User's Manual for Sustainable Transportation Performance Measures Calculator

Project 5-5541-01

Implementation of Project 0-5541: Developing Sustainable Transportation Performance Measures for TxDOT's Strategic Plan

Product 5-5541-01-P2

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Developed by:

SUSTAINABLE TRANSPORTATION PERFORMANCE MEASURES CALCULATOR

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DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT). 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 TxDOT. This report does not constitute a standard, specification, or regulation.

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This project was conducted in cooperation with TxDOT. The authors gratefully acknowledge the contributions of numerous persons who made the successful completion of this calculator and user's manual possible.

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Section 1

Overview

Sustainable transportation can be viewed as the provision of safe, effective, and efficient access and mobility into the future while considering economic, social, and environmental needs. For the Texas Department of Transportation (TxDOT) to assess options and monitor progress toward achieving the goals of sustainable transportation it is essential that the underlying sustainability-related goals and objectives be quantified and applied to project, corridor, and network levels for planning, operation, and maintenance.

In recognition of this need, TxDOT sponsored research under project 0-5541 "Developing Sustainable Transportation Measures for TxDOT's Strategic Plan." The overall goal of this project was to develop sustainable transportation performance measures for TxDOT's strategic goals and objectives as well as a framework for TxDOT to implement a sustainable transportation system in Texas. The end result of this framework is a user-friendly analysis tool developed in Microsoft Excel® to serve as a platform for evaluating the performance measures and combining them into a final sustainability index.

This chapter serves as an introduction to the User's Manual for Sustainable Transportation Performance Measures Calculator. This chapter also highlights the intended audience for the material and lists the remaining chapters in this user's manual.

Section 2

Audience for This User's Manual

The typical audience for this user's manual is an employee of the Texas Department of Transportation or an affiliated consultant or contractor. The typical user will generally have some level of overview or responsibility for developing or assessing project options. This tool provides the user with a means to examine the sustainability implications of the projects and relate them to the strategic goals of the department. Specific examples of users may include (but are not limited to) the following:

♦ technical staff, including planners, engineers, designers, construction engineers, and traffic engineers;

♦ management-level and executive-level staff responsible for formulating policies, identifying program vision, goals, and objectives, and setting program-level priorities;

♦ appropriate representatives from the department responsible for assessing the sustainability implications of a project and its relation to the strategic goals of the department;

♦ TxDOT staff, particularly those with oversight responsibilities for Federal-aid highway projects; and

♦ appropriate non-TxDOT staff—such as consultants, contractors, other highway workers, and local law enforcement officials—who partner with or are contracted by TxDOT to plan, design, and build road projects.

Section 3

Remaining Chapters in This User's Manual

This user's manual contains the following remaining chapters. A brief description of the content of each is provided below.

♦ Chapter 2 – A general overview of the calculator, including hardware and software requirements and a general description of its main components.

♦ Chapter 3 – How to use the calculator while performing an analysis.

♦ Chapter 4 – An overview of the performance measures used within the calculator.

♦ Chapter 5 – Understanding the results of the calculator.

Section 4

For More Information

For more information on the 0-5541 project and the methodology behind the performance measures used in the calculator, please refer to the full research report located at: http://tti.tamu.edu/documents/0-5541-1.pdf.

Chapter 2

Overview of the Sustainable Transportation Performance Measures Calculator

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Section 1

Overview of the Calculator

The 0-5541 project developed a methodology for analyzing project alternatives based on the strategic goals of the Department and the performance measures chosen to represent those goals. This methodology is embedded into the sustainable performance measures calculator.

As a general overview, the calculator contains a series of input sheets covering both the base and future cases. The calculations of the performance measures are automatic based on data input. The user has the ability to select a variable number of future cases (up to three) to analyze in comparison to the base case.

The calculator uses the concept of a study corridor for the analysis. The corridor may be broken up into as many as 10 links depending on the predominant physical characteristics, such as length, number of lanes, traffic levels, and more. Section 5 describes the data input requirements for the calculator.

As data are entered, the calculator constantly updates and revises the computation of the individual performance measures. There is no need to trigger an update of any calculation when data entry is complete. Upon completion of the data entry, the user can proceed immediately to the executive summary to assess the performance of the alternatives.

The weighting of the various performance measures may be changed once data input is complete and that this change may affect the results. There is, however, no need to re-enter data if the user simply changes the weightings assigned to the various performance measures. The performance measures used in this calculator are overviewed in Section 4 and discussed in more detail in Chapter 4.

Section 2

Objectives of the Calculator

The sustainable performance measures calculator developed for the 0-5541 project had several objectives, including to:

♦ support the goals of the TxDOT strategic plan;

♦ provide a performance measurement based methodology for comparing alternative projects;

♦ be user-friendly;

♦ be menu driven;

♦ utilize clear data entry fields and data requirements;

♦ perform all of the necessary computations automatically;

♦ produce tangible results based on solid research;

♦ implement measures and variable weighting in a simple, easily understood manner;

♦ provide for a variable number of links (up to 10) in the study corridor;

♦ provide for a variable number of future cases (up to 3);

♦ allow for a visual comparison of alternative options; and

♦ produce a visually appealing executive summary.

Section 3

Software/Hardware Requirements for Calculator

3.1 – Software Requirements

This spreadsheet has been designed to operate under Microsoft Office® 2003 and later versions. Specifically, the required programs are:

♦   Microsoft Excel® 2003 or later.

The electronic materials have been tested with all later versions of the above Microsoft Office® programs and found to be compatible.

3.2 – Hardware Requirements

Microsoft Office® 2003 was designed to run on personal computers with the following *minimum* specifications:

♦   personal computer with an Intel Pentium 233-MHz or faster processor;

♦   Microsoft Windows 2000 with Service Pack 3 (SP3), Windows XP, or later;

♦   128 MB of RAM or greater;

♦   400 MB of hard disk space;

♦   CD-ROM or DVD-ROM drive;

♦   Super VGA monitor with at least 800×600 pixels and 256 colors; and

♦   a Microsoft mouse or compatible pointing device.

Please note that substantial performance enhancements will be achieved by using computers with specifications that exceed the above minimum requirements.

The empty spreadsheet occupies approximately 2 MB of disk space without data. Depending on the number of future case cases chosen, the spreadsheet with data entered can occupy up to approximately 10 MB of disk space. This spreadsheet should fit on hard disk drives and flash drives, but will not fit onto a floppy drive.

Section 4

Performance Measures Used in the Calculator

4.1 – TxDOT Strategic Plan

The TxDOT strategic plan (2009–2013) has the following goals:

♦ reduce congestion,

♦ enhance safety,

♦ expand economic opportunity,

♦ preserve the value of transportation assets, and,

♦ improve air quality.

In the plan, funding was recognized as one of the critical issues facing the state and its transportation system. The analysis tool produced in Project 0-5541 can be used to provide a basis for project selection, and impact assessment, providing a solid performance measurement based methodology to a number of funding decisions.

4.2 – Performance Measures used in Calculator and Their Relation to TxDOT Strategic Goals

Table 2-1 provides an overview of the 12 performance measures used in the sustainable transportation performance measures calculator developed for Project 0-5541 and their relation to the TxDOT strategic plan goals.

Table 2-1. Performance Measures Used in Sustainable Transportation Calculator.

Goal No.	TxDOT Strategic Plan Goal	Objectives	Measure No.	Performance Indicator
1	Reduce congestion	Improve mobility on highways	1a	Travel time index
		Improve reliability of highway travel	1b	Buffer index
2	Enhance safety	Reduce crash rates and crash risk	2a	Annual severe crashes per mile
		Improve traffic incident detection and response	2b	Percentage lane-miles under traffic monitoring/surveillance
3	Expand economic opportunity	Optimize land use mix for development potential	3a	Land use balance
		Improve road-based freight movement	3b	Truck throughput efficiency
4	Preserve the value of transportation assets	Maintain existing highway system quality	4a	Average pavement condition score
		Reduce cost and impact of highway capacity expansion	4b	Capacity addition within available right of way
		Leverage non-traditional funding sources for highways	4c	Cost recovery from alternative sources
		Increase use of alternatives to single-occupant automobile travel	4d	Proportion of non single-occupant vehicle travel
5	Improve air quality	Reduce adverse human health impacts and comply with ambient air quality standards	5a	Air Quality Index
		Reduce greenhouse gas emissions	5b	Daily CO_2 emissions per mile of roadway

Chapter 3 details how weightings can be used to change the sensitivity of the evaluation to reflect different goal areas of the strategic plan. In addition, each individual measure is assigned a weighting that reflects its contribution to the overall goal area. Default weightings (both goal area and individual performance measure) are provided for the user and are stratified across a rural and urban project setting. The user can change these weightings as desired or simply keep the default weightings.

Section 5

Data Input Requirements

The sustainable performance measures calculator also has data requirements in addition to the hardware and software requirements listed in Section 3.

The data requirements are broken down into three areas:

♦   Base Case Required Inputs,

♦   Future Case Required Inputs, and

♦   Future Case Optional Inputs.

The data required for each area are described in the following sections.

5.1 – Base Case Required Inputs

Table 2-2 lists the required inputs for the base case. The table lists each item number, provides a brief description, identifies the units of the parameter (if any), and in some cases provides supplemental information in the additional remarks column.

Table 2-2. Base Case Data Requirements.

Item	Description	Units	Additional Remarks
Link Description	Link name or description—user is encouraged to describe in terms of start and end points	None	
Link Length	Distance between start and end points of the link	Miles	
Number of Lanes	Average number of through lanes over length of link	None	
Average Daily Traffic (ADT)	Average daily number of vehicles (observed/projected) traversing the link, in both directions	Vehicles/day	
Roadway Type	Classification of link for safety analysis purpose as freeway, rural highway, or urban street	None	
Pavement Condition Score	Average condition score (maximum of 100) from TxDOT's Pavement Management Information System (PMIS) database for link	None	
Percent Trucks	Bidirectional average truck volumes on link, expressed as percentage of ADT	Percentage	
TMC Surveillance	Yes or No response for whether link is under surveillance by a traffic monitoring center	None	
Posted Speed Limit	Average posted daytime speed limit on link	Miles per hour	

Table 2-2. Base Case Data Requirements (continued).

Item	Description	Units	Additional Remarks
Non-attainment classification for a) Ozone b) Particulate Matter c) Carbon Monoxide ambient air quality standards	Classification of the county in which the link is in, according to the National Ambient Air Quality Standards (NAAQS) for each of the pollutants	None	Classifications are: In attainment, basic deferred/early action compact, marginal non-attainment, serious or severe non-attainment, or extreme non-attainment
Land Area - Residential	Land area in zone half-mile to either side of link that is occupied by residential land use	Square Miles	
Land Area - Commercial	Land area in zone half-mile to either side of link that is occupied by commercial or industrial land use	Square Miles	
Land Area - Institutional and Public	Land area in zone half-mile to either side of link that is occupied by institutional and public land uses	Square Miles	Undeveloped land is also included in this category
Lane Additions within Right of Way (ROW)	Number of additional through lanes that can be accommodated on the given link, within the available right of way	None	
Presence of High Occupancy Vehicle (HOV) Restrictions	Yes or No response for whether link has any lanes with HOV restrictions	None	
Presence of Bus Service	Yes or No response for whether link has any bus/Bus Rapid Transit (BRT) service operating on it	None	
Presence of Rail Service	Yes or No response for whether link has any rail/Light Rail Transit (LRT) facilities paralleling it	None	
HOV Occupancy Requirement	Average minimum occupancy levels for HOV restrictions (2 or 3)	None	Applicable only if "Y" for HOV restrictions
Estimated veh/day on HOV lanes	Total estimated ridership (vehicles/day) making use of HOV restricted lanes during restricted times	veh/day	Applicable only if "Y" for HOV restrictions
Average number of buses/day	Average daily number of buses traversing the link in both directions	buses/day	Applicable only if "Y" for bus service
Average bus occupancy	Occupancy of bus in terms of average number of passengers	Number of persons/bus	Applicable only if "Y" for bus service
Average number of trains/day	Average daily number of trains traversing the link in both directions	trains/day	Applicable only if "Y" for rail service
Average number of rail cars	Average number of rail cars on each train	None	Applicable only if "Y" for rail service
Average rail car occupancy	Occupancy of rail car in terms of average number of passengers	Number of persons/rail car	Applicable only if "Y" for rail service

Table 2-2. Base Case Data Requirements (continued).

Item	Description	Units	Additional Remarks
Recovery of Operations and Maintenance (O&M) Costs	Proportion of O&M expenses for most recent year covered by alternate sources	None	Alternate sources are defined as non-state/non-federal funds (i.e., municipal funds, toll revenue, private sector funding)
Recovery of Capital Expenditures	Proportion of total capital expenditure, to date, covered by alternate sources	None	Alternate sources are defined as non-state/non-federal funds (i.e., municipal funds, toll revenue, private sector funding)
Proportion of traffic under peak conditions	Average proportion of daily traffic that occurs during the peak period	Percentage	Includes combined AM and PM peak traffic. Duration of peak period is location specific, and defined based on local traffic patterns

5.2 – Future Case Required Inputs

Table 2-3 lists the required inputs for the future case. The format and information provided is the same as in Table 2-2. Note that a few data requirements are reduced. For example, all future case cases will use the same section breakdown as in the base case. Users are encouraged to provide sufficient information for the section descriptions to ensure clear and unambiguous understanding of the each section of the study corridor.

Table 2-3. Future Case Data Requirements.

Item	Description	Units	Additional Remarks
Number of Lanes	Average number of through lanes over length of link	None	
Average Daily Traffic (ADT)	Average daily number of vehicles (observed/projected) traversing the link, in both directions	Vehicles/day	
Roadway Type	Classification of link for safety analysis purpose as freeway, rural highway, or urban street	None	
Pavement Condition Score	Average link condition score (maximum of 100) from TxDOT's PMIS database.	None	
Percent Trucks	Bidirectional average truck volumes on link, expressed as percentage of ADT	Percentage	

Table 2-3. Future Case Data Requirements (continued).

Item	Description	Units	Additional Remarks
Traffic Management Center (TMC) Surveillance	Yes or No response for whether link is under surveillance by a traffic monitoring center	None	
Posted Speed Limit	Average posted daytime speed limit on link	Miles per hour	
Land Area - Residential	Land area in zone half-mile to either side of link that is occupied by residential land use	Square Miles	
Land Area - Commercial	Land area in zone half-mile to either side of link that is occupied by commercial or industrial land use	Square Miles	
Land Area - Institutional and Public	Land area in zone half-mile to either side of link that is occupied by institutional and public land uses	Square Miles	Undeveloped land is also included in this category
Lane Additions within ROW	Number of additional through lanes that can be accommodated on the given link, within the available right of way	None	
Presence of HOV Restrictions	Yes or No response for whether link has any lanes with HOV restrictions	None	
Presence of Bus Service	Yes or No response for whether link has any bus/BRT service operating on it	None	
Presence of Rail Service	Yes or No response for whether link has any rail/LRT facilities paralleling it	None	
HOV Occupancy Requirement	Average minimum occupancy levels for HOV restrictions (2 or 3)	None	Applicable only if "Y" for HOV restrictions
Estimated veh/day on HOV lanes	Total estimated ridership (vehicles/day) making use of HOV restricted lanes during restricted times	veh/day	Applicable only if "Y" for HOV restrictions
Average number of buses/day	Average daily number of buses traversing the link in both directions	buses/day	Applicable only if "Y" for bus service
Average bus occupancy	Occupancy of bus in terms of average number of passengers	Number of persons/bus	Applicable only if "Y" for bus service
Average number of trains/day	Average daily number of trains traversing the link in both directions	trains/day	Applicable only if "Y" for rail service
Average number of rail cars	Average number of rail cars on each train	None	Applicable only if "Y" for rail service
Average rail car occupancy	Occupancy of rail car in terms of average number of passengers	Number of persons/rail car	Applicable only if "Y" for rail service

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Table 2-3. Future Case Data Requirements (continued).

Recovery of O&M Costs	Proportion of O&M expenses for most recent year covered by alternate sources	None	Alternate sources are defined as non-state/non-federal funds (i.e., municipal funds, toll revenue, private sector funding)
Recovery of Capital Expenditures	Proportion of total capital expenditure, till date, covered by alternate sources	None	Alternate sources are defined as non-state/non-federal funds (i.e., municipal funds, toll revenue, private sector funding)
Proportion of traffic under peak conditions	Average proportion of daily traffic that occurs during the peak period	Percentage	Includes combined AM and PM peak traffic. Duration of peak period is location specific, and defined based on local traffic patterns

5.3 – Future Case Optional Inputs

Table 2-4 lists the optional inputs for the future case. The format and information provided is the same as in Table 2-2. Providing the optional inputs provide better precision on the calculation of the performance measures. In the absence of these optional inputs, defaults are assumed as detailed in the earlier tables. While the results may not be as precise, the overall impact on the analysis is anticipated to be minimal.

Table 2-4. Future Case Optional Data.

Item	*Description*	*Units*	*Additional Remarks*
Grade	Average grade over length of link, expressed as a positive percentage	Percentage	Default of 0% is assumed
Lane Width	Average width of through lanes on link	Feet	Default of 12 ft is assumed
Median Type - For freeways	Classification of median type, dependent upon roadway type. For freeways - Depressed or Surfaced; for Rural Highways - Depressed, Surfaced, or Two Way Left Turn Lane (TWLTL); For Urban Streets - Raised Curb, Undivided, or TWLTL	None	Defaults Assumed: Freeways - Depressed, Rural Highways - Depressed, Urban Streets - Raised Curb

Table 2-4. Future Case Optional Data (continued).

Outside Shoulder Width	Average width of outside shoulder on link	Feet	Defaults Assumed: Freeways - 10 ft, Rural Highways - 8 ft. For Urban Streets, it may be indicated whether a curb-and-gutter section is used, in which case the effective shoulder width is 1.5 ft
Inside Shoulder Width	Average width of inside shoulder on link	Feet	Applicable only for freeways and rural highways. Defaults Assumed: Freeways - 4 ft for 4 lanes or less, 10 ft otherwise, Rural Highways - 4 ft
Number of Unsignalized 4-leg intersections	Number of unsignalized 4-leg intersections on link	None	Only applicable to rural highways and urban streets. Default assumed = 0
Number of Signalized 4-leg intersections	Number of Signalized 4-leg intersections on link	None	Only applicable to rural highways and urban streets. Default assumed = 0
Average Minor Road ADT for all 4-leg intersections	Average ADT for cross streets at all 4-leg intersections on link	veh/day	Only applicable to rural highways and urban streets. Default assumed = 50% of main street ADT
Number of Unsignalized 3-leg intersections	Number of unsignalized 3-leg intersections on link	None	Only applicable to rural highways and urban streets. Optional Input - Default assumed = 0
Number of Signalized 3-leg intersections	Number of Signalized 3-leg intersections on link	None	Only applicable to rural highways and urban streets. Default assumed = 0
Average Minor Road ADT for all 3-leg intersections	Average ADT for cross streets at all 3-leg intersections on link	veh/day	Only applicable to rural highways and urban streets. Default assumed = 15% of main street ADT
Driveway Density	Average number of driveways (not intersecting streets) per mile on link	driveways/mile	Applicable to rural highways and urban streets. Default assumed = 5/mile for rural highways, 25/mile for urban streets with raised median, and 50/mile for urban streets without raised median
Area Characterization	Qualitative characterization of area surrounding link, used for crash estimation purposes	None	Applicable to freeways and urban streets. For freeways can be urban or rural, urban is assumed as default; for urban streets, can be commercial/business/office, or residential/industrial, residential is assumed as default

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Section 6

Components of the Calculator

6.1 – Worksheets

The sustainable transportation performance measures calculator (which can also be referred to as a spreadsheet), was developed in Microsoft Excel 2003®. This user's manual assumes readers know the basics for using Excel. Instructions will not be provided for tasks such as data entry, moving around the spreadsheet, using Excel commands, printing, and more.

The calculator uses the Excel concept of multiple individual worksheets within the spreadsheet system. In particular, the following worksheet types have been defined within the calculator:

♦   Menu – The overall menu system for the calculator;

♦   Instructions – A quick reference instruction page for the sustainable transportation performance measures calculator;

♦   Data Entry – Worksheets that require data entry from the user;

♦   Calculated Data – Worksheets that are completely automatic and serve to calculate and tabulate the data across the range of performance measures; and

♦   Summary – Worksheets that function as an executive summary, tabulating the results of the individual measures across the cases (both base and future).

6.2 – Tab Bar

Worksheets are implemented via the tab bar in Excel. Figure 2-1 pictures an example of the tab bar in the calculator. Clicking on each individual tab will take the user to that worksheet.
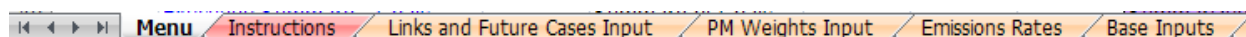

Figure 2-1. Example Tab Bar for Calculator.

With the tab bar containing a tab with the name of every worksheet in the calculator, moving around the tab bar can be tedious with the large number of individual components. For that reason, the calculator was designed with a menu system to facilitate navigation.

6.3 – Menuing System

Figure 2-1 shows that the first tab listed is "Menu." Figure 2-2 shows the opening menu for the calculator. Note that the menu is organized into columns, providing the worksheet name, a brief description, and the type of worksheet (as detailed in Section 6.1). Each name is hyperlinked to the worksheet, so clicking on it with the mouse will take the user to that particular worksheet.
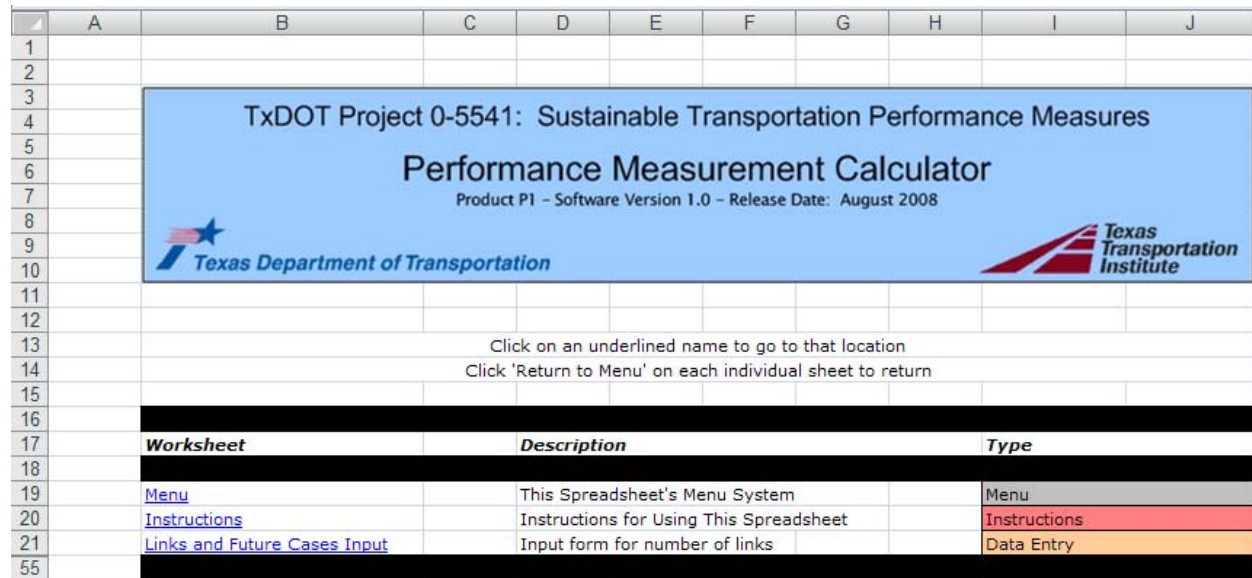
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Figure 2-2. Opening Menu for Calculator.

Note also that the worksheet name listed in the first column of the menu is the same worksheet name listed on the tab bar in Figure 2-1. This provides consistency and multiple ways to move around the spreadsheet.

The menu shown in Figure 2-2 is the initial menu the user sees upon opening the calculator. As initial decisions are made, such as the number of sections and the number of cases under analysis, the menu expands to show additional items.

As mentioned previously, because it can be tedious to move around the calculator using the tab bar, each worksheet provides a "return" feature to quickly and easily return to the main menu. Figure 2-3 shows a hyperlink phrase "Return to Menu" in the upper left-hand corner of the worksheet. This hyperlink appears in the same spot in every worksheet and allows a user to quickly return to the starting point of the calculator, where selection of an additional worksheet can be made.

Figure 2-3 also highlights that each worksheet is topped with a header bar that corresponds to the worksheet name and the name in the tab bar. In some cases, the header bar may provide slightly different wording to provide additional detail or information.

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Figure 2-3. Return to Menu Feature of Calculator.

6.4 – Instructions

The calculator contains a basic instruction sheet to provide information to users. Shown in Figure 2-4, the instruction sheet covers information such as the security settings and how to get started, by setting the number of sections and future cases. The instruction sheet also contains a key to the various colors used in the cells of the calculator.

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	A	B	C	D
1	**Return to Menu**			
2				
3			**Instructions**	
4		**Step**		**Instruction**
5		1		This spreadsheet contains worksheets that will calculate performance measure values based on user input.
6		2		The Menu system and the tabs at the bottom of the worksheets will allow for easy navigation. Each worksheet also contains a link back to the menu in the upper left hand corner.
7		3		The menu and worksheet tabs are color coded assist in navigating through the sheets. The color of the tab matches the color shown on the menu under the type column.
8				Any tabs colored light orange are sheets that require data to be entered by the user.
9				Any tabs colored light green contain data calculated by the spreadsheet based on user input.
10				Any tabs colored light purple contain summarized output data.
11				Any tabs colored light yellow contain calculated crash data based on user input.
12				Any tabs colored gray contain default data. This data can be changed if desired, but no input is required by the user on these sheets.
13		4		To use this spreadsheet your security setting must be set to allow a macro to run. To check this select Tools->Macro->Security and ensure that either Low or Medium is selected. It is recommended that you use Medium. If you have Very High or High selected you must reopen the spreadsheet to allow the changes to take effect.
14		5		To begin using this spreadsheet select the "Links and Future Cases Input" tab. There you will be asked to select a number of links. Once this is selected press the "Create Forms" button. This will create all the necessary forms for entering the required data
15		6		Once the forms have been created you may start entering the data for each link. The forms are color coded to allow for easy entering of data. The color codes are as follows:
16				Any cells colored light orange require input from the user for base calculations.
17				Any cells colored blue require input from the user future calculations
18				Any cells colored yellow are optional user inputs. If the user does not enter a value then a default value will be used for all calculations.
19				Any cells colored gray are default values. They can be changed if desired.
20				Any cells colored light green are calculated by the spreadsheet. No user input is required in these cells.
21		7		Any cells that require user input will turn red if incorrect values are entered.
22		8		Once all data has been entered the spreadsheet will calculate all necessary values. The menu system can then be used to navigate through the spreadsheets and view the data.

Figure 2-4. Instruction Sheet from Calculator.

Section 7

Macro Support

In Excel, a macro is a set of pre-programmed steps or menu options that can be stored and called repeatedly. The use of macros enhances the usability of the calculator and removes quite a bit of repetitive work from the end-user.

The calculator makes use of a small number of macros to provide a dynamic capability to "size" the spreadsheet to the number of sections and future cases. While the maximum is 10, and 3, respectively, it would be cumbersome to the user to always see the maximum amount of data requirements if they are not going to be used. Within the calculator, macros are used to hide sections and worksheets that are not in use. The formulas adjust automatically, as needed, to accommodate empty and/or hidden data cells.

Because macros are employed within the calculator, macro support must be enabled for it to work properly.

In Excel 2003, the decision of whether or not macros are allowed to run is based on the options a user configures. From the main menu of Excel, a user can choose Tools, and then Options to obtain a dialogue box similar to Figure 2-5. Note that this dialogue box may appear slightly different, depending on what patches or security fixes have been applied to the Excel program.
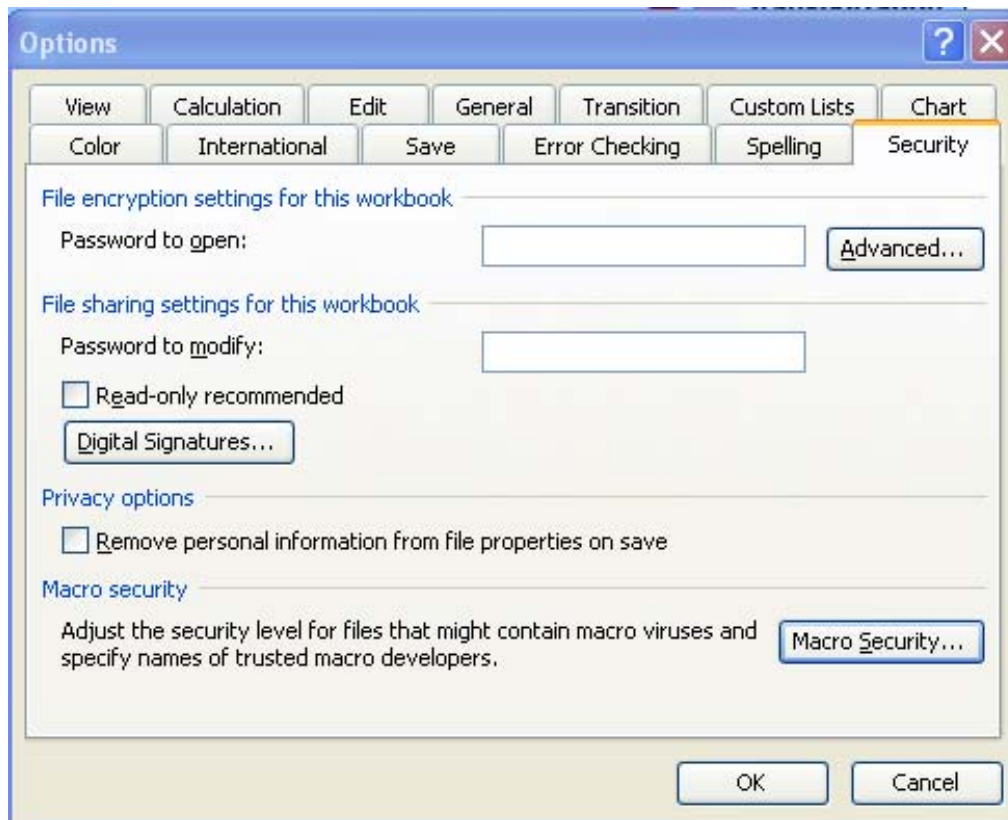
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Figure 2-5. Excel 2003 Options Dialogue Box.

Clicking on the Macro Security tab at the bottom of the dialogue box will open a second dialogue box similar to Figure 2-6. For this calculator, the security level should be set to Medium. If it is not, click on the radio button in front of medium and click "OK" at the bottom of the box.
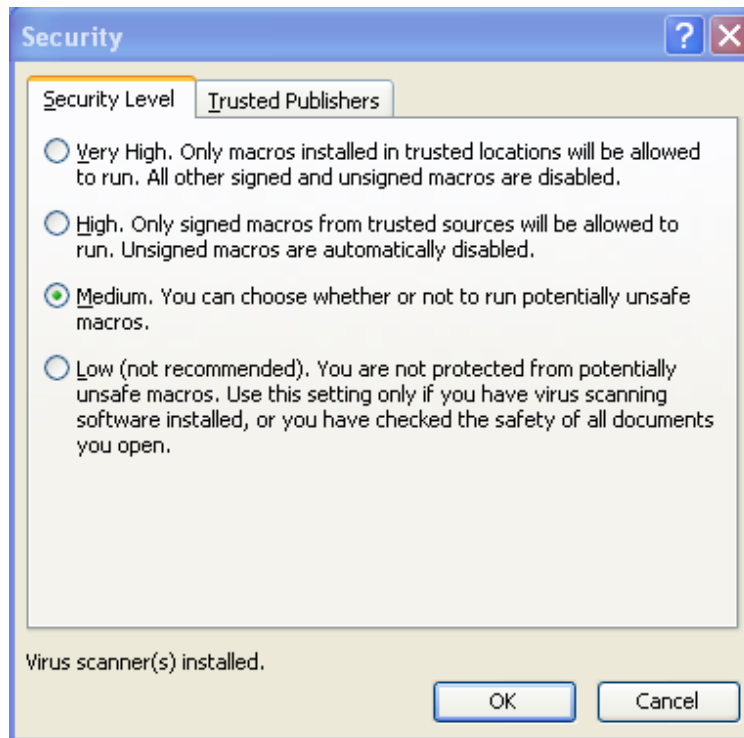
Figure 2-6. Excel 2003 Macro Security Levels.

After verifying or selecting a medium macro security level, when a user opens the calculator, they should see an alert box similar to Figure 2-7.
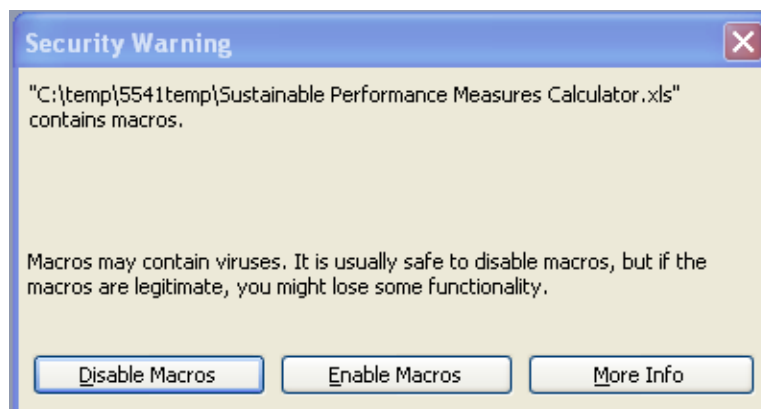

Figure 2-7. Excel 2003 Macro Alert Dialogue Box.

The user should click the "Enable Macros" button and the calculator will start. The process of starting the calculator will be covered in the next chapter.

Chapter 3

Using the Sustainable Transportation Performance Measures Calculator

Contents:

Section 1

Starting the Calculator

Starting the sustainable performance measures calculator is straightforward. The calculator does not come with an install procedure or program as it is only a single Excel spreadsheet file. The filename is

"Sustainable Transportation Performance Measures Calculator.xls"

and will have the standard Microsoft Excel icon.

Because there is no install procedure, the file can be copied anywhere on the user's hard disk drive and placed in a directory. Figure 3-1 and Figure 3-2 illustrate two potential views of how the calculator file would look on the drive. In both cases, double clicking on the filename or icon with the left mouse button will start the file in Excel.

Be aware that if the calculator is distributed on a CD-ROM, the recommended practice is to copy it to the local hard drive and run it from there. While it can be run from the CD, the results cannot be saved back to the CD-ROM. To avoid any problems with potentially losing data, copy the file to the local hard drive so that data inputs can be saved.
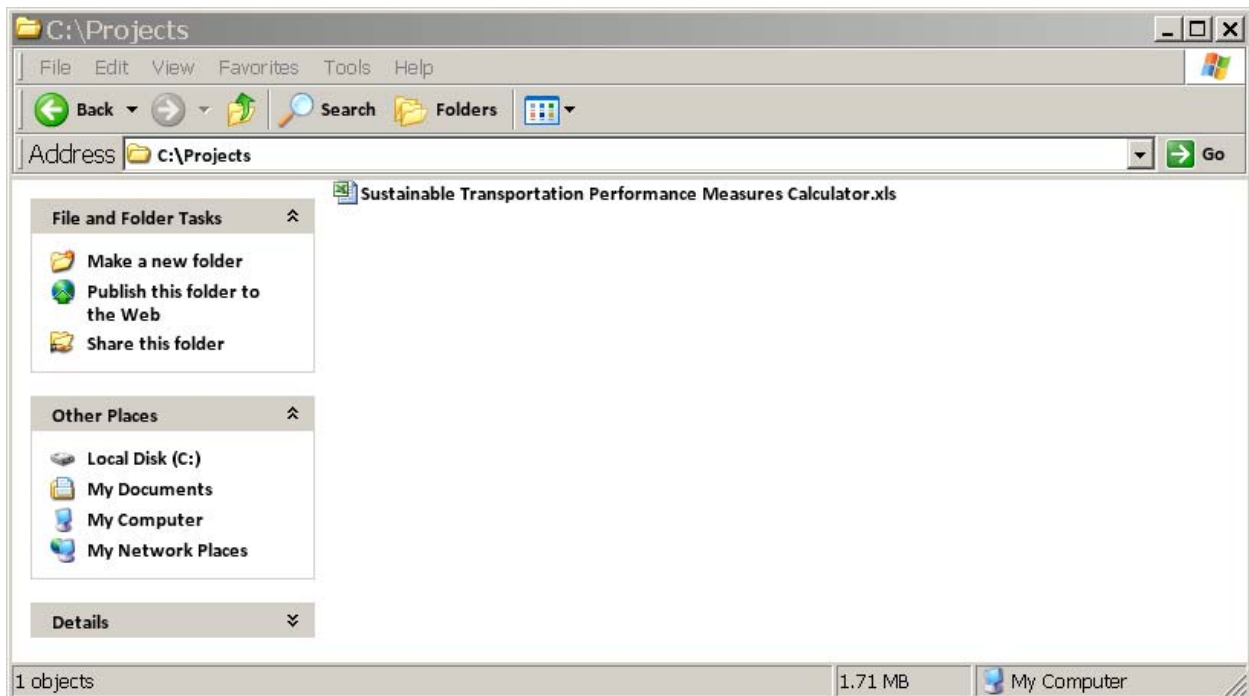

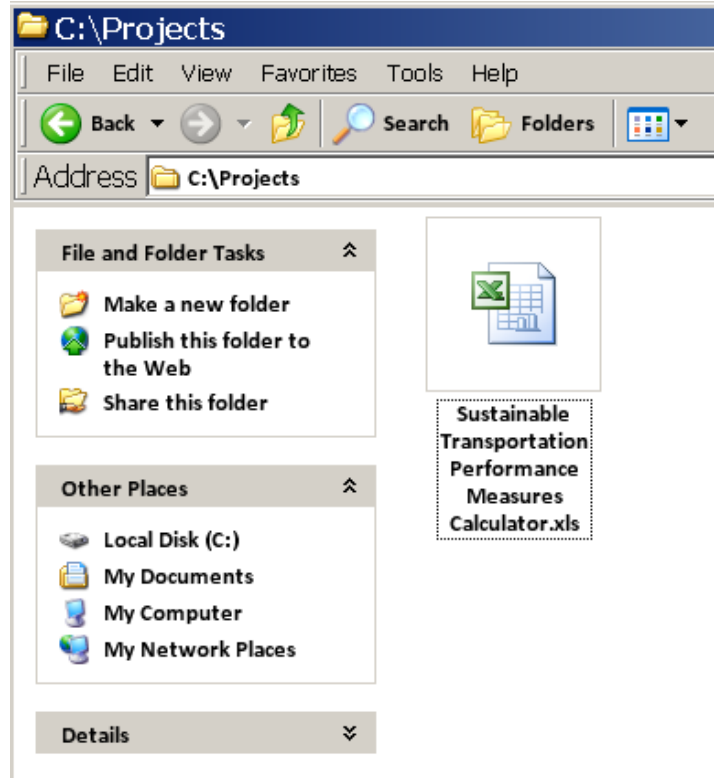**Figure 3-1. Example Directory Listing for Calculator (details view).**

Figure 3-2. Example Directory Listing for Calculator (icon view).

The calculator can also be started by starting Excel, selecting File, then Open from the menus and navigating the hard drive (or CD-ROM) until the file is found and then selecting "Open" from the dialogue box. This is shown in Figure 3-3.
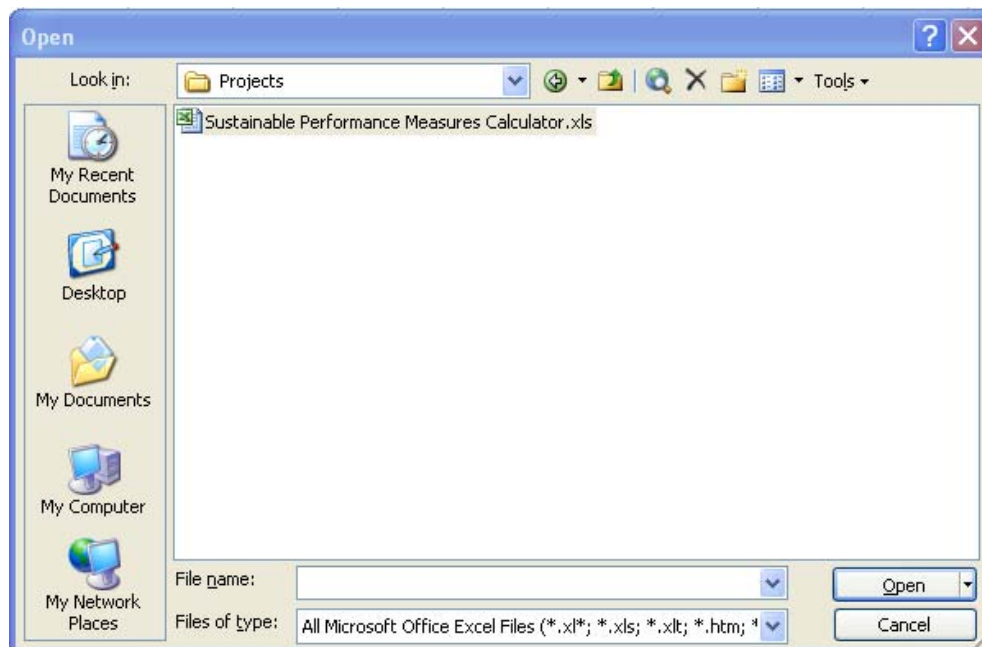

Figure 3-3. File, Open Dialogue Box from Excel.

Section 2

Setting the Number of Links and Future Cases

Once the calculator is open, the user will be presented with the base menu, as shown in Figure 3-4. The first step in using the calculator is to determine the number of links that the analysis corridor will be broken into. The second step is determining the number of future cases that the analysis will use. Both of these inputs take place on the 'Links and Future Case Input' worksheet, which can be accessed from either the menu or the tab bar.

Figure 3-4. Initial View after Opening Calculator.

Once in the 'Links and Future Cases Input' worksheet, the user will be presented with a screen similar to Figure 3-6. Notice that the default value for the number of links in the corridor is set to the maximum, 10, as is the number of future cases, which is set to 3.
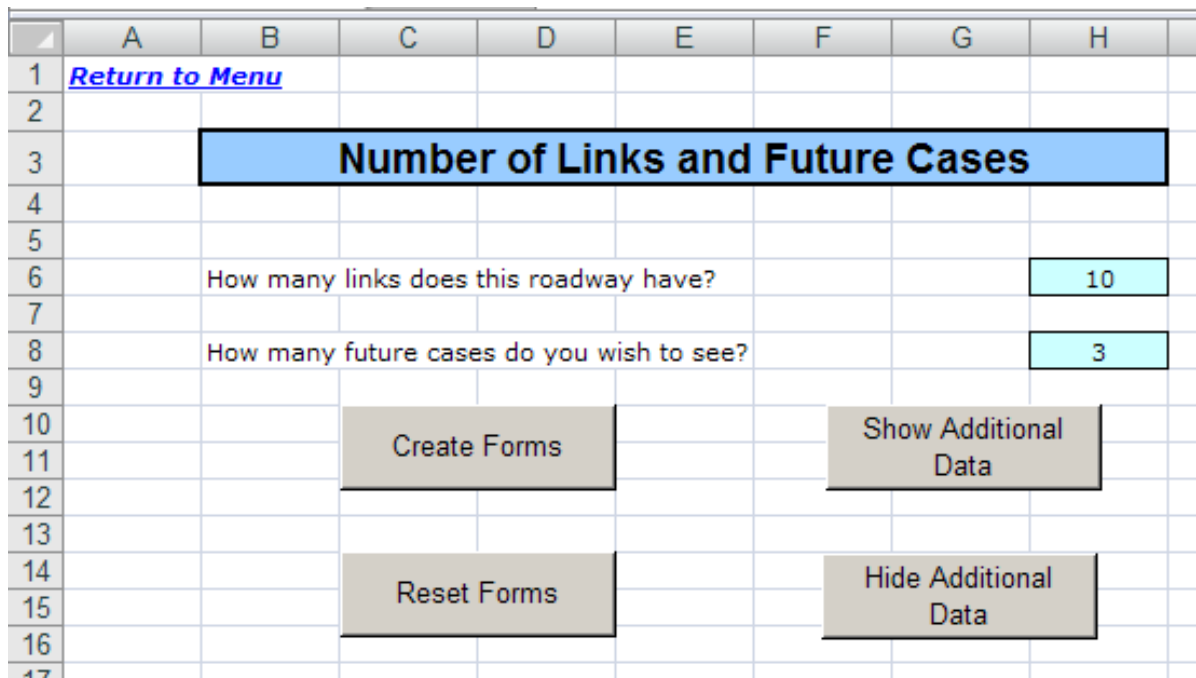
Figure 3-5. Initial View of "Links and Future Cases Input" Worksheet.

The first task is selecting the number of links if the user desires anything less than the maximum value of 10. To choose a different value, click anywhere in the cell containing the value "10," which will bring up the drop-down arrow at the right edge of the cell. Clicking on the drop-down arrow will bring up the list of the possible number of links. This is shown in Figure 3-6.
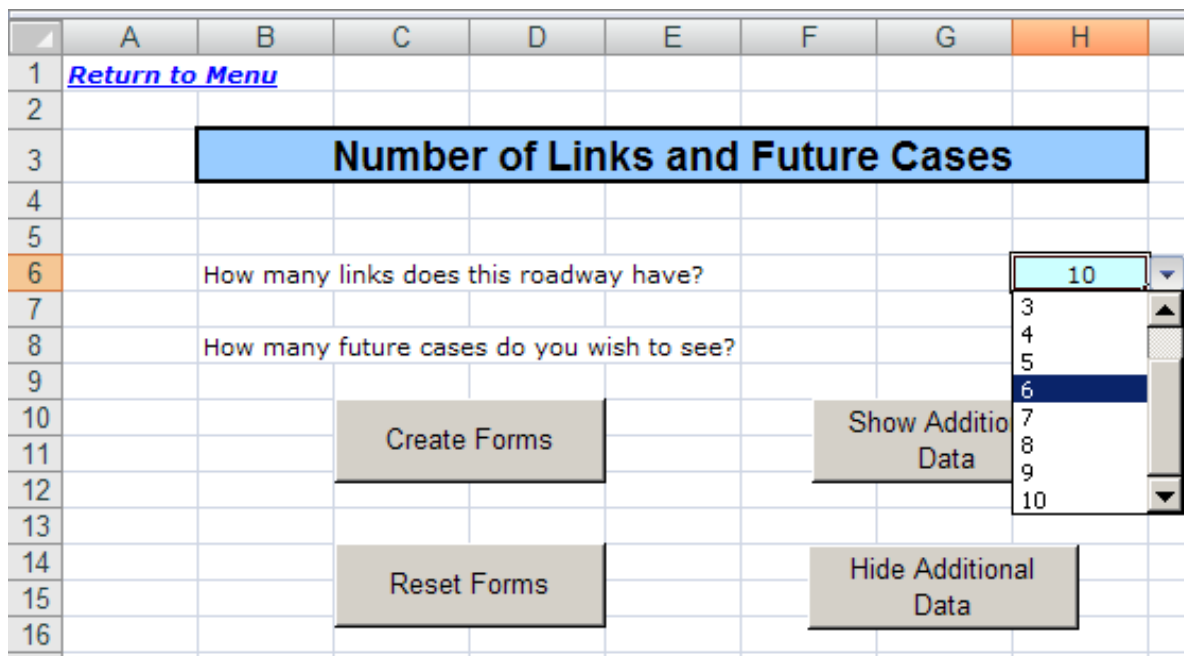

Figure 3-6. Selecting the Number of Links.

In a similar manner, the number of future cases can be selected by clicking in the box containing the value of 3. To choose a different value, click anywhere in the cell containing the value 3. Use the drop-down arrow to select the desired number of future cases. This is shown in Figure 3-7.
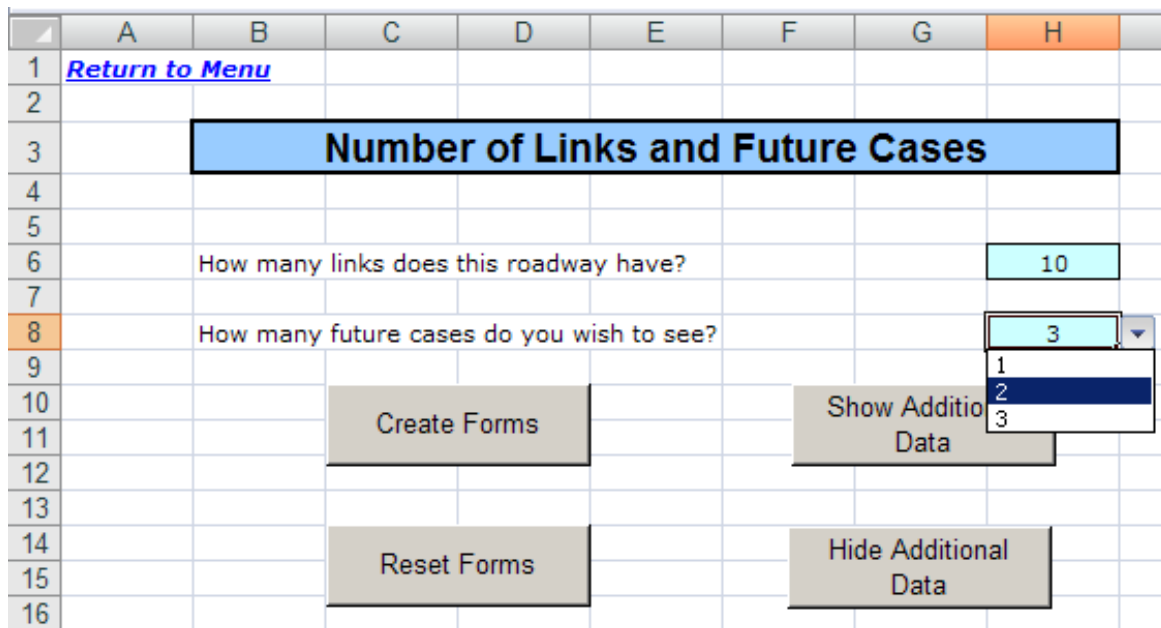

Figure 3-7. Selecting the Number of Future Cases.

Once the selection of the number of links and the number of future cases is complete, the user must create the forms. This is done via a macro, which is executed by clicking on the "Create Forms" button, as shown in Figure 3-8. The figure shows that in this case, the user selected three links and two future cases.

In reality, all of the forms are already created inside the spreadsheet, they are merely hidden. The macro first displays the required worksheets, and then unhides the number of links selected by the user. In this manner, the user never sees more links or worksheets than they need to complete the desired analysis.
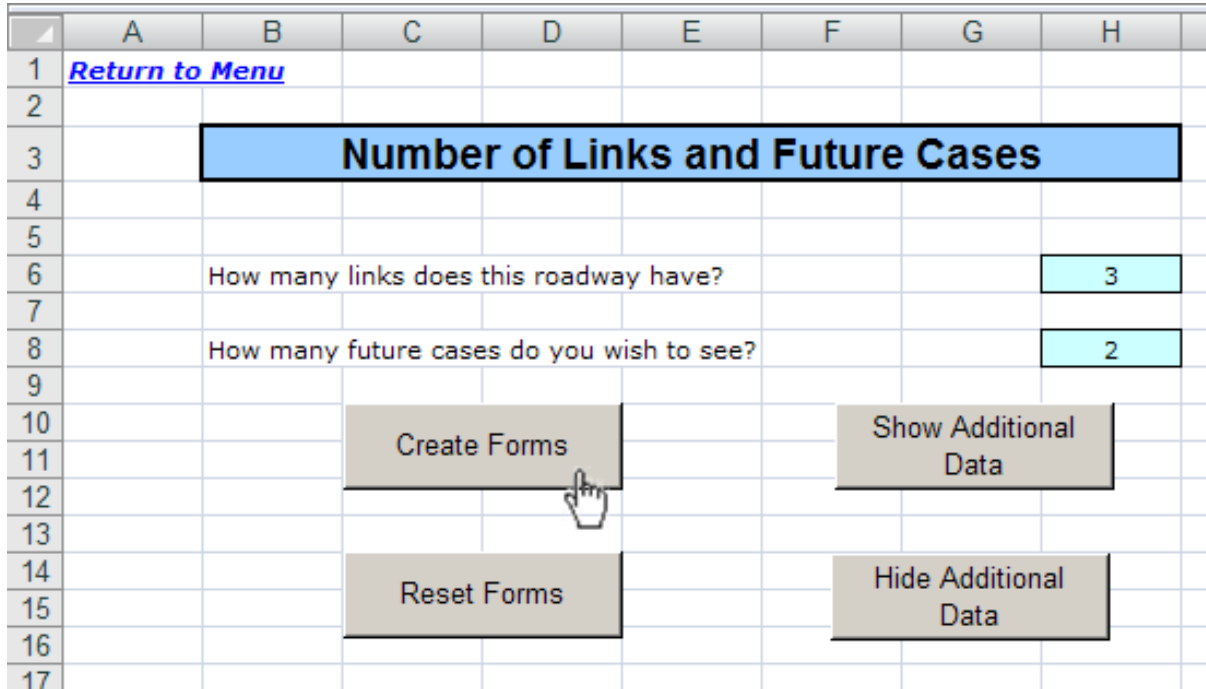
Figure 3-8. Creating Forms after Selection of Parameters.

Once the button is clicked, the macro will execute. When the macro has completed running, the user will be returned to the menu. Users will note that the menu will now have several additional worksheets available, since the selections pertinent to the desired analysis have been made. As before, each menu choice is hyperlinked and clicking on it will take the user to that worksheet. An example is shown in Figure 3-9.

	Worksheet	Description	Type
19	Menu	This Spreadsheet's Menu System	Menu
20	Instructions	Instructions for Using This Spreadsheet	Instructions
21	Links and Future Cases Input	Input form for number of links	Data Entry
22	PM Weights Input	Performance Measures Weights entry form	Data Entry
23	Emissions Rates	Emission rates used in calculations	Data Entry
24	Input Form - Base Case	Data entry for base case	Data Entry
25	Input Form - Future Case 1	Data entry for future case #1	Data Entry
26	Input Form - Future Case 2	Data entry for future case #2	Data Entry
31	Measure Calculations - Base	Calculations for base case	Calculated Data
32	Measure Calculations - Future 1	Calculations for future case #1	Calculated Data
33	Measure Calculations - Future 2	Calculations for future case #2	Calculated Data
35	Output Data - Base	Base case ouptut data	Calculated Data
36	Output Data - Future 1	Future case #1 output data	Calculated Data
37	Output Data - Future 2	Future case #2 output data	Calculated Data
39	Executive Summary - Measures	Summary of Performance Measures	Summarized Output Data
40	Executive Summary - Goals	Summary of Goals	Summarized Output Data
41	Executive Summary - Links	Summary of Links	Summarized Output Data
42	Executive Summary - Graphs	Output Graphs	Summarized Output Data

Figure 3-9. Additional Menu Items after Macro Execution.

Section 3

Resetting the Forms

As shown in Figure 3-10, the worksheet for determining the number of links and future cases also has a button labeled "Reset Forms." If a user clicks this button to execute the macro, the spreadsheet will revert to its default state and hide all of the worksheets, with one major exception.

That exception is that the data will *NOT* be deleted. There is no delete function built into the reset forms macro.
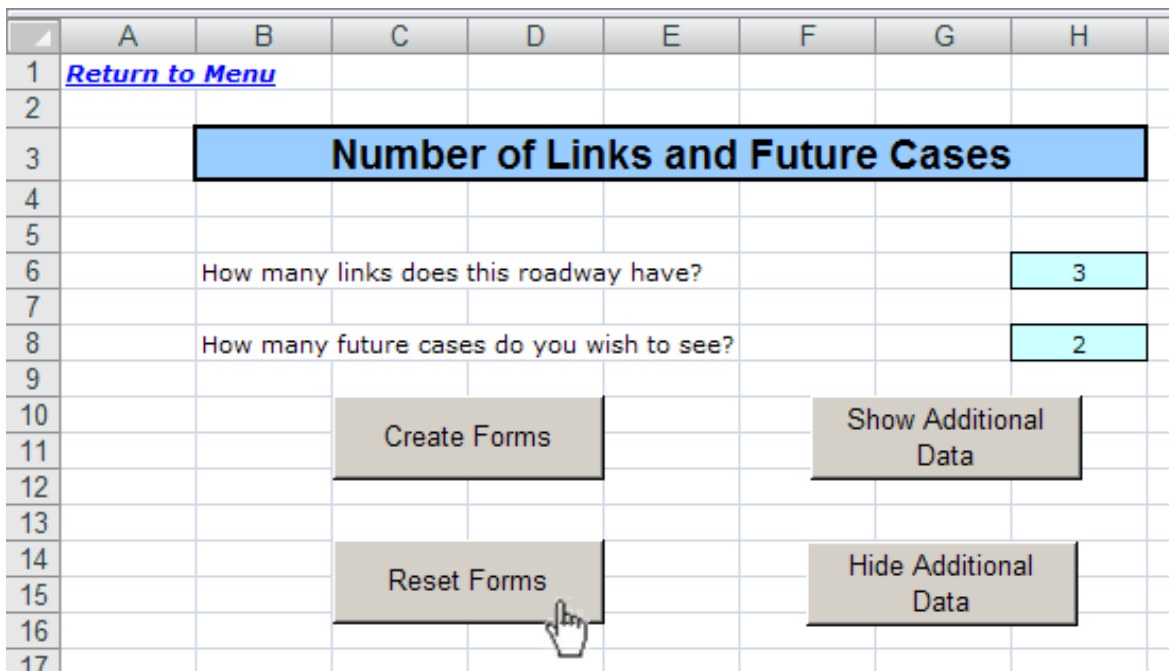

Figure 3-10. Resetting the Forms in the Calculator.

There is one situation where this choice could cause some confusion. Suppose that a user created an analysis using 5 links and 2 future cases. Later, presuming to simplify the analysis, the user decided to reset the forms and this time only use 3 links. While the forms will reset appropriately, the data for links 4 and 5 will still be present in the worksheets and they will affect the answers and the analysis!

It is therefore best, when wanting to redo the analysis, to start over from a clean copy of the calculator and choose more appropriate parameters for number of links and future cases.

Section 4

Show/Hide Additional Data

Figure 3-11 shows the cursor over a button that states "Show Additional Data." This is an option that can be selected if the user wishes to see every bit of information contained within the calculator. Some information, such as crash data and emission standards, are not shown in general use because they are largely default values that do not require user input. The user is, however, free at any time to toggle these worksheets visible to see the information contained within. The other button shown in Figure 3-11 says "Hide Additional Data" and is simply a toggle off for those worksheets.
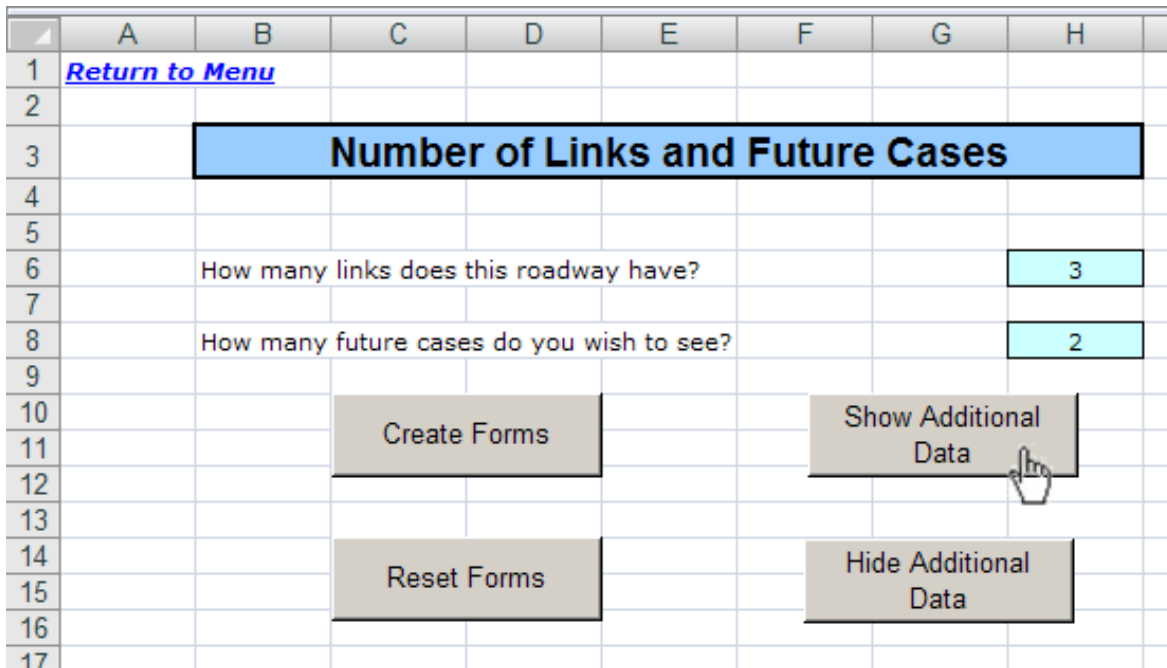

Figure 3-11. Showing Additional Data in the Calculator.

Section 5

Performance Measure Weighting

After the selection of the number of links and future cases, the critical step is to examine the goal areas and performance measures associated with the analysis and more specifically, their weighting. The methodology behind the calculator arrives at a final scaled value for a future case by using a weighting factor for each goal area and for each set of performance measures within a goal area.

5.1 – Goal Area Weighting

Figure 3-12 shows a view of the performance measurement weighting worksheet. There are several items to note in the figure.

Figure 3-12. Performance Measure Weighting Worksheet.

The first is the drop-down box next to the question that asks if this is a rural or urban setting. The default is "Rural." The choice changes the weights listed in the 5th column from the left in the figure. This column is also shaded light blue, indicating that it can be changed from the default.

If the selection is changed to "Urban," the weights change, as shown in Figure 3-13.

In both cases, the user has the ability to change the weightings from the default by entering numbers in the 5th column. The worksheet forces the weighting to add up to 100 percent. If, for example, a user changes the weighting for goal area 1 'Reduce Congestion' in Figure 3-12 to 20 percent from 10 percent, the worksheet identifies the error of the weights adding up to more than 100 percent by turning the entire column red and putting a note at the bottom of the worksheet alerting the user to the error. This alert is shown in Figure 3-14.

Performance Measures Weights Entry Form

Is Area Rural or Urban? **Urban**

Assigned Goal Weights and Measure Weights (may be overwritten)

Goal No.	Sustainability Dimension	TxDOT Goal	Recomended Values	Your Weights	Objectives	Measure No.	Performance Indicator	Recomended Values	Measure Weight
1	Social	Reduce congestion	25.00%	25.00%	Improve mobility on highways	1a	Travel time index	60.00%	60.00%
					Improve reliability of highway travel	1b	Buffer index	40.00%	40.00%
2		Enhance safety	30.00%	30.00%	Reduce crash rates and crash risk	2a	Annual severe crashes per mile	80.00%	80.00%
					Improve traffic incident detection and response	2b	Percentage lane miles under traffic monitoring/surveillance	20.00%	20.00%
3	Economic	Expand economic opportunity	10.00%	10.00%	Optimize land use mix for development potential	3a	Land use balance	50.00%	50.00%
					Improve road-based freight movement	3b	Truck throughput efficiency	50.00%	50.00%
4		Preserve the value of transportation assets	10.00%	10.00%	Maintain existing highway system quality	4a	Average pavement condition score	20.00%	20.00%
					Reduce cost and impact of highway capacity expansion	4b	Capacity addition within available right of way	20.00%	20.00%
					Leverage non-traditional funding sources for highways	4c	Cost recovery from alternative sources	40.00%	40.00%
					Increase use of alternatives to single-occupant automobile travel	4d	Proportion of non single-occupant travel	20.00%	20.00%
5	Environmental	Improve air quality	25.00%	25.00%	Reduce adverse human health impacts and comply with ambient air quality standards	5a	Air Quality Index	85.00%	85.00%
					Reduce greenhouse gas emissions	5b	Daily CO_2 emissions per mile of roadway	15.00%	15.00%

Figure 3-13. Weights for Urban Selection in Performance Measurement Worksheet.

Performance Measures Weights Entry Form

Is Area Rural or Urban? **Rural**

Assigned Goal Weights and Measure Weights (may be overwritten)

Goal No.	Sustainability Dimension	TxDOT Goal	Recomended Values	Your Weights	Objectives	Measure No.	Performance Indicator	Recomended Values	Measure Weight
1	Social	Reduce congestion	10.00%	20.00%	Improve mobility on highways	1a	Travel time index	30.00%	30.00%
					Improve reliability of highway travel	1b	Buffer index	70.00%	70.00%
2		Enhance safety	40.00%	40.00%	Reduce crash rates and crash risk	2a	Annual severe crashes per mile	90.00%	90.00%
					Improve traffic incident detection and response	2b	Percentage lane miles under traffic monitoring/surveillance	10.00%	10.00%
3		Expand economic opportunity	10.00%	10.00%	Optimize land use mix for development potential	3a	Land use balance	10.00%	10.00%
					Improve road-based freight movement	3b	Truck throughput efficiency	90.00%	90.00%
4	Economic	Preserve the value of transportation assets	30.00%	30.00%	Maintain existing highway system quality	4a	Average pavement condition score	20.00%	20.00%
					Reduce cost and impact of highway capacity expansion	4b	Capacity addition within available right of way	20.00%	20.00%
					Leverage non-traditional funding sources for highways	4c	Cost recovery from alternative sources	50.00%	50.00%
					Increase use of alternatives to single-occupant automobile travel	4d	Proportion of non single-occupant travel	10.00%	10.00%
5	Environmental	Improve air quality	10.00%	10.00%	Reduce adverse human health impacts and comply with ambient air quality standards	5a	Air Quality Index	85.00%	85.00%
					Reduce greenhouse gas emissions	5b	Daily CO_2 emissions per mile of roadway	15.00%	15.00%

** Goal weights must equal 100%

Figure 3-14. Error Condition for Goal Area Weighting.

5.2 – Measure Weighting

In much the same way as the goal areas add up to 100 percent and utilizing weighting, each set of measures within an individual goal area must also add up to 100 percent. Likewise, the user may change the defaults in the last shaded column on the right in the worksheet. If the measure weights do not add up to 100 percent, the worksheet will alert the user to the error condition and color the measure set for that particular goal area red. This is shown in Figure 3-15.

C	D	E	F	G	H	I	J	K	L	M

Performance Measures Weights Entry Form

Is Area Rural or Urban? [Urban]

* Assigned Goal Weights and Measure Weights (may be overwritten)

Goal No.	Sustainability Dimension	TxDOT Goal	Recomended Values	Your Weights	Objectives	Measure No.	Performance Indicator	Recomended Values	Measure Weight
1	Social	Reduce congestion	25.00%	25.00%	Improve mobility on highways	1a	Travel time index	60.00%	60.00%
					Improve reliability of highway travel	1b	Buffer index	40.00%	40.00%
2		Enhance safety	30.00%	30.00%	Reduce crash rates and crash risk	2a	Annual severe crashes per mile	80.00%	80.00%
					Improve traffic incident detection and response	2b	Percentage lane miles under traffic monitoring/surveillance	20.00%	25.00%
3	Economic	Expand economic opportunity	10.00%	10.00%	Optimize land use mix for development potential	3a	Land use balance	50.00%	50.00%
					Improve road-based freight movement	3b	Truck throughput efficiency	50.00%	50.00%
4		Preserve the value of transportation assets	10.00%	10.00%	Maintain existing highway system quality	4a	Average pavement condition score	20.00%	20.00%
					Reduce cost and impact of highway capacity expansion	4b	Capacity addition within available right of way	20.00%	20.00%
					Leverage non-traditional funding sources for highways	4c	Cost recovery from alternative sources	40.00%	40.00%
					Increase use of alternatives to single-occupant automobile travel	4d	Proportion of non single-occupant travel	20.00%	20.00%
5	Environmental	Improve air quality	25.00%	25.00%	Reduce adverse human health impacts and comply with ambient air quality standards	5a	Air Quality Index	85.00%	85.00%
					Reduce greenhouse gas emissions	5b	Daily CO_2 emissions per mile of roadway	15.00%	15.00%

**Measure Weights must equal 100%

Figure 3-15. Error Condition for Measure Weighting.

Users can return to the performance measure weighting worksheet at any time during their analysis and change the measure weighting. The results will be reflected in the executive summary worksheets discussed in Chapter 5 of this manual. Changing the weights will not change any of the data inputs for the measures. Users may want to save the results using the default weight set and then change the weights and save a different result set to compare the sensitivity of the weightings for their particular corridor and future cases.

Section 6

Entering Base and Future Case Data

Once the various weights for the goal area and specific measures are selected, the next step for the user is to start inputting the data. Figure 3-9 showed the additional menu items that appeared when the selection of links and future cases was complete.

As an example, the user can select the worksheet named 'Input Form – Base Case.' Figure 3-16 shows the start of the data entry form for the base case. The user first enters a description for each link, then the other associated data, such as length, number of lanes, ADT, and more. The total set of required inputs was detailed in Chapter 2.

Figure 3-16. Base Case Data Entry Worksheet.

As much as possible, the data entry sheets have been formatted to scroll vertically with most of the data table appearing horizontally on the screen. Occasionally, the user should anticipate needing to perform some horizontal scrolling for wide data entry tables.

When the user switches to the future case data inputs, a number of the initial data elements will already be present, having been linked automatically from the base case input form. Other data elements, both required and optional, were detailed in Chapter 2.

When data entry is complete, the return to menu feature can be used to get back to the spreadsheet menu. At that point in time, the user can examine the output data worksheets or the executive summary worksheets. Output data worksheets are described in the next section, while the executive summary worksheets are described in more detail in Chapter 5.

6.1– Data Copy Function

There are two data copy function buttons located at the bottom of the "Links and Future Cases Input" worksheet, as shown in Figure 3-17. These can be used to copy over data in cases where multiple analysis scenarios have very similar parameters. This makes it easy for users to copy data into the other cases and simply change the few values that differ between the scenarios. The first function can be used to copy data entered into the base case into the future case worksheets. The second one can be used to copy data entered into the first future case into other future cases. Using the data copy function will overwrite any existing data in the future case worksheets that are being copied to.
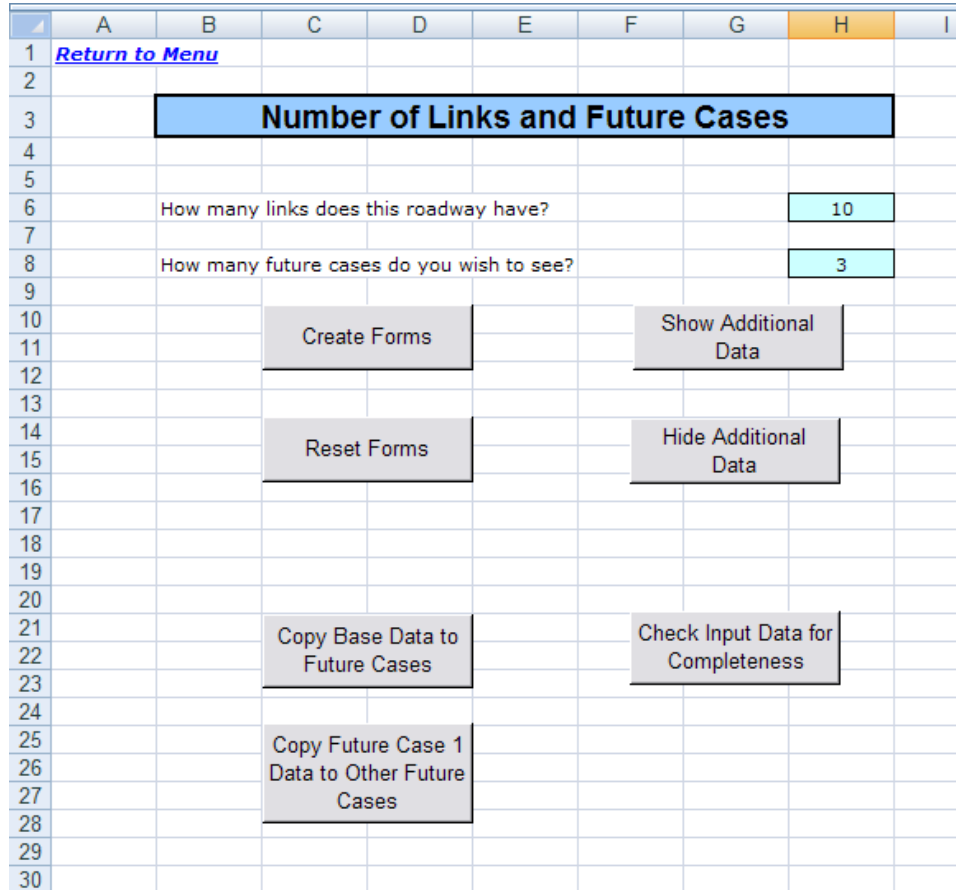
Figure 3-17. Data Copy and Data Check Functions.

6.2– Data Check Function

The data check function, also shown in Figure 3-17, can be used to identify where data fields are missing an input. Clicking on the button titled "Check Input Data for Completeness" will generate a hyperlinked list of cells that require data in them before a complete analysis and results can be generated.

Section 7

Output Data Worksheets

Figure 3-18 shows an example of a portion of the output data worksheet for the base case. No data are currently in this worksheet. There are no data entry requirements on the output worksheets. All of the data will be linked in and calculated automatically from the data entry and calculation worksheets. Likewise, the data presented in the output data worksheets are linked to the executive summaries.

Chapter 4 presents a brief summary of the weighting and scaling used on the performance measures.

Figure 3-18. Base Case Output Data Worksheet.

Chapter 4
Overview of Performance Measures

Contents:

Section 1

Introduction

Chapter 4 provides a brief introduction and overview of the performance measures used in the sustainable transportation performance measures calculator. The intention of this chapter is not to provide significant detail, equations, or reference material. The intent is to provide a quick reference to the measure, the parameters in use, data requirements, and a flow chart for how the measure is calculated.

For more information on the 0-5541 project and the full methodology behind the performance measures used in the calculator, please refer to the full research report located at: http://tti.tamu.edu/documents/0-5541-1.pdf.

Section 2

Scaling and Weighting of Measures

The sections throughout the rest of this chapter describe the calculation of the individual performance measures. However, the process of evaluating the base and future cases is significantly more involved than the calculation of each individual measure. Figure 4-1 illustrates the overall process of scaling and weighting the measures to obtain the final number used for a comparison analysis.

Once the individual measures are calculated, they are scaled to a value between "0" for the worst case and "1" for the best case to achieve a consistent magnitude. This occurs for each individual link and the total section. The performance measures corresponding to each goal are then weighted by the values defined for each individual measure, as detailed in Chapter 3. The outputs of this step are the goal-wise index values that represent a weighted index value for each specific goal area. These indices will also be on a "0" to "1" basis.

The final step is weighting each individual goal area with the goal weights (also detailed in Chapter 3) to achieve a combined index value (again, from "0" to "1"). This value is a single number assessment of the case (base or future) and can be used in direct comparison to other combined index values to determine the relative viability of a particular case.
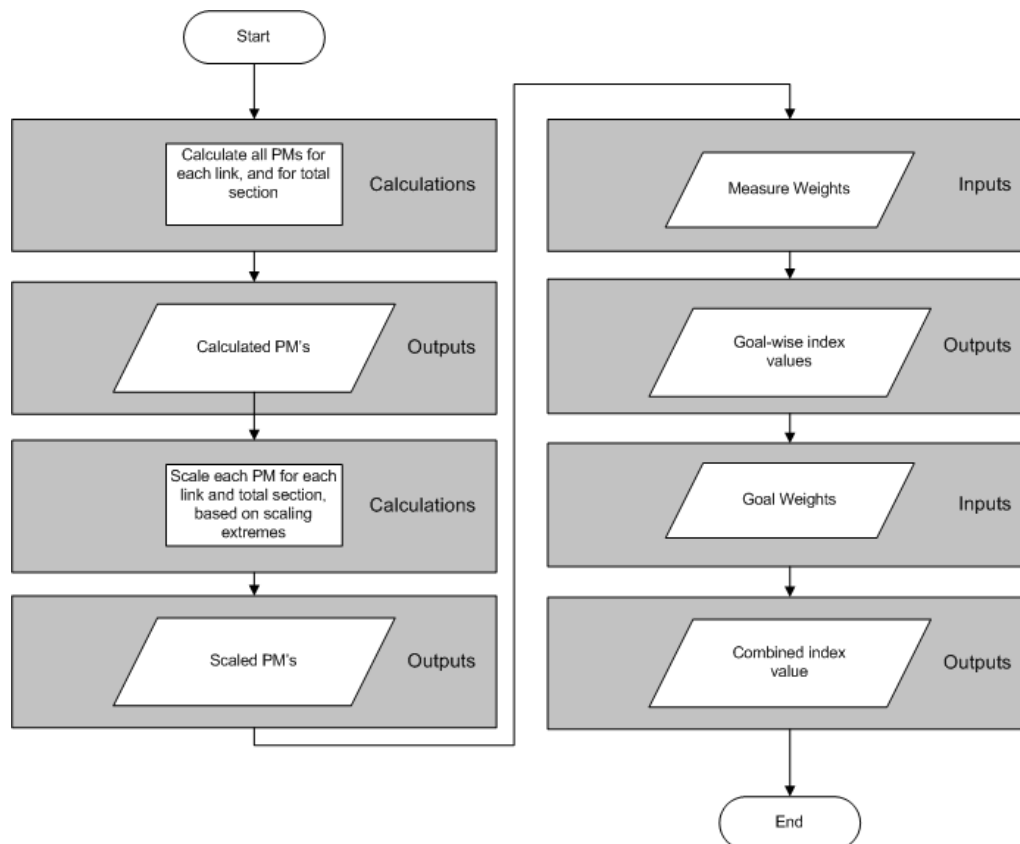
Figure 4-1. Scaling and Weighting Process for Performance Measures.

Section 3

Performance Measure 1a – Travel Time Index

3.1 – Overview

The Travel Time Index is a measure that indicates the extent of delays in travel caused by traffic congestion alone. It is generally quantified as a ratio between the peak period travel times and off-peak travel times for a given roadway section.

3.2 – Measure Parameters

♦ Goal Area – Reduce Congestion

♦ Objective – Improve Mobility on Highways

♦ Default Weights

- Urban: 60%

- Rural: 30%

♦ Requirements for Measure Calculation

- Length (miles)
  – Required as input in Base Inputs worksheet
  – Values are carried over for each future case

- Posted Speed Limit (MPH)
  – Required as input in Base and Future Inputs worksheets
  – Separate value must be entered for each future case

- Number of Lanes
  – Required as input in Base and Future Inputs worksheets
  – Separate value must be entered for each future case

- ADT (veh/day)
  – Required as input in Base and Future Inputs worksheets
  – Separate value must be entered for each future case

♦ Flow Chart

- See Figure 4-2
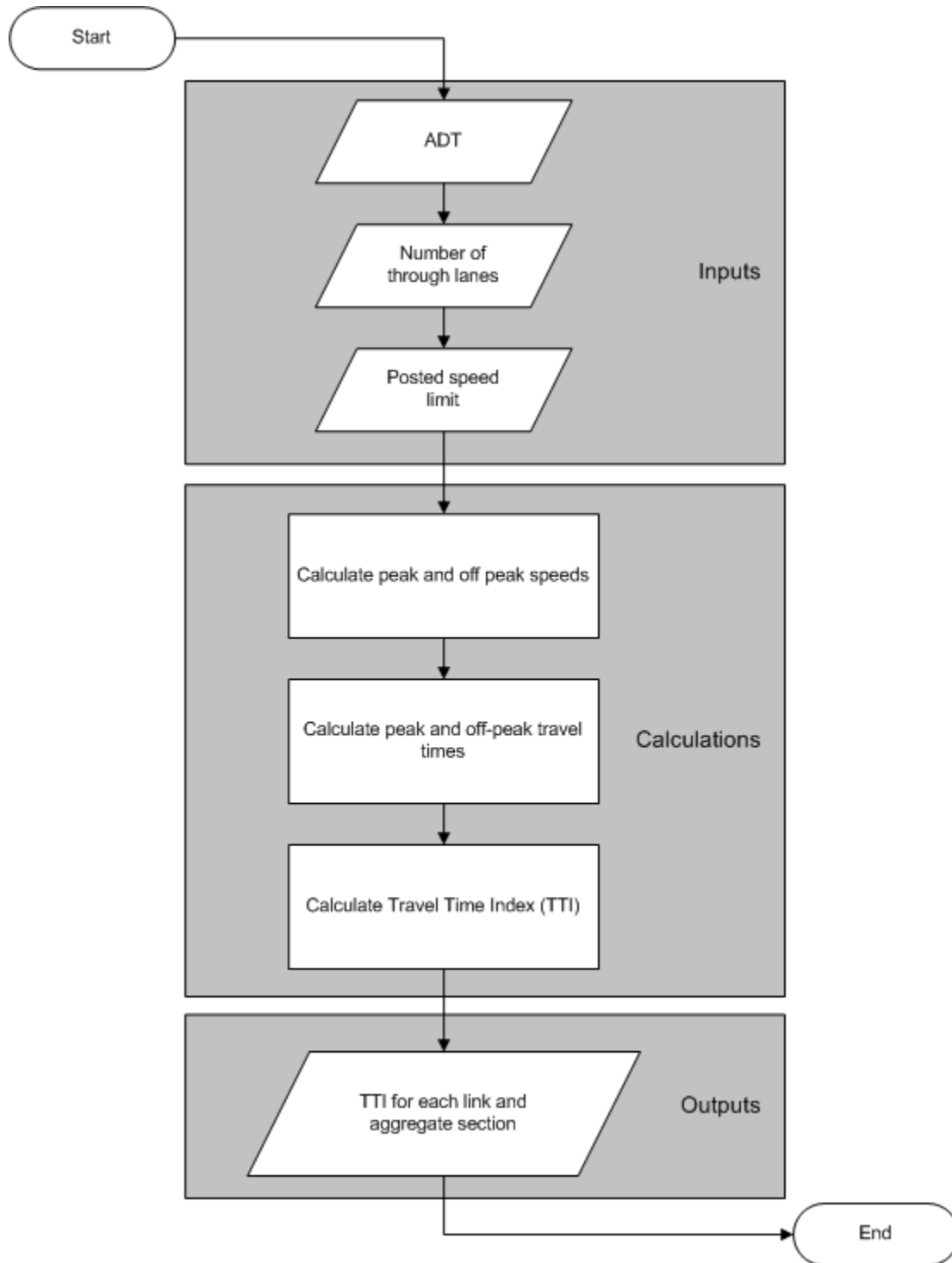
Figure 4-2. Estimation of Travel Time Index.

Section 4

Performance Measure 1b – Buffer Index

4.1 – Overview

The Buffer Index is an indicator of travel time reliability that provides an estimate of the variation of travel times observed over a period of time. It indicates the extent to which the 95th percentile travel time for a roadway exceeds the mean travel time.

4.2 – Measure Parameters

♦ Goal Area – Reduce Congestion

♦ Objective – Improve Reliability of Highway Travel

♦ Default Weights

• Urban: 40%

• Rural: 70%

♦ Requirements for Measure Calculation

• Travel Time Index
 – Calculated in Base and Future Calculations worksheets

♦ Flow Chart

• See Figure 4-3
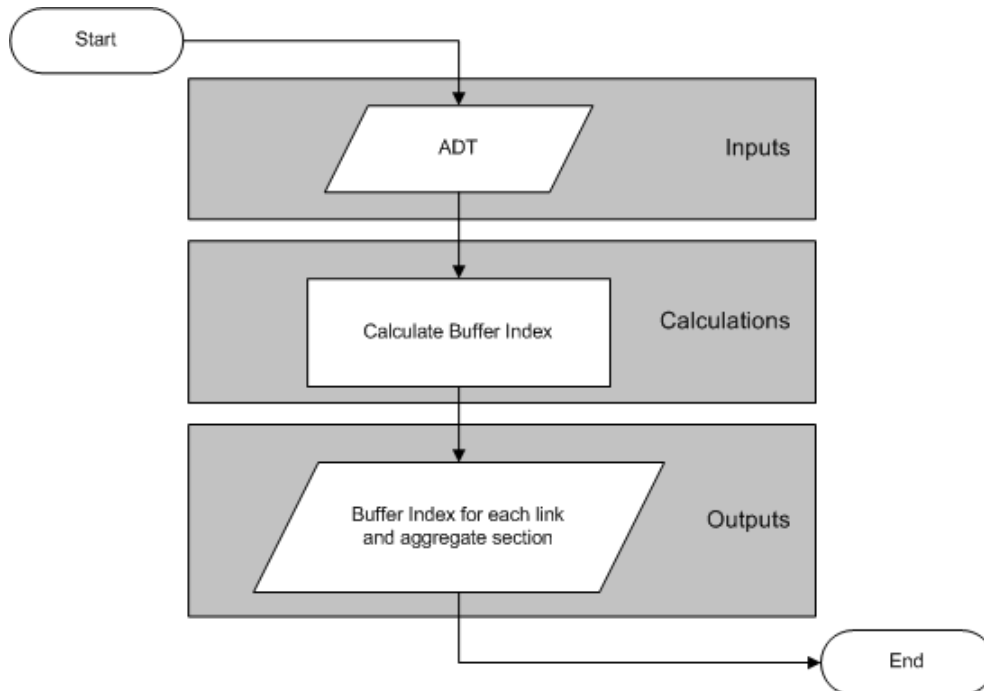
Figure 4-3. Estimation of Buffer Index.

Section 5

Performance Measure 2a – Annual Severe Crashes per Mile

5.1 – Overview

Crashes are most commonly expressed as a crash rate (the number of crashes per million vehicle miles traveled [MVMT]), a statistic that allows for comparison of crashes between different locations, while accounting for the differences in levels of travel in the locations. The use of a crash rate, however, does not account for the increased number of crashes resulting from increased vehicle miles of travel (VMT). This is an important consideration from a sustainability perspective; therefore, the indicator considered here is the severe crash frequency per mile of highway. To evaluate this measure, crash prediction models are used that consider traffic volumes, basic geometrics of the roadway, roadway type, and other design features. The annual frequency (crashes per mile) of severe crashes—defined as fatal crashes or those resulting in injury—is estimated by a prediction model.

5.2 – Measure Parameters

- ◆ Goal Area – Enhance Safety

- ◆ Objective – Reduce Crash Rates and Crash Risk

- ◆ Default Weights
  - Urban: 80%
  - Rural: 90%

- ◆ Requirements for Measure Calculation
  - Road Type
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case
    - The values entered here will affect what optional measurements are used in the calculations
  - Number of Lanes
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case

- ◆ Optional Inputs for Measure Calculation
  - Grade (%)
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case
  - Lane Width (ft)
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case

- Shoulder Width (ft)
    - Required as input in Base and Future Inputs worksheets
   - Separate value must be entered for each future case

- Median Type (ft)
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case

- Median Width (ft)
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case

- Driveway Density (driveways/mile)
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case

- Area Classification
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case

- Land Use
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case

- Truck Percentage
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case

♦ Flow Charts

- See Figure 4-4 through Figure 4-7
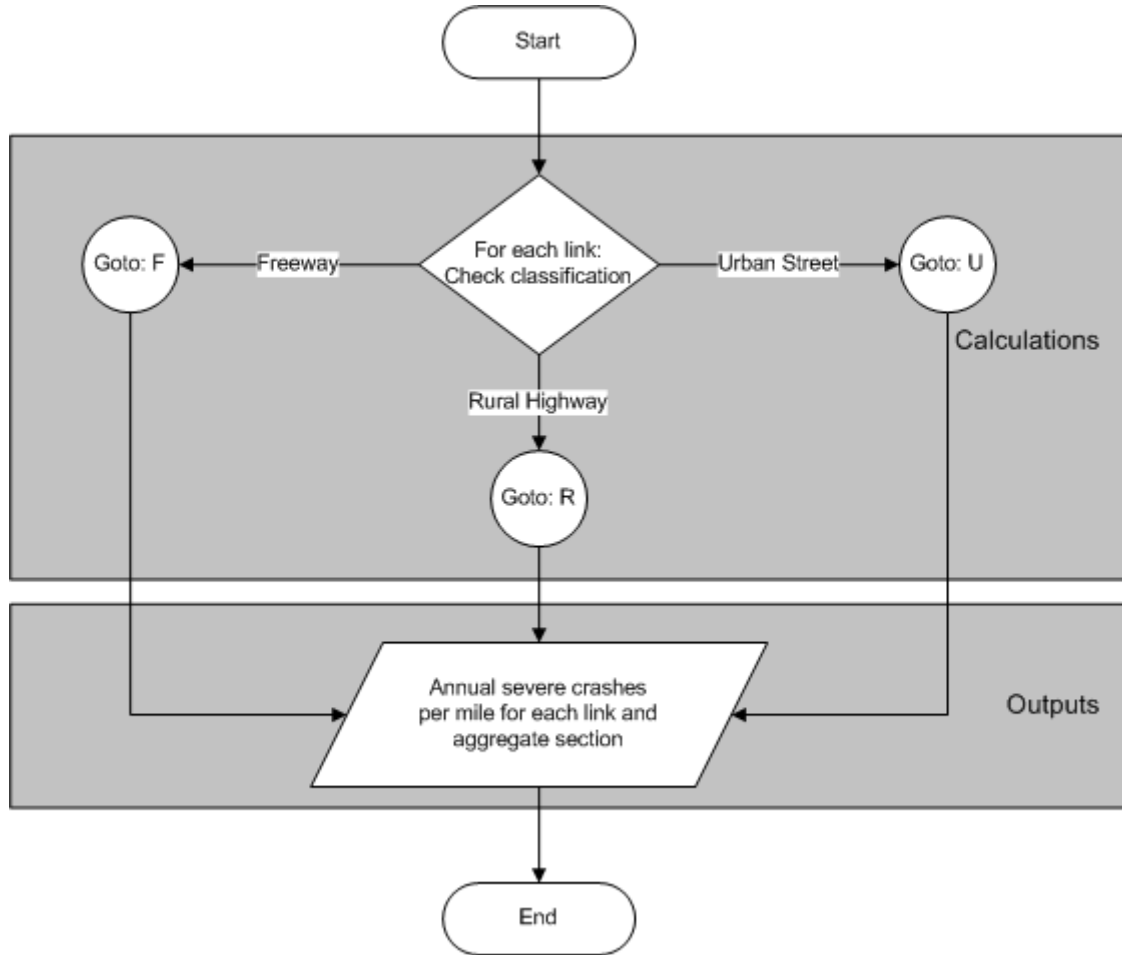
Figure 4-4. Estimation of Annual Severe Crashes per Mile.
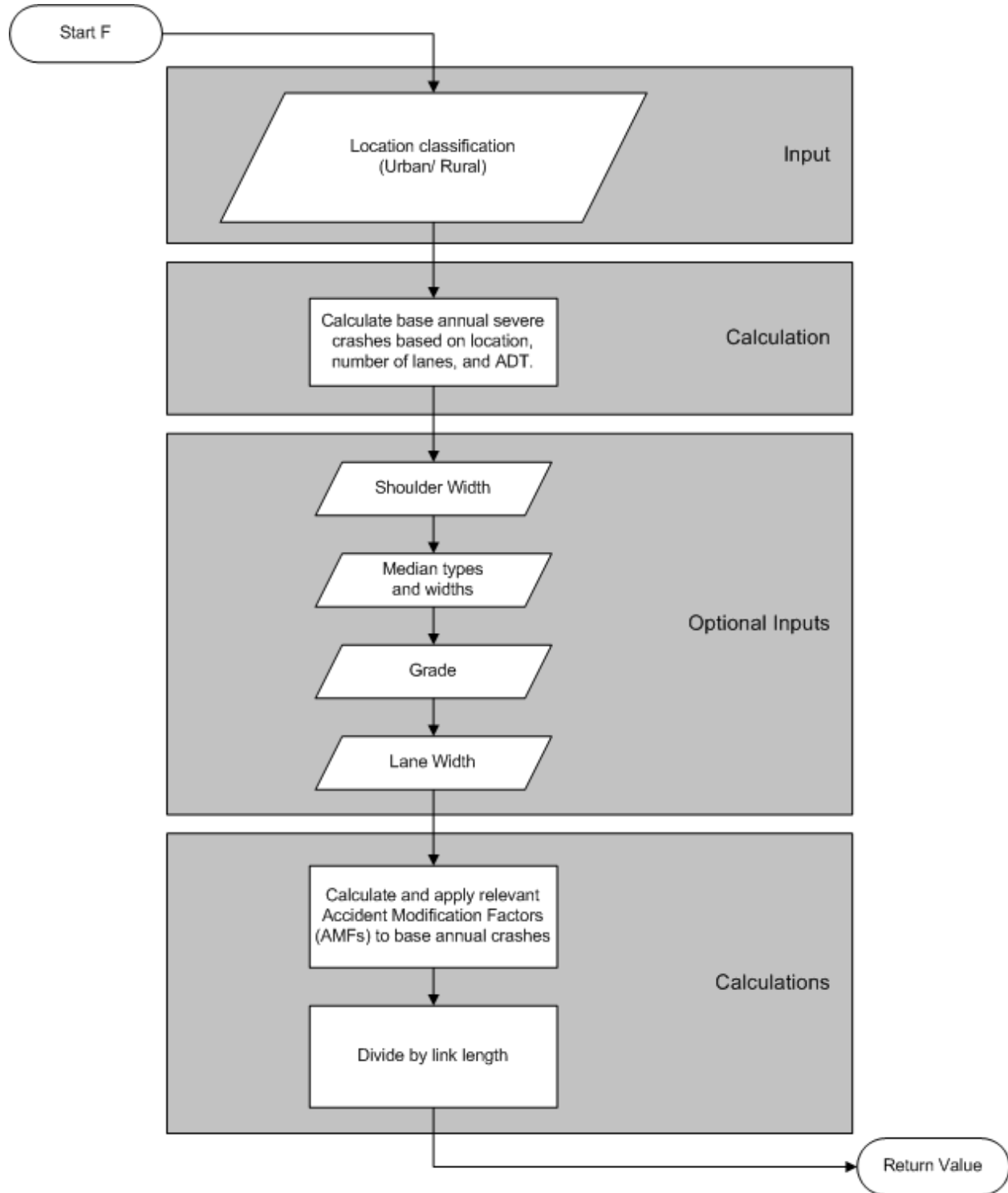
Figure 4-5. Estimation of Annual Freeway Severe Crashes per Mile.
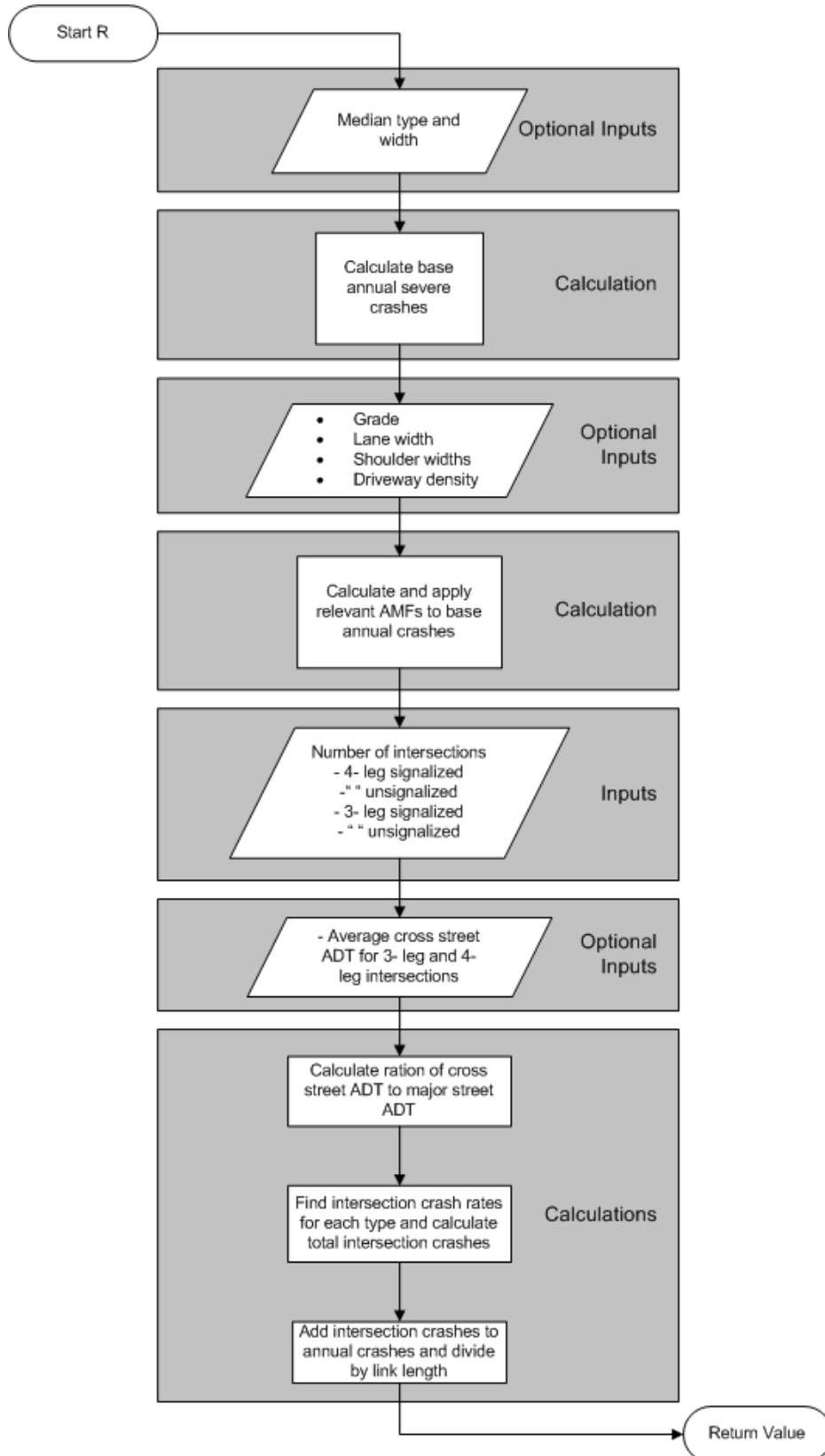
Figure 4-6. Estimation of Annual Rural Severe Crashes per Mile.
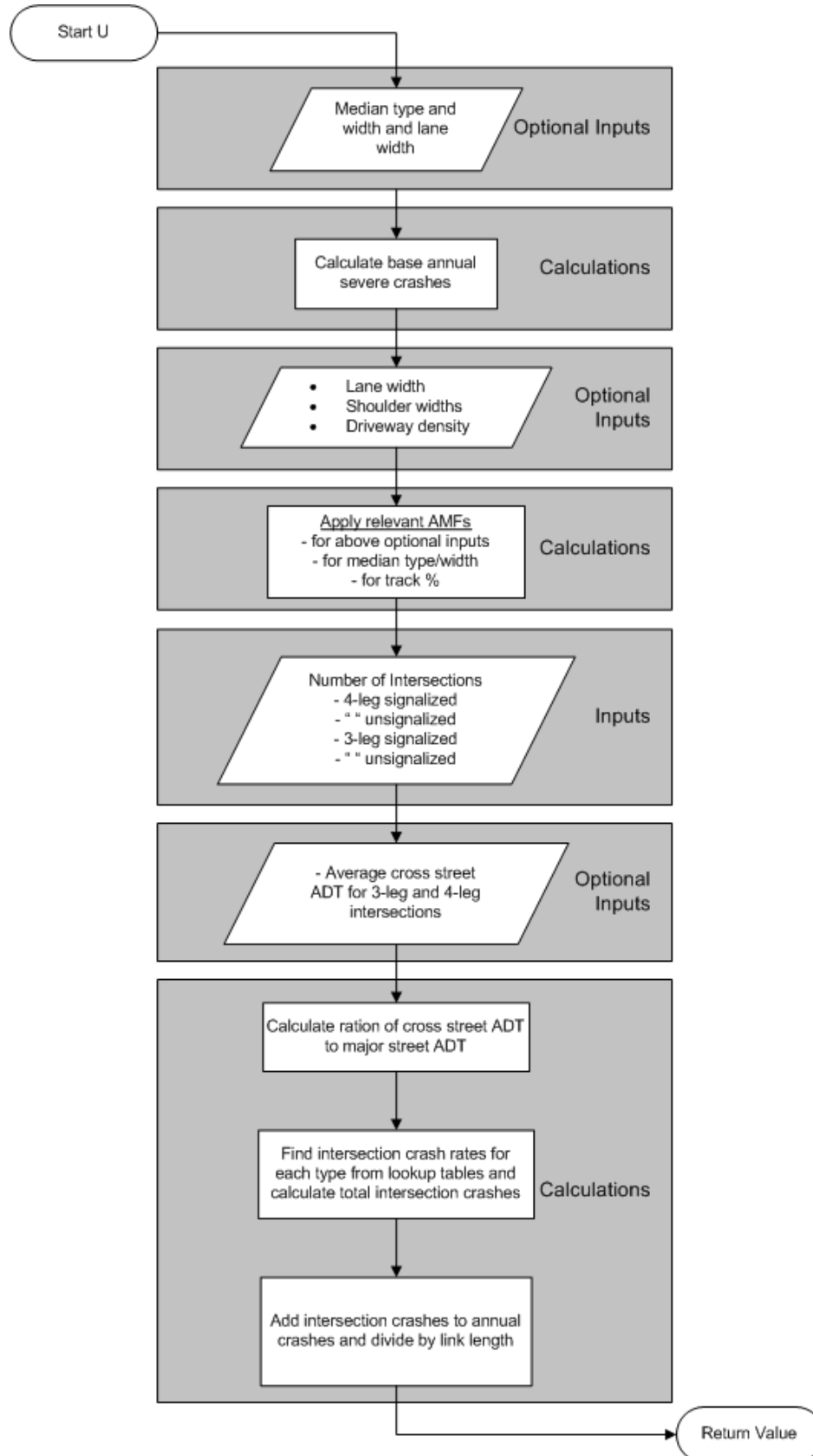
Figure 4-7. Estimation of Annual Urban Severe Crashes per Mile.

Section 6

Performance Measure 2b – Percent Lane-Miles under TMC Surveillance

6.1 – Overview

This measure estimates the presence of Intelligent Transportation Systems (ITS), including traffic monitoring and emergency response facilities in terms of coverage of a highway section by a Traffic Monitoring Center (TMC). This coverage is expressed in terms of percentage of the total lane-miles.

6.2 – Measure Parameters

- Goal Area – Enhance Safety

- Objective – Improve Traffic Incident Detection and Response

- Default Weights
    - Urban: 20%
    - Rural: 10%

- Requirements for Measure Calculation
    - Length
        – Required as input in Base Inputs worksheet
        – Values are carried over for each future case

    - Number of Lanes
        – Required as input in Base and Future Inputs worksheets
        – Separate value must be entered for each future case

    - Link Under Surveillance
        – Required as input in Base and Future Inputs worksheets
        – Separate value must be entered for each future case

- Flow Chart
    - See Figure 4-8
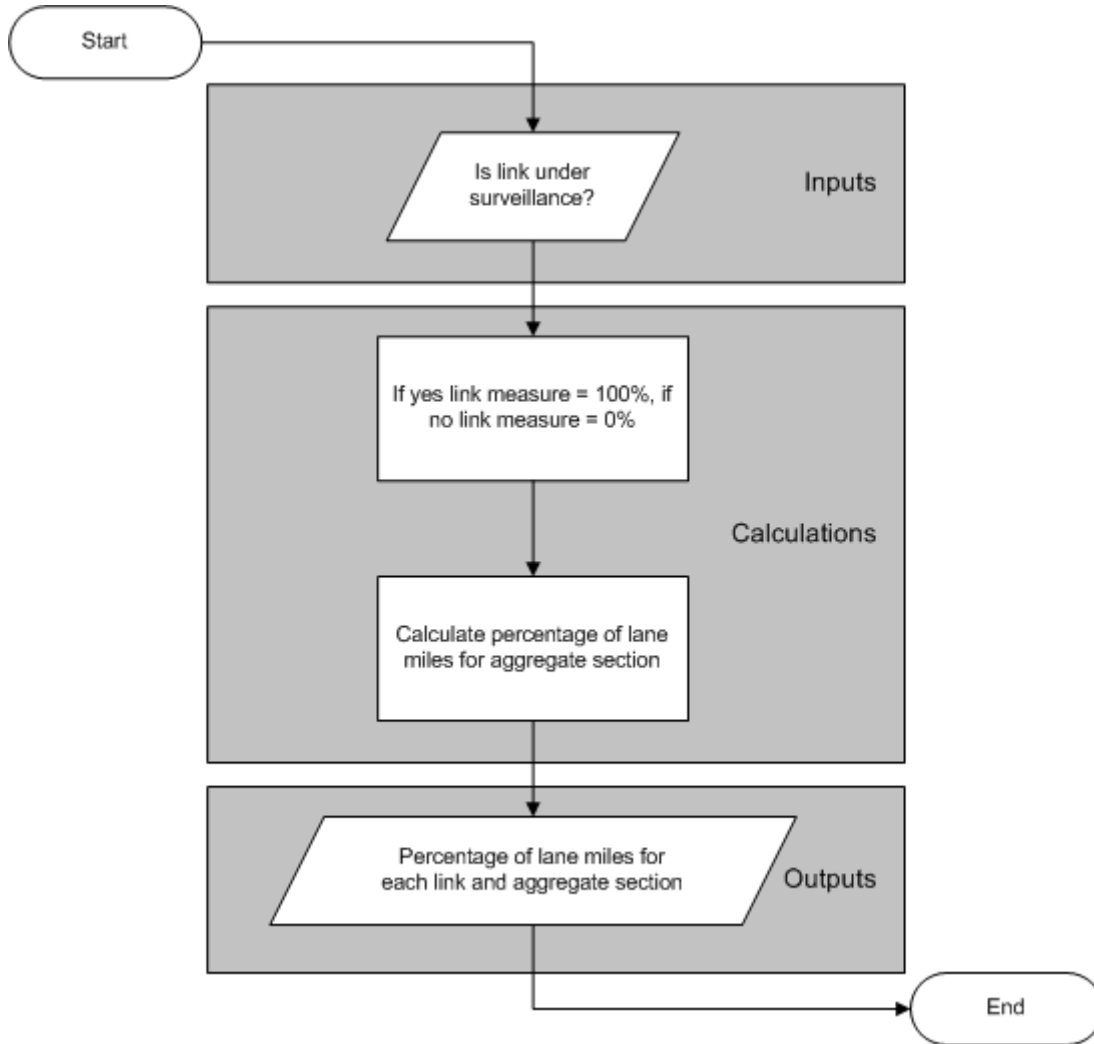
**Figure 4-8. Estimation of Percent Lane-Miles under Surveillance.**

Section 7

Performance Measure 3a – Land Use Balance

7.1 – Overview

This measure is a formulation that examines a mix of land uses in a half-mile zone along the highway section. The land area is classified into three categories: Residential, Commercial/Industrial, and Institutional/Public. While this measure does not explicitly examine economic growth or progress, the presence of an adequate area devoted to commercial establishments balanced with residential land use types ensures a positive impact on economic vitality of an area, when compared to having land occupied by a single land use, or land that is completely vacant.

7.2 – Measure Parameters

♦ Goal Area – Expand Economic Opportunity

♦ Objective – Optimize Land Use Mix for Development Potential

♦ Default Weights

   • Urban: 50%

   • Rural: 10%

♦ Requirements for Measure Calculation

   • Area in Zone (square miles)
      – Required as input in Base and Future Inputs worksheets
      – Separate value must be entered for each future case
      – Zone is considered to be half mile on each side of corridor
      – Values must be entered for residential, commercial/industrial, and institutional/public

♦ Flow Chart

   • See Figure 4-9
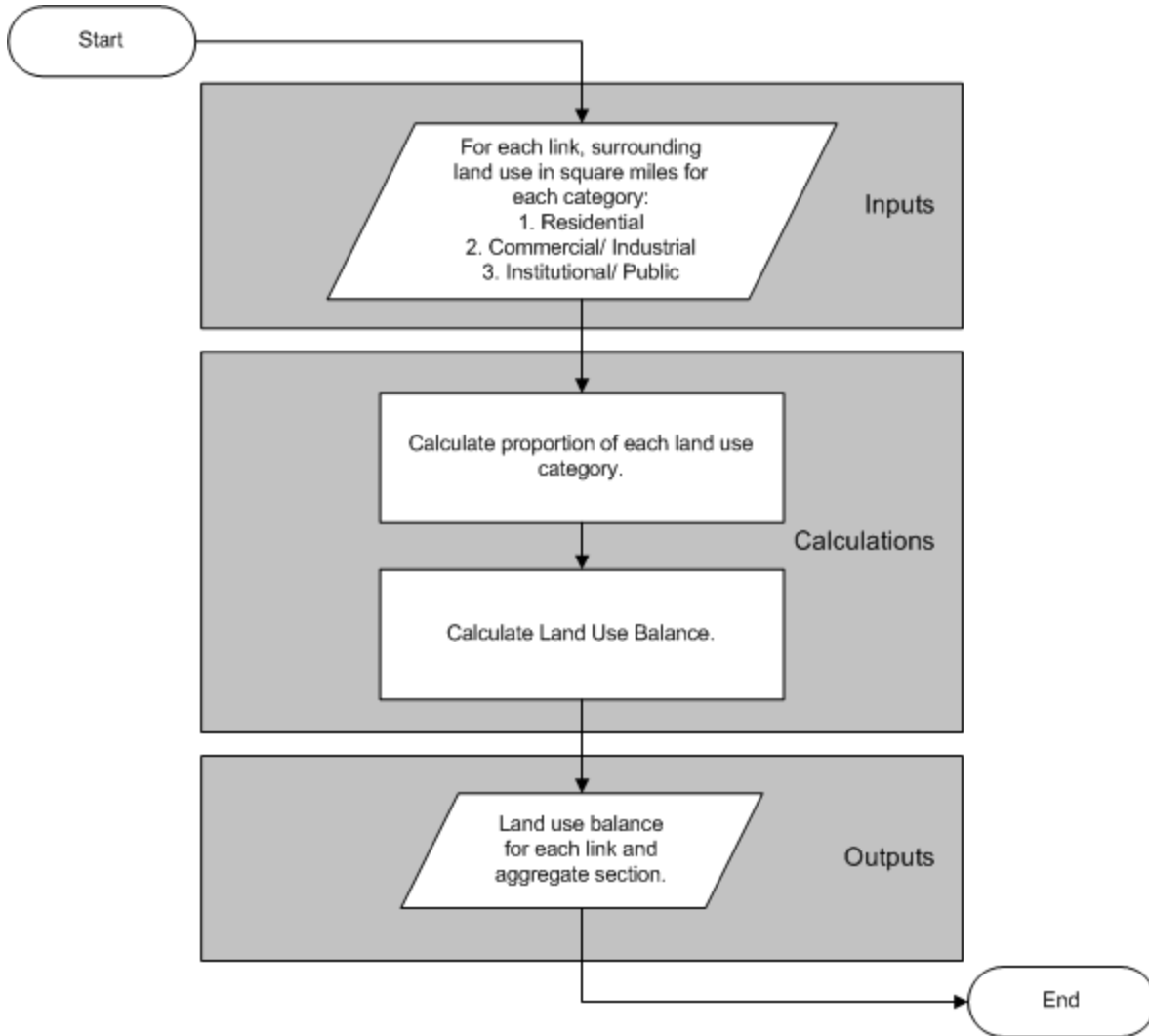
Figure 4-9. Estimation of Land Use Balance.

Section 8

Performance Measure 3b – Truck Throughput Efficiency

8.1 – Overview

This measure is a reflection of truck volumes along the highway section, combined with the travel speeds on the links. Freight movement is a key economic benefit of highways, and the objective in this analysis is to maximize freight throughput without affecting highway performance. The theory behind this measure is that the impact of having trucks in terms of economic benefits should be measured in a way that accounts for possible reductions in travel speeds due to excessive truck volumes, or existing low speeds along the corridor. Thus, a measure that examines a combination of truck volumes and speeds as an output, rather than truck percentages alone, is utilized.

8.2 – Measure Parameters

- Goal Area – Expand Economic Opportunity

- Objective – Improve Road-Based Freight Movement

- Default Weights
  - Urban: 50%
  - Rural: 90%

- Requirements for Measure Calculation
  - Number of Lanes
    – Required as input in Base and Future Inputs worksheets
    – Separate value must be entered for each future case
  - ADT (veh/day)
    – Required as input in Base and Future Inputs worksheets
    – Separate value must be entered for each future case
  - Truck Percentage
    – Required as input in Base and Future Inputs worksheets
   – Separate value must be entered for each future case
  - Travel Time for Peak Conditions
    – Calculated in Base and Future Calculations worksheets
  - Truck Speed
    – Calculated in Base and Future Calculations worksheets
  - Truck Volumes per Lane (veh/lane/day)
    – Calculated in Base and Future Calculations worksheets

- Flow Chart
  - See Figure 4-10
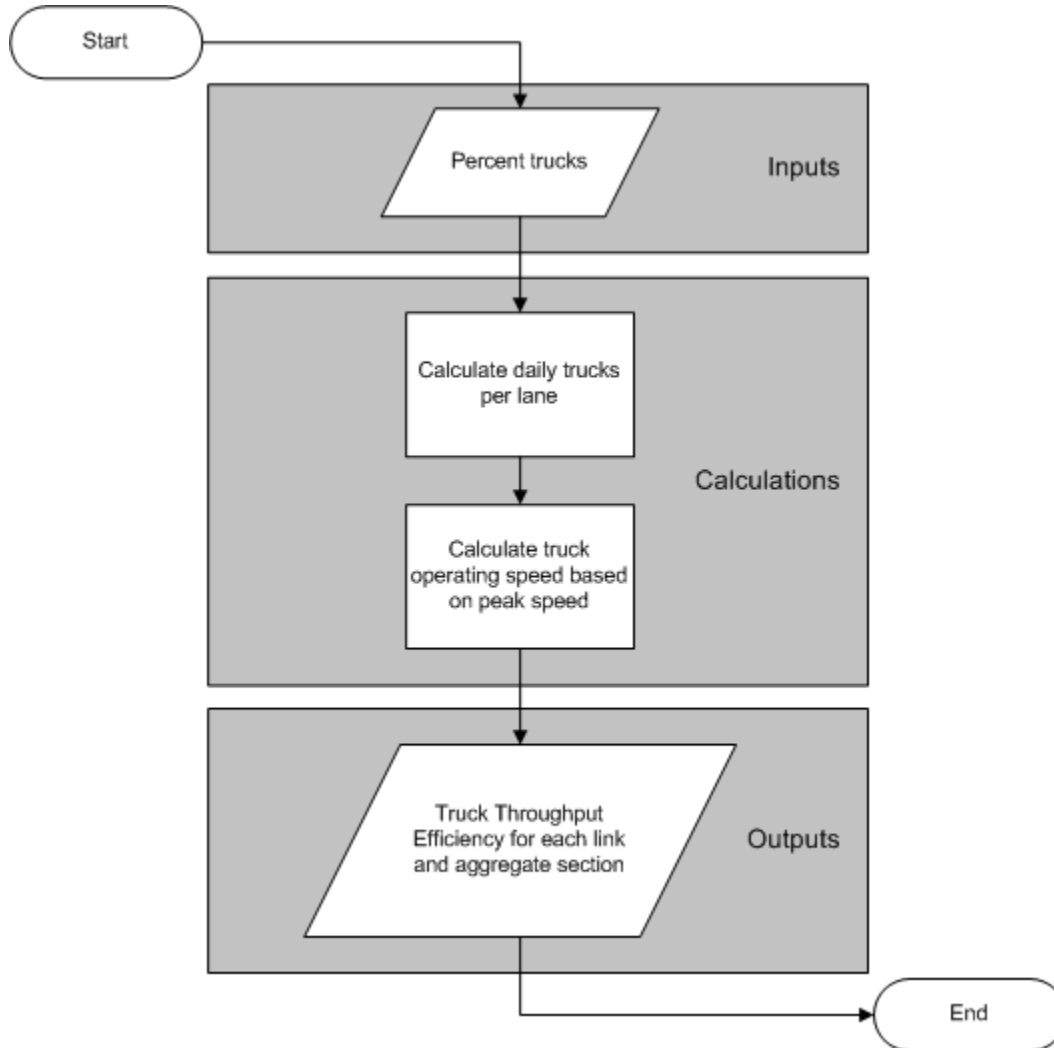
Figure 4-10. Estimation of Truck Throughput Efficiency.

<div align="center">

Section 9

Performance Measure 4a – Average Pavement Condition Score

</div>

9.1 – Overview

TxDOT monitors the condition of the pavements in the road network by considering factors such as surface distress, rutting, and ride quality. The data for the entire network are collected in a Pavement Management Information System (PMIS), which combines these factors into a pavement condition score expressed on a scale of 0–100. This score is utilized as a performance measure that indicates the quality of maintenance of a road section.

9.2 – Measure Parameters

♦ Goal Area – Increase the Value of Transportation Assets

♦ Objective – Maintain Existing Highway System Quality

♦ Default Weights

- Urban: 20%
- Rural: 20%

♦ Requirements for Measure Calculation

- TxDOT PMIS Pavement Condition Score
  – Required as input in Base and Future Inputs worksheets
  – Separate value must be entered for each future case
- Length (miles)
  – Required as input in Base Inputs worksheet
  – Values are carried over for each future case

♦ Flow Chart

- See Figure 4-11
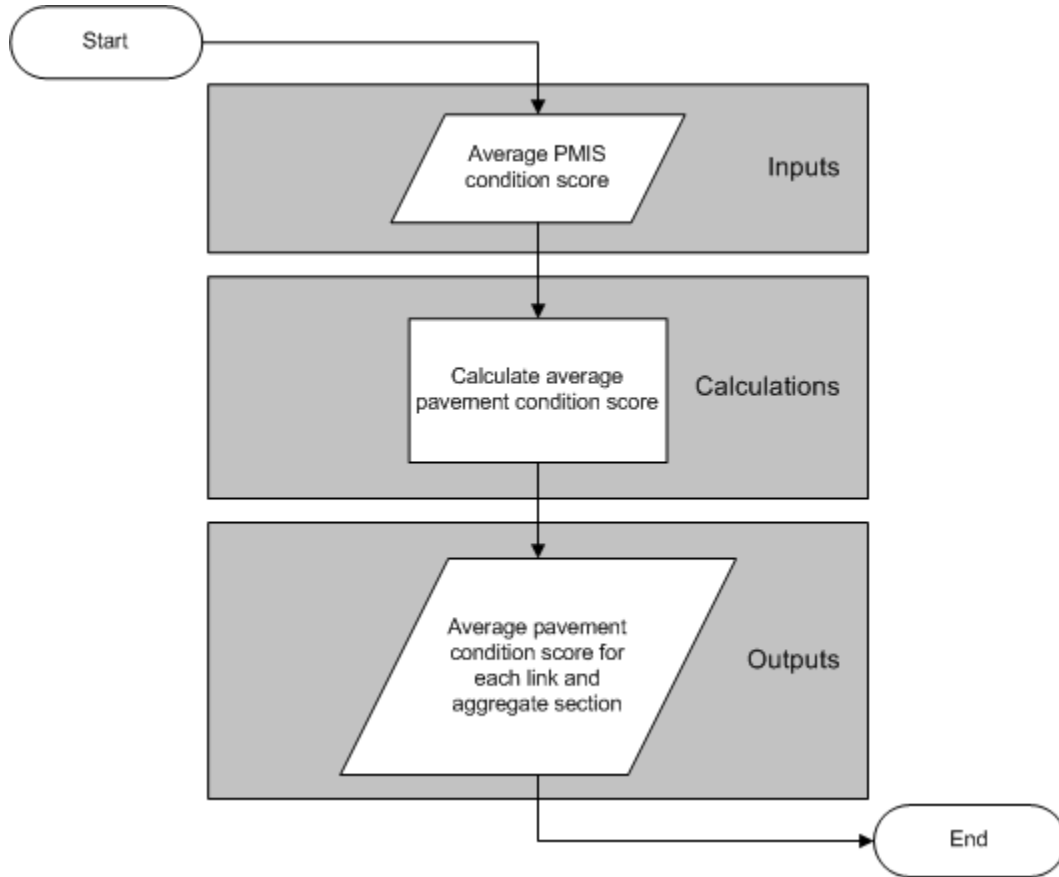
Figure 4-11. Estimation of Average Pavement Condition Score.

Section 10

Performance Measure 4b – Capacity Addition

10.1 – Overview

While having increased highway capacity can often be beneficial from the standpoint of improving the value of the highway system, simply adding lanes miles of pavement is not sustainable in every situation. This measure addresses this issue by only considering expansion that is possible within the existing right of way (ROW). This represents value addition at a lesser social, environmental, and economic cost than acquiring land solely for the purpose of highway construction. Though the impact of increased traffic due to a capacity expansion is not reflected in this particular performance measure, it will affect the value of other measures relating to congestion levels, crash numbers, and emissions rates.

10.2 – Measure Parameters

♦   Goal Area – Increase the Value of Transportation Assets

♦   Objective – Reduce Cost and Impact of Highway Capacity Expansion

♦   Default Weights

- Urban: 20%

- Rural: 20%

♦   Requirements for Measure Calculation

- Number of Lanes that can be added within available right of way (ROW)
  – Required as input in Base and Future Inputs worksheets
  – Separate value must be entered for each future case

♦   Flow Chart

- See Figure 4-12

Figure 4-12. Estimation of Capacity Addition.

Section 11

Performance Measure 4c – Cost Recovery from Alternative Sources

11.1 – Overview

The expenditure on a highway can be classified as the initial capital cost required for construction, and the recurring (annual) cost for operation and maintenance (O&M). When some of these costs are contributed from sources external to the department it can be considered a positive occurrence. This performance measure is structured to consider the proportion of capital costs, as well as the proportion of the current annual O&M cost that is contributed from external sources. For this calculator, external sources are considered to include funds from local/municipal agencies, toll revenue recovered, or roads that are built or operated by the private sector.

11.2 – Measure Parameters

♦ Goal Area – Increase the Value of Transportation Assets

♦ Objective – Leverage Non-Traditional Funding Sources for Highways

♦ Default Weights

- Urban: 40%

- Rural: 50%

♦ Requirements for Measure Calculation

- Weight for Capital Costs
  – Required as input in Base Inputs worksheet
  – Values are carried over for each future case
  – Default values are provided, but can be changed if desired

- Proportion of Capital Covered
  – Required as input in Base and Future Inputs worksheets
  – Separate value must be entered for each future case

- Proportion of Operations and Maintenance Covered
  – Required as input in Base and Future Inputs worksheets
  – Separate value must be entered for each future case

♦ Flow Chart

- See Figure 4-13
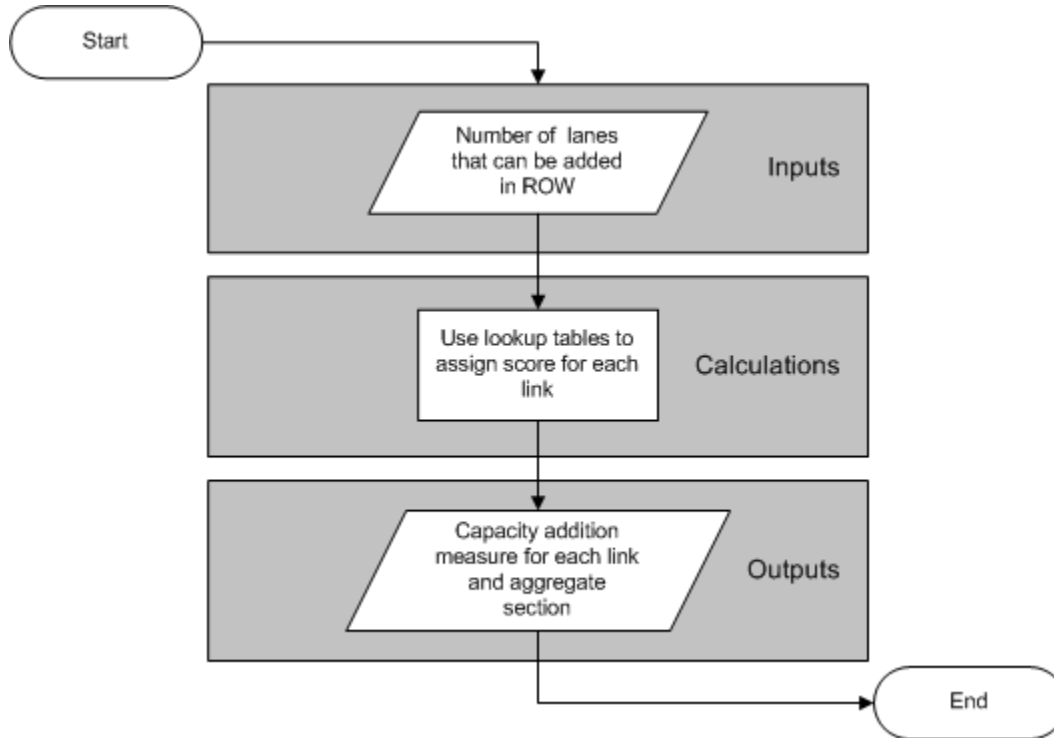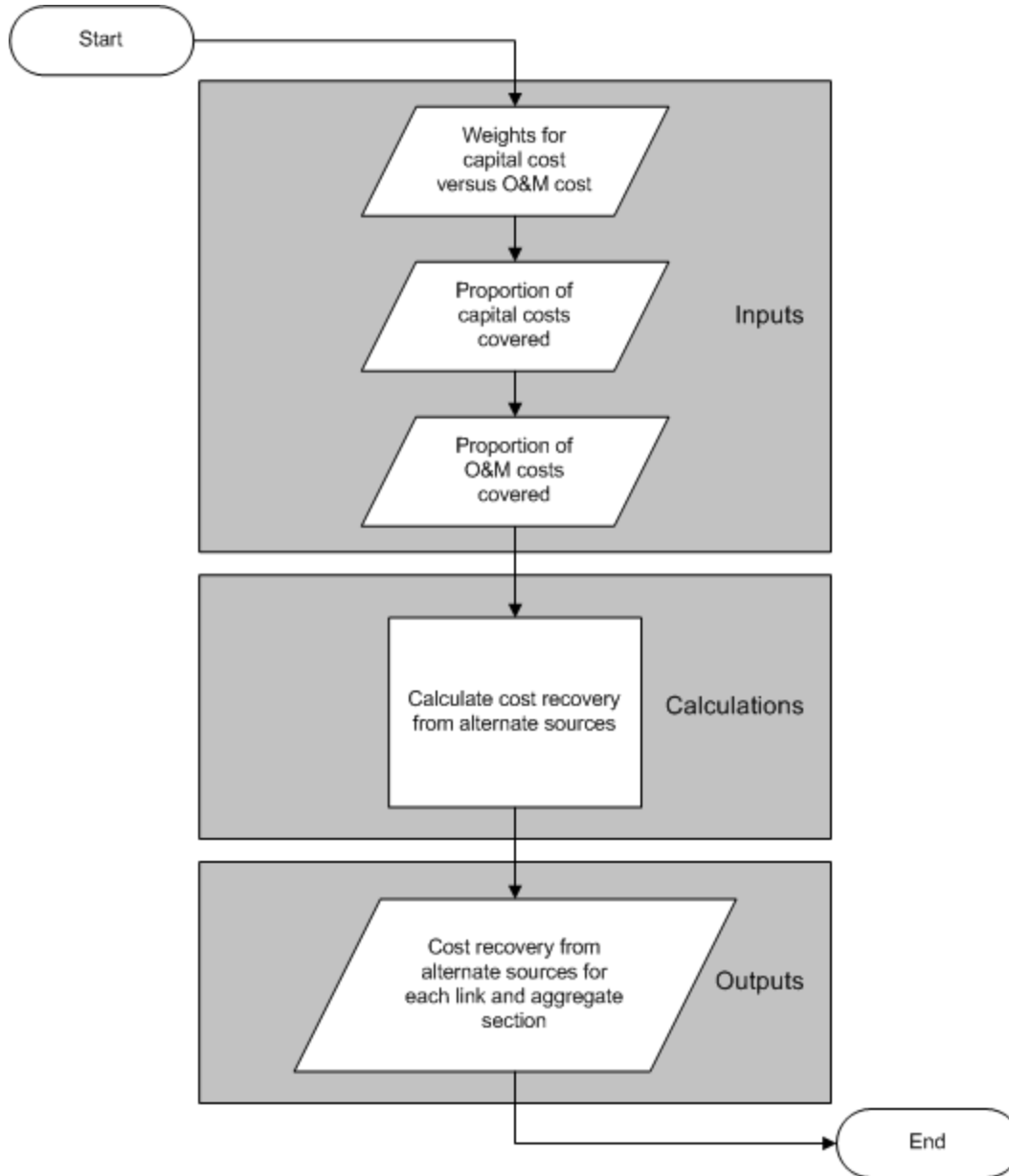
Figure 4-13. Estimation of Cost Recovery from Alternative Sources.

Section 12

Performance Measure 4d – Proportion of Non-SOV Travel

12.1 – Overview

This measure is used primarily as an indicator of reducing overall VMT. It evaluates the higher occupancies achieved by carpooling, use of bus transit or parallel rail facilities. This measure is calculated by accounting for non-SOVs in the general purpose lanes, high-occupancy vehicle (HOV) lanes, buses, and parallel rail facilities.

12.2 – Measure Parameters

- ♦ Goal Area – Increase the Value of Transportation Assets

- ♦ Objective – Increase use of Alternatives to Single-Occupant Automobile Travel

- ♦ Default Weights
  - Urban: 20%
  - Rural: 10%

- ♦ Requirements for Measure Calculation
  - Lanes with HOV Restrictions
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case

  - Estimated Vehicles per Day on HOV Lanes during Restricted Times
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case
    - Only used if there are lanes with HOV restrictions

  - Minimum Occupancy Requirement for HOV Lanes
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case
    - Only used if there are lanes with HOV restrictions

  - Length (miles)
    - Required as input in Base Inputs worksheet
    - Values are carried over for each future case

  - Average Number of Busses per Day
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case
    - Only used if there are lanes with HOV restrictions

  - Average Bus Occupancy
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case
    - Only used if there are lanes with HOV restrictions

- ADT (veh/day)
  - Required as input in Base and Future Inputs worksheets
  - Separate value must be entered for each future case

- Average Vehicle Occupancy on General Purpose Lanes
  - Required as input in Base Inputs worksheet
  - Values are carried over for each future case

- Paralleling Rail Service
  - Required as input in Base and Future Inputs worksheets
  - Separate value must be entered for each future case

- Average Number of Trains per Day
  - Required as input in Base and Future Inputs worksheets
  - Separate value must be entered for each future case
  - Only used if there is paralleling rail service

- Average Rail Cars per Train
  - Required as input in Base and Future Inputs worksheets
  - Separate value must be entered for each future case
  - Only used if there is paralleling rail service

- Average Rail Car Occupancy
  - Required as input in Base and Future Inputs worksheets
  - Separate value must be entered for each future case
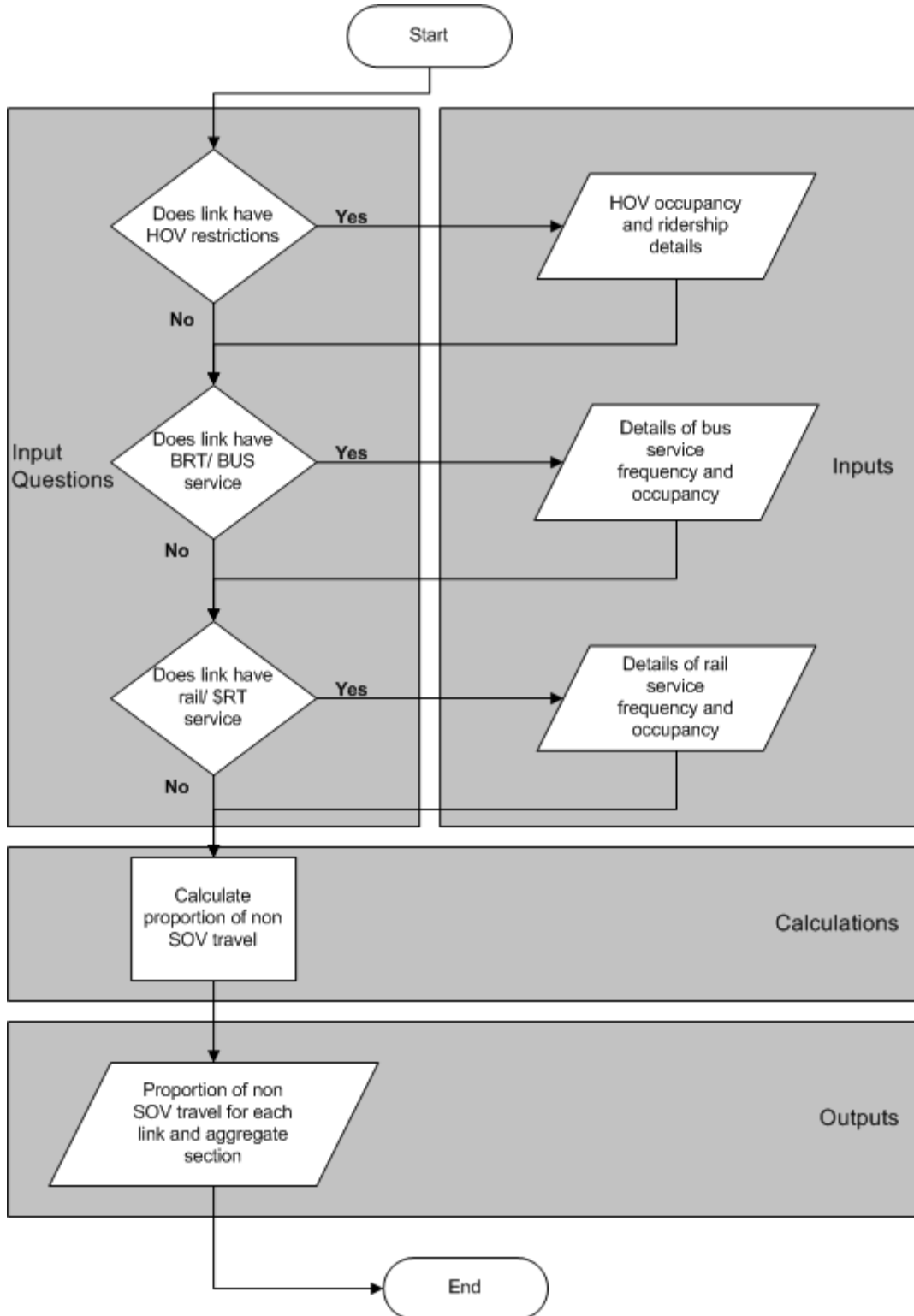 - Only used if there is paralleling rail service

♦ Flow Chart

- See Figure 4-14

Figure 4-14. Estimation of Proportion of Non-SOV Travel.

Section 13

Performance Measure 5a – Air Quality Index

13.1 – Overview

The Air Quality Index is a measure structured to take into account the mobile source emissions that affect human health, as well as the non-attainment status of the area under consideration. One aspect of the Air Quality Index is the importance factors assigned to various components of the index. The components considered are Ozone, Particulate Matter and Carbon Monoxide, and the NAAQS non-attainment status for this influence the importance factors assigned. Then, the emissions for Ozone precursors (combined NOx and VOC), PM and CO are individually quantified. For the purposes of this calculator, the total quantity of emissions is expressed in grams per mile of roadway, which is dependent upon the vehicle fleet mix, vehicle operating speed, as well as the total traffic volumes. The three components' emissions are then rated on a 0-1 scale by comparing with extreme values. These ratings are then combined based on the importance factors to obtain a final Air Quality Index value expressed on a 0-1 scale.

13.2 – Measure Parameters

♦ Goal Area – Improve Air Quality

♦ Objective – Reduce Adverse Human-Health Impacts and Comply with Ambient Air Quality Standards

♦ Default Weights

- Urban: 85%
- Rural: 85%

♦ Requirements for Measure Calculation

- Current Non-Attainment Status for Ozone, Particulate Matter, and Carbon Monoxide as per NAAQS Standards

- Proportion of Traffic Occurring under Peak Conditions
  – Required as input in Base and Future Inputs worksheets
  – Separate value must be entered for each future case
  – Default values are provided, but can be changed if desired

- ADT (veh/day)
  – Required as input in Base and Future Inputs worksheets
  – Separate value must be entered for each future case

- Travel Time for Peak Conditions
  – Calculated in Base and Future Calculations worksheets

- Length (miles)
  – Required as input in Base Inputs worksheet
  – Values are carried over for each future case

- Posted Speed Limit (MPH)
  - Required as input in Base and Future Inputs worksheets
  - Separate value must be entered for each future case

- Emission Rates
  - Default values are provided, but can be changed if desired in Emissions Rates worksheet
  - Values are the same for all future cases
  - There are separate values for VOC, NOx, PM, and CO
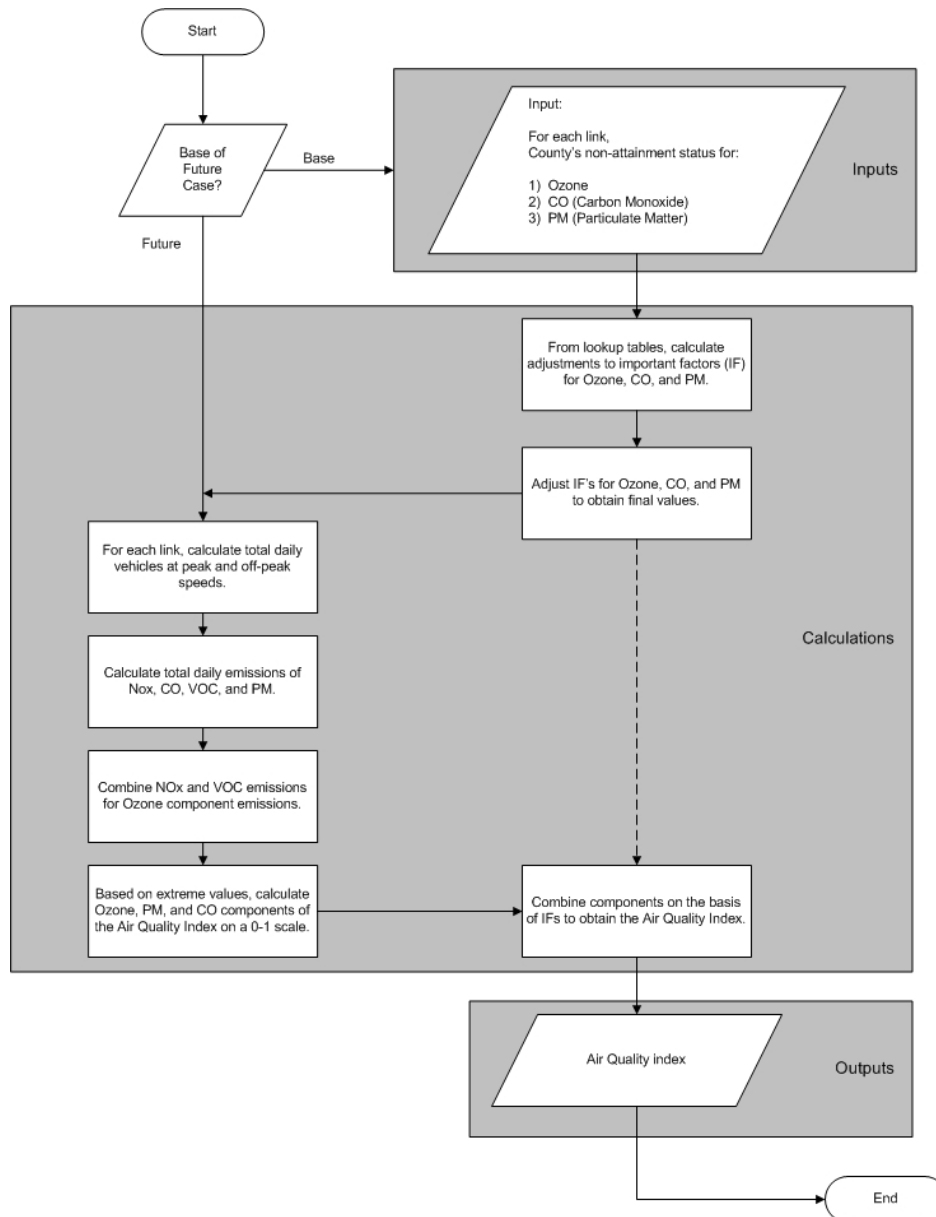
♦ Flow Chart

- See Figure 4-15

Figure 4-15. Estimation of Air Quality Index.

Section 14

Performance Measure 5b – Daily CO_2 Emissions per Mile

14.1 – Overview

CO_2 is a gas emitted from burning fossil fuels, which is associated with global warming. Vehicular emissions are the most significant anthropogenic source of CO_2, and these must be considered while assessing the sustainability of transportation systems. Emissions rates are obtained from an emissions model and are expressed as the daily emissions of CO_2 in grams per mile of roadway.

14.2 – Measure Parameters

- Goal Area – Improve Air Quality

- Objective – Reduce Greenhouse Emissions

- Default Weights
  - Urban: 15%
  - Rural: 15%

- Requirements for Measure Calculation
  - Proportion of Traffic Occurring under Peak Conditions
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case
    - Default values are provided, but can be changed if desired
  - ADT (veh/day)
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case
  - Travel Time for Peak Conditions
    - Calculated in Base and Future Calculations worksheets
  - Length (miles)
    - Required as input in Base Inputs worksheet
    - Values are carried over for each future case
  - Posted Speed Limit (MPH)
    - Required as input in Base and Future Inputs worksheets
    - Separate value must be entered for each future case
  - Emission Rates
    - Default values are provided, but can be changed if desired in Emissions Rates worksheet
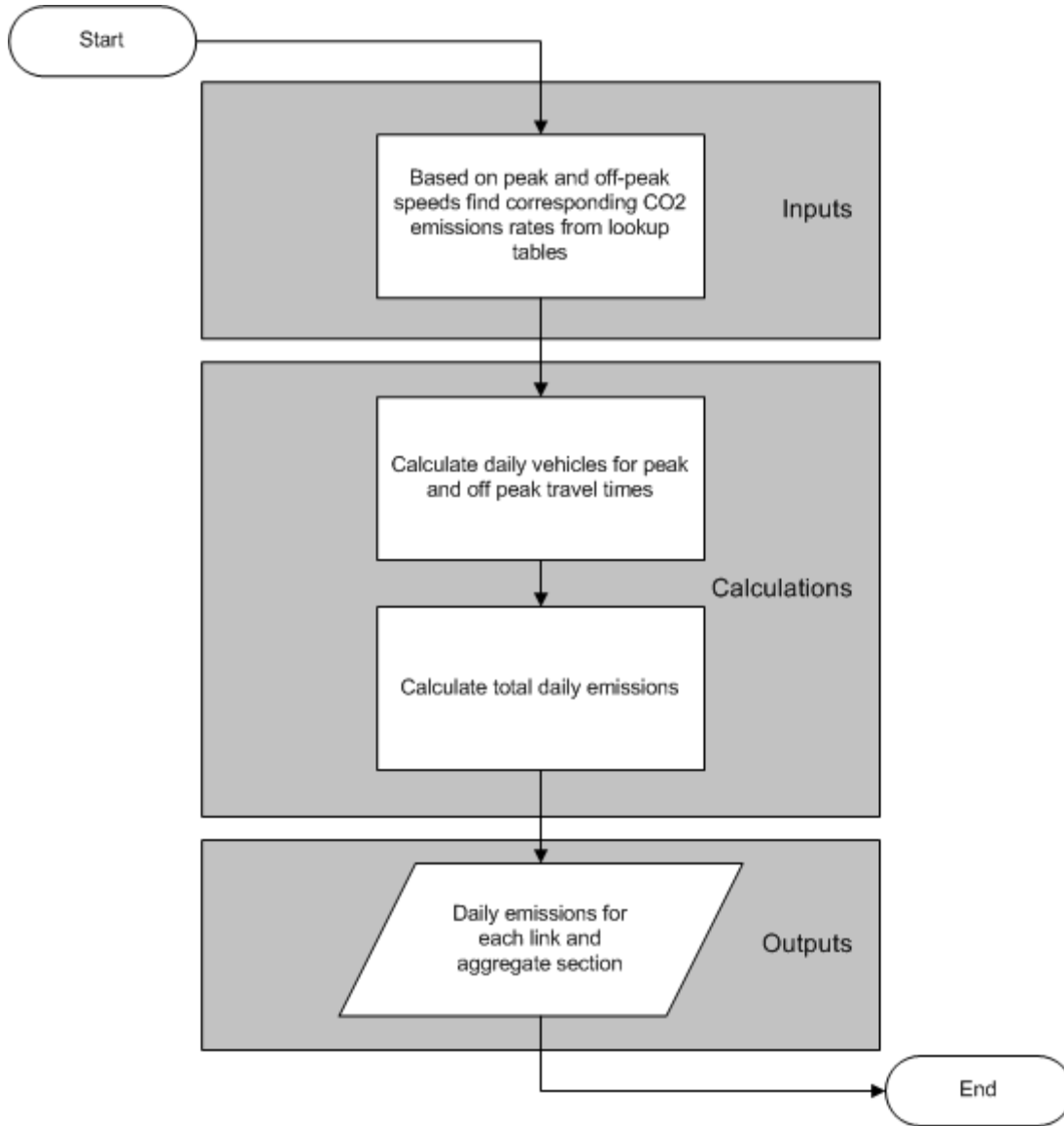   - Values are the same for all future cases

- Flow Chart
  - See Figure 4-16

Figure 4-16. Estimation of CO₂ Emissions per Mile.

Chapter 5
Executive Summaries

Contents:

Section 1

Overview

One of the strengths of the sustainable transportation performance measures calculator is the provision of executive summary sheets that summarize the data. The tremendous detail and sheer number of calculations contained within the calculator would make it extraordinarily difficult, if not impossible, to compare alternatives by looking at individual data elements. There are different types of outputs and data elements provided in the calculator. Some are provided for both individual links, and for the aggregate section, while others are provided for the aggregate section alone. These include:

♦ *Performance measure values* – These are the calculated measure values, which are each expressed in different units, depending upon the measure itself. These are generally calculated for individual links, and for the aggregate section, for base and future cases.

♦ *Scaled measure values* – Since the calculated performance measures may be expressed in different units that are not comparable with each other, a process of scaling is used to express all measures on a common basis (on a 0 to 1 scale). For each measure, there are predefined "best" and "worst" case values, which correspond to scaled values of 1 and 0, respectively. Depending on the value of an individual measure, the scaled value is calculated. The scaled values are capped at a minimum of 0 and maximum of 1.

♦ *Goal-wise index values* – The scaled values of measures corresponding to the individual goal areas are combined together as a weighted sum, based on the predefined measure weights. This results in an index value for each goal, which is also on a 0 to 1 scale.

♦ *Aggregate index values* – This index value is obtained as the weighted sum of goal-wise index values, weighted by the predefined goal weights. This results in a single aggregate index value expressed on a 0 to 1 scale.

Instead, the executive summaries provide that basis for effective comparison. An additional strength of these summary sheets is that absolutely no additional calculations or work effort is necessary. A user can simply click on them and then print the output as per normal Excel commands.

Executive summaries are provided in four areas, and help effectively tabulate and summarize the most important data elements output from the calculator:

♦ Goals – This worksheet compares the base and future cases across each of the five goal areas contained in the TxDOT strategic plan. All links are aggregated into a single number for each goal area. This provides a summary of the goal-wise performance for the base and future cases, for the entire study section.

♦ Links – This worksheet compares the base and future cases across each link and also provides the breakdown of each individual performance measure across each link. This worksheet provides the actual performance measure values for individual links, and for the aggregate section, for the base and future case. It also indicates which measures have improved/worsened over the base case.

♦ Measures – This worksheet compares the result of each measure across both the base and future cases as well as computing a weighted value across each link. This worksheet compares the scaled measure values for the entire section across both the base and future cases.

♦ Graphs – This worksheet produces basic graphic output of the aggregate index value by link, strategic goal performance comparing base and future cases, and a change metric between the base and future cases.

Each section illustrates the results a user would see in these summaries and points out important information to understand when looking at the summaries.

Section 2

Executive Summary – Goals

Figure 5-1 illustrates the type of information presented in the goal based executive summary worksheet. The cases of base and future cases are represented in rows, while the strategic goal areas are represented in columns. Additionally, the worksheet tabulates the percentage change between the base case and each future case.

Note that the worksheet contains an Excel comment that explicitly states that no input data are required for this worksheet and that no information is required to be changed. Because this is a comment, it will not be visible when the worksheet is printed. It is meant solely as an information note to the user.

Notice also that the executive summary worksheets will all contain the 'Return to Menu' hyperlink in the upper left-hand corner to provide ease of navigation.

	A	B	C	D	E	F	G	H
1	**Return to Menu**							
2								
3			**Executive Summary - Goals**					
4								
5			**This worksheet contains no input data. You do not need to change any**					
6								
7			**information included on this page.**					
8								
9								
10								
11		Goal	Congestion	Safety	Economic Opportunity	Transportation Assets	Air Quality	All Goals Combined
12		Base Case	0.91	0.24	0.59	0.30	0.43	0.50
13		Future Case 1	0.10	0.30	0.59	0.38	0.67	0.38
14		Future Case 1-Change	-89.01%	22.34%	-0.05%	27.08%	54.84%	-23.74%

Figure 5-1. Goal Based Executive Summary Worksheet.

Section 3

Executive Summary – Links

In much the same way that the goals worksheet provided a comparison view across the strategic goals, the links view provides a comparison view across the links within the study corridor. Essentially, the links view is a step down into additional detail from the goal view.

Figure 5-2 shows the overview section of the links based executive summary. This summarizes the aggregate index value of all the performance measures across each individual link within the study corridor. This aggregate index value uses the performance measure weighting values discussed in Chapter 3. As with pervious executive summary worksheets, there is a note to the user via an Excel comment that alerts them to the fact that no user input or interaction is required for this page.

	Link	Base Case	Future 1
	1	0.43	0.33
	2	0.54	0.30
	3	0.51	0.54
	4	0.51	0.70
	Total Section	0.50	0.38

Figure 5-2. Links Based Executive Summary Worksheet – Overview.

Figure 5-3 shows the detail section of the links based executive summary. In this portion of the worksheet, the value of each performance measure on each link is tabulated, stratified by the base and future cases. At the right of each comparison, the figure shows a column containing either red or green arrows. These arrows represent two conditions related to the change in the performance measure.

The first condition is the numerical direction of the change in the measure. As an example, Measure 1a on link 1 went from a base case value of 1.09 to a future case value of 1.58. That is an increase and is represented by an arrow pointing upward. A decrease would be represented by an arrow pointing downward.

The second condition is represented by the color of the arrow. In the same example as above, the arrow in Figure 5-3 is red. Red indicates a change for the worse. Measure 1a, which is the travel time index, increased in the future case. With other performance measures, an increase might correspond to a green arrow, as the increase would be a change for the better, such as measure 3a, Land Use Balance.

	Link	Base Case	Future 1
11	Link	Base Case	Future 1
12	1	0.43	0.33
13	2	0.54	0.30
14	3	0.51	0.54
15	4	0.51	0.70
22	Total Section	0.50	0.38

Summarized Performance Measure Values by Link

	Measure	Base	Future 1	
27	1a	1.04	1.51	▲
28	Link 1	1.09	1.58	▲
29	Link 2	1.00	1.86	▲
30	Link 3	1.00	1.19	▲
31	Link 4	1.00	1.00	—
38	1b	0.08	0.49	▲
39	Link 1	0.19	0.64	▲
40	Link 2	0.00	0.64	▲
41	Link 3	0.00	0.35	▲

Figure 5-3. Links Based Executive Summary Worksheet – Detail.

It is important for a user to carefully analyze and understand the information presented in this executive summary to ensure that the correct interpretations and results are being drawn from the analysis.

Users are reminded that they can return to the performance measure weighting worksheet at any time during their analysis and change the weighting of the measures, which may affect the results displayed in the executive summary worksheets. Changing the weights will not change any of the data inputs for the measures. Users may want to save the results using the default weight set and then change the weights and save a different result set to compare the sensitivity of the weightings for their particular corridor and future cases.

Section 4

Executive Summary – Measures

The final method of looking at the data in a tabulated executive summary is provided in the measures view, which aggregates each measure across all links and presents that value for both the base and future cases. An example illustration is presented in Figure 5-4.

Measure	Scaled Measure Values		
	Base	Future 1	
1a	0.92	0.00	▼
1b	0.88	0.25	▼
2a	0.30	0.22	▼
2b	0.00	0.61	▲
3a	0.98	0.90	▼
3b	0.21	0.28	▲
4a	0.89	0.95	▲
4b	0.32	0.13	▼
4c	0.00	0.27	▲
4d	0.29	0.29	▼
5a	0.36	0.76	▲
5b	0.53	0.00	▼

Figure 5-4. Measures Based Executive Summary Worksheet.

Users should note that this executive summary also presents information in the same manner as the links summary, utilizing both the direction and color of the arrow to provide an indication of the relative change of the performance measure between the base and future cases.

Section 5

Executive Summary – Graphs

The last executive summary worksheet provides a visual view into the data and illustrates the changes between base and future cases. Figure 5-5 through Figure 5-7 show examples of these graphs.

The calculator contains all of these graphs in a single worksheet. If the user desires to have a full screen printout of any, simply click on an individual graph and do a print operation (File, Print). This will produce a full-scale version of the graphic on the default paper size (normally 8.5 × 11 inches). If an individual graph is not selected, performing a print operation will print the entire worksheet, which may insert page breaks in the middle of the graphs.
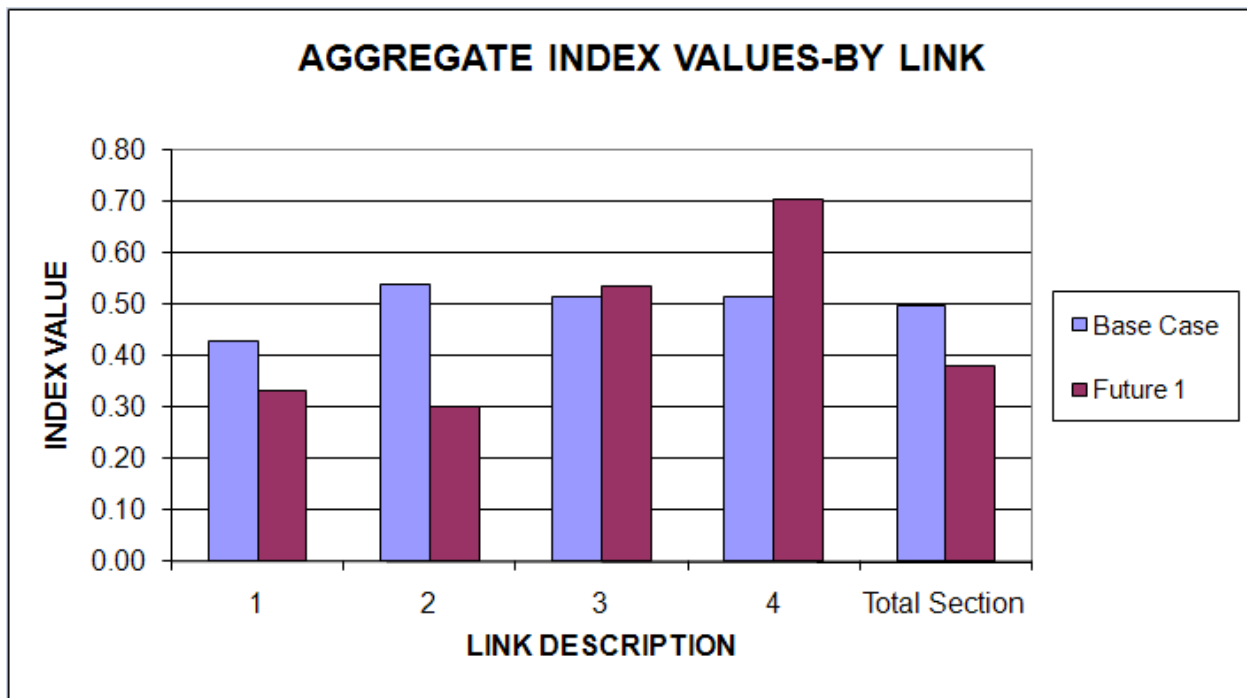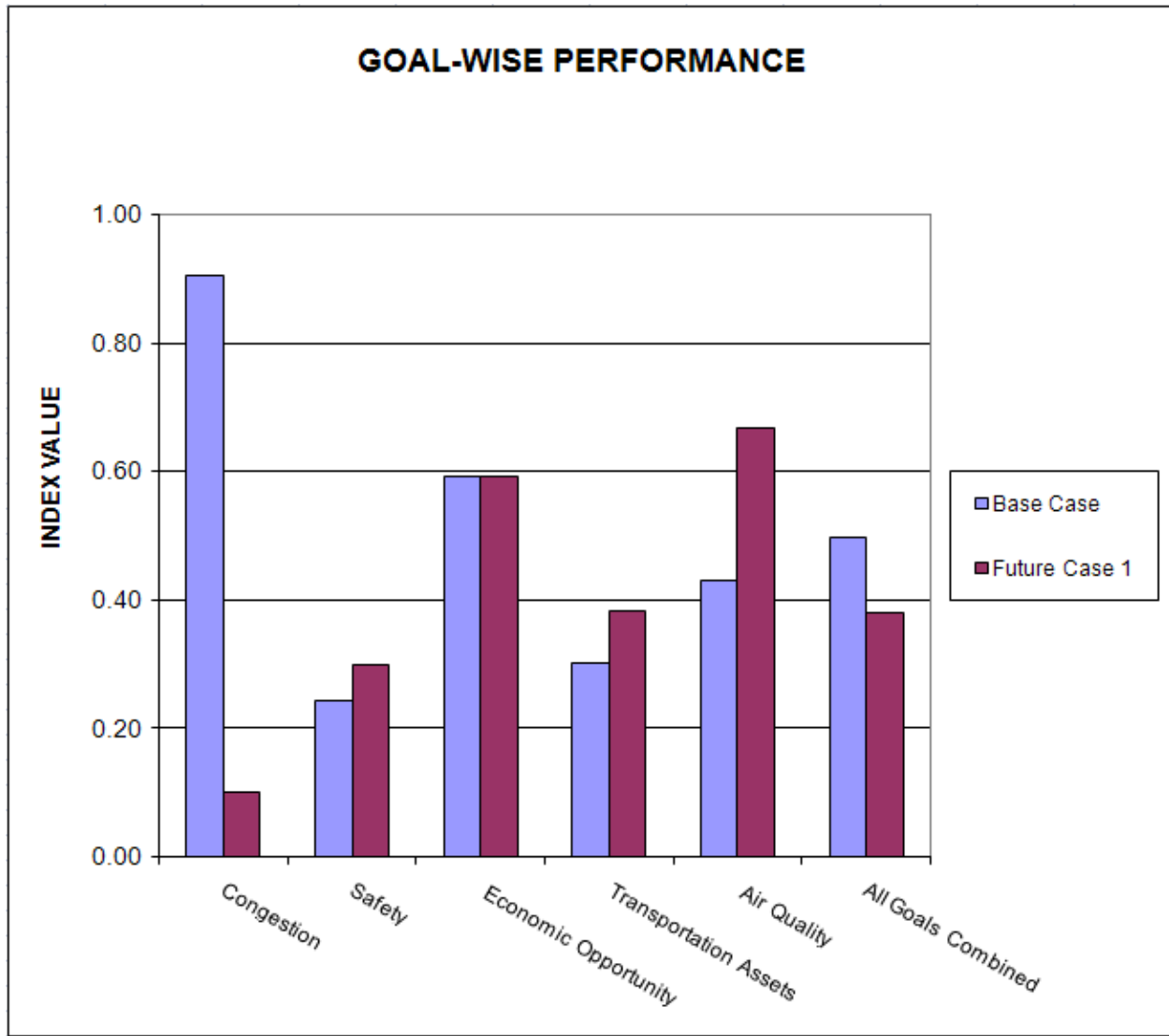

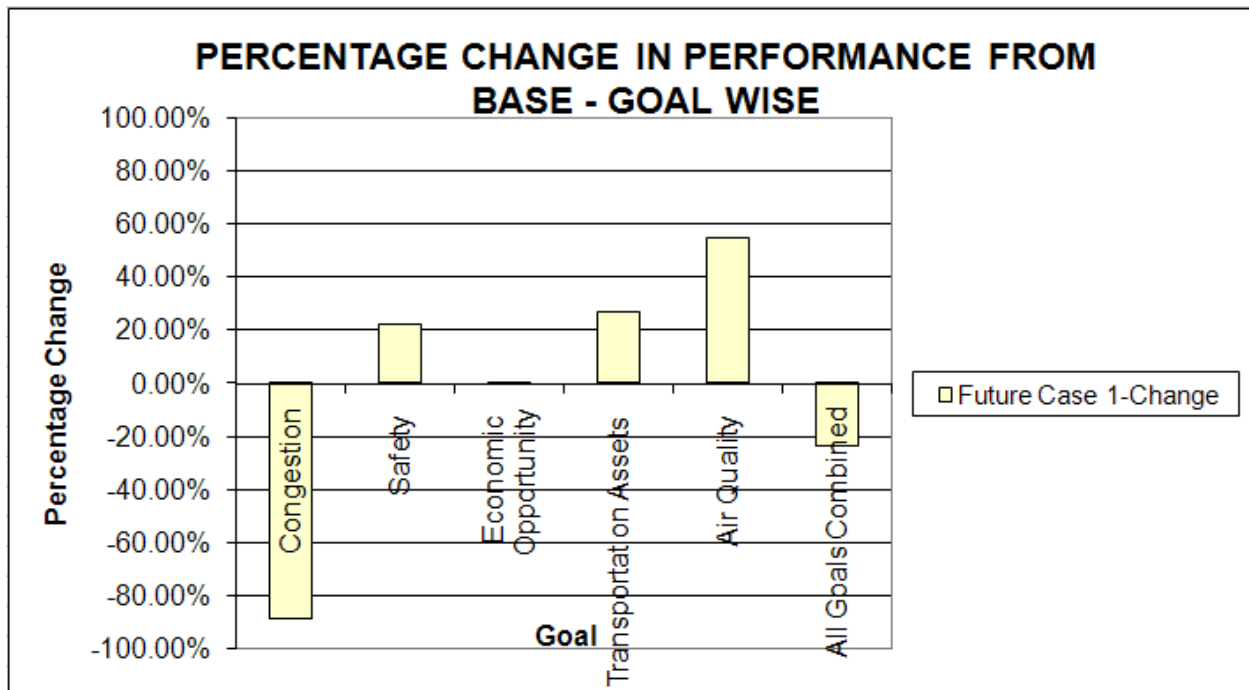**Figure 5-5. Aggregate Index Value Graph by Link.**

Figure 5-6. Aggregate Goal Value Graph.

Figure 5-7. Change in Goal Value Graph.