Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/TX-05/0-4898-P1		

4. Title and Subtitle	5. Report Date
GUIDEBOOK FOR HOV TO HOT LANE ADAPTATION: HOT START SOFTWARE USER'S GUIDE	August 2005 Resubmitted August 2006 Published: September 2006
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
William L. Eisele, Hannah T. Wilner, Michael J. Bolin, and William R. Stockton	Report 0-4898-P1

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135	11. Contract or Grant No. Project 0-4898

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Texas Department of Transportation Research and Technology Implementation Office P. O. Box 5080 Austin, Texas 78763-5080	14. Sponsoring Agency Code

15. Supplementary Notes

Project performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration.
Project Title: Criteria for Adapting HOV Lanes to HOT Lanes
URL: http://tti.tamu.edu/documents/0-4898-P1.pdf

16. Abstract

This guidebook describes the High-Occupancy/Toll STrategic Analysis Rating Tool (HOT START) program that was developed for the Texas Department of Transportation (TxDOT) to provide a tool to aid in analyzing key issues related to converting a high-occupancy vehicle (HOV) lane to a high-occupancy/toll (HOT) lane. The tool includes three broad categories of factors to consider, including facility considerations, performance considerations, and institutional considerations.

The HOT START program was developed in Visual Basic.NET®, and it is designed to be easily tailored to local needs. This guidebook walks the user through an example including key screen shots to guide the user. Three appendices provide additional detail of the analysis tool including factor definitions, scoring the factors, and factor interaction effects.

17. Key Words	18. Distribution Statement
HOT Lane, HOV Lane, HOV Lane to HOT Lane Conversion	No restrictions.

19. Security Classif.(of this report)	20. Security Classif.(of this page)	21. No. of Pages	22. Price
		82	

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

GUIDEBOOK FOR HOV TO HOT LANE ADAPTATION:

HOT START SOFTWARE USER'S GUIDE

by

William L. Eisele, Ph.D., P.E.
Associate Research Engineer
Texas Transportation Institute

Hannah T. Wilner, E.I.T.
Graduate Assistant Research
Texas Transportation Institute

Michael J. Bolin, P.E.
Graduate Assistant Research
Texas Transportation Institute

and

William R. Stockton, P.E.
Research Engineer and Associate Director
Texas Transportation Institute

Report 0-4898-P1
Project 0-4898
Project Title: Criteria for Adapting HOV Lanes to HOT Lanes

Performed in cooperation with the
Texas Department of Transportation
and the
Federal Highway Administration

August 2005
Resubmitted: August 2006
Published: September 2006

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 data presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation (TxDOT) or the Federal Highway Administration (FHWA). This report does not constitute a standard, specification, or regulation. The engineer in charge of this project was William R. Stockton (P.E. #41188).

ACKNOWLEDGMENTS

This document represents the investigative and analysis phase of a research project involving the design, development, and testing of a tool used to assist in analyzing the suitability of the conversion of an established or planned HOV lane to an HOT lane.

The authors appreciate the ongoing assistance and guidance of the project director, David Rodgers of the Houston District of the Texas Department of Transportation (TxDOT), as well as that of the program coordinator, Sally Wegmann, also of the Houston District. Also making valuable contributions and providing insight into the decision-making processes were Diana Vargas and others in the Texas Turnpike Authority Division, Elvia Cardinal and David Fink from the Houston District, Matt MacGregor and Stephen Endres from the TxDOT Dallas District, and Flor Sanchez from the Traffic Operations Division. Wade Odell of the TxDOT Research and Technology Implementation Office was exceptional in his support and direction for the project.

Special thanks are also due to the various people who have graciously contributed time and effort in providing test data and constructive feedback and review of the project, the software, and all associated official documents relating to this effort.

Finally, the authors would like to thank Ginger Goodin, Mark Burris, Tina Collier, and Michelle Hoelscher of the Texas Transportation Institute for their technical assistance and Pam Rowe for her word processing of this report.

TABLE OF CONTENTS

Page

LIST OF FIGURES viii
LIST OF TABLES x
LIST OF ACRONYMS AND ABBREVIATIONS xi
CHAPTER 1 INTRODUCTION 1
1.1 Project Objectives 1
1.2 Research Analysis Procedure 2
1.3 Guidebook Organization 4
1.4 How to Use This Guidebook and HOT START 5
CHAPTER 2 HOT START COMPUTER REQUIREMENTS AND INPUT DATA REQUIREMENTS 7
2.1 System Requirements 7
2.2 Corridor/Community Information Requirements 7
CHAPTER 3 INSTALLING AND RUNNING THE HOT START SOFTWARE 15
3.1 Installing HOT START 15
3.2 Running HOT START 15
3.2.1 Getting Started 15
3.2.2 Introductory Screen 16
3.3 Entering General Information 20
3.4 Weighting and Scoring Each Factor 20
3.4.1 Weighting Each Factor 20
3.4.2 Weight Summary 22
3.4.3 Scoring Each Factor 24
3.5 Computing and Interpreting HOT START Results 28
3.6 Printing 32
3.7 Help Menu 33
CHAPTER 4 REFERENCES 35
APPENDIX A FACILITY, PERFORMANCE AND INSTITUTIONAL FACTORS WITH DEFINITIONS AND DEFAULT TTI WEIGHTS 37
APPENDIX B SCORING DECISION TREES FOR ALL FACTORS 43
APPENDIX C STEP-BY-STEP INSTRUCTIONS FOR CREATING AND LOCKING WEIGHT PROFILES 59
APPENDIX D INTERACTIONS OF FACILITY AND PERFORMANCE FACTORS 65

LIST OF FIGURES

Figure Page

1-1 Flowchart of Research Activities to Develop HOV Lane to HOT Lane Conversion Tool ... 3
1-2 Decision Flowchart for Converting HOV Lanes to HOT Lanes ... 4
3-1 HOT START Icon ... 15
3-2 HOT START Introductory Screen ... 16
3-3 Weighting Profile Question Box ... 17
3-4 Default Weights for Critical Factors ... 18
3-5 Restore Defaults Option When Adjusting Default Weights ... 19
3-6 General Information Entry Page ... 20
3-7 Facility Information ... 21
3-8 Weight Summary with Initial User Inputs ... 22
3-9 Error Message for Weight Sum ... 23
3-10 Weight Summary after Adjusting User Weights to Sum to 100 ... 23
3-11 Example Question Prompts for Scoring the "Facility Cross Section" Factor ... 24
3-12 Scored Facility Factors ... 25
3-13 Scored Performance Factors ... 26
3-14 Scored Institutional Factors ... 27
3-15 Page 1 of 3 of HOT START Results ... 29
3-16 Page 2 of 3 of HOT START Results ... 30
3-17 Page 3 of 3 of HOT START Results ... 31
3-18 "Print" Option in the "File" Menu ... 32
3-19 Printing Options Textbox ... 33
3-20 "Help" Dropdown Menu ... 33
B-1 Facility Cross Section ... 43
B-2 Lane Separation for Toll Collection ... 43
B-3 Facility Access Satisfies O-D Requirements ... 44
B-4 Facility Access Design ... 45
B-5 Ability to Enforce ... 47

Figure Page

B-6 Facility Traffic Control 49
B-7 Pricing Strategy 49
B-8 Incident Management 50
B-9 Maintenance 50
B-10 HOV Lane Utilization 51
B-11 Travel Time 52
B-12 Benefits 52
B-13 Willingness to Pay Tolls 53
B-14 Safety 53
B-15 Environment 54
B-16 Public Acceptance 55
B-17 Political Acceptance 55
B-18 Environmental Justices/Title VI Issues 56
B-19 Revenue Use 56
B-20 Interagency Cooperation 56
B-21 Media Relations 57
B-22 Public Education/Information 57
C-1 Locating Default Weight Profile 59
C-2 Opening Default.wpf with Notepad 60
C-3 Notepad View of Default Weights 60
C-4 New Austin Weight Profile 61
C-5 New Austin Weight Profile in HOT START Directory 61
C-6 Loaded Austin Weight Profile 62
C-7 Saving New Weight Profile 63
C-8 Renaming Weight Profile 63
C-9 Loaded San Antonio Weight Profile 64

LIST OF ACRONYMS AND ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
AVI	Automatic Vehicle Identification
CCTV	Closed Circuit Television
CMS	Changeable Message Sign
ETC	Electronic Toll Collection
FHWA	Federal Highway Administration
GPL	General-Purpose Lane
HOT START	High-Occupancy/Toll STrategic Analysis Tool
HOTL	High-Occupancy/Toll Lane
HOVL	High-Occupancy Vehicle Lane
ITS	Intelligent Transportation Systems
LOS	Level of Service
ML	Mainlane
MOEs	Measures of Effectiveness
TMUTCD	Texas Manual on Uniform Traffic Control Devices
O-D	Origin-Destination
TTI	Texas Transportation Institute
TxDOT	Texas Department of Transportation

CHAPTER 1

INTRODUCTION

High-occupancy/toll (HOT) lanes offer drivers the option of traveling on a high-occupancy vehicle (HOV) lane for a toll, when they would normally not meet the occupancy requirements of the lane. These characteristics have led to the growing perception that HOT lanes offer both substantial revenue opportunities and a solution to popular concern about underused HOV lanes.

There are only five existing projects where HOV lanes have been converted to HOT lanes, and the www.valuepricing.org Internet site lists numerous cities that are in various stages of implementation *(1)*. Transportation departments and transit authorities are aware that there are complexities and costs associated with converting HOV lanes to HOT lanes and operating HOT lanes, but the exact nature and magnitude of these issues are generally unknown.

The complexities and costs associated with converting HOV lanes to HOT lanes necessitate detailed evaluations of such projects. Further, each project is case specific and the importance/relevance of the numerous factors that must be considered in an HOV lane to HOT lane conversion vary from one project to the next. Though detailed analysis of the factors is necessary prior to dedicating financial resources to such a significant transportation improvement, there is a need for a sketch-planning tool that can evaluate the multiple factors (quantitative and qualitative) involved in implementing a conversion project.

This research project evolved from more than two decades of experience with HOV lanes in Texas. The Texas Transportation Institute (TTI) has teamed with the Texas Department of Transportation (TxDOT) and the transit authorities in Houston and Dallas to perform ongoing, comprehensive evaluations of existing and proposed HOV lanes and HOT lanes since 1979. This research project captures the benefits of this extensive experience in a manner that is applicable not only to Texas projects, but readily applicable to HOV lane to HOT lane conversions everywhere.

1.1 PROJECT OBJECTIVES

When developing HOT START, the research team initially prepared a list of the most likely goals behind the conversion of an HOV lane to an HOT lane. These goals included:

- increase corridor mobility;
- generate revenue;
- improve air quality;
- provide travel options; and
- ensure public acceptance.

Researchers then developed a list of the primary measures of effectiveness (MOEs) of these goals and issues/elements that would prevent obtaining each goal. These items were then grouped into three main categories:

1. Identify, analyze, and quantify the *facility considerations* in a potential conversion of an HOV lane to an HOT lane. This objective includes those design, operations, and enforcement features or characteristics that would be essential and/or desirable for a successful HOT lane operation.
2. Identify, analyze, and quantify the *performance considerations* associated with a conversion of an HOV lane to an HOT lane. This objective includes how to best measure and predict the potential for a conversion project to accomplish the goals of the transportation agencies and communities involved in the project. These goals might include increasing person-movement, reducing congestion, generating revenue, providing travel options, and/or achieving other performance goals.
3. Identify, analyze, and quantify the *institutional considerations* in evaluating the appropriateness of converting an HOV lane to an HOT lane. This objective includes factors such as public acceptance, revenue use, interagency cooperation, and media relations.

In addition to the above categories, it was necessary to develop an appropriate mechanism (analytical tool) to allow public agencies to evaluate the *trade-offs* within and among the project objectives listed above. It is unlikely that any potential HOV lane project represents an ideal combination of features, demands and characteristics to assure success as an HOT lane. Satisfying this objective allows the analyst to assess the relative significance of trade-offs among facility, performance and institutional objectives and considerations in reaching decisions about the most appropriate decision. The result of developing this analytical tool is the HOT START software program.

1.2 RESEARCH ANALYSIS PROCEDURE

Because of the combined familiarity of TTI and TxDOT participants, the start-up and progress of the research progressed rapidly. The TTI team developed a lengthy list of factors that have been identified throughout the documented research as having had some demonstrated or suspected degree of impact on the HOV lane to HOT lane conversion. That list was consolidated to those that could have a meaningful bearing on the decision to convert.

Once the key factors were identified, described and bounded, the research focused on how to incorporate these relevant factors into an analysis of the whole set that was logical, comprehensive and explainable. That process took into account three dimensions for each factor:

- Weight—how significant or important is this factor relative to the goals of conversion,
- Score—how well does this factor compare to a desirable or minimum standard, and
- Interaction—how does this factor interact with other factors and how can that be captured quantitatively.

Each of these dimensions required comprehensive development, which is described in further detail elsewhere in this report (*2*).

With the large number of factors and detailed guidance associated with each, a hard copy workbook was not very practical, so the TTI team developed a software tool that accomplishes

two tasks: it guides the user through logical steps in the development of an assessment, and it performs all of the recording-keeping and calculations automatically. This model was envisioned from the outset of the project and has been developed in parallel with the technical details. A flowchart of the research activities is included as Figure 1-1.

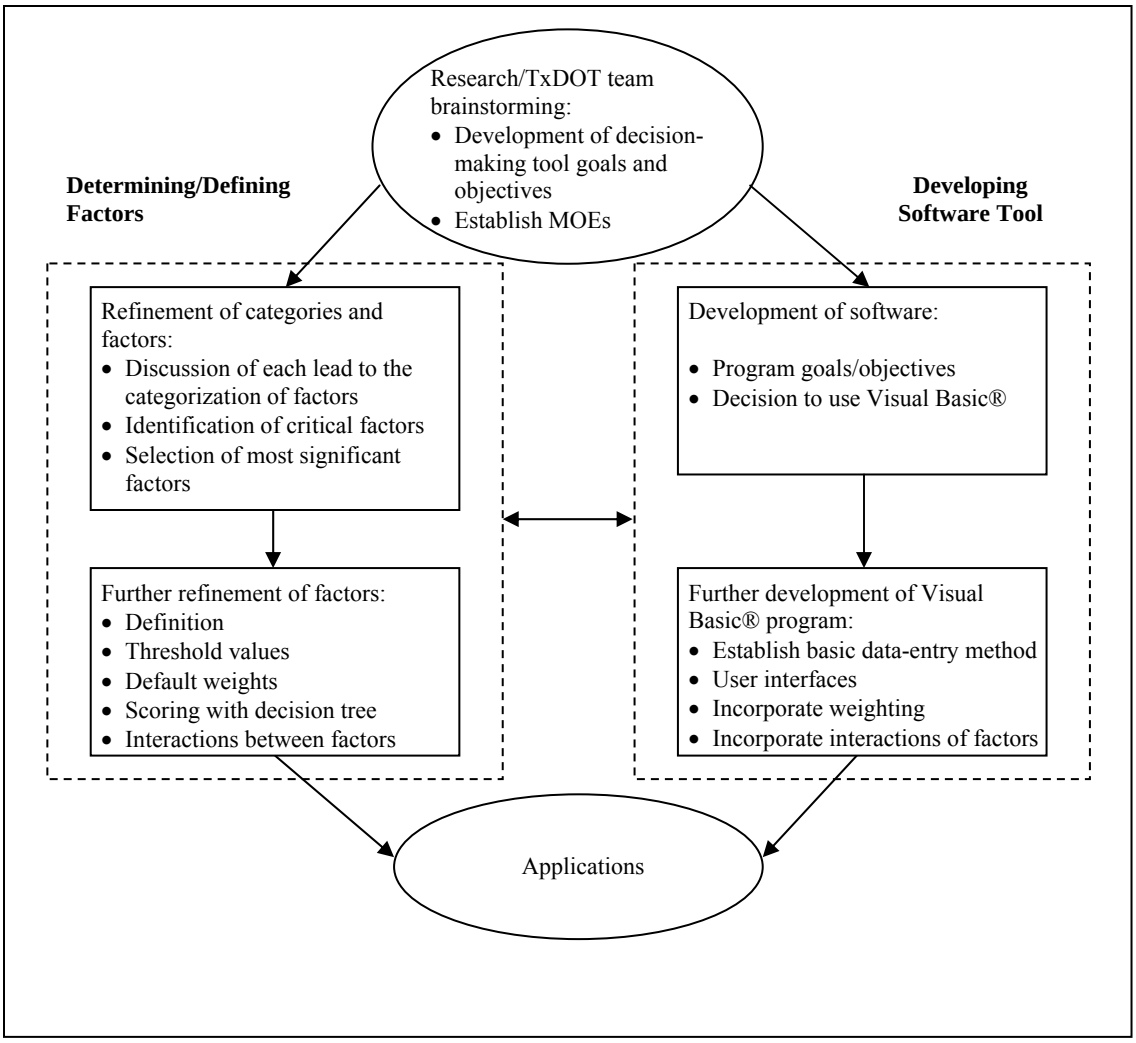


Figure 1-1. Flowchart of Research Activities to Develop HOV Lane to HOT Lane Conversion Tool

Figure 1-2 illustrates the analytical process. The "analyst" is assumed to be a staff person in a transportation organization who has access to routine design, operations, and performance information. Using that routine design, operations, and performance information, along with links embedded in the software program, the analyst prepares the analysis of the facility and performance categories, and prepares the input data for the institutional category of factors. While the analyst may conduct part of the institutional analysis, the final elements are likely left to a senior management individual who may be more likely to appreciate the political sensitivities and interagency cooperation issues. In the case of TxDOT, this individual is assumed to be the District Engineer, the ranking staff person over a geographic region of several

counties, though the duties could certainly be delegated. The analysis shown to the left of the vertical dotted line in Figure 1-2 is incorporated in HOT START.

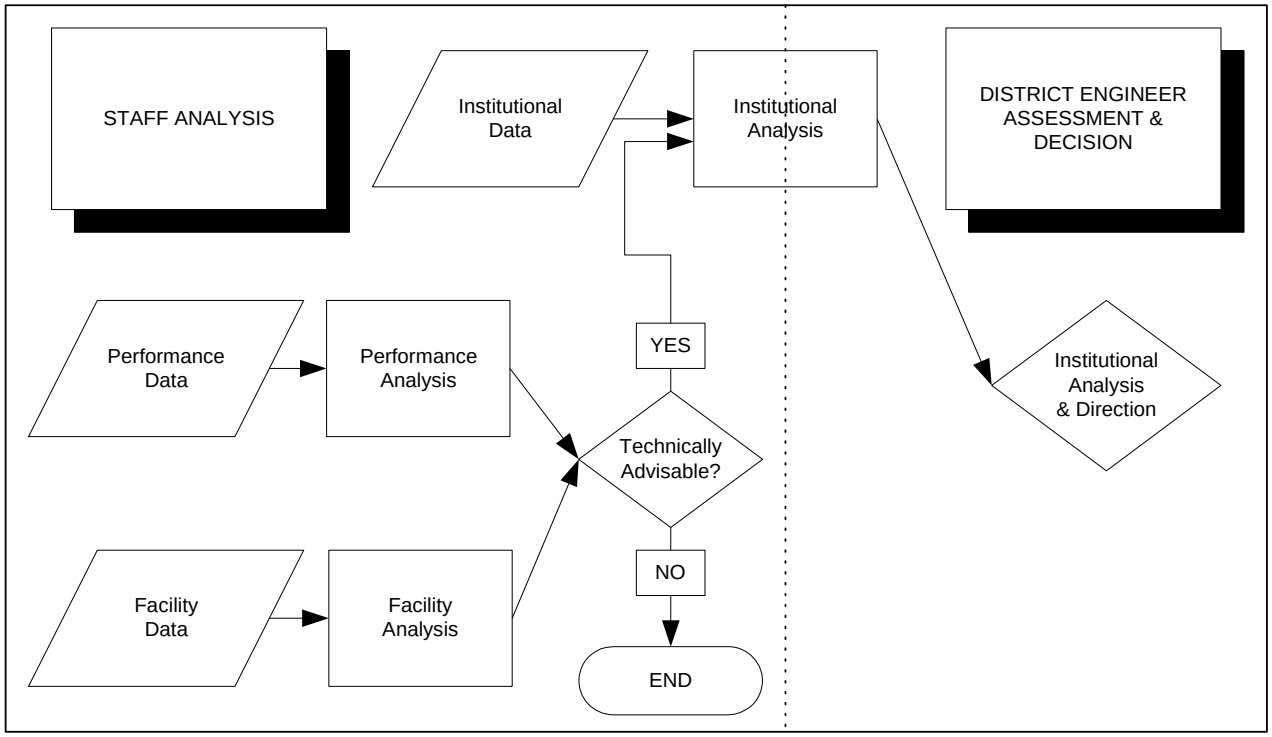


Figure 1-2. Decision Flowchart for Converting HOV Lanes to HOT Lanes

1.3 GUIDEBOOK ORGANIZATION

This Guidebook is organized into four chapters and three appendices, as described below.

- **Chapter 1: Introduction.** This chapter presents a brief introduction of the research and provides the framework within which the HOT START program was developed.
- **Chapter 2: HOT START Computer Requirements and Input Data Requirements.** This chapter describes the computer system requirements for the HOT START program and provides corridor/community information requirements for HOT START.
- **Chapter 3. Installing and Running the HOT START Software.** This chapter walks the analyst through an example use of the HOT START program including weighting and scoring all the factors and reviewing the results.
- **Chapter 4: References.** This section lists the references used in this report.
- **Appendix A.** Includes the facility, performance and institutional factors with definitions and default weights.

- **Appendix B.** Includes the scoring decision trees for all factors.

- **Appendix C.** Includes step-by-step instructions for creating and locking weighting profiles.

- **Appendix D.** Includes the interactions of facility and performance factors.

1.4 HOW TO USE THIS GUIDEBOOK AND HOT START

This Guidebook provides a guide for analysts using the HOT START analysis tool. The tool can be used to assist the user in analysis of the suitability of conversion from an existing or planned HOV lane to an HOT lane. It should be used to assess whether an HOT lane can be effectively implemented, given the HOV decision has already been made, and the potential it would have to serve or disserve users who have paid for a premium service. The tool is not intended to justify or validate the HOV lane.

In addition to providing system requirements and installation instructions, the Guidebook walks the analyst through an example that illustrates screen shots of the program throughout the example.

For initial applications, the analyst will benefit by going through this Guidebook in detail. The new user will also benefit from the appendices, which show details and definitions of factors as well as more detail on the decision trees for the factors used in the program.

On subsequent uses, the analyst may not need the Guidebook as often as they become more familiar with the HOT START program features.

The analyst using HOT START may also benefit from reviewing the full report for more details on the research (*2*).

CHAPTER 2

HOT START COMPUTER REQUIREMENTS AND INPUT DATA REQUIREMENTS

2.1 SYSTEM REQUIREMENTS

A computer with Microsoft Windows versions 9X/ME/NT/2000/XP is necessary to install the HOT START program.

Required:

- PC with 486 processor or greater
- Windows 9X or later operating system
- 40 MB available hard disk space
- Super VGA (1024x768) or higher resolution monitor

Recommended:

- Internet connection
- PDF file reader (Adobe Acrobat or equivalent)

Without an Internet connection or PDF file reader, certain help functions will be unavailable to the user, but an analysis can still be performed.

2.2 CORRIDOR/COMMUNITY INFORMATION REQUIREMENTS

To ease the data entry process, routine information about the design, operations, and performance of an HOV lane should be collected prior to using the HOT START program. A list of necessary resources is provided in Table 2-1. Tables 2-2 through 2-4 provide data collection forms for facility, performance, and institutional considerations, respectively. Detailed explanations of the factors the analyst will weigh and score can be found in Appendix A.

Tables 2-2 through 2-4 list each factor by category (facility, performance and institutional) in the order they appear in HOT START. The second column lists the main resources needed to answer the question prompts that HOT START asks to aid the user in determining the score. The numbers in this column refer to the resources listed in Table 2-1. The "Corresponding Scoring Decision Tree Table" column lists the figure in Appendix B that illustrates the scoring process for that factor. The "HOT START Questions" column is the information HOT START needs to determine the score while the "Answer Choices" column shows the form of the answer the user must enter into the program. Section 3.4.3 (Scoring Each Factor) explains more details about scoring.

Table 2-1. HOT START Resources Needed

Resource Number	Type	Description
1	Report	"Guide for High-occupancy Vehicle (HOV) Facilities." American Association of State Highway and Transportation Officials. Washington, D.C., 2004.
2	Report	Perez, B., and G. Sciara. "A Guide for HOT Lane Development." FHWA-OP-03-009FHWA, Federal Highway Administration, Washington, D.C., 2003.
3	Report	Cothron, A.S, D.A. Skowronek, and B.T. Kuhn, "Enforcement Issues on Managed Lanes." TTI Report 0-4160-11, January 2003.
4	Data	Corridor lane geometric design and measurements
5	Data	Corridor O-D patterns
6	Data	HOV ramp volumes and terminus volumes
7	Data	Weave volumes/Corridor volume (LOS)
8	Data	Current facility sign inventory, pricing points where new signs might be needed
9	Website	Census data: http://factfinder.census.gov
10	Website	State Implementation Plans for Texas: http://www.tceq.state.tx.us/nav/eq/sip.html
11	Plans	Plans for ITS implementation for toll collection and verification and incident management
12	Plans	Definition of primary or target users, i.e., express bus, long distance commuters, etc.
13	Plans	Ongoing maintenance and equipment resources for supporting operations: law enforcement, incident management, maintenance

Table 2-2. Data Collection Form – Facility Considerations

Factor	Resources Needed (Table 2-1)	Corresponding Scoring Decision Tree Table (Appendix B)	HOT START Questions	Answer Choices
Cross Section	1, 2	B-1	Does the design envelope satisfy AASHTO minimum requirements for the entire length?	Yes No
	4	B-1	If "No," what are lengths of unsatisfied sections?	<100 ft 100-1000 ft 1000 ft-1 mile 1 mi – ½ facility > ½ facility entire facility
Lane Separation for Toll Collection	1, 2	B-2	What type of lane separation exists?	Rigid Flexible Buffer
	1, 4	B-2	Are AASHTO guidelines satisfied for this type of separation?	Yes No
	11	B-2	Can tolls be collected?	Yes No
Facility Access Satisfies O-D Requirements	12	B-3	Are primary or target users defined?	Yes No
	5	B-3	If "Yes," are access points located to serve primary users?	Yes No
Facility Access Design	6	B-4	What type of access is provided?	At-grade slip ramp Direct connect ramp No designated access (continuous)
	4	B-4	If "At-grade slip ramp," is buffer/barrier opening length 1300-1500 ft?	Yes No
	N.A.	B-4	What is design year LOS on freeway?	C/D E/F
	7	B-4	What is weaving volume (HOV ramp entrance)?	less than 400 vph less than 250 vph
	7	B-4	Is up to 10 mph mainlane (ML) speed reduction for managed lane weaving allowed?	Yes No
	7	B-4	What is the minimum length of weaving distance per lane?	950 ft 900 ft 750 ft 700 ft 600 ft 650 ft 500 ft

Table 2-2. Continued

Factor	Resources Needed (Table 2-1)	Corresponding Scoring Decision Tree Table (Appendix B)	HOT START Questions	Answer Choices
Ability to Enforce	1, 2	B-5	What is operating scheme?	HOV free, SOV toll by electronic card. All toll, HOV reimbursed via business. All toll, HOV reimbursed via another electronic card.
	3	B-5	If "Pay by exception," how is occupancy check performed?	Stationary Roving
	4	B-5	If stationary, do enforcement areas conform to AASHTO?	Yes No
	4	B-5	How is occupation verification performed?	High speed Low speed
	11	B-5	Is there supporting technology (vehicle-based tag read units)?	Yes No
	13	B-5	Is there adequate law enforcement?	Yes No
Facility Traffic Control	12	B-6	Are target users defined?	Yes No
	8	B-6	If yes, are any special signing features to be used?	Yes No
	2, 8	B-6	Does sign placement conform to guidance?	Yes No
Pricing Strategy	11	B-7	Is there an operating policy for the HOT lanes?	Yes Partial No
Incident Management	1, 11, 13	B-8	Operational treatments for incident management that can be provided to assure travel time reliability	Tow truck, Emergency access points, CCTV, CMS, Speed monitoring (loops, AVI) None
Maintenance	4	B-9	Is the facility reversible?	Yes No
	13	B-9	Level of maintenance support available	Full Most Some None

Note: More information related to the descriptions and questions addressed by each factor can be found in Appendix A.

Table 2-3. Data Collection Form – Performance Considerations

Factor	Resources Needed (Table 2-1)	Corresponding Scoring Decision Tree Table (Appendix B)	HOT START Questions	Answer Choices
HOV Lane Utilization	N.A.	B-10	Percent buses (to be used to determine f_b for vphpl calculation)	
	N.A.	B-10	Type of terrain (to be used to determine f_b for vphpl calculation)	Level Rolling Mountainous
	N.A.	B-10	Vphpl on facility (non-toll-paying) = (autos + buses * f_b)/# lanes	<1200 1200-1400 >1400
	N.A.	B-10	Is LOS on general-purpose lane D, E, or F?	Yes No
	N.A.	B-10	Will conversion have a positive impact on the HOT lane?	Yes No
Travel Time	N.A.	B-11	What are the average travel time savings?	>1 min/mile & >5 min overall >0.25 min/mile & >2 min overall <2 min overall
	N.A.	B-11	Will there be a higher reliability of travel times on the HOT lane?	Yes No
	N.A.	B-11	Will the conversion create a negative impact on HOT lane(s) speed?	Yes No
Benefits	N.A.	B-12	How will the net agency/societal benefits change?	Increase No change Decrease
Willingness to Pay Tolls	9	B-13	Are there many high-income travelers?	Yes No
	N.A.	B-13	Are there other local toll facilities?	Yes No
	N.A.	B-13	If yes, are the tags interoperable?	Yes No
Safety	N.A.	B-14	Is there currently a high crash rate on the facility?	Yes No
	N.A.	B-14	How will HOT lanes affect the crash rate on the facility?	Increase Slight reduction No change Great reduction

Table 2-3. Continued

Factor	Resources Needed (Table 2-1)	Corresponding Scoring Decision Tree Table (Appendix B)	HOT START Questions	Answer Choices
Environment	10	B-15	Is facility in non-attainment area?	Yes No
	N.A.	B-15	How will conversion affect fuel use?	Increase No change Decrease
	N.A.	B-15	How will conversion affect emissions?	Increase No change Decrease

Note: More information related to the descriptions and questions addressed by each factor can be found in Appendix A.

Table 2-4. Data Collection Form – Institutional Considerations

Factor	Resources Needed (Table 2-1)	Corresponding Scoring Decision Tree Table (Appendix B)	HOT START Questions	Answer Choices
Public Acceptance	N.A.	B-16	Which of the following is the public familiar with?	Tolling ETC HOV Video enforcement
	N.A.	B-16	Which of the following does the public find acceptable?	Tolling ETC HOV Video enforcement
Political Acceptance	N.A.	B-17	Is there a political champion for conversion?	Yes No
	N.A.	B-17	Is there political familiarity with the conversion concept?	Yes No
	N.A.	B-17	Is there political support for conversion?	Yes No
	N.A.	B-17	Does conversion achieve statewide or national goals?	Yes No
Environmental Justice/Title VI Issues	9	B-18	Are low income/minority populations negatively affected by conversion?	Yes No
	N.A.	B-18	If Yes, are low income/minority populations involved in the planning process?	Yes No
	N.A.	B-18	Can a mitigation plan be developed?	Yes No
Revenue Use	N.A.	B-19	Is there agreement among agencies and the public on net revenue use?	Yes No
	N.A.	B-19	If No, does revenue use support public policy goals?	Yes No
	N.A.	B-19	If No, is revenue use determined by Federal requirement?	Yes No
Interagency Cooperation	N.A.	B-20	Do all agencies support the HOT lane concept?	Yes No
	N.A.	B-20	If No, are any agencies actively opposed to HOT lane concept?	Yes No

Table 2-4. Continued

Factor	Resources Needed (Table 2-1)	Corresponding Scoring Decision Tree Table (Appendix B)	HOT START Questions	Answer Choices
Media Awareness	N.A.	B-21	Is there media awareness and support?	Yes No Misrepresentation
	N.A.	B-21	If No, is media receptive to new ideas?	Yes No
Public Education/ Information	N.A.	B-22	What is the level of outreach efforts for public education and information?	Active Minimal None

Note: More information related to the descriptions and questions addressed by each factor can be found in Appendix A.

CHAPTER 3

INSTALLING AND RUNNING THE HOT START SOFTWARE

3.1 INSTALLING HOT START

The compact disk (CD) included with this Guidebook contains the HOT START program folder that contains three files: Setup.exe, Setup.ini, and Setup.msi. If the installation program does not automatically start when the CD is inserted into the CD drive, then navigate to this folder using Windows Explorer. Double click the Setup.exe file to begin the installation program. The installation program will prompt the user to select the desired location for the HOT START program.

After installation is complete, the user should view the Readme.txt file that is created in the HOT START program directory.

3.2 RUNNING HOT START

3.2.1 Getting Started

After HOT START has been saved to the user's computer, the user can simply click on the "HOT START.exe" file. The executable file has a small car icon (red) as shown in Figure 3-1, and when clicked, it will automatically start the program.

Figure 3-1. HOT START Icon

3.2.2 Introductory Screen

The user will first see an introductory screen as shown in Figure 3-2. This screen provides the vision and goals of an HOV lane to HOT lane conversion, and allows the user to mouse over the vision and goals for detailed descriptions. Disclaimers are also provided on the title page to illustrate the limitations and expectations of HOT START analysis.

Figure 3-2. HOT START Introductory Screen

The introductory screen also gives the user the option of starting a new analysis or loading an existing analysis. If the user selects the option to "Load Existing Analysis," a dialog box appears from which they can select the previously saved file from their computer. If the user selects "Start New Analysis," they are immediately asked whether they want to use the default weights for the factors within each category (facility, performance and institutional), as shown in Figure 3-3.

TIP: **Having trouble finding your existing analysis? The default location for saved HOT START files is the same directory in which the HOT START program is located.**

Weighting and scoring are used in this program as a way to compare alternatives for HOV lane to HOT lane conversion. Based on a community's needs and project specifics (e.g., political, public, operations, geometry), conversion may or may not be practical. This tool allows the analysts to compare alternatives for their unique community. It also allows the analysts to compare against what they feel is a desirable score. Weights should be understood as the quantitative value of the importance of each factor for any community in the analysts' jurisdiction, whereas the score for each factor represents how the particular project performs. The more important a factor is to the analyst, the heavier the weight should be. A high score for a factor denotes that the factor is satisfied while a low score means the factor is relatively unsatisfied. Weights are from 0 to 10 while scores range from -5 to 5.

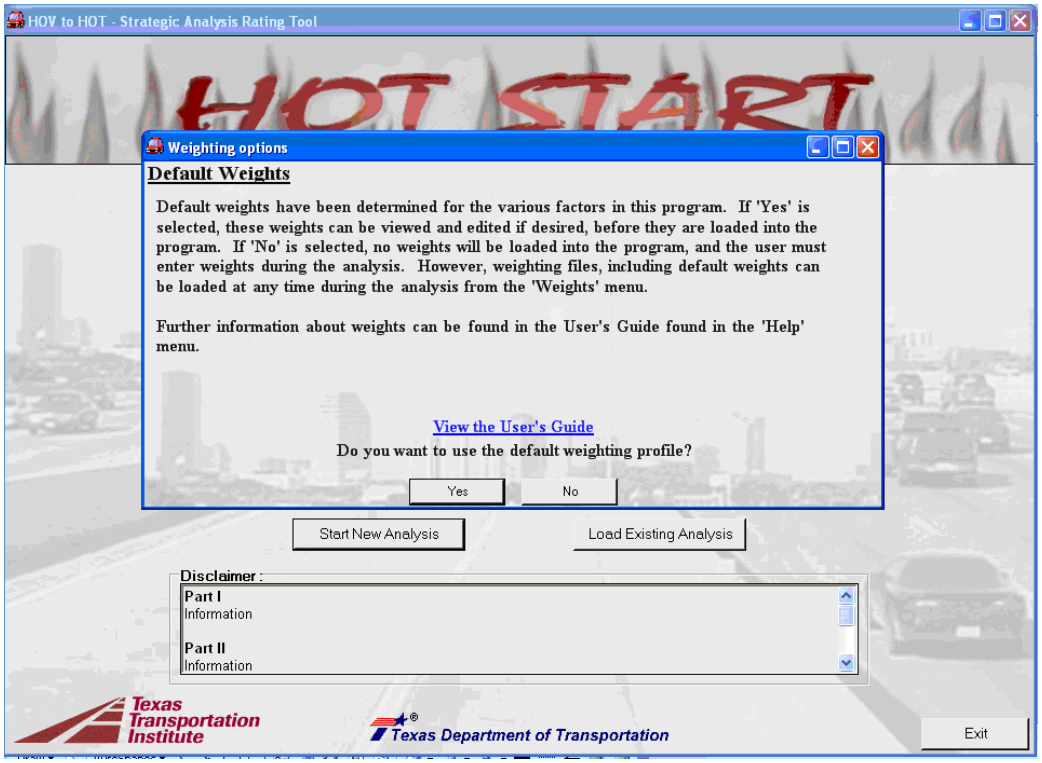


Figure 3-3. Weighting Profile Question Box

Selecting Weights (Using Default Values)

If the user elects to use the default weights, the screen shown in Figure 3-4 appears. Figure 3-4 illustrates the default weights for each of the nine facility factors, six performance factors and seven institutional factors. These default weights along with the detailed definitions are also shown in the tables in Appendix A. These 22 factors are used by the program to ultimately provide an assessment of the proposed HOV lane to HOT lane conversion. If the user is satisfied with the default weights, they can select "Accept Weights – Continue."

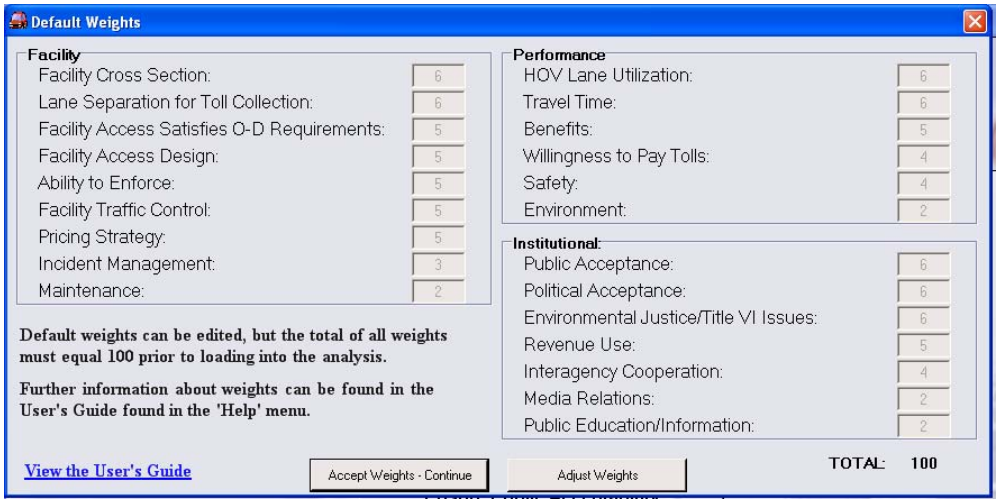


Figure 3-4. Default Weights for Critical Factors

If the user is not satisfied with the default weights, they can select the "Adjust Weights" button. The sum of the weights across the 22 factors must total to 100. If the weights do not sum to 100, the user is not allowed to continue to the next screen. The user can select "Accept Weights – Continue" when satisfied with the adjusted weights to continue with the analysis. As illustrated in Figure 3-5, "Restore Defaults" can be selected if the user wishes to use the default weights shown previously. Upon selecting this option, the user is sent to the General tab where general information for the analysis is entered (see Figure 3-6).

TIP: **Ready to save? At any stage in the software, the current analysis can be saved by going to File → Save Analysis… Additionally, the current weight profile can be saved by going to Weights → Save Weighting Profile…**

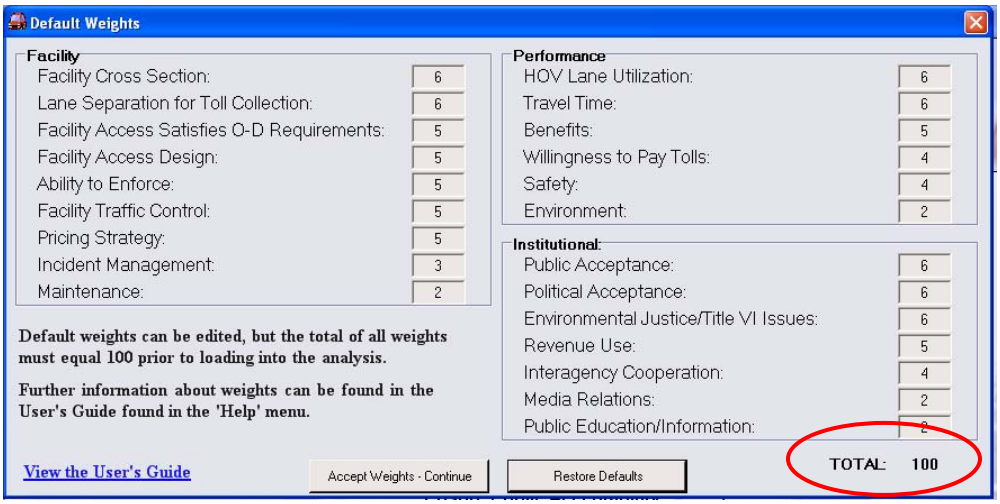


Figure 3-5. Restore Defaults Option When Adjusting Default Weights

TIP: **The above procedure is best for the experienced HOT START user. Inexperienced users should not select the default weights. Instead, they should review Section 3.4.1.**

Selecting Weights (Not Using the Default Values)

If the user selects "No" in response to loading the default weights (see Figure 3-3), the user is sent to the General tab where general information for the analysis is entered as shown in Figure 3-6.

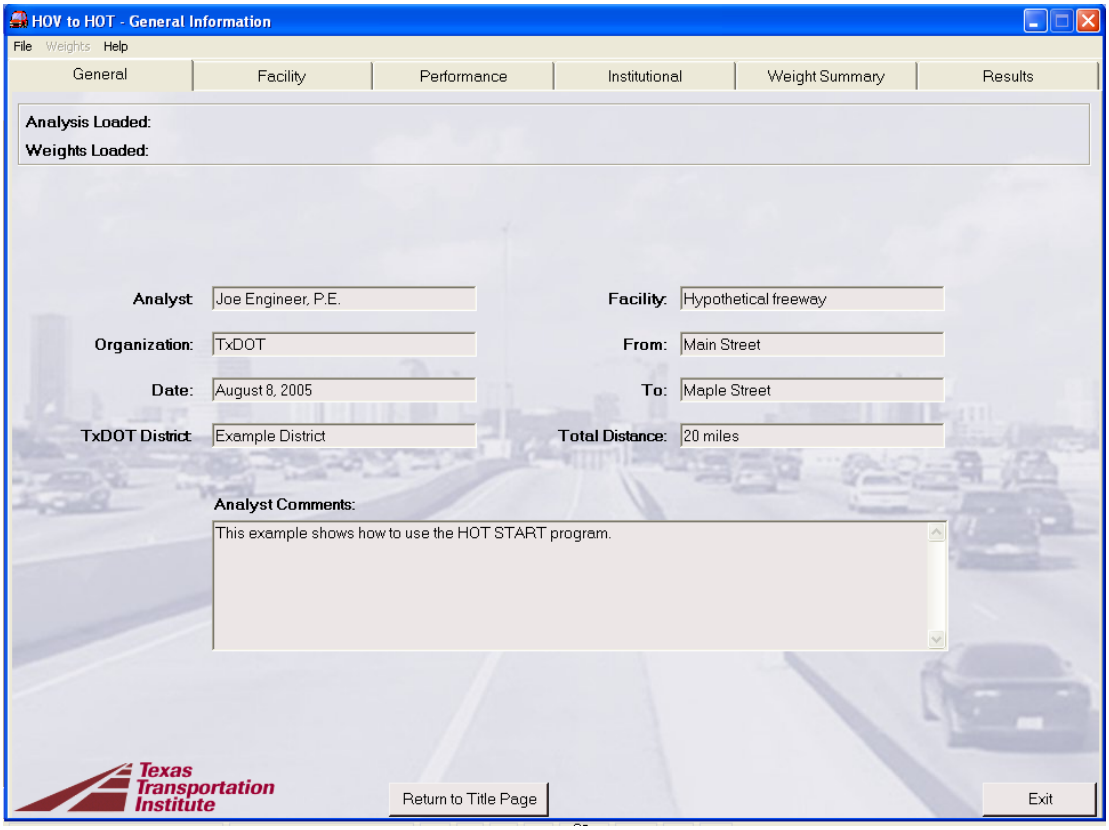


Figure 3-6. General Information Entry Page

3.3 ENTERING GENERAL INFORMATION

This page requests information that includes the analyst's name, organization, date, TxDOT district, facility name, limits of the analysis on the facility, total project distance and any additional comments. At the top of the page, HOT START illustrates the analysis and/or weights loaded from an existing file, if the user chose to either "Load an Existing Analysis" as shown in Figure 3-2 and/or to use the default weighting profile as shown in Figure 3-3.

TIP: **Because a new analysis was selected (see Figure 3-2), there are no filenames provided where it says "Analysis Loaded" and "Weights Loaded" in Figure 3-6. Had files been loaded, the names would appear in the blank space at the top of the screen.**

3.4 WEIGHTING AND SCORING EACH FACTOR

3.4.1 Weighting Each Factor

After entering the general information as illustrated in Figure 3-6, the user can toggle to the "Facility" tab to see Figure 3-7. There is a separate tab for each category of factors (facility, performance, and institutional). These tabs allow the user to focus attention on the aspects of

each category prior to moving to the next category of factors. The user simply clicks on the tab of interest.

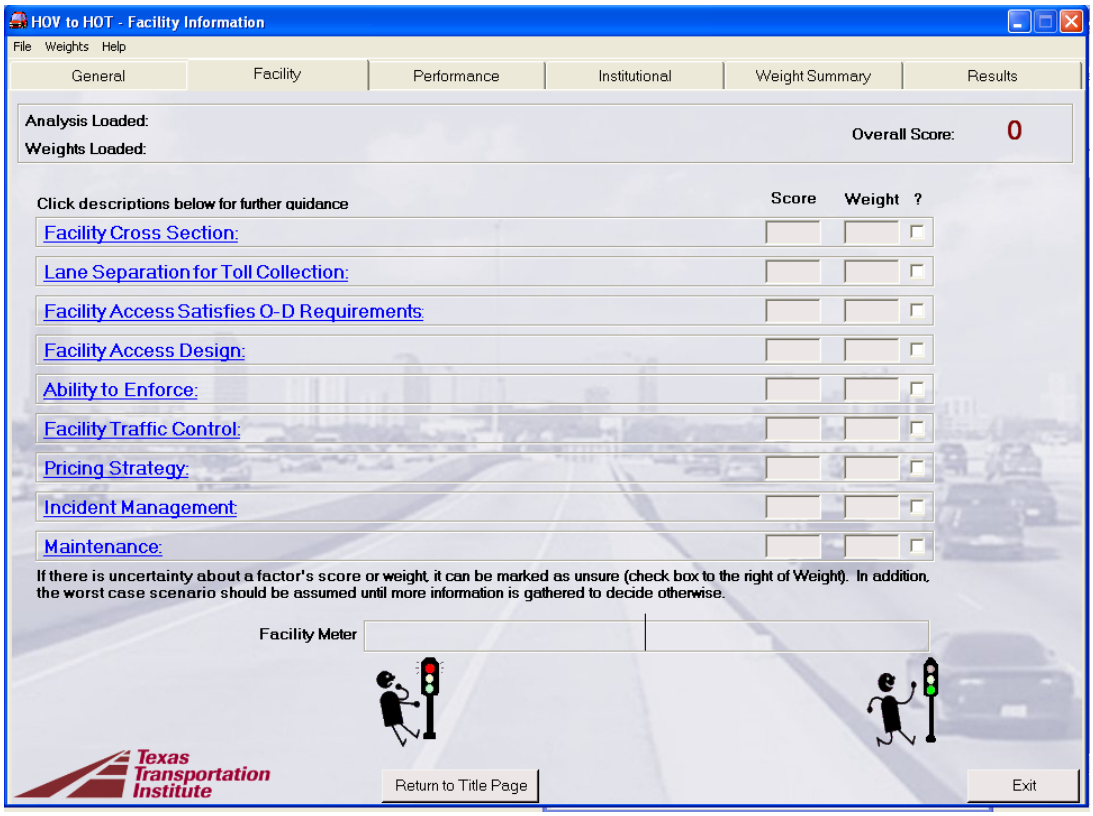


Figure 3-7. Facility Information

The inexperienced user will likely benefit from first inputting the weights of each factor (across all categories) and then scoring the factors. The discussion below describes the process with this assumption. Several features are shown in the "Facility" screen in Figure 3-7. First, each factor is highlighted in blue. By simply rolling the computer mouse over each factor name, a one-line description of the factor appears. The "weight" column is where the user can manually enter their assessment of how much weight each of the facility factors should have. Values from 1 to 10 are accepted. If the user chooses to use the default or adjusted weights (per Figures 3-3 through 3-5), these weights will automatically appear in these boxes.

The weighting profile can be saved anytime by going to "Weights" and then selecting "Save Weighting Profile." The HOT START program has established four weighting profile names: Austin, DFW, Houston, San Antonio. Whenever any one of these four weighting schemes is loaded, the weights are locked and cannot be changed. A note is also placed on the results page and the printed output indicating that these weights were used.

Files cannot be saved under these names from the HOT START program. The current weighting profile names serve as a placeholder. In the future, after TxDOT personnel develop these profiles for the region of interest, the weighting file can be created by editing the default weight file in Notepad, and saving it under the appropriate name in the HOT START directory.

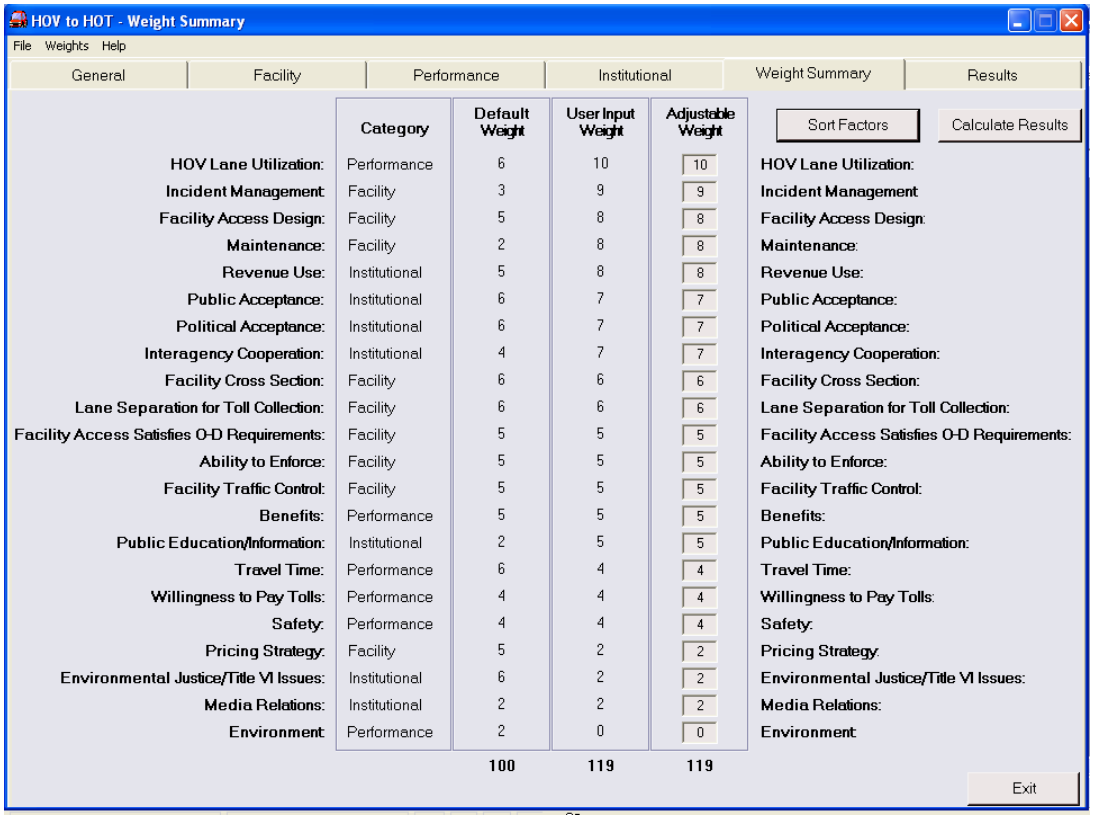
Alternatively, the weights can be entered into the HOT START program, and then saved under a temporary name. The user can then go into Windows Explorer and change the temporary name of the file to one of the four priority names.

TIP: **For step-by-step instructions on creating weighting profiles for Austin, DFW, Houston, or San Antonio, check out Appendix C.**

The other elements shown in Figure 3-7—factor scoring and factor descriptions—are described in Section 3.4.3 "Scoring Each Factor."

3.4.2 Weight Summary

After the analyst enters their assessment of the weights for each category, the user can click on the "Weight Summary" tab and Figure 3-8 will appear. This figure illustrates several useful columns of information. Each factor is listed in the first and last columns. The second column shows whether the factor is related to facility, performance, or institutional. The default weights are shown in the third column for reference, while the fourth column shows the user input weights. The adjustable weight column gives the user the opportunity to adjust the weights as necessary to make sure they sum to 100.



	Category	Default Weight	User Input Weight	Adjustable Weight	
HOV Lane Utilization:	Performance	6	10	10	HOV Lane Utilization:
Incident Management:	Facility	3	9	9	Incident Management:
Facility Access Design:	Facility	5	8	8	Facility Access Design:
Maintenance:	Facility	2	8	8	Maintenance:
Revenue Use:	Institutional	5	8	8	Revenue Use:
Public Acceptance:	Institutional	6	7	7	Public Acceptance:
Political Acceptance:	Institutional	6	7	7	Political Acceptance:
Interagency Cooperation:	Institutional	4	7	7	Interagency Cooperation:
Facility Cross Section:	Facility	6	6	6	Facility Cross Section:
Lane Separation for Toll Collection:	Facility	6	6	6	Lane Separation for Toll Collection:
Facility Access Satisfies O-D Requirements:	Facility	5	5	5	Facility Access Satisfies O-D Requirements:
Ability to Enforce:	Facility	5	5	5	Ability to Enforce:
Facility Traffic Control:	Facility	5	5	5	Facility Traffic Control:
Benefits:	Performance	5	5	5	Benefits:
Public Education/Information:	Institutional	2	5	5	Public Education/Information:
Travel Time:	Performance	6	4	4	Travel Time:
Willingness to Pay Tolls:	Performance	4	4	4	Willingness to Pay Tolls:
Safety:	Performance	4	4	4	Safety:
Pricing Strategy:	Facility	5	2	2	Pricing Strategy:
Environmental Justice/Title VI Issues:	Institutional	6	2	2	Environmental Justice/Title VI Issues:
Media Relations:	Institutional	2	2	2	Media Relations:
Environment:	Performance	2	0	0	Environment:
		100	119	119	

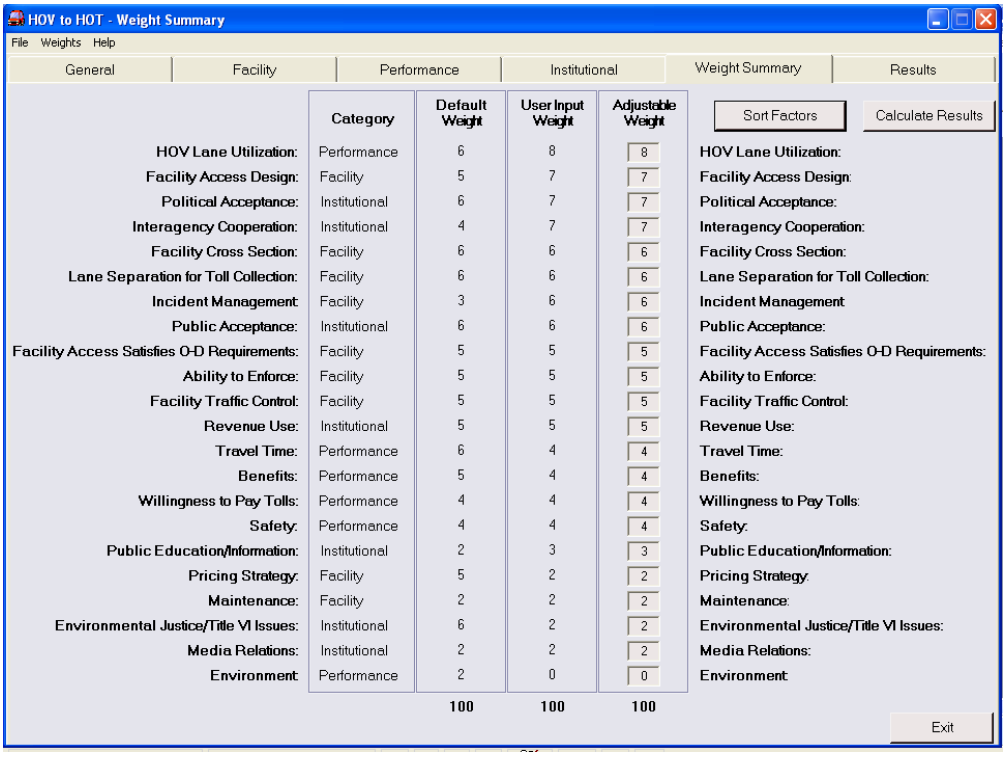
Figure 3-8. Weight Summary with Initial User Inputs

Note that in Figure 3-8 the adjustable weights sum to 119. If the user tries to continue, a message box appears as shown in Figure 3-9 to let the user know of the error.

TIP: **Wondering what the big concern is with the weights? The weights assigned by the user reflect the importance of an individual factor for a community. By making this weighting process rigorous, the user is compelled to reconsider the importance of individual factors until a community-acceptable ranked order is determined.**

Figure 3-9. Error Message for Weight Sum

When the weights are adjusted, the user can click on "Sort Factors" to get the list of factors reordered from highest to lowest weighting. Figure 3-10 shows the initial weights shown in Figure 3-8 after they are readjusted to sum to 100. After the weights sum to 100, the user is ready to go back to the Facility tab to begin scoring each factor.



	Category	Default Weight	User Input Weight	Adjustable Weight	
HOV Lane Utilization:	Performance	6	8	8	HOV Lane Utilization:
Facility Access Design:	Facility	5	7	7	Facility Access Design:
Political Acceptance:	Institutional	6	7	7	Political Acceptance:
Interagency Cooperation:	Institutional	4	7	7	Interagency Cooperation:
Facility Cross Section:	Facility	6	6	6	Facility Cross Section:
Lane Separation for Toll Collection:	Facility	6	6	6	Lane Separation for Toll Collection:
Incident Management:	Facility	3	6	6	Incident Management:
Public Acceptance:	Institutional	6	6	6	Public Acceptance:
Facility Access Satisfies O-D Requirements:	Facility	5	5	5	Facility Access Satisfies O-D Requirements:
Ability to Enforce:	Facility	5	5	5	Ability to Enforce:
Facility Traffic Control:	Facility	5	5	5	Facility Traffic Control:
Revenue Use:	Institutional	5	5	5	Revenue Use:
Travel Time:	Performance	6	4	4	Travel Time:
Benefits:	Performance	5	4	4	Benefits:
Willingness to Pay Tolls:	Performance	4	4	4	Willingness to Pay Tolls:
Safety:	Performance	4	4	4	Safety:
Public Education/Information:	Institutional	2	3	3	Public Education/Information:
Pricing Strategy:	Facility	5	2	2	Pricing Strategy:
Maintenance:	Facility	2	2	2	Maintenance:
Environmental Justice/Title VI Issues:	Institutional	6	2	2	Environmental Justice/Title VI Issues:
Media Relations:	Institutional	2	2	2	Media Relations:
Environment:	Performance	2	0	0	Environment:
		100	100	100	

Figure 3-10. Weight Summary after Adjusting User Weights to Sum to 100

3.4.3 Scoring Each Factor

After the weights are adjusted to sum to 100, the user can go back to the "Facility" tab to begin scoring each factor (see Figure 3-7). The score of each factor reflects how well the facility satisfies the factor. When the user clicks on any given factor, HOT START prompts the user to provide information that will establish the score for a given factor. Figure 3-11 shows the completed prompting questions for the "Facility Cross Section" factor. In this example, the final score is a "-1." The decision-scoring trees for which this feature of HOT START is based can be found in Appendix B. For example, the decision-scoring tree corresponding to Figure 3-11 is shown in Figure B-1 of the Appendix.

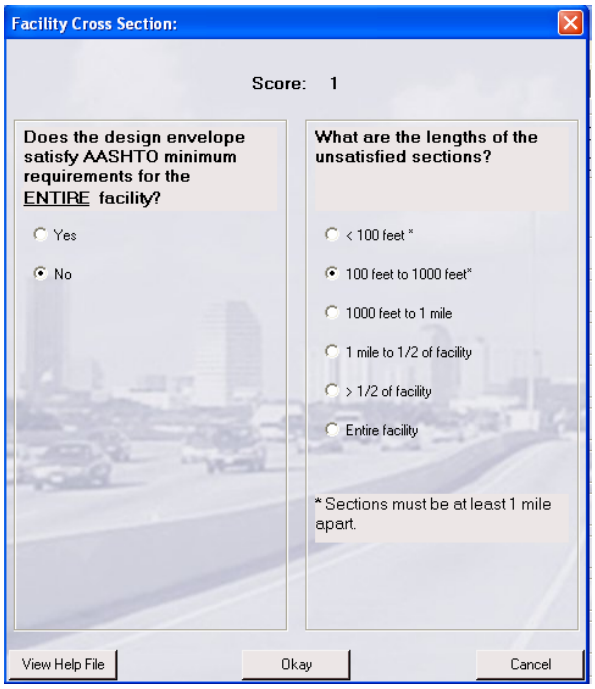


Figure 3-11. Example Question Prompts for Scoring the "Facility Cross Section" Factor

If the analyst is familiar with the program and question prompts are not needed, the scores for each factor can also be entered manually by typing the score in the score box.

Figure 3-12 shows the Facility tab after the scoring has been done for each factor. A checkmark appears to the left of each factor after the scoring has been completed. At the bottom of the page, HOT START presents a qualitative assessment (meter with a colored scale) of the category (facility, performance, or institutional) based on the scores entered for each factor. An overall score is also shown in the upper right corner. The overall score is the sum of the values for each category (205 in Figure 3-12). Figures 3-13 and 3-14 show the completed screens for the performance factors and institutional factors, respectively.

Note that the first two factors of the Facility tab in Figure 3-12 have caution symbols next to them (to the left) and their weights and scores are red. They also have a checkmark in the "?" column. This feature of HOT START is discussed later in the "Flagging Uncertainty" section.

TIP: **Not initially certain about scoring a particular factor? Just select the box in the "?" column. Read Section 3.4.3 "Flagging Uncertainty" and Section 3.5 for more information about this feature! Another suggestion is to continue the analysis by assuming the worst case for unknown factors.**

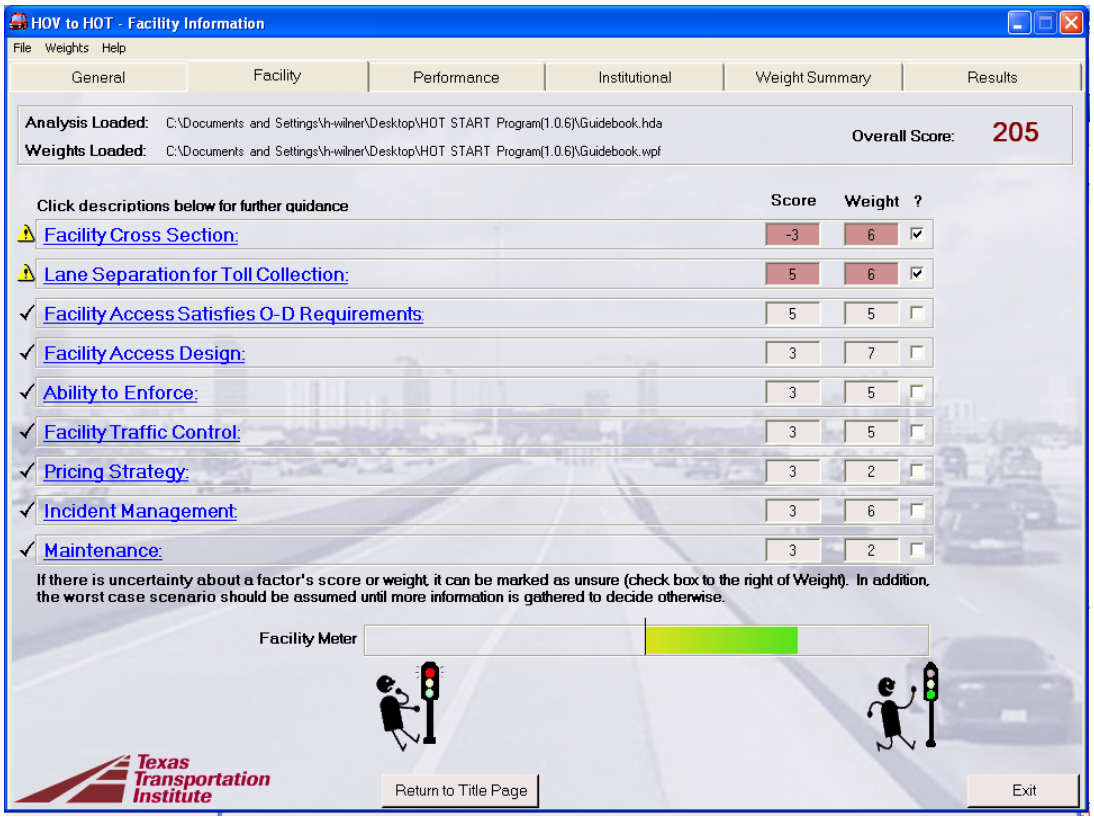


Figure 3-12. Scored Facility Factors

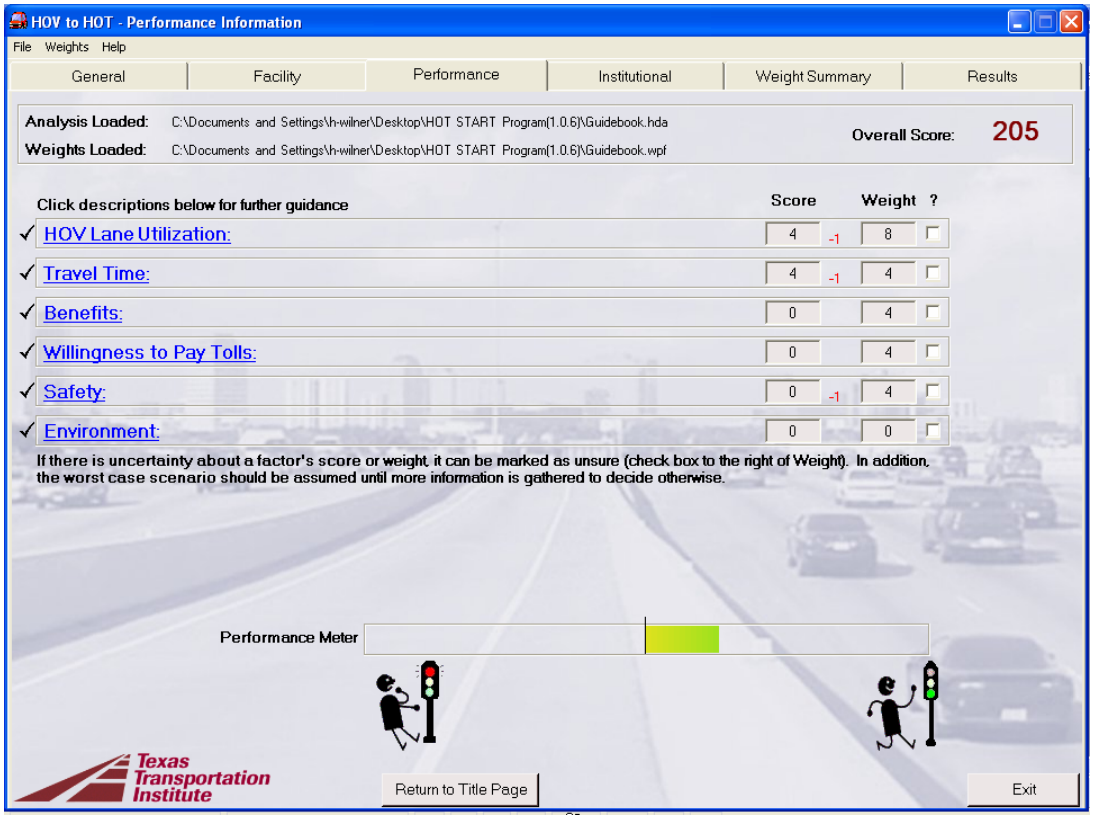


Figure 3-13. Scored Performance Factors

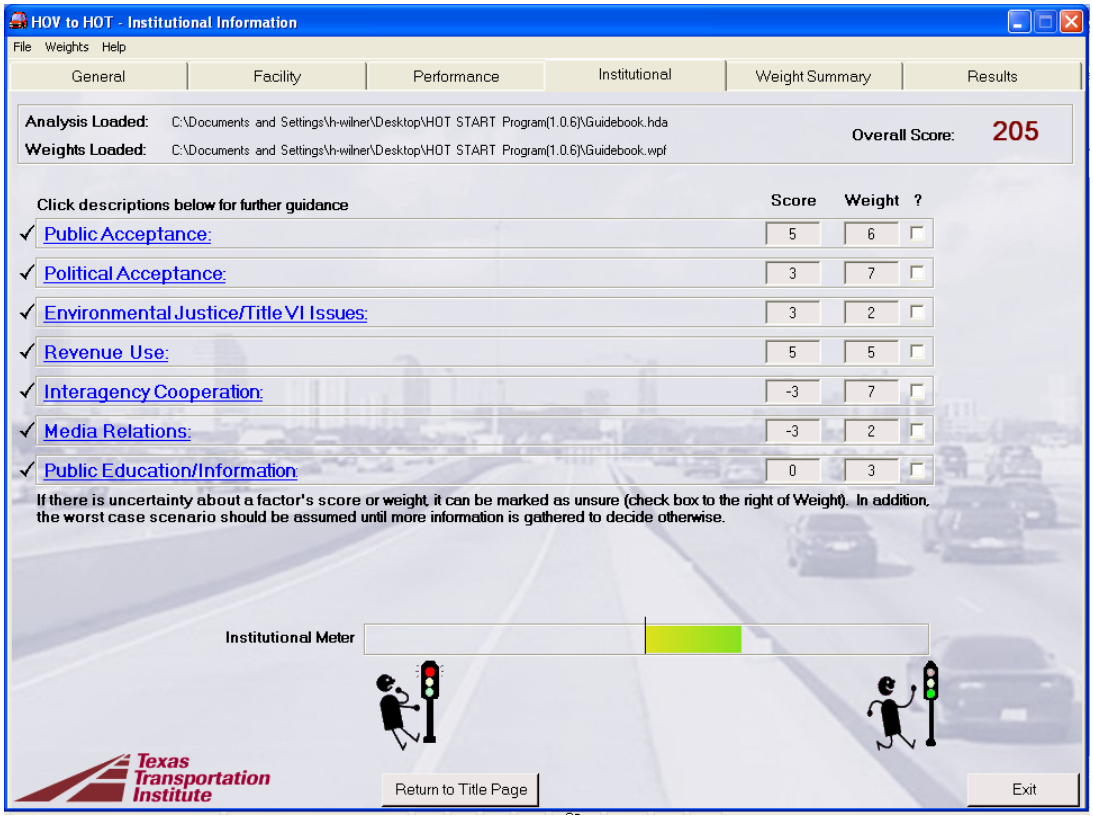


Figure 3-14. Scored Institutional Factors

Accounting for Effects of Factor Interactions

The score of some factors can have an impact on other factors. For example, it is intuitive that a poor (narrow) facility cross section would have a negative impact not only on the cross section factor, but on several performance factors as well. The narrow cross section would likely reduce the vehicle capacity of the lane, thereby reducing HOT lane utilization. It could also increase the crash rate, decrease average travel speeds, and decrease the traveler's willingness to pay to use the lane. HOT START automatically accounts for these types of effects as illustrated in Figure 3-13.

Note that there are red negative numbers in Figure 3-13. Adjacent to the scores for the "HOV Lane Utilization," "Travel Time," and "Safety" factors, a red "-1" is shown. Red numbers appearing in this area are the result from interactions of factors between the specified factor and an entry that was input into the facility factors. In this case, the "Facility Cross Section" in the Facility tab (Figure 3-12) was scored a "-3," which results in interaction effects for "HOV Lane Utilization," "Travel Time," and "Safety" (Figure 3-13) that reduces the scores by 1 point. The user can move the mouse over these numbers to see a description of where the interaction effect is located. Appendix D contains tables that quantitatively demonstrate and discuss the effects of the interactions.

Flagging Uncertainty

It is likely that the analyst running HOT START would need to obtain information from other individuals, and therefore, may need to check some of the question marks and come back to those factors. Figure 3-12 shows an example of the Facility tab with the first two factors marked as uncertain. HOT START reminds the analyst to return to these marked factors by devoting a section to them in the Results page as discussed in the next section (Section 3.5).

After the factor scoring is completed, the user is ready to compute and interpret the results.

3.5 COMPUTING AND INTERPRETING HOT START RESULTS

After the scores and weights have been entered for all factors, the user can click on the "Weight Summary" tab at the top of HOT START. The screen shown in Figure 3-10 will reappear. The user simply clicks on "Calculate Results" to compute the results of the analysis.

Figure 3-15 shows page 1 of 3 of the HOT START results. This page is called "Resulting Scores." As with the other pages in HOT START, if analysis and/or weight files were loaded, they are shown at the top of the page. Along the right side of this page is the overall score (39) shown in bold underline. The scores for each sub-category of the overall score are also shown as facility score (-67), performance score (23), and institutional score (83). This allows the analyst to assess the relative contribution of each category to the overall score. A bar chart graphically shows the scores as well as other important information. This is discussed in more detail in the *Interpreting and Using the Results* section.

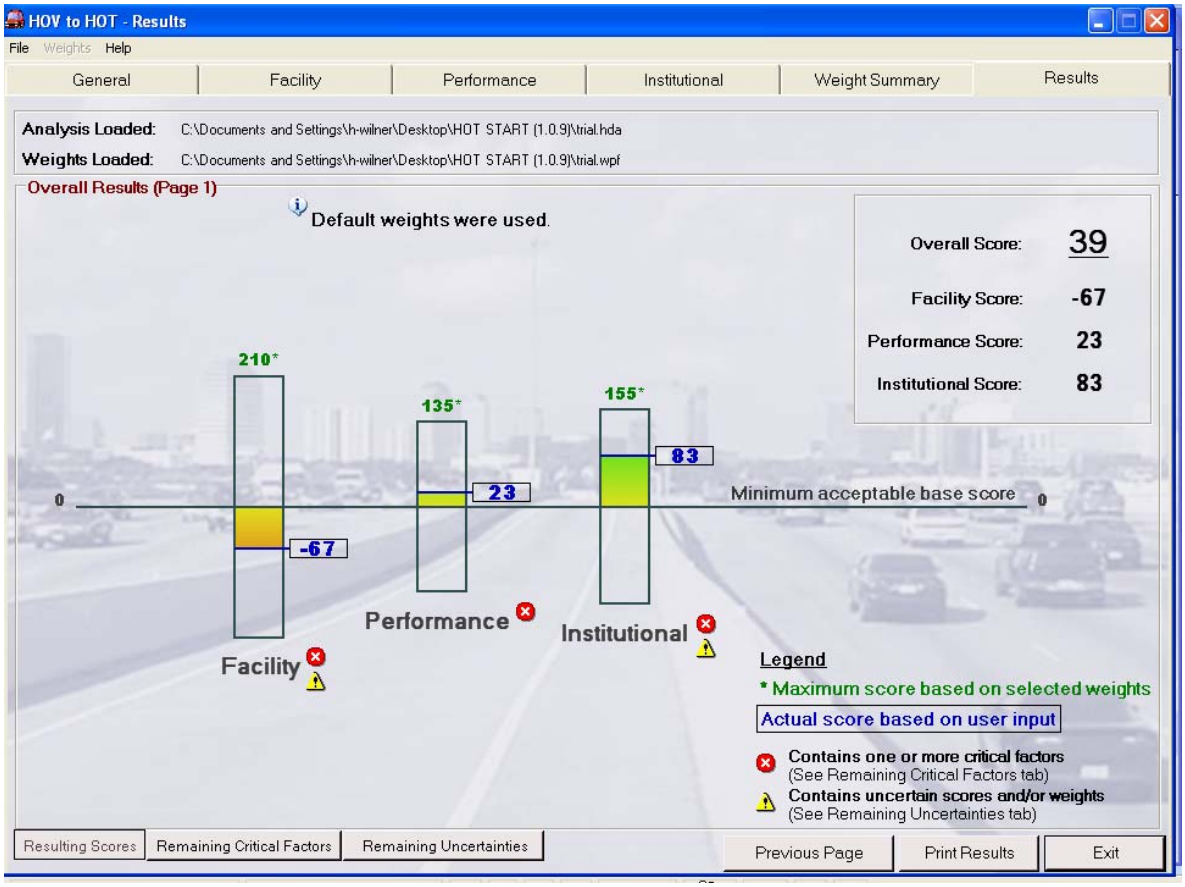


Figure 3-15. Page 1 of 3 of HOT START Results

In this example, there are critical and uncertain factors. These are specifically identified in the other pages of the results. Page 2 of the results (Figure 3-16) shows the general information entered (Figure 3-4) in the beginning as well as the specific factors needing to be addressed. This page is called "Remaining Critical Factors."

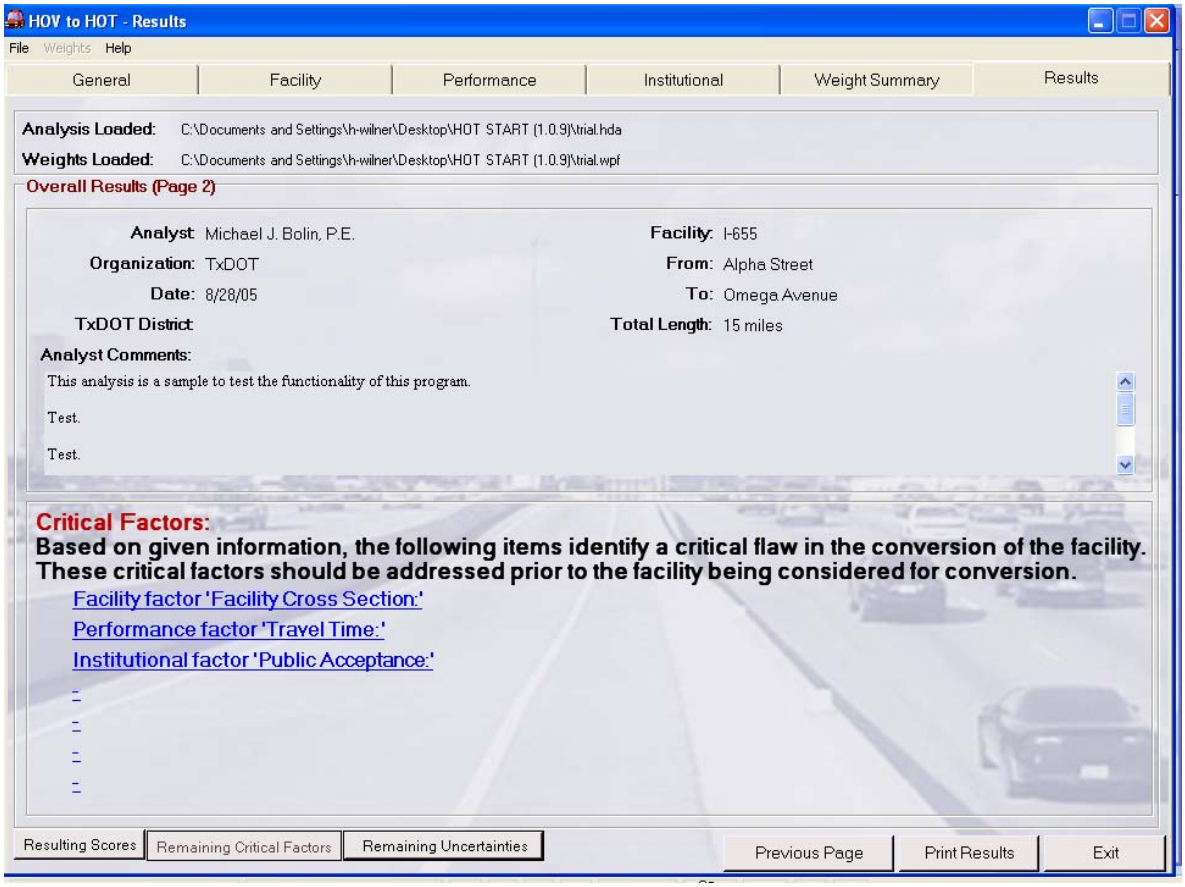


Figure 3-16. Page 2 of 3 of HOT START Results

In the middle of the screen, critical factors are identified in blue, if appropriate. This area is blank when there are no critical factors to be addressed.

Page 3 of the HOT START results is shown in Figure 3-17. Primarily, the third page of the results highlights to the analyst any factors in which no score has been indicated. In the "Facility Issues" section of this figure, it can be seen that the factors that were marked with the question mark (see Figure 3-12) are identified. This page is called "Remaining Uncertainties."

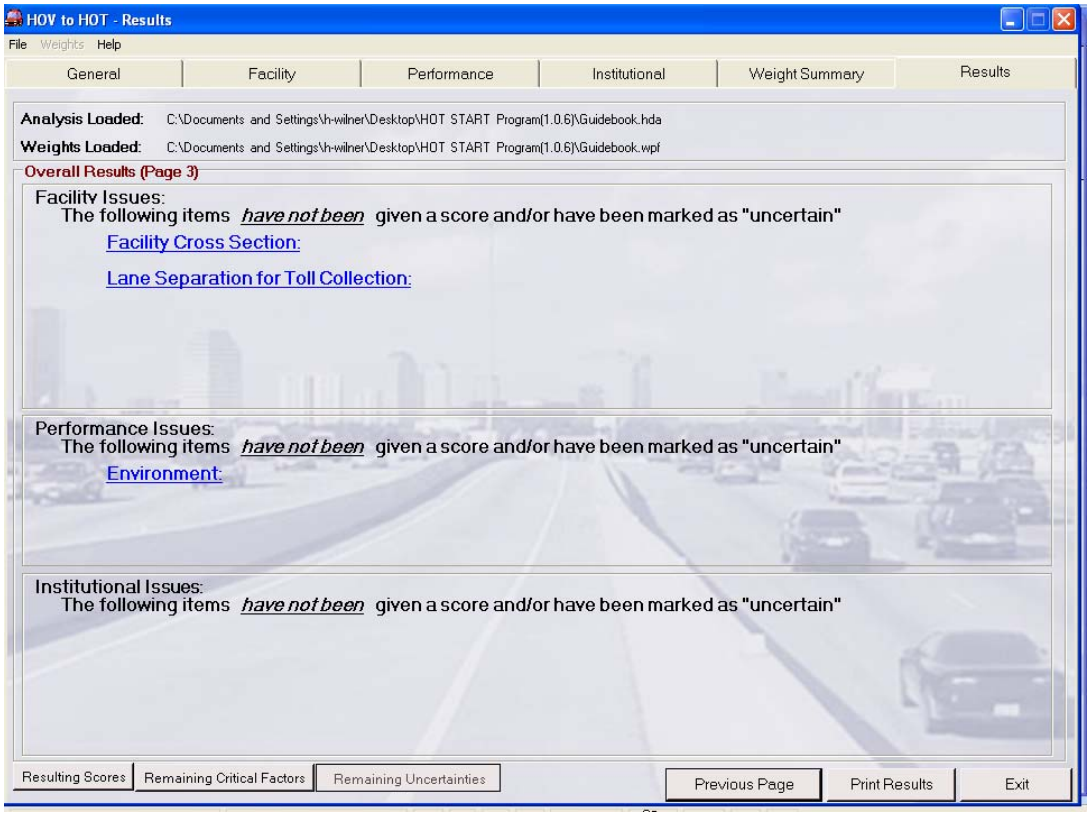


Figure 3-17. Page 3 of 3 of HOT START Results

After calculating the results, HOT START allows the analyst to print both the results and the analysis.

Interpreting and Using Results

The results of HOT START will not produce go/no-go indicators, at least not by themselves. These results are not decision-makers themselves, but rather indicators of the potential positive or negative impacts of a conversion. The presence of low scores or warning indicators may be more reliable as cautions than high scores are as indicators of success. There are three measures to consider: the overall score, a review of critical factors, and uncertainties.

The overall score is presented in three columns, reflecting the three categories of factors considered. Figure 3-15 shows an example. There are three germane values in each column. The value at the top of each column, denoted with green font and an asterisk (*), is the ideal (maximum) score for that column based on weights chosen by the analyst at the beginning. The minimum possible score is simply the negative of the ideal score. For example, in Figure 3-15, the ideal score for Facilities is 210. The minimum possible score for Facilities must be -210. The height of each column provides a visual depiction of the combined weight assigned by the analyst for each of the categories.

The second important value is the category (actual) score. This value is shown in blue and has a box around it. In Figure 3-15, the category score for the facilities category is -67. This

value will typically be smaller than the ideal. Intuitively, the closer the actual score is to the ideal, the more reliable the conclusion that the HOT lane conversion is wise.

It should be noted that the overall score could be above the minimum and still contain unacceptable factors, thus the second measure: critical factors. In the course of the analysis there may have been important factors that received unacceptably low scores. These factors then appear on the Critical Factors section of the output (Figure 3-16). While their relevant category may not have a low score overall, the presence of a critical issue should signal to the analyst that the issue must be resolved to achieve a successful conversion.

The third measure to be considered is remaining uncertainties as shown in Figure 3-17. In HOT START, factors marked as uncertain are treated the same way as zero-scoring factors. They neither increase nor decrease the specific category and overall scores. However, this should not deflect from the program's capability to identify vulnerabilities associated with the project in these very early, conceptual stages.

Therefore, either an unacceptable overall score or irresolvable critical factors should serve as bold cautions for the analyst.

3.6 PRINTING

The analysis and/or the results can be printed by going to the "File" dropdown menu as shown in Figure 3-18.

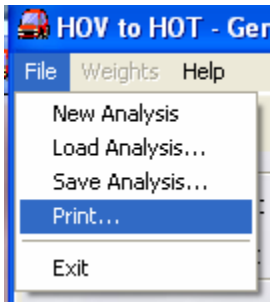


Figure 3-18. "Print" Option in the "File" Menu

When "Print" is selected, a text box as shown in Figure 3-19 appears providing several printing options including printing of only the analysis, only the results, or both.

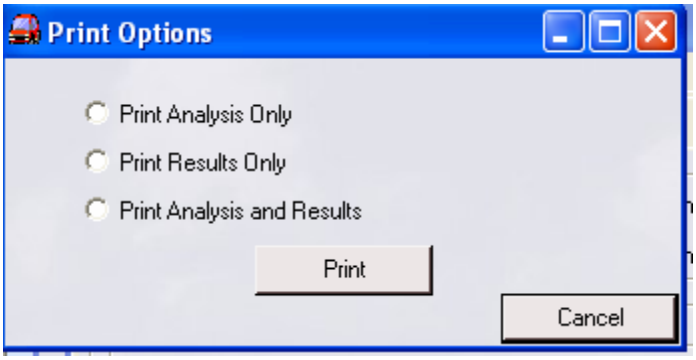


Figure 3-19. Printing Options Textbox

After selecting "Print," the user is directed to a print menu where they can specify information such as the printer to be used and the number of pages.

3.7 HELP MENU

At any point during the analysis, if the users need help, they can go to the "Help" dropdown menu as shown in Figure 3-20. From this menu, the user can choose to view the research report, view the *A Guide for HOT Lane Development* (3), view the Data Collection Form which describes the data that must be gathered for the analysis, view this guide, or get general information about the HOT START program. All but the last item are documents or in Acrobat Reader.

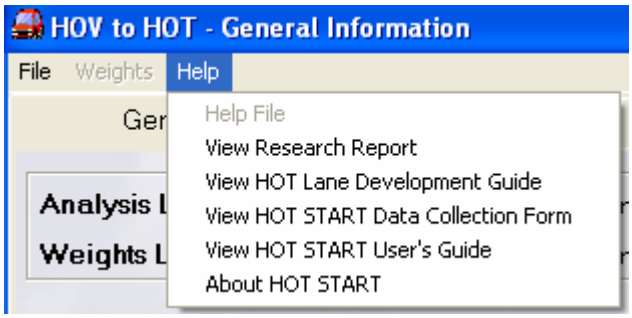


Figure 3-20. "Help" Dropdown Menu

Another way the user can get help is by selecting the "View Help File" button as shown in the lower left corner of Figure 3-11. Additionally, similar buttons appear throughout the program for the user.

CHAPTER 4

REFERENCES

1. http://www.valuepricing.org, Projects, accessed 7/29/05.

2. Eisele, W.L., H.T. Wilner, M.J. Bolin, W.R. Stockton, M.W. Burris, J. Winn, L. Xu, G. Goodin, T. Collier, and M. Hoelscher. "Criteria for Adapting HOV Lanes to HOT Lanes." Texas Transportation Institute Research Report 0-4898-1. Sponsored by the Texas Department of Transportation. Collect Station, Texas, October 2005. DRAFT.

3. Perez, B., and G. Sciara. "A Guide for HOT Lane Development." FHWA-OP-03-009FHWA. Federal Highway Administration. Washington, D.C., 2003.

4. "Guide for High-Occupancy Vehicle (HOV) Facilities." American Association of State Highway and Transportation Officials. Washington, D.C., 2004.

5. Fitzpatrick, K., M.A. Brewer, and S. Venglar. "Managed Lane Ramp and Roadway Design Issues." Texas Transportation Institute Research Report 0-4160-10. Sponsored by the Texas Department of Transportation. College Station, Texas, January 2003.

6. Chrysler, S.T., A. Williams, S.D. Schrock, and G. Ullman. "Traffic Control Devices for Managed Lanes." Texas Transportation Institute Research Report 0-4160-16. Sponsored by the Texas Department of Transportation. College Station, Texas, April 2004.

APPENDIX A

FACILITY, PERFORMANCE AND INSTITUTIONAL FACTORS WITH DEFINITIONS AND DEFAULT TTI WEIGHTS

Table A-1. Facility Factors when Considering HOV Lane to HOT Lane Conversion

Factor	Description and/or Question(s) Addressed	Default Weight
Facility Cross Section	This factor is concerned with the design envelope available along the proposed HOT lane. The American Association of State Highway and Transportation Officials (AASHTO) *Guide for High-Occupancy Vehicle (HOV) Facilities* (4) provides examples of cross sections for barrier- and buffer-separated HOV facilities. These cross sections, including lane width and shoulder width, are typically applicable to HOT facilities. Typical questions include: • Is there adequate space to bypass a disabled vehicle? • For buffer-separated facilities, is there adequate space for a vehicle to avoid an encroaching vehicle?	6
Lane Separation for Toll Collection	This factor is concerned with the adequacy of lane separation between HOT and general-purpose lanes to support tolling operations. Three types of lane separation can be considered, each with advantages and drawbacks: • Rigid barrier – concrete barrier separates HOT lane from general-purpose lanes (GPL) • Flexible barrier – also known as plastic channelizers, pylons, or candlesticks separating HOT from GPL • Buffer – Striped separation, varies in width and may consist of "double double" lines or raised pavement makers	6
Facility Access Satisfies O-D Requirements	The principal consideration for this factor is, "Do the access points serve potential HOT lane demand?" Answering this question begins with defining the primary or target users of the facility. HOV lanes are designed to serve buses, carpools and long-distance commute trips. If the facility becomes an HOT lane, will these still be the primary users? Do lower-occupant vehicles buying into the lane have a different set of origin-destination (O-D) patterns? By defining the primary or target users, in priority order, along with their O-D patterns, the location of access points can be determined based on how best to serve their needs.	5
Facility Access Design	The design of access points can impact the operation of both the HOT lane and adjacent general-purpose lanes. This factor evaluates the access design in terms of the ability to meet guidelines developed in Texas research (5) and other nationally accepted guidance. There are three types of access that can be provided: • At-grade slip ramp • Direct connect ramp • No designated access (continuous)	5
Ability to Enforce	HOT lane enforcement involves verifying occupancy requirements as well as toll account validity. This factor asks the question: "Can adequate compliance be achieved through planned enforcement operations?" There are three areas of consideration: • Adequate space for occupancy verification • Ease of occupancy check • Level of law enforcement	5

Table A-1. Continued

Factor	Description and/or Question(s) Addressed	Default Weight
Facility Traffic Control	Signing, pavement marking and other forms of driver communication can be challenging for HOT lanes for several reasons. First, the HOT lanes are located in an existing freeway corridor with their own set of signing needs and requirements, sometimes conflicting with messages and information requirements for drivers in the HOT lanes. This creates the potential for confusion and information overload. Second, there are additional messages for an HOT lane operation that are not necessary for a typical HOV lane, namely price level that can vary by time of day and/or user group. This facility factor poses the question, "Can effective driver communication be accommodated when converting to an HOT lane?" Since there is limited specific guidance available in the Texas Manual on Uniform Traffic Control Devices (TMUTCD), the general guidance and best practices comes from Texas research *(6)* and current research with the Federal Highway Administration (FHWA). • Define target users and their information needs • Signing features • Signing placement	5
Pricing Strategy	"Lane management technique" refers to the overall operating strategy for the HOT lane, in particular the pricing strategy and how it works in combination with eligibility requirements, facility design and supporting technology. • Lane management for priority or target users • Setting the toll rate and eligibility requirements	5
Incident Management	Can reasonable incident management be provided to assure travel time reliability?	3
Maintenance	Is there adequate maintenance support to assure quality service and operations, including all Intelligent Transportation Systems (ITS) technology, flexible barriers, operation policy and changes to service?	2

Table A-2. Performance Factors when Considering HOV Lane to HOT Lane Conversion

Factor	Description and/or Question(s) Addressed	Default Weight
HOV Lane Utilization	This factor examines actual usage (or predicted usage in the case of a planned HOV lane) of the HOV lane by non-toll-paying vehicles from three viewpoints: • Can the conversion to an HOT lane remedy an existing utilization problem? This is measured by the number of non-toll-paying users of the HOV lane and if a lack of such travelers causes the lane to appear "empty." • Is there a potential that the increased use of the HOV lane will have a positive impact on general-purpose level-of-service? • Will the conversion have a positive impact on person-movement in the corridor? As long as HOV lane performance does not deteriorate due to the additional toll paying vehicles, then at least some travelers (those toll paying vehicles) have improved trips while no travelers' trips were worsened, therefore positively impacting person movement in the corridor.	6
Travel Time Savings/ Reliability	This factor examines both the amount of travel time savings offered by the HOT lane and the reliability of travel times on both the HOT lane and the general-purpose lanes. Like the lane utilization factor, the travel time factor will be examined from three viewpoints: • Does the HOT lane offer significant travel time savings over the general-purpose lanes? This must include any additional time required for travelers to access the HOT lanes in the case where access is restrictive (as with the Katy HOV lane in Houston or I-15 express lanes in San Diego). This is a key consideration for conversion as few drivers will pay for small travel time savings. • Does converting the lane to an HOT lane negatively impact the travel time on the HOT lane? If there is a negative impact—is it large and does it reduce the operating speed of the HOT lane below an agency prescribed minimum acceptable speed? • Are travel times on the HOT lane significantly more reliable (have less variance) than travel times on the general-purpose lanes? Even if the average travel time savings is small, travelers will pay for additional reliability in their travel times. This measure must consider the impact of incidents (crashes, stalls, etc.) on travel times for both the HOT lane and the general-purpose lanes. This measure is subjective based on the congestion in the city/corridor under investigation. However, one measure of reliability would be the percentage of time the trip takes within 5 minutes of the average travel time. Ideally, the HOT lane would offer such reliability at least 95% of the time. If the GPLs did not offer such reliability then the HOT lanes would be considered more reliable.	6
Public Agency/ Societal Benefits	This factor includes benefits of the HOT lane conversion from both an agency revenue point of view and a net benefit to society point of view. From the agency point of view, the greater the surplus toll revenue (total revenue minus start-up, operating, and maintenance costs) the better. From society's point of view, any overall travel time savings, reduction in emissions or reduction in fuel use are all benefits.	5

Table A-2. Continued

Willingness to Pay Tolls	This factor examines local drivers' willingness to pay tolls, both from their familiarity with tolls and their income levels. An interaction of these two issues will yield the appropriate scale values. • Are there other toll facilities already in the area? Do these other local facilities use the same toll technology as on the HOT lanes and will the transponders be interoperable? • Travelers with higher incomes generally have higher value of travel time savings and are therefore more willing to pay a toll to avoid congestion and reduce their total travel time. A general rule of thumb is that travelers are willing to pay approximately 50% of their wage rate for travel time savings. For example, if a group of commuters had incomes of $80,000 per year, then their wage would be approximately $40 per hour and their willingness to pay would be approximately $20 per hour (but highly variable on any given day for any given commuter). Defining high income is subjective based on the city, but if over half of the commuters on the corridor had incomes in excess of $80,000 then that could be considered a high income corridor that had many travelers well-off enough to afford tolls and willing to pay tolls for travel time savings.	4
Safety	This factor examines the likelihood that the conversion will adversely affect safety on the HOV lane. A reduction in safety causes concerns for additional injuries due to the conversion. Additionally, if there are frequent crashes on the HOT lane then travelers will not pay to use the lane due to a fear of their own safety and the travel delays caused by crashes. The issue of safety is again relative to the city and corridor in question. However, for the scoring in this category, a significant decrease is a change in crash rate that is significantly lower than the old rate at a level of confidence of 95%. A slight reduction is a lower rate but it is not statistically significant.	4
Environment	This factor includes impact of the HOT lane conversion on both emissions and fuel use. Due to the high likelihood that the conversion will have minimal impact on either fuel or emissions, the default weight of this factor is relatively low. The minimal impact is caused by travelers in the (presumably congested) general-purpose lanes reducing some fuel use and emissions output by changing to the faster moving HOT lane, but travelers in HOV modes switching to HOT lane use will increase the amount of fuel use and emissions output.	2

Table A-3. Institutional Factors when Considering HOV Lane to HOT Lane Conversion

Factor	Description and/or Question(s) Addressed	Default Weight
Public Acceptance	This factor is concerned with public acceptability of converting an HOV lane to an HOT lane or implementing a new HOT lane. The level of acceptability can be ascertained through focus groups or surveys. Additionally, public perception research can identify issues that are of importance to the public so that they can be addressed proactively.	6
Political Acceptance	This factor is concerned with the political knowledge of and acceptability for implementing an HOT lane. The political acceptance should be measured at all levels (e.g., local, regional and state). Acceptance can be determined through stakeholder interviews, supporting legislation, project champions and media reports. Acceptance of HOT lanes can be demonstrated by the adoption of such strategies into the long-range plan of an area and by enacting legislation that allows for such conversions. A conversion of an HOV lane to an HOT lane may also facilitate other regional goals such as increasing person movement or increasing auto occupancy.	6
Environmental Justice/Title VI Issues	This factor concerns the disproportionate impact on low-income or minority populations that would be affected by an HOT lane. This may be different depending on whether the project proposes to convert an HOV lane or to implement an HOT lane where none currently exists. This factor can be measured by the participation of affected groups in the planning process and through focus groups or surveys.	6
Revenue Use	There should be agreement prior to project implementation on the use of revenues derived from the project, if any. There may also be federal requirements that stipulate what excess revenues may be used for.	5
Interagency Cooperation	Interagency cooperation will be paramount to the success of an HOT lane. All agencies will need to support a conversion. Will multiple entities be responsible for maintenance and operation of the HOT lane? Operating agreements that are drafted may be required to stipulate certain provisions such as level-of-service or bus speeds per federal regulations.	4
Media Relations	This factor deals with the media's portrayal of the project. It may be influenced by an existing project or familiarity with the HOT lane concept. It can be measured through editorials, media stories and news clippings.	2
Sustained Public Education/ Information	This factor concerns the mechanisms in place to generate support for an HOT lane project and the willingness to continue public outreach after the project is implemented. Project success depends on the promotion of benefits the project provides. Cross-jurisdictional support for project implementation is important to project success. Additionally, continued funding for advertising and outreach is needed.	2

APPENDIX B

SCORING DECISION TREES FOR ALL FACTORS

Facility Considerations

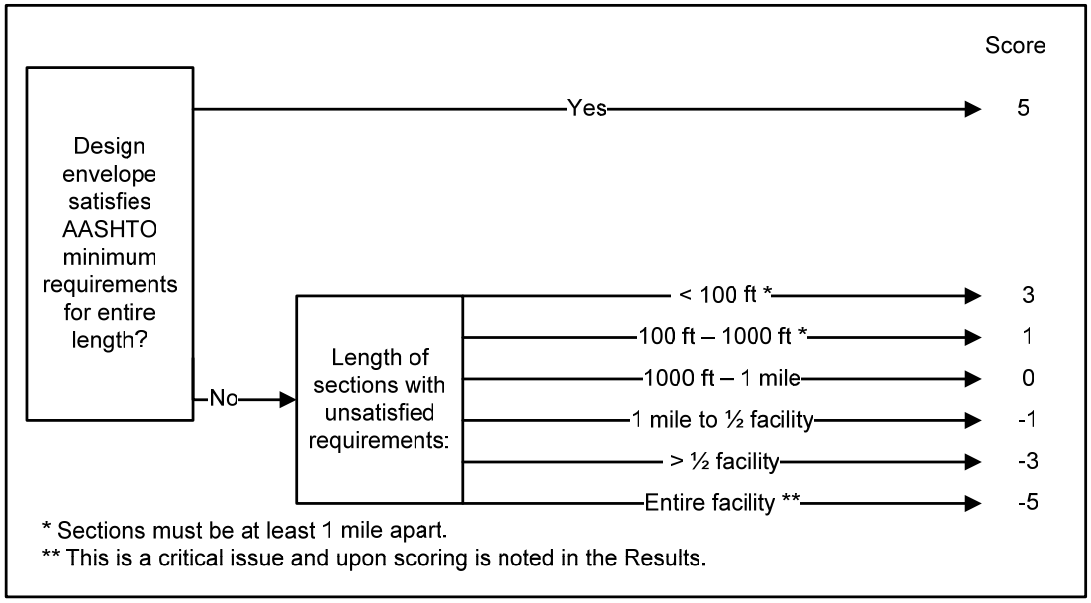


Figure B-1. Facility Cross Section

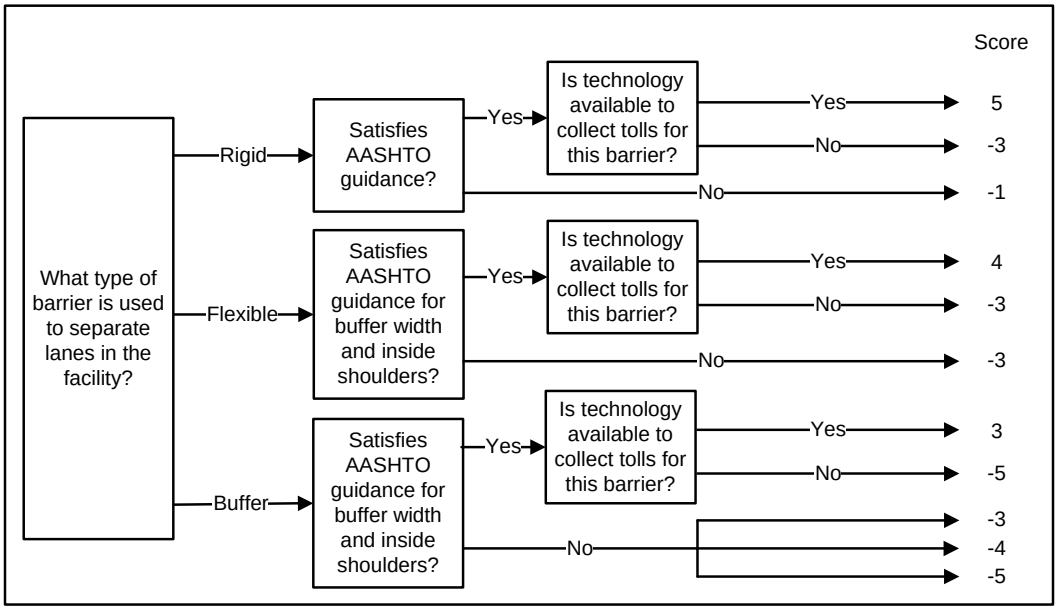


Figure B-2. Lane Separation for Toll Collection

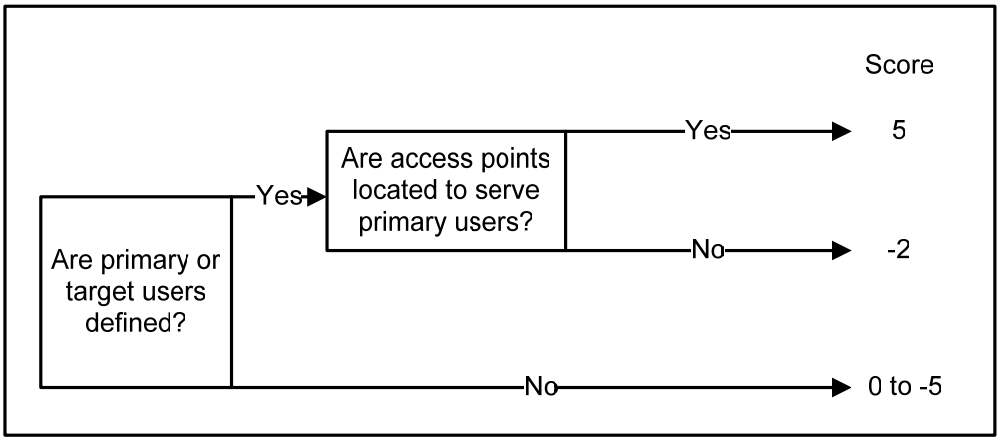
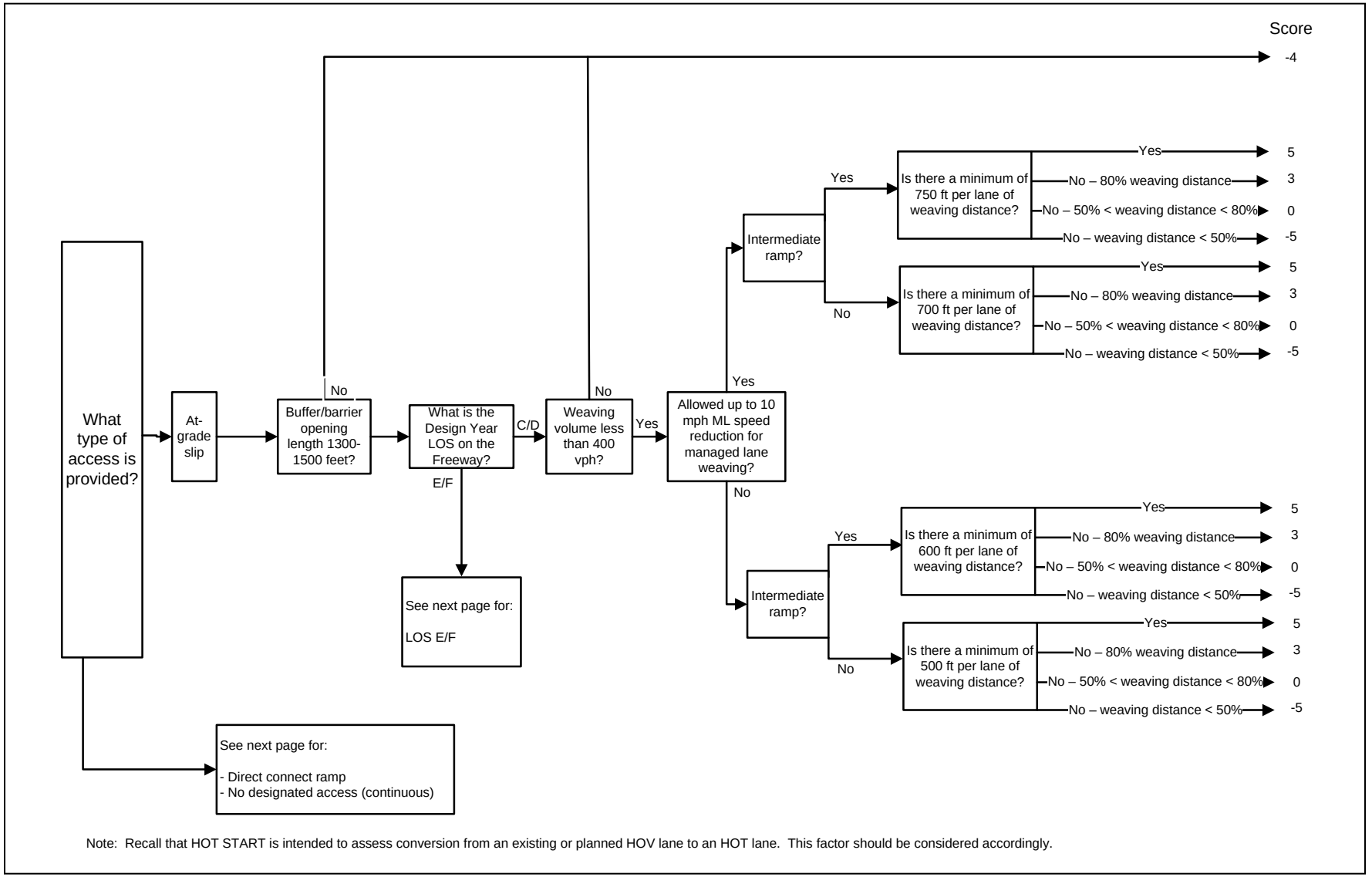


Figure B-3. Facility Access Satisfies O-D Requirements



Note: Recall that HOT START is intended to assess conversion from an existing or planned HOV lane to an HOT lane. This factor should be considered accordingly.

Figure B-4. Facility Access Design

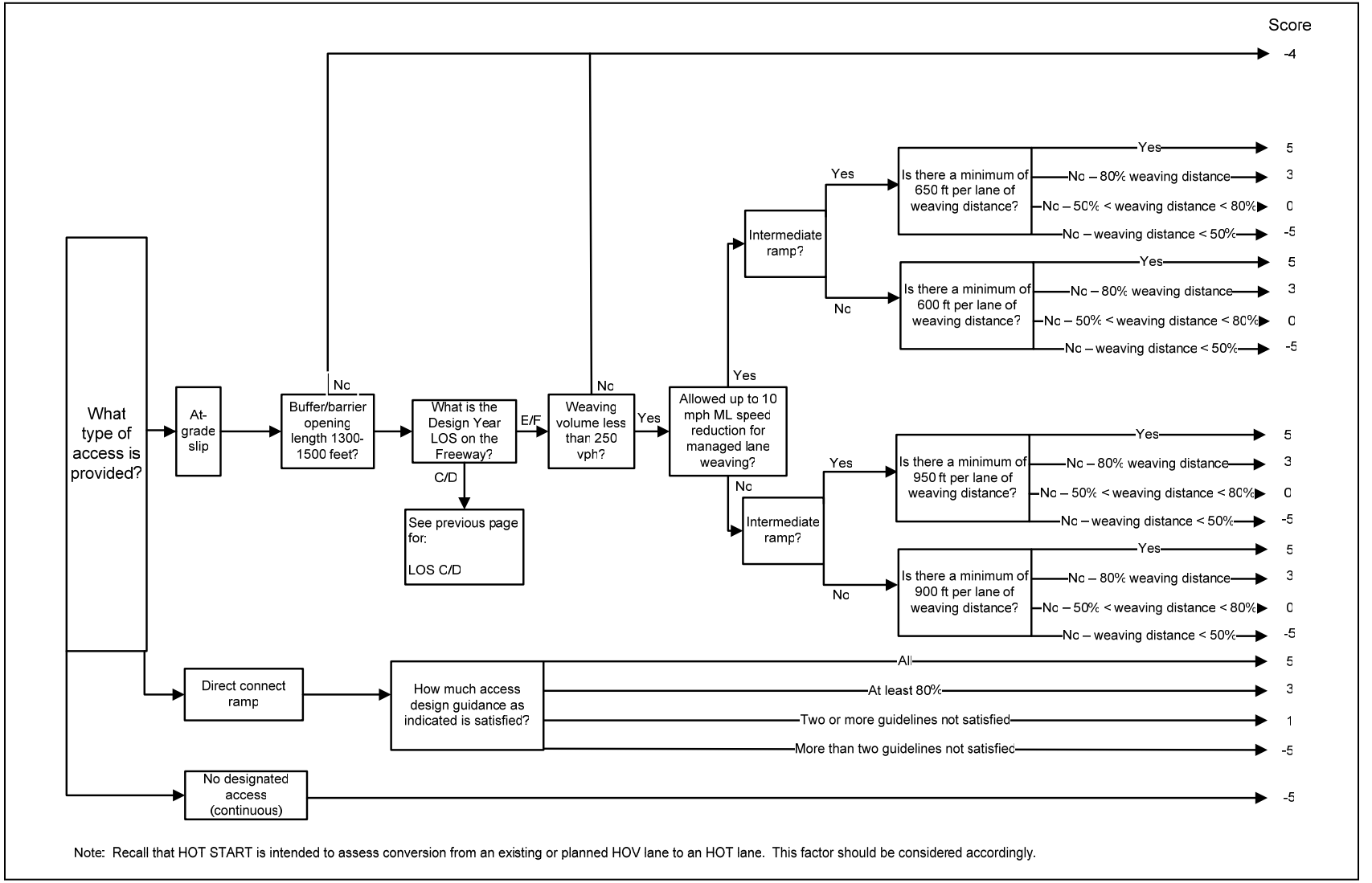


Figure B-4. Continued

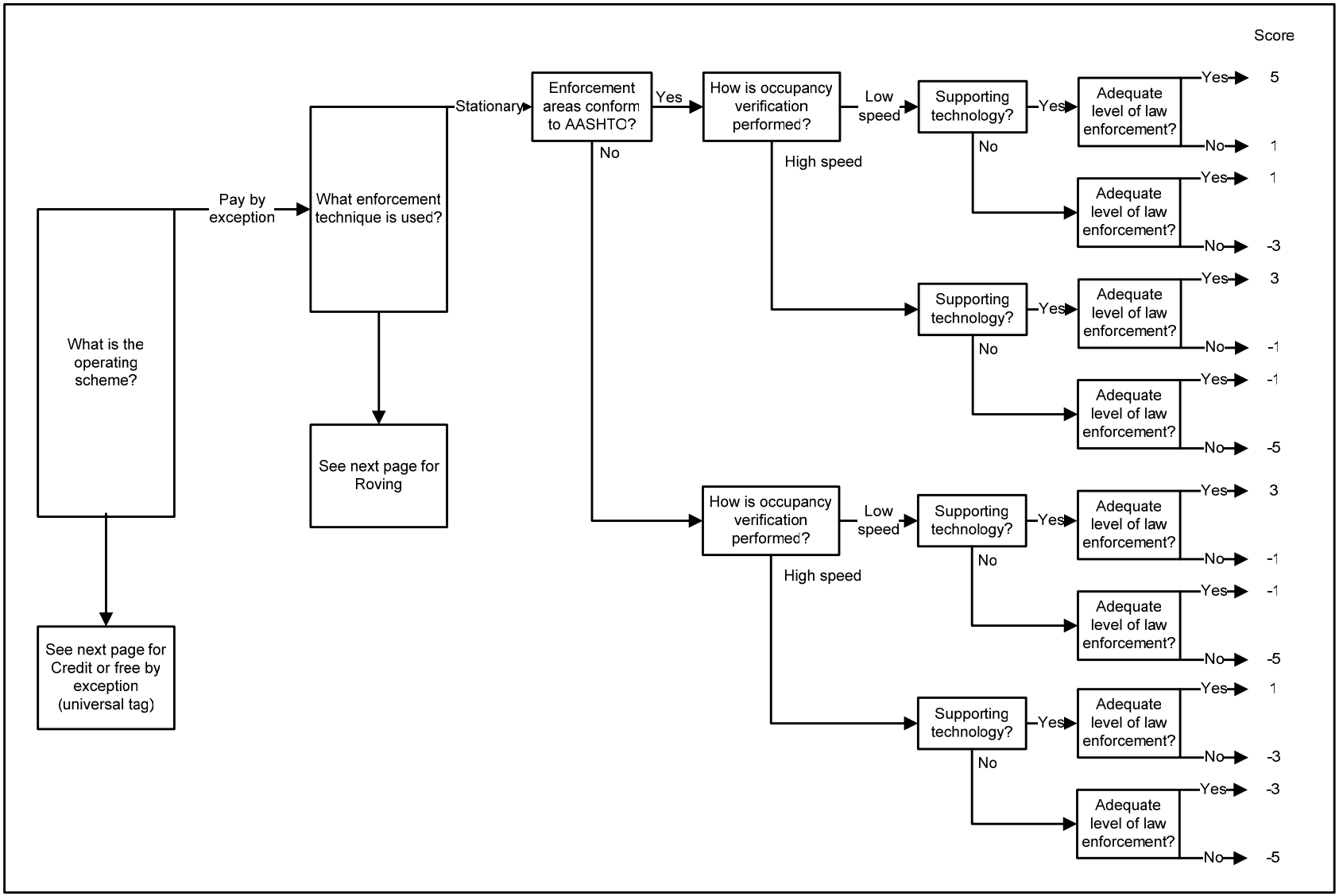


Figure B-5. Ability to Enforce

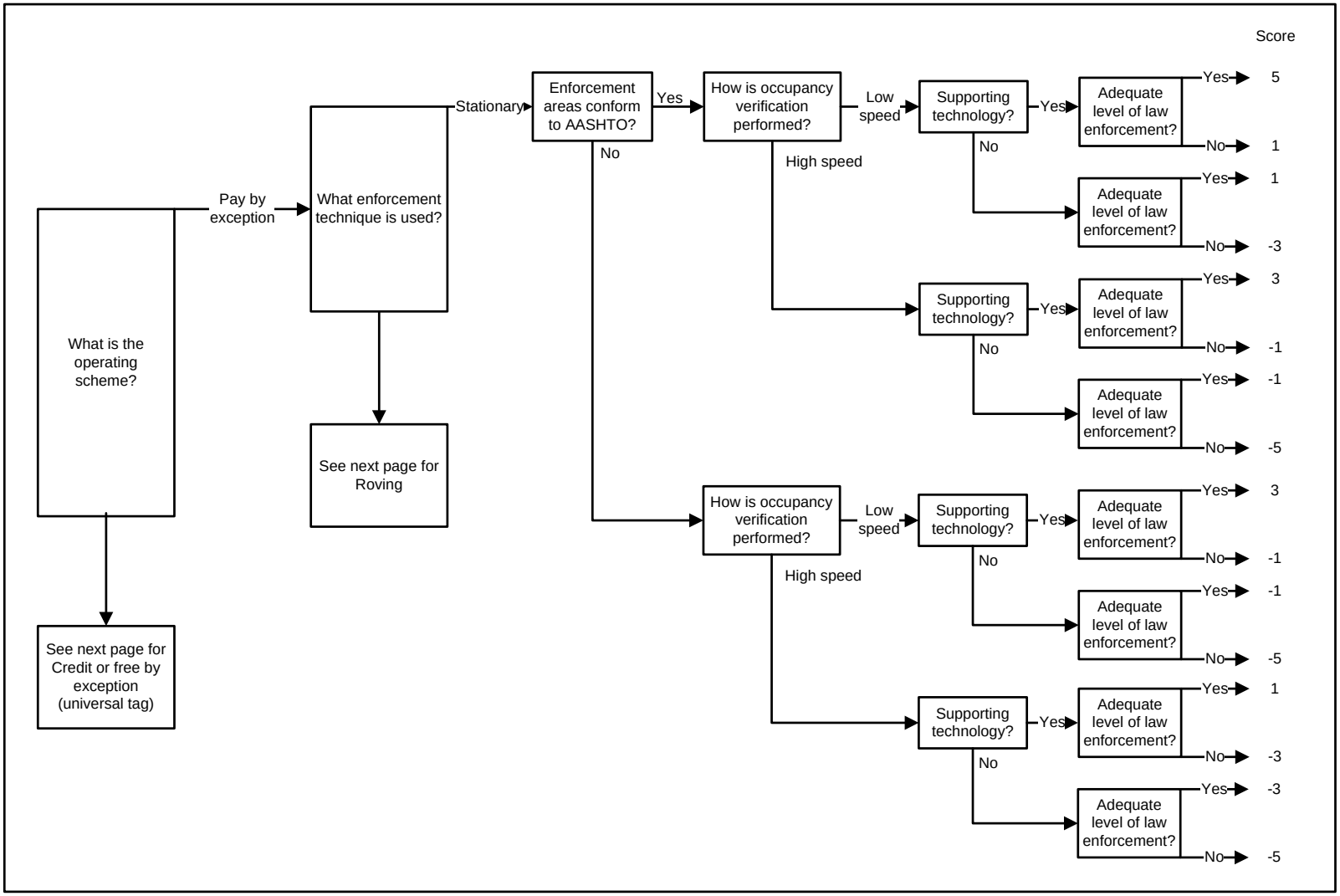


Figure B-5. Continued

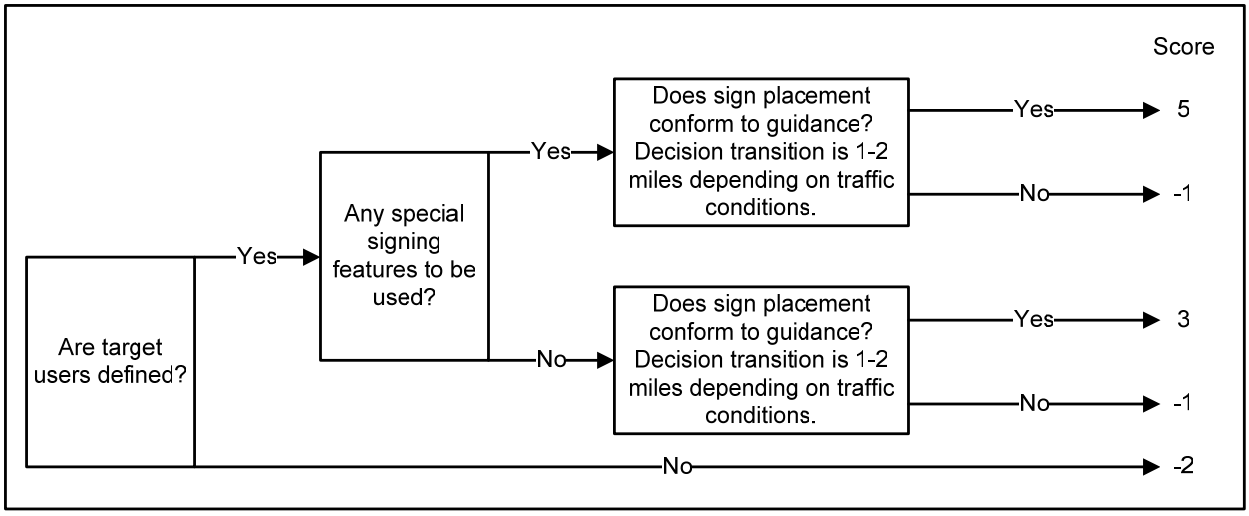


Figure B-6. Facility Traffic Control

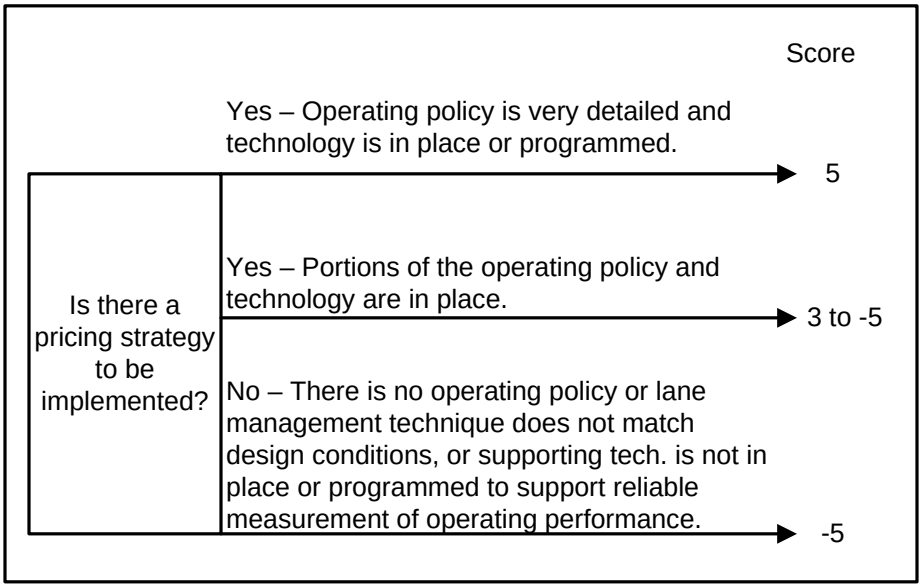


Figure B-7. Pricing Strategy

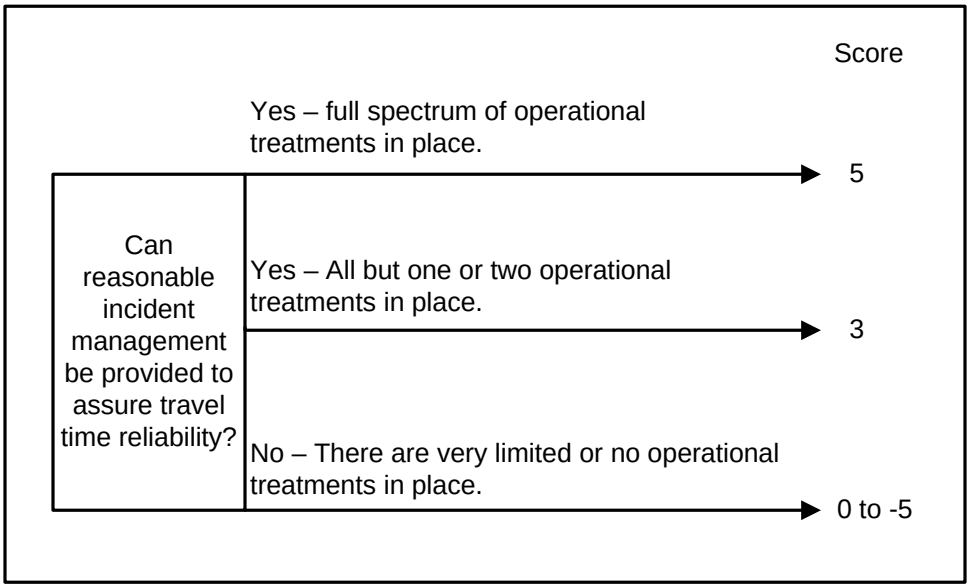


Figure B-8. Incident Management

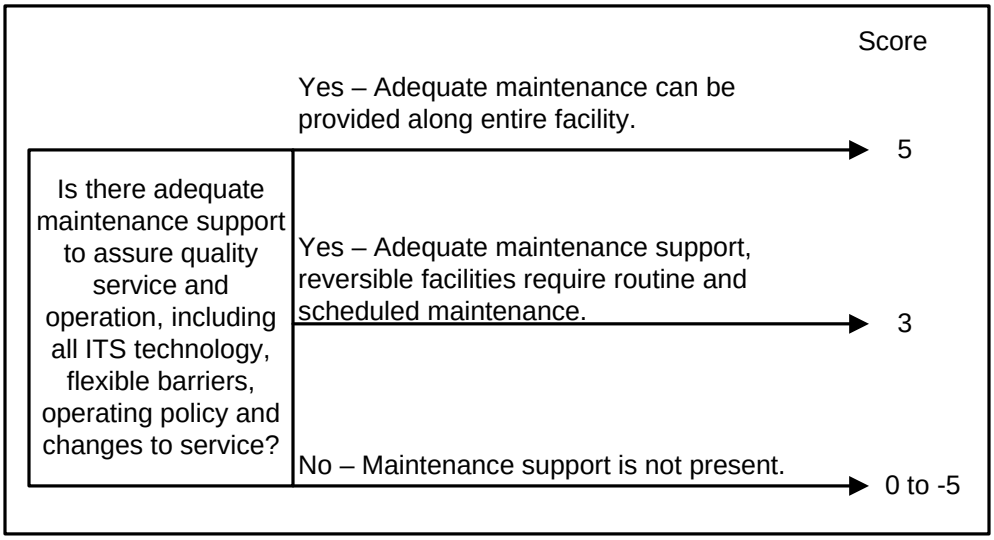


Figure B-9. Maintenance

Performance Considerations

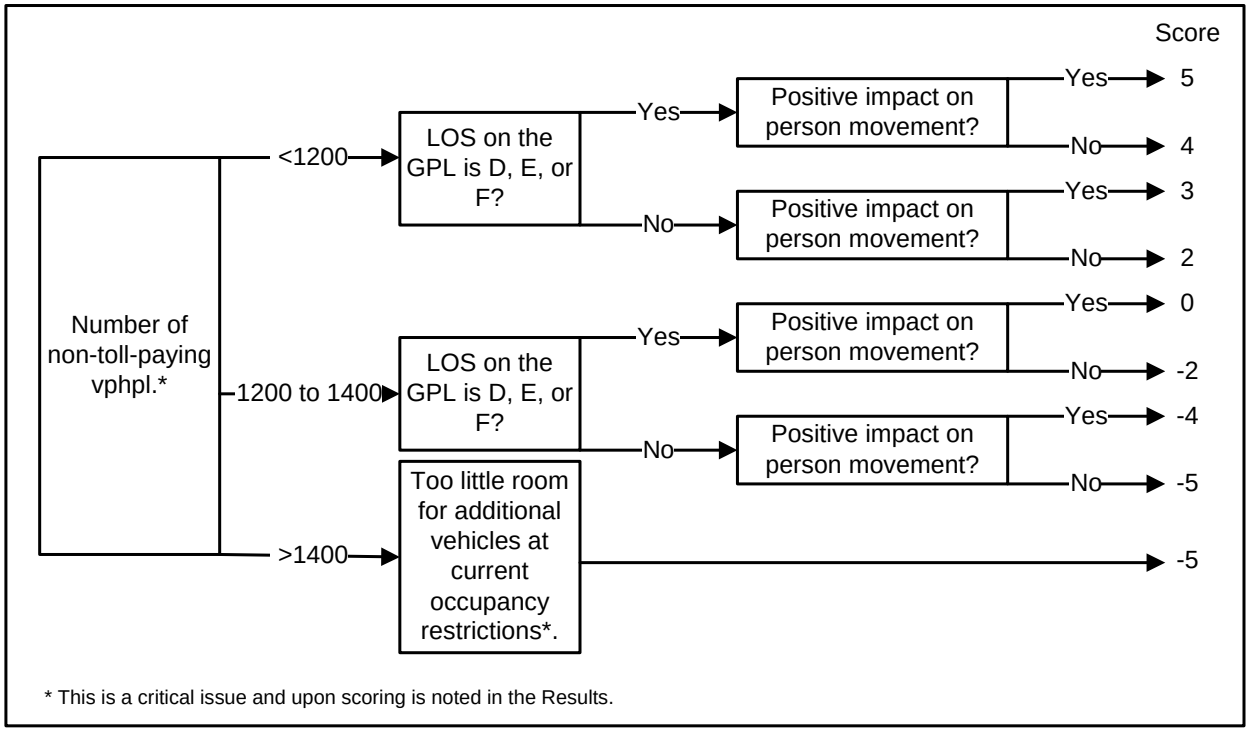


Figure B-10. HOV Lane Utilization

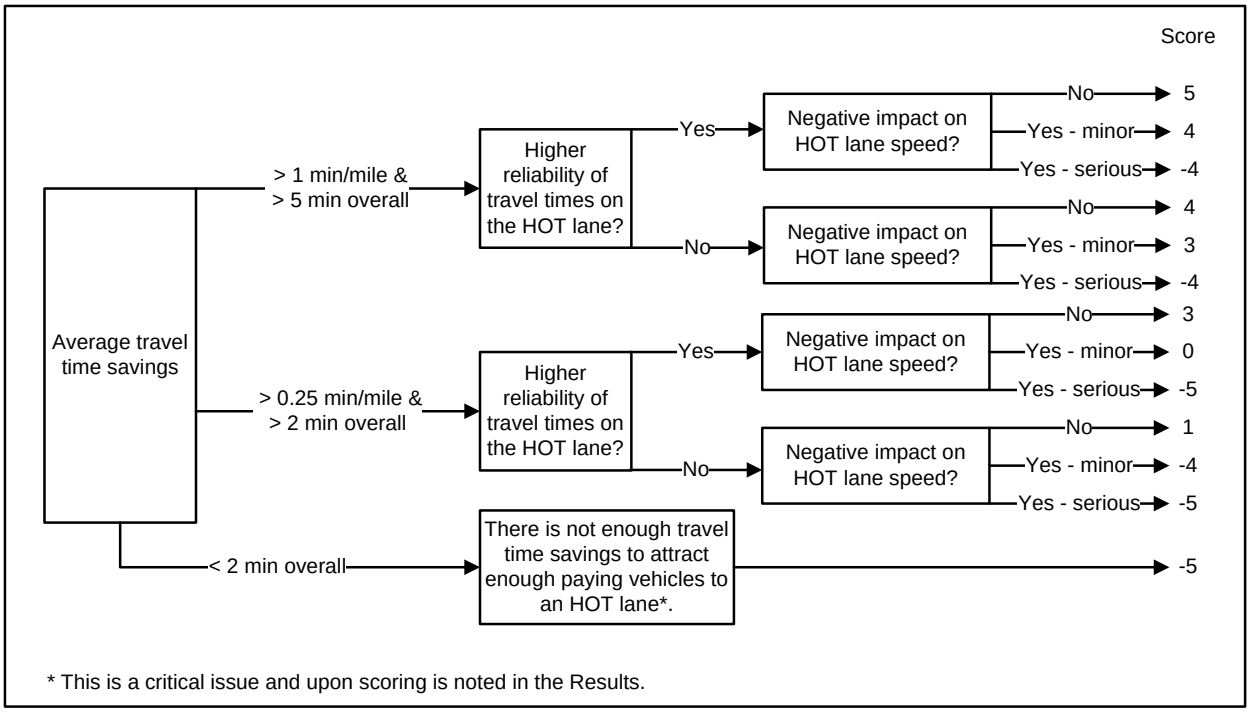


Figure B-11. Travel Time

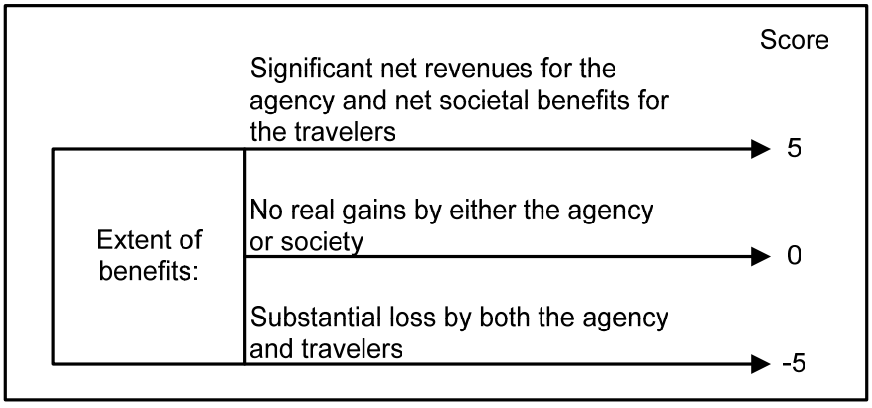


Figure B-12. Benefits

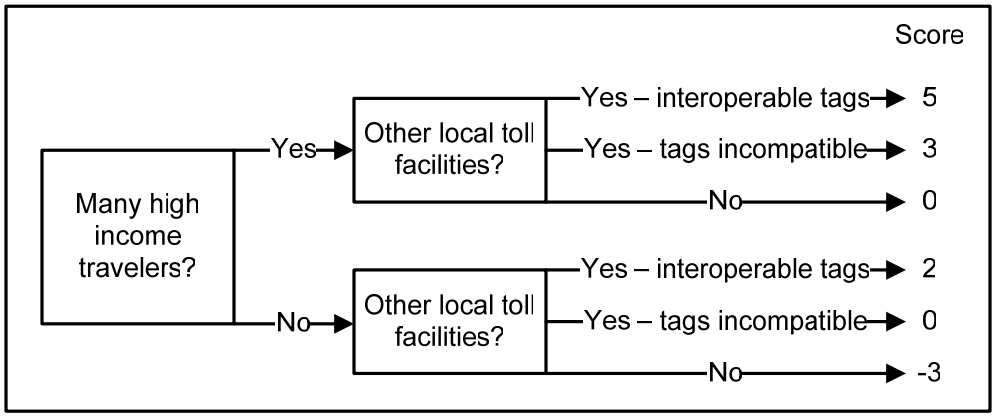


Figure B-13. Willingness to Pay Tolls

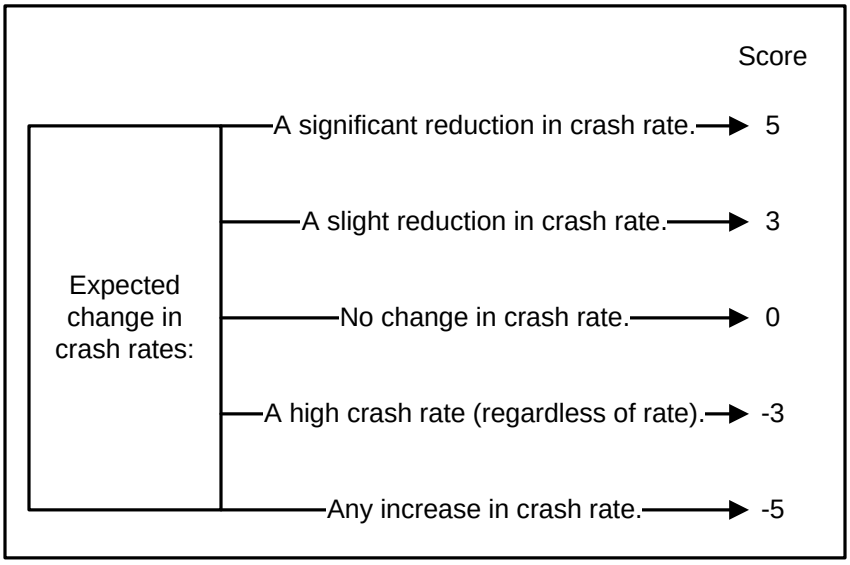


Figure B-14. Safety

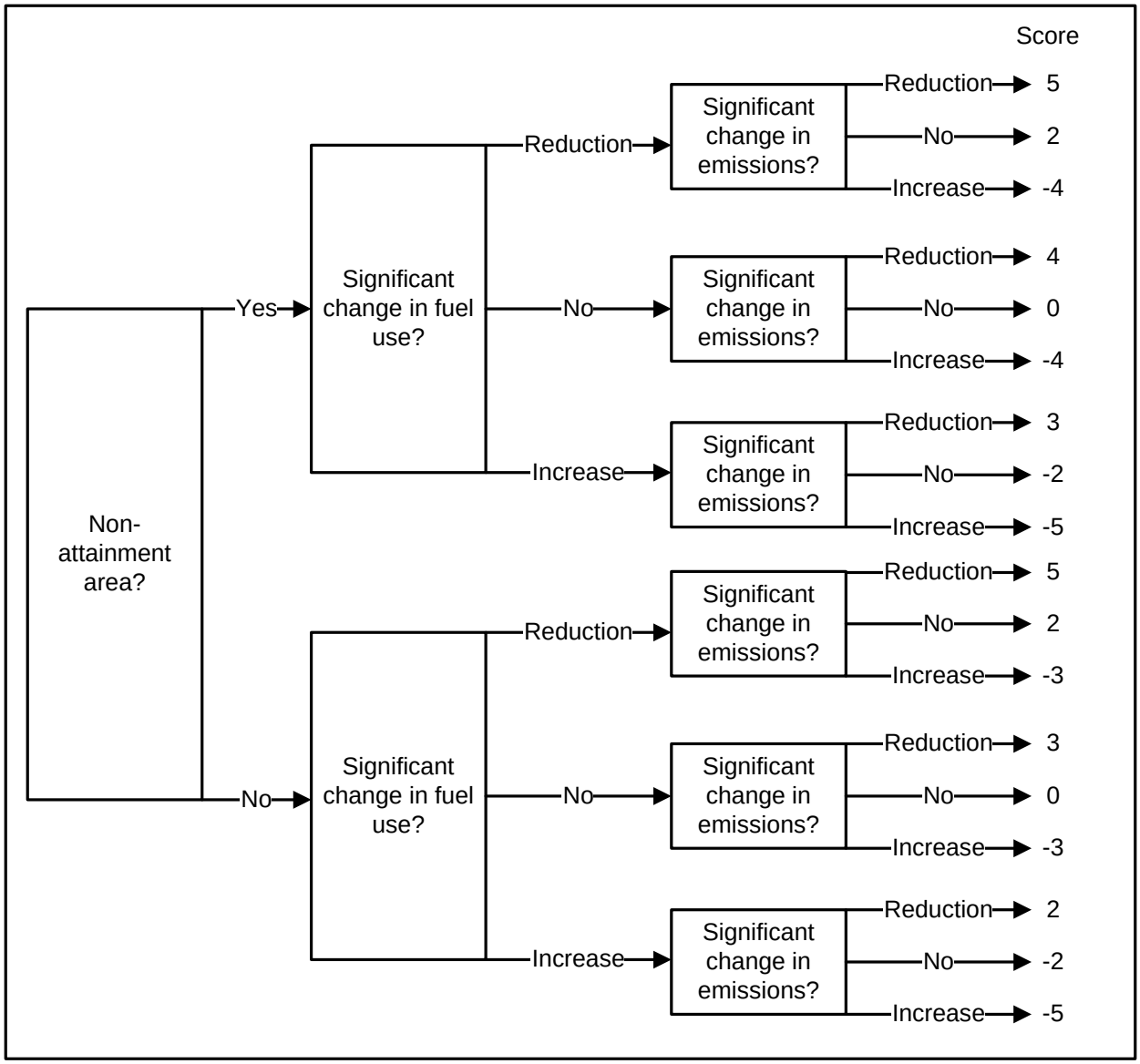


Figure B-15. Environment

Institutional Considerations

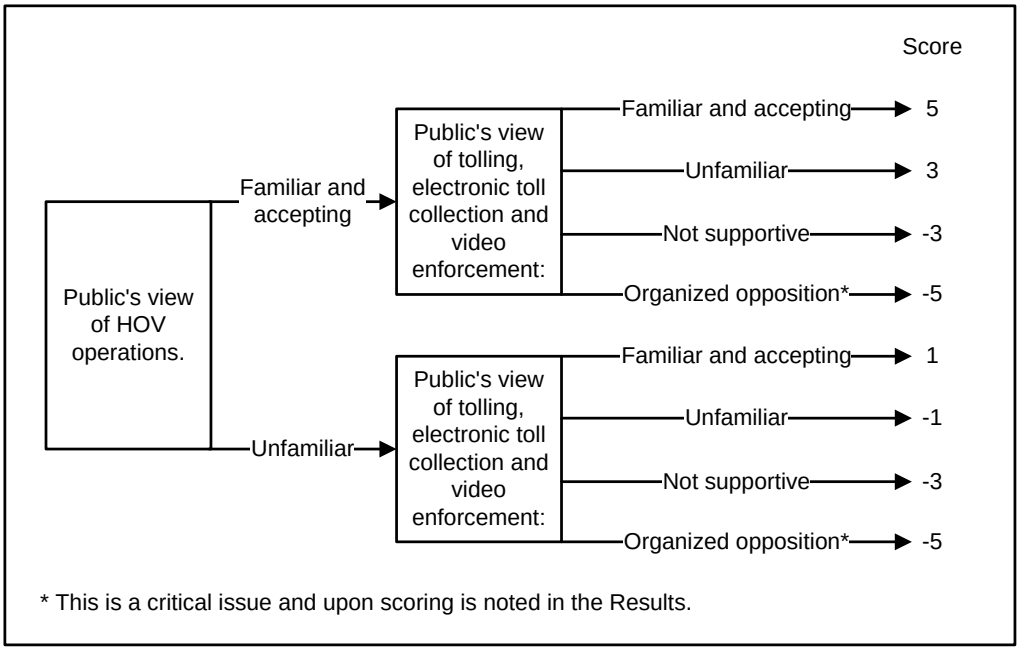


Figure B-16. Public Acceptance

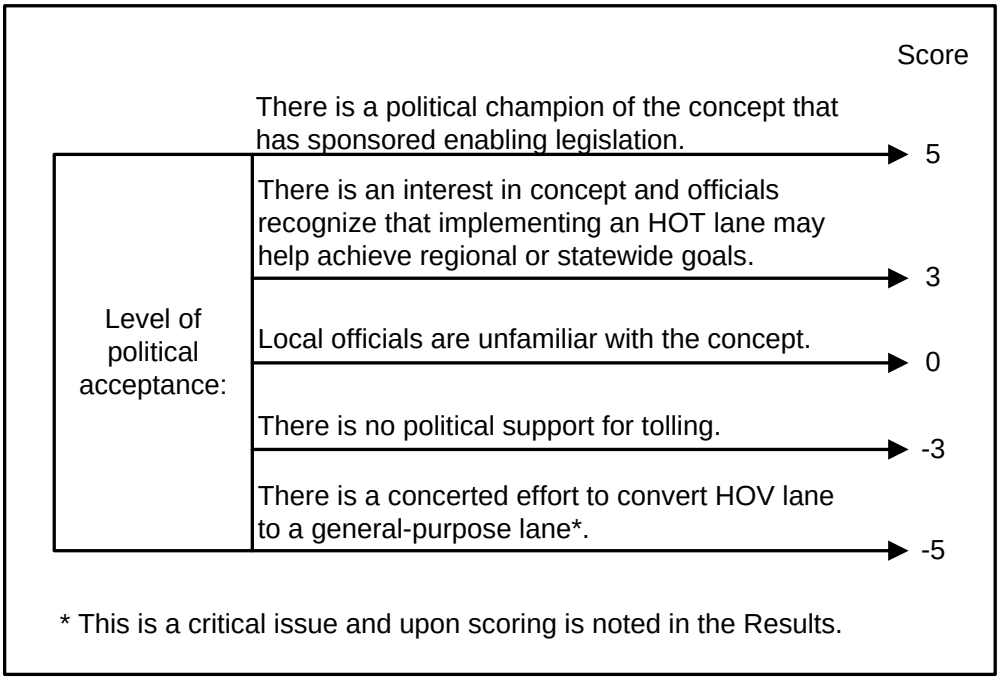


Figure B-17. Political Acceptance

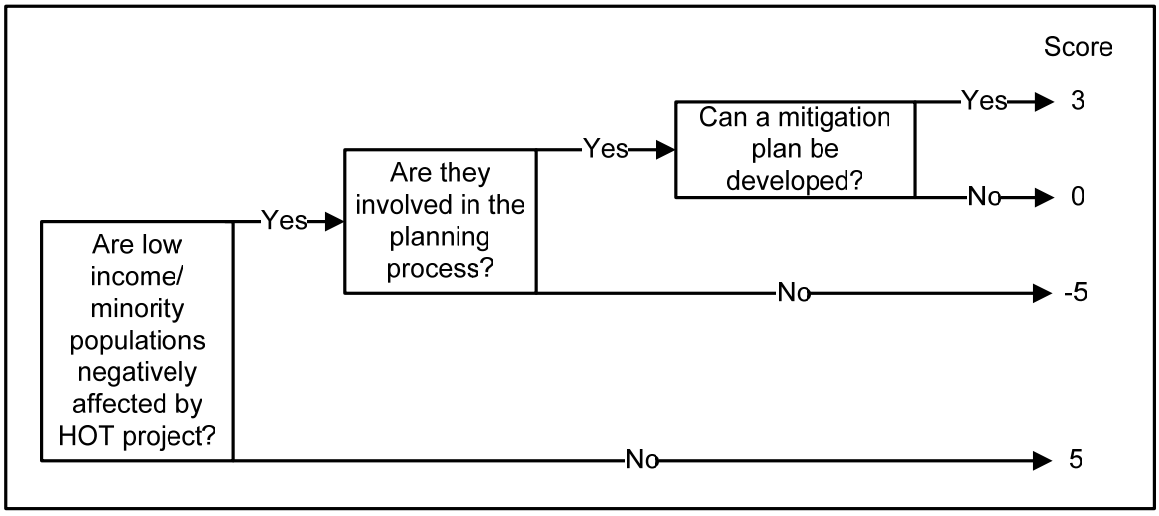


Figure B-18. Environmental Justices/Title VI Issues

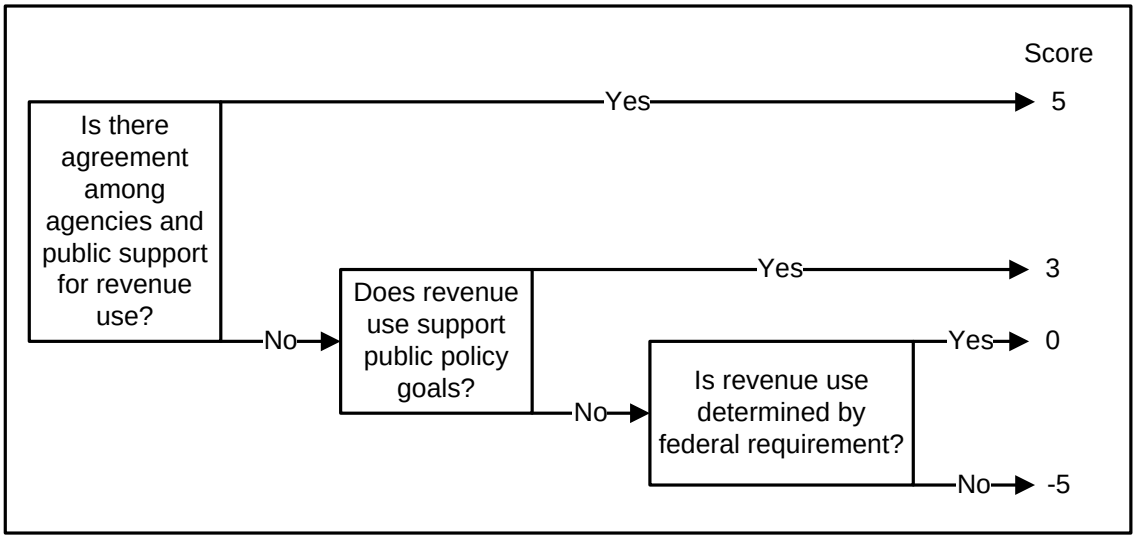


Figure B-19. Revenue Use

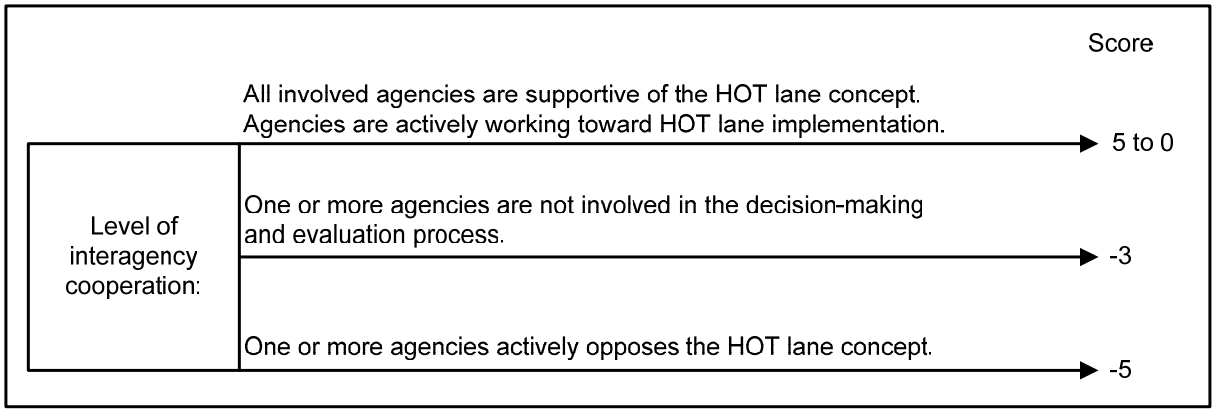


Figure B-20. Interagency Cooperation

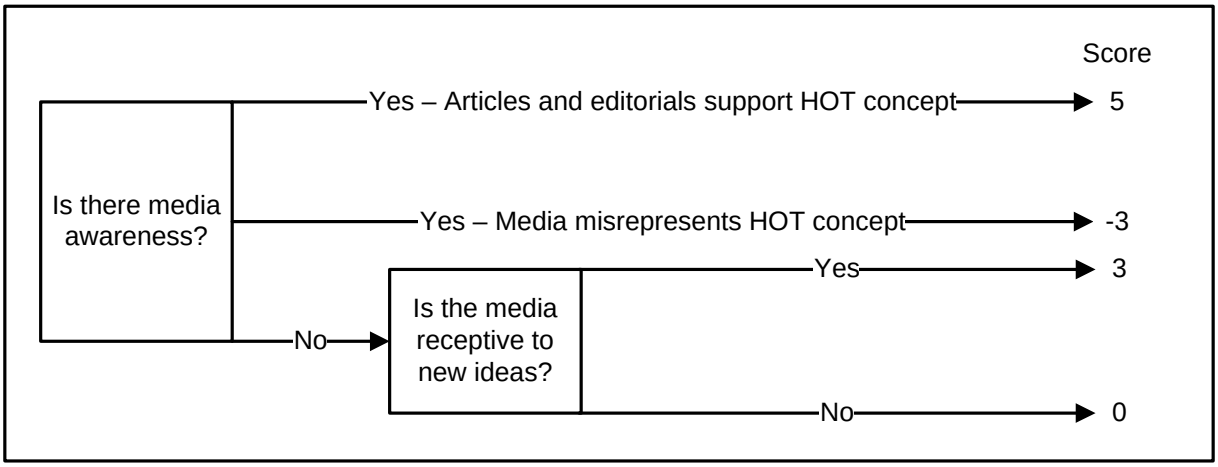


Figure B-21. Media Relations

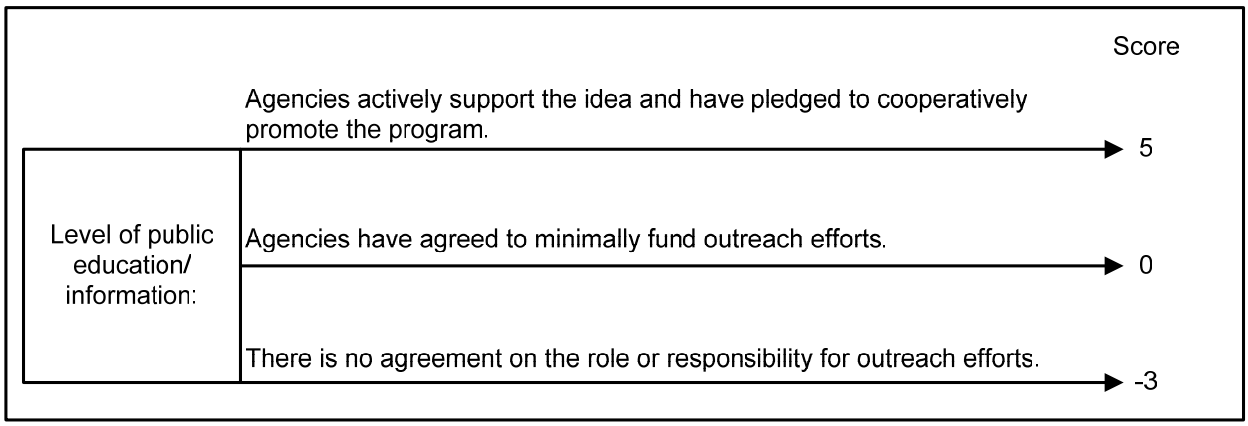


Figure B-22. Public Education/Information

APPENDIX C

STEP-BY-STEP INSTRUCTIONS FOR CREATING AND LOCKING WEIGHT PROFILES

There are two different ways to take advantage of HOT START's ability to lock weight profiles for Austin, DFW, Houston, and San Antonio. Both are demonstrated in this appendix. The first way involves using Notepad and the second way uses a temporary name to be changed.

Method 1 – Using Notepad

1. Open the default weight file in Notepad. This can be done by locating the "default.wpf" file in the HOT START folder as shown in Figure C-1. As shown in Figure C-2, the file should be opened with Notepad by choosing to "Select the program from a list" when told Windows cannot open this file.

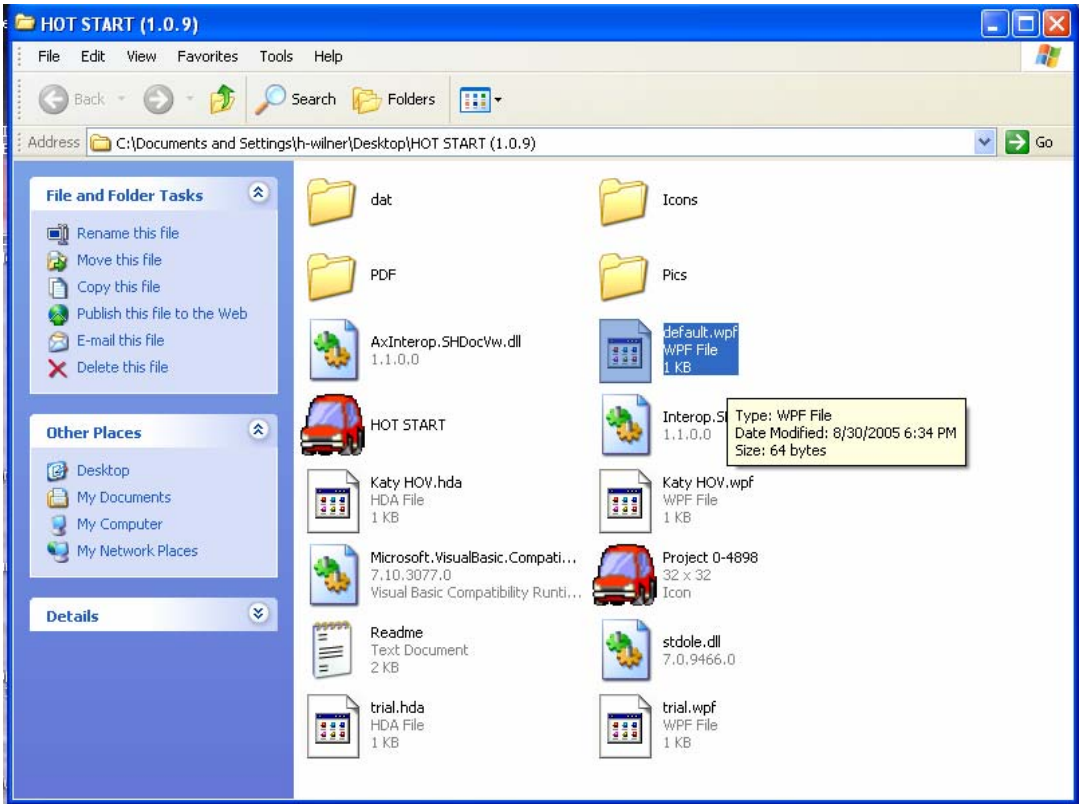


Figure C-1. Locating Default Weight Profile

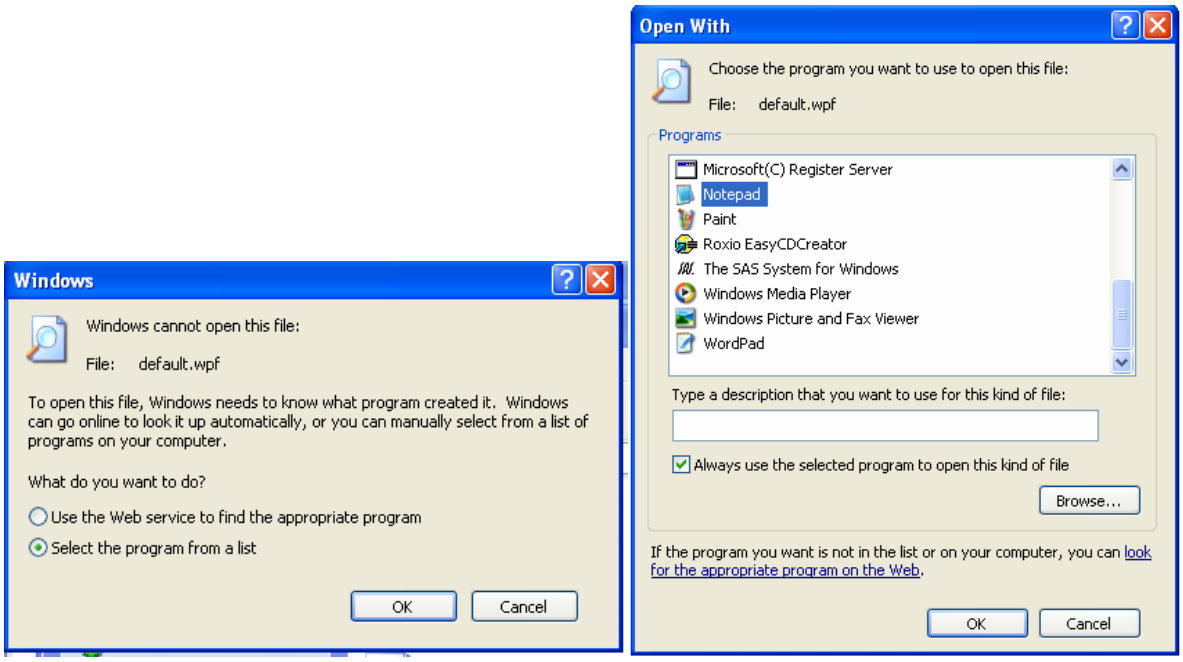


Figure C-2. Opening Default.wpf with Notepad

2. Change default weights. The default weighting profile appears as shown in Figure C-3 once the file is opened in Notepad. Notice that the factors are not listed next to the weights. It is strongly suggested that the user refers to Figure 3-4 to be reminded of the factors, their order, and the original default weights. The user can now change the weights as desired but **must ensure they still equal 100!**

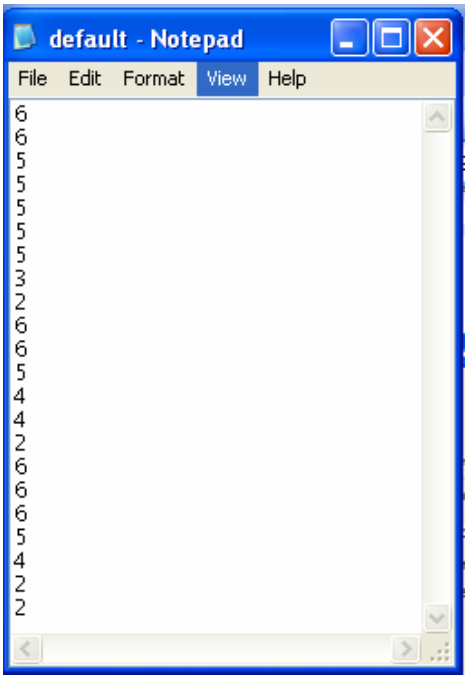


Figure C-3. Notepad View of Default Weights

3. Save new weights to specific profile. Once the default weights have been changed, they can be saved with the new profile name to be locked – Austin, DFW, Houston, or San Antonio – by going to "File" and then selecting "Save As" and typing the corresponding name. Make sure to place the profile in the appropriate folder **and to type ".wpf" after the file name**. Figure C-4 shows the new weights saved as the Austin profile in the Notepad, and Figure C-5 shows the new Austin weight profile in the HOT START directory.

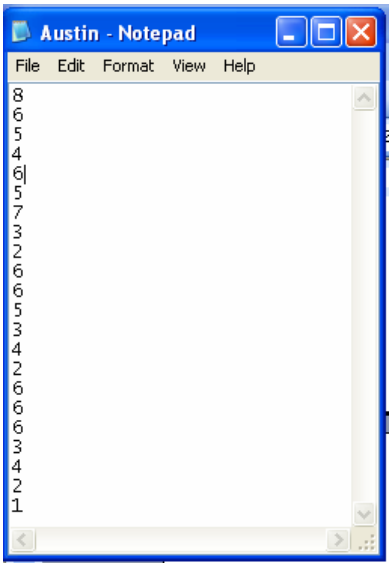


Figure C-4. New Austin Weight Profile

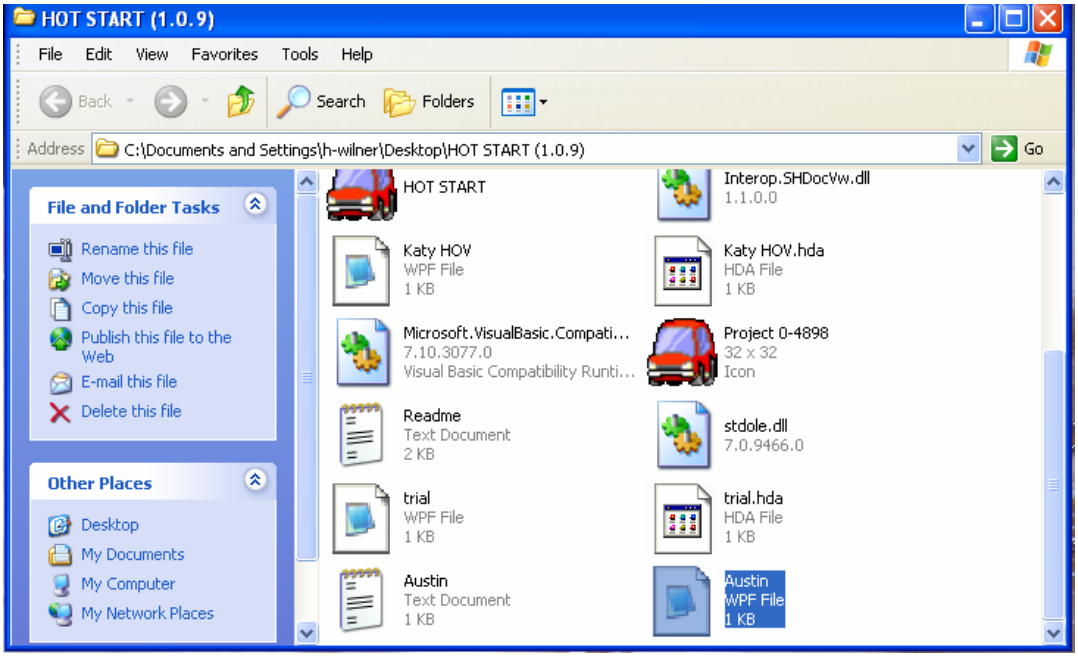


Figure C-5. New Austin Weight Profile in HOT START Directory

4. The new profile can be loaded. Once located in the directory, the new weighting profile is ready for use as described in Chapter 3 of this Guidebook. Figure C-6 shows the loaded Austin weight profile just created in Steps 1-3. Note how the scores are lightened because they are locked and cannot be adjusted.

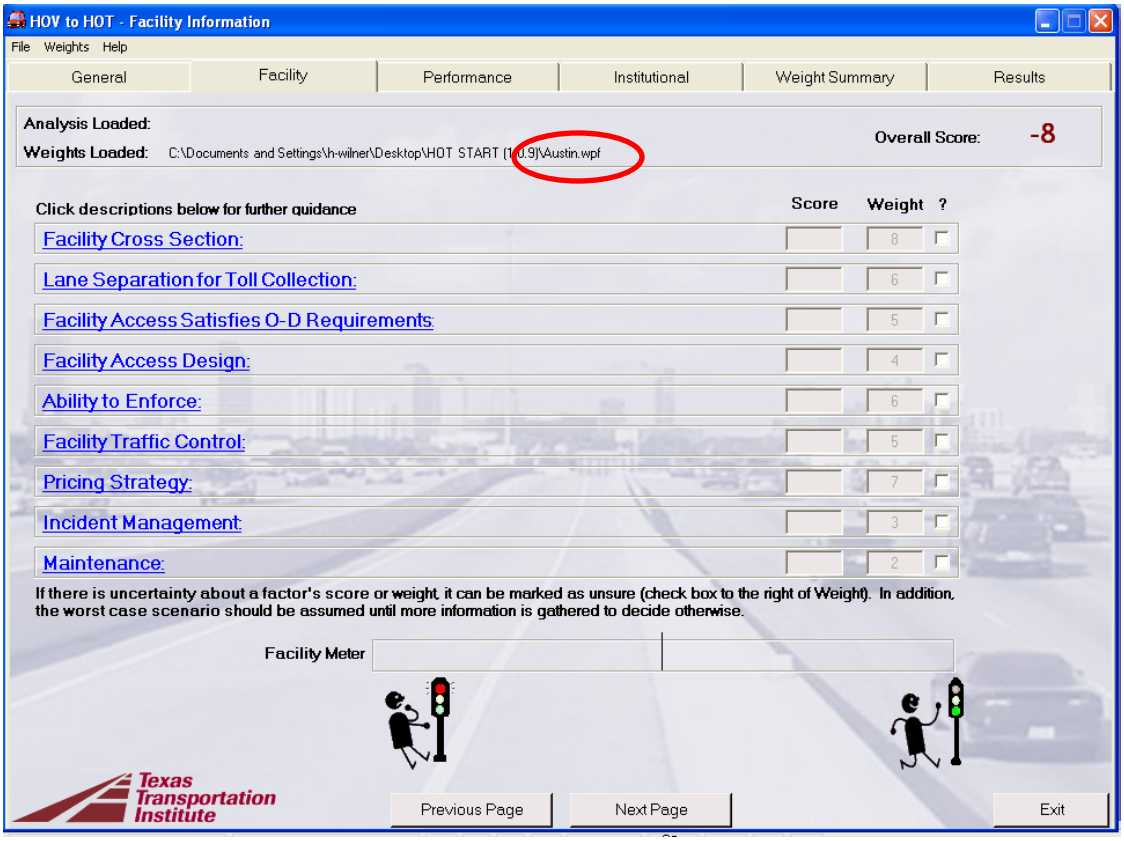


Figure C-6. Loaded Austin Weight Profile

Method 2 – Changing a Temporary Name

1. Adjust the weights as preferred as shown in Figure 3-5.

2. Save new weight profile. The revised weight profile can be saved by going to "Weights" and then "Save Profile." Select the correct directory and a temporary name as shown in Figure C-7.

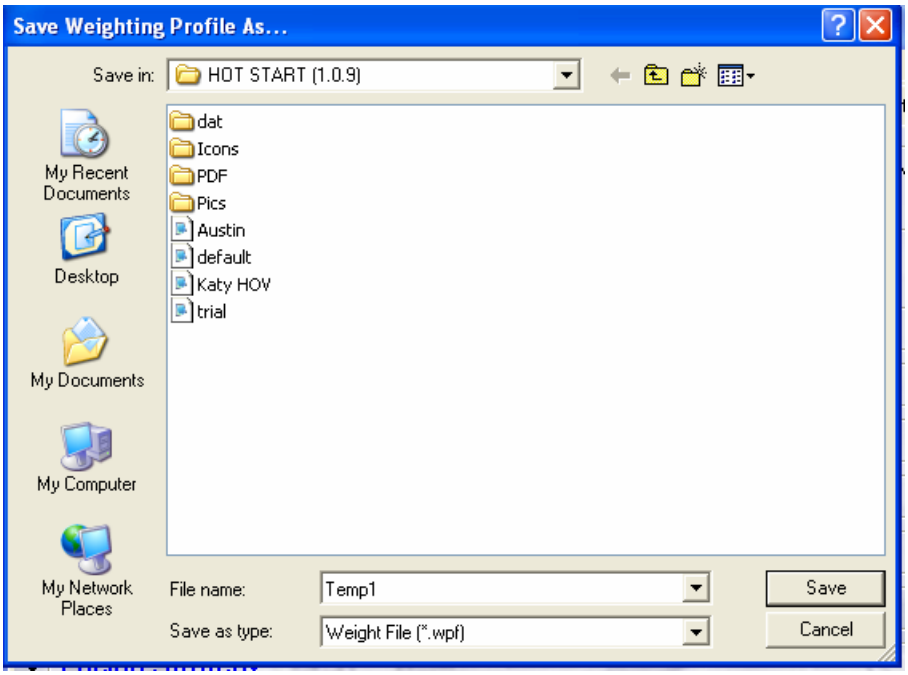


Figure C-7. Saving New Weight Profile

3. Find new weight profile in Windows Explorer. Locate and select the new profile in Windows Explorer. Right mouse-click the file to rename it Austin, DFW, Houston, or San Antonio as shown in Figure C-8. In this example, the "Temp1" name was replaced with "San Antonio."

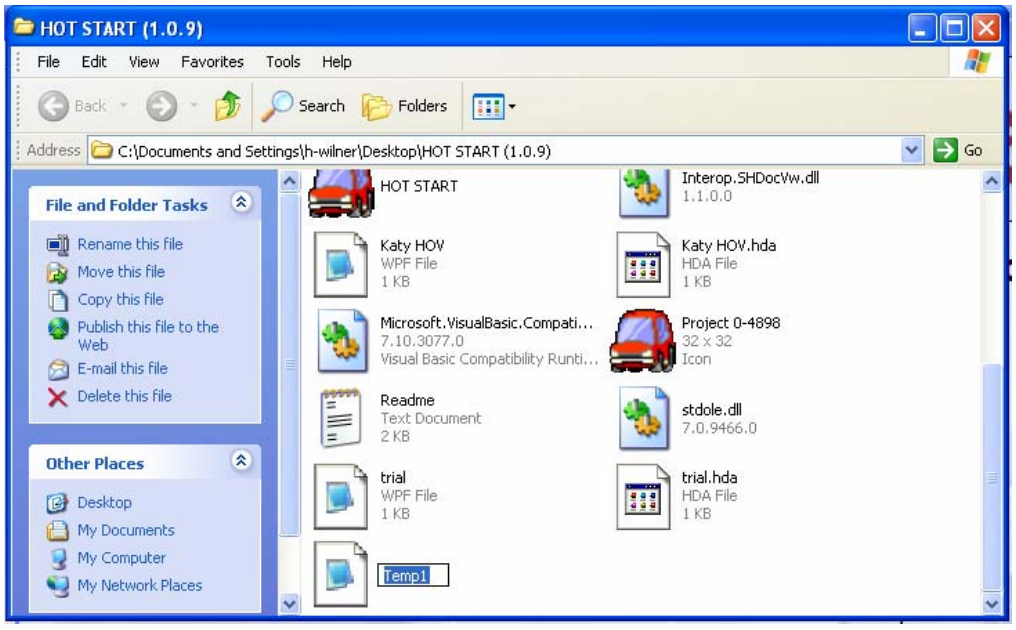


Figure C-8. Renaming Weight Profile

4. The new profile can be loaded. Once renamed in the directory, the new weighting profile is ready for use as described in Chapter 3 of this Guidebook. Figure C-9 shows the loaded San Antonio weight profile just created in Steps 1-3. Note how the scores are lightened because they are locked and cannot be adjusted.

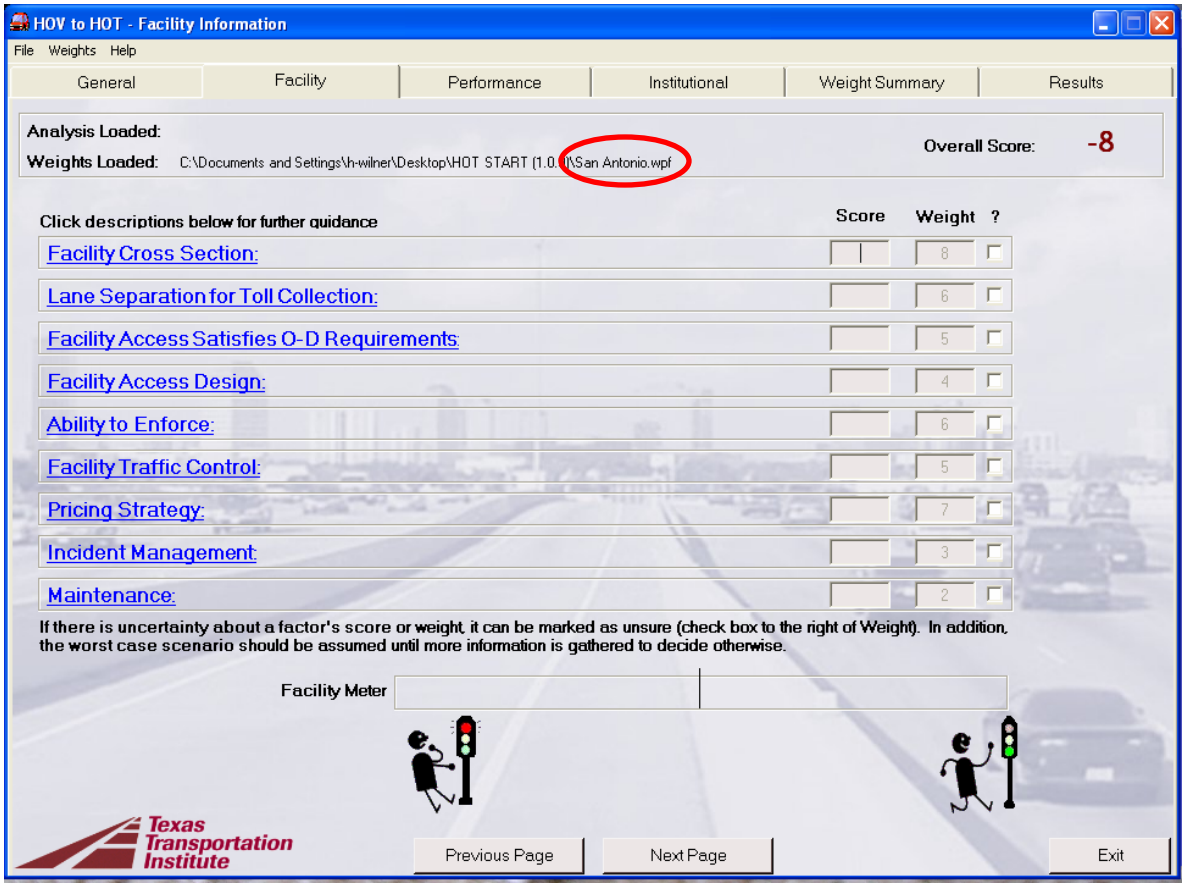


Figure C-9. Loaded San Antonio Weight Profile

APPENDIX D

INTERACTIONS OF FACILITY AND PERFORMANCE FACTORS

After the identification of the final list of the most critical performance, facility and institutional factors, it was necessary to investigate any possible interactions between these factors. These interactions affect scoring. For example, a poor (narrow) facility cross section would have a negative impact not only on the cross section factor, but on several performance factors as well. The narrow cross section could reduce the vehicle capacity of the lane, thereby reducing HOT lane utilization. It could also increase the crash rate, decrease average travel speeds, and decrease a traveler's willingness to pay to use the lane. After examining the factors from each area, it was determined that those with the most impact were between the facility characteristics and performance measures. Although both can certainly have some interaction with institutional factors, those interactions would be much smaller in magnitude and would make the analysis unnecessarily complex without significantly impacting the outcome. Therefore, the remainder of this section, and the software itself, focuses on the interactions between performance and facility factors.

There can be an argument made that almost any of the important facility features listed in Table D-1 can, in some way, impact any of the performance measures in that table. It is the goal of this research, and the accompanying software program, to focus on those interactions that will make a material impact on the decision whether or not to convert an HOV lane to an HOT lane. To identify these interactions, researchers first identified facility and performance measures with interactions that were ranked from (1) strong, (2) moderate, and (3) weak, but still of significance (see Table D-1). Second, researchers examined each of these interactions as discussed in Table D-2. Finally, researchers adjusted the software package such that these interactions were accounted for in the final HOV to HOT rating as shown in Table D-3.

These strong, moderate and weak interactions are accounted for in the software by first obtaining the score for the relevant facility characteristic (for example, cross section) from the user. If the score on the characteristic is less than ideal then some adjustment of the related performance factor (for example, lane utilization) is required as the default performance factor values assume an ideal facility. The software will automatically update the performance factor to reflect this sub-optimal facility characteristic by subtracting the appropriate number of points from the value of the performance factor (from the 5 to -5 scale). These points vary by interaction type and strength of the interaction but are typically around 1 to 2 points. The exact number of points deducted for sub-optimal facility specifications are shown in Table D-3.

Table D-1. Interaction of Factors Impacting the Conversion of an HOV Lane to an HOT Lane

	Interaction Level					
	Performance Factor					
Facility Factor	HOV Lane Utilization	Travel Time	Willingness to Pay Tolls	Safety	Environment	Benefits
Cross Section						Anytime any of
Lane Separation						the first five
Facility Access for HOT O-D						performance factors
Facility Access Design						are impacted
Ability to Enforce						then the benefits
Facility Traffic Control						of the HOT
Pricing Strategy						lane are impacted.
Incident Management						
Maintenance						

Legend:

- Strong Interaction
- Moderate Interaction
- Weak, but Significant, Interaction
- Secondary Interaction

Table D-2. Discussion of Significant Interactions between Factors

Facility Factor	Performance Factor	Interaction Discussion
Cross Section	HOV Lane Utilization	As the cross section narrows, the volume of vehicles accommodated on the lane at free-flow speeds decreases.
	Travel Time	As the cross section narrows, the free-flow speed drops, decreasing the travel time benefits of the HOV lane.
	Willingness to Pay Tolls	With very narrow lanes travelers may not feel comfortable and safe in the lanes, decreasing their willingness to pay for travel in those lanes.
	Safety	Both actual and perceived safety may decrease as lane widths decrease. Increased crashes will also adversely impact travel times. Additionally, if insufficient room exists to move stalled or crashed vehicles out of the way on a barrier-separated lane then travel times could be much worse than on the general-purpose lanes.
Lane Separation	Travel Time	If a significant blockage occurs in a barrier-separated facility (frequently), then travel times on the HOV lane will deteriorate significantly.
	Safety	Limited research suggests barrier-separated lanes to be safer than lanes separated by a buffer or a flexible barrier.
Facility Access for HOT Lane Origins and Destinations	HOV Lane Utilization	If the access points for toll paying drivers are congested or located long distances from their preferred entry point, then the travel time savings decreases along with the number of non-paying travelers at those access points.
	Willingness to Pay Tolls	
Facility Access Design	Travel Time	Poor access/egress points can add travel time and driver frustration to the HOV lane option, thus reducing the number of toll paying users and their willingness to pay for the lane.
	Willingness to Pay Tolls	
	Safety	Poor access/egress points can reduce perceived/actual safety.
Ability to Enforce	Willingness to Pay Tolls	Some potential paying customers may choose to be violators instead if they perceive/recognize lax enforcement.
Facility Traffic Control	Willingness to Pay Tolls	Adequate pricing/occupancy requirement information must be available prior to many travelers electing to pay for HOV lane use.
Pricing Strategy	HOV Lane Utilization	The pricing strategy clearly has a major impact on both the utilization of the lane and the traveler's willingness to pay the toll. The software provides guidance on the preferred pricing strategy for different lane options and assumes the HOV lane operator selects an appropriate strategy.
	Willingness to Pay Tolls	
Incident Management	All	An aggressive incident management strategy that rapidly clears incidents from the HOV lane can improve all performance aspects.
Maintenance	All	If there is debris in the lane on a regular basis or there are issues with reversing a reversible lane then this will impact all aspects of HOT lane performance.

Table D-3. Interaction Adjustments to Performance Scores

	Performance Factor									
	HOV Lane Utilization		Travel Time		Willingness to Pay Toll		Safety		Environment	
Facility Factor	FS	IA	FS	IA	FS	IA	FS	IA	FS	IA
Facility Cross Section	-3,-4 -5	-1 -2	-5	-1	-5	-1	-3,-4 -5	-1 -2		
Lane Separation for Toll Collection			Br[1]	-1			No Br	-2		
Facility Access Satisfies O-D Requirements					-1 to -3 -4,-5	-1 -2				
Facility Access Design			-5	-1	-5	-1	-3,-4 -5	-1 -2		
Ability to Enforce					-1 to -3 -4,-5	-1 -2	-4,-5	-1		
Facility Traffic Control					-1 to -3 -4,-5	-1 -2				
Pricing Strategy	-5	-1			-3,-4 -5	-1 -2				
Incident Management			-4,-5	-1	-4,-5	-1	-4,-5	-1	-4,-5	-1
Maintenance			-4,-5	-1	-4,-5	-1	-4,-5	-1	-4,-5	-1
Possible Deduction:		*-3*		*-5*		*-12*		*-9*		*-2*
Deduction Cap:		**-3**		**-2**		**-5**		**-6**		**-2**
Minimum Score Cap:		**-5**		**-5**		**-5**[2]		**-5**[2]		**-5**

FS = Facility Score. IA = Interaction Adjustment. Br. = Barrier separated.
[1]*Facility Cross Section* score must also be -3 to -5.
[2]Even though the minimum score allowed is -5, the HOT START software will track the theoretical adjusted score, and if this falls below -5, the factor will be flagged and noted in the results.

As shown in Table D-3, the interaction adjustments often follow a standard deduction method. For weak to medium interactions, very poor facility scores will usually result in a performance factor score reduction of -1. For moderate to strong interactions, poor facility scores will usually result in a performance factor score reduction of -1, and a very poor facility score will usually result in a performance factor score reduction of -2.

Based on the research team's knowledge of how these factors interact, some of the interactions are slightly different from this standard. The primary differences are with the HOV Lane Utilization performance factor. This factor focuses on non-toll-paying vehicles and the capacity available in the lane for toll-paying vehicles. Many of the facility factors greatly impact the number of toll-paying customers, but their impact is considerably less on non-toll-paying vehicles. Therefore, some of these interactions do not result in a reduction in score.

In addition, when combining all of the potential negative impacts, it could be possible to have an extremely large deduction to the performance score. However, many of these deductions would not have a cumulative impact equal to the sum of the interaction adjustments. Rather, the impacts would combine to have an impact smaller than their sum would indicate.

Therefore, a deduction cap is set, and total performance scores may not be reduced by more than this deduction cap. Finally, no performance score can drop below the prescribed minimum of -5.