Revised
per R-1105

1992

AIR QUALITY REPORT FOR US 31, BERRIEN COUNTY

MICHIGAN DEPARTMENT OF
STATE HIGHWAYS AND TRANSPORTATION

AIR QUALITY REPORT FOR US 31, BERRIEN COUNTY

Research Laboratory Section
Testing and Research Division
Research Project 73 TI-183
Research Report No. R-899R

Michigan State Highway Commission
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Lansing, May 1976

This report presents air quality information for a proposed section of US 31 in Berrien 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 density of Berrien County is 157 per square mile with 42 percent urban. Three cities in the county have populations greater than 10,000.

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 Muskegon County Airport. Hourly weather data were obtained from the National Climatic Center at Asheville, N. C. for the years 1968 through 1972 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.

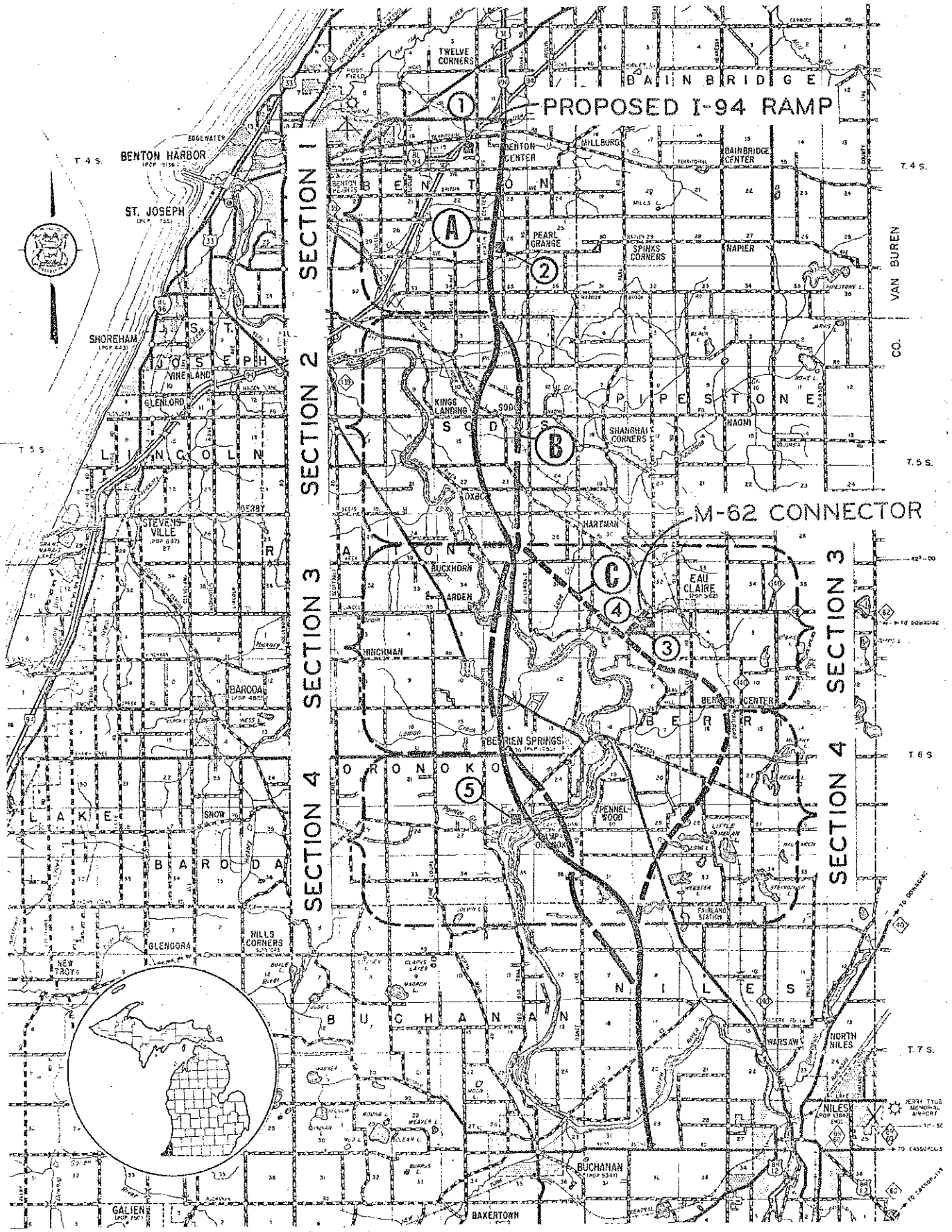

Figure 1. Location of proposed US 31, Berrien County.

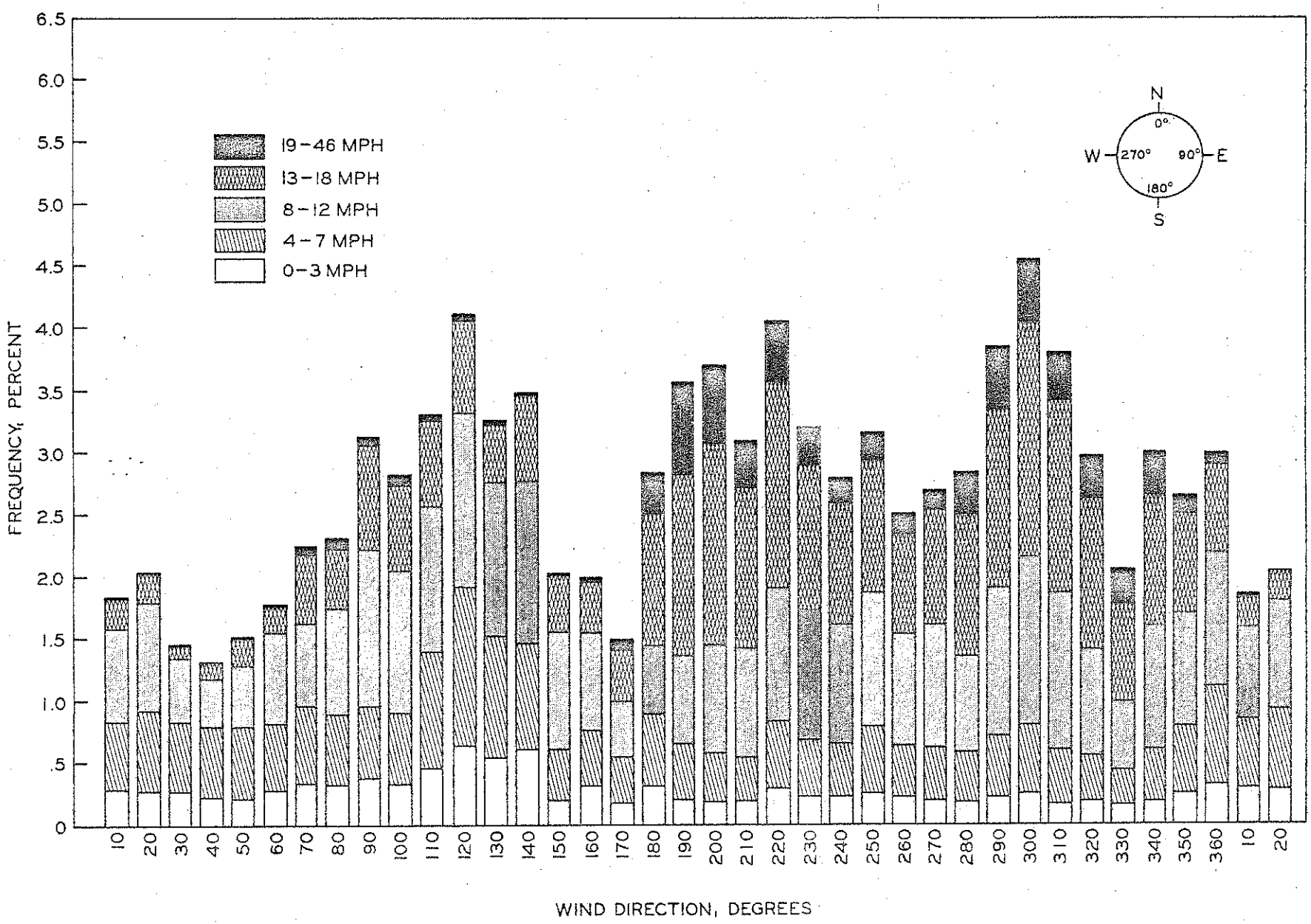

Figure 2. Wind speed and direction occurrences at Muskegon County Airport.

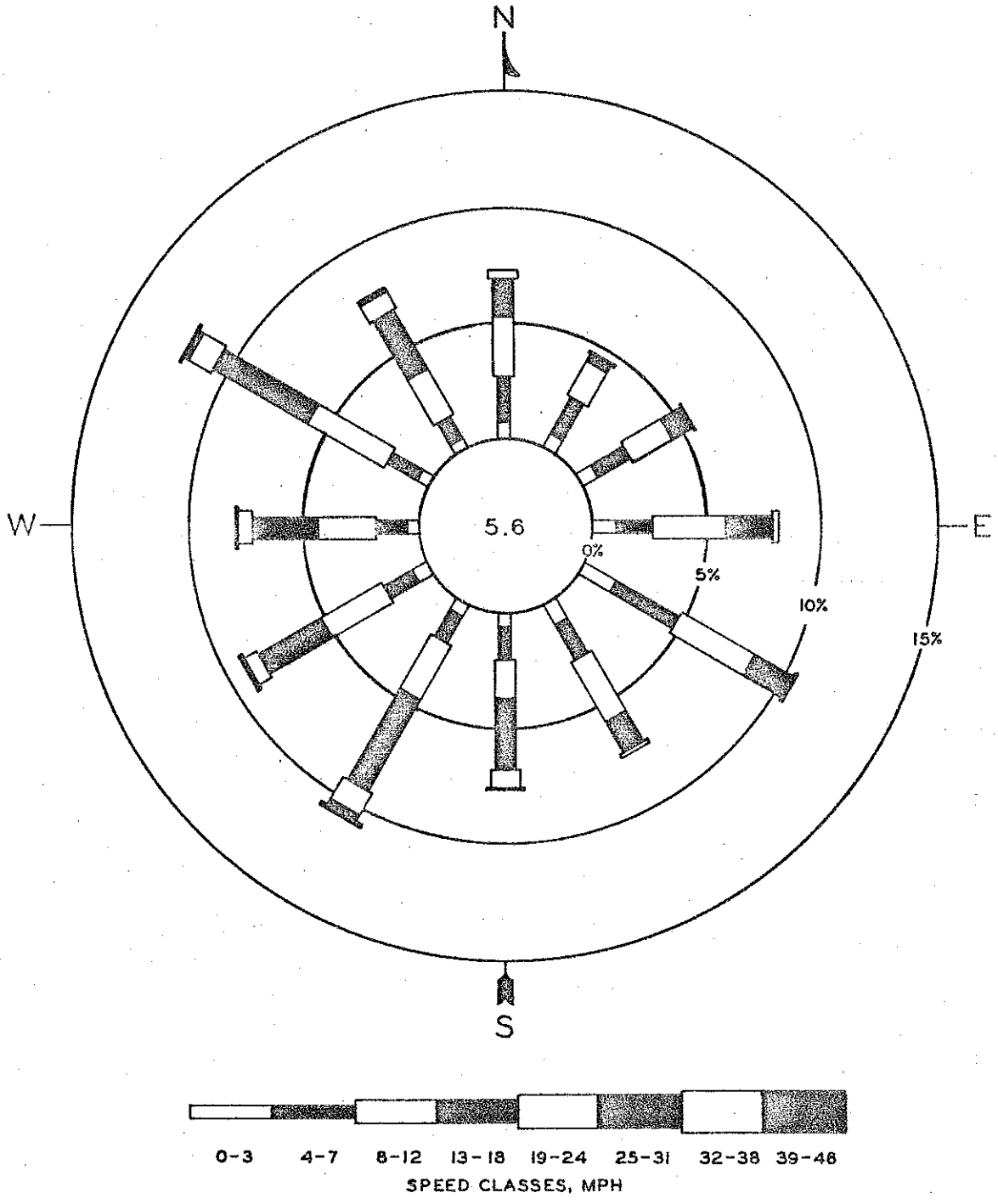

Figure 3. Frequency of wind direction and speed, percent (calms distributed).

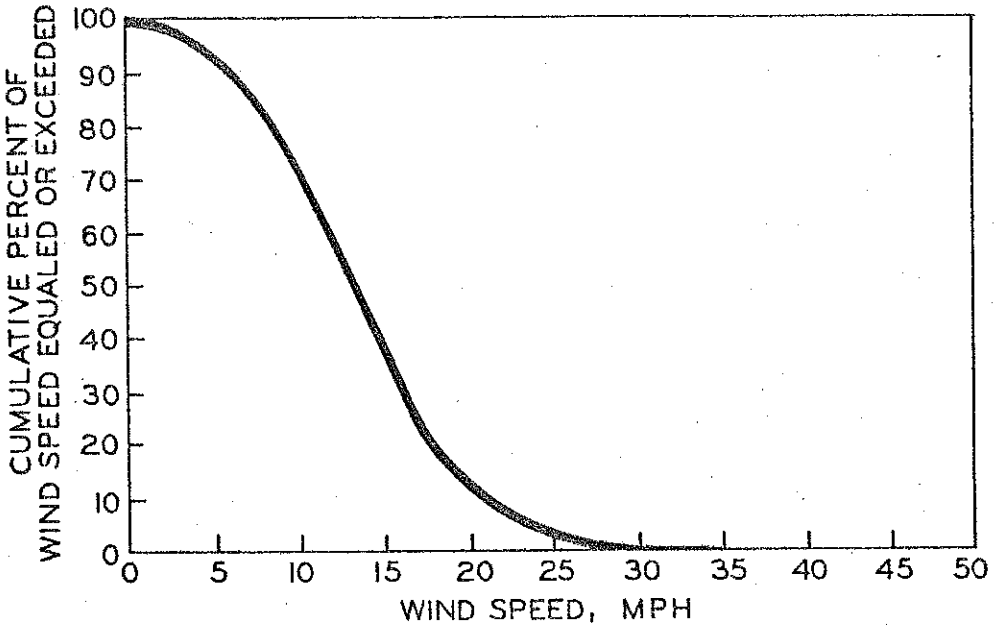

Figure 4. Wind speed distribution at Muskegon County Airport.

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.

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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.

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 all vehicles in hot operation mode. Vehicle age mix data used were obtained from the Michigan Department of State. Average annual miles driven for various age vehicles were national figures from AP 42.

CARBON MONOXIDE EMISSION FACTORS
(g/mile at 55 mph - 5 percent commercial)

1985	3.6
2000	3.1

Carbon monoxide concentrations were estimated for:

1) Three alternate routes (A, B, and C). Alternates A and B are the western alignments and are divided into four representative sections. Alternate C is the eastern alignment and is divided into two sections. See Figure 1 for the location of the sections which are identified as follows:

Alternates A and B

Section	Location
1	I 94/I 196 to Townline Rd
2	Townline Rd to Tabor Rd
3	Tabor Rd to Shawnee Rd
4	Shawnee Rd to Matthew Rd

Alternate C

Section	Location
3	Tabor Rd to Deans Hill Rd
4	Deans Hill Rd to Matthew Rd

2) The years 1985 and 2000.

3) The area above the pavement (mixing cell) and at the edge of the right-of-way.

Information used as input to the model consisted of:

1) Traffic estimates as shown in Table 1. Highest traffic volumes are estimated to occur in the evening -- 6 to 7 p.m. Fifty-three percent of this evening peak traffic is southbound, 47 percent is northbound. Off-peak traffic was taken as 4 percent of ADT, with half of the traffic in each direction.

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.

b) Most probable meteorological conditions for the evening - a 12 mph wind at 300 degrees under atmospheric stability class D. 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 36 ft roadways with shoulders, separated by a variable 176 ft minimum median.

All estimates of carbon monoxide levels represent maximum one-hour concentrations and are in addition to existing background levels. Table 3 presents estimates of carbon monoxide levels in the area over the pavement (mixing cell) and at the edge of the right-of-way.

Comparison of Estimates with Air Quality Standards

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

The highest estimated carbon monoxide concentrations from the roadway, 2.0 mg/cu m, occurs in Alternate C - section 4 in the year 2000. If this peak value is added to the 1 to 3 mg/cu m estimated background a total carbon monoxide concentration of 3 to 5 mg/cu m results. These values are well below the 8 hr air quality standard.

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 2.0 plus 4 to 8 mg/cu m, a range of 6 to 10 mg/cu m. This is far below the 40 mg/cu m standard.

TABLE 1
TRAFFIC ESTIMATES FOR PROPOSED US 31
(Total Traffic in Both Directions)

Year	Section 1	Section 2	Section 3		Section 4	
	Alternates A or B	Alternates A or B	Alternates A or B	Alternate C	Alternates A or B	Alternate C
1985	27,900 ⟨4,250⟩ [1,120]	31,700 ⟨4,810⟩ [1,260]	35,200 ⟨5,360⟩ [1,400]	31,700 ⟨4,810⟩ [1,260]	35,800 ⟨5,460⟩ [1,440]	35,800 ⟨5,460⟩ [1,480]
2000	48,400 ⟨7,560⟩ [1,940]	47,600 ⟨7,250⟩ [1,900]	49,000 ⟨7,330⟩ [1,960]	49,200 ⟨7,390⟩ [1,960]	47,800 ⟨7,200⟩ [1,920]	49,600 ⟨7,430⟩ [1,980]

Peak Duration - Variable, around 1 hr

All speeds - 55 mph

000 = Average daily traffic, vehicles in 24 hours
⟨000⟩ = Peak traffic, vehicles per hour
[000] = Off-peak traffic, vehicles per hour

Commercial vehicles - all sections, 5 percent of peak, 8 percent of off-peak.

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	61.0	13.8	25.2
2	0.0	0.0	0.0	63.1	12.1	24.8
3	0.0	0.0	0.0	61.5	15.7	22.8
4	0.0	0.0	0.0	63.9	11.1	24.9
5	0.0	0.0	0.0	63.8	13.4	22.8
6	8.5	6.2	4.4	59.3	9.3	12.1
7	9.7	12.5	8.9	60.0	4.6	4.4
8	6.6	15.2	14.9	60.2	2.3	0.8
9	5.9	13.0	18.4	62.8	0.0	0.0
10	3.0	13.3	20.2	63.6	0.0	0.0
11	2.3	10.8	21.0	65.9	0.0	0.0
12	2.6	9.7	20.7	67.0	0.0	0.0
13	1.1	9.8	21.0	68.0	0.0	0.0
14	1.1	8.4	24.3	66.2	0.0	0.0
15	0.5	8.0	26.1	65.4	0.0	0.0
16	1.0	8.9	25.6	62.1	2.0	0.5
17	0.2	13.0	19.7	60.7	5.1	1.5
18	1.8	11.3	12.3	55.9	12.0	6.7
19	0.0	0.0	0.0	60.3	22.0	17.7
20	0.0	0.0	0.0	57.0	18.5	24.4
21	0.0	0.0	0.0	57.9	17.2	24.9
22	0.0	0.0	0.0	57.7	16.2	26.1
23	0.0	0.0	0.0	58.2	15.7	26.1
24	0.0	0.0	0.0	58.4	15.1	26.6
Overall percent	1.8	5.8	9.9	61.7	8.6	12.2

TABLE 3
ESTIMATE OF CARBON MONOXIDE CONCENTRATIONS [1, 2]
FROM THE ROADWAY

Location (Section No. and Alternate)		Traffic Projection Year	CO (mg/cu m)	
			Worst Condition, Peak Traffic, Stability F, Parallel 3 mph Wind	
			Over the Roadway (mixing cell)	Edge of Right-of-Way
1	A or B	1985	1.3	0.4
	A or B	2000	2.0	0.6
2	A or B	1985	1.5	0.5
	A or B	2000	1.9	0.6
3	A or B	1985	1.7	0.5
	C		1.5	0.5
	A or B	2000	1.9	0.6
	C		2.0	0.6
4	A or B	1985	1.7	0.5
	C		1.7	0.6
	A or B	2000	1.9	0.6
	C		2.0	0.7

[1] All vehicle speeds are 55 mph.

[2] Carbon monoxide estimates for worst condition off-peak traffic and most probable condition peak and off-peak traffic are much lower than the estimates shown above so they are not included.

Conclusions

The estimated concentrations of carbon monoxide above the pavement, including 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 four schools and a boy scout camp near the proposed route. The locations are shown in Figure 1.

No. 1 - The school on the southwest corner of Territorial Rd and Benton Center Rd. The school is located about 500 ft east of existing I 94 and about 400 ft east of a proposed I 94 exit ramp (to be constructed if the proposed roadway is constructed).

No. 2 - The school on the northwest corner of Napier Rd and Blue Creek Rd. The school is located about 1,000 ft east of the proposed roadway and about 400 ft east of a proposed entrance ramp.

No. 3 - Eau Claire High School on Hochberger Rd. The school is located about 600 ft southeast of the proposed M 62 connector.

No. 4 - Eau Claire Elementary School on Pipestone Rd. The school is located about 600 ft south of the proposed M 62 connector.

No. 5 - The boy scout camp on the southeast side of Snow Rd. The camp grounds extend to the west right-of-way line of the proposed roadway.

The estimated carbon monoxide concentration at any of these sites under worst meteorological conditions is less than 2.0 mg/cu m above background, thus no adverse environmental effects are indicated.

The meteorological condition yielding the highest calculated values at site 1 is a 3 mph wind blowing across existing I 94 toward the school, stability class F. The highest calculated values at the other sites were obtained with a 3 mph wind parallel to the proposed roadway, atmospheric stability class F.