

Data Reconciliation Based
Traffic count Analysis System

USER'S GUIDE

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Introducing the Traffic Count Analysis System

Chapter 1

The Traffic Count Analysis System (TCAS) is a software package written in the FORTRAN computer programming language. It is developed to analyze traffic count data for freeways, and is designed to perform the following functions:

- Calculate average annual daily traffic (AADT) values for ramps and certain mainline sections using hourly traffic count data.
- Estimate AADTs for uncounted mainline sections.
- Adjust the ramp AADTs and the estimated mainline AADTs so that they are balanced at all intersections.

The TCAS can also be used to update the station location data file. The station location data file contains the information required to calculate the AADTs and to form the incidence matrix (which is a numerical representation of the freeway network). Updating of the station location data file is required whenever changes occur in the configuration of the freeway.

The minimum amount of input data required for the TCAS includes:

1. Hourly traffic counts,
2. Expansion factors,
3. Station location data.

System Requirements

Programs in the TCAS are mainly written in the standard FORTRAN 77. A few features of the Microsoft FORTRAN version 5.1 have been used. The programs are compiled using the Microsoft FORTRAN version 5.1 compiler. The TCAS requires the following configurations:

1. An IBM Personal Computer or 100%-compatible running DOS version 3.0 or later, or OS/2 version 1.1 or later.
2. 512K of RAM.
3. One high-density 3.5" double-sided disk drive.
4. A hard disk drive with 5 MB available disk space.

Installation

The SETUP utility (on Disk 1) must be used to install the TCAS since the TCAS files on the floppy disks must be copied to designated sub-directories on the hard disk. The SETUP utility creates these sub-directories and copies files to these sub-directories. The SETUP utility never deletes or changes any files on the floppy disks. The user can quit the utility by pressing CTRL+C and start over at any time.

Before Beginning For safety, the disks should be backed up before installing the TCAS. Be sure that enough disk space is available for installation. The disk space required depends primarily on the number of years of traffic count data to be installed since the traffic count data files are large.

Starting SETUP Insert the disk with the SETUP utility (Disk 1) into the floppy drive A and make that drive the current drive. Type SETUP and press ENTER. A screen will appear as follows.

```
=====
TRAFFIC COUNT ANALYSIS SYSTEM INSTALLATION
Welcome to the SETUP program
=====

Start Menu

Here's what you can do:

    1. Install the TCAS
    2. Add file/files to the TCAS
    3. Delete the TCAS
    4. Exit

Type the number you want and press ENTER:
```

Select a choice by typing the number for the choice and then pressing the ENTER key. A series of self-explanatory prompts will be provided by the SETUP utility for completing the operation.

Preparing Input Data Files

Chapter 2

Four data files are required as input in the TCAS for a given year for almost all freeways. These data files are:

1. The traffic count data file.
2. The expansion factor data file.
3. The station location data file.
4. The additional data file.

The first three data files are required for all freeways. The additional data file is not required for some freeways of which all traffic count data required by the TCAS are available from the traffic count data file. The data required by the TCAS for a given freeway are traffic count data for all ramps of the freeway and traffic count data for at least one mainline section. Following sections discuss these data files.

Traffic Count Data File

The ConnDOT's mainframe traffic count data file is used as the traffic count data file in the TCAS. The traffic count data file contains hourly traffic count data and other pertinent information for every active counting station for the study year. A section of the traffic count data file is shown in Table 2.1 (a). Table 2.1(b) is a full listing of the content of each column of the traffic count data file.

Expansion Factor Data File

The ConnDOT's mainframe expansion factor data file is used as the expansion factor data file in the TCAS. This data file contains the expansion factors required for expanding 24-hour total traffic volumes to AADTs. Table 2.2 shows a part of an expansion factor data file.

Station Location Data File

The station location data file for a freeway in the TCAS contains a subset of the ConnDOT's mainframe station location data file. This subset is the

Table 2.3 A Part of an Expansion Factor Data File

11.12,1.12,1.12,1.12,0.97,
 21.13,1.13,1.13,1.13,1.03,
 31.11,1.11,1.11,1.11,0.97,
 41.01,1.01,1.01,1.01,0.92,
 51.57,1.57,1.57,1.57,1.14,
 61.22,1.22,1.22,1.22,1.05/
 11.11,1.11,1.11,1.11,0.94,
 21.11,1.11,1.11,1.11,1.01,
 31.08,1.08,1.08,1.08,0.94,
 41.01,1.01,1.01,1.01,0.92,
 51.54,1.54,1.54,1.54,1.07,
 61.19,1.19,1.19,1.19,1.01/
 11.06,1.06,1.06,1.06,0.90,
 21.07,1.07,1.07,1.07,0.96,
 31.06,1.06,1.06,1.06,0.90,
 40.99,0.99,0.99,0.99,0.91,
 51.48,1.48,1.48,1.48,1.05,
 61.15,1.15,1.15,1.15,0.96/
 11.00,1.00,1.00,1.00,0.86,
 21.01,1.01,1.01,1.01,0.91,
 31.01,1.01,1.01,1.01,0.87,
 40.94,0.94,0.94,0.94,0.87,
 51.33,1.33,1.33,1.33,1.00,
 61.07,1.07,1.07,1.07,0.89/
 10.97,0.97,0.97,0.97,0.82,
 20.94,0.94,0.94,0.94,0.86,
 30.98,0.98,0.98,0.98,0.82,
 40.92,0.92,0.92,0.92,0.83,
 51.27,1.27,1.27,1.27,0.94,
 61.04,1.04,1.04,1.04,0.80/

 10.98,0.98,0.98,0.98,0.82,
 20.96,0.96,0.96,0.96,0.86,
 30.98,0.98,0.98,0.98,0.83,
 40.93,0.93,0.93,0.93,0.85,
 51.24,1.24,1.24,1.24,0.79,
 61.03,1.03,1.03,1.03,0.85/
 11.02,1.02,1.02,1.02,0.87,
 21.00,1.00,1.00,1.00,0.90,
 31.00,1.00,1.00,1.00,0.86,
 40.93,0.93,0.93,0.93,0.84,
 51.41,1.41,1.41,1.41,0.90,
 61.08,1.08,1.08,1.08,0.93/
 11.03,1.03,1.03,1.03,0.89,
 20.97,0.97,0.97,0.97,0.91,
 30.99,0.99,0.99,0.99,0.88,
 40.91,0.91,0.91,0.91,0.85,
 51.42,1.42,1.42,1.42,1.14,
 61.08,1.08,1.08,1.08,0.93/

records associated with the freeway. The station location data file also includes the stream numbers, which are required to form the incidence matrix. Refer to the technical report of the project [1] for details about the stream numbers and the incidence matrix.

Generally there are two types of traffic counting stations that are monitored on a freeway. They are ramp counting stations and mainline counting stations. For each station, there is a record associated with it in the station location data file. Here two records in the station location data file are discussed. These two records are associated with a ramp counting station and a mainline counting station. Other special records in the station location data file will be discussed in the technical report of the project [1].

A section of the station location data file for I-91 is shown in Table 2.3. Two records, (1) and (2), associated with a ramp counting stations and a mainline counting station, are highlighted as examples.

The record for the ramp counting station (Record (1)) contains six items. The first item is the stream number which is assigned sequentially to each stream on the freeway. The second item is the station number which is a unique number assigned by ConnDOT for every counting station. The third item is the route number. The fourth item is the expansion factor group number. The fifth item is the route direction code which indicates the direction on which the counting station is installed. The last item is a station location description which begins with either ON or OFF. ON or OFF is used to indicate the ramp stream direction with reference to the freeway mainline.

Table 2.3 Station Location Data File

```

=====
146 0467184 I-91 4 N.B. OFF RAMP TO U.S. 5
148 0467185 I-91 4 N.B. ON RAMP FROM U.S. 5
164 0467186 I-91 4 S.B. ON RAMP FROM ROUTE 140
166 0467187 I-91 4 S.B. OFF RAMP TO ROUTE 140
150 0467188 I-91 4 N.B. OFF RAMP TO ROUTE 140 . . . . .(1)
150 0467188 I-91 4 N.B. OFF RAMP TO ROUTE 140
152 0467189 I-91 4 N.B. ON RAMP FROM ROUTE 140
167 0469053*I-91 0 S.B. OUT CONTINUOUS COUNT STATION 53 . . (2)
153 0469053*I-91 0 N.B. IN CONTINUOUS COUNT STATION 53
123 0631022*I-91 1 S.B. OUT BETWEEN EXIT 33 AND EXIT 34
111 0631022*I-91 1 N.B. IN BETWEEN EXIT 33 AND EXIT 34
=====

```


The record for a mainline counting station (Record (2)) is similar to that for a ramp counting station. The major difference is that, rather than ON or OFF, IN or OUT is used to indicate the stream direction.

It is necessary to clearly define the stream directions for a mainline stream. The records in the station location data file are associated with streams, and each stream for the freeway mainline is connected to two nodes. The stream leaves (OUT) one node and enters (IN) the other. If the stream directions are not defined clearly, it will cause confusion. The stream directions are determined by the traffic flow direction and how the streams are labeled. The stream direction for a mainline stream is defined by the following:

- If the traffic in the study stream flows to a stream with higher stream number, the stream direction is IN.
- If the traffic in the study stream flows to a stream with lower stream number, the stream direction is OUT.

A completed station location data file for a freeway must contain records for all ramps of the freeway and at least two records for the mainline counting stations (each for one direction of the freeway). The stream numbers and the stream directions are used to form the incidence matrix. Other information, such as the station number and the expansion factor group numbers, are used to calculate the AADTs.

Additional Data File

In addition to the three above mentioned data files, the additional data file is used to explicitly provide AADTs for certain ramps and/or mainline streams. This file is required only when traffic count data for the ramp or mainline streams are not available directly from the traffic count data file.

Usually all required AADTs can be obtained using the data in the traffic count data file; however, there are special cases where AADTs need to be given explicitly. These special cases include the following:

1. The traffic count data of the Continuous Count Stations and some other control stations are sometimes not available from the traffic count data file.
2. Traffic count data of a ramp or ramps are sometimes not available from the traffic count data file. In most cases, they have been deleted because there is strong evidence that the data were incorrect.

3. Traffic count data of a ramp or ramps are not available from the traffic count data file because they are not counted and the data of the roadway sections directly connected to the ramp are not counted either.
4. A specific AADT value is desired to be used instead of the value calculated from the traffic count data file.

The additional data file can be used to provide the AADT values in all of these cases. An example of the additional data file for I-91 northbound is shown in Table 2.4. For each record, the first item is the stream number, the second item is the station number, and the third item is the AADT value associated with the stream. Every item in a record should be separated by a comma or space.

Table 2.4 Additional Data File

10	0920000	8300
24	1007030	9500
45	1489055	30500
56	0797064	3200
86	1598102	3400
106	0638104	1700
134	1648102	1500
153	0469953	41000

Using the Traffic Count Analysis System

Chapter 3

Getting Started

Enter the sub-directory TCAS by using the DOS command CD and then type TCAS at the DOS command prompt to start the TCAS. The operational choices for the TCAS will show on screen as follows:

```
*****  
*****  
**                                     **  
**          TRAFFIC DATA RECONCILIATION          **  
**                                     **  
*****  
*****  
  
1 - Non-interactive Mode  
2 - Interactive Mode  
3 - Updating Station Location Data File  
4 - Exit  
  
My choice is (1->4):_
```

Select one of the four choices by giving the number for the choice and then pressing ENTER. The first two choices, Non-interactive Mode and Interactive Mode, both start the traffic count data analysis. The third choice, Updating Station Location Data File, starts the procedure of updating the existing station location data file. The last choice, Exit, quits the program without any operation.

The non-interactive mode calculation will be discussed in the next section followed by a discussion of the interactive mode calculation. The procedure of updating the station location data file will be presented in Chapter 5.

Non-Interactive Mode

In order to perform the traffic count data analysis, calculation control parameters must be provided for the TCAS. These parameters include the study year, the route, the route direction, the starting station number, the ending station number, and sometimes a list of year(s) in the previous cycle(s). These years are the years of which AADTs are desired to be calculated for the purpose of comparison.

For the non-interactive mode, these calculation control parameters are stored in a data file, named PARAMETR.DAT. When the non-interactive mode is selected, the TCAS reads the calculation control parameters from this data file and starts the calculation.

An example of PARAMETR.DAT is shown below. PARAMETR.DAT typically contains two records. The first record provides the study year, the route, the route direction, the starting station number, the ending station number, and the number of years that list in the second record. The second record is a list of the year(s) in the previous cycles(s). It is needed only when the calculation of AADTs for previous year(s) is desired, in other words, when the last number in the first record is not zero.

```
'1994', '91', 'N', 1489055, 0337071, 1,  
'1991'
```

The parameters in this example indicates that the analysis of traffic count data are desired to be performed for year 1994 and I-91 northbound, from the Continuous Counting Station 9055 to station 0337071. The AADTs for one previous year (1991) are desired to be calculated.

Interactive Mode

For the interactive mode, the same calculation control parameters as in the non-interactive mode are required. The only difference is that they are provided interactively. Let us illustrate the interactive mode using the example for the non-interactive mode.

If you select the interactive mode from the operation choice screen, a prompt appears as follows:

```
-----  
DATA RECONCILIATION - YEAR OF THE DATA TO BE USED  
-----
```

The year of the data to be used:

Enter 1994, and press ENTER. The program will continue to provide similarly self-explanatory prompts for you to select the route and the route direction, and to enter the starting station number and the ending station number. Note that the starting station number must be the number of a station that is on the freeway mainline and the hourly traffic counts or the AADT is available. And the ending station number must be the number of a ramp station.

After entering the ending station number, prompts appear on screen as follows:

How many previous cycles do you want to compare?

Enter 1, which indicates that AADTs for one previous year is desired to be calculated and listed.

After this, prompts for entering the year of the previous year appear as follows:

Year 1 of previous cycles to be used:

Enter 1991, and press ENTER. The program starts to read the input data and do the calculation. Again, the status of the calculation will appear on the screen.

Displaying the Results

Chapter 4

Two output data files have been developed for presenting the calculation results. The formats of the output data files are shown in Table 4.1 and Table 4.2. These two tables contain the calculation results for the example calculation discussed in Chapter 3.

Table 4.1. Reconciliation Results

```
=====
STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION
BUREAU OF POLICY AND PLANNING
PLANNING INVENTORY AND DATA

DAILY COUNTS, AADTS AND RECONCILIATION RESULTS

ROUTE 91          DIRECTION N          YEAR 1994

STREAM  STATION  DAILY  YEAR  RECON.
NUMBER  NUMBER   COUNT  AADT  RESULT

045     1489055   30500   30500  30500
046     1487052    5915    5500   5500
047                                     25000
048     1487053    5414    5035   5000
049                                     30000
050     0797055    2882    2680   2700
051                                     27300
052     0797058   10947   10180  10200
053                                     17100
054     0797059   15130   14070  14200
055                                     31300
056     0797064    3200    3200   3200
057                                     28100
058     0000999    9692    8839   8900
059                                     37000
060     0797068    1139    1070   1100
061                                     38100
062     0827075    3244    3049   3000
063                                     35100
064     0827076    1330    1250   1300
065     0821021   40462   38507  36400
066     0337071    3379    3176   3200
067                                     33200

END OF FILE
-----
```

Table 4.1 shows the reconciliation results. In addition to the title section, there are five columns, which contain stream numbers, station numbers, daily counts (24 hour total), AADTs, and reconciliation results. The reconciliation results are rounded values. The procedure and criteria for the rounding is discussed in detail in the technical report of this project [1].

Table 4.2 shows the AADTs for the study year and the previous year. The four columns in Table 2 are the stream numbers, station numbers, AADTs for the study year (1994) and AADT for the previous year (1991).

Table 4.2. List of AADTs

```

=====
STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION
BUREAU OF POLICY AND PLANNING
PLANNING INVENTORY AND DATA

LIST OF AADTS FOR DESIRED CYCLES

ROUTE 91          DIRECTION  N          CURRENT YEAR  1994
STREAM  STATION  1994-AADT  1991-AADT
046    1487052    5500      4941
048    1487053    5035      4161
050    0797055    2680      2631
052    0797058    10180     9134
054    0797059    14070     12195
056    0797064    3200      3010
060    0797068    1070      1031
062    0827075    3049      2986
064    0827076    1250      1286
065    0821021    38507     35131
066    0337071    3176      3277
END OF FILE
=====

```

Updating the Station Location Data File

Chapter 5

The station location data file is required for generating the incidence matrix for the freeway network and for calculating the AADTs. Whenever the freeway network is changed, the station location data file must be updated accordingly. A program has been developed to simplify the updating procedure. This chapter discusses the procedure of updating the station location data file using the program.

Two types of changes to the freeway network need to be considered. One is the opening of a new ramp, and the other is the closing of an existing ramp. For opening a new ramp, (1) a new record for the counting station on this new ramp must be added to the station location data file and (2) the stream numbers must be changed accordingly. For the closing of an existing ramp, (1) the record for the counting station on this ramp must be deleted from the station location data file and (2) again the stream numbers must be changed accordingly.

Updating for the Opening of a New Ramp

In step one of the updating for the opening of a new ramp, a new record needs to be added to the station location data file. This new record contains the following items:

- the stream number,
- the station number,
- the route number,
- the expansion factor group number,
- the route direction code, and
- the description of the station.

These items were discussed in section four of Chapter 2. The stream number and the station number are the numbers assigned to the new ramp and the associated counting station respectively. The route number, the expansion factor group number and the description of the station are determined by the location of the new ramp.

In step two, certain stream numbers in the station location data file are changed to reflect the network changes. If we assume the stream number for the new ramp is N , and the stream number for each stream on the same direction as the new ramp in the station location data file is M . The changes for the station location data file are:

For each record, if $M < N$, $M = M$;
 if $M \geq N$, $M = M + 2$.

In other words, for the streams in the same direction as the new ramp in the station location data file, if the stream numbers are less than the stream number for the new ramp, then these stream numbers remain unchanged; if the stream numbers are greater than or equal to the stream number for the new ramp, then these stream numbers are increased by two.

Updating for the Closing of an Existing Ramp

The two steps for the closing of an existing ramp is similar. In step one, delete the record for the existing ramp from the station location data file. In step two, change the stream numbers in the station location data file. The difference is that, stream numbers which are greater than or equal to the stream number for the existing ramp are decreased by two, rather than increased by two.

Procedure for Using the Program

This section describes the procedure for using the updating program. To start the procedure of updating the station location data file, select the third choice (Updating Station Location Data File) from the operational choices discussed in Chapter 3.

Prompts for the year of the station location data file will be given for you to type in the year. Then a list of route numbers for freeways in Connecticut and prompts for selecting a freeway will appear on screen. Select the freeway by giving the number before the route number and press ENTER. The year and the route number are used to determine the file name of the station location data file.

After that prompts of operation selection will appear on screen as follows:

1 - ADD 2 - DELETE 3 - EXIT

Your choice (1->3):

If it is intended to add a new record to the station location data file, select 1 by entering 1. Prompts as follows will appear on screen sequentially for entering the station number, the stream number, the expansion factor group number, and the direction and description of the station. The last prompt is a confirmation line. Use Y or N to confirm or abort the inputs.

```
-----  
ADD A STATION  
-----
```

```
Station Number(town + station):  
Stream Number(up to 3 digits):  
Group Number(1->6):  
Direction (N, S, E, or W):  
Location Description:  
Add it to C:\TCAS\LOCATION\911994.LOC? (Y/N):
```

Note that the direction must be a capital letter of N, S, E, or W. The description must contain the information of route direction and ramp direction, which are essential for generating the incidence matrix.

If it is intend to delete an existing record from the station data file, select 2 by entering 2, and follow the similar procedure as above.

At the end of the adding or deleting procedure, the program returns to the prompts of operation selection. You can keep adding or deleting records in the station location data file until you select 3 to exit the program.

Error Messages

Appendix

This appendix lists error messages you may encounter as you run the TCAS. It also describes actions you can take to correct the errors.

Number	Error Messages
--------	----------------

- | | |
|-------------|---|
| E101 | parameter data file not found
File PARAMETR.DAT does not exist in the current directory. This file is needed for the non-interactive mode calculation. You may create the file or use the interactive mode for calculation. |
| E102 | station location data file not found
The station location data file, with extension .LOC, does not exist in the appropriate directory. This file is needed for forming the incidence matrix and calculating the AADTs. |
| E103 | current year traffic count data file not found
The traffic count data file of current year does not exist in the appropriate directory. |
| E104 | current year expansion factor data file not found
The expansion factor data file of current year does not exist in the appropriate directory. |
| E107 | previous year traffic data file not found
A desired traffic count data file of previous year does not exist in the appropriate directory. Copy the traffic count data file to the directory or choose not to calculate the AADTs for that year. |
| E108 | previous year expansion factor data file not found
A desired expansion factor data file of previous year does not exist in the appropriate directory. Copy the expansion |

factor file to the directory or choose not to calculate the AADTs for that year.

- E201 error/errors in parameter data file**
Check for error or errors in the file PARAMETR.DAT. Pay special attention to the first three items. The study year, route, and direction need to be within quotes.
- E202 error/errors in additional data file**
Check for error or errors in the additional data file.
- E204 error/errors in station location data file**
Check error or errors in the station location data file. Refer to the last section of Chapter 2 for details of the station location data file.
- E205 error/errors in stream direction of starting stream**
Check the stream direction code of the starting stream in the station location data file. The code should be either 'IN' or 'OUT'.
- E206 error/errors in stream direction**
Check the stream direction code of every stream other than the starting or ending streams. The code should be either 'ON' or 'OFF'.
- E207 error/errors in incidence matrix**
Check for error or errors in the incidence matrix which is printed out in TRACE.REC. Note that the incidence matrix is generated using the data in station location data file. Problems may occur at the location data file.
- E208 error/errors in expansion factor data file**
Check for error or errors in the expansion factor data file.
- E209 error/errors in traffic count data file**
Check for error or errors in the traffic count data file.
- E301 not enough data for reconciliation**
In order to perform the data reconciliation, AADTs for all ramps and for at least one mainline stream in the study area

have to be available. The stream numbers and the station numbers of the streams where AADTs are not available to the program are printed out in TRACE.REC. If AADTs necessary for the data reconciliation are missing, you can provide the AADTs explicitly by adding records in the additional data file.

- E302** **starting stream number missing**
The program cannot find the starting stream number associated with the starting station number. Check the stream numbers in the station location data file.
- E303** **ending stream number missing**
The program cannot find the ending stream number associated with the ending station number. Check the stream numbers in the station location data file
- E304** **singular matrix occurred in coaptation procedure**
Check the incidence matrix and the desired traffic count for every stream in TRACE.REC. If no error is found, consult Dr. Norman W. Garrick at the Department of Civil and Environmental Engineering, University of Connecticut, Storrs, CT 06269.
- E305** **too many iterations occurred in coaptation procedure**
Check the incidence matrix and the desired traffic count for every stream in TRACE.REC. If no error is found, consult Dr. Norman W. Garrick at the Department of Civil and Environmental Engineering, University of Connecticut, Storrs, CT 06269.
- E306** **singular matrix occurred in reconciliation procedure**
Check the incidence matrix and the desired traffic count for every stream in TRACE.REC. If no error is found, consult Dr. Norman W. Garrick at the Department of Civil and Environmental Engineering, University of Connecticut, Storrs, CT 06269.

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2. State of Connecticut, Traffic Monitoring System For Highways (TMS/H), Connecticut Department of Transportation, Bureau of Policy and Planning, Division of Planning Inventory and Data, 1994.