TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle User's Guide for the TEXIN Model		5. Report Date June 25, 1982 6. Performing Organization Code FCIP-1-8-81-541
7. Author(s) A.D. Messina, J.A. Bullin, J.P. Nelli, and R.D. Moe		8. Performing Organization Report No. FHWA/TX-81/541-2F
9. Performing Organization Name and Address Chemical Engineering Dept. Texas Transportation Inst. Texas A&M University College Station, TX 77843	Texas State Dept. of Highways & Public Transportation, P.O.Box 5051 Austin, TX 78763	10. Work Unit No. 33F3562 11. Contract or Grant No. DTFH-61-81-C-00040
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Highway Administration Washington, D.C. 20590		13. Type of Report and Period Covered Final Report April 15, 1981 to June 25, 1982 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

The Texas Intersection (TEXIN) Model is a user-oriented FORTRAN computer program for the estimation of carbon monoxide pollution concentrations near simple signalized intersections. In this User's Guide the TEXIN Model and its use are briefly described. The input procedures are outlined in detail, the possible outputs are discussed, and three comprehensive illustrative examples are presented.

Further information regarding the use of the TEXIN Model, as well as comparison of model results to experimental data and to other models, are available in the final project report FHWA/TX-81/541-1 , "Estimation of Air Pollution Near Simple Signalized Intersections." A magnetic computer tape of the model, as well as copies of the User's Guide and the final project report are available from the Texas State Department of Highways and Public Transportation and NTIS. They are also available at modest cost from Dr. A.D. Messina or Dr. Jerry A. Bullin, Chemical Engineering Department, Texas A&M University, College Station, Texas 77843, phone 713-845-3361.

17. Key Words	18. Distribution Statement
Intersection, Pollution, Carbon Monoxide, Signalized Intersection, TEXIN, User's Guide.	No restrictions. This document is available to the public through the National Technical Information Service, 5285 Port Royal Road Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	47	

Form DOT F 1700.7 (8-69)

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IMPLEMENTATION

A user-oriented computer model has been developed to predict carbon monoxide pollution concentrations near simple signalized roadway intersections. The model is written in FORTRAN and has been released with a detailed user's guide. The model is superior in accuracy and functionality to previous intersection pollution models and is highly efficient in terms of computer requirements.

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration, nor does this report constitute a standard, specification or regulation.

ACKNOWLEDGMENTS

The authors wish to recognize the contributions made by several individuals during the project. Mr. Jack Rodden provided valuable advice and assistance in the computer aspects of the project. Mrs. Sharon Bower was extremely helpful in the acquisition and analyses of the College Station and Houston data as well as in the compilation of the draft final report. As always, the staff support of the Chemical Engineering Department and Texas Transportation Institute at Texas A&M University was also very helpful and is greatly appreciated.

The authors also wish to acknowledge the contributions made by the reviewers of the draft final report and user's guide. Their comments and suggestions proved to be very valuable in the development of the final model. These individuals included Dr. Howard Jongedyk, Mr. Jeffrey Thwing, Mr. Mark Stahr, Dr. Stephen Cohen and Mr. Kenneth Jones of the FHWA; Mr. Earl Shirley and Mr. Paul Benson of the California Department of Transportation; Mr. Denis Donnelly and Mr. Richard Griffin of the Colorado Department of Highways; Mr. Ronald Piracci of the New York Department of Transportation; and Mr. D. Bruce Turner and Mr. William Peterson of the E.P.A. Meteorology Branch at Research Triangle Park, North Carolina. Comments received by Dr. Amulakh Parikh of the New Jersey Department of Transportation also proved to be extremely useful in the final version of the TEXIN Model.

SUMMARY

The Texas Intersection (TEXIN) Model is a user-oriented FORTRAN computer program for the estimation of carbon monoxide pollution concentrations near simple signalized intersections. In this User's Guide the TEXIN Model and its use are briefly described. The input procedures are outlined in detail, the possible outputs are discussed, and three comprehensive illustrative examples are presented.

Further information regarding the use of the TEXIN Model, as well as comparison of model results to experimental data and to other models, are available in the final project report FHWA/TX-81/541-1 , "Estimation of Air Pollution Near Simple Signalized Intersections." A magnetic computer tape of the model, as well as copies of the User's Guide and the final project report are available from the Texas State Department of Highways and Public Transportation and NTIS. They are also available at modest cost from Dr. A.D. Messina or Dr. Jerry A. Bullin, Chemical Engineering Department, Texas A&M University, College Station, Texas 77843, phone 713-845-3361.

USER'S GUIDE FOR THE TEXIN MODEL

The TEXIN Model is a tool intended to provide improved perspective in the evaluation of pollution impacts from intersections considering temporal and spatial variations of traffic, emissions, meteorology, the nature of receptors, and their relation to local intersection air quality. This User's Guide briefly describes the TEXIN Model and its use. The input procedures are outlined in detail, the possible outputs are discussed, and several illustrative examples are presented.

Model Description

The TEXIN Model is a FORTRAN computer program which estimates carbon monoxide emissions and concentrations at

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The Texas Intersection (TEXIN) Model was developed by the Chemical Engineering Department and the Texas Transportation Institute at Texas A&M University. The work was sponsored by the U.S. Department of Transportation Federal Highway Administration through the Texas State Department of Highways and Public Transportation. A complete discussion of the development and validation of the TEXIN Model is presented in the Texas Transportation Institute final research report FHWA/TX-81/541, "Estimates of Air Pollution Near Simple Signalized Intersections" [A1]. Questions or comments regarding the model should be directed to Professor A.D. Messina or Professor J.A. Bullin, Chemical Engineering Department, Texas Transportation Institute, Texas A&M University, College Station, Texas, 77843, Phone (713) 845-3361 or to Mr. Roderick Moe, Texas State Department of Highways and Public Transportation, File D-8P, 11th & Brazos, Austin, Texas, 78701, Phone (512) 465-6170.

roadway intersections. The program performs three distinct tasks: (1) estimation of traffic parameters (stopped delay, time in queue, etc.);(2) estimation of vehicle emissions and their distribution; and (3) modelling of pollutant dispersion downwind of the intersection. The general flow diagram for the TEXIN Model is presented in Figure A1. The model requires a minimal set of four types of geometrical, meteorological, and traffic-related inputs, as shown in the figure.

The TEXIN Model is flexible enough to handle most intersection configurations which would realistically be encountered by highway engineers. The program can model the basic case of a simple intersection (signalized or unsignalized) with four straight legs; as well as more complex situations where the legs of the intersection may be curved. This is accomplished by approximating the curves as a series of connected straight links. In addition to modelling the major intersection, the program has the flexibility to concurrently model several minor intersections (controlled by stop or yield signs) arising from nearby side streets. The TEXIN Model is not applicable to street canyon configurations, however.

The first function performed by the program is that of traffic flow analysis. Initially, the traffic flow on the major intersection is evaluated, and afterwards any minor intersections are handled. The Level of Service, and thus

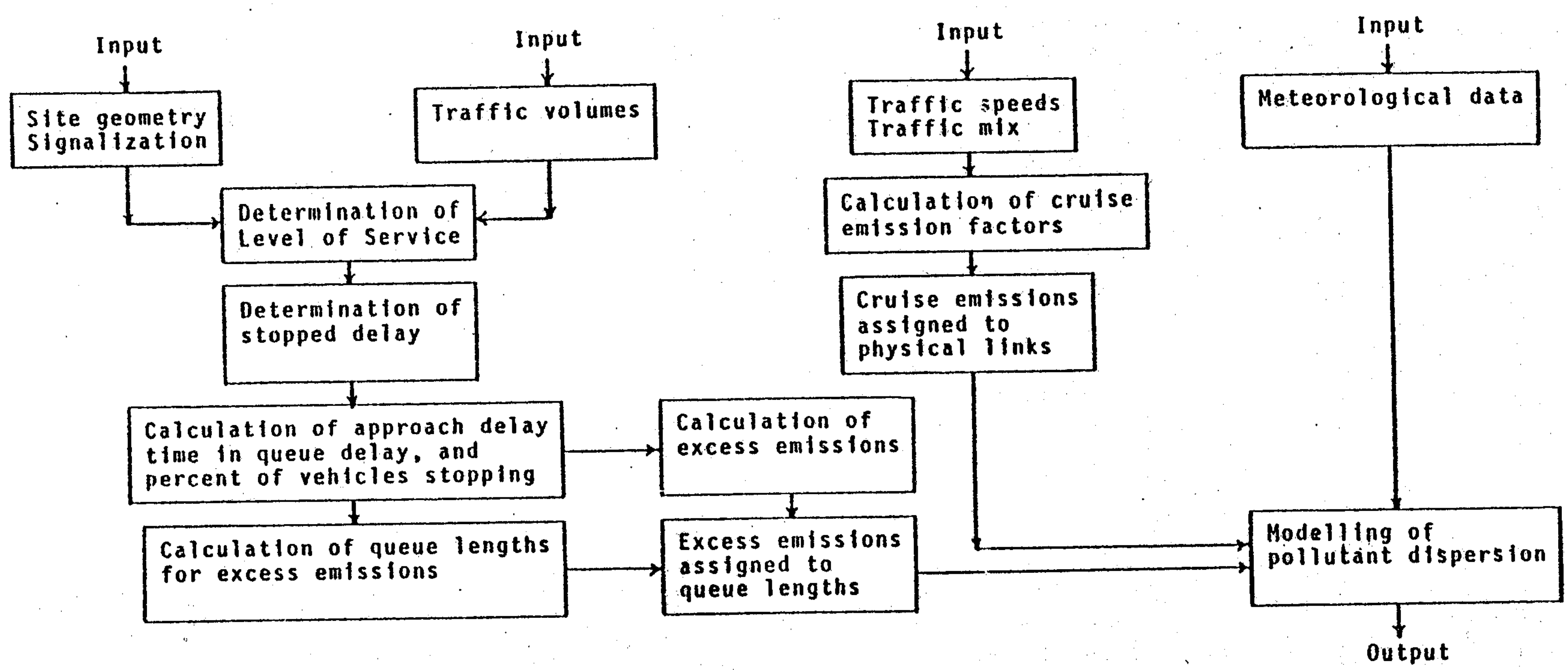

Figure A1. General flow diagram for the TEXIN Model.

the stopped delay per vehicle, of the major intersection is first determined. For a signalized intersection, this is accomplished through the use of Critical Movement Analysis, as presented in NCHRP Project 3-28, "Development of an Improved Highway Capacity Manual" [A2]. For an unsignalized intersection, a corresponding methodology presented in the same report is utilized. Several other traffic parameters of interest, including approach delay, time in queue, percent of vehicles stopping, and queue length are next calculated using the results from a study by Reilly, et al. [A3]. For minor side-street intersections, the methodologies for unsignalized intersections are utilized with certain simplifying assumptions made to keep the analyses tractable.

The second function performed by the program is the estimation of vehicle emissions. The emissions are modelled as the sum of two components: (1) the cruise emissions from free flowing traffic (assumed to be uniformly distributed along the entire length of the roadway); and (2) the excess emissions from vehicles incurring delay (assumed to be emitted only over the queue length). The MOBILE-2 [A4] program is incorporated into the TEXIN Model to estimate the cruise emissions of free flowing vehicles as well as the idle emission rate. The methodology for estimating excess emissions utilizes the traffic parameters calculated previously and nomographs relating excess emissions to speed changes, as suggested by Ismart [A5].

Once the estimation of vehicle emissions and distribution is accomplished, the final task of modelling the pollutant dispersion is performed. The Gaussian dispersion model, CALINE-3 [A6], is incorporated in the TEXIN program to calculate the dispersion of pollutants downwind of the intersection. Several minor modifications were made to the CALINE-3 program, mainly to the input/output routines, so that it could handle the constructed psuedolinks. Additionally, a modification raising the emission source height at very low wind speeds extended the applicability of the CALINE-3 to wind speeds below one metre per second [A1].

To conserve computer compilation and execution time, an effort was made to delete sizeable portions of the extremely large MOBILE-2 program which were not needed by the TEXIN Model. These deletions included the nitrogen oxides and hydrocarbon emission factors, optional correction factors for inspection/maintenance programs, air conditioning and extra-load towing, and most of the input/output processing. These modifications resulted in an approximate two-thirds decrease in storage space as well as a similar decrease in the compilation and execution time required to process the MOBILE-2 program. The deletions in the MOBILE-2 program, and a general effort throughout the development of the TEXIN Model to minimize the amount of computer time required, have produced an efficient computer program. The TEXIN Model requires less than a tenth of the execution time required by the well known Intersection Midblock Model [A7], and yet achieves an accuracy surpassing the same [A1]. A further decrease in the execution time required can be achieved by performing numerous simulations in a single computer run. When more than ten simulations are performed, the execution time per simulation is approximately one-fourth of the execution time for a single simulation run.

Input Procedure

The TEXIN program requires five types of input cards. They are (in order):

(1) Heading and Flags card (one card)
(2) Link Description cards (one card per link)
(3) Receptor Location cards (one card per receptor)
(4) Meteorological Conditions card (one card)
(5) Vehicle Scenario card (one card).

The input sequence of the data is presented in Table A1 and described below. As shown in the table, all the input data are formatted according to standard FORTRAN conventions (it is especially important to note that all integer values are right-justified). These conventions are shown in Figure A2. Numerous runs may be simulated by repeating the sequence of input cards.

Heading and Flags Card. The first input card is the Heading and Flags card (See Table A1). The first 40 spaces are for the job title and may contain any combination of alphanumeric characters. The next 21 spaces are for the seven 3-digit integer variables: VMFLAG, PRTFLG, INTFLG, NR,

Table A1. Input data for the TEXIN Model.

Format	Variables	Units
Heading and Flags Card,	(1 card):	
10A4	HEAD	-
3I3	VMFLAG,PRTFLG,INTFLG,	-
4I3	NR,NNDL,NDL,NP	-
F4.0	CY	s
Link Description Cards,	(4+NNDL+NDL cards):	
I3	LA	-
4F6.0	XL1,YL1,XL2,YL2	m
A2	TYP	-
2F4.0	WL,HL	m
F6.0	VPHI	veh/hr
F4.0	VSP	mph
3I3	NLN,NLTL,NRTL	-
2F5.0,I3	FLT,FRT,LTFLG	-
Receptor Location Cards,	(NR cards):	
3F6.0	XR,YR,ZR	m
Meteorological Conditions Card,	(1 card):	
F4.0	U	m/s
F4.0	BRG	deg
F4.0	TAMB	^oF
I1	CLAS	-
F5.0	MIXH	m
F5.0	AMB	ppm
F5.0	Z0	cm
F5.0	ATIM	min
Vehicle Scenario Card,	(1 card):	
I1,I2	IREJN,ICY	-
3F5.0	PCCN,PCHC,PCCC	%
8F5.0	VMTMIX	-

DATA PROCESSING CENTER TEXAS A & M UNIVERSITY	PROBLEM: INPUT DATA FOR TEXIN MODEL	PAGE 1 OF 1
	PROGRAMMER: JPN	DATE 15/04/82

FORTRAN STATEMENT

HEADING AND FLAGS CARD:

HEAD	VMFLAG	PRTFLG	VNTFLG	NR	NNDL	NDL	NP	CY	
INPUT DATA CONVENTIONS	1	2	1	1	0	0	4	80.	(1 card)

LINK DESCRIPTION CARDS:

LA	XL1	YL1	XL2	YL2	TYP	WL	HL	VPHI	VSP	NLN	NLTL	NRTL	FLT	FRT	LTFLG	
1	0.	0.	0.	1000.	AG	15.0	0.	950.	45.	2	1	0	0.25	0.15	1	(4+NNDL+NDL cards)

RECEPTOR LOCATION CARDS:

XR	YR	ZR	
20.	20.	2.	(NR cards)

METEOROLOGICAL CONDITIONS CARD:

U	BRG	TAMB	CLAS	MIXH	AMB	Z0	ATIM	
2.5	135.	68.	4	1000.	0.0	100.	60.	(1 card)

VEHICLE SCENARIO CARD:

IREGN	ICY	PCCN	PCHC	PCCC	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC	
1	80	19.9	34.6	25.7	0.520	0.176	0.043	0.223	0.000	0.000	0.007	0.031	(1 card)

Figure A2. Input Data Conventions for the TEXIN Model.

NNDL, NDL, NP. The purposes of these variables are as follows:

VMFLAG - option flag for the VMT mix:
  0 - MOBILE-2 supplied VMT mix,
  1 - user-supplied VMT mix;

PRTFLG - output option flag (see the discussion of output for further clarification):
  0 - abbreviated output,
  1 - basic output,
  2 - extended output;

INTFLG - option flag for the type of intersection:
  0 - unsignalized intersection,
  1 - signalized intersection;

NR - the number of receptors (maximum of twenty);

NNDL - the number of additional links (other than the four intersection links) on which the traffic incurs no delay (i.e., extensions of an intersection link to account for a curve in the road);

NDL - the number of additional links on which the traffic incurs delay (i.e., side streets controlled by stop or yield signs);

NP - the number of phases (zero for an unsignalized intersection).

The final variable on the card is the signal cycle length, CY, in seconds.

Link Description Cards. The second type of input card is the Link Description card. Unlike the Heading and Flags card (for which there is only one card per run), the number of Link Description cards depends upon the intersection configuration. CALINE-3 treats the entire roadway as a link, rather than each lane as an individual link, with uniform emissions within a mixing zone centered along the physical centerline of the link (roadway); thus, the TEXIN program does the same. To model various intersection configurations, the TEXIN program recognizes three different types of links: (1) intersection links representing the four legs of the major intersection (there must always be four of these cards, although for a "T" intersection one would contain zero values); (2) links on which the traffic incurs no delay, such as connecting links approximating curves in the roadway significantly distant from the intersection to be free of delay (there must be NNDL number of these); and (3) links on which the traffic incurs delay, such as side streets controlled by stop or yield signs (there must be NDL number of these). Table A1 gives the input data sequence (and format) for the Link Description cards as described below. Not all of these data are necessary for each type of link, and any unnecessary parameters may be omitted from the Link Description card. (see example two).

In determining geometrical inputs to the TEXIN program, a localized x-y coordinate system is assumed for the intersection locale with the origin of the coordinate system lying at the approximate physical center of the intersection. The positive y-axis is then taken as being aligned with due north (this is an arbitrary assignment, but must be adhered to for all geometric inputs).

The first four Link Description cards are for the four intersection links with the first card for the north leg, the second for the east leg, the third for the south leg, and the fourth for the west. <u>This sequence must be followed for proper traffic evaluation</u>. The Link Description cards contain the following data:

LA - the link association number (for the four intersection links, this is simply the link number where 1=North, 2=East, 3=South, 4=West; for NNDL and NDL links, this is the intersection link with which the link is associated);

XL1,YL1 - the endpoints of the intersection-end of the link (these should be at the approximate center of the intersection);

XL2,YL2 - the endpoints of the upstream-end of the link;

TYP - type of link:
- AG - at grade,
- FL - fill,
- DP - depressed,
- BR - bridge;

WL - the actual width of the roadway (do not include the width of the shoulders);

HL - the source emission height (zero for at-grade);

VPHI - the number of vehicles <u>approaching</u> the intersection on the link;

VSP - the average speed of non-delayed vehicles on the link;

NLN - the number of <u>approach</u> lanes on the link;

NLTL - the number of exclusive left-turn lanes on the link;

NRTL - the number of exclusive right-turn lanes on the link;

FLT - the fraction of vehicles turning left on the link;

FRT - the fraction of vehicles turning right on the link;

LTFLG - flag indicating left turn signalization for the link:
0 - no left turn phase,
1 - left turn phase.

For unsignalized intersections, the major roadway (that is, the roadway with the right-of-way) must align with the north-south direction (links 1 and 3), and the flag, LTFLG, indicates whether the minor street is controlled by a stop or yield sign (0 - yield sign, 1 - stop sign). The program is not capable of modelling an uncontrolled or four-way stop sign controlled intersection.

The program is capable of modelling a "T" intersection (three legs); however, four intersection Link Description cards must be inputted to preserve the input sequence. A "T" intersection is handled by simply setting the incoming traffic volume on the "missing" leg to zero. Additionally, the fraction of vehicles turning on the other three legs must be such that no traffic leaves the intersection on the "missing" leg.

If there are any links on which the traffic does not incur delay, Link Description cards for these are supplied next. The data on these cards begin with the link association number, LA, and ends with the source emission height, HL. The link association number simply indicates which of the four intersection links the particular link is associated with (1 - north, 2 - east, 3 - south, 4 - west), and the other variables are as described previously. There should be NNDL number of these cards and no particular sequencing of the cards is necessary (see Example Two).

Next, Link Description cards for any minor streets on which the traffic incurs delay are inputted. The cards must contain all the data from LA to LTFLG. The link association number, LA, indicates which of the intersection links the particular link intersects; the endpoints, XL1 and YL1, are the endpoints of the intersection-end of the minor link; the flag, LTFLG, is once again indicative of the type of control on the minor link (0 - yield, 1 - stop); and, the rest of the variables are as defined previously (see Example Three). Minor streets can only be modelled if they intersect one of the four intersection links; however, if they do not intersect one of these links, they are presumably at such a great distance from the intersection that they will contribute little to the air quality in the vicinity of the intersection.

<u>Receptor Location Cards</u>. The third type of input card is the Receptor Location card (See Table A1). One card is needed for each receptor, and thus, there must be NR number of these cards in any order. The Receptor Location card contains the coordinates, XR and YR (with respect to the

localized x-y coordinate system), as well as the height, ZR, of the receptor.

Meteorological Condition Card. The next type of input card is the Meteorological Conditions card. Only one card is necessary per run, and Table A1 gives the input data sequence and format. This card contains the following data:

- U - the wind speed;
- BRG - the wind angle with respect to the positive y-axis (e.g., a wind from due east would be entered as 90 degrees);
- TAMB - the ambient temperature;
- CLAS - the Pasquill stability class (A=1 to F=6);
- MIXH - the mixing height;
- AMB - the ambient background concentration;
- Z0 - the surface roughness;
- ATIM - the averaging time.

Pasquill's analysis [A8] of atmospheric stability (Figure A3) and Myrup and Ranzieri's table [A6] of suggested surface roughness values (Table A2) are recommended for use in determining the stability class and surface roughness, respectively. A value of 100 metres is recommended for the mixing height.

Vehicle Scenario Card. The final type of input card required is the Vehicle Scenario card (See Table A1). Only one card is needed per run and contains the following data:

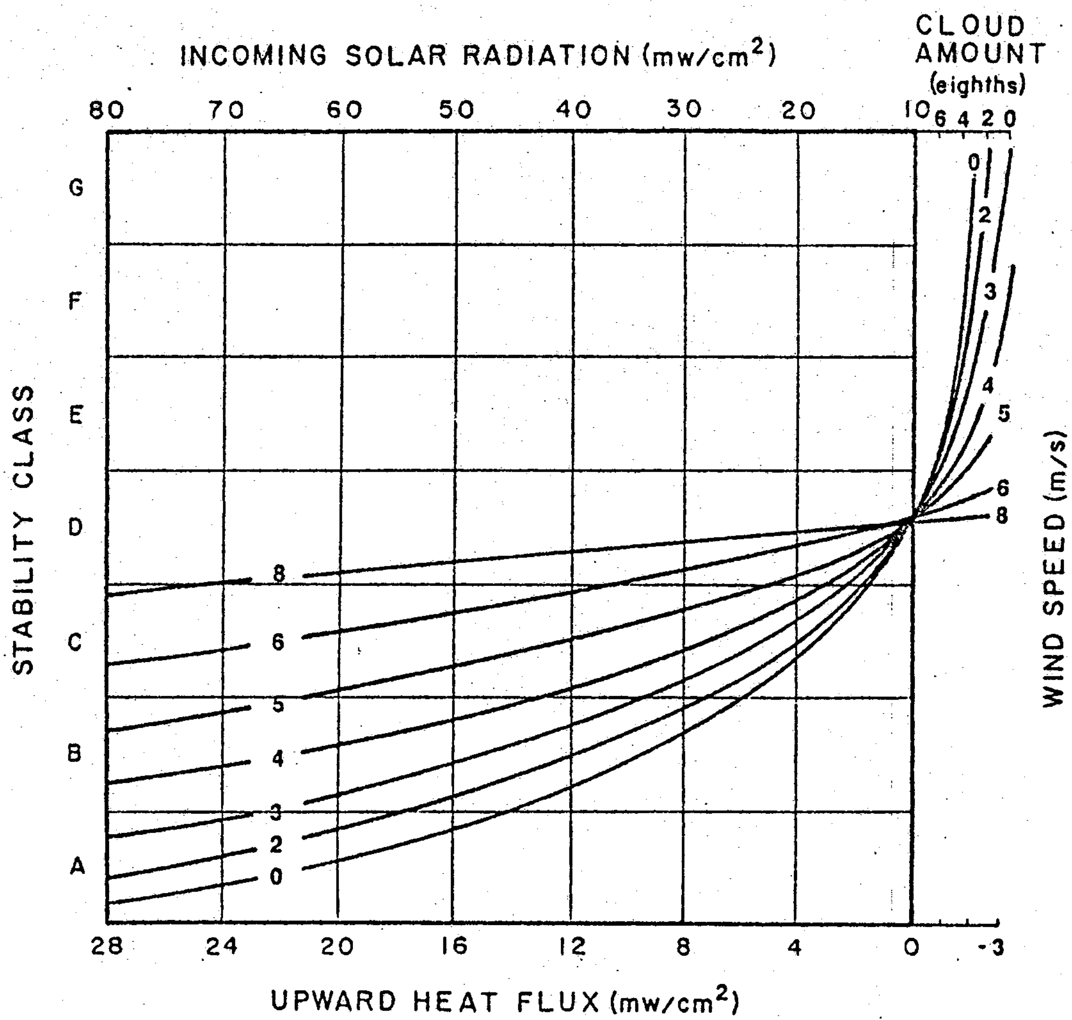

Figure A3. Pasquill stability, A-G, as related to wind speed and incoming solar radiation. [A8]

Table A2. Surface Roughness for Various Land Uses [A6].

TYPE OF SURFACE	Z_0 (cm)
Smooth mud flats	0.001
Tarmac (pavement)	0.002
Dry lake bed	0.003
Smooth desert	0.03
Grass (5-6 cm)	0.75
(4 cm)	0.14
Alfalfa (15.2 cm)	2.72
Grass (60-70 cm)	11.4
Wheat (60 cm)	22
Corn (220 cm)	74
Citrus orchard	198
Fir forest	283
City land-use:	
Single-family residential	108
Apartment residential	370
Office	175
Central-business district	321
Park	127

IREJN - the region being modelled:
1 - low altitude, non-California
2 - low altitude, California
3 - high altitude, non-California;

ICY - the last two digits of the calendar year being modelled;

PCCN - the percent non-catalyst equipped vehicles in cold start mode;

PCHC - the percent catalyst equipped vehicles in hot start mode;

PCCC - the percent catalyst equipped vehicles in the cold start mode;

VMTMIX - the VMT mix for the eight individual vehicle types (LDGV, LDGT1, LDGT2, HDGV, LDDV, LDDT, HDDV, and MC).

The VMT mix is only needed if a value of one (1) is inputted for VMFLAG on the Headings and Flags card; otherwise, the VMT mix is omitted and the MOBILE-2 supplied VMT mix will be utilized.

Discussion of Output

The output from the TEXIN Model is variable, depending on the value inputted on the Heading and Flags Card for the integer variable, PRTFLG. Three different output formats are available, and are: the abbreviated output, the basic output, and the extended output (corresponding to PRTFLG values of 0, 1, and 2, respectively).

The abbreviated output consists of a summary of the input meteorological conditions and a listing of the pollutant concentration at each receptor. In addition, the basic output also contains a section summarizing the intersection traffic flow analysis (including the volume to capacity ratio, stopped delay per vehicle, etc.) and a link description section (for both the physical links and the constructed psuedolinks). The extended output includes the MOBILE-2 emission factors and the contribution from each link to the pollutant concentration at each receptor.

Examples

Three examples have been prepared and are presented in order to facilitate the user's understanding of the capabilities and use of the TEXIN model.

Example One. The first example is the simple case of an intersection with four right angle corners. All four legs extend 1000 metres from the intersection and are geometrically identical (e.g., two approach lanes, one exclusive left turn lane, no right turn lanes, 15 metres in width, and at-grade). The x-y Cartesian coordinate system is mapped onto the intersection site, such that, the four legs lie along the x- and y-axes and the approximate center of the intersection is located at the origin of the coordinate system. This is shown in Figure A4.

The input cards for example one are presented in Figure A5. The first card is the Heading and Flags card. Note the flag values of zero for VMFLAG indicating that the MOBILE-2 supplied VMT mix is to be used, two for PRTFLG for the extended output format, and one for INTFLG indicating a signalized intersection. Two receptor locations are being

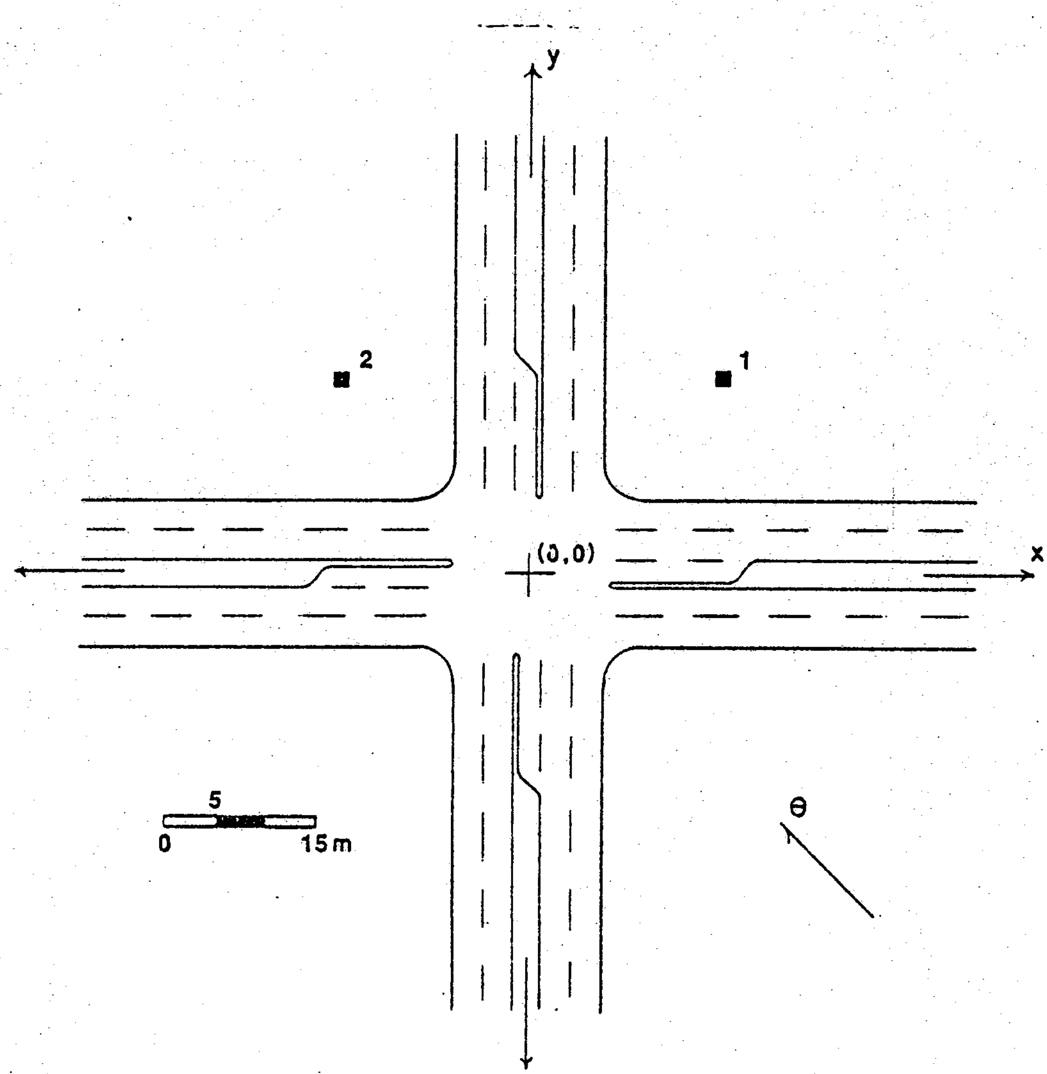

Figure A4. Intersection Geometry for example one.

```
 EXAMPLE ONE                                    Ø  2  1  2  Ø  Ø  4 8Ø.
  1    Ø.     Ø.     Ø. 1ØØØ.AG15.Ø  Ø.  95Ø. 45.  2  1  Ø  .25  .15  1
  2    Ø.     Ø. 1ØØØ.     Ø.AG15.Ø  Ø. 125Ø. 35.  2  1  Ø  .15  .1Ø  1
  3    Ø.     Ø.     Ø.-1ØØØ.AG15.Ø  Ø.  95Ø. 45.  2  1  Ø  .25  .15  1
  4    Ø.     Ø.-1ØØØ.     Ø.AG15.Ø  Ø. 125Ø. 35.  2  1  Ø  .15  .1Ø  1
   2Ø.    2Ø.     2.
  -2Ø.    2Ø.     2.
 3. 135. 68.41ØØØ.   Ø. 15Ø.  6Ø.
18Ø  2Ø.   35.   25.
```

Figure A5. Input file for example one.

modelled (NR = 2), and no additional links are needed for the simulation (NNDL = NDL = 0). The signalization is four phase (NP = 4) with an eighty second total cycle length (CY = 80.0) and these data are included on the first card as well.

The next four cards are Link Description cards which describe the four intersection legs. Note that XL1 and YL1 are the endpoints of the intersection-end of the link (e.g., (0.,0.) for all four links in this case), and that XL2 and YL2 are the upstream end of the link (1000 metres from the origin; e.g., (0., +1000.), (+1000., 0.), (0., -1000.), and (-1000., 0.) for links one through four, respectively). The links are all at-grade (TYP = AG), 15 metres in width (WL = 15.0), and the source emission height is taken as zero (HL = 0.0). All four links have two approach lanes (NLN = 2), one exclusive left turn lane (NLTL = 1), no exclusive right turn lanes (NRTL = 0), and a value of one is inputted on each card for the integer variable, LTFLG, indicating a left turn phase for all four approaches. The approach volumes, vehicle speeds, and fractions of left and right turning vehicles for the individual links are as shown on the Link Description cards (Figure A5); thus for link one: VPHI = 950.0, VSP = 45.0, FLT = 0.25, and FRT = 0.15.

Since there are no additional links to be modelled (NNDL = NDL = 0), the next input cards are the Receptor Location cards giving the geometric coordinates of the receptors (one card per receptor) as shown in Figure A5.

(These values are: XR = +20., YR = +20., and ZR = 2. for receptor one; and, XR = -20., YR = +20., and ZR = 2. for receptor two). Following these is the Meteorological Conditions card. The wind speed is three metres per second (U = 3.0). Note that wind direction is measured clockwise from the positive y-axis, thus a bearing of 135 degrees is inputted (BRG = 135.). The temperature is 68 degrees Fahrenheit (TAMB = 68.0), and the atmospheric stability is Pasquill type D (CLAS = 4). The mixing height is 1000 metres (MIXH = 1000.), the background concentration is zero (AMB = 0.0), the surface roughness is 150 cm (Z0 = 150.0), and the averaging time is 60 minutes (ATIM = 60.0), as shown on the Meteorological Condition card (Figure A5).

The final card is the Vehicular Scenario card. The region being modelled is low-altitude, non-California (IREJN = 1). Note that only the last two digits of the year being modelled (1980) are inputted (ICY = 80). The percentage of vehicles in the cold and hot start modes are as shown in Figure A4 (PCCN = 25.0, PCHC = 35.0, PCCC = 25.0), and since a value of zero is inputted for VMFLAG on the first card, no VMT mix data are supplied on this card.

Figure A6 gives the output from example one in the extended format. The first section gives the run title and a summary of the meteorological conditions. Following this are the MOBILE-2 emission factors (differentiated according to vehicle speed and vehicle type, and the idling emission rates) as well as a summary of the vehicle scenario. The

```
****************************************** TAMU INTERSECTION MODEL --- TEXIN ****************************
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TITLE:    EXAMPLE ONE

METEOROLOGICAL CONDITIONS:

WIND SPEED   =  3.Ø M/S              STABILITY CLASS        = 4              SURFACE ROUGHNESS= 15Ø. CM
WIND BEARING= 135. DEG               MIXING HEIGHT          = 1ØØØ. M        AVERAGING TIME   =  6Ø. MIN
TEMPERATURE = 68.Ø F                 AMBIENT CONCENTRATION=  Ø.Ø PPM
```

Figure A6. Output from example one.

-----MOBILE2 EMISSION FACTORS (GRAMS CO/VEHICLE MILE)-----

SCENARIO: REGION= 1
YEAR = 8Ø
PCCN = 2Ø.Ø
PCHC = 35.Ø
PCCC = 25.Ø

VEHICLE MIX: LDGV = Ø.782
LDGT1= Ø.Ø82
LDGT2= Ø.Ø47
HDGV = Ø.Ø42

LDDV = Ø.ØØ2
LDDT = Ø.ØØØ
HDDV = Ø.Ø35
MC = Ø.ØØ8

SPEED	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC	LDGT	ALL MODES
45.Ø	22.9	22.9	21.6	122.Ø	Ø.8	1.1	6.4	14.6	22.4	26.2
35.Ø	27.9	27.6	26.8	134.8	Ø.9	1.2	7.4	17.9	27.3	31.4
MOBILE2 IDLE EMISSION RATE (GRAMS CO/MIN)										
	13.6	11.5	9.1	9.9	Ø.2	Ø.3	Ø.9	3.7	1Ø.6	12.5

-----TRAFFIC FLOW ANALYSIS (MAJOR INTERSECTION - SIGNALIZED)-----

VOLUME/CAPACITY= Ø.86
STOPPED DELAY= 32.3 SEC/VEH
APPROACH DELAY= 43.9 SEC/VEH
TIME IN QUEUE= 4Ø.8 SEC/VEH
FRACTION STOPPING= Ø.76

FRACTION OF EXCESS
EMISSIONS DUE TO:
VEHICLES SLOWING= Ø.23
VEHICLES STOPPING= Ø.44
VEHICLES IDLING= Ø.33

Figure A6. (continued).

LINK DESCRIPTION

LINK	XL1	YL1	XL2	YL2	LENGTH	VEH/HR	SPEED	MGM CO/M-SEC
1	Ø.Ø	Ø.Ø	Ø.Ø	1ØØØ.Ø	1ØØØ.Ø	1832.	45.Ø	8.3Ø
2	Ø.Ø	Ø.Ø	1ØØØ.Ø	Ø.Ø	1ØØØ.Ø	2567.	35.Ø	13.9Ø
3	Ø.Ø	Ø.Ø	Ø.Ø	-1ØØØ.Ø	1ØØØ.Ø	1832.	45.Ø	8.3Ø
4	Ø.Ø	Ø.Ø	-1ØØØ.Ø	Ø.Ø	1ØØØ.Ø	2567.	35.Ø	13.9Ø
5	Ø.Ø	Ø.Ø	Ø.Ø	64.4	64.4	1832.	45.Ø	82.44
6	Ø.Ø	Ø.Ø	84.7	Ø.Ø	84.7	2567.	35.Ø	82.44
7	Ø.Ø	Ø.Ø	Ø.Ø	-64.4	64.4	1832.	45.Ø	82.44
8	Ø.Ø	Ø.Ø	-84.7	Ø.Ø	84.7	2567.	35.Ø	82.44

LINK POLLUTANT CONTRIBUTION

CONTRIBUTION FROM EACH LINK TO POLLUTANT CONCENTRATION AT RECEPTOR 1:

LINK NUMBER:	1	2	3	4	5	6	7	8
CONTRIBUTION(PPM):	Ø.Ø	Ø.8	Ø.Ø	Ø.Ø	Ø.Ø	4.6	Ø.Ø	Ø.Ø

CONTRIBUTION FROM EACH LINK TO POLLUTANT CONCENTRATION AT RECEPTOR 2:

LINK NUMBER:	1	2	3	4	5	6	7	8
CONTRIBUTION(PPM):	Ø.3	Ø.3	Ø.2	Ø.4	2.6	2.Ø	2.Ø	2.6

Figure A6. (continued).

---------------------------RECEPTOR DESCRIPTION AND MODEL PREDICTIONS---------------------------

RECEPTOR	XR	YR	ZR	CO (PPM)*
1	2Ø.Ø	2Ø.Ø	2.Ø	5.4
2	-2Ø.Ø	2Ø.Ø	2.Ø	1Ø.4

*INCLUDES BACKGROUND AMBIENT CONCENTRATION OF Ø.Ø PPM

****

Figure A6. (continued).

next section presents the intersection traffic flow analysis and gives values for the volume/capacity ratio, stopped delay, approach delay, time in queue, fraction stopping, and the fraction of excess emissions due to vehicles slowing, stopping, and idling.

A description of the links (both physical and psuedo) is presented in the following section. This description includes link endpoints, link length, link volume, vehicle speed, and the link emission factor for each link. The contributions from each link to the pollutant contribution at the individual receptors follow the link descriptions. The model's predicted concentrations at the receptors (including the background concentration) are presented in the final section of the output.

Example Two. The second example is an unsignalized intersection and illustrates the program's ability to model curved roadways (Figure A7 presents the site geometry). A value of one for VMFLAG (user-supplied VMT mix), zero for PRTFLG (abbreviated output), and zero for INTFLG (unsignalized) are inputted on the first card. A value of six is inputted for NNDL as that is the number of additional links required to model the curved portions of roadway. Since the intersection is unsignalized, values for NP and CY need not be inputted. The input cards are shown in Figure A8.

The four Link Description cards for the intersection legs are inputted next. The coordinate system must be

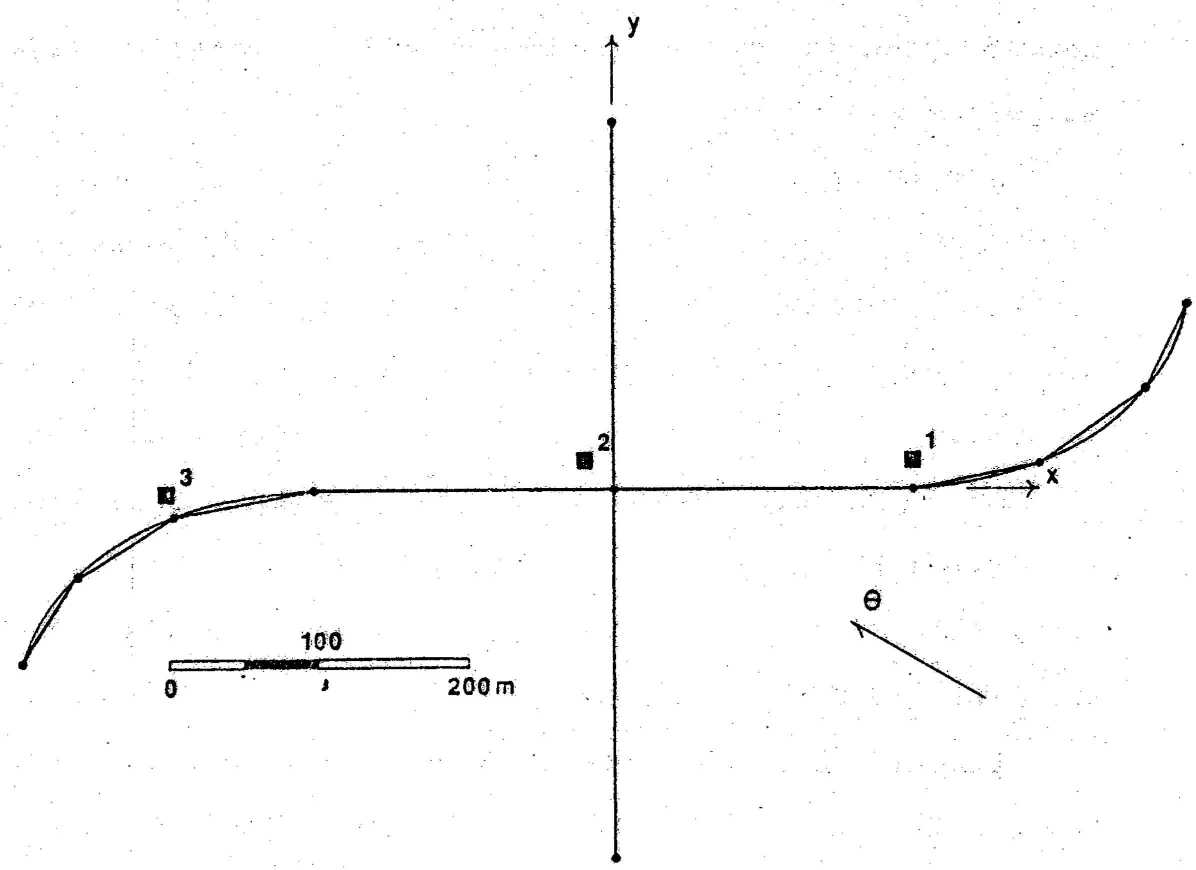

Figure A7. Intersection Geometry for example two.

```
EXAMPLE TWO                                              1  Ø  Ø  3  6  Ø  Ø  Ø.
 1    Ø.     Ø.     Ø.  4ØØ.AG17.5  Ø.  45Ø. 35.  2  1  Ø  .1Ø  .1Ø  Ø
 2    Ø.     Ø.   2ØØ.     Ø.AG14.Ø  Ø.  1ØØ. 35.  2  Ø  Ø  .2Ø  .15  1
 3    Ø.     Ø.     Ø. -4ØØ.AG17.5  Ø.  35Ø. 35.  2  1  Ø  .1Ø  .1Ø  Ø
 4    Ø.     Ø.  -2ØØ.     Ø.AG14.Ø  Ø.  125. 35.  2  Ø  Ø  .2Ø  .15  1
 2  2ØØ.     Ø.   285.    2Ø.AG14.Ø  Ø.
 2  285.    2Ø.   36Ø.    7Ø.AG14.Ø  Ø.
 2  36Ø.    7Ø.   39Ø.   12Ø.AG14.Ø  Ø.
 4 -2ØØ.     Ø.  -295.   -2Ø.AG14.Ø  Ø.
 4 -295.   -2Ø.  -36Ø.   -6Ø.AG14.Ø  Ø.
 4 -36Ø.   -6Ø.  -4ØØ.  -12Ø.AG14.Ø  Ø.
 2ØØ.   2Ø.      2.
 -2Ø.   2Ø.      2.
-1ØØ.    Ø.      2.
2. 12Ø. 75.31ØØØ.   Ø.  5Ø.  6Ø.
175 39.2 44.5 37.8 .52Ø .176 .Ø43 .223 .ØØØ .ØØØ .ØØ7 .Ø31
```

Figure A8. Input file for example two.

chosen such that the major road lies along the y-axis (and thus assigned to links one and three). Traffic on the major roadway is assumed to not incur delay (except for left turning vehicles). Values for LTFLG are not necessary for the major road (links 1 and 3), but are necessary for the minor road (links 2 and 4), and a value of one is inputted for both indicating stop sign controlled approaches. The next six cards are for the additional links required to fit the curves. The first variable on each of these cards is the link association number, LA, and indicates from which of the four intersection links the additional links extend. In this case, three of the links have an LA value of four (and three a value of two) since they are extensions of the minor road. The traffic on these links are assumed to incur no delay (as they are entered as NNDL links), and thus, must be sufficiently distant from the intersection to insure this. The variables VPHI through LTFLG are not needed for NNDL links and are omitted from the Link Description cards.

Following the Receptor Location and Meteorological Conditions cards is the Vehicular Scenario card. Since a value of one is inputted on the Heading and Flags card, the VMT mix data are supplied on this card as shown (LDGV = 0.520, LDGT1 = 0.176, LDGT2 = 0.043, HDGV = 0.223, LDDV = 0.000, LDDT = 0.000, HDDV = 0.007, MC = 0.031).

Figure A9 shows the output from example two in the abbreviated format. This output format includes a summary of the meteorological conditions and the model's predicted concentrations at the receptor sites.

```
****************************************** TAMU INTERSECTION MODEL --- TEXIN ******************************
-----------------------------------------------------------------------------------------------------------

TITLE:    EXAMPLE TWO

METEOROLOGICAL CONDITIONS:

WIND SPEED  =  2.0 M/S          STABILITY CLASS        = 3           SURFACE ROUGHNESS=  50. CM
WIND BEARING= 120. DEG          MIXING HEIGHT          = 1000. M     AVERAGING TIME   =  60. MIN
TEMPERATURE = 75.0 F            AMBIENT CONCENTRATION=  0.0 PPM

--------------------------------RECEPTOR DESCRIPTION AND MODEL PREDICTIONS---------------------------------

        RECEPTOR          XR            YR            ZR            CO (PPM)*
        --------       --------      --------      --------        --------

           1            200.0          20.0          2.0             0.2

           2            -20.0          20.0          2.0             4.7

           3           -300.0           0.0          2.0             0.3

        *INCLUDES BACKGROUND AMBIENT CONCENTRATION OF  0.0 PPM

***********************************************************************************************************
```

Figure A9. Output from example two.

<u>Example Three</u>. The third example illustrates TEXIN's ability to model several minor unsignalized intersections in conjunction with the major intersection. The intersection geometry is presented in Figure A10 (the major roadways in bold) and the input cards are shown in Figure All. Three additional links are necessary to model the minor intersections. Traffic on these links will incur delay, and thus, they are inputted as NDL links (NDL = 3).

The Link Description cards for the three additional links follow the cards for the four intersection links. The first variable on all three cards is the link association number, LA, and indicates which leg of the intersection the minor road intersects. For the minor roadway which intersects (and terminates at) the positive x-axis, a value of two (corresponding to link 2) is inputted for the integer variable, LA. For the minor roadway which intersects (and crosses) the negative x-axis, two links are necessary for the modelling and both have values of four inputted for LA. Note that like the four intersection links, the values, XL1 and YL1, for the three additional links correspond to the intersection-end of the link. The minor roadway intersecting the positive x-axis is controlled by a yield sign, and thus a value of zero is inputted for the integer variable, LTFLG. The other minor roadway is controlled by a stop sign, thus a value of one is inputted. Note that all the roadways actually extend further than shown in Figure A10.

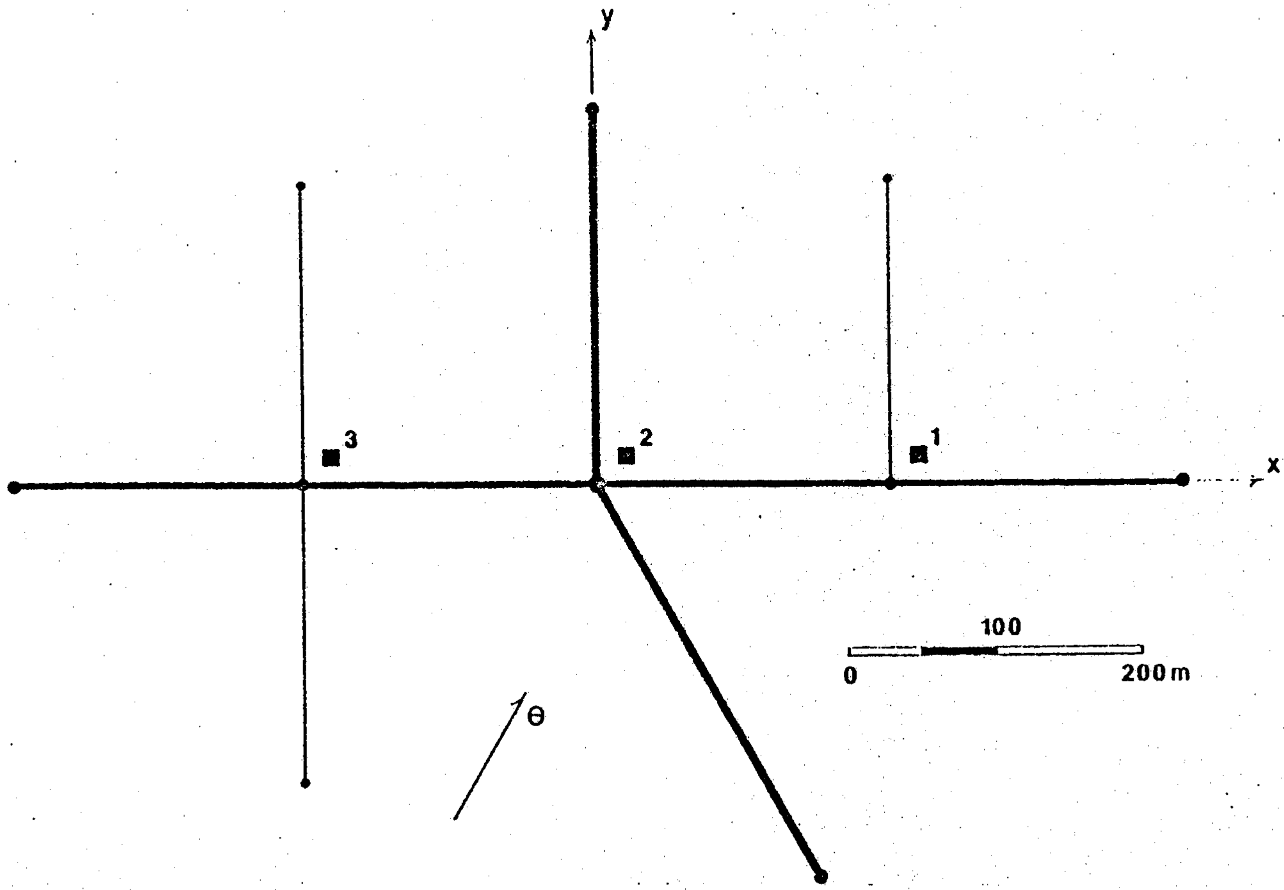

Figure A10. Intersection Geometry for example three.

```
 EXAMPLE THREE                                       Ø  1  1  3  Ø  3  41ØØ.
  1     Ø.     Ø.     Ø. 1ØØØ.AG15.Ø  Ø. 125Ø. 45.  2  1  Ø  .2Ø  .Ø5  1
  2     Ø.     Ø.  2ØØ.     Ø.AG17.Ø  Ø.  6ØØ. 45.  2  1  1  .15  .2Ø  1
  3     Ø.     Ø.  5ØØ. -866.AG15.Ø  Ø. 1Ø5Ø. 45.  2  1  Ø  .Ø5  .15  1
  4     Ø.     Ø.-12ØØ.     Ø.AG17.Ø  Ø.  4ØØ. 45.  2  1  Ø  .3Ø  .1Ø  1
  4  -2ØØ.     Ø. -2ØØ. 12ØØ.AG14.Ø  Ø.   7Ø. 35.  2  Ø  Ø  .1Ø  .4Ø  1
  4  -2ØØ.     Ø. -2ØØ.-12ØØ.AG14.Ø  Ø.   8Ø. 35.  2  Ø  Ø  .Ø5  .45  1
  2   2ØØ.     Ø.  2ØØ. 12ØØ.AG 8.Ø  Ø.   65. 35.  1  Ø  Ø  .35  .65  Ø
  22Ø.   2Ø.     2.
   2Ø.   2Ø.     2.
 -18Ø.   2Ø.     2.
 2.521Ø. 68.31ØØØ.   Ø. 15Ø.   6Ø.
281 21.5 3Ø.6 29.4
```

Figure A11. Input file for example three.

Figure A12 illustrates the output from example three in the basic output format. For this example, there are two traffic flow analysis sections. The first is for the major intersection, and presents values for volume/capacity ratio, stopped delay, approach delay, time in queue, fraction stopping, and fraction of excess emissions due to vehicles slowing, stopping, and idling. The second is for the minor intersections and the same values are given, with the exception that the reserve capacity of the unsignalized intersections is given rather than the volume/capacity ratio. Note that for a stop sign controlled intersection the fraction of vehicles stopping is always one, while the same for a yield sign controlled intersection may be less than one. The link descriptions and model predictions follow these sections.

```
****************************************** TAMU INTERSECTION MODEL --- TEXIN ****************************
----------------------------------------------------------------------------------------------------------

TITLE:    EXAMPLE THREE

METEOROLOGICAL CONDITIONS:

WIND SPEED  =  2.5 M/S          STABILITY CLASS        = 3              SURFACE ROUGHNESS= 15Ø. CM
WIND BEARING= 21Ø. DEG          MIXING HEIGHT          = 1ØØØ. M        AVERAGING TIME   =  6Ø. MIN
TEMPERATURE = 68.Ø F            AMBIENT CONCENTRATION=  Ø.Ø PPM

---------------------------------TRAFFIC FLOW ANALYSIS (MAJOR INTERSECTION - SIGNALIZED)------------------

          VOLUME/CAPACITY= Ø.7Ø                          FRACTION OF EXCESS
          STOPPED DELAY= 21.9 SEC/VEH                    EMISSIONS DUE TO:
          APPROACH DELAY= 3Ø.1 SEC/VEH                   VEHICLES SLOWING= Ø.27
          TIME IN QUEUE= 27.4 SEC/VEH                    VEHICLES STOPPING= Ø.57
          FRACTION STOPPING= Ø.67                        VEHICLES IDLING= Ø.16
```

Figure A12. Output from example three.

----------------TRAFFIC FLOW ANALYSIS (MINOR INTERSECTION(S) - UNSIGNALIZED)----

```
FOR LINK  9:
     RESERVE CAPACITY=    93. VEH              FRACTION OF EXCESS
     STOPPED DELAY= 34.4 SEC/VEH               EMISSIONS DUE TO:
     APPROACH DELAY= 46.6 SEC/VEH              VEHICLES SLOWING= Ø.13
     TIME IN QUEUE= 43.5 SEC/VEH               VEHICLES STOPPING= Ø.6Ø
     FRACTION STOPPING= 1.ØØ                   VEHICLES IDLING= Ø.27

FOR LINK 1Ø:
     RESERVE CAPACITY=    96. VEH              FRACTION OF EXCESS
     STOPPED DELAY= 34.2 SEC/VEH               EMISSIONS DUE TO:
     APPROACH DELAY= 46.4 SEC/VEH              VEHICLES SLOWING= Ø.13
     TIME IN QUEUE= 43.3 SEC/VEH               VEHICLES STOPPING= Ø.6Ø
     FRACTION STOPPING= 1.ØØ                   VEHICLES IDLING= Ø.27

FOR LINK 11:
     RESERVE CAPACITY=    5Ø. VEH              FRACTION OF EXCESS
     STOPPED DELAY= 37.Ø SEC/VEH               EMISSIONS DUE TO:
     APPROACH DELAY= 5Ø.Ø SEC/VEH              VEHICLES SLOWING= Ø.2Ø
     TIME IN QUEUE= 46.8 SEC/VEH               VEHICLES STOPPING= Ø.49
     FRACTION STOPPING= Ø.79                   VEHICLES IDLING= Ø.3Ø
```

Figure A12. (continued).

LINK DESCRIPTION

LINK	XL1	YL1	XL2	YL2	LENGTH	VEH/HR	SPEED	MGM CO/M-SEC
1	0.0	0.0	0.0	1000.0	1000.0	2330.	45.0	7.96
2	0.0	0.0	1000.0	0.0	1000.0	1247.	45.0	4.26
3	0.0	0.0	500.0	-866.0	1000.0	2117.	45.0	7.24
4	0.0	0.0	-1000.0	0.0	1000.0	905.	45.0	3.09
5	0.0	0.0	0.0	93.4	93.4	2330.	45.0	49.45
6	0.0	0.0	44.8	0.0	44.8	1247.	45.0	49.45
7	0.0	0.0	39.2	-67.9	78.4	2117.	45.0	49.45
8	0.0	0.0	-29.9	0.0	29.9	905.	45.0	49.45
9	-200.0	0.0	-200.0	1000.0	1000.0	140.	35.0	0.57
10	-200.0	0.0	-200.0	-1000.0	1000.0	170.	35.0	0.69
11	200.0	0.0	200.0	1000.0	1000.0	130.	35.0	0.53
12	-200.0	0.0	-200.0	8.0	8.0	140.	35.0	30.01
13	-200.0	0.0	-200.0	-8.0	8.0	170.	35.0	36.39
14	200.0	0.0	200.0	10.4	10.4	130.	35.0	20.62

Figure A12. (continued).

----------------------------RECEPTOR DESCRIPTION AND MODEL PREDICTIONS----------------------------

RECEPTOR	XR	YR	ZR	CO (PPM)*
1	22Ø.Ø	2Ø.Ø	2.Ø	Ø.5
2	2Ø.Ø	2Ø.Ø	2.Ø	6.Ø
3	-18Ø.Ø	2Ø.Ø	2.Ø	Ø.8

*INCLUDES BACKGROUND AMBIENT CONCENTRATION OF Ø.Ø PPM

****

Figure A12. (continued).

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