

AIR QUALITY SECTION FOR THE FINAL ENVIRONMENTAL  
IMPACT STATEMENT FOR PROPOSED I 475

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MICHIGAN DEPARTMENT OF STATE HIGHWAYS

AIR QUALITY SECTION FOR THE FINAL ENVIRONMENTAL  
IMPACT STATEMENT FOR PROPOSED I 475.

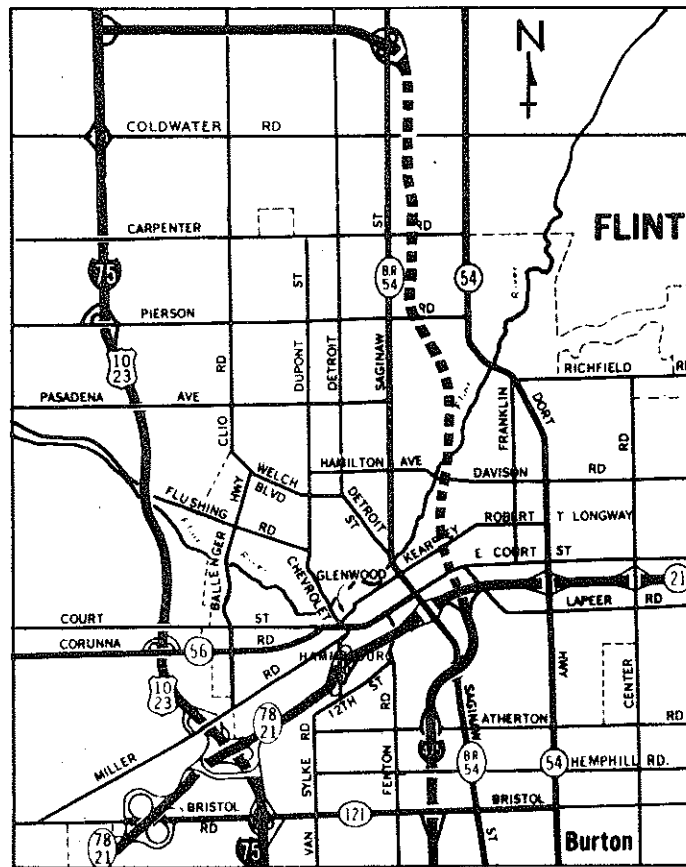
Research Laboratory Section  
Testing and Research Division  
Research Project 72 TI-100  
Research Report No. R-862  
(EV-25)

Michigan State Highway Commission  
E. V. Erickson, Chairman; Charles H. Hewitt,  
Vice-Chairman, Claude J. Tobin, Peter B. Fletcher  
Lansing, June 1973

This report presents air quality information for the environmental impact statement concerning a part of proposed I 475. Included are meteorological data, a limited quantity of ambient air quality data, and estimates of pollution levels that might occur adjacent to the freeway if it is constructed.

### General Description of the Project

This 6.5 mile freeway project is in an urban area, in the city of Flint, Genesee County, and is surrounded by flat to gently rolling terrain, which facilitates dispersal of air pollutants.



### Summary

Examination of meteorological data shows that the potential for air pollution episodes in the area of this project is quite low. Wind direction is variable and the probable daytime wind speed exceeds 11 mph, which means that pollutants are quickly diluted and dispersed.

Pollution estimates made by a mathematical model indicate that pollutant levels adjacent to this segment of I 475 will be quite low. The project does not conflict with the State of Michigan Implementation Plan for meeting Federal air quality standards.

Figure 1 shows estimated worst condition carbon monoxide levels which are (in addition to existing background) resulting from traffic on the proposed freeway. These values were calculated using peak traffic estimates under unfavorable wind conditions of a 3 mph wind blowing parallel to the roadway. Carbon monoxide levels will seldom reach even these modest values because the wind will normally blow across the freeway at considerably higher speeds, and peak traffic persists for only a few hours each day.

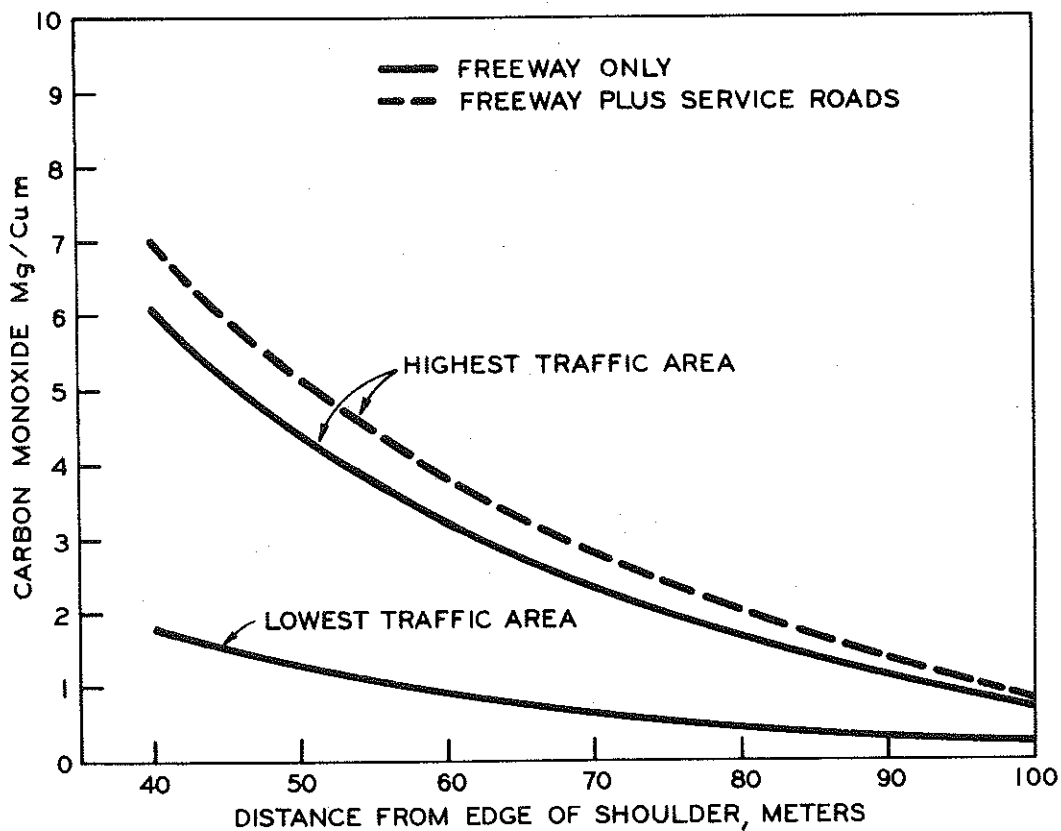


Figure 1. Estimated worst condition of carbon monoxide concentrations from the proposed freeway, 1980.

Figure 2 shows the trend of estimated total carbon monoxide emissions during a 20-year period after completion of the project. The decrease in carbon monoxide emission, even though traffic volumes will increase, is due to Federal exhaust emission controls on vehicles.

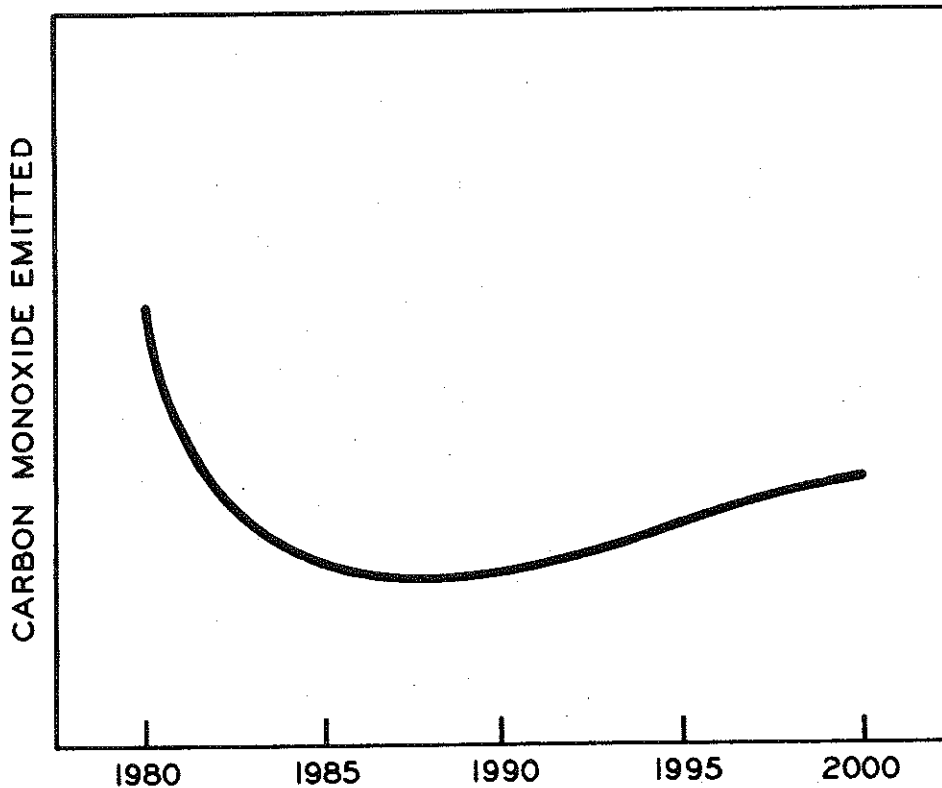


Figure 2. Trend of carbon monoxide emission from the proposed freeway over a 20-year period.

### Meteorology

Meteorological data (hourly observations) recorded at Bishop Airport near Flint were summarized over a five year period from 1967 through 1971 using a one day in nine day statistical sampling with a random start each year. The data were obtained from the National Weather Records Center at Asheville, North Carolina. Figure 3 shows the frequency of wind direction and wind speed on a 36-point bar graph. Figure 4 shows a 12-point wind rose for the same data. Since Michigan lies in the normal track of migrating high and low pressure centers at all times of the year, there is great variation in day to day weather. Thus, while the "prevailing" wind direction is from westerly directions, the wind actually comes from any given direction only about 6 percent of the time. Even on occasions when atmospheric inversions restrict vertical dispersion of pollutants, horizontal ventilation continues freely. Figure 5 shows that about 97 percent of the time wind speeds exceed 4 mph. The most probable wind speeds are 12 mph for off-peak daytime traffic and 11 mph for peak p. m. traffic (3:30 to 4:30).

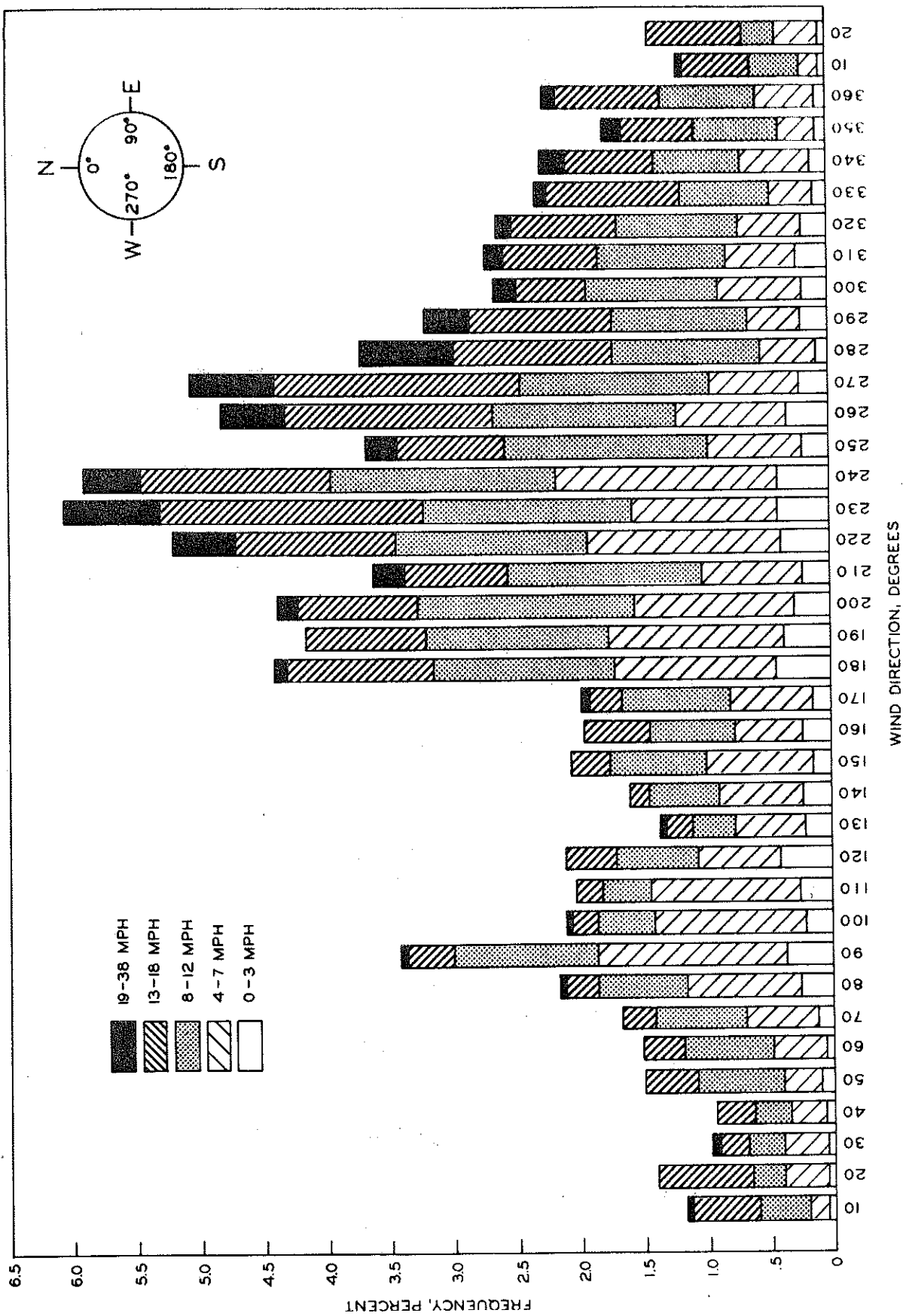


Figure 3. Wind speed and direction occurrences at Bishop Airport.

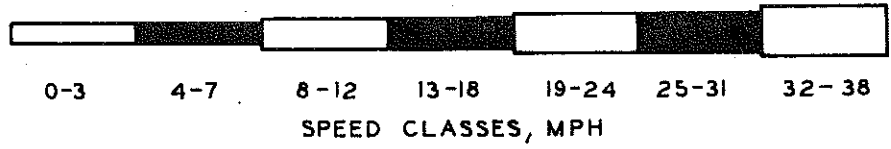
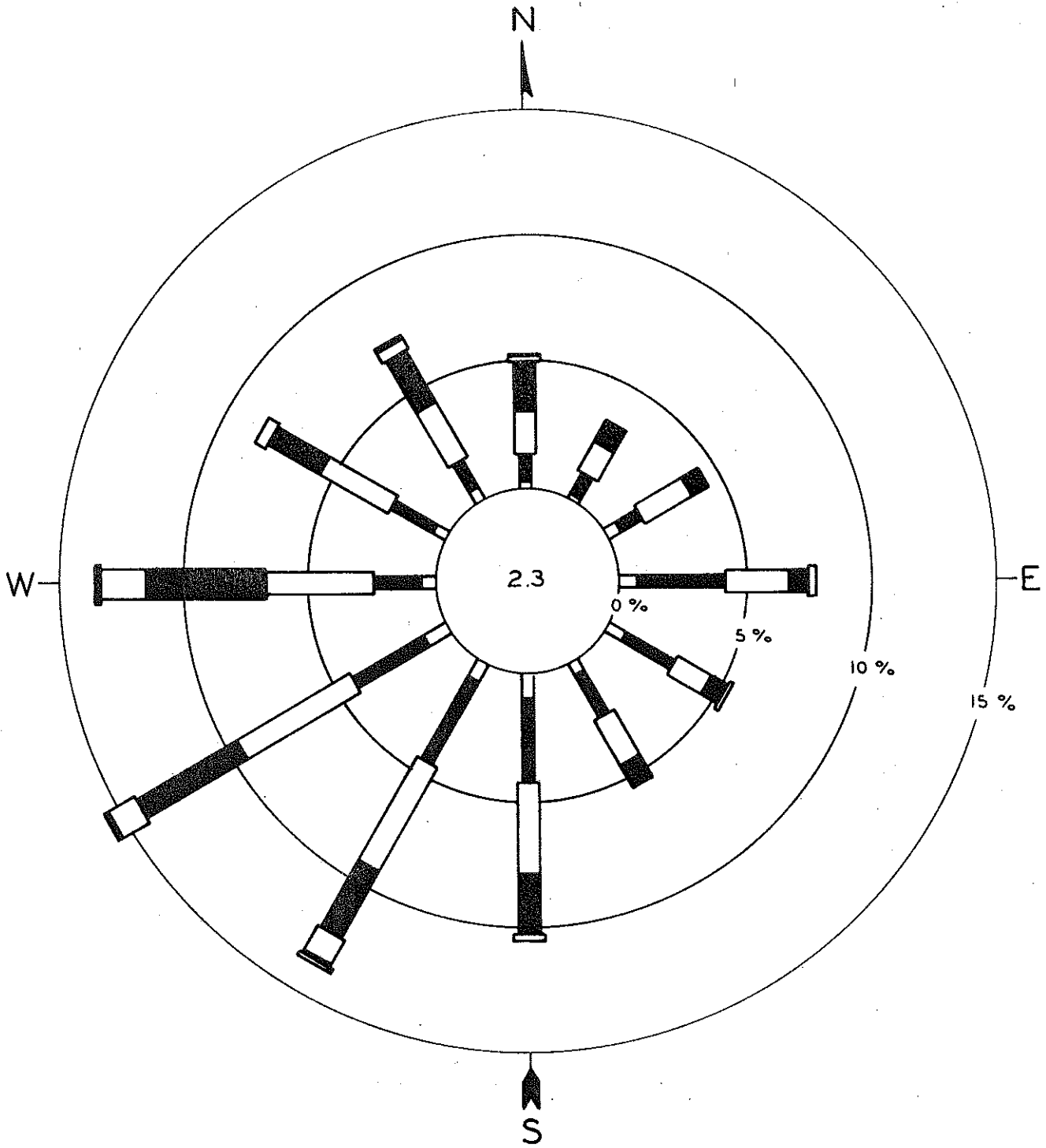


Figure 4. Frequency of wind direction and speed, percent (calms distributed).

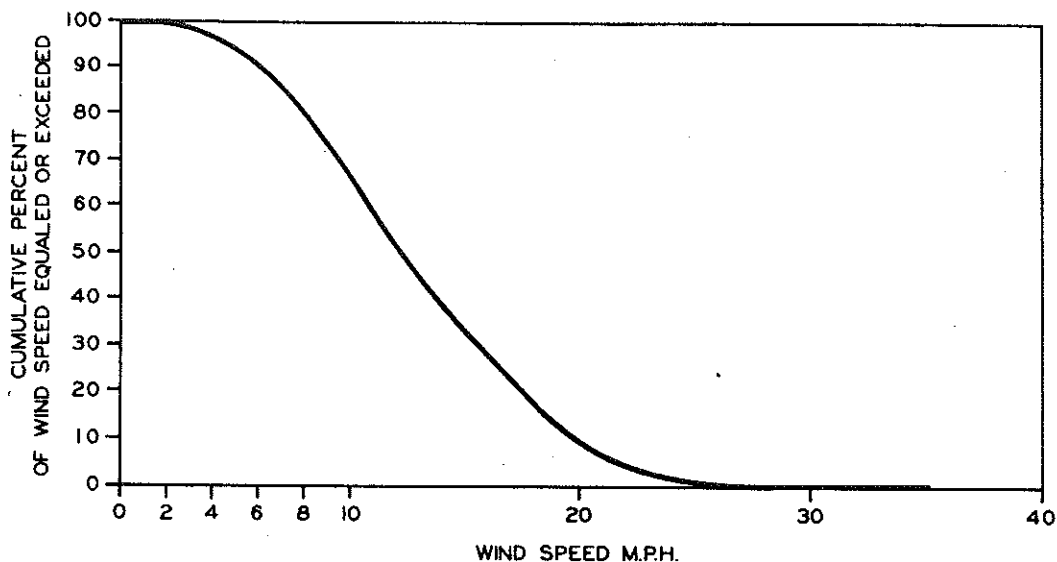


Figure 5. Wind speed distribution at Bishop Airport.

There is insufficient time for photochemical reaction between air pollutants to take place before dispersion and dilution occur. As a result, photochemical smog of the Los Angeles type is not thought to occur in Michigan<sup>1</sup>.

The potential for air pollution episodes is related to the incidence of stagnating anticyclones (high pressure areas) with associated inversions that linger a few days. A study covering the 30 year period, 1936 through 1965<sup>2</sup> found that stagnating anticyclones lasting 4 days or more occurred in the Michigan vicinity on the average about once every two years. Thus, the potential for air pollution episodes in the area of this project is quite low.

#### Existing Ambient Air Quality

No data for carbon monoxide levels in the proposed construction area were available from any source. The only information available on nitrogen dioxide levels was from a National Air Sampling Network Station at the Flint City Hall, near the proposed project. Those data are strongly dis-

<sup>1</sup>Implementation Plan for the Control of Suspended Particulates, Sulfur Oxides, Carbon Monoxide, Hydrocarbons, Nitrogen Oxides, and Photochemical Oxidants in the State of Michigan, January 1972, pp. 5-9 to 5-11.

<sup>2</sup>Ibid p. 1-2.



puted by the State of Michigan<sup>3</sup>, which contends that the nitrogen dioxide levels reported exceed actual levels by a considerable margin. For the present we conclude that no useable data on nitrogen dioxide levels are available.

A limited number of carbon monoxide determinations were made along the proposed construction corridor by the Department's Research Laboratory, using the NBS indicator tube method. Table 1 presents the results obtained at locations indicated by numbers on the map in Figure 6, and shows the meteorological conditions that prevailed during the sampling periods.

### Pollution Estimates

Estimates of pollutant concentrations 1.8 meters (5 ft) above the ground were made for carbon monoxide and nitrogen oxides (as nitrogen dioxide) under various wind conditions at distances up to 100 meters from the shoulder of the roadway. A mathematical model based on the Gaussian Diffusion Equation<sup>4</sup>, modified for a line source, was used. This model has not been completely validated but it is accepted by the Federal Environmental Protection Agency and the Federal Highway Administration. Inputs to the model include, meteorological conditions, traffic volumes, vehicle emission factors, and design and direction of the highway.

Vehicle emission factors shown in the following Table were developed using a calculation method recommended at a FHWA Air Pollution Workshop held at Airlie Virginia, during February 1973. These emission factors are believed to be based on the work of D. S. Kircher and D. O. Armstrong, Environmental Protection Agency, Durham, North Carolina.

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<sup>3</sup>Implementation Plan for the Control of Suspended Particulates, Sulfur Oxides, Carbon Monoxide, Hydrocarbons, Nitrogen Oxides, and Photochemical Oxidants in the State of Michigan, January 1972, p. 1-2.

<sup>4</sup>J. L. Beaton, A. J. Ranzieri, E. C. Shirley and J. B. Skog, Mathematical Approach to Estimating Highway Impact on Air Quality. Prepared by California Division of Highways. National Technical Information Service, Springfield, Va. 22157 Report No. FHWA-RD-72-36.

EMISSION FACTORS g/mi  
(5% Heavy Duty Vehicles)

Carbon Monoxide

| Year | Speed, Miles Per Hour |      |     |      |      |     |     |     |     |
|------|-----------------------|------|-----|------|------|-----|-----|-----|-----|
|      | 15                    | 20   | 25  | 30   | 35   | 40  | 45  | 50  | 55  |
| 1980 | ---                   | 16.0 | --- | 11.2 | 10.1 | 8.9 | 8.1 | 7.9 | 7.7 |
| 1985 | ---                   | 7.5  | --- | 5.3  | 4.7  | 4.2 | 3.8 | 3.7 | 3.6 |
| 1990 | 8.3                   | ---  | --- | 4.5  | 4.1  | --- | 3.3 | 3.2 | 3.1 |
| 1995 | 8.3                   | ---  | 5.3 | 4.5  | ---  | 3.6 | 3.3 | 3.2 | 3.1 |
| 2000 | 8.3                   | ---  | 5.3 | 4.5  | ---  | 3.6 | 3.3 | --- | 3.1 |

Nitrogen Dioxide

| Year | Speed, Miles Per Hour |     |     |     |     |     |     |     |     |
|------|-----------------------|-----|-----|-----|-----|-----|-----|-----|-----|
|      | 15                    | 20  | 25  | 30  | 35  | 40  | 45  | 50  | 55  |
| 1980 | ---                   | 2.2 | --- | 2.5 | 2.6 | 2.7 | 2.9 | 3.0 | 3.1 |
| 1985 | ---                   | 1.4 | --- | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 |
| 1990 | 1.2                   | --- | --- | 1.4 | 1.5 | --- | 1.7 | 1.7 | 1.8 |
| 1995 | 1.2                   | --- | 1.3 | 1.4 | --- | 1.6 | 1.7 | 1.7 | 1.8 |
| 2000 | 1.2                   | --- | 1.3 | 1.4 | --- | 1.6 | 1.7 | --- | 1.8 |

TABLE 1  
 AMBIENT AIR DATA ALONG PROPOSED I 475 CORRIDOR

| Sample Site No. | Location                    | Sample Date | Time       | CO, mg/cu m | Wind                   |            | Sky Cover, tenths | Ceiling, k-ft | Temp, F |
|-----------------|-----------------------------|-------------|------------|-------------|------------------------|------------|-------------------|---------------|---------|
|                 |                             |             |            |             | Direction <sup>1</sup> | Speed, mph |                   |               |         |
| 1               | Saginaw St. at M 78         | 9-14-72     | 2:10 p.m.  | 1           | 01                     | 18         | 1                 | 20            | 67      |
| 2               | Park St. at M 78            | 9-11-72     | 12:35 p.m. | 2           | 22                     | 8          | 10                | 20            | 68      |
| 3               | Court St. SW corner         | 9-14-72     | 5:15 p.m.  | 1           | 35                     | 4          | 0                 | 20            | 67      |
| 4               | Court St. NE corner         | 9-11-72     | 11:45 a.m. | 2           | 22                     | 8          | 10                | 20            | 68      |
| 5               | First St. at East St.       | 9-27-72     | 8:30 a.m.  | 1           | 03                     | 14         | 7                 | 20            | 50      |
| 6               | Kearsley St. at Lewis Blvd  | 9-11-72     | 11:20 a.m. | 3           | 25                     | 8          | 10                | 20            | 67      |
| 7               | Avon St. at Lewis Blvd      | 9-14-72     | 3:00 p.m.  | 2           | 02                     | 7          | 3                 | 20            | 67      |
|                 | Avon St. at Lewis Blvd      | 9-14-72     | 4:45 p.m.  | 2           | 35                     | 4          | 0                 | 20            | 67      |
|                 | Avon St. at Lewis Blvd      | 9-27-72     | 10:00 a.m. | 1           | 04                     | 10         | 5                 | 20            | 52      |
| 8               | Broadway Ave                | 9-11-72     | 10:40 a.m. | 1           | 25                     | 8          | 10                | 20            | 67      |
| 9               | Leith St. at Boulevard Dr   | 9-14-72     | 3:45 p.m.  | 1           | 02                     | 7          | 2                 | 20            | 67      |
|                 | Leith St. at Boulevard Dr   | 9-27-72     | 9:30 a.m.  | 1           | 04                     | 10         | 5                 | 20            | 52      |
| 10              | Stewart Ave                 | 9-27-72     | 7:30 a.m.  | 2           | 05                     | 12         | 7                 | 20            | 49      |
|                 | Stewart Ave                 | 9-27-72     | 10:30 a.m. | 1           | 04                     | 8          | 7                 | 20            | 55      |
| 11              | Thetford at Keenly Ave      | 9-27-72     | 8:00 a.m.  | 2           | 05                     | 12         | 7                 | 20            | 49      |
| 12 <sup>1</sup> | Pierson Rd and C&O RR       | 4-26-73     | 2:30 p.m.  | 5           | 04                     | 10         | 8                 | 20            | 61      |
| 13              | Carpenter Rd and Horton Ave | 4-26-73     | 1:50 p.m.  | 2           | 01                     | 12         | 7                 | 20            | 60      |
| 14              | Kurtz Ave and Alfred St     | 4-26-73     | 1:15 p.m.  | 1           | 04                     | 10         | 10                | 20            | 58      |
| 15              | Coldwater Rd and Alfred St  | 4-26-73     | 12:15 p.m. | 2           | 05                     | 6          | 6                 | 20            | 57      |
| 16              | Hartman Ave and George St   | 4-26-73     | 11:00 a.m. | 1           | 08                     | 9          | 3                 | 20            | 55      |
| 17              | Chrysler Ave and Saginaw St | 4-26-73     | 11:45 a.m. | 1           | 05                     | 6          | 6                 | 20            | 57      |
|                 |                             |             |            | avg.<2      |                        |            |                   |               |         |

<sup>1</sup> wind direction is reported on a 36 position scale representing 360°. N = 0, E = 09,

S = 18, W = 27

<sup>2</sup> Traffic stopped at rail crossing led to high value.

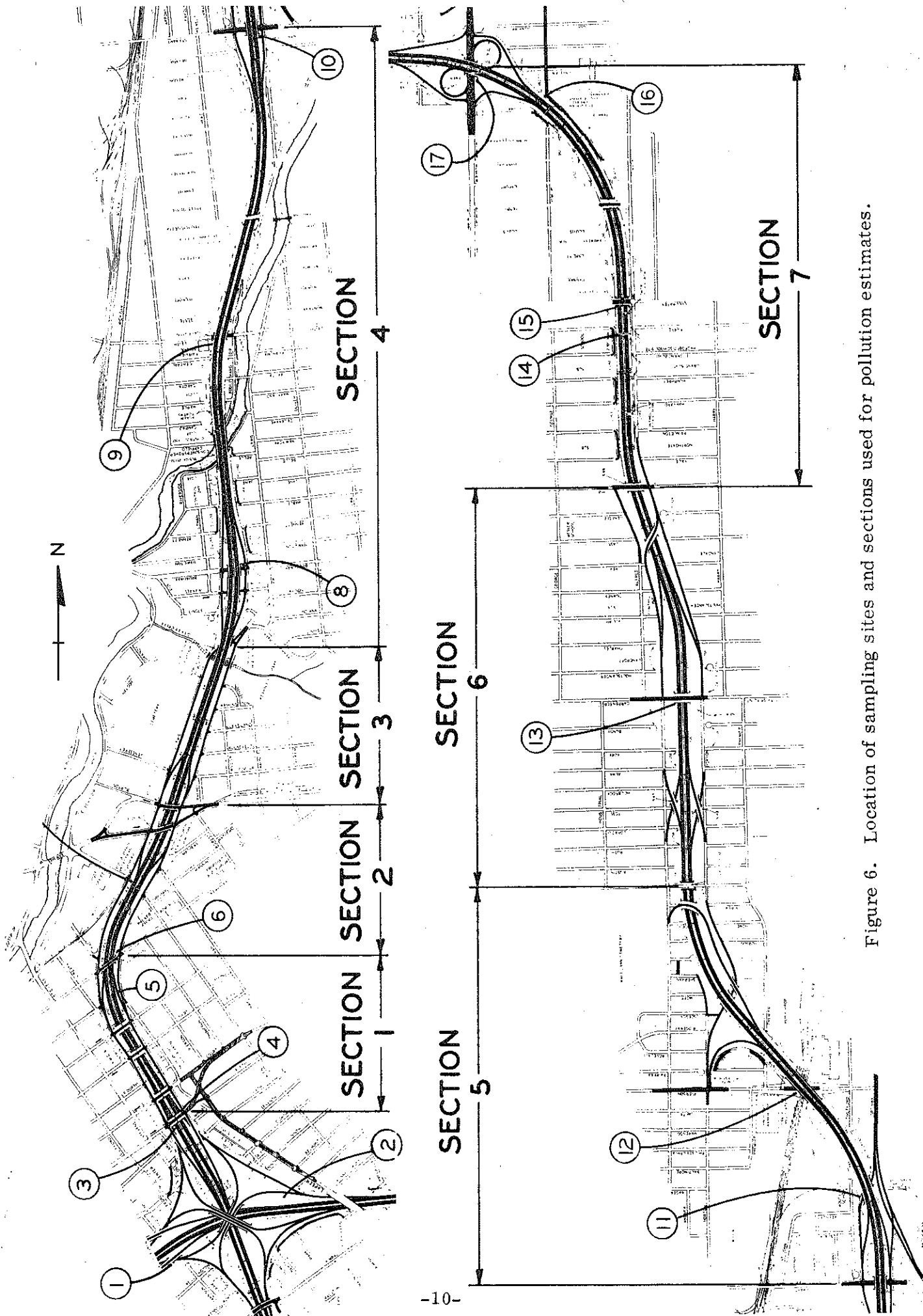


Figure 6. Location of sampling sites and sections used for pollution estimates.

Pollution concentrations were estimated for:

1. Seven representative sections, which covered the entire length of the project. See Figure 6 for location of the sections which are as follows:

| Section | Location                          |
|---------|-----------------------------------|
| 1       | 5th St to Kearsley St             |
| 2       | Kearsley St to Longway Ave        |
| 3       | Longway Ave to Kearsley Park Blvd |
| 4       | Kearsley Park Blvd to Stewart Ave |
| 5       | Stewart Ave to Austin Ave         |
| 6       | Austin Ave to Cornell Ave         |
| 7       | Cornell Ave to Saginaw St         |

2. Carbon monoxide and nitrogen oxides (as NO<sub>2</sub>)
3. The years 1980, 1985, 1990 and 2000
4. Distances of 40, 60 and 100 meters from the edge of the freeway shoulder.

Information used as input to the model consisted of:

1. Peak p. m. (3:30 to 4:30) and off-peak traffic volumes. Traffic estimates are shown in Table 2 for the freeway and in Table 3 for the service roads. Off-peak traffic was taken as 4 percent of ADT.

2. Meteorological conditions. (a) Worst meteorological conditions, which will seldom occur, were taken as a 3 mph wind parallel to the roadway, under atmospheric stability class D. Parallel wind buildup distances used were: Section 1 and 2) 2,300 ft; Section 3) 2,000 ft; Section 4) 8,700 ft; Section 5) 6,000 ft; Section 6) 5,500 ft; Section 7) 4,500 ft. Calculated pollution levels under parallel wind conditions were found to be higher for atmospheric stability class D than for class F. (b) Most probable meteorological conditions (shown in data tables) were chosen for the time of day involved, and the overall most likely stability class (D) was used. Table 4 shows the frequency distribution of atmospheric stability classes for the meteorological data used.

3. Roadway profile. Section 4 is elevated an average of 17 ft. The remaining sections are depressed to average depths as follows:

|           |   |       |
|-----------|---|-------|
| Section 1 | - | 19 ft |
| 2 and 3   | - | 10 ft |
| 5         | - | 17 ft |
| 6 and 7   | - | 13 ft |

TABLE 2  
TRAFFIC ESTIMATES FOR PROPOSED I 475  
(Total Traffic in Both Directions)

| Year | Section 1                             | Section 2                             | Section 3                              | Section 4                              | Section 5                             | Section 6                            | Section 7                            |
|------|---------------------------------------|---------------------------------------|--|--|---------------------------------------|--------------------------------------|--------------------------------------|
| 1980 | 70,215<br><6,530(40)><br>[2,809(50)]  | 70,215<br><6,530(40)><br>[2,809(50)]  | 99,463<br><9,250(35)><br>[3,978(45)]   | 95,469<br><8,878(35)><br>[3,918(50)]   | 69,182<br><6,433(42)><br>[2,767(52)]  | 30,982<br><2,882(52)><br>[1,239(56)] | 42,779<br><3,979(52)><br>[1,711(56)] |
| 1985 | 84,229<br><7,833(35)><br>[3,369(50)]  | 84,229<br><7,833(35)><br>[3,369(50)]  | 113,457<br><10,137(30)><br>[4,538(45)] | 109,882<br><10,213(30)><br>[4,393(45)] | 80,263<br><7,464(38)><br>[3,211(51)]  | 34,208<br><3,182(51)><br>[1,368(55)] | 47,235<br><4,393(51)><br>[1,889(56)] |
| 1990 | 87,176<br><9,037(30)><br>[3,487(45)]  | 87,176<br><9,037(30)><br>[3,487(45)]  | 123,446<br><10,137(30)><br>[4,938(45)] | 121,793<br><11,127(30)><br>[4,872(45)] | 90,793<br><8,469(35)><br>[3,632(49)]  | 37,220<br><3,462(49)><br>[1,489(55)] | 53,680<br><4,992(49)><br>[2,147(55)] |
| 1995 | 107,288<br><9,391(30)><br>[4,292(45)] | 107,288<br><9,391(30)><br>[4,292(45)] | 136,195<br><10,137(30)><br>[5,448(40)] | 132,353<br><10,918(30)><br>[5,294(45)] | 100,908<br><9,384(31)><br>[4,036(47)] | 40,232<br><3,742(48)><br>[1,609(54)] | 60,379<br><5,615(47)><br>[2,414(54)] |
| 2000 | 114,706<br><9,391(30)><br>[4,588(45)] | 114,706<br><9,391(30)><br>[4,588(45)] | 143,426<br><10,137(30)><br>[5,737(40)] | 141,505<br><10,918(30)><br>[5,660(45)] | 104,015<br><9,673(30)><br>[4,161(46)] | 43,012<br><4,000(46)><br>[1,720(54)] | 67,429<br><6,271(45)><br>[2,697(53)] |

Peak Duration - Variable, around 2 hours

Commercial Vehicles

5 percent of Peak

5 percent of Off-Peak

000 = Avg. Daily Traffic

<000> = p. m. Peak Traffic

[000] = Off-Peak Traffic (4 percent ADT)

(00) = Avg. Speed

TABLE 3  
TRAFFIC ESTIMATES FOR SECTION 1, 2 AND 6  
SERVICE ROADS

| Year | Sections 1 and 2                   |                                      | Section 6                          |                                      |
|------|------------------------------------|--------------------------------------|------------------------------------|--------------------------------------|
|      | Southbound                         | Northbound                           | Southbound                         | Northbound                           |
| 1980 | 14,444<br><1,343(20)><br>[578(30)] | 23,058<br><2,144(20)><br>[922(30)]   | 9,330<br><868(29)><br>[373(32)]    | 24,039<br><2,236(29)><br>[962(32)]   |
| 1985 | 15,083<br><1,403(20)><br>[603(30)] | 23,929<br><2,225(20)><br>[957(30)]   | 10,302<br><958(27)><br>[412(32)]   | 26,543<br><2,468(27)><br>[1,062(32)] |
| 1990 | 16,683<br><1,552(15)><br>[667(30)] | 25,029<br><2,328(15)><br>[1,001(30)] | 11,240<br><1,045(25)><br>[450(32)] | 28,920<br><2,690(25)><br>[1,157(32)] |
| 1995 | 17,881<br><1,565(15)><br>[715(25)] | 26,709<br><2,338(15)><br>[1,068(25)] | 11,974<br><1,114(24)><br>[479(32)] | 30,361<br><2,824(24)><br>[1,214(32)] |
| 2000 | 19,118<br><1,565(15)><br>[764(25)] | 28,556<br><2,338(15)><br>[1,142(25)] | 12,410<br><1,154(22)><br>[496(32)] | 31,562<br><2,935(22)><br>[1,262(32)] |

000 = Avg. Daily Traffic  
 <000> = p. m. Peak Traffic  
 [000] = Off-Peak Traffic (4 percent ADT)  
 (00) = Avg. Speed

TABLE 4  
STABILITY CLASS FREQUENCY DISTRIBUTION BY HOUR  
(Percent)

| Hour            | Stability Class |      |      |      |      |      |
|-----------------|-----------------|------|------|------|------|------|
|                 | A               | B    | C    | D    | E    | F    |
| 1               | 0.0             | 0.0  | 0.0  | 55.2 | 16.3 | 28.6 |
| 2               | 0.0             | 0.0  | 0.0  | 53.7 | 16.7 | 29.6 |
| 3               | 0.0             | 0.0  | 0.0  | 50.2 | 20.2 | 29.6 |
| 4               | 0.0             | 0.0  | 0.0  | 49.8 | 17.7 | 32.5 |
| 5               | 0.0             | 0.0  | 0.0  | 52.2 | 17.7 | 30.0 |
| 6               | 9.9             | 4.4  | 2.5  | 52.7 | 11.3 | 19.2 |
| 7               | 9.4             | 12.3 | 13.3 | 48.3 | 9.4  | 7.4  |
| 8               | 6.9             | 13.8 | 17.2 | 56.2 | 2.0  | 3.9  |
| 9               | 5.4             | 13.8 | 18.2 | 62.6 | 0.0  | 0.0  |
| 10              | 3.0             | 16.7 | 14.3 | 66.0 | 0.0  | 0.0  |
| 11              | 3.4             | 17.2 | 17.7 | 61.6 | 0.0  | 0.0  |
| 12              | 3.0             | 14.3 | 16.3 | 66.5 | 0.0  | 0.0  |
| 13              | 2.0             | 12.8 | 20.7 | 64.5 | 0.0  | 0.0  |
| 14              | 1.0             | 13.8 | 22.2 | 63.1 | 0.0  | 0.0  |
| 15              | 3.0             | 10.8 | 20.7 | 65.5 | 0.0  | 0.0  |
| 16              | 1.5             | 13.3 | 20.2 | 62.6 | 1.5  | 1.0  |
| 17              | 3.4             | 9.9  | 18.7 | 62.6 | 3.9  | 1.5  |
| 18              | 3.0             | 7.4  | 10.3 | 60.1 | 12.8 | 6.4  |
| 19              | 0.0             | 0.0  | 0.0  | 62.1 | 22.7 | 15.3 |
| 20              | 0.0             | 0.0  | 0.0  | 57.1 | 24.1 | 18.7 |
| 21              | 0.0             | 0.0  | 0.0  | 54.7 | 25.1 | 20.2 |
| 22              | 0.0             | 0.0  | 0.0  | 51.7 | 26.6 | 21.7 |
| 23              | 0.0             | 0.0  | 0.0  | 51.2 | 25.6 | 23.2 |
| 24              | 0.0             | 0.0  | 0.0  | 52.2 | 19.7 | 28.1 |
| Overall percent | 2.3             | 6.7  | 8.8  | 57.6 | 11.4 | 13.2 |



4. The width of the freeway sections was calculated as follows:

|  |              |
|--|--------------|
| Sections 1, 4, 5, 6 and 7                        |              |
| six 12-ft lanes                                  | 72 ft        |
| two 11-ft shoulders                              | 22 ft        |
| one median                                       | <u>26 ft</u> |
|  | 120 ft       |
| Sections 2 and 3                                 |              |
| eight 12-ft lanes including two<br>weaving lanes | 96 ft        |
| two 11-ft shoulders                              | 22 ft        |
| one median                                       | <u>26 ft</u> |
|  | 144 ft       |

Service roads adjacent to Sections 1 and 2 were 55 ft from the freeway shoulder and were 36 ft in width. Service roads associated with section 6 were 160 to 170 ft from the freeway shoulder, with widths of 36 ft. Sections 3, 4, 5, and 7 had no service roads. Therefore, pollutant levels for sections 1, 2, and 6 were obtained by adding calculated pollutant levels at appropriate distances from the freeway to the calculated pollutant levels from the service road.

Pollution estimates for the a. m. peak traffic are not included because the predicted traffic volume was only 5 percent of ADT, not sufficiently different than off-peak traffic to cause a problem.

All estimates are intended to provide maximum one hour concentrations and are in addition to the existing background levels. Traffic estimates for the condition of not building the freeway were not available, so future air quality for the no-build condition could not be estimated. Deterioration of air quality as traffic increases on existing roadways is to be expected.

Tables 5, 6, and 7 present the pollution estimates. Nitrogen oxides, as nitrogen dioxide, are included for information only. There is no emission factor for nitrogen dioxide as such, so no comparison of the estimates with the air quality standard is possible.

Federal air quality standards for carbon monoxide and nitrogen dioxide are:

CO: (a) 10 mg/cu m maximum 8 hr concentration not to be exceeded more than once per year.

(b) 40 mg/cu m maximum 1 hr concentration not to be exceeded more than once per year.

NO<sub>2</sub>: 100 μg/cu m annual arithmetic mean.

The data are organized as follows:

Tables 5 and 6 - Pollution estimates for peak and off-peak traffic under worst and most probable meteorological conditions for the freeway without consideration of pollution generated by associated service roads located only along Sections 1, 2, and 6.

Table 7 - Pollution estimates for Sections 1, 2, and 6 including pollutants generated on the service roads.

TABLE 5  
POLLUTION ESTIMATES FOR OFF PEAK TRAFFIC  
(Freeway Only)

| Location  | Traffic Projection Year | 40 Meter Distance From Edge of Freeway Shoulder |                           |   |                           | 60 Meter Distance From Edge of Freeway Shoulder |                           |   |                           | 100 Meter Distance From Edge of Freeway Shoulder |                           |   |                           |
|-----------|-------------------------|---|---------------------------|---|---------------------------|---|---------------------------|---|---------------------------|--|---------------------------|---|---------------------------|
|           |                         | Worst Condition Parallel Wind, 3 mph            |                           | Most Probable Condition, 12 mph wind <sup>1</sup> |                           | Worst Condition Parallel Wind, 3 mph            |                           | Most Probable Condition, 12 mph wind <sup>1</sup> |                           | Worst Condition Parallel Wind, 3 mph             |                           | Most Probable Condition, 12 mph wind <sup>1</sup> |                           |
|           |                         | CO, mg/cu m                                     | NO <sub>2</sub> , µg/cu m | CO, mg/cu m                                       | NO <sub>2</sub> , µg/cu m | CO, mg/cu m                                     | NO <sub>2</sub> , µg/cu m | CO, mg/cu m                                       | NO <sub>2</sub> , µg/cu m | CO, mg/cu m                                      | NO <sub>2</sub> , µg/cu m | CO, mg/cu m                                       | NO <sub>2</sub> , µg/cu m |
| Section 1 | 1980                    | 1.8   | 682                       | 0.1   | 32                        | 0.9   | 339                       | 0.1   | 30                        | 0.2  | 67                        | 0.1   | 26                        |
|           | 1985                    | 1.0   | 513                       | *   | 24                        | 0.5   | 255                       | *   | 23                        | 0.1  | 51                        | *   | 20                        |
|           | 1990                    | 0.9   | 470                       | *   | 22                        | 0.5   | 234                       | *   | 21                        | 0.1  | 46                        | *   | 18                        |
|           | 1995                    | 1.1   | 579                       | 0.1   | 27                        | 0.6   | 288                       | 0.1   | 25                        | 0.1  | 57                        | *   | 22                        |
|           | 2000                    | 1.2   | 619                       | 0.1   | 29                        | 0.6   | 307                       | 0.1   | 27                        | 0.1  | 61                        | *   | 24                        |
| Section 2 | 1980                    | 1.3   | 504                       | 0.2   | 61                        | 0.7   | 256                       | 0.1   | 57                        | 0.1  | 52                        | 0.1   | 51                        |
|           | 1985                    | 0.7   | 378                       | 0.1   | 46                        | 0.4   | 192                       | 0.1   | 43                        | 0.1  | 39                        | 0.1   | 38                        |
|           | 1990                    | 0.7   | 347                       | 0.1   | 42                        | 0.3   | 176                       | 0.1   | 39                        | 0.1  | 36                        | 0.1   | 35                        |
|           | 1995                    | 0.8   | 427                       | 0.1   | 52                        | 0.4   | 217                       | 0.1   | 48                        | 0.1  | 44                        | 0.1   | 43                        |
|           | 2000                    | 0.9   | 457                       | 0.1   | 55                        | 0.5   | 232                       | 0.1   | 52                        | 0.1  | 47                        | 0.1   | 46                        |
| Section 3 | 1980                    | 1.9   | 674                       | 0.2   | 83                        | 1.0   | 343                       | 0.2   | 77                        | 0.2  | 70                        | 0.2   | 69                        |
|           | 1985                    | 1.0   | 482                       | 0.1   | 59                        | 0.5   | 245                       | 0.1   | 55                        | 0.1  | 50                        | 0.1   | 49                        |
|           | 1990                    | 1.0   | 487                       | 0.1   | 60                        | 0.5   | 247                       | 0.1   | 56                        | 0.1  | 50                        | 0.1   | 50                        |
|           | 1995                    | 1.2   | 511                       | 0.1   | 63                        | 0.6   | 260                       | 0.1   | 58                        | 0.1  | 53                        | 0.1   | 52                        |
|           | 2000                    | 1.2   | 538                       | 0.2   | 66                        | 0.6   | 274                       | 0.1   | 61                        | 0.1  | 56                        | 0.1   | 55                        |
| Section 4 | 1980                    | 2.0   | 778                       | 0.1   | 41                        | 1.1   | 409                       | 0.1   | 39                        | 0.2  | 86                        | 0.1   | 36                        |
|           | 1985                    | 1.1   | 535                       | 0.1   | 28                        | 0.6   | 281                       | 0.1   | 27                        | 0.1  | 59                        | 0.1   | 25                        |
|           | 1990                    | 1.1   | 551                       | 0.1   | 29                        | 0.6   | 290                       | 0.1   | 28                        | 0.1  | 61                        | 0.1   | 25                        |
|           | 1995                    | 1.2   | 599                       | 0.1   | 32                        | 0.6   | 315                       | 0.1   | 30                        | 0.1  | 66                        | 0.1   | 28                        |
|           | 2000                    | 1.3   | 640                       | 0.1   | 34                        | 0.7   | 337                       | 0.1   | 32                        | 0.1  | 71                        | 0.1   | 30                        |
| Section 5 | 1980                    | 1.9   | 717                       | 0.1   | 30                        | 1.0   | 359                       | 0.1   | 28                        | 0.2  | 72                        | 0.1   | 24                        |
|           | 1985                    | 1.0   | 521                       | *   | 22                        | 0.5   | 261                       | *   | 20                        | 0.1  | 52                        | *   | 18                        |
|           | 1990                    | 1.0   | 548                       | *   | 23                        | 0.5   | 274                       | *   | 21                        | 0.1  | 55                        | *   | 19                        |
|           | 1995                    | 1.1   | 581                       | *   | 24                        | 0.6   | 290                       | *   | 22                        | 0.1  | 58                        | *   | 20                        |
|           | 2000                    | 1.2   | 599                       | *   | 25                        | 0.6   | 299                       | *   | 23                        | 0.1  | 60                        | *   | 20                        |
| Section 6 | 1980                    | 0.8   | 314                       | *   | 17                        | 0.4   | 159                       | *   | 16                        | 0.1  | 32                        | *   | 14                        |
|           | 1985                    | 0.4   | 217                       | *   | 12                        | 0.2   | 110                       | *   | 11                        | *  | 22                        | *   | 10                        |
|           | 1990                    | 0.4   | 220                       | *   | 12                        | 0.2   | 111                       | *   | 11                        | *  | 22                        | *   | 10                        |
|           | 1995                    | 0.4   | 237                       | *   | 13                        | 0.2   | 120                       | *   | 12                        | *  | 24                        | *   | 11                        |
|           | 2000                    | 0.4   | 254                       | *   | 14                        | 0.2   | 128                       | *   | 13                        | *  | 26                        | *   | 11                        |
| Section 7 | 1980                    | 1.0   | 425                       | 0.1   | 21                        | 0.5   | 215                       | *   | 19                        | 0.1  | 43                        | *   | 17                        |
|           | 1985                    | 0.5   | 294                       | *   | 14                        | 0.3   | 149                       | *   | 13                        | 0.1  | 30                        | *   | 12                        |
|           | 1990                    | 0.5   | 310                       | *   | 15                        | 0.3   | 157                       | *   | 14                        | 0.1  | 32                        | *   | 12                        |
|           | 1995                    | 0.6   | 349                       | *   | 17                        | 0.3   | 176                       | *   | 16                        | 0.1  | 36                        | *   | 14                        |
|           | 2000                    | 0.7   | 390                       | *   | 19                        | 0.3   | 197                       | *   | 18                        | 0.1  | 40                        | *   | 16                        |

<sup>1</sup> Average vehicle speeds are reported in Tables 2 and 3.  
<sup>2</sup> Angle between wind direction and roadway direction - section 1, 75°; sections 2 and 3, 27°; section 4, 50°; section 5, 90°; section 6, 50°; section 7, 62°.  
\* value less than 0.1.

TABLE 6  
POLLUTION ESTIMATES FOR PEAK TRAFFIC  
(Freeway Only)

| Location  | Traffic Projection Year | 40 Meter Distance From Edge of Freeway Shoulder |                           |                                       |                           | 60 Meter Distance From Edge of Freeway Shoulder |                           |                                       |                           | 100 Meter Distance From Edge of Freeway Shoulder |                           |                                       |                           |
|-----------|-------------------------|---|---------------------------|---------------------------------------|---------------------------|---|---------------------------|---------------------------------------|---------------------------|--|---------------------------|---------------------------------------|---------------------------|
|           |                         | Worst Condition Parallel Wind, 3 mph            |                           | Most Probable Condition, 11 mph wind? |                           | Worst Condition Parallel Wind, 3 mph            |                           | Most Probable Condition, 11 mph wind? |                           | Worst Condition Parallel Wind, 3 mph             |                           | Most Probable Condition, 11 mph wind? |                           |
|           |                         | CO, mg/cu m                                     | NO <sub>2</sub> , µg/cu m | CO, mg/cu m                           | NO <sub>2</sub> , µg/cu m | CO, mg/cu m                                     | NO <sub>2</sub> , µg/cu m | CO, mg/cu m                           | NO <sub>2</sub> , µg/cu m | CO, mg/cu m                                      | NO <sub>2</sub> , µg/cu m | CO, mg/cu m                           | NO <sub>2</sub> , µg/cu m |
| Section 1 | 1980                    | 4.7   | 1441                      | 0.2                                   | 72                        | 2.3   | 716                       | 0.2                                   | 67                        | 0.5  | 142                       | 0.2                                   | 58                        |
|           | 1985                    | 3.0   | 1029                      | 0.1                                   | 51                        | 1.5   | 511                       | 0.1                                   | 48                        | 0.3  | 102                       | 0.1                                   | 42                        |
|           | 1990                    | 3.3   | 1044                      | 0.2                                   | 52                        | 1.6   | 519                       | 0.2                                   | 48                        | 0.3  | 103                       | 0.1                                   | 42                        |
|           | 1995                    | 3.4   | 1085                      | 0.2                                   | 54                        | 1.7   | 539                       | 0.2                                   | 50                        | 0.3  | 107                       | 0.1                                   | 44                        |
|           | 2000                    | 3.4   | 1085                      | 0.2                                   | 54                        | 1.7   | 539                       | 0.2                                   | 50                        | 0.3  | 107                       | 0.1                                   | 44                        |
| Section 2 | 1980                    | 3.5   | 1064                      | 0.3                                   | 98                        | 1.8   | 541                       | 0.3                                   | 91                        | 0.4  | 110                       | 0.3                                   | 81                        |
|           | 1985                    | 2.2   | 759                       | 0.2                                   | 70                        | 1.1   | 386                       | 0.2                                   | 65                        | 0.2  | 78                        | 0.2                                   | 58                        |
|           | 1990                    | 2.4   | 771                       | 0.2                                   | 71                        | 1.1   | 392                       | 0.2                                   | 66                        | 0.3  | 80                        | 0.2                                   | 59                        |
|           | 1995                    | 2.5   | 801                       | 0.2                                   | 73                        | 1.3   | 407                       | 0.2                                   | 68                        | 0.3  | 83                        | 0.2                                   | 61                        |
|           | 2000                    | 2.5   | 801                       | 0.2                                   | 73                        | 1.3   | 407                       | 0.2                                   | 68                        | 0.3  | 83                        | 0.2                                   | 61                        |
| Section 3 | 1980                    | 5.5   | 1417                      | 0.5                                   | 131                       | 2.8   | 720                       | 0.5                                   | 122                       | 0.6  | 146                       | 0.4                                   | 109                       |
|           | 1985                    | 3.1   | 921                       | 0.3                                   | 85                        | 1.6   | 468                       | 0.3                                   | 79                        | 0.3  | 95                        | 0.2                                   | 71                        |
|           | 1990                    | 2.7   | 856                       | 0.3                                   | 79                        | 1.4   | 435                       | 0.2                                   | 74                        | 0.3  | 88                        | 0.2                                   | 66                        |
|           | 1995                    | 2.7   | 856                       | 0.3                                   | 79                        | 1.4   | 435                       | 0.2                                   | 74                        | 0.3  | 88                        | 0.2                                   | 66                        |
|           | 2000                    | 2.7   | 856                       | 0.3                                   | 79                        | 1.4   | 435                       | 0.2                                   | 74                        | 0.3  | 88                        | 0.2                                   | 66                        |
| Section 4 | 1980                    | 6.1   | 1562                      | 0.3                                   | 77                        | 3.2   | 821                       | 0.3                                   | 73                        | 0.7  | 173                       | 0.3                                   | 67                        |
|           | 1985                    | 3.6   | 1066                      | 0.2                                   | 53                        | 1.9   | 560                       | 0.2                                   | 50                        | 0.4  | 118                       | 0.2                                   | 46                        |
|           | 1990                    | 3.4   | 1078                      | 0.2                                   | 53                        | 1.8   | 567                       | 0.2                                   | 50                        | 0.4  | 119                       | 0.1                                   | 46                        |
|           | 1995                    | 3.4   | 1058                      | 0.2                                   | 52                        | 1.8   | 556                       | 0.2                                   | 50                        | 0.4  | 117                       | 0.1                                   | 45                        |
|           | 2000                    | 3.4   | 1058                      | 0.2                                   | 52                        | 1.8   | 556                       | 0.2                                   | 50                        | 0.4  | 117                       | 0.1                                   | 45                        |
| Section 5 | 1980                    | 5.0   | 1516                      | 0.2                                   | 71                        | 2.5   | 758                       | 0.2                                   | 66                        | 0.5  | 152                       | 0.2                                   | 58                        |
|           | 1985                    | 2.7   | 1101                      | 0.1                                   | 51                        | 1.3   | 551                       | 0.1                                   | 48                        | 0.3  | 110                       | 0.1                                   | 42                        |
|           | 1990                    | 3.0   | 1102                      | 0.1                                   | 52                        | 1.5   | 551                       | 0.1                                   | 48                        | 0.3  | 110                       | 0.1                                   | 42                        |
|           | 1995                    | 3.7   | 1157                      | 0.2                                   | 54                        | 1.8   | 578                       | 0.1                                   | 50                        | 0.4  | 116                       | 0.1                                   | 44                        |
|           | 2000                    | 3.8   | 1192                      | 0.2                                   | 56                        | 1.9   | 596                       | 0.2                                   | 52                        | 0.4  | 119                       | 0.1                                   | 45                        |
| Section 6 | 1980                    | 1.8   | 699                       | 0.1                                   | 36                        | 0.9   | 353                       | 0.1                                   | 33                        | 0.2  | 71                        | 0.1                                   | 29                        |
|           | 1985                    | 0.9   | 483                       | *                                     | 25                        | 0.5   | 244                       | *                                     | 23                        | 0.1  | 49                        | *                                     | 20                        |
|           | 1990                    | 0.9   | 488                       | *                                     | 25                        | 0.5   | 247                       | *                                     | 23                        | 0.1  | 50                        | *                                     | 21                        |
|           | 1995                    | 1.0   | 528                       | *                                     | 27                        | 0.5   | 267                       | *                                     | 25                        | 0.1  | 54                        | *                                     | 22                        |
|           | 2000                    | 1.1   | 538                       | 0.1                                   | 28                        | 0.5   | 272                       | 0.1                                   | 26                        | 0.1  | 55                        | *                                     | 23                        |
| Section 7 | 1980                    | 2.5   | 946                       | 0.1                                   | 46                        | 1.3   | 476                       | 0.1                                   | 43                        | 0.3  | 97                        | 0.1                                   | 38                        |
|           | 1985                    | 1.3   | 954                       | 0.1                                   | 32                        | 0.6   | 330                       | 0.1                                   | 29                        | 0.1  | 67                        | 0.1                                   | 26                        |
|           | 1990                    | 1.3   | 690                       | 0.1                                   | 33                        | 0.6   | 349                       | 0.1                                   | 31                        | 0.1  | 70                        | 0.1                                   | 27                        |
|           | 1995                    | 1.5   | 741                       | 0.1                                   | 36                        | 0.7   | 374                       | 0.1                                   | 33                        | 0.1  | 76                        | 0.1                                   | 29                        |
|           | 2000                    | 1.6   | 827                       | 0.1                                   | 40                        | 0.8   | 418                       | 0.1                                   | 37                        | 0.2  | 85                        | 0.1                                   | 33                        |

1 average vehicle speeds are reported in Tables 2 and 3.  
2 angle between wind direction and roadway direction - section 1, 89°; sections 2 and 3, 41°; section 4, 64°; section 5, 76°; section 6, 64°; section 7, 76°.  
\*value less than 0.1

TABLE 7  
 POLLUTION ESTIMATES FOR OFF PEAK AND PEAK PM TRAFFIC  
 (Service Roads Included)

| Location           | Traffic Projection Year | 40 Meter Distance From Edge of Freeway Shoulder  |                           |   |                           | 60 Meter Distance From Edge of Freeway Shoulder |                           |   |                           | 100 Meter Distance From Edge of Freeway Shoulder |                           |   |                           |
|--------------------|-------------------------|--|---------------------------|---|---------------------------|---|---------------------------|---|---------------------------|--|---------------------------|---|---------------------------|
|                    |                         | Worst Condition Parallel Wind, 3 mph   |                           | Most Probable Condition, 12 mph wind <sup>1</sup> |                           | Worst Condition Parallel Wind, 3 mph            |                           | Most Probable Condition, 12 mph wind <sup>2</sup> |                           | Worst Condition Parallel Wind, 3 mph             |                           | Most Probable Condition, 12 mph wind <sup>2</sup> |                           |
|                    |                         | CO, mg/cu m  | NO <sub>2</sub> , µg/cu m | CO, mg/cu m                                       | NO <sub>2</sub> , µg/cu m | CO, mg/cu m                                     | NO <sub>2</sub> , µg/cu m | CO, mg/cu m                                       | NO <sub>2</sub> , µg/cu m | CO, mg/cu m                                      | NO <sub>2</sub> , µg/cu m | CO, mg/cu m                                       | NO <sub>2</sub> , µg/cu m |
| Section 1 Off Peak | 1980                    | 2.5  | 847                       | 0.2   | 53                        | 1.2   | 408                       | 0.1   | 44                        | 0.3  | 91                        | 0.1   | 37                        |
|                    | 1985                    | 1.3  | 612                       | 0.1   | 37                        | 0.6   | 297                       | 0.1   | 31                        | 0.1  | 65                        | 0.1   | 26                        |
|                    | 1990                    | 1.2  | 567                       | 0.1   | 35                        | 0.6   | 274                       | 0.1   | 29                        | 0.1  | 61                        | 0.1   | 24                        |
|                    | 1995                    | 1.5  | 676                       | 0.1   | 40                        | 0.7   | 329                       | 0.1   | 34                        | 0.2  | 71                        | 0.1   | 29                        |
| 2000               | 1.6                     | 723  | 0.1                       | 43  | 0.8                       | 351   | 0.1                       | 36  | 0.2                       | 76   | 0.1                       | 31  |                           |
| Section 2 Off Peak | 1980                    | 2.1  | 667                       | 0.4   | 105                       | 1.0   | 325                       | 0.3   | 87                        | 0.2  | 76                        | 0.2   | 74                        |
|                    | 1985                    | 1.1  | 477                       | 0.2   | 73                        | 0.5   | 234                       | 0.1   | 61                        | 0.1  | 54                        | 0.1   | 52                        |
|                    | 1990                    | 1.0  | 443                       | 0.2   | 66                        | 0.5   | 217                       | 0.1   | 57                        | 0.1  | 50                        | 0.1   | 49                        |
|                    | 1995                    | 1.2  | 524                       | 0.2   | 78                        | 0.6   | 258                       | 0.2   | 67                        | 0.1  | 58                        | 0.1   | 57                        |
| 2000               | 1.3                     | 560  | 0.2                       | 84  | 0.6                       | 276   | 0.2                       | 71  | 0.2                       | 62   | 0.1                       | 61  |                           |
| Section 6 Off Peak | 1980                    | Service road is more than 40 meters from freeway shoulder.   |                           |   |                           |   |                           |   |                           |  |                           |   |                           |
|                    | 1985                    | Service road is 60 meters from freeway shoulder, but the mathematical model cannot be applied directly over a roadway. |                           |   |                           |   |                           |   |                           |  |                           |   |                           |
|                    | 1990                    | 0.4  | 106                       | 0.4   | 106                       | 0.2   | 74                        | 0.2   | 74                        | 0.2  | 74                        | 0.1   | 28                        |
|                    | 1995                    | 0.2  | 75                        | 0.2   | 75                        | 0.2   | 75                        | 0.2   | 75                        | 0.2  | 75                        | 0.1   | 19                        |
| 2000               | 0.2                     | 83   | 0.2                       | 83  | 0.2                       | 83  | 0.2                       | 83  | 0.2                       | 83   | 0.1                       | 22  |                           |
| Section 1 PM Peak  | 1980                    | 7.0  | 1758                      | 0.5   | 114                       | 3.3   | 850                       | 0.4   | 96                        | 0.8  | 188                       | 0.4   | 80                        |
|                    | 1985                    | 4.1  | 1234                      | 0.3   | 79                        | 2.0   | 598                       | 0.2   | 67                        | 0.5  | 132                       | 0.2   | 56                        |
|                    | 1990                    | 4.6  | 1231                      | 0.3   | 77                        | 2.2   | 598                       | 0.3   | 66                        | 0.5  | 130                       | 0.2   | 55                        |
|                    | 1995                    | 4.8  | 1273                      | 0.3   | 79                        | 2.3   | 618                       | 0.3   | 68                        | 0.5  | 135                       | 0.2   | 57                        |
| 2000               | 4.8                     | 1273   | 0.3                       | 79  | 2.3                       | 618   | 0.3                       | 68  | 0.5                       | 135  | 0.2                       | 57  |                           |
| Section 2 PM Peak  | 1980                    | 5.8  | 1378                      | 0.8   | 162                       | 2.7   | 673                       | 0.6   | 135                       | 0.7  | 156                       | 0.5   | 115                       |
|                    | 1985                    | 3.3  | 963                       | 0.4   | 112                       | 1.6   | 472                       | 0.3   | 94                        | 0.4  | 108                       | 0.3   | 80                        |
|                    | 1990                    | 3.7  | 956                       | 0.5   | 109                       | 1.8   | 470                       | 0.4   | 92                        | 0.4  | 107                       | 0.3   | 79                        |
|                    | 1995                    | 3.8  | 987                       | 0.5   | 112                       | 1.8   | 486                       | 0.4   | 95                        | 0.5  | 110                       | 0.3   | 81                        |
| 2000               | 3.8                     | 987  | 0.5                       | 112   | 1.8                       | 486   | 0.4                       | 95  | 0.5                       | 110  | 0.3                       | 81  |                           |
| Section 6 PM Peak  | 1980                    | Service road is more than 40 meters from freeway shoulder.   |                           |   |                           |   |                           |   |                           |  |                           |   |                           |
|                    | 1985                    | Service road is 60 meters from freeway shoulder, but the mathematical model cannot be applied directly over a roadway. |                           |   |                           |   |                           |   |                           |  |                           |   |                           |
|                    | 1990                    | 1.0  | 244                       | 1.0   | 244                       | 0.6   | 169                       | 0.6   | 169                       | 0.6  | 169                       | 0.1   | 49                        |
|                    | 1995                    | 0.5  | 171                       | 0.5   | 171                       | 0.5   | 171                       | 0.5   | 171                       | 0.5  | 171                       | 0.1   | 50                        |
| 2000               | 0.5                     | 181  | 0.5                       | 181   | 0.5                       | 181   | 0.5                       | 181   | 0.5                       | 181  | 0.1                       | 54  |                           |
| 2000               | 0.5                     | 187  | 0.5                       | 187   | 0.5                       | 187   | 0.5                       | 187   | 0.5                       | 187  | 0.2                       | 56  |                           |

<sup>1</sup> average vehicle speeds are reported in Tables 2 and 3.

<sup>2</sup> angle between wind direction and roadway direction - section 1, 75° off peak, 89° peak p. m.; section 2, 27° off peak, 41° peak p. m.; section 6, 50° off peak, 64° peak p. m.

\*value less than 0.1