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AIR QUALITY REPORT FOR
US 31, BERRIEN COUNTY

MICHIGAN DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION

AIR QUALITY REPORT FOR US 31, BERRIEN COUNTY

Research Laboratory Section
Testing and Research Division
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Michigan Department of Transportation
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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

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. Figure 2 shows a 36-point bar graph of wind speed and direction occurrences at the 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.

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 eight-hour concentration, and 4 to 8 mg/cu m for a maximum one-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.

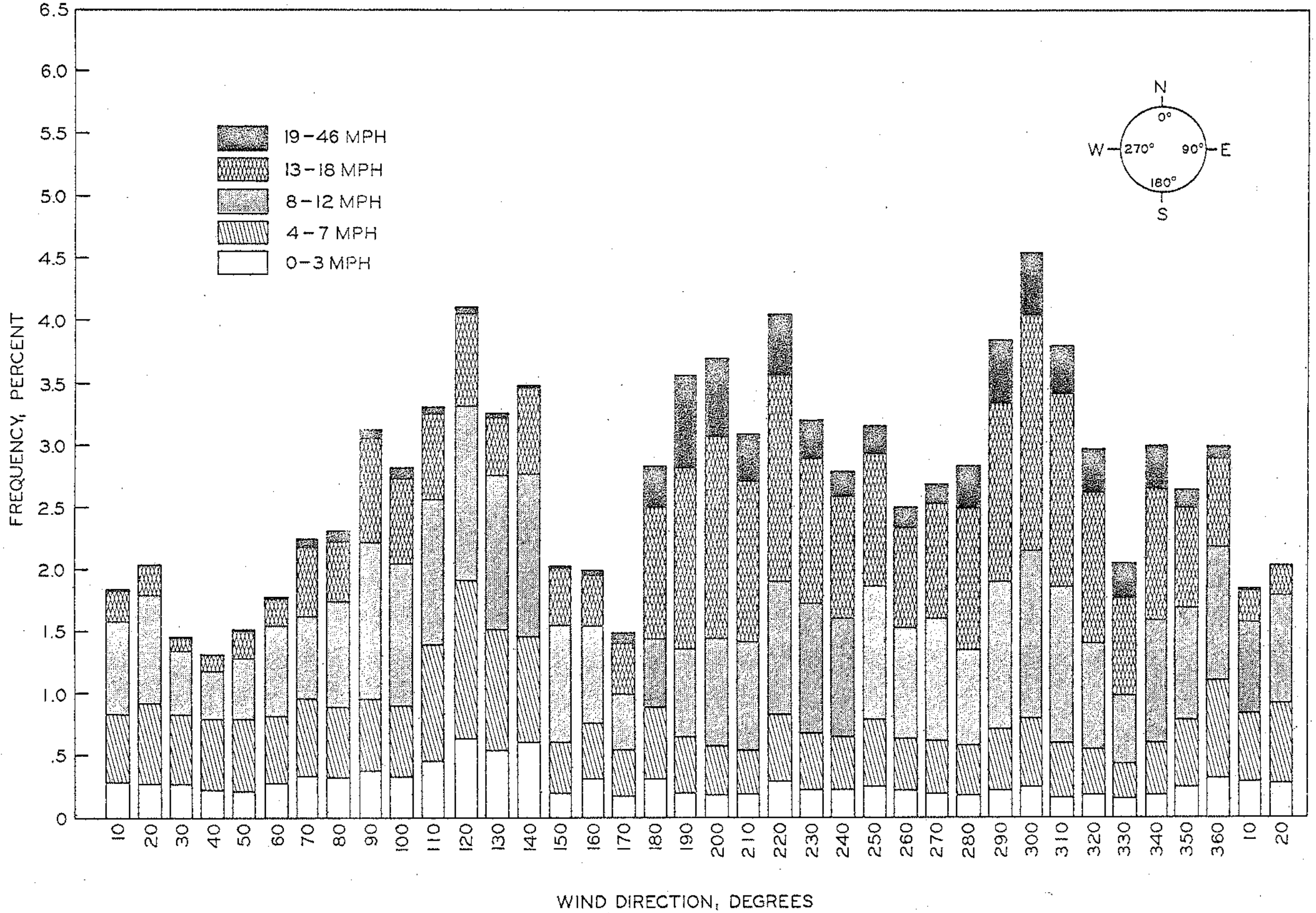

Figure 2. Wind speed and direction occurrences at Muskegon County Airport.

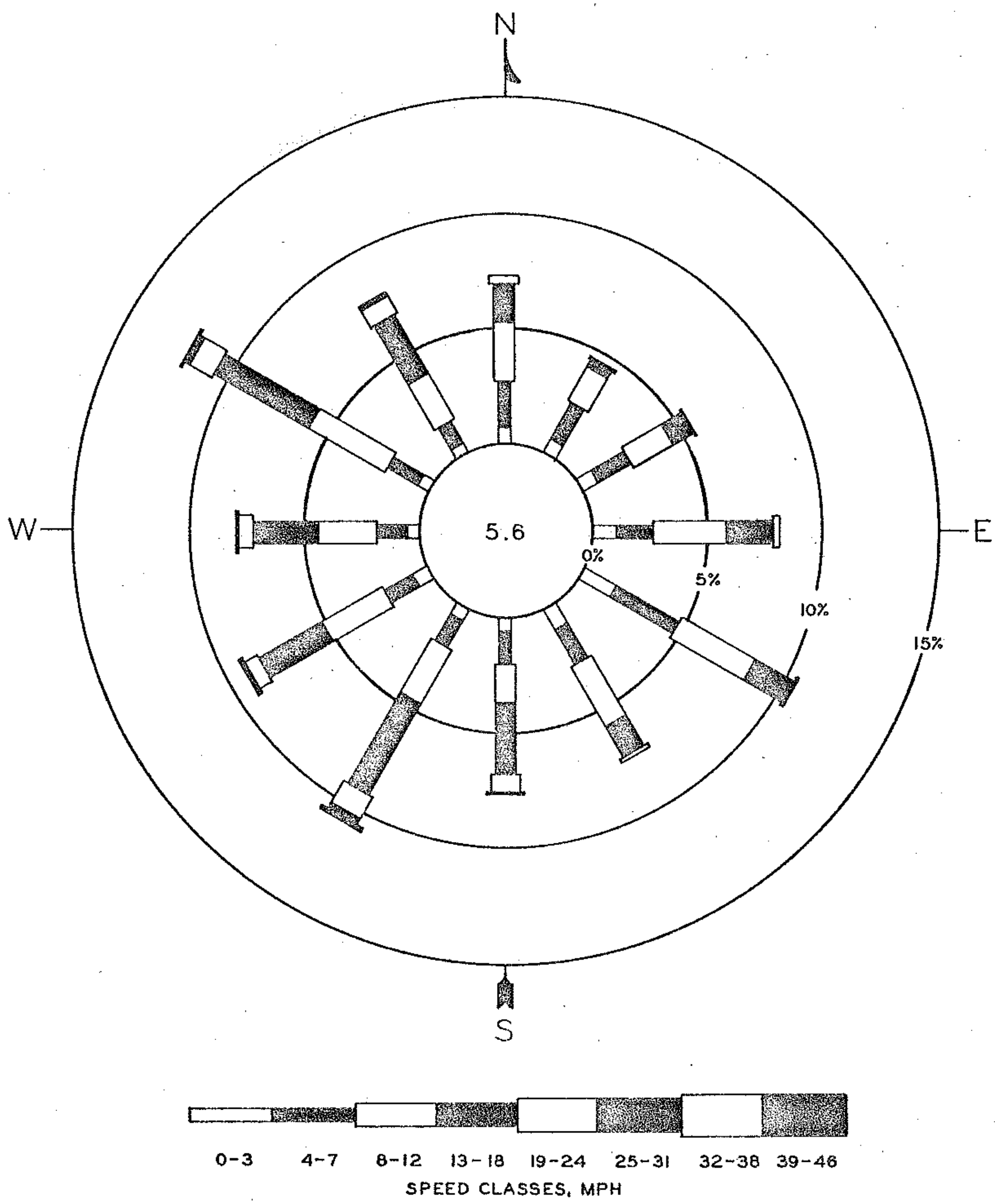

Figure 3. Frequency of wind direction and speed, percent (calms distributed).

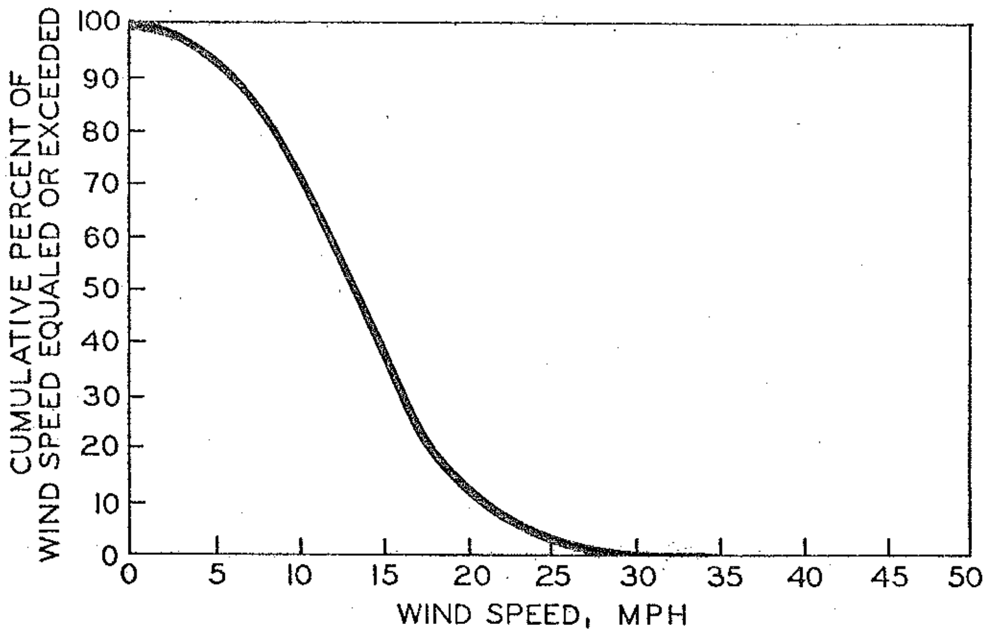

Figure 4. Wind speed distribution at Muskegon County Airport.

Pollution Estimates

Estimates of carbon monoxide concentrations were made at a height of 5 ft (1.5 m) 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.

Carbon monoxide concentrations were estimated for:

1) Three alternate alignments (A, B, and C). Alternates A and B are western alignments and Alternate C is an eastern alignment.

2) The years 1985 and 2000.

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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.

3) At the estimated distance to the nearest receptor (at the edge of the right-of-way).

4) Four major crossroads, I 94, I 94 BL, Napier Rd, and existing US 31.

5) At five sensitive receptors described later.

Information used as input to the model consisted of:

1) Vehicle emission factors shown in the following table were calculated using "Mobile Source Emission Factors," March 1978, U. S. Environmental Protection Agency. Emission factors were calculated at temperatures of 30 and 60 F with 20 percent of the vehicles in a cold start condition, 27 percent of the vehicles in a hot start condition, and the remainder of vehicles in a hot operation mode.

Vehicle age mix data is from Michigan's registrations and average annual miles driven for various age vehicles used were national estimates from "Mobile Source Emission Factors."

EMISSION FACTORS FOR
CARBON MONOXIDE, g/mi*

Year	Temperature	
	30 F	60 F
1985	18.5	15.6
2000	12.2	10.5

* Vehicle speed 55 mph with 5 percent heavy duty vehicles.

2) Estimated peak p.m. (4:00 to 5:00) 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.

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

Year	Alternates A, B, and C	Major Crossroad			
		I 94	I 94 BL	Napier Rd	Existing US 31
1985	5,730	9,960	2,300	1,490	1,330
2000	7,590	13,270	3,060	1,940	1,100

All speeds - 55 mph
Commercial vehicles - 5 percent
000 = peak traffic, vehicles per hour

b) Most probable meteorological conditions, 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.

4) Width of all alternates, 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, excluding background, at the nearest possible receptor to the roadway for the highest traffic volume section within each alternate. Also included in Table 3 are estimates of carbon monoxide adjacent to the I 94, I 94 BL, Napier Rd, and existing US 31 intersections.

Comparison of Estimates with Air Quality Standards

a) One-hour carbon monoxide standard - 40 mg/cu m (35 ppm), not to be exceeded more than once per year.

The maximum estimated one-hour concentration of carbon monoxide adjacent to the roadway in 1985 is 2.8 mg/cu m for all of the alternates and 8.7, 3.4, 4.2, and 3.9 mg/cu m adjacent to the I 94, I 94 BL, Napier Rd, and existing US 31 intersections, respectively. Adding these concentrations

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

Traffic Projection Year	Worst Condition, Parallel Wind, 1 m/sec, Stability D, Peak Traffic				
	Alternates A, B, and C	Major Crossroad			
		I 94	I 94 BL	Napier Rd	Existing US 31
1985	2.8	8.7	3.4	4.2	3.9
2000	2.4	7.6	2.9	3.7	2.9

In 1985 the worst condition for interchanges at I 94, Napier Rd, and at existing US 31 was found to be a wind parallel to the crossroads and 90 degrees to proposed US 31. The worst condition for the I 94 BL interchange was found to be a wind parallel to proposed US 31 and 90 degrees to I 94 BL. In 2000 the worst condition for the existing US 31 interchange was found to be a wind parallel to proposed US 31 and 90 degrees to existing US 31. The worst condition for the other interchanges did not change for the year 2000.

to the 4 to 8 mg/cu m estimated background results in total one-hour concentrations of 5.8 to 10.8 mg/cu m for all of the alternates and 12.7 to 16.7, 7.4 to 11.4, 8.2 to 12.2, and 7.9 to 11.9 mg/cu m adjacent to the I 94, I 94 BL, Napier Rd, and existing US 31 intersections, respectively. All are below the 40 mg/cu m standard.

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

The Federal Highway Administration's report "Project Level Considerations to Assure Adequate Air Quality Analyses," June 1977, suggests a technique for determining the eight-hour carbon monoxide concentration from the one-hour concentration.

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

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

V_1 = peak hour traffic volume in both directions

P = one to eight-hour meteorological persistence factor for the eight-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 eight-hour carbon monoxide level in 1985 for each alternate, and also adjacent to the major intersections the highest eight-hour concentration from the roadway for the alternates is:

Alternates A, B and C $= \frac{\text{1,460 vehicles per hour}}{\text{5,730 vehicles per hour}} \times 2.8 \text{ mg/cu m} \times 0.6 =$

0.4 mg/cu m

The highest eight-hour concentrations for all of the alternates adjacent to the intersections are:

I 94 Intersection

Proposed US 31 $= \frac{\text{1,460 vehicles per hour}}{\text{5,730 vehicles per hour}} \times 1.3 \text{ mg/cu m} \times 0.6 = 0.2 \text{ mg/cu m}$

I 94 $= \frac{\text{2,680 vehicles per hour}}{\text{9,960 vehicles per hour}} \times 7.4 \text{ mg/cu m} \times 0.6 = 1.2 \text{ mg/cu m}$

Total for I 94 intersection = 1.4 mg/cu m

I 94 BL Intersection

Proposed US 31 $= \frac{\text{1,460 vehicles per hour}}{\text{5,730 vehicles per hour}} \times 2.8 \text{ mg/cu m} \times 0.6 = 0.4 \text{ mg/cu m}$

I 94 BL $= \frac{\text{680 vehicles per hour}}{\text{2,300 vehicles per hour}} \times 0.6 \text{ mg/cu m} \times 0.6 = 0.1 \text{ mg/cu m}$

Total for I 94 BL intersection = 0.5 mg/cu m

Napier Rd Intersection

$$\text{Proposed US 31} = \frac{1,470 \text{ vehicles per hour}}{5,500 \text{ vehicles per hour}} \times 1.3 \text{ mg/cu m} \times 0.6 = 0.2 \text{ mg/cu m}$$

$$\text{Napier Rd} = \frac{640 \text{ vehicles per hour}}{1,490 \text{ vehicles per hour}} \times 2.9 \text{ mg/cu m} \times 0.6 = 0.7 \text{ mg/cu m}$$

Total for Napier Rd intersection = 0.9 mg/cu m

Existing US 31 Intersection

$$\text{Proposed US 31} = \frac{1,470 \text{ vehicles per hour}}{5,500 \text{ vehicles per hour}} \times 1.3 \text{ mg/cu m} \times 0.6 = 0.2 \text{ mg/cu m}$$

$$\text{Existing US 31} = \frac{590 \text{ vehicles per hour}}{1,330 \text{ vehicles per hour}} \times 2.6 \text{ mg/cu m} \times 0.6 = 0.7 \text{ mg/cu m}$$

Total for Existing US 31 intersection = 0.9 mg/cu m

Adding these concentrations to the 1 to 3 mg/cu m estimated maximum eight-hour background results in total carbon monoxide concentrations of 1.4 to 3.4 mg/cu m for all of the alternates and 2.4 to 4.4, 1.5 to 3.5, 1.9 to 3.9, and 1.9 to 3.9 mg/cu m adjacent to the I 94, I 94 BL, Napier Rd, and existing US 31 intersections, respectively. Carbon monoxide levels adjacent to all of the alternates are below the air quality standard.

The estimated concentrations of carbon monoxide including existing background, adjacent to 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 for carbon monoxide.

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).

TABLE 4
TRAFFIC ESTIMATES FOR US 31 TOTAL
POLLUTANT BURDEN (MESOSCALE) ANALYSIS

Roadway	Alternates A and B		Alternate C	
	1985	2000	1985	2000
I 94 to I 94 BL				
VMT	47,000	62,400	47,000	62,400
Average Speed	55	55	55	55
Percent Commercial	8	8	8	8
I 94 to Pipestone Rd				
VMT	148,400	197,900	199,500	266,000
Average Speed	55	55	55	55
Percent Commercial	8	8	8	8
Pipestone Rd to M 62				
VMT	134,900	180,400	75,700	101,100
Average Speed	55	55	55	55
Percent Commercial	8	8	8	8
M 62 to US 31				
VMT	82,100	109,300	82,500	109,700
Average Speed	55	55	55	55
Percent Commercial	8	8	8	8
US 31 to Snow Rd				
VMT	88,000	117,500	83,300	111,300
Average Speed	55	55	55	55
Percent Commercial	8	8	8	8
Snow Rd to Matthew Rd				
VMT	146,400	195,500	136,200	182,000
Average Speed	55	55	55	55
Percent Commercial	8	8	8	8

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 south side of Snow Rd. The camp grounds extend to the west right-of-way line of the proposed roadway.

The highest estimated carbon monoxide concentration at any of these sites under worst meteorological conditions is 2.7 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 2.2 mph (1 m/sec) wind blowing across existing I 94 toward the school, stability class D. The highest calculated values at 2, 3, and 4 sites were obtained with a 2.2 mph (1 m/sec) wind 90 degrees to the proposed roadway, stability class D. The highest value at site 5 was obtained with a 2.2 mph (1 m/sec) wind parallel to the proposed roadway, stability D.

Total Pollutant Burden Analysis

A total pollutant burden analysis for carbon monoxide, hydrocarbons, and oxides of nitrogen is included for each of the alternates for the years 1985 and 2000. Information used included:

1) Vehicle emission factors calculated as described previously in Item (1), under information used as input to the model.

2) Estimates of daily vehicle miles traveled, average vehicle speeds, and percent heavy duty vehicles (Table 4). The percentage of commercial vehicles is higher in Table 4 than in Table 1, 8 percent vs. 5 percent, because the burden analysis is based on average daily traffic rather than peak traffic. During peak traffic the percentage of commercial vehicles is diluted by an influx of automobiles. The total pollutant burden data presented in Table 5 show no significant difference in pollutant emissions for the alternate routes.

TABLE 5
ESTIMATES OF TOTAL POLLUTANT BURDEN

Traffic Projection Year	Alternate	Pollutant (tons/day)					
		Carbon Monoxide		Hydro-carbons		Oxides of Nitrogen	
		30 F*	60 F	30 F	60 F	30 F	60 F
1985	A and B	14.62	12.56	1.29	1.14	2.84	2.84
	C	14.11	12.12	1.25	1.10	2.74	2.74
2000	A and B	12.88	11.35	1.16	0.99	2.83	2.83
	C	12.43	10.95	1.12	0.96	2.73	2.73

* Ambient air temperature