UTCM

University Transportation Center for Mobility™

Improving the Quality of Life by Enhancing Mobility

Development of an Early-Stage Toll Revenue Estimation Model

Final Report

Curtis Beaty and Henry Lieu

Performing Organization
University Transportation Center for Mobility™
Texas Transportation Institute
The Texas A&M University System
College Station, TX

Sponsoring Agency
Department of Transportation
Research and Innovative Technology Administration
Washington, DC

Texas Transportation Institute

1. Report No. UTCM 09-22-02	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Development of an Early-Stage Toll Revenue Estimation Model		5. Report Date May 2012	
		6. Performing Organization Code Texas Transportation Institute	
7. Author(s) Curtis Beaty and Henry Lieu		8. Performing Organization Report No. UTCM 09-22-02	
9. Performing Organization Name and Address University Transportation Center for Mobility™ Texas Transportation Institute The Texas A&M University System 3135 TAMU College Station, TX 77843-3135		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. DTRT06-G-0044	
12. Sponsoring Agency Name and Address Department of Transportation Research and Innovative Technology Administration 400 7th Street, SW Washington, DC 20590		13. Type of Report and Period Covered Final Report January 2009–September 2009	
		14. Sponsoring Agency Code	
15. Supplementary Notes Supported by a grant from the US Department of Transportation, University Transportation Centers Program			

16. Abstract

With agencies and states increasingly considering tolls as a means to finance transportation infrastructure, there is an increasing need to quickly assess the feasibility of potential tolling projects. In the early stages of a project when an agency—either public or private—merely wants to see the possibility of future traffic and tolled revenues, there still exists a need for a tool to capture basic assumptions and perform preliminary forecasting calculations to see if a project even warrants further examination as a toll road. Both as an early screening tool and as a continuing reasonableness test, this early-stage toll revenue estimation model will allow a user to simultaneously examine the interaction of multiple tolling variables and traffic scenarios so that agencies can make more informed decisions. The authors develop a stand-alone, spreadsheet-based model that prepares early-stage traffic and toll revenue estimates. The model allows users to examine a potential tolled project as a single phase or multiple phases—up to three—then examine the results individually or cumulatively.

17. Key Word Toll Roads, Tolls, Infrastructure, Financing, Screening Programs, Revenue Generation, Toll Revenues, Texas, Research Projects		18. Distribution Statement Public distribution	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 50	22. Price n/a

Form DOT F 1700.7 (8-72)   Reproduction of completed page authorized

Development of an Early-Stage Toll Revenue Estimation Model

by

Curtis Beaty
Associate Research Engineer
Texas Transportation Institute
Texas A&M University

Henry Lieu
Graduate Research Assistant
Texas Transportation Institute
Texas A&M University

UTCM Final Report
for
Project Title: "Development of an Enhanced Toll Project Screening Model"
Project #09-22-02

University Transportation Center for Mobility™
Texas Transportation Institute
The Texas A&M University System
College Station, Texas 77843-3135

Disclaimer

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. This document is disseminated under the sponsorship of the U.S. Department of Transportation, University Transportation Centers Program in the interest of information exchange. The U.S. Government assumes no liability for the contents or use thereof.

Acknowledgment

Table of Contents

Executive Summary

As public transportation agencies explore for financing options to advance much needed highway transportation projects, these agencies and elected officials are more willing to at least consider the possibility of tolling as a revenue alternative. Often these individuals and organizations need to examine the possibilities and potentials of a project as tolled facilities without investing large amounts of time or money into this discovery process. Although there are several consulting firms with well-developed proprietary models than can perform toll road traffic and revenue forecasting analysis, there is still a need for even earlier stage, more fundamental assessments of prospective toll road projects that allow agencies to quickly gather project information, propose tolling options, and generate estimates of future traffic and revenue all without devoting sizeable amounts of money and time to the process.

The authors develop a stand-alone, spreadsheet-based model that prepares early-stage traffic and toll revenue estimates. The model allows users to examine a potential tolled project as a single phase or multiple phases—up to three—then examine the results individually or cumulatively. A user's guide to the model is provided that contains instructions, definitions, and screen-capture images of the model itself.

Background

As reported by Standard & Poor's (Bain, Traffic Forecasting risk: Study Update 2004, 2004) and Fitch Ratings (Trommer, 2006), toll road forecasts have, on average, overestimated traffic in the opening years of the facility by 20%–30%. This apparent under performance results in actual toll revenues to be significantly less than projected. It is, therefore, very important to mitigate errors and bias in traffic and revenue forecasts in order to realistically determine a project's true viability as a tolled facility. By having a tool to initially screen traffic and revenue forecasts of a proposed project, public agencies can better predict the impact a tolled facility will have on a transportation network and better predict the value of projects to other public or private toll developers. To fully examine this problem, there needs to be an enhanced ability to simultaneously model multiple tolling terms and traffic scenarios so that agencies can make more informed decisions. Both private sector companies and transportation agencies need a screening tool to help make initial assessments of the financial feasibility of projects before they spend millions of dollars preparing proposals to design, build, and operate toll projects through public-private partnership (PPP) contracts with transportation agencies.

Leading consulting companies have made strides in taking lessons learned from previous projects and incorporating actual results into newer forecasts (George, Streeter, & Trommer, 2003). These refinement and development efforts, however, occur with advanced models once a toll project is well into planning and financing options are being explored. In the early stages of a project when an agency—either public or private—merely wants to see the possibility of future traffic and tolled revenues, there still exists a need for a tool to capture basic assumptions and perform preliminary forecasting calculations to see if a project even warrants further examination as a toll road. A toll viability screening tool was developed by the Texas Transportation Institute (Smith, Chang-Albitres, Stockton, & Smith, 2004). The tool was designed to provide a preliminary determination of the viability of a toll road or toll-supported project. The spreadsheet-based model requires the use of a third-party analytic add-on that costs several hundred of dollars to purchase. There is still a need for a "first-cut" screening model that can provide early insight to the traffic and toll revenue possibilities or a proposed project using a spreadsheet program only and does not require additional software.

Approach

Besides developing a means of performing early-stage traffic and revenue estimates for a proposed toll road, another objective of this research project was to produce a model that is easily accessible to any organization and does not require the use of additional software beyond a basic spreadsheet application. Because of the pervasiveness of the software in government, academia, and private-sector organizations, the early-stage estimating model was developed in Microsoft™ Excel™ 2010. Using the functions and formatting features provided within Excel™ including the use of Visual Basic for Applications (VBA) to create customized macros, the model uses a series of input forms to gather rudimentary information on a proposed toll project. These inputs then generate preliminary estimates for future traffic and revenues in both tabular and graphical formats. The model allows a user to then go back and change base assumptions and examine what-if scenarios to see the possible impact these adjustments have on projected traffic volumes and revenues.

The purpose of this early-stage traffic and revenue estimation tool is to allow users and agencies to easily examine the possibilities of a toll road given initial core assumptions and preliminary facts at a low-cost level of financial investment. As additional information is required in the decision-making process for a given tolled project, the greater data requirements and analytical abilities of more sophisticated traffic and revenue studies should be employed.

Structure of the Model

As previously stated, the early-stage toll revenue estimation model was developed with Microsoft™ Excel™ 2010. The model takes advantage of the ability to create and use multiple worksheets within a single document so that information can be entered and organized in an intuitive manner. A main menu and navigation buttons located on each worksheet allow users to efficiently navigate through input forms and analysis results. Because the final configuration of a toll road often must be developed over several years in multiple phases, the revenue estimation model permits the user to examine base traffic and tolling assumptions of a project in one, two, or three phases. Results can then be reviewed by individual phases or cumulative across the project as a whole. A detailed user's guide to the model containing instructions, definitions, and screen-capture images of the model itself is contained in the appendix of this report.

Conclusions and Recommendations

With the growing interest and acceptability of turning to tolling as a viable means of advancing much needed surface transportation projects, both public and private agencies desire the ability to examine the traffic and toll revenue potential of a proposed project. The federal government has provided some guidance on practices related to estimating toll road traffic and revenue (Kriger, Shiu, & Naylor, 2006), and various consultants have developed sophisticated, proprietary models to perform advanced traffic and revenue forecasting. Although the rigors and voracity of these models have been questioned and examined (European Investment Bank, 2007) (Lunkett, 2006) (Bain, 2010) (Lindquist & Wendt, 2006), there still exists the fact that agencies expend large amounts of money and time to explore the early potential of a tolled project when a more simple approach is required to begin asking basis what-if questions.

The early-stage toll revenue estimation model developed through this research project provides users and agencies a means to easily assemble fundamental project characteristics, make basic tolling assumptions, and quickly generate possible traffic and revenue estimates. This high-level analysis is performed using standard computer software (i.e., Microsoft™ Excel™ 2010) without the need for additional, often costly, applications or products.

The model was developed as a version 1.0 installment with the idea that additional features and functionalities can be included in future versions. For example, additional inputs and assumptions could be incorporated so that the percentage of tolls collected by electronic toll tag versus video image capture along with appropriate discounts/premiums could be considered. Likewise, assumptions about traffic volumes during peak/non-peak travel periods could be made along with corresponding toll rate adjustments could be examined. The flexibility of Excel™ and customization permitted through VBA programming allows users and agencies to expand and modify the early-stage toll revenue estimation model to fit their needs.

References

Bain, R. (2004). *Traffic Forecasting risk: Study Update 2004.* New York, NY: Standard & Poor's Ratings Direct.

Bain, R. (2010, Winter). Modeling Best Practices: The Benefits of Peer Pressure. *Local Transport Today*, pp. 9-10.

European Investment Bank. (2007). *Why Traffic Forecasts in PPP Contracts are Often Overestimated.* Madrid: EIB University Research Sponsorship Program.

George, C., Streeter, W., & Trommer, S. (2003). *Bliss, Heartburn, and Toll Road Forecasts.* New York, New York: Fitch Ratings Ltd.

Kriger, D., Shiu, S., & Naylor, S. (2006). *NCHRP Synthesis 364: Estimating Toll Road Demand and Revenue.* Washington, D.C.: Transportation Research Board.

Lunkett, C. (2006, May 28). Road to Riches. *Denver Post*.

Smith, D. R., Chang-Albitres, C., Stockton, W. R., & Smith, C. (2004). *Estimating Revenues Using a Toll Viability Screening Tool.* College Station, TX: Texas Transportation Institute.

Trommer, S. (2006). Mitigating Toll Road Forecasting Risks. *The Workshop on Public-Private Partnerships in Highways: Institution, Legal, Financial, and Technical Aspects.* Fitch Ratings.

Appendix

Early-Stage Toll Revenue Estimation Model: A User's Guide

An Early-Stage Toll Revenue Estimation Model: A User's Guide

by

Curtis Beaty
Associate Research Engineer
Texas Transportation Institute
Texas A&M University

Henry Lieu
Graduate Research Assistant
Texas Transportation Institute
Texas A&M University

DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. This document is disseminated under the sponsorship of the U.S. Department of Transportation's University Transportation Centers Program in the interest of information exchange. The U.S. Government assumes no liability for the contents or use thereof.

IMPORTANT NOTE TO USERS

Execution of this model requires the purchase and installation of the 2007 or later version of Microsoft® Excel®; any earlier version may not properly execute the model. Therefore, please upgrade the version of Microsoft® Excel® if necessary. No other add-on is required to use the model.

More information related to Microsoft® Excel® can be obtained from the following website: http://office.microsoft.com.

Table of Contents

List of Figures

NOTE: Color figures in this report may not be legible if printed in black and white. A color PDF copy of this report may be accessed via the UTCM website at http://utcm.tamu.edu, the Texas Transportation Institute website at http://tti.tamu.edu, or the Transportation Research Board's TRID database at http://trid.trb.org.

1   Introduction

With the downturn of the economy in late 2008 and early 2009, it has become increasing clear to elected officials, departments of transportation, and some businesses that the traditional source of funding for transportation – the motor fuel tax – is no longer sufficient to maintain let alone expand the surface transportation infrastructure in this nation.

As the recession progressed, the public reduced the amount of traveling they did and for the first time annual vehicle miles traveled (VMT) declined both in Texas and across the country. This reduction in travel had a direct negative impact on the revenues generated from the motor fuel tax. Governments at all levels are searching for new sources of revenue to build and maintain surface transportation. Currently, funding for highway infrastructure comes from 18.4 cents per gallon federal tax on each gallon of gas purchased plus 20 cents per gallon tax by the State of Texas. Bond financing is another option to fund highway projects; however, some critics claim highway bonds merely pushes the financial problem into the future by committing future budgets to cover the incurred debt.

Over the past decade, toll roads have garnered increase attention as a way to build or expand highway projects without increasing motor fuel taxes. For one reason, only those that use the toll road pay for its costs. (Note: this opinion is more theoretical and not always true due to the complex financing methods and guarantees required to obtain the necessary capital to construct he facility.) Another reason for toll road interest is the fact that the anticipated revenues from the future project can be used to attract other investors to put in money and accept some financial risk in exchange for those toll revenues. This is commonly referred to as public-private partnerships.

But before a government or other agency considers a toll road project, they need to assess the economic viability of proposed construction by examining the potential traffic and revenue that can be generated by the project. This project developed a Toll Revenue Estimation Model to examine future toll revenue streams over a predefined study period. The design of this spreadsheet-based model gives the user ample freedom to consider various critical fields for the computation of the traffic volumes and annual toll revenues for a toll road project. The Toll Revenue Estimation Model then examines the probability of the revenue stream based on the inputs and choices selected by the user.

2   Objective of the Research

The objective of this research is to develop an Excel®-based spreadsheet model that generates revenues estimates for proposed toll roads. This spreadsheet, or Toll Revenue Estimation Model, also allows the user to simultaneously examine proposed projects in sections similar to how projects are often built in phases. Finally, this model analyzes the probability of the resulting revenue estimates based on the data provided by the user.

This Toll Revenue Estimation Model builds on previous research of a similar nature. In October 2004, the Texas Transportation Institute published the research report "Development of a Toll Viability Screening Tool."[1] That analysis model could only consider a toll project as a single section and did not allow the user to examine a project in phases over time. And although the Toll Viability Screen Tool

---

[1] Smith, et al. Development of a Toll Viability Screening Tool. FHWA/TX-05/0-4726-1. Texas Department of Transportation. October 2004.

(TVST) was also an Excel®-based model, it required the third-party add-in @Risk® by Palisade to conduct the Monte Carlo simulation on the input variables and perform the probability analysis on the revenue estimates. The Toll Revenue Estimation Model takes the concept of the TVST and builds on the features and usability of the model through macros, look-up tables, and other core Excel® features to make the Toll Revenue Estimation Model more user-friendly, expansive, and accessible by not requiring any third-party add-in software.

3   Toll Revenue Estimation Model

Because of the core structure of Excel®, it is possible to create numerous worksheets in a single file to facilitate the analysis and navigation within the Toll Revenue Estimation Model. Because numerous macros are incorporated into the Toll Revenue Estimation Model, the worksheets and certain cells are protected, i.e., locked, and the user is not able to modify them. This ensures the integrity of the model when used multiple times by multiple users.

3.1   Opening the Tool

To open the tool, the user double-clicks the Excel®-based file: *2010 Toll Revenue Estimation Model.xlsm*. Depending on the version of Excel® and the security setting selected within Excel®, a warning message similar to the one in Figure 3-1 will appear indicating that the file is open but macros contained within the spreadsheet are currently disabled. In order to use the analysis calculations and navigational aids within the Toll Revenue Estimation Model, macros must be enabled.
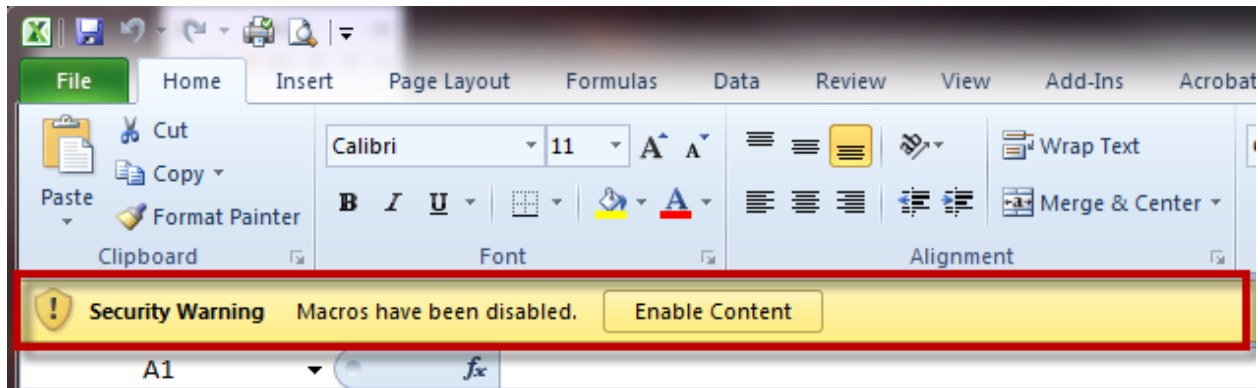
Figure 3-1: Security Warming Regarding Macros

Again, depending on the version of Excel® and security settings, a window as shown in Figure 3-2 may appear when the user clicks to enable macros.

Figure 3-2: **Security Alert to Enable/Disable Macros**

By default, the option "Help protect me from unknown content (recommended)" is checked. Selecting "Enable this content" is necessary to use the Toll Revenue Estimation Model.

3.2   General Organization by Worksheets

The Toll Revenue Estimation Model is organized into multiple worksheets within a single file. When the spreadsheet if first opened, only two worksheets are visible: Introduction and Menu (see Figure 3-3.)
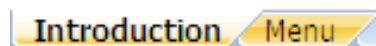
Figure 3-3: Worksheet Modules at the Opening of the Model

3.2.1   Introduction Worksheet

The Introduction tab (Figure 3-4) provides the name of the model, the organization that was in charge of its development, and the copyright and legal terms that protect the model. At the bottom of the screen is a button in the shape of an arrow with the words "Click to begin," which permits navigation to the "Menu" worksheet. The user does not need to click on the Menu tab but can do so without any effect on the Feasibility Tool.
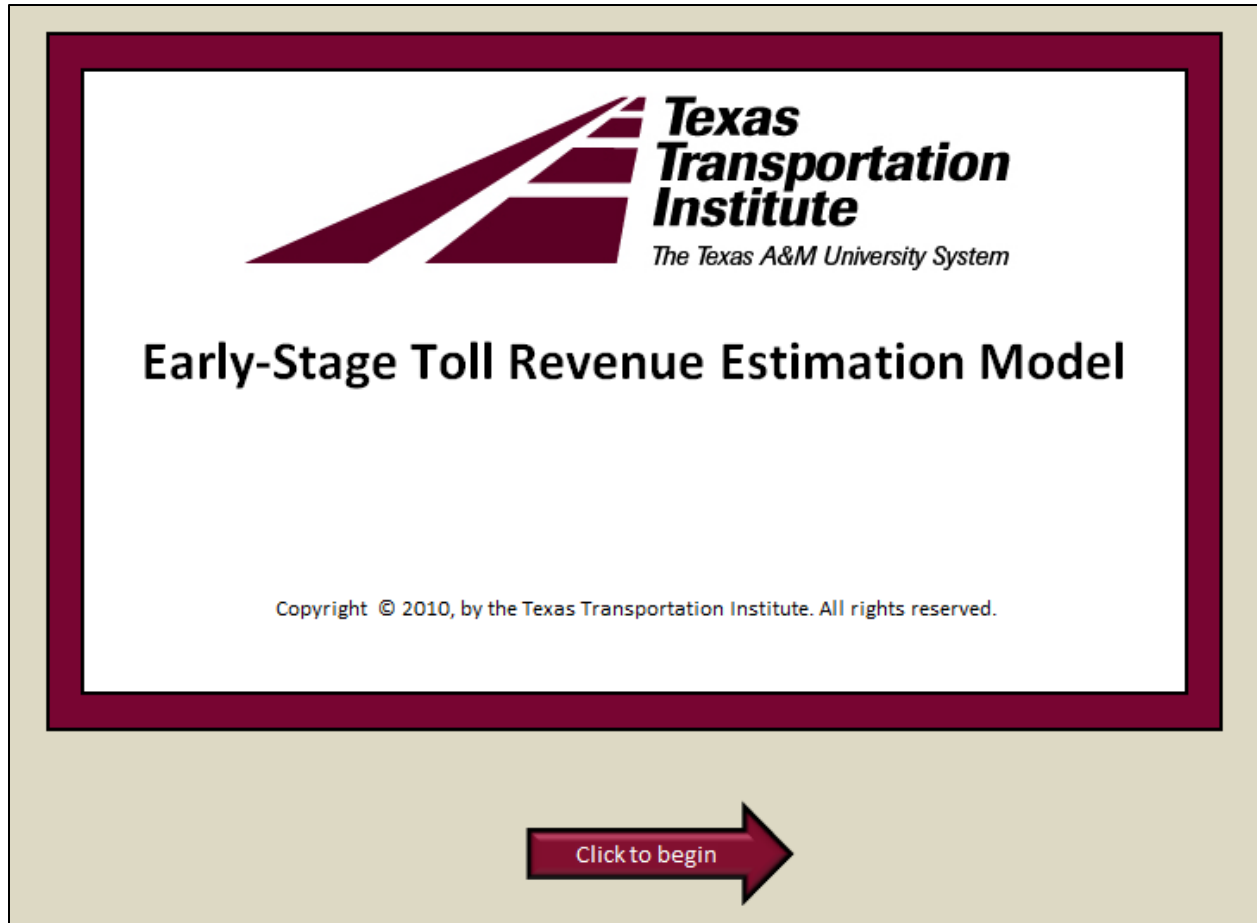
Figure 3-4: Introductory Worksheet Screen

3.2.2 Menu Worksheet

The Menu is the backbone for the Toll Revenue Estimation Model by providing macro "buttons" to navigate through the various worksheets. First, the user decides how many sections of toll road he or she wants to study. By default, the Toll Revenue Estimation Model opens with only one toll section ready to be studied. By selecting the appropriate button shown in Figure 3-5, the user can examine more than one section or phase of a proposed toll road. At this time, the maximum number of toll road sections that the user can study simultaneously with the Toll Revenue Estimation Model is limited to three.

Figure 3-5: Number of Projects Studied

The default Menu screen for a single study section is shown in Figure 3-6. When multiples sections are to be studied, additional buttons appear on the screen in order to navigate through the various worksheets. Figure 3-7 provides an example screen image when three toll road sections are to be analyzed.

22
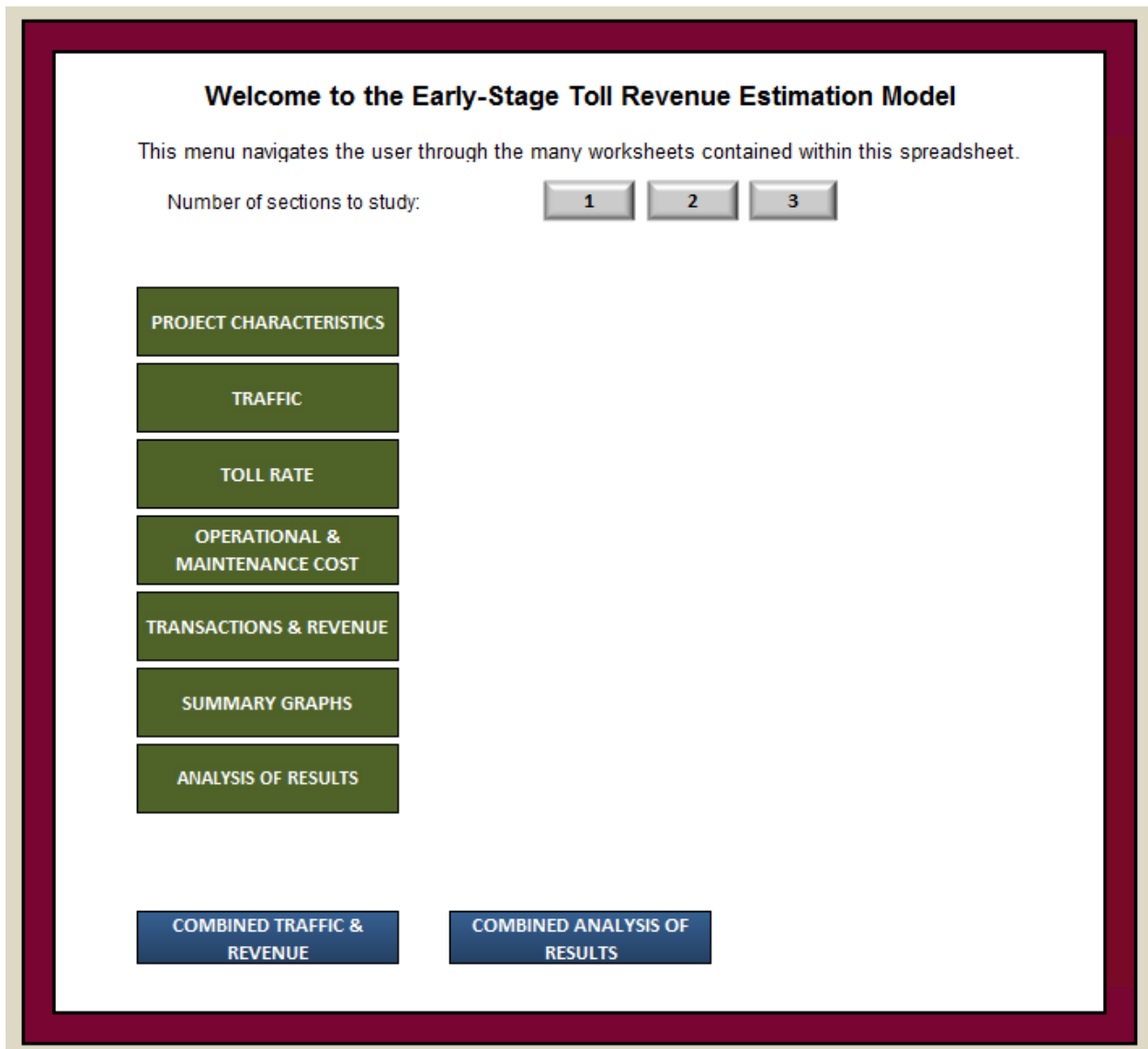
Figure 3-6: Menu – Study of One Section

This worksheet presents options (macro buttons) that permit the user to switch among the model worksheets. A click on the options from "Project Characteristics" to "Estimations" will make the corresponding worksheet appear, and thus the corresponding tab becomes visible.
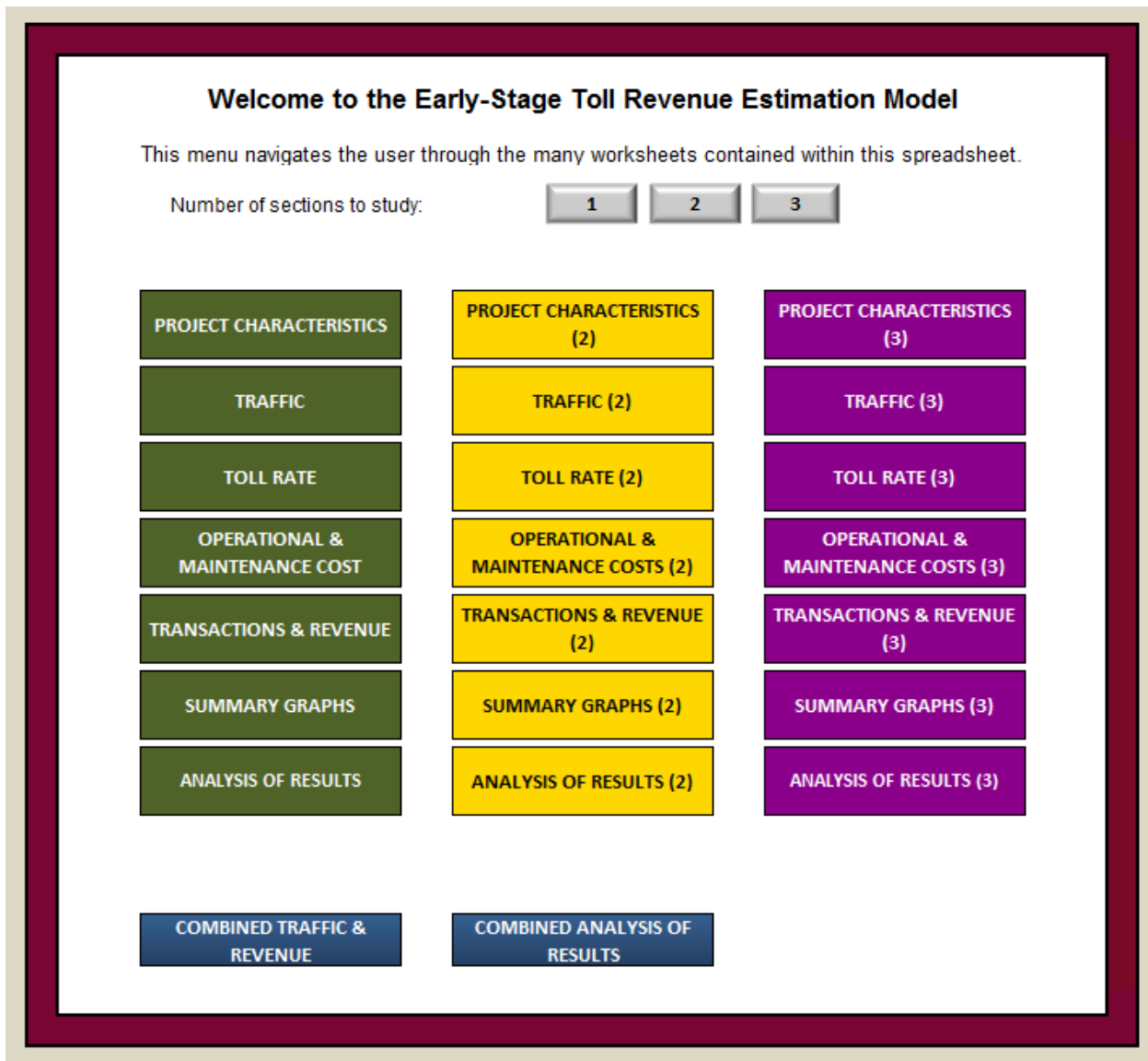
Figure 3-7: Menu – Study of Three Sections

The Menu worksheet provides macro buttons that permit the user to switch among the many worksheets of the Toll Revenue Estimation Model. By clicking on an option, a new worksheet is opened for data inputs or to present analysis results. The tab for each worksheet is color-coded and labeled to correspond with the appropriate selection from the Menu. The Toll Revenue Estimation Model is designed as a sequential process where the user should first begin with "Project Characteristics" then "Traffic" and continuing through the remaining options for each study section.

3.3   Using the Toll Revenue Estimation Model

To orient the user in the navigation of the Toll Revenue Estimation Model, the following sections explain what occurs when each option on the Menu is selected. For purposes of simplicity, the user's guide presents as an example the study of one toll road section. The navigation and operations of the worksheets are the same regardless of the number of sections that are being examined.

Any cell on a worksheet with a light-yellow background – as illustrated in Figure 3-8 – is defined as a user-input field.   These are the only field that can be selected and modified by the user.   If the user tries to select and modify a cell that is protected, i.e., locked, a pop-up window appears indicating that the cell selected cannot be modified. Figure 3-9 provides an example of such warning.

Figure 3-8: Yellow Cells Indicate the User May Input Values
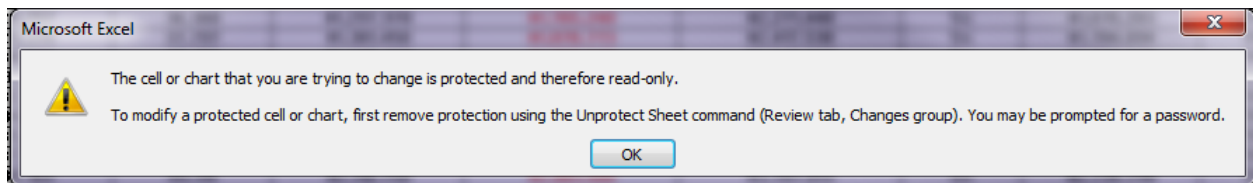
Figure 3-9: Access Denied to Protected Cell

At the bottom of every worksheet are navigation options to aid the user in maneuvering through the various worksheets. These navigation options are shown in Figure 3-10 and allow the user to quickly move through the Toll Revenue Estimation Model.

Figure 3-10: Worksheet Navigation Aids

The "Go to Top" arrow takes the user to the top of the current worksheet.

When the user is done with a worksheet, he or she clicks the "Back to Menu" button to go back to the Menu and select the next topic area (or worksheet) to complete. When the "Back to Menu" button is selected, the tab for the current worksheet disappears from the tab bar at the bottom of the spreadsheet.   Because there are more than 25 worksheets that make up the Toll Revenue Estimation Model, this feature of temporarily hiding worksheets prevents the tab bar from becoming too long and requiring excessive scrolling to find the desired worksheet.   When the user wants to make any changes to or review a worksheet, the user clicks the appropriate button on the Menu and the worksheet reappears in the tab bar.

4 Project Characteristics Worksheet

To begin, the user selects the "Project Characteristics" option from the Menu worksheet. The Project Characteristics worksheet groups the general characteristics and basic data required by the Toll Revenue Estimation Model for the project to be studied. The worksheet is divided into three main sections that the user completes as inputs to the Toll Revenue Estimation Model: General Facility Data, Traffic Data, and Toll Data.

4.1 General Facility Data Inputs

The first main section of the Project Characteristics worksheet is the General Facility Data Inputs. Both data entry fields and drop-down lists are used to collect the basic information on the proposed toll road. Some of the data are used as descriptive information to summarize the characteristics of the facility. Other data entries are necessary to estimate future traffic, transactions, and revenues for each year of the study period. Again, a hypothetical project consisting of a single section/phase is presented in the following figures to illustrate the data inputs and operational aspects of the Toll Revenue Estimation Model.

Figure 4-1 shows the general facility data inputs for the example projects. The individual data elements are discussed in the following sections of the user guide.

Note that in Figure 4-1 there is a button titled "Click Here to Clear General Inputs." By clicking on this button, a macro will run where all of the previously entered data (if any) are cleared from the yellow cells.

Figure 4-1: General Facility Data Inputs

4.1.1 Facility Name

The project's name specified by the user is entered as a text field. For the example, the name of the hypothetical project is "Northwest Toll Road."

4.1.2 Project ID

This field is the identity number or code for the project or the particular section of toll road being examined. Data is entered as a text value. The identification (ID) of the hypothetical project is "SH 345." If the project does not have any identity number or code, then this cell may be left blank.

4.1.3 District/Region

This field is the name of the government district or region where the toll road project is located. This data is entered as a text value. The district name of the hypothetical project is "12." If the project is not located in a district or region with a predetermined name, then this cell may be left blank.

4.1.4 County

This field is the name of the county where the toll road project is located. The name of the county for the hypothetical project is "Taylor." If the toll road project crosses multiples counties, the user can write the list of counties separated by a "/" sign because this item is a text field.

4.1.5   Opening Year

This field is the year the project is expected to be operational. For instance, the hypothetical project will begin full operation in 2015. The model assumes a full calendar year of operation for the starting year.

4.1.6   Origin

This field is the name of the origin point of the toll road project. If this field is not relevant for the user, this cell can be left blank. The origin of the hypothetical project is "CSJ 123-45-6789." An intersection, cross street, or some other designator may also be used.

4.1.7   Destination

This field is the name of the destination point of the toll road project. If this field is not relevant for the user, this cell can be left blank. The destination of the hypothetical project is "CSJ 987-65-4321." Again, other landmarks or references may be used to designation the determination point of the toll road being examined.

4.1.8   Length of Tolled Facility

This field relates to the centerline length of the toll road. It is assumed that the toll road will be constructed as one contiguous effort for the specific section being examined. The examples project's length is 12 miles. This variable will be used in the calculation of toll revenues. This is a numeric field and accepts fractions of a mile as decimal number, e.g., 12.75 would represent 12 and three quarters miles.

4.1.9   Total Number of Lanes

This field is the total number of tolled lanes that comprise the project. For the example, a four-lane project over a 12-mile length is studied. The current model does not support variable lane designs, e.g., two lanes for "x" miles and then four lanes for "y" miles. To examine such a configuration, the user can divide the project into two sections within the Toll Revenue Estimation Model where one section is a two-lane toll road for "x" miles and the second section would be the four-lane toll road for "y" miles. The number of tolled lanes is used in determining the maximum amount of traffic that that the toll facility can carry, i.e., the toll road capacity.

4.1.10 Project Type

This field describes the type of project that is being studied. The user selects one of the five options given by the drop-down list:

- local-rural,
- local-urban,
- regional-rural,
- regional-urban, and
  - loop.

In the example, the option "local-urban" is selected. This item is used to summarize the project characteristics but does not impact the traffic and revenue forecasts.

4.1.11 Existing Typical Section

This field relates to the typical section of the *existing* facility. The user has the following six choices from a pull-down selection to describe the existing typical section of the roadway:

- two-lane undivided,
- four-lane divided,
- four-lane undivided,
- six-lane divided,
- eight-lane divided, and
- 10-lane divided.

Our example is a four-lane undivided highway. This item is used to summarize the project characteristics but does not impact the traffic and revenue forecasts.

4.1.12 Tolled Typical Section

This field relates to the typical section of the *tolled (future)* facility. The user has the following six choices available by pull-down selection:

- two-lane undivided,
- four-lane divided,
- four-lane undivided,
- six-lane divided,
- eight-lane divided, and
- 10-lane divided.

In the example, the existing typical section is a six-lane divided highway. This item is used to summarize the project characteristics but does not impact the traffic and revenue forecasts.

4.1.13 Frontage Roads

A frontage road is a non-limited-access road running parallel to a higher-speed road, usually a highway, and providing access to highway at controlled access points, i.e., entrance and exit ramps. The user can choose from the following characteristics for the frontage roads of the proposed toll facility:

- none,
- continuous, and
- discontinuous.

In the example, we have a continuous frontage road parallel to the toll facility. This item is used to summarize the project characteristics but does not impact the traffic and revenue forecasts.

4.1.14 Classification

The classification is the class, or type, of roads that the road is currently categorized if the proposed toll road is a brownfield project. The classification can be selected from a pull-down menu:

- interstate highway,
- U.S. highway,
- state highway,
- loop,
- urban street, or
- business route.

In the example, we selected "state highway." This item is used to summarize the project characteristics but does not impact the traffic and revenue forecasts.

4.1.15 Current Statewide Mobility Plan (SMP) Priority

This field attempts to address whether or not the project is included in the current Statewide Mobility Plan and, if it is, what the project's priority status. For the Toll Revenue Estimation Model, there are currently four options for this variable through a pull-down selection:

- construct,
- plan,
- develop, or
- not in the SMP.

This item is used to summarize the project characteristics but does not impact the traffic and revenue forecasts.

4.1.16 Maximum AADT per Lane

This field is the maximum-AADT-per-lane constraint. (AADT stands for Annual Average Daily Traffic.) The maximum AADT for a lane is used to calculate the traffic capacity of the toll road. The Toll Revenue Estimation Model checks to ensure that more traffic is not placed on the toll road in future years than can be accommodated by the facility.

4.1.17 Inflation Rate

The inflation rate is the general decrease of purchasing power of the dollar over time and is a necessary field when the time value of money is involved in the analysis. This rate also is the factor to which annual toll rates will be indexed unless the user provides some other tolling plan in the Toll Rate worksheet of the Toll Revenue Estimation Model. For this example, a three percent inflation rate per year over the study period was assumed for the hypothetical project.

4.1.18 Comments

The user can use this field to leave notes or explanations that clarify the choice of the input values within the General Facility Data portion of the Project Characteristics worksheet.

4.2   Traffic Data Inputs

The second part of the Project Characteristics worksheet is Traffic Data Inputs. Figure 4-2 shows the layout and content of this section of the worksheet.

Traffic Data Inputs - Section 1		
Traffic Type	Constrained	▾
Level of Service of Constrained Traffic	D	▾
	Anticipated Minimum	**Anticipated Maximum**
Total (Autos & Trucks) Average Daily Traffic (ADT) at Opening Year	12,000	21,000
Mean Percentage of Auto Traffic: Opening Year (% of ADT)	96.0%	
Mean Percentage of Truck Traffic: Opening Year (% of ADT)	4.0%	

		% Growth
Mean Annual Growth Rate of Auto Traffic:	Years 1-10	5.0%
	Years 11-20	4.0%
	Years 21-30	3.0%
	Years 31-40	2.0%
	Years 41-50	1.0%
Mean Growth Rate of Truck Traffic:	Years 1-10	3.0%
	Years 11-20	2.5%
	Years 21-30	2.0%
	Years 31-40	1.5%
	Years 41-50	1.0%

Click Here to Clear Traffic Inputs

Comments:

Figure 4-2: Traffic (AADT) Data Options Input

4.2.1 Traffic Type

This field characterizes the type of traffic that is expected on the toll facility: constrained or unconstrained. A constraint can be, for instance, a crash or construction.

4.2.2 Level of Service for Constrained Traffic

If the option "constrained" is selected for the type of traffic, the anticipated level of service should be selected by the user.

4.2.3 Total Traffic (AADT) at Opening Year

This field relates to the average daily traffic (AADT) of autos and trucks combined during the first year of the project.

If the normal distribution is used, the user is expected to enter the mean and standard deviation of the traffic distribution. For instance, the mean is equal to 19,000, and the standard deviation is 1,200.

If the triangular distribution is used, the user is expected to enter the minimum value, the mode value, and the maximum value. The values of these fields should respect the following constraint: minimum ≤ mean ≤ maximum and minimum ≤ mode ≤ maximum. The mode can be higher or lower than the mean.

For this example, these are equal to 12,000, 19,000 and 21,000, respectively, when the triangular distribution is selected.

4.2.4   Mean Percentage of Auto Traffic: Opening Year (% AADT)

This field indicates the share of traffic that derived from autos during the first year of the toll road. For the example, autos represent 96 percent of the total traffic.

4.2.5   Mean Percentage of Truck Traffic: Opening Year (% AADT)

This field indicates the percentage of traffic that is assumed be trucks when the toll road opens. For the example, trucks represent 4 percent of the total traffic. The Toll Revenue Estimation Model automatically calculates the percentage of trucks by subtracting the percent of auto traffic from 100 percent. That is why the data field is shaded white instead of yellow.

4.2.6   Mean Growth Rate of Auto Traffic (Years 1-10)

The Toll Revenue Estimation Model uses the minimum, maximum, and mode – or mean and standard deviation – of the traffic demand curves to compute future traffic estimates based on the opening-year traffic demand and the annual mean growth rates of the traffic.

This field is the anticipated mean growth rate of the auto traffic from year 1 to year 10. It is assumed that the growth rate is constant over this period of time. In the example, auto traffic is expected to grow by 5 percent from year 1 to year 10. The user should also enter growth rates for the following time periods:

- Mean Growth Rate of Auto Traffic (Years 11-20)
- Mean Growth Rate of Auto Traffic (Years 21-30)
- Mean Growth Rate of Auto Traffic (Years 31-40)
- Mean Growth Rate of Auto Traffic (Years 41-50)

4.2.7   Mean Growth Rate of Truck Traffic (Years 1-10)

This field is the anticipated mean growth rate of truck traffic from year 1 to year 10. It is assumed that the growth rate is constant over this period of time. For instance, in the example, truck traffic is expected to grow by 3 percent from year 1 to year 10. The user should also enter growth rates for the following time periods:

- Mean Growth Rate of Truck Traffic (Years 11-20)
- Mean Growth Rate of Truck Traffic (Years 21-30)
- Mean Growth Rate of Truck Traffic (Years 31-40)
- Mean Growth Rate of Truck Traffic (Years 41-50)

4.2.8   Comments

The user can use this field to leave notes or explanations that clarify the choice of the input values within the Traffic Data portion of the Project Characteristics worksheet.

4.3   Toll Data Input

The third part of the Project Characteristics worksheet is reserved for Toll Data Inputs. It is found by scrolling down the worksheet to find the table represented in Figure 4-4. The data inputs required for this portion of the Project Characteristics worksheet is described in the following section of the user guide.

Figure 4-3: Toll Data Input

4.3.1 Mean Toll-Revenue Days (Days per Year)

This field indicates the number of toll-revenue days that compose an operational year. Full revenue will not be generated on some days such as during weekends, holidays, severe weather, crashes, construction, etc. It is, therefore, reasonable to consider that the mean number of toll-revenue days is less than 365 days. This value is used to compute annual toll revenues.

4.3.2 Time Period between Increases (Years)

This field indicates the frequency in which manual increases to toll rates can be applied. By default for the Toll Revenue Estimation Model, the toll rate can be forced to increase every five years beyond what is accounted for through the annual inflation rate adjustment. In other words, the toll rates will automatically increase annually by the inflation rate entered in the "General Facility Data" section, but the user can also have additional toll rate adjustments every five years. This cell cannot be changed, as shown by the white background.

4.3.3 Toll Rate for Autos at Opening Year ($ per mile)

This field shows how the rate users will be charged for using the toll road during the opening year of the facility. The toll rate is shown as a cost per mile due to the fact that the Toll Revenue Estimation Model examines toll road in a generic manner. In other words, the number of and configuration of tolling locations (i.e., gantries) that impact the tolls charge – due to the need to have minimum tolls per transaction at certain locations – for every possible tolling plan is not programmed within the Toll Revenue Estimation Model.

4.3.4 Toll Rate for Trucks at Opening Year ($ per mile)

This field shows how much users driving a truck are charged for taking the toll road during the opening year of the facility. Again, toll rates are entered on a per mile basis.

4.3.5 Video-Tolling Premium (%)

Video tolling is a technique that identifies a vehicle by using video to capture the license plate number of vehicles. Then the license plate information is matched against vehicle registration records to identify the owner of the vehicle. An invoice for toll transactions is mailed to the address of the owner. Video tolling makes the purchase of a transponder unnecessary; however, a premium is typically applied to transactions collected by video versus transponder due to the additional administrative efforts required to process and collect toll charges through a video system. This field estimates how much of a premium a user taking the toll facility should pay for using video tolling instead of electronic toll collection (ETC). For the example, video tolling costs 25 percent more than ETC in the example project.

4.3.6 Ramp-Up Factors (%)

This field indicates the reduced traffic volumes of the toll road during its first few years of service as people become aware and accustomed to the new facility. This "ramp-up" period tends to stabilize as the public becomes comfortable with and see the benefits provided by the new toll road. This values used in these field tends to be project specific, and often depends on the familiarity of the public with tolling and other tolled facility.

4.3.7 ETC Penetration Rate for Autos and Trucks

The number of vehicles using electronic toll collection (ETC) in-vehicle transponders, commonly called "toll tags", to facilitate toll transactions is not 100 percent of the driving public. There are many reasons why some drivers elect not to open an account with a toll agency and place a transponder in their vehicle. This attitude coupled with the fact that it takes time for citizens to become familiar with the use and advantages of toll tags requires a method for accounting for the percentage of vehicles that use toll tags and those that will have their toll transactions conducted through video tolling. Toll tag penetration rates permit a way to gradually adjust the percentage of users opting to use toll tags as the toll facility matures. The Toll Revenue Estimation Model allows the user to indicate these penetration rates separately for autos and trucks.

4.3.8 Comments

The user can use this field to leave notes or explanations that clarify the choice of the input values within the Toll Data portion of the Project Characteristics worksheet.

5 Traffic Data Worksheet

After the Project Characteristics worksheet, there is the Traffic Data worksheet as shown in Figure 5-1. This worksheet does not include any input cells. It is intended as a summary table for the user to review the future traffic estimates based on the data included on the Project Characteristics worksheet.

Traffic Data - Section 1

Year of Opening	2015					Maximum Total ADT	60,000

* Traffic volumes shown do NOT include ramp-up factors.

Year		Auto		Truck		TOTAL	
Year No.	Year	Auto Mean Growth	Auto Tolled ADT	Truck Mean Growth	Truck Tolled ADT	TOTAL ADT	FEASIBLE TOTAL ADT
1	2015	5.0%	17,510	3.0%	730	18,240	18,240
2	2016	5.0%	18,386	3.0%	751	19,137	19,137
3	2017	5.0%	19,305	3.0%	774	20,079	20,079
4	2018	5.0%	20,270	3.0%	797	21,068	21,068
5	2019	5.0%	21,284	3.0%	821	22,105	22,105
6	2020	5.0%	22,348	3.0%	846	23,194	23,194
7	2021	5.0%	23,466	3.0%	871	24,337	24,337
8	2022	5.0%	24,639	3.0%	897	25,536	25,536
9	2023	5.0%	25,871	3.0%	924	26,795	26,795
10	2024	5.0%	27,164	3.0%	952	28,116	28,116
11	2025	4.0%	28,251	2.5%	976	29,227	29,227
45	2059	1.0%	69,233	1.0%	1,812	71,045	60,000
46	2060	1.0%	69,925	1.0%	1,830	71,755	60,000
47	2061	1.0%	70,625	1.0%	1,848	72,473	60,000
48	2062	1.0%	71,331	1.0%	1,867	73,198	60,000
49	2063	1.0%	72,044	1.0%	1,885	73,930	60,000
50	2064	1.0%	72,765	1.0%	1,904	74,669	60,000
Average		3.0%	46,677	2.0%	1,345	48,022	Maximum Allowable ADT is: Exceeded

Comments:
-

Figure 5-1: Traffic Data Worksheet

This table is composed of four major columns: year, auto, truck, and total. Two controlling data points copied from the Project Characteristics worksheet are indicated at the top of the table: the opening year of the facility and the maximum total AADT the toll facility can handle.

5.1 Year of Opening

The year of opening is the year the project is expected to be operational. The Toll Revenue Estimation Model assumes a full calendar year of operation for the opening year. For instance, the hypothetical project will begin full operation in January 2015.

5.2 Maximum Total AADT

The maximum total AADT is the capacity limit (on a daily basis) for the toll facility. This number cannot be changed directly on this worksheet. Its value is calculated from the values for the number of lanes and the maximum total AADT per lane in the Project Characteristics worksheet.

5.3 Worksheet Information

The Traffic Data worksheet provides a summary of the annual traffic volumes that are used in the calculation of annual toll revenues. The user can review the information on this worksheet to see how

both auto and truck traffic increases annually based on the data included on the Project Characteristics worksheet. The data table is divided into four main items.

5.3.1   Year
This item is divided into two columns:

- *Year No.:* this field goes from 1 to 50, with 1 being assigned to the opening year, 2 to the following year, etc.
- *Year*: this field goes from the opening year to 50 years after the opening year. In the example, the calendar goes from 2015 to 2061.

5.3.2   Auto
This item is divided into two columns:

- *Auto Mean Growth*: this field corresponds to the assumed growth rate of the auto traffic for a given year. These values are taken from the Project Characteristics worksheet. For easier identification, the changes in growth rates are highlighted by red text.
- *Auto Tolled AADT*: this column contains the estimated daily tolled auto traffic for each year over the course of the 50-year period. The change of AADT from one year to the next is due to the provided auto traffic growth rates.

5.3.3   Truck
This item is divided into two columns:

- *Truck Mean Growth*: this field corresponds to the assumed growth rate of the truck traffic for a given year. These values are taken from the Project Characteristics worksheet. For easier identification, the changes in growth rates are highlighted by red text.
- *Truck Tolled AADT*: this column contains the estimated daily tolled auto traffic for each year over the course of the 50-year period. The change of AADT from one year to the next is due to the provided truck traffic growth rates.

5.3.4   Total
This item is also divided into two columns:

- *Total AADT*: this column represents the daily traffic estimates for autos and trucks in each year.
- *Feasible Total AADT*: if the total estimated AADT exceeds the maximum total AADT, the traffic demand is equal to the maximum total AADT. The cell at the bottom of the worksheet with the dark-green background indicates whether or not the traffic did or did not exceed the maximum total AADT at some point over the 50-year study period. In the example, the maximum is fixed at 60,000 vehicles (autos and trucks), and this value is exceeded several times.

5.3.5 Averages

These fields display the averages for each column over the 50-year study period. These averages are provided for reference only and are not used within the Toll Revenue Estimation Model for transaction and revenue calculations.

5.3.6 Comments

The user can use this field to leave notes or explanations that clarify the values presented within the Traffic Data worksheet.

6   Toll Rates Worksheet

The Toll Rates worksheet (Figure 6-1) allows the user to set the toll rate schedule that will be applied in order to estimate annual toll revenues. The user can apply toll rates based on the information entered on the "Project Characteristics" worksheet, or make additional adjustments as appropriate.

Base Toll Rate Schedule - Section 1

Year of Analysis	2010
Year of Opening	2015
Toll Revenue Days	285
Project Length (miles)	12
Inflation Rate (%)	2.50%
Period Between Manual Toll Changes	every five years

The Early-Stage Toll Revenue Estimation Model assumes an annual adjustment to the toll rates based on the inflation rate from the Project Characteristics worksheet. The user, however, may enter other toll rate adjustments on a five-year basis in the yellow cells shown below.

Year No.	Year of Toll Rate	Auto Toll Rate (per mile)	Truck Toll Rate (per mile)
1	2015	$0.15	$0.55
2	2016	$0.15	$0.56
3	2017	$0.16	$0.58
4	2018	$0.16	$0.59
5	2019	$0.17	$0.61
6	2020	$0.17	$0.62
7	2021	$0.17	$0.64
8	2022	$0.18	$0.65
9	2023	$0.18	$0.67
10	2024	$0.19	$0.69
11	2025	$0.19	$0.70

45	2059	$0.44	$1.65
46	2060	$0.46	$1.67
47	2061	$0.47	$1.71
48	2062	$0.48	$1.76
49	2063	$0.49	$1.80
50	2064	$0.50	$1.84
Average Toll Rate		$0.29	$1.07

Comments:
-

Figure 6-1: Toll Rates Worksheet

6.1   Worksheet Information

This worksheet provides a summary of the base annual toll rates (on a per mile basis) that are used in the calculation of annual toll revenues. The user can review the information on this worksheet to see how both auto and truck toll rates increase annually based on the data included on the "Project Characteristics" worksheets. If desired, the user can make periodic adjustments to the rate schedule if appropriate for the toll road under consideration.

6.1.1   Year of Analysis

This is the year the toll project is being analyzed to assess its feasibility. The year of analysis can be different from the year of opening. A full date (MM/DD/YYYY) may be entered as a record keeping device to know when the last analysis occurred.

6.1.2   Other Information

The following information is taken directly from the Project Characteristics worksheet:

- Year of Opening
- Toll Revenue Days
- Project Length (miles)
- Inflation Rate (%)

If the user wishes to make changes to any of these items, return to the Project Characteristics worksheet for the appropriate section of toll road (e.g., Section 1, Section 2, or Section 3) and modify the corresponding fields to the desired values.

6.1.3   Period between Manual Toll Changes

This field indicates the frequency in which the toll rates can be manually adjusted beyond the annual inflation rate. By default for the Feasibility Tool, the toll rate can be forced to a new value every five years. At this time, the frequency for making manual adjustments to the toll rate cannot be changed as indicated by the white background.

6.1.4 Toll Rate Schedule

The Toll Rate worksheet provides a summary table of the base toll rates by vehicle type for each year in the study period. This toll rate schedule is used to estimate future toll revenues.

6.1.4.1 Year No.

This column goes from 1 to 50 representing the number of years in the study period, with 1 being assigned to the opening year, 2 to the following year, etc.

6.1.4.2 Year of Toll Rate

This column represent the calendar year from the opening year to 50 years after the opening year. In the example, the calendar goes from 2015 to 2064.

6.1.4.3 Auto Toll Rate

The Toll Revenue Estimation Model will initially take the base toll rate and inflation rate defined on the Project Characteristics worksheet and calculate the per mile annual toll rate for each year of the study period. If it is desired by the user to do so, the toll rate can be adjusted every five years by an amount greater than the basic inflation rate. Only the cells with a pale-yellow background can be modified by the user.

6.1.4.4 Truck Toll Rate

The Toll Revenue Estimation Model will initially take the base toll rate and inflation rate defined on the Project Characteristics worksheet and calculate the per mile annual toll rate for each year of the study period. If it is desired by the user to do so, the toll rate can be adjusted every five years by an amount greater than the basic inflation rate. Only the cells with a pale-yellow background can be modified by the user.

6.1.4.5 Average Toll Rate

These fields provide the average toll rate over a 50-year period of time for both autos and trucks. These averages are for informational purposes only and are not used in the calculation of toll revenues.

6.1.5 Comments

The user can leave notes or explanations that clarify the choice of the input values within the Toll Rates worksheet.

7 Operations & Maintenance Worksheet

The Operations & Maintenance (O&M) worksheet allows the user to consider the cost of operating and maintaining the toll road during the study period. These costs will be used to determine the anticipated net revenues on an annual basis. If the fields on the O&M worksheet are left blank, then the Toll Revenue Estimation Model will provide *gross* revenues in the summary tables described later in this manual. The O&M worksheet is composed of three tables: annual transactional cost, annual operations cost, and annual maintenance cost per mile.

7.1 Annual Transactional Cost Table

The annual transactions are computed as the traffic multiplied by factor that has been derived from the examination of numerous traffic and revenue studies conducted by various Departments of

Transportations and their consultants. The annual transactions table (Figure 20) is composed of six columns and two fields.

Figure 7-1: Annual Transactions

7.1.1 Year of Opening

The year of opening is the year the project is expected to be operational taken from the Project Characteristics worksheet. For instance, the hypothetical project will begin full operations in 2015. The Toll Revenue Estimation Model assumes a full calendar year of operation for the starting year.

7.1.2 Cost of Each Transaction

This factor reflects the cost of each transaction using ETC technology. In the example, this cost is $0.085 per transaction.

7.1.3 Organization of Table

The Annual Transactional Costs table presents data similar to that shown on previous worksheets. The one exception is that the numbers of annual *transactions* are presented rather they traffic volumes. The columns shown in the summary table include:

- Year Number
- Calendar Year
- Auto Transactions
- Percentage of ETC Transactions for Autos
- Truck Transactions
- Percentage of ETC Transactions for Trucks

As with other tables and worksheets, a Comment field is provided for the user to include any notes or explanation of for future reference.

7.2 Annual Operations Cost Table

The second table (see Figure 7-2) on the Operations and Maintenance worksheet addresses assumed annual operational cost of the toll road. The table accounts for items that may not be included in the transaction cost entered in the Annual Transactional Cost table (see Section 7.1.2 - Cost of Each Transaction.)

Figure 7-2: Annual Operations Cost

7.2.1 Year of Opening

The year of opening is the year the project is expected to be operational taken from the Project Characteristics worksheet. For instance, the hypothetical project will begin full operations in 2015. The Toll Revenue Estimation Model assumes a full calendar year of operation for the starting year.

7.2.2 Annual Operations Cost

These fields reflect the annual operational costs associated with the toll road beyond what is included in the transactional costs. Items such as annual marketing, courtesy patrols, and similar organizational costs associated with this toll facility can be included if this user desires. The dollar amount entered for each year should be a total annual cost for the entire section of the toll road and not presented on a per mile basis.

The table is set up so that the user can enter an annual cost for operations in the first year, then the remaining years are populated by applying the annual inflation rate to the initial value. The user can override any of the values by simply entering the preferred values in the appropriate years.

7.3   Annual Maintenance Cost

The third and last table of the O & M worksheet concerns annual maintenance cost (Figure 22) for the toll road.

Figure 7-3: Annual Maintenance Cost per Mile

7.3.1   Year of Opening

The year of opening is the year the project is expected to be operational taken from the Project Characteristics worksheet. For instance, the hypothetical project will begin full operations in 2015. The Toll Revenue Estimation Model assumes a full calendar year of operation for the starting year.

7.3.2   Annual Maintenance Cost per Mile

This field reflects the annual maintenance cost per mile over the 50-year period. Typically, the maintenance cost includes items associated with keeping the toll facility open, operational, and in good repair. The costs to expand and/or reconstruct the facility are considered major capital investments and should not be included in on-going maintenance expenses.

The table is set up so that the user can enter an annual cost for maintenance in the first year, then the remaining years are populated by applying the annual inflation rate to the initial value. The user can override any of the values by simply entering the preferred values in the appropriate years.

8   Transactions & Revenue Worksheet

The Transactions & Revenue (T&R) worksheet is composed of three tables: total, autos only, and trucks only values. Each table is described below.

8.1   Total Transactions and Revenue

Figure 8-1 show how the Total Transactions and Revenue table is composed of eight columns that represents the combined totals for autos and trucks on the section of toll road being examined.

TOTAL TRANSACTIONS & REVENUE - Section 1

Year No.	Year	Annual Traffic	Annual Toll Transactions	Annual Toll Revenue	Operational Costs	Maintenance Costs	Net Annual Revenue
1	2015	3,291,750	3,291,750	$7,256,334	$5,116,047	$480,000	$1,660,287
2	2016	3,947,090	3,947,090	$8,901,877	$5,308,428	$492,000	$3,101,448
3	2017	4,659,013	4,659,013	$10,750,416	$5,512,935	$504,300	$4,733,181
4	2018	5,431,524	5,431,524	$12,823,084	$5,730,608	$516,908	$6,575,569
5	2019	5,698,990	5,698,990	$13,766,404	$5,902,197	$529,830	$7,334,377
6	2020	5,979,705	5,979,705	$14,445,679	$6,065,485	$543,076	$7,837,118
7	2021	6,274,329	6,274,329	$15,509,609	$6,249,157	$556,653	$8,703,800
8	2022	6,583,553	6,583,553	$16,652,570	$6,439,847	$570,569	$9,642,154
9	2023	6,908,104	6,908,104	$17,880,472	$6,637,916	$584,833	$10,657,723
10	2024	7,248,744	7,248,744	$19,199,668	$6,843,747	$599,454	$11,756,467

Figure 8-1: Traffic and Revenue

8.1.1   Table Information

The first table on the Transaction and Revenue worksheet contains an annual summary for both autos and trucks for the toll road being examined. The table contains the following columns:

- Year Number
- Calendar Year
- Annual Traffic
- Annual Toll Transactions
- Annual Toll Revenue
- Operations Costs (includes transaction and other operational costs)
- Maintenance Costs
- Net Annual Revenue (Toll revenue minus operational and maintenance costs)

8.2   Transactions and Revenue for Autos and Trucks

Following the table summarizing total annual transactions and revenues, two tables are presented that show transactions and revenues for auto and trucks separately. Figure 8-2 shows the summary table for auto-only values on an annual basis. The table is composed of four major columns: year, annual traffic, annual transactions, and annual gross revenues.

TRANSACTIONS & REVENUE FOR AUTOS - Section 1									
Year		ANNUAL TRAFFIC		ANNUAL TRANSACTIONS			ANNUAL GROSS REVENUE		
Year No.	Year	% of Total Veh	Autos	% ETC	ETC	VIDEO	TOTAL	ETC	VIDEO	TOTAL
1	2015	96.0%	3,160,080	60%	1,896,048	1,264,032	3,160,080	$3,412,886	$2,844,072	$6,256,958
2	2016	96.1%	3,792,096	60%	2,275,258	1,516,838	3,792,096	$4,197,850	$3,498,209	$7,696,059
3	2017	96.1%	4,479,413	60%	2,687,648	1,791,765	4,479,413	$5,082,678	$4,235,565	$9,318,244
4	2018	96.2%	5,225,982	60%	3,135,589	2,090,393	5,225,982	$6,078,036	$5,065,030	$11,143,066
5	2019	96.3%	5,487,281	60%	3,292,369	2,194,913	5,487,281	$6,541,487	$5,451,239	$11,992,725
6	2020	96.4%	5,761,645	70%	4,033,152	1,728,494	5,761,645	$8,213,654	$4,400,172	$12,613,826
7	2021	96.4%	6,049,728	70%	4,234,809	1,814,918	6,049,728	$8,839,945	$4,735,685	$13,575,630
8	2022	96.5%	6,352,214	70%	4,446,550	1,905,664	6,352,214	$9,513,991	$5,096,781	$14,610,772
9	2023	96.6%	6,669,825	70%	4,668,877	2,000,947	6,669,825	$10,239,433	$5,485,410	$15,724,843
10	2024	96.6%	7,003,316	70%	4,902,321	2,100,995	7,003,316	$11,020,189	$5,903,673	$16,923,862
11	2025	96.7%	7,283,449	80%	5,826,759	1,456,690	7,283,449	$13,425,730	$4,195,544	$17,621,283

Figure 8-2: Transactions and Revenue for Autos

8.2.1 Table Information – Autos and Trucks

The second and third tables on the Transaction and Revenue worksheet contain an annual summary for autos and trucks for the toll road under study. The tables contain the following columns:

- Year Number
- Calendar Year
- Percentage of Total Traffic
- Annual Traffic
- Percentage of Transactions attributed to ETC
- Annual Transactions attributed to ETC
- Percentage of Transactions attributed to Video Tolling
- Annual Transactions attributed to Video Tolling
- Total Annual Transactions
- Revenues from ETC
- Revenues from Video Tolling
- Total Gross Revenues for Autos
- Transactions and Revenue for Trucks

The organization of the annual transactions and revenue for trucks as shown in Figure 8-3 is similar to the table for autos.

TRANSACTIONS & REVENUE FOR TRUCKS - Section 1									
Year		ANNUAL TRAFFIC		ANNUAL TRANSACTIONS			ANNUAL GROSS REVENUE		
Year No.	Year	% of Total Veh	Trucks	% ETC	ETC	VIDEO	TOTAL	ETC	VIDEO	TOTAL
1	2015	4.0%	131,670	40%	52,668	79,002	131,670	$347,609	$651,767	$999,375
2	2016	3.9%	154,994	40%	61,998	92,997	154,994	$419,415	$786,403	$1,205,818
3	2017	3.9%	179,600	40%	71,840	107,760	179,600	$498,147	$934,025	$1,432,172
4	2018	3.8%	205,542	40%	82,217	123,325	205,542	$584,354	$1,095,664	$1,680,018
5	2019	3.7%	211,708	40%	84,683	127,025	211,708	$616,932	$1,156,747	$1,773,679
6	2020	3.6%	218,059	50%	109,030	109,030	218,059	$814,157	$1,017,696	$1,831,853
7	2021	3.6%	224,601	50%	112,301	112,301	224,601	$859,546	$1,074,433	$1,933,979
8	2022	3.5%	231,339	50%	115,670	115,670	231,339	$907,466	$1,134,333	$2,041,799
9	2023	3.4%	238,279	50%	119,140	119,140	238,279	$958,057	$1,197,572	$2,155,629
10	2024	3.4%	245,428	50%	122,714	122,714	245,428	$1,011,469	$1,264,336	$2,275,805

Figure 8-3: Traffic and Revenue for Trucks

9   Summary Graphs

The projected results for the annual traffic, annual transactions, and annual revenue are presented by graphs to understand how the various estimates change over time. The graphs are generated automatically based on the results of the Toll Revenue Estimation Model. The graphs are divided into three groups:

- totals for all vehicles
- information for autos only
- information for trucks only.

Figure 9-1 shows an example of the types of graphs available with the Toll Revenue Estimation Model. The graphs presented in Figure 9-1relate to autos only.

These graphs illustrate Annual Traffic, Annual Transactions ,and Annual Revenues for Autos - SECTION 1

Annual Traffic Estimates for Autos

Annual Transaction Estimates for Autos
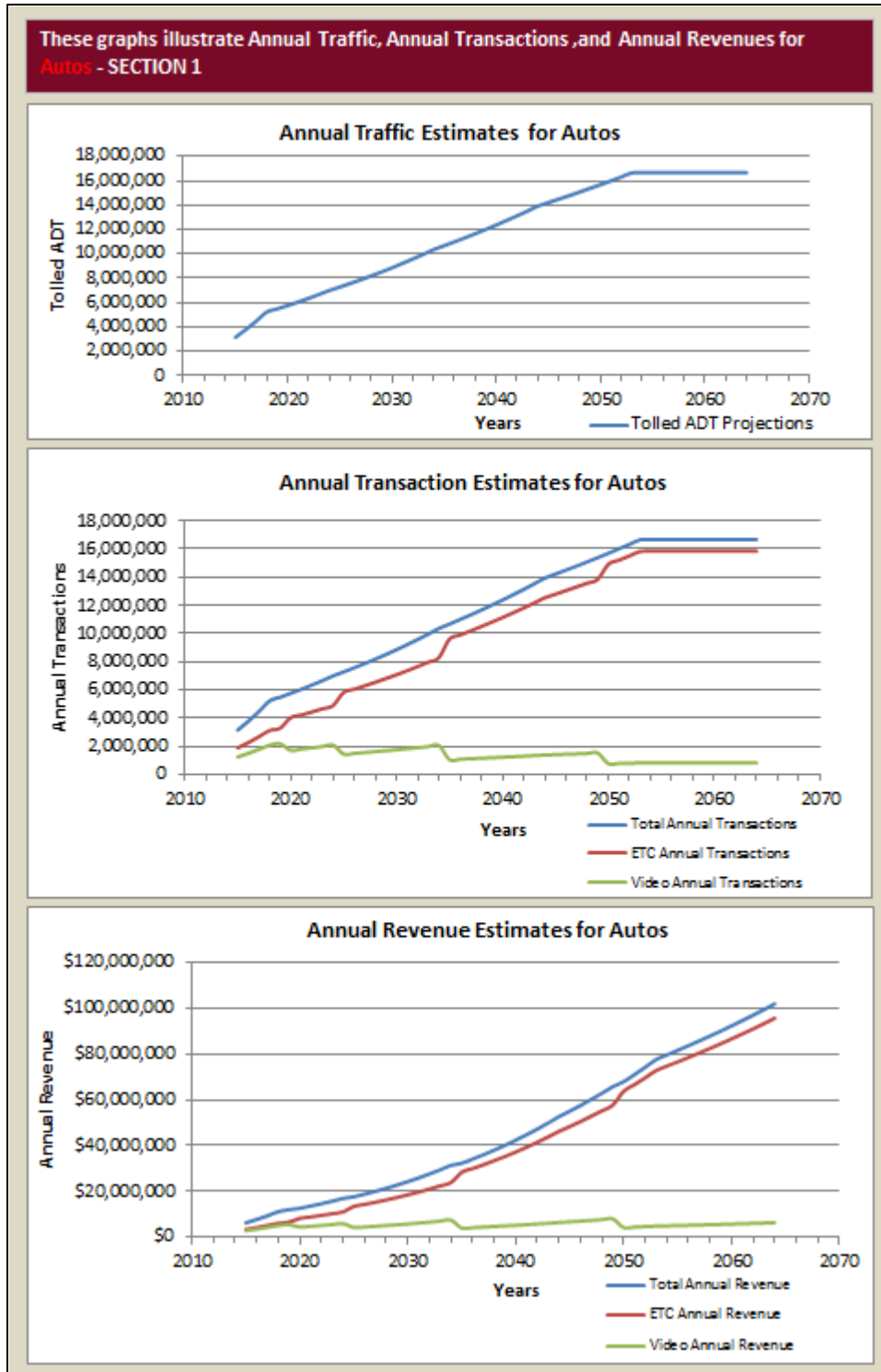
Annual Revenue Estimates for Autos

Figure 9-1: Graphs for Total Traffic

46

10 Analysis of Results

There are three tables in the Analysis of Results worksheet: one for combined autos and trucks, one for autos only, and one for trucks only. Since the content and layout of the tables are similar, the discussion in this section of the user guide will only focus on the one providing information on autos as illustrated in Figure 10-1.

Analysis of Results (Autos) - Section 1

YEAR		TRAFFIC (AADT)	ANNUAL REVENUE	CONFIDENCE INTERVAL					
Year No.	Year	Most Likely	Most Likely	Lower Bound	Lower Revenue Limit	Upper Bound	Upper Revenue Limit	Confidence Interval
1	2015	11,088	$ 6,256,958	5%	$ 5,321,342	95%	$ 7,192,575	90%
2	2016	13,306	$ 7,696,059	5%	$ 6,545,251	95%	$ 8,846,867	90%
3	2017	15,717	$ 9,318,244	5%	$ 7,924,867	95%	$ 10,711,621	90%
4	2018	18,337	$ 11,143,066	5%	$ 9,476,820	95%	$ 12,809,313	90%
5	2019	19,254	$ 11,992,725	5%	$ 10,199,427	95%	$ 13,786,023	90%
6	2020	20,216	$ 12,613,826	5%	$ 10,727,653	95%	$ 14,499,998	90%
7	2021	21,227	$ 13,575,630	5%	$ 11,545,637	95%	$ 15,605,623	90%
8	2022	22,288	$ 14,610,772	5%	$ 12,425,992	95%	$ 16,795,552	90%
9	2023	23,403	$ 15,724,843	5%	$ 13,373,474	95%	$ 18,076,213	90%
10	2024	24,573	$ 16,923,862	5%	$ 14,393,201	95%	$ 19,454,524	90%
11	2025	25,556	$ 17,621,293	5%	$ 14,986,225	95%	$ 20,256,231	90%
...								
47	2061	58,470	$ 94,591,493	5%	$ 80,450,518	95%	$ 108,656,477	90%
48	2062	58,470	$ 96,931,684	5%	$ 82,449,479	95%	$ 111,413,889	90%
49	2063	58,470	$ 99,354,976	5%	$ 84,510,716	95%	$ 114,199,236	90%
50	2064	58,470	$ 101,838,850	5%	$ 86,623,483	95%	$ 117,054,217	90%
Average		41,106	$ 47,213,896		$ 40,156,401		$ 54,271,392	
TOTAL		2,055,282	$ 2,360,694,823		$ 2,007,820,030		$ 2,713,569,616	

Figure 10-1: Analysis of Results for Autos

The table contains the following columns:

- Year Number
- Calendar Year
- Traffic Estimates
- Toll Revenue Estimates
- Confidence Intervals for the resulting revenue forecasts.

10.1 Traffic Estimates

As seen in Figure 10-1, the estimated AADT for each year is presented. In addition to the "most likely" values that are used in the Toll Revenue Estimation Model up to this point, the possible minimum and maximum values are presented. These upper and lower limits are determined from the type of traffic distribution selected on the "Project Characteristic" worksheet as well as the minimum, maximum, mode, mean, and/or standard deviation values chosen. Because the "minimum" and "maximum" calculations are based on input values provided by the user, the results on not absolute, i.e., it is still theoretically possible that actual traffic volumes on the toll road could fall below – or above – the limits presented in the table. Ramp-up assumptions are included in the estimated traffic volumes.

10.2 Toll Revenue Estimates

The revenue estimates shown on the Analysis worksheet take the three traffic volumes – minimum, most likely, and maximum – and calculates the resulting toll revenue for each scenario. The revenue

estimates take into consideration ETC toll tag penetration assumptions, video toll surcharges, and toll rate escalation.

10.3 Confidence Interval

This section of the table provides an analysis that determines a confidence interval for the revenue estimate in each of the future years. A confidence interval is used to indicate the reliability of an estimate (in this case, toll revenues).

A confidence interval with a particular confidence level is intended to give the assurance that, if the statistical model is correct, then taken over all the data that *might* have been obtained, the procedure for constructing the interval would deliver a confidence interval that included the true value of the parameter the proportion of the time set by the confidence level.[2]

For the Toll Revenue Estimation Model, the Analysis worksheet shows a confidence interval of toll revenues at a 90% confidence level. In other words, based on the information provided throughout the Toll Revenue Estimation Model, there is a 90% level of confidence that the actual revenues will fall between the upper and lower boundaries presented in the table.

At present, the Toll Revenue Estimation Model does not examine the probability of results. That will be included in future versions of the model. Also, the Toll Revenue Estimation Model only determines the confidence internal at the 90% confidence level. It will be possible for the user to select the confidence level in future versions of the model.

11 Combined Results

The organization of this worksheet is similar to the Transactions & Revenue worksheet and combines the results from all toll road sections depending on the number of sections the user chose to examine: one, two, or three. The combined results respect the opening year dates selected for each section and the unique attributes provided on the various worksheets for each section. Figure 11-1 shows an example of multiple sections examined through the Toll Revenue Estimation Model.

Combined Traffic & Revenue

Year No	Year	Tolled AADT	Gross Annual Toll Revenue	Annual Operations Costs	Annual Maintenance Costs	Net Annual Revenue
1	2015	16,500	$ 7,256,334	$ 400,000	$ 40,000	$ 6,816,334
2	2016	28,050	$ 12,587,859	$ 820,000	$ 92,250	$ 11,675,609
3	2017	44,817	$ 20,286,772	$ 1,260,750	$ 136,581	$ 18,889,441
4	2018	49,199	$ 23,785,798	$ 1,292,269	$ 139,996	$ 22,353,534
5	2019	55,121	$ 26,966,752	$ 1,324,575	$ 143,496	$ 25,498,681
6	2020	60,957	$ 30,225,302	$ 1,357,690	$ 147,083	$ 28,720,529
7	2021	63,988	$ 32,570,796	$ 1,391,632	$ 150,760	$ 31,028,404
8	2022	67,185	$ 35,108,722	$ 1,426,423	$ 154,529	$ 33,527,770
9	2023	70,559	$ 37,855,819	$ 1,462,083	$ 158,392	$ 36,235,343
10	2024	74,120	$ 40,830,378	$ 1,498,636	$ 162,352	$ 39,169,390
11	2025	77,217	$ 42,701,943	$ 1,536,101	$ 166,411	$ 40,999,430

Figure 11-1: Combined Results of Multiple Sections

2 Wikipedia. http://en.wikipedia.org/wiki/Confidence_interval (accessed January 26, 2011.)

If the user has already selected and generated the combined results on this worksheet then makes changes to items on previous worksheets, the user needs to refresh the results in the Combined Results worksheet by clicking on the appropriate button again.

12 Combined Analysis

The organization of Combined Analysis worksheet is similar to the individual Analysis worksheet for each individual section. The combined results respect the opening year dates selected for each section and the unique attributes provided on the various worksheets for each section.

\multicolumn{2}{c}{YEAR}	TRAFFIC (AADT)	ANNUAL REVENUE	\multicolumn{5}{c}{CONFIDENCE INTERVAL}
Year No	Year	Most Likely	Most Likely	Lower Bound	Lower Revenue Limit	Upper Bound	Upper Revenue Limit	Confidence Interval
1	2015	16,500	$ 7,256,334	5%	$ 6,171,279	95%	$ 8,341,389	90%
2	2016	28,050	$ 12,587,859	5%	$ 10,619,591	95%	$ 14,556,128	90%
3	2017	44,817	$ 20,286,772	5%	$ 17,033,955	95%	$ 23,539,590	90%
4	2018	49,199	$ 23,785,798	5%	$ 19,906,041	95%	$ 27,665,555	90%
5	2019	55,121	$ 26,966,752	5%	$ 22,801,796	95%	$ 31,131,709	90%
6	2020	60,957	$ 30,225,302	5%	$ 25,848,601	95%	$ 34,602,003	90%
7	2021	63,988	$ 32,570,796	5%	$ 27,871,962	95%	$ 37,269,631	90%
8	2022	67,185	$ 35,108,722	5%	$ 30,063,837	95%	$ 40,153,606	90%
9	2023	70,559	$ 37,855,819	5%	$ 32,439,180	95%	$ 43,272,457	90%
10	2024	74,120	$ 40,830,378	5%	$ 35,014,359	95%	$ 46,646,397	90%
11	2025	77,217	$ 42,701,943	5%	$ 36,642,615	95%	$ 48,761,271	90%

Figure 12-1: Analysis of Combined Results from Multiple Sections

13 Conclusion

The Toll Revenue Estimation Model and this user's guide present a simulation-based model to aid in assessing the viability of a proposed toll road from a revenue perspective. The model presented allows a user to experiment with various assumptions and data values to identify the possible resulting revenues over the course of 50 years.   The Toll Revenue Estimation Model also migrates previous toll viability models to an Excel®-only environment that does not require third-party add-ons.

The Toll Revenue Estimation Model permits the user to incorporate some perceived risk and uncertainty based upon the ranges of estimates of the key input fields. The subsequent analysis translates those values into a range of possible results. This can be of great benefit in that a given project can be more easily evaluated in terms of its potential to generate sufficient revenues to proceed with more detailed analysis required to support the financing and subsequent construction of the project.

14 Bibliography

Eschenbach, T., Engineering Economy: Applying Theory to Practice, 2nd edition, Oxford University Press, 2003.

Roman, S., Writing Excel Macros with VBA, 2nd edition, O'Reilly Media, Inc., 2002.

Spiegelman, C., Transportation Statistics and Microsimulation, 1st edition, Chapman & Hall/CRC, 2010.

UTCM

University Transportation Center for Mobility™

Texas Transportation Institute

The Texas A&M University System

College Station, TX 77843-3135

Tel: 979.845.2538   Fax: 979.845.9761

utcm.tamu.edu

**Texas
Transportation
Institute**