AIR QUALITY REPORT FOR THE RECONSTRUCTION OF I 94 BL SOUTHWEST OF BATTLE CREEK, CALHOUN COUNTY

MICHIGAN DEPARTMENT OF
STATE HIGHWAYS AND TRANSPORTATION

AIR QUALITY REPORT FOR THE RECONSTRUCTION OF I 94 BL SOUTHWEST OF BATTLE CREEK, CALHOUN COUNTY

Research Laboratory Section
Testing and Research Division
Research Project 76 AP-13(A)
Research Report No. R-1031

Michigan State Highway Commission
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This report presents estimates of pollution levels that might occur adjacent to the roadway for the proposed reconstruction of I 94 BL southwest of Battle Creek in Calhoun County as shown in Figure 1.

Terrain and Demography

The terrain surrounding this project is flat to gently rolling, so that dispersion of air pollutants is facilitated. The population density of Calhoun County is 202 per square mile with 60 percent urban.

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. Figure 2 shows a 36-point bar graph of wind speed and direction occurrences at Kalamazoo City Weather Station. Hourly weather data (6 a.m. to 11 p.m. only recorded) 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 12 mph.

According to air pollution publication AP 101, U. S. Environmental Protection Agency, 1972, atmospheric mixing depths in lower Michigan generally are 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 existing air quality in the area of this project; however, estimates of background air quality that may exist in the project area are:

carbon monoxide - 1 to 3 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.

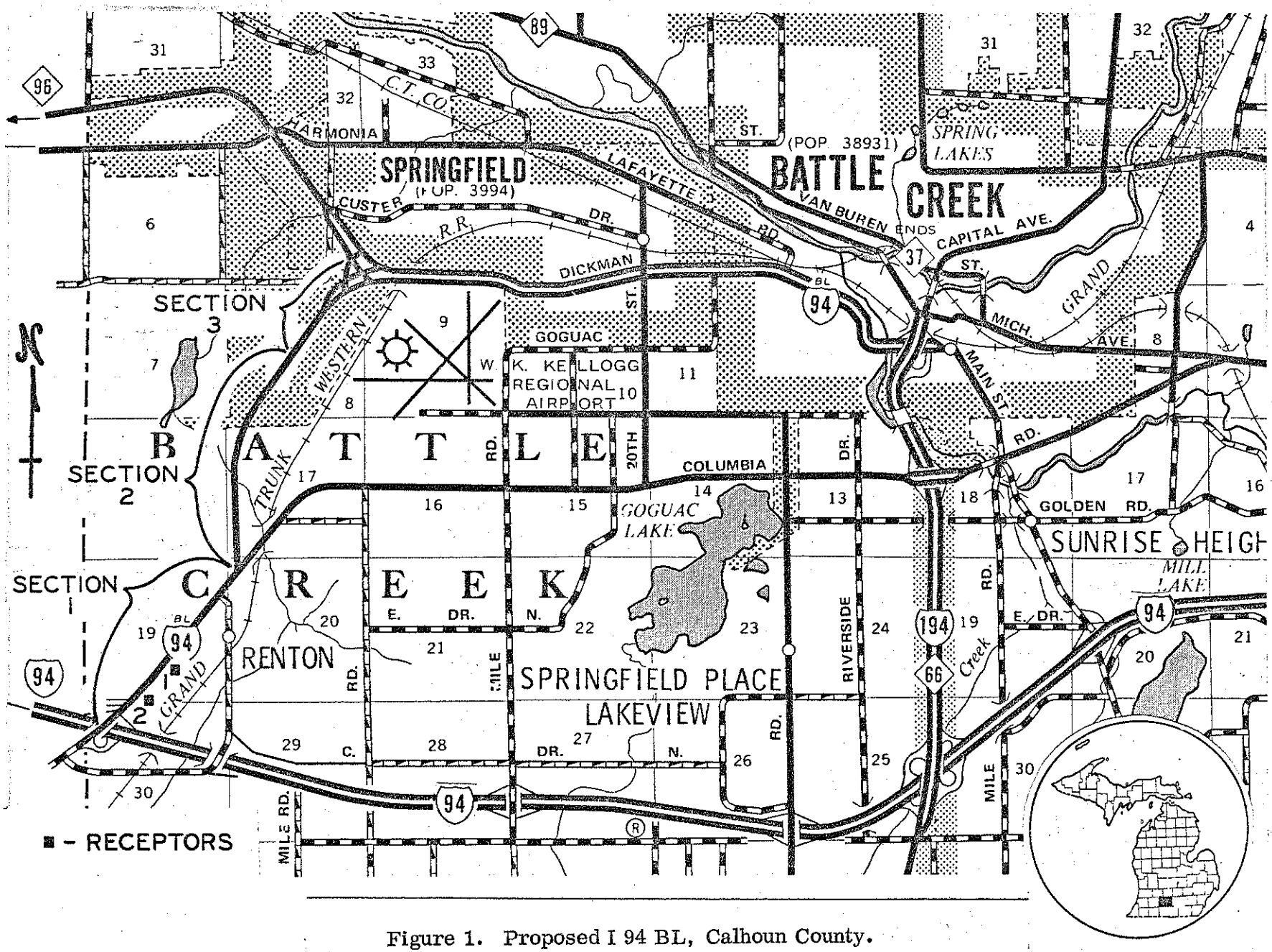

Figure 1. Proposed I 94 BL, Calhoun County.

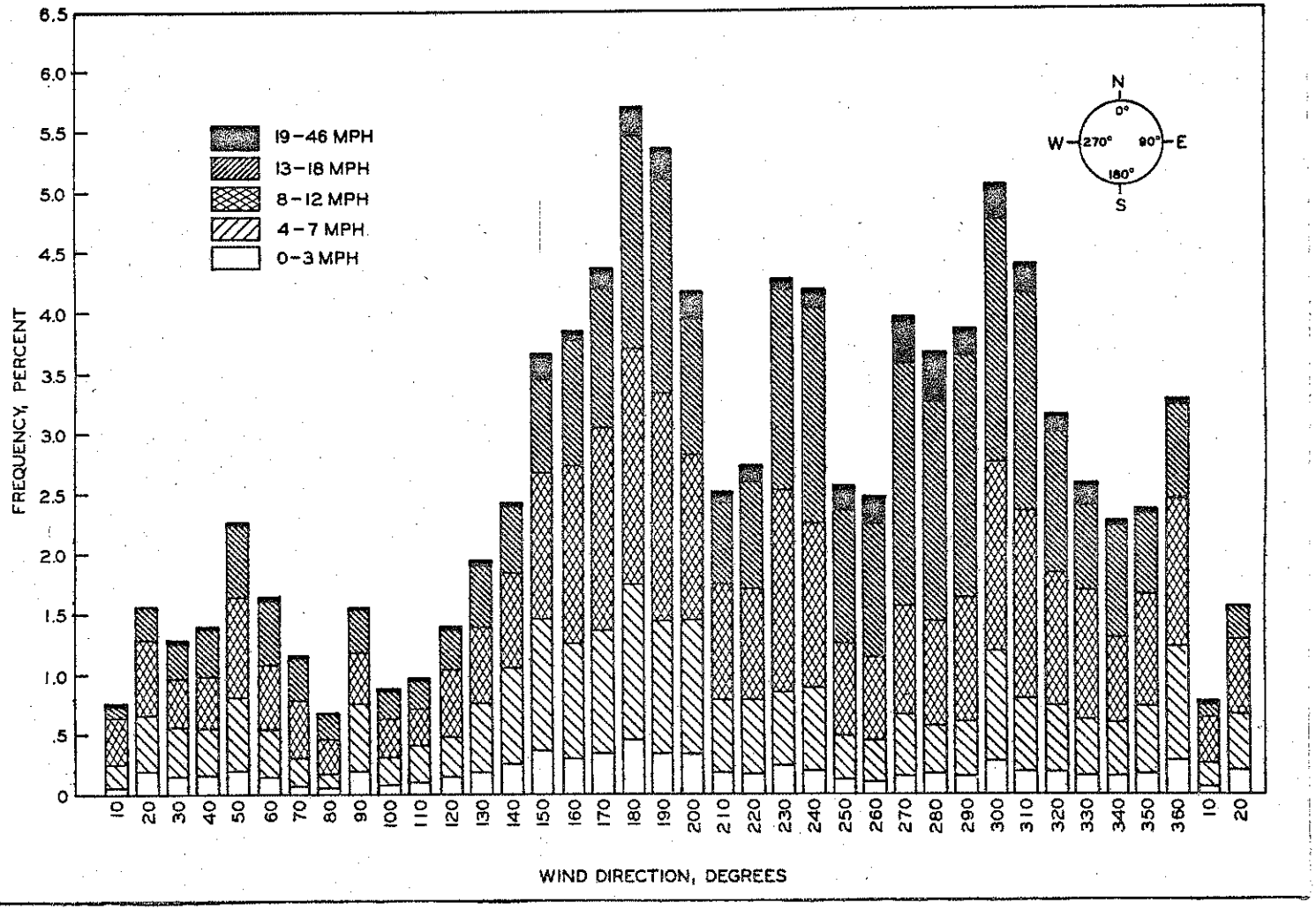

Figure 2. Wind speed and direction occurrences at Kalamazoo City Weather Station.

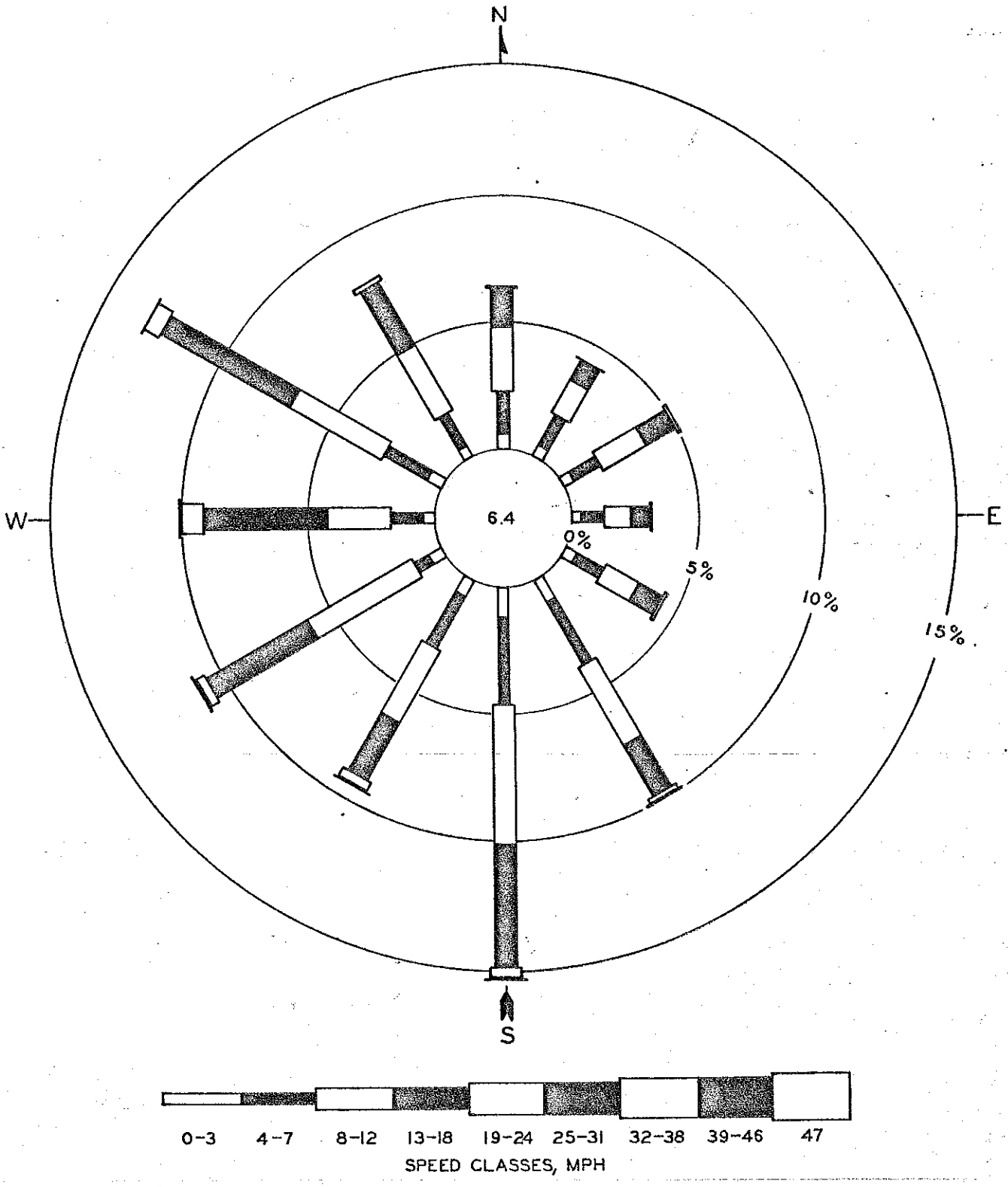

Figure 3. Frequency of wind direction and speed, percent (calms distributed).

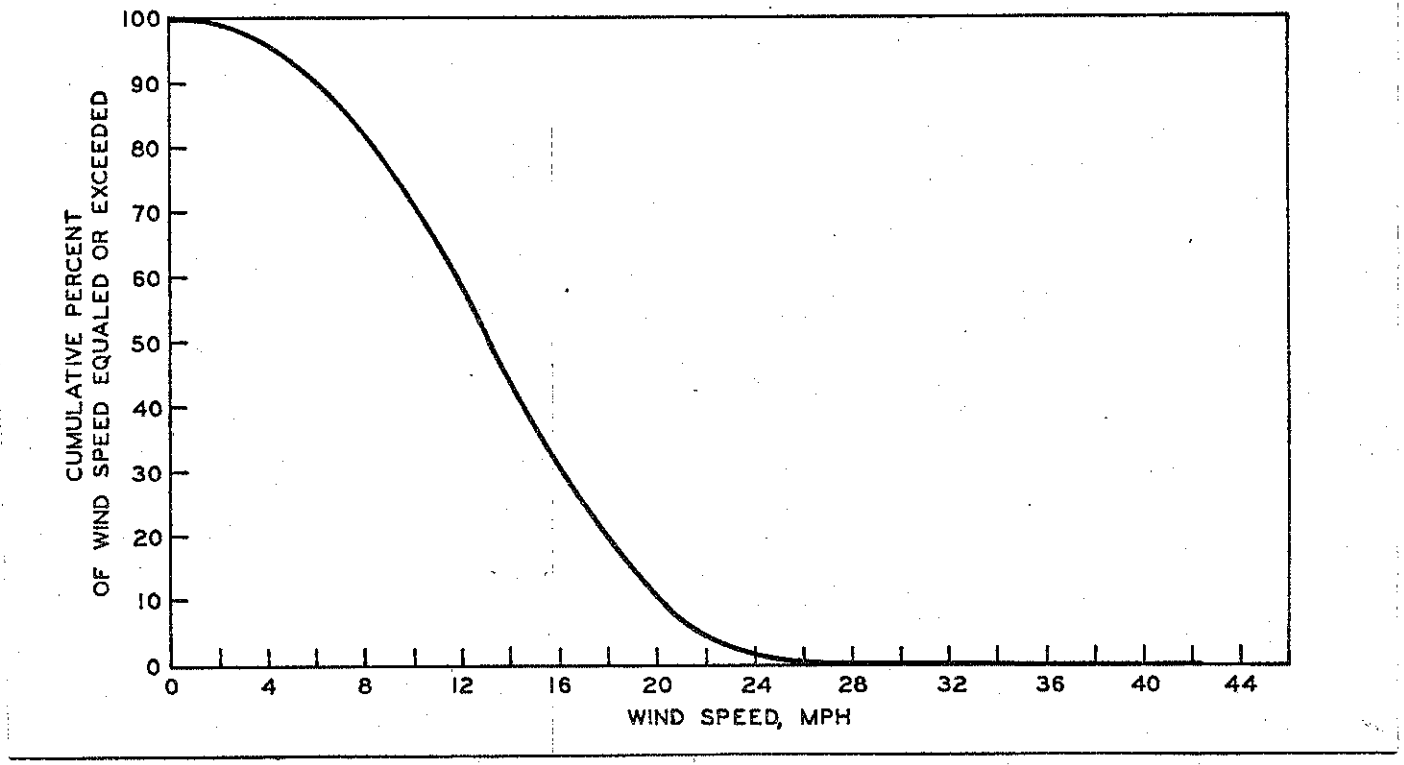

Figure 4. Wind speed distribution at Kalamazoo City Weather Station.

Pollution Estimates

Estimates of carbon monoxide concentrations were made at a height of 1.5 meters (5 ft) above the roadway. A mathematical model based on the Gaussian diffusion equation, modified for a line source, was used[1]. Inputs to the model include meteorological conditions, traffic volumes, vehicle emission factors and design of the highway.

Estimates of nitrogen dioxide concentrations are not included in this report because, while the national air quality standard is for nitrogen dioxide (NO_2), the mixture of nitrogen oxides (NO_x) emitted by vehicles consists largely of nitric oxide (NO) with less than five percent of the nitrogen oxides emitted as NO_2, according to Federal EPA data. Subsequent to being emitted from the tailpipe, NO may be converted to NO_2 at varying rates, depending on atmospheric conditions. There is no air quality standard for NO, which is much less toxic than NO_2. Thus, there is no meaningful way of comparing vehicle exhaust emissions with the air quality standard for NO_2.

Carbon monoxide concentrations were estimated for:

1) Two alternate routes (C and D). Alternate C follows and incorporates the existing roadway the entire length with the existing roadway serving as the northbound lanes of the proposed roadway. Alternate D consists of two new roadways parallel to the existing roadway with the northbound lanes about 75 ft to the west. Alternate D extends only from I 94 north to Columbia Rd then becomes Alternate C.

2) Three 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 94 to Columbia Rd
2	Columbia Rd to Cedar Point Entrance
3	Cedar Point Entrance to M 96

[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.

3) The years 1978 and 2000.

4) The area above the pavement (mixing cell) and at two receptors near the proposed roadway.

Information used as input to the model consisted of:

1) Vehicle emission factors shown in the following table were calculated using procedures from "Compilation of Air Pollutant Emission Factors," AP 42, Supplement No. 5, December 1975 edition, U. S. Environmental Protection Agency. Emission factors were calculated at a temperature of 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
(5 percent commercial)

Year	Average Vehicle Speed, mph	
	45	55
1978	---	15.5
2000	4.1	3.6

2) Estimated peak traffic (10:00 to 11:00 a.m.) and off-peak traffic volumes. Traffic estimates are shown in Table 1. Off-peak traffic was taken as 4 percent of ADT.

3) Meteorological conditions. Worst meteorological conditions were taken as a 3 mph wind parallel to the roadway, under atmospheric stability class E.

4) Road profile. All sections are at grade.

5) Width of all sections, two 24-ft roadways with shoulders, separated by an 84-ft median.

All estimates of carbon monoxide levels represent maximum one-hour concentrations and are in addition to existing background levels. Table 2

TABLE 1
TRAFFIC ESTIMATES FOR PROPOSED
I 94 BL, BATTLE CREEK

Year	Section 1	Section 2	Section 3
1978	20,800 ⟨2,400(55)⟩ [830(55)]	17,000 ⟨2,300(55)⟩ [680(55)]	5,100 ⟨700(55)⟩ [240(55)]
2000	41,000 ⟨4,300(45)⟩ [1,640(55)]	39,000 ⟨4,700(45)⟩ [1,560(55)]	16,200 ⟨2,800(45)⟩ [650(55)]

Commercial vehicles - all sections 5 percent of peak and off-peak

Traffic volumes are total for both directions

000 = Average daily traffic, vehicles in 24 hr
⟨000⟩ = Peak traffic, vehicles per hr
[000] = Off-peak traffic, vehicles per hr
(00) = Average speed

TABLE 2
ESTIMATES OF CARBON MONOXIDE
CONCENTRATIONS FROM THE ROADWAY[1]
(Not Including Background)

Location	Traffic Projection Year	CO (mg/cu m) Worst Condition, Stability E, Parallel Wind, 3 mph	
		Peak Traffic	Off-Peak Traffic
Section 1	1978	3.9	1.4
	2000	1.9	0.6
Section 2	1978	3.8	1.1
	2000	2.0	0.6
Section 3	1978	1.1	0.4
	2000	1.2	0.2

[1] average vehicle speeds are reported in Table 1.

presents estimates of carbon monoxide levels in the area over the pavement (mixing cell).

Comparison of Estimates with Air Quality Standards

a) 8 hr carbon monoxide air quality standard - 10 mg/cu m (9 ppm)

If for 1978 the highest carbon monoxide levels from the roadway are used (Section 1), and an 8-hr period is taken as two peak hours of 3.9 mg/cu m and six off-peak hours of 1.4 mg/cu m, the 8-hr average carbon monoxide concentration from the roadway is 2.0 mg/cu m. Adding this concentration to the 1 to 3 mg/cu m estimated background results in a total carbon monoxide concentration of 3.0 to 5.0 mg/cu m, which is below the air quality standard. For the year 2000 the carbon monoxide concentrations are estimated to be much lower than the 1978 concentrations due to a larger percentage of exhaust controlled vehicles required by Federal law.

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

The maximum estimated one-hour concentration of carbon monoxide (roadway plus background) is 3.9 plus 4 to 8 mg/cu m, a range of 7.9 to 11.9 mg/cu m. This is far below the 40 mg/cu m standard.

Conclusions

The estimated concentrations of carbon monoxide above the pavement, including estimated existing background, for each alternate route of the proposed roadway are within national air quality standards. No significant difference in carbon monoxide concentrations between the alternate routes was found and no adverse environmental effects are expected. The project is consistent with the state implementation plan for meeting national air quality standards.

Additional Information for Receptor Sites

Concentrations of carbon monoxide were estimated at a day care center and a church near the proposed route. The locations are shown in Figure 1.

1. Day care center located approximately 400 ft east of existing I 94 BL.

2. Church of Christ located approximately 250 ft east of existing I 94 BL.

The estimated carbon monoxide concentration at any of these sites under worst meteorological conditions is less than 1.0 mg/cu m above background, thus no adverse environmental effects are indicated.

The meteorological condition yielding the highest calculated values at both sites is a 3 mph wind blowing across the proposed route toward the receptors, stability class E.