COMPILATION OF THREE DIMENSIONAL CARBON MONOXIDE CONCENTRATIONS IN MECKLENBURG COUNTY, NORTH CAROLINA

Contract No. 68-02-3509
Work Assignment No. 27

Prepared for

U.S. Environmental Protection Agency
Region IV
345 Courtland Street, N.E.
Atlanta, Ga. 30365

March 1983
9227.00/84

Submitted by

Engineering-Science
10521 Rosehaven Street
Fairfax, Virginia 22030

ES ENGINEERING-SCIENCE

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CHAPTER 1

INTRODUCTION

BACKGROUND

Mecklenburg County, North Carolina, has been designated as a nonattainment area for carbon monoxide (CO). This designation was made because measured concentrations of CO exceeded the air quality standards. For areas designated as nonattainment, the Clean Air Act (CAA) Amendments of 1977 require that the States revise their State Implementation Plans (SIPs) to attain the air quality standards as expeditiously as possible. The 1979 SIP revision submitted by North Carolina stated that Mecklenburg County would not attain the National Ambient Air Quality Standards (NAAQS) for CO by 1982. Subsequently, the Environmental Protection Agency (EPA) granted an extension until 1987 for attaining the CO standards in Mecklenburg County. The Act requires that when an extension is granted, an air quality analysis be performed and a strategy developed to bring the area into compliance with the NAAQS by the end of 1987.

SUMMARY OF PRIOR WORK

The 1979 SIP revision submitted by North Carolina predicted attainment of the CO standards by 1987. This prediction was based on the inclusion of air quality benefits to be derived from a proposed automobile Inspection and Maintenance (I&M) program. The need and air quality benefits of the I&M program were based on an analysis performed in mid-1978. Since the air quality analysis was performed several years ago under a compressed time schedule, it was considered necessary to revise the analysis using up-to-date information and refined modeling techniques.

As a part of this effort, Engineering-Science under contract to the USEPA analyzed the CO problem in Mecklenburg County. Since CO problems in urban areas are related to localized traffic situations, the Charlotte-Mecklenburg Transportation Advisory Committee (TAC) identified twenty-nine (29) potential hot spots on the basis of street configuration and traffic congestion for further study. Using an air quality simulation model, ES computed the maximum expected CO concentrations in the vicinity of each of these intersections. The results of the analysis indicated that the following four of these twenty-nine intersections would not attain the CO standard by 1987 even if the proposed I&M program was implemented:

Central Avenue and Sharon Amity Road
Albermarle Road and Sharon Amity Road
Independence Boulevard and Sharon Amity Road
Independence Boulevard and Idlewild Road

In a subsequent study, the consulting firm of Peat, Marwick, Mitchell and Co. (PMM) considered the implementation of Transportation Control Measures (TCMs) for further reduction of CO concentrations at these four intersections. The PMM study considered several sets of TCMs and evaluated their impact on traffic movements at these intersections.

PURPOSE OF THIS STUDY

The main purpose of this study is to perform a detailed air quality analysis of these hot spots and determine the extent of the CO problem at these intersections. Earlier studies had analyzed only one receptor at each of these intersections; in this study, a large number of receptors for each intersection is to be modeled in order to make a graphical presentation of the extent of the CO problem. Another purpose of this study is to determine 1987 CO concentrations under several transportation scenarios including I&M only, TCMs only, I&M and TCMs, effects of Leuken Bill, etc. A part of this study also concerns the comparison of the air dispersion model to be used. Various tasks to be performed in this study are outlined below:

1a. Model Calibration

1b. 1982 Air Quality

1c. 1987 Air Quality with traffic growth only

2. 1987 Air Quality with growth and I&M but no TCMs

3. 1987 Air Quality with growth and TCMs but no I&M

4. 1987 Air Quality with growth, TCMs and I&M

5. 1982, 1987 and 1995 Air Quality with relaxed auto emissions standard

6. Three-dimensional plot of isosurface with 10 mg/m^3 CO concentration

7. Two-dimensional plot of CO concentrations

These tasks are to be performed for a number of different intersections as given below:

Task 1a

Sharon Amity Road and Central Avenue

Task 1b thru 4

Sharon Amity Road and Central Avenue
Sharon Amity Road and Albemarle Avenue
Sharon Amity Road and Independence Boulevard
Independence Boulevard and Idlewild Road
Fairview Road and Providence Road
Park Road and Woodlawn Road

Task 5

Sharon Amity Road and Central Avenue

Task 6

Same as Tasks 1b thru 4

Task 7

College Street corridor between 1st and 4th Streets

REPORT ORGANIZATION

This report is divided into four chapters. This chapter provides background information for the study. The results and conclusions of this study are summarized in Chapter 2. Chapter 3 presents a general methodology used to perform the various tasks. Chapter 4 presents the task by task results of this study. In addition there are five attachments to the report which provide most of the data upon which this study is based.

CHAPTER 2

SUMMARY AND CONCLUSIONS

1. The Intersection Midblock Model (IMM) was used for dispersion calculations in this study. A revision to the model was made by Engineering-Science as part of another contract for USEPA Region IV. The main purpose of the revision was to incorporate the latest available emission factors as contained in EPA's document MOBILE 2 (Mobile Source Emission Model).

2. The IMM predicted values were compared with data collected during a 4-1/2 day monitoring program at the Sharon Amity Road and Central Avenue intersection. Data on traffic and meteorology collected during the monitoring program were input to the model, and predicted CO concentrations were compared with measured CO concentrations for the same time period. The results show good agreement between the model predicted and measured values.

3. Predicted 1987 CO concentrations under several scenarios are summarized in Table 2.1. Predicted 1982 concentrations and NAAQS are included in this table for comparison. The results indicate a potential for violation of the CO standard at two intersections even after the implementation of the proposed I&M program and TCMs. If I&M is not implemented, four of the six intersections shown in Table 2.1 are likely to exceed the CO standard.

4. The effects of the Leuken Bill were shown to be increased CO concentrations. In 1987, the expected CO concentrations would be 8.3% higher than those without the Leuken Bill. By 1995, however, this increase reduces to only 2.3%. The increases are due to delayed compliance with the emission standards.

5. Of the six intersections modeled under Tasks 1 through 4, only two were found to be in violation of the CO standards by 1987 with I&M and TCMs in place. Hence, a CO concentration isosurface of 10 mg/m^3 was only plotted for these two intersections. The results indicate that CO violations are confined to a limited area near the intersection.

TABLE 2.1

1982 and 1987 AIR QUALITY[a]
(Tasks 1b thru 4)

Intersection	8-Hour CO Concentration (mg/m^3)					
		1987 w/o TCMs		1987 w/TCMs		
	1982	w/o I&M	w/I&M	w/o I&M	w/I&M	Standard
Sharon Amity Road/Central Avenue	21.4	16.7	13.0	15.9	12.4	10.0
Sharon Amity Road/Albemarle Road	16.0	14.8	11.5	15.4	12.0	10.0
Sharon Amity Road/Independence Blvd.	16.4	14.7	11.6	11.7	9.4	10.0
Independence Blvd./Idlewild Road	17.0	15.9	12.4	12.7	9.9	10.0
Fairview Road/Providence Road	10.9	9.5	7.4	N.A.	N.A.	10.0
Woodlawn Road/Park Road	12.1	9.4	7.5	N.A.	N.A.	10.0

[a] Includes a background concentration of 1.5 mg/m^3 for 1982 and 1.0 mg/m^3 for 1987.

N.A. = Not applicable (No TCMs considered).

NOTE: All predicted CO concentrations simulate worse-case meteorological and traffic conditions.

6. Study of the College Street corridor shows the potential for violation of the CO standard near all intersections analyzed. No transportation control measures have been proposed for this intersection. As a result, any improvements resulting from TCMs could not be determined.

CHAPTER 3

METHODOLOGY

The methodology consisted mainly of predicting, through the use of a computer diffusion model, ambient concentrations of CO. The model selected for this study was the Intersection Midblock Model which was developed in 1978 by GCA Corporation under contract to the USEPA. Details of the model are available in Reference 1. In an earlier study of the CO problem in Mecklenburg County (Reference 2), ES revised this model to include the latest mobile source emission factors. The revised version of the model was used in this analysis. Since the 8-hour CO concentration is of critical importance (historical measurements show no violation of the 1-hour standard), only 8-hour CO concentrations were modeled using traffic volumes for the peak 8-hour period. Basic inputs to the model are traffic and meteorological data. Since emissions calculation is an inherent part of this model, other automobile-related parameters are required. In addition, the model requires a set of receptors at which concentrations are to be predicted. These model inputs are described below.

TRAFFIC DATA

Three sets of traffic data were used in this analysis, namely

- o 1982 peak 8-hour traffic volumes
- o 1987 peak 8-hour traffic volumes without TCMs
- o 1987 peak 8-hour traffic volumes with TCMs

1982 traffic volumes for all intersections were provided by the Charlotte Department of Transportation. Data provided by Charlotte DOT included intersection geometry and signal cycle times for signalized intersections. The data as provided are included in Attachment I.

1987 traffic volumes without TCMs (Attachment II) were computed by ES using 1982 traffic volumes and growth factors (also given in Attachment II) provided by Charlotte DOT. Annual percentage growth rates were compounded to determine growth factors from 1982 to 1987.

1987 traffic volumes with TCMs were computed by ES using information developed during another related study (Reference 3). Procedures used to compute these traffic volumes and the computed traffic data are given in Attachment III.

METEOROLOGICAL DATA

Since the NAAQS for CO are in terms of 1-hour and 8-hour averages not to be exceeded more than once per year, it is imperative that the analysis be performed for the worst case meteorological conditions. A review of historical data (Reference 2) indicated that the highest concentrations of CO in Mecklenburg County were measured during calm to light winds and stable atmospheric conditions. For reasons discussed in detail in Chapter 4 of Reference 2, all modeling was performed for an assumed worst case meteorological condition; i.e., a wind speed of 2 m/sec and stability Class 6 (very stable). A different wind direction was selected for each receptor being modeled depending upon the intersection geometry and traffic volumes so as to maximize the predicted concentrations. Many receptors were modeled for several wind directions in order to make sure that the maximum concentration was obtained.

RECEPTOR DATA

A number of receptors were selected for each intersection in order to provide adequate coverage of the intersection under consideration. The plotting package used to generate the three-dimensional and two-dimensional plots of concentrations required that the receptors be equally spaced. In order to economize on the number of receptors to be modeled and still provide adequate coverage of the intersection with equally spaced receptors, a coordinate system with an axis parallel to one of the roadways at the intersection was selected. The coordinate system selected by Charlotte DOT to determine link coordinates did not correspond to this coordinate system; hence, coordinate transformation became necessary in order to make all model inputs consistent. A grid receptor spacing of 0.02 to 0.05 km was used depending upon the intersection geometry. On the average, 35 receptors were considered for each intersection.

BACKGROUND CONCENTRATION

The major contribution to the total CO concentration is due to traffic on immediately adjacent roadways. However, a small contribution generally referred to as background is attributable to other emission sources including other roadways. Since there are no large point source CO emitters in the area under consideration, background is primarily attributable to roadways not included the in modeling. Because roadway impact falls off rapidly with distance, the background concentration is considered small. In an earlier study (Reference 2) a background concentration of 1.5 mg/m^3 was assumed for 1987. Model comparison performed as a part of this study indicated a much lower background concentration. For 1982 conditions, the difference between the 8-hour modeled and measured concentrations was estimated to be 0.7 mg/m^3. Adjusting this to 1987 conditions, the estimated background concentration would be 0.35 mg/m^3. To be somewhat on the conservative side, it was agreed by the North Carolina Division of Environmental Management and the USEPA that a background concentration of 1.0 mg/m^3 for the 8-hour averaging period for 1987 should be used in this study. The background concentration for 1982 was assumed to be 1.5 mg/m^3.

ADJUSTMENT FOR VEHICLES NOT SUBJECT TO I&M AND ADJUSTMENT FOR I&M APPLIED TO HEAVY DUTY GASOLINE TRUCKS

When modeling CO concentrations under the I&M scenarios, the model predicted concentrations were adjusted to account for the following conditions:

1. Vehicles not subject to I&M -- these are vehicles in the study area but not registered in Mecklenburg County or the City of Charlotte and thus not subject to I&M and

2. I&M applied to heavy duty gasoline trucks as required by the current North Carolina program -- MOBILE 2 does not include adjustment factors for heavy duty gasoline trucks subject to I&M.

Adjustment factors to account for these conditions were discused in detail in the Technical Memorandum for Task 2 which is included in this report as Attachment V.

CALCULATION OF TOTAL CO CONCENTRATIONS

A background concentration of 1.0 mg/m^3 was added to the model predicted CO concentrations. For scenarios considering the impact of I&M, further adjustments using factors given in Attachment V were made to obtain the total CO concentration.

TWO-DIMENSIONAL AND THREE-DIMENSIONAL PLOTS OF CO CONCENTRATIONS

The two-dimensional plot of CO concentrations was straightforward. Ground level concentrations at equally spaced receptors were input to the graphics package called "DISPLA" and the results were output on a CALCOMP plotter.

For a three-dimensional plot, it is a common practice to plot ground level concentrations along the vertical axis as a function of horizontal (x) and transverse (y) coordinates using a cartesian coordinate system. To plot concentrations (or for that matter any variable) as a function of x, y, and z in reality requires a four-dimensional plot. Since such a plot is impractical and we only wish to show a three-dimensional space where violation of the CO standard is expected, it was decided to plot a CO isosurface of 10 mg/m^3. The height of any point on this surface above ground level represents the height beyond which there would be no violation of the CO standard. For the purposes of this plot, the height was determined by solving the vertical term of the Gaussian equation. Such calculations were only made for those receptors where the predicted ground level concentration exceeded the 8-hour CO standard of 10 mg/m^3. These heights, along with coordinates of the equally spaced receptors, were input to the plotting package and the results were output on a CALCOMP plotter.

CHAPTER 4

RESULTS

This chapter presents the results of the analyses for the various tasks performed under this study.

TASK 1a. MODEL COMPARISON

The analysis performed under this task indicates that the model predicted concentrations are in good agreement with measured concentrations. However, due to the limited data used in this analysis, the comparison coefficients were not used in subsequent analyses. Details of the model comparison are given in Attachment I.

TASK 1b. 1982 AIR QUALITY

Predicted 1982 CO concentrations are shown in Table 4.1 and exceed the CO standard for all six intersections. The highest predicted concentration was at the Sharon Amity Road and Central Avenue intersection. A background value of 1.5 mg/m^3 was added to the model predicted concentrations to obtain total CO concentrations.

TASK 1c. 1987 AIR QUALITY WITH GROWTH BUT NO I&M AND TCMs

Predicted 1987 CO concentrations shown in Table 4.2 show a violation of the CO standard at four of the six intersections modeled.

TASK 2. 1987 AIR QUALITY WITH GROWTH AND I&M BUT NO TCMs

The results shown in Table 4.3 still indicate a violation of the 8-hour CO standard at four of the six intersections modeled. The impact of I&M is estimated to be a 20 to 23 percent reduction in CO concentrations (Table 4.2).

TASK 3. 1987 AIR QUALITY WITH GROWTH AND TCMs BUT NO I&M

The results are shown in Table 4.4. Without I&M, violations of the CO standard are expected at four of the intersections.

TABLE 4.1

TASK 1b. 1982 AIR QUALITY

INTERSECTION	PREDICTED 8-HOUR CO CONCENTRATION[a] (mg/m^3)
Sharon Amity Road and Central Avenue	21.4
Sharon Amity Road and Albermarle Avenue	16.0
Sharon Amity Road and Independence Boulevard	16.4
Independence Boulevard and Idlewild Road	17.0
Fairview Road and Providence Road	10.9
Park Road and Woodlawn Road	12.1

[a] Includes a background concentration of 1.5 mg/m^3.

NOTE: All predicted CO concentrations simulate worst case meteorological and traffic conditions.

TABLE 4.2

TASK 1c. 1987 AIR QUALITY WITH GROWTH BUT NO TCMs AND NO I&M

INTERSECTION	PREDICTED 8-HOUR CO CONCENTRATION[a] (mg/m^3)
Sharon Amity Road and Central Avenue	16.7
Sharon Amity Road and Albermarle Avenue	14.8
Sharon Amity Road and Independence Boulevard	14.7
Independence Boulevard and Idlewild Road	15.9
Fairview Road and Providence Road	9.5
Park Road and Woodlawn Road	9.4

[a] Includes a background concentration of 1.0 mg/m^3.

NOTE: All predicted CO concentrations simulate worst case meteorological and traffic conditions.

TABLE 4.3

TASK 2. 1987 AIR QUALITY WITH GROWTH AND I&M BUT NO TCMs

INTERSECTION	PREDICTED 8-HOUR CO CONCENTRATION[a] (mg/m^3)
Sharon Amity Road and Central Avenue	13.0
Sharon Amity Road and Albermarle Avenue	11.5
Sharon Amity Road and Independence Boulevard	11.6
Independence Boulevard and Idlewild Road	12.4
Fairview Road and Providence Road	7.4
Park Road and Woodlawn Road	7.5

[a] Includes a background concentration of 1.0 mg/m^3 and an adjustment factors for vehicles not subject to I&M and for I&M applied to heavy duty gasoline trucks.

NOTE: All predicted CO concentrations simulate worst case meteorological and traffic conditions.

TASK 4. 1987 AIR QUALITY WITH GROWTH, TCMs AND I&M

The results of this analysis are shown in Table 4.5. With the implementation of I&M and TCMs as proposed, two of the intersections still show potential for violation of the standard. The standard at these two intersections will be exceeded by approximately 20 percent.

TASK 5. 1982, 1987 AND 1995 AIR QUALITY WITH RELAXED AUTO EMISSION STANDARD

The effects of the relaxed auto emission standard as proposed in the draft Clean Air Act Amendment by Representative Luken (R-Ohio) (H.R. Bill 5252) was evaluated. Only one intersection (Sharon Amity Road and Central Avenue) was considered for this evaluation. Carbon monoxide concentrations at this intersection with a relaxed auto emissions standard were predicted under two scenarios; one with I&M and the second without I&M. The effects of transportation control measures were not included. For predicting 1995 air quality, 1995 traffic volumes estimated from 1982 traffic volumes and growth factors were used. The results of the analysis are shown in Table 4.6. The effects of the relaxed auto emission standard were estimated to be an increase in CO concentrations of 8.3% in 1987 and 2.5% in 1995.

TASK 6. THREE-DIMENSIONAL PLOT OF CO CONCENTRATIONS

Of the six intersections modeled, two intersections were found to be in violation of the CO standard by 1987 if the proposed I&M and TCMs are implemented. Hence, three-dimensional plots were only made for the two intersections. The plots are shown in Figures 4.1 through 4.4. For each intersection, two three-dimensional plots are shown based on two different viewpoints. These plots depict the three-dimensional surface where the 8-hour average CO concentration is expected to be 10 mg/m^3. The area below the surface in each plot is in violation of the 8-hour CO standard.

TASK 7. TWO-DIMENSIONAL PLOT FOR COLLEGE STREET CORRIDOR

The College Street corridor between the 1st and 4th Streets was modeled for 1987 traffic conditions with the I&M program in effect. The ground level concentrations were determined for a number of receptors and the results were input to a plotting package which produced a two-dimensional graphic display. The plot is shown in Figure 4.5. As can be seen from the plot in Figure 4.5, there are areas near each intersection in this corridor where violation of the eight-hour CO standard is expected. The highest predicted concentration in this corridor is even higher than those predicted at the other intersections in this study. This is mainly because v/c (volume demand over capacity) ratios for some of the streets in the corridor are much higher than those for other intersections. For some streets (see Table 1 of Attachment II) this ratio approaches and even exceeds unity.

TABLE 4.4

TASK 3. 1987 AIR QUALITY WITH TCMs AND GROWTH BUT NO I&M

INTERSECTION	PREDICTED 8-HOUR CO CONCENTRATION[a] (mg/m^3)
Sharon Amity Road and Central Avenue	15.9
Sharon Amity Road and Albermarle Avenue	15.4
Sharon Amity Road and Independence Boulevard	11.7
Independence Boulevard and Idlewild Road	12.7
Fairview Road and Providence Road	N/A
Park Road and Woodlawn Road	N/A

[a] Includes a background concentration of 1.0 mg/m^3.

N/A = Not applicable (no TCMs considered)

NOTE: All predicted CO concentrations simulate worst case meteorological and traffic conditions.

TABLE 4.5

TASK 4. 1987 AIR QUALITY WITH TCMs, GROWTH AND I&M

INTERSECTION	PREDICTED 8-HOUR CO CONCENTRATION[a] (mg/m^3)
Sharon Amity Road and Central Avenue	12.4
Sharon Amity Road and Albermarle Avenue	12.0
Sharon Amity Road and Independence Boulevard	9.4
Independence Boulevard and Idlewild Road	9.9
Fairview Road and Providence Road	N/A
Park Road and Woodlawn Road	N/A

[a] Includes a background concentration of 1.0 mg/m^3 and an adjustment for vehicles not subject to I&M and for I&M applied to heavy duty gasoline trucks.

N/A = Not applicable (no TCMs considered for these intersections)

NOTE: All predicted CO concentrations simulate worst case meteorological and traffic conditions.

TABLE 4.6

TASK 5. EFFECT OF LEUKEN BILL[a,b]

YEAR	8-HOUR CO CONCENTRATION[c] (mg/m^3)	
	Without Leuken Bill	With Leuken Bill
1982	21.4	21.4
1987 with I&M	13.0	14.1
1987 without I&M	16.7	18.1
1995 with I&M	11.6	11.9
1995 without I&M	14.3	14.6

[a] Based on the ratio of emission factors with and without Leuken Bill as given in the Memorandum from Tom Cackette, Chief, I&M Staff, to Air Program Branch Chiefs of USEPA Regions I-X, dated January 11, 1982.

[b] For Sharon Amity Road and Central Avenue intersection.

[c] Includes a background concentration of 1.5 mg/m^3 for 1982 and 1.0 mg/m^3 for 1987 and 1995.

NOTE: All predicted CO concentrations simulate worst case meteorological and traffic conditions.

CENTRAL/SHARON AMITY (87, IM, TCM, GROWTH)

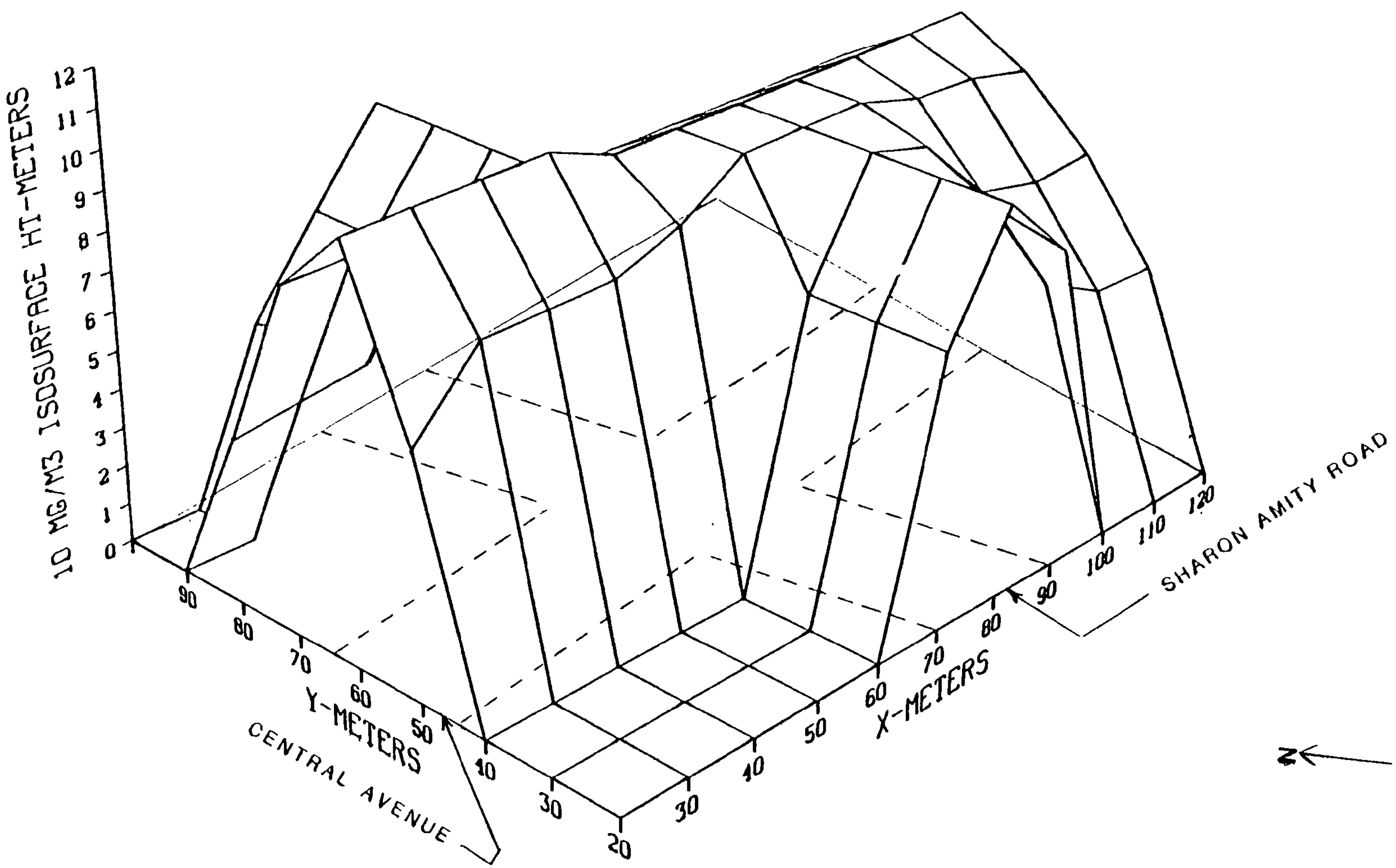

FIGURE 4.[illegible]

CENTRAL/SHARON AMITY (87, IM, TCM, GROWTH)

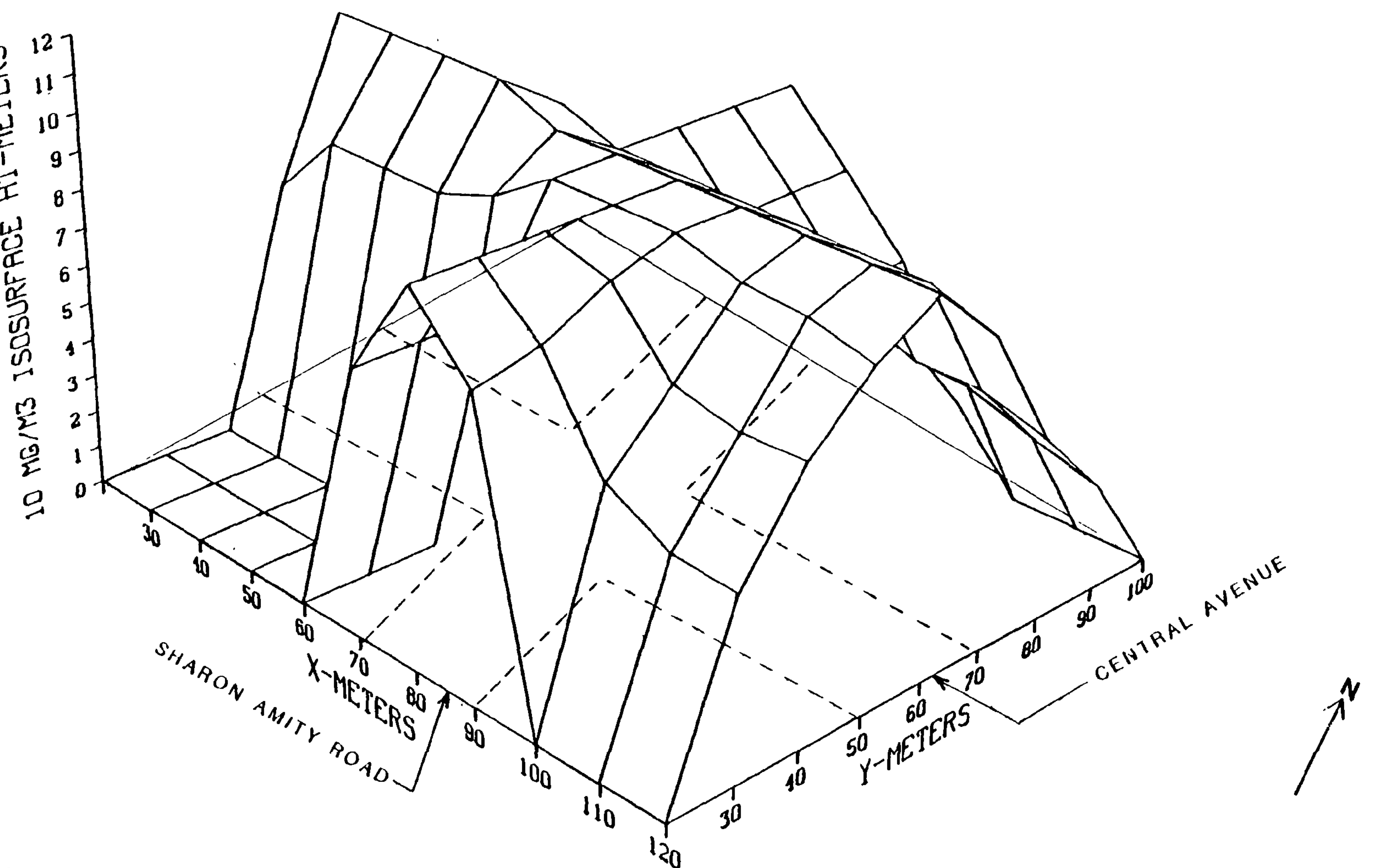

FIGURE 4.2

ALBEMARLE/SHARON AMITY (87, IM, TCM, GROWTH)

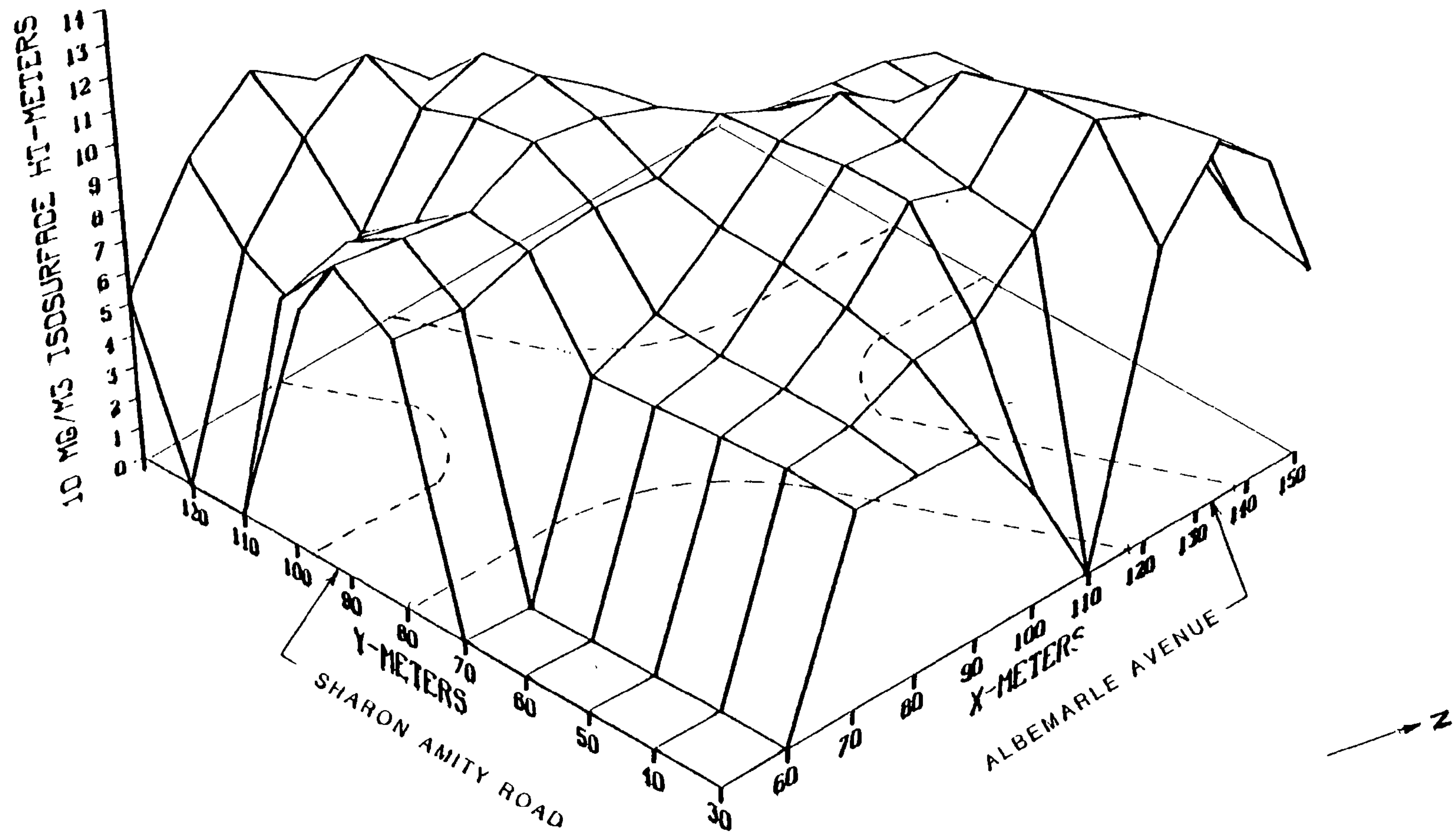

FIGURE 4.3

ALBEMARLE/SHARON AMITY (87, IM, TCM, GROWTH)

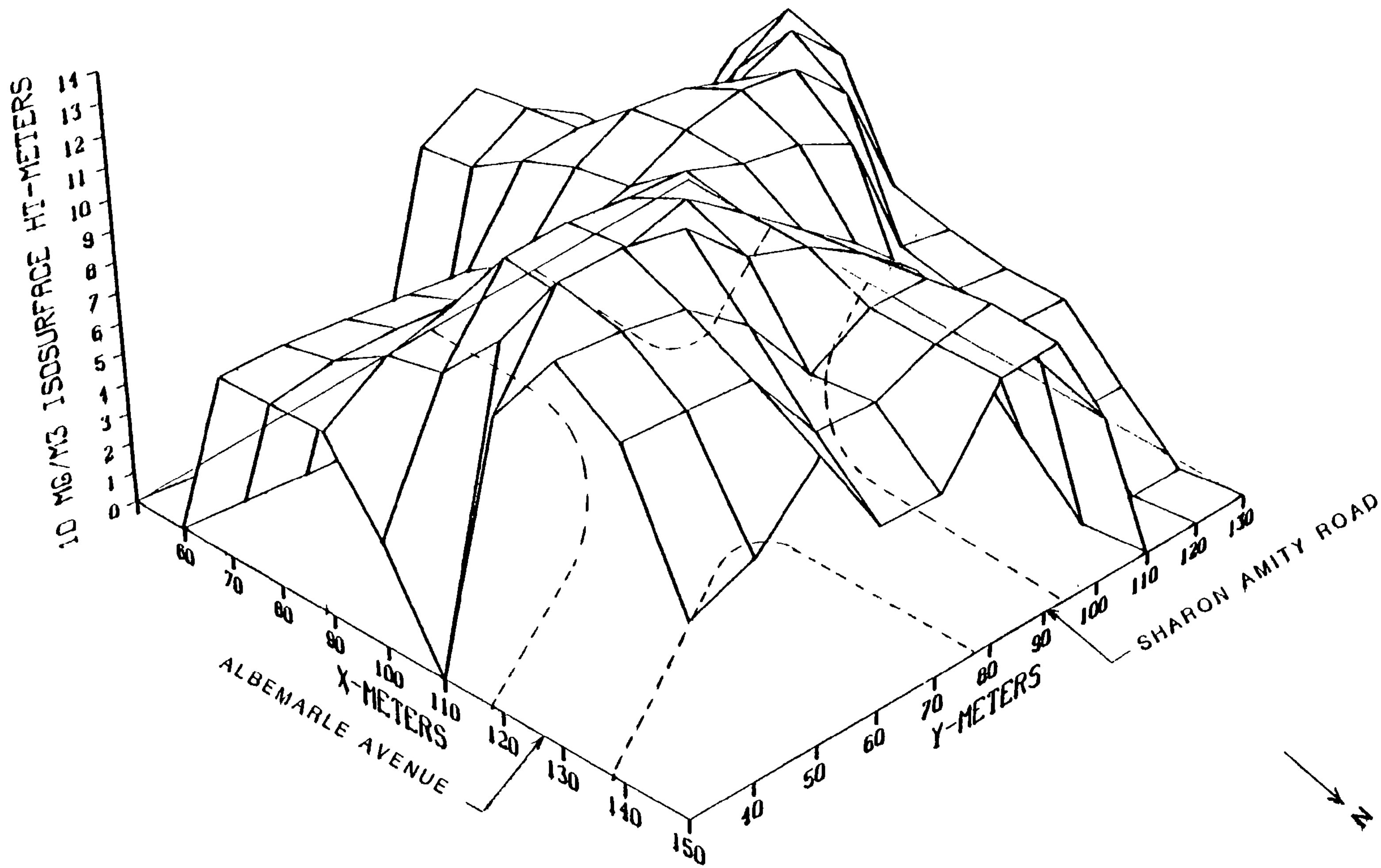

FIGURE 4.4

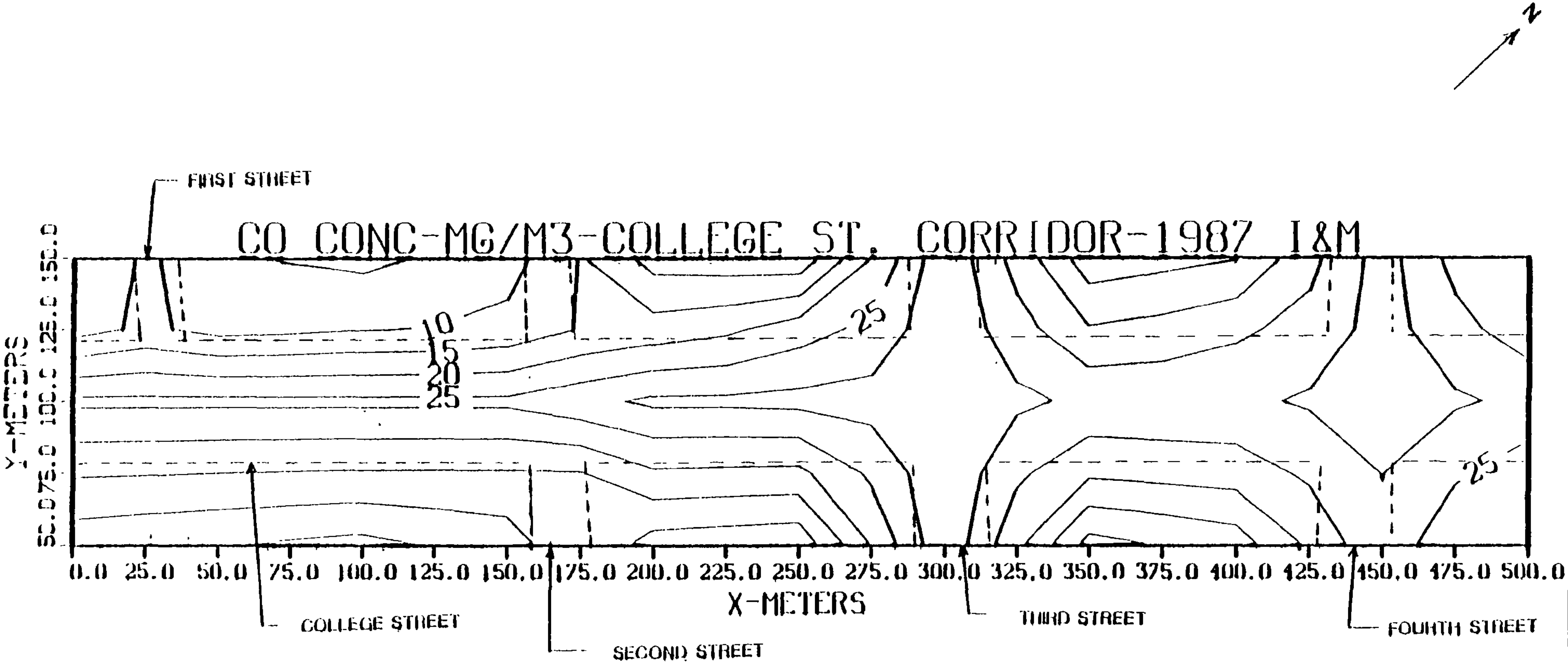
CO CONC-MG/M3-COLLEGE ST. CORRIDOR-1987 I&M
FIRST STREET
COLLEGE STREET
SECOND STREET
THIRD STREET
FOURTH STREET
X-METERS
Y-METERS
0.0 25.0 50.0 75.0 100.0 125.0 150.0 175.0 200.0 225.0 250.0 275.0 300.0 325.0 350.0 375.0 400.0 425.0 450.0 475.0 500.0
50.0 75.0 100.0 125.0 150.0
10
15
20
25
N

FIGURE 4.5

The intersections of this corridor were not analyzed in previous studies. Transportation control measures were also not considered for this analysis because there were no such data available.

REFERENCES

1. Carbon Monoxide Hot Spot Guidelines, Volume V: User's Manual for Intersection Midblock Model, EPA-450/3-78-037, August 1978.

2. Review and Update of Modeling Analysis of Carbon Monoxide Emissions in Mecklenburg County, North Carolina, Prepared for USEPA Region IV by Engineering-Science, July 1981.

3. Findings of CO Hot Spot Analysis for Mecklenburg County, North Carolina, prepared for USEPA Region IV by Peat, Marwick, Mitchell & Co., March 11, 1982.

4. Personal Communication with David Johnson, North Carolina Division of Environmental Management, and Donald E. Stone, USEPA Region IV, January 19-20, 1983.

COMPILATION OF THREE-DIMENSIONAL CARBON MONOXIDE CONCENTRATIONS IN MECKLENBURG COUNTY, NORTH CAROLINA

Task 1
Model Comparison

Submitted to:

U.S. Environmental Protection Agency
Region IV
345 Courtland Street, N.E.
Atlanta, Georgia 30365

June 1982
9227.00/91A

Submitted by:

Engineering-Science
7903 Westpark Drive
McLean, Virginia 22102

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MODEL COMPARISON FOR DETERMINING CARBON MONOXIDE CONCENTRATIONS IN MECKLENBURG COUNTY, NORTH CAROLINA

INTRODUCTION

The 1979 State Implementation Plan submitted by North Carolina demonstrated that Mecklenburg County would not attain the CO standards by 1982. Therefore, EPA granted an extension until 1987 to attain the CO standards in Mecklenburg County. Under this extension, North Carolina is required to submit a revised State Implementation Plan for the attainment of CO standards. U.S. EPA Region IV has contracted with Engineering-Science (ES) to study the problem of attaining the CO standards in Mecklenburg County.

SCOPE OF WORK

In an earlier study, ES used the Intersection Midblock Model (IMM) to determine CO concentrations in the vicinity of 29 intersections in the Charlotte - Mecklenburg area. The study identified several intersections which had the potential for the violation of the standard in 1987. In the previous study, no attempt was made to compareIMM prediction with measured values. Furthermore, no growth in traffic was assumed because site-specific growth factors were not available.

One of the tasks specifically identified in this Work Assignment is the comparison of IMM prediction with measured values. This report presents the results of the analysis undertaken for this task.

TECHNICAL APPROACH

A project initiation meeting was held on March 24, 1982 in Raleigh, North Carolina. The following parties took part in the meeting:

U.S. Environmental Protection Agency, Region IV
N.C. Department of Natural Resources and Community Development
City of Charlotte, Department of Transportation
Mecklenburg County, Department of Environmental Health
Engineering-Science, Air Quality Planning

After discussion of several aspects of the entire study, it was decided to conduct a monitoring program to collect data required to compare the model. Meteorological and traffic data collected during the monitoring period would be input to the model, and predicted concentrations would be compared with ambient air quality data collected during the same period.

MONITORING PROGRAM

The monitoring program was conducted during the period March 30 to April 2, 1982 at the intersection of Central Avenue and Sharon Amity

Road. A general layout of the intersection is shown in Figure 1. There are two gasoline service stations (Shell in the northeast and Exxon in the southwest corners), one tire center (northwest corner) and a fast food restaurant (Burger King in the southeast) at the four corners of the intersection.

Ambient air quality and meteorological data were collected at two sites. The CO monitor (Site 1, Figure 1) operated by Mecklenburg County is located in the northwest corner and is a permanent monitor. Another CO monitor was installed in a trailer in the southwest corner. This is shown as Site 2 in Figure 1. The CO monitors were operated by the Mecklenburg County Department of Environmental Health. The measured data as provided by the Department are given in Appendix A.

Two meteorological towers were installed as shown in Figure 1, one on the top of the roof of Price Tire Center (Tower 1) and the other on the top of the trailer (Tower 2). The location of air vanes on the meteorological towers were as follows:

Tower 1:	distance from Sharon Amity Road	= 44 ft.
	distance from Central Avenue	= 72 ft.
	height above ground	= 17 ft.
Tower 2:	distance from Sharon Amith Road	= 24 ft.
	distance from Central Avenue	= 136 ft.
	height above ground	= 15 ft.

The meteorological instruments were operated by U.S. EPA Region IV personnel. Wind speed, wind direction and temperature were recorded by these instruments. Cloud cover data required to determine stability classes were obtained from the airport. Data reduction and stability classification were performed by Region IV personnel. The data on wind speed, wind direction, temperature and atmospheric stability are given in Appendix B.

Traffic data were collected by the City of Charlotte Department of Transportation (DOT). Traffic counts were obtained by mechanical counters as well as by manual methods. Mechanical counters were placed on all four links of the intersection. Manual counts of traffic were performed by persons stationed in the northeast and southwest corners of the intersection. The data were analyzed by the City of Charlotte DOT and are given in Appendix C.

DATA AVAILABILITY FOR MODEL COMPARISON

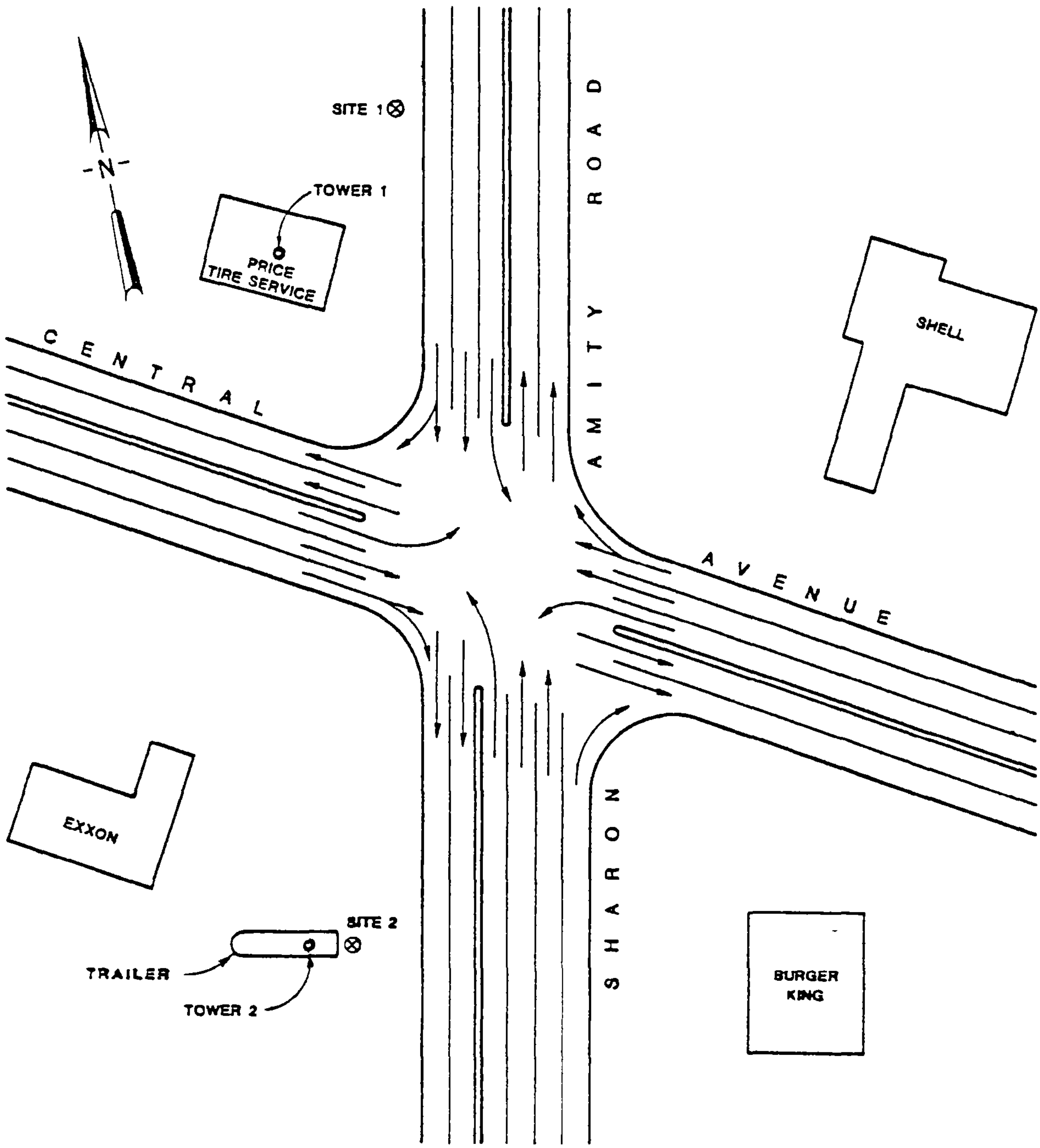
Three sets of measured data are required to compare the model. These are data on:

- o Traffic
- o Meteorology, and
- o Ambient air quality.

Availability of these data is shown in Table 1. Collection of traffic data only covered periods of 7:00 a.m. to 7:00 p.m. over the 4-day period

Attachment I

Intersection Geometry and Monitor Locations



(March 30 through April 2). Meteorological and ambient air quality monitors are continuous instruments. Meteorological data collected at Tower 1 covered a period from 11:00 a.m. on March 30 to 9:00 a.m. on April 2 whereas those for Tower 2 did not start till 3:00 p.m. on March 30 and ended at 9:00 a.m. on April 2. No air quality data from Site 1 is available for March 30 and the first 7 hours on March 31. Air quality measurements at Site 2 began at 6:00 p.m. on March 30 and continued until 9:00 a.m. on April 2.

A review of the data presented in Table 1 shows that there is only one hour on March 30, 12 hours on March 31, 12 hours on April 1, and 2 hours on April 2 for which all three sets of data are available. Thus, there are a total of 27 hours of data which can be used in model comparison. These hours are marked in Table 1.

MODELING RESULTS

Data on traffic and meteorology were input to the IMM and air quality predictions were obtained. Model predicted concentrations are compared with measured concentrations in Tables 2 and 3 for Site 1 and 2, respectively.

For Site 1, model predicted concentrations are always higher than the measured concentrations by a factor of almost 2 to 3. For Site 2, model calculated values are lower than the measured values. Within hours 11 through 18 on April 1, there were wide fluctuations in the wind direction (as noted by Region IV personnel, see Appendix B). Modeling results for these hours are inconsistent and were not considered for model calibration.

Low monitored CO concentrations at Site 2 during hours 10 through 19 on March 31 are due to the fact that (1) the wind was mostly from the south, thus only free flowing traffic on south Sharon Amity Road was influencing the CO monitor; (2) The atmospheric stability was neutral during these hours and the wind speeds were light to moderate; (3) The monitor is further from the edge of the nearby lane as compared to the monitor at Site 1; and (4) Site 2 is not located on the queue side of the road.

When the wind blew from 360° as during the morning hours of April 1, higher CO concentrations were measured. The model predictions were also higher. This is because the wind blew from the intersection toward the receptor; thus, the monitor was influenced by traffic with high emission rates caused by idling and accelerating conditions.

MODEL COMPARISON

For reasons mentioned above, data for hours 11 through 18 on April 1, 1982 are not considered suitable for model comparison. An accurate estimate of wind direction could not be made due to wide fluctuations in the wind direction during these hours.

TABLE 1

DATA AVAILABILITY

		Site 1 (NW)			Site 2 (SW)		
Date	Hour[1]	Air Quality	Meteoro-logical	Traffic	Air Quality	Meteoro-logical	Traffic
3-30-82	0						
	1						
	2						
	3						
	4						
	5						
	6						
	7			X			X
	8			X			X
	9			X			X
	10			X			X
	11		X	X			X
	12		X	X			X
	13		X	X			X
	14		X	X			X
	15		X	X		X	X
	16		X	X		X	X
	17		X	X		X	X
	18		X	X	X	X	X
	19		X		X	X	
	20		X		X	X	
	21		X		X	X	
	22		X		X	X	
	23		X		X	X	

1 Beginning hour (hour 0 is 12 p.m. to 1 a.m.)

Table 1 -- Continued
Data Availability

Date	Hour[1]	Site 1 (NW) Air Quality	Site 1 (NW) Meteorological	Site 1 (NW) Traffic	Site 2 (SW) Air Quality	Site 2 (SW) Meteorological	Site 2 (SW) Traffic
3-31-82	0		X		X	X	
	1		X		X	X	
	2		X		X	X	
	3		X		X	X	
	4		X		X	X	
	5		X		X	X	
	6		X		X	X	
	7		X	X	X	X	X
	8	X	X	X	X	X	X
	9	X	X	X	X	X	X
	10	X	X	X	X	X	X
	11	X	X	X	X	X	X
	12	X	X	X	X	X	X
	13	X	X	X	X	X	X
	14	X	X	X	X	X	X
	15	X	X	X	X	X	X
	16	X	X	X	X	X	X
	17	X	X	X	X	X	X
	18	X	X	X	X	X	X
	19	X	X		X	X	
	20	X	X		X	X	
	21	X	X		X	X	
	22	X	X		X	X	
	23	X	X		X	X	

Table 1 -- Continued
Data Availability

Date	Hour[1]	Site 1 (NW) Air Quality	Site 1 (NW) Meteoro-logical	Site 1 (NW) Traffic	Site 2 (SW) Air Quality	Site 2 (SW) Meteoro-logical	Site 2 (SW) Traffic
4-1-82	0	X	X		X	X	
	1	X	X		X	X	
	2	X	X		X	X	
	3	X	X		X	X	
	4	X	X		X	X	
	5	X	X		X	X	
	6	X	X		X	X	
	7	X	X	X	X	X	X
	8	X	X	X	X	X	X
	9	X	X	X	X	X	X
	10	X	X	X	X	X	X
	11	X	X	X	X	X	X
	12	X	X	X	X	X	X
	13	X	X	X	X	X	X
	14	X	X	X	X	X	X
	15	X	X	X	X	X	X
	16	X	X	X	X	X	X
	17	X	X	X	X	X	X
	18	X	X	X	X	X	X
	19	X	X		X	X	
	20	X	X		X	X	
	21	X	X		X	X	
	22	X	X		X	X	
	23	X	X		X	X	

Table 1 -- Continued
Data Availability

Date	Hour[1]	Site 1 (NW) Air Quality	Site 1 (NW) Meteoro-logical	Site 1 (NW) Traffic	Site 2 (SW) Air Quality	Site 2 (SW) Meteoro-logical	Site 2 (SW) Traffic
4-2-82	0	X	X		X	X	
	1	X	X		X	X	
	2	X	X		X	X	
	3	X	X		X	X	
	4	X	X		X	X	
	5	X	X		X	X	
	6	X	X		X	X	
	7	X	X	X	X	X	X
	8		X	X	X	X	X
	9			X			X
	10			X			X
	11			X			X
	12			X			X
	13			X			X
	14			X			X
	15			X			X
	16			X			X
	17			X			X
	18			X			X
	19						
	20						
	21						
	22						
	23						

TABLE 2

MEASURED VERSUS MODELLED CONCENTRATIONS (SITE 1)

		Meteorological Data			CO Concentration (mg/m^3)	
Day	Hour	Wind Direction	Wind Speed (m/s)	Stability Class	Measured	Modelled
3-30-82	18	130	2.2	D	--	3.7
3-31-82	10	170	2.2	D	2.6	8.6
	11	170	3.6	D	3.2	6.0
	12	180	3.6	D	4.6	8.7
	13	180	4.9	D	2.6	4.9
	14	180	3.6	D	2.3	6.8
	15	150	4.0	D	3.5	3.0
	16	180	3.6	D	2.9	8.8
	17	170	4.0	D	3.5	9.2
	18	200	3.6	D	4.3	9.8
4-1-82	7	360	2.2	D	5.2	0.3
	7	360	2.2	D	2.6	0.5
	9	360	2.7	C	0.9	0.0
	10	360	1.8	C	0.9	0.0
	11	360	1.8	C	1.7	0.2
	12	340	1.8	C	1.2	0.1
	13	220	2.2	C	1.4	4.9
	14	200	2.2	D	2.3	5.1
	15	240	1.8	D	1.4	3.0
	16	240	1.3	D	1.4	4.7
	17	330	1.3	E	1.4	0.0
	18	270	1.3	E	3.2	5.4
4-2-82	7	60	1.8	D	7.8	2.0
	8	60	2.2	D	--	1.6

TABLE 3

MEASURED VERSUS MODELLED CONCENTRATIONS (SITE 2)

		Meteorological Data			CO Concentration (mg/m^3)	
Day	Hour	Wind Direction	Wind Speed (m/s)	Stability Class	Measured	Modelled
3-30-82	18	140	2.2	D	4.5	1.4
3-31-82	7	170	1.1	D	2.8	2.4
	8	170	1.1	D	3.7	2.3
	9	170	2.2	D	2.0	0.9
	10	170	2.2	D	0.6	0.7
	11	170	2.2	D	1.4	0.8
	12	180	2.6	D	2.0	0.6
	13	180	3.4	D	1.4	0.5
	14	180	3.4	D	1.1	0.5
	15	180	3.4	D	1.7	1.4
	16	180	2.5	D	1.4	0.7
	17	180	3.1	D	2.0	0.6
	18	180	1.3	D	2.0	1.4
4-1-82	7	10	2.2	D	9.3	4.8
	7	20	2.5	D	5.9	6.5
	9	350	3.1	C	3.4	1.6
	10	330	2.2	C	2.8	0.8
	11	180	1.8	C	4.2	0.0
	12	210	1.3	C	4.2	0.0
	13	210	1.3	C	4.5	0.0
	14	210	1.3	D	4.8	0.0
	15	240	1.1	D	5.9	0.0
	16	240	1.1	D	5.1	0.0
	17	280	0.7	E	5.6	0.0
	18	210	0.5	E	7.6	0.5
4-2-82	7	60	1.3	D	9.3	10.8
	8	70	1.8	D	6.2	8.0

Under normal conditions, model predictions are expected to be lower than measured concentrations, because model predictions only relate to the impact of traffic being modelled and do not account for background concentrations from sources not being modelled. The measured concentrations, on the other hand, include background. Modelled CO concentrations at Site 2 are lower, in general, than measured concentrations.

Data for Site 1 do not follow the expected trend; i.e., predictions are in general higher than measurements. One possible reason for this appears to be the wide separation between the meteorological and ambient CO monitor. The two instruments were approximately 70 feet apart. The air vane was locted on top of the building and was approximately 17 feet above the ground whereas the CO monitor was about 8 feet above the ground. There were heavy bushes immediately to the north of the CO monitor and there was a large tree to the west of the air vane. It is suspected that the CO monitor at Site 1 did not experience the some wind regime as the instruments on Tower 1. Due to its location, the CO monitor at Site 1 was subject to a localized wind flow pattern which was not observed at Tower 1.

At Site 2, the ambient CO monitor and meteorological instruments were located close to each other, about 7 feet apart. The vertical distance between the two instruments was not more than 5 feet. Thus, it is believed that the CO monitor at Site 2 was subject to the same wind conditions monitored at Tower 2.

It is concluded that data collected at Site 2 can be used for model comparison with the exception that data collected during hours 11 through 18 on April 1 be excluded from consideration due to wide fluctuations in wind directions. The data to be used for model comparison is summarized in Table 4 and plotted in Figure 2. A linear regression analysis on these data gives the following relationship between measured and modelled CO concentrations:

$$y = 1.3 + 0.67\ x$$

where y = measured concentration
x = modelled concentration

Since the values plotted in Figure 2 are one-hour CO concentrations, the intercept of 1.3 mg/m^3 is the background concentration for a one-hour averaging period. The correlation coefficient was determined to be 0.93 which shows that measured and modelled values are in good agreement.

Sufficient data for examining 8-hour averaging period are not available. A maximum of 5 eight-hour averaging periods can be formed from the data given in Table 4 for March 31, 1982. The measured and modelled CO concentrations for these 5 eight-hour periods are as follows:

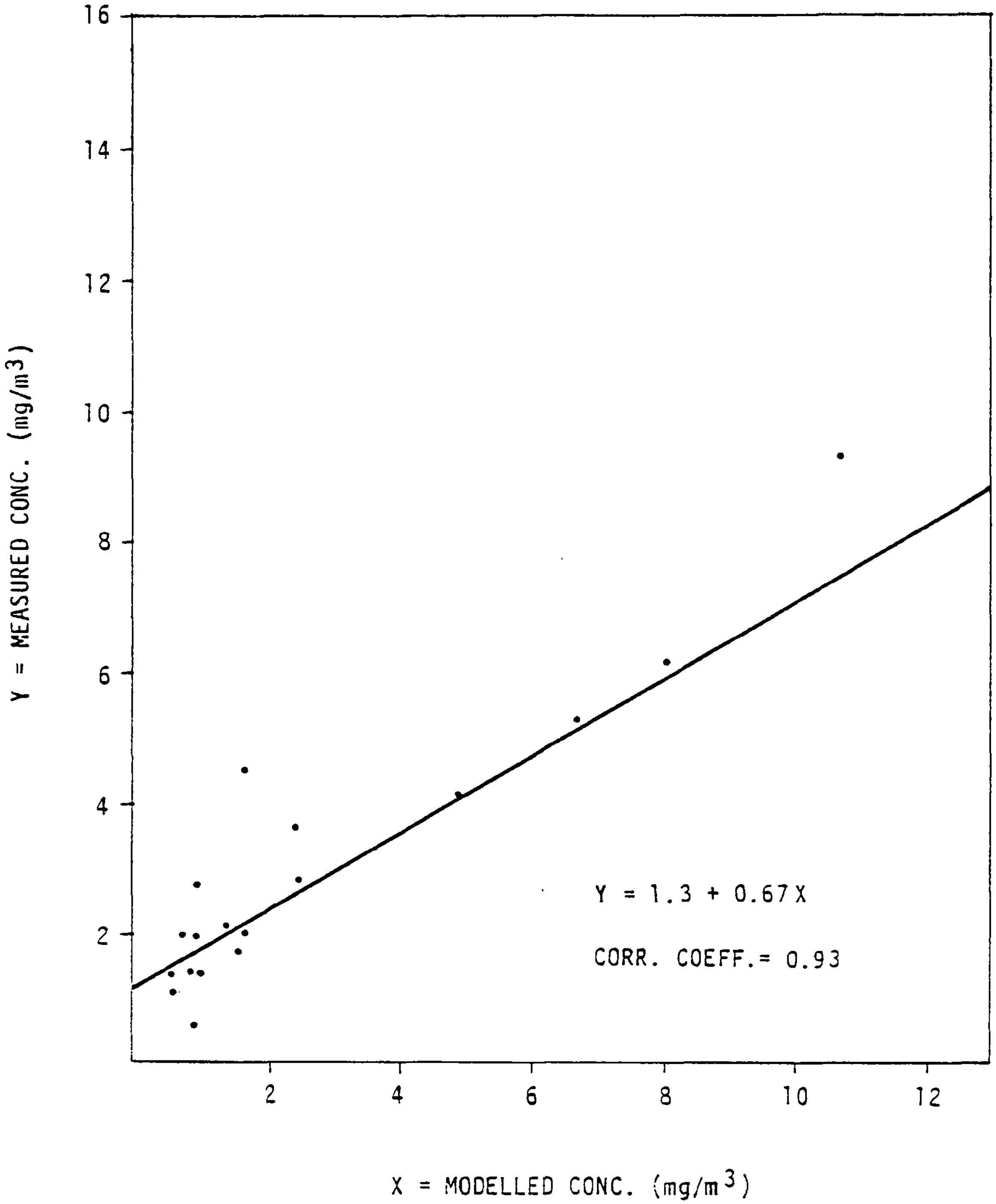
Hours	Measured	Modelled	Difference
7-14	1.9	1.1	0.8
7-18	1.7	1.0	0.7
7-19	1.5	0.8	0.7

TABLE 4

DATA USED FOR MODEL COMPARISON

		Meteorological Data			CO Concentration (mg/m^3)	
Day	Hour	Direction	Speed (m/s)	Stability Class	Measured	Modelled
3-30-82	18	140	2.2	D	4.5	1.4
3-31-82	7	170	1.1	D	2.8	2.4
	8	170	1.1	D	3.7	2.3
	9	170	2.2	D	2.0	0.9
	10	170	2.2	D	0.6	0.7
	11	170	2.2	D	1.4	0.8
	12	180	2.6	D	2.0	0.6
	13	180	3.4	D	1.4	0.5
	14	180	3.4	D	1.1	0.5
	15	180	3.4	D	1.7	1.4
	16	180	2.5	D	1.4	0.7
	17	180	3.1	D	2.0	0.6
	18	180	1.3	D	2.0	1.4
4-1-82	7	360	2.2	D	4.1	4.8
	7	360	2.2	D	5.2	6.5
	9	360	2.7	C	2.1	1.6
	10	360	1.8	C	2.8	0.8
4-2-82	7	60	1.3	D	9.3	10.8
	8	70	1.8	D	6.2	8.0

Measured vs. Modelled Concentration
(Site 2)



Hours	Measured	Modelled	Difference
10-17	1.5	0.8	0.7
11-18	1.6	0.8	0.8
Average	1.6	0.9	0.7

The average difference of 0.7 mg/m^3 can be considered as the background for the 8-hour averaging period. The ratio between 8-hour and 1-hour background concentrations is 0.5.

MODELLING FOR MAXIMUM CONCENTRATION

The NAAQS for carbon monoxide are 10 and 40 mg/m^3 for the 8-hour and 1-hour averages not to be exceeded more than once per year. This introduces the concept of modeling for the worst-case. Since predicted concentration is dependent upon emission rate (hence traffic) and meteorological conditions, the determination of the worst condition should consist of worse case meteorology and maximum emission rates. Experience indicates that for such low level sources as traffic, maximum concentrations are expected under stable atmospheric conditions and low wind speeds. The wind direction from the source to the receptor would produce the highest predicted concentrations. For a given intersection, high emission rates are expected during the time period when the traffic demand is the highest. For a given capacity of the roadway, this produces maximum congestion and longest queue lengths.

Assuming worst-case meteorology, the calibrated model predicted a value of 15.6 mg/m^3 for Site 1. The following conditions were used for this worstcase analysis:

1. Wind speed = 2.0 m/sec
2. Stability = 5 (stable)
3. Wind direction = 180° from north
4. Peak hour traffic during the period of the on-site monitoring program

Conditions 1 through 3 are the same as used in previous analysis under Assistance to States Contract No. 68-02-3509, Work Assignment No. 5.

The highest model predicted value compared well with the highest measured during the monitoring program. A maximum CO concentration of 13.0 mg/m^3 was measured on April 1 for hour 19. Wind direction during this hour was widely fluctuating, wind speed was low and the atmospheric conditions were stable. Such atmospheric characterisitcs are related to calm or near calm conditions and usually result in high concentrations from low level sources such as traffic generated emissions. It should be noted that the highest predicted concentration of 15.6 mg/m^3 is based on the peak-hour traffic during this monitoring program. A peak-hour traffic value higher than the one used would certainly result in a higher concentration. Traffic values less than the peak-hour traffic value would result in a lower concentration which might be the case when the highest CO concentration was measured during the late evening hours of April 1.

SUMMARY AND CONCLUSION

1. A monitoring program was conducted over a 4 day period to collect data for calibrating IMM.

2. A total of 27 hours were identified for which all data were available to be used in model calibration; however, due to fluctuating wind conditions, about eight hours of these data were considered inappropriate for inclusion in model calibration.

3. Model predicted concentrations for Site 1 did not correlate with measured CO concentrations at this site. It is suspected that local distrubances caused the CO monitor to experience different wind conditions than the meteorological instrument at Tower 1. Thus, the data from Site 1 are not considered appropriate for model comparison.

4. Measured and modelled concentrations for Site 2 compare well, with measured values being higher than modelled concentrations. The difference between these two values is the background concentration.

5. Measured and modelled concentrations at Site 2 are consistent with the meteorological and traffic data.

6. Using a worst-case meteorology and the comparison coefficients developed in this analysis, the model-predicted highest concentration compares well with the highest measured during the same period.

7. It is concluded that IMM predicts CO concentrations which are in good agreement with measured concentrations.

RECOMMENDATIONS

A rigorous model comparison could not be performed due to limited data availability; however, the limited data suggest that IMM is an appropriate model for predicting CO concentrations near traffic intersections. Although the data used in model comparison represented neutral stability conditions, the model is considered appropriate to calculate maximum 1-hour and 8-hour CO concentrations using worst-case conditions. Based on the analysis performed here, ES recommends the following:

1. Assume a stable atmospheric conditions and low wind speeds with the wind blowing directly from the intersection to the receptor to estimate the highest concentrations.

2. Carbon monoxide concentrations predicted by IMM model be adjusted using comparions coefficients developed in this analysis and as given below:

$$Ca = A + B\ C_p$$

where Ca = adjusted CO concentration
C_p = model predicted concentration

A and B represent the y-intercept and slope of the regression line. Values A and B using 1982 automobile emissions were determined to be 1.3 and 0.67.

3. When predicting CO concntrations for other years the y-intercept (or background as commonly known) be modified to reflect emission factors for the year under consideration.

APPENDIX A

AMBIENT AIR QUALITY DATA

HOURLY AVERAGES

Attachment I

STATION Central-Steam-Quality-Exp... STATION OPERATOR

DATE 3/30/82 DATE 3/31/82 Rec 2

HOUR	CO READING	BASE LINE	DIFFERENCE	+5	mg/m³	CO READING	BASE LINE	DIFFERENCE	+5	mg/m³
0-1						6	4.5	1.5		0.8
1-2						5	4.5	.5		0.3
2-3						4.5	4.5	0		0
3-4						4.5	4.5	0		0
4-5						4.5	4.5	0		0
5-6						4.5	4.5	0		0
6-7						6	4.0	2		1.1
7-8						9	4.0	5		2.8
8-9						10.5	4.0	6.5		3.7
9-10						7.5	4.0	3.5		2.0
10-11						5	4.0	1		0.6
11-12						6	3.5	2.5		1.4
12-13						7	3.5	3.5		2.0
13-14						6	3.5	2.5		1.4
14-15						5.5	3.5	2		1.1
15-16						6.5	3.5	3		1.7
16-17						6	3.5	2.5		1.4
17-18						6.5	3.0	3.5		2.0
18-19	13	5	8		4.5	6.5	3.0	3.5		2.0
19-20	12	5	7		3.9	6.5	3.0	3.5		2.0
20-21	10.5	5	5.5		3.1	6.5	3.0	3.5		2.0
21-22	11	5	6		3.4	5	3.0	2		1.1
22-23	9	5	4		2.3	4	3.0	1		0.6
23-24	7	5	2		1.1	3.5	2.5	1		0.6

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HOURLY AVERAGES

Attachment I

STATION Central-[illegible]-Carson STATION OPERATOR ____________

DATE 4/1/82 DATE 4/2/82

RECD ✓

HOUR	CO READ-ING	BASE LINE	DIFFER-ENCE	+5	mg/m³	CO READ-ING	BASE LINE	DIFFER-ENCE	+5	mg/m³
0-1	3.5	2.5	1		0.6	4.5	.5	4		2.3
1-2	3.5	2.5	1		0.6	2	.5	1.5		0.8
2-3	4	2.5	1.5		0.8	1	.5	.5		0.3
3-4	3.5	2.5	1		0.6	1.5	0	1.5		0.8
4-5	4.5	2.5	2		1.1	1.5	0	1.5		0.8
5-6	5	2	3		1.7	5	0	5		2.8
6-7	12	2	10		5.6	12	0	12		6.8
7-8	18.5	2	16.5		9.3	16.5	0	16.5		9.3
8-9	12.5	2	10.5		5.9	11	0	11		6.2
9-10	8	2	6		3.4					
10-11	6.5	1.5	5		2.8					
11-12	9	1.5	7.5		4.2					
12-13	9	1.5	7.5		4.2					
13-14	9.5	1.5	8		4.5					
14-15	10	1.5	8.5		4.8					
15-16	12	1.5	10.5		5.9					
16-17	10	1	9		5.1					
17-18	11	1	10		5.6					
18-19	14.5	1	13.5		7.6					
19-20	24.5	1	23.5		13.2					
20-21	30	1	29		16.3					
21-22	31	1	30		16.9					
22-23	10.5	.5	10		5.6					
23-24	7.5	.5	7		3.9					

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HOURLY AVERAGES

Attachment I

STATION Central   STATION OPERATOR [initials]

DATE 3-28-82   DATE 3-29-82 Rec. #1

HOUR	CO READING	CO BASE LINE	CO DIFFERENCE	+5	CO mg/m³	CO READING	CO BASE LINE	CO DIFFERENCE	+5	CO mg/m³
0-1	7	5	2		1.2	7	5	2		1.2
1-2	″	5	2		1.2	6.5	″	1.5		.9
2-3	″	5.5	1.5		.9	6	″	1		.6
3-4	7	6	1		.6	6.5	″	1.5		.9
4-5	6	5	″		″	6	″	1		.6
5-6	6	″	″		″	6.5	″	1.5		.9
6-7	6		1		.6	9.5	″	4.5		2.6
7-8	6.5	″	1.5		.9	14	″	9		5.2
8-9	6	5	1		.6	10	5	5		2.9
9-10	6	4.5	1.5		.9	7	4.5	2.5		1.4
10-11	5.5	4	1.5		.9	6	4	2		1.2
11-12	5	3.5	1.5		.9	7	3.5	3.5		2.0
12-13	8.5	5	3.5		2.0	7	5	2		1.2
13-14	8.5	5	3.5		2.0	8.5	5	3.5		2.0
14-15	7	4.5	2.5		1.4	Cal	Cal	Cal		Cal
15-16	7	4.5	3		1.7	8	4	4		2.3
16-17	8.5	5	3.5		2.0	12	5	7		4.0
17-18	10	5	5		3.2	13.5	″	8.5		4.9
18-19	12.5	5.5	7		4.0	15	″	10		5.8
19-20	13	6	7		4.0	13.5	″	8.5		4.9
20-21	12	5	7		4.0	9	″	4		2.3
21-22	10	″	5		2.9	8	″	3		1.7
22-23	8	″	3		1.7	8.5	″	3.5		2.0
23-24	7.5	5	2.5		1.4	7	5	2		1.2

EHD #453 - 1/74

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HOURLY AVERAGES

Attachment I

STATION: Central   STATION OPERATOR: [illegible signature]

DATE: 3-30-82   DATE: 3-31-82   Rec F

HOUR	CO READING	CO BASE LINE	CO DIFFERENCE	+5	CO mg/m³	CO READING	CO BASE LINE	CO DIFFERENCE	+5	CO mg/m³
0-1	*	*				*				
1-2										
2-3										
3-4										
4-5										
5-6										
6-7										
7-8										*
8-9						11	5	6		3.5
9-10						11	5	6		3.5
10-11						9	4.5	4.5		2.6
11-12						9.5	4	5.5		3.2
12-13						13	5	8		4.6
13-14						9.5	|	4.5		2.6
14-15						9	|	4		2.3
15-16						11	|	6		3.5
16-17						10	|	5		2.9
17-18						11	|	6		3.5
18-19						12.5	|	7.5		4.3
19-20						10.5	|	5.5		3.2
20-21						8	|	3		1.7
21-22						7	5	2		1.2
22-23						5.5	4.5	1		.6
23-24					*	5	4	1		.6

EHD #453 - 1/74   * - data not valid (no span gas flow)

Attachment I

HOURLY AVERAGES

STATION: Central | STATION OPERATOR: [illegible signature]

DATE: 4-1-82 | DATE: 4-2-82

HOUR	CO READING	CO BASE LINE	CO DIFFERENCE	+5	CO mg/m³	CO READING	CO BASE LINE	CO DIFFERENCE	+5	CO mg/m³
0-1	6.5	5	1.5		.9	7.5	5	2.5		1.4
1-2	7	5	2		1.2	7	5	2		1.2
2-3	7	5.5	1.5		.9	6.5	5.5	1		.9
3-4	7	5.5	1.5		.9	6.5	6	.5		.3
4-5	7.5	5.5	2		1.2	7	5.5	1.5		.9
5-6	8	6	2		1.2	10	|	4.5		2.6
6-7	11.5	6.5	5		2.9	15	|	9.5		5.5
7-8	16	7	9		5.2	19	5.5	13.5		7.8
8-9	10	5.5	4.5		2.6					
9-10	7	5	1.5		.9					
10-11	7	|	1.5		.9					
11-12	8.5	|	3		1.7					
12-13	7.5	|	2		1.2					
13-14	8	5.5	2.5		1.4					
14-15	9	5	4		2.3					
15-16	7.5	|	2.5		1.4					
16-17	7.5	|	2.5		1.4					
17-18	7.5	5	2.5		1.4					
18-19	11	5.5	5.5		3.2					
19-20	28.5	6	22.5		13.0					
20-21	22	5	17		9.8					
21-22	19.5	5	14.5		8.4					
22-23	11.5	4.5	7		4.0					
23-24	8	4	4		2.3					

EHD #453 - 1/74

APPENDIX B

METEOROLOGICAL DATA

Charlotte NC   Wind direction / Wind Speed

Date	TIME	NW Corner	TX	SW Corner	Airport	TX	STABILITY
3/30	11-12 noon	120/7.5	67	—	100/7	66	D
	12-1 PM	150/7.5	70	—	180/9	69	↓
	1-2 PM	170/7.5	71	—	170/7	70	↓
	2-3	140/6.0	73	—	190/7	74	↓
	3-4	140/7.0	73	140/7.0	200/12	73	↓
	4-5	150/8.0	73	150/7.0	180/6	71	↓
	5-6	140/7.0	70	140/7.0	210/7	72	↓
	6-7	130/5.0	66	140/5.0	180/7	68	↓
	7-8	140/5.0	64	140/4.5	180/7	65	↓
	8-9	150/5.0	63	150/5.0	180/8	63	↓
	9-10	150/5.0	60	150/3.0	190/8	62	↓
	10-11	170/4.0	58	160/5.0	170/7	60	↓
	11-12 PM	170/4.0	57	150/5.0	170/6	58	↓

* Note: Weather Service speed = KNOTS
Strip chart data = MPH

** Note: Refer to strip chart data for better definition of wind direction. There are large shifts in direction for certain hours.

Attachment I

Charlotte NC

Date	TIME	wind direction / wind speed (MPH) (NW) CORNER	TX	SW Corner	airport (↑ KNOTS)	TX	STABILITY
/31/82	12-1AM	160/5	55	160/5	170/6	57	D
	1-2AM	150/5	55	160/5	170/7	56	
	2-3AM	150/5	54	160/5	180/8	56	
	3-4AM	210/4	53	170/5	170/5	55	
	4-5	210/4	53	190/3	220/6	56	
	5-6	180/4	52	200/3	230/6	55	
	6-7	180/5	53	180/2.5	230/3	55	
	7-8	180/4	54	170/2.5	220/6	56	
	8-9	170/5	55	170/2.5	170/6	57	
	9-10	180/5	55	170/5	210/8	60	
	10-11	170/5	56	170/5	220/8	59	
	11-12 NOON	170/8	57	170/5	190/9	60	
	12-1PM	180/8 (mph)	61	180/6	190/10	63	
	1-2	180/11	63	180/7.5	180/12	66	
	2-3	180/8	63	180/7.5	220/11	67	
	3-4	150/9	64	180/7.5	210/13	69	
	4-5	180/8	65	180/5.5	200/14	67	
	5-6	170/9	65	180/7.0	210/13	68	
	6-7	200/8	62	180/3.0	220/12	65	
	7-8	210/5	61	180/4.0	220/6	64	
	8-9	210/5	60	170/4.5	230/8	63	
	9-10	210/5	60	180/4.0	220/8	64	
	10-11	210/5	58	210/2.5	230/9	62	
	11-12 Midnight	11-11:30 210/5 11:30-12 270/2	57	210/2.0	230/7	61	↓

+ Rain 10:20 to 3:15 PM

Attachment I

4/1/82

	NW CORNER TX		SW Corner Wt	airport	TV	STABILITY
* 12-1AM	240/2	55	270/1.5	290/4	59	E
1-2	220/2	54	240/1.0	300/3	57	↓
2-3	270/2	52	300/1.0	020/5	55	↓
3-4	300/2	52	300/1.5	340/5	55	↓
4-5	350/2	52	350/1.5	090/3	54	↓
5-6	360/2	50	360/2.0	050/7	54	↓
6-7	360/5	52	010/4.0	040/7	55	D
7-8	360/5	55	010/5.0	050/9	58	↓
8-9	360/5	61	020/5.5	060/9	62	↓
9-10	360/6	64	350/7.0	050/10	66	C
10-11	360/4	69	330/5.0	070/4	67	↓
11-12 NOON	360/4	72	180/4.0	350/6	71	↓
12-1 PM	340/4	74	210/3.0	110/4	72	↓
1-2	220/5	76	210/3.0	070/3	74	↓
2-3	200/5	77	210/3.0	320/6	75	D
3-4	240/4	78	240/2.5	250/9	77	D
4-5	240/3	75	240/2.5	260/8	77	D
5-6	230/3	74	280/1.5	Calm	76	E
* 6-7	270/3	69	210/1.0	090/3	72	↓
7-8	060/3	65	110/1.0	Calm	68	↓
8-9	060/3	62	060/1.5	090/3	62	↓
9-10	040/3	59	060/1.5	030/6	62	↓
10-11	330/3	59	300/2.5	040/5	60	↓
11-12 Midnight	360/3	60	360/5.0	050/7	62	↓

* ? Wind direction not constant...

Attachment I

1/2/82	NW Corner	Tx	SW Corner	Weather Service	Tx	Stability
Midnight - 1 AM	010/3	60	010/5	140/3	61	4
1-2 AM	030/3	57	030/5	130/4	60	4
2-3	050/3	54	060/2.5	080/3	59	5
3-4	050/2	51	060/2	080/4	56	5
4-5	050/1	48	060/1	080/3	54	5
5-6	050/1	51	040/1	080/4	50	5
6-7	050/1	52	050/1.0	100/5	53	4
7-8	060/4	58	060/3	110/6	61	4
8-9	060/5	62	070/4	090/7	64	4
9-9:30	060/5	65	070/5	130/5	67	4

Attachment I

APPENDIX C

TRAFFIC DATA

Attachment I

#460

TRAFFIC ENGINEERING DEPARTMENT
ENGINEERING DIVISION/PLANNING & RESEARCH SECTION
CITY OF CHARLOTTE, NORTH CAROLINA

COPY
ORIGINAL HAS BEEN FILED

MANUAL VEHICLE SURVEY SUMMARY

LOCATION: Central Ave & Sharon Amity

WEATHER: Clear COUNTED BY: P.B, J.D, C.N, J.H DATE: 3-31-82

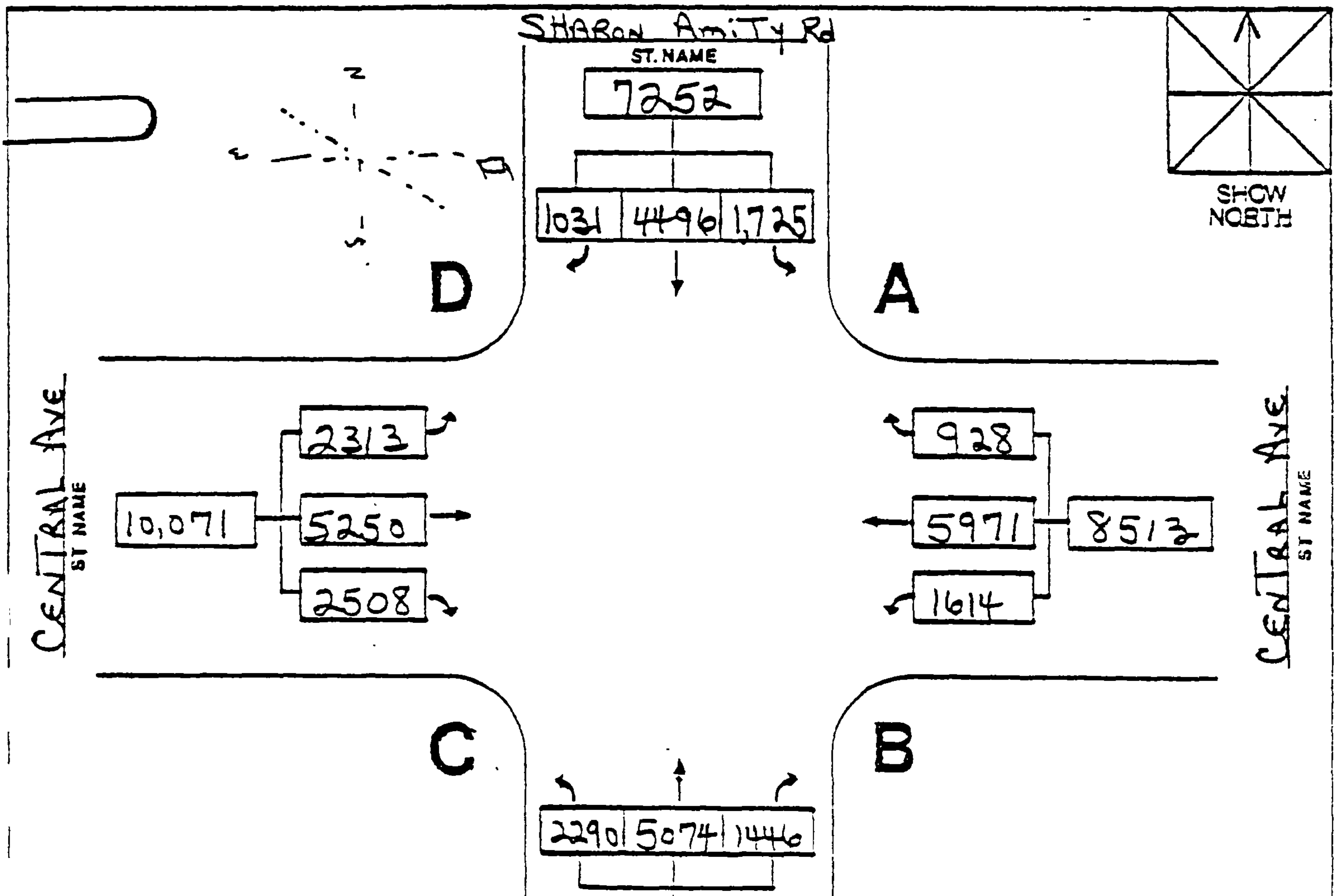
TIME PERIOD: 7Am-7Pm NO. HOURS OF COUNT: ______ DAY: Wednesday

COMPILED BY: [illegible] DATE: 4-8-82

REMARKS:

24-HOUR CONTROL LOCATION: Central Ave S of Sharon Amity Rd FACTOR: 1.32

ESTIMATED AVERAGE ANNUAL ENTERING TRAFFIC VOLUME (VEH/DAY): 45,700



CROSSWALK LOC. ______
☒ SIGNALIZED ______
☐ STOP ST ______
☐ OTHER ______

TED-15 (REV 1/79)

TRAFFIC ENGINEERING DEPARTMENT
ENGINEERING DIVISION/PLANNING & RESEARCH SECTION
CITY OF CHARLOTTE, NORTH CAROLINA

COPY
ORIGINAL HAS BEEN FILED

MANUAL VEHICLE SURVEY SUMMARY

Attachment I

LOCATION: Central Ave x Sharon Amity Rd

WEATHER: Clear — COUNTED BY: J.D. J.H. C.N. R.B — DATE: 3-30-82

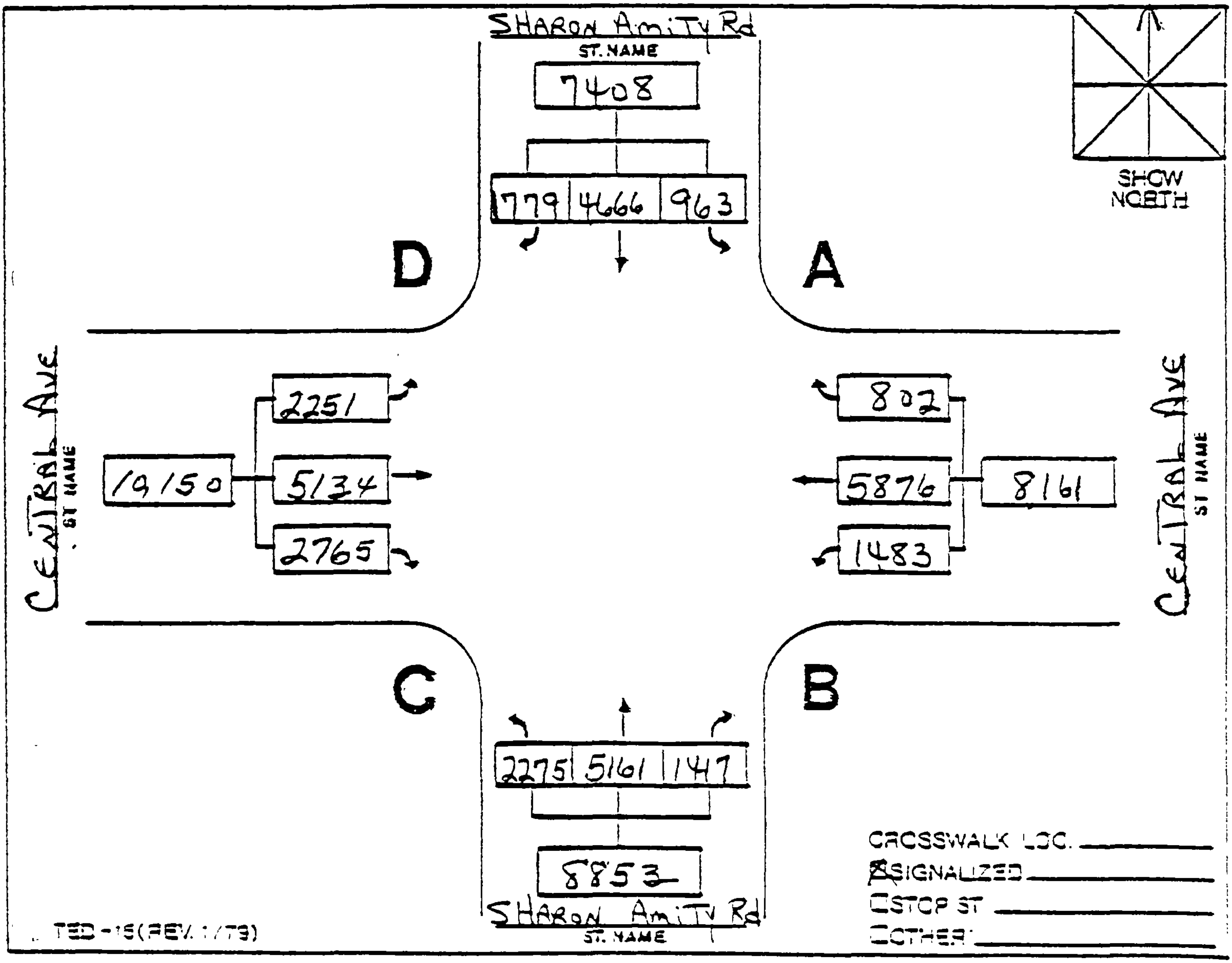
TIME PERIOD: 7AM-7PM — NO. HOURS OF COUNT: 11 — DAY: Tuesday

COMPILED BY: JO — DATE: 4-21-82

REMARKS:

24-HOUR CONTROL LOCATION: Central Ave S of Sharon Amity Rd — FACTOR: 1.32

ESTIMATED AVERAGE ANNUAL ENTERING TRAFFIC VOLUME (VEH/DAY): 45,600



TRAFFIC ENGINEERING DEPARTMENT
ENGINEERING DIVISION/PLANNING & RESEARCH SECTION
CITY OF CHARLOTTE, NORTH CAROLINA

COPY
ORIGINAL HAS BEEN FILED

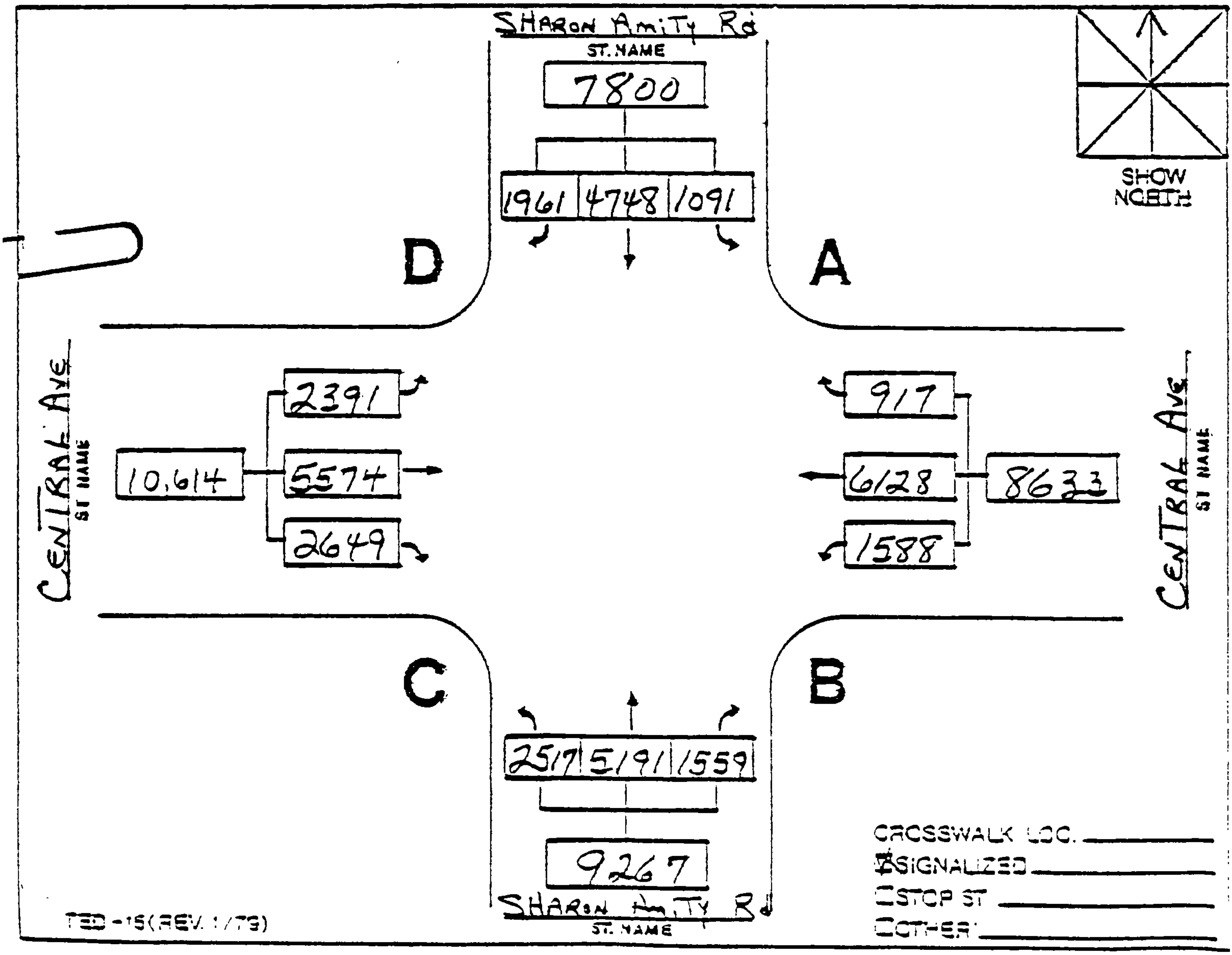
#460

MANUAL VEHICLE SURVEY SUMMARY

Attachment I

LOCATION: Central Ave & Sharon Amity Rd
WEATHER: Clear
COUNTED BY: C.N., J.D., P.B., M.C.
DATE: 4-1-82
TIME PERIOD: 7Am-7Pm
NO. HOURS OF COUNT: 11
DAY: Thursday
COMPILED BY: SJO
DATE: 4-8-82
REMARKS:

24-HOUR CONTROL LOCATION: Central Ave S of Sharon Amity Rd
FACTOR: 1.32
ESTIMATED AVERAGE ANNUAL ENTERING TRAFFIC VOLUME (VEH/DAY): 47,900



CROSSWALK LOC.
☒ SIGNALIZED
☐ STOP ST
☐ OTHER

TED-15 (REV. 1/79)

#460

Attachment I

TRAFFIC ENGINEERING DEPARTMENT
ENGINEERING DIVISION/PLANNING & RESEARCH SECTION
CITY OF CHARLOTTE, NORTH CAROLINA

COPY
ORIGINAL HAS BEEN FILED

MANUAL VEHICLE SURVEY SUMMARY

LOCATION: CENTRAL AVE & SHARON AMITY Rd

WEATHER: CLEAR COUNTED BY: C.N., J.D., P.B., CG DATE: 4-2-82

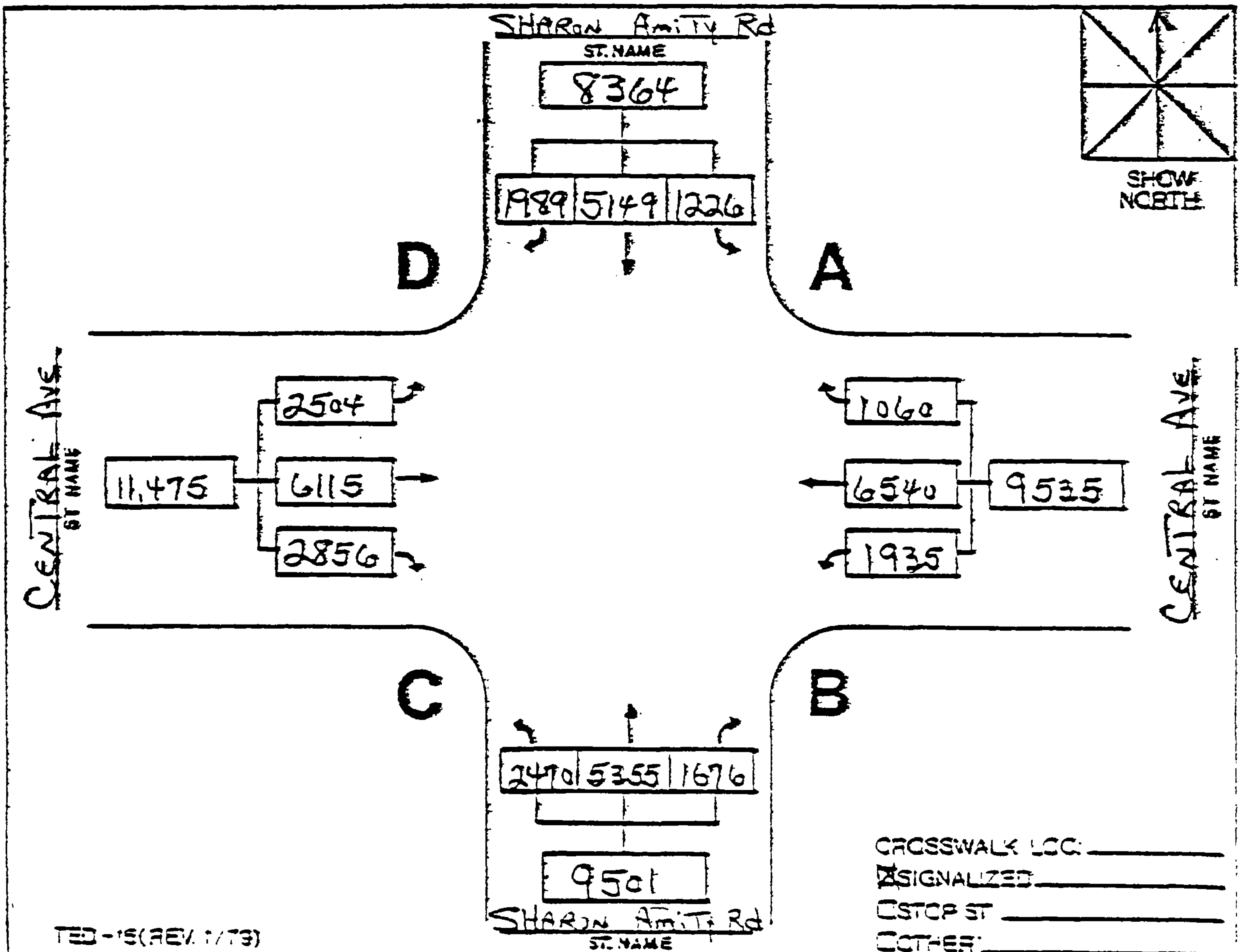
TIME PERIOD: 7AM-7PM NO. HOURS OF COUNT: 11 DAY: Friday

COMPILED BY: JD DATE: 4-21-82

REMARKS:

24-HOUR CONTROL LOCATION: Central Ave S of Sharon Amity Rd FACTOR: 1.32

ESTIMATED AVERAGE ANNUAL ENTERING TRAFFIC VOLUME (VEH/DAY): 51,300



ATTACHMENT II

1982 TRAFFIC DATA

TABLE 1
1982 TRAFFIC DATA

DATA FOR MIDBLOCK MODEL

Time Period: 10:00 - 16:00

Intersection: First St./College St.; X= .088 Km; Y= .070 Km

Stop sign controlled: First Street stops

(Link) Parameter	N(College)	E(1st)	S(College)	W(1st)	Units
	Link				
Approach Link:					
Beg.X	.184	--	.004	.016	Km
Beg.Y	.146	--	.005	.150	Km
End X	.092	--	.083	.080	Km
End Y	.074	--	.066	.078	Km
Width	13.4	--	13.4	5.3	Meters
# of Lanes	4	--	4	1	#
Capacity	6000	--	6000	1400	veh/hr. (Level E)
Speed Limit	0	--	35	35	m.p.h.
Volume	0	--	2418	939	veh/hr.
Exit Link:					
Beg.X	.092	--	.083	.080	Km
Beg.Y	.074	--	.066	.078	Km
End X	.184	--	.004	.016	Km
End Y	.146	--	.005	.150	Km
Width	13.4	--	0	2	Meters
# of Lanes	4	--	0	0	#
Speed Limit	35	--	35	0	m.p.h.
Volume	3357	--	0	0	veh/hr.
Receptor Location:					
X			.086		Km
Y			.248		Km
Z			3		Meters

DATA FOR MIDBLOCK MODEL Time Period: 16:00 - 18:00

Intersection: First St./College St.; X= .088 Km; Y= .070 Km

Stop sign controlled: First Street stops

(Link) Parameter	Link N(College)	E(1st)	S(College)	W(1st)	Units
Approach Link:					
Beg.X	.184	--	.004	.016	Km
Beg.Y	.146	--	.005	.150	Km
End X	.092	--	.083	.080	Km
End Y	.074	--	.066	.078	Km
Width	13.4	--	13.4	5.3	Meters
# of Lanes	4	--	4	1	#
Capacity	6000	--	6000	1400	veh/hr. (Level E)
Speed Limit	0	--	35	35	m.p.h.
Volume	0	--	1098	540	veh/hr.
Exit Link:					
Beg.X	.092	--	.083	.080	Km
Beg.Y	.074	--	.066	.078	Km
End X	.184	--	.004	.016	Km
End Y	.146	--	.005	.150	Km
Width	13.4	--	0	2	Meters
# of Lanes	4	--	0	0	#
Speed Limit	35	--	35	0	m.p.h.
Volume	1638	--	0	0	veh/hr.
Receptor Location:					
X			.086		Km
Y			.248		Km
Z			3		Meters

DATA FOR MIDBLOCK MODEL

Time Period: 10:00 - 16:00

Intersection: Second St./College St.; X= .192 Km; Y= .152 Km

Phasing: 2-Phase, fixed time (coordinated); cycle = 90 sec.

(Link) Parameter	Link N(College)	E(2nd)	S(College)	W(2nd)	Units
Approach Link:					
Beg.X	.286	.239	.092	.103	Km
Beg.Y	.229	.100	.074	.250	Km
End X	.199	.201	.184	.185	Km
End Y	.158	.144	.146	.162	Km
Width	15.0	7.2	14.7	6.1	Meters
# of Lanes	0	2	4	0	#
Capacity	0	2900	5900	0	veh/hr. (Level E)
Speed Limit	35	35	35	35	m.p.h.
Volume	0	1295	2896	0	veh/hr.
Exit Link:					
Beg.X	.199	.201	.194	.185	Km
Beg.Y	.158	.144	.146	.162	Km
End X	.286	.239	.092	.103	Km
End Y	.229	.100	.074	.250	Km
Width	15.0	7.4	14.7	6.1	Meters
# of Lanes	4	2	0	2	#
Speed Limit	35	35	35	35	m.p.h.
Volume	2455	347	0	1389	veh/hr.
Receptor Location:					
X			.086		Km
Y			.248		Km
Z			3		Meters

DATA FOR MIDBLOCK MODEL Time Period: 16:00 - 18:00

Intersection: Second St./College St.; X= .192 Km; Y= .152 Km

Phasing: 2-Phase, fixed time (coordinated); cycle = 90 sec.

(Link) Parameter	Link N(College)	E(2nd)	S(College)	W(2nd)	Units
Approach Link:					
Beg.X	.286	.239	.092	.103	Km
Beg.Y	.229	.100	.074	.250	Km
End X	.199	.201	.184	.185	Km
End Y	.158	.144	.146	.162	Km
Width	15.0	7.2	14.7	6.1	Meters
# of Lanes	0	2	4	0	#
Capacity	0	2900	5900	0	veh/hr. (Level E)
Speed Limit	35	35	35	35	m.p.h.
Volume	0	713	1769	0	veh/hr.
Exit Link:					
Beg.X	.199	.201	.194	.185	Km
Beg.Y	.158	.144	.146	.162	Km
End X	.286	.239	.092	.103	Km
End Y	.229	.100	.074	.250	Km
Width	15.0	7.4	14.7	6.1	Meters
# of Lanes	4	2	0	2	#
Speed Limit	35	35	35	35	m.p.h.
Volume	1552	298	0	632	veh/hr.
Receptor Location:					
X			.086		Km
Y			.248		Km
Z			3		Meters

DATA FOR MIDBLOCK MODEL Time Period: 10:00 - 16:00

Intersection: Third St./College St.; X= .295 Km; Y= .236 Km

Phasing: 2-Phase, fixed time (coordinated); cycle = 90 sec.

(Link) Parameter	Link N(College)	E(3rd)	S(College)	W(3rd)	Units
Approach Link:					
Beg.X	.392	.350	.199	.237	Km
Beg.Y	.208	.174	.158	.300	Km
End X	.302	.303	.286	.288	Km
End Y	.242	.226	.229	.244	Km
Width	14.8	12.0	14.7	13.3	Meters
# of Lanes	0	0	4	3	#
Capacity	0	0	5900	4700	veh/hr. (Level E)
Speed Limit	0	0	35	35	m.p.h.
Volume	0	0	2751	2965	veh/hr.
Exit Link:					
Beg.X	.302	.303	.286	.288	Km
Beg.Y	.242	.226	.229	.244	Km
End X	.392	.350	.199	.237	Km
End Y	.308	.174	.158	.300	Km
Width	14.8	12.0	14.7	13.3	Meters
# of Lanes	4	3	0	0	#
Speed Limit	35	35	0	0	m.p.h.
Volume	2764	2952	0	0	veh/hr.
Receptor Location:					
X			.086		Km
Y			.248		Km
Z			3		Meters

DATA FOR MIDBLOCK MODEL Time Period: 16:00 - 18:00

Intersection: Third St./College St.; X= .295 Km; Y= .236 Km

Phasing: 2-Phase, fixed time (coordinated); cycle = 90 sec.

(Link) Parameter	Link N(College)	E(3rd)	S(College)	W(3rd)	Units
Approach Link:					
Beg.X	.392	.350	.199	.237	Km
Beg.Y	.208	.174	.158	.300	Km
End X	.302	.303	.286	.288	Km
End Y	.242	.226	.229	.244	Km
Width	14.8	12.0	14.7	13.3	Meters
# of Lanes	4	3	4	3	#
Capacity	0	0	5900	4700	veh/hr. (Level E)
Speed Limit	0	0	35	35	m.p.h.
Volume	0	0	1806	1982	veh/hr.
Exit Link:					
Beg.X	.302	.303	.286	.288	Km
Beg.Y	.242	.226	.229	.244	Km
End X	.392	.350	.199	.237	Km
End Y	.308	.174	.158	.300	Km
Width	14.8	12.0	14.7	13.3	Meters
# of Lanes	4	3	4	3	#
Speed Limit	35	35	0	0	m.p.h.
Volume	1506	2282	0	0	veh/hr.
Receptor Location:					
X			.086		Km
Y			.248		Km
Z			3		Meters

TABLE 1--Continued

DATA FOR MIDBLOCK MODEL

Time Period: 10:00 - 16:00

Intersection: Fourth St./College St.; X= .404 Km; Y= .317 Km

Phasing: 2-Phase, fixed time (coordinated); cycle = 90 sec.

(Link) Parameter	Link N(College)	E(4th)	S(College)	W(4th)	Units
Approach Link:					
Beg.X	.496	.456	.302	.350	Km
Beg.Y	.387	.250	.242	.278	Km
End X	.411	.413	.392	.398	Km
End Y	.322	.307	.308	.325	Km
Width	14.8	12.7	14.6	10.3	Meters
# of Lanes	0	2	4	0	#
Capacity	0	2900	5900	0	veh/hr. (Level E)
Speed Limit	35	35	35	0	m.p.h.
Volume	0	3164	2582	0	veh/hr.
Exit Link:					
Beg.X	.411	.413	.392	.398	Km
Beg.Y	.322	.307	.308	.325	Km
End X	.496	.456	.302	.350	Km
End Y	.387	.250	.242	.378	Km
Width	14.7	12.7	14.6	10.3	Meters
# of Lanes	4	0	0	2	#
Speed Limit	35	35	35	35	m.p.h.
Volume	2759	0	0	2987	veh/hr.
Receptor Location:					
X			.086		Km
Y			.248		Km
Z			3		Meters

TABLE 1--Continued

DATA FOR MIDBLOCK MODEL — Time Period: 16:00 - 18:00

Intersection: Fourth St./College St.; X= .404 Km; Y= .317 Km

Phasing: 2-Phase, fixed time (coordinated); cycle = 90 sec.

(Link) Parameter	Link: N(College)	E(4th)	S(College)	W(4th)	Units
Approach Link:					
Beg.X	.496	.456	.302	.350	Km
Beg.Y	.387	.250	.242	.278	Km
End X	.411	.413	.392	.398	Km
End Y	.322	.307	.308	.325	Km
Width	14.8	12.7	14.6	10.3	Meters
# of Lanes	0	2	4	0	#
Capacity	0	2900	5900	0	veh/hr. (Level E)
Speed Limit	35	35	35	0	m.p.h.
Volume	0	1372	1656	0	veh/hr.
Exit Link:					
Beg.X	.411	.413	.392	.398	Km
Beg.Y	.322	.307	.308	.325	Km
End X	.496	.456	.302	.350	Km
End Y	.387	.250	.242	.378	Km
Width	14.7	12.7	14.6	10.3	Meters
# of Lanes	4	0	0	2	#
Speed Limit	35	35	35	35	m.p.h.
Volume	1691	0	0	1337	veh/hr.
Receptor Location:					
X			.086		Km
Y			.248		Km
Z			3		Meters

Attachment II

TABLE 2

1982 TRAFFIC DATA

DATA FOR MIDBLOCK MODEL

Time Period: 11:00 - 19:00

Intersection: Central Ave./Sharon Amity Rd.; X= 0.078 Km;Y= 0.097 Km

Phasing: 7-phase full actuated

(Link) Parameter	Link N(S.A)	E(Cent.)	S(S.A.)	W(Cent.)	Units
Approach Link:					
Beg.X	0.097	0.177	0.065	0.000	Km
Beg.Y	0.197	0.046	0.000	0.137	Km
End X	0.077	0.094	0.079	0.064	Km
End Y	0.116	0.103	0.081	0.099	Km
Width	7.6	7.4	6.9	7.0	Meters
# of Lanes	2	2	2	2	#
Capacity	2800	2700	2400	2800	veh/hr.(Level E)
Speed Limit	45	45	45	45	m.p.h.
Volume	670	1030	1000	1230	veh/hr.
Exit Link:					
Beg.X	0.088	0.089	0.070	0.069	Km
Beg.Y	0.113	0.084	0.085	0.109	Km
End X	0.107	0.172	0.051	0.004	Km
End Y	0.195	0.036	0.003	0.146	Km
Width	7.4	7.1	6.9	6.7	Meters
# of Lanes	2	2	2	2	#
Speed Limit	45	45	45	45	m.p.h.
Volume	980	1000	950	1000	veh/hr.
Receptor Location:					
X	0.080				Km
Y	0.155				Km
Z	3				Meters

TABLE 3

1982 TRAFFIC DATA

DATA FOR MIDBLOCK MODEL Time Period: 11:00 - 19:00

Intersection: Albemarle/Sharon Amity (444); X= 0.141 Km;Y= 0.132 Km

Phasing: 5-phase full actuated

(Link) Parameter	Link				Units
	N(S.A.)	E(Albe.)	S(S.A.)	W(Albe.)	
Approach Link:					
Beg.X	0.142	0.228	0.141	0.050	Km
Beg.Y	0.245	0.180	0.023	0.092	Km
End X	0.136	0.157	0.146	0.124	Km
End Y	0.150	0.147	0.114	0.117	Km
Width	7	7.5	6.5	7	Meters
of Lanes	2	2	2	2	#
Capacity	3000	3000	2800	3000	
Speed Limit	45	45	45	45	m.p.h.
Volume	840	830	1140	920	veh/hr.
Exit Link:					
Beg.X	0.147	0.156	0.135	0.121	Km
Beg.Y	0.152	0.134	0.114	0.130	Km
End X	0.154	0.232	0.131	0.046	Km
End Y	0.250	0.170	0.018	0.093	Km
Width	6	7.5	7	8	Meters
# of Lanes	2	2	2	2	#
Speed Limit	45	45	45	45	m.p.h.
Volume	990	1100	970	660	veh/hr.
Receptor Location:					
X		0.199			Km
Y		0.184			Km
Z		3			Meters

Attachment II

TABLE 4

1982 TRAFFIC DATA

DATA FOR MIDBLOCK MODEL   Time Period: 11:00 - 19:00

Intersection: Independence/Sharon Amity (446) X= 0.092 Km;Y= 0.105 Km

Phasing: 8-phase full actuated

(Link) Parameter	N(S. A.)	E(Indep)	S(S. A.)	W(Indep)	Units
	Link				
Approach Link:					
Beg.X	0.157	0.191	0.038	0.000	Km
Beg.Y	0.203	0.000	0.009	0.202	Km
End X	0.100	0.110	0.082	0.072	Km
End Y	0.132	0.100	0.079	0.111	Km
Width	8	12	8	12	Meters
# of Lanes	2	3	2	3	#
Capacity	3100	4600	3100	4600	
Speed Limit	45	45	45	45	m.p.h.
Volume	740	1400	740	1430	veh/hr.
Exit Link:					
Beg.X	0.110	0.110	0.071	0.072	Km
Beg.Y	0.124	0.084	0.086	0.128	Km
End X	0.175	0.160	0.022	0.021	Km
End Y	0.202	0.002	0.010	0.212	Km
Width	7	12	7	12	Meters
# of Lanes	2	3	2	3	#
Speed Limit	45	45	45	45	m.p.h.
Volume	960	1590	660	1100	veh/hr.
Receptor Location:					
X			0.084		Km
Y			0.052		Km
Z			3		Meters

TABLE 5

Attachment II

1982 TRAFFIC DATA

DATA FOR MIDBLOCK MODEL

Time Period: 11:00 - 19:00

Intersection: Idlewild/Independence (448) X= 0.552 Km;Y= 0.130 Km

Phasing: 7-phase, full actuated

(Link) Parameter	N(Indep)	E(Idlwd)	S(Indep)	W(Idwld)	Units
	Link				
Approach Link:					
Beg.X	0.446	0.655	0.663	0.102	Km
Beg.Y	0.203	0.142	0.055	0.081	Km
End X	0.529	0.579	0.579	0.532	Km
End Y	0.138	0.135	0.123	0.124	Km
Width	11	6	11	6.5	Meters
# of Lanes	3	2	3	2	#
Capacity	4500	2800	4500	2900	veh/hr.(Level E)
Speed Limit	45	35	45	35	m.p.h.
Volume	1520	430	1160	600	veh/hr.
Exit Link:					
Beg.X	0.552	0.587	0.552	0.522	Km
Beg.Y	0.145	0.129	0.119	0.132	Km
End X	0.456	0.655	0.652	0.092	Km
End Y	0.223	0.136	0.038	0.087	Km
Width	11	4	12	4	Meters
# of Lanes	3	1	3	1	#
Speed Limit	45	35	45	35	m.p.h.
Volume	1320	540	1430	430	veh/hr.
Receptor Location:					
X				0.475	Km
Y				0.152	Km
Z				3	Meters

TABLE 6

Attachment II

1982 TRAFFIC DATA

DATA FOR MIDBLOCK MODEL Time Period: 11:00 - 19:00

Intersection: Fairview/Providence/Sardis (510) X= 0.109 Km;Y= 0.095 Km

Phasing: 8-phase full actuated

(Link) Parameter	Link N(Prov.)	E(Sard.)	S(Prov.)	W(Fair.)	Units
Approach Link:					
Beg.X	0.006	0.158	0.199	0.070	Km
Beg.Y	0.201	0.201	0.000	0.000	Km
End X	0.087	0.115	0.124	0.103	Km
End Y	0.109	0.116	0.086	0.068	Km
Width	7	7	7	7	Meters
# of Lanes	2	2	2	2	#
Capacity	3000	3000	3000	3000	veh/hr.(Level E)
Speed Limit	45	45	45	45	m.p.h.
Volume	740	680	510	1050	veh/hr.
Exit Link:					
Beg.X	0.094	0.125	0.119	0.094	Km
Beg.Y	0.117	0.109	0.075	0.074	Km
End X	0.013	0.171	0.186	0.057	Km
End Y	0.201	0.201	0.000	0.000	Km
Width	7	7	7	6	Meters
# of Lanes	2	2	2	2	#
Speed Limit	45	45	45	45	m.p.h.
Volume	540	820	840	780	veh/hr.
Receptor Location:					
X				0.148	Km
Y				0.076	Km
Z				3	Meters

TABLE 7

Attachment II

1982 TRAFFIC DATA

DATA FOR MIDBLOCK MODEL — Time Period: 10:30 - 18:30

Intersection: Park Rd./Woodlawn Rd.; X= 0.102 Km; Y= 0.107 Km

Phasing: 8-phase fully actuated

(Link) Parameter	Link: N(Park)	E(Wood.)	S(Park)	W(Wood.)	Units
Approach Link:					
Beg.X	0.107	0.208	0.102	0.000	Km
Beg.Y	0.216	0.103	0.000	0.130	Km
End X	0.100	0.123	0.104	0.080	Km
End Y	0.126	0.110	0.090	0.107	Km
Width	7.0	6.8	7.3	8.1	Meters
# of Lanes	2	2	2	2	#
Capacity	2900	3000	3000	2900	veh/hr.(Level E)
Speed Limit	35	35	35	45	m.p.h.
Volume	750	610	880	900	veh/hr.
Exit Link:					
Beg.X	0.111	0.126	0.095	0.083	Km
Beg.Y	0.124	0.097	0.090	0.119	Km
End X	0.120	0.209	0.089	0.000	Km
End Y	0.215	0.091	0.000	0.138	Km
Width	7.4	7.3	7.3	7.1	Meters
# of Lanes	2	2	2	2	#
Speed Limit	35	35	35	45	m.p.h.
Volume	840	870	780	650	veh/hr.
Receptor Location:					
X				0.070	Km
Y				0.098	Km
Z				3	Meters

ATTACHMENT III

TRAFFIC DATA FOR 1987
WITHOUT TCMs

TABLE 8

Attachment III

1987 TRAFFIC DATA

DATA FOR MIDBLOCK MODEL

Time Period: 11:00 - 19:00

Intersection: Central Ave./Sharon Amity Rd.; X= 0.078 Km;Y= 0.097 Km

Phasing: 7-phase full actuated

(Link) Parameter	Link N(S.A)	E(Cent.)	S(S.A.)	W(Cent.)	Units
Approach Link:					
Beg.X	0.097	0.177	0.065	0.000	Km
Beg.Y	0.197	0.046	0.000	0.137	Km
End X	0.077	0.094	0.079	0.064	Km
End Y	0.116	0.103	0.081	0.099	Km
Width	7.6	7.4	6.9	7.0	Meters
# of Lanes	2	2	2	2	#
Capacity	2800	2700	2400	2800	veh/hr.(Level E)
Speed Limit	45	45	45	45	m.p.h.
Volume	704	1030	1050	1230	veh/hr.
Exit Link:					
Beg.X	0.088	0.089	0.070	0.069	Km
Beg.Y	0.113	0.084	0.085	0.109	Km
End X	0.107	0.172	0.051	0.004	Km
End Y	0.195	0.036	0.003	0.146	Km
Width	7.4	7.1	6.9	6.7	Meters
# of Lanes	2	2	2	2	#
Speed Limit	45	45	45	45	m.p.h.
Volume	1023	1000	998	1000	veh/hr.
Receptor Location:					
X	0.080				Km
Y	0.155				Km
Z	3				Meters

TABLE 9

Attachment III

1987 TRAFFIC DATA

DATA FOR MIDBLOCK MODEL — Time Period: 11:00 - 19:00

Intersection: Albemarle/Sharon Amity (444); X= 0.141 Km; Y= 0.132 Km

Phasing: 5-phase full actuated

(Link) Parameter	N(S.A.)	E(Albe.)	S(S.A.)	W(Albe.)	Units
Approach Link:					
Beg.X	0.142	0.228	0.141	0.050	Km
Beg.Y	0.245	0.180	0.023	0.092	Km
End X	0.136	0.157	0.146	0.124	Km
End Y	0.150	0.147	0.114	0.117	Km
Width	7	7.5	6.5	7	Meters
# of Lanes	2	2	2	2	#
Capacity	3000	3000	2800	3000	
Speed Limit	45	45	45	45	m.p.h.
Volume	882	1112	1197	1232	veh/hr.
Exit Link:					
Beg.X	0.147	0.156	0.135	0.121	Km
Beg.Y	0.152	0.134	0.114	0.130	Km
End X	0.154	0.232	0.131	0.046	Km
End Y	0.250	0.170	0.018	0.093	Km
Width	6	7.5	7	8	Meters
# of Lanes	2	2	2	2	#
Speed Limit	45	45	45	45	m.p.h.
Volume	1040	1474	1019	884	veh/hr.
Receptor Location:					
X		0.199			Km
Y		0.184			Km
Z		3			Meters

TABLE 10 Attachment III

1987 TRAFFIC DATA

DATA FOR MIDBLOCK MODEL Time Period: 11:00 - 19:00

Intersection: Independence/Sharon Amity (446) X= 0.092 Km;Y= 0.105 Km

Phasing: 8-phase full actuated

(Link) Parameter	N(S. A.)	E(Indep)	S(S. A.)	W(Indep)	Units
Approach Link:					
Beg.X	0.157	0.191	0.038	0.000	Km
Beg.Y	0.203	0.000	0.009	0.202	Km
End X	0.100	0.110	0.082	0.072	Km
End Y	0.132	0.100	0.079	0.111	Km
Width	8	12	8	12	Meters
# of Lanes	2	3	2	3	#
Capacity	3100	4600	3100	4600	
Speed Limit	45	45	45	45	m.p.h.
Volume	777	1876	777	1916	veh/hr.
Exit Link:					
Beg.X	0.110	0.110	0.071	0.072	Km
Beg.Y	0.124	0.084	0.086	0.128	Km
End X	0.175	0.160	0.022	0.021	Km
End Y	0.202	0.002	0.010	0.212	Km
Width	7	12	7	12	Meters
# of Lanes	2	3	2	3	#
Speed Limit	45	45	45	45	m.p.h.
Volume	1008	2131	693	1474	veh/hr.
Receptor Location:					
X			0.084		Km
Y			0.052		Km
Z			3		Meters

TABLE 11

1987 TRAFFIC DATA

DATA FOR MIDBLOCK MODEL Time Period: 11:00 - 19:00

Intersection: Idlewild/Independence (448) X= 0.552 Km;Y= 0.130 Km

Phasing: 7-phase, full actuated

(Link) Parameter	N(Indep)	E(Idlwd)	S(Indep)	W(Idwld)	Units
Approach Link:					
Beg.X	0.446	0.655	0.663	0.102	Km
Beg.Y	0.203	0.142	0.055	0.081	Km
End X	0.529	0.579	0.579	0.532	Km
End Y	0.138	0.135	0.123	0.124	Km
Width	11	6	11	6.5	Meters
# of Lanes	3	2	3	2	#
Capacity	4500	2800	4500	2900	veh/hr.(Level E)
Speed Limit	45	35	45	35	m.p.h.
Volume	1854	525	1415	732	veh/hr.
Exit Link:					
Beg.X	0.552	0.587	0.552	0.522	Km
Beg.Y	0.145	0.129	0.119	0.132	Km
End X	0.456	0.655	0.652	0.092	Km
End Y	0.223	0.136	0.038	0.087	Km
Width	11	4	12	4	Meters
# of Lanes	3	1	3	1	#
Speed Limit	45	35	45	35	m.p.h.
Volume	1610	659	1745	525	veh/hr.
Receptor Location:					
X				0.475	Km
Y				0.152	Km
Z				3	Meters

TABLE 12

1987 TRAFFIC DATA

DATA FOR MIDBLOCK MODEL Time Period: 11:00 - 19:00

Intersection: Fairview/Providence/Sardis (510) X= 0.109 Km;Y= 0.095 Km

Phasing: 8-phase full actuated

(Link) Parameter	Link N(Prov.)	E(Sard.)	S(Prov.)	W(Fair.)	Units
Approach Link:					
Beg.X	0.006	0.158	0.199	0.070	Km
Beg.Y	0.201	0.201	0.000	0.000	Km
End X	0.087	0.115	0.124	0.103	Km
End Y	0.109	0.116	0.086	0.068	Km
Width	7	7	7	7	Meters
# of Lanes	2	2	2	2	#
Capacity	3000	3000	3000	3000	veh/hr.(Level E)
Speed Limit	45	45	45	45	m.p.h.
Volume	903	748	622	1218	veh/hr.
Exit Link:					
Beg.X	0.094	0.125	0.119	0.094	Km
Beg.Y	0.117	0.109	0.075	0.074	Km
End X	0.013	0.171	0.186	0.057	Km
End Y	0.201	0.201	0.000	0.000	Km
Width	7	7	7	6	Meters
# of Lanes	2	2	2	2	#
Speed Limit	45	45	45	45	m.p.h.
Volume	659	902	1025	905	veh/hr.
Receptor Location:					
X				0.148	Km
Y				0.076	Km
Z				3	Meters

TABLE 13

1987 TRAFFIC DATA

DATA FOR MIDBLOCK MODEL   Time Period: 10:30 - 18:30

Intersection: Park Rd./Woodlawn Rd.;   X= 0.102 Km; Y= 0.107 Km

Phasing: 8-phase fully actuated

(Link) Parameter	N(Park)	E(Wood.)	S(Park)	W(Wood.)	Units
Approach Link:					
Beg.X	0.107	0.208	0.102	0.000	Km
Beg.Y	0.216	0.103	0.000	0.130	Km
End X	0.100	0.123	0.104	0.080	Km
End Y	0.126	0.110	0.090	0.107	Km
Width	7.0	6.8	7.3	8.1	Meters
# of Lanes	2	2	2	2	#
Capacity	2900	3000	3000	2900	veh/hr.(Level E)
Speed Limit	35	35	35	45	m.p.h.
Volume	825	702	968	1035	veh/hr.
Exit Link:					
Beg.X	0.111	0.126	0.095	0.083	Km
Beg.Y	0.124	0.097	0.090	0.119	Km
End X	0.120	0.209	0.089	0.000	Km
End Y	0.215	0.091	0.000	0.138	Km
Width	7.4	7.3	7.3	7.1	Meters
# of Lanes	2	2	2	2	#
Speed Limit	35	35	35	45	m.p.h.
Volume	924	1000	858	748	veh/hr.
Receptor Location:					
X				0.070	Km
Y				0.098	Km
Z				3	Meters

TABLE 14

1987 TRAFFIC DATA

DATA FOR MIDBLOCK MODEL Time Period: 10:00 - 16:00

Intersection: First St./College St.; X= .088 Km; Y= .070 Km

Stop sign controlled: First Street stops

(Link) Parameter	Link N(College)	E(1st.)	S(College)	W(1st.)	Units
Approach Link:					
Beg.X	.184	--	.004	.016	Km
Beg.Y	.146	--	.005	.150	Km
End X	.092	--	.083	.080	Km
End Y	.074	--	.066	.078	Km
Width	13.4	--	13.4	5.3	Meters
# of Lanes	4	--	4	1	#
Capacity	6000	--	6000	1400	veh/hr. (Level E)
Speed Limit	0	--	35	35	m.p.h.
Volume	0	--	2611	1014	veh/hr.
Exit Link:					
Beg.X	.092	--	.083	.080	Km
Beg.Y	.074	--	.066	.078	Km
End X	.184	--	.004	.016	Km
End Y	.146	--	.005	.150	Km
Width	13.4	--	0	2	Meters
# of Lanes	4	--	0	0	#
Speed Limit	35	--	35	0	m.p.h.
Volume	3625	--	0	0	veh/hr.
Receptor Location:					
X			.086		Km
Y			.248		Km
Z			3		Meters

DATA FOR MIDBLOCK MODEL

Time Period: 16:00 - 18:00

Intersection: First St./College St.; X= .088 Km; Y= .070 Km

Stop sign controlled: First Street stops

(Link) Parameter	Link				Units
	N(College)	E(1st)	S(College)	W(1st)	
Approach Link:					
Beg.X	.184	--	.004	.016	Km
Beg.Y	.146	--	.005	.150	Km
End X	.092	--	.083	.080	Km
End Y	.074	--	.066	.078	Km
Width	13.4	--	13.4	5.3	Meters
# of Lanes	4	--	4	1	#
Capacity	6000	--	6000	1400	veh/hr. (Level E)
Speed Limit	0	--	35	35	m.p.h.
Volume	0	--	1186	583	veh/hr.
Exit Link:					
Beg.X	.092	--	.083	.080	Km
Beg.Y	.074	--	.066	.078	Km
End X	.184	--	.004	.016	Km
End Y	.146	--	.005	.150	Km
Width	13.4	--	0	2	Meters
# of Lanes	4	--	0	0	#
Speed Limit	35	--	35	0	m.p.h.
Volume	1769	--	0	0	veh/hr.
Receptor Location:					
X			.086		Km
Y			.248		Km
Z			3		Meters

DATA FOR MIDBLOCK MODEL Time Period: 16:00 - 18:00

Intersection: Second St./College St.; X= .192 Km; Y= .152 Km

Phasing: 2-Phase, fixed time (coordinated); cycle = 90 sec.

(Link) Parameter	Link N(College)	E(2nd)	S(College)	W(2nd)	Units
Approach Link:					
Beg.X	.286	.239	.092	.103	Km
Beg.Y	.229	.100	.074	.250	Km
End X	.199	.201	.184	.185	Km
End Y	.158	.144	.146	.162	Km
Width	15.0	7.2	14.7	6.1	Meters
# of Lanes	0	2	4	0	#
Capacity	0	2900	5900	0	veh/hr. (Level E)
Speed Limit	35	35	35	35	m.p.h.
Volume	0	770	1910	0	veh/hr.
Exit Link:					
Beg.X	.199	.201	.194	.185	Km
Beg.Y	.158	.144	.146	.162	Km
End X	.286	.239	.092	.103	Km
End Y	.229	.100	.074	.250	Km
Width	15.0	7.4	14.7	6.1	Meters
# of Lanes	4	2	0	2	#
Speed Limit	35	35	35	35	m.p.h.
Volume	1676	321	0	682	veh/hr.
Receptor Location:					
X			.086		Km
Y			.248		Km
Z			3		Meters

DATA FOR MIDBLOCK MODEL Time Period: 10:00 - 16:00

Intersection: Second St./College St.; X= .192 Km; Y= .152 Km

Phasing: 2-Phase, fixed time (coordinated); cycle = 90 sec.

(Link) Parameter	Link N(College)	E(2nd)	S(College)	W(2nd)	Units
Approach Link:					
Beg.X	.286	.239	.092	.103	Km
Beg.Y	.229	.100	.074	.250	Km
End X	.199	.201	.184	.185	Km
End Y	.158	.144	.146	.162	Km
Width	15.0	7.2	14.7	6.1	Meters
# of Lanes	0	2	4	0	#
Capacity	0	2900	5900	0	veh/hr. (Level E)
Speed Limit	35	35	35	35	m.p.h.
Volume	0	1399	3128	0	veh/hr.
Exit Link:					
Beg.X	.199	.201	.194	.185	Km
Beg.Y	.158	.144	.146	.162	Km
End X	.286	.239	.092	.103	Km
End Y	.229	.100	.074	.250	Km
Width	15.0	7.4	14.7	6.1	Meters
# of Lanes	4	2	0	2	#
Speed Limit	35	35	35	35	m.p.h.
Volume	2651	375	0	1500	veh/hr.
Receptor Location:					
X			.086		Km
Y			.248		Km
Z			3		Meters

DATA FOR MIDBLOCK MODEL Time Period: 10:00 - 16:00

Intersection: Third St./College St.; X= .295 Km; Y= .236 Km

Phasing: 2-Phase, fixed time (coordinated); cycle = 90 sec.

(Link) Parameter	Link N(College)	E(3rd)	S(College)	W(3rd)	Units
Approach Link:					
Beg.X	.392	.350	.199	.237	Km
Beg.Y	.208	.174	.158	.300	Km
End X	.302	.303	.286	.288	Km
End Y	.242	.226	.229	.244	Km
Width	14.8	12.0	14.7	13.3	Meters
# of Lanes	0	0	4	3	
Capacity	0	0	5900	4700	veh/hr. (Level E)
Speed Limit	0	0	35	35	m.p.h.
Volume	0	0	2970	3202	veh/hr.
Exit Link:					
Beg.X	.302	.303	.286	.288	Km
Beg.Y	.242	.226	.229	.244	Km
End X	.392	.350	.199	.237	Km
End Y	.308	.174	.158	.300	Km
Width	14.8	12.0	14.7	13.3	Meters
# of Lanes	4	3	0	0	#
Speed Limit	35	35	0	0	m.p.h.
Volume	2985	3188	0	0	veh/hr.
Receptor Location:					
X			.086		Km
Y			.248		Km
Z			3		Meters

TABLE 14--Continued

DATA FOR MIDBLOCK MODEL — Time Period: 16:00 - 18:00

Intersection: Third St./College St.; X= .295 Km; Y= .236 Km

Phasing: 2-Phase, fixed time (coordinated); cycle = 90 sec.

(Link) Parameter	N(College)	E(3rd)	S(College)	W(3rd)	Units
	Link				
Approach Link:					
Beg.X	.392	.350	.199	.237	Km
Beg.Y	.208	.174	.158	.300	Km
End X	.302	.303	.286	.288	Km
End Y	.242	.226	.229	.244	Km
Width	14.8	12.0	14.7	13.3	Meters
# of Lanes	4	3	4	3	#
Capacity	0	0	5900	4700	veh/hr. (Level E)
Speed Limit	0	0	35	35	m.p.h.
Volume	0	0	1950	2140	veh/hr.
Exit Link:					
Beg.X	.302	.303	.286	.288	Km
Beg.Y	.242	.226	.229	.244	Km
End X	.392	.350	.199	.237	Km
End Y	.308	.174	.158	.300	Km
Width	14.8	12.0	14.7	13.3	Meters
# of Lanes	4	3	4	3	#
Speed Limit	35	35	0	0	m.p.h.
Volume	1626	2465	0	0	veh/hr.
Receptor Location:					
X			.086		Km
Y			.248		Km
Z			3		Meters

DATA FOR MIDBLOCK MODEL Time Period: 10:00 - 16:00

Intersection: Fourth St./College St.; X= .404 Km; Y= .317 Km

Phasing: 2-Phase, fixed time (coordinated); cycle = 90 sec.

(Link) Parameter	Link N(College)	E(4th)	S(College)	W(4th)	Units
Approach Link:					
Beg.X	.496	.456	.302	.350	Km
Beg.Y	.387	.250	.242	.278	Km
End X	.411	.413	.392	.398	Km
End Y	.322	.307	.308	.325	Km
Width	14.8	12.7	14.6	10.3	Meters
# of Lanes	0	2	4	0	#
Capacity	0	2900	5900	0	veh/hr. (Level E)
Speed Limit	35	35	35	0	m.p.h.
Volume	0	3417	2788	0	veh/hr.
Exit Link:					
Beg.X	.411	.413	.392	.398	Km
Beg.Y	.322	.307	.308	.325	Km
End X	.496	.456	.302	.350	Km
End Y	.387	.250	.242	.378	Km
Width	14.7	12.7	14.6	10.3	Meters
# of Lanes	4	0	0	2	#
Speed Limit	35	35	35	35	m.p.h.
Volume	2980	0	0	3226	veh/hr.
Receptor Location:					
X			.086		Km
Y			.248		Km
Z			3		Meters

DATA FOR MIDBLOCK MODEL Time Period: 16:00 - 18:00

Intersection: Fourth St./College St.; X= .404 Km; Y= .317 Km

Phasing: 2-Phase, fixed time (coordinated); cycle = 90 sec.

(Link) Parameter	Link N(College)	E(4th)	S(College)	W(4th)	Units
Approach Link:					
Beg.X	.496	.456	.302	.350	Km
Beg.Y	.387	.250	.242	.278	Km
End X	.411	.413	.392	.398	Km
End Y	.322	.307	.308	.325	Km
Width	14.8	12.7	14.6	10.3	Meters
# of Lanes	0	2	4	0	#
Capacity	0	2900	5900	0	veh/hr. (Level E)
Speed Limit	35	35	35	0	m.p.h.
Volume	0	1482	1788	0	veh/hr.
Exit Link:					
Beg.X	.411	.413	.392	.398	Km
Beg.Y	.322	.307	.308	.325	Km
End X	.496	.456	.302	.350	Km
End Y	.387	.250	.242	.378	Km
Width	14.7	12.7	14.6	10.3	Meters
# of Lanes	4	0	0	2	#
Speed Limit	35	35	35	35	m.p.h.
Volume	1826	0	0	1444	veh/hr.
Receptor Location:					
X			.086		Km
Y			.248		Km
Z			3		Meters

TABLE 15

GROWTH FACTORS

	Growth Factor	
	Per Year	1982-1987
Albemarle Road	6.0%	1.34
Independence Blvd. at Sharon Amity	6.0%	1.34
Independence Blvd. at Idlewild Road	4.0%	1.22
Sharon Amity Road	1.0%	1.05
Idlewild Road	4.0%	1.22
Central Avenue	0.0%	1.00
Second Street	1.5%	1.08
Third Street	1.5%	1.08
College Street	1.5%	1.08
Fourth Street	1.5%	1.08
Tryon Street	1.5%	1.08
Fairview Road	3.0%	1.16
Providence Road	4.0%	1.22
Sardis Road	2.0%	1.10
Woodlawn Road	2.9%	1.15
Park Road	0.0%	1.00

ATTACHMENT IV

TRAFFIC DATA FOR
1987 WITH TCMs

(Letter dated December 10, 1982 and
November 20 with attachments)

ENGINEERING-SCIENCE

TWO FLINT HILL • 10521 ROSEHAVEN STREET • FAIRFAX, VIRGINIA 22030 • 703/591-7575

TELEX. 67-5428

December 10, 1982
9227.00/58

Mr. Don Stone
Air Management Branch
U.S. Environmental Protection Agency,
Region IV
345 Courtland Street, N.E.
Atlanta, GA 30308

Subject: 1987 Traffic Data for Charlotte CO Study.

Dear Don:

With reference to my letter of November 30, 1982, on the same subject, Nancy Williams of Charlotte DOT suggested certain modifications to the predicted 1987 peak 8-hour traffic volumes. Her suggestions were as follows:

- o Determine the peak 8-hour to 1-hour ratio based on total (two-way) traffic for a roadway link rather than using directional traffic volume.

- o Determine total traffic volumes for 1987 peak 8-hour using total peak 1-hour traffic and the ratio developed above.

- o Split the projected total 8-hour traffic volumes into approach and exit link volumes using directional split based on data provided for the base year peak 8-hour period.

Based on these modifications, the revised traffic data are attached for your information. These are the traffic volumes which will be used in the final analysis.

Sincerely yours,

ENGINEERING-SCIENCE

Prasad

Chandrika Prasad
Air Quality Planning

cc: Dave Johnson
Nancy Williams
Bobby Cobb

TABLE 1

TRAFFIC DATA FOR CENTRAL/SHARON AMITY

	Link Description	Base Year Peak 8-hr Traffic (Veh/Hr)	Base Year Peak 1-hr Traffic (Veh/Hr)	Ratio Peak 8-hr / Peak 1-hr	1987 Peak 1-Hr Traffic with TCMs (Veh/Hr)	1987 Peak 8-Hr Traffic with TCMs (Veh/Hr)	Directional Split Ratio[a]	1987 Peak 8-hr Directional Traffic with TCMs (Veh/Hr)
ENTIRE LINK	N.S.A.	1650	2070	0.80	2079	1657		
	S.S.A.	1950	2390	0.82	2396	1955		
	E. Central	2030	2537	0.80	2525	2019		
	W. Central	2230	2727	0.82	2718	2223		
APPROACH LINK	N.S.A.	670					0.41	679
	S.S.A.	1000					0.51	1003
	E. Central	1030					0.51	1025
	W. Central	1230					0.55	1226
EXIT LINK	N.S.A.	980					0.59	978
	S.S.A.	950					0.49	952
	E. Central	1000					0.49	994
	W. Central	1000					0.45	997

a. Based on Base Year peak 8-hour traffic volumes.

Attachment IV

TABLE 2

TRAFFIC DATA FOR ALBERMARLE/SHARON AMITY

	Link Description	Base Year Peak 8-hr Traffic (Veh/Hr)	Base Year Peak 1-hr Traffic (Veh/Hr)	Ratio Peak 8-hr / Peak 1-hr	1987 Peak 1-Hr Traffic with TCMs (Veh/Hr)	1987 Peak 8-Hr Traffic with TCMs (Veh/Hr)	Directional Split Ratio[a]	1987 Peak 8-hr Directional Traffic with TCMs (Veh/Hr)
ENTIRE LINK	N.S.A.	1830	2066	0.89	2074	1837		
	S.S.A.	2110	2397	0.88	2326	2048		
	E. Albermarle	1930	2480	0.78	3710	2887		
	W. Albermarle	1580	2031	0.78	3284	2554		
APPROACH LINK	N.S.A.	840	915				0.46	845
	S.S.A.	1140	1315				0.54	1106
	E. Albermarle	830	922				0.43	1241
	W. Albermarle	920	1336				0,58	1481
EXIT LINK	N.S.A.	990	1151				0.54	992
	S.S.A.	970	1082				0.46	942
	E. Albermale	1100	1558				0.57	1646
	W. Albermale	660	695				0.42	1073

a. Based on Base Year peak 8-hour traffic volumes.

Attachment IV

TABLE 3

TRAFFIC DATA FOR INDEPENDENCE/SHARON AMITY

Link	Description	Base Year Peak 8-hr Traffic (Veh/Hr)	Base Year Peak 1-hr Traffic (Veh/Hr)	Ratio Peak 8-hr / Peak 1-hr	1987 Peak 1-Hr Traffic with TCMs (Veh/Hr)	1987 Peak 8-Hr Traffic with TCMs (Veh/Hr)	Directional Split Ratio[a]	1987 Peak 8-hr Directional Traffic with TCMs (Veh/Hr)
ENTIRE LINK	N.S.A.	1700	2154	0.79	1999	1578		
	S.S.A.	1400	1743	0.80	1683	1351		
	E. Independence	2990	3573	0.84	4347	3638		
	W. Independence	2530	3114	0.81	4081	3316		
APPROACH LINK	N.S.A.	740	846				0.44	694
	S.S.A.	740	950				0.53	716
	E. Independence	1400	1404				0.47	1709
	W. Independence	1430	2092				0.57	1890
EXIT LINK	N.S.A.	960	1308				0.56	884
	S.S.A.	660	793				0.47	635
	E. Independence	1590	2169				0.53	1929
	W. Independence	1100	1022				0.43	1426

a. Based on Base Year peak 8-hour traffic volumes.

TABLE 4

TRAFFIC DATA FOR INDEPENDENCE/IDLEWILD

Link Description		Base Year Peak 8-hr Traffic (Veh/Hr)	Base Year Peak 1-hr Traffic (Veh/Hr)	Ratio Peak 8-hr / Peak 1-hr	1987 Peak 1-Hr Traffic with TCMs (Veh/Hr)	1987 Peak 8-Hr Traffic with TCMs (Veh/Hr)	Directional Split Ratio[a]	1987 Peak 8-hr Directional Traffic with TCMs (Veh/Hr)
ENTIRE LINK	N. Independence	2840	3553	0.89	4206	3361		
	S. Independence	2590	3299	0.79	3697	2902		
	E. Idlewild	970	1350	0.72	1527	1097		
	W. Idlewild	1030	1316	0.78	1443	1129		
APPROACH LINK	N. Independence	1520	2122				0.53	1782
	S. Independence	1160	1382				0.45	1306
	E. Idlewild	430	419				0.44	482
	W. Idlewild	600	836				0.58	655
EXIT LINK	N. Independence	1320	1431				0.47	1579
	S. Independence	1430	1917				0.55	1596
	E. Idlewild	540	931				0.56	615
	W. Idlewild	430	480				0.42	474

a. Based on Base Year peak 8-hour traffic volumes.

Attachment IV

Attachment IV

ENGINEERING-SCIENCE

TWO FLINT HILL • 10521 ROSEHAVEN STREET • FAIRFAX, VIRGINIA 22030 • 703/591-7575

TELEX. 67-5428

November 30, 1982
9227.00/51

Mr. Don Stone
Air Management Branch
U.S. EPA Region IV
345 Courtland Street, N.E.
Atlanta, Georgia 30308

Sub: 1987 Traffic Data for Charlotte CO Study

Dear Don:

As you know, the remaining tasks for the study referenced above require 1987 traffic volumes which reflect the expected growth in traffic and effects of transportation control measures (TCMs). Problems resulting from the unavailability of such data were brought to the attention of all parties concerned through my Technical Memorandum of October 11 and Monthly Progress Reports for September and October 1982.

Dave Johnson in his letter of October 18 (copy attached) suggested two possible approaches to generate the data needed and recommended that the second approach be used. I have discussed in detail the difficulties in using this approach with Dave and the same was brought to your attention. From these discussions it was concluded that the first approach (use of the peak 8-hour to peak 1-hour traffic ratio) would be more appropriate under present circumstances. Data required under this approach are readily available and the Study could proceed without further delays.

Based on this approach I have compiled a table of traffic volumes for 1987 with growth and TCMs (See Attachments). The methodology used in compiling these traffic volumes is also attached. Through copies of this letter and Attachments, this information is being forewarded to all parties concerned so that everyone will be aware of the traffic data to be used in this Study.

Attachment IV

Unless otherwise directed, I intend to use these traffic data in completing the remainder of this Study. Anyone having objections to the same is requested to contact me as soon as this letter is received so that the study can be completed in an expedient time frame.

Sincerely,

ENGINEERING-SCIENCE

Chandrika Prasad
Air Quality Planning

P.S. Please note that we have moved and our new address and telephone number appear on the letterhead.

CP/sf

cc: Nancy Williams
Bobby Cobb
Dave Johnson

Enclosure:

METHODOLOGY USED TO COMPUTE 1987 PEAK 8-HOUR TRAFFIC VOLUMES TO INCLUDE EFFECTS OF TCMs AND GROWTH

The Methodology used to determine 1987 peak 8-hour traffic volumes with growth and TCMs was as follows:

(i) Determine a ratio for peak 8-hour to peak 1-hour traffic volumes using data for the base year.

(ii) Multiply the 1987 peak 1-hour traffic data as given in the PMM report by the ratio determined above.

For the base year, peak 8-hour traffic volumes in IMM format (total for each approach and exit link) were provided by Charlotte DOT. Peak 1-hour traffic volumes for the same year were calculated from data available in the PMM report which provided data for each lane including turning lanes. By adding traffic volumes for each lane (including turning lanes) of a given approach or exit link, the peak 1-hour traffic volume for that link was computed. From these two base year data sets, the ratio of peak 8-hour to peak 1-hour traffic for each approach and exit link was determined.

The PMM report also provided 1987 peak 1-hour traffic data which include the effects of growth and TCMs. Using the same procedure mentioned above, 1987 peak 1-hour traffic volumes for each approach and exit link were first determined. On the basis of the peak 8-hour to peak 1-hour traffic ratios, the 1987 peak 1-hour traffic volumes were transformed into peak 8-hour traffic volumes.

The PMM report provided 1987 peak 1-hour traffic volumes for two scenarios given below:

1. Alternative 1 (geometric improvements to the intersection)
2. Alternative 2 (parallel facility improvements) and Alternative 3 (coordinated signal system) combined.

For the purposes of this study, traffic data for scenario #2 were considered.

It should be noted here that the PMM report only considered four of the six intersections to be analyzed for this study. For the other two intersections, Park/Woodlawn and Fairview/Providence, it was assumed that there are no TCMs. For these two intersections, 1987 peak 8-hour traffic volumes were calculated using base year peak 8-hour traffic volumes and growth factors provided by Charlotte DOT.

<u>Anomaly</u> Normally 8-hour average traffic is expected to be lower than the peak 1-hour traffic volumes. Slight variations from such expectations were noticed for two links (East Idlewild Road approach link and West Independence Blvd. exit link, see tables attached).

TRAFFIC DATA

Intersection: Central/Sharon Amity

TRAFFIC VOLUMES IN VEHICLES PER HOUR							
Link Description		Base Year Peak 8-Hour	Base Year Peak 1-Hour	Ratio Peak 8-hr / Peak 1-hr	1987 Peak 1-hr with TCMs	1987 Peak 8-hr with TCMs
APPROACH LINKS:	N. S. A.	670	782	0.86	767	660
	S. S. A.	1000	1229	0.81	1239	1015
	E. Central	1030	1368	0.75	1368	1026
	W. Central	1230	1481	0.83	1485	1232
EXIT LINKS:	N. S. A.	980	1288	0.76	1312	997
	S. S. A.	950	1161	0.82	1157	948
	E. Central	1000	1169	0.86	1157	995
	W. Central	1000	1246	0.80	1233	986

Attachment IV

TRAFFIC DATA

<u>Intersection:</u> Albemarle/Sharon Amity

TRAFFIC VOLUMES IN VEHICLES PER HOUR							
Link Description		Base Year Peak 8-Hour	Base Year Peak 1-Hour	Ratio Peak 8-hr / Peak 1-hr	1987 Peak 1-hr with TCMs	1987 Peak 8-hr with TCMs
APPROACH LINKS:	N. S. A.	840	913	0.92	897	825
	S. S. A.	1140	1315	0.87	1297	1128
	E. Albemarle	830	922	0.90	1387	1248
	W. Albemarle	920	1336	0.69	2116	1460
EXIT LINKS:	N. S. A.	990	1151	0.86	1177	1012
	S. S. A.	970	1082	0.90	1029	926
	E. Albemarle	1100	1558	0.71	2323	1650
	W. Albemarle	660	695	0.95	1168	1109

Attachment IV

TRAFFIC DATA

Intersection: Sharon Amity/Independence

TRAFFIC VOLUMES IN VEHICLES PER HOUR							
Link Description		Base Year Peak 8-Hour	Base Year Peak 1-Hour	Ratio Peak 8-hr / Peak 1-hr	1987 Peak 1-hr with TCMs	1987 Peak 8-hr with TCMs
APPROACH LINKS:	N. S. A.	740	846	0.87	782	680
	S. S. A.	740	950	0.78	936	730
	E. Independence	1400	1404	0.99	1842	1824
	W. Independence	1430	2092	0.68	2570	1748
EXIT LINKS:	N. S. A.	960	1308	0.73	1217	888
	S. S. A.	660	793	0.83	747	620
	E. Independence	1590	2169	0.73	2505	1828
	W. Independence	1100	1022[a]	1.07	1511	1616

a. Data anomely (1-hr traffic less then 8-hr traffic)

Attachment IV

TRAFFIC DATA

Intersection: Independence/Idlewild

		TRAFFIC VOLUMES IN VEHICLES PER HOUR				
Link Description		Base Year Peak 8-Hour	Base Year Peak 1-Hour	Ratio Peak 8-hr / Peak 1-hr	1987 Peak 1-hr with TCMs	1987 Peak 8-hr with TCMs
APPROACH LINKS:	N. Independence	1520	2122	0.72	2582	1859
	S. Independence	1160	1382	0.84	1548	1301
	E. Idlewild	430	419[a]	1.03	446	459
	W. Idlewild	600	836	0.72	860	620
EXIT LINKS:	N. Independence	1320	1431	0.92	1624	1494
	S. Independence	1430	1917	0.75	2149	1611
	E. Idlewild	540	931	0.58	1081	627
	W. Idlewild	430	480	0.89	583	519

a. Data anomely (Peak 1-hr traffic less then peak 8-hr traffic)

Attachment IV

Rcd 10-21-82

Attachment IV

North Carolina Department of Natural Resources & Community Development

James B. Hunt, Jr., Governor   Joseph W. Grimsley, Secretary

DIVISION OF ENVIRONMENTAL MANAGEMENT
Air Quality Section

October 18, 1982

Mr. Doug Toothman
Engineering - Science
7903 Westpark Drive
McLean, Virginia 22102

Dear Doug:

As we discussed by phone, the CO study for Mecklenburg County has reached the point where the effect of selected transportation control measures must be considered in calculating future CO ambient concentrations. However, the difficulty in determing the effects of the TCM's and relating the effects to air quality necessitate that certain assumptions be made. Futhermore, it is important that the different parties involved in this project agree that these assumptions are reasonable and that the approach that is selected for analyzing the TCM's is based on an acceptable rationale.

In light of past studies and available data or projections, it seems that there are at least two approaches for performing the TCM analysis. These approaches are as follows:

(1) Using the TCM analysis performed by Peat, Marwick & Mitchell, determine an appropriate 1-hr to 8-hr ratio and apply this ratio to the PMM analysis based on 1-hr peak traffic.

(2) Using turning movement ratios based on existing data or other available data appropriate for the intersections, allocate the future midblock traffic volumes to the straight and turn lanes at the intersection. The effect of TCM's would show up as either reduced volumes at the intersection or as an additional lane(s) to handle the turning movement. Following the allocation of volumes to intersection lanes, the intersection would have to be "balanced" to be sure that future midblock volumes were not changed. This procedure could be done for the peak 8-hr period.

It seems to me that the second approach, although based on a continuation of existing turning movement allocations, might represent a more direct effort at analyzing the 8-hr peak concentrations at the subject intersections. This approach would also be more independent since it would not necessarily rely on the assumptions of the earlier study. Therefore, I suggest we pursue the second approach unless you or one of the persons copied on this letter have another suggestion.

I assume that Dr. Prasad will be able to perform the tasks involved in this approach if the existing volumes and turning movement distributions are supplied by Charlotte DOT. Unless this data for the six intersections has already been supplied to you, I hope Charlotte DOT will able to furnish you the data within the next two weeks. If there are other data needs, please let me know.

I realize that this point in the CO analysis probably has more questionable inputs and outputs than other parts of the study, but I also believe we can select an approach that produces meaningful results based on the limited data and time we have for performing this task. If there are objections, I hope they are aired now and I hope they are accompanied by alternative suggestions.

Please let me know if you have any questions or if you feel this matter needs further discussion by other participants in this study.

Sincerely,

David

David G. Johnson

lh

cc: Nancy Williams
Don Stone
Bobby Cobb
Frank Vick

ATTACHMENT V

ADJUSTMENT FACTORS
(TASK 2, Technical Memorandum)

TECHNICAL MEMORANDUM

TASK 2: 1987 AIR QUALITY WITH I&M
FOR
WORK ASSIGNMENT NO. 27
CONTRACT NO. 68-02-3509

COMPILATION OF THREE-DIMENSIONAL CARBON MONOXIDE CONCENTRATIONS IN MECKLENBURG COUNTY, NORTH CAROLINA

Prepared for

U.S. Environmental Protection Agency
Region IV
345 Courtland Street, N.E.
Atlanta, Georgia 30308

September 1982
9227.00/79A

Prepared by

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1987 AIR QUALITY WITH I&M AND GROWTH BUT NO TCMs

This technical memorandum documents the results of Task 2 of Work Assignment No. 27 under the Assistance to States Contract No. 68-02-3509. The purpose of this task was to determine 1987 air quality with the inclusion of I&M and considering traffic growth but no transportation control measures. This memorandum summarizes the results of this task.

1987 Air Quality With I&M and Growth But No TCMs

The six intersections as analyzed in Task 1 were again modeled for 1987 traffic conditions considering growth in traffic and including an automobile inspection and maintenance program. No transportation control measures were considered for purposes of this analysis. Traffic volumes for 1987 were obtained from 1982 traffic data and growth rates as provided by Charlotte DOT. The results of the analysis are shown in Table 1 along with 1982 predicted concentrations and 1987 predicted concentration without I&M or TCMs. I&M specifications used in this analysis were as follows:

- o Calendar year of projection = 1987
- o Start of I&M program = January 1983
- o Stringency factor = 30%
- o Mechanics Training = yes
- o First model year to be inspected = 1975
- o Last model year to be inspected = 1986

The carbon monoxide concentrations presented in Table 1 do not include background or any adjustment based on model comparison. However, two adjustments were made to the IMM predicted values for 1987 with I&M and growth. These adjustment factors are described below.

1. Adjustment for Vehicles Not Subject to I&M

Under the proposed I&M program, only vehicles registered in Mecklenburg County and the City of Charlotte will be subject to the inspection and maintenance program. Hence, an adjustment is required to account for the impact due to vehicles not subject to the I&M program. Neither a site-specific breakdown of these vehicles nor a breakdown by vehicle-type (autos, light duty trucks, diesel trucks, etc) is available. Therefore, an adjustment factor based on overall vehicle population was derived. As suggested by the Project Officer in consultation with the North Carolina Department of Natural Resources and Community Development, the percentage of non I&M vehicles was assumed to be 10% for this analysis. Using this percentage, an adjustment factor was developed as follows:

- o Composite 1987 emission factor w/o I&M = E_1 gm/vehicle-mile
- o Composite 1987 emission factor w/I&M = E_2 gm/vehicle-mile
- o Percentage of vehicles not subject to I&M = P_1

Therefore, the adjustment factor (F_1) is:

TABLE 1

1982 AND 1987 AIR QUALITY[a]

Intersection	8-Hour CO Concentration[b] (mg/m^3) 1982	1987[c] w/o I&M	1987[d] w/I&M	Standard
Sharon Amity Road/Central Avenue	19.89	15.72	11.98	10.0
Sharon Amity Road/Albemarle Road	14.46	13.83	10.44	10.0
Sharon Amity Road/Independence Blvd.	14.86	13.65	10.59	10.0
Independence Blvd./Idlewild Road	15.50	14.91	11.36	10.0
Fairview Road/Providence Road	9.37	8.49	6.40	10.0
Woodlawn Road/Park Road	10.61	8.91	6.45	10.0

[a] Does not include background or adjustments resulting from model comparison.

[b] Predicted under peak 8-hour traffic conditions as provided by Charlotte DOT.

[c] Does not include TCMs or I&M but includes growth in traffic.

[d] Does not include TCMs but includes growth in traffic and I&M program as proposed for Charlotte-Mecklenburg area.

$$F_1 = \frac{(100 - P_1) \times E_2 + P_1E_1}{100\ E_2}$$

Since emission factors vary with speed, correction factors were calculated for idling, average speed and cruise speed and an average of these factors was used in the final analysis. The composite emission factor is dependent upon the vehicle-mix for a given intersection; hence, a separate correction factor was calculated for each intersection.

A review of the analysis indicated that variation in this factor with respect to speed was insignificant (less than 0.3%). Variation in this factor for the six intersections analyzed was also found to be insignificant (less than 0.2%). The average value of the correction factor was 1.05. This factor was multiplied by the IMM predicted concentrations with I&M to determine the corrected CO concentrations.

2. Adjustment for I&M Applied to Heavy Duty Gasoline Vehicles

The current version of MOBILE 2 includes options to calculate emission factors for I&M applicable to a limited combination of vehicles as given below:

Option	Type of Vehicle Affected by I&M[a]
0	LDV
1	LDV and LDT1
2	LDV and LDT2
3	LDV, LDT1 and LDT2

The I&M program proposed for the Charlotte-Mecklenburg area will apply to all gasoline vehicles including heavy duty gasoline trucks. Limited testing[b] of such vehicles indicates an 18% reduction in CO emissions due to I&M. A correction factor to account for the North Carolina I&M program was developed as follows:

- 1987 HDG emission factor w/o I&M = E_3
- 1987 HDG emission factor w/I&M = E_4
- 1987 composite emission factor with EPA I&M[c] = E_2
- Percentage of HDG vehicles = P_2
- Reduction in emission factor due to HDG I&M = $P_2\ (E_3 - E_4)$
- Net 1987 emission factor = $E_2 - P_2\ (E_3 - E_4)$

Therefore, the correction factor (F_2) is:

$$F_2 = \frac{E_2 - P_2\ (E_3 - E_4)}{E_2}$$

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a LDV = light duty vehicles
LDT1 = light duty trucks (0-6000 lbs)
LDT2 = light duty trucks (6000-8500 lbs)

b Personal communication with Phil Lorange, U.S. EPA Mobile Source Pollution Control, Ann Arbor, Michigan, July 1982.

c I&M for LDV, LDT1, and LDT2.

Since emission factors vary with speed and the percentage of HDG vehicles varies from one intersection to the other, correction factors were calculated for each intersection and for each of several vehicle speeds.

Computions indicated that the variation in the correction factor with respect to speed and intersection was not significant (less than 0.3%). The average value was determined to be 0.995. This factor was used for all intersections and for all vehicular speeds.

Total (Net) Correction

To determine resultant effect of the two correction factors previously discussed, a total correction factor was obtained by multiplying factors F_1 and F_2. The resultant factor was determined to be 1.045.

Summary and Conclusions

Results of this analysis indicate that:

- The percentage of vehicles not subject to I&M will have an identifiable impact on CO concentrations. In this case, with 10% of the vehicles not subject to I&M, the CO concentrations are 5% higher than if all vehicles were subject to I&M.

- Due to the low volume of heavy duty gasoline trucks, I&M for these vehicles will have very little impact (about 0.5% reduction) on overall CO concentrations at the intersections analyzed in this task.

The results further indicate a potential for nonattainment of the 8-hour CO standard by 1987 at four intersections even with the application of proposed I&M program.