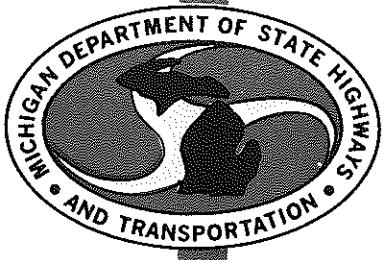
AIR QUALITY REPORT FOR I 69 IN INGHAM, CLINTON, AND SHIAWASSEE COUNTIES



TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION

AIR QUALITY REPORT FOR I 69 IN INGHAM, CLINTON, AND SHIAWASSEE COUNTIES

Research Laboratory Section
Testing and Research Division
Research Project 78 AP-21A
Research Report No. R-1092

Michigan State Highway Commission
Peter B. Fletcher, Chairman; Carl V. Pellonpaa,
Vice-Chairman; Hannes Meyers, Jr., Weston E. Vivian
John P. Woodford, Director
Lansing, June 1978

This report presents air quality information for a proposed section of I 69 in Ingham, Clinton, and Shiawassee Counties as shown in Figure 1. Meteorological data, and estimates of pollution levels that might occur adjacent to the existing roadway and the proposed roadway are included.

Terrain and Demography

The terrain surrounding this project is flat to gently rolling so that dispersion of air pollutants is not hindered. Ingham and Clinton Counties are considered part of the Tri-County Region of central Michigan centered around the City of Lansing. The Lansing Metropolitan Region has a population of 378,000 according to the 1970 census.

Meteorology

Meteorological conditions in Michigan are generally good for dispersion and dilution of air pollutants. According to air pollution publication AP 101, U. S. Environmental Protection Agency, 1972 (p. 96) there are few days with a high meteorological potential for air pollution.

Daily weather data recorded every third hour at Capital City Airport (Lansing) were obtained from the National Climatic Center in Asheville, N. C. for the years 1967 through 1973. Figure 2 shows a 36-point bar graph of wind speed and direction occurrences. 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.

Existing Ambient Air Quality

No data are available to establish presently existing air quality in the area of this project; however, estimates of background carbon monoxide that may exist in the project area are: 1 to 4 mg/cu m for a maximum 8-hour concentration, and 4 to 8 mg/cu m for a maximum 1-hour concentration. These estimates were supplied by the Michigan Department of Natural Resources, Air Pollution Control Division.

Pollution Estimates

Estimates of carbon monoxide concentrations were made at a height of 1.5 meters (5 ft) above ground level. A mathematical model based on the Gaussian diffusion equation, modified for a line source, was used.(1) Inputs to the model include wind speed and direction, atmospheric stability class, traffic volumes, vehicle emission factors and design of the roadway.

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(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, Report No. FHWA-RD-72-36. CALINE 2 modification, programmed March 1975, was used.

Carbon monoxide concentrations were estimated for:

1) Four alternate alignments identified as follows:

Alternate 1 - "No Build" - existing roadway.

Alternate 2 - "Upgrade" - two 24-ft roadways separated by a variable (94-ft minimum) median constructed to the north, paralleling and incorporating part of the existing roadway. Two lanes of the existing roadway would remain intact to serve as a service road (Fig. 1).

Alternate 3 and 4 - Two 24-ft roadways separated by a variable (94-ft minimum) median in 418 ft of right-of-way.

2) At the estimated distance from the edge of the roadway to the nearest possible receptor for each alternate: Alternate 1, 4 m; Alternates 2, 3 and 4, 45 m (edge of the right-of-way).

3) The years 1985 and 2000.

Information used as input to the model consisted of:

1) Vehicle emission factors, shown in the following table, calculated using procedures from "Compilation of Air Pollution Emission Factors," AP 42, Supplement No. 5, December 1975 edition, U. S. Environmental Protection Agency. Emission factors were calculated at temperatures of 30 F and 60 F with 20 percent of vehicles in a cold start condition, 27 percent of vehicles in a hot start condition, and the remainder of vehicles in a hot operation mode. Vehicle age mix data used were for Michigan registrations obtained from the Secretary of State. National estimates from AP 42 for average annual miles driven for various age vehicles were used.

EMISSION FACTORS FOR
CARBON MONOXIDE, g/mi

Temp	Year	Average Vehicle Speed, mph							
		25 (3)*	25 (6)	30 (2)	30 (3)	30 (6)	35 (2)	55 (6)	55 (10)
30 F	1985	----	----	----	18.8	20.2	15.4	13.2	14.5
	2000	15.7	17.6	12.4	----	----	----	9.3	10.6
60 F	1985	----	----	----	11.0	12.6	8.8	8.3	9.8
	2000	9.2	11.0	7.1	----	----	----	6.0	7.4

(*) (0) percent heavy duty vehicles.

2) Estimated P.M. peak (4:30 p.m. to 5:30 p.m.) traffic volumes. Traffic estimates are shown in Table 1.

3) Meteorological Conditions

a) Worst meteorological conditions were taken as a 2.2 mph (1 m/sec) wind parallel to the roadway, under atmospheric stability class D.

b) Most probable meteorological conditions, a 11 mph wind at 270 degrees under atmospheric stability class D.

4) Road Profile. All alternates are at grade.

5) Roadway Widths. The widths for each of the alternates were previously described in Item 1, under carbon monoxide concentrations.

All estimates of carbon monoxide levels represent 1-hour concentration and are in addition to existing background levels. Table 2 presents estimates of carbon monoxide, excluding background, at the nearest possible receptor to the roadway for the highest traffic volume section within each alternate.

Comparison of Estimates with Air Quality Standards

a) Eight-hour carbon monoxide air quality standard - 10 mg/cu m (9 ppm)

The Federal Highway Administration's report "Project Level Consideration to Assure Adequate Air Quality Analyses" suggests a technique for determining the 8-hour carbon monoxide concentration from the 1-hour concentrations.

$$\frac{V_8}{V_1} \times (\text{1-hr CO concentration}) \times P = \text{8-hr CO concentration}$$

where V_8 = average hourly traffic volume in both directions during the 8-hour period of interest

V_1 = peak hour traffic volume in both directions

P = 1 to 8-hour meteorological persistence factor for the 8-hour period

A value of $P = 0.6$ is suggested unless data are available to calculate a persistence factor for the proposed highway projects.

If this technique is used to calculate the 8-hour carbon monoxide level in 1985 for each alternate, the highest 8-hour concentrations from the roadway for the four alternates are:

$$\text{Alternate 1} = \frac{1{,}900 \text{ vehicles per hour}}{4{,}940 \text{ vehicles per hour}} \times 10.4 \text{ mg/cu m} \times 0.6 = 2.4 \text{ mg/cu m}$$

Alternates 2, 3 and 4 = less than 1 mg/cu m

Adding these concentrations to the 1-4 mg/cu m estimated maximum 8-hour background results in total carbon monoxide concentrations of 3.4 to 6.4 mg/cu m for Alternate 1 and 2.0 to 5.0 mg/cu m for Alternates 2, 3 and 4 (using 1 mg/cu m as highest 8-hour concentration from the roadway). Carbon monoxide levels adjacent to all of the alternates are below the air quality standard. For the year 2000 the carbon monoxide concentrations are estimated to be much lower than 1985 concentrations due to vehicle exhaust controls required by Federal Law.

b) One-hour carbon monoxide standard - 40 mg/cu m (36 ppm)

The maximum 1-hour concentrations of carbon monoxide from the roadway at the edge of the right-of-way in 1985 are 10.4 and 1.4 mg/cu m for Alternates 1 and 2, respectively, and 1.0 mg/cu m for both Alternates 3 and 4. Adding these concentrations to the 4 to 8 mg/cu m estimated background results in total 1-hour concentrations of 14.4 to 18.4 and 5.4 to 9.4 mg/cu m for Alternates 1 and 2, respectively, and 5.0 to 9.0 mg/cu m for both Alternates 3 and 4. All are below the 40 mg/cu m standard.

The estimated concentrations of carbon monoxide including existing estimated background adjacent to all of the alternates of the proposed roadway are within national air quality standards. Alternates 2, 3 and 4 offer a significant reduction in carbon monoxide levels over Alternate 1 (No Build) with Alternates 3 and 4 offering the greatest reduction. For Alternates 2, 3 and 4 the highest carbon monoxide concentration at the right-of-way line, caused by the roadway, is 1.4 mg/cu m. Thus, there will be no problem for any receptor should Alternates 2, 3, or 4 be constructed. The project is consistent with the State Implementation Plan for meeting national air quality standards for carbon monoxide.

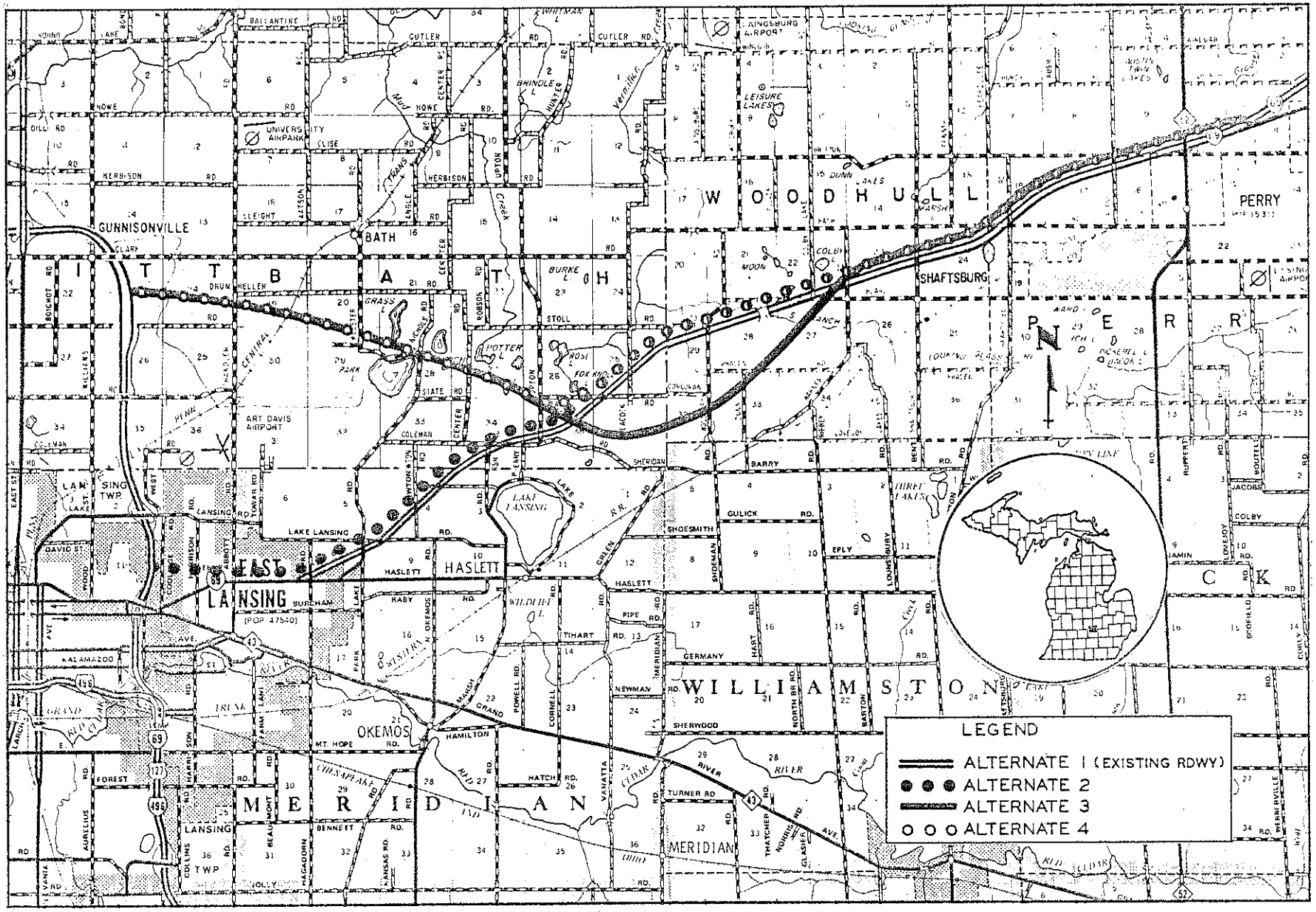

Figure 1. Proposed I 69, Ingham, Clinton and Shiawassee Counties.

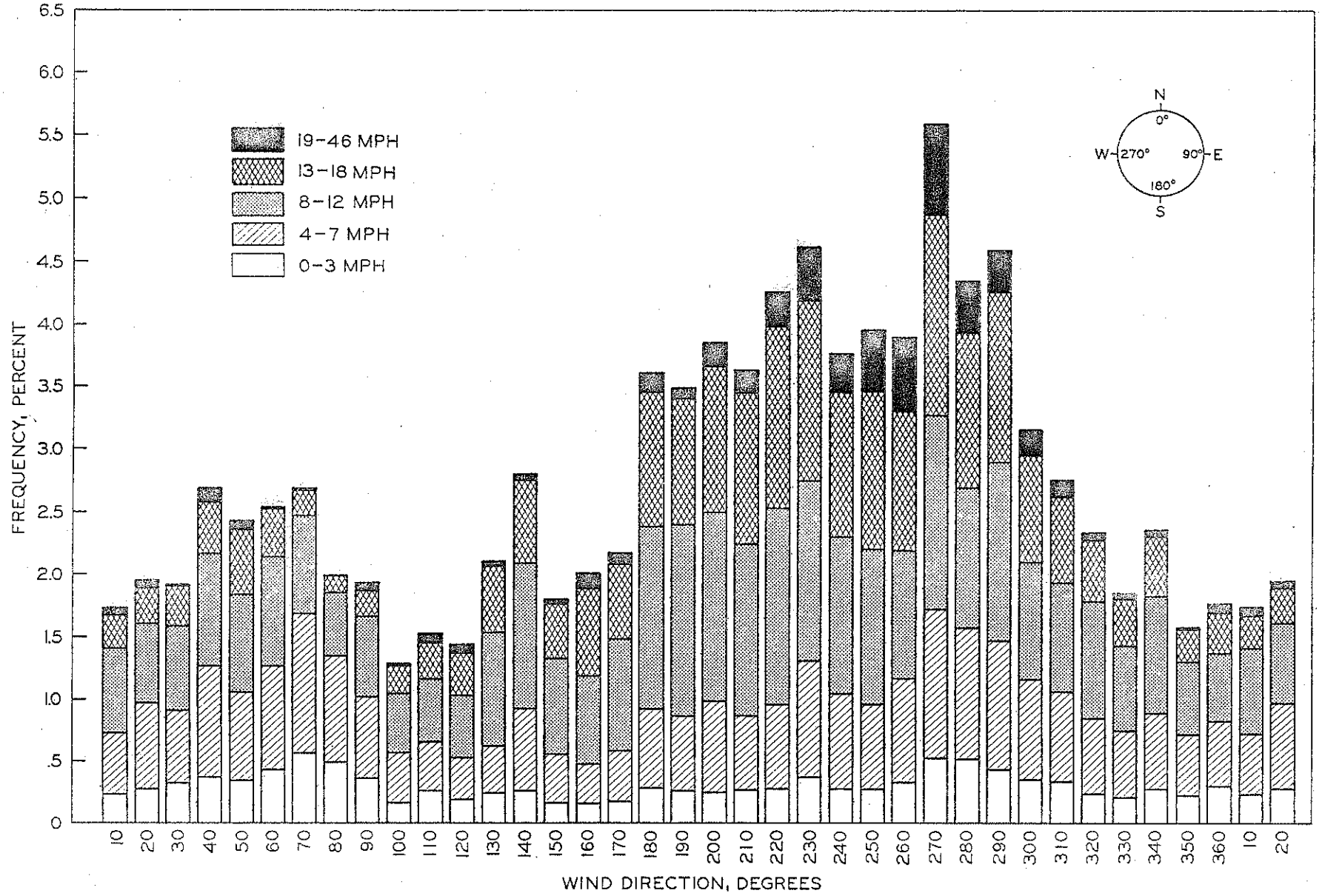

Figure 2. Wind speed and direction occurrences at Capital City Airport (Lansing).

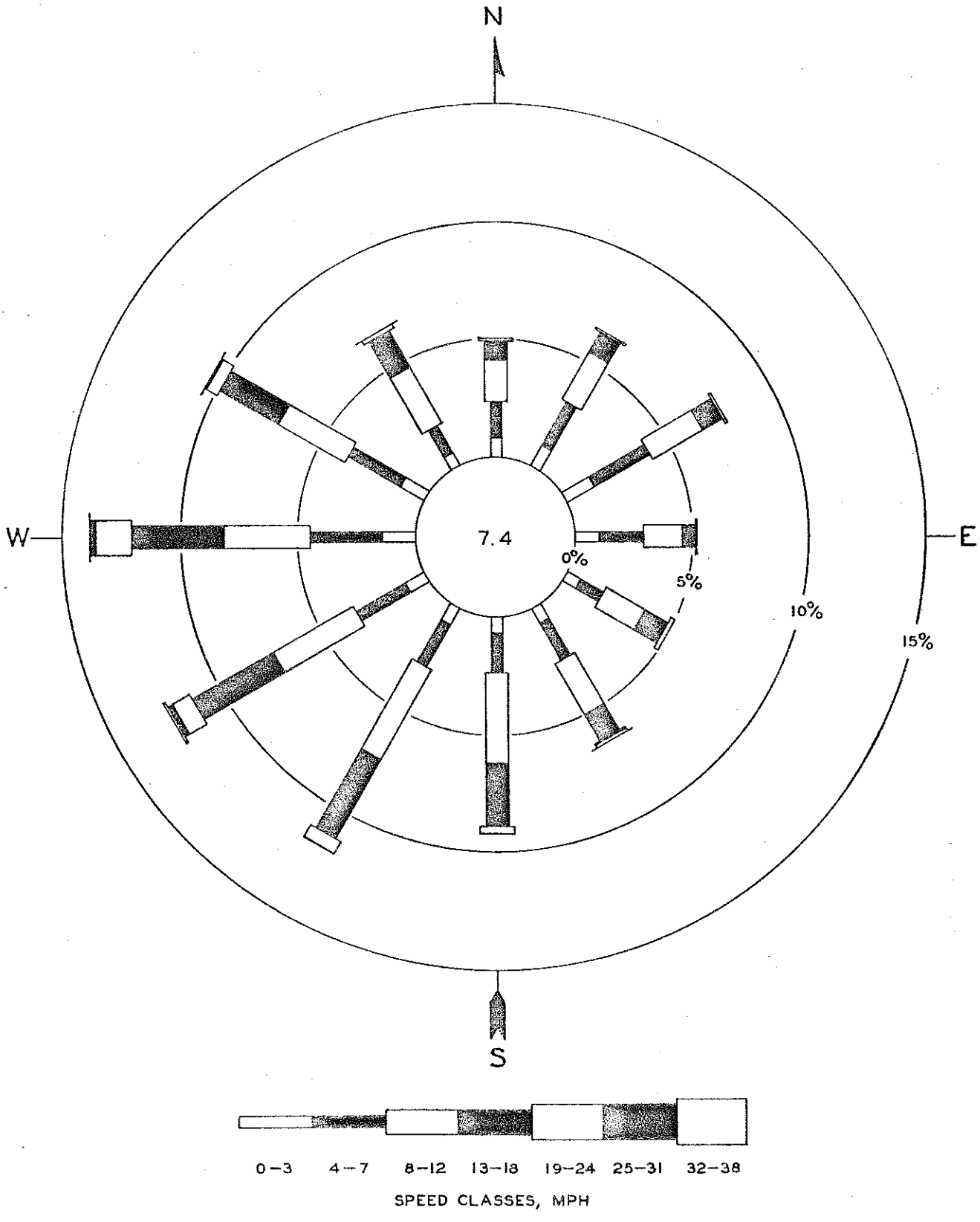

Figure 3. Frequency of wind direction and speed at Capital City Airport (Lansing). Calms, recorded 7.4 percent of the time, are distributed.

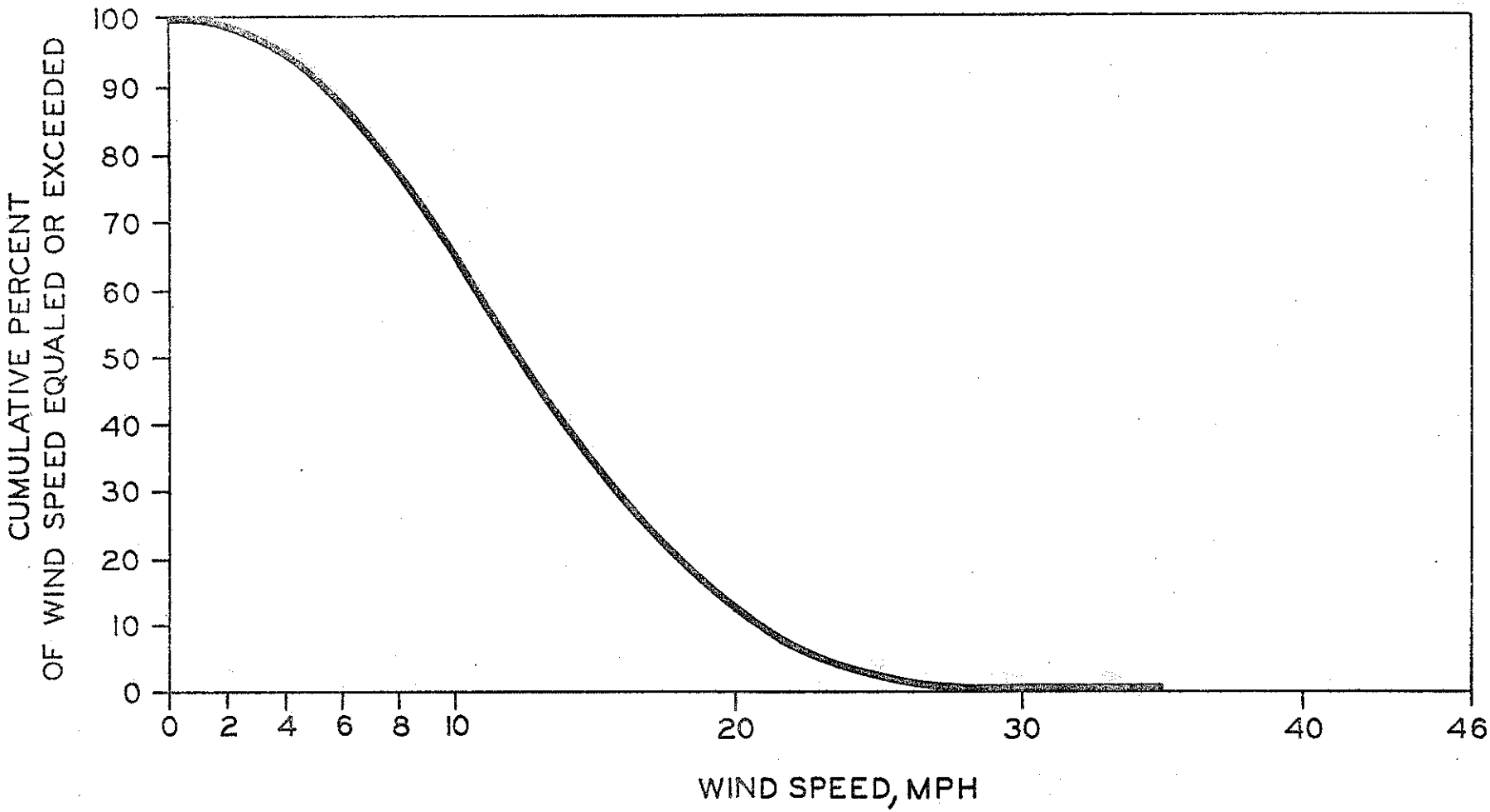

Figure 4. Distribution of wind speeds at Capital City Airport (Lansing).

TABLE 1

TRAFFIC ESTIMATES FOR PROPOSED I 69 (total both directions)

Location	Year	Alternate 1	Alternate 2	Alternate 3	Alternate 4
Proposed	1985	-------	3,650 (55)	2,460 (55)	2,440 (55)
	2000	-------	4,770 (55)	3,450 (55)	3,440 (55)
Existing	1985	4,940 (30)	1,660 (30)	3,390 (35)	3,390 (35)
	2000	6,440 (25)	1,960 (25)	4,200 (30)	4,200 (30)

Commercial Vehicles:

Alternate 1, 6 percent
Alternate 2, 6 percent on proposed roadway, 3 percent on service road
Alternates 3 and 4, 10 percent on proposed roadway, 2 percent on existing roadway.

000 = p.m. peak traffic, vehicles per hour
(00) = average traffic speeds

TABLE 2

ESTIMATES OF CARBON MONOXIDE FROM THE ROADWAY, mg/cu m
(Not Including Background)

Location	Traffic Projection Year	Worst Condition, Parallel Wind, 1 m/sec, Stability D, Peak Traffic				Most Probable Condition [1], Stability D, Peak Traffic			
		Alternate [2]				Alternate [2]			
		1	2	3	4	1	2	3	4
Proposed Roadway	1985	----	1.4	1.0	1.0	---	0.2	0.1	0.1
	2000	----	1.3	1.1	1.1	---	0.2	0.1	0.1
Existing Roadway	1985	10.4	3.3	---	---	1.2	0.4	---	---
	2000	11.6	3.2	---	---	1.4	0.4	---	---

[1] Most probable wind: 11 mph; angle between wind direction and roadway direction, 20 degrees

[2] Alternate 1 - No Build
Alternate 2 - Upgrade
Alternates 3 and 4 - Construct two 24-ft roadways along alignments shown in Fig. 1.