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16. Abstract

The Texas Department of Transportation (TxDOT) sponsored Project 0-4986, "An Assessment of Frontage Road Yield Treatments," to assess the effectiveness of a wide variety of frontage road–exit ramp and frontage road–U-turn yield treatments that exist in Texas. Toward this goal, simulation modeling procedures compensated for the impracticability of the data collection effort that would be required to compile every possible combination of volume, geometry, and yield treatment types.

Researchers ran several thousand simulations and generated significant numbers of measures of performance and comparative analysis. Researchers, in consultation with TxDOT, sought to develop a database software tool to incorporate all the results obtained from the initial research. This will provide TxDOT staff with a more useful tool in determining appropriate yield treatments at exit ramp/U-turn and frontage road merge areas.

This report summarizes the work completed during the extension year, which resulted in the development of the Frontage Road Yield Treatment Analysis Tool (FRYTAT). The report briefly summarizes the interaction and coordination between the TxDOT panel and the Texas Transportation Institute research team, describes the development of the main framework of the tool, and illustrates the final product, FRYTAT.

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DEVELOPMENT OF FRONTAGE ROAD YIELD TREATMENT ANALYSIS TOOL (FRYTAT) DATABASE SOFTWARE

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The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Federal Highway Administration (FHWA) or the Texas Department of Transportation (TxDOT). This report does not constitute a standard, specification, or regulation. This report is not intended for construction, bidding, or permit purposes. The engineer in charge of this project was Russell H. Henk, P.E. (Texas #74460).

ACKNOWLEDGMENTS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ACRONYMS, ABBREVIATIONS, AND TERMS

CD   Compact Disc

COM   Component Object Model

EFRYT   Exit Frontage Road Yield Treatment

FHWA   Federal Highway Administration

FRYTAT   Frontage Road Yield Treatment Analysis Tool

GIF   Graphics Interchange Format

GUI   Graphical User Interface

HTML   HyperText Markup Language

MOE   Measures of Effectiveness

OD   Origin-Destination

ODBC   Open Database Connectivity

PC   Personal Computer

PDF   Portable Document Format

PMC   Project Monitoring Committee

RAD   Rapid Application Development

SQL   Structured Query Language

TxDOT   Texas Department of Transportation

UFRYT   U-Turn and Frontage Road Yield Treatment

VB   Visual Basic

VPH   Vehicles per Hour

CHAPTER 1. INTRODUCTION

BACKGROUND

In the state of Texas there are a variety of exit ramp and U-turn ramp configurations in use along the frontage roads of Texas Department of Transportation (TxDOT) highways. After surveying the 25 TxDOT districts, seven categories of exit ramp design and five categories of U-turn ramp design were identified.

The objective of the original Project 0-4986 was to assess the effectiveness of various yield treatment signing at freeway exit and frontage road merge areas as well as U-turn and frontage road merge areas. The details of the research conducted are documented in the final report at the end of the third year of the project (Report 0-4986-1).

A total of 2268 exit ramp–frontage road and 540 U-turn–frontage road simulation runs were made using various combinations of exit ramp, frontage road, and U-turn volumes as well as a number of driveways and distances from the exit ramp gore to the downstream intersection. Since each scenario was run three times, a total of 8424 runs were made, and over 25 measures of effectiveness (MOEs) were collected during each simulation.

Results from the simulation showed that certain designs (such as Category 1A for exit ramp–frontage road scenarios) were identified as performing well in most of the cases, while certain other designs (such as Categories 3 and 6) only performed well if certain conditions were present. In those cases, however, those poorly performing categories performed better than the best category under other circumstances. A need developed to create a tool to transfer the knowledge gained by modeling and apply it to either a new design or existing roadway configuration.

RESULTS AND DATA PRESENTATION - FRYTAT

The original research resulted in the analysis of several combinations of various geometric, traffic volume, and vehicle maneuver scenarios. Researchers ran several thousand simulations and generated significant numbers of MOEs, resulting in various comparative analysis results. To present the results in tabular or graphical formats would mean the production of large quantities of tables, charts, and/or graphs. The research team in consultation with TxDOT decided not to pursue this route and instead decided to develop a simple database tool to present the results.

The resulting database tool, hereafter referred to as the Frontage Road Yield Treatment Analysis Tool (FRYTAT), was designed to develop a more user-friendly interpretation of the results obtained from the initial research. For a given scenario, this program finds the best and safest yield treatment for the conditions inputted. It considers the effects of traffic volume, weaving, and geometric layout scenarios including number of driveways and distance from the yield point/gore point to the downstream intersection.

It also allows the comparison of one kind of treatment to another and shows the effect that adding one more driveway or intersection has on the overall operation of the exit or U-turn ramp. Built-in warning statements for very high delays and high potential crash results are also displayed.

This report documents the findings of the research project organized in chapters as follows:

- Chapter 1 is the introduction chapter.
- Chapter 2 reviews the project development process.
- Chapter 3 describes the development of the main framework of the tool.
- Chapter 4 describes in detail the development of the software, including the programming procedure.
- Chapter 5 provides an illustration of the software tool, including some application examples.
- Chapter 6 provides the conclusions and remarks.

CHAPTER 2. REVIEW OF FRYTAT DEVELOPMENT PROCESS

INTERACTION WITH TXDOT

Researchers and TxDOT's Project Monitoring Committee (PMC) interacted frequently during the conceptual stage of FRYTAT, its development, and the evaluation process. Several TxDOT districts were involved in the evaluation process in particular to ensure that the final version of FRYTAT would serve its purpose of being useful to TxDOT staff. Figure 1 presents an overview of the various stages of the software development and the input from TxDOT.
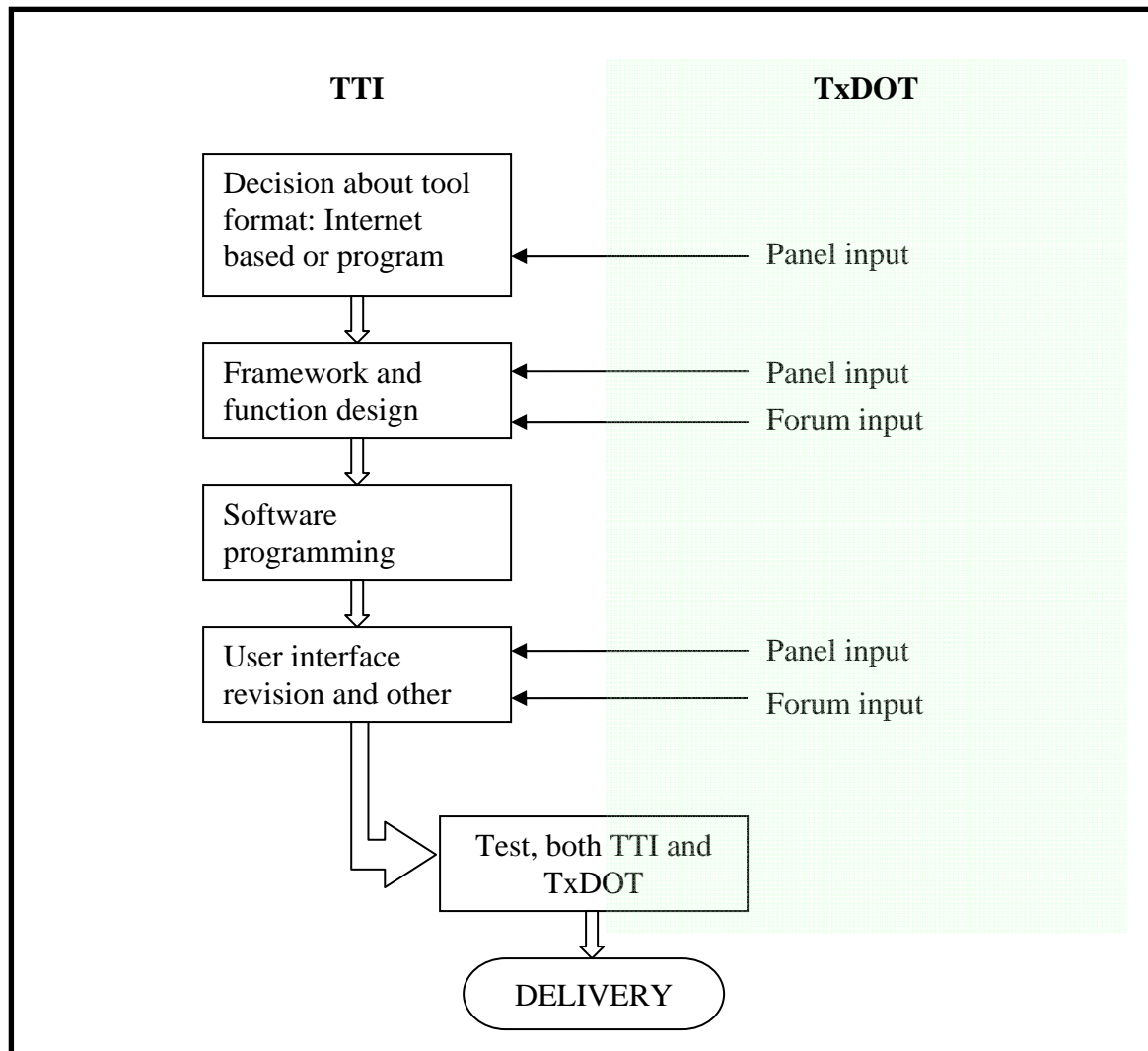
Figure 1. Overview of Program Development and TxDOT Input.

The most prolific source for outside input in the program development process was the panel meetings held between the research team and the PMC. During the project year, researchers hosted three full panel meetings as well as numerous rounds of emails to ensure the database development was in accordance with the PMC's vision. This involved several rounds of iterative revision of the functions and features of FRYTAT.

PANEL INPUT

The following bulleted list outlines the main concerns and recommendations received from the PMC throughout the conceptual, developmental, and evaluation stages of FRYTAT: The appropriate action taken by researchers to address these concerns are outlined below each concern.

- The user interface of the program needs to be user-friendly, with particular concern for self-explanatory symbols and terms in the user interface. The panel felt the fewer times a user had to refer to the user manual the better.
  - o FRYTAT was developed with this in mind, and the feedback from the various districts suggests that this goal of simplicity and user-friendliness has been achieved.
- The program should be able to run easily on ordinary personal computers (PCs) found at various TxDOT districts without the need to install any new software or updates.
  - o An extensive discussion and subsequent reprogramming was conducted to develop the FRYTAT database as a stand-alone tool without the need to install Microsoft Access®. This involved changing the programming environment from a purely database format to a Visual Basic (VB) based format.
- The study needs to consider the reality of the variety of different categories existing in the state of Texas.
  - o Researchers were thorough in their investigation of different yield treatment categories currently being deployed in Texas.
- The FRYTAT database needs to be verified with the actual output of simulation results.
  - o Several test examples were conducted, and the output of the software proved to be valid.
- The program should provide easy access to diagrams of various yield treatment options.
  - o The schematic plots of the different yield treatments were added into the program to allow the user to have a direct impression.
- A more comprehensive and academic user manual is needed.
  - o Several useful examples were outlined in the user manual to help guide district engineers in using FRYTAT.
- The team should conduct a broader user test of the program to identify and fix potential bugs.
  - o FRYTAT went through a round of iterative evaluations at several TxDOT districts to determine the usefulness of its functionality and to assess its performance by a sample of TxDOT staff who will be using it eventually. This process led to important changes in the program to make it a better tool for TxDOT staff.

A few other suggestions and concerns could not be addressed by researchers:

- The PMC proposed asking the TxDOT Design Division for their input on the database format and features; no conclusion or motion was produced in the meeting.
    o There was little input from the Design Division. However, there were a few representatives at one of the forums conducted to present the research results to TxDOT staff.
- There was some concern about the use of surrogate crash data and whether the safety results could be verified with hard crash data.
    o After some discussion, the panel finally agreed that it would prove difficult getting good information from the state crash database given the inconsistencies in that database. The surrogate safety analysis used during the research involved the use of a tool that was sponsored by the Federal Highway Administration (FHWA).

FORUMS INPUT

Throughout the entire project, three forums were conducted to present the results of the research to transportation engineering professionals. The primary focus was TxDOT staff. The forums were held in three separate locations in the state of Texas, namely Corpus Christi, San Antonio, and Fort Worth. The intention was to afford various professionals across the various parts of the state an opportunity to comment on the research results and be updated on current research in the area of yield treatments on frontage roads.

The first two forums were held in the third year of the project and have been discussed in depth in Report 0-4986-1. The third and final forum was at the end of the fourth year, and the research team presented research findings at a forum organized in collaboration with the TxDOT Dallas and Fort Worth Districts. The forum was held at the Fort Worth TransVision Training Center on August 14, 2008. A total of about 30 people attended from the following broad categories:

- Texas Department of Transportation:
    o Fort Worth District (representatives of Planning, Operations, and Design) and
    o Dallas District (representatives of Planning, Operations, and Design);
- City of Fort Worth;
- City of Dallas; and
- Consultants.

The forum presented a unique opportunity for researchers to explain the functions of the FRYTAT database tool to likely users in the districts. There was very positive feedback from the group after the research goals and FRYTAT functionality had been explained. Several participants indicated their satisfaction with the ease of use of FRYTAT and were eager to make use of it in their daily tasks, at the districts in particular. Consultants had also indicated a desire to have access to the tool. Based on the feedback, further fine-tuning of the database tool was initiated to ensure that the final deliverable to TxDOT was of the highest standard.

CHAPTER 3. DEVELOPMENT OF MAIN FRAMEWORK

OVERVIEW

In an effort to give the prototype software tool a more convenient name, the researchers considered many alternatives. In response to a suggestion by the research advisory panel, the preliminary name of the software is FRYTAT.

FRYTAT is primarily designed to provide guidance on the selection of yield treatment signing at freeway exit ramp and frontage road merge areas as well as U-turn and frontage road merge areas. TxDOT users can use FRYTAT as both an operational and planning tool to determine the potential impact of various geometry configurations within the exit ramp/U-turn and frontage road merge areas on vehicle delays and potential crash frequency.

The VB program framework allows for FRYTAT to be a stand-alone tool. This enables the user to bypass the need to have a database program already installed on the computer. The format also allows easy distribution among the various TxDOT districts. FRYTAT can be copied on a compact disc (CD) or other portable storage device or emailed as a zipped file. This allows easy access by various TxDOT districts as well as a wide range of external consultants and contractors.

FUNCTIONAL REQUIREMENTS

Based on input from the PMC, researchers developed a list of functional requirements.

Two Modules

The program has two modules:

- Exit Ramp and Frontage Road Yield Treatment: analyzes input data for various exit ramp and frontage road yield treatment scenarios, and
- U-Turn and Frontage Road Yield Treatment: analyzes input data for various U-turn and frontage road yield treatment scenarios.

User Interface

The user interface contains:

- Graphical user interface (GUI): The program interface is user friendly and Microsoft Windows® compatible.
- Real-time help onscreen: Explanatory definitions pop up when the cursor indicator is held over the specific term. This helps the user quickly understand the term without accessing the user manual.

- Glossary: The glossary contains definitions of various terms used in FRYTAT. It also contains details on:
  - definitions of various vehicle maneuver terminologies,
  - definitions of various levels of traffic volumes, and
  - definitions of various distance measures.
- User manual: The user manual provides an in-depth guide to using FRYTAT with several practical examples of using the tool.

The user manual and glossary can be accessed directly through the GUI. This allows the user to obtain quick references and tips for navigating FRYTAT without having to find a hard copy of the user manual.

Data Input

Two options for input of values are defined in FRYTAT:

- Basic Version: The user has a general idea of the range of input parameters required for analysis without detailed data obtained through a thorough data collection process.
- Detailed Version: The user has detailed data on volumes, weaving maneuvers, distances, and driveway density for each site through a thorough data collection process.

Scenario Evaluation

There are two general ways of analyzing frontage road yield treatments in FRYTAT:

- Analyzing a specific case: Under this scenario, FRYTAT selects a single yield treatment category as the best yield treatment for the selected case.
- Analyzing a general case: This is the case when the user wants to use FRYTAT more as a planning tool. Performing this type of analysis allows the user to obtain the relative performance of the various yield treatment categories over the range of combinations of parameters not selected.

Visualization

FRYTAT offers several options for visualization:

- visualization of the best yield treatment category in a schematic plot,
- a detailed report on the performance measures of the various yield treatments under the specific case selected, and
- visualization of the percentage of best-performing cases over various variables.

FRYTAT DEVELOPMENT FLOW CHART

Researchers designed the main framework of the program based on the functional requirements. Figure 2 shows the streamlined flow chart depicting the process of developing the

program. In the flow chart, the two databases, Category Guidance and Performance Analysis, refer to the dataset containing the raw data from the simulation results.
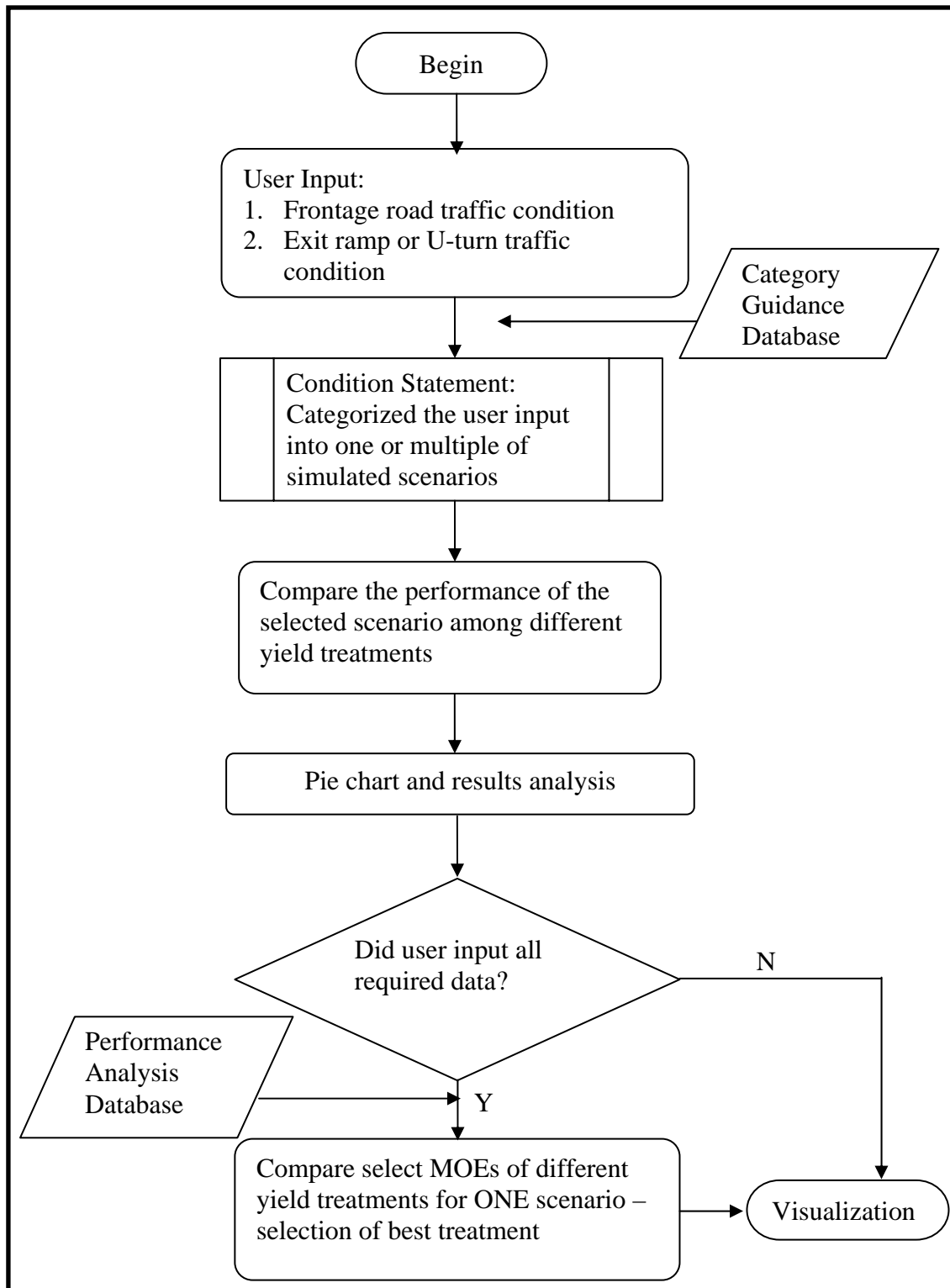
Figure 2. Flow Chart for FRYTAT.

SUMMARY OF PROGRAM DEVELOPMENT TIMELINE

The first version of the database analysis tool, which is named Exit Frontage Road Yield Treatment (EFRYT), was created during the summer of 2007 in Microsoft Access. It required the user to have the Microsoft Access program installed on the computer in order to run EFRYT. Since very few TxDOT computers have Microsoft Access, researchers considered ways of developing a more independent program framework.

Both web-based database and executable program formats were considered as plausible formats for developing the database tool. In January of 2008, researchers finally decided to convert the program into an executable program to provide easy access to a wide range of users. This newer version of FRYTAT contains both the original EFRYT but also the U-Turn Frontage Road Yield Treatment (UFRYT). The major control program was coded by using Microsoft Visual Basic .NET[®]. The research team also incorporated the data-processing capability of Microsoft Access and the graphical functionality of Microsoft Excel[®]. Further details on the programming aspect of FRYTAT are provided in the next chapter.

CHAPTER 4. SOFTWARE PROGRAMMING

SELECTION OF PROGRAMMING LANGUAGE AND OTHER TOOLS

Microsoft Access is a Microsoft Windows–based database program. It is fairly quick and easy to use to read, add, or modify data. Because of its ease of use, ability to store large quantities of data, and relatively quick data-editing capabilities, researchers stored all simulation results data using Microsoft Access.

Researchers used Microsoft Visual Basic.NET (VB.NET) to create the software GUI. With this program, FRYTAT developers were able to connect data from Microsoft Access, transport user-selected data into Microsoft Excel to create charts, and load all images back to the appropriate window in FRYTAT. We chose the Visual Basic.NET framework to build our software because VB.NET enables the software developer to design independent software and also customize, extend, and integrate the development environment right out of the box.

The use of Microsoft Excel was primarily based on its popularity and powerful calculation and graphing abilities. VB.NET sends the user's selected data into Excel and uses Excel to create various charts. After the chart creation, the program converts all charts into Graphics Interchange Format (GIF) image files and saves them in one folder for later use as requested by the user. The images are encoded with HyperText Markup Language (HTML), which is interpreted by the browser (hence the need for Internet Explorer® installation). Figure 3 gives a broad overview of the framework for FRYTAT.
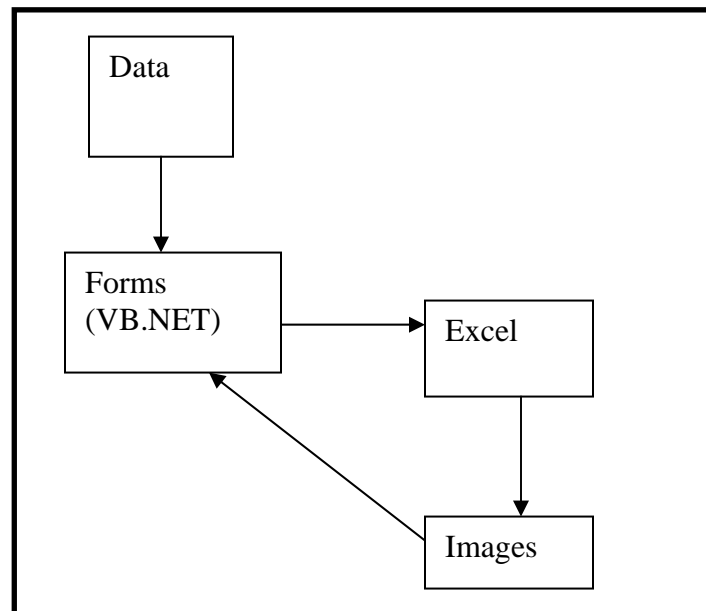
Figure 3. Broad Overview of Programming Language Framework.

DATA PRE-PROCESSING

All the data from the simulation analysis were originally stored in Microsoft Excel format. Microsoft Access has better programming capabilities, and thus all the data were exported from Microsoft Excel into Microsoft Access. Fields name and types created in Access were based upon previous field names from the Excel format.

EFRYT contains two table formats, Sheet1 and Sheet2, shown in Figure 4:

- Sheet1 stores EFRYT's category data, which are filtered by the "Input Parameters" tab in FRYTAT, resulting in the "Frequency of Best Performance Category for Inputted Factors" result. This result gives the user the best performing yield treatment category.
- Sheet2 stores the performance data. The performance result will only show when all input parameters are selected.

Sheet1:

Field	Yieldcat	Rampvol	Rampvm	Frvol	Dist	Nod	Frvm	Savgde	Totcss	Index
Type	Number	Text	Text	Text	Text	Number	Text	Number	Number	number

Sheet2:

Field	F1	TTT	AvgSpd	AvgD	AvgStp	Vgrp1a	Vgrp1b	Vgrp1c	Vgrp1d	
Type	Text	number	number	number	number	number	number	number	number	

Vgrp2a	Vgrp2b	Vgrp2c	Vgrp2d	Vgrp3a	Vgrp3b	Vgrp3c	Vgrp3d	Vgrp4a	Vgrp4b	Vgrp4c	Vgrp4d
number	number	number	number	number	number	number	number	number	number	number	number

Figure 4. Sample Data Storage Format in FRYTAT—EFRYT.

UFRYT contains three table formats, PiechartA, PiechartB, and Performance, shown in Figure 5:

- PiechartA reflects data from the UFRYT input parameter for Entrance Ramp within 1000 ft.
- PiechartB reflects data from the UFRYT input parameter for Entrance Ramp Greater than 1000 ft.
- Performance result will only show when all input parameters are selected.

Performance Table:										
Field	Trtmnt	Dist	Drway	Frtage	Uturn	ODcd	L1spd	L2spd	L3spd	Avgspd	L1D
Type	Num	Num	Num	Num	Num	Num	Num	Num	Text	Num	Num

L2D	L3D	AvgD	AvgDelay	avgSDelay	avgStop	#veh	Totcss	Lcss	Crss	Res	unclss	index
Num	text	Num	Num	Num	Num	Num	Num	Num	Num	Num	Num	Num

PiechartA Table:									
Field	Treatment	Dist	DrWay	Frtage	Uturn	ODC	avgSpd	avgDelay	Totcss	Index
Type	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number

PiechartB Table:									
Field	Treatment	Dist	DrWay	Frtage	Uturn	ODC	avgSpd	avgDelay	Totcss	Index
Type	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number

Figure 5. Sample Data Storage Format in FRYTAT—UFRYT.

PROGRAMMING

The computer languages used for the development of FRYTAT include Visual Basic, Structured Query Language (SQL), and HyperText Markup Language. VB is a Rapid Application Development (RAD) process that makes it easy to create GUIs through a drag and drop process. This, in turn, increases productivity by reducing the time frame for graphical programming while allowing the programmer to focus on logical programming.

For data storage and manipulation, VB utilizes SQL via Microsoft Access. By default, Microsoft Access generates an Open Database Connectivity (ODBC) entry that allows connectivity to its database. Using this connection, VB implements data adapters to communicate between Microsoft Access and VB. VB utilizes a virtual data source and dataset to manipulate the data from this database. This program connects to two different databases, EFRYT and UFRYT, using two major functions, Filter Data and Create Chart.

Filter Data

The primary function of Filter Data is to produce results from the user input. After the user selects various input parameters, Filter Data gathers the appropriate data from UFRYT or EFRYT (depending on whether the selection was for U-turns or exit ramps). Filter Data uses the Excel Automation and Component Object Model (COM) to communicate with Excel. Excel Automation uses COM to give access to external programs by exposing certain functionalities and allowing seamless integration without user interaction. Filter Data interfaces with Excel to create a new worksheet where the data will be stored. Then the Create Chart function is used for graphical representation of the data.

13

Create Chart

The primary objective of the Create Chart function is to use the acquired filtered data that have been transferred to the new worksheet. This is done by using Microsoft Excel's graphing function to present the data in a visual format via GIF images to minimize the computer's memory usage.

TESTING AND DEBUGGING

The testing process ensures that the software functions properly and does what the programmer intends for it to do. Several types of testing were done for this software, some of which are listed in the following section.

Defects and Failures Testing

This implements programming techniques to detect syntax or logical errors through interaction with the program. The following is the procedure used to test the Frontage Road Yield Treatment Main:

1. With the mouse over the text "Basic Version" or "Detailed Version," ensure the command text box displays the proper message.
2. Test each button: the "Exit Ramp and Frontage Road Yield Treatment" button, the "U-Turn and Frontage Road Yield Treatment" button, and the "Exit Program" button.

The following is the procedure used to test the Basic Version of Exit Ramp and Frontage Road Yield Treatment:

1. With the mouse over each text conditions/parameters ("Normal Weaving," "High" Weaving," etc.), verify if the display message appears correctly.
2. Click Glossary to test if the glossary file is linked properly.
3. Click Result to check the results for accuracy.
4. Select particular conditions to see if the appropriate warning messages are displayed.
5. Select all conditions to see the best category and performance for the selected parameter combinations displayed.
6. Unselect all conditions to see the summary category result.
7. Under Category Result, test each category link, "Category1A," "Category1," "Category2," "Category3," "Category4," "Category5," and "Category6," to ensure these are linked to the correct images.
8. Under Performance Result, test each category link, "Category1A," "Category1," "Category2," "Category3," "Category4," "Category5," and "Category6," to ensure these are linked to the correct images.

The following is the procedure used to test the Detailed Version of Exit Ramp and Frontage Road Yield Treatment:

1. With no input parameters entered, verify the results with a similar test in the Basic Version.
2. Input numerical values in some text boxes and verify the results with a similar input in the Basic Version.
3. Input numerical values in all text boxes and check for accuracy in the results; verify the results with a similar input in the Basic Version.
4. Input no numerical values in text boxes. Check for the appropriate warning message indicating the invalidity of data input. No results should be displayed in that situation.

A similar testing procedure was applied to the U-turn portion of FRYTAT (UFRYT) except that UFRYT does not display any warning message for an undesirable selection.

Input Combinations and Preconditions Testing

This is a technique that was implemented after 95 percent of the program was completed. Various scenarios are used to simulate potential user input error or misuse of inputs for program instability or corruption.

1. Test all combinations of inputs and preconditions for FRYTAT including UFRYT and EFRYT.
2. Test if the combination of inputs does what it is supposed to do.
3. Test a number of runs for various input parameter combinations.

Static and Dynamic Testing

This type of testing is the final testing phase, which happens at the time of installation to detect any incompatibilities during the installation process:

1. Send the software to TxDOT for review and inspection.
2. Have engineers and the research group test the software for the final release.

CHAPTER 5. ILLUSTRATION OF DATABASE TOOL

OVERVIEW

Screen Structure and Menu Options

The user double clicks the executable file, *TreatmentData.exe*, to open the FRYTAT GUI as shown in Figure 6. The FRYTAT opening screen has two general sections—the toolbar and the menu as shown in Figure 6:

- Toolbar: This area, at the top of the user interface, includes the File and Help menu options.
  - File contains the Exit button to help the user close the program safely, and
  - Help contains the Glossary of Terms and the User Manual in Portable Document Format (PDF) format.
- Menu: The menu section contains options for selecting the Basic or Detailed Version of the FRYTAT program, followed by a choice of what kind of Yield Treatment Analysis the user intends to perform—the Exit Ramp and Frontage Road or U-Turn and Frontage Road options.
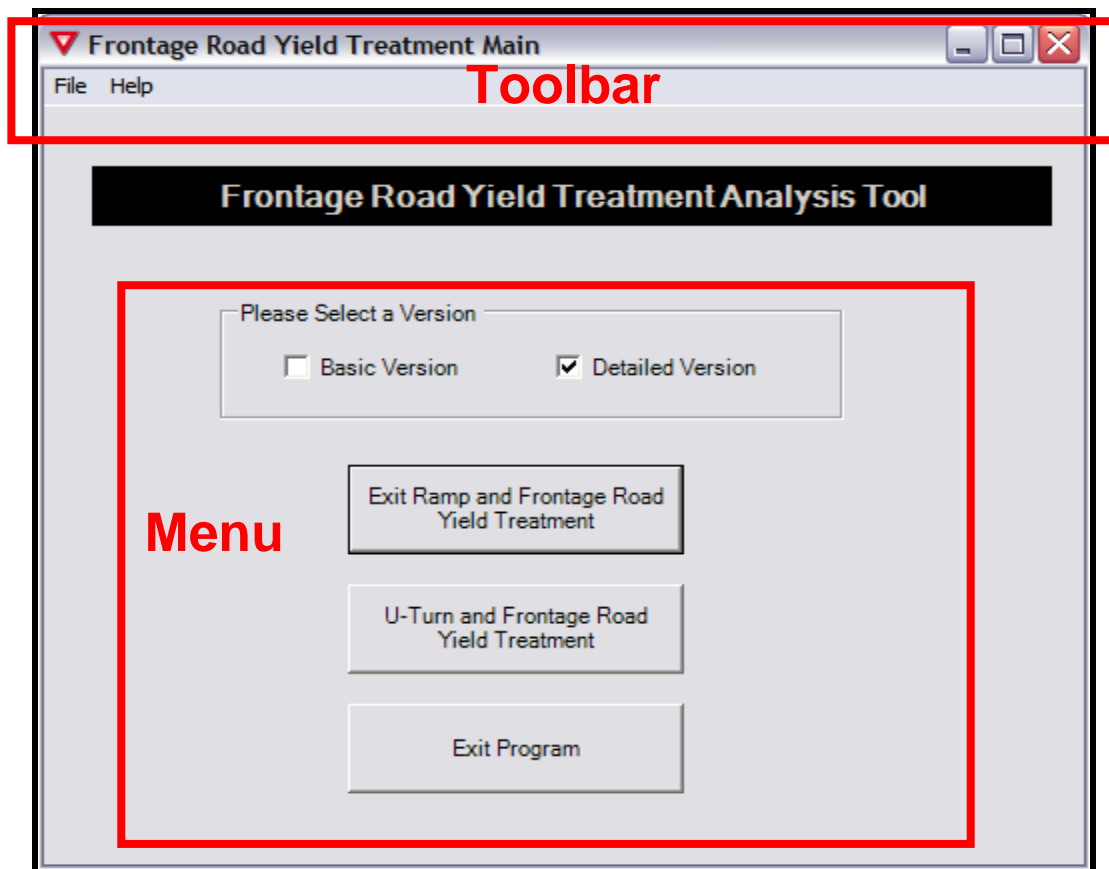

Figure 6. FRYTAT Opening GUI.

Toolbar Options

The following are the toolbar options:

- File: Click on "File" to display the "Exit" button that allows the user to close FRYTAT. FRYTAT can also be ended by using the Exit Program tab under the menu section of the GUI as shown in Figure 6.
- Help: Click on "Help" in the toolbar to select either the Glossary (glossary of terms) or the User Manual (same document as this) in Acrobat® PDF format.

FUNCTIONALITIES AND APPLICATIONS
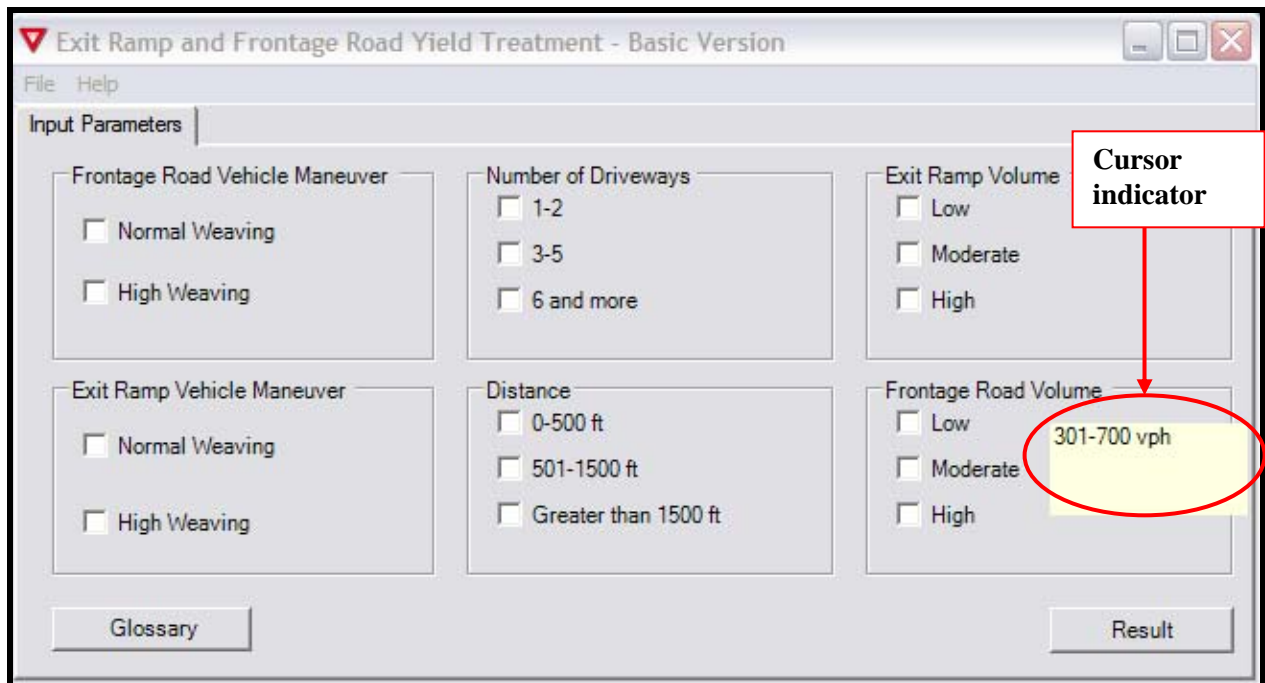
Exit Ramp and Frontage Road Yield Treatment

Under the Exit Ramp and Frontage Road Yield Treatment module, the user can select either the Basic Version or the Detailed Version.

Basic Version

The user is advised to use this version when he or she has only a general knowledge of exit ramp and frontage road volumes as well as origin-destination (OD) patterns of exit ramp and frontage road vehicles.

Select the Basic Version option and click the "Exit Ramp and Frontage Road Yield Treatment" button to display the GUI for data input into the basic version of the database as shown in Figure 7. This allows you to select options for Frontage Road Vehicle Maneuver, Exit Ramp Vehicle Maneuver, Number of Driveways, Distance, Exit Ramp Volume, and Frontage Road Volume.

The definitions for the various input parameters are presented in the Glossary under the Help option on the toolbar (or button on the menu as shown in Figure 7). FRYTAT displays these definitions in a text box that pops up whenever the cursor is on the input parameter. After selecting various inputs for the various sections, the user can look up the results of best performing yield treatments by clicking on the "Result" button shown in Figure 7.
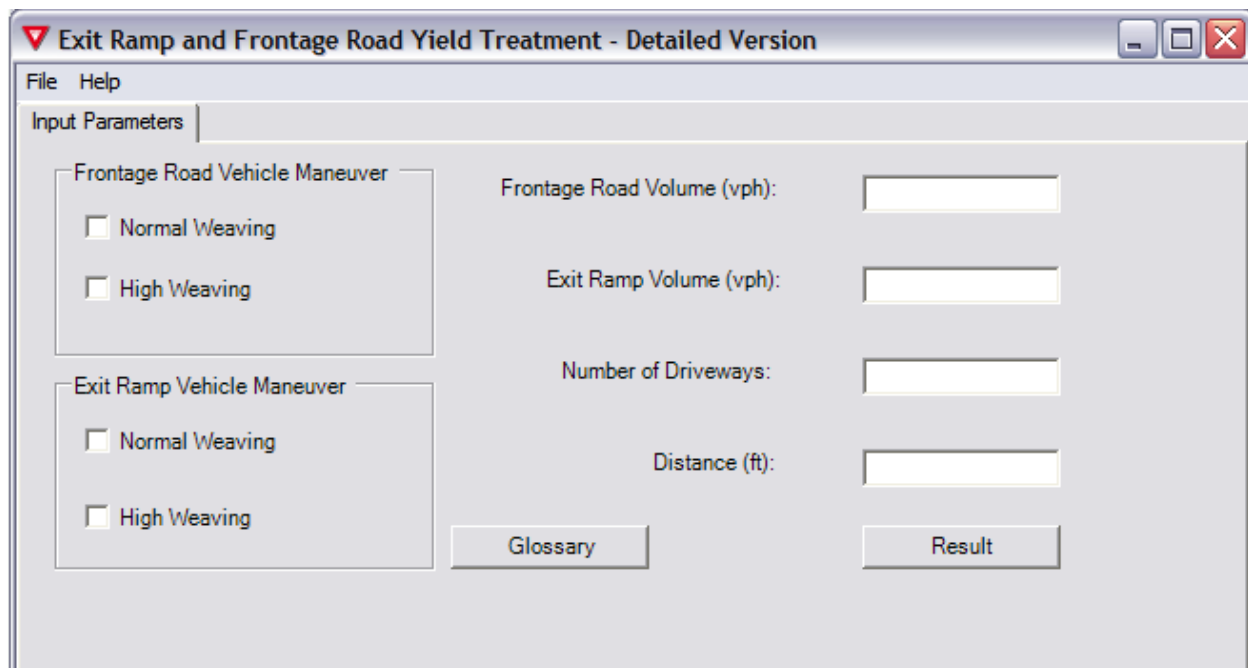
Figure 7. Exit Ramp and Frontage Road Yield Treatment GUI—Basic Version.

Detailed Version

The user is advised to use this version when he or she has detailed knowledge of exit ramp and frontage road volumes as well as OD patterns of exit ramp and frontage road vehicles. To use the detailed version, the user will need accurate data on the following:

- peak hour volume (vehicles per hour [vph]) and OD patterns of exit ramp vehicles,
- peak hour volume (vph) and OD patterns of frontage road vehicles (vph), and
- distance from exit ramp and frontage road gore to downstream intersection (feet).

Select the Detailed Version and click on the "Exit Ramp and Frontage Road Yield Treatment" button to open the GUI shown in Figure 8. Here the user can input specific values for Frontage Road Volume, Exit Ramp Volume, Number of Driveways, and Distance (from the exit ramp and frontage road gore to the stop bar of the downstream intersection).

Figure 8. Exit Ramp and Frontage Road Yield Treatment GUI—Detailed Version.
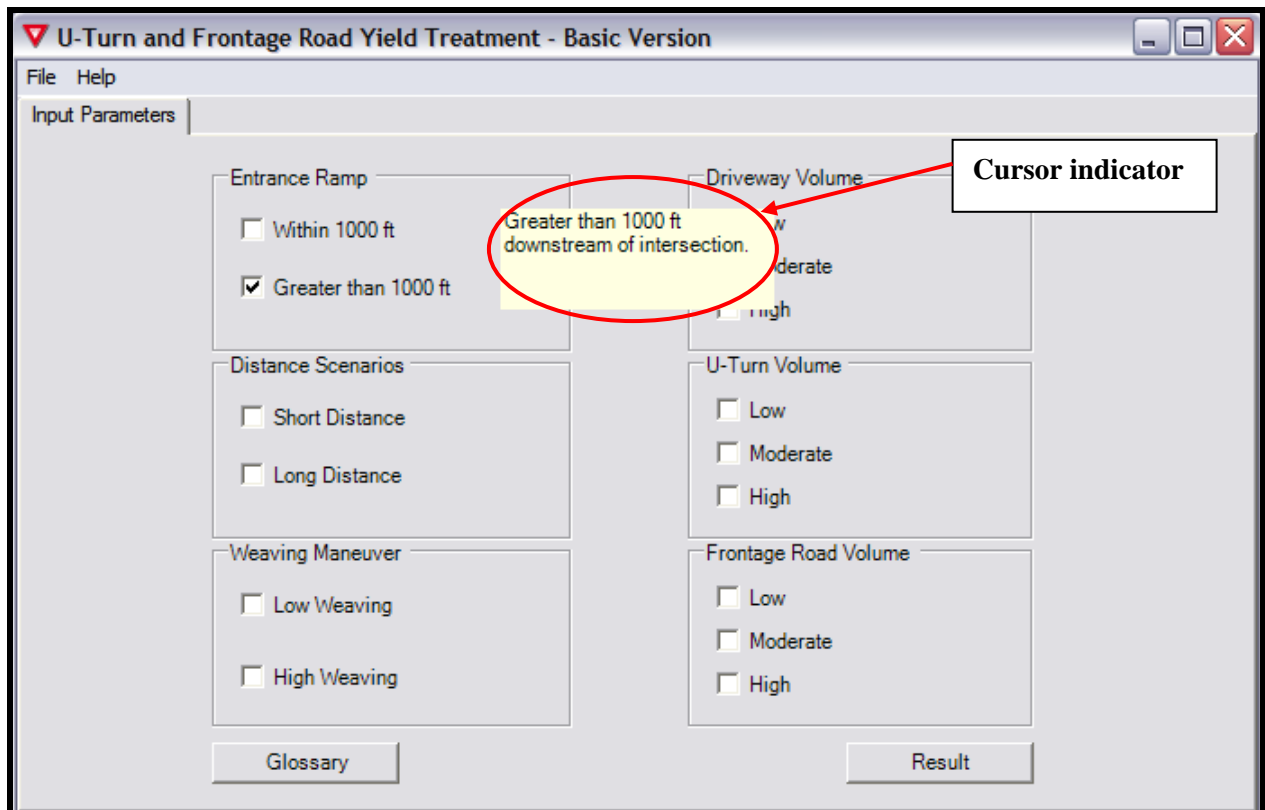
U-Turn and Frontage Road Yield Treatment

Under the U-Turn and Frontage Road Yield Treatment module, the user can select either the Basic Version or the Detailed Version.

Basic Version

The user is advised to use this version when he or she has only a general knowledge of exit ramp and frontage road volumes as well as OD patterns of U-turn and frontage road vehicles.

Select the Basic Version option and click the "U-Turn and Frontage Road Yield Treatment" button to display the GUI for input into the basic version of the database as shown in Figure 9. This allows you to select options for Entrance Ramp, Distance Scenarios, Weaving Maneuver, Driveway Volume, U-Turn Volume, and Frontage Road Volume.

After selecting various inputs for the various sections, the user can look up the results of the best performing yield treatments by clicking on the "Result" button shown in Figure 9.
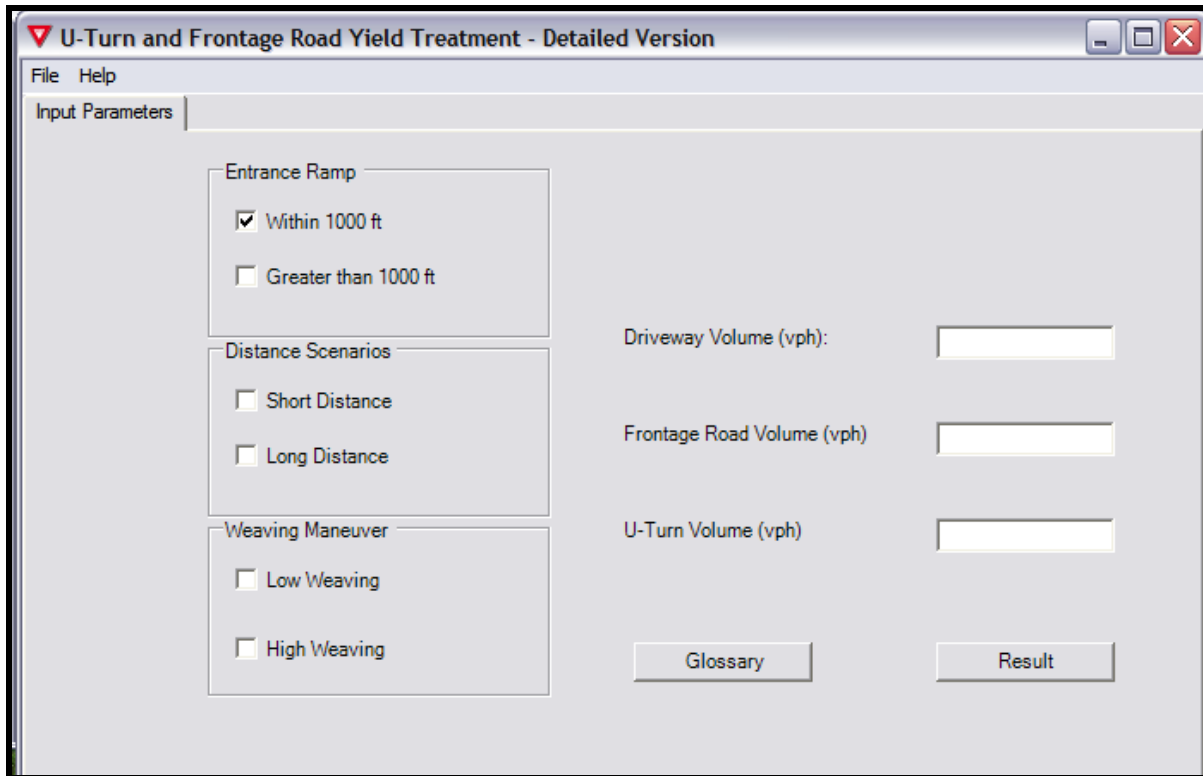
Figure 9. U-Turn and Frontage Road Yield Treatment GUI—Basic Version.

Detailed Version

The user is advised to use this version when he or she has detailed knowledge of exit ramp and frontage road volumes as well as OD patterns of exit ramp and frontage road vehicles. To use the detailed version, the user will need accurate data on the following:

- peak hour volume (vph) and OD patterns of U-turn vehicles,
- peak hour volume (vph) and OD patterns of frontage road vehicles (vph), and
- distance from the U-turn–frontage road gore to both the first driveway on the frontage road and the entrance ramp downstream.

Select the Detailed Version and click on the "U-Turn and Frontage Road Yield Treatment" button to open the GUI shown in Figure 10. Here the user can input specific values for Driveway Volume, Frontage Road Volume, and U-Turn Volume.

Figure 10. U-Turn and Frontage Road Yield Treatment GUI—Detailed Version.

CHAPTER 6. SUMMARY

OVERVIEW

After the total of 8424 runs were made and over 25 MOEs were collected during each simulation for Project 0-4986, the major challenge was to better present the data in a more coherent manner that presents the detailed results graphically without producing a large quantity of charts or graphs.

FRYTAT is designed to incorporate the results of Project 0-4986, "An Assessment of Frontage Road Yield Treatments." The executable application allows easy access by TxDOT. TxDOT users can use it as a planning tool for future yield treatments; it can also be used to evaluate current treatments and provide better alternatives.

FRYTAT APPLICATION

FRYTAT was developed primarily to provide an easy way of presenting the results of Project 0-4986. More importantly, researchers envision that FRYTAT will provide TxDOT with an easy-to-use tool to provide fairly quick answers for yielding treatments at the numerous exit ramp and frontage roads as well as U-turn and frontage road merge areas within the state of Texas.

The results provided by FRYTAT for selected combinations of traffic volumes, driveway densities, and geometry configurations should be coupled with TxDOT's *Signing Handbook* to provide the user with real solutions to yield signing for the concerned location. Detailed data collection is recommended but not needed to use FRYTAT since ranges of volumes are used in the analysis and generally a good estimate of volumes should be enough to provide a fairly accurate result.

The results provided by FRYTAT do not incorporate the effects of limited sight distance issues, particularly with the presence of a horizontal or vertical curvature. In such instances, it is recommended that the user perform an engineering assessment of the situation and use engineering judgment for the best results. Such instances might require a STOP sign on the frontage road or the use of a YIELD sign (the YIELD sign was not recommended at the end of Project 0-4986).