

AIR QUALITY REPORT FOR PROPOSED
I 69 FROM I 96 TO US 27



MICHIGAN DEPARTMENT OF STATE HIGHWAYS

AIR QUALITY REPORT FOR PROPOSED
I 69 FROM I 96 TO US 27

Research Laboratory Section
Testing and Research Division
Research Project 74 TI-220
Research Report No. R-929

Michigan State Highway and Transportation Commission
E. V. Erickson, Chairman; Charles H. Hewitt,
Vice-Chairman, Carl V. Pellonpaa, Peter B. Fletcher
John P. Woodford, Director
Lansing, July 1974

This report presents air quality information for a proposed section of I 69 in southwestern Clinton County as shown in Figure 1. Meteorological data, and estimates of pollution levels that might occur adjacent to the roadway should it be constructed, are included.

Terrain and Demography

The terrain surrounding this project is flat to gently rolling, so that dispersion of air pollutants is facilitated. The population of Clinton County is only 21 percent urban with a population density of 85 per square mile. Clinton County is part of the Tri-County region of central Michigan centered around the city of Lansing. The population of the Lansing Metropolitan Area is 378,000 according to the 1970 census.

Meteorology

Michigan lies in the normal track of migrating high and low pressure centers at all times of the year. This results in great variation in day to day weather. Frequent changes in wind speed and direction are experienced. Even on occasions when an atmospheric inversion restricts vertical dispersion of pollutants, horizontal dispersion continues freely. Figure 2 shows a 36-point bar graph of wind speed and direction occurrences at Capital City Airport (Lansing). Hourly weather data were obtained from the National Climatic Center at Asheville, N. C. for the years 1967 through 1971 and a one day in three day sampling of the hourly data with a random start each year was used to prepare meteorological data. Figure 3 is a 12-point wind rose obtained by condensing the 36-point wind data.

Figure 4 shows the distribution of wind speeds observed. Wind speeds are greater than 5 mph more than 90 percent of the time. The most probable daytime wind speed was found to be 11 mph. Atmospheric mixing depths generally range between 500 and 1,200 meters (547 to 1,300 yd), which is very favorable for vertical dispersion of pollutants.

Existing Ambient Air Quality

No data are available to establish presently existing air quality in the area of this project.

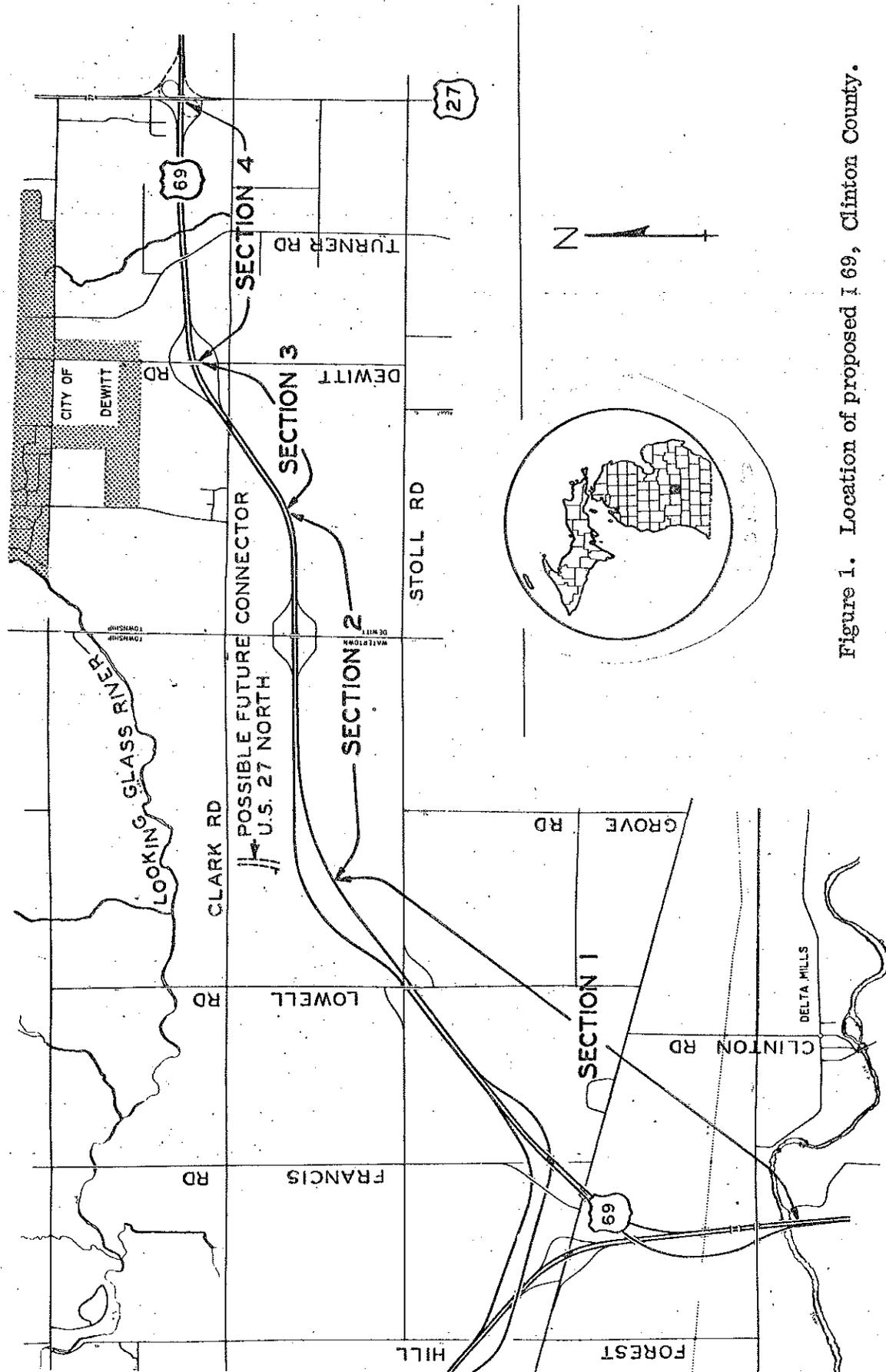


Figure 1. Location of proposed I 69, Clinton County.

Pollution Estimates

Estimates of pollutant concentrations at a height of 1.5 meters (5 ft) above the ground were made for carbon monoxide and nitrogen oxides as nitrogen dioxide under various wind conditions. A mathematical model based on the Gaussian diffusion equation, modified for a line source, was used¹. This model has been accepted by the Federal Highway Administration and the Federal Environmental Protection Agency. Inputs to the model include meteorological conditions, traffic volumes, vehicle emission factors, and design of the highway.

Vehicle emission factors shown in the following table were calculated using procedures from "Compilation of Air Pollutant Emission Factors," AP 42, 2nd edition, U. S. Environmental Protection Agency, April 1973 and interim light duty vehicle standards promulgated by the EPA administrator in September 1973.

EMISSION FACTORS (g/mile at 55 mph)

Carbon Monoxide

| Year | 7 Percent Commercial Vehicles | 8 Percent Commercial Vehicles |
|------|----------------------------------|----------------------------------|
| 1980 | 10.0 | 10.5 |
| 1985 | 5.8 | 6.3 |
| 2000 | 5.2 | 5.8 |

Oxides of Nitrogen

| Year | 7 Percent Commercial Vehicles | 8 Percent Commercial Vehicles |
|------|----------------------------------|----------------------------------|
| 1980 | 3.5 | 3.6 |
| 1985 | 1.9 | 2.0 |
| 2000 | 1.7 | 1.8 |

¹ Beaton, J. L., Ranzieri, A. J., Shirley, E. C., and Skog, J. B., "Mathematical Approach to Estimating Highway Impact on Air Quality," Prepared by California Division of Highways, National Technical Information Service, Report No. FHWA-RD-72-36.

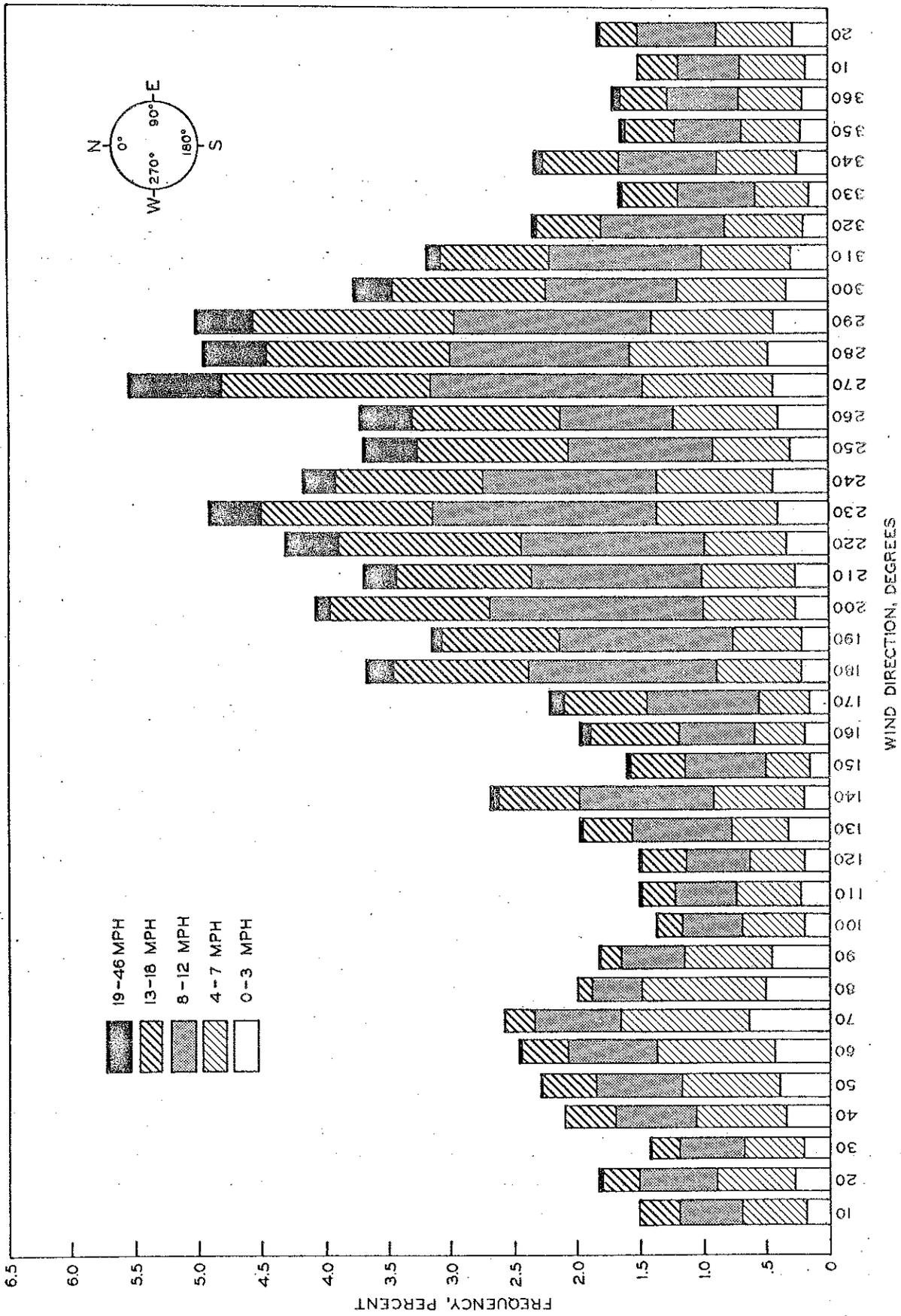


Figure 2. Wind speed and direction occurrences at Capital City Airport (Lansing).

Pollution concentrations were estimated for:

1) Four representative sections which covered the length of the project. See Figure 1 for the location of the sections which are identified as follows:

| Section | Location |
|---------|---------------------------------------|
| 1 | I 96 to Lowell Rd (near) |
| 2 | Lowell Rd (near) to Schavey Rd (near) |
| 3 | Schavey Rd (near) to DeWitt Rd |
| 4 | DeWitt Rd to US 27 |

2) The years 1980, 1985, and 2000.

3) The area above the pavement (mixing cell).

Information used as input to the model consisted of:

1) Estimated peak p.m. (4:30 to 5:30) and off-peak traffic volumes. Traffic estimates are shown in Table 1. Off-peak traffic was taken as 4 percent of ADT.

2) Meteorological Conditions

a) Worst meteorological conditions, which will seldom occur according to meteorological records, were taken as a 3 mph wind parallel to the roadway, under atmospheric stability class F. Parallel wind buildup distances used were: Section 1) 20,450 ft; Section 2) 11,050 ft; Section 3) 5,500 ft; Section 4) 9,450 ft.

b) Most probable meteorological conditions (shown in data tables) were chosen for the time of day involved, and the overall most likely stability class (D) was used. Table 2 shows the frequency distribution of atmospheric stability classes for the meteorological data used.

3) Road profile. All sections are at grade.

4) Width of all sections, two 24-ft roadways with 10-ft shoulders, separated by a variable (94-ft minimum) median.

All estimates of pollution levels represent maximum one hour concentrations and are in addition to existing background levels. Table 3 presents

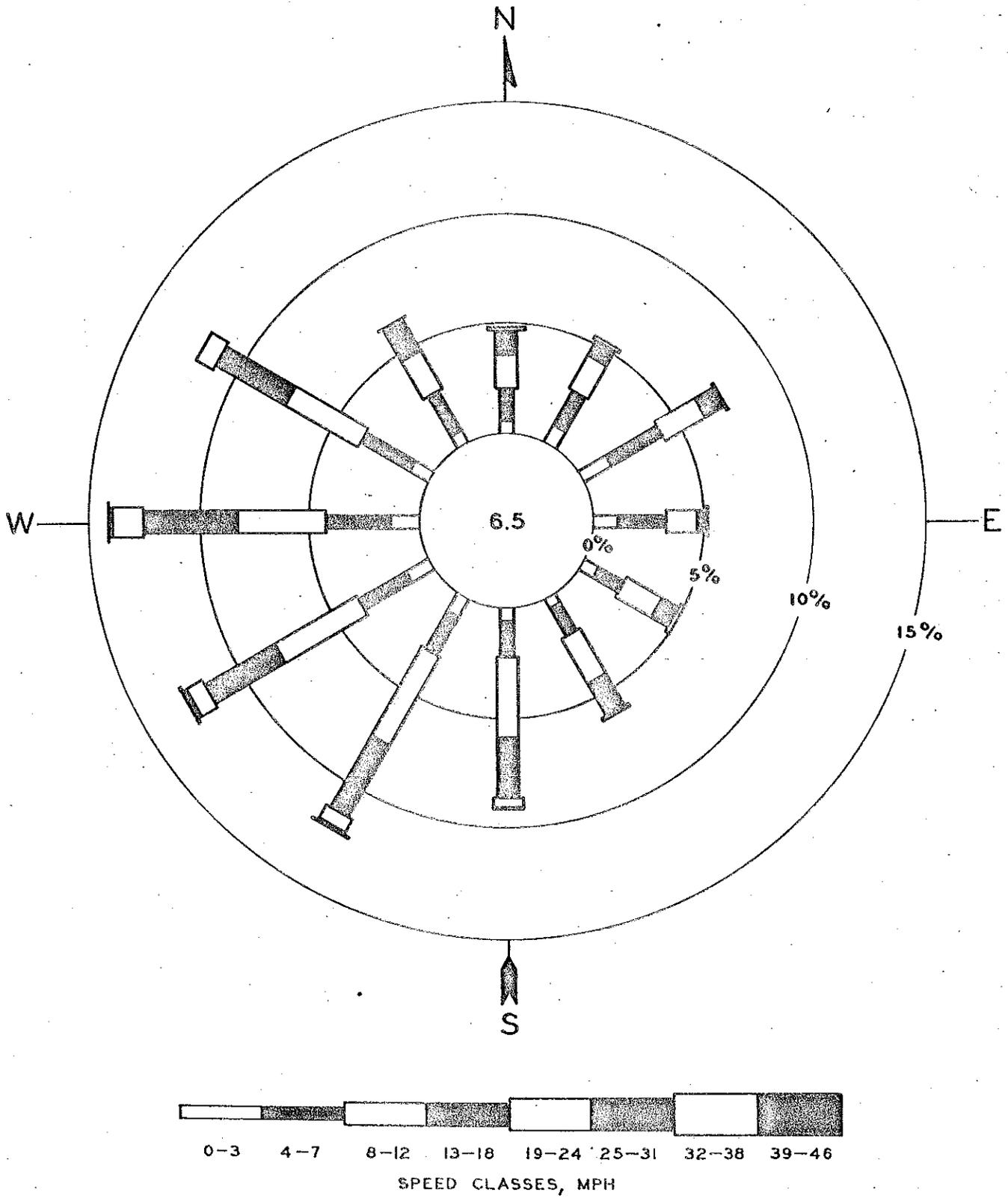


Figure 3. Wind speed and direction occurrences at Capital City Airport (Lansing).

estimates of pollutant levels for carbon monoxide and nitrogen dioxides in the area over the highway (mixing cell). Nitrogen oxide data are included as information only. There is no emission factor for nitrogen dioxide as such, so no comparison of the estimates with an air quality standard is possible.

Pollution estimates are calculated based on the present speed limit (55 mph). Should speed limits be increased to the previous 70 mph limit then pollution levels will decrease by 9 percent.

Federal air quality standards for carbon monoxide and nitrogen dioxide are:

CO: (a) 10 mg/cu m (9 ppm) maximum 8 hr average concentration not to be exceeded more than once per year.

(b) 40 mg/cu m (36 ppm) maximum 1 hr concentration not to be exceeded more than once per year.

NO₂: 100 µg/cu m (0.05 ppm) annual arithmetic mean.

The estimated concentrations of carbon monoxide on and near the proposed roadway are low. No adverse environmental effects are expected. The project is consistent with the state implementation plan for meeting air quality standards.

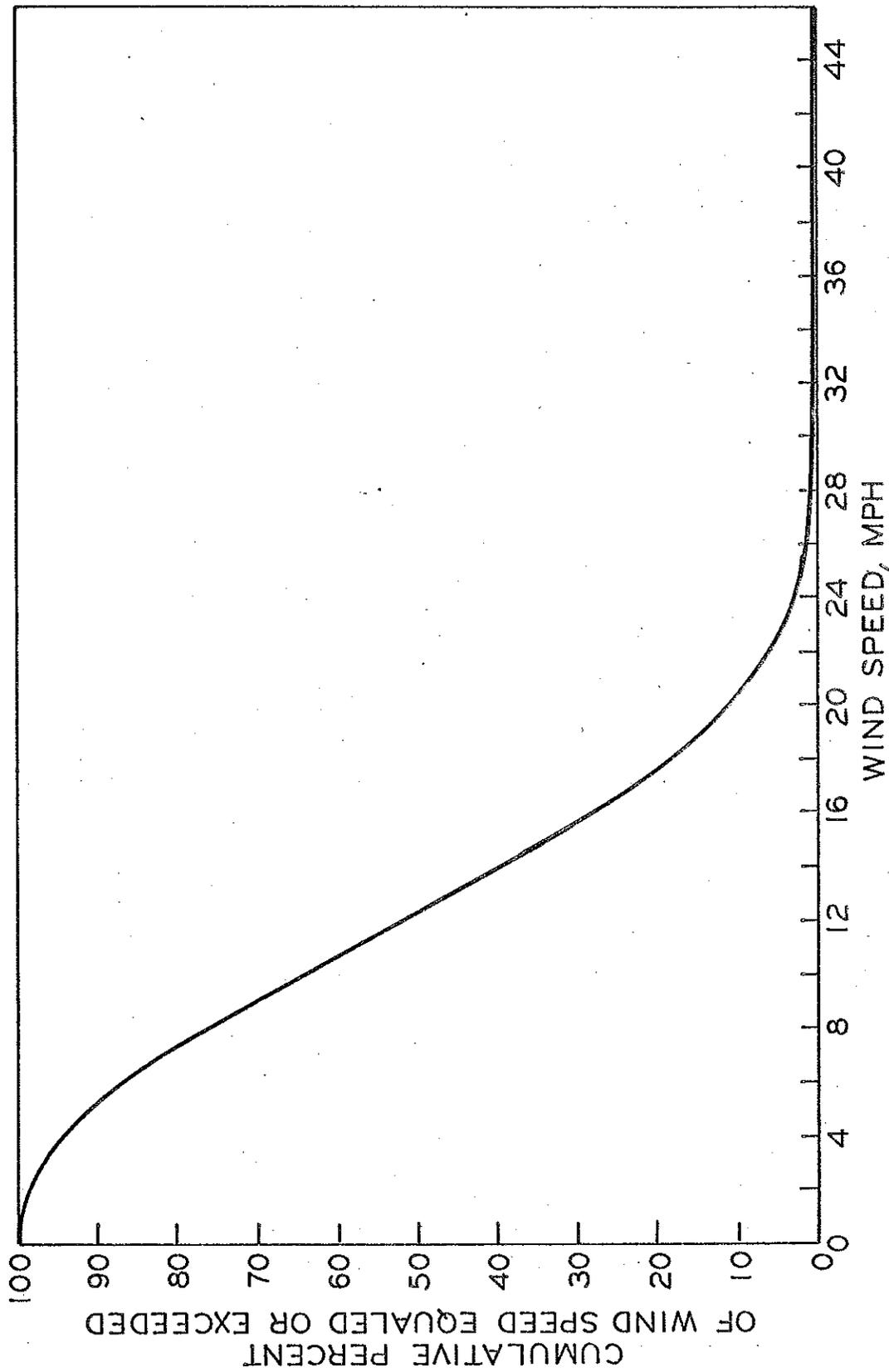


Figure 4. Distribution of wind speeds at Capital City Airport (Lansing).

TABLE 1
 TRAFFIC ESTIMATES FOR PROPOSED I 69
 (Total Traffic in Both Directions)

| Year | Section 1 | Sections 2 & 3 | Section 4 |
|------|------------------------------|------------------------------|------------------------------|
| 1980 | 18,800 <1,696> [752] | 23,000 <2,060> [900] | 25,900 <2,328> [1,036] |
| 1985 | 21,800 <1,966> [872] | 26,700 <2,404> [1,068] | 30,000 <2,700> [1,200] |
| 2000 | 31,000 <2,790> [1,240] | 37,600 <3,382> [1,504] | 41,800 <3,766> [1,672] |

All Speeds - 55 mph

Peak Duration - variable, around 1 hour

Commercial Vehicles:

7 percent of peak

8 percent of off-peak

000 = Average Daily Traffic (24 hr avg.)

<000> = Peak Traffic (vehicles per hr)

[000] = Off-Peak (vehicles per hr)

TABLE 2
 STABILITY CLASS FREQUENCY DISTRIBUTION BY HOUR
 (Percent)

| Hour | Stability Class | | | | | |
|--------------------|-----------------|------|------|------|------|------|
| | A | B | C | D | E | F |
| 1 | 0.0 | 0.0 | 0.0 | 51.7 | 18.9 | 29.5 |
| 2 | 0.0 | 0.0 | 0.0 | 50.8 | 18.2 | 31.0 |
| 3 | 0.0 | 0.0 | 0.0 | 48.8 | 18.2 | 32.9 |
| 4 | 0.0 | 0.0 | 0.0 | 48.5 | 20.2 | 31.3 |
| 5 | 0.0 | 0.0 | 0.0 | 50.7 | 19.5 | 29.8 |
| 6 | 9.3 | 6.5 | 5.0 | 48.0 | 12.4 | 18.9 |
| 7 | 10.4 | 14.9 | 10.8 | 47.7 | 6.1 | 10.1 |
| 8 | 8.3 | 16.2 | 16.7 | 52.8 | 3.1 | 2.8 |
| 9 | 6.6 | 13.6 | 24.7 | 55.1 | 0.0 | 0.0 |
| 10 | 3.6 | 14.7 | 21.2 | 60.4 | 0.0 | 0.0 |
| 11 | 4.1 | 12.4 | 21.7 | 61.8 | 0.0 | 0.0 |
| 12 | 4.5 | 10.6 | 21.4 | 63.6 | 0.0 | 0.0 |
| 13 | 3.3 | 10.4 | 19.9 | 66.4 | 0.0 | 0.0 |
| 14 | 3.6 | 10.4 | 21.2 | 64.7 | 0.0 | 0.0 |
| 15 | 3.5 | 10.8 | 20.4 | 65.4 | 0.0 | 0.0 |
| 16 | 3.6 | 11.9 | 19.0 | 62.6 | 2.0 | 0.8 |
| 17 | 3.5 | 10.9 | 17.9 | 59.6 | 5.6 | 2.5 |
| 18 | 4.6 | 6.1 | 12.4 | 57.0 | 10.8 | 9.1 |
| 19 | 0.0 | 0.0 | 0.0 | 60.8 | 21.4 | 17.9 |
| 20 | 0.0 | 0.0 | 0.0 | 53.8 | 20.2 | 26.0 |
| 21 | 0.0 | 0.0 | 0.0 | 51.0 | 20.4 | 28.6 |
| 22 | 0.0 | 0.0 | 0.0 | 50.8 | 17.9 | 31.3 |
| 23 | 0.0 | 0.0 | 0.0 | 50.7 | 19.5 | 29.8 |
| 24 | 0.0 | 0.0 | 0.0 | 51.7 | 19.2 | 29.1 |
| Overall percent | 2.9 | 6.2 | 9.8 | 55.6 | 10.6 | 15.1 |

TABLE 3
ESTIMATES OF MIXING CELL CONCENTRATIONS¹

| Location | Traffic Projection Year | CO (mg/cu m) | | | NOx (µg/cu m) | | | | |
|----------|-------------------------|--|------------------|--|--|------------------|--|------------------|----|
| | | Worst Condition Stability F, Parallel 3 mph Wind | | Most Probable Condition ² Stability D | Worst Condition Stability F, Parallel 3 mph Wind | | Most Probable Condition ² Stability D | | |
| | | Peak Traffic | Off Peak Traffic | Peak Traffic | Peak Traffic | Off Peak Traffic | Peak Traffic | Off Peak Traffic | |
| 1 | 1980 | 1.8 | 0.5 | 0.4 | 0.1 | 611 | 189 | 125 | 19 |
| | 1985 | 1.3 | 0.4 | 0.3 | * | 407 | 123 | 83 | 13 |
| | 2000 | 1.6 | 0.5 | 0.3 | * | 514 | 153 | 105 | 16 |
| 2 | 1980 | 2.0 | 0.6 | 0.4 | 0.1 | 679 | 207 | 122 | 46 |
| | 1985 | 1.4 | 0.4 | 0.2 | 0.1 | 453 | 137 | 81 | 30 |
| | 2000 | 2.8 | 0.5 | 0.3 | 0.1 | 568 | 170 | 102 | 39 |
| 3 | 1980 | 2.1 | 0.6 | 0.4 | 0.1 | 699 | 212 | 143 | 23 |
| | 1985 | 1.4 | 0.4 | 0.3 | * | 468 | 140 | 96 | 15 |
| | 2000 | 1.8 | 0.5 | 0.4 | 0.1 | 586 | 175 | 120 | 19 |
| 4 | 1980 | 2.4 | 0.7 | 0.4 | 0.2 | 821 | 256 | 122 | 67 |
| | 1985 | 1.7 | 0.5 | 0.2 | 0.1 | 548 | 165 | 81 | 44 |
| | 2000 | 2.2 | 0.6 | 0.3 | 0.2 | 680 | 203 | 101 | 48 |

¹ All vehicle speeds are 55 mph.

² Angle between roadway direction and wind direction, off peak (speed 11 mph) - Sections 1 and 3, 40°; Section 2, 5°; Section 4, 0°; peak (speed 9 mph) - Sections 1 and 3, 0°; Section 2, 35°; Section 4, 40°.

* Value less than 0.1.