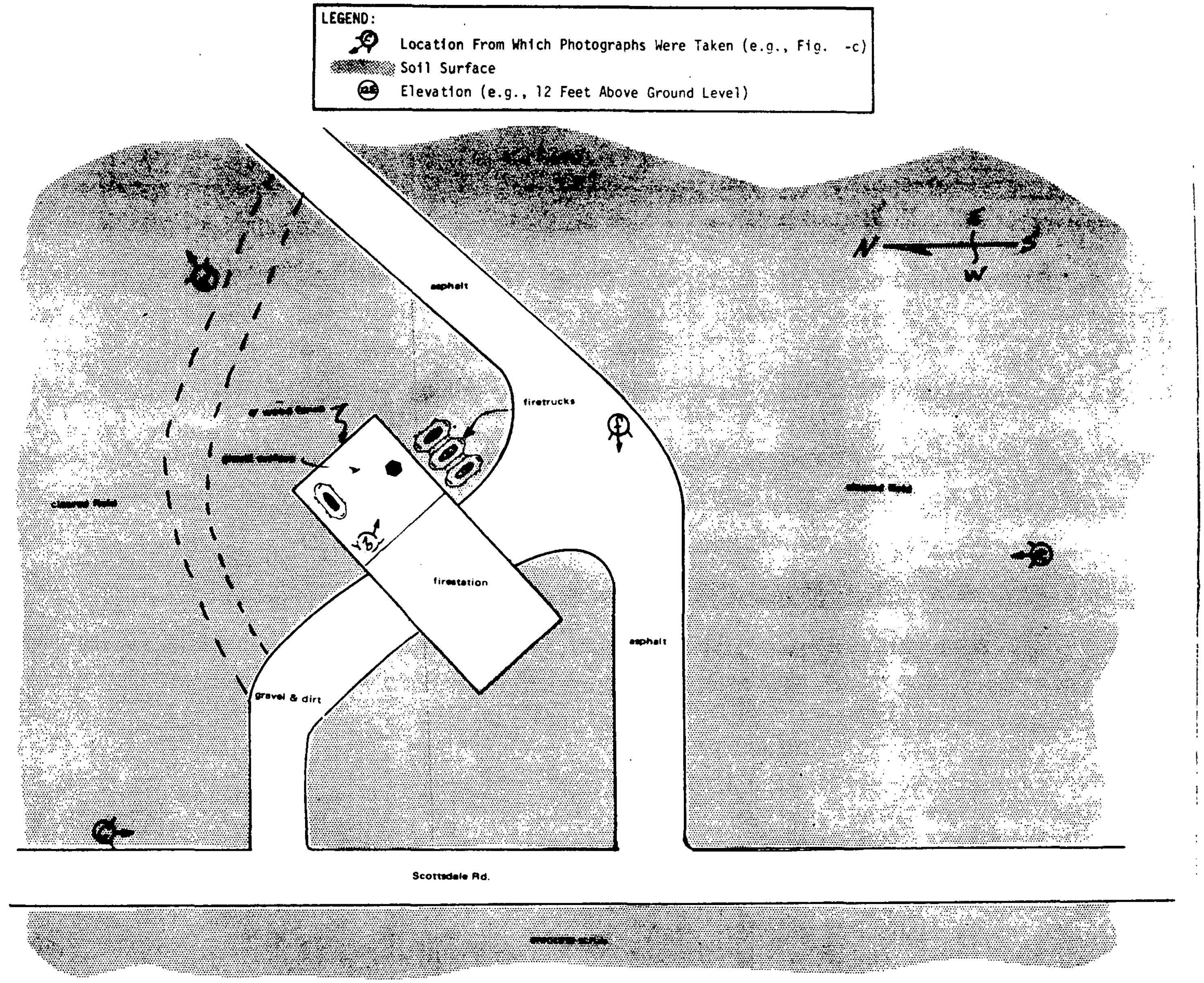
The plot description of Figure A-8a shows the orientation of structures, objects, and emission sources in the immediate vicinity of the Hi-Vol at the North Scottsdale site. The Hi-Vol is located within a fenced storage yard behind the Scottsdale fire station. The monitor is mounted on a conventional stand five feet above the gravelled floor of the enclosure (Figure A-8b). The monitor has adequate vertical clearance with objects in all directions.

The environment immediately surrounding the monitor is typical of the general area. Except for the fire station and its landscaped yard, the vicinity around the site is comprised of vast open fields. To the north, east, and south (Figure A-8c, A-8d, and A-8e), the fields are relatively hard packed with a soft soil cover. These fields are scraped clear of brush annually. Beyond the open field to the west is the Scottsdale Municipal Airport. To the west are several miles of desert fields, covered with various types of desert vegetation (Figure A-8f). There are numerous unpaved back roads in this area. Excavation and construction are being conducted along many of these backroads.

The most significant local source of particulates is fugitive dust. Thick layers of dust were observed on nearby buildings and motor vehicles. The suspension of this dust is caused by vehicle activity and activities which disturb the soil surfaces sufficiently to permit suspension of the soil particles by wind. The fields to the north, east, and south of the monitor receives occasional motor vehicle traffic, and the soil surface is affected appreciably by the annual brush clearing operation. The fields west of the station receive frequent off-road motorcycle traffic, as evident by the numerous tire tracks which were observed. Also, dust emissions are generated by vehicle traffic on the unpaved roads more distant to the west.

A.10

A local conventional source (other than dust) of minor significance to air quality at the monitor consists of the fire trucks parked adjacent to the monitor (Figure A-8e). The trucks are run for five minutes each day in their parked positions. Lead concentrations from the Hi-Vol filters confirm the negligible effect on this service operation. Aircraft



(a)

Figure A-8. North Scottsdale/Paradise Valley Site

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Figure A-8 (Continued). North Scottsdale/Paradise Valley Site activity at the airport consists of small private craft, and is not a potentially significant influence on monitor measurements at the fire station site.

Discussion with the station attendants revealed no major changes in the surrounding environment the past few years, except for 1) the annual brush clearing operation on the adjacent vacant field, and 2) increased construction and excavation activity to the west (in a direction toward the Paradise Valley monitor site. except for continued development activity expected in the west, no significant changes are planned for the surrounding environment in the near term.

Representativeness of Monitor

Air quality measured at the monitor appears to be representative of both site specific and area-wide levels of suspended particulates. The general area is dominated by open desert fields and numerous unpaved roads. The monitor location is directly representative of exposures experienced around these open fields. This situation has existed throughout the term of the monitor sampling history, and is not expected to change significantly in the near term.

A-9 Carefree

Site Specific Environment

The plot description of Figure A-9a shows the orientation of landmarks in the immediate vicinity of the Hi-Vol at the Carefree monitor site. The Hi-Vol is located in the open desert about 250 yards from the Carefree Airport runway. The monitor is mounted on a conventional stand five feet above the ground (Figure A-9b). The monitor has vertical clearance with nearby objects in all directions.

The environment immediately surrounding the monitor is typical of the general area. Except for an occasional residence and the sparcely populated community of Carefree a few miles from the site, the region is characterized by vast expanses of open desert. The composition of soil surrounding the site was observed to be distinct from that at lower elevations in Phoenix. The loose coarse gravel and coarse sand underneath appear to be relatively stable, including the portions which have been subjected to vehicle traffic near the monitor and airport runway. Dust clouds raised by the vehicle

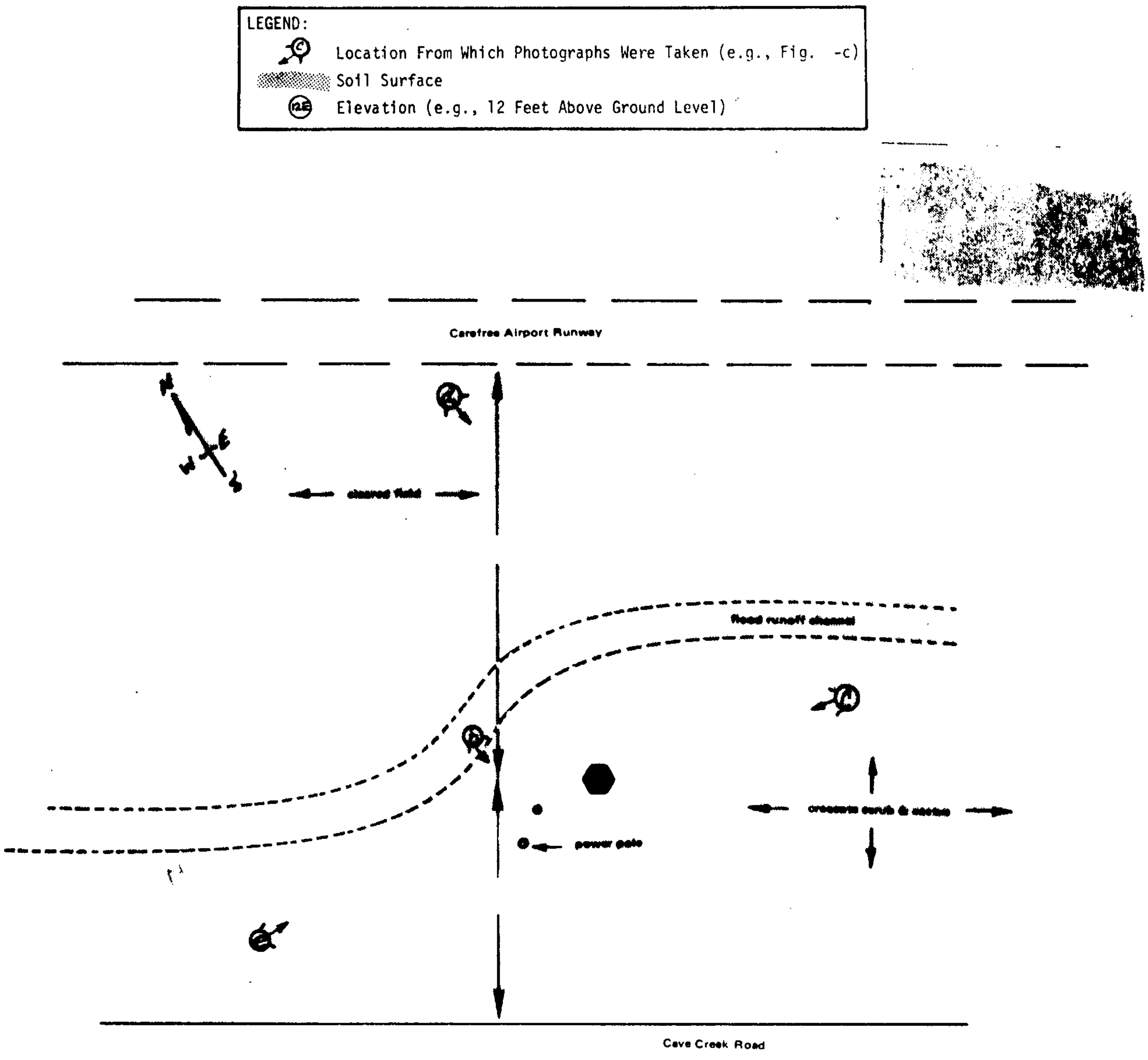

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Figure A-9. Carefree Site.

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Figure A-9 (Continued). Carefree Site.

used for the site visit were observed to be almost non-existent. Soil stabilization is also aided by a ground cover of various desert growth, including creosote and numerous types of cactus (Figure 3-9e).

The most significant local source of suspended particulates is undoubtedly fugitive dust. There are few man-made sources within miles of the site. Off-road travel is prohibited in the general area, and most accessways in this affluent area (including private dirveways) are paved. Aircraft activity is limited, and consists of small private aircraft.

The status of the environment near the monitor site has remained relatively unchanged for the past few years. Except for intermittent residentialdevelopment consisting mainly of custom single residence homes, only minor changes are expected to occur in the environment at the monitor site, both in the near and far term.

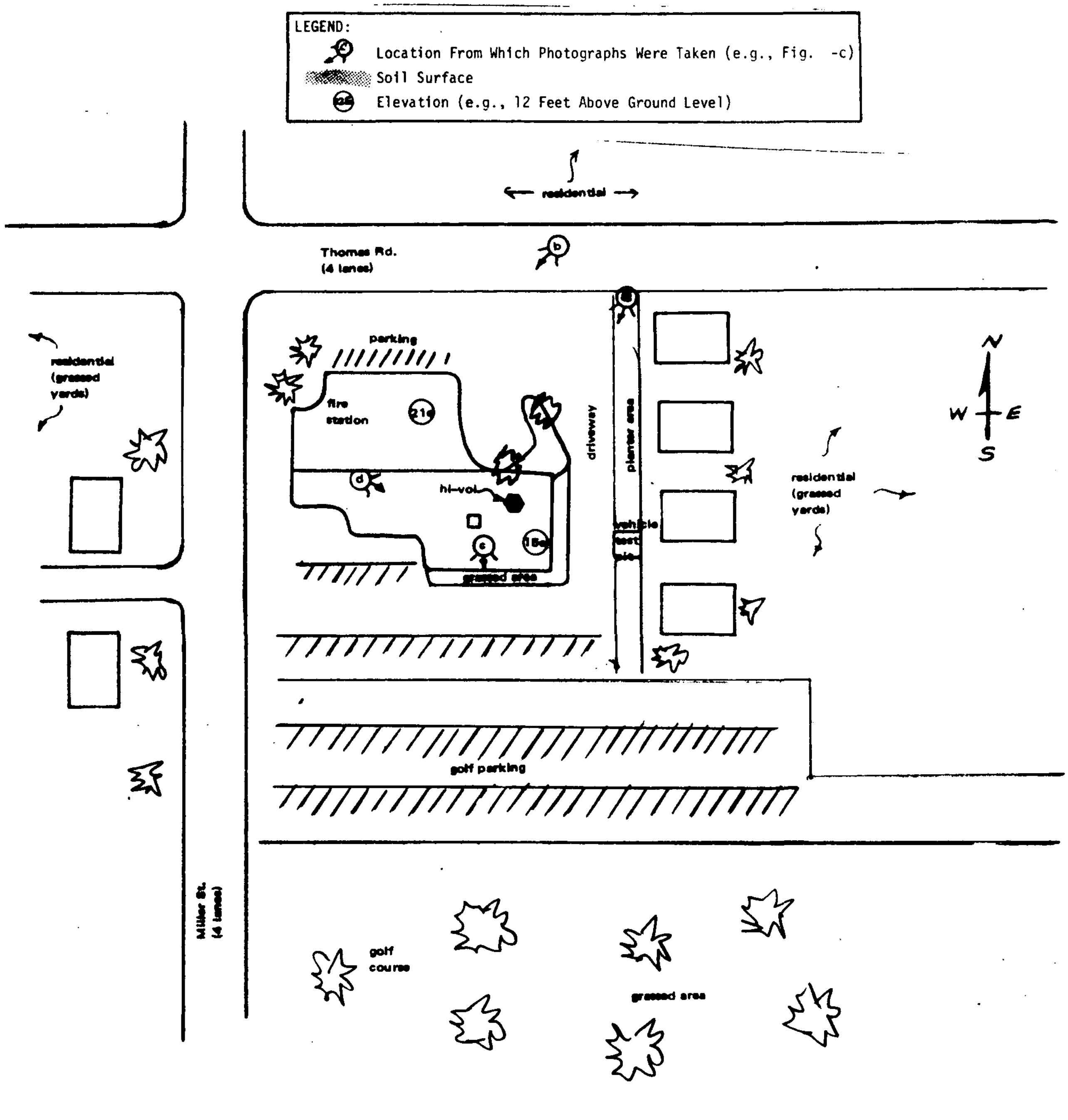
Representativeness of Monitor

Air quality measurement at the monitor site appears to be representative ov both site specific and area-wide levels of suspended particulates. The gneeral area is characterized by continuous open desert. The gently rolling desert terrain is covered by typical upper desert growth, and the soil surface is stable and resistant to suspension by wind. The specific monitor location is directly representative of this area-wide characterization, and of air quality exposures experienced in this open desert region.

3.2.1 Scottsdale

Site Specific Environment

The plot description of Figure A-10a shows the orientation of structures, objects, and emission sources in the immediate vicinity of the Hi-Vol at the Scottsdale monitor site. The Hi-Vol is located on the rooftop of the Miller Road Fire Station, about 15 feet above ground level. The monitor is mounted on a conventional stand about 1-1/2 feet above the flat tarpaper roof. The monitor has adequate vertical clearance with all objects in every direction.



(a)

Figure A-10. Scottsdale Site (August 1974 to Present).

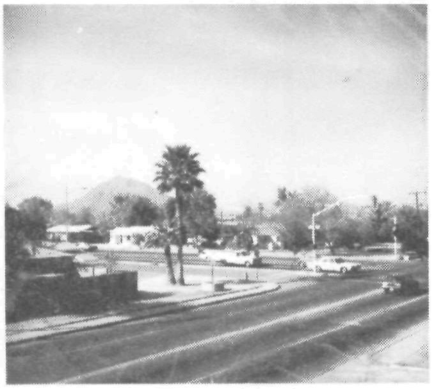


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Figure A-10 (Continued). Scottsdale Site (August 1974 to Present).

The environment immediately surrounding the monitor consists of paved parking lots and streets, and an established residential community. To the south of the monitor are two consecutive parking lots. One of these parking areas is for fire station use while the larger lot (Figure A-10c) is for the Coronado Golf Couse south of the station. The station is bordered on the east by residential dwellings. To the north and west are the four lane streets of Thomas Road and Miller Road followed by blocks of residential dwellings.

The most significant local source of suspended particulates at the present is probably entrained dust and exhaust arising from motor vehicle activity. The adjacent intersection experiences substantial traffic volume throughout the day, and the Coronado golf course parking lot experiences frequent use, particularly on week ends. A minor local emission source includes the fire station trucks. The truck pumps are tested periodically in a pit on the driveway about 70 feet from the monitor. During this operation the truck engines are run at full load for approximately ten minutes. Another minor source includes the station locker room and bathroom vents which exit on the roof a few feet away from the monitor.

Except for entrained dust off the heavily-travelled paved roads nearby, there are presently no conspicuous sources of fugitive dust in the immediate surroundings. Residential development in the adjacent neighborhood includes grassed yards, vegetation, and paved sidewalks and alleys. However, discussion with the station attendants revealed that the driveway on the east side of the station, and the southside parking lot, were unpaved before August of 1975. Previously dust clouds were observed as vehicles traveled on the unpaved dirveway and parking area. During the period of sampling prior to August of 1975, it is probable that this dust source may have contributed significantly to levels measured at the Hi-Vol.

Prior to August of 1974 the Scottsdale Hi-Vol monitor was located for a year at the Salt River project substation approximately one mile west of the present site. The Hi-Vol was placed in the northeast corner of an enclosure used to house emergency flood runoff control equipment. Figure A-11 shows that the monitor at this site was surrounded by open fields. Vehicle traffic and soil dumps on the vacant land immediately east of the site resulted in deposits of fine soil dust over the surrounding area. Vehicle traffic on the paved road adjacent to the monitor suspends the

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Figure A-11 (Continued). Scottsdale Site (October 1973 to August 1974) soil on the shoulder of the road resulting in observable dust clouds. In addition, service vehicle traffic on the unpaved Salt River Canal roadway above the monitor causes substantial dust suspension. During the period of sampling at this location, this roadway was used several times a day for service operations. The predominance of dust sources in the area of the monitor is illustrated dramatically by thick layers of dust which are observed on all nearby surfaces. Company vehicles at the Salt River project are washed weekly to remove this dust.

Because the area surrounding the present monitor site at the fire station is fully developed, few future changes are likely to occur which would significantly impact air quality at the monitor.

Representativeness of Monitor

Air quality presently measured at the monitor site appears to be representative of both site specific and area-wide levels of suspended particulates. The general area is primarily residential, and the monitor is surrounded by residential dwellings. Traffic activity may be slightly non-representative of the general area, and could have some effect in distorting the area-wide representativeness of the monitor. Representativeness of the site should remain fairly unchanged in future years owing to the established and comprehensive status of current developments there.

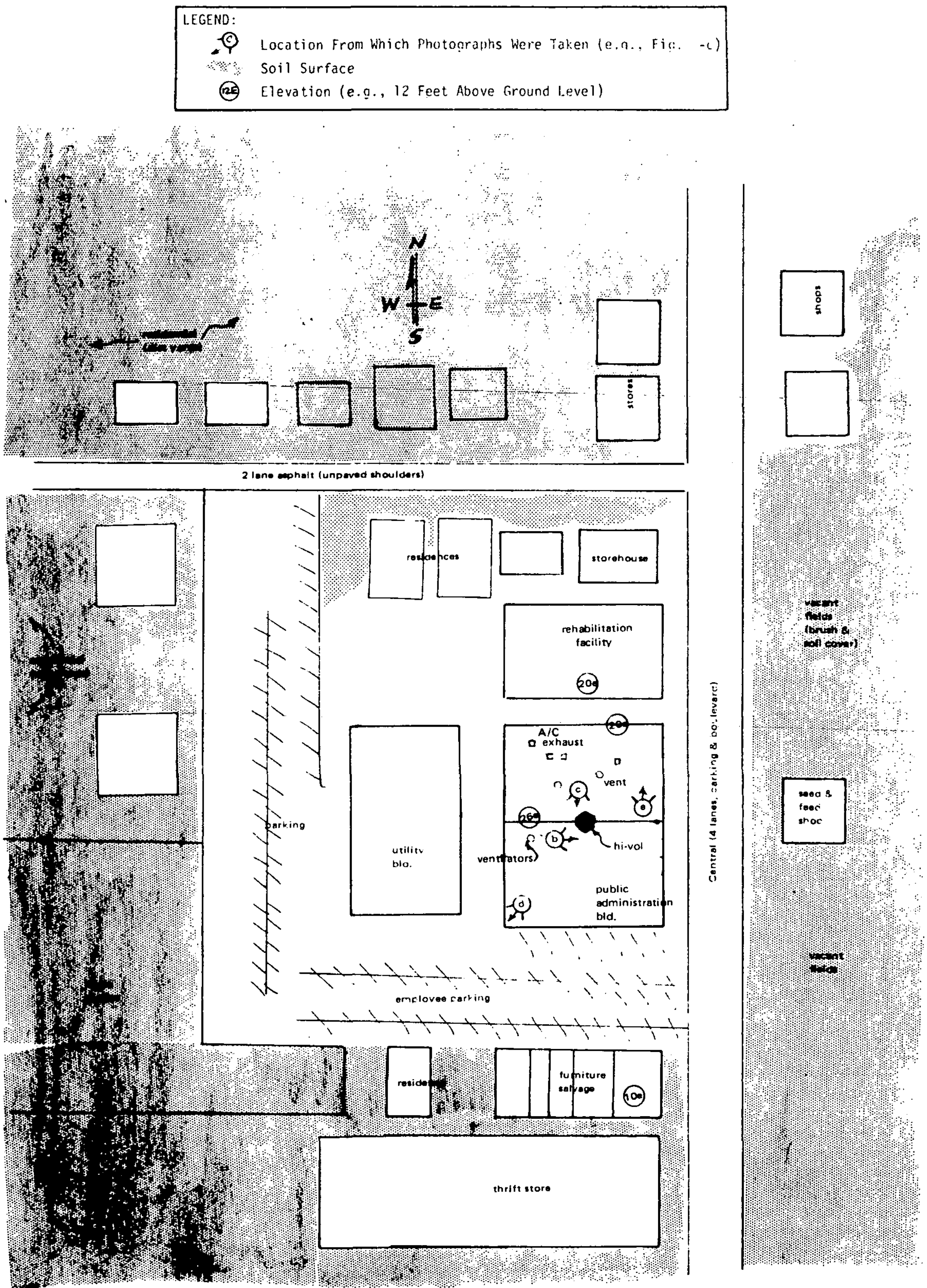
The potentially significant dust source (the unpaved driveway and parking area) at the station prior to August 1975 may have resulted in site specific dust levels unrepresentative of the general area. However, traffic from attendant's private vehicles at the fire station is limited and infrequent, and probably would have exerted only minor influence on air quality measured by the monitor.

Air quality measured at the Salt River project site from October 1973 to August 1974 is clearly site specific as the monitor was oriented in the center of a hotspot of fugitive dust emissions, while the general area beyond this hotspot is primarily of residential composition.

A.11 South Phoenix

Site Specific Environment

The plot description of Figure A-12a shows the orientation of structures, objects, and emission sources in the immediate vicinity of the Hi-Vol at the



(a)

Figure A-12. South Phoenix Site.

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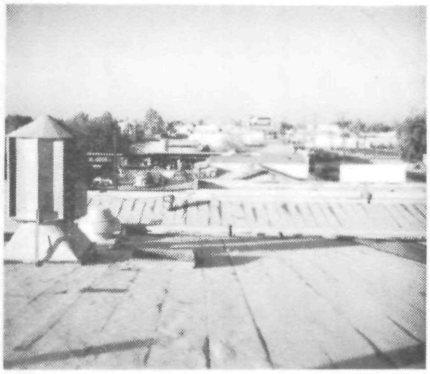

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Figure A-12 (Continued). South Phoenix Site.

South Phoenix site. The Hi-Vol is located on the rooftop of the county public administration building, approximately 36 feet above ground level. The monitor is mounted on the roof peak on a conventional stand, about 1-1/2 feet above the tarpaper roof surface (Figure A-12c). The administration building is the highest structure in the vicinity.

The environment immediately surrounding the county building consists of a mix of commercial and residential buildings, parking lots, and major traffic links. The east side of the building is bordered by Central Avenue, a four lane arterial (plus curbside parking space) with appreciable traffic activity. Beyond Central Avenue to the east are various shops and vacant lots, followed further beyond by several blocks of residential dwellings (Figure A-12d). South of the monitor is the county parking lot, and further beyond, a furniture salvage store and horse stables. To the west is another county building, followed further beyond by an additional county parking area, and then by horse stables and several blocks of residential dwellings. Immediately north of the monitor site is a "self-help" rehabilitation facility, a warehouse, and a two lane narrow roadway. Further beyond are several blocks of residential dwellings, and various shops and commercial buildings bordering Central Avenue.

The most significant local source of suspended particulates is apparently fugitive dust. Heavy dust layers were observed on surfaces of buildings, sidewalks, streets, and motor vehicles throughout the area. Dust is suspended by traffic activity on numerous dirt, gravel and dirt, and asphalt and dirt roads in the immediate residential vicinity. Dust also originates from other activities occurring on numerous unpaved or nonvegetated soil areas. Many residential yards consist of undeveloped areas with fine soil dust cover. Horses walking in their enclosure nearby were observed to produce puffs of dust clouds in their footsteps. Vacant lots in the area are subject to pedestrian traffic and are characterized by loose soil surfaces. The dust is easily suspended by wind, and is deposited throughout the neighborhood. Air movement from vehicles traveling on Central Avenue (which is paved) was observed to produce sliding films of dust on the adjacent sidewalk.

Other than fugitive dust sources, the next most significant local origin of suspended particulates at the monitor site is probably motor vehicles. Heavy traffic volume on Central Avenue and frequent activity in the county parking lots (approximately 160 vehicle occupancy) result in substantial exhaust emissions which may impact monitor measurements significantly. The larger vents on the county building rooftop emit exhaust air from a refrigeration cooling system driven by electric power. Emissions are negligible from this unit. Other smaller vents exhaust the ambient air in the building. Insignificant quantities of particulates (i.e., cigarette smoke) emit from the vents. Flue gases from the boiler emit through a large stack (Figure A-12e) about 30 feet from the monitor. Particulate emissions in these flue gases are negligible owing to the use of natural gas in the boiler operation.

The status of the environment near the monitor has remained relatively unchanged for the past few years. The community is generally economically depressed and unable to support new growth or even minimal upkeep and maintenance. Present improvement plans indicate this environment will experience no significant changes in the near term.

<u>Representativeness of Monitor</u>

Air quality measured at the monitor site appears to be representative of both site specific and area-wide levels of suspended particulates. The general area is characterized by a mix of commercial buildings and residential dwellings. There are numerous fugitive dust sources in the general area, including the resuspendable deposits of this dust observed throughout the community. This characterization is entirely representative of the site specific description. Two principal factors may distort the general representativeness of the air quality measured at the site. First, it is possible that air quality at the monitor site is representative of motor vehicle emissions (exhaust and entrained dust) in a site specific manner since traffic at the site is appreciably greater than at most exposure points throughout the general area. However, the effect of emissions from greater traffic activity near the monitor is probably minor in comparison to the area-wide levels of fugitive dust experienced there. Second, the elevation of the monitor is inappropriate to represent typical ground level exposures.

3.2.12 Guadalupe

The plot description of Figure A-13a shows the orientation of structures, objects, and emission sources in the immediate vicinity of the Hi-Vol at the Guadalupe monitor site. The Hi-Vol is located on a vacant lot in a residential block in Guadalupe (Figure A-13b). The monitor is mounted on a conventional stand five feet above ground level, and has unobstructed vertical clearance in all directions. The site Hi-Vol monitor is protected by a fenced enclosure, and there is evidence of only very minimal soil disturbance within the confine.

The environment immediately surrounding the monitor is entirely residential. To the north and south are several blocks of residential dwellings. Beyond the two neighboring dwellings to the west is an open field used as a park and playground area (Figure A-13d). At the end of the block to the east, commercial highways flank each side of 56th Street (the main road through Guadalupe).

The only apparent significant local souce of suspended particulates consists of fugitive dust. The suspension of this dust is related to vehicle activity and activities which disturb the ground surface sufficiently to permit suspension of the soil particles by wind. A substantial portion of the activity in the immediate vicinity of the monitor occurs on soil surfaces. The area is generally economically depressed, and residence yards are unkept. Most residence yards are bare ground without vegetation. Driveways are unpaved, and loose soil dust overflows onto the paved roads (Figure A-13c). The soil on the dirt playground 300 feet west of the site is periodically disturbed by group recreational activities. The neighboring yard adjacent to the monitor has been trampled to a fine power dust by the action of a horse confined to limited quarters. These factors all contribute to the suspension of dust at the monitor site.

Local sources other than fugitive dust probably exert negligible effects on air quality at the monitor. Emissions from home wood stoves may contribute to particulate levels in the winter season, however, these stoves are used in only a few homes near the site. Commercial activities on 56th Street are generally limited to operations of shops, and many of these are vacated and boarded up.

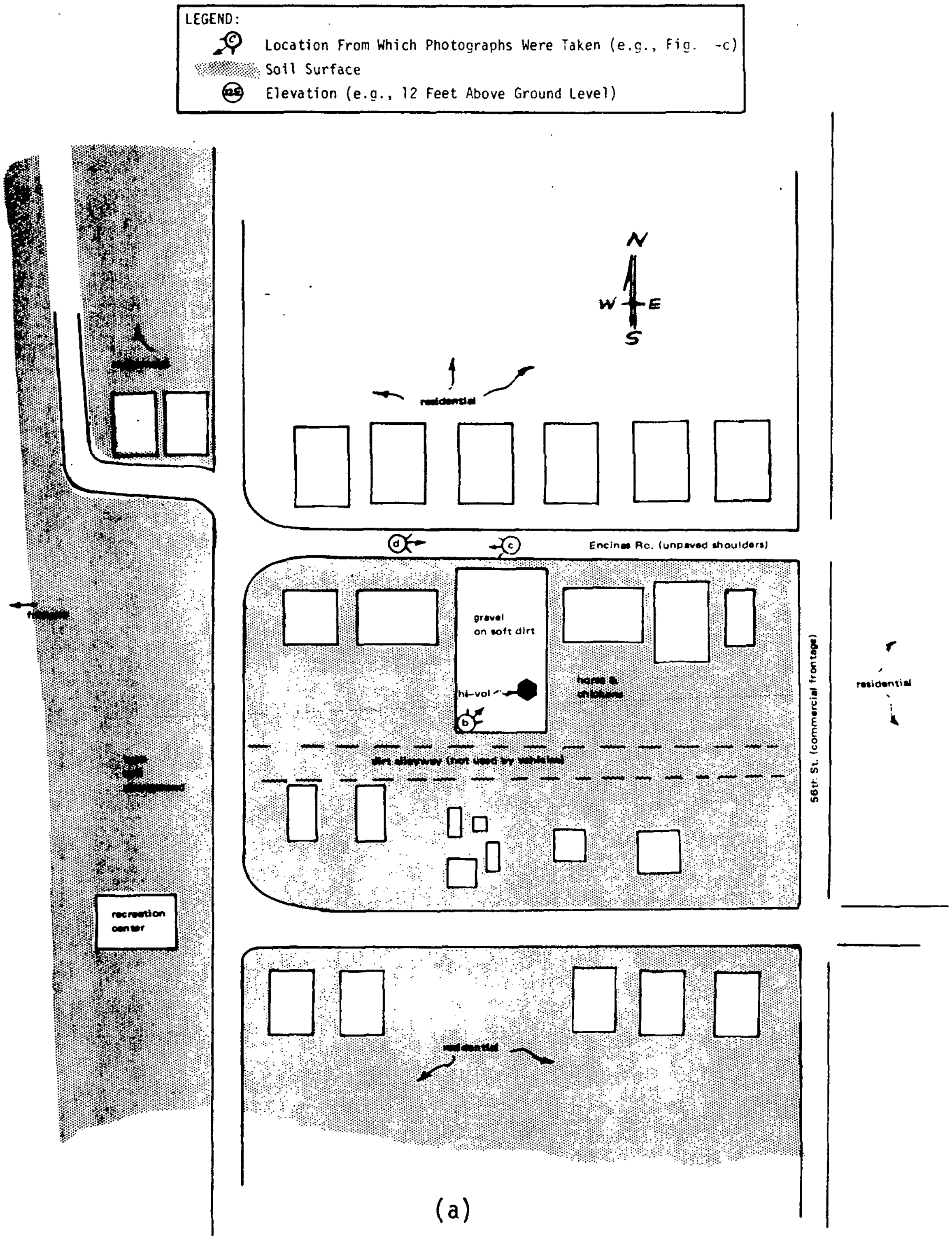

Figure A-13. Guadalupe Site.

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Figure A-13 (Continued). Guadalupe Site

The status of the environment near the monitor has remained relatively unchanged for the past few years. The economic depression characteristic of this community prevents improvements and general upkeep. Present plans for the neighborhood do not include significant developments in the near term.

Representativeness of Monitors

Based on the review of apparent sources in the vicinity of the monitor site it appears that air quality at the site is representative of both site specific and area-wide levels of suspended particulates. The general area surrounding the site is a hotspot for fugitive dust source activity, and the monitor is centered in this activity. There are no conspicuous sources immediately neighboring the monitor which would be causing air quality there to depart from typical area-wide exposure levels.

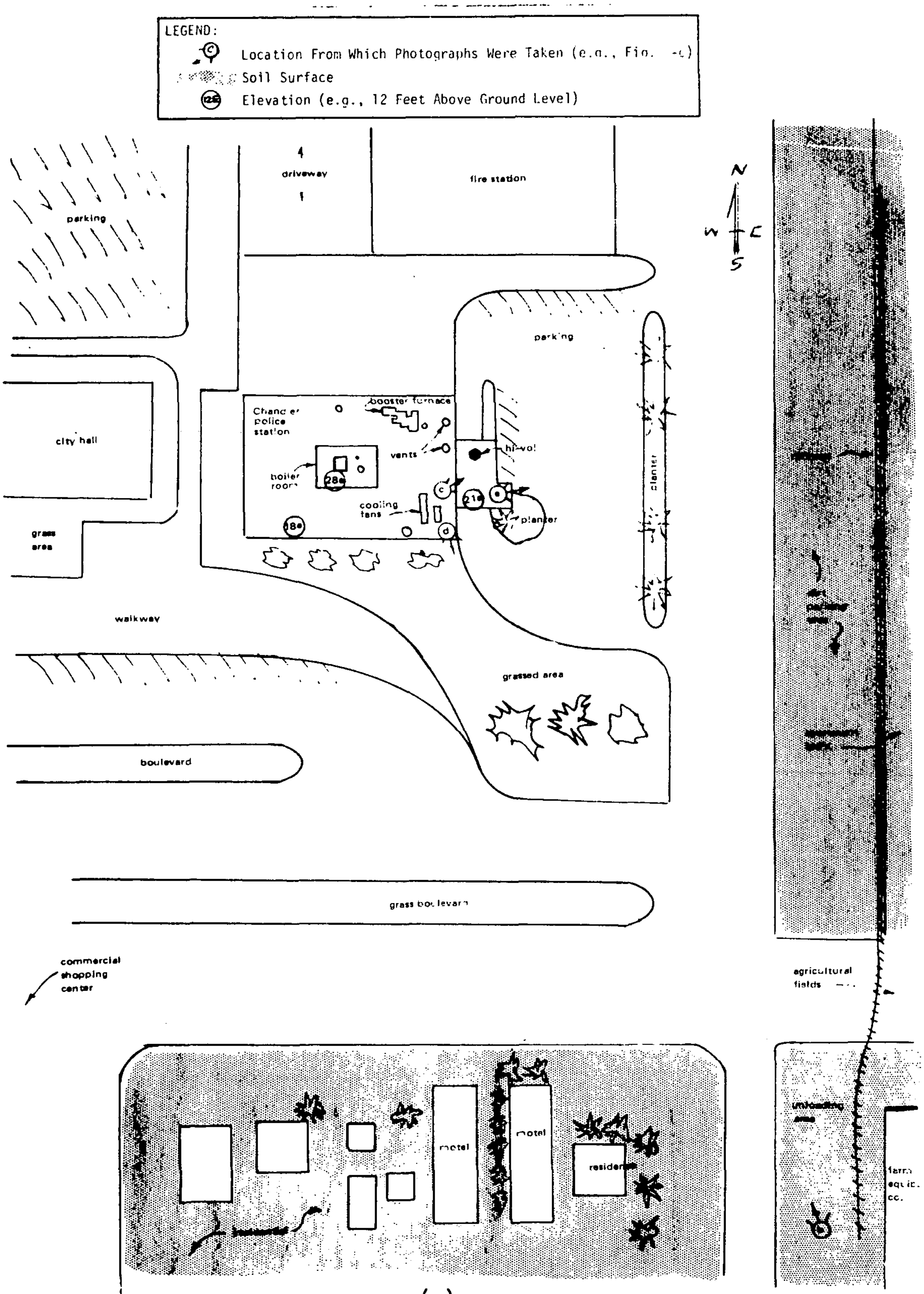
A.13 Chandler

Site Specification Environment

The plot description of Figure A-14a shows the orientation of structures, objects, and emission sources in the immediate vicinity of the Hi-Vol at the Chandler monitor site. The Hi-Vol is located on the rooftop of the Chandler City Police Department building, about 21 feet above ground level. The monitor is mounted in a conventional housing about 1-1/2 feet above the flat tarpaper roof, and has unobstructed vertical clearance in all directions.

The environment immediately surrounding the monitor is comprised of parking lots, city buildings, and vacant fields. Immediately south of the police building is a parking area. Bordering this parking area is Commonwealth Street and further beyond are residential units (Figure A-14d). To the immediate east there is a limited parking area bordered beyond by Delaware Street. Across Delaware Street are several acres of open field, and numerous apartments (Figure A-14e) and agricultural fields. Grassed areas and other municipal buildings characterize the landscape immediately west and north of the policy building.

The most conspicuous local source of suspended particulates at the monitor site is fugitive dust. Open fields covered with soft soil dust were observed directly east and south of the monitor site. These fields are subject to frequent vehicle traffic, as is evident from the tire tracks shown in Figure A-14e. The dust cover on these fields is easily suspended



(a)

Figure A-14. Chandler Site.

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Figure A-14 (Continued). Chandler Site

by air movement. The agricultural fields,located further east, are a seasonal source of fugitive dust. During the day of the site survey, these fields were being tilled. Dust clouds were constantly observable behind the tractor plow. Signs of deposition of fugitive dust sources were apparent on the rooftop of the police building, and in the dust soaked walls of the course white stucco exterior of the municipal buildings.

Local sources other than fugitive dust probably exert negligible effects on air quality at the monitor. Numerous vents on the rooftop of the police building exhaust ventilation and boiler flue gases. The boilers are fired with natural gas and emit negligible quantities of particulates. Gases exiting the ventilation vents consist of ambient air inside the building and contain only minor emissions of particulates (i.e., cigarette smoke). None of the vents are closer than 15 feet from the monitor (see Figure A-14c).

Substantial development activities have been occurring in the immediate area during the period of air sampling (3 years). Most of this activity concerns landscaping operations conducted on the municipal grounds. These activities were probably responsible for significant dust emissions. Additional fugitive dust sources and dust emissions may result from future landscaping anticipated along the railroad tracks. A grassed park area is eventually planned, which in the far term, would contribute to reductions in dust sources near the monitor site.

Representativeness of Monitor

Based on the review of apparent sources in the vicinity of the monitor site, it appears that air quality at the site may be representative of site specific and area-wide levels of suspended particulates. The area east of the monitor site is an expansive potential fugitive dust source, and air quality at the monitor is subject to emissions from these sources, particularly during southeasterly winds (a common occurrence). However, the general area around the monitor is characterized by a mixture of residential, commercial, and agricultural property. The mix at the monitor site reflects the overall area-wide description, and may, under most meteorological conditions, exhibit air quality representative of the area wide pattern. As development continues to take place in Chandler, and the community becomes more homogenious with fewer fugitive dust sources, it is clear that representativeness of the present monitor site will become more definitive.

A.14 Mesa

Site Specific Environment

The plot description of Figure A-15a shows the orientation of structures, objects, and emission sources in the immediate vicinity of the Hi-vol at the Mesa monitor site. The Hi-vol is located within an enclosure containing a maintenance shack and a water tower (Figure A-15b) at the southwest corner of Center Street and 3rd Place. The monitor is mounted on a conventional stand approximately 2 feet above the soil ground surface in the enclosure. The monitor has adequate verticle clearance with objects to the north, east, and west, but is somewhat sheltered by the maintenance shack from prevailing southerly breezes.

The environment immediately surrounding the monitor is a mixture of residential dwellings, commercial operations, parking lots, and a public park. To the north accross 3rd Place is an unpaved parking lot and a recycle collection center. South of the monitor is a small house and Rendezvous Park. East of the site, beyond the water tower, there is a park picnic area and a park service and maintenance area. West, accross Center Street, are various shops and residential dwellings.

The most significant apparent local source of suspended particulates is fugitive dust. Soil dust is suspended from vehicle activity in the unpaved parking lot accross the street and on the unpaved service vehicle driveway east of the monitor. Vehicles are also parked on the dirt parkway adjacent to the monitor, and on occasion, inside the water tower enclosure. The vehicle activity raises dust clouds sufficiently to permit suspension of soil particles by air movement.

Discussions with city employees working at the park revealed that vehicle activity in the park service area near the monitor is sporadic, and depends on various construction and maintenance requirements at the park. The maintenance shack inside the water tower enclosure is used periodically for various assorted tasks, particularly wood-work activity. There are no immediate plans which would alter the current landscape and activities influencing local source emissions.

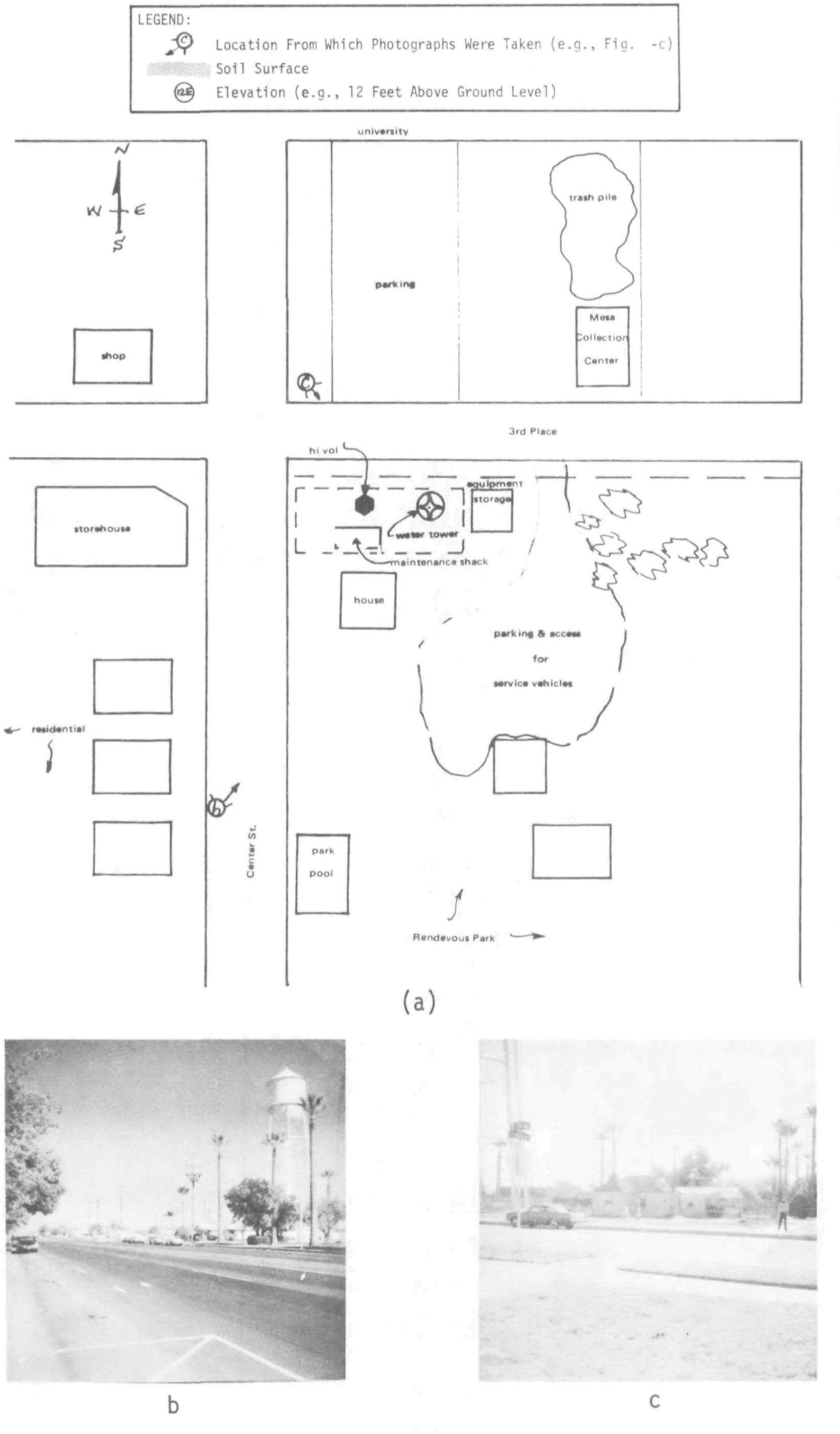


Figure A-15. Mesa Site.

Representativeness of the Monitor

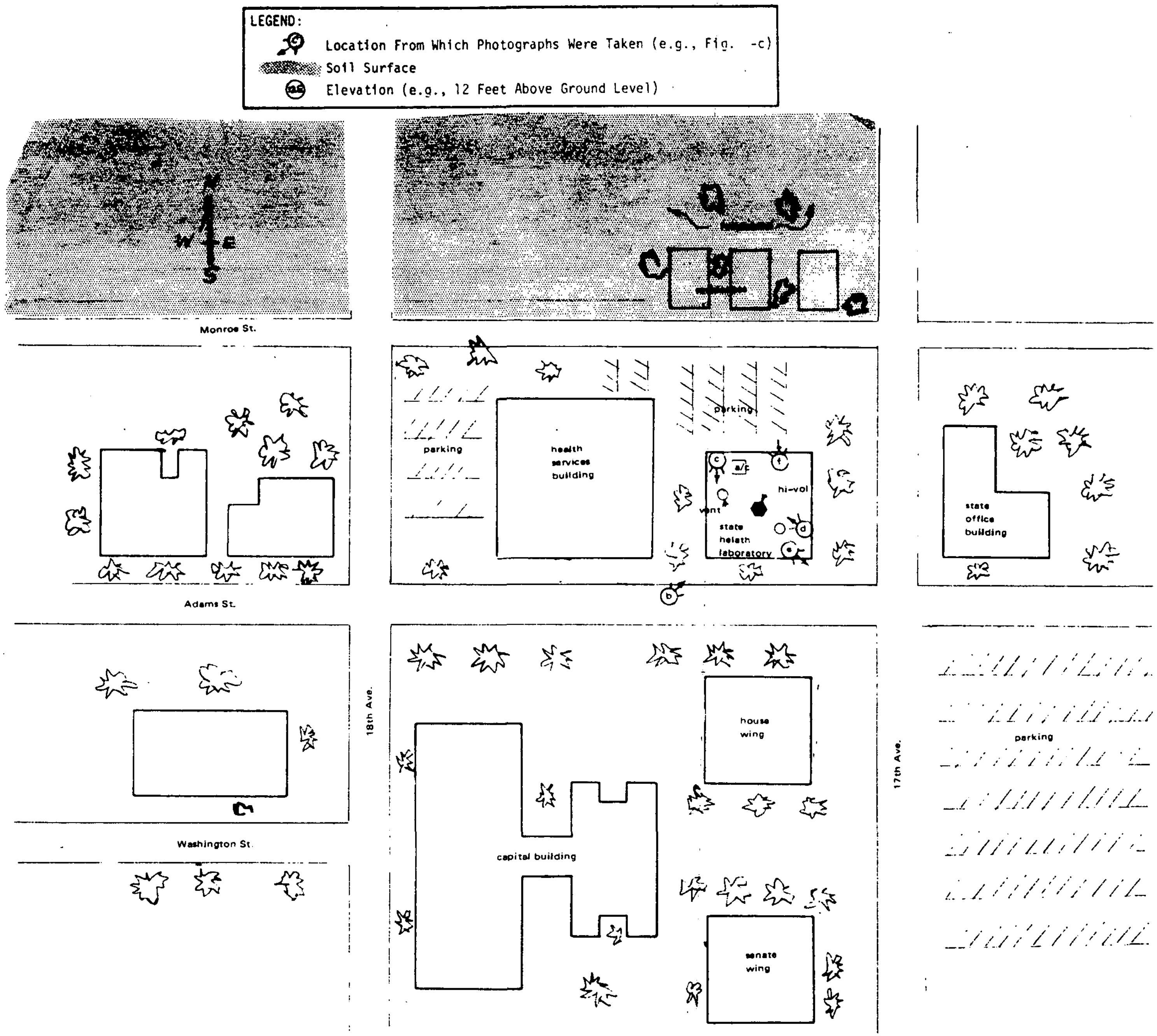
Air quality measured at the monitor appears to be representative in a site specific manner, but not representative of the general area. The general area is characterized by residential development, including grassed residential yards, paved roads and driveways, and few sources of fugitive dust. By contrast the monitor is exposed to dust loadings created by vehicle activity on soil surfaces of the adjacent parkway, the parking lot accross the street, and the park service area nearby. In addition, the Hi-vol is positioned over a soil surface which is subject to substantial human traffic and vehicle parking. This ground source was observed to be composed of a fine soil dust cover which was susceptible to suspension by air movement. The significance of the various sources surrounding the monitor is unclear. Additional analysis of the local sources would be necessary to assess the potential utility of the air quality data obtained there.

A.15 Arizona State

The plot description of Figure A-16a shows the orientation of structures, objects, and emission sources in the vicinity of the Hi-vol at the Arizona State Monitor site. The Hi-vol is located on the roof of the State Health Laboratory, about 15 feet above ground level. The monitor is mounted in a conventional housing about 1 1/2 feet above the flat tarpaper roof, and has unobstructed vertical clearance in all directions.

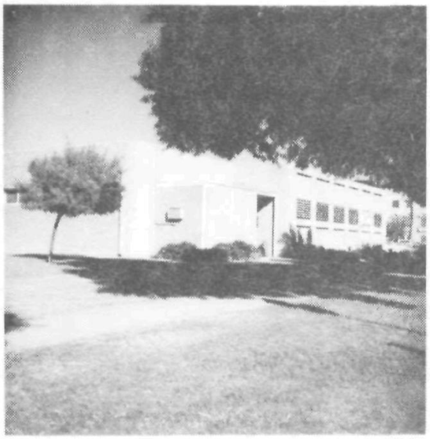
The area immediately surrounding the monitor site is characterized by a mix of parking lots, access streets, grassed yards and state buildings, and nearby residences. To the North of the monitor site (Figure A-16f) is the employee parking lot, and beyond the lot (across Monroe St.) is a cleared area of exposed soil bordering the adjacent residential community. The site is surrounded in the remaining directions by multi-level State buildings and the associated grounds and employee parking lots.

Significant fugitive dust sources apparent in the immediate area consist of entrained dust from vehicle activity, and dust emissions from construction activities South of the monitor site (and from other locations where new construction has been prevalent in the Capitol area in recent



(a)

Figure A-16. Arizona State Site.



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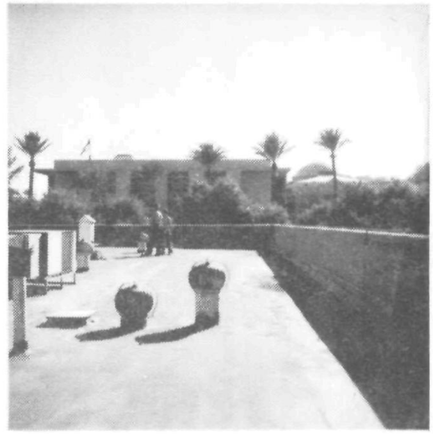

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Figure A-16 (Continued). Arizona State Site months). Two sources other than fugitive dust may exert significant influence on TSP levels measured at the monitor. These sources are motor vehicle exhaust from heavy traffic activity in the area, and particulate emissions from the nearby feed grain factory Northwest of the monitor site. The numerous roof vents atop the health laboratory emit negligible amounts of particulate matter. The boiler is gas fired and the hooded fumes from the chemical lab are primarily gaseous emissions.

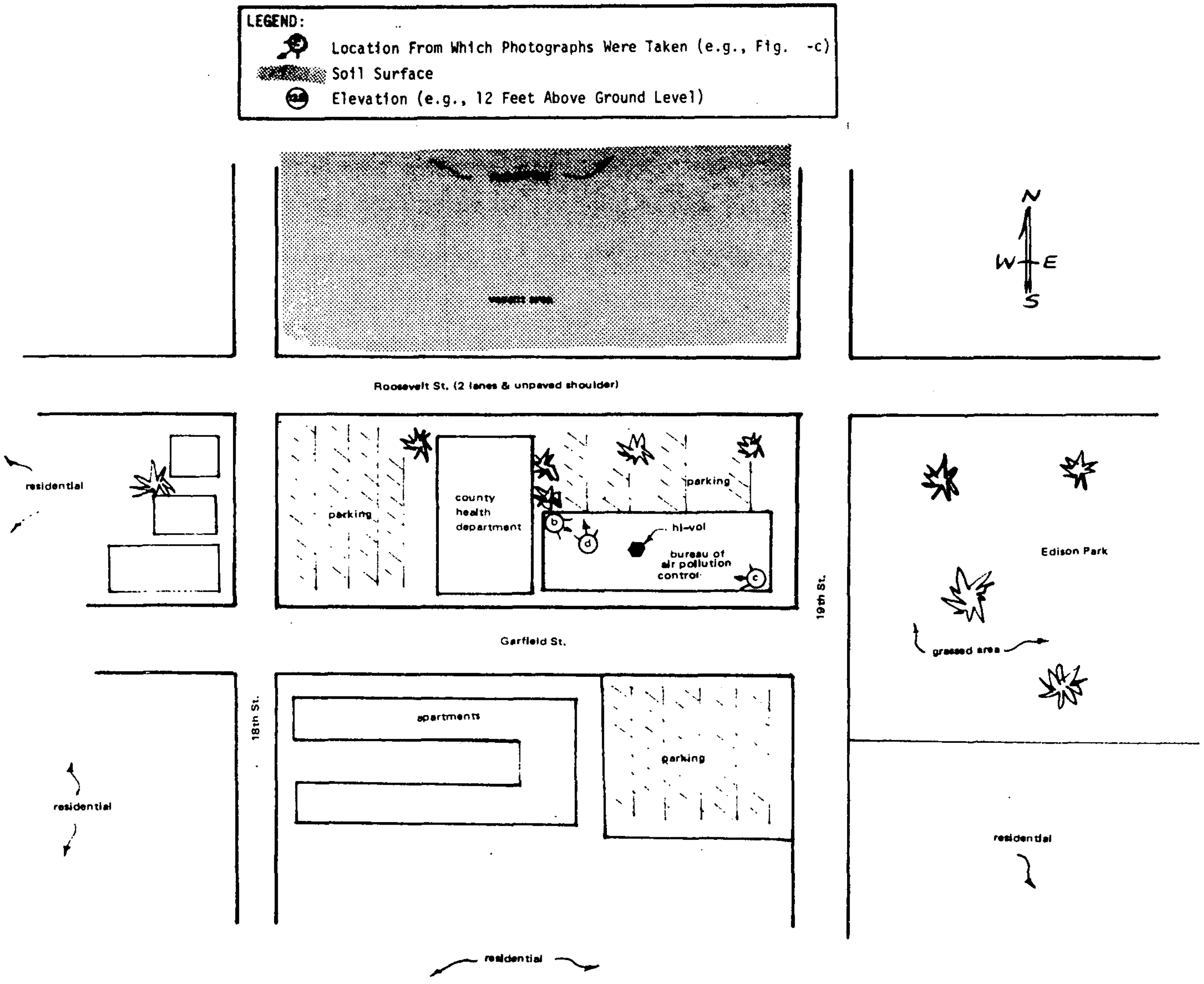
Various construction activities have been occurring in the capitol area over the past few years. New buildings have been erected, numerous parking lots have been paved, and extensive landscaping has been conducted throughout the area. These activities were probably responsible for significant dust emissions. Additional development of the Capitol Area may contribute to high levels of TSP at the monitor in the future, however, in the far term, such developments will contribute to significant reductions in dust sources near the monitor site.

Representativeness of Monitor

Based on the review of apparent sources in the vicinity of the monitor site, air quality at the site is probably fairly representative of site specific and area-wide levels of suspended particulates. The general local area consists primarily of state buildings, commercial businesses, and private residences; and the mix of property at the site also reflects this description. Heavy traffic activity is typical of the general area as well as the vicinity immediately surrounding the site. Construction activity is typical throughout the area. As development continues in the area, eliminating various fugitive dust sources (including the construction activities themselves), TSP levels will become more homogeneous and air quality measured at the monitor site more representative of the general local area.

A.16 Central Phoenix

The plot description of Figure A-17a shows the orientation of structures, objects, and emission sources in the vicinity of the Hi-vol at the Central Phoenix site. The Hi-vol is located on the rooftop of the Maricopa County Health Services building about 22 feet above ground level. The monitor is



(a)

Figure A-17. Central Phoenix Site.

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Figure A-17 (Continued). Central Phoenix Site.

mounted in a conventional housing (Figure A-17b) about 1 1/2 feet above the flat tarpaper roof, and has relatively unobstructed vertical clearance in all directions.

The area in the vicinity of the monitor site is generally residential. A few commercial enterprises are scattered along the major road frontages, and there are numerous apartment dwellings in the area. North of the site is the Health Services employee parking lot, Roosevelt Street, and substantial areas of cleared earth (see Figure A-17d). East of the site is Edison Park, a grassed and landscaped recreational area. To the South are two-level apartment complexes and a paved parking lot. East of the site are several blocks of residential housing.

The most significant apparent sources of suspended particulate matter in the local area consist of entrained dust from motor vehicle activity, and suspension of dust from disturbance of cleared vacant lands in the area. Roosevelt Street, which experiences significant volumes of traffic, is unpaved at the shoulders and susceptible to accumulation of substantial dust loadings. Other streets in the area are also uncurbed, as are many driveways and parking areas.

Except for motor vehicle exhaust, local sources other than fugitive dust probably exert negligible effects on TSP levels at the monitor. Numerous vents on the rooftop of the County building exhaust ventilation and boiler flue gases. The boilers are fired with natural gas and emit negligible quantities of particulates, while gases emitting from ventilation vents contain only minor levels of particulates.

Construction activities are potentially feasible in this area over the long term. Substantial vacant property is available for development, and construction on these properties over the next several years would exert significant effects on dust levels measured at the Hi-vol. Improvements which would occur to nearby streets and vacant areas would ultimately be expected to result in significant reductions in TSP levels at the site.

Representativeness of Monitor

Because the sources immediately surrounding the site are typical of those in the general local area, TSP levels measured at the monitor are considered to be representative of the general area. The site experiences exhaust emissions from numerous parking lots in the area, but these emissions are probably minor relative to the fugitive dust sources which are typical throughout the area. Development in the area, and particularly near the site, could affect the representativeness of air quality measured there, but there are no immediate plans for construction in the nearby areas.

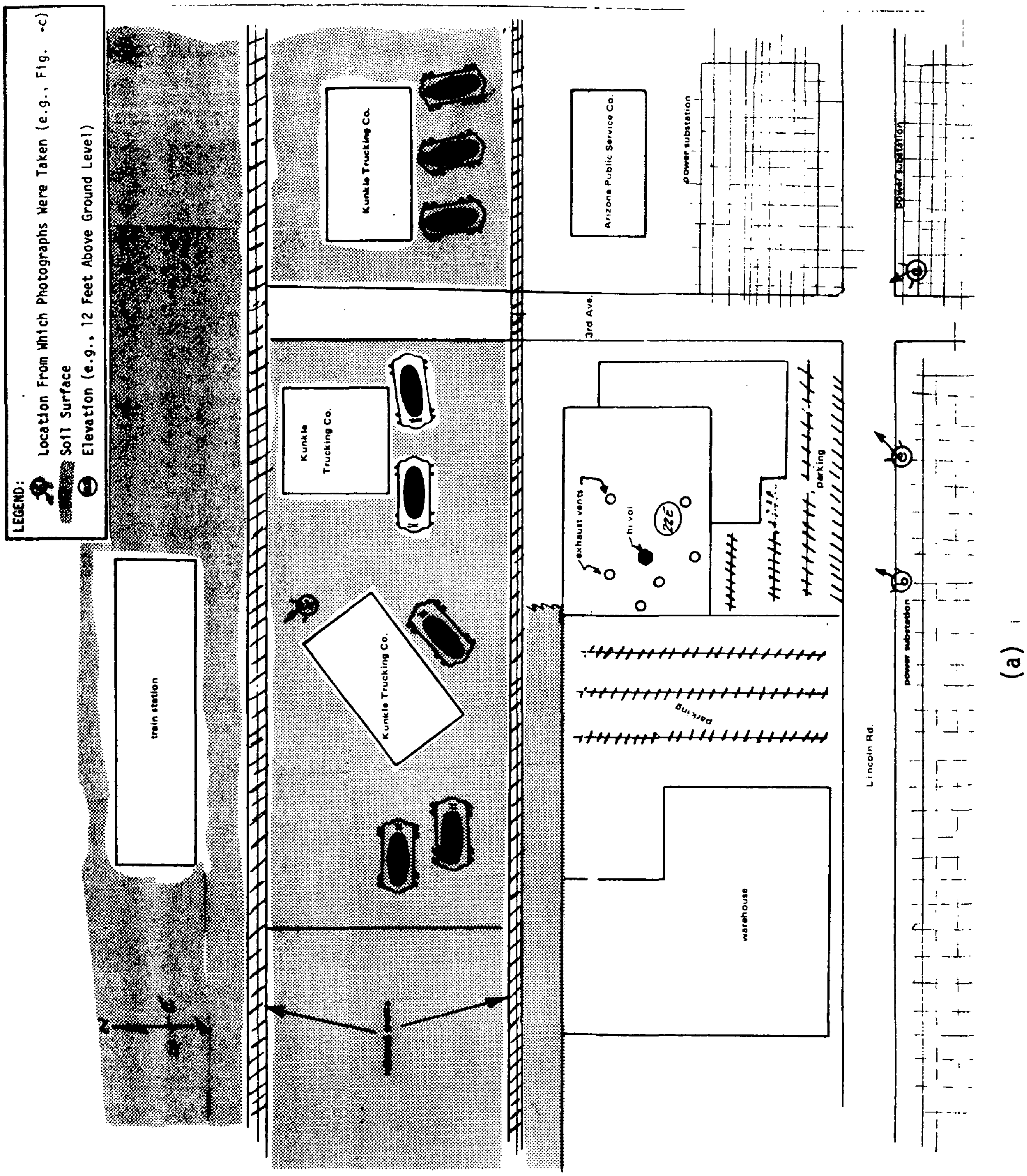
A.17 Downtown Phoenix

The plot description of Figure A-18a shows the orientation of structures, objects, and emission sources in the vicinity of the Hi-Vol at the Downtown Phoenix Site. The Hi-Vol is located on the rooftop of a private corporation (Figure A-18d) about 22 feet above ground level. The monitor is mounted in a conventional housing about 1 1/2 feet above the flat tarpaper roof, and has unobstructed clearance in all directions.

The area immediately surrounding the site is commercial. Directly South of the site is the corporation parking lot (Figure A-18b), and further beyond is Lincoln Road (4 lanes plus curb parking) and an electric power substation. To the east of the site is 3rd Avenue and a portion of the power substation (Figure A-18e). West of the monitor are additional parking areas and a warehouse. North of the monitor are substantial unpaved areas subject to frequent vehicle traffic. Trucks move over fine powder-dirt surfaces on the premises of the Kunkle Trucking Company grounds, generating visible dust clouds throughout the day. Other traffic is responsible for emissions of dust off an unpaved accessway running West of the site adjacent to the railroad tracks. Grounds north of the Trucking Company around the train station (Figure A-18f) are exposed earth, and are subject to occasional foot and motor vehicle traffic.

The most significant apparent sources of suspended particulate matter in the local area are probably related to truck traffic on unpaved truck parking areas at the nearby Kunkle Trucking Company. Other significant sources would consist of the unpaved access road adjacent to the railroad, and entrained dust from heavy street surface loadings in the nearby area.

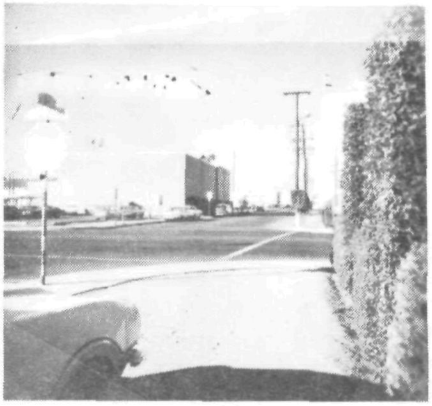
Local sources other than fugitive dust probably exert only minor influence on TSP levels measured at the monitor. Numerous vents on the



(a)

Figure A-18. Downtown Phoenix Site.

b



c

d

e

f

Figure A-18 (Continued). Downtown Phoenix Site.

rooftop of the building exhaust ventilation and boiler flue gases. However, the boilers are fired with natural gas and emit negligible amounts of particulate matter. The most significant conventional source affecting TSP levels is motor vehicle exhaust from traffic activity in the parking lots and nearby streets.

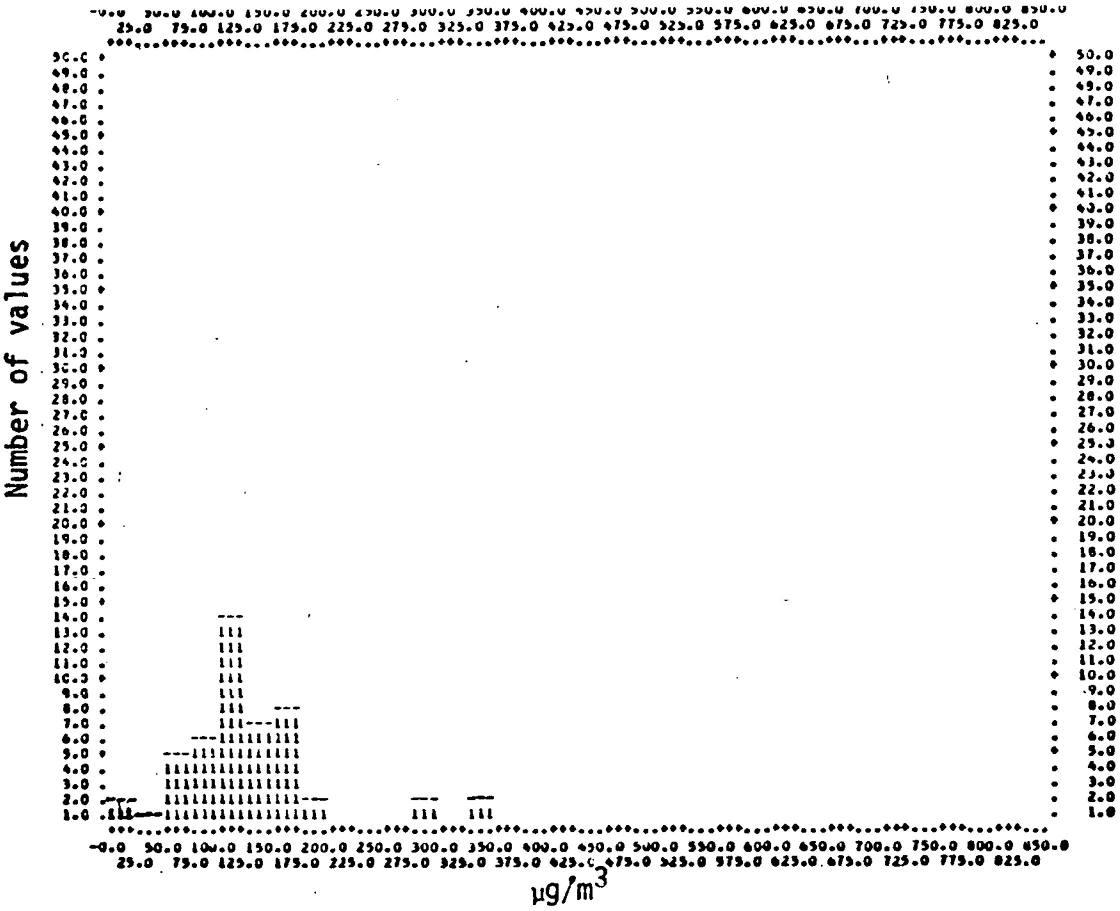
No immediate improvements are planned in the vicinity of the monitor site. Eventual road improvements and paving of truck parking lots are imminent over the long term, and would significantly affect dust levels measured at the Hi-Vol, particularly during Northerly breezes.

Representativeness of Monitor

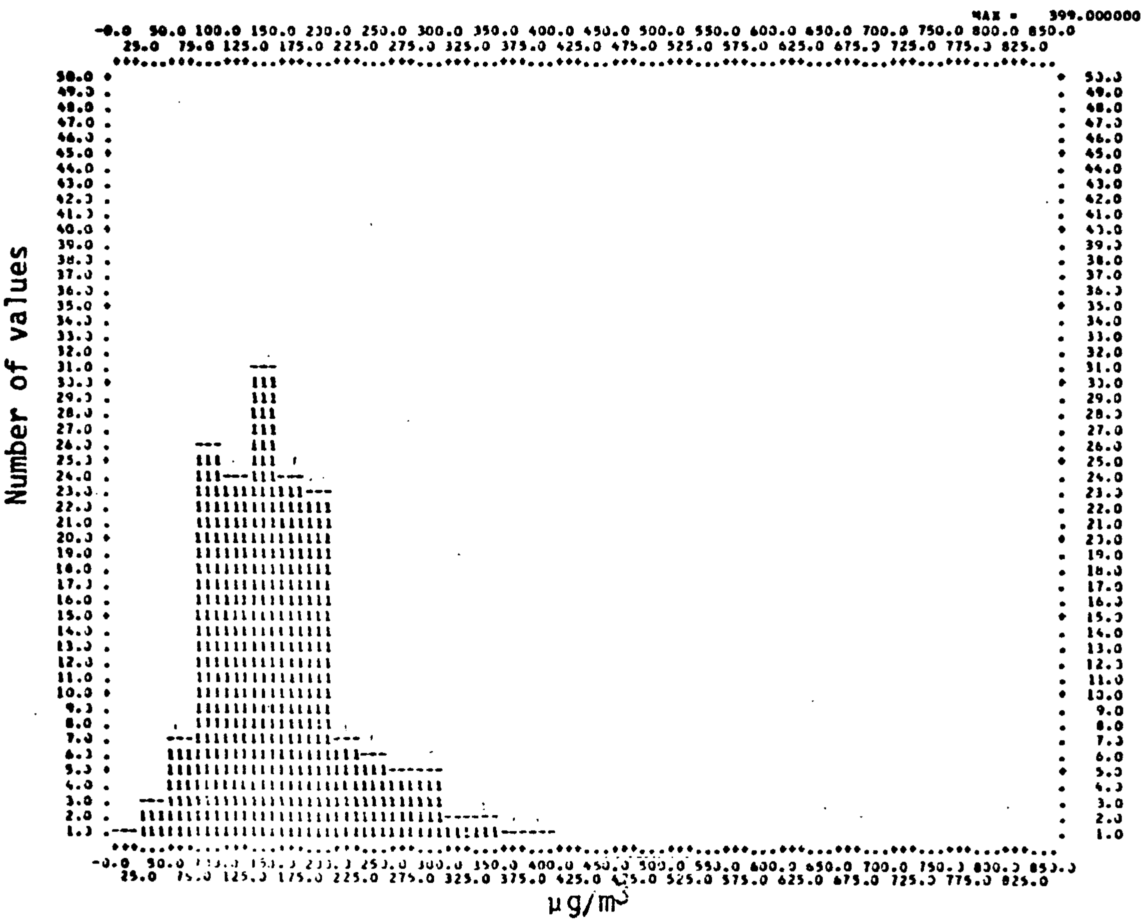
Substantial fugitive dust sources immediately north of the Hi-Vol site tend to limit the representativeness of air quality measured there to site specific values. While the general area contains numerous fugitive dust sources comparable to those directly adjacent to the monitor site, the close proximity of the sources to the Downtown Hi-Vol site probably causes TSP levels there to be significantly higher than typical, or representative levels in the general area. TSP levels at the site are probably especially site specific during Northerly breezes, but dust carryout and local deposition from the nearby fugitive sources may contribute to site specific impact around the monitor for other prevailing wind directions as well. Improvements in nearby roadways and parking lots would probably alter the representativeness of TSP levels at the monitor, however such changes are not planned in the near term.

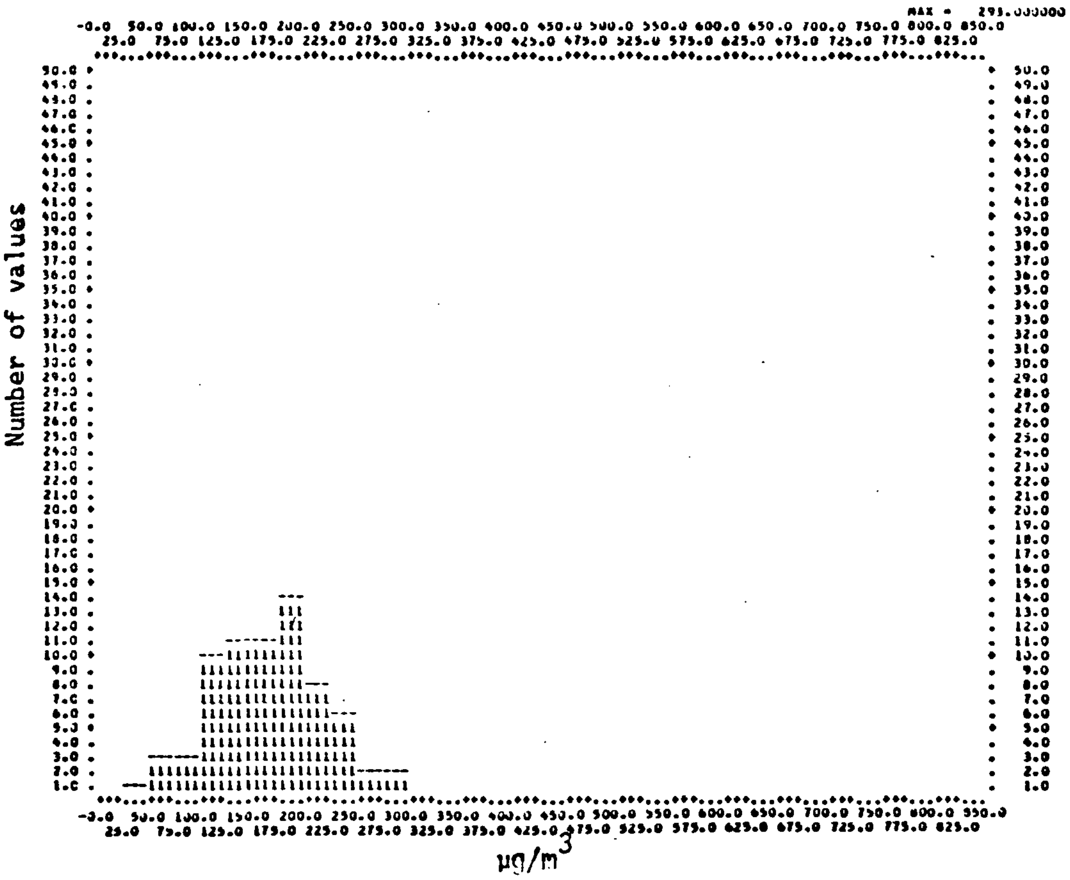
APPENDIX B

HISTOGRAMS OF HI-VOL FREQUENCY DISTRIBUTIONS

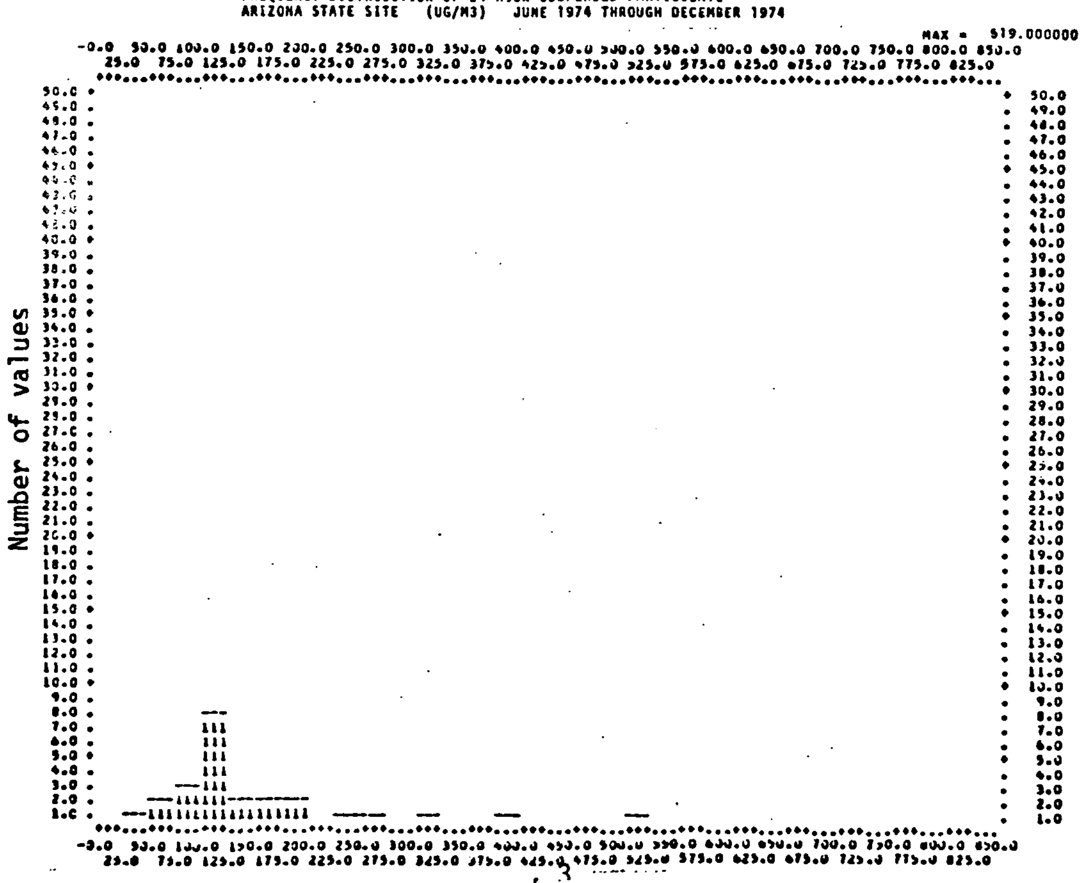


FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE
CENTRAL PHOENIX SITE (UG/M3) JANUARY 1973 THROUGH DECEMBER 1975

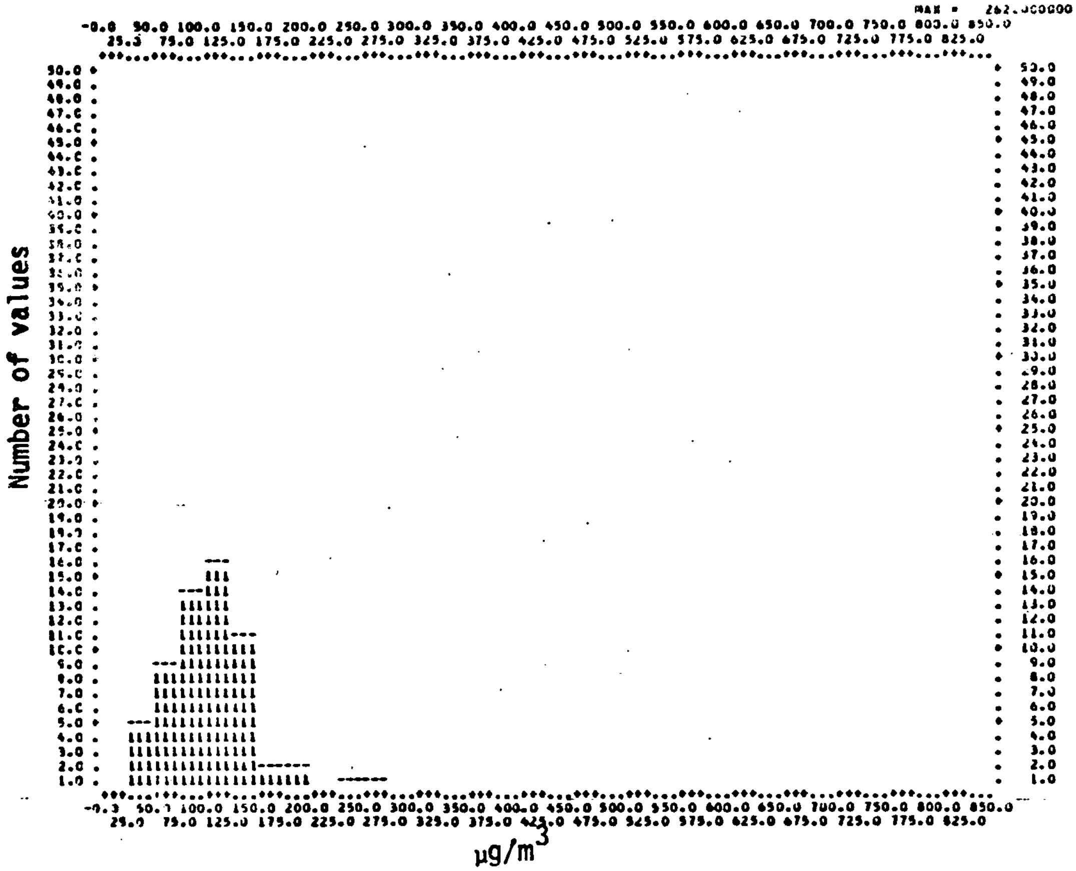




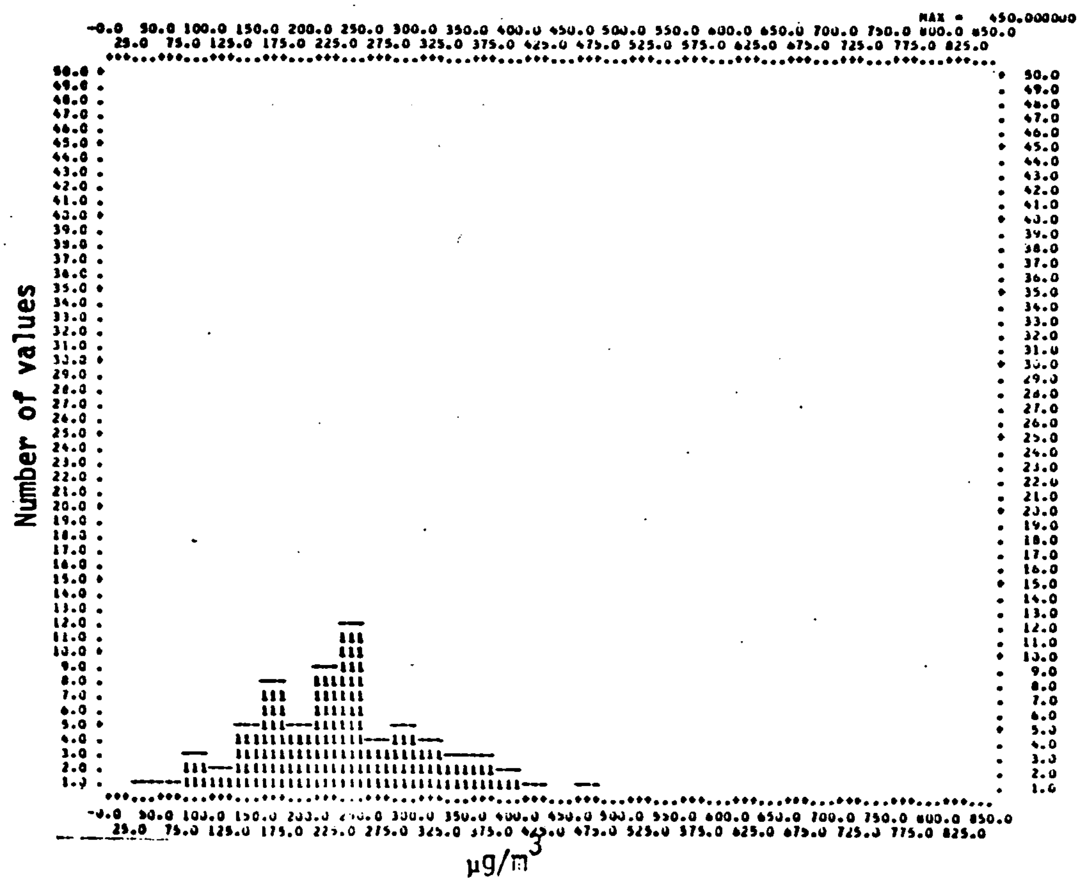
FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE
ARIZONA STATE SITE (UG/M3) JUNE 1974 THROUGH DECEMBER 1974



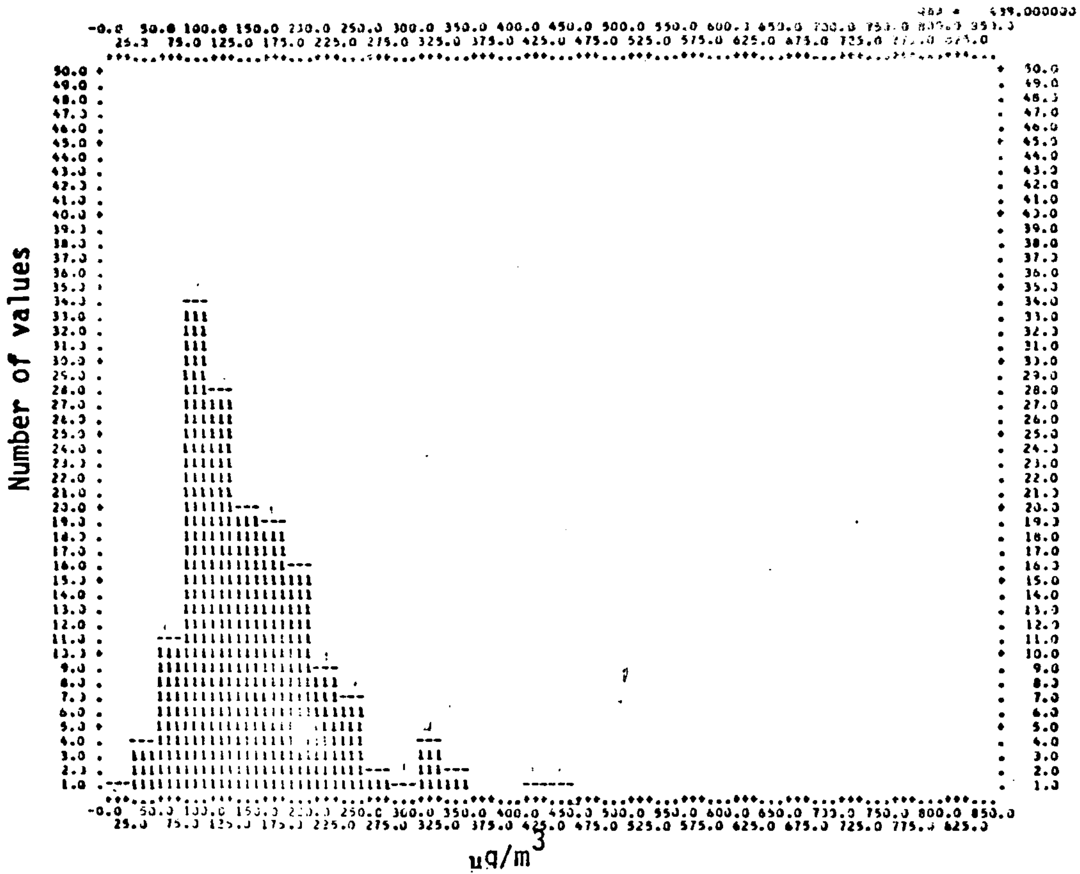
FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE
GLENDALE SITE (UG/M3) JULY 1974 THROUGH DECEMBER 1975



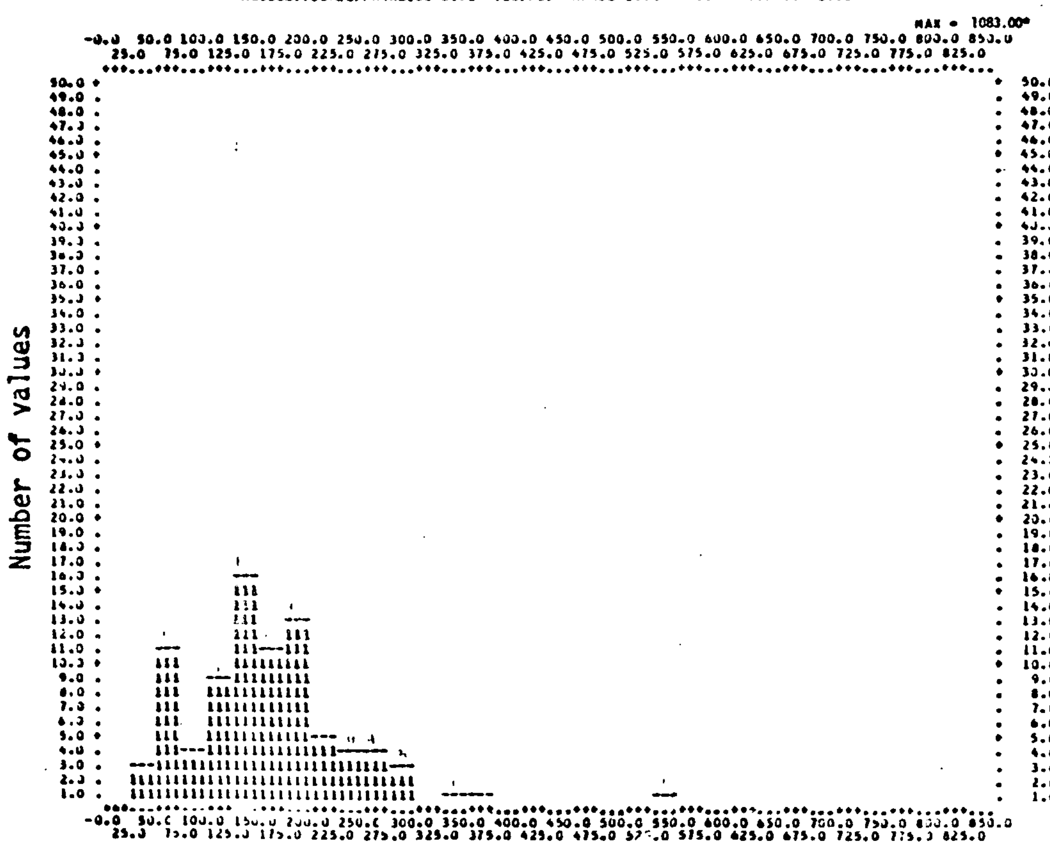
FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE
WEST PHOENIX SITE (UG/M3) JANUARY 1973 THROUGH MAY 1974



FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE
NORTH PHOENIX SITE (UG/M3) JANUARY 1973 THROUGH DECEMBER 1975

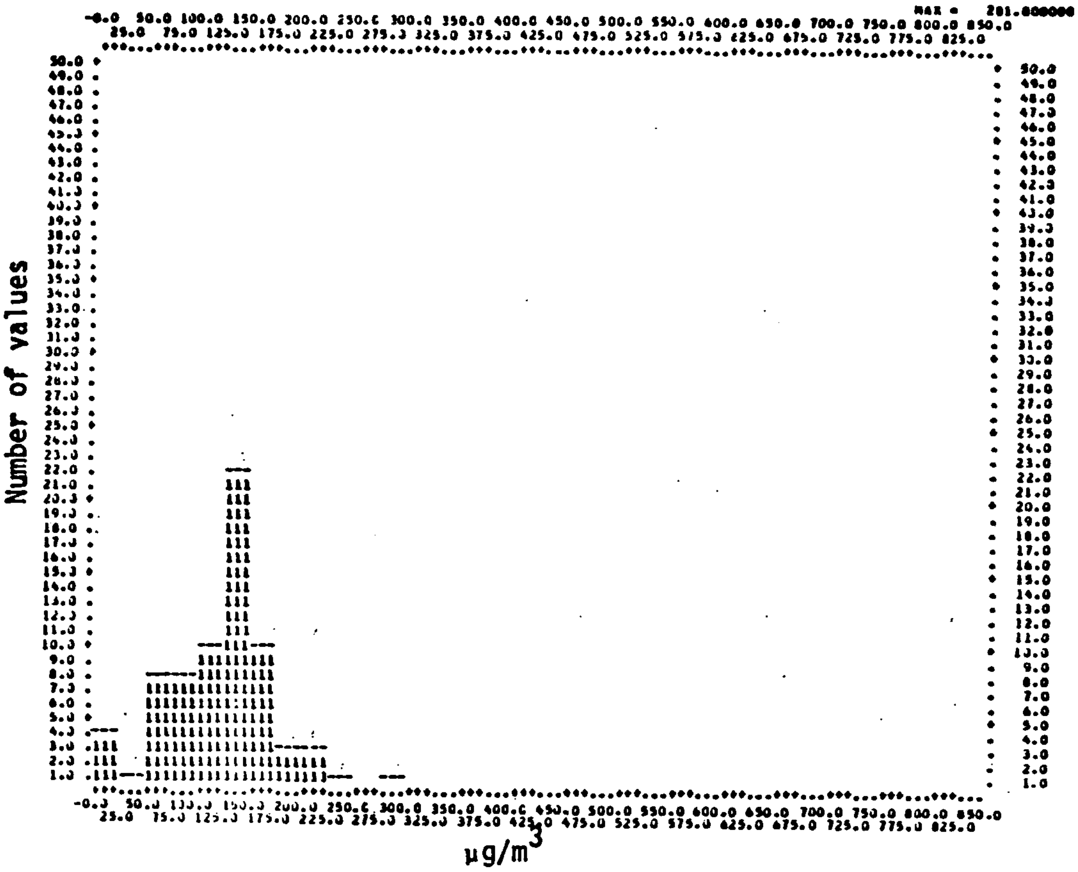


FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE
NO.SCOTTSDALE/PARADISE SITE (UG/M3) APRIL 1974 THROUGH DECEMBER 1975

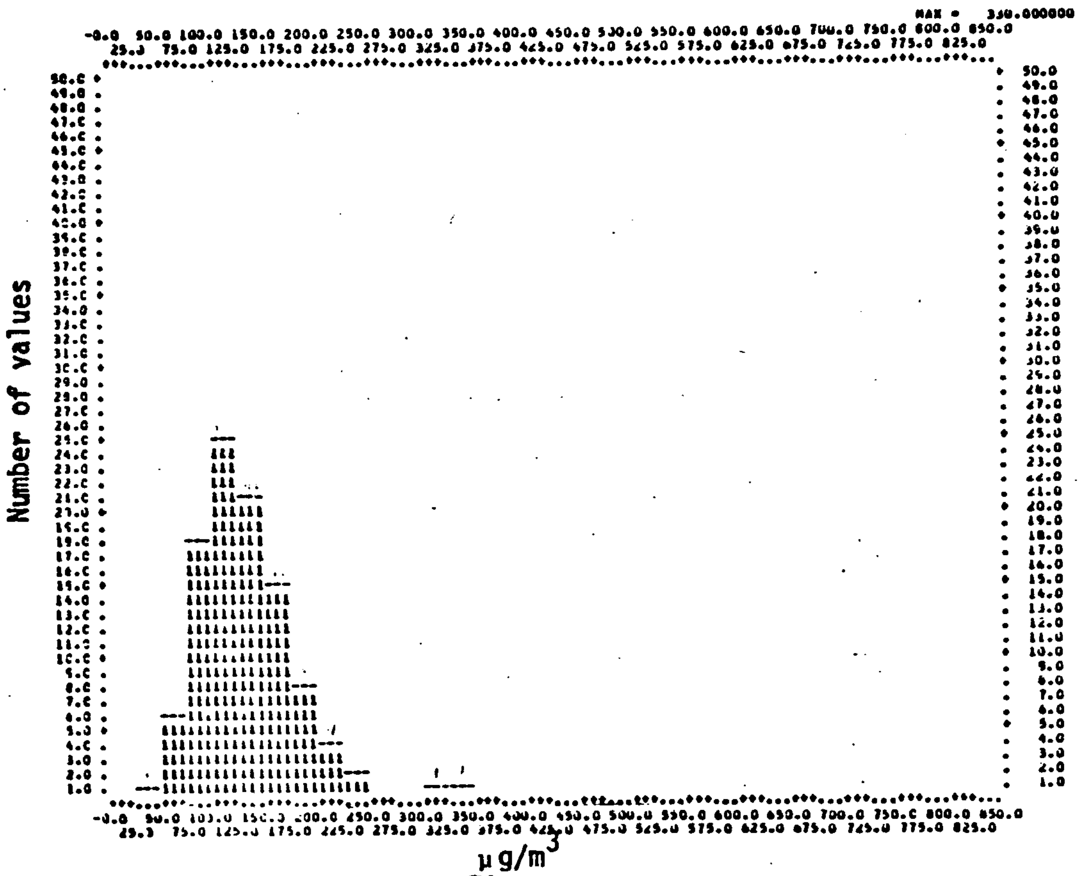


* Maximum observed value is not plotted.

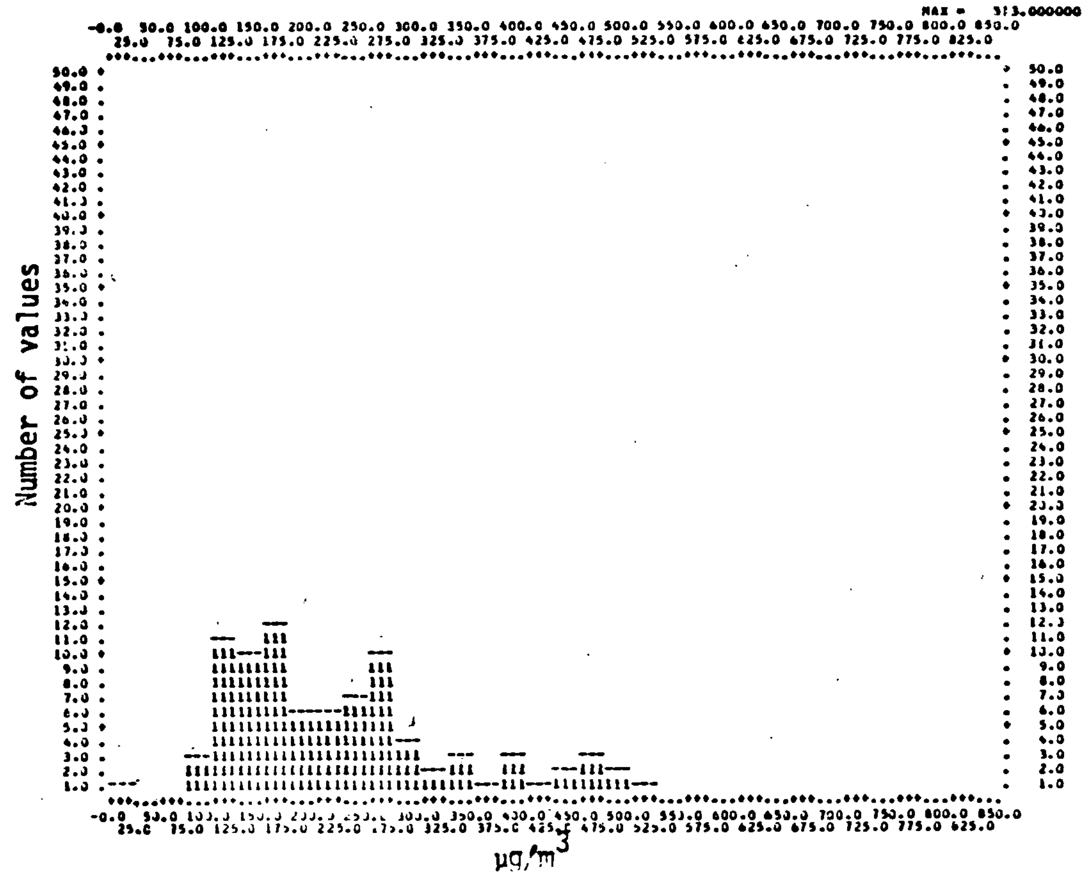
FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE
SCOTTSDALE SITE (UG/M3) AUGUST 1974 THROUGH DECEMBER 1975



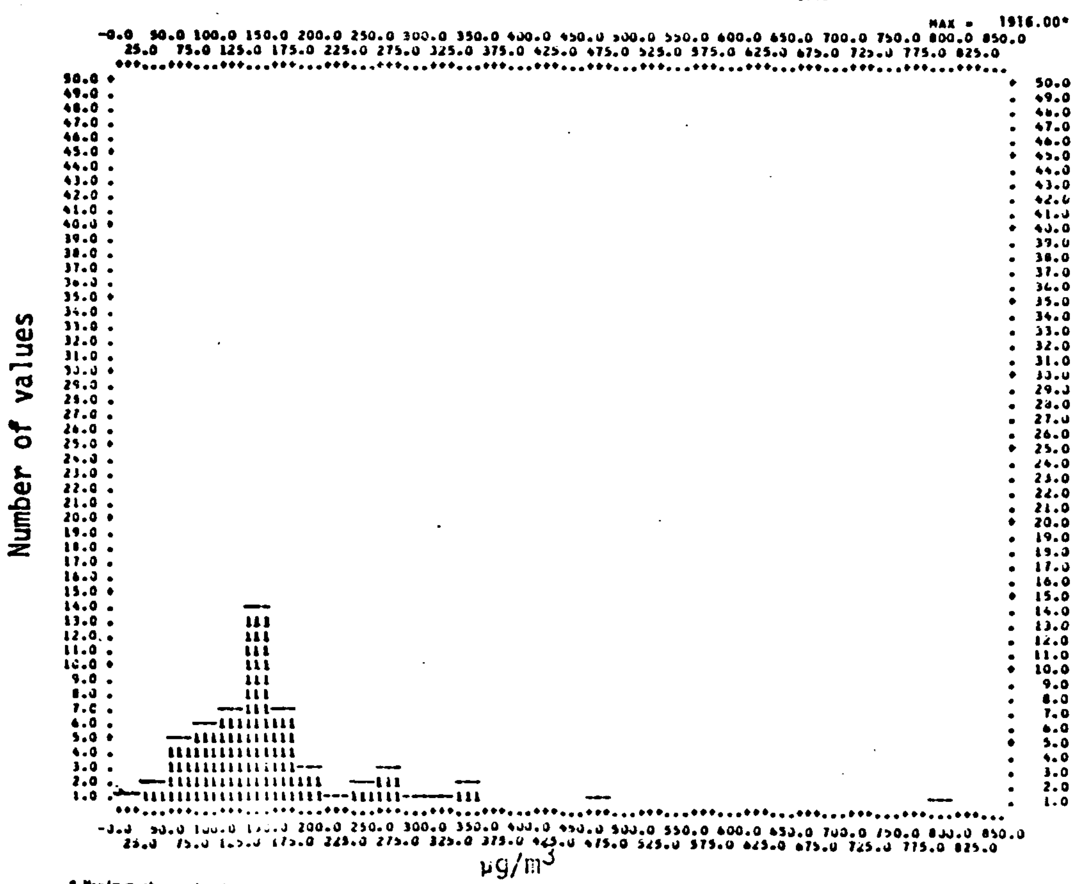
FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE
MESA SITE (UG/M3) FEBRUARY 1974 THROUGH DECEMBER 1975



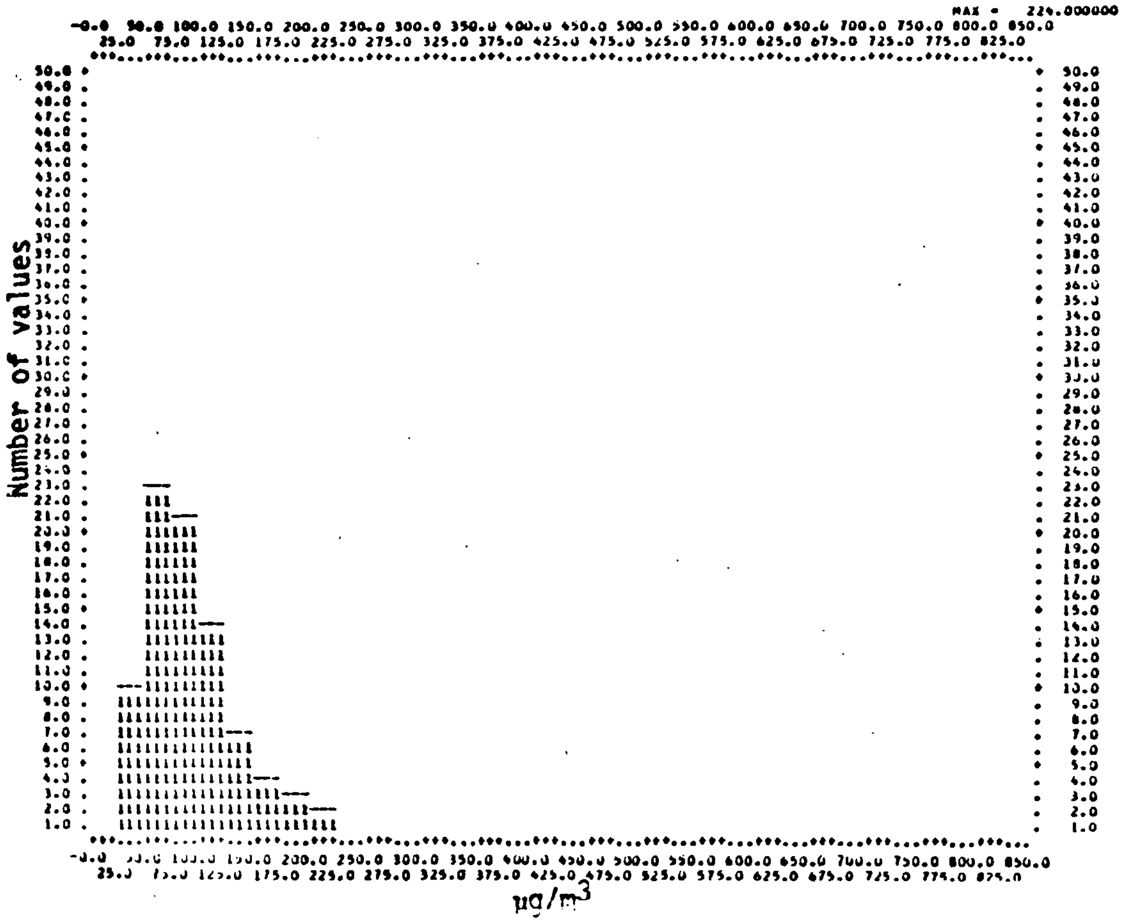
FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE
DOWNTOWN PHOENIX SITE (UG/M3) JUNE 1973 THROUGH FEBRUARY 1975



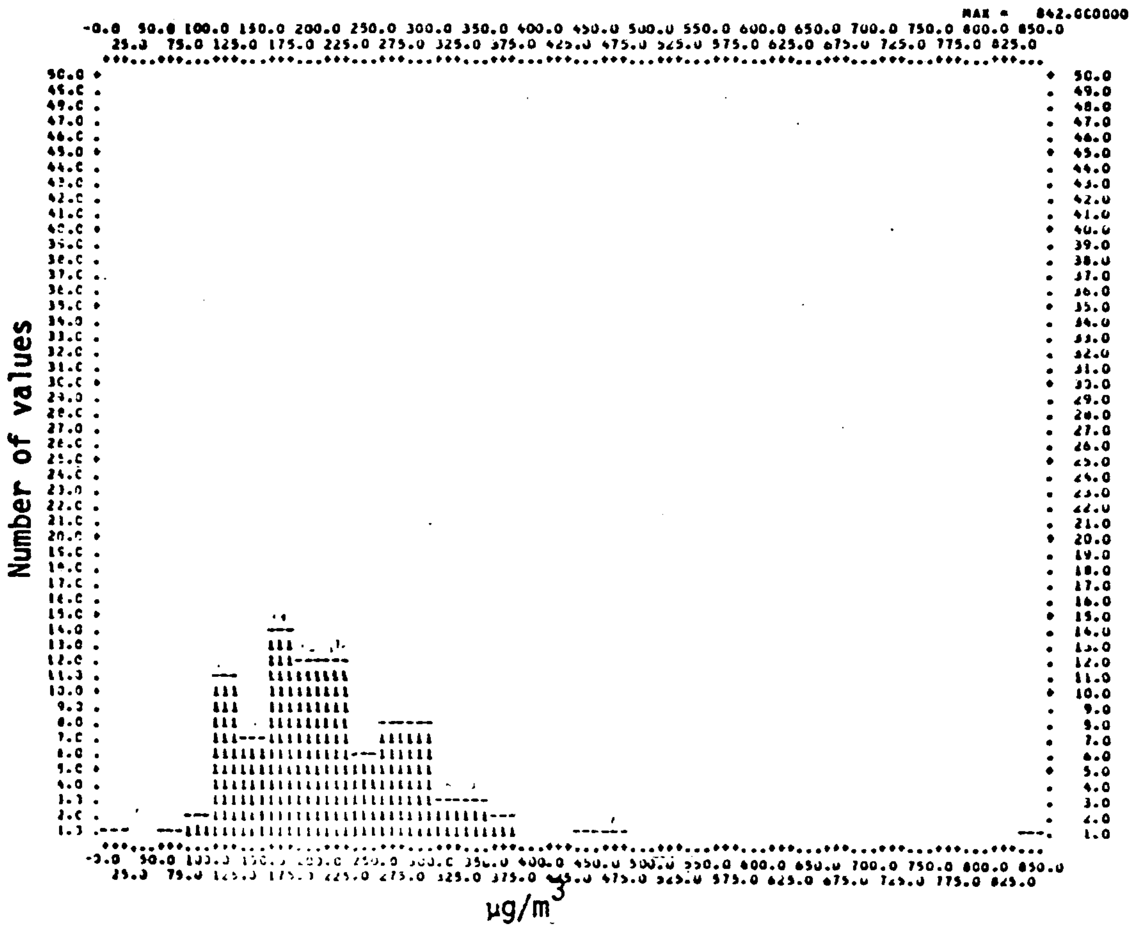
FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE
ST. JOHN'S SITE (UG/M3) JANUARY 1975 THROUGH DECEMBER 1975



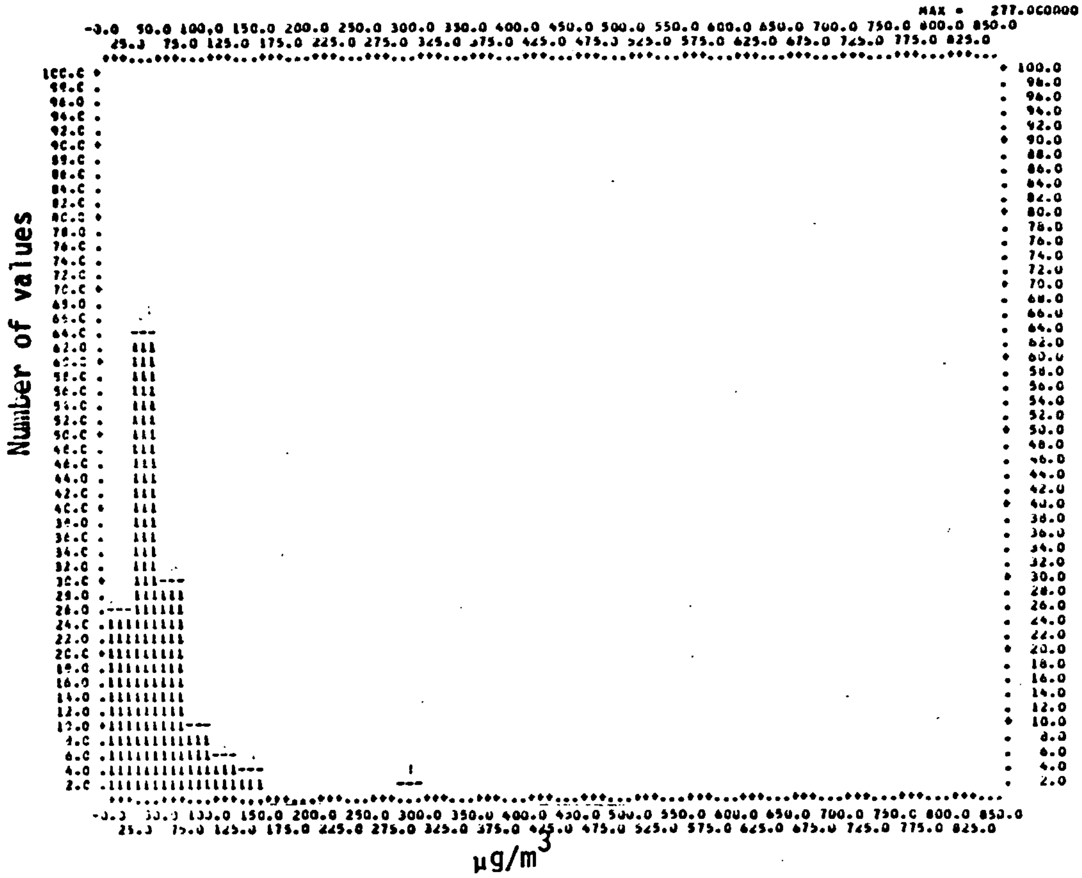
* Maximum observed value (1916 ug/m³) and 2nd highest value (1082 ug/m³) are not plotted.



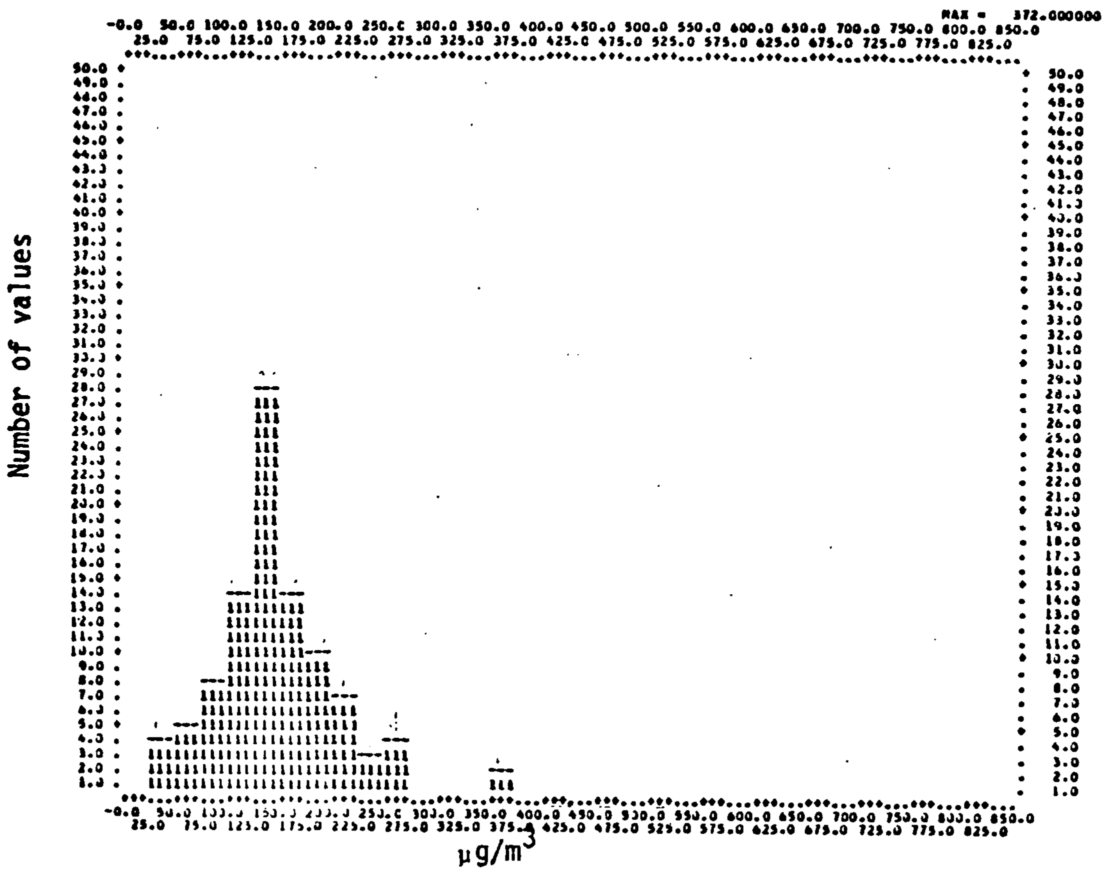
FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE
PARADISE SITE (UG/M3) JUNE 1973 THROUGH MARCH 1975



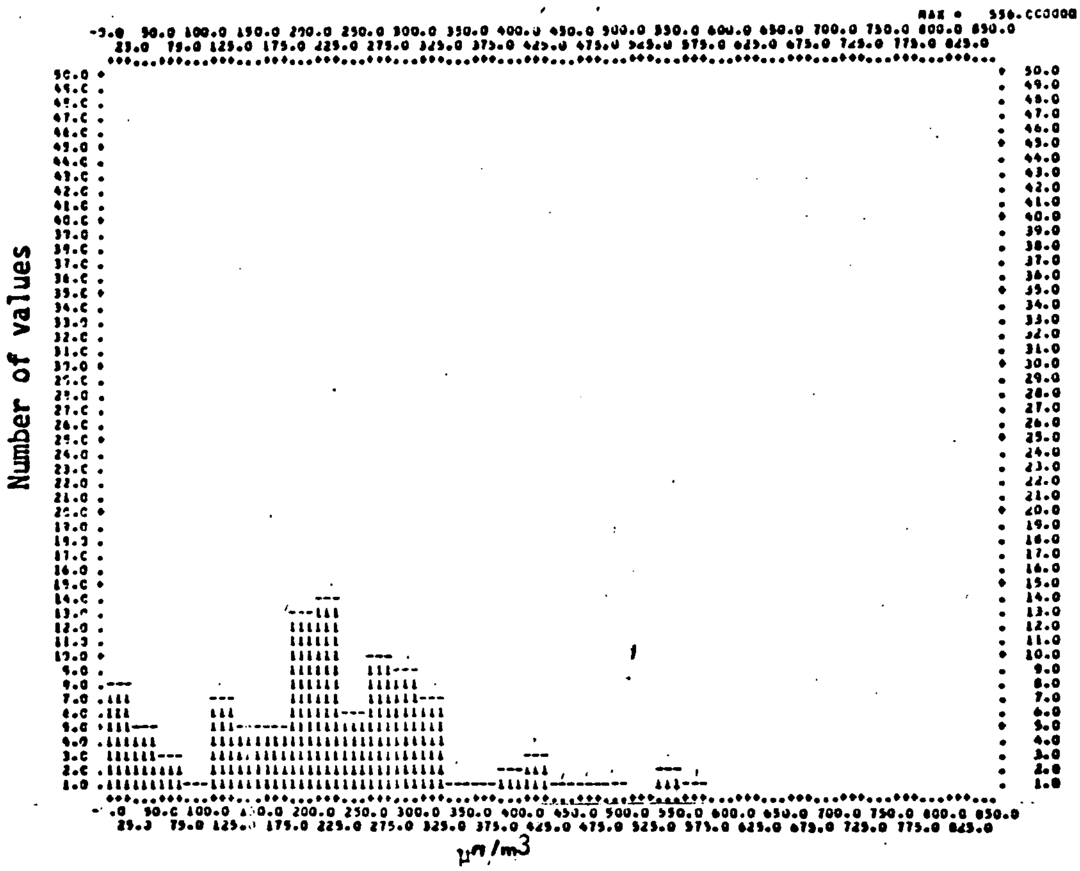
FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE
CAREFREE SITE (UG/M3) JUNE 1973 THROUGH DECEMBER 1975



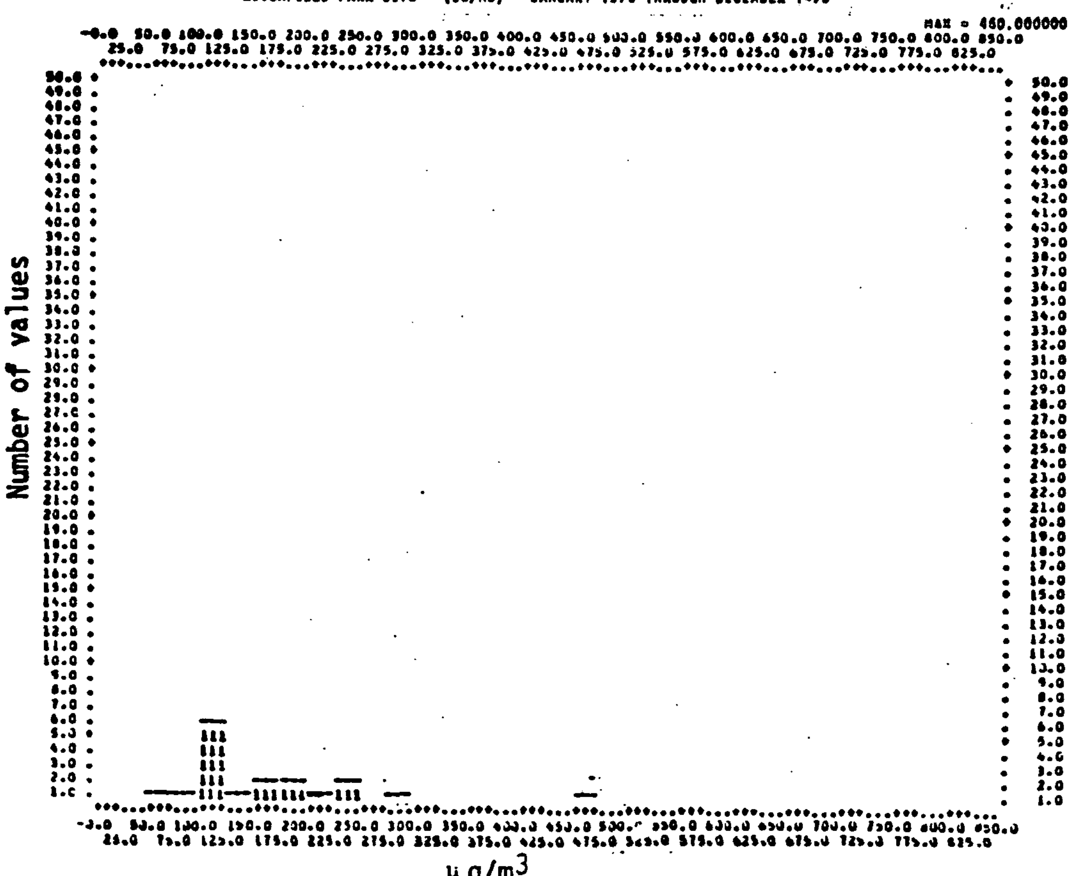
FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE
CHANDLER SITE (UG/M3) JUNE 1973 THROUGH MARCH 1975



FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE
GUADALUPE SITE (UG/M3) JAN 74 THROUGH DECEMBER 1975



FREQUENCY DISTRIBUTION OF 24-HOUR SUSPENDED PARTICULATE
LITCHFIELD PARK SITE (UG/M3) JANUARY 1975 THROUGH DECEMBER 1975



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16. ABSTRACT

This document is one volume of a four-volume report presenting an implementation plan for control of suspended particulate matter in the Phoenix area.

17. KEY WORDS AND DOCUMENT ANALYSIS

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Particulate Matter Total Suspended Particulate Fugitive Dust Air Quality Measurements		

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