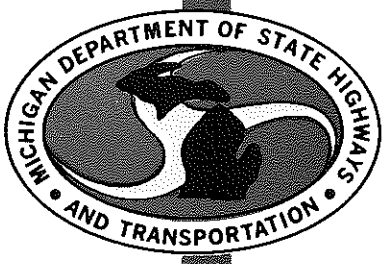
AIR QUALITY REPORT FOR M 29 IN THE CITY OF ALGONAC, ST. CLAIR COUNTY



TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION

AIR QUALITY REPORT FOR M 29 IN THE CITY OF ALGONAC, ST. CLAIR COUNTY

Research Laboratory Section
Testing and Research Division
Research Project 74 TI-199
Research Report No. R-920RR

Michigan State Highway Commission
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Vice-Chairman; Hannes Meyers, Jr., Weston E. Vivian
John P. Woodford, Director
Lansing, June 1978

This report presents air quality information on a proposed section of M 29 in the City of Algonac, St. Clair County. Figure 1 shows the project location. The report includes meteorological data and estimates of pollutant levels that might occur adjacent to the proposed roadway.

Topography and Demography

St. Clair County is part of a flat plain, which facilitates dispersion of air pollutants. The population of St. Clair County is 46 percent urban with a population density of 164 per square mile.

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 Detroit City Airport, 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 4 mph more than 95 percent of the time. The most probable daytime wind speed was found to be 11 mph.

Existing Ambient Air Quality

Since no data were available to establish presently existing air quality in the area of this project, the background concentration of carbon monoxide was estimated at the same levels that exist in other small urban areas (1 to 3 mg/cu m for a maximum 8-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.

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 wind speed and direction, traffic volumes, vehicle emission factors, and design of the highway.

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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) Two alternate alignments identified as follows:

Alternate A:

East-West Section - Five 11-ft lanes in 90 ft of right-of-way.
North-South Section - Four 11-ft lanes in 70 ft of right-of-way.

Alternate B:

East-West Section - Five 11-ft lanes in 90 ft of right-of-way.
North-South Section - A one way system. Northbound - three 12-ft lanes in 70 ft right-of-way. Southbound - three 12-ft lanes in 60 ft of right-of-way.

(2) The location of the nearest possible receptor; 4 m (13 ft) from the edge of the roadway for both alternates.

(3) Five locations near three sensitive receptors described later.

(4) The years 1980 and 2000.

Information used as input to the model consisted of:

(1) Vehicle emission factors, shown in the following table. These factors were 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 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 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 *

Year	Temperature 30°F	60°F
1980	27.4	17.3
2000	10.4	6.0

* Vehicle speed 35 mph with 2 percent heavy duty vehicles.

(2) Estimated p.m. peak (4:00 p.m. to 5:00 p.m.), traffic volumes. Traffic estimates are shown in Table 1.

(3) Meteorological Conditions

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

(b) Most probable meteorological conditions, a 5 m/sec (11 mph) wind at 280 degrees under atmospheric stability class D.

(4) Road Profile. All alternates are at grade.

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

All estimates of carbon monoxide levels represent 1-hour concentrations and are in addition to existing background levels. Table 2 presents estimates of carbon monoxide, excluding background, at the nearest 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 Considerations to Assure Adequate Air Quality Analyses" suggests a technique for determining the 8-hour carbon monoxide concentration from the 1-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 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 1980 adjacent to both alternates the highest 8-hour concentration from the roadway at 30°F ambient temperature are:

Alternate A

$$\text{East-West Section} = \frac{440 \text{ vehicles per hour}}{1740 \text{ vehicles per hour}} \times 5.0 \text{ mg/cu m} \times 0.6 = 0.8 \text{ mg/cu m}$$

North-South Section = $\frac{620 \text{ vehicles per hour}}{2020 \text{ vehicles per hour}}$ x 5.8 mg/cu m. x 0.6 = 1.1 mg/cu m

Alternate B

East-West Section = $\frac{660 \text{ vehicles per hour}}{2600 \text{ vehicles per hour}}$ x 7.4 mg/cu m x 0.6 = 1.1 mg/cu m

North-South Section

Northbound = $\frac{390 \text{ vehicles per hour}}{1400 \text{ vehicles per hour}}$ x 4.0 mg/cu m x 0.6 = 0.7 mg/cu m

Southbound = $\frac{390 \text{ vehicles per hour}}{1400 \text{ vehicles per hour}}$ x 4.0 mg/cu m x 0.6 = 0.7 mg/cu m

Adding these concentrations to the 1 to 3 mg/cu m estimated maximum 8-hour background results in total carbon monoxide concentrations of 1.8 to 3.8 and 2.1 to 4.1 mg/cu m for Alternate A East-West and North-South Section, respectively, and 2.1 to 4.1 and 1.7 to 3.7 mg/cu m for Alternate B East-West and North-South Sections, respectively (northbound and southbound roadways have identical concentrations). Carbon monoxide levels adjacent to both of the alternates are below the air quality standard. For the year 2000 the carbon monoxide concentrations are estimated to be much lower than 1980 concentrations due to vehicle exhaust controls required by Federal Law.

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

The maximum estimated 1-hour concentrations of carbon monoxide adjacent to the roadway in 1980 are 5.0 and 5.8 mg/cu m for Alternate A, East-West and North-South Sections, respectively, and 7.4 and 4.0 mg/cu m for Alternate B, East-West and North-South Sections, respectively (northbound and southbound roadways have identical concentrations). Adding these concentrations to the 4-8 mg/cu m estimated background results in total 1-hour concentrations of 9.0 to 13.0 and 9.8 to 13.8 mg/cu m for Alternate A, East-West and North-South Sections, respectively, and 11.4 to 15.4 and 8.0 to 12.0 mg/cu m for Alternate B, East-West and North-South Sections, respectively. All are below the 40 mg/cu m standard.

The estimated concentrations of carbon monoxide including existing estimated background adjacent to both of the alternates of the proposed roadway are within national air quality standards. No significant difference in carbon monoxide concentrations between the two alternates 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 Receptors

Concentrations of carbon monoxide were estimated at five locations; three in a school and playground complex, one in a senior citizens housing complex, and one

in a low income housing complex near the intersection of Fruit Street and proposed M 29 as shown in Figure 5. The locations are as follows:

School and Playground Complex

Site 1. At the wall of a classroom building closest to the proposed roadway.

Site 2. At the wall of the main school building closest to the proposed roadway.

Site 3. At the fence separating the playground from the proposed right-of-way.

Low Income Housing Complex

Site 4. At the northwest edge of the low income housing property (edge nearest the proposed roadway).

Senior Citizen Housing Complex

Site 5. At the southwest edge of the senior citizen housing property (edge nearest the proposed roadway).

Estimated worst case levels of carbon monoxide from the roadway under peak traffic conditions, with a 1 m/sec wind blowing parallel to the roadway under Stability D for the receptors for both alternates are shown in Table 3. Receptor 5 is the only one included under Alternate A, since Alternate A is so far from the other receptors that it would have no significant influence on carbon monoxide levels in their proximity. The highest carbon monoxide levels from either of the alternates adjacent to any of the receptors in 1980 is 4.5 mg/cu m for Alternate A. If the highest estimated 1-hour background of 8 mg/cu m is added, the highest 1-hour carbon monoxide concentration at any of the receptors is 12.5 mg/cu m which is far below the Federal one hour Air Quality Standard. The 8-hour average corresponding to a one-hour average of 4.5 mg/cu m of carbon monoxide for Alternate A is 0.8 mg/cu m. Adding this to the maximum 8-hour average estimated background of 3 mg/cu m yields a total carbon monoxide concentration of 3.8 mg/cu m, well below the Federal eight hour air quality standard of 10 mg/cu m.

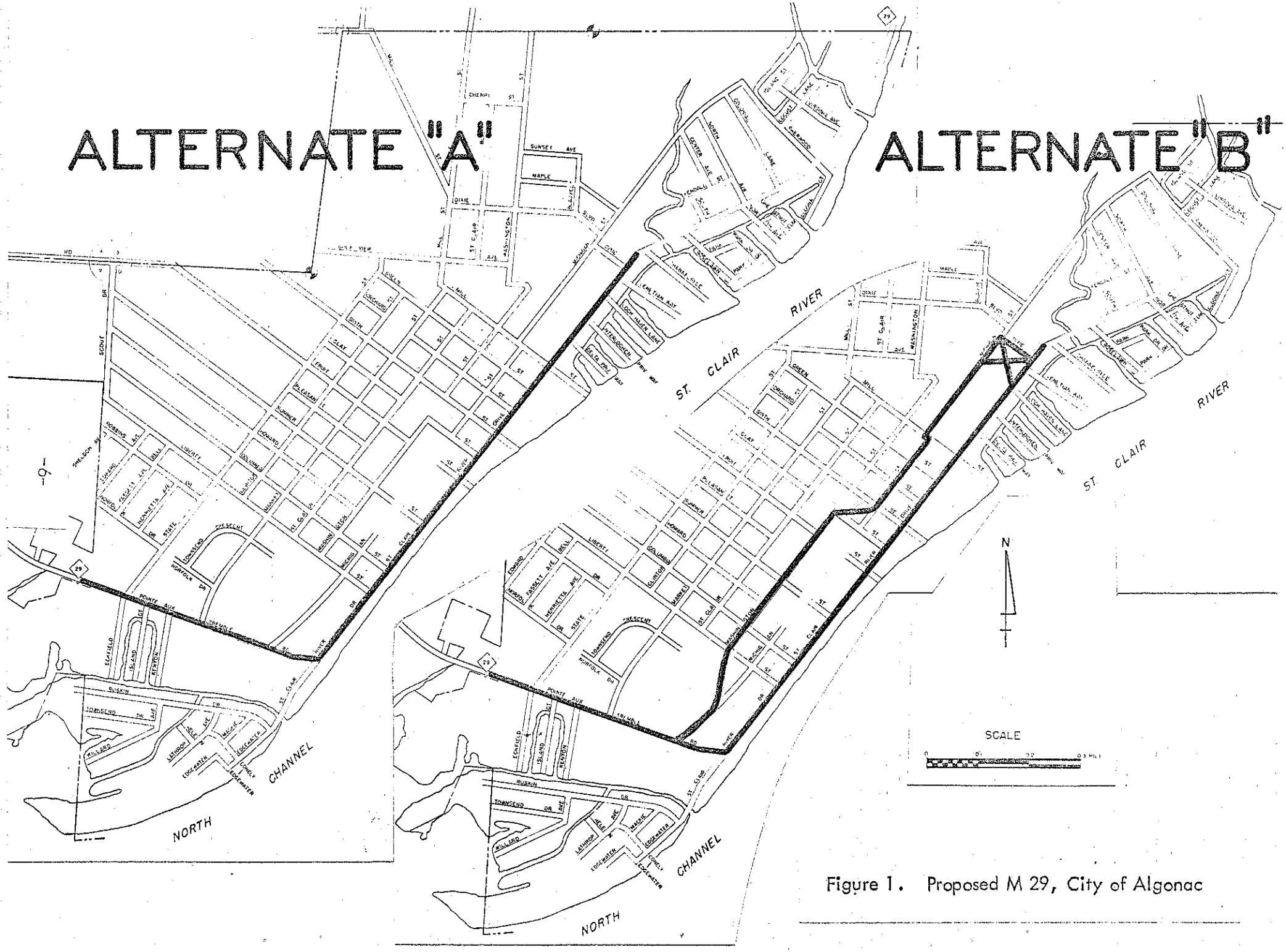

Figure 1. Proposed M 29, City of Algonac

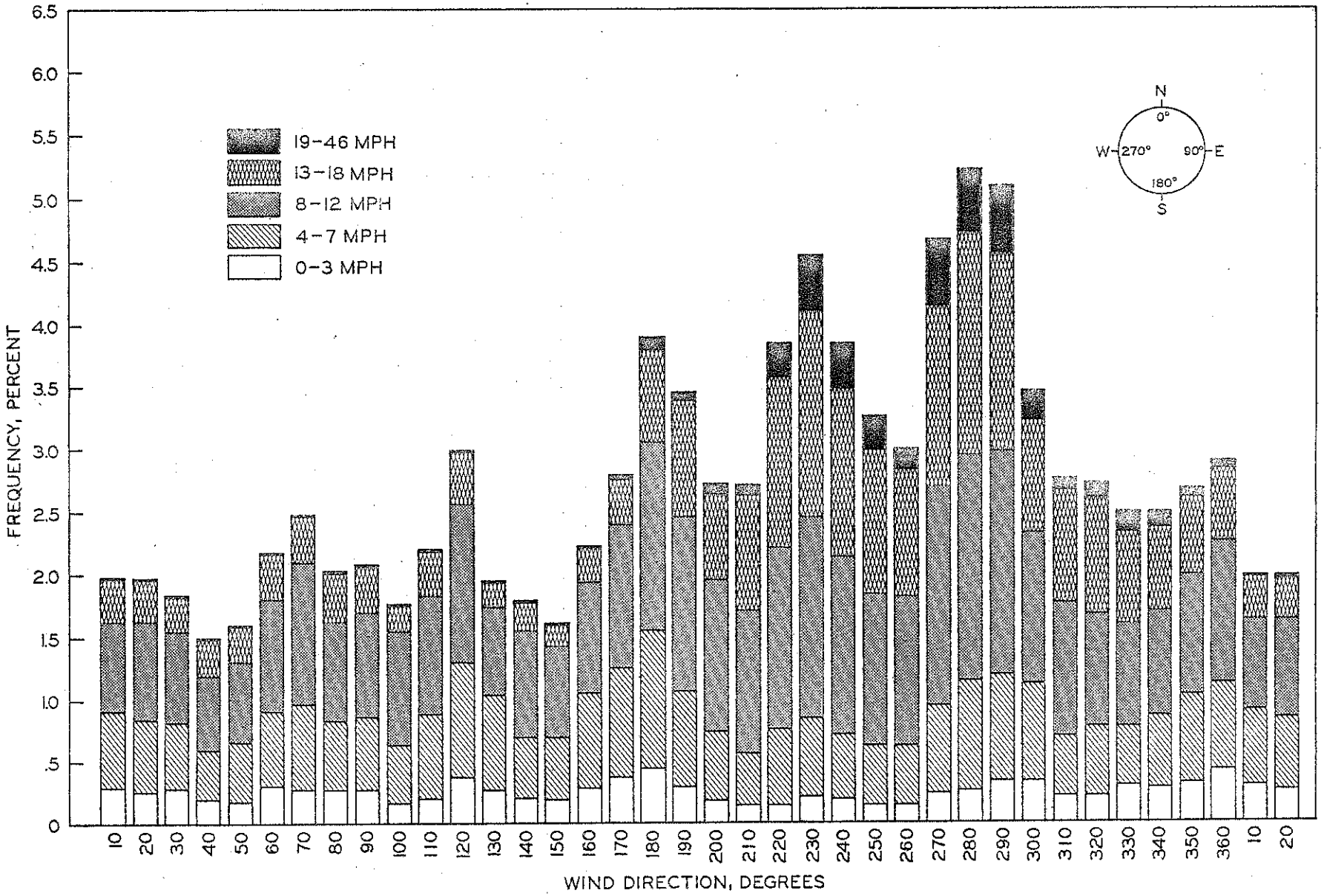

Figure 2. Wind speed and direction occurrences at Detroit City Airport.

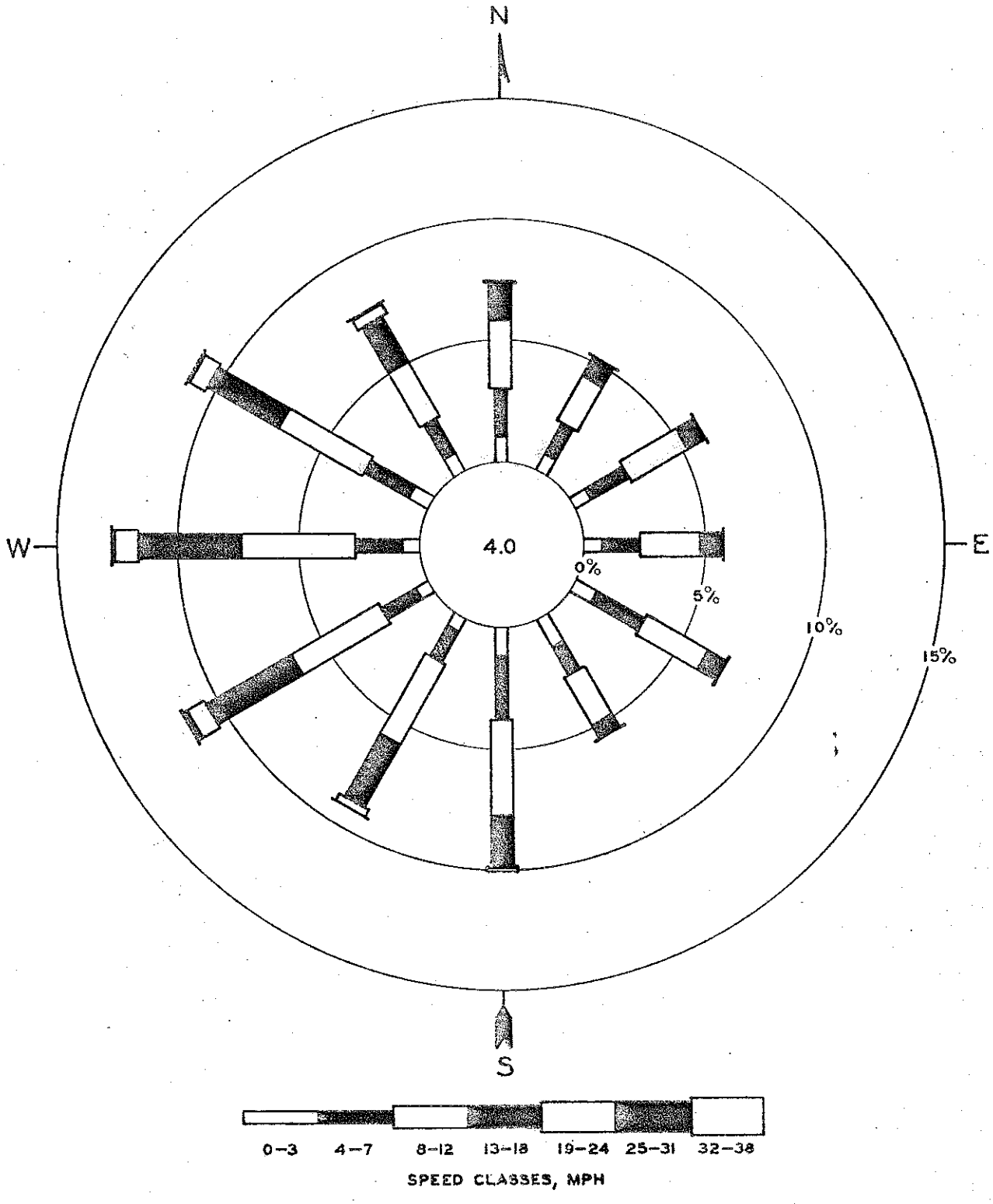

Figure 3. Frequency of wind direction and speed, percent (calms distributed).

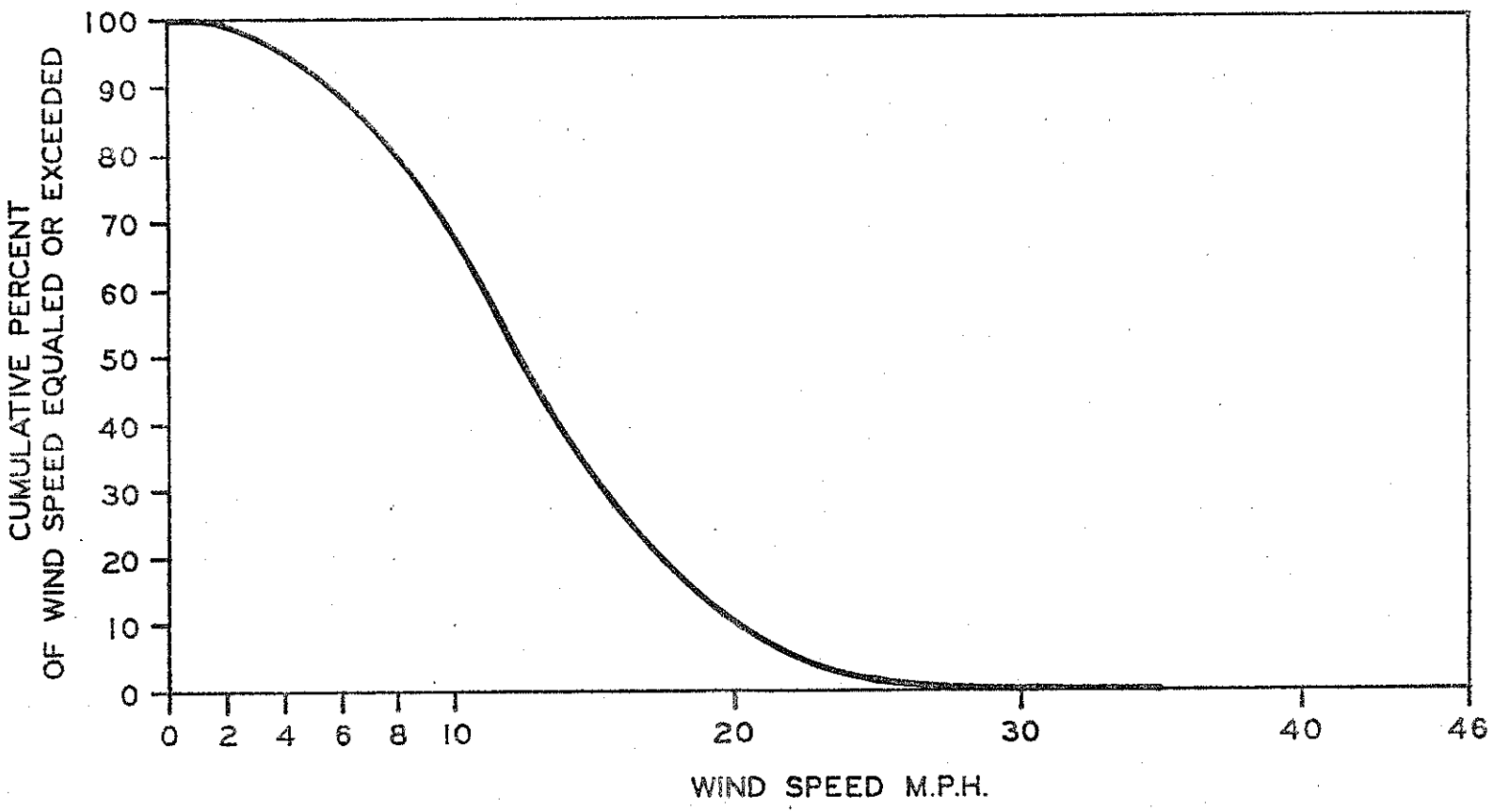

Figure 4. Wind speed distribution at Detroit City Airport.

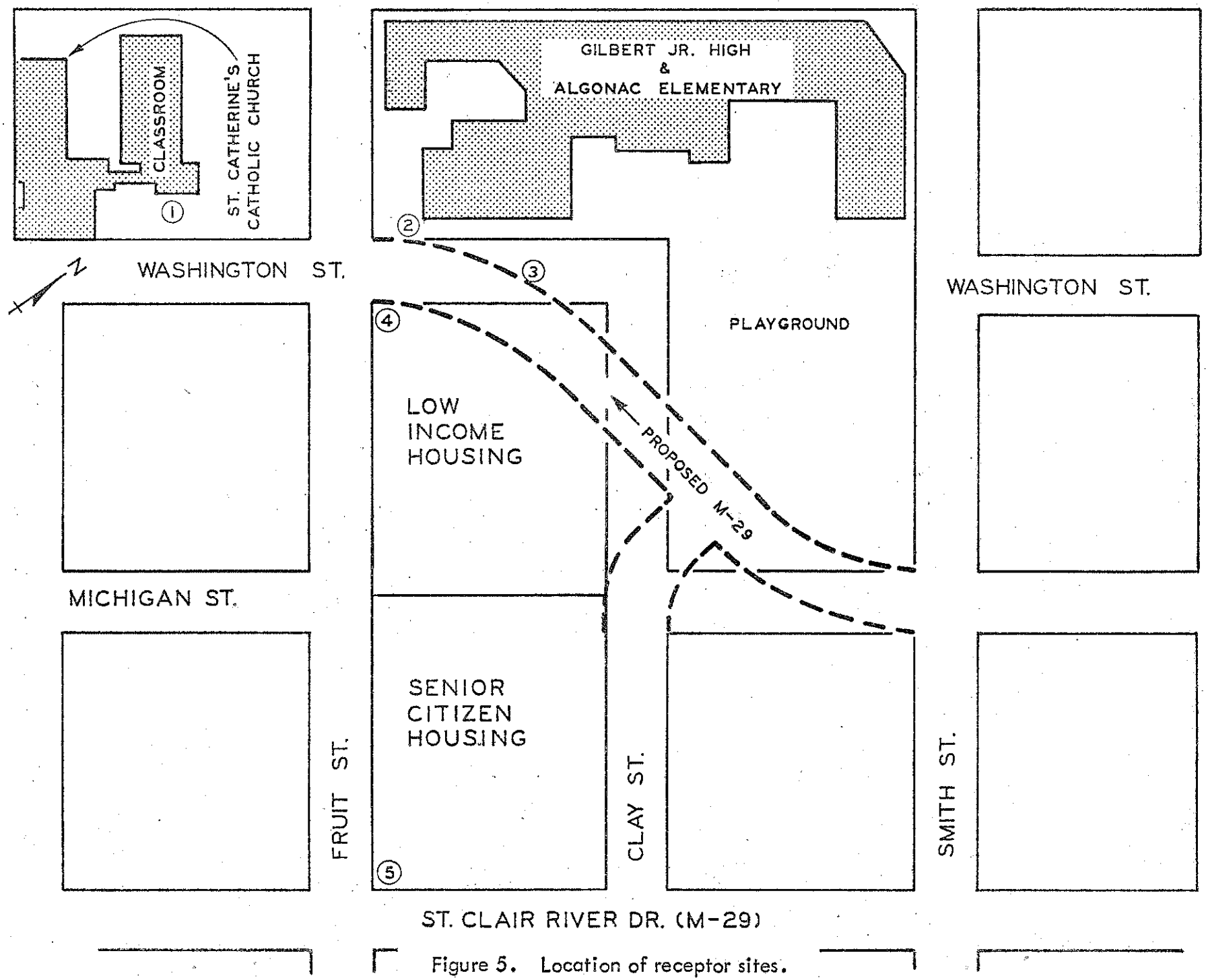

Figure 5. Location of receptor sites.

TABLE 1

Traffic Estimates for Proposed M 29 in the City of Algonac

Year	Alternate				
	A		B		
	East-West Section	North-South Section	East-West Section	North-South Section	
				Northbound	Southbound
1980	10,900 〈1,740〉	15,600 〈2,020〉	16,600 〈2,600〉	9,800 〈1,400〉	9,800 〈1,400〉
2000	16,600 〈2,480〉	23,600 〈3,000〉	27,300 〈4,000〉	15,000 〈2,000〉	15,000 〈2,000〉

Commercial vehicles: 2 percent all sections

000 average daily traffic, vehicles in 24 hr.

〈000〉 p.m. peak traffic, vehicle per hour.
average vehicle speed - 35 mph all sections.

TABLE 2

Estimates of Carbon Monoxide From the Roadway, mg/cu m
(Not Including Background)

Traffic Projection Year	Location	Worst Condition, Parallel Wind, 1 m/sec, Stability D, Peak Traffic		Most Probable Condition[1], Stability D, Peak Traffic	
		30°F*	60°F	30°F	60°F
1980	Alternate A				
	East-West	5.0	3.2	1.0	0.6
	North-South	5.8	3.7	0.4	0.3
	Alternate B				
	East-West	7.4	4.7	1.5	0.9
	North-South				
	Northbound	4.0	2.5	0.3	0.2
	Southbound	4.0	2.5	0.3	0.2
2000	Alternate A				
	East-West	2.7	1.5	0.5	0.3
	North-South	3.3	1.9	0.2	0.1
	Alternate B				
	East-West	4.3	2.5	0.9	0.5
	North-South				
	Northbound	2.2	1.3	0.2	0.1
	Southbound	2.2	1.3	0.2	0.1

(*) Ambient Air Temperature.

1 Most probable wind: 5 m/sec (11 mph); angle between wind direction and roadway direction, East-West Section 10 degrees, North-South Section 75 degrees.

TABLE 3
Carbon Monoxide, mg/cu m at Receptor Sites

Location	Traffic Projection Year	Alternate A	Alternate B
1	1980	---	2.6
	2000	---	1.4
2	1980	---	2.6
	2000	---	1.4
3	1980	---	4.0
	2000	---	2.2
4	1980	---	4.0
	2000	---	2.2
5	1980	4.5	3.1
	2000	2.5	1.7