MINNESOTA POLLUTION CONTROL AGENCY
717 Delaware Street S.E./ Minneapolis, Minnesota 55440
Telephone: (612) 378-1320

January 26, 1973

Honorable Roger A. Laufenburger
Senator, District 34
Box Six
Lewiston, Minnesota 55952

Dear Senator Laufenburger:

Enclosed is a copy of the Minnesota Pollution Control Agency's Implementation Plan to Achieve Carbon Monoxide Ambient Air Quality Standards.

We are happy to answer any questions you may have. Feel free to write or call any time.

Thank you for your interest.

Sincerely,

John G. Olin by jd

John G. Olin, Ph. D.
Deputy Director
Division of Air Quality
(612) 296-5554

jad

Enclosure

STATE OF MINNESOTA

COUNTY OF HENNEPIN

POLLUTION CONTROL AGENCY

In the Matter of the Adoption of a Transportation Control Plan as Part of the Minnesota Air Quality Implementation Plan

NOTICE OF HEARING

NOTICE IS HEREBY GIVEN that a public hearing will be held pursuant to Minnesota Statutes 1971, section 15.0412 and chapters 115 and 116, in the above-entitled matter in the City of Minneapolis, Minnesota, in the Board Room of the State Department of Health Building, 717 Delaware Street S.E., on Tuesday, February 20th, 1973, commencing at 9:00 a.m., and continuing until all persons, representatives, organizations and other interested parties have had an opportunity to be heard concerning the adoption of the proposed plan captioned above, by submitting oral or written data, statements, comment, or argument. Statements or briefs may be submitted in writing without the necessity for appearance at the hearing.

The Agency proposes to adopt a transportation control plan to achieve ambient air quality standards for carbon monoxide in the St. Paul-Minneapolis metropolitan area. The transportation control plan will become part of the Minnesota Air Quality Implementation Plan, which will be submitted to the federal government for approval. The plan will focus on the following:

1. Modern express bus service with roadway improvements and traffic control to provide for priority movement of express busses.

2. Off-street parking structures at the fringe of the central business districts to intercept inbound traffic.

3. Micro-transit system and skyway linkages to connect fringe parking, express bus terminals, and major downtown traffic generators, utilizing:

   a. Interim shuttle busses and separate transit lanes.

   b. People-mover systems on separate transit guideways.

4. Traffic surveillance and control systems to provide automated traffic monitoring and to establish traffic responsive control techniques, including:

   a. Signal timing coordination and optimization.

   b. Traffic diversion from congestion areas.

   c. Regulation of traffic controls to provide priority movement of busses.

d. Metering of freeway ramp traffic flow and establishing changeable lane direction patterns.

Copies of the proposed plan are available from the Minnesota Pollution Control Agency, Division of Air Quality, 717 Delaware Street Southeast, Minneapolis, Minnesota, 55440. Additional copies will be available at the Hearing.

A preliminary hearing on the proposed Transportation Control Plan was held on January 16th, 1973. The record of the preliminary hearing shall be open for inspection in the offices of the Minnesota Pollution Control Agency, Division of Air Quality, 717 Delaware Street Southeast, Minneapolis, Minnesota, after January 25, 1973. This record will be incorporated into the record of the February 20, 1973, hearing.

This plan is a proposed plan only and is subject to alteration or modification as the Agency deems necessary and appropriate from its consideration of all the evidence adduced at the public hearings.

Dated this 17th day of January, 1973.

STATE OF MINNESOTA
POLLUTION CONTROL AGENCY

By [signature]
Grant J. Merritt,
Executive Director

STATE OF MINNESOTA
POLLUTION CONTROL AGENCY
GRANT J. MERRITT, EXECUTIVE DIRECTOR

EDWARD M. WIIK, P.E.
DIRECTOR, DIVISION OF AIR QUALITY

IMPLEMENTATION PLAN TO ACHIEVE CARBON MONOXIDE AMBIENT AIR QUALITY STANDARDS

FEBRUARY, 1973

PREPARED BY

JOHN G. OLIN, PH. D.
DEPUTY DIRECTOR, DIVISION OF AIR QUALITY

PREPARED FOR
U. S. ENVIRONMENTAL PROTECTION AGENCY

FOREWARD

On January 28, 1972, the Minnesota Pollution Control Agency officially submitted its "Implementation Plan to achieve National Ambient Air Quality Standards" to the U. S. Environmental Protection Agency pursuant to the requirements set forth in Federal Register, Vol 36, No. 158, August 14, 1971 (Reference 1). This Implementation Plan presented MPCA's strategies for achievement by the year 1975 of ambient air quality standards for sulfur oxides, particulate matter, carbon monoxide, photochemical oxidants, hydrocarbons, and nitrogen oxides. An extension to July 1, 1977, was requested by PCA for achievement of carbon monoxide standards in the Minneapolis-St. Paul Air Quality Control Region (No. 131) -- the only region, among a total of seven, in which the carbon monoxide standard is exceeded by the year 1977. EPA granted this request and required in Federal Register, Vol 37, No. 105, May 31, 1972, that PCA submit to EPA by February 15, 1973, its "Implementation Plan to Achieve Carbon Monoxide Ambient Air Quality Standards" by July 1, 1977. PCA's Implementation Plan for carbon monoxide is presented herewith. Its required content is described in a future amendment to the August 14, 1971, Federal Register, entitled "Transportation Control Measures" (Reference 2).

EPA contracted a consultant, GCA Corporation of Bedford, Massachusetts, to prepare a PCA report making recommendations for inclusion in Minnesota's Implementation Plan. Wilbur-Smith and Associates of Columbia, South Carolina, and ABT Associates of Cambridge, Massachusetts, are sub-contractors to GCA Corporation in this project. The PCA staff has worked closely with this consultant team, as well as with EPA, in the preparation of the GCA report. Consequently, this Plan is in essential agreement with the GCA report.

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APPENDICES

I. SUMMARY

The Minnesota Pollution Control Agency presents herewith its plan for achievement of carbon monoxide ambient air quality standards by July 1, 1977.

Analysis of emissions showed that the central business districts (CBD's) of the Cities of Minneapolis and St. Paul presently have by far the highest emissions density in the entire Minneapolis-St. Paul Air Quality Control Region (AQCR 131). Therefore, carbon monoxide strategies are directed towards these two sensitive sub-regions.

Carbon monoxide data is analyzed for 1970, 1971, and the first six months of 1972 for the three monitoring sites in Minnesota - Downtown Minneapolis, Downtown St. Paul, and Midway. Data from the carbon monoxide monitor in downtown Minneapolis (Fourth Street and Third Avenue) is chosen as the basis for the control strategies because of its high value, accuracy of the data, high emissions density, and representativeness of CBD's. The maximum carbon monoxide concentration occurring at the downtown Minneapolis site is an eight-hour average of 18.9 ppm, occurring on November 11, 1971. Roll-back calculations are based on this value.

By 1977, the 8-hour average carbon monoxide standard of 9 ppm is met via the Federal Motor Vehicle Emissions Control Program in all sub-regions (Urban Activity Districts) of the Metropolitan area, except the Minneapolis and St. Paul CBD's. By 1978 the standard is met in the two CBD's. Oxidant standards are met in all sub-regions by 1977. The following table shows the reductions in carbon monoxide emissions required in the two CBD's to met the 9 ppm standard by July 1, 1977, in addition to the reductions achieved by the Federal

Motor Vehicle Emissions Control Program:

CBD	Reduction of 1971 emission density required by control strategies	
	%	Total kg/sq. mile (12 hr)
Minneapolis	3.7	475
St. Paul	3.1	391

The following transportation control strategies are considered for achievement of these additional reductions in carbon monoxide emissions:

<u>Reductions in Travel Density</u>

Improved public transit
Improved public transit combined with other pricing policies
Improved transit combined with other transportation regulations (fringe parking)
Car-pool incentives
Changes in work-hours
Shuttle bus service
People-mover (micro-transit) systems

<u>Control of the Effectiveness of the Performance of the Engine and Pollution Control Devices</u>

Mandatory inspection/maintenance at idle
Mandatory inspection/maintenance under load
Road-side, spot-check inspection
Retro-fit devices for in-use vehicles

<u>Increasing Traffic Flow</u>

Traffic management and control systems
Improvements in pedestrian movement
Minor roadway modifications
Improvements in goods movement
Staggered work hours

The following table shows the major transportation control strategies selected for downtown Minneapolis and St. Paul and their impact on CBD traffic:

Control Strategy	Change in CBD Traffic Caused by Implementation of Strategy
<u>Minneapolis CBD</u>	
1. Express bus service to CBD with traffic controls to provide priority movement of buses.	Negligible
2. Parking at fringe of CBD to intercept in-bound traffic.	7% reduction in VMT } 8% combined reduction in VMT*
3. People-mover, or equivalent micro-transit, system which links fringe parking with core city and skyway system.	1% reduction in VMT } 8% combined reduction in VMT*
4. Traffic surveillance and control system to increase CBD traffic flow.	Increase average speed from 14 to 20 mph.
<u>St. Paul CBD</u>	
1. Parking at fringe of CBD to intercept in-bound traffic.	10% combined reduction in VMT
2. Shuttle bus service, or equivalent system, which links fringe parking with core city and skyway system.	10% combined reduction in VMT
3. Auto free malls.	Negligible
4. Traffic signal system to increase CBD traffic flow.	Increase average speed from 12 to 18 mph.

These major control strategies are all characterized as transportation technology and services measures. All have the advantage of decreasing the emissions of hydrocarbons and nitrogen oxides, as

* Vehicle Miles Traveled

well as carbon monoxide. Strategies based on motor vehicle inspection/maintenance were rejected relative to the chosen strategies because inspections have lower cost-effectiveness, long implementation time, require an extensive mechanic training program, and do not decrease emissions of nitrogen oxides. Inclusion of the express bus system and micro-transit systems as control strategies does not imply that other modes of mass transit are not as effective in reducing emissions of air contaminants. These strategies were chosen because they are implementable by 1977. Other mass transit modes, such as those operating on fixed guideways, will have a beneficial air quality impact - but in the longer range.

Additional minor control strategies to be applied include: (1) public information campaign, (2) strict enforcement of existing ordinances regarding idling, visible emissions (APC-12), purposeful dismantling or removal of pollution control devices (APC-12), on-street parking, and pedestrian movement, and (3) ordinances limiting idling of motor vehicles parked on the street or in public facilities.

The major control strategies are combined as follows:

Minneapolis CBD

Strategy 1: Fringe parking combined with people-mover system, estimated to reduce 1977 light-duty VMT's by 8%.

Strategy 2: Traffic surveillance and control system estimated to increase average speed in Minneapolis CBD from 14 mph to 20 mph by 1977.

St. Paul CBD

Strategy 1: Fringe parking combined with shuttle bus service, estimated to reduce 1977 light duty VMT's by 10%.

Strategy 2: Traffic signal system, estimated to increase average speed in St. Paul CBD from 12 mph to 18 mph by 1977.

The following table summarizes the impact of these strategies on total emissions and on air quality in the two CBD's.

			EMISSION DENSITY (Kg/Sq. Mile/12 Hours)			
CBD	Area (Square Mile)	1971	"Safe" Emission Density Level	1977: No Transport. Controls Applied	1977 Appl. of Strategy #1	1977 Appl. of Strategies #1 and #2
Minneapolis	2.2	12,822	6,100	6,571 (7.2%)(1)	6,164 (6.2%)(2)	4,703 (28.4%)
St. Paul	0.8	12,617	6,100	6,488 (6.0%)	5,983 (7.8%)	4,664 (28.2%)

			AIR QUALITY (Highest 8-Hour Average CO Concentration in PPM)			
CBD	Area (Square Mile)	1971	Ambient Air Quality Standard	1977: No Transp. Controls Applied	1977: Appl. of Strategy #1	1977: Appl. of Strategies #1 and #2
Minneapolis	2.2	18.9	9	9.7	9.1	6.9
St. Paul	0.8	18.6	9	9.6	8.8	6.8

The above table shows that both strategy 1 and strategy 2 must be employed to yield enough margin of safety to confidently estimate that the 9 ppm standard can be achieved. This margin of safety is also necessary to compensate for unforseen contingencies, such as the construction of a new stadium, an extension from 1975 to 1976 by EPA for compliance by manufacturers with the federal emissions regulations, and one or more of the strategies are not successful.

(1) Percent reduction in 1977 emissions required to meet standard.
(2) Percent reduction in 1977 emissions achieved by the strategies.

All of the major control strategies are either on-going or planned programs of governmental bodies* other than PCA. They are not totally new programs, and this is a primary reason for their selection. Initial contacts have been made with these governmental bodies. They all are in essential agreement with the strategies. Therefore, the probability that the selected control strategies become implemented is high.

The major obstacles to implementation of the control strategies is the necessity to restrict parking in the core of the CBD's to their present capacities so that the fringe parking lots will be used. This can be accomplished by zoning ordinances or by designation of the two CBD's as "development districts."

The progress of the control strategies will be surveyed by monitoring traffic volumes and speeds and by air quality monitoring. This data will be compared with a time-table of expected values of these parameters.

The objective of the program to enforce the selected control strategies is to insure their on-schedule implementation by 1977. The basic instrument for achievement of this objective is an Inter-Agency Agreement to be co-signed by the PCA and other responsible governmental bodies.* This agreement will be executed by July 30, 1973, and will include a time-table for achievement of the specific control strategies, performance specifications for the strategies, the responsibilities of each agency in implementing each strategy, a requirement to pass necessary ordinances limiting core parking, and a program for enforcing existing regulations and ordinances.

* The major responsible governmental bodies are: The City of Minneapolis, the City of St. Paul, the Metropolitan Transit Commission, the Metropolitan Council, and the Highway Department.

The Minnesota Pollution Control Agency will establish a Transportation Control Unit within the Division of Air Quality. Funding for this Unit is requested of the Minnesota Legislature in PCA's budget for the next biennium (July, 1973, to July, 1975). The major tasks of this Unit are: supporting and assisting the responsible governmental bodies, establishing the Inter-Agency Agreement, conducting progress surveillance programs, making mid-course corrections to the control strategies, and conducting the public-information campaign.

Three staff members are requested for the next biennium - Senior Engineer, Planner II and Engineer II. The total budget for the next biennium, including direct salaries, equipment, and special studies, is:

- FY 1974 $65,240
- FY 1975 $70,851

II. DERIVATION OF POTENTIAL AIR QUALITY LEVELS IN 1977

A. General Methodology

(Section II A - to be provided)

B. DISCUSSION OF 1971 AIR QUALITY LEVELS

1. Background

The Minnesota Implementation Plan submitted to EPA in January, 1972, showed that the cities of Minneapolis and St. Paul cannot meet the 8-hour average national ambient carbon monoxide standard by 1975. This Plan did show, however, that the Photochemical Oxidant standard can be met by 1975 throughout the state. EPA has, as discussed earlier, granted a two-year extension to achieve the carbon monoxide standard by the application of transportation control strategies. This section reviews and analyzes the carbon monoxide and photochemical oxidant air quality data contained in the Implementation Plan submitted in January, 1972, as well as data collected after the submission of the Plan.

2. The Natural Features of the Minneapolis-St. Paul Metropolitan Area

a. General

The Minneapolis-St. Paul Metropolitan area is situated on a gently rolling plain with many lakes and ponds, where the Minnesota and St. Croix Rivers intersect the Mississippi River. The altitude is generally less than 1000 feet above sea level. The generally flat terrain and high average wind speeds are favorable to the dispersion of air pollutants.

The climate is controlled on a macro-scale by the interface between the continental polar air and warm moist air from the Gulf of Mexico. This interface region experiences wide variations in temperature and a general tendency to reach the extremes in most climatic features. Seasonal temperatures range from very cold in the winter to hot in the summer. The average mean temperature for the four seasons for the period 1931 to 1955 is: winter, 14°F; spring, 42°F; summer, 68°F; and fall, 46°F.

b. Meteorology

Three conditions having a major impact on the dispersion of air pollutants are: low wind speeds, temperature, inversions, and condensation.

The wind speed in the Minneapolis-St. Paul area averages slightly over 10 miles per hour, with little variation in monthly averages, as seen in Table II B1. Figure II B1 shows that the predominant wind prevails from the northwest in winter and southeast in summer. Lower wind speeds are more frequent at night, prevailing at less than 8 miles per hour from 40 to 50 percent of the time (Figure II B2). In the summer, wind speeds are higher than in other seasons during the day and lower during the night.

Temperature inversions usually occur at night and occur more frequently in the fall and winter when the ski is clear, and the wind speed is low. Clear skies allow the earth's surface to radiate and cool at a fast rate, thereby cooling the air near its surface and restricting vertical mixing with the warmer, lighter air above it. Low wind speeds also prevent mixing and the dispersion of air contaminants. Such inversions often contribute to high levels of air pollution around midnight.

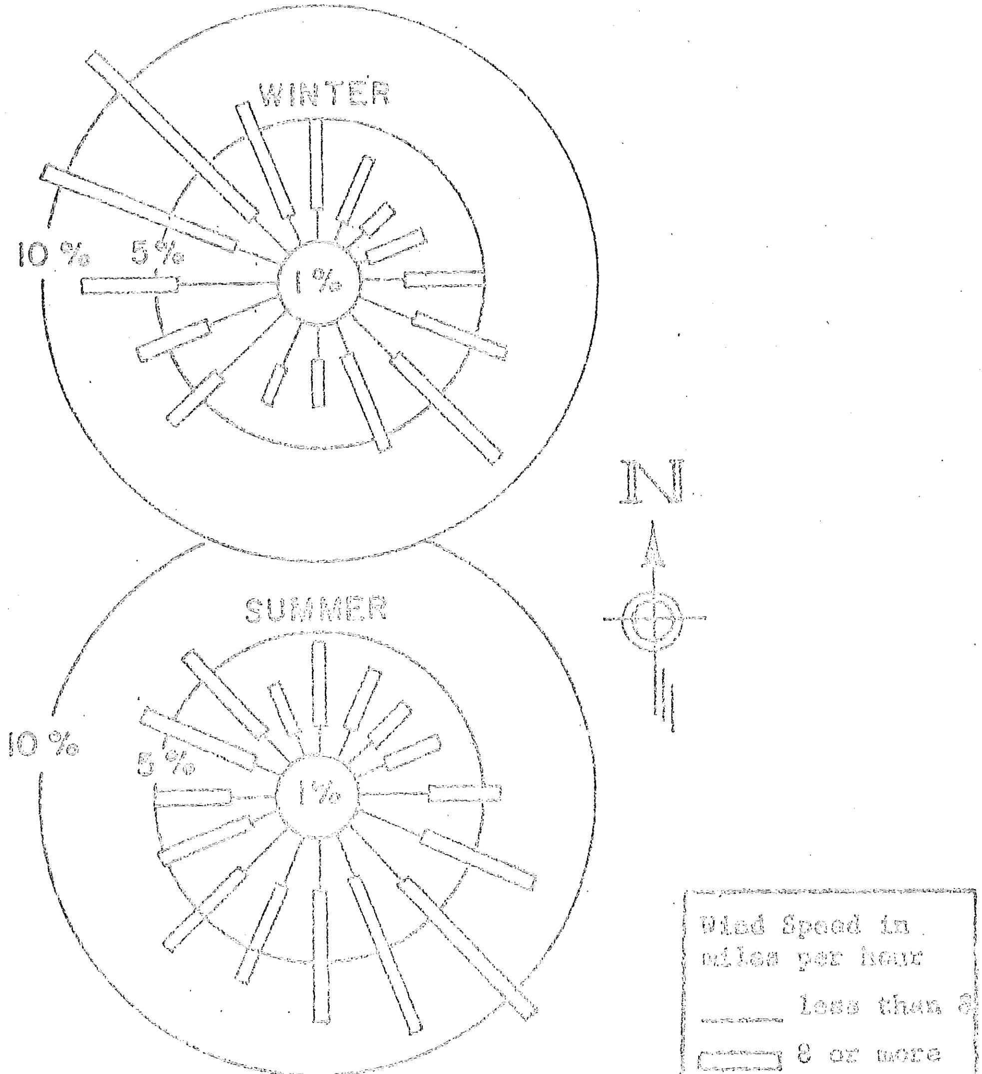

Figure II B1. Per cent frequency of wind direction
Per cent calm given in center circle

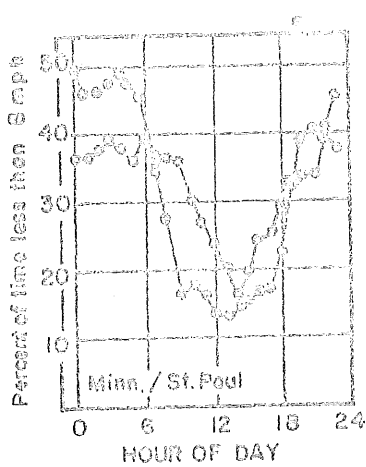

Figure II B2. Hourly Frequency of Wind Speeds Less than Eight Miles Per Hour

TABLE II B1

PREVAILING DIRECTION AND MEAN HOURLY SPEED OF WIND (mph)
FOR THE MINNEAPOLIS-ST. PAUL AREA

Jan.	NW	10.6	July	SE	9.5
Feb.	NW	10.9	Aug.	SE	9.4
Mar.	NW	11.6	Sept.	S-SE	10.5
Apr.	NW	12.7	Oct.	SE	10.9
May	SE	11.6	Nov.	NW	11.6
June	SE	11.1	Dec.	NW	10.8

The third condition, condensation, either in the form of clouds above or as fog close to the earth's surface, limits solar heating and decreases vertical circulation. In general, the presence of fog prolongs inversions and thereby makes the situation worse; however, in Minnesota heavy fogs usually do not last longer than 24 hours and only occur about 10 to 20 times per year.

Meteorological conditions are important not only in the transport and diffusion of carbon monoxide, but also in the rate of formation of photochemical oxidants. As a consequence, two periods of the year require special attention: the fall-winter period for CO and the spring-summer period for photochemical oxidants. In the fall-winter months, when stagnant conditions occur more frequently, maximum CO concentrations can be expected. However, during this period the rate of formation of photochemical oxidants is slow, keeping ambient concentrations low. Photochemical oxidants, which are formed by complex chemical reactions with hydrocarbons and nitrogen oxides, increase as light intensity increases. Thus, concentrations are higher in the late spring and summer when solar radiation is most intense.

3. Location and Type of Instrumentation

Air quality is monitored at three stations in the Minneapolis-St. Paul area: downtown St. Paul, downtown Minneapolis, and at a location between the two cities (Midway Site). Whereas CO was measured at all three stations, oxidants, which were not deemed a problem in Minnesota, were measured continuously at downtown Minneapolis only for the period 1971-1972. The location of each station and the instrumentation for CO and oxidants follows below.

a. Local Station No. 1 (Midway Site)

A trailer is located about 20 feet generally east of Bedford Street, about 100 feet generally south of the thoroughfare University Avenue. The trailer is located about 100 feet from the tower of the KSTP TV-radio station. The sampling port above the trailer is well exposed, and the air flow is not seriously influenced by nearby structures. Air quality, however, could be influenced by several local sources: the emptying and filling of the adjacent KSTP parking lot, the trucking operations at the Century Trucking platform, which is located about 500 feet away, and several other local trucking operations.

During the period from July 1, 1971, to August 15, 1972, a Beckman 315A non-dispersive infrared analyzer with an optical filter was used to monitor CO. This is the EPA reference method. The data is collected once per minute and is telemetered back to MPCA offices for reduction. The instrument is well-maintained, and the data should be reliable. The data must be corrected for the 5 ppm offset and the moisture interference. The Beckman correction factor is 1 ppm for a 3.2 mole percent H_2O content.

A Beckman Air Quality Acralizer was used to measure total oxidants for only the first two months of 1972. Since this instrument is not adopted by EPA as a reference method and has questionable accuracy, its operation was discontinued when the pump failed. Presently a McMillan instrument using the dry chemiluminescent technique is being installed.

b. Local Station No. 2 (Downtown Minneapolis Site)

Station No. 2 is located in the Minneapolis Public Health Building on the corner of Fourth Street and Third Avenue, Minneapolis. Air is sampled about 12 feet above the main doorway through one of the metal channels on the side of the building. The instruments are located on the fifth floor above ground. Sample loss in the channel is negligible because of the high sampling rate. The air flow is restricted to 180° since the sampling port is on the side of the building. Streamlines are mainly from the corner of the two streets, whose curbs are about 15 and 30 feet away from the sampling inlet. Both streets are one-way with three or four lanes and are frequently traveled, especially during the morning and evening commuter rush hours.

A Beckman 315AL non-dispersive infrared CO analyzer - the EPA reference method - with a desiccant to remove water vapor is operated continuously in the laboratory. The instrument is well maintained, and the desiccant is changed daily or on alternate days depending on its color. The data are recorded on strip-chart paper, is manually averaged hourly, and is sent to MPCA.

A Beckman Air Quality Acralizer was used to measure total oxidants for the 1971-1972 period. This instrument in not based on an EPA reference method and is judged to be generally inaccurate.

c. Local Station No. 3 (Downtown St. Paul Site)

This station is located on the corner of East Tenth Street and Minnesota Street, St. Paul. The sampling pipe protrudes from an old brick building, about 60 feet above a parking lot with a 50-car capacity. The air flow is restricted by the building. Therefore the sampled air comes mostly from the parking lot and the streets whose curbs are about 100 feet away. Both streets are frequently used.

A MSA Lira non-dispersive infrared CO analyzer was used to collect the data at one-minute intervals. Up to August, 1972, a method to correct the moisture interference was not used. Recently a refrigerator was installed to eliminate the moisture in the sampling air stream. Since February, 1972, the data were telemetered to MPCA with no correction for offset or for moisture interference. The new system is closely watched and maintained, but the old system without the refrigeration system is judged to be generally inaccurate. Data prior to August, 1972, can still be utilized to show relative diurnal and seasonal variations, as shown in Figures IIB5 and II B6.

4. Review of Air Quality Data

a. General

CO and total oxidant concentrations observed at the three stations during the one-year period from 1 July, 1971, through 30 June, 1972, have been reviewed and compared. Ozone data from an independent EPA study are presented for support and comparison. In addition, seasonal and daily variations for the period have been examined to further define the problem and to provide guidance in developing control strategies.

b. CO Data

One-hour averages of CO are available on computer cards for the downtown Minneapolis and the downtown St. Paul stations, making it relatively easy to obtain 8-hour averages. Data from the Midway Site was on the printed teletype output, requiring more effort to locate high data values. When the one-hour CO concentration exceeded 15.3 ppm, which was the third highest value measured at the Minneapolis station, the associated 8-hour average was calculated.

Table II B2 gives the highest and second highest one-hour and 8-hour CO concentrations observed during the period from 1 July, 1971, through 30 June, 1972, and during the entire year 1970, which was the period used for Minnesota's Implementation Plan. The highest one-hour average occurred in 1970, whereas the 8-hour averages were higher during the 1971-1972 period. It is interesting to note the excellent agreement between the CO monitors at Midway Site and Downtown Minneapolis Site. For example, the highest CO concentrations occurred on the same day at both stations on November 11, 1971. Figures II B5 through II B10, which are discussed in the following, further illustrate this agreement. This good agreement adds credulity to the data.

Figures II B3, II B4, II B5 and II B6 compare the diurnal concentration on typical days of each season for the three stations. Since data were not available from the Downtown St. Paul Site for 1971, only 1972 data are presented. Examination of these data show that the monitors are generally in relative agreement as to the time during which peak concentrations occur. Figure II B4 illustrates this correlation especially well.

Figure II B2A give the carbon monoxide concentrations for downtown Minneapolis from July 1, 1971 to June 30, 1972, in the format required in Appendix A of Federal Register, Vol 36, No. 158, August 14, 1971.

TABLE II B2

HIGHEST AND SECOND HIGHEST CARBON MONOXIDE LEVELS FOR THE MINNEAPOLIS-ST. PAUL STATIONS

(Values are in Parts per Million by Volume)

DATA SOURCE	HIGHEST (ppm) 1 Hour (Date)	HIGHEST (ppm) 8 Hour (Date)	SECOND HIGHEST (ppm) 1 Hour (Date)	SECOND HIGHEST (ppm) 8 Hour (Date)
Station No. 1 - Midway (July '71 - June '72)	35.8 (11-11-71)	26.2 (11-11-71)	27.2 (11-15-71)	21.6 (11-15-71)
Station No. 2 - Mpls (July '71 - June '72)	33.0 (11-10-71)	18.9 (11-11-71)	29.0 (9-22-71) 29.0 (11-17-71)	17.5 (11-10-71)
Station No. 2 - Mpls (Jan.'70 - Dec. '70)	44.6**	17.1**		
Station No. 3 - St. Paul (Jan. '71 - June '72)	17.5 (1-18-72)	*	14.0 (2-10-72)	*
Used in Implementation Plan				

* Not calculated form one-hour averages because of inaccuracies in data.

** Values used in Implementation Plan, Table 4.1.

TABLE II B2A

CARBON MONOXIDE CONCENTRATIONS AT DOWNTOWN MINNEAPOLIS SITE*

(July 1, 1971, to June 30, 1972)

Parts per million by volume)

Site Location					Maximum Values		Second Highest Values				
MPCA No.	SARROAD No.	x	y	No. of Hourly Samples	1-Hour	8-Hour	1-Hour	8-Hour	Annual Arith. Mean	Standard Deviation (Based on Hourly Values)	Geometric Standard Deviation (Based on Hourly Values)
901 A	24-2260-022	479.0	4980.2	8423	33.0 11/10 1971	18.9 11/11 1971	29.0 9/22 1971	17.5 11/10 1971	5.5	3.30	1.94

* Similar data for Midway and Downtown St. Paul Sites requires extensive additional data prepartation, storage, and analysis and will not be available until the end of 1973.

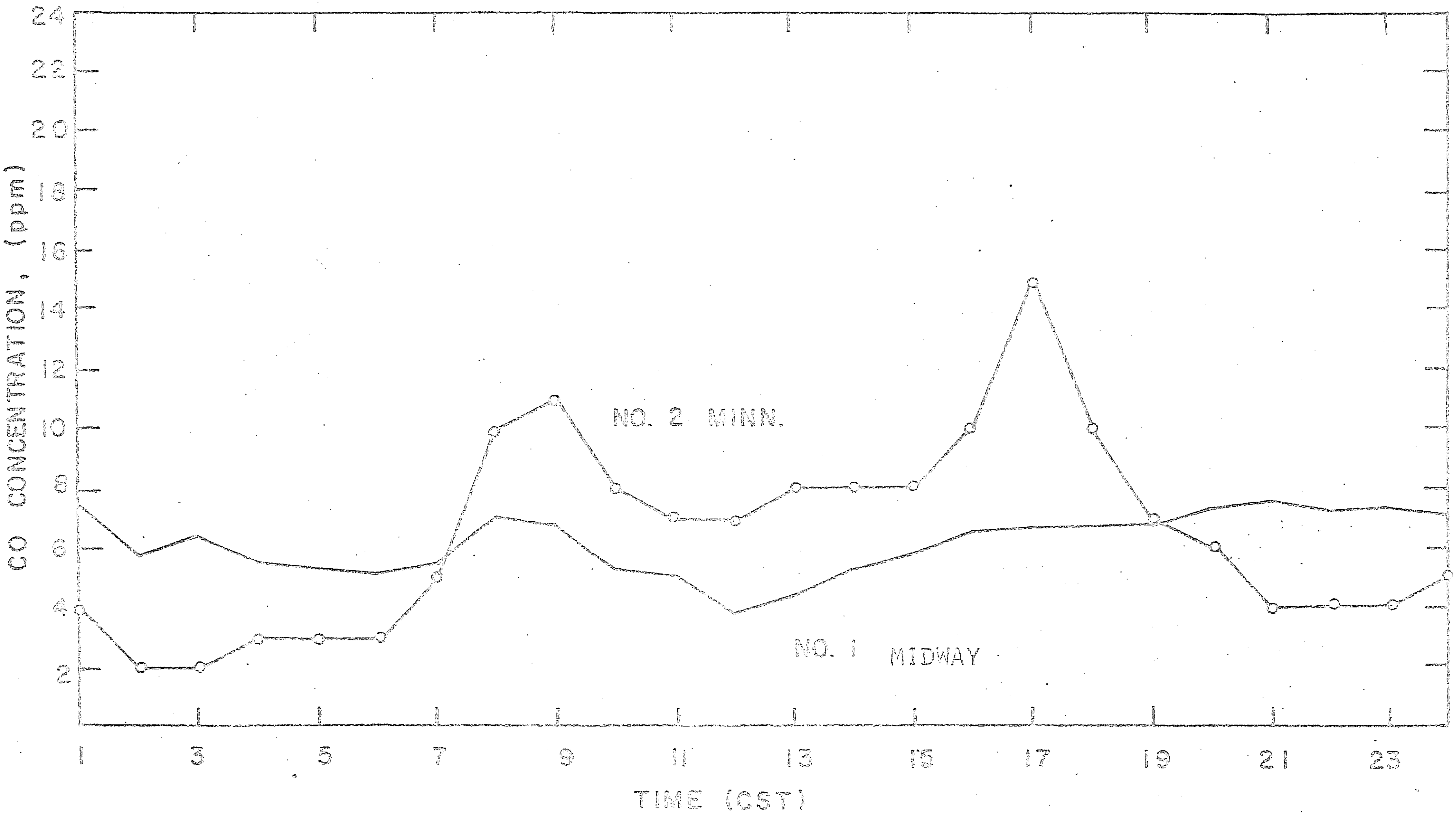

Figure II B 3. Diurnal Variation in Average 1-hour Carbon Monoxide Concentration at Midway and Downtown Minneapolis - Aug. 16 - Summer 1971

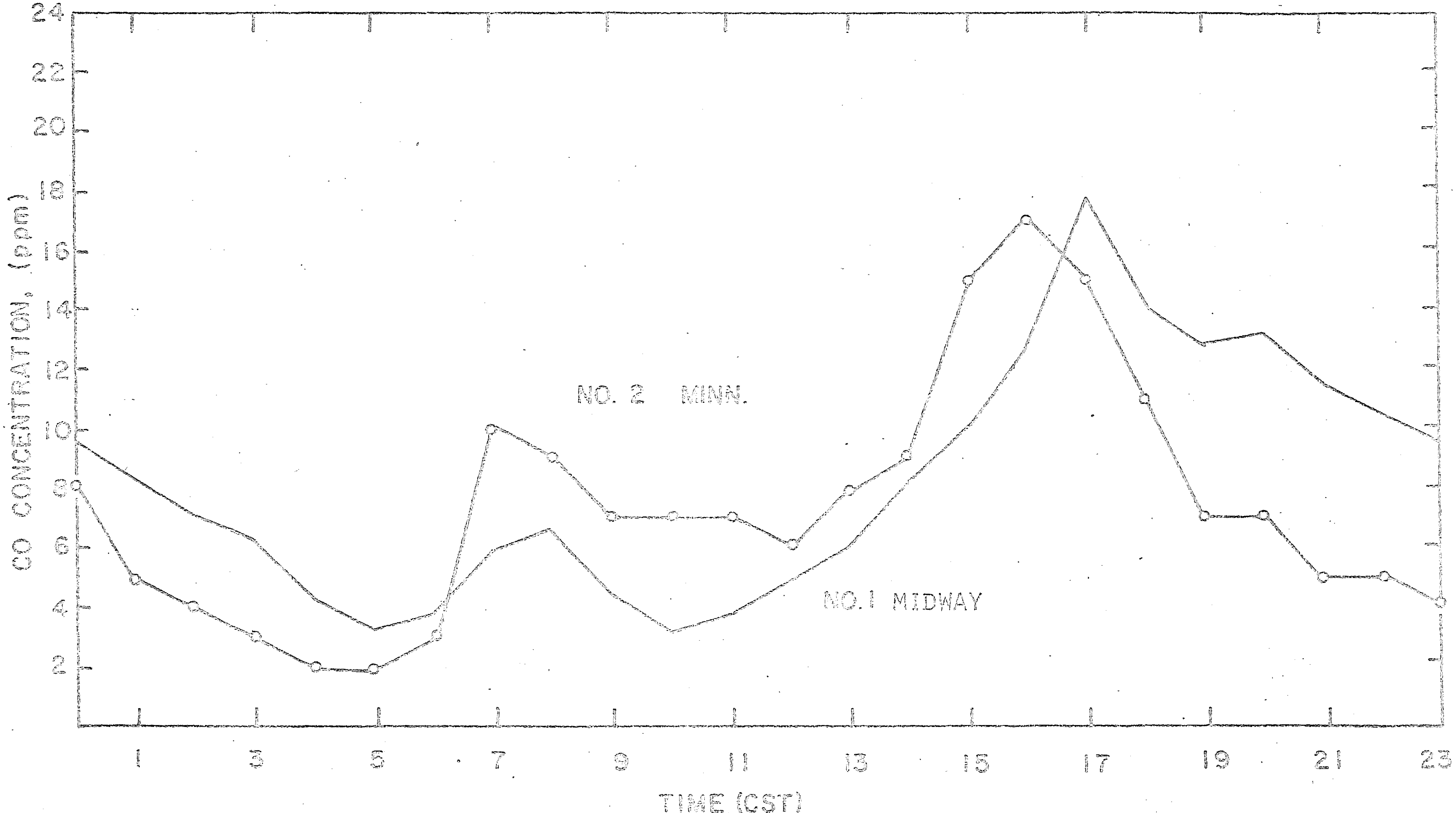

Figure II B4. Diurnal Variation in Average 1-hour Carbon Monoxide Concentration at Midway and Minneapolis - Nov. 12 - Fall 1972

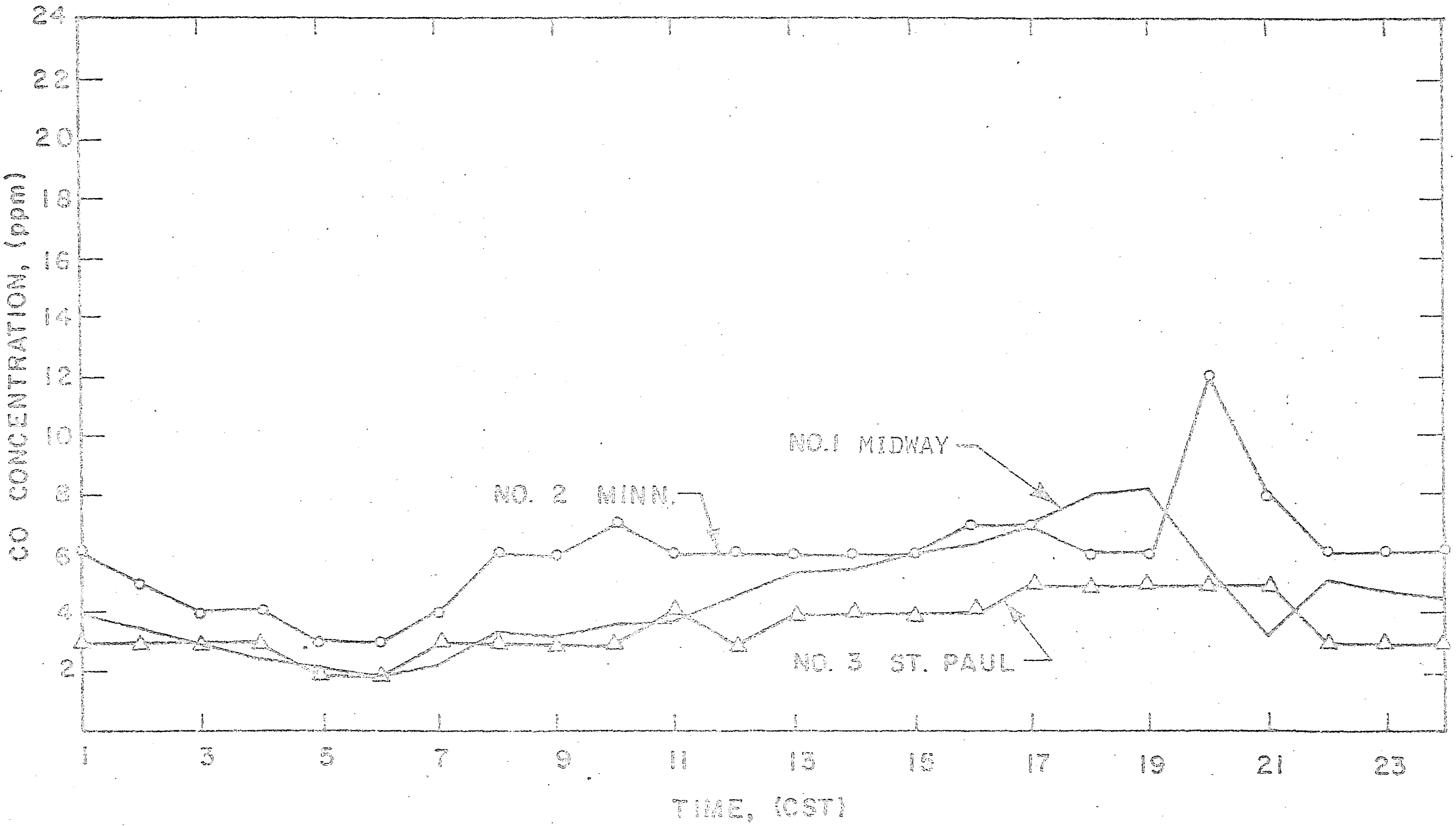

Figure II B5. Diurnal Variation in Average 1-hour Carbon Monoxide Concentration at Midway, Minneapolis, and St. Paul - Feb. 12 - Winter 1972

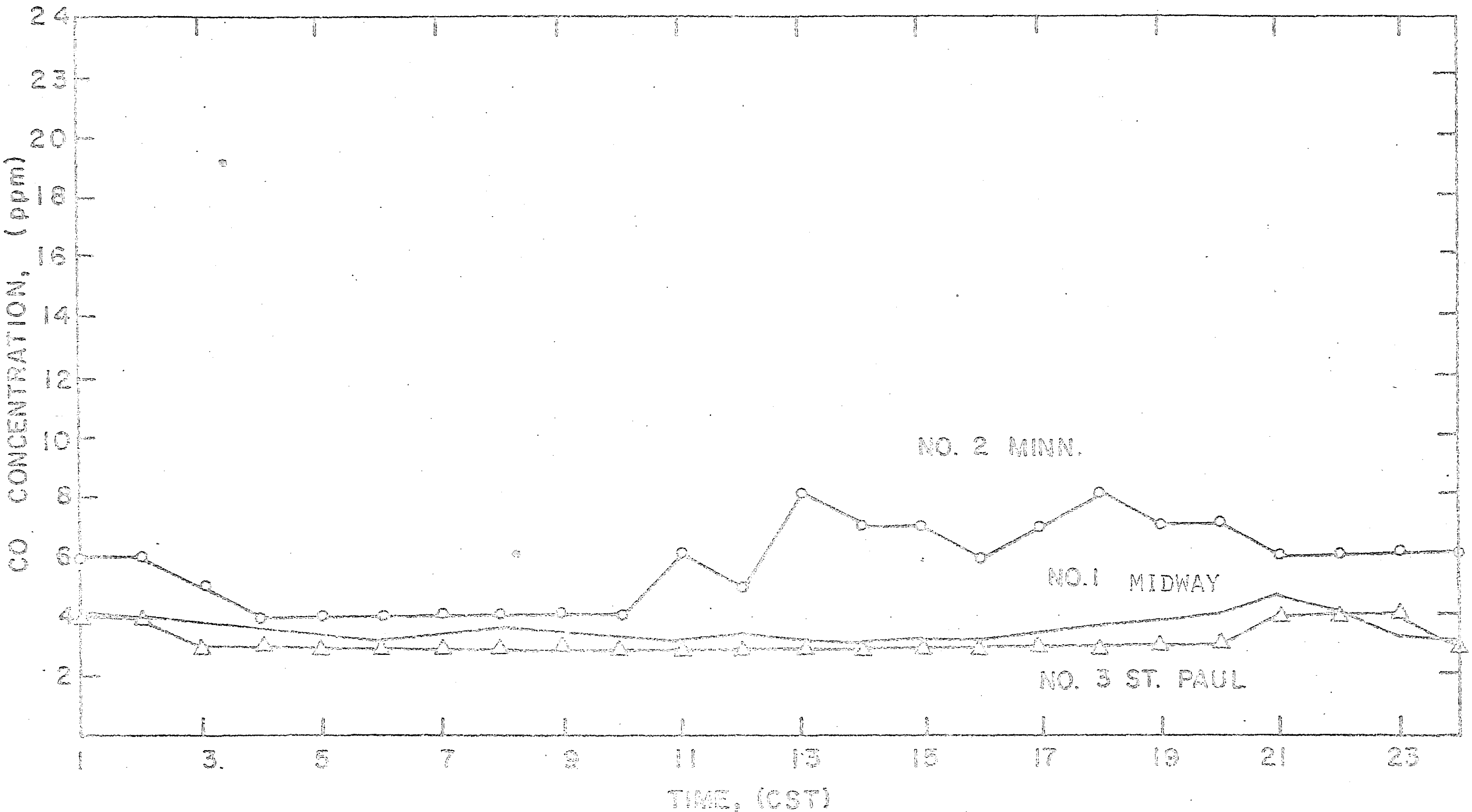

Figure II B6. Diurnal Variation in Average 1-hour Carbon Monoxide Concentration at Midway, Minneapolis, and St. Paul - May 14 - Spring 1972

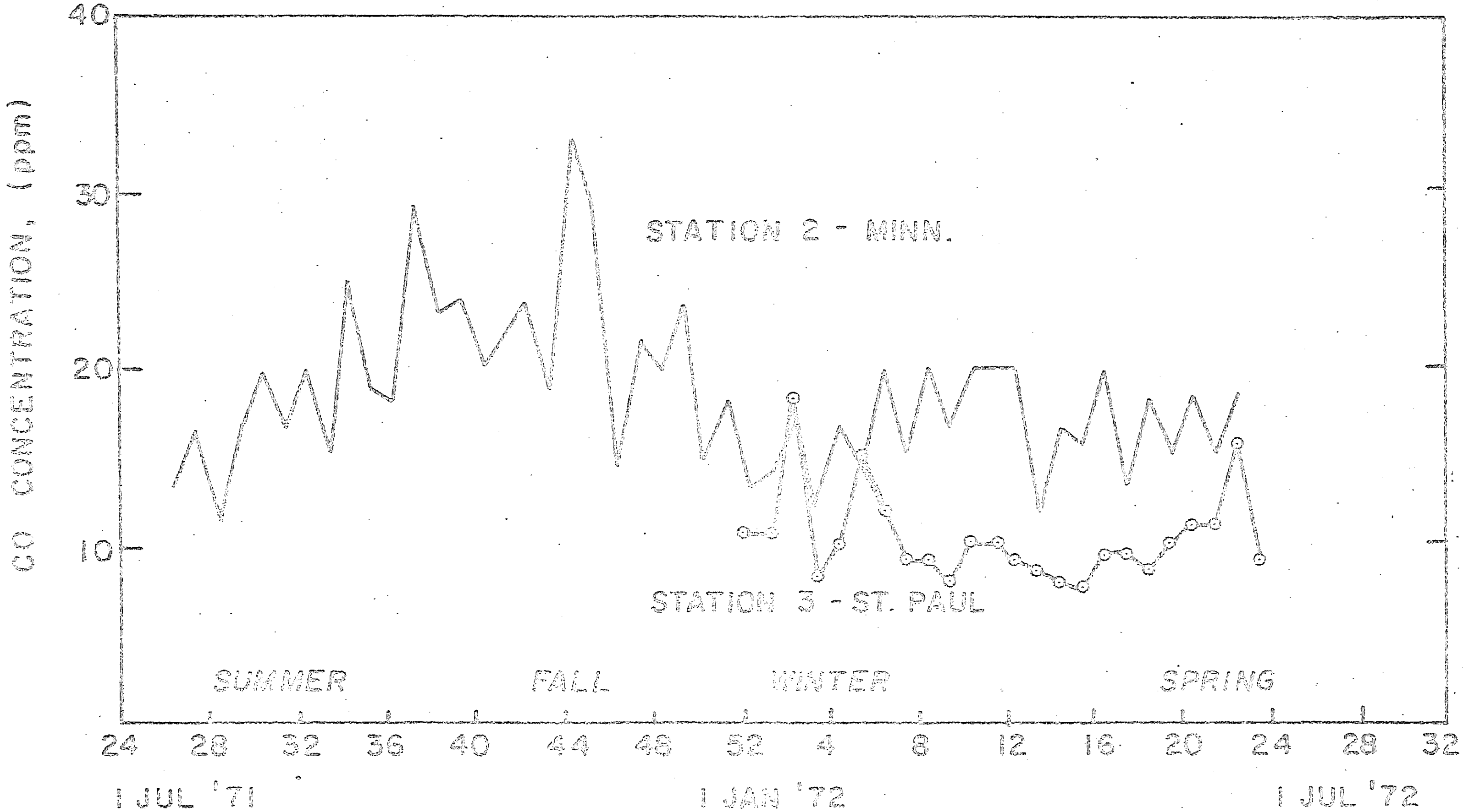

Figure II B7. Seasonal Weekly Maximum 1-hour Carbon Monoxide Concentration at Minneapolis and St. Paul

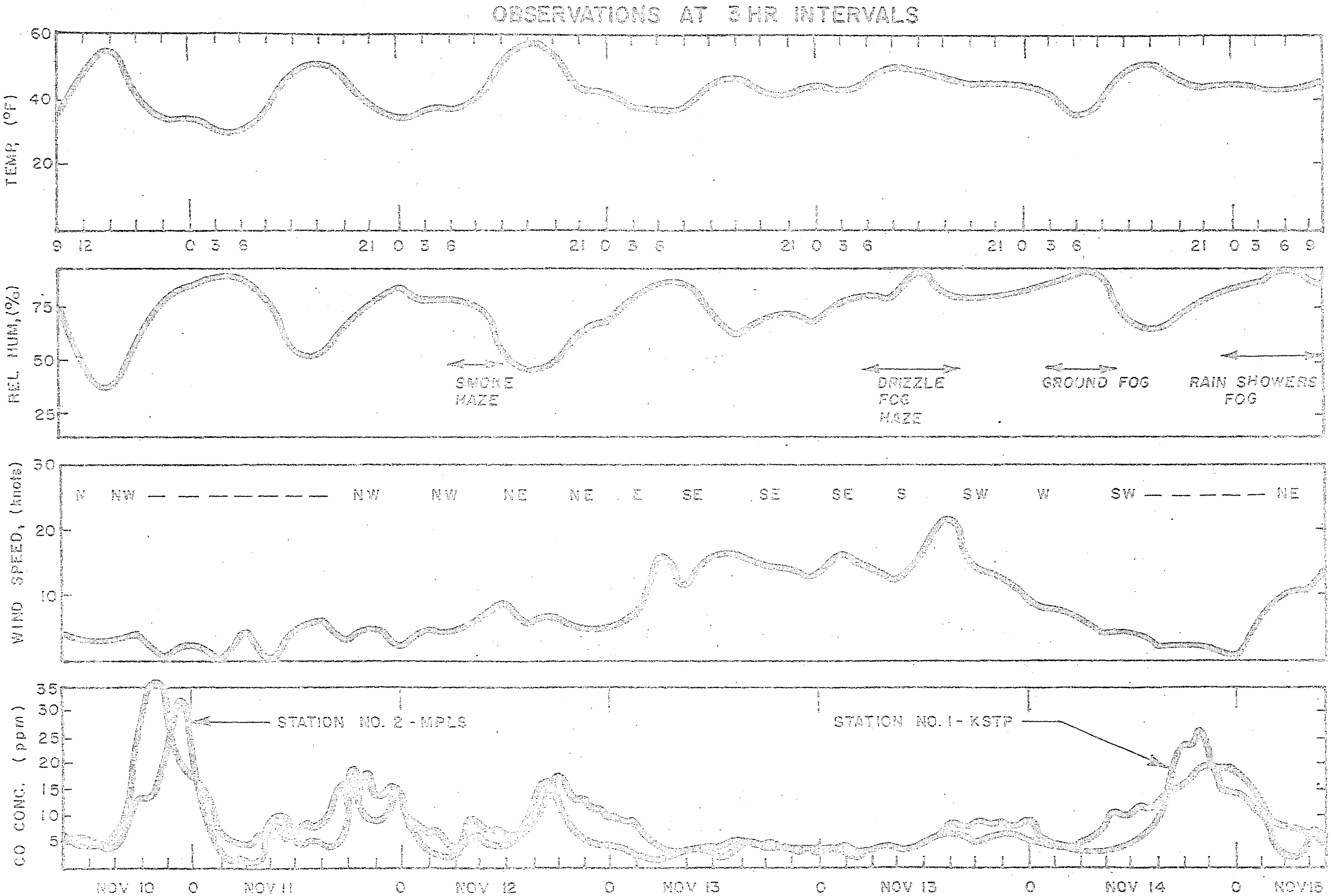

Figure II B8. Diurnal Variation of Average 1-hour CO Concentration with Metereological Conditions During the Highest and Second Highest Peaks.

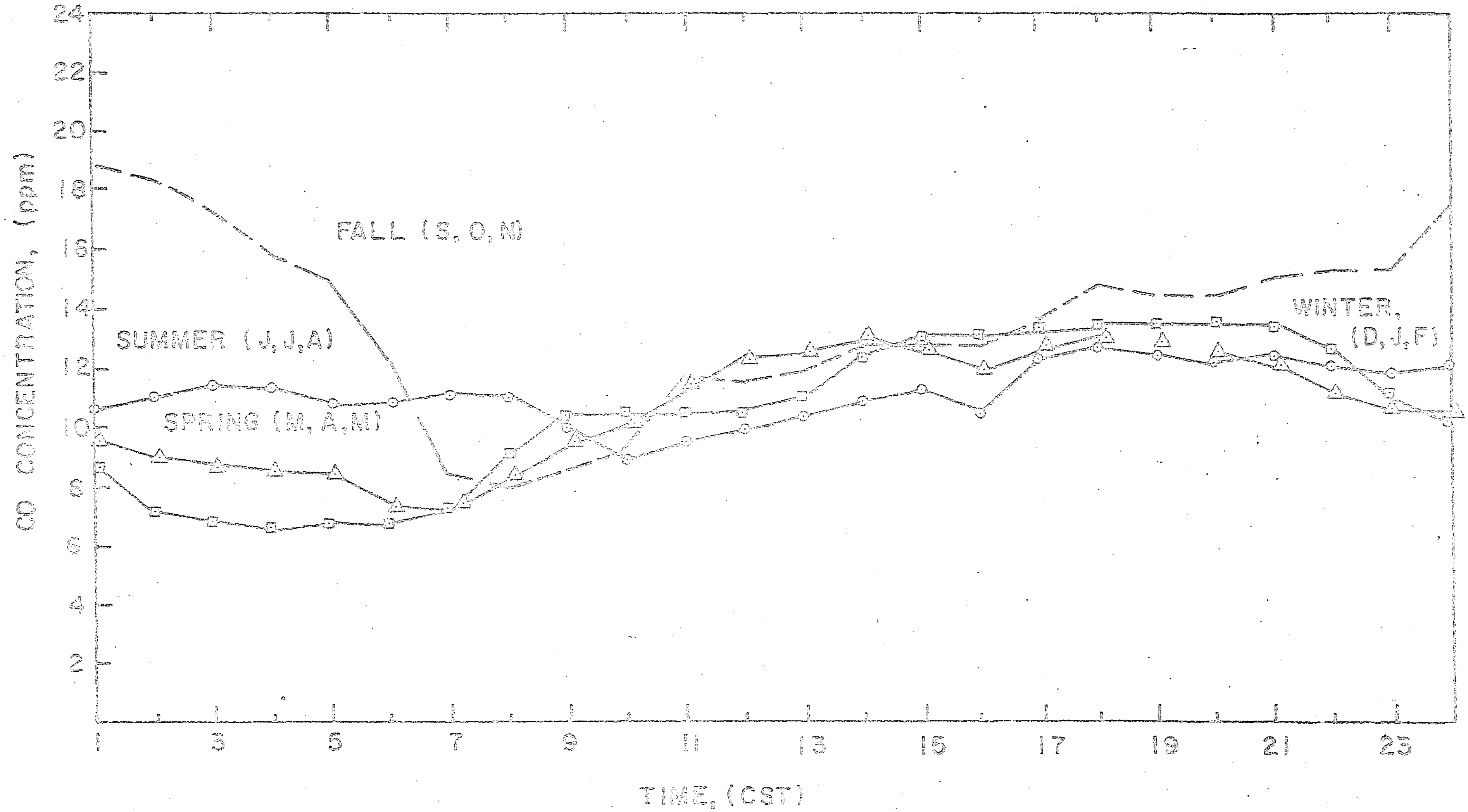

Figure II B9. Diurnal Variation of the Maximum 8-hour Carbon Monoxide Concentration at Station No. 2 - Minneapolis (July '71 - June '72).

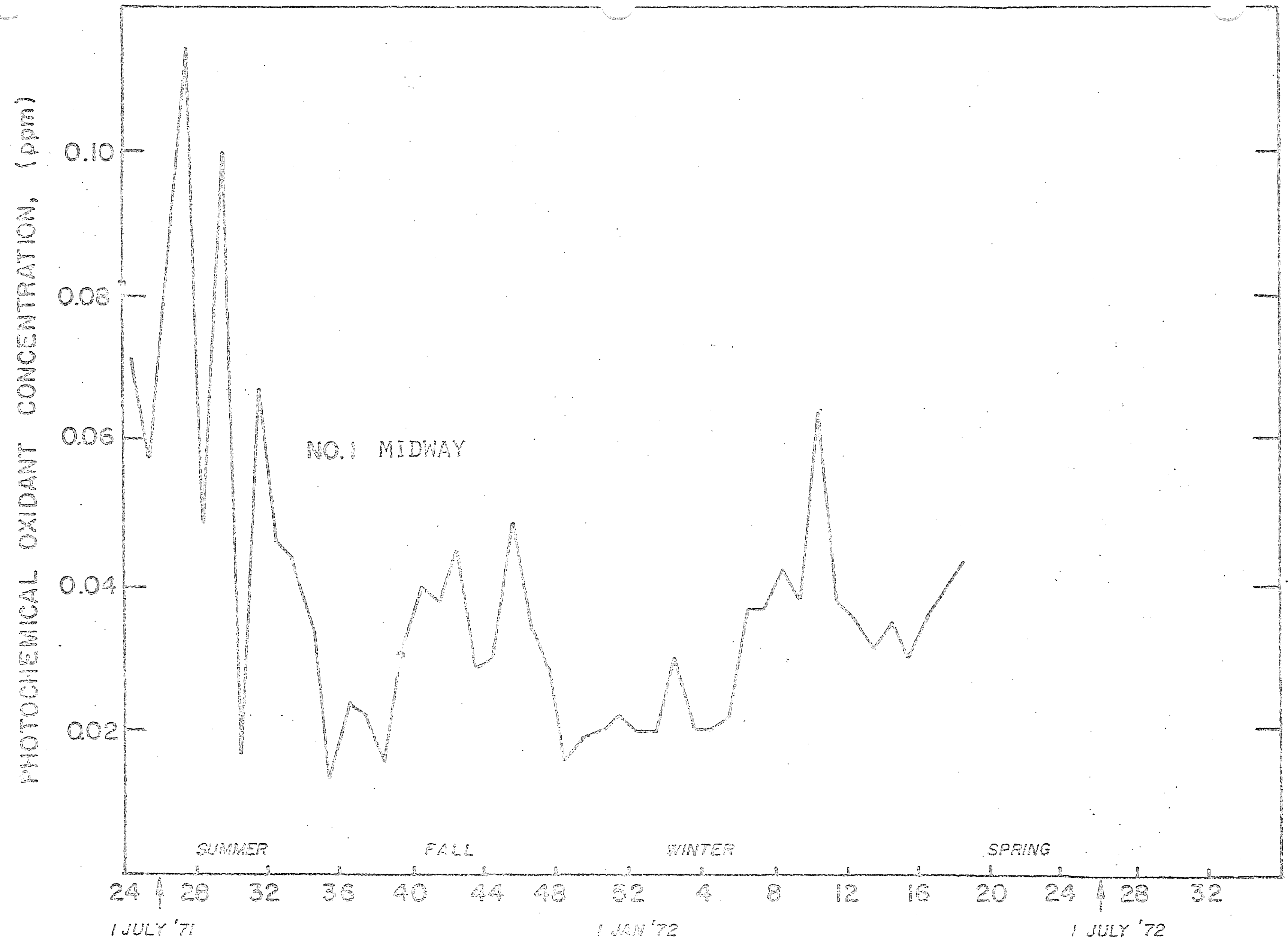

Figure II B10. Weekly 1-hour Maximum Total Oxidant Concentration at Minneapolis.

The period November 10 - 15, 1971, is very important because the highest and second highest one-hour and 8-hour average CO concentrations occurred at both the Downtown Minneapolis and Midway Sites. Figure II B8 shows the one-hour CO averages for this period, along with the concurrent meteorological conditions of temperature, relative humidity, wind speed, and wind direction. These data were obtained from the climatological summaries measured at the Minneapolis-St. Paul International Airport. The CO concentration pattern for the two stations is very similar. The concentration fluctuates more at the Downtown Minneapolis Site and usually peaks during the commuting hours. The pattern is highly influenced by the weather as will be discussed below.

During the time period in Figure II B8, the effects of the three conditions that severely influence the level of air pollution can be seen. The high peaks occur when there is no wind. The average CO concentration was less than 7 ppm when the wind was blowing over 10 mph. The first and highest peak of the period was caused by low wind speeds and a temperature inversion during the night. The second and third peaks occurred during early night when the wind speed prevailed at less than 6 mph, and temperatures decreased considerably. The second highest peak occurred around 9:00 P.M. on November 15 when fog was present, light winds prevailed, and temperatures decreased. Because of poor mixing, the evening and early night vehicle emissions accumulated over the area causing the high CO level.

Figure II B9 presents a summary of the diurnal variation of maximum 8-hour CO concentrations in downtown Minneapolis for each of the four seasons from July, 1972 through June, 1972. The diurnal pattern is similar in all seasons except for the fall's amplitude during the night. This significant difference can be misleading because these large 8-hour concentrations only occurred a few times in the fall, specifically from 10:00 P.M. to 6:00 A.M. The concentration falls from about midnight to six o'clock in the morning, rises during the day when vehicle activity increases and persists through the night only when poor dispersion conditions exist. A higher rise is observable during the commuting hours.

Several other conclusions about the diurnal and seasonal variations can be obtained from Table II B3, which gives the highest 8-hour concentration observed during each hour of the day for each month. The federal standard of 9 ppm is frequently exceeded from the afternoon to midnight. The number of times the standard is exceeded increases from 1 at 7:00 A.M. to a maximum of 76 at 6:00 P.M., and decreases thereafter. During the fall-winter months, especially in October, the standard is frequently exceeded.

c. Total Oxidant Data

Total oxidant data were generated only from the Downtown Minneapolis Site. Summary data from this station is available as average daily and maximum one-hour concentrations. This data was obtained with the wet technique (Beckman Air Quality Acralyzer). Figure II B10 is a plot of the weekly maximum one-hour oxidant concentration. Although the variance is high, because the sky cover varied, the higher concentrations of total oxidants occur in the spring and summer months when solar radiation is most intense. The standard of 0.08 ppm was exceeded just a few times during the year; specifically, July 5 - 20, 1971.

TABLE II B3

MAXIMUM 8-HR. CO CONCENTRATION (PPM) AND THE NUMBER OF TIMES THE STANDARD WAS EXCEEDED IN MINNEAPOLIS DURING THE PERIOD 1 JULY 1971 to 31 JULY 1972

(Entry is at hour ending 8-hour period)

HOUR	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	MAX	NO. OF TIMES OVER STANDARD
01	8	8	11 (1)	10 (2)	19 (3)	7	7	9	10 (2)	7	9	11 (1)	18.9	(9)
02	8	7	10 (1)	9 (1)	19 (3)	6	5	7	9	7	9.	11 (1)	18.5	(6)
03	7	7	9 (1)	8	17 (2)	6	5	7	8	6	9	11 (1)	17.4	(4)
04	7	7	9	7	16 (2)	6	5	7	7	6	9	11 (1)	15.8	(3)
05	7	8.	8	7	15 (2)	6	4	7	6	6	8	11 (1)	14.9	(3)
06	6	7	8	7	12 (1)	7	5	7	6	6	7	11 (1)	12.4	(2)
07	6	6	8	7	8	7	5	7	6	7	8	11 (1)	11.1	(1)
08	6	6	8	7	6	7	6	9 (1)	7	8	8	11 (1)	11.0	(2)
09	7	6	8	8	7	8	8	10 (1)	7	10 (1)	8	10 (2)	10.1	(4)
10	7	7	8	9 (1)	7	8	8	10 (2)	8	10 (1)	9	9 (1)	10.5	(5)
11	8	7	8	12 (2)	8	9	9 (1)	10 (2)	8	11 (1)	10 (1)	10 (2)	11.8	(9)
12	8	8	9	12 (2)	8	10 (2)	10 (1)	11 (3)	9	12 (2)	10 (1)	10 (5)	12.4	(16)
13	9	9 (1)	9 (1)	12 (6)	8	11 (3)	11 (1)	11 (3)	10 (1)	13 (2)	11 (1)	12 (6)	13.0	(25)
14	10 (4)	10 (1)	10 (2)	13 (7)	10 (2)	13 (4)	11 (4)	12 (4)	11 (5)	13 (5)	12 (1)	14 (6)	13.7	(45)
15	10 (5)	10 (1)	10 (3)	13 (10)	11 (4)	13 (6)	10 (5)	12 (4)	11 (5)	13 (5)	12 (1)	14 (7)	13.6	(57)
16	11 (7)	10 (2)	10 (2)	13 (9)	12 (4)	13 (5)	10 (4)	11 (3)	12 (6)	12 (3)	12 (1)	14 (5)	13.7	(51)
17	12 (7)	11 (5)	11 (4)	14 (12)	12 (6)	13 (6)	10 (4)	11 (2)	12 (8)	13 (3)	12 (1)	16 (9)	14.0	(69)
18	12 (8)	11 (9)	13 (4)	15 (12)	14 (8)	13 (8)	10 (3)	11 (3)	12 (8)	13 (3)	12 (1)	13 (9)	14.8	(76)
19	12 (7)	11 (6)	13 (5)	15 (13)	14 (7)	13 (7)	10 (1)	10 (3)	13 (8)	13 (3)	12 (3)	13 (9)	14.5	(70)
20	12 (6)	11 (5)	12 (4)	14 (13)	14 (7)	13 (7)	8 (1)	11 (2)	12 (8)	12 (2)	12 (3)	13 (9)	14.4	(67)
21	11 (6)	10 (5)	12 (5)	14 (12)	15 (7)	13 (2)	9	11 (2)	12 (7)	12 (1)	12 (2)	12 (9)	15.0	(58)
22	11 (4)	10 (4)	13 (4)	13 (11)	15 (7)	13 (2)	8	11 (2)	11 (6)	12 (1)	11 (2)	12 (4)	15.3	(47)
23	10 (2)	10 (3)	13 (2)	13 (10)	13 (6)	11 (2)	5	11 (2)	10 (1)	11 (1)	11 (1)	12 (3)	15.3	(33)
24	5 (1)	9 (1)	12 (1)	11 (0)	10 (4)	9 (1)	8	10 (2)	11 (1)	9 (1)	10 (1)	12 (1)	17.5	(23)
MAX	12.0	11.1	13.1	14.8	18.9	13.4	10.6	11.6	12.6	13.0	12.4	13.7	18.9	
NO. TIMES STD. EXCEEDED	(57)	(43)	(40)	(130)	(73)	(59)	(25)	(41)	(70)	(35)	(20)	(96)		

* NO. TIMES STANDARD EXCEEDED WAS NOT CALCULATED

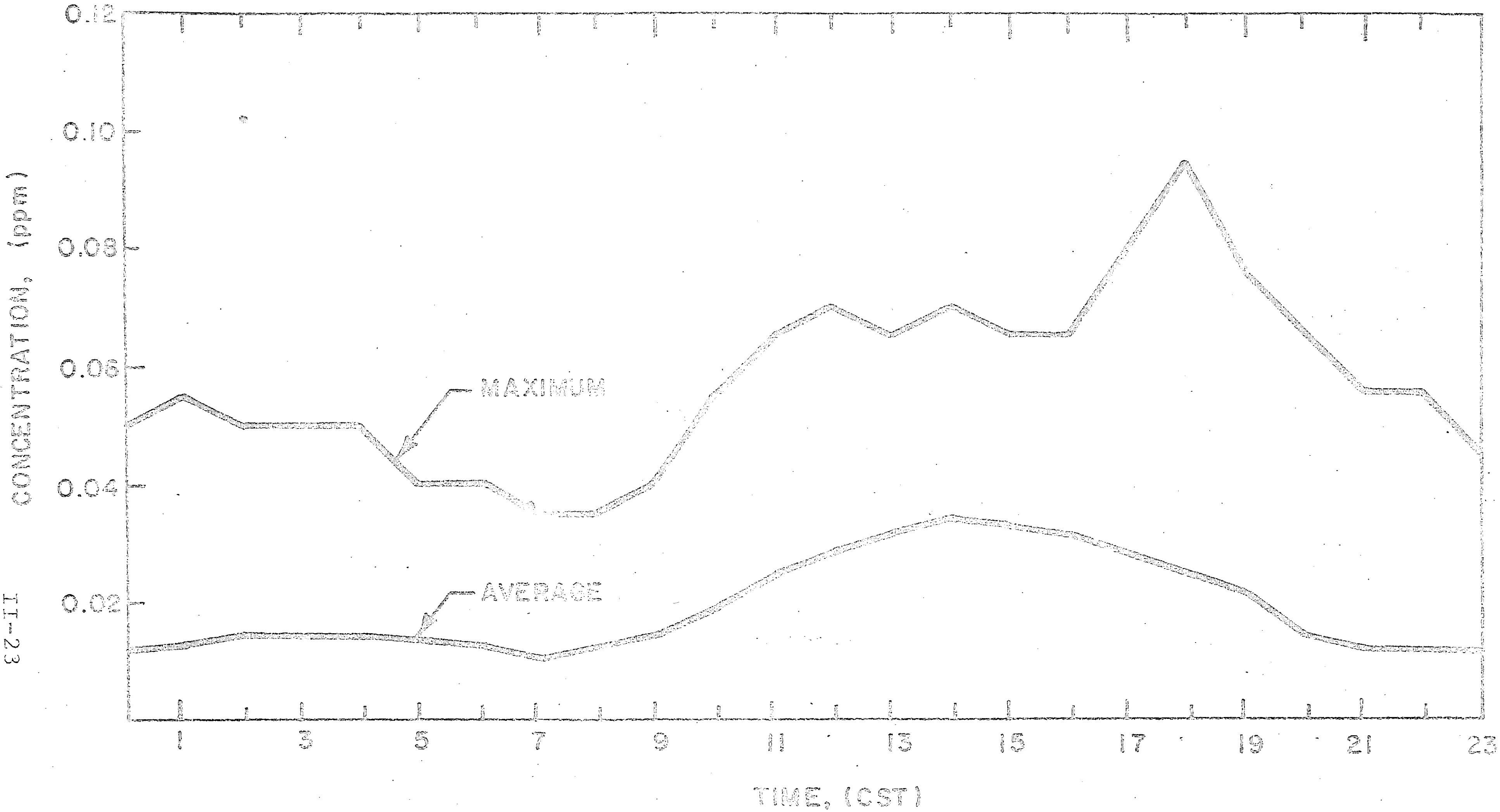

Figure II B11 Diurnal Variation of the Maximum and Average 1-hour Ozone Concentration for July - Sept. 1971 at Midway Station, by EPA.

A special study of ozone levels in the Minneapolis-St. Paul area was carried out by EPA in conjunction with state and local agencies for the months of July through September, 1971. Using the dry chemiluminescent reference method specified in the Federal Register, Vol 26, No. 84, April 30, 1971, ambient ozone concentrations were measured continuously at the Midway Site. The date showed that the 0.08 ppm standard was exceeded only once at 0.095 ppm. This agrees with the few times the standard was exceeded at the Downtown Minneapolis Site in which the wet, total oxidant technique, was used - a technique which normally does yield slightly higher readings. Figure II B11 plots the maximum and average one-hour diurnal variations for the three months during which the EPA study was conducted. Both curves show higher concentrations when solar radiation is intense.

Table II B4 lists the highest and second highest oxidant levels observed from the EPA study and from the data generated at the Downtown Minneapolis Site. The first and second highest data points measured in Minneapolis are believed to be high because the instrument experienced performance difficulties several times in July, 1971, the time during which the high value occurred.

5. Present and Projected Non-Vehicular Source Emissions in Air Quality Control Region (AQCR) 131

Tables II B5 through II B8 present 1970 non-vehicular CO and hydrocarbon emissions in Air Quality Control Region 131 and in Hennepin and Ramsey counties, the two most populous counties in the region. These Tables were developed from the Emissions Inventory in Minnesota's Implementation Plan. Growth factors for each source category were also obtained from the Implementation Plan and used to project emissions for both 1971 and 1977. The projected emissions for these years are also presented in these Tables.

TABLE II B4

HIGHEST AND SECOND HIGHEST OXIDANT LEVELS OBSERVED
AT DOWNTOWN MINNEAPOLIS SITE

Sampling Source and Period	Concentrations (ppm)	
Station No. 2 - Mpls (July, 1971 - June, 1972)	.114 (Total Oxidant)	.100 (Total Oxidant)
EPA Study at Station No. 1 - Midway (July, 1971 - September, 1971)	0.095 (Ozone)	.080 (Ozone)

TABLE II B5

REGION 131 CO EMISSIONS FROM NON-MOTOR VEHICLE SOURCES

Sources	1970 CO Emissions (Tons/yr)	Growth Factors (1971) X	Growth Factors (1977) X^7	Projected CO Emissions Assuming that no control strategies Applied (tons) 1971	Projected CO Emissions Assuming that no control strategies Applied (tons) 1977
Fuel Combustion					
Residential	1,895	1.0176	1.130	1,920	2,140
Commercial & Institutional	650	1.054	1.445	685	940
Industrial	108	1.039	1.309	112	141
Power Plants	1,940	1.039	1.309	2,020	2,540
Process Losses	9,600	1.028	1.213	9,860	11,600
Solid Waste Disposal	16,027	1.018	1.133	16,300	18,200
Railroads	1,500	1.021	1.157	1,530	1,730
Aircraft	55,500	1.042	1.334	57,900	74,000
Total (tons/yr)	87,220			90,327	111,291

TABLE II B6

REGION 131 HYDROCARBON EMISSIONS FROM NON-MOTOR VEHICLE SOURCES

Sources	1970 HC Emissions (tons/yr)	Growth Factors 1971	1977	Projected Hydrocarbon Emissions Assuming that no Control Strategies Applied (tons) 1971	1977
		X	X^7		
Fuel Combustion					
Residential	670	1.076	1.130	720	757
Commercial & Institutional	300	1.054	1.445	316	434
Industrial	1,470	1.039	1.309	1,530	1,920
Power Plants	3,060	1.039	1.309	3,180	4,000
Process Losses	25,280	1.028	1.213	26,000	30,600
Solid Waste Disposal	5,300	1.018	1.133	5,390	6,010
Railroads	1,150	1.021	1.157	1,175	1,330
Aircraft	13,000	1.042	1.334	13,580	17,360
Handling	9,300	1.035	1.272	9,630	11,850
Evaporative Losses	22,500	1.018	1.133	22,900	25,000
Total (tons/yr)	82,000			84,421	99,261

TABLE II B7

CO EMISSIONS FROM NON-MOTOR VEHICLE SOURCES FOR HENNEPIN AND RAMSEY COUNTIES

Sources	1970 CO Emissions (Tons/yr)	Growth Factors (1971) X	Growth Factors (1977) X^7	Projected CO Emissions Assuming that no control strategies Applied (tons) 1971	Projected CO Emissions Assuming that no control strategies Applied (tons) 1977
Fuel Combustion					
Residential	1,276	1.0176	1.130	1,373	1,442
Commercial & Institutional	453	1.054	1.445	477	655
Industrial	41	1.039	1.309	43	54
Power Plants	1,632	1.039	1.309	1,696	2,136
Process Losses	9,384	1.028	1.213	9,647	11,383
Solid Waste Disposal	10,212	1.018	1.133	10,396	11,570
Railroads	640	1.021	1.157	653	740
Aircraft	50,542	1.042	1.334	52,665	67,423
Total (tons/yr)	74,180			76,950	95,403

TABLE II B8

HYDROCARBON EMISSIONS FROM NON-MOTOR VEHICLE SOURCES FROM HENNEPIN AND RAMSEY COUNTIES

Sources	1970 HC Emissions (tons/yr)	Growth Factors 1971 X	Growth Factors 1977 X^7	Projected Hydrocarbon Emissions Assuming that no Control Strategies Applied (tons) 1971	Projected Hydrocarbon Emissions Assuming that no Control Strategies Applied (tons) 1977
Fuel Combustion					
Residential	461	1.076	1.130	496	521
Commercial & Institutional	197	1.054	1.445	208	285
Industrial	966	1.039	1.309	1,004	1,264
Power Plants	2,879	1.039	1.309	2,991	3,769
Process Losses	25,236	1.028	1.213	25,943	30,611
Solid Waste Disposal	3,217	1.018	1.133	3,275	3,645
Railroads	517	1.021	1.157	528	598
Aircraft	11,910	1.042	1.334	12,410	15,888
Handling	6,195	1.035	1.272	6,412	7,880
Evaporative Losses	18,270	1.018	1.133	18,599	20,700
Total (tons/yr)	69,848			71,866	85,161

C. TRANSPORTATION DATA (1971 and 1977) VEHICLE MILES TRAVELED)

Basic data were provided by a number of cooperating agencies, particularly: the Traffic Bureau of Department of Public Works, City of St. Paul; the Traffic Division, Public Works Department, City of Minneapolis; the Twin Cities Area Transportation Program and its participants (Metropolitan Council, Minnesota Highway Department, Metropolitan Transit Commission, and the Metropolitan counties and municipalities).

The following information sources were used to estimate the present vehicle miles of travel (VMT) and to project these travel magnitudes to the study period:

(a) Vehicle Traffic Flow Map, City of Minneapolis, 1970 Average Daily Traffic.

(b) Traffic Volume Flow Map, City of St. Paul, 1969-1971.

(c) Travel Behavior Inventory, Twin Cities Area.

(d) Registration Data on Motor Vehicles.

(e) Vehicular Traffic Flow in Central Business District, Average One Hour in 1969, City of Minneapolis, and

(f) Travel Speed Data.

1. Estimation of VMT in 1970

The estimation of 1970 average daily traffic for the Central Business Districts (CBD's) of Minneapolis and St. Paul, as well as those for the Urban Activity Districts in the remaining areas of the Twin Cities, required the use of the traffic volume maps. Basic differences is data presentation caused slight variation in method of calculation.

a. Minneapolis CBD

Traffic data available for this district related flow magnitudes on city streets as the average one hour volumes of the 12-hour period between 6:30 A.M. to 6:30 P.M. in 1969. These street volumes were converted to vehicle-miles by multiplying by the distances between intersections on the map. The average hourly vehicle-miles thus obtained was expanded to 24-hour values by multiplying by the factor 15.9, derived by the Minneapolis Traffic Division.

b. St. Paul CBD

Traffic flow data available for this area were in terms of ADT volumes for major facilities determined over the period 1969 to 1971. On the assumption that these data would average to conditions in 1970, volumes on each link were multiplied by link distance to obtain 24-hour VMT values. The sum of all link VMT's then corresponded to the total VMT generated in the CBD.

c. Municipal Urban Activity Districts

Traffic volume maps for the cities of Minneapolis and St. Paul were divided by an overlay relating these standard planning areas to the data shown in Figures II.C.1 and II.C.2. Linkages on these maps were categorized as "Freeway/Interstate" and "Other." The "Other" category of linkages was divided into "Principal Arterials" if ADT exceeded 5000 and to "Secondary Streets" if the facilities had less volume. Linkage distances were scaled from maps and used to convert ADT to 24-hour VMT in these three categories.

d. Conversion of 24-hour VMT to 12-hour VMT

A conversion factor was derived for this purpose using expansion factors developed by the Minneapolis Traffic Division for CBD traffic. Two factors were used. The factor for converting

FIGURE II.C.1 TO BE PROVIDED

FIGURE II.C.2 TO BE PROVIDED

average hourly volumes to 12-hour volumes was "12." The factor used to convert hourly average to 24-hour volumes was "15.9." Thus the conversion factor to convert all 24-hour VMT volumes to 12-hour VMT volumes is:

$$\frac{12}{15.9} = 0.75$$

2. Estimating 1972 and 1977 Travel

The 1970 VMT estimates were expanded using information on person-trips data and forecasts contained in the travel behavior inventory generated in the Twin Cities Area Transportation Program. The following data was obtained:

$$\text{Person-trips (1970)} = 5{,}095{,}000$$

$$\text{Person-trips (1980)} = 6{,}725{,}000$$

$$\text{10-year travel growth} = \frac{6{,}725{,}000}{5{,}095{,}000} = 1.32$$

Therefore, the linear annual growth rate is:

$$\text{Rate} = \frac{0.32}{10} \text{ or } 3.2\% \text{ growth per year.}$$

Therefore to expand 1970 base year data, the following relationships are used:

VMT Base Data (1970) x 1.064 = VMT (1972)

VMT Base Date (1970) x 1.224 = VMT (1977)

3. Vehicle Type

The average vehicle mix in the traffic stream was based upon information from the traffic division of the Cities as follows:

	Minneapolis (%)	St. Paul (%)
Light Duty (includes automobiles, taxis, and light trucks)	92.5	90.0
Heavy Duty (includes medium and heavy trucks)	6.0	8.5
Other (includes buses)	1.5	1.5
TOTAL	100.0	100.0

4. Estimation of Traffic Density

Traffic density in units of VMT per square mile was obtained by measuring (with a planimeter) the area of each urban activity district and the CBD's. The VMT volume by type of facility was divided by the area of each district. The resultant traffic densities are shown in Tables II.C.1, II.C.2, and II.C.3.

TABLE II.C.1

TRAFFIC DENSITY

FREEWAY/INTERSTATE

Urban Activity District	Area Square Miles	1970 VMT	1972 VMT	1972 VMT Per Sq. Mile	1977 VMT	1977 VMT Per Sq. Mile
MINNEAPOLIS						
57-61 (CBD)	2.2	0	0	0	0	0
52	5.28	0	0	0	0	0
53	8.60	0	0	0	0	0
54	5.04	118,900	126,510	25,100	145,530	28,880
55	5.48	49,950	53,150	9,700	61,140	11,160
56	5.96	190,990	203,210	34,100	233,770	39,220
63	1.40	113,520	120,790	86,280	138,950	99,250
64	5.56	224.700	239,000	42,990	275,000	49,460
65	5.60	94,600	100,650	17,970	115,790	20,680
66	5.20	103,900	110,550	21,260	127,180	24,460
67	4.08	103,960	110,610	27,110	127,250	31,190
68	2.60	90,900	96,720	37,200	111,260	42,790
69	6.20	90,900	96,720	15,600	111,260	17,950
ST. PAUL						
84-88 (CBD)	0.8	20,600	21,900	27,400	25,200	31,400
79	6.00	90,300	96,080	16,010	110,530	18,420
80	3.12	71,040	75,590	24,230	86,950	27,870
81	6.60	53,280	56,690	8,590	65,220	9,880
82	3.20	166,800	177,480	55,460	204,160	63,800
83	6.88	196,650	209,240	30,410	240,700	34,990
89	3.84	79,600	84,900	22,110	97,680	25,440
90	13.48	87,075	92,650	6,870	106,580	7,910
91	4.48	73,500	78,200	17,460	89,960	20,080
92	7.28	7,350	7,820	1,070	9,000	1,240
93	3.80	0	0	0	0	0

TABLE II.C.2

TRAFFIC DENSITY

PRINCIPAL ARTERIAL

Urban Activity District	Area Square Miles	1970 VMT	1972 VMT	1972 VMT Per Sq. Mile	1977 VMT	1977 VMT Per Sq. Mile
MINNEAPOLIS						
57-61(CBD)	2.2	283,000	302,000	137,000	347,000	157,800
52	5.28	134,740	143,360	27,150	164,920	31,240
53	8.60	367,560	391,080	45,470	449,890	52,310
54	5.04	224,610	238,990	47,420	274,920	54,550
55	5.48	351,020	373,480	68,150	429,650	78,400
56	5.96	284,770	302,990	50,840	348,560	58,320
63	1.40	57,200	60,860	43,470	70,020	50,010
64	5.56	385,170	409,820	73,710	471,450	84,790
65	5.60	188,850	200,940	35,880	231,150	41,280
66	5.20	120,580	128,[illegible]	24,670	147,590	28,380
67	4.08	124,220	132,170	32,400	152,050	37,270
68	2.60	148,880	158,410	60,930	182,230	70,090
69	6.20	179,470	190,950	30,800	219,670	35,430
ST. PAUL						
84-88(CBD)	0.8	82,500	87,700	109,800	101,000	126,100
79	6.00	189,000	201,090	33,520	231,330	38,550
80	3.12	84,340	89,740	28,760	103,230	33,090
81	6.60	161,540	171,880	26,040	197,730	29,960
82	3.20	156,520	166,540	52,040	191,580	59,870
83	6.88	309,000	328,770	47,790	378,210	54,970
89	3.84	67,120	71,410	18,600	82,150	21,390
90	13.48	188,760	200,840	14,900	231,040	17,140
91	4.48	161,850	172,210	38,440	188,100	41,990
92	7.28	216,390	230,240	31,630	264,860	36,380
93	3.80	119,990	127,670	33,600	146,870	38,650

TABLE II.C.3

TRAFFIC DENSITY

SECONDARY STREETS
(<5,000 ADT)

Urban Activity District	Area Square Miles	1970 VMT	1972 VMT	1972 VMT Per Sq. Mile	1977 VMT	1977 VMT Per Sq. Mile
MINNEAPOLIS						
57-61(CBD)	2.2	0	0	0	0	0
52	5.28	29,160	31,026	5,880	35,690	6,760
53	8.60	14,710	15,651	1,820	18,010	2,090
54	5.04	7,650	8,140	1,620	9,360	1,860
55	5.48	9,810	10,430	1,900	12,000	2,190
56	5.96	30,760	32,730	5,490	37,650	6,320
63	1.40	6,400	6,810	4,860	7,830	5,590
64	5.56	32,630	34,720	6,250	39,940	7,180
65	5.60	44,810	47,680	8,510	54,850	9,800
66	5.20	45,120	48,010	9,230	55,230	10,620
67	4.08	12,980	13,810	3,390	15,890	3,900
68	2.60	7,240	7,700	2,960	8,860	3,410
69	6.20	29,750	31,650	5,110	36,410	5,870
ST. PAUL						
84-88 (CBD)	0.8	0	0	0	0	0
79	6.00	27,200	28,940	4,820	33,290	5,550
80	3.12	16,640	17,700	5,670	20,370	6,530
81	6.60	55,190	58,720	8,900	67,550	10,240
82	3.20	25,970	27,630	8,630	31,790	9,930
83	6.88	68,910	73,320	10,660	84,350	12,260
89	3.84	1,770	1,880	490	2,170	570
90	13.48	28,430	30,250	2,240	34,800	2,580
91	4.48	29,630	31,520	7,040	36,260	8,090
92	7.28	31,280	33,280	4,570	38,280	5,260
93	3.80	30,710	32,670	8,600	37,590	9,890

5. Speed

Speeds of travel on streets and freeways were estimated as follows from data and information obtained from the traffic divisions of the Cities:

		Average Speed (mph)		
		Freeways/ Interstates	Principal Arterials	Secondard Streets
MINNEAPOLIS				
	CBD	N.A.	14	N.A.
UAD*	52	N.A.	35	25
UAD	53	N.A.	35	25
UAD	54	50	35	25
UAD	55	45	30	23
UAD	56	45	30	23
UAD	63	40	30	23
UAD	64	43	35	25
UAD	65	45	35	25
UAD	66	50	35	25
UAD	67	50	35	25
UAD	68	55	35	25
UAD	69	55	35	25
ST. PAUL				
	CBD	35	12	N.A.
UAD	79	50	35	25
UAD	80	48	35	25
UAD	81	48	35	25
UAD	82	48	35	25
UAD	83	40	30	23
UAD	89	40	30	23
UAD	90	48	35	25
UAD	91	50	35	25
UAD	92	45	35	25
UAD	93	N.A.	35	25

* "UAD" means Urban Activity District

D. ESTIMATION OF 1977 AIR QUALITY DATA

1. 1971 and 1977 Emission Densities of CO and Hydrocarbons in Minneapolis and St. Paul Metropolitan Area

Tables II D-1 and II D-2 indicate the emission densities of carbon monoxide and hydrocarbons in the Minneapolis and St. Paul CBD's as well as the other 22 Urban Activity Districts (UAD) comprising the Minneapolis and St. Paul metropolitan area. These emission densities were developed for the years 1971 and 1977 and include emissions from non-vehicular as well as vehicular sources. The 1977 emission estimates were based on projected growth of both the vehicular and non-vehicular sources as well as the effect of the Federal Motor Vehicle Emission Control Program on automotive emissions.

a. Non-Vehicular Sources of Emissions

Tables II B7-8 in Section II B present the non-vehicular emissions estimates of carbon monoxide and hydrocarbons in Ramsey and Hennepin counties for the years 1971 and 1977. The following procedures were followed to estimate non-vehicular emissions in the CBD's and UAD's as presented in Tables II D-1 and II D-2.

- Hennepin and Ramsey county CO and HC emission totals were ratioed to the Metropolitan areas by population.
- These metropolitan totals were then apportioned to the various UAD's by geographic area
- Emissions from solid waste disposal (open burning) were not included because existing regulations now prohibit such a practice.

TABLE II D1

SUMMARY OF CO EMISSION INFORMATION WITH NO CONTROL STRATEGIES APPLIED FOR METROPOLITAN AREAS OF MINNEAPOLIS AND ST. PAUL

Location	Square Miles	CO Emission Density (kgm/sq mile/12 hrs) 1971 Vehicles	1971 Other	1971 Total	1977 Vehicles	1977 Other	1977 Total	1978 Vehicles	1978 Other	1978 Total	1979 Vehicles	1979 Other	1979 Total
Minn. Metrop. Area; Urban Activity Dist.													
57-61 (CBD)	2.20	12,713	109	12,822	6,442	129	6,571	5,433	131	5,564	4,560	133	4,693
52	5.28	1,156	109	1,265	613	129	742						
53	8.60	1,588	109	1,647	844	129	973						
54	5.04	2,252	109	2,361	1,228	129	1,357						
55	5.48	2,823	109	2,932	1,495	129	1,624						
56	5.96	3,007	109	3,116	1,606	129	1,735						
63	1.40	4,373	109	4,482	2,342	129	2,471						
64	5.56	3,900	109	4,009	2,097	129	2,226						
65	5.60	2,035	109	2,144	1,089	129	1,218						
66	5.20	1,742	109	1,851	937	129	1,066						
67	4.08	1,883	109	1,992	1,020	129	1,149						
68	2.60	2,982	109	3,091	1,620	129	1,749						
69	6.20	1,594	109	1,703	860	129	989						
KSTP Tower Area (within Dist. 54)	1.13	2,271	109	2,380	1,215	129	1,344						
St. Paul Metro. Area; Urban Activity Dist.													
84—88(CBD)	0.80	12,508	109	12,617	6,359	129	6,488	5,367	131	5,498	4,510	133	4,643
79	6.00	1,743	109	1,852	977	129	1,106						
80	3.12	1,845	109	1,954	950	129	1,079						
81	6.60	1,521	109	1,630	830	129	959						
82	3.20	3,565	109	3,674	2,013	129	2,142						
83	6.88	3,202	109	3,311	1,764	129	1,893						
89	3.84	1,381	109	1,490	769	129	898						
90	13.48	779	109	888	436	129	565						
91	4.48	2,044	109	2,153	1,108	129	1,237						
92	7.28	1,298	109	1,407	719	129	848						
93*	3.80	1,517	21,509	23,026	836	27,549	28,385						

*Includes CO emissions from St. Paul Airport.

TABLE II D2

SUMMARY OF HYDROCARBON EMISSIONS WITH NO CONTROL STRATEGIES APPLIED FOR METROPOLITAN MINNEAPOLIS AND ST. PAUL

Location	Square Miles	Hydrocarbon Emission Density (kg/sq mile/12 hrs)					
		1971			1977		
		Vehicles	Other	Total	Vehicles	Other	Total
Minn. Metropolitan Area; Urban Act. Dist.:							
57 61 (CBD)	2.20	1,616	703	2,319	783	837	1,620
52	5.28	207	703	910	97	837	934
53	8.60	291	703	994	136	837	973
54	5.04	434	703	1,137	205	837	1,042
55	5.48	505	703	1,208	237	837	1,074
56	5.96	553	703	1,256	260	837	1,097
63	1.40	815	703	1,517	382	837	1,219
64	5.56	735	703	1,438	345	837	1,182
65	5.60	377	703	1,080	177	837	1,014
66	5.20	328	703	1,031	154	837	991
67	4.08	365	703	1,068	171	837	1,008
68	2.60	584	703	1,287	273	837	1,110
69	6.20	304	703	1,007	142	837	979
St. Paul Metropolitan Area; Urban Act. Dist.:							
84 88 (CBD)	0.80	1,603	703	2,306	779	837	1,616
79	6.00	334	703	1,037	164	837	1,001
80	3.12	357	703	1,060	164	837	1,001
81	6.60	282	703	985	136	837	973
82	3.20	698	703	1,401	343	837	1,180
83	6.88	579	703	1,282	285	837	1,122
89	3.84	259	703	962	127	837	964
90	13.48	148	703	851	73	837	910
91	4.48	389	703	1,092	185	837	1,022
92	7.28	239	703	942	117	837	954
93	3.80	274	703	977	135	837	972

- CO emissions from the St. Paul Airport were added directly to Urban Activity District No. 93.
- Hydrocarbon emissions from both the International and St. Paul airports were apportioned over the Minneapolis and St. Paul Metropolitan areas.

b. Vehicular Sources of Emissions

The VMT data presented in Section II C was utilized in conjunction with the automobile age distribution in Minnesota AQCR 131 and EPA automotive emission factors to estimate CO and hydrocarbon emissions for 1971 and 1977.

c. Nitrogen Oxide Emissions

Tables II D-3 to II D-5 show the emissions of nitrogen oxides (and all other major pollutants) from all transportation sources and the total from all sources for AQCR 131, Hennepin County, and Ramsey County over the period 1970 to 1975. These tables are taken directly from Minnesota's Implementation Plan.

d. Discussion of Emission Densities

Examination of Tables II D-1 and II D-2 clearly indicates that the Minneapolis and St. Paul CBD's have significantly higher CO and hydrocarbon emission densities than other zones in the metropolitan areas. This is primarily the result of a high density of slow-moving vehicles in the CBD's during the peak travel hours. The one exception is Urban Activity District 93 which contains the St. Paul airport. The CO emissions from this airport were added directly to district 93, making the emission density extremely high relative to the other Urban Activity Districts in the metropolitan areas. Hydrocarbon emissions from the two airports, because of the nature of the reactions which generate photochemical oxidants, were not assigned to their

TABLE II D3

EMISSIONS INVENTORY SUMMARY, TONS/YEAR
MINNESOTA AIR QUALITY CONTROL REGION 131
DATA REPRESENTATIVE OF CALENDAR YEARS 1970, 1975

Source Category	TOTAL 131 REGION									
	Part		SO_2		CO		HC		NOx	
	1970	1975	1970	1975	1970	1975	1970	1975	1970	1975
C Other (specify) 1 Area Src 2 Pt Src										
D Total Solid Wste	5502	0	412	0	16027	0	5344	0	1398	0
IV Trans (area src only) A Motor Veh 1 Gsln	3341	1312	2053	2443	1300961	958898	173996	108748	89139	82186
2 Dsl	2014	2477	3611	4442	24960	30701	4971	6114	25697	29226
B Off-hwy fuel usage										
C Arcrft	1676	2061	2239	2754	55633	68244	12928	15901	1260	1557
D RR	616	684	1462	1623	1492	1656	1148	1274	1708	1930
E Ves	55	65	58	69	68	81	51	61	447	93
F Gsln Handling Evp Losses							9351	0		
G Other (specify)										
H Tot Trans	7702	6599	9423	11331	1382964	1059490	202445	132098	118161	115162
V Misc (area src only) A For Frs B Str Frs C Coal Ref Brn D Agrc Brn E Other (specify)										
F Tot Misc							22463	0		
VI Grand Tot A Area Src	15404	12341	33151	33651	1400848	1062344	232124	167452	132644	131262
B Pt Src	67208	44766	236188	175277	12365	13437	28860	32390	84826	72155
C Total	82712	57107	269339	208928	1413213	1075781	260984	199842	217490	203417

TABLE II D4
EMISSIONS INVENTORY SUMMARY, TONS/YEAR
MINNESOTA AIR QUALITY CONTROL REGION 131
DATA REPRESENTATIVE OF CALENDAR YEARS 1970, 1975

Source Category	HENNEPIN COUNTY 13104									
	Part		SO_2		CO		HC		NOx	
	1970	1975	1970	1975	1970	1975	1970	1975	1970	1975
C Other (specify)										
1 Area Src										
2 Pt Src										
D Total Solid Wste	3390		185		6419		2346		577	
IV Trans (area src only)										
A Motor Veh										
1 Gsln	1516	593	904	1076	560620	413177	74749	46718	39615	36525
2 Dsl	877	1079	1575	1937	10610	13050	2058	2531	11096	13648
B Off-hwy fuel usage										
Arcrft	723	889	1602	1970	8741	10751	6207	7635	1035	1273
RR	109	121	258	286	269	299	196	218	296	329
E Ves	3	4	8	10	2	2	1	1	2	2
F Gsln Handling							3783	0		
Evp Losses										
G Other (specify)										
H Tot Trans	3228	2686	4347	5279	580242	437279	86994	57103	52044	51777
V Misc (area src only)										
A For Frs										
B Str Frs										
C Coal Ref Brn										
D Agrc Brn										
E Other (specify)										
F Tot Misc							11604	0		
VI Grand Tot										
A Area Src	6174	6005	12438	14881	587568	445443	101567	57938	57109	57703
B Pt Src	6000		153400		2078		1725		53023	
C Total	12106		165838		589646		103292		110132	

TABLE II D5

EMISSIONS INVENTORY SUMMARY, TONS/YEAR

MINNESOTA AIR QUALITY CONTROL REGION 131

DATA REPRESENTATIVE OF CALENDAR YEARS 1970, 1975

Source Category	RAMSEY COUNTY 13105									
	Part		SO_2		CO		HC		NOx	
	1970	1975	1970	1975	1970	1975	1970	1975	1970	1975
C Other (specify) 1 Area Src 2 Pt Src										
D Total Solid Wste	725	0	46	0	3793	0	865	0	231	0
IV Trans (area src only) A Motor Veh										
1 Gsln	724	284	431	513	282994	208567	38446	24029	19285	17781
2 Dsl	427	525	871	1071	5557	6835	1133	1393	5524	6795
B Off-hwy [illegible]l usage										
C Arcrft	776	954	290	357	41601	51415	5703	7015	95	117
D RR	163	181	409	454	371	412	321	356	481	534
E Ves	0		0		0		0		0	
F Gsln Handling							2412	0		
Evp Losses										
G Other (specify)										
H Tot Trans	2090	-1944	2001	2395	330723	277165	48015	32793	25385	25227
V Misc (area src only) A For Frs B Str Frs C Coal Ref Brn D Agrc Brn E Other (specify)										
F Tot Misc							6666	0		
VI Grand Tot										
A Area Src	4262	4431	9641	11398	335250	280565	56274	33651	30672	31022
B Pt Src	44083		44075		9069		26669		27229	
C Total	48345		53716		344314		82943		57901	

specific zones (the International Airport is located adjacent to Urban Activity District 69), but instead were apportioned over the entire St. Paul and Minneapolis metropolitan area.

2. 1977 CO Air Quality Levels

a. Relating Air Quality Data to an Appropriate Emission Density

Table II D-6 presented below shows the highest 8-hour average CO concentrations recorded through July, 1971, at the Downtown Minneapolis and Midway Sites. The St. Paul monitor was not considered reliable and so these data were not included. The value of 26.2 ppm recorded at the Midway Site was the highest reported by either station. However, because of the extremely low CO emission density in the area of the Midway Site (2380 kg/sq mile /12 hours) relative to the emission densities in the two CBD areas (> 12,500 kg/ sq mile/12 hours), we feel that localized effects such as the nearby trucking operations and parking lot and/or meteorology contributed to this high concentration level. We therefore conclude that it would be highly unjustified to "roll-back" the low emission density level of 2380 kg/ sq mile (12 hours), by the 65.6 percent figure shown in Table II D-6.

The maximum value of 18.9 ppm measured by the Minneapolis monitor, on the other hand, is located in an area of high emission density in an area representative of the true urban CO problem. Thus, we have selected the 18.9 ppm value at Minneapolis as the basis for roll-back. Appendix A provides further justification for selecting the maximum value at the Minneapolis Site.

Utilizing such a roll-back, Table II D-6 illustrates that a 52.4 percent reduction in 1971 emissions is required in the Minneapolis CBD to meet the CO 8-hour ambient air quality standard.

TABLE II D-6

SUMMARY OF HIGHEST 8-HOUR CO CONCENTRATIONS

Location	Highest 8-hr Ave. CO Level (ppm)	Date Occurred	Percent Reduction Needed to Meet Standards of 9ppm	Corresponding "Safe" Emission Density (kgm/sq.mile)	Percent Reduction Achieved by 1977 from Federal Motor Vehicle Control Program	Percent Reduction Needed from Control Strategies
Minneapolis CBD	18.9	11/11/71	52.4	6,100	48.7	3.7
St. Paul CBD	*	-	-	-	-	-
Midway Area	26.2	11/11/71	65.6	819	43.5	22.1

*Data not considered reliable by MPCA personnel and so was not included.

The Federal Motor Vehicle Control Program can achieve 48.7 percent reduction, with the remaining 3.7 precent dependent upon the application of traffic control strategies. The safe emission density level of 6,100 kg/sq. mile (12 hours) (corresponding to the level that is achieved with a 52.4 percent reduction in Minneapolis CBD emissions) can therefore be utilized as the reference value in determining whether emission densities in other zones will result in acceptable or unacceptable CO air quality. Examination of the estimated 1977 total emission densities shown in Table II D-1 indicate that all zones with the exception of the two CBD's (and zone 93 which contains St. Paul airport) will have emission density levels well below this 6,100 "safe" value.

b. Calculation of 1977 Air Quality Data

The projected 1977 CO air quality data without application of transportation control strategies can be calculated by the following equation, using the Minneapolis air quality and emission density data discussed above:

$$\left(\frac{C_{71}}{E_{71}}\right)_{\text{Minneapolis zone}} \cdot E_{77\,\text{Zone X}} = C_{77\,\text{Zone X}},$$

where C = 8-hour average CO concentration (ppm) and

E = Emission density (kgm/sq. mile (12 hour)).

The $(C/E)_{71}$ ratio for the Minneapolis zone is equal to:

$$\frac{18.9}{12,822} = 1.47 \times 10^{-3}.$$

Figure II D1 shows the projected 1977 CO air quality for each of the Urban Activity Districts comprising the Minneapolis and St. Paul metropolitan areas. This figure indicated that only the two CBD areas exceed the 9 ppm 8-hour average CO standard (except for UAD 93 which has large CO emission levels from the St. Paul airport). Consequently transportation control strategies are necessary in the two CBD areas to achieve the CO standard by 1977. Such strategies will be needed to achieve:

- an additional 3.7% reduction in total 1971 CO emissions in the Minneapolis CBD by 1977, and
- an additional 3.1% reduction in total 1971 CO emissions in the St. Paul CBD by 1977.

Note, however, that without application of transportation control strategies, the Federal Motor Vehicle Control Program will result in achievement of the CO standards by 1978. This is shown in Table II D-1 where the projected 1978 emission densities in the two CBD's fall below the "safe" level of 6100 kg/sq mile (12 hrs).

3. <u>1977 Oxidant Air Quality Levels</u>

Table II D-7 presented below shows the highest 1-hour average oxidant concentrations recorded through July 1971, at the downtown Minneapolis and Midway monitoring stations. Table II D-7 indicates that if the proportional rollback technique is applied to the highest oxidant value of 0.114 ppm, then a 29.8% hydrocarbon emission reduction is required in the area whose emissions caused this high concentration. The hydrocarbon emission densities for the Minneapolis and St. Paul metropolitan area as presented in Table II D-2, indicate that the two CBD areas have

Figure II D1 to be provided.

TABLE II D-7

SUMMARY OF HIGHEST 1-HOUR OXIDANT CONCENTRATIONS

Location	High 1-hr Oxidant Level (ppm)	Date Occurred	Percent Reduction Needed To Meet Standard of 0.08 ppm
Minneapolis CBD	0.114	7/71	29.8
St. Paul CBD	Not Available	-	-
Midway Area	0.095	Summer 1971	15.8

the most significant hydrocarbon emission levels by at least a factor of 2. It is reasonable to assume that excessive oxidant concentrations in the Metropolitan areas are the result of hydrocarbon emissions from the CBD areas and that emission densities in the CBD's would have to be "rolled back" by at least 29.8% to achieve oxidant standards by 1977. Table II D-2 shows, however, that the Federal Motor Vehicle Control Program will achieve this percent total hydrocarbon emission reduction in the CBD's:

CBD	% of 1971 Total Hydrocarbon Emissions Reduced by 1977
Minneapolis	30.1
St. Paul	29.9

Consequently, transportation control strategies will not be required to achieve the oxidant air quality standard by 1977.

E. CONCLUSIONS

In summarizing the above subsections, the following conclusions have been derived:

- 1-hr average oxidant air quality standards will be achieved by 1977 with the hydrocarbon emission reductions obtained from the Federal Motor Vehicle Control Program. In addition, the application of control strategies for non-vehicular sources, which were not considered in our estimates, would achieve further hydrocarbon emission reductions by 1977. we conclude, therefore that oxidant air quality standards can be achieved by 1977 in the Minneapolis St. Paul Metropolitan areas without the application of transportation control strategies.
- 8-hr average CO air quality standards will be achieved by 1977 in all areas of Region 131 with the exception of the Minneapolis CBD and St. Paul CBD with the CO emission reductions obtained from the Federal Motor Vehicle Control Program. Figure II D1 shows the projected 1977 air quality for each Urban Activity District comprising the Metropolitan Areas of Minneapolis and St. Paul.
- 8-hour average CO air quality standards will be achieved by 1978 in all areas of Region 131 including the Minneapolis and St. Paul CBD's, with the CO emission reductions obtained from the Federal Motor Vehicle Control Program.

- The reduction in 1971 emissions needed from Transportation Control Strategies, to achieve the 8-hour average CO standard in the Minneapolis and St. Paul CBD's by 1977 are as follows:

CBD	Reduction of 1971 emission density required by control strategies	
	%	Total kg/sq. mile (12 hr)
Minneapolis	3.7	475
St. Paul	3.1	391

III. DESCRIPTION OF CONTROL STRATEGIES

Emissions from motor vehicles depend upon the extent of their use, the effectiveness of pollution control devices, and the nature and mode of their operation.

Control over these parameters can be accomplished with the three following general strategies:

1. Reduce the density of travel;
2. Control the effectiveness of emission control devices and operational condition of the engine; and,
3. Increase the speed and lessen periods of idle, acceleration, and deceleration by improving traffic flow.

The first control strategy usually requires a reduction in the vehicle-miles of travel (VMT), especially in the major problem areas. VMT reduction is generally accomplished by shifting automobile trips to public transit, by increasing automobile occupancy, by encouraging car pools, and by restricting auto travel and, thereby, forcing other modes of travel, including walking. The strategies include enhancement of the competitive attributes of other travel modes, regulation and enforcement of travel restrictions, pricing policies, and changes in working hours.

Emission control devices are being installed on new cars to meet progressively stricter Federal emission regulations. However, at present, older cars are not required by the Federal Government to meet such emissions regulations. Control devices on new cars deteriorate with use.* Therefore, the gradual decrease in total automotive potential emissions depends on the age distribution of the automobile population, and their maintenance. Strategies based on

* Federal emissions regulations include deterioration factors.

periodic motor vehicle inspection/maintenance and retrofit of older cars with after-market pollution control devices are typical of approaches being considered by states and municipalities. And, in some areas, these are being applied.

Strategies for improving traffic flow and operations result in decreasing emission levels by increasing the average speed of the vehicles (and, therefore, their engines) and by decreasing the travel time, the number of stops, the idle-time, the acceleration time, and the deceleration time. These improvements usually involve some sophistication in traffic control systems, removal of conflicts in traffic by parking and turning restrictions, turning lanes, and removal of conflicts between pedestrian and vehicular traffic by grade separation, conversion to one-way street flow, and other traffic engineering approaches. These are typical approaches usually incorporated in TOPICS (Traffic Operations to Improve Capacity and Safety) programs.

All of the above control strategies must be tested for their applicability to Minnesota by considering their cost-effectiveness, political and public acceptability, degree of the improvement, etc. A specific strategy which is applicable and beneficial in one area may prove ineffective, undesirable, or even untenable, in another area. In some cases, a single strategy may not be as effective as a combination of inter-related strategies, carefully designed and coordinated. Prior to selecting or evaluating strategies tailored to the Metropolitan Area, a brief discussion of selected strategies is given as background and for possible future consideration. It is paramount that the control strategies selected be implementable by 1977, as opposed to strategies having an effect in the long-term only.

A. Alternative Strategies for Reducing Density of Travel.

Density of travel is measured by vehicle-miles per square mile. Therefore, the general aim of these strategies is to reduce the number of vehicles and/or distance travelled. The work-trip is categorically the most troublesome travel, for it generates peaks in traffic in the morning and evening, resulting in overstressing existing capacity of linkages between home and work. Congestion during these periods results in longer travel times. Many consider it uneconomical to expand the corridor vehicular capacity to meet the peak-hour demands when off-peak loads are far below peak capacity.

The work-trip by automobile is inefficient in occupancy, which averages only 1.52 persons per car in the State of Minnesota. Although this value is approximately the National average, existing road and street capacity can serve more person-trips if more people could be carried per vehicle.

1. Improved Public Transit.

One means of concentrating more person-trips into an efficient vehicle is diverting auto drivers and passengers to public transit. Simple mathematics indicates that a bus carrying 55 passengers -- yet occupying slightly more than the equivalent of two standard automobiles -- is over 18 times as efficient in meeting work-trip demands. Improved transit operations have been attempted in many areas. Those which merely increase frequency of service, or reduce existing fares, do not appear to successfully compete with the comfort, availability, privacy and independence of movement perceived by the automobile user. Even though busses operate in a very flexible manner in the collection and distribution phases of the trip, they cannot offer the door-to-door transportation service of the private automobile.

An example of this is the Rapid Bus Transit operating on segregated busways of the Shirley Highway in the Northern Virginia/ District of Columbia area. This system offers a travel-time advantage of about 30 minutes over car travel in the same corridor. Nevertheless, conversion of automobile travellers to transit, so far, has been a small percentage of total travel...although a three-year Urban Mass Transportation Administration demonstration program is in progress, and considerable improvement is anticipated. Incentives may result in more bus patronage and less automobile work-trips; suburban fringe parking is such an incentive, which provides an intercept function by permitting part of the trip to be performed by car and has frequent bus service from the fringe parking to the CBD, as well as an effective CBD distribution system.

All travellers, including those in higher income ranges, are sensitive to "perceived" trip costs. Where pricing policies, other than fare adjustments, are combined with improved level of service and other changes, additional conversion to transit can be realized. This is discussed in a following section.

A study of transit improvement in the Twin Cities area[1] indicated that automobile use in downtown and within about two miles of downtown could be reduced, in the long term (about 15 years), by about 13 percent. On the Metropolitan-wide basis, a reduction of about 3 percent in 1985 automobile use, compared with current use, could be expected from test systems producing the largest diversion. Air pollution impacts for alternative transit systems in the Twin Cities is subjectively summarized in Table III.A.1.

TABLE. A. 1.

AIR POLLUTION IMPACTS
for ALTERNATIVE TRANSIT SYSTEMS
in the TWIN CITIES[2]

System	Impact on Reducing Air Pollution: DOWNTOWN	Impact on Reducing Air Pollution: REGIONAL
1. Rapid Rail Transit	Excellent	Negligible
2. Rapid Rail Transit with Extended Station Spacing	Excellent	Negligible
3. Busses in Freeways and Streets	Fair	Negligible
4. Commuter Railroad	Good	Negligible
5. Busways without CBD Subways or Microtransit	Fair	Negligible
6. Busways with CBD Subways or Microtransit	Fair	Negligible
7. Metered Freeway Busses	Fair	Negligible

(1) Voorhees, Alan M. and Associates, Inc., Development of a Long Range Transit Improvement Program for the Twin-Cities Area, Twin-Cities Metropolitan Transit Commission, November, 1969.

(2) Ibid.

2. Improved Public Transit Combined with Other Pricing Policies.

Pricing policies may be combined with improvements in transit to realize increased patronage of transit by the automobile traveller. These policies include substantial increases in parking fees in the CBD for all-day parking, increased tolls for single-occupancy cars, commuting taxes, and other monetary assessments against the private vehicle user.

An example cited often is the Philadelphia-Lindenwold system which has obviously made its mark in improving rapid-rail service. Its sole impact on reducing highway congestion is difficult to measure. Apparently, vehicular traffic over two corridor bridges has been reduced about seven percent (7%). Two factors external to the system confound the analysis of the diversion: 1) the tolls applied to private cars had been increased 100% during the period, but only 25% for commutation tickets; and, 2) the depressed economic conditions in the Camden area. A user survey indicated that a large percentage of the ridership on the system represented passengers diverted from other transit service, rather than from private cars.

Whereas transit ridership has been found to be relatively in-elastic with respect to fare changes[3][4], parking fee policies appear to offer another strategy to discourage private auto use for

(3) Larsaw, W., Effect of the Fare Increase of July 1966 on the Number of Passengers Carried on the New York City Transit System; Highway Research Record No. 213, 1968.

(4) Curtin, J. F., Effect of Fares on Transit Riding; Highway Research Record No. 213, 1968.

the work-trip. A study in the Minneapolis-St. Paul area in 1958[5] indicated that doubling the parking resulted in an increase in transit patronage from about 30 percent to about 45 percent. To achieve a level of 80 percent transit usage, the model indicated that a quadrupling of parking fees would be required.

Similar models have been developed for the Baltimore area relating parking fees to transit ridership. Although some results have not been satisfactorily explained, particularly within the first increments of change, the model did forecast a transit ridership above 50 percent for a daily parking cost of $2.50 or higher. The lowest income group would perform about 80 percent of the travel by transit, whereas about 50 percent of the highest income group's travel would be by transit. The Baltimore study assumed a large rapid transit system with substantial improvement in transit travel time. With a quadrupling of parking costs, relatively large diversions could be obtained from the upper income groups.[6]

Many assumptions were made in the development of these Models. The data are encouraging from an air pollution reduction standpoint. However, much more research is required in modal-split model development to reliably relate driver reactions with cost differential factors. Direct application to other areas should be discouraged.

(5) U.S. Dept. of Commerce, Bureau of Public Roads, Modal-Split, Documentation of Mines Methods for Estimating Transit Usage. Government Printing Office, 1966.

(6) Voorhees, Alan M. and Associates, A Report on Mode Choice Analysis for the Baltimore Region; AMV-R-20-1043 (921).

3. <u>Improved Transit Combined with Other Transportation Regulations.</u>

Parking bans in the CBD tend to divert automobile trips to areas where parking is available if the trip can be completed satisfactorily by other travel modes. If the parking is provided in the outer fringes, the automobile trip will be short and on relatively uncongested street networks. If the parking is available on the CBD fringe, vehicle-miles of travel to those facilities will still be generated and could possibly shift the pollution concentration from the CBD to the surrounding areas. However, this shift is advantageous because the fringes' of the CBD's have lower CO levels and, hence, can accommodate increased emissions and because the fringe areas have a lower population density with resultant decreases in total exposure to pollutants. Such parking facilities would requite some distribution system improvement in the CBD if walking distances are greater than several blocks. Mini-busses, or other micro-transit systems (such as people-mover systems), can respond to these requirements.

A combination of CBD fringe parking and shuttle bus service to destinations within the CBD has proved successful in Atlanta. A demonstration of this concept indicates that the auto driver will patronize such a combined system and will avoid congestion in the CBD. Many of the attributes of the private car are retained by this scheme.

Another approach falling in this general category is the various priority treatments afforded busses to increase levels of service and to decrease the time of the bus trip. Priority treatment includes preferential bus lanes, streets exclusive of busses, extension of green phase of traffic signals by approaching busses, metered on-off ramps on express-ways for busses during peak hours, and segregated busways. Some of these measures can be applied at relatively low investment costs by traffic control regulations, whereas others may require substantial capital improvements.

4. Decreasing Traffic Density through Car-Pool Incentives.

Another means of decreasing traffic density is to encourage car-pooling. For example, if car occupancy in private cars were to double*, which is a reasonable objective, the vehicle-miles committed to the work-trip would be reduced by 50 percent. Various incentives have been applied to accomplish this objective with mixed results. They include providing preferential parking by the employer to car-pool vehicles, special toll rates for high-occupancy vehicles, shared use of reserved freeway lanes with busses, and other privileges to car-pool riders. Negative features to car-pooling include:

- Car-pool passengers must live close to each other;
- Car-pool passengers must have common work hours and locations;
- Car-pool passengers must be personally compatible.

Car-pools including people who may work unscheduled over-time are not successful because of inconvenience to others in the pool. Concepts to overcome some of these negative features must be developed. Car-pools will have a great impact on traffic -- if they

* A doubling of occupancy in Minneapolis would require three, rather than one & one-half, people per car on the average.

can be made to work.

5. <u>Decreasing Traffic Density through Changes in Work Hours.</u>

Consideration has been given to the four-day, forty-hour work week for employees. This would potentially reduce the number of work-trips over the work-week by 20 percent. If spread over six days, a theoretical 10 percent reduction in daily vehicle-miles would be realized. A major difficulty in establishing the reduced work-week is that business enterprises often require a commonality of working periods. The increased free time afforded by three off-days will induce more recreational travel, but probably not in the CBD's -- the problem areas.

6. <u>Shuttle-Bus Service.</u>

Downtown districts, historically developed as compact pedestrian-oriented centers, must continue and be revitalized on the pedestrian scale. Pedestrian CBD circulation studies indicate that people desire to limit their walking-trips to something less than 1500 to 2000 feet and will pay a premium to achieve this convenience. These trips reflect movement from parking and transit terminals to major employment centers, to and from shops in the concentrated retail core, and inter-building trips for business or meal purposes.

When pedestrian volumes and distances fall within certain ranges, augmentation of the pedestrian trip by some form of transportation should be considered. Within certain ranges of these parameters and operating costs, shuttle-bus service is feasible for a CBD distribution system.

Since short "headways" between vehicles is usually desired, small -- 15 to 25 seat "minibusses" -- are often employed in this type service, operating on existing streets or exclusive bus lanes in malls. When demands are higher, conventional busses may be employed. In cases where shuttle-bus service is employed to interconnect concentrated points of demand, such as connecting the CBD with fringe parking facilities, buses are used to perform collection and distribution functions in the core, with frequent closely-spaced stops at employment centers and retail stores. The movement is subject to delays, due to conflict with other vehicles on shared street facilities. Priority treatment often is necessary to shorten trip times.

7. <u>People-Movers (Micro-Transit Systems)</u>.

Although most transportation systems are literally "people-movers", this term is used to designate micro-systems which range from moving walkways to bi-rail and monorail systems. These systems should provide maximum service in a minimum distance -- be limited in length to maximize the number of passengers in each mile of route. The micro-system should serve, rather than bypass, major retail and office concentrations, complement line-haul transit, rather than compete, and follow linear movement channels.

Factors favorable to micro-system development include: extensive core-area congestion; limited parking in core areas;

anticipated rapid center city growth; extensive urban renewal prospects; and, major barriers to movement within the center city. Movement distances should be greater than 700 -to- 1,000 feet in order that a significant reduction in trip duration over walking can be realized. High capital costs suggest the need to serve heavy pedestrian concentrations. The economic feasibility of micro-systems as compared with shuttle busses depends upon the relationship of capital and operating costs to patronage levels. In a recent study, comparisons were made between assumed operating bus costs and construction costs of alternative micro-systems (1). The study showed that, at a bus operating cost of $1.20 per mile, a volume of 8,000 -to- 13,000 persons or more per mile per eight-hour day is compatible with a micro-system having a construction cost of $2-Million per mile. A volume of 20,000 -to- 32,000 persons per mile per eight-hour-day is required to justify a micro-system whose construction cost is about $5-Million per mile. A micro-system costing $15-Million per mile becomes feasible at a volume between 60,000 -and- 90,000 passengers per mile per eight-hour-day.

For a micro-system to effectively intercept automobiles at the periphery of the CBD, the following factors should be considered. The free market demand for micro-system riding to peripheral parking facilities would come from that group of downtown employees and visitors who are now walking long distances to avoid high parking costs. These usually represent only a small portion of the total number of people parking. Would these persons be willing to pay rates high enough to pay the capital costs of both new peripheral

(1) Wilbur Smith and Associates, Urban Transportation Concepts -- Center City Transportation Project, September 1970, for the Urban Mass Transportation Administration, U.S. Department of Transportation.

garages and a micro-system transit without other measures? Under most circumstances, it is felt that some additional incentives are necessary to realize the potential. One strategy often considered is regulation of the number of spaces available in the core of the CBD. Another is to increase core parking charges well in excess of park-ride costs. These dis-incentives combined with effective and economic park-and-ride facilities usually are considered necessary to assure patronage and reduce core parking.

B. Strategies for Control of Effectiveness of Emission Control Devices and the Operational Condition of Engines.

Automobile manufacturers are providing a reduction in emission levels of new motor vehicles through changes in engine design and installation of emission control devices. Pollution control devices have maximum effectiveness when the motor vehicle is properly tuned and the control equipment is maintained. Deterioration of the pollution control devices is considered in the Environmental Protection Agency emissions regulations imposed on manufacturers. The required gram-per-mile emissions levels are the average over the first 50,000 miles on the automobile. An interim maintenance of control devices at about 25,000 miles may be allowable. Motor vehicle inspection/maintenance has been proposed as a means to keep cars properly tuned and to repair faulty control equipment. Two inspection/maintenance procedures have been identified: 1) an engine parameter inspection followed as necessary by specified parameter maintenance; and 2) emission signature analysis producing further diagnosis and corrective maintenance. Each of these procedures contains a number of sub-strategies and tactics. The main difference between these two procedures is the diagnostic method and the instrumentation employed.

An economic effectiveness study has been performed[7][8] to evaluate the more significant sub-strategies and tactics, to develop figures of merit and cost of inspection/maintenance per car, and to optimize emission reductions for each sub-strategy.

The engine characteristics included in both tests were idle, with and without load, ignition mis-fire, and air induction. Within the weighting factors assigned to the reduction of CO, HC, and NO_x emissions, the "Best" alternative within a given strategy is assessed from the data summarized in Table III.B.1. A comparison is made between inspections performed in state-owned and operated lanes and a franchised operator or garage.

In addition to an idle adjustment program, other inspection maintenance strategies were assessed, as shown in Table III.B.2. In these cases, the overall figures of merit were found to be considerably poorer than that of the idle adjustment program. Although these more elaborate procedures substantially reduce HC emission levels below that obtained by the idle adjustment procedures, they are more than offset by higher cost. These costs are the result of more difficult and lengthy inspections required to find ignition and induction system malfunctions. For example, the study indicated that fifteen minutes of inspection time on 100 percent of the vehicles would be required to find the 3 -to- 4 percent of engines with misfire defects under load. Only in regions

(7) TRW Systems Group et al, The Economic Effectiveness of Mandatory Engine Maintenance for Reducing Vehicle Exhaust Emissions, Vol. 1, APRAC/CAPE-13-68, CRC & EPA, August 9, 1971.

(8) Control Strategies for In-Use Vehicles, U.S. EPA, Office of Air and Water Programs, Mobile Source Pollution Control Program, Washington, D. C., 20460, November, 1972.

TABLE III.B.1

SUMMARY OF THE MORE COST EFFECTIVE
INSPECTION/MAINTENANCE PROCEDURE

Procedure	Figure of Merit ($/Ton)	Cost Per Vehicle ($)	Emission Reduction*** HC (%)	CO (%)	NO (%)
Engine Parameter Diagnosis					
1. Idle (State Lane)	320	1.50	0	15	-7
2. Idle (Franchised)	370	2.50	3	13	-3
3. Extensive A* (Franchised)	460	6.00	18	14	0
4. Extensive B** (Franchised)	540	13.00	22	33	-5
Emission Signature Analysis					
5. Idle (State Lane)	430	2.50	2	12	-4
6. Extensive A* (State Lane)	360	4.00	11	16	-4
7. Extensive B** (State Lane)	410	4.00	15	20	-3

*Idle Plus Ignition Subsystem Inspection.

**Idle Plus Ignition Plus Induction Subsystem.

***Average emission reduction over a four-year period.

Source: TRW Systems Group et al., The Economic Effectiveness of Mandatory Engine Maintenance for Reducing Vehicle Exhaust Emissions, August 9, 1971.

TABLE III.B.2

EQUIPMENT AND PROCEDURES REQUIRED FOR DIAGNOSING
ENGINE PARAMETER MALFUNCTIONS

Subsystem	Engine Parameter		Emission Signature	
	Equipment	Procedure	Equipment	Procedure
Idle				
- Rpm	Tachometer	Idle Rpm	NDIR HC Analyzer	Idle HC
- Timing	Timing Light	Basic Timing	NDIR HC Analyzer	Idle HC
- Fuel-to-Air	NDIR CO Analyzer	Idle CO	NDIR CO Analyzer	Idle CO
Ignition-Misfire	Engine Electronic Analyzer Dynamometer	Misfire at 45 mph road-load	NDIR HC Analyzer/ Dynamometer	45-Mph HC
Induction				
- PCV	Pressure gage	Idle Crankcase pressure	NDIR CO Analyzer/ Dynamometer	45-Mph CO
- Air cleaner	AC air cleaner tester	Pressure drop across element	NDIR CO Analyzer/ Dynamometer	45-Mph CO
- Air reactor	NDIR CO/CO_2 Analyzer	Idle dilution correction	NDIR CO Analyzer/ Dynamometer	CO Connected - CO Disconnected

Source: TRW Systems Group et al., The Economic Effectiveness of Mandatory Engine Maintenance for Reducing Vehicle Exhaust Emissions, August 9th, 1971.

with chronic air pollution and large motor-vehicle population are such costs warranted.

The emissions reductions cited in Table III.B.1. are those realized immediately after inspection/maintenance. In reality, initial reductions are degraded over the 12-month period. As a minimum, the degradation can be assumed to be linear, in which case the reductions in Table III.B.1. must be divided by two. Actually, the reductions probably degrade faster than linearly.

The procedures discussed above were for the idle-engine mode. EPA does not consider idle testing to be capable of achieving and maintaining a suitable emissions reduction. They prefer a loaded test. Idle testing is judged a useful first step toward the implementation of an ultimate inspection/maintenance strategy. The program preferred by EPA includes a loaded emission inspection with maintenance diagnostics.

Programs for pre-controlled vehicles at a minimum must cover the following engine parameters: PCV valve, air cleaner, idle adjustments, spark-plug wires, points, condenser, spark-plugs, and distributor cap and rotor. Programs for controlled vehicles must include any emission control-related component or adjustment for which the manufacturer recommends periodic servicing.

EPA's official reduction [9][10] for mandatory annual inspection/maintenance with a loaded test for light-duty vehicles are:

Hydrocarbons....12%
Carbon Monoxide.10%
Nitrogen Oxides. 0%

The loaded test procedures require the use of a calibrated chassis dynamometer. Not only does this requirement increase in-

(9) Amendment entitled "Transportation Control Measures" to Federal Register, Vol. 36, No. 158, August 14, 1971.

(10) Control Strategies for In-Use Vehicles, U.S. Environmental Pollution Agency, Office of Air and Water Programs, Mobile Source Pollution Control Program, Washington, D. C., 20460, Nov. 1972.

spection costs, but it also requires additional test set-up time, with resulting decreases in the through-put of inspection lines. In summary, the total cost of loaded inspections is very high.

C. Strategies Related to Improved Traffic Flow.

Measures which smooth the flow of traffic or increase the average speed of the traffic stream are beneficial in reducing CO emissions. However, some measures which reduce congestion might be counter-productive, because it may induce more people to drive. Other measures might be required concommitantly with traffic operation improvements to reduce the overall number and length of auto trips in problem urban areas.

Techniques for improving traffic flow on freeways are relatively well developed. They include: 1) reverse lane operations, where one or more lanes are employed for moving traffic selectively during various times to meet the direction-of-flow demand; 2) driver advisory displays indicating alternative routes and advising motorists of traffic conditions; 3) ramp control or metering where freeway access is permitted consistent with freeway traffic volumes; and, 4) interchange design to more adequately accommodate weaving or merging maneuvers.

Arterials are generally obsolete for modern traffic demands. Much can be done to improve their effectiveness, as demonstrated in TOPICS programs. These techniques include: modifications to horizontal alignments to remove small radius curves; decreases in vertical grades to maintain constant speeds; widening intersections by minor construction and elimination of curb-parking; reversible lanes and one-way streets; channelization of traffic flow; turning lanes for left-turn maneuvers; and, other traffic engineering techniques.

The street system in the CBD is often judged as the most complex component of the urban area road system. Traffic flow is frequently interrupted by pedestrian movements, turning vehicle conflicts, a high number of start-stop transit vehicles in the traffic stream, and traffic signals. Lower average speeds result from the vehicle time spent in idling, accelerating, and decelerating.

In addition to the measures employed by TOPICS programs, a traffic responsive signal control system has proved beneficial in improving downtown circulation. In Wichita Falls, such a system reduced vehicle stops by 16.3 percent and average vehicle delays by 31 percent and increased peak-hour speeds on many downtown approach and exit streets from 20 to about 30 miles per hour.

In many downtown areas, loading and unloading of commercial vehicles impedes smooth traffic flow. One effective measure to lessen the immediate problem is peak-hour restrictions on such operations. Another is the designation of service streets which are segregated as much as possible from the arterial street system. The long-range solution is the establishment of off-street loading facilities. Urban goods movements by truck are also inefficient in that small consignments are delivered by many truck trips rather than combined loads in a smaller number of trucks.

Pedestrian/vehicle conflicts can be minimized by special controls, by creation of pedestrian malls, and by grade separation of pedestrian traffic from vehicular traffic, such as the skyway systems in downtown Minneapolis and St. Paul.

Staggering of work hours can effectively spread out peak-hour transportation demands for both private vehicles and transit. This permits more effective use of existing street capacity and facilitates traffic flow. Demonstration programs in such towns as Atlanta, New York, and other cities have proved the workability of such approaches.

D. <u>Transportation Control Strategies Selected for Minneapolis and St. Paul.</u>

In this study, a relatively small reduction in traffic density is required in the CBD's of Minneapolis and St. Paul to achieve Federal air quality standards by 1977, as shown in Section II.D. Planned and on-going programs in these cities appear to potentially achieve the reductions required. Under these circumstances, no new control strategies per se were <u>developed</u> for Minnesota. The following discusses control strategies selected for the Minneapolis CBD and the St. Paul CBD:

1. <u>Evaluation of Programs for the Minneapolis CBD.</u>

a. <u>Express Bus Service</u> -- Planning for an express bus service is already underway for the I-35W Urban Corridor. The service will be operating initially as a demonstration program. Continuation of the service will be based on the results of the demonstration and the availability of funds to support the service.

Full operation of the service is planned for mid-1973. It will include ramp-metering facilities on the freeway. It is anticipated that the service will divert approximately 2,000 riders daily from automobiles. On the assumption that these trips are all work-trips, this means a decrease of about 2,700 automobiles in that corridor (4,000 person-trips daily at an occupancy of 1.5 persons per car). The ADT in 1970 on I-35W is about 100,000 vehicles. Thus, the impact in the corridor, and for that matter in the CBD, would have a minor impact on reducing the traffic density and, therefore, the emission levels in either area, when taken by itself.

The express bus system is evaluated as a candiate control strategy for two reasons:

(1) It is an on-going transportation project and
(2) It is implementable by 1977.

Consideration of the express bus system does not constitute a favoring by PCA of busses over other modes of mass transit. Indeed, transit systems operated on guideways would have a favorable air quality impact, but no such system will be implementable in the Twin Cities by 1977.

b. CBD Fringe Parking -- The concept of providing convenient, low-cost parking at the fringe of the CBD, along with restricting and discouraging parking in the core, is expected to be implemented by 1976. City-owned and operated parking ramps totalling 11,350 spaces connected to the distribution network and freeways on one end and pedestrian skyways into the core on the other will be operative by 1976. An additional 10,00 spaces will be added by 1985. The elimination of a like number of spaces in the core will be further inducement supportive of the plan; in fact, maintenance of the present status of core parking spaces constitutes sufficient incentive because the total traffic will grow by about 25 percent from 1971 - to - 1977. Thus, it can be estimate that about 16,500 auto passengers will be diverted from the CBD. With an estimate 363,000 two-way person-trips into the

CBD, this would correspond to a potential reduction in passenger-car vehicle-miles of about 9 percent. Assuming this density is 80 percent of the total VMT in the CBD, about a 7 percent reduction in VMT is the maximum influence.

c. People-Mover System -- Planning is currently underway by the City of Minneapolis, the Metropolitan Transit Commission and the downtown Council for an automated people-mover system in downtown Minneapolis which would provide linkage between CBD fringe parking facilities, downtown offices and stores, and the pedestrian skyway system. A grant from the Urban Mass Transit Authority of U.S. DOT is needed to help finance this project. The total system would consist of approximately sixty (60) vehicles with a capacity of 20-40 people operated on a fixed guideway elevated to the second story level of downtown buildings, thereby being at the same level as the skyways. The maximum walking distance from any point in the downtown area to a people-mover station is expected to be 2-1/2 blocks and to average 1 -to- 1-1/2 blocks. The first stage of the system -- the east-west loop -- is anticipated to be operational by 1976, and represents half of the total mileage. The second stage will be a north-south loop.

This planned system or some other pedestrian-augmentation facility has already been assumed in operation to serve the CBD fringe parking for Minneapolis. Therefore, the further impact of this system on reducing CBD VMT volumes will be minimal and will be largely the reduction in private cars making internal CBD trips between activity centers.

It is estimated that this total circulation presently is about 1 percent of total volume. Therefore, by 1977, the additional VMT reduction achieved by the people-mover system is less than about 1 percent.

d. Traffic Surveillance and Control -- Detailed planning for a traffic-responsive surveillance and control system has been completed for Minneapolis. The volume, speed, and direction of vehicles along controlled CBD streets will be monitored. The data will be transmitted to a central computer to determine the cycle phase of traffic signals and, thereby, provide an adaptive signal system. The system will control reverse lanes and divert traffic from congested streets. It will require 3 years to implement, and is expected to be operational by the first quarter of 1976.

Similar systems have been operational in a number of cities of the same size. The results of these demonstrations vary widely. The effectiveness of the computerized signal system depends not only on the location and number of sensors or detectors used in measuring traffic conditions, but also on the computer algorithms employed to develop the control programs. Therefore, results depend on both hardware installation and design and on computer programming. The effectiveness also depends on careful analysis of conflicts in traffic flow and corrective measures to lessen these problems.

Experience has shown that an optimum system can yield substantial improvements in average traffic speed. Based on this experience, it is estimated that the average speed in the Minneapolis CBD can be increased from the present 15 miles-per-hour to about 20 miles-per-hour.

2. Evaluation of Recommended Programs for the St. Paul CBD.

a. Fringe Parking -- Bulk parking facilities in the fringe of the St. Paul CBD is part of the present policy of both the City of St. Paul and the downtown business community. Long-term employee parking structures are planned on the periphery of the core. Executive parking in limited quantities convenient to place of employment and located in structures is also part of this policy. Shopper, business, and patron parking in structures convenient to destinations is supported by the policy. Off-street and well distributed errand parking is included in the policy, along with regulation and pricing to encourage short-term use. The policy also embraces the elimination of all on-street parking in the retail and office areas.

Specifically proposed action by OPERATION '85, the development arm of the Downtown Business Association, includes the development of three open fringe parking lots to provide spaces for 10,000 cars, with expansion as necessary in the form of multi-level facilities. These plans, if associated with an effective shuttle-bus service, which is also planned, could contribute to the reduction in CBD traffic volume, with the provision that a like number of spaces are eliminated in the core. This elimination does fit into the above stated policy and should be definitely committed in that development.

On the basis of past assumptions, about 15,000 persons would be diverted from the CBD core. When comparing this to the number of person-trips projected for the area in 1977, properly accounting for the vehicle travel that would be generated by these trips, it is estimated that about a 10 percent reduction in VMT volume related to the CBD can be realized.

b. Shuttle Bus Service -- A shuttle bus service is an integral part of the recommended strategy for the fringe parking program of OPERATION '85. The service would supplement the expanding skyway system and would provide transportation from the parking facilities to the downtown area.

In addition, the Metropolitan Transit Commission's unified work program for 1973 includes a circulation and collection/distribution study for St. Paul. The study, with support from the Urban Mass Transportation Administration, will be a six-month effort which may lead to design of a transportation center to inter-connect the St. Paul Skyway System with the fast-link system, the shuttle bus system, and other transit. Such a program will enhance the downtown circulation and will contribute to the improvement of core circulation. The VMT reduction realized by the shuttle-bus system is embodied in the 10 percent reduction attributed to fringe parking.

c. Auto Free Malls -- The transportation plan for the St. Paul core area recommends an auto free mall on Seventh Street between Jackson and Wabasha. Auto free malls have also been proposed for Fourth and Minnesota. Only shuttle busses would operate on these streets.

These facilities would not,

in themselves, substantially contribute to the reduction of traffic volume in the core, and may be counter-productive in inducing vehicle travel unless fringe parking and shuttle bus service is adequate to off-set the attraction of downtown travel of shoppers. If shuttle bus service on-the-mall includes the parking facilities, the access will tend to accomplish this objective.

d. Traffic Signal System -- Improvements in the traffic signal system have been proposed as part of the St. Paul TOPICS Plan. The same comments made relative to the Minneapolis Traffic Signal System are applicable here. Substantial improvements in core area travel speed also should be realized in St. Paul. It is estimated that an increase in average speed from 12 mph to about 18 mph is a realistic and achievable objective for this program. With such potential, this program is an important element of the overall control strategy for the St. Paul CBD.

E. Other Control Strategies Selected.

The strategies presented in previous Section III.D all fall into the category of transportation technology and services. Such strategies will cause the major reductions in CO emissions. This section discusses three other minor control strategies:

-- Strict enforcement of existing ordinances and regulations regarding visible emissions, removal of pollution control devices, and idling.

-- Public information program.

-- Direct restrictions on idling.

These minor strategies are added because they: 1) Complete the total program; 2) Augment the major strategies; and, 3) Address themselves to problems indigenous to Minnesota. Although it is difficult to assess quantitative reductions in CO to these minor strategies, it is safe to say that such reductions will be small.

This section also evaluates the applicability of motor vehicle inspection/maintenance as a control strategy for Minnesota. This strategy is rejected for several reasons.

1. Strict Enforcement of Existing Ordinances and Regulations.

a. Visible Emissions -- MPCA's existing regulation, APC-12, entitled, "Emission of Visible Air Contaminants from Vehicles and Other Internal Combustion Engines", states that:

> "(a)(1) No person shall cause or permit the emission of visible air contaminants from any internal combustion engine other than a diesel cycle engine for more than 10 consecutive seconds.
>
> "(a)(2) No person shall cause or permit the emission of visible air contaminants from any diesel cycle engine in excess of 20 percent opacity or No. 1 Ringelmann for engines produced prior to January 1, 1973, and in excess of 10 percent opacity or No. 1/2 Ringelmann for engines produced after January 1, 1973, for more than 10 consecutive seconds.
>
> "(b) Where the presence of uncombined water is the only reason for failure of an emission to meet the requirements of this regulation, the provisions of this regulation shall not apply."

Visible emissions, other than condensed water vapor, are caused primarily by particulate emissions, which are a nuisance, odorous, and aesthetically repulsive. Although motor vehicles constitute a relatively small source of total particulate emissions, such emissions often indicate a maladjustment or malfunctioning* which will also cause emissions of carbon monoxide,

* Faulty exhaust system, improper timing and/or carburetion, burning oil, removal of air-pollution control devices, etc.

hydrocarbons, nitrogen oxides, or gaseous odors. Elimination of the problem causing visible emissions often will simultaneously reduce such non-particulate emissions.

A complete, consistent program for reduction of CO emissions must include strict enforcement of existing APC-12. Minnesota Statutes 116.08, Subdivision 1, requires all law enforcement officials in the State to fully enforce PCA regulations:

> "Violation of any such provision shall be a misdemeanor. Each day of any such violation shall constitute a separate offense. It shall be the duty of all county attorneys, sheriffs, and other peace officers, and other officers having authority in the enforcement of the general criminal laws to take all action to the extent of their authority, respectively, that may be necessary or proper for the enforcement of said provisions."

MPCA will initiate a program designed to make the highway officers of the State Highway Patrol and county and local police departments fully execute their statutory obligations to enforce APC-12. Local pollution control agencies also will be encouraged to increase their efforts to enforce APC-12. These organizations have the authority to issue tickets for violations of APC-12. PCA will institute a program to notify police officers of APC-12 and to educate them in detecting motor vehicles with visible emissions. EPA will be asked to assist in this training program by giving their standard visible emissions course, or a specially designed course, for detection of motor vehicle emissions by police officers. MPCA will discuss and coordinate this effort with law-enforcement officials. Citizen's groups will be encouraged to publicize APC-12 and to report violations. The Metropolitan

Clean Air Committee (MCAC), Minneapolis, Minnesota, has already undertaken such a campaign.

The general public information program described in another section will encourage drivers to have their smoking cars repaired and will ask citizens to report violations. Such a program should meet with success because public awareness and interest in this area is presently high.

PCA will investigate low-cost, reliable field instrumentation for use by law enforcement officials in measuring exhaust opacity.

Amendments to APC-12 will be considered to make the opacity judgment more simple.

b. <u>Deliberate Removal or Dismantling of Pollution Control Equipment</u> -- Regulation APC-12 also states:

> "(c) No person shall intentionally remove, alter or otherwise render inoperative, exhaust emission control, crankcase ventilation or any other air pollution control device which has been installed as a requirement of Federal law or regulation.
>
> "(d) No person shall operate a motor vehicle originally equipped with air pollution control devices as required by Federal law or regulation unless such devices are in place and in operating condition."

By far, the Federal emissions regulation on new motor vehicles constitutes the major means of reducing CO emissions in Minnesota; therefore, maintenance of its full effectiveness is essential. Dismantling or removal of the automotive pollution control devices used to achieve Federal emissions regulations must be prevented. The following action will be taken to implement the enforcement of sub-sections (c) and (d) of APC-12:

(1) The State Highway Patrol will be asked to include a visual check on the existence and the integrity of motor vehicle pollution control devices, along with their existing road-side, spot-check inspection for vehicle safety.

(2) All oil companies, car dealers, repair garages, etc., will be notified of their serious liability* should they remove or dismantle any pollution control device.

c. Idling -- Since carbon monoxide emissions, at idle, are much greater than emissions at the average speed in the central business districts (CBD's) of the Cities of Minneapolis and St. Paul, emissions from idling motor vehicles constitute a significant fraction of the total winter-time emissions in the CBD's.

Existing ordinances in the Cities of Minneapolis and St. Paul require a person to lock his car and remove the keys:

St. Paul City Charter and Legislative Code	"Article 144.10 Locking Required. No person shall leave a motor vehicle, except a commercial motor vehicle, unattended on any street, alley, used car lot, or unattended parking lot, without first stopping the engine, locking the ignition, removing the key and taking it with him; provided, however, that any violation of these provisions shall not instigate the offense of stealing such motor vehicle, nor shall such violation be used to affect a recovery in any civil action for theft of such motor vehicle, or the insurance

* Violation of APC-12 is a criminal (misdemeanor) offense with a maximum penalty of $300 fine and/or 90 days in Jail. Federal Laws are also applicable to this offense.

thereon, or have any other bearing in any civil action.

Whenever any police officer of said City of St. Paul shall find any such motor vehicle standing in violation of the foregoing provisions, such police officer is authorized and directed to remove therefrom the keys left therein and to deliver the same to the officer in charge of the Traffic Division of the Central Police Station.

Minneapolis Code of Ordinances

"Article 411.190 Locking Ignition. Every person parking a passenger automobile on a public street or alley in the City shall lock the ignition, remove the key, and take the same with him."

Since idling normally requires keys in the ignition, strict enforcement of these ordinances, especially in the two CBD's, will eliminate a substantial portion of the total number of idling cars. PCA will encourage the police in the two Cities to strictly enforce these ordinances relative to idling motor vehicles, especially in the CBD's. Enforcement of such ordinances is an interim measure until ordinances directly prohibiting idling are passed. (See Section E.3.)

d. Pedestrian Laws -- PCA will encourage the police departments of the two Cities to strictly enforce existing pedestrian ordinances, especially in the two CBD's. "Jaywalking" -- disobeying "walk" signals -- and -- crossing streets at locations other than the white-marked cross-walks can impede the flow of traffic and, thereby, increase CO emissions.

2. Public Information Program.

Because motor vehicle pollution control directly involves the public, a public information program designed to educate and motivate the citizenry will be employed to augment the major transportation technology and services strategies. This program will involve the use of radio and TV spots, leaflets, mailers, and stickers, emphasizing the following elements:

a. What is air pollution? How does the automobile contribute to air pollution?

b. We do have an air pollution problem in Minnesota, particularly a carbon monoxide problem.

c. Use car pools.

d. Take the bus -- Ride your bike ---- alternatives to driving.

e. Keep your car tuned...saves mileage and runs better.

f. Does your car smoke? -- Have it tuned!

g. Citizens--report smoking motor vehicles to Police or to PCA.

h. Don't let your car idle on public streets or in parking lots, especially in CBD's.

i. Obey parking regulations.

j. Pedestrians--stay in cross-walks, obey signals, etc.

k. Industry--arrange car pools and stagger work-hours.

l. Announce class schedules at local schools for auto mechanics to learn how to tune-up cars for minimum pollution.

m. Garages--tune cars for minimum emissions.

This program will be coordinated with PCA's total air quality public information program.

This public information program is an essential ingredient of the total program, both as an individual strategy and because it will greatly assist in obtaining public support for the four major strategies. Federal support for this program is essential. To this end, preliminary discussions have been held with representatives of EPA Region V and the federal office of Public Affairs. It was agreed that active participation in this program by citizen groups is an important requirement for success. We urge EPA to fund this program in Minnesota.

3. Direct Restrictions on Idling.

Because of the severity of Minnesota winters, parked motor vehicles (cars, trucks, busses, etc.) are often left idling and automatic devices often are used to periodically start parked cars and leave them idling until they are warmed up. Since carbon monoxide emissions at idle are much greater than emissions at the average speed in the CBD's, emissions from idling motor vehicles constitute a significant fraction of the total winter-time emissions in the CBD's. Another problem is the obnoxious, odorous emissions from busses idling in the parking lots during sporting events (e.g., University of Minnesota or Viking Football Games), or other public events.

To reduce this source of carbon monoxide emissions, PCA will undertake the following measures:

a. Encourage stricter enforcement of existing city ordinances outlawing leaving cars unattended with the ignition keys in them (Section 1.c.).

b. Encourage, and if necessary coordinate, the passage of city ordinances outlawing idling of attended or unattended motor vehicles parked in public roadways or lots for more than a short time (e.g., five minutes).

Regulations on idling will provide the solution to the high CO levels at the Midway site.

Propane engine heaters are now commercially available at competitive cost to aid in starting cars in cold weather. These devices should be used instead of the electric auto starters often used in parking lots and ramps in the CBD's. The propane heaters also have better overall thermal efficiency and, therefore, will result in less energy consumption.

4. Motor Vehicle Inspections.

A control strategy based on motor vehicle inspections was thoroughly studied by the PCA staff. On-going and planned programs in other cities and states (New York City, Chicago, New Jersey, California and Wisconsin) and available literature in this new field[(1)-(9)] were reviewed.

Two approaches were investigated:

a. Mandatory annual inspection at idle of motor vehicles in the Metropolitan Area conducted by State personnel or a franchise, combined with a safety and noise inspection.

b. Road-side, spot-checks conducted throughout the State by the Department of Public Safety or local Police Departments, combined with existing safety inspections.

The estimated [(1)-(9)] effectiveness of these two measures in

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References 1 to 9 cited in this Sub-section (Sub-section III E-4) are given at the end of this Sub-section.

reducing CO emissions is:

	Percent Reduction in CO Based on 1977 Emissions
Mandatory Annual Inspection......	10%
Road-side Spot-checks............	1% -to- 3%

The 10% reduction applies to a loaded test (dynamometer test) and a straight-line degradation. An idle test would have a lower percent reduction.

Motor vehicle inspection programs were rejected as control strategies when compared with the four selected transportation technology and services strategies. The major reasons for this decision are given below[(1)(9)]:

Mandatory Annual Inspection, followed by Maintenance

1. High Cost of Inspection

The cost per test is estimated to be approximately $2.00, including capital, operating, and administrative costs, but not including the lost time and other costs of the driver (estimated to be worth $5.50). Approximately 1.5 Million tests would be made annually at a total cost of $3 Million per annum. These costs would be paid by the General Fund through increased license fees, etc. The total capital cost of the approximately twenty inspection stations required for the Metropolitan Area is about $2.0 Million. The Minnesota Legislature may not favorably view increased expenditures and license fees. It should be noted that a cost-effective vehicle emissions inspection program should be combined with safety and noise inspections, so that the burden of cost is allocable to these other services as well. The incremental cost of emissions inspection is still high relative to the incremental cost of the proposed strategies.

2. High Cost of Tune-Up

Cars which fail the inspection must be tuned. The average cost is about $30.00. However, it is estimated that 4.2% of the repair jobs will cost over $75.00 -- and, 1.7% will cost over $100.00. These latter figures demonstrate the regressive nature of the repair costs: poorer people with older cars will pay higher repair bills. Although initial public opinion towards inspection appears favorable, it is likely to change when the public is faced with high repair costs, inconveniences, and loss of time.

3. Long Implementation Time

In 1966, the State of New Jersey passed a law authorizing a mandatory annual vehicle emissions inspection program, using existing safety inspection lanes. The State of New Jersey initiated its vehicle emission inspection program in 1966; however, actual inspections won't begin until July of 1973 -- a total of seven years from initiation of the program. In Minnesota, it is estimated that at least four years from the passage of the required legislation will be required to have a full inspection program -- approximately July 1, 1977. Thus, the inspection program may not be into full effect by the July 1st, 1977, EPA deadline.

4. Extensive Training Program Required.

Drivers of vehicles failing the inspection must have a reliable, reasonably-priced place to get their car tuned. This means mechanics must have expert training in tuning cars for minimum emissions. Therefore, a massive mechanics training program, probably conducted primarily by the Metropolitan Vocational-Technical Schools, will be required. This program will be costly and have a long lead-time. Furthermore, garages capable of making the required tune-ups must be certified and periodically inspected by State officials.

5. EPA Favors a Dynamometer Test

The United States Environmental Protection Agency has strong preference for a "loaded" (dynamometer) inspection test, rather than an idle test, primarily because the loaded test correlates better with the Federal test cycle for new cars and provides much better diagnostics upon which to base the tune-up. However, a loaded inspection requires much more expensive equipment and takes much more time per test -- with substantial increases in cost. If an idle test is proposed, EPA probably will assign it an emissions reduction capability somewhat lower than the 10%(1) attributed to a loaded test.

6. Possible Increases in Nitrogen Oxides

Minimizing carbon monoxide emissions can increase emissions of nitrogen oxides. Preventing this with assurance requires monitoring nitrogen oxides. Low cost, reliable field instrumentation for use in garages is not yet available for this purpose.

Road-Side, Spot-Check Inspection

1. Low Effectiveness

It is estimated that this strategy has only a 1% -to- 3% effectiveness in reducing carbon monoxide emissions, primarily because it relies on the "threat" of being caught -- an indirect enforcement method which is difficult to quantify.

(1) This opinion obtained via personal contact with EPA Region V.

2. Institutional Problems

This program most likely would require uniformed police officers to divert traffic to the road-side. Personal contact has revealed the State Highway Patrol and the Police Department of the Cities of Minneapolis and St. Paul already are heavily burdened with ancillary tasks and will be reluctant to staff another such program, even if funds are made available.

3. Other Problems

Items 2, 4, 5 and 5 under Mandatory Annual Inspection also apply wholly, or in part, to road-side, spot-check inspections.

SUMMARY

At first glance, vehicle emissions inspection programs seem to be the answer to the carbon monoxide problem, and it is difficult to find many groups in opposition. However, with the low magnitude of the problem in Minnesota -- which requires only a 3.7 % reduction in 1971 emissions in Minneapolis and 3.1% in St. Paul -- vehicle inspection has much less cost-effectiveness than the proposed strategies based on transportation technology and services. The proposed strategies all are based on presently planned or on-going projects and, therefore, require little incremental cost to be borne by the taxpayer. They have high effectiveness -- a 28% reduction in 1977 emissions for both Minneapolis and St. Paul -- based on 1971 emissions; and about 20% based on 1977 emissions -- and they reduce all pollutants: hydrocarbons, nitrogen oxides, as well as carbon monoxide.

REFERENCES FOR SUB-SECTION III E-4

1. Amendment entitled "Transportation Control Measures" to Federal Register, Vol. 36, No. 158, August 14, 1971.

2. Pattison, J. N., "Inspection Procedures Available for Control of Emissions from Used Cars," Journal of the Air Pollution Control Association, October, 1971, Vol. 21, No. 10.

3. Andreach, A. J., Elston, J. C., Lakey, N. W., "New Jersey Repair Project: Tune-up at Idle," December, 1971, Vol. 21, No. 12.

4. Hawthorn, G. C. and Kirchner, D. S., "The Necessity of Transportation Controls to Achieve and Maintain the National Ambient Air Quality Standards," APCA Paper No. 72-162, Presented at the 65th Annual Meeting of the Air Pollution Control Association, Miami Beach, Florida, June 18-22, 1972.

5. "Mandatory Vehicle Emission Inspection and Maintenance," Northrop Corporation Report, Contract ARB 15522 with State of California Air Resources Board, December 10, 1971.

6. Schwartz, S., "A Systems View of Automobile Inspection Programs," APCA Paper No. 72-47, Presented at 65th Annual Meeting of the Air Pollution Control Association, Miami Beach, Florida, June 18-22, 1972.

7. "Evaluating Transportation Controls to Reduce Motor Vehicle Emissions in Major Metropolitan Areas," Institute of Public Information Report, Contract No. 68-02-0048 with the United States Environmental Protection Agency, March 16, 1972.

8. Clino, E. L. and Tinkham, L., "A Realistic Vehicle Emission Inspection System," APCA Paper No. 68-152, Presented at the Annual Meeting of the Air Pollution Control Association, June, 1968.

9. Control Strategies for In-Use Vehicle, U. S. Environmental Protection Agency, Office of Air and Water Programs, Mobile Source Pollution Control Program, Washington, D. C., 20460, November, 1972.

F. Possible Increases in Other Pollutants Resulting from Application of Selected Control Strategies.

It is essential[1] that the transportation control strategies selected do not result in a net increase in the emissions of any other pollutants -- in this case, hydrocarbons and nitrogen oxides. A major advantage of the proposed strategies is that they result in significant decreases in emissions of hydrocarbons and nitrogen oxides. The first three major strategies -- express bus service, fringe parking, and micro-transit systems (people-movers or shuttle buses)-- all result in a decrease in VMT's. Therefore, emissions of hydrocarbons and nitrogen oxides will be reduced by about the same proportion as carbon monoxide emissions (CO emissions reduced by about 7% based on 1977 emissions). The fourth major strategy, the computerized traffic management system, increases average vehicle speed. This will decrease hydrocarbons emissions (the total reduction in CO emissions from all strategies is about 28% based on 1977 emissions). EPA states [2] that "The oxides of nitrogen emissions/average speed relationship has not been quantified to date. In the absence of this relationship, the variable is assumed to be one for oxides of nitrogen." Thus, the fourth major strategy will not change the emissions of nitrogen oxides. The total net result of the four major strategies is a decrease in both hydrocarbons and nitrogen oxides.

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(1) Federal Register, Vol. 36, No. 158, August 14, 1971.

(2) Kirchner, D. J. and Armstrong, D. P., "An Interim Report on Motor Vehicle Emission Estimates, EPA, Office of Air Quality Planning and Strandards, Research Triangle Park, North Carolina, 27711, October, 1972.

IV. ESTIMATED IMPACT OF TRANSPORTATION CONTROLS ON AIR QUALITY

The impact of the following candidate transportation strategies was evaluated for the Minneapolis and St. Paul CBD's:

MINNEAPOLIS CBD

Strategy 1: Fringe parking combined with people-mover system, estimated to reduce 1977 light duty VMT's by 8%.

Strategy 2: Traffic surveillance and control, estimated to increase average speed in Minneapolis CBD from 14 mph to 20 mph by 1977.

ST. PAUL CBD

Strategy 1: Fringe parking combined with shuttle-bus service, estimated to reduce 1977 light duty VMT's by 10%.

Strategy 2: Traffic signal system, estimated to increase average speed in St. Paul CBD from 12 mph to 18 mph by 1977.

Table IV.1 summarizes the impact of these strategies on total emissions and on air quality in the two CBD's. Examination of this table indicates that CO ambient air quality standards are approximated in both the Minneapolis and St. Paul CBD's by application of the #1 candidate strategy: fringe parking and accompanying people-mover or shuttle-bus system. By additionally applying the second strategy in the CBD's, traffic surveillance and control in Minneapolis and a traffic signal system in St. Paul, the air quality is brought to levels well below the 9 ppm standard.

TABLE IV-1

IMPACT OF CANDIDATE STRATEGIES ON EMISSIONS AND AIR QUALITY IN CBD'S

CBD	Area (Square Mile)	EMISSION DENSITY (Kg/Sq. Mile/12 Hours)				
		1971	"Safe" Emission Density Level	1977: No Transport Controls Applied	1977 Appl. of Strategy #1	1977 Appl. of Strategies #1 and #2
Minneapolis	2.2	12,822	6,100	6,571 (7.2%)(1)	6,164 (6.2%)(2)	4,703 (28.4%)
St. Paul	0.8	12,617	6,100	6,488 (6.0%)	5,983 (7.8%)	4,664 (28.2%)

CBD	Area (Square Mile)	AIR QUALITY (Highest 8-Hour Average CO Concentration in PPM)				
		1971	Ambient Air Quality Standard	1977: No Transp. Controls Applied	1977 Appl. of Strategy #1	1977 Appl. of Strategies #1 and #2
Minneapolis	2.2	18.9	9	9.7	9.1	6.9
St. Paul	0.8	18.6	9	9.6	8.8	6.8

(1) Percent reduction in 1977 emissions required to meet standard.
(2) Percent reduction in 1977 emissions achieved by the strategies.

Based on the results illustrated in Table IV-1, MPCA proposes that the two strategies for each CBD discussed in this section be implemented. If fringe parking and accompanying people-mover or shuttle transportation in the core area were adopted in both CBD's without traffic surveillance and control, it is unclear from the inherent accuracy band of the data, whether CO standards can indeed be achieved. Implementation of traffic surveillance and control procedures as well, will provide enough margin of safety to confidently estimate that the standard can be achieved.

Employing both strategies #1 and #2 is further justified to account for contingencies which may cause unexpected increases in CO emissions, such as:

(1) EPA extends the date for compliance with 1975 motor-vehicle emissions regulations to 1976;

(2) Law suits by environmental groups requiring EPA to not allow the extension from 1975 to 1977 for achievement of CO standards are successful;

(3) One or more of the proposed strategies is not as successful as predicted.

(4) The estimates in VMT's are based on annual averages, but over on 8-hour period the actual VMT's can be substantially higher than the average, thereby causing higher CO emissions than accounted for in this Plan.

(5) Air stagnation and temperature-inversion conditions can occur which are more severe than those which occurred on the day chosen as the data base - November 11, 1972, in downtown Minneapolis (18.9 ppm). In such cases, CO concentrations can increase to levels greater than anticipated by this Plan.

A further contingency can be created by special construction within the CBD's. This Plan accounts for an increase in traffic from 1971 to 1977 of about 25%. This increase is based on normal growth and business expansion within the two CBD's. However, the Plan does not account for special new structures which can potentially cause abnormally high increases in traffic (see Section VI). The domed stadium proposed for the Minneapolis CBD falls into this category. An air quality environmental impact statement should be prepared for such special structures to assess their effect on CO concentrations within the CBD.

V. IMPLEMENTATION ISSUES AND OBSTACLES

A. RESEARCH METHODOLOGY

Research on the issues associated with the implementation of transportation controls to improve air quality consisted of a systematic process of data collection, interpretation and evaluation, as shown in Figure V-1 below. The first step was to review the candidate strategies for transportation control identified by the traffic engineer. Once this preliminary list was known, it was possible to identify the public agencies and private interest groups at city, state and regional levels, who would have an interest in the implementation of these strategies. This process was facilitated in Minneapolis- St.Paul by an early informational meeting to which representatives of a large number of public agencies were invited.

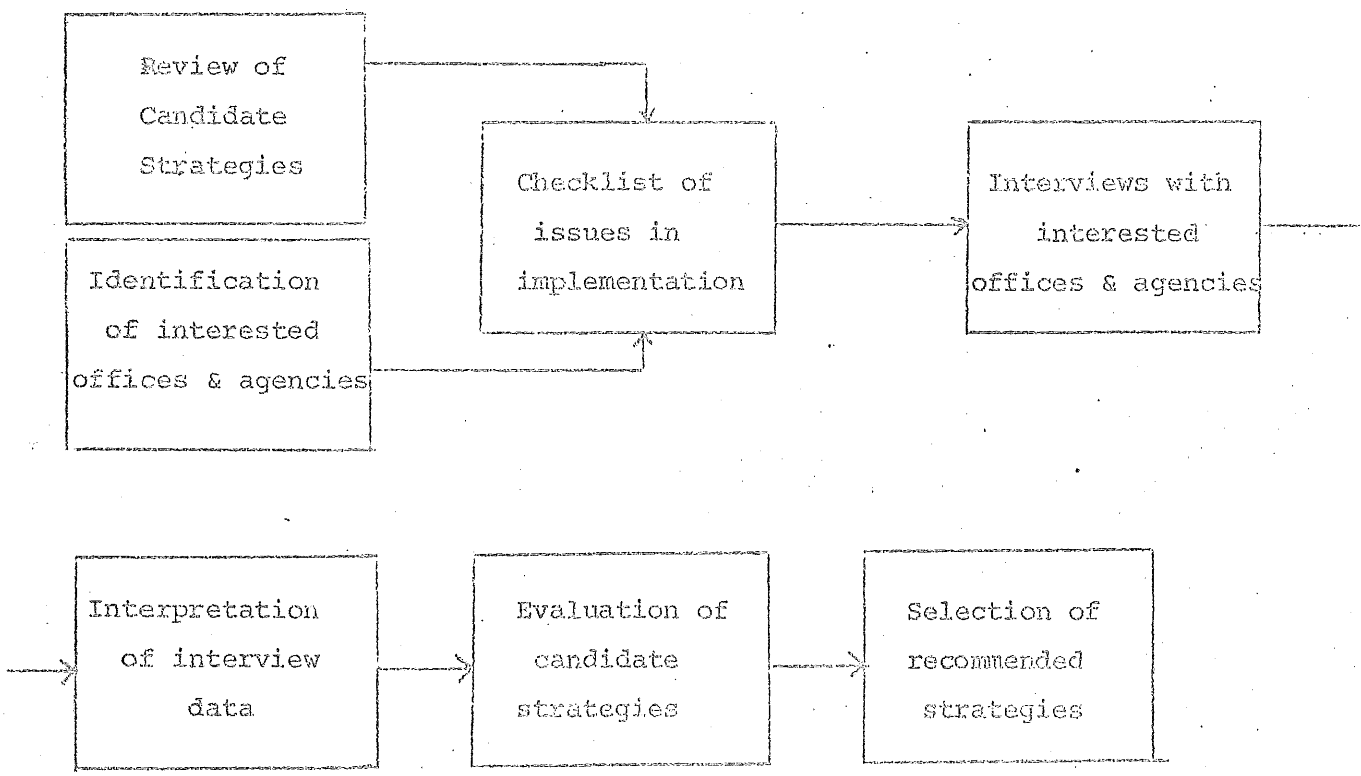

Figure V-1
Research Methodology

Given brief descriptions of the candidate strategies, a list of interest groups, and an understanding of the problems generally associated with change in the urban environment, it was possible to identify the types of issues (or sometimes, obstacles) that might be associated with implementation of the transportation controls. A general checklist of the types of issues anticipated was prepared for subsequent review with representatives of interested parties. The checklist consisted of the following items:

- Legal Authorization and Requirements
- Financial Requirements: amount of funding needed; type and sources of financing possible
- Management and Enforcement Responsibility
- Economic Impact
- Political Feasibility
- User Acceptance

Interviews were held with representatives of virtually all of the public agencies who might be concerned about the candidate control measures, and with representatives of downtown business. Other citizen interest groups were not interviewed at this stage. Each of the relevant candidate control strategies was discussed in terms of the types of issues included in the checklist. Respondents also provided us with reports and other written material relevant to the issues being discussed. Suggestions for alternative strategies were also solicited at this time. Lists of the people interviewed in Minneapolis and St. Paul can be found in Appendix B.

The qualitative data resulting from the interviews was interpreted in light of our growing understanding of the transportation issues active in the cities at the present time, and our understanding of the political and economic forces that must be balanced in the urban environment. This information, in conjunction with the written material supplied, made it possible to evaluate the candidate transportation control strategies in terms of the timeliness and feasibility of their implementation. From this evaluation, recommendations were made for the selection of transportation control strategies.

In Minneapolis - St. Paul, only the vehicle performance inspection was eliminated from the list of candidate strategies finally recommended. The problems associated with the implementation of such a program are discussed in Appendix C.

B. EVALUATION OF STRATEGIES RECOMMENDED FOR MINNEAPOLIS' CENTRAL BUSINESS DISTRICT (CBD)

1. Express Bus Service

Planning for the major portion of the express bus service recommended here is already underway in the form of the I-35W Urban Corridor Demonstration on a Bus-Metered Freeway System. Full operation of the service, including metered entrance ramps for the buses, is expected by mid-1973. It is anticipated that the service will attract approximately 2,000 riders daily from their automobiles.

The service will be operating initially on a demonstration basis. Continuation of the program will depend on its initial success, as indicated by the results of continuous evaluation, and on the availability of additional funds for operation.

Legal Authorization and Requirements

Legal authority to manage and operate such an express bus on an Interstate Freeway exists within the combined authorities of the Metropolitan Transit Commission and the Minnesota Highway Department. The land required for the construction of the metered freeway ramps is within the highway right-of-way, and no additional land acquisition will be required for this purpose. Since the buses will operate with other vehicular traffic on the freeway itself, no additional right-of-way will be required here either.

Management and Enforcement Responsibility

The project is managed by a Project Management Board consisting of representatives of the Metropolitan Council (coordinates all planning in the Seven County area), Minnesota Highway Department, Metropolitan Transit Commission, Hennepin County and the City of Minneapolis. The Board provides overall technical direction for the project. The project director is a full time staff member of the Minnesota Highway Department and is the individual responsible for dealing with the consultants and coordinating local staff participation. Expansion of the project to include St. Paul would require expansion of the Project Management Board of include appropriate city and county representatives.

Financial Requirements

The capital cost for all elements of the Bus-Metered Freeway system has been estimated at $4,731,000, including the surveillance and control system ($1,703,000) and the bus ramps, vehicles, park-ride facilities, waiting shelters, and bus stop signs that comprise the transit service ($3,028,000). The annual operating expenses of the transit service plan are estimated at $558,000 for the first year. Additional operating funds will be necessary for the surveillance and control system ($148,000) and marketing ($102,150).

Financial support for the demonstration project has been committed from several sources: Federal Highway Administration, Urban Mass Transit Administration and the Metropolitan Transit Commission. However, operation of the express bus system beyond the demonstration phase will require a small amount of additional financing. As indicated in the final planning report on the system,* operating expenses for the first year are expected to be as follows:

Service Plan Operation	$ 558,800
Surveillance & Control System	148,000
Marketing	102,150
Total Operating Cost	$ 808,950
Passenger Revenues	$ 689,700
Operating deficit offset by initial grants and local service reductions	($119,250)

* I-35W Urban Cooridor Demonstration Project: Bus Metered Freeway System, September, 1971.

In the second and subsequent years, we can expect passenger revenues to increase by about 5% (extrapolation of current trend in the Minneapolis-St. Paul metropolitan area) and marketing costs to be reduced by about $30,000 (3/4 of the expenses for creative planning and advertising for metering). Thus, for the second and subsequent years, additional financing of $54,765 would be required to support the program, as shown below:

Service Plan Operation	$ 558,800
Surveillance & Control System	148,000
Marketing	72,150
Total Operating Cost	$ 778,950
Passenger Revenues	$ 724,185
Operating Deficit Requiring additional financial support	$ 54,765

It is possible that this sum could be financed by the State or by a continuing grant from the Federal Highway Administration. Resolution of this issue must await evaluation of the program's first full year of operation.

Also awaiting evaluation of this demonstration program is the expansion of freeway metering and express bus service to connect Minneapolis and St. Paul. This project would require substantial capital and operating financing of the same order of magnitude as the I-35W corridor project.

User Acceptance

Vital to the success and continued operation of the express bus service is the market's acceptance of it. In recognition of this fact, the system planners have already devoted considerable effort to the marketing strategy. The major appeal would be made on the basis of the time and money saving features of the system. An attitudinal study for the Twin Cities Area Metropolitan Transit Commission conducted in early 1969 by Simpson and Curtin showed the importance of a number of characteristics of transit travel to work, shown below in Table V-1.

Percentages refer to the percentage of the sample who ranked the trip characteristic as "very important" of "of some importance".

TABLE V-1*

Ranking of Characteristics of Transit Trips to Work

	Very Important	Of Some Importance	Total
Getting to Work on Time	91.6%	5.6%	97.2%
Your Safety	83.3%	13.0%	96.2%
Travel Time	55.1%	26.0%	81.1%
Need Not to Transfer from one bus to another	54.2%	25.1%	79.3%
Having your Mind free while going to and from work	39.0%	40.9%	79.9%
Your Comfort	36.8%	41.8%	79.6%
Cleanliness of the Car	31.9%	52.9%	84.8%
Cost of the Trip	26.0%	36.2%	62.2%

While all of these factors are of considerable importance, as indicated by the total percentages, it is clear that getting to work on time and other travel time issues are paramount. If the credibility of time saving by bus can be established with auto users, than this should be the major thrust of the marketing appeal. Other factors, especially safety and convenience should also be highlighted. Less money should probably be spent on advertising the money-saving features of the system, (now targeted for major emphasis) because of the relatively little importance ascribed to this characteristic by potential users. Since the primary market (auto users of the corridor) consists of people with higher than average income, this appeal is likely to have little impact. With these minor changes in the marketing strategy, it seems possible that the system will achieve the anticipated ridership goals.

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* I-35W Urban Corridor Demonstration Project: Bus Metered Freeway System, September, 1971. P. 107

Economic Impact

The major economic impact anticipated at this time is a reduction in parking lot revenues normally received from auto commuters. This would not amount to more than about $3,000 per day, and be spread among a large number of parking lot owners. Since reductions in the number of downtown parking spaces are planned, it is not likely that this impact will be sufficient to present an obstacle to full implementation of the express bus service.

Political Feasibility

The political feasibility of the service depends, ultimately, on the attitudes of users and downtown employers and parking lot owners. If they continue to support it, there is not likely to be any political opposition.

2. CBD Fringe Parking

The concept of providing convenient, low cost parking at the fringe of the CBD, while restricting and discouraging parking in the downtown core is an integral part of current planning for Minneapolis. The Metro Center '85 report* includes as policies:

> "Creation of fringe parking ramps connected to the distributor network and freeways on one end and pedestrian skyways into the core on the other.
>
> Prohibiting through zoning, the development of any new parking ramps within the core by restricting the maximum number of parking spaces that may be permitted in any new building."

Full implementation of the city's parking policy is anticipated by 1976, by which time peripheral parking ramps will be in operation with a total of 11,350 spaces. By the same time, through the redevelopment of the downtown area, approximately 11,000 CBD spaces will be eliminated.

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* Metro Center '85: Study for Development of Program and Priorities for Expanded Job and Investment Opportunities in Central Minnesota, Minneapolis Planning and Development, March, 1970, P. 102

Legal Authorization and Requirements

Minneapolis has the legislative authority necessary to develop parking facilities in the locations it desires. Minnesota Statutes Chapter 459 include the right to issue bonds to finance parking facilities, securing low interest rates with the full faith and credit of the city. Through the power of eminent domain, Minneapolis has the right to acquire the necessary land and to build on it.

The City's capacity to limit the private construction of parking facilities is less clear. While it is legally possible for the city to restrict parking through its zoning powers, developers are frequently granted the right to construct parking in excess of the desired 200 spaces per block of development in exchange for other concessions. To remedy this situation, it will be necessary to redraft the present zoning ordinance to explicitly restrict parking in the downtown area to accessory parking (less than 200 spaces per block of development), and to prohibit construction in this area of any major new facilities intended exclusively for parking. The new zoning ordinance will require passage by the city council. As indicated in the Metro Center '85 report*, restriction of downtown parking through zoning and redrafting of the zoning ordinance is the policy of the city. Several new versions of the ordinance have been prepared, and agreement is anticipated shortly. The City's parking policy has the full support of the Minneapolis Downtown Council (the development arm of the Chamber of Commerce) and can thus be expected to pass the City Council.

Another tool potentially available to control the location and quantity of downtown parking in Minneapolis is the development district. Chapter 677 of the 1971 Minnesota State Statutes authorized the creation of two development districts until 1973.

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* Metro Center '85, P. 140

In the 1973 legislative session, the City will propose that the downtown area also be designated a development district, thereby giving the City unprecedented control over the design and location of all new construction in designated areas. City planners are presently identifying the possible boundaries of a downtown development district, and no opposition has yet arisen to the plan.

Financial Requirements

Bonds have already been sold for a major portion of the fringe parking structures, and the remainder are in preparation. It is likely that arrangements will be made with the operators of the parking garages to guarantee the City a fixed annual income from the facilities sufficient to repay the initial investment and debt service. Although it is not anticipated that any additional financing will be necessary, grants are available from the Federal Highway Administration for the construction of parking ramps for commuters in conjunction with Interstate Highway projects.

Another financing alternative, proposed in the Metro '85 report is the creation of a parking fund which would be the recipient of money from private downtown developers for the construction of a required number of parking spaces. Pooling of this money in a special fund would make it possible to construct parking more efficiently and at locations chosen by the City rather than at the development sites.

Management and Enforcement Responsibility

Management of CBD fringe parking ramps would be delegated to the operators to whom the facilities were leased.

Responsibility for the revision of the zoning ordinance and the possible creation of a downtown development district rest with the City Planning and Development Department and the Coordinator's office.

User Acceptance

Acceptance of CBD fringe parking in lieu of downtown core area parking will depend somewhat on the price of the parking, but much more on the quality and timeliness of the linkage to downtown that is provided. A people mover system and an expanded skyway system are planned for this purpose, and discussed in Section C.

Pricing Controls

Also at issue is the possible institution of pricing controls which would raise the price of downtown CBD parking in relation to fringe CBD parking. This would theoretically discourage all but executives and perhaps shoppers (whose parking fees might be paid through their purchases) from parking in the CBD. The economic impact of this policy could be detrimental to downtown parking operators and even downtown stores who could be at a disadvantage in relation to suburban businesses. At present, the City does not have the right to review parking rates. And a new City ordinance would be required to implement these controls. Such an ordinance would require council approval. Given its economic disadvantages, it is unlikely that this policy will be politically feasible within the period of the implementation plan.

3. People Mover System

Planning is currently underway by the City of Minneapolis, Metropolitan Transit Commission and the Downtown Council for an automated people mover system in downtown Minneapolis which would provide an efficient linkage between CBD fringe parking facilities, downtown offices and stores, and the skyway system. The system would consist of 20-40 passenger vehicles operating on a fixed guideway elevated to the second story of the downtown buildings. The maximum walking distance from any point in the downtown area to a people mover station is expected to be 2 or 2 1/2 blocks, and the average about 1 or 1 1/2 blocks. It is anticipated that the first stage of the system - the east, west loop comprising half the total mileage - will be operating by 1976.

Legal Authorization and Requirements

Chapter 429 of the 1971 Minnesota State Statutes permits the city of Minneapolis to finance, construct, operate and maintain a people mover system of the type contemplated. However, additional legal steps must be taken before construction can begin. Agreements will need to be reached between the City and all of the individual property owners abutting the proposed right of way. One problem which may interfere with this process is the system's potential infringement on the abutting property owners' right to light and air. If this becomes a serious issue, then delays are likely to result.

Financial Requirements

The initial capital investment required for the system has been estimated at $53,000,000, with annual operating expenses of $3,100,000 including debt service. Ongoing negotiations with the Urban Mass Transit Administration indicate that approximately 80% federal funding may be available for the initial capital investment.

Minneapolis has in mind several options for financing the remaining costs. One option would involve the creation of an economic development district in downtown Minneapolis and the application of tax increment financing. Under this scheme, taxes in the district are frozen at the level of a designated year, and the increase in tax revenue resulting from the improvement (the people mover, in this case) is returned exclusively to the district, through the general fund. The potential for creating an economic development district within the city of Minneapolis exists in Chapter 677 of the 1971 State Statutes. However, application of this law to downtown Minneapolis would require approval of the Legislature sometime after July 1, 1973. An additional constraint on the use of this funding mechanism is a current limit of 5 mils on the additional tax levy that can be made on the property owners in a development district. This revenue would cover only about one fourth of the cost of the system.

If this restriction were not lifted, then additional revenue would be required from other sources.

Construction of the people mover system, however, is not dependent on approval of Minneapolis as an economic development district. The city of Minneapolis itself and the Metropolitan Transit Commission are both prepared to sell bonds to raise the initial capital required. A benefit assessment district could also be established with the beneficiaries of the service being assessed in proportion to their benefit. If necessary, it would also be possible to charge a 10 cent fare to defray operating expenses, instead of the service being free.

The financing options for this proposal are many, and its ultimate feasibility rests with the economic strength of the entities involved and not with which option is chosen. The City of Minneapolis has a AAA bond rating, and the Metropolitan Transit Commission an AA rating. Thus it appears that some satisfactory financing scheme can be found to implement the people mover system.

Management Responsibility

Responsibility for management of the people mover system is now under discussion, and the obvious candidates are the city of Minneapplis and the Metropolitan Transit Commission. A decision about this is expected shortly.

Economic Impact

The people mover system is likely to have a positive economic impact on retail sales, office space leasing, and development of tourist and convention facilities. Land values are likely to increase near the stations. No groups have been identified which would be likely to suffer economically as a result of the people mover service.

User Acceptance

Acceptance by the residents of Minneapolis will depend largely on the financing scheme that is chosen, the quality of the service, and perhaps the aesthetic impact of the aerial structure itself. Until the financial and design details have been decided, it is not possible to anticipate citizen response.

Political Feasibility

While there is substantial support for the concept of the people mover system, political opposition may arise during the process of detailed design and location. This can and is being avoided by involving the downtown business community early in the system's planning.

4. Traffic Management System

Detailed planning for a traffic surveillance and control system (or traffic management system) has been completed for Minneapolis. The system will monitor the number, speed and direction of vehicles along the controlled roadways. This information will be fed into a computer which will coordinate the signal system, meter traffic, reverse lanes and divert traffic from congested streets as appropriate in order to optimize the smooth flow of vehicular traffic. The system will require 3 years to implement, and is expected to be operational by the first quarter of 1976.

Legal Authorization and Requirements

No special legal authorization is required to install the system. Maintenance agreements between Minneapolis, Hennepin County and the State of Minnesota will have to be prepared to define maintenance responsibilities on the roads belonging to these different political entities. There is ample time to reach an agreement on this issue, and it is not expected to be an obstacle to the system's operation.

Financial Requirements

The traffic management system will cost about $4,000,000 and be supported by a TOPICS grant from the Federal Highway Administration for approximately $2,000,000 (50%). Twenty percent of the remaining $2,000,000 will be paid for by the City and 30% by Minnesota and Hennepin County. The funding has been authorized informally and official approval is anticipated very shortly.

Management and Enforcement Responsibility

Management of the system will rest with the City of Minneapolis and enforcement of the traffic regulations will remain with the police now in force on the affected streets.

User Acceptance

There may be resistance to the system from travelers who, during peak travel periods, are diverted from their intended direction and must find alternate routes to their destination. Opposition may arise from truckers and other delivery services (Postal Service, etc.) who may find it difficult to follow their accustomed routes. These problems are not expected to be sufficient to interfere with the system's implementation, but may reduce its efficiency for a few months until travelers have become accustomed to it.

Political Feasibility

There are no political problems anticipated at this late stage in the planning.

Economic Impact

Implementation of the traffic management system will change the flow of traffic, but is not expected to increase the total number of vehicles that regularly enter the city. Thus no significant economic impact is expected.

SECTION V-C

SURVEILLANCE REVIEW MILESTONES
MINNEAPOLIS

EXPRESS BUS SERVICE	
Construction	1 Complete bus ramps
	2 Pretest control equipment
Operation	3 Begin full operation
	4 End of demonstration phase
Evaluation	5 Complete "before" measurements
	6 Complete "after" measurements
Continuation	7 Decision to continue program
CBD FRINGE PARKING	
Legal restrictions on downtown parking	1 Legislative approval of development district or 2
	2 Council approval of revised zoning ordinance
PEOPLE MOVER SYSTEM	
Finance	1 Informal UMTA approval
	2 Decision on local financing scheme
	3 Formal UMTA approval
Management	4 Selection of system manager
Legal	5 Agreements with property owners
Construction	6 Begin construction
TRAFFIC MANG'T SYSTEM	
Finance	1 Formal FHWA approval for construction funding
Construction	2 Let bids
	3 Contractor selected & gets authorization to proceed
	4 Contractor orders equipment
	5 Equipment received & construction begins
	6 Operation begins
Evaluation	7 Take "after" measurements

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D. EVALUATION OF STRATEGIES RECOMMENDED FOR ST. PAUL CENTRAL BUSINESS DISTRICT (CBD)

1. Central Business District Fringe Parking

The creation of bulk parking facilities at the fringe of the St. Paul CBD is part of the present policy of both the city of St.Paul and the downtown business community. The parking concept for the St.Paul area* includes

" • Long-term employee parking in structures located on the periphery of the core on the minor arterial system.

• Executive parking in limited quantity located convenient to place of employment and in structures.

• Shopper, business and patron parking in structures and very convenient to destinations.

• Errand parking off-street and well distributed with regulation and pricing to encourage short stays.

• Elimination of all on-street parking in the retail and office areas."

Operation '85, the development arm of the downtown business association, has proposed specifically that bulk parking (open lots) be developed in three locations:

1) Civic Center Ramp area to Chestnut Street and between Seventh Street and Shepard Road

2) The area of the railroad yards east of the Union Depot and east of the new Toni facility between Kellogg and Fifth Street

3) The state capitol area including all the area not in public ownership south of Arch Penn between Rice and Jackson Streets.

Together, these lots would provide parking spaces for 10,000 cars, and could be expanded, as necessary, as multi-level facilities.

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* Transportation Plan for the St. Paul Core Area, Bather, Wolsfeld, Inc., July, 1970, P. 22

Legal Authorization and Requirements

The City of St. Paul has the authority necessary to acquire land for parking purposes. Several legal steps would be necessary, however, to implement the Operation '85 plan. In the case of the Civic Center area, additional land would need to be acquired by the Housing and Redevelopment Authority to expand the capacity of the Civic Center Ramp. Long-term agreements for the use of the area near the Burlington Northern Tracks would need to be drawn between the railroad, City and parking lot operators. In the vicinity of the Capitol complex, an urban renewal program of acquisition and clearance would need to be established involving the Capitol Approach Planning Commission and the Housing and Redevelopment Authority, with the support of the City and other organizations cited. All of these legal actions are possible within several months, or a year maximum.

Financial Requirements

The cost of the parking program outlined above has not been determined. However, since open lots are planned initially, the total cost should be relatively low. Operation '85 has recommended that the Industrial Bond Act currently used by the Port Authority of St. Paul be amended by the next State Legislature to include parking ramps and parking lots in the scope of possible funding activities. This would permit private parking lot operators to enjoy the benefits of public acquisition of land and lower financing. If this option is not approved by the legisture, then the land could be acquired privately or by the City of St. Paul.

In order to further encourage drivers to park in the fringe lots, steps must be taken to discourage peak hour travelers from parking downtown. This can be accomplished by prohibiting the construction of large CBD parking facilities and controlling the price of downtown parking.

The City has the authority to restrict construction of downtown parking ramps through zoning. However, the St. Paul Housing and Redevelopment Authority presently requires that developers provide 1 stall for every 1500 square feet of office space. A change in this requirement will require approval by the Redevelopment Board, and a vote of the City Council and approval by the Mayor.

Another mechanism for discouraging downtown parking is the control of parking fees. This approach is understood by the business community to be unfair to downtown lot operators whose revenues would be likely to drop. The City of St. Paul now has the authority to set maximum parking rates, but not minimum. Given local opposition to this approach, it is not likely that the City Council would approve an expansion of the City's authority for this purpose.

Management Responsibility

As currently conceived, the proposed parking facilities would be managed and operated privately. This does not pose any obstacles to the implementation plan.

Economic Impact

The overall economic impact of this plan is expected to be positive, in that now vacant or underutilized land will be put to a more productive purpose. As long as convenience and executive parking is not curtailed, there should be no negative economic impact on downtown businesses and retail stores.

Political Feasibility

There is no major opposition to the plan at present, and approval by the City Council is anticipated.

User Acceptance

Use of the parking facilities by travelers downtown will depend primarily on the convenience of the linkage to the core area. It is expected that this will be accomplished initially through the skyway system and a shuttle bus service, and eventually by a people mover system. The first two alternatives will be operative by 1977.

2. Shuttle Bus Service

A recommendation has also been made by Operation '85 to operate a shuttle bus service connecting the bulk parking facilities, including the capitol area, with the downtown area. The following routes are being considered: During the hours of 7:00 a.m. to 9:30 a.m. and 3:30 p.m. to 6:00 p.m. buses would run on Fourth Street from the Civic Center Ramp on the west, to and through a bulk parking area owned by the Burlington Northern on the east; from 9:30 a.m. to 6:00 p.m. buses will also make a loop through the Seventh Street retail area. The shuttle bus service would supplement the expanding skyway system and could be supplanted by the people mover system proposed for a later time.

The Metropolitan Transit Commission's unified work program for calendar year 1973 includes a circulation and collection/distribution study for St. Paul to begin in the third quarter of 1973 and continue for 6 months. The total cost of the study would be $50,000, of which the Urban Mass Transportation Administration would pay two-thirds. They indicate that the study "may lead to the design of a transportation center with facilities for the fast link systems, shuttle bus systems, and other bus services all interfacing with the St. Paul skyway system."*

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* Memorandum: Unified Work Program, CY 1973, To Transit Development Committee from Cam Andre, Oct., 1972

Legal Authorization and Requirements

The Metropolitan Transit Commission has the authority to operate a shuttle bus service in downtown St. Paul.

Financial Requirements

Financing is available to conduct the study, and additional funds would be needed to purchase, operate and maintain the shuttle buses. Two-thirds funding would probably be available through the UMTA Capital grants program for purchase of the buses. Operation and maintenance would have to be supported by a fare or by taxes.

Management Responsibility

The Metropolitan Transit Commission would have responsibility for managing the program.

Economic Impact

The service would be expected to improve the economic situation of downtown businesses. Without it, concentration of parking on the fringe of the CBD could discourage growth in the core area.

Political Feasibility

The shuttle bus service has the support of the downtown business community as well as local governing agencies. No political obstacles are anticipated.

User Acceptance

Acceptance of the service by users will depend on the waiting and travel times, and the quality of the wait and the ride. If the buses operate on short headways and in special bus lanes, and if waiting can be done in a heated, attached bus shelter, the service should be successful.

3. Auto Free Malls

The Transportation Plan for the St. Paul Core Area* recommends an auto free mall on Seventh Street between Jackson and Wabasha. Auto free malls have also been proposed for Fourth and Minnesota. Only shuttle buses would operate on these streets.

Legal Authorization and Requirements

Implementation of this plan would require approval of the Mayor and City Council. There are no legal problems associated with closing the streets to automobile traffic.

Financing Alternatives

There are several ways in which the street improvements needed for the malls could be financed. One approach would be to designate the area a benefited district and assess the abutting property owners in proportion to the benefits they receive. The revenues collected from the benefit assessment could be used to repay the bonded debt for the improvements. Another possibility would be to request of the state Legislature that the area be declared a special development district. This would permit the increment in tax revenues over the base year to be used to finance these and possibly other improvements. The City of St. Paul could also use general tax revenues to pay for the project. Given these alternatives and the financial capacity of the City, financial considerations do not appear to be an obstacle to the project.

Management Responsibility

Management of the project would depend, in part, on how it was financed, but would rest ultimately with the City of St. Paul.

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* Bather, Wolsfeld, Inc. July, 1970

Economic Impact

The economic impact of the Seventh Street Mall is likely to follow that of Nicollet Mall in Minneapolis where retail business has improved substantially. In recognition of this potential, Operation '85 and the downtown business community have spoken out in favor of the proposal.

Political Feasibility

The only potentially significant political obstacle to auto free malls could arise from the truckers unions who may need to make deliveries to the stores and business along the mall. This opposition can be overcome by improving off-street loading facilities at the rear of the buildings or making other arrangements to accommodate this need.

User Acceptance

The Nicollet Mall in Minneapolis has enjoyed great popularity among shoppers and sightseers, and the malls proposed for St. Paul can be expected to bring the same response.

4. Traffic Signal System

Improvements to the traffic signal system have been proposed in St. Paul's TOPICS plan and are supported by this air quality implementation plan.

Legal Authorization and Requirements

The Department of Public Works of the City of St. Paul, with approval of the Mayor and City Council, has the authority to implement changes to the traffic signal system and street network.

Financial Requirements

The improvements proposed will be supported by the Federal Highway Administration's TOPICS program. Informal commitment of funds has been made and formal approval is expected.

Management and Enforcement Responsibility

The city of St. Paul will retain responsibility for operating the signal system.

Economic Impact

The TOPICS program will improve traffic flow and thereby encourage more people to travel into the downtown area. This should have a small, but beneficial, economic impact.

Political Feasibility

There is no political opposition to the TOPICS program.

User Acceptance

Since the system will improve mobility in the downtown area, it should be welcomed by downtown drivers.

SECTION V-E

SURVEILLANCE REVIEW MILESTONES
ST. PAUL

CBD FRINGE PARKING

Legal	1 Obtain right to use vacant land
	2 Acquire land near capitol
	3 Change zoning ordinance to restrict downtown parking construction
Finance	4 Council approval of bonds for parking facilities
Operation	5 Open Phase I lots

SHUTTLE BUS SERVICE

Planning	1 Complete study
Design	2 Complete design
Finance	3 Obtain UMTA grant approval
Operation	4 Order equipment
	5 Begin operation

AUTO FREE MALLS

Legal	1 Mayor and council approve plan
Finance	2 Decide on financing scheme
	3 Implement financing program
Design	4 Complete design
Construction	5 Begin construction

TRAFFIC SIGNAL SYSTEM

Finance	1 Obtain formal FHWA approval for construction funds & authorization to let bids
Construction	2 Bid letting
	3 Contractor selected & orders equipment
	4 Contractor receives equipment
	5 Construction begins
Evaluation	6 Begin annual data collection

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VI. SURVEILLANCE AND ENFORCEMENT OF CONTROL STRATEGIES

A. Surveillance

1. Introduction/External Influences

This air quality Implementation Plan incorporates a number of strategies presently planned for the Minneapolis and St. Paul CBD's. Most of these programs are in the planning or early implementation phase. Those programs which are just in the planning stage must be implemented in timely fashion if the projected benefits assigned to them are to be realized by 1977. Therefore, the surveillance program for this Implementation Plan must include the monitoring of implementation of these programs against the projected completion dates.

On the assumption that implementation is achieved within the scheduled target dates, the second part of the surveillance program is that of measuring the performance of the system against the projected benefits.

Two attributes of traffic benefits have been estimated in this study. These are reduction in vehicle miles of travel and improvement in traffic flow. Both of these parameters are subject to standard traffic engineering techniques of measurement. The problem becomes principally one of assigning the changes in these parameters sensed by standard techniques to the improvements anticipated under this plan. However, changes may occur in influences external to the specific strategies related to air quality improvement, which may cause additional increases in benefits measured or may off-set their positive contributions.

Examples of possible changes in external influences are identified below:

<u>Induced Travel</u> - Whenever improvements in traffic flow are achieved by increases in capacity, improved regulation, surveillance and control, or other measures, there is a tendency for this improvement to induce travel demand that would otherwise not develop. While these factors are difficult to predict with accuracy, they must be anticipated in improvement programs. While the result of the improvement may be achieving the target objectives in diversion, or the like, these benefits may be obscured in gross measurements. Therefore, corrective actions may be difficult to identify and to develop.

For example, volume, capacity, and speed on urban streets are interrelated variables. When evaluating the effectiveness of traffic control system improvements, the assigned benefit in increased traffic flow must relate to the comparable traffic volumes. Improvements in traffic speed might be offset if substantial increases in traffic volume occur. The signal system improvements could be yielding benefits under these circumstances, but at lower-than-anticipated speeds. Without the signal improvements, substantial lower speed would have resulted and the same degree of induced travel would not have occurred. The corrective action would probably not be assignable to the traffic signal system, but rather to measures to counteract the induced travel, if speed improvements are to be achieved.

To make such assignments, the travel behavior must be understood. This includes origin destination studies such as those employed in the Travel Behavior Inventory conducted in the Comprehensive Transportation Study conducted for the area. Changes in trip origin and destination patterns as well as trip purpose distributions will then identify the causes for increased travel and lead to the development of corrective actions.

Changes in the land-use patterns in the CBD may be the cause of travel pattern changes. The development of unanticipated, large employment centers may increase work-trip volumes. Unless adequate access to these facilities are a integral part of the development plan, increased volumes without increased capacity will probably result in a decrease in travel speed. The expected reduction in vehicle emissions will not be realized.

Parking Facility Patronage - Patronage of parking lots can be measured by vehicle counts. The personal characteristics of the users may well be other than that assumed in the Implementation Plan. Facilities may be planned to serve primarily the workers in the core, and therefore sized for this patronage. It may be that shoppers find the facility also attractive and place unanticipated demands on it use. Unless these characteristics are identified through surveys, corrective actions may not be easy to develop. The reductions in traffic volume may not be those estimated by the strategy evaluation incorporated here.

2. Traffic Surveillance Program

Although other strategies are potentially useful, the recommended strategies primarily involve the above discussed attributes. The surveillance program proposed to measure effectiveness includes the following:

Traffic Density - Estimates of annual daily traffic (ADT) are made from periodic surveys conducted by the Traffic Divisions or Sections of the Municipal Departments of Public Works. From these data, updated traffic density estimates on the CBD streets will be made following the procedures illustrated in this study. Annual trends will be maintained from these estimates and compared with the baseline 1971 and 1977 estimates. From such updates, the gross measure of traffic flow is made.

Traffic Operating Speeds - These data were basically derived by the Traffic Engineering studies performed by the Muncipalities and are gathered by a number of means. The "floating car" method is perhaps the most suitable. In this technique, a car is driven in mixed traffic at various times of the day and the average speed along determined route segments is measured. By these sampling techniques, average speed will be determined and weighted against prevailing volumes. Data will be obtained on a before-and-after improvement basis to determine speed trends.

Travel Behavior Inventories - Data obtained by sampling procedures, either conducted for transportation study up-dates by the Highway Department, the Twin Cities Area Transportation Department, or established under other special purposes, will be analyzed and compared with basic data in the latest Travel Behavior Inventory used in projecting travel demand in this study. These up-dates indicate meaningful developing trends in person-trips, trip purposes, origins and destinations, car ownership, and other socio-economic travel factors. Changes in these data from predicted trends will be assessed as to their impact on VMT projections made here.

Parking Facility Inventory - The surveillance program will maintain inventories of number, type, and location of core parking spaces to monitor the planned shift of availability of these from the core to the fringe of the CBD's. Profiles of user characteristics will be developed and up-dated periodically to detect shifts in these patterns from planned objectives. The development of new centers of core activity will be monitored to assure that the parking policies are being followed.

Micro-System Circulation - The success of fringe parking depends on the pedestrian augmentation provided. Therefore, the surveillance program will monitor their development versus the implementation schedule. Patronage volumes and use patterns probably will be determined as part of facility development. Trends in these data will be compared with the predicted results.

3. Air Quality Surveillance Program

The ultimate objective of the total transportation control program is to achieve the 8-hour average carbon-monoxide standard of 9 ppm. Carbon monoxide concentrations will be measured continuously throughout the program, using NDIR (non-dispersive infrared) analyzers. Measurements will continue to be made at the present sites - Downtown Minneapolis, Downtown St. Paul, and Midway - and additional monitors probably will be added at other locations having the potential for high CO concentrations.

This actual CO concentration data will be compared on a periodic basis with the concentrations expected from the emissions reduction achieved via the Federal Motor Vehicle Emission Control Program and emissions reductions expected and measured (thru the traffic surveillance program) via the transportation control strategies proposed herein.

B. ENFORCEMENT

1. General Methodology

The major control strategies are either on-going or planned programs over which PCA does not have direct jurisdiction. Therefore, the major objectives of the enforcement program are to:

(1) Insure that the strategies are implemented by 1977,

(2) Maintain the strategies on the schedules given in Sections V-C and V-E,

(3) Provide the necessary restrictions on core parking, via zoning ordinances, development districts, or other means,

(4) Get ordinances passed preventing idling,

(5) Enforce existing regulations on visible emissions, removal of pollution control equipment, leaving keys in unattended cars, and pedestrian behavior.

(6) Make necessary mid-course corrections, or even major changes, in control strategies.

A fundamental enforcement tool to be employed by PCA to insure that these objectives are achieved is the Inter-Agency Agreement described below. Appendix D presents a draft Agreement.

2. Inter-Agency Agreement to Achieve Carbon Monoxide Standards by 1977

A single agreement will be co-signed by the cognizant governmental bodies, including the Pollution Control Agency, the City of St. Paul, the City of Minneapolis, the Metropolitan Transit Commission, the Metropolitan Council, the Highway Department, and possibly others. The purpose of the agreement is to insure on-schedule implementation of control strategies by the responsible agencies. The agreement will be fully executed by July 30, 1973.

The Inter-Agency Agreement will include the following major provisions,* or their equivalents:

(1) The co-signees agree to implement the following programs by 1977:

<u>In the Minneapolis Central Business District</u>:

(a) Construct fringe parking lots and simultaneously restrict the construction of new lots in the core city. Necessary zoning ordinances will be passed. "Development District" designation shall be obtained from State Legislature if necessary.

(b) Construct and operate a people-mover system, or equivalent system, integrated with the fringe lots and the pedestrian skyway system.

(c) Install and operate a traffic surveillance and control system.

<u>In the St. Paul Central Business District</u>:

(a) Construct fringe parking lots and simultaneously restrict the construction of new lots in the core city. Necessary zoning ordinances will be passed. "Development District" designation shall be obtained from the State Legislature if necessary.

(b) Construct and operate a shuttle-bus, or equivalent, system integrated with the fringe parking lots and the pedestrian skyway system.

(c) Install and operate a traffic signal system.

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* During negotiations, some changes in these provisions may prove necessary. However, their basic intent will not be altered.

(2) The agreement will include performance specifications for each measure, such as:

(a) The number of fringe parking spaces.

(b) The capacity and headway of micro-transit systems (e.g., people-mover system, shuttle bus-system, etc.).

(c) The performance of the CBD traffic management system.

The term "performance" specifications is used because PCA is interested in results, not in the details of how they are achieved. The cognizant governmental agency, municipality, etc., will make its own implementation decisions.

(3) A program for enforcing existing regulation APC-12 related to visible emissions from motor-vehicles and removal of air pollution control devices shall be implemented. Pedestrian laws and ordinances related to leaving keys in an unattended car shall be enforced.

(4) Ordinances shall be passed by the two cities prohibiting idling.

(5) The agreement will include an implementation time-table for each measure.

(6) The agreement will specify the lead agency for each measure and outline the responsibilities of all agencies in achieving each measure. Such responsibilities include funding, design, operation, enforcement, and progress surveillance.

(7) The agreement will include provisions for amendment. Possible changes include addition or subtraction of measures and increasing or decreasing the extent of the proposed measures.

Several meetings already have been held with both top officials and their staffs of the cognizant governmental bodies relative to the objective of reducing CO emissions and the basic control strategies. Essential agreement has been obtained. Several future meetings are planned. For this reason, we do not anticipate strong opposition to the Inter-Agency Agreement.

3. <u>The Role of the Minnesota Pollution Control Agency (PCA)</u>

The tasks of PCA include:

(1) Cooperating with the cognizant governmental agencies.

(2) Supporting and assisting in their efforts to obtain Federal, State, or local funds, federal technical assistance, legislative authority, and necessary ordinances.

(3) Preparing, negotiating, and executing the Inter-Agency Agreement by July 30, 1973 (Legislative Authority deadline of EPA

(4) Insuring that necessary ordinances are adopted by December 31, 1973 (Adopted Regulations deadline of EPA).

(5) Preparing a detailed time-table (included in Inter-Agency Agreement) based on Sections V-C and V-E, showing exact milestone and completion dates.

(6) Preparing a detailed time-table by July 30, 1974, showing expected reductions in traffic, CO emissions, and CO concentrations and expected increases in average speed.

(7) Conducting traffic and air quality surveillance programs and comparing these with the time-table.

(8) Obtaining up-dated motor-vehicle CO emissions data from Federal studies and from cooperative tests conducted in Minnesota by industry, educational institutions (e.g., Vocational-Technical Institutes), etc. Participating in such tests.

(9) Comparing such emissions data with expected emission rates used in this Implementation Plan.

(10) Evaluating the impact of new, unexpected CO emissions sources, such as stadiums, major highways, and large industry.

(11) Making mid-course changes in control strategies as indicated by the previous tasks, using the principles of PERT. The "over-kill" factor in the major control strategies will allow accommodation for some contingencies.

(12) Conducting the public information campaign.

4. <u>PCA Organization and Budget - Transportation Control Unit</u>

Appendix E presents the organization, activities, and budget, as proposed to the Minnesota Legislature, for the Transportation Control Unit of PCA's Division of Air Quality for the next biennium (July 1, 1973, to July 1, 1975). A total of three staff members are required by the end of FY 1975:

- Senior Engineer
- Engineer II
- Planner II

In addition, the Deputy Director of the Division of Air Quality will have the following tasks relative to the Transportation Control Unit:

(1) Initial program management and staffing,

(2) Assistance in negotiations of the Inter-Agency Agreement,

(3) Continuing management support.

The legal staff assigned to PCA by the Attorney General of the State of Minnesota will have prime responsibility for executing the Inter-Agency Agreement.

VII. LIST OF GENERAL REFERENCES

1. Federal Register, Vol. 36, No. 158, August 14, 1971.

2. Amendment to Reference 1, Entitled "Transportation Control Measures."

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5. "Evaluation Transportation Controls to Reduce Motor Vehicles Emissions in Major Metropolitan Areas," Report of Institute of Public Information, Contract No. 68-02-0048 with the United States Environmental Protection Agency.

6. "A Guide for Reducing Automobile Air Pollution," Report of Alan M. Voorhees and Associates, Incorporated, Contract No. CPA 70-100 with the United States Environmental Protection Agency, November, 1971.

7. Pattison, J. N., "Inspection Procedures Available for Control of Emissions from Used Cars," Journal of the Air Pollution Control Association, October, 1971, Vol. 21, No. 10.

8. Andreach, A. J., Elston, J. C., Lakey, N. W., "New Jersey Repair Project: Tune-up at Idle," December, 1971, Vol. 21, No. 12.

9. "Mandatory Vehicle Emission Inspection and Maintenance," Northrop Corporation Report, Contract ARB 15522 with the State of California Air Resources Board, December 10, 1971.

10. Schwartz, S., "A Systems View of Automobile Inspection Programs," APCA Paper No. 72-47, Presented at the 65th Annual Meeting of the Air Pollution Control Association, Miami Beach, Florida, June 18-22, 1972.

11. Clino, E. L. and Tinkham, L., "A Realistic Vehicle Emission Inspection System," APCA Paper No. 68-152, Presented at the Annual Meeting of the Air Pollution Control Association, June, 1968.

12. Control Strategies for In-Use Vehicle, U. S. Environmental Protection Agency, Office of Air and Water Programs, Mobile Source Pollution Control Program, Washington, D. C., 20460, November, 1972.

Appendix A

BASIS FOR SELECTION OF MINNEAPOLIS CARBON-MONOXIDE DATA

(Section II D)

APPENDIX A

BASIS FOR SELECTION OF MINNEAPOLIS CARBON-MONOXIDE DATA (SECTION II D)

A summary of the eight-hour average carbon monoxide concentrations for the Minneapolis and Midway Sites, expressed as the maximum value for over the day, is presented in Figures A1 to A3. The following table presents the first and second highest values for the two sites (over the period July 1, 1971, to June 30, 1972):

Minneapolis	Midway
18.9 ppm	26.2 ppm
17.5 ppm	21.6 ppm

The maximum value occurring anywhere in the Minneapolis-St. Paul Air Quality Control Region is 26.2 ppm, at the Midway site. Normally, this value would be used in the roll-back calculation. Nevertheless, we have chosen to use the maximum value of 18.9 ppm occurring at the Minneapolis site.

This decision is justified for the following reasons:

(1) The carbon monoxide emissions density in the Minneapolis CBD (and the St. Paul CBD) is more than five times greater than the density at the Midway site. Thus, the Minneapolis site has a much greater potential for high CO concentrations. The high concentration at Midway is not compatible with emissions densities.

(2) The Minneapolis site samples pollutants at a typical congested intersection of the downtown area and is very representative of the entire CBD. In contrast, the Midway site is located next to a side street often used by local truck traffic. Several trucking companies are located nearby. The Midway site therefore monitors a very localized

pollution situation. The high values at Midway in the above table were most likely caused by extraordinarily high activities in truck movements, loading, unloading, and idling, as well as appropriate meteorological conditions. The high concentrations at Midway can be reduced by a control strategy dealing with the localized truck problem - a strategy unable to totally cope with the truly serious problem in the two CBD's. The proposed strategy on limitation of idling motor vehicles will greatly reduce truck emissions near the Midway site.

(3) The exposure of people to carbon monoxide in downtown Minneapolis is much greater than near the Midway site, which is generally a sparsely-populated, mixed, residential/industrial zone. Therefore, control strategies based on the Minneapolis problem will have much more impact in protecting human health.

(4) The maximum value at the Midway site (26.2 ppm), and even the second highest value (21.6 ppm), is statistically rare, as shown in Figures A1 to A3. On the other hand, the maximum value at the Minneapolis site is much more probable, i.e., high values close to the maximum value occurred several times at the Minneapolis site.* This lends much more credibility to the Minneapolis data; or conversely, the highest value at the Midway site is more probably caused by experimental error. Furthermore, the Minneapolis site has high CO values much more often than

* In fact, in the first six months of 1971, two very high values also occurred: 15.3 ppm, February 22, 1971 and 18.6 ppm on February 26, 1971.

the Midway site. Values equal to, or above, 10 ppm occurred on 72 days over the year (19.7% of the time) at the Minneapolis site, but occurred only eight days over the year (2.2% of the time) at the Midway site - a factor of nine difference. Figure A3 shows the cumulative distribution at both sites, showing similarly that the Minneapolis site has high concentrations more frequently.

Often, the second highest pollutant value is used as the basis for roll-back calculations. The second highest value at the Midway site is 21.6 ppm (which is much lower than maximum value, unlike the Minneapolis site). Even if this value were used as the data base for Minneapolis the proposed control strategies #1 and #2 would permit achievement of the 9 ppm CO standard (see Section IV).

FIGURE A1

Ranking of High CO Values at the Midway Site from July 1, 1971, to June 30, 1972

Ranking	CO Concentration (ppm) [1]
1	26.2
2	21.6
3	15.5
4	15.4
5	15.1
6	12.6
7	12.4
8	10.4

(1) Maximum eight-hour average CO concentration during a day, greater than 10 ppm.

FIGURE A2

Ranking of High CO Values at the Downtown Minneapolis Site from July 1, 1971, to June 30, 1972

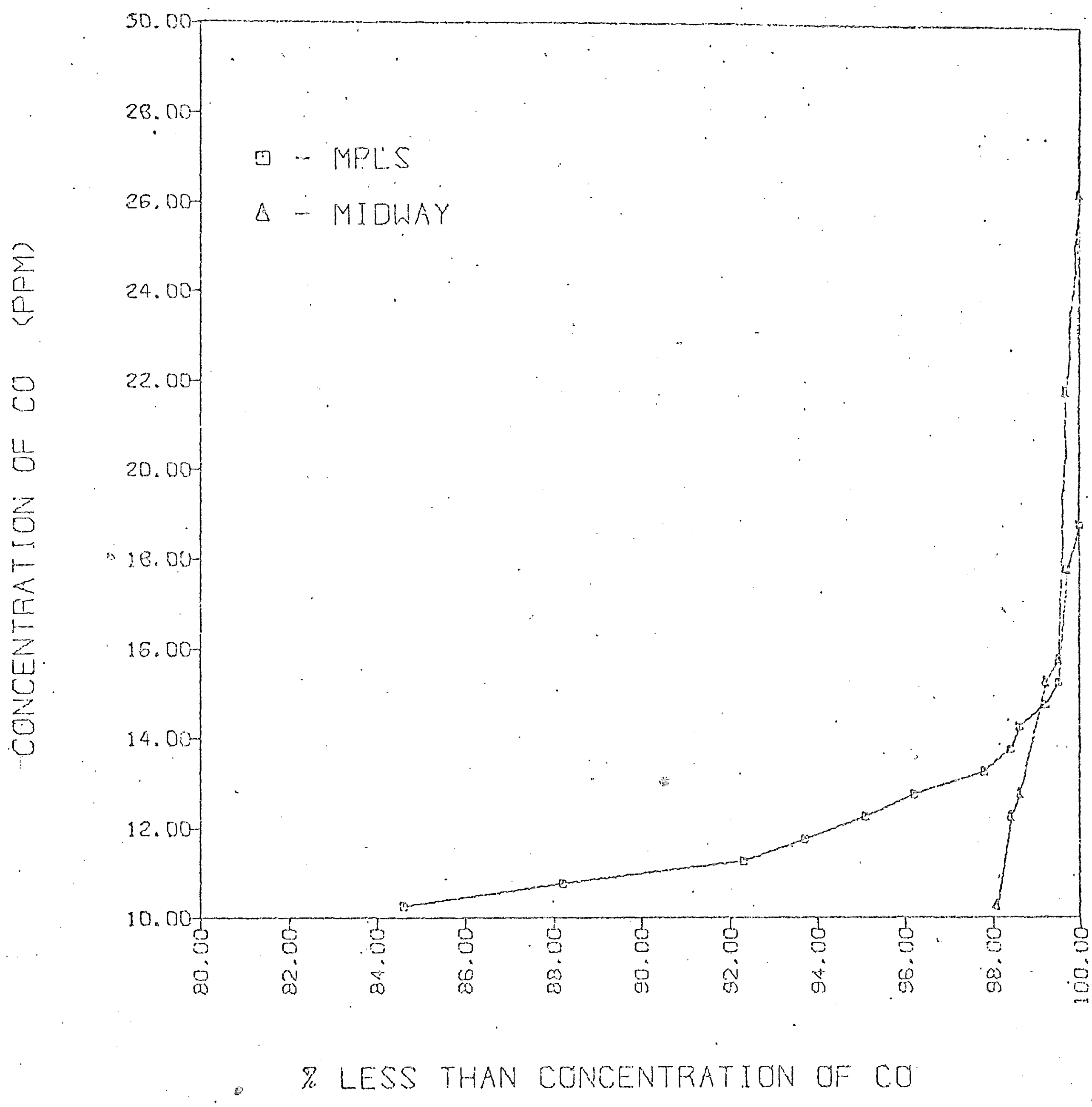
Ranking	CO Concentration (ppm)[1]	Ranking	CO Concentration (ppm)	Ranking	CO Concentration (ppm)
1	18.9	25	11.8	49	10.8
2	17.5	26	11.8	50	10.8
3	15.3	27	11.6	51	10.8
4	14.8	28	11.5	52	10.8
5	14.6	29	11.4	53	10.6
6	14.1	30	11.4	54	10.6
7	13.8	31	11.4	55	10.5
8	13.6	32	11.3	56	10.5
9	13.4	33	11.3	57	10.4
10	13.4	34	11.3	58	10.4
11	13.3	35	11.3	59	10.4
12	13.1	36	11.3	60	10.3
13	13.0	37	11.3	61	10.3
14	13.0	38	11.1	62	10.3
15	12.8	39	11.1	63	10.2
16	12.8	40	11.1	64	10.1
17	12.6	41	11.1	65	10.1
18	12.5	42	11.1	66	10.0
19	12.4	43	11.1	67	10.0
20	12.4	44	10.9	68	10.0
21	12.3	45	10.9	69	10.0
22	12.1	46	10.9	70	10.0
23	12.0	47	10.9	71	10.0
24	11.9	48	10.9	72	10.0

(1) Maximum eight-hour average CO concentration during a day, greater than 10 ppm.

FIGURE A3

CUMULATIVE DESTRIBUTION OF HIGH CO DATA

AT DOWNTOWN MINNEAPOLIS AND MIDWAY SITES



APPENDIX B

LIST OF PERSONS CONTACTED ABOUT IMPLEMENTATION OBSTACLES AND ISSUES

(SECTION V A)

APPENDIX B

LIST OF PERSONS* CONTACTED ABOUT IMPLEMENTATION

OBSTACLES AND ISSUES
(SECTION V A)

Bob Benke, Transportation Planner for Highway Department

Don Cosgrove, St. Paul City Planning Department

Thomas Duffee, Downtown Council, Minneapolis

Chuck Ewert (with Consultant) Operation 85, St. Paul

John Jamieson, Metropolitan Transit Commision

Burt Johnson, Minnesota Highway Patrol

Dave Koski, Minneapolis, Traffic Engineer

Fritz Marshall, State Highway Department

Dick Meyer, Metro Council

Bob Moffet, City Coordinator's Office, Minneapolis

Bob Peterson, Traffic Engineer, St. Paul

Bob Ready, Minneapolis, City Planning Department

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* Many others were contacted about other subjects involving this Plan.

Appendix C

Evaluation of the Candidate Strategy Rejected for Minneapolis and St. Paul: Motor Vehicle Inspection/Maintenance

(Section V A)

APPENDIX C

EVALUATION OF THE CANDIDATE STRATEGY REJECTED FOR MINNEAPOLIS AND ST. PAUL: MOTOR VEHICLE INSPECTION/MAINTENANCE

(SECTION V A)

The motor-vehicle inspection/maintenance program, discussed with the candidate strategies for Minneapolis-St. Paul was rejected, in large part because of the difficulty of implementing such a program. The major local obstacles to its implemenation are discussed here.

Legal Authorization and Requirements

The Metro Clean Air Committee plans to propose the necessary legislation in the January session for a mandatory engine performance inspection program. The bill will include provisions that vehicles be given an idle test within 20 days of their sale (new or used) and annually. A similar bill has been proposed twice before and failed.

Financial Requirements

The cost of a motor-vehicle inspection/maintenance program is high. If two man-teams were used, each testing about 50 cars per day in conjunction with the safety inspection, 80 to 100 people would be needed for only that portion of the cars that receive a safety inspection. Additional funds would be needed for equipment, certification of garages, enforcement and follow-up. Some of this money could come from the state highway funds, but the Minnesota Pollution Control Agency would be expected to support it in part.

Management and Enforcement Responsibility

The logical candidate for managing and enforcing a vehicle inspection program would be the Highway Patrol within the State Department of Public Safety, since enforcement would clearly require a uniformed officer. However, this agency is not interested in undertaking an engine performance inspection, since they see it serving public health purposes and not safety purposes. This leaves the State without an appropriate agency for implementing the program.

Economic Impact

An engine performance inspection has several problems in Minnesota of an economic nature. An important consideration is the difficulty of finding a garage to make the necessary repairs.* While this in not difficult in the major metropolitan centers, there is a shortage of repair garages of any type in the more rural parts of the state. This could make the cost of repairs in rural areas very high.

A vehicle inspection program also discriminates against the poor, since they are usually the drivers of older cars which have maintenance problems and require repair. If the repairs were expensive, the program could curtail their mobility.

User Acceptance

The vehicle performance test would take at least 10 minutes if it were an idle test, and longer for other types of tests. On either a spot check or mandatory basis, this could aggravate drivers and turn them against the program. This problem, combined with the high cost of operating the program and the vehicle owner's need to make sometimes costly repairs could make it very unpopular.

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* This assumes a state-wide program. A strictly Metropolitan-wide program would not have this difficulty.

APPENDIX D

INTER-AGENCY AGREEMENT
TO ACHIEVE CARBON MONOXIDE STANDARDS BY 1977

Inter-Agency Agreement to be provided.

APPENDIX E

ORGANIZATION, ACTIVITIES, AND BUDGET OF TRANSPORTATION CONTROL UNIT

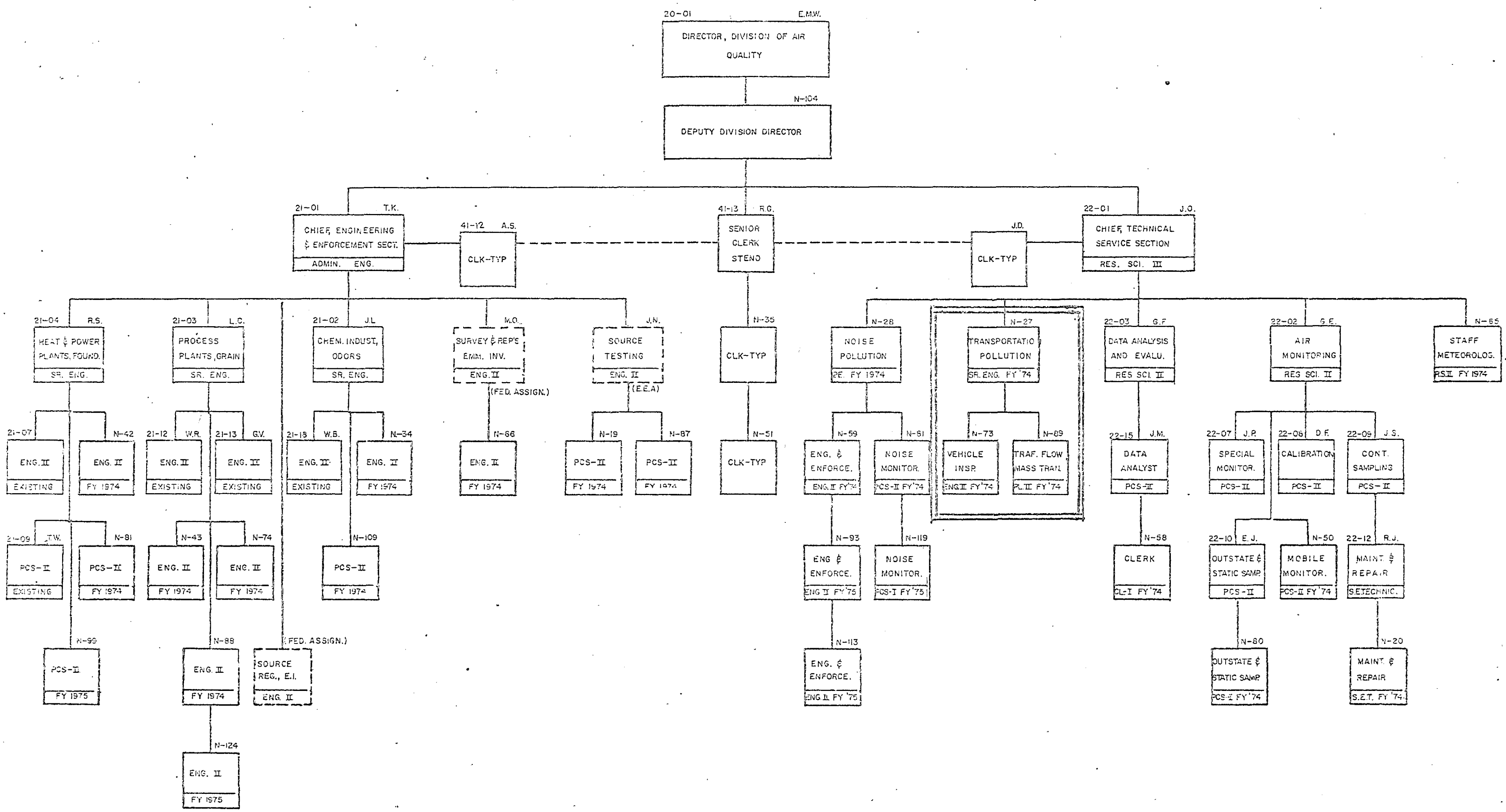

Figure E-1 Proposed Organization of Transportation Control Unit for FY 1974 and 1975

Figure E-2 Activities of Transportation Control Unit for FY 1974 and 1975

STATE OF MINNESOTA -- DEPARTMENT OF ADMINISTRATION

Biennial Budget

GENERAL STATEMENTS — and-EXPLANATIONS

Vehicle Emissions and Transportation Control Activity

Ambient air standards for automotive source pollutants have frequently been exceeded in the seven county Mpls.-St. Paul Metro Area. This region is classed as a Priority I region for automotive source emissions by EPA under the Clean Air Act Amendments of 1970. Due to the present technological difficulty in controlling emissions, especially those from older vehicles, the Minnesota Pollution Control Agency requested and was granted a two-year extension (to 6/'77) to attain the standard for carbon monoxide. There are a total of 1,026,543 motor vehicles registered in the metro area. These are in the following categories: Passenger cars: 880,943; Trucks: 129,254; Recreation: 3,356; and tax exempt (estimated): 12,990.

In order to attain this standard, an effective program of expanded public transit use, traffic and parking controls, staggered working hours, express bus service, development of fringe area parking facilities, micro-transit systems, additional skyway linkages, shuttle-busses, and people-mover systems must be developed and/or expanded, plus more effective enforcement of existing regulations and ordinances.

The program will be one of coordinating the efforts of the two cities, Metro Transit, and Highway Department towards achieving the needed 60% -to- 70% reductions in vehicle emissions by June 1st, 1977.

Many of the control strategies in the category of transportation management and technology services are based on programs either on-going or planned by existing governmental bodies, such as the Cities of Minneapolis and St. Paul, the Metropolitan Transit Commission, etc. One & one-half man-years of effort are needed to effect the requisite coordination and liaison between the Minnesota Pollution Control Agency and these other governmental bodies. This effort also will be directed towards aiding in the implementation of these programs and in insuring their full operation by the 1977 deadline.

One-half of a man-year of effort is required in studying, and keeping abreast of, new developments in mass transportation and traffic control and management. This activity is essential for making mid-course corrections or other changes in the program.

One man-year is needed to monitor the progress of the effort to decrease carbon monoxide emissions. This entails direct monitoring of automotive emissions by the Minnesota Pollution Control Agency, coordination with the monitoring activities of other agencies and organizations, direct monitoring of ambient carbon monoxide levels, and coordination with the existing ambient air monitoring activity within the Division of Air Quality, Minnesota Pollution Control Agency.

Figure E-3 Proposed Budget of Transportation Control Unit for 1974 and 1975

BUDGET ANALYSIS BY ACTIVITY

1. Dept. Pollution Control Agency

2. Activity Title Vehicle Emissions and Transportation Control

3. Personnel	Actual FY 71		Actual FY 72		Estimated FY 73		Requested FY 74		Requested FY 75	
	No.	Cost	No.	Cost	No.	Cost	No.	Cost	No.	Cost
Management	.05	963.57	.15	2,378.65	.25	3,899.56	.25	5,244	.28	5,834
Prof. & Tech.			.10	1,285.10	.10	1,336.50	1.08	15,044	3.0	39,063
Clerical							.02	121	.04	209
Labor & Service										
Total	.05	963.57	.25	3,663.75	.35	5,236.06	1.35	20,409	3.32	45,106

	Actual FY 71	Actual FY 72	Estimated FY 73	Requested FY 74	Requested FY 75
4. Grants-In-Aid					
5. Supplies & Expense	634.83	1,355.58	1,937.34	44,831	25,745
6. Total Expenditures	1,571.40	5,019.33	7,173.40	65,240	70,851

7. Account/Fund	Actual FY 71	Actual FY 72	Estimated FY ..	Requested FY 74	Requested FY 75
42000:00-10	523.80	1,673.11	2,391.13	41,731.90	34,666.50
42000:05-40	1,047.60	3,346.22	4,782.27	23,508.10	36,184.50
8. Totals	1,571.40	5,019.33	7,173.40	65,240	70,851

9. Requested Deficiency