USER'S GUIDE

Highway Safety Program Evaluation and Statistical Crash Table Development

by

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User's Guide

Transportation Safety Evaluation Database System

Includes guides for:
TEAAS
BEATS
TCPM

Table of Contents

Introduction

This document is a user's guide written to assist a transportation engineer in using a database system called Transportation Safety Evaluation Database System (TSEDS) and several transportation programs, which are linked to TSEDS. The layout of the User's Guide therefore follows the design of TSEDS. This User's Guide accompanies the software developed and delivered in July 2000.

The User's Guide along with a separate report are products of a research project entitled Highway Safety Program Evaluation and Statistical Crash Table Development funded by the NCDOT. The two objectives of the research project were to recommend software that will allow the NCDOT Traffic Safety Systems Management Unit to regularly perform statistically valid evaluations of countermeasures that the NCDOT is installing, and to write software to execute crash prediction models to judge the relative hazardousness of different highway sites. Both of these software packages are linked to TSEDS.

The flowchart in Figure 1 shows how each software program was used to accomplish the project objectives. The program recommended for countermeasure evaluation was Bayesian Estimation of Accidents in Transportation Systems (BEATS) and the Transportation Crash Prediction Models software (TCPM) was developed for the crash prediction objective. The other software programs shown in the flow chart were used to gather necessary input data or organize information for BEATS or TCPM, or to use the output from BEATS and TCPM.

Although several programs are linked to TSEDS, detailed sections are given for BEATS and TCPM. These two programs were evaluated and developed to fulfill the two objectives of the research project. For each of these two programs, the User's Guide contains the following information:

- Purpose
- System requirements and training requirements
- Input
- Procedure
- Output
- Problems encountered

The last section of the user's guide is an example showing how two intersections were evaluated using BEATS and TCPM. This example will hopefully clarify any questions with program input, output, or interface procedure.
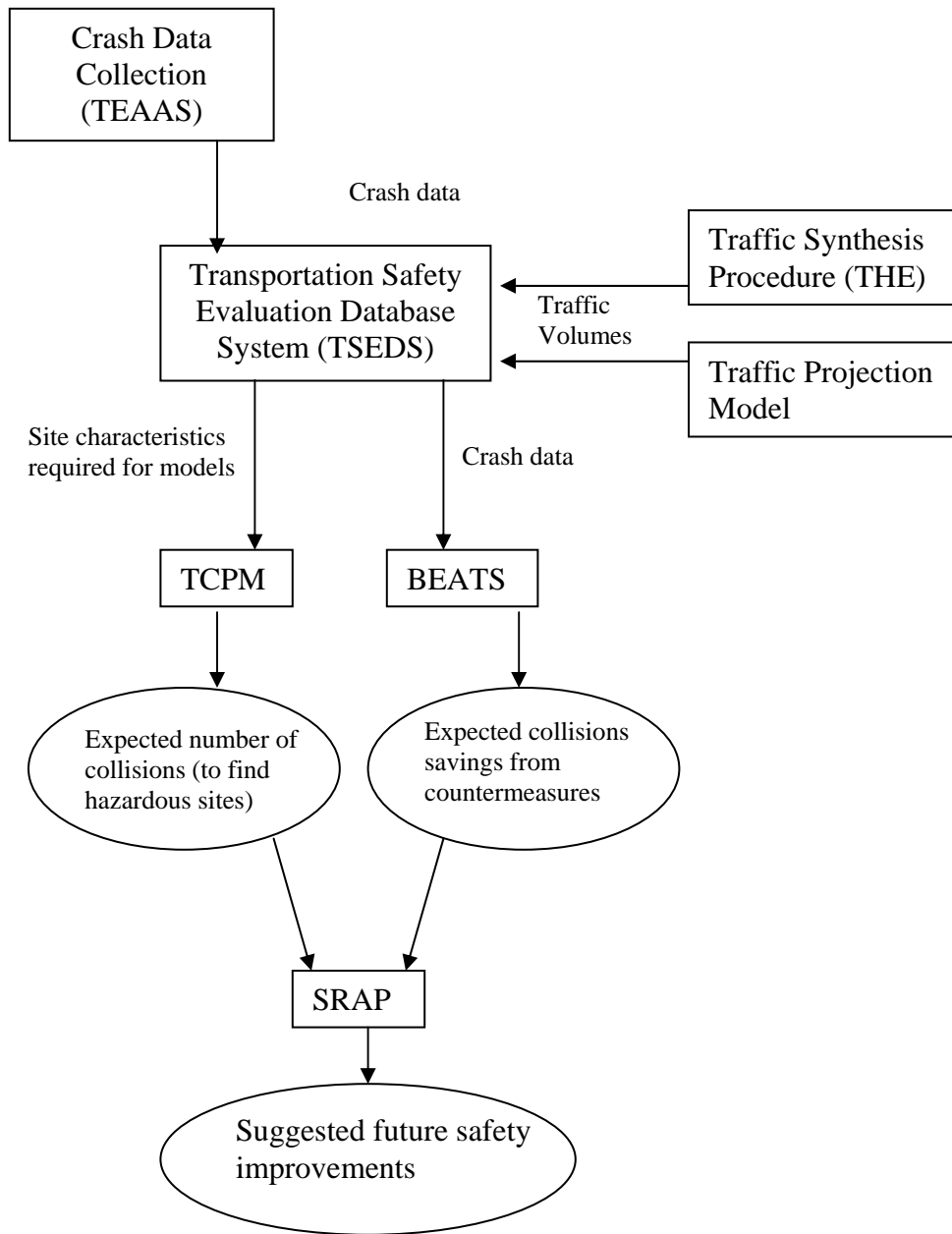
Figure 1. Program relationships

Transportation Safety Evaluation Database System

The Transportation Safety Evaluation Database System (TSEDS) is essentially a Microsoft® Access database that contains links to other relevant transportation programs. The purpose of the database is to store the information about the intersections to be used in crash prediction, countermeasure evaluation, hazardous site investigation, and other transportation procedures. The original database was structured and created by McPherson Engineering Solutions for the North Carolina Department of Transportation.

Hardware Requirements

Microsoft® Access 97 was used to create the database. The requirements to run Microsoft® Access 97 are listed below.

- PC with a Pentium 75 megahertz (MHz) or higher processor, and
- Microsoft Windows® 95 or later operating system, or Microsoft Windows NT® Workstation.

For Windows 95 or Windows 98:

- 16 megabytes (MB) of RAM for the operating system, plus an additional 8 MB of RAM for Access.

For Windows NT Workstation:

- 32 MB of RAM for the operating system, plus an additional 8 MB of RAM for Access, and
- 161 MB of available hard-disk space. (this estimate is for a typical installation; your hard-disk usage will vary depending on configuration. Choices made during custom installation may require more or less hard-disk space.)

Contact **http://www.microsoft.com/office/access/default.htm** for further information on ordering MS Access or for any other MS-related questions.

TSEDS Main Screen: The Switchboard

The first screen that appears when TSEDS is opened is called the switchboard (Figure 2). The switchboard contains the links to the **database forms** and to the various transportation-related **procedures** (shown below). These forms and procedures are discussed individually in their respective sections of the User's Guide.

Below each procedure buttons, there is a **help button**. This button opens a Microsoft® Word document containing the section of this User's Guide pertaining to that procedure. This button is for convenience, if the user does not have the hardcopy User's Guide at hand.
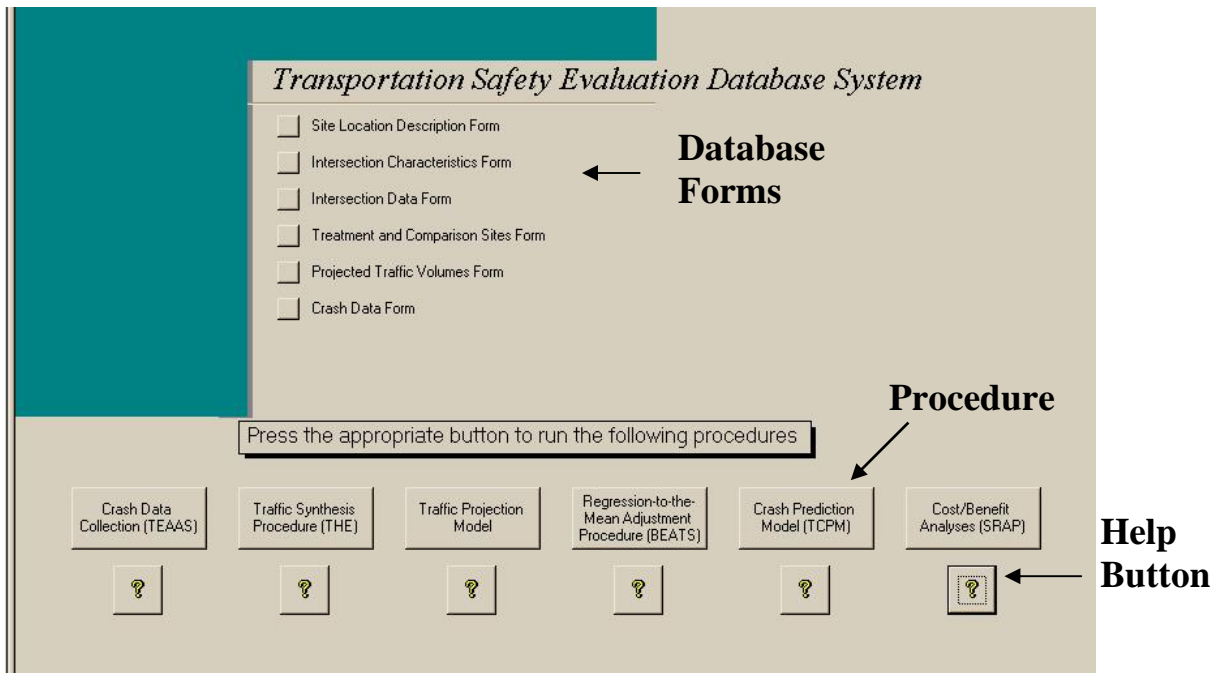

Figure 2. TSEDS Switchboard

Database Forms

TSEDS's main function is to store intersection data. The database has six different electronic storage areas. These storage areas can be accessed by the use of forms or tables. A **form** is a type of interaction that displays a single screen for each intersection. A **table** is in the form of a spreadsheet with rows and columns. Each storage area has one form and one table. If data are entered by means of a form, they will show up on the table also, and vice versa.

Only the forms can be accessed from the switchboard. To access the tables, close the switchboard and click on the "Tables" tab on the main screen.

Entering data

To enter data into the database, the user should open the appropriate form. Each individual intersection is called a "record" and will be on a separate page. The arrows at the bottom of the form may be used to navigate through the records.

If the user has the data in rows and columns (i.e. spreadsheet format) and wishes to copy and paste the data directly into the database, it will be necessary to use the tables instead of the forms. From the spreadsheet, select the data to be entered into the database, and go to Edit -> Copy. Next, open the appropriate database table. Click the cell in the table where the data are to be placed, and go to Edit -> Paste. In this copy and paste manner, data can be easily transferred between the database tables and spreadsheets.

> **CAUTION**: When making changes to *existing* data, an "undo" option is available while the data are on-screen. This is accessed by going to Edit -> Undo. However, if the user closes the form or table accidentally, the program will not ask if the user wishes to save the changes. It will **automatically** save any changes made to the form or table.

Modifying the forms and tables

It may become necessary to modify the database tables to accommodate the data that the user wishes to input. Columns and rows may be inserted in the tables, as the data require. To change the type of data input (i.e., number, text, yes/no) of a form or table or to redesign it, return to the screen that lists all the forms and tables on tabs. Highlight the form or table and click on the Design button to the right.

Description of Forms

The following paragraphs describe the forms and what type of data each one requires. The intersection number is required in all the forms and is used as the "index mark" so that all the forms will stay synchronized.

Site Location Description Form:
Intersection Number - The number designated by the larger database from which the intersection data were taken.
Study Location Number – The number designated by the study being performed currently.
State, County, Nearby City/Town – Data describing the location of the intersection.
Area Type – The choices are rural or urban, entered as 'R' or 'U', respectively.

Major Road Name, Minor Road Name – The road names can either be actual names (Creedmore Road) or designations (SR1009).

Intersection Characteristics Form:
Intersection Number - The number designated by the larger database from which the intersection data were taken (same as for other forms).
Number of Approaches – Number of approaches to the intersection
Signalization, Channelization, Pavement Markings – Click the box to mark a Yes/No answer
Predicted Crashes – The number of predicted crashes for the time period the user wishes to evaluate (filled in after the user has run TCPM).

Intersection Data Form:
Intersection Number - The number designated by the larger database from which the intersection data were taken (same as for other forms).
Major Approach East, West Lanes – Number of lanes on major road
Minor Approach North, South Lanes – Number of lanes on minor road
Major, Minor Approach Volumes – ADT's of each road
Major, Minor Approach Channelization – Channelization on each road (Yes/No)

Treatment and Comparison Sites Form:
Intersection Number - The number designated by the larger database from which the intersection data were taken (same as for other forms).
Year Treatment Completed – This can be entered as a two-digit year (i.e. 94)
    NOTE: This is simply a data storage area. The two-digit year will not cause any Y2K problems in the database.
Major, Minor Road Traffic – ADT's for each road
Before, After Crashes – Number of crashes before and after treatment was installed

Projected Traffic Volumes Form:
Intersection Number - The number designated by the larger database from which the intersection data were taken (same as for other forms).
1990, 1991, etc. Major, Minor Roads – ADT's for the year indicated

Crash Data Form
Intersection Number - The number designated by the larger database from which the intersection data were taken (same as for other forms).
Year 1990, 1991…2002 – number of recorded crashes for each year

Switchboard Procedures

The buttons listed along the bottom of the switchboard are links to various programs covering different areas related to transportation safety. Upon clicking a button, the respective program will be opened. The links have been provided on the TSEDS switchboard for easy access to all programs. The following sections explain the purpose of each program.

> **NOTE**: These programs are simply opened when the procedure button is clicked. The data from the database is NOT automatically fed into the program. This must be done by the user.

Crash Data Collection

The <u>T</u>raffic <u>E</u>ngineering <u>A</u>ccident <u>A</u>nalysis <u>S</u>oftware (TEAAS) was developed by the NCDOT for collision analyses. Currently, the application is used primarily by the Traffic Safety Systems Management Unit (TSSMU) of the NCDOT. TEAAS contains only information for the State of North Carolina. The database contains only reported collisions that occurred on state owned and maintained roads and that are contained in the NCDOT database.

Only the Intersection Analysis Report section of TEAAS was used for this project. The relevant information in the TEAAS Public User Manual is found in Section 13 – Fiche Report and Section 14 – Intersection Analysis Report (Keane 1999).

All information below is intended to supplement the relevant sections of the TEAAS Public Users Manual for the task of collecting collision frequency data. The collision frequency data were collected for 56 intersection sites during certain time periods for this demonstration and used as input into BEATS for evaluating countermeasure effectiveness.

The NCDOT contacts for TEAAS as of June 21, 2000 are Dwayne Tharpe @ (919) 733-8304 or Cheryl Bitting @ (919) 733-3915 at the Traffic Safety Systems Management Unit (TSSMU). A complete TEAAS User's Manual is available at the TSSMU of the NCDOT.

Instructions for downloading the TEAAS software are included in Appendix A of the User's Guide. A user account is required to access the TEAAS program. The NCDOT contacts would be responsible for establishing a user account.

System Requirements

The minimum system requirements to download and use the TEAAS program are:

- Windows 95/98/NT,
- 80 Mb disk space available on the C:\ drive, and
- 64 Mb RAM.

With the TEAAS Users Manual and approximately one hour of training, one beginning user could collect an accurate collision frequency for one intersection site as discussed below in approximately 10-20 minutes. A more experienced TEAAS user could probably complete the study for one location in approximately 8-10 minutes. The number of reported crashes at a location causes the time required to vary.

Input

Only one feature of TEAAS was used to collect collision data. The input information required for this feature is discussed. TEAAS uses input road characteristics such as name, numerical code, and location to query a crash database and return crash data. The road or intersection road names for which the user desires to collect data should be identified before using the Intersection Analysis feature.

The input fields required for the Intersection Analysis feature are given below. Road name, road code, and ADT are explained in more detail. The input fields are shown in Figures 4 and 5 below and are labeled with arrows.

- Study Name – identifies the working file; the name that TEAAS uses when saving the file.
- County – the county name containing the location where crash data is desired.
- Begin Date – numerical date (mm/dd/yyyy) that crash data collection period starts.
- End Date – numerical date (mm/dd/yyyy) that crash data collection period ends.
- Road Name – the alphabetical designation of the road(s) used for crash data collection.
- Road Code – the numerical designation of the road(s) used for crash data collection.
- ADT – sum of traffic volumes of all intersection approaches where crash data desired (vpd). ADT is not required to generate crash study, so ADT input was not used during this demonstration.

ADT

The ADT volume input was not used in this project. An ADT value is not required to complete crash data collection; however, the ADT value is used in the calculation of the crash rate in the crash summary output. The ADT volume for intersections should be input as the total volume of the two intersecting roads. The rate calculated in the Accident Study output uses the summed crash frequency of both roads divided by the summed ADT of both roads. The result is the crash rate at the intersection.

Road Name

The road name is an alphabetical designation for the road(s) used in the crash data collection. TEAAS is not case sensitive. Words such as road, street, place, boulevard, etc. should be excluded from the Road Name input. For example Tryon Road in Wake County would be input as 'TRYON.'

Road Code

Each road is identified in TEAAS by an 8-digit numerical Road Code or Road Name. The first digit of the 8-digit code represents the route's functional classification as follows:

1 – Interstate route,
2 – US route,
3 – NC route,
4 – Secondary route, and
5 – Alternative road code for secondary route.

The last digits of the code are the route's numerical designation. Any intermediate digits should be 0's. For example, Interstate 85 would be represented as 10000085; US 64 would be represented as 20000064; and S.R. 1152 in Wake County would be represented as 40001152 for the Road Code. The road code 40001152 represents S.R. 1152, which is also Holly Springs Road. The road code 40001152 will not access crashes that are reported on Holly Springs Road but only crashes reported on SR 1152. Holly Springs Road is represented by the road code 50014265, which accompanies the Road Name HOLLY SPRINGS.

Procedure

The Intersection Analysis feature of TEAAS was used to collect most collision data. Figure 3 below shows the location of the Intersection Analysis feature in TEAAS.
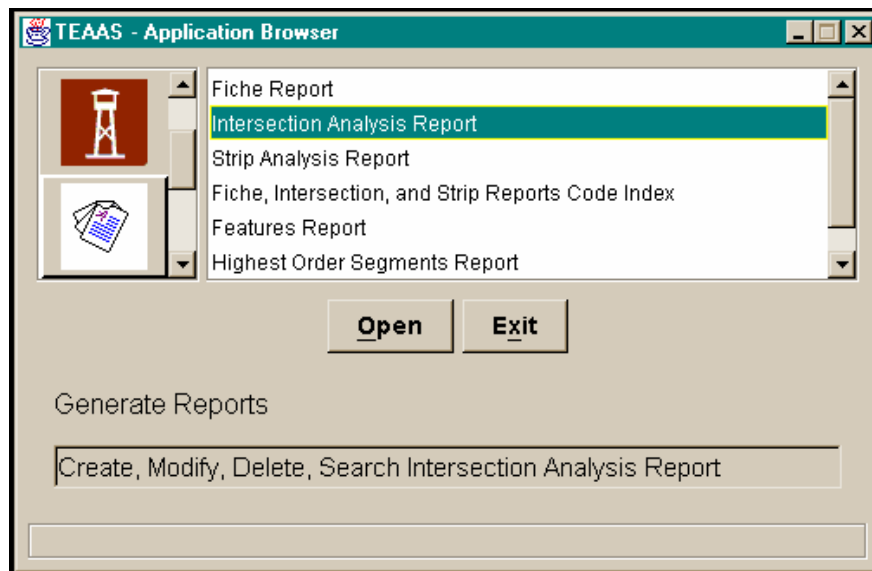

Figure 3. Intersection Analysis location in TEAAS

The Intersection Analysis feature of TEAAS contains three tabs as shown in Figure 4. After access to TEAAS is established, intersection crash data collection may be accomplished in four steps – study information, generate fiche, generate study, and accident adjustments.

Step 1.   Study Information

The Study Information tab input should be completed first. The required input fields are labeled with arrows in Figure 4. The study information is used to query the database for the desired crash data. Each accident study may be saved using the Study Name input and retrieved at a later time if desired. The default location of the saved file is the "C:\Teaas\classes\teaas" directory.

An important field on the study information screen is the "Y-Line Feet" entry seen in Figure 4. This field extends the intersection boundaries away from the intersection by the input number of feet down each approach. This intersection boundary defines the limits for TEAAS when returning crash data. The default value is 150 feet, but may be adjusted, if desired.

Figure 4. Study Information for intersection 002

Step 2.   Generate Fiche

Input

A Fiche Report may be generated for each study location. The Fiche Report lists all collisions that occurred on one particular road during the specified time period. The Fiche Report serves as a check for the total number of collisions at a road or intersection. The screen from which the Fiche Report may be generated is shown below with the road code and road name input fields.

The upper section of the screen is used to generate the fiche output. The Fiche Road input fields are located in the Road 1 (Fiche Road) section and labeled Table Input. The left field is used for the road code input and the right field is used for the road name. Some roads have a road code and road name, but only one is required for input. The other road identification may be found by clicking the 'Lookup' button after either the road name or road code is input as shown in Figure 5 below. The Road code 30000211 has been input. To find additional identifications of that road, the road code would be highlighted and the Lookup button would be clicked.
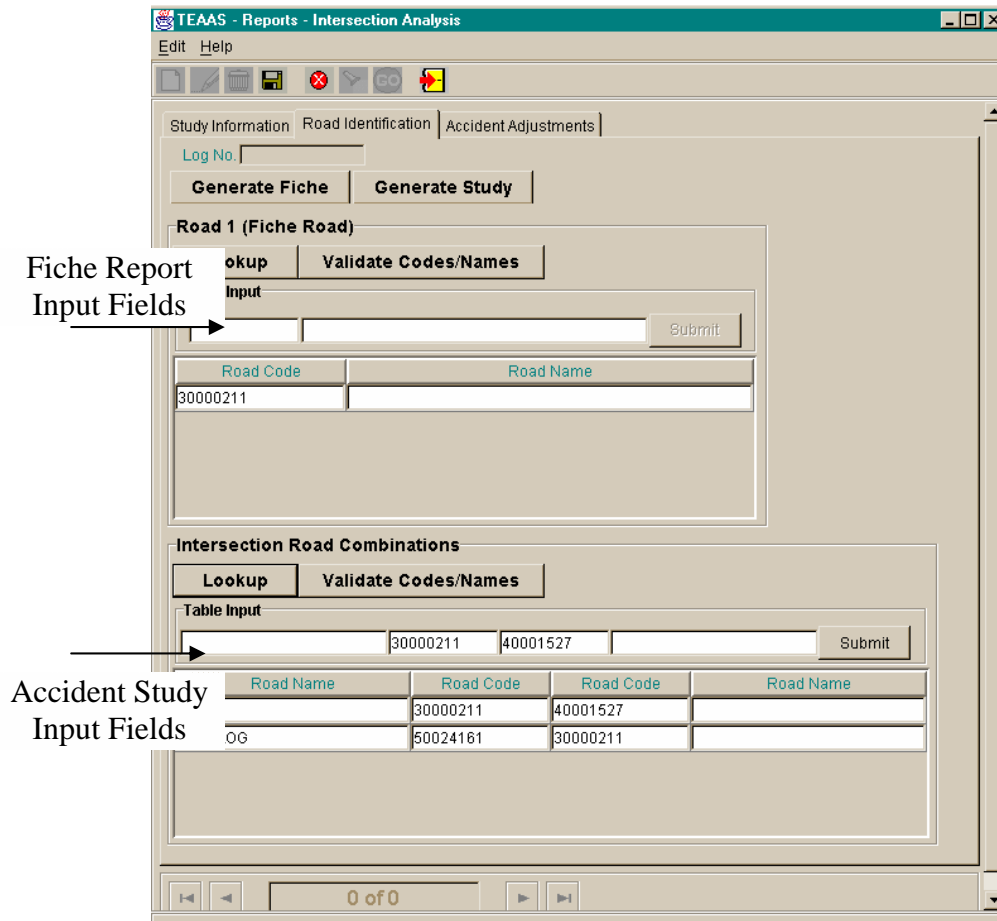

Figure 5. Road Identification (Fiche and Study input) for intersection 002

Output

When the desired road is input, click the Generate Fiche button. A separate window will appear with summaries for all crashes that occurred on the road during the time period.

A sample Fiche output is shown in the figure below. The Fiche Report is helpful because this list of collisions also contains any reported collisions with missing or mislabeled information. These misreported collisions would not be included in the Accident Study output unless they are manually added. The misreported crash entry is usually denoted by an asterisks (*) beside the crash entry as shown in the next to last entry in Figure 6 below.

Figure 6. Fiche output for intersection 002

After the Fiche Report is generated, it may be desirable to reorganize or manipulate the data output. The Fiche output returned in TEAAS is a read-only file. To make data management easier the data can be saved and opened in MS EXCEL. From the TEAAS window click the Save button from the menu bar at the top, left of the Fiche Report screen. Select the CSV export file type. Type in the name of the file and click OK. The file is saved in the C:\Teaas\classes\Teaas directory. The file can now be opened in MS EXCEL. When opening in EXCEL, make sure the "All Files" file type is selected.

Step 3.   Generate Accident Study

Input

After generating the Fiche Report, an intersection Accident Study may be generated. The input field used to generate the intersection accident study are shown and labeled in the lower section of Figure 5 above. The road identification combinations for the intersecting roads should be input in the same row. The shorter fields are used for the 8-digit road code and the longer fields are used for the road names. Like the fiche input fields, either the road name or road code may be entered. Click the 'Lookup' button to retrieve the identifications associated with the road.

Output

The Accident study output contains summary information for all intersection collisions. A sample of the intersection accident study output is shown in Figure 7 below. The accident study output is simple to understand. Only the collision frequencies for each intersection were used in the demonstration conducted in this project.

Figure 7. Sample Accident Study Output

Step 4.   Accident Adjustments

Some collisions are reported incorrectly or entered incorrectly into the database. Collision reports also have missing data. The Fiche Report may include some of these collisions for the road of interest. In the Fiche Report, collisions with missing or misreported information are marked with an asterisk (*) as seen in the next to last output row in Figure 6 above.

These collisions are not included automatically in the generated accident study output. These collisions may be included in the accident study using the accident adjustment process. This is accessed by clicking on the Accident Adjustments tab from the Intersection Analysis window (Figure 4). This option will allow the user to add collisions to or delete collisions from the accident study results.

The Crash ID number is required to add or remove collisions from the accident study. This number is found in the eighth column in the Fiche Report and also in the accident study output.

Problems Encountered

Memory Usage

The TEAAS application seemed to steadily increase the required computer memory usage during the time the application was open. Approximately 30-60 minutes after TEAAS was opened on the computer, the computer's RAM (64 MB) approximately doubled which caused any task or operation such as closing a window to be time consuming. To avoid this situation, the TEAAS user should perform approximately 2-4 intersection crash analyses and then close the TEAAS application. Subsequently, the computer's memory usage would decrease and the TEAAS software could be reopened and the process repeated.

Crash Location Identification

Crash reports may not contain a valid milepost, which is used to identify the location of the crash. Crash reports with invalid milepost data are represented in the Fiche output of TEAAS as having a milepost value of 999.999 as seen in Figure 6. This was not a great concern in this project because study sites were intersections and could be identified by the two road names. However, invalid milepost data would present a problem for identifying crashes at highway section locations.

Loop Roads

The problem with incorrect milepost data would be a problem for intersection studies if two intersections had the same intersecting road identifications such as in situations with loop
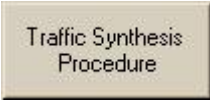
roads. It is a good idea to have a map of the two intersecting roads available to determine if the two roads intersect at more than one location.

The TEAAS output lists all reported accidents matching at all locations where the two roads intersect. This problem can be solved by examining the mile marker data for one of the roads on the Fiche Report. The Fiche Report contains the mile marker of the road where the accident occurred. If the mile marker data are incorrect as mentioned above, it is difficult to determine the location of the crash.

One loop road situation was present in the demonstration, but the intersection crash locations were identified by a road present at one intersection and not the other. One intersection had three approaches and the other had four approaches with the fourth approach being a different road name.

Crash Data Collection Time

For a beginning TEAAS user, approximately 10-20 minutes is required to complete the above procedure for one intersection location. This time may vary depending on length of the Fiche Report, complexity of the study location, or computer characteristics.

Traffic Synthesis Procedure

The Highway Emulator (THE) is a traffic volume prediction model, designed for microcomputer modeling and analysis. Given the description of a highway network and volume estimates for some links in the network, THE estimates volumes for the remaining links. THE is a powerful tool for the analyst when (as is often the case) a complete set of volume estimates is not available in an area of interest. Consult the THE manual (Bromage 1988) for more information.

Due to difficulties with the software, the switchboard button for this procedure does not directly start the THE program. Instead, clicking on this button will bring up instructions on how to start the program. The instructions are as follows:

```
To start THE: the traffic synthesis program,
Click the Start button.
Click Run.
Type the following line into the Run window -
C:\TransportationSafetyEvaluation\TrafficSynthesis\menu.com
```

Traffic Projection Model

This model, developed by Larry McPherson, Ph.D., PE, uses a linear estimation to predict traffic volumes for some future year given a base year, base year traffic volume, and traffic growth rate. The model is essential for identifying hazardous sites and for evaluating countermeasures when (as is often the case) a complete set of volume estimates through time is unavailable for a site of interest. Over a short time period, as in most safety analyses, linear estimation is entirely appropriate. Together with THE (discussed above), the Traffic Projection Model allows analysts to reasonably estimate ADT's for nearly any highway link in NC in any year of interest.

Regression-to-the-
Mean Adjustment
Procedure

Regression-to-the-Mean Adjustment Procedure

This procedure uses a program called Bayesian Estimation of Accidents in Transportation Studies (BEATS). The BEATS program evaluates the effectiveness of a countermeasure based on crash frequency. The program adjusts for regression-to-the-mean in the data, if necessary. BEATS calculates the amount of regression-to-the-mean in the data and uses an EBEST method (accounts for regression-to-the-mean) and frequentist method (does not account for regression-to-the-mean) to statistically analyze data.

The BEATS software is an MS-DOS based program used to statistically evaluate input data and correct for any regression-to-the-mean bias in a before-and-after safety study. BEATS was developed by FHWA and is based on Bayesian statistics. The BEATS program corrects the regression-to-the-mean bias of the input data. A three-volume report was published that discusses the EBEST methodology used in the BEATS software and the statistical approach used to evaluate the data. The report is entitled "Application of New Accident Analysis Methodologies". Volume II of the report is a Users Manual for the BEATS software (Pendleton 1991). However, the manual is very basic and does not address some important topics necessary to produce valid results with the software. This section of the Users Guide along with an example using BEATS will hopefully cover most of those important topics.

Regression-to-the-mean is usually present when study sites are not randomly selected. For example, in this project, intersection sites with left-turn lanes were required for the study. If the intersection sites selected due to high crash frequencies relative to other similar intersection sites, regression-to-the-mean would be present in the data. These selected high-crash-frequency intersections should experience a reduction in crashes in the coming year(s), even without a countermeasure. The reduction would bring the crash frequency at these sites down toward the mean crash frequency of *all* similar intersections. This reduction to the true mean of the group of similar sites is known as regression-to-the-mean.

Requirements

BEATS is an MS-DOS based program that will run on virtually any computer. The size of the BEATS application file is 117 KB, so it requires very little storage space.

A first time BEATS user could get confused attempting to use the software. One to two hours of training should be sufficient for a first-time user. The time required to complete an evaluation using BEATS will vary depending on the size of the input file to be created. Most of the time and labor is required to complete the input file, which could be any size. The program runs almost instantaneously and produces an output file in the same folder as the input file is stored.

Program Input

BEATS requires a separate text file for input. The input file should be in a table format with data columns separated by tabs (Figure 9). An example input file can be found in Appendix B. From left to right, the columns should correspond to the following headings:

Identification Number or Site Number – a numeric variable 5 digits or less. The identification number or site number may only contain numbers.

Treatment Period – 1 before treatment, 2 after treatment. NOTE: Even though the reference sites did not receive treatment, entering '2' for a reference site refers to data collected after the treatment was installed in the treatment sites.

Group Type – 1 if treatment, 2 if reference group, 3 if comparison group. A site is labeled as a treatment site if the countermeasure has been recently installed and is being evaluated.

The reference group is the population of all treatable sites. It includes the selected treatment sites and all other sites that could have been selected as treatment sites. It is not required for the reference site to have similar traffic or geometric characteristics as any treatment site.

The comparison group is the population of treatable sites with similar traffic and geometric characteristics to the treatment sites. The comparison group is a small group that is included in the reference group, but a comparison site must have similar traffic and geometric characteristics to a treatment site.

The EBEST method of calculating output requires reference groups. In the evaluation of left-turn lanes in this project, sites selected as comparison sites for data collection purposes were labeled as reference sites in the input file for BEATS. This was done as an example, because comparison sites could not be used for this method, only reference sites. The label "reference" or "comparison" determines whether the user inputs a 2 or 3, and determines the manner in which BEATS calculates its statistics.

Number of crashes – crash frequency
The crash frequency may be reported over any time period, provided the exposure is calculated over the same time period. In this project, the crash frequency was recorded for 3, 4 or 5 years for each intersection location.

Exposure – exposure of site; may only be one number
The most common form of exposure is AADT volume. The exposure units may be scaled to any desired dimensions such as AADT/10,000 miles, etc. For our demonstration involving intersections, the ADT volumes of both roads were summed to have an intersection ADT. To account for differing number of years of crash data collection, the ADT for the intersection was summed over the same number of years. For example, the first row in Figure 9 would represent Site # 1, before treatment was completed, treatment group, crash frequency of 13 from 1/1/1990 to 12/31/1992 (3 years), and an exposure of 13885. The exposure is the sum of intersection ADT volumes for 1990, 1991, and 1992.

The number should be the exposure of the vehicles during the same time period and location as the crash data was collected. For example, if crash data was collected for AM peak hour, then the exposure should be calculated for the location during the AM peak hour.

The most common form of exposure is AADT volume. The exposure units may be scaled to any desired dimensions such as AADT/10,000 miles, etc. For intersections, sum the AADT volume of each approach road.

Procedure for Creating BEATS Input

In order to create input with the correct format, a spreadsheet is recommended to organize the data and allow for easy manipulation (Figure 8).

Figure 8. Example of a spreadsheet containing BEATS input data.

Having the input data in a spreadsheet allows the user to perform calculations easily. For example, if the sum of the major and minor road traffic volumes is to be used as the exposure data, the separate traffic volumes can be copied and pasted from the database and then added together using spreadsheet formulas (i.e., G4+H4=E4).

If a spreadsheet is used to create the data table, copy the numerical data into a text file. **Make sure that only numbers are copied into the text file!** If cells containing words are copied into the text file, BEATS will not run.

When copied correctly, the text file should appear like Figure 9 below. Whether the input file is copied from a spreadsheet or typed into the text editor, spaces or tabs *must* separate the numbers, and each site must be on a separate line. One potential problem with the input file is missing data that creates blank spaces in the file. BEATS cannot produce a result with missing input data. Save this file in the same directory that the Beats.exe file is in. When saving the file, be sure the

file extension is **.txt** and that the file name is **LESS THAN 9 characters** (excluding the file extension).

Figure 9. Correct format for BEATS input file.

During the BEATS run process, the program will prompt for the input file name. At the prompt, type the name of the input file that is saved in text format. **INCLUDE the .txt extension** with the file name.

BEATS also prompts for an output file name. Type the desired name of the output file and **INCLUDE a .txt extension**.

After BEATS prompts for an output file name, it will present four types of output from which to choose. Pressing F1 through F4 will format the output file. The program will not close after the format is chosen, but the output file **will** have been created.

Output Interpretation

The output file generated by BEATS is located in the same directory as the input file and it is in text format.

The output file includes:

- A narrative summary and interpretation of the results,
- Descriptive statistics about the study data,
- Data listings and rankings as requested by the user, and
- Statistical details of the parameter estimates and test statistics from which the narrative is based.

Three methods are used to estimate the treatment effect - the EBEST method using the comparison group (if available), the frequentist or cross product ratio, and the EBEST method using the reference group in place of the comparison group, if available.

The frequentist method does not adjust for regression-to-the-mean. This method assumes the number of accidents in the treatment group after treatment is equal to the number of accidents in the treatment group before treatment. The method then reports any difference in the treatment groups before and after treatment.
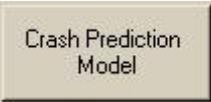
The EBEST method adjusts for regression-to-the-mean in the data. The total accident count for the treatment group is adjusted using the EBEST method.

A sample BEATS output is included in Appendix C. Page 4 of the BEATS output contains summary statistics and results using the methods described above. The bottom row of numbers contains the summary treatment effect and test statistics used to evaluate the treatment. The trteEBr value and trtefr value are the percent changes in total accidents in the treatment group before treatment was applied and after treatment was applied using the EBEST method and frequentist method, respectively.

Selecting the appropriate method's results to report depends on several factors. One indication is the B_{avg} value shown on page 4 of the output. If this number is close to 1.00, regression-to-the-mean was present in the data and one of the EBEST methods should be used. If this number is close to 0.00, then regression-to-the-mean is not high in the data and the frequentist method may be used.

Potential Problems / Limitations

- BEATS will not function correctly if there are blank spaces in the input file.
- BEATS does not offer any suggestions or information on how to organize the data used in the program. The user must decide which years of data to use and the appropriate procedure for collecting and inputting the data into the BEATS software. BEATS is a program that may be used to evaluate countermeasure effectiveness, but the results are only as meaningful as the input data.
- BEATS offers no guide as to the best way to enter exposure data. Many options exist – summing yearly ADT, multiplying major and minor road ADT, etc.

Crash Prediction Model

This procedure runs a program called Transportation Crash Prediction Models (TCPM). The purpose of this program is to predict an expected crash frequency over a three-year period for a particular intersection, interchange, or railway crossing.

TCPM is a Windows-based program developed by McPherson Engineered Solutions for use in the NCDOT Traffic Safety Systems Management Unit. It is designed as an interface for the intersection and interchange crash prediction models formed by Bauer and Harwood (1996 and 1998). The Final Report for this project (Hummer et al. 2000) contains a detailed review of the Bauer and Harwood models. The railway crossing models in TCPM are from the NCDOT Rail Division.

The version of TCPM delivered with this user's guide in July 2000 is the first version of its type. McPherson Engineered Solutions anticipates future releases of this software. These future releases would correct any errors contained in this release of the software.

TCPM requires the following system components:

- Windows 95/98/NT,
- 1 Mb disk space available, and
- 4 Mb RAM.

Of the models reported in the Bauer and Harwood documents, TCPM contains the interfaces for five intersection models, and eight interchange models. TCPM also provides three railway-crossing models. Upon selection of a model, the software provides the user an input screen with a listing of the characteristics needed for the particular model. The following models are programmed into the software:

Intersections (total multiple-vehicle accidents)

1. Rural, four-leg, STOP-controlled intersection,
2. Rural, three-leg, STOP-controlled intersection,
3. Urban, four-leg, STOP-controlled intersection,
4. Urban, three-leg, STOP-controlled intersection, and
5. Urban, four-leg, signalized intersection.

Interchanges (total accidents of all types)

1. Ramp proper segments,
2. Ramp proper segments on off-ramps (rear-end crashes excluded),
3. Entire ramps,
4. Entire off-ramps (rear-end crashes excluded),
5. Acceleration lanes,
6. Deceleration lanes,
7. Entire ramp plus adjacent speed change lanes (10% significance level), and
8. Entire ramp plus adjacent speed change lanes (20% significance level).

Railway crossings

1. Passive warning device,
2. Light warning device, and
3. Gate warning device.

Program Input

The input for TCPM consists of intersection, interchange, or railway crossing characteristics. However, if a group of sites is being analyzed, the source(s) for these data may be scattered. In this case, a certain characteristic may be unavailable and the user may wish to use the suggested default values listed below each variable. All AADT's are considered two-direction volumes, and number of lanes does not include turning bays or auxiliary lanes at intersections. It is recommended that the default AADT's be used only as a last resort. Collecting actual AADT information should be the highest priority.

Procedure for using the models

1. Click on the appropriate heading at the top of the screen for the type of road section to be analyzed.
2. Choose the type of model that you wish to use.
3. Input the requested data in the blanks. Note especially the units on the inputted data.
4. Click the button at the bottom of the screen to see the crash prediction.
5. To print the prediction, click the print button. The entire page will be printed, including all the input variables.

Input for Intersection Models

1. *Model for rural, four-legged, stop-controlled intersections*

X1 – AADT of the minor road (vehicles/day)
The range of values for this variable used in this model is 100-9500 vehicles/day.
Suggested default: 500 veh/day
X2 – AADT of the major road (vehicles/day)
The range of values for this variable used in this model is 400-72000 vehicles/day.
Suggested default: 7,000 veh/day
X3 – Number of lanes on major road
Suggested default: 3 or fewer
X4 – Major road design speed (mph)
The range of values for this variable used in this model is 25-70 miles/hour.
Suggested default: 45 mph
X5, X6 – Functional class of major road
To determine this variable, the user may have to refer to the city or state thoroughfare plans.
Suggested default: Minor arterial
X7 – Access control on major road (Yes/No)
Suggested default: No access control
X8, X9 – Terrain
This variable is fairly subjective and is a judgement call for the analyst.
Suggested default: Flat
X10, X11 – Major road left-turn channelization
If left-turn lane is a painted turn lane, enter '0' for both.
Suggested default: No left-turn lane

2. *Model for rural, three-legged, STOP-controlled intersections*

X1 – AADT of the major road (vehicles/day)
The range of values for this variable used in this model is 400-72,000 vehicles/day.
Suggested default: 7,000 veh/day
X2 – AADT of the minor road (vehicles/day)
The range of values for this variable used in this model is 100-10,000 vehicles/day.
Suggested default: 300 veh/day
X3, X4 - Major road left-turn channelization
If left-turn lane is a painted turn lane, enter '0' for both.
Suggested default: No left-turn lane
X5, X6 – Functional class of major road
To determine this variable, the user may have to refer to the city or state thoroughfare plans.
Suggested default: Minor arterial
X7 – Access control on major road (Yes/No)
Suggested default: No access control

3. Model for urban, four-legged, STOP-controlled intersections

X1 – AADT of major road (vehicles/day)
The range of values for this variable used in this model is 1100-79,000 vehicles/day.
Suggested default: 22,000 veh/day
X2 – AADT of minor road (vehicles/day)
The range of values for this variable used in this model is 100-17,000 vehicles/day.
Suggested default: 1000 veh/day
X3 – Major road left-turn prohibition (Yes/No)
Suggested default: No, left turns not prohibited
X4 – Access control on major road (Yes/No)
Suggested default: No access control
X5 – Major road average lane width
The range of values for this variable used in this model is 8-15 feet.
Suggested default: 12 ft
X6, X7 – Number of lanes on major road
Suggested default: 3 or fewer
X8 – Major road right-turn channelization (Yes/No)
Separate roadway for free right turns
Suggested default: No free right turns
X9 – Lighting (Yes/No)
Suggested default: Yes, lighting present

4. Model for urban, three-legged, STOP-controlled intersections

X1 – AADT of major road (vehicles/day)
The range of values for this variable used in this model is 520-97,000 vehicles/day.
Suggested default: 25,000 veh/day
X2 – AADT of minor road (vehicles/day)
The range of values for this variable used in this model is 100-22,000 vehicles/day.
Suggested default: 650 veh/day
X3 – Major road left-turn prohibition (Yes/No)
Suggested default: No, left turns not prohibited
X4 – Minor road right-turn channelization
Suggested default: No free right turns
X5, X6 – Major road left-turn channelization
If left-turn lane is a painted turn lane, enter '0' for both.
Suggested default: No left-turn lane
X7 – Major road design speed
The range of values for this variable used in this model is 25-70 miles/hour.
Suggested default: 50 mph
X8 – Presence of median on major road (Yes/No)
Suggested default: Yes, median present

X9 – Average lane width on major road
The range of values for this variable used in this model is 8-15 feet.
Suggested default: 12 ft

5. Model for urban, four-legged, signalized intersections

X1 – AADT of major road (vehicles/day)
The range of values for this variable used in this model is 2400-79,000 vehicles/day.
Suggested default: 31,000 veh/day
X2 – AADT of minor road (vehicles/day)
The range of values for this variable used in this model is 100-48,000 vehicles/day.
Suggested default: 7,000 veh/day
X3, X4 – Signal timing
The choices presented are pre-timed and fully actuated. If signal is semi-actuated, enter '0' for both X3 and X4.
Suggested default: Pre-timed
X5 – Access control on major road (Yes/No)
Suggested default: No access control
X6 – Signal phasing
If phasing is multiphase, enter '1'. If phasing is two-phase, enter '0'.
Suggested default: Two-phase
X7 – Number of lanes on MINOR road
Suggested default: 3 or fewer
X8 – Average lane width on major road
The range of values for this variable used in this model is 8-15 feet.
Suggested default: 12 ft
X9, X10 – Number of lanes on major road
Suggested default: 4 or 5
X11 – Major road right-turn channelization (Yes/No)
Suggested default: No free right turns

Interchange Models

> **NOTE**: Descriptions of ramp configurations may be unclear. For this reason, a guide to naming ramp configurations has been included in Appendix D.

1. Model for Ramp Proper Segments

X1 – AADT of the ramp segment (vehicles/day)
The range of values for this variable used in this model is 27-24,000 vehicles/day.
Suggested default: 5,000 veh/day
X2 – Length of the ramp segment (miles)
The range of values for this variable used in this model is 0.01-0.69 miles.
Suggested default: 0.12 miles

X3 – Ramp type
Suggested default: Off-ramp
X4 – Number of lanes
Suggested default: 1 lane
X5, X6, X7, X8, X9, X10 – Ramp configuration
Parclo and free-flow loops are grouped together under "loop ramps".
Suggested default: Diamond

2. *Model for Ramp Proper Segments on Off-Ramps (Rear-end Crashes Excluded)*

X1 – AADT of the ramp segment (vehicles/day)
The range of values for this variable used in this model is 27-24,000 vehicles/day.
Suggested default: 5,000 veh/day
X2 – Number of lanes
Suggested default: 1 lane
X3, X4, X5 – Ramp configuration
Parclo and free-flow loops are grouped together under "loop ramps".
Suggested default: Diamond
X6 – Length of the ramp segment (miles)
The range of values for this variable used in this model is 0.01-0.5 miles.
Suggested default: 0.12 miles
X7 – Average lane width (ft)
The range of values for this variable used in this model is 10-36 feet.
Suggested default: 14 ft

3. *Model for Entire Ramps*

X1 – AADT of the ramp (vehicles/day)
The range of values for this variable used in this model is 27-24,000 vehicles/day.
Suggested default: 4,000 veh/day
X2, X3, X4, X5 – Ramp configuration
If the ramp is direct or semi-direct connection, enter '0' for all the configuration variables.
Suggested default: Diamond
X6 – Ramp type
Suggested default: Off-ramp
X7 – Area type
Suggested default: Urban

4. *Model for Entire Off-Ramps (Rear-end Crashes Excluded)*

X1 – AADT of the ramp (vehicles/day)
The range of values for this variable used in this model is 27-24,000 vehicles/day.
Suggested default: 4,000 veh/day

X2, X3, X4, X5 – Ramp configuration
If the ramp is direct or semi-direct connection, enter '0' for all the configuration variables.
Suggested default: Diamond

5. Model for Acceleration Lanes

X1 – AADT of the ramp (vehicles/day)
The range of values for this variable used in this model is 54-21,000 vehicles/day.
Suggested default: 4,000 veh/day
X2 – Length of acceleration lane (miles)
The range of values for this variable used in this model is 0.02-0.38 miles. This length includes the taper.
Suggested default: 0.25 miles
X3 – Area type
Suggested default: Urban
X4 – Mainline freeway AADT (vehicles/day)
The range of values for this variable used in this model is 4,000-100,000 vehicles/day.
Suggested default: 30,000 veh/day

6. Model for Deceleration Lanes

> **NOTE: The crash prediction software (TCPM) delivered with this report in July 2000 contains computational errors in this Deceleration Lane model. It is recommended NOT to use this model until future versions of TCPM are released.**

X1 – AADT of the ramp (vehicles/day)
The range of values for this variable used in this model is 54-24,000 vehicles/day.
Suggested default: 3,000 veh/day
X2 – Area type
Suggested default: Urban
X3 – Right shoulder width (ft)
The range of values for this variable used in this model is 0-16 feet.
Suggested default: 8 ft

7. Model for Entire Ramp plus Adjacent Speed Change Lanes (10-Percent Significance Level)

> **NOTE: In the July 2000 release of TCPM, this model is labeled as "Entire Ramp plus Adjacent Speed Change Lanes."**

X1 – AADT of the ramp (vehicles/day)
The range of values for this variable used in this model is 27-24,000 vehicles/day.
Suggested default: 3,000 veh/day
X2 – Area type

Suggested default: Urban
X3, X4, X5, X6 – Ramp configuration
Suggested default: Diamond

8. Model for Entire Ramp plus Adjacent Speed Change Lanes (20-Percent Significance Level)

> **NOTE: In the July 2000 release of TCPM, this model is labeled as "Entire Ramp plus Adjacent Speed Change Lanes by Ramp Type."**

X1 – AADT of the ramp (vehicles/day)
The range of values for this variable used in this model is 27-24,000 vehicles/day.
Suggested default: 3,000 veh/day
X2 – AADT of the mainline freeway (vehicles/day)
The range of values for this variable used in this model is 2300-106,000 vehicles/day.
Suggested default: 30,000 veh/day
X3, X4, X5, X6 – Ramp configuration
Suggested default: Diamond
X7 – Area type
Suggested default: Urban
X8 – Ramp type
Suggested default: Off-ramp
X9 – Speed-change lane length (miles)
The range of values for this variable used in this model is 0.04-0.5 miles.
Suggested default: 0.18 miles
X10 – Ramp length (miles)
The range of values for this variable used in this model is 0.14-0.82 miles.
Suggested default: 0.33 miles

Output Interpretation

The TCPM output is an estimate of expected reported crashes over a three-year period. The intersection models are designed to estimate total **multiple-vehicle** crashes. If the user wishes to compare the intersection crash predictions with actual crash data, he will need to sort out single-vehicle crashes and only compare with actual multiple-vehicle crashes. Issues concerning the models and their output are discussed in the following paragraphs.

- **Upper and Lower 90% Confidence Levels**
  The rural, four-legged, STOP-controlled intersection model has two additional output options. These are the upper and lower 90% confidence limits of the regression coefficients. These procedures use different coefficients for each of the variables in the model, and thus show the range of estimates that would be possible if the upper or lower 90% confidence level were used. One will quickly see that the range of crash estimates is beyond practical

use, and therefore is only included in the program to demonstrate what the output would be if these limits were used.

- **Significant figures**
  Although the crash prediction estimate is given to several decimal places, users should not read the estimate past one or two significant figures. The estimate is not precise enough to predict beyond that.
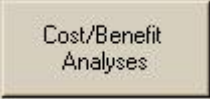
- **The difference between 10 and 20 percent significance in the "Entire Ramp plus Adjacent Speed-change Lanes" models**
  The percent significance has mainly to do with which variables are included in the model. When a model is created, it is run with many variables at first. In the analysis afterwards, if the variables are not *statistically significant*, then they are taken out of the model. At 20 percent significance, the user can see that more variables remained in the model than at the 10 percent significance level.
  The FHWA document (Bauer and Harwood 1998) recommends that "…caution be exercised in including variables that are not statistically significant at the 10 percent significance level in a predictive model…" There is less risk in predicting crashes with the 10 percent significance level model.

Potential Problems

- The information required by the models is not always available or easily attained. The information on some features (functional classification, presence of lighting) is not stored on a centralized database in North Carolina.
- The intersection crash prediction is given for only multiple-vehicle crashes. If this prediction is used as an expected value for a given intersection, the actual number of crashes may be higher, due to the inclusion of unpredicted single-vehicle crashes.
- The crash prediction is given for a three-year period. If this number is to be compared with actual crash records, the user must take care to ensure that the actual crash data is in three-year increments or some average three-year increment.

Cost/Benefit Analyses

This procedure refers to a program called Safety Resource Allocation Programs (SRAP). SRAP evaluates the benefits and costs of candidate safety projects and makes a recommended priority list. SRAP offers three methodologies to perform the prioritization: incremental benefit-cost analysis, integer programming, and dynamic programming. Expected collision frequencies from the models in TCPM and expected countermeasure collision savings from BEATS could be key input values for SRAP. SRAP was developed for MS-DOS by FHWA and a user's manual is available (Liu and Chen 1988).

Due to difficulties with the software, the switchboard button for this procedure does not directly start the SRAP program. Instead, clicking on this button will bring up instructions on how to start the program. The instructions are as follows:

```
To start SRAP: the cost-benefit analyses program,
Click the Start button.
Click Run.
Type the following line into the Run window -
C:\TransportationSafetyEvaluation\CostBenefitAnalyses\srap.com
```

Example of Software Use

As an example of the process described in this user's guide, this section describes how the NCSU team examined two intersections – a treatment site and its reference site. For these sites, the team obtained intersection characteristics data, retrieved collision data using TEAAS, entered the information into the TSEDS database, and used these data in the BEATS and TCPM programs.

These intersections were part of a larger group of sites gathered for an FHWA project labeled *Safety Evaluation of Intersection Design Improvements*. The Principal Investigator of the project was Douglas Harwood at the Midwest Research Institute. The proposal was submitted to the Federal Highway Administration in response to Request for Proposal No. DTFH61-96-R-00055.

STEP 1.   Intersection Characteristics Data

The treatment site and the reference site were labeled 002 and 002A, respectively, in the larger database from which these sites were chosen. The countermeasure was the installation of a left-turn lane, which was only installed at site 002.

Both sites were rural, three-legged, STOP-controlled intersections. The classification of an intersection as rural or urban was a subjective selection based on type of traffic control, ADT volumes, and familiarity with the site locations.

The Average Daily Traffic (ADT) volumes for each intersection were necessary for input into the model equations. The ADT volumes were obtained using traffic counts from the Traffic Surveys unit of the NCDOT. Projected ADT volumes were calculated for the years of interest using the linear traffic projection model. The Highway Emulator may also be used to calculate traffic volumes on a particular road in a network but was not needed in this case because volume estimates were available for the intersection approaches.

STEP 2.   Retrieve Crash Data using TEAAS

TEAAS was used to collect collision frequencies for intersections 002 and 002A for the before treatment period and after treatment period. The treatment (left-turn lane installation) was completed at intersection 002 in 1994. The before treatment period used for collision data collection was 1/1/1990 to 12/31/1993 at both treatment and reference intersections. The after treatment period for both intersections was 1/1/1995 to 12/31/1999.

TEAAS was downloaded to a computer following the download instructions located in Appendix A. The Intersection Analysis feature was used to find collision data for intersections 002 and 002A for both before and after treatment installation. The following procedure was used to determine the crash frequency for each intersection:

1. Input Study Information
2. Generate Fiche Report
3. Examine Fiche Report for misreported crashes
4. Generate Accident Report
5. Complete Accident Adjustments (if necessary)
6. Record crash frequency from Accident Report

Intersection Number	002	002
Time Period	Before treatment	After treatment
Study Name	Site1treatmentbefore	Site1treatmentafter
County	Robeson	Robeson
Begin Date	1/1/1990	1/1/1995
End Date	12/31/1993	12/31/1999
ADT	14000 (year)	14000 (year)

Intersection Number	002A	002A
Time Period	Before treatment	After treatment
Study Name	Site1referencebefore	Site1referenceafter
County	Robeson	Robeson
Begin Date	1/1/1990	1/1/1995
End Date	12/31/1993	12/31/1999
ADT	9300	9300

Figure 10. TEAAS Study Information input for both intersections

The ADT's are approximate values to fill in a field for TEAAS. It is not essential that these volumes be exact at this stage.

A Fiche Report was generated for each of the four cases shown above. The major road codes were used to generate the Fiche Report. The Fiche Report returns a list of all reported crashes that occurred on the major road. This list may be examined for possible misspellings or misreported information for crashes that would not be generated in the final accident report. If any are found, they may be manually added to the accident report using the CrashID in the Fiche Report.

After the Fiche Report was examined and misreported crashes were accounted for, the road codes and road names are entered to generate an accident report. The two intersection roads are entered on the same row as either road names or road codes. All combinations of road codes and road names should be entered for the Accident Report. The different combinations used to generate the Accident Report for the two intersections are listed in Figure 11.

Intersection 002			
Road Name	Road Code	Road Code	Road Name
	30000211	40001527	
	30000211	50024161	PINE LOG

Intersection 002A			
Road Name	Road Code	Road Code	Road Name
	30000041	40001002	
	30000041	50004375	BURNT ISLAND

Figure 11. Road codes and names for the Accident Report

Four Accident Reports were generated – a before treatment and an after treatment for each intersection. In this case there were no misreported crashes found in the Fiche Report and no crashes were included or removed from the accident report. The crash frequency for each case was recorded from the Accident Report.

The recorded crash frequencies for intersections 002 and 002A were:

- 002 before – 13
- 002 after – 15
- 002A before – 7
- 002A after – 23

STEP 3.   Entered the Intersection Data into TSEDS

Database forms were used to input the intersection data into the TSEDS database (see Figure 12 below). The section below lists the data inputted on each form.

Site Location Description Form:
Intersection Number – 002
Study Location Number – 1
State – nothing entered. All intersections in our study were in North Carolina.
County – Robeson
Nearby City/Town – nothing entered
Area Type – R
Major Road Name – NC211
Minor Road Name – SR1527

Intersection Characteristics Form:
Intersection Number – 002
Number of Approach – 3
Signalization – No

Channelization – Yes
Pavement Markings – Yes
Predicted Crashes – This is entered later after running Crash Prediction software

Intersection Data Form:
This form was not used.

Treatment and Comparison Sites Form:
Intersection Number – 002
Year Treatment Completed – 94
Major Road Traffic – 10081
Minor Road Traffic – 3804
Before Crashes – 13
After Crashes – 15

Projected Traffic Volumes Form:
Intersection Number – 002
1990 Major Road – 8397
1990 Minor Road – 3169
…
2002 Major Road – 11284
2002 Minor Road – 4258
(All future traffic volumes were projected using a linear traffic projection model.)

Crash Data Form
Intersection Number – 002
1990 – 2
1991 – 5
1992 – 2
1993 – 4
1994 – No crash data collected for the treatment year
1995 – 4
1996 – 2
1997 – 2
1998 – 7
1999 – 3

Figure 12. Example of TSEDS Database Form.

The same process was followed to enter the information for site 002A.

STEP 4.   Evaluate Countermeasure using BEATS

The BEATS software was used to determine the effectiveness of countermeasure installation on crash reduction at all sites. The input values and examples used in BEATS for intersections 002 and 002A will be given in this section; however, all available data for all intersections were used in the BEATS program to evaluate the effectiveness of left-turn lane installation.

Program Input

Figure 13 shows the input file created for this example. The BEATS text input file contains this above-mentioned information for both sites in the example.

Figure 13. BEATS input file for 002 and 002A

The first and third rows of data in Figure 13 above correspond to intersection 002. Identification number 1 represents intersection 002, both before and after. The data in row 1 represents intersection number 1, before treatment, treatment site, with 13 crashes in the before period, and an exposure of 48251 (The sum of the major and minor road ADT's from 1990 through 1993). Row 3 is also data for intersection 002 – intersection number 1, after treatment, treatment site, with 15 crashes and an exposure of 69425. Row 2 represents intersection 002A – intersection number 2, before treatment, reference site, with 7 crashes and an exposure of 32495. Row 4 also represents intersection 002A – intersection number 2, after treatment, reference site, with 23 crashes and an exposure of 46755.

One may notice that the values used for exposure are not the same as the single-year ADT. This stems from an issue in data collection. The crash data were collected over different time periods. Some "before treatment" crashes are a total over 4 years, while others are a total of 6 years. To take this into consideration when running BEATS, the exposure values were summed ADT over the years that the crash data were collected. This was deemed sufficient to account for the different number of years of data collection. Be sure to use different traffic volumes for the before and after periods at a site. During the treatment time, the traffic volumes are sure to have changed, and this will have an effect on the BEATS treatment evaluation.

Please refer to the BEATS section of the User's Guide for a more detailed explanation of the input values shown in the figure above.

After the input file is created, it was saved as a text file with a .txt extension. BEATS was then opened to analyze the data. In response to BEATS questions, the following were answered:

Exposure data?   YES
Reference group?   YES
Comparison group?   NO

BEATS prompts users for the input file name and an output file name. A .txt extension must follow both the input file name and output file name during this step. For example, the input file name in this example was named *testin.txt* and the output file was named *testout.txt*.

Output

The output file generated by BEATS is located in the same directory as the input file and it is also in text format. For a more detailed description of the output file, see the BEATS section of the User's Guide.

Three methods are used to estimate the treatment effect - the EBEST method using the comparison group (if available), the frequentist or cross product ratio, and the EBEST method using the reference group in place of the comparison group, if available. The intersections in the input file were labeled as reference sites; therefore, only two methods were used to analyze the data. The entire output is included in Appendix C.

Some summary output statistics for the entire group of treatment and reference sites include:

- trteEBr = -50.66
- trtefr = -52.06
- tEBr = -11.25
- zfr = -6.48
- Bavg = 0.183

Accidents at the sites after treatment were reduced by 51% using the EBEST method to adjust for regression-to-the-mean and 52% using the frequentist method that does not adjust for regression-to-the-mean. The reduction was strongly significant using both methods; therefore, it would not matter which result was selected. The B_{avg} for the data was 0.18, which indicates there was not much regression-to-the-mean in the data and the frequentist method may be selected to represent the best estimate of the savings.

STEP 5. Predicted Expected Number of Collisions

From the information stored in the database, the appropriate data were input into TCPM, using the model for rural, three-legged, STOP-controlled intersections. Figure 14 shows the characteristics of site 002 being entered into the model.
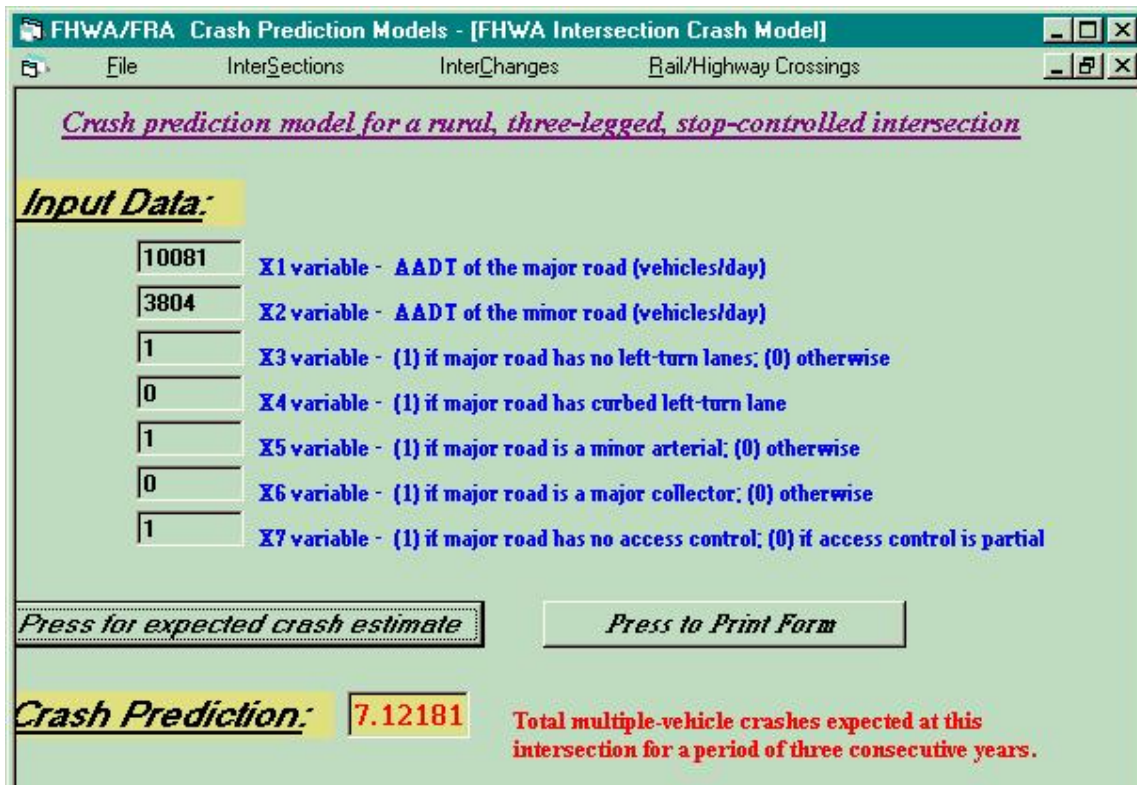

Figure 14. TCPM model with input.

The AADT data that the team used were the traffic volumes from 1997. This was chosen arbitrarily for the purposes of this example. The program user should input the AADT from the year **just before** the three-year period that he wishes to analyze.

As one can see from the information entered into the TSEDS database, information on the functional classification of the major road and access control were not given. This information proved difficult to track down without a field visit, so default values were used. The default values used were:

- **No left turn lanes** (Installation of left-turn lanes was our treatment, so this allowed us to predict crashes before treatment)
- **Minor arterial**
- **No access control**

A list of the default values used by the NCSU team for crash predictions at all sites in the demonstration is given in Appendix E.

The results of TCPM for site 002 is 7 crashes and for site 002A is 3 crashes. These crash predictions can now be compared to the actual crash records of these sites to determine if these sites are abnormally hazardous. Also using these predictions, these sites can be ranked with other sites' crash predictions to determine the most probable hazardous sites from the group. In addition, analysts could use these predictions to judge the impacts of changes like new left-turn lanes or higher traffic volumes.

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