Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/TX-98/1756-2		

4. Title and Subtitle	5. Report Date
PROCEDURES AND CRITERIA USED TO EVALUATE THE FINANCIAL VIABILITY OF PRIVATE TOLL ROAD PROJECTS BY STATES AND PRIVATE ENTITIES INVOLVED IN THE APPROVAL, FINANCING, AND/OR EVALUATION OF PRIVATE TOLL ROAD PROJECTS	April 1998
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Thomas L. Glenn	Research Report 1756-2
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.
	Study No. 0-1756
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Texas Department of Transportation Research and Technology Transfer Office P. O. Box 5080 Austin Texas 78763-5080	Research: Sept .1-Dec.31, 1996
	14. Sponsoring Agency Code

15. Supplementary Notes

Research performed in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration.
Research Study Title: Feasibility of Private Toll Roads: An Evaluation Procedure for TxDOT – Phase II

16. Abstract

This is the second in a series of six research reports focusing on the process of preparing and evaluating feasibility studies for private toll road projects in Texas. At present, one of the requirements for preliminary approval of a private toll road by the Texas Transportation Commission is that the Commission must find, on the basis of a feasibility study submitted by the sponsors of a private toll road project, that the project will be financially viable. An attempt to evaluate the financial viability of one private toll road project seeking preliminary approval by the Commission revealed some problems in the evaluation process, stemming from an inadequate list of the data and information that should be included in the required feasibility study and an imprecise definition of financial viability. The overall objective of this research project is to develop improved procedures for TxDOT's use in determining whether a proposed private toll road project will be financially viable. This report describes the procedures and criteria that other states, investment banks, and bond rating agencies use to evaluate the financial viability of private toll road projects.

17. Key Words	18. Distribution Statement
Private Toll Roads, Feasibility Studies	No restrictions. This document is available to the public through NTIS: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161

19. Security Classif.(of this report)	20. Security Classif.(of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	58	

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Research Report 1756-2
Research Study Number 0-1756
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Sponsored by the
Texas Department of Transportation
In Cooperation with the
U.S. Department of Transportation
Federal Highway Administration

April 1998

TEXAS TRANSPORTATION INSTITUTE
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ACKNOWLEDGMENT

Research performed in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration.

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The author wishes to express his gratitude to the following individuals who agreed to be interviewed for this report:

Barry Adair, Morgan Stanley & Co.

Thomas Bradshaw, Smith Barney Shearson.

Rhonda Brooks, Public/Private Initiative Program, Washington Department of Transportation.

Deborah Brown, Virginia Department of Transportation.

William Chew, Standard & Poor's Corp.

Richard Fitzgerald, Goldman, Sachs & Co.

Kurt Forsgren, Standard & Poor's Corp.

William Hayden, Office of Privatization, Arizona Department of Transportation.

Adeel Lari, Office of Alternative Transportation Financing, Minnesota Department of Transportation.

Edward McCarron, Financial Planning Office, Florida Department of Transportation.

Frank McDonough, Bear, Stearns & Co.

Carol Muller, Paine Webber.

Robert Muller, J. P. Morgan & Co.

Raymond Nagy, California Department of Transportation.

James Ryan, Salomon Brothers.

Deborah Steemly, Office of Toll Operations, Florida Department of Transportation.

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CHAPTER 1
INTRODUCTION

This is the second in a series of six research reports focusing on the process of preparing and evaluating feasibility studies for private toll road projects in Texas. At present, one of the requirements for preliminary approval of a private toll road project by the Texas Transportation Commission is that the Commission must find, on the basis of a feasibility study submitted by the sponsors of a private toll road project, that the project will be financially viable. An attempt to evaluate the financial viability of the first private toll road project to seek preliminary approval by the Commission revealed some problems in the feasibility study evaluation process, stemming from omissions in the list of the data and information that should be included in the required feasibility study and an imprecise definition of financial viability. The overall objective of this research project is to develop improved procedures for TxDOT's use in determining whether a proposed private toll road project will be financially viable.

The first report described the data and information that other states, investment banks, and rating agencies require or expect in feasibility studies for private toll roads. This report describes the procedures and criteria used by other states, investment banks, and rating agencies to evaluate feasibility studies for private toll roads (i.e., to determine whether a proposed private toll road will be financially viable). The third report will present a set of suggested guidelines that TxDOT can promulgate to guide the preparation of feasibility studies for private toll road projects by their sponsors. The purpose of these more detailed guidelines is to ensure that all data and information required to evaluate the financial viability of each private toll road project will be provided. The fourth report will present a set of suggested guidelines for TxDOT's use in evaluating the completeness of feasibility studies for private toll road projects received by the Department. The fifth report will present suggested procedures and more precise criteria for TxDOT's use in determining whether a proposed private toll road will be financially viable on the basis of a complete feasibility study. The sixth report (a project summary report) will summarize the work accomplished, the research findings, and provide recommendations for implementing the research findings.

Background

Before proceeding to a description of the procedures and criteria used by other states, investment banks and rating agencies to evaluate feasibility studies for private toll roads, a summary of the data and information that these institutions require or expect in feasibility studies for

private toll roads is provided here. For a description of the laws and regulations governing the process of obtaining approval from the Texas Transportation Commission for construction of a private toll road in Texas and a description of the specific objectives of this research project, the reader is referred to the first report in this series.

A survey of the practices of other states conducted in 1996 revealed that, of the 10 states that permit private or public/private toll roads provided that such projects have been approved by the state DOT, six states had developed formal requirements governing the financial data and information that must be provided to obtain DOT approval. Two states (Arizona and Minnesota) are similar to Texas in regard to the specific financial data and information required, two states (Virginia and Washington) have somewhat more detailed requirements than Texas, and two states (California and Florida) have significantly more detailed requirements than Texas. In particular, Florida's requirements could serve as a partial model for Texas because, like Texas, Florida's more detailed data and information requirements have been incorporated into the Florida Administrative Code. The data and information requirements of the other five states are incorporated into Requests for Proposals rather than Administrative Codes.

Arizona does not require a feasibility study *per se*, but rather a "preliminary financial plan." Aside from noting that the preliminary financial plan is to include sources and uses of funds, Arizona does not specify any other data or information that must be included in the preliminary financial plan.

Minnesota is much like Arizona in that Minnesota does not require a feasibility study *per se*, but rather a "financial proposal." Aside from noting that the financial proposal is to include traffic and demand forecasts and a financial plan for the proposed project, Minnesota does not specify any other data or information that must be included in the financial proposal.

Virginia's proposal submission process has two phases. In the first phase, a "Conceptual Proposal" must be submitted that includes: (1) an estimate of the cost of the project by phase; (2) a plan for the development, financing, and operation of the project, showing the anticipated schedule on which funds will be required and proposed sources for such funds; (3) a list and discussion of assumptions underlying all major elements of the plan; (4) the proposed risk factors and methods for dealing with these factors; and (5) the total commitment, if any, expected from governmental sources and the timing of any anticipated financial commitment. In the second phase of the proposal submission process, certain "specific deliverables" might be requested, including the proposed total life-cycle cost of the facility or facilities; anticipated commitment of

all parties; equity, debt, and other financing mechanisms; a schedule of project revenues and project costs; and a detailed discussion of assumptions about user fees or toll rates, and usage of the facility such as traffic forecasts and assumptions.

Washington's specific financial data and information requirements include: (1) an estimate of the cost of the project by phase; (2) a plan for the development and operation of the project, showing the anticipated schedule on which funds will be required; potential sources for funds including equity, debt, and other financing mechanisms; a schedule of project revenues, project costs, and return on investment; and (3) a list and discussion of assumptions underlying all major elements of the plan, including assumptions about user fees or toll rates, and usage of the facility.

Of the two states (California and Florida) that require significantly more detailed data and information than Texas, California implicitly requires a very detailed description of the financing structure of the project, including: (1) current and proposed equity contributions, if any, to the proposed project, including source and nature of equity contributions; (2) type and mix of debt financing to be used for the proposal, including foreign debt; (3) terms of any proposed debt structure including maturity schedule, refunding opportunity, redemption provisions, defeasance procedures, default options, coverage ratios, and debt service reserve requirements; (4) where assessment or other special district financing is proposed, all assumptions regarding the boundaries of the districts, level and reasonableness of assessments, historical appreciation rates, impact of the proposed project on property values, projected development, and reasonableness of build-out development scenario; (5) letter of credit/line of credit agreements and requirements concerning assignment of revenues to the credit support provider; (6) secured and unsecured loans which are or will be part of the proposed financial plan, nature of collateral pledged to support bank loans, and loan guarantees which are part of the proposed financial plan; (7) loan-to-value ratio of all real estate financing required as part of the finance plan and security for real estate financing; (8) agreements with any multilateral development banks or other supranational lending institutions; and (9) local government agreements which provide funding for the proposal.

In connection with the description of the financing structure for the project, California also requires a detailed statement of the costs of issuance, underwriters discount, legal fees, trustee fees, letter/line of credit fees, origination and commitment fees for bank loans, and other transaction costs associated with the debt financing.

With respect to cash flow projections, California requires: (1) cash flow projections for the construction period and all years the facility is proposed to remain under private operation; (2) interest rates including assumptions regarding the cost of funds and borrowing rates; (3) toll and fee structure of the proposal; (4) traffic count estimates for the proposal; (5) projected operations and maintenance costs of the proposed project and the proposed funding sources for these costs; and (6) non-toll revenues including airspace, advertising, roadside concessions, special truck fees, emergency road service fees, access fees, local governmental contributions, real estate, and other sources.

California also requires proposers to subject their cash flow projections to a "Sensitivity Analysis" consisting of the following tasks: (1) test the financial plan under different assumptions regarding traffic volume, toll structure, inflation, interest rates, time delay, and project area development; (2) identify a best-case, a most-probable, and a worst-case scenario under specified assumptions; and (3) for any proposals that assume real estate development or assessment revenue as part of the financial plan, develop sensitivity models that test different assumptions regarding property values, development timetables, and market absorption.

Like California, Florida has very detailed requirements regarding the financing structure for the project. These requirements include: (1) the level and source of public sector funding required, including the amounts and periods over which it will be required; (2) the amount and source of equity funds to be contributed by the private entity, substantiated through bank letters of intent or other appropriate banking instruments; (3) the amounts, timing, terms, conditions and methods of obtaining bond financing, and estimated costs of underwriting and issuing the bonds; and (4) amount and source of other debt financing along with the methods and conditions for obtaining such financing, cost associated with underwriting and issuing this debt instrument, and method of issuance (e.g., public offering or private placement).

Although Florida does not specify a format for required projections, Florida implicitly requires a projected income statement and cash flow projections. With respect to the projected income statement, Florida's requirements include: (1) operating revenue projections including toll revenues based on the estimate of ridership and the anticipated fare structure, other operating revenue streams such as receipts from advertising, station concessions, royalties and licenses, and amount of associated real estate development and supplemental revenue sources that will be used to supplement operations, and public sector subsidies; (2) a proposed operating budget that contains detailed annual costs of proposed activity and subactivity expenditures consistent with the project schedule including traffic and revenue studies, project financing and debt service,

preliminary engineering, environmental impact, engineering design, right-of-way acquisition, construction, equipment acquisition, operations and maintenance, renewal and replacement, support services, and administration; and (3) contributions from net operating revenues that will be used toward capital infrastructure costs and for debt retirement.

With respect to the cash flow statement, Florida requires a total cash flow analysis beginning with project implementation and extending for a 30-year period.

Florida also requires that the sensitivity of project financing scenarios be tested and results presented with respect to 25% variations in (1) interest rates; (2) inflation rates; (3) capital costs; (4) traffic estimates; (5) operating and maintenance costs; and (6) other revenue streams (i.e., receipts from advertising, station concessions, royalties and licenses; amount of associated real estate development and supplemental revenue sources that will be used to supplement operations; and public sector subsidies).

The most significant practice of Florida is the required documentation of all financial data presented in the required projections. Thus, in connection with the required cost estimates, Florida stipulates that the methods and assumptions used to develop the cost estimates must be presented for verification. In connection with the required revenue projections, Florida requires a description of the methods and rationale used to develop the estimates. For toll revenues, Florida stipulates that the method of producing the estimates be described in sufficient detail to allow the projections to be verified and that all assumptions used in the process be clearly indicated. For other operating revenue streams, Florida requires clearly stated assumptions, data, and methods used to develop the forecasts.

Our survey of the practices of investment banks revealed that investment banks typically receive a traffic and revenue study for a private toll road project from traffic consultants and produce a feasibility study for the project by adding projections of annual local, state, and federal taxes and projections of annual debt service to the projections of toll revenues and operating and maintenance costs in the traffic and revenue study. All of the investment bankers interviewed for this study stressed two expectations for traffic and revenue studies: (1) that there be projections of revenues and cash flows for the entire term of the revenue bonds issued to finance the toll road; and (2) that there be sufficient documentation of all numerical projections in the traffic and revenue study to permit due diligence to be performed. On the other hand, these investment bankers said that there have not been enough private toll road financings in the United States to establish a formal list of line items that should be required in every traffic and revenue study.

As the most active agency in the provision of credit ratings for revenue bonds issued to finance both public and private toll roads, Standard & Poor's has a written set of criteria covering toll road revenue bonds. Standard & Poor's states that a "well-documented feasibility study" includes: (1) a market and demand analysis that examines the following factors: demographic patterns; historical and projected traffic patterns; traffic mix; competing facilities; historical and projected toll rates; and, where practicable, the sensitivity of motorists to various toll levels; and (2) a financial analysis examining revenues and operating costs, as well as projecting the impact of planned improvements, competitive highways, and motor fuel availability. Standard & Poor's expects a detailed feasibility study reviewing the underlying economic underpinnings and project-specific issues that result in the projected traffic and revenue forecast. The forecast should clearly state all assumptions used and be sufficient to analyze the debt through its repayment term. In addition, Standard & Poor's also expects sensitivity analyses to be performed to simulate normal changes in economic conditions to help gauge the project's ability to withstand change.

Definitions

Two terms were frequently used by the individuals interviewed for this report when describing their institutions' procedures and criteria used to evaluate feasibility studies for private toll road projects: "due diligence" (or "due diligence review") and "debt coverage ratio."

Ideally, due diligence means the verification or validation of every numerical projection presented in a feasibility study. Verification of numerical projections typically involves determining that a projected cost or price is realistic. The source of a verifiable numerical projection might be a contingent construction bid or contingent electronic toll collection system lease agreement or contingent liability insurance premium quotation ("contingent" meaning a price or rate from a specific vendor that will apply for a specified period of time). Validation of numerical projections typically involves determining whether a given numerical projection is reasonable, attainable, and/or likely. The source of a numerical projection that can be validated might be the annual operation or maintenance cost of an existing facility that is comparable to the proposed facility, or a set of assumptions and calculations that appear to be reasonable. In practice, due diligence amounts to verifying or validating the construction cost and the revenue and expense projections for the first year of operation. Ordinarily, revenue and expense projections from the second year onwards will be based on the first year projections and an assumed annual rate of increase. Hence, verification or validation of line item projections from the second year

onwards will hinge on the reasonableness of the assumed annual rate of increase in each line item.

Debt coverage ratio is the ratio of net revenue available for debt service divided by debt service (interest and principal repayments). In most cases, debt coverage ratios are computed for each year of operation during the term of the revenue bonds to be issued to finance the project. In the case of public toll facilities, the debt coverage ratio is simple to compute: it is the net revenue from operations (i.e., toll revenues minus operations and maintenance expenses) calculated by the traffic consultant in the traffic and revenue study divided by the investment bank's projection of annual debt service requirements. Computation of a debt coverage ratio is more complex in the case of a private toll facility because of the fact that private toll facilities have local, state, and federal tax liabilities. Local taxes are usually property taxes based on the initial value of the facility less accumulated depreciation. State and federal taxes are income taxes based on taxable income (i.e., net revenue from operations less depreciation and interest payments, and, in the case of federal taxes, less local and state taxes). To arrive at a measure of the debt coverage ratio of a private toll facility that is comparable to the debt coverage ratio of a public toll facility, the cash flow statement must start with net income after taxes and then add back interest payments (which were treated as an allowable expense in computing state and federal income tax liability) and depreciation expense. This figure divided by interest payments and principal repayments will yield an annual debt coverage ratio that is comparable to the debt coverage ratios that are computed for public toll facilities.

Report Organization

Chapter 2 describes the procedures and criteria that other states use to evaluate feasibility studies for private toll roads. Chapter 3 describes the procedures and criteria that investment banks and rating agencies use to evaluate feasibility studies for private toll roads. Chapter 4 identifies the common patterns in the procedures and criteria of these three types of organizations involved in the approval and financing of private toll roads. Chapter 5 discusses the adequacy of these procedures and criteria in light of the number of recently opened toll roads that are achieving only a fraction of the revenues projected in their traffic and revenue studies. Chapter 6 describes what is known about the methods used by traffic consultants to project revenues and argues that the principal source of these forecasting errors lies in an inappropriate methodology for determining diversion rates (i.e., the proportion of total traffic in the corridor served by the toll road project that is expected to use the toll road at the projected toll rates). Chapter 7 describes

two alternatives to current methodology that promise to provide more accurate projections of diversion rates.

CHAPTER 2
PROCEDURES AND CRITERIA USED TO EVALUATE FEASIBILITY STUDIES FOR PRIVATE TOLL ROAD PROJECTS BY OTHER STATES

Procedures and Criteria Used by Arizona

Although Arizona has not formally required any data and information beyond a preliminary financial plan that includes sources and uses of funds, the evaluation procedures and criterion of financial viability used by the Arizona Department of Transportation (ADOT) suggest that ADOT is receiving feasibility studies for private toll road projects. ADOT's first step is to review the financial projections in-house, relying on an ADOT economist and the Department's finance office. ADOT then uses an outside financial consultant that specializes in financial assessments of toll roads to provide a risk assessment and a due diligence review of the financial projections. A list of the tasks expected of the outside financial consultant can be found in ADOT's *HDR-MetroRoad Toll Road and Express Lane Proposal: Recommendation to the State Transportation Board* dated April 3, 1997. The financial consultant was asked to provide a "Review of Financial Capacity, Capability and Strength" and a "Review and Assessment of the Financial Plan." The review of the financial plan included the following tasks:

A. Identify all sources and uses of funds in the financial plan. For all revenue sources, describe the process necessary to secure funds.
B. Identify all required public funds utilized in the financial plan and the year(s) of requirement.
C. Verify the mathematical calculations contained in the financial plan.
D. Review and comment on all assumptions used in the financial plan.
E. Identify and review any third party financing commitments.
F. Review and comment on the type of debt proposed for the project, including tax status, security provisions, market acceptability, rating assumptions, and assumed cost of capital.
G. Determine and comment upon the impact of the financial plan on the state, the state's credit standing, and/or the financial impact on any local government.
H. Comment upon the reasonableness of assumptions made regarding any public funds.
I. Identify the level of contingency for the project.

J. Determine the allocation of risk between the public and private sector and/or between the members of the proposer team.

K. Identify any project risks with regard to approval, construction, ridership/traffic, intergovernmental funding, market access, etc.

L. Verify the return on equity/internal rate of return calculation contained in the proposal.

M. Provide sensitivity analyses which identify changes in financial plan assumptions which would cause the project to 'not work' financially [Test One was amount by which toll revenues could drop and still provide target debt coverage ratio of 1.5; Test Two was amount by which annual debt service could increase and still provide target debt coverage ratio of 1.5].

N. Provide a summary and assessment of the financial plan as a whole.

ADOT has also used an outside traffic consultant to provide a risk assessment of the traffic projections. As a final step in its review of financial projections, Arizona reviews the projections in the traffic and revenue study with the traffic consultants that provided the study. The objective of these procedures is to determine what adjustments, if any, should be made in the financial projections of the feasibility study to satisfy ADOT and its consultants that all the projections are reasonable. ADOT has found that the initial traffic and revenue projections in the feasibility studies it has received tend to be excessively optimistic. When they are satisfied with the reasonableness of all financial projections in the feasibility study, both the Department's in-house staff and the outside financial consultant provide opinions regarding the financial viability of the project. ADOT's criterion of financial viability is a debt coverage ratio of 1.5 or better in each year of operation.

Procedures and Criteria Used by California

With respect to procedures and criteria used by California to evaluate the financial plans submitted in response to A.B. 680's call for four private toll road demonstration projects, a California Department of Transportation (Caltrans) official told the author that Caltrans did not need to be concerned about financial feasibility because the state owns these facilities under the build-transfer-operate model, and leases the facilities to private operators. If the private operator defaults, the facility reverts to the state unless the creditors want to bring in new management. Therefore, Caltrans undertook no evaluation of its own. Instead, according to *Guidelines for Conceptual Project Proposals for Toll Revenue Transportation Projects* dated March 1990,

Caltrans required proposers to obtain a statement of their Financial Plan's adequacy from a financial consultant prequalified by Caltrans. The statement of opinion required was:

> "It is our opinion, as of _____, 1990, that the financial plan contained in the proposer's conceptual proposal appears to be based on reasonable financial assumptions consistent with the level of analysis provided in the conceptual transportation project development proposal, and as a result provides a reasonable basis for the further development of the conceptual proposal. It is our opinion that the financial plan, at the conceptual level, adequately identifies the source(s), type(s), amount(s), and schedule of financing based on conditions that currently prevail in the capital and debt markets, and which are contemplated at specific stages in the development of the conceptual proposal."

In turn, Caltrans' *Guidelines for Conceptual Project Proposals for Toll Revenue Transportation Projects* provided financial consultants with the following list of "Representative Tasks for Consideration":

1. Financing Structure Analysis
   - A. Identify Equity Contribution
     - 1) Quantify the current and proposed equity contributions, if any, to the proposed project. Indicate the source and nature of equity contributions (cash, in-kind services, materials, real estate, etc.).
   - B. Analyze Debt Financing
     - 1) Review and determine the total aggregate of debt financing required for the proposal.
     - 2) Identify the type and mix of debt financing to be used for the proposal, including foreign debt.
     - 3) Review the terms of any proposed debt structure including the following: maturity schedule, refunding opportunity, redemption provisions, defeasance procedures, default options, coverage ratios, and debt service reserve requirements.
     - 4) Where assessment or other special district financing is proposed, review all assumptions regarding the boundaries of the districts, level and reasonableness of assessments, his-

torical appreciation rates, impact of the proposed project on property values, projected development, and reasonableness of build-out development scenario.

C. Analyze Credit Support Letters or Lines of Credit

1) Review all letter of credit/line of credit agreements.

2) Determine the requirements concerning assignment of revenues to the credit support provider.

D. Analyze Bank Lending

1) Identify all secured and unsecured loans which are or are to be part of the proposed financial plan.

2) Determine the nature of collateral pledged to support bank loans.

3) Identify and analyze any loan guarantees which are part of the proposed financial plan.

E. Analyze Real Estate Financing

1) Review the loan-to-value ratio of all real estate financing required as part of the finance plan.

2) Review the security for real estate financing.

F. Analyze Other Funding

1) Identify and review any agreements with any multilateral development banks or other supranational lending institutions.

2) Identify and review any local government agreements which provide funding for the proposal.

2. Cash Flow Analysis

A. Review Cash Flow

1) Review all cash flow projections for the construction period and all years the facility is proposed to remain under private operation.

2) Confirm that all debt required to fund and operate the proposed project will be retired within the period of private development and subsequent operation.

3) Review the reasonableness of all interest rates including assumptions regarding the cost of funds and borrowing rates.

4) Review the costs of issuance, underwriters discount, legal fees, trustee fees, letter/line of credit fees, origination and

commitment fees for bank loans, and other transactional related costs associated with the debt financing. Report as to the reasonableness of those costs.

5) Review the expected rate of annual return required by investors, pre-tax and after tax.

6) Review the proposed project Internal Rate of Return (IRR) over the operating life of the proposed project and the design and construction period. What is the projected rate of return indicated by your review?

7) Review the reasonableness and sufficiency of the toll and fee structure of the proposal.

8) Review the traffic count estimates for the proposal.

9) Review the projected operations and maintenance costs of the proposed project and the proposed funding sources for these costs.

10) Review for reasonableness all estimates for non-toll revenues including airspace, advertising, roadside concessions, special truck fees, emergency road service fees, access fees, local governmental contributions, real estate, and other sources.

B. Perform Sensitivity Analysis

1) Test the financial plan under different assumptions regarding traffic volume, toll structure, inflation, interest rates, time delay, and project area development.

2) As part of the sensitivity analysis, identify a best-case, a most-probable, and a worst-case scenario under specified assumptions.

3) For any proposals that assume real estate development or assessment revenue as part of the financial plan, develop sensitivity models that test different assumptions regarding property values, development timetables, and market absorption.

According to the Caltrans official interviewed for this report, "adequacy" meant that the project made some kind of financial sense; that is, if all the assumptions were to hold, then the project could make it financially. It was not a definitive assessment of feasibility. The same offi-

cial reiterated the point that, since Caltrans has no financial responsibility for the toll road project, it does not need to evaluate financial viability.

Procedures and Criteria Used by Florida

The Florida Department of Transportation (FDOT) has prepared a flowchart to describe its "Private Transportation Facilities Proposal Review Process." According to the flowchart, FDOT will create a "PTF Executive Review Team" when it receives a private transportation facility proposal. This review team will be subdivided into two groups: a Technical Review Group and a Financial/Administrative Review Group. Each of these groups will in turn retain outside consultants: the Technical Review Group will retain an engineering consultant, and the Financial/Administrative Review Group will retain a financial consultant. The flowchart clearly shows that the applicant will be expected to provide additional information and data requested by the Executive Review Team and the two groups. The groups and their outside consultants will analyze the proposal and make recommendations to the Executive Review Team, which will in turn make a recommendation to accept or deny the proposal to Florida's Secretary of Transportation.

According to the FDOT official interviewed for this report, FDOT's actual practice differs somewhat from the idealized portrait presented in the flowchart. Primary responsibility for the evaluation of stand-alone private toll road projects falls on the Financial Planning Office. The toll revenue projections in the traffic and revenue study are verified by another traffic consultant, which is asked to review the assumptions and methods used by the author(s) of the traffic and revenue study. The operation and maintenance expense projections in the traffic and revenue study are checked for reasonableness by FDOT's Office of Toll Facilities and "maintenance people" in FDOT. The criterion of financial viability used by FDOT is a debt coverage ratio of 1.5 or better.

Procedures and Criteria Used by Minnesota

According to the Minnesota Department of Transportation (MDOT) interviewed for this report, MDOT's Office of Alternative Transportation Financing received five proposals in response to its *Request for Proposals for Transmart, Minnesota's Toll Facilities Public-Private Initiatives Program*. In preparation for evaluating these proposals, MDOT issued a Request for Proposals (RFP) to select an outside financial consultant to provide services to the TRANSMART program in three consecutive phases. In Phase I, the financial consultant was to

"determine whether the financial plan submitted for a proposed project demonstrates a reasonable basis for funding project development and operations." Because detailed financial plans cost too much, however, MDOT got financial plans that were too "sketchy" to be evaluated.

MDOT's future RFPs will not ask for anything more than a "back-of-envelope" analysis that says why the sponsors think the proposed project is viable; that is, not a detailed analysis and not a preliminary traffic and revenue study. A more detailed financial plan will be required in the second phase after preliminary approval has been given. The evaluation of this more detailed financial plan will consist of a recognized traffic consultant showing in a traffic and revenue study that the project can be funded, and an investment bank confirming that the project can be funded.

Procedures and Criteria Used by Virginia

The Virginia Department of Transportation (VDOT) uses an outside financial advisor to evaluate the financial standing of proposers of private toll road projects and to determine if the project is financially feasible. The financial advisor cannot verify the traffic assumptions in the proposal, but should check all other figures. VDOT tries to verify the traffic assumptions in-house. VDOT's criterion of financial viability is a debt coverage ratio of 1.3 or better.

Procedures and Criteria Used by Washington

The Washington State Department of Transportation (WSDOT) described its proposal and selection criteria in its *New Partners: Public-Private Initiatives in Transportation* Request for Proposals issued in January 1994. With respect to the required financial plan, WSDOT's criteria were embodied in the following four questions:

- Does the financial plan demonstrate a reasonable basis for funding project development and operations?
- Are the assumptions on which the plan is based well defined and reasonable in nature?
- Are the plan's risk factors identified and dealt with satisfactorily?
- Are the planned sources of funding and financing realistic?

In practice, WSDOT's Public-Private Initiative Program hired an outside financial consultant to determine if proposed projects were feasible. According to the confidential evaluations

of five proposals submitted in response to the New Partners RFP (only one of these projects was a toll road), the financial consultant was asked to review the following items in the financial plans:

A. Revenue sources
B. Assumptions in the financial plan
C. Effects of inflation on revenues and expenses
D. Unit costs of the project
E. Reasonableness of construction cost estimates on a per unit basis
F. Level of contingency in the project
G. Proposed funding and in-kind contributions to the project
H. Current status of availability of public funding or contributions for the project
I. Allocation of risk between proposers and between the public and private sector
J. Reasonableness of financial plan
K. Risk issues that WSDOT should consider in evaluating the proposal

The five evaluations show that the financial consultant changed various estimates in some of the proposals upon consultation with WSDOT and recomputed the financial projections. Construction cost was the most frequently changed estimate, followed by traffic estimates. The financial consultant also performed sensitivity analyses to determine the effects of various (generally plus or minus 2%) interest rate levels, operations and maintenance costs, and revenues on excess cash flows (i.e., net operating revenues minus annual debt service) and debt coverage ratios. It is not clear what criterion was used to determine whether a given financial plan was "reasonable." It appears that a "reasonable" financial plan was a plan that provided a "viable financial approach." The WSDOT official interviewed for this report said that there was no criterion of feasibility in terms of a minimum debt coverage ratio.

CHAPTER 3
PROCEDURES AND CRITERIA USED TO EVALUATE FEASIBILITY STUDIES FOR PRIVATE TOLL ROAD PROJECTS BY INVESTMENT BANKS AND RATING AGENCIES

Procedures and Criteria Used by Investment Banks

In addition to being asked what financial data are required in feasibility studies for private toll road projects by their institutions, the investment bankers interviewed for this report were also asked what adjustments and/or verification procedures are applied to such feasibility studies and what criteria are used to determine if a project is financially viable. In contrast to the widespread agreement regarding the financial data required, there are many differences between the seven investment banks regarding their procedures and their criteria.

Bear, Stearns & Co. attempts to verify or validate all assumptions used in the feasibility study, but finds that this is very difficult to do for the traffic and revenue forecast. Several rules of thumb are used in evaluating the traffic and revenue forecast. One of these is to take the estimate of traffic using the facility if it were free and decreasing that estimate by one-third to account for the effect of tolls. Another rule of thumb is to ask what traffic volume is required to break even. Twenty to twenty-five percent of total trips in the corridor is considered a reasonable share if it can be captured at a reasonable toll rate.

Goldman, Sachs & Co. performs a due diligence review of all projections in the feasibility study, with a focus on historical patterns as a guide to the reasonableness of the traffic projections. This firm also performs certain "stress tests" on the projections in the feasibility study to see whether the minimum debt coverage ratio is met if the traffic projections are not met. The criterion of financial viability used by Goldman, Sachs is an annual debt coverage ratio of 1.25 or better.

J. P. Morgan & Co. performs a due diligence review of all assumptions used in the feasibility study. This firm is particularly skeptical of the diversion rates assumed in many feasibility studies because the traffic consultants do not make allowances for the fact that trucks will not divert in the first five years of operation of toll roads and the fact that diversion rates in the morning rush hours are significantly higher than diversion rates in the evening rush hours during the early years of operation. Hence, there is a strong tendency to overstate diversion rates in feasibility studies, especially preliminary feasibility studies. In turn, there is a strong tendency to over-

state toll revenues in feasibility studies. J. P. Morgan & Co. also utilizes sensitivity analyses in its evaluations, but these analyses are performed by consultants. J. P. Morgan's criterion of financial viability is an annual debt coverage ratio of 1.3 or better, but debt coverage may include the ability to draw on a cash reserve or a Letter of Credit in addition to annual cash flows available for debt service.

Morgan Stanley & Co. attempts to verify or validate all numbers in the feasibility study, but the official interviewed for this report said that investment banks really cannot verify the traffic and revenue projections. They must rely on the qualifications of nationally recognized firms in the toll industry and accept the traffic and revenue projections in the feasibility study. Morgan Stanley's criterion of financial viability is not a specific debt coverage ratio, but whether the project can achieve an Investment Grade rating from a rating agency. In most cases, some equity and a backup Letter of Credit with partial coverage is necessary. If the minimum annual debt coverage ratio is 1.5 or better, a backup Letter of Credit will not be needed.

Paine Webber attempts to establish the reasonableness of all assumptions in the traffic and revenue study. This firm requests stress tests employing different assumptions about economic growth, traffic, etc. from consulting engineers. Because each project is different, Paine Webber does not have any rules of thumb for stress tests like assuming only 50% or 25% of the traffic projected in the traffic and revenue study. Paine Webber's criterion of financial viability is an annual debt coverage ratio of 1.25 or better, but the official interviewed for this report said that the criterion ought to be "obtain an Investment Grade rating from one of the rating agencies."

Salomon Brothers believes that the traffic and toll revenue projections in the traffic and revenue study must be accepted, but the firm does check the expense projections. Stress testing may take the form of looking at the effect of only one-half or one-quarter of the projected traffic volume. Salomon Brothers' criterion of feasibility is a minimum annual debt coverage ratio, but that ratio depends on the credit rating desired.

Smith Barney Shearson checks all calculations in the traffic and revenue study. Stress tests consist of alternative scenarios assuming 10% or 20% less traffic than projected, no economic growth or even negative economic growth, and less inflation. Smith Barney Shearson's criterion of financial viability is an annual debt coverage ratio of 1.0 or better, although the desired ratio is 1.3 or better. To achieve a minimum annual debt coverage ratio of 1.0 in the worst scenario, Smith Barney Shearson might design a debt structure that minimizes debt service in the

early years of operation when annual cash flows available for debt service are lower than they will be in later years.

Procedures and Criteria Used by Rating Agencies

Standard & Poor's tries to evaluate the reasonableness of the traffic forecast by verifying all computations in the traffic and revenue study. Standard & Poor's traffic experts based in the firm's San Francisco office are sure that traffic projections will be wrong to some degree or another. Hence the firm asks for different sensitivity analyses to be run, including a worst-case scenario. There are no hard and fast rules for defining the worst-case scenario as a specific percentage of the base case traffic projections. The individuals interviewed for this report stressed that Standard & Poor's does not simply evaluate the financial viability of a private toll road project; the firm assigns a credit rating indicating the likelihood of a project meeting all its debt service requirements. Thus, Standard & Poor's has more complex procedures and criteria than the states and the investment banks, and looks at many more things than the revenue, expense, and debt service projections of the feasibility study. For example, the greater the experience of the sponsors, the better the credit rating is likely to be; the better the track record of the operator, the better the credit rating is likely to be; and the greater the share of equity in total capitalization, the better the credit rating is likely to be.

Standard & Poor's also looks at the projected annual debt coverage ratio when assigning a credit rating. Although many firms in the investment banking community believe that the minimum annual debt coverage ratio must be 1.3 or better to get an Investment Grade rating (as opposed to a Speculative rating), Standard & Poor's representatives said that the threshold coverage ratio for an Investment Grade rating depends on the project and the financial standing of its sponsors. In this connection, the firm looks only at the annual cash flows available to cover debt service requirements (that is, Standard & Poor's does not include such cash sources as capitalized interest, standby equity commitments and the like when computing annual debt coverage ratios). The more level the annual debt service requirements are, the higher the rating is likely to be (this is a response to the investment bankers' practice of designing a debt structure that minimizes debt service requirements in the early years of operation to minimize the chances of the debt coverage ratio falling below 1.3 when revenues are lower than they are expected to be in later years). Standard & Poor's is also favorably impressed by arrangements that keep sponsors and equity investors in the project until the revenue bonds have been retired. One practice of this agency that is particularly notable is that Standard & Poor's will provide a preliminary rating to-

gether with specific recommendations to improve the rating upon request. One such suggestion could be a higher proportion of equity to debt in project financing.

CHAPTER 4
SUMMARY

Practices of Other States

Of the six states that require some sort of financial projections as a part of the approval process for private toll road projects, four states (Arizona, Florida, Virginia, and Washington) have a two-phase evaluation procedure. The first phase is similar to the investment banks' practice of due diligence; that is, these state DOTs attempt to verify or validate all of the revenue and expense projections in the financial plan. All four of these states used an outside financial consultant to perform this review. Two of these states (Arizona and Florida) used an outside traffic consultant to review the assumptions and methods of the traffic and revenue study, while Virginia and Washington used in-house staff to review the traffic and revenue projections . Three of these four states (Arizona, Florida, and Washington) are prepared to request or make changes in some or all of the financial projections submitted by applicants. If some of the projections do not appear to be reasonable, Arizona and Florida may request changes in the projections from the applicants (or their traffic consultants). Washington's outside financial consultant apparently adjusts projections found to be unrealistic by WSDOT without consulting the applicant. In the second phase, once the state DOTs are comfortable with the construction cost estimate and the revenue and expense projections in the financial plan or feasibility study, these four states apply a criterion of financial viability. Arizona, Florida, and Virginia utilize a minimum annual debt coverage ratio (1.5 in the case of Arizona and Florida, and 1.3 in the case of Virginia).

Washington's criterion is that the proposed project provides a "viable financial approach" in the estimation of WSDOT's outside financial consultant. In this respect, Washington appears to be closer to California than to the other three states that evaluate financial viability; that is, Washington and California appear to be more concerned with the ability of a proposed project to obtain financing than with the financial viability of the project. In part, this primary concern with the ability of a project to obtain financing flows naturally from the RFP process which might produce more applicants than can be accepted under state laws permitting a fixed number of "demonstration" projects. Selecting a project that cannot obtain financing would not only embarrass the state DOT, but would also be unfair to sponsors of projects not selected that could have obtained financing. In addition, the financial plans received and reviewed by WSDOT's outside financial consultant were too sketchy to permit the application of a strict numerical criterion of financial viability.

Rather than a determination of financial viability, California requires a statement that the financial plan for a proposed private toll road project is "adequate" from a pre-qualified outside financial consultant. "Adequacy" seems to mean the ability of a proposed project to obtain financing. In particular, that part of the required statement of adequacy that reads "It is our opinion that the financial plan, at the conceptual level, adequately identifies the source(s), type(s), amount(s), and schedule of financing based on conditions that currently prevail in the capital and debt markets, and which are contemplated at specific stages in the development of the conceptual proposal" appears to focus directly on the ability of the proposed project to obtain financing.

Minnesota was prepared to utilize an outside financial consultant to evaluate the financial plans of project proposals submitted in response to MDOT's *Request for Proposals for Transmart*, but MDOT found that the financial plans submitted at the initial stage of the project selection and approval process were too sketchy to determine if projects "demonstrated a reasonable basis for funding project development and operations." In other words, Minnesota is similar to California and Washington in that MDOT is primarily concerned with the ability of a project to obtain financing. In future RFPs, MDOT will not ask for detailed financial plans (that is, plans containing traffic and revenue studies) until after preliminary approval of a project has been given. Even then, MDOT will not evaluate the financial plans; it will ask the project sponsors to produce a recognized traffic consultant that says the project can be funded and an investment bank that confirms that the project can be funded.

Practices of Investment Banks

Of the seven investment bankers interviewed for this report, five (representing Goldman, Sachs; J. P. Morgan; Paine Webber, Salomon Brothers; and Smith Barney Shearson) attempt to perform a due diligence review of all projections in the traffic and revenue study and then utilize a minimum annual debt coverage ratio (1.25 for Goldman, Sachs; 1.3 for J. P. Morgan; 1.25 for Paine Webber; variable, depending on credit rating desired, for Salomon Brothers; and 1.0, but 1.3 desired, for Smith Barney Shearson) as a criterion of financial viability. One banker (representing Morgan Stanley) attempts to perform a due diligence review of all projections in the traffic and revenue study and then utilizes the achievement of an Investment Grade rating as a criterion of financial viability. The seventh banker (representing Bear, Stearns) also attempts to perform a due diligence review of all projections in the traffic and revenue study and then utilizes a "reasonable diversion rate" (that is, if not more than 25% of total trips in the corridor are required to break even) as a criterion of financial viability.

Some readers may wonder why the investment bankers focus their due diligence efforts on the projections (traffic, toll revenues, operating costs, and maintenance costs) in the traffic and revenue study rather than all projections in the feasibility study. There are two reasons for this particular focus on the part of the investment bankers. The first, and most obvious, reason is that the other elements of the complete feasibility study (local, state and federal taxes, and annual debt service requirements) have been developed by the investment banks. The second reason is that these other elements of the complete feasibility study are easy to verify or validate: allowable depreciation rates and tax rates at the local, state, and federal level are a matter of public knowledge.

On the other hand, the assumptions and methods utilized by the traffic consultants to produce the projections in the traffic and revenue study are not a matter of public knowledge and some traffic consultants insist that large parts of their assumptions and methods are proprietary, making it extremely difficult to perform due diligence on the projections of their traffic and revenue studies. Four of the investment bankers interviewed for this report mentioned problems of one kind or another with the effort to perform due diligence on the traffic and revenue study. Bear, Stearns' representative simply finds that it is difficult to verify or validate the assumptions and calculations in the traffic and revenue forecast. J. P. Morgan's representative is skeptical of the traffic and revenue forecasts, but admits that knowing that a revenue forecast is too high is not the same thing as knowing what the revenue forecast should be. The representatives of Morgan Stanley and Salomon Brothers both said that the methodologies of traffic consultants are not really understood by investment bankers; thus, they must rely upon the competence of nationally recognized traffic consultants and simply accept the traffic and revenue projections provided by these consultants.

Practices of Rating Agencies

It is difficult to summarize the procedures and criteria of Standard & Poor's. Since this firm tries to assign a credit rating to the revenue bonds of private toll road projects, many of its procedures and criteria are not applicable to the question of a project's financial viability. However, two elements of this agency's procedures are similar to the practices of some of the states and the investment banks: Standard & Poor's does try to verify or validate the projections in the feasibility study, and it does utilize the annual debt coverage ratio as one of its rating criteria.

Conclusions

This survey of states, investment banks, and a rating agency reveals a modal set of procedures and criteria. First, nearly all of these entities attempt to verify in some way that the projections in the feasibility study are reasonable, attainable, and likely. Most of the states utilize outside traffic consultants to review the traffic and revenue projections, and outside financial consultants to review the other parts of the feasibility studies or financial plans. Second, when they are satisfied that the revenue and expense projections are reasonable, attainable, and likely (which may involve adjustments with or without consultation with applicants), the majority of these entities utilize a minimum annual debt coverage ratio as their criterion of financial viability. The modal value of this criterion is a minimum annual debt coverage ratio of 1.25 to 1.3, a ratio that is thought to be the dividing line between an Investment Grade and a Speculative rating in the view of the rating agencies.

Some entities ask the applicants or their outside consultants to subject the projections in the financial plan or feasibility study to various "stress" tests involving other assumptions about background economic variables such as economic growth, inflation, and interest rates, or other assumptions about traffic and revenue. In turn, most of these entities that ask for, or utilize, stress tests apply their criterion of financial viability to the worst-case scenario rather than the baseline scenario.

It is worth repeating that a number of the states and investment banks mentioned difficulties validating traffic and revenue forecasts. In part, the difficulties stemmed from the fact that neither state DOT personnel nor investment bankers could see every assumption and calculation that went into the traffic and revenue forecast because traffic consultants regard their traffic assignment models and/or their methods of estimating diversion rates as proprietary. Several investment bankers admitted being unable to judge the reasonableness of the traffic and revenue forecasts owing to a lack of understanding of the methodology employed by traffic consultants. Finally, some state DOT personnel and investment bankers mentioned being strongly skeptical of the traffic and revenue forecasts they are receiving (generally believing that they are too high) without being able to say what the traffic and revenue forecast should be. The next chapter will demonstrate that there are solid grounds for this skepticism.

CHAPTER 5
ADEQUACY OF PROCEDURES AND CRITERIA USED BY OTHER STATES, INVESTMENT BANKS, AND RATING AGENCIES

Introduction

The preceding chapters have shown that the feasibility study for a recently constructed toll road project has been subjected to as many as three separate evaluations (one by an investment bank, one by a state DOT, and one by a rating agency). In spite of the efforts by these entities to verify or validate the projections in the feasibility study or financial plan before applying a criterion of financial viability, however, a number of toll road projects have been approved and financed that may not be financially viable. Specifically, there are a disturbing number of recently opened toll roads, both public and private, that have defaulted on their debt service obligations, or would have defaulted on their debt service obligations had they not been "bailed out" by other state agencies, because they are achieving only a fraction of the toll revenues projected for the early years of operation in the traffic and revenue study. It appears that current procedures and criteria for evaluating the financial viability of toll roads are not able to detect when significant overprojections in the forecasts of toll revenues provided by the traffic and revenue studies may be present in feasibility studies, nor how large the overprojections may be.

The Accuracy of Recent Toll Revenue Forecasts

Robert Muller (1996) of J. P. Morgan Securities was perhaps the first person to draw attention to some significant forecasting errors in recent traffic and revenue studies for private and public toll roads. Writing in the March 22, 1996 issue of J. P. Morgan Securities' *Municipal Market Monitor*, Mr. Muller compared the actual revenue performance of 14 urban toll roads that have been financed in the last 12 years with the original forecasts (see Table 1 for a list of these toll roads). The original forecasts were prepared by one of the three major firms in the traffic forecasting business, Wilbur Smith Associates, Vollmer Associates, or URS.

Of the 14 projects analyzed, Muller found that only two, the Illinois North South Tollway in suburban Chicago and the Georgia 400 in northern Atlanta, had actual revenues that exceeded projected revenues during the first four years of operation. In a third case, the Dallas North Tollway, the first phase extension project and the previously opened segment of road basically achieved projected revenues in the fourth year following completion of the extension. Muller also noted that initial indications were favorable for the Foothill Corridor extension in Orange

County, California, where revenues averaged about 12% below forecast through the first 10 months of operations. On the original Foothill segment, which opened in 1993, actual revenues exceeded projected revenues after the initial year. For the remaining 10 projects studied, however, actual revenues missed projected revenues by anywhere from 20% to 75% in the initial years after opening. A majority missed the revenue forecast in the second year by 40% or more (see Table 2).

Table 1. Tollroads Used in Muller's Analysis

Tollway	Opened	Projected rev. growth, first full 4 yrs. (%)	Consultant
Georgia 400	1993	6.3	Vollmer Associates
Hardy, TX	1988	15.0	Wilbur Smith
Illinois N.S. Tollway	1989	18.0	Wilbur Smith
Dallas North Tollway	1986, 1987	20.4	Wilbur Smith
Kilpatrick (OK City)	1991	31.4	Wilbur Smith
FL GreeneWay South Segment	1990	31.7	Vollmer Associates
Sam Houston, TX	1988, 1990	41.1	Wilbur Smith
Seminole, FL	1994	42.6	URS
FL GreeneWay Southern Connector	1993	43.0	Vollmer Associates
Creek (Tulsa)	1992	43.2	Wilbur Smith
Sawgrass Expwy., FL	1986	47.6	Wilbur Smith
Veterans' Expwy., FL	1994	50.6	URS
FL GreeneWay North Segment	1989	54.8	Vollmer Associates
Foothill North, CA	1995	NA	Wilbur Smith

Source: Muller, 1996

According to Muller, these forecasting failures have drawn little attention because, as of early 1996, none had resulted in a monetary default. Approximately half of the financing for the Harris County toll roads was supplied by general obligation bonds which are paid after the senior lien bonds. Revenues have barely been sufficient to pay debt service on these general obligation bonds. In Florida, the bonds initially used to build the Sawgrass Expressway were issued by the Broward County Expressway Authority and supported by county gasoline taxes as well as tolls.

Because revenues on the road fell so short of projections, the county was required to use far more of its gas tax than expected. The Florida Turnpike Authority finally took over the road in 1990 and the bonds are now being paid from toll revenues of the road and surplus funds of the Turnpike Authority, thereby relieving Broward County of its large subsidy. However, Muller thought that the Dulles Greenway's substantial shortfall of revenues as of early 1996 made it likely that form of monetary default or debt restructuring might occur on the outstanding taxable private placement. In any event, Muller pointed out that reducing the uncertainty associated with these forecasts represents one of the major challenges for transportation agencies, traffic consultants, investment bankers, and investors. Continued forecast variability could dampen investor interest at the very least and could lead to actual defaults at the extreme.

Table 2. Actual Revenues as Percentage of Projected Revenues in the Original Traffic and Revenue Forecast

Tollway	Yr. 1 (%)	Yr. 2 (%)	Yr. 3 (%)	Yr. 4 (%)
Georgia 400	117.0	133.1		
Hardy, TX	29.2	27.7	23.8	22.8
Illinois N.S. Tollway	94.7	104.3	112.5	116.9
Dallas North Tollway	73.9	91.3	94.7	99.3
Kilpatrick (OK City)	18.0	26.4	29.3	31.4
FL GreeneWay South Segment	34.1	36.2	36.0	50.0
Sam Houston, TX	64.9	79.7	81.0	83.2
Seminole, FL	45.5	52.5		
FL GreeneWay Southern Connector	27.5	36.6		
Creek (Tulsa)	49.0	55.0	56.8	
Sawgrass Expwy., FL	17.8	23.4	32.0	37.1
Veterans' Expwy., FL	50.1	54.1		
FL GreeneWay North Segment	96.8	85.7	81.4	69.6
Foothill North, CA	88.0			

Source: Muller, 1996

This trend to overprojections of revenues in recent toll road feasibility studies has also been closely monitored by the *Toll Roads Newsletter*, which has been highly critical of the errors made by the traffic consultants.

Toll Roads Newsletter Number 9 (November 1996) reported that Muller had drawn attention to poor traffic and revenue studies, most of which overestimated toll revenues, at the 1996 IBTTA meeting in Rome. Noting that Muller had said forecasting failures have attracted little attention because there has been no financial default, the editor of *Toll Roads Newsletter* added that the real financial "crocks" among the new public toll roads had all been bailed out, or quietly taken over, by other state agencies to avoid default on debt.

Summarizing Muller's presentation, *Toll Roads Newsletter* Number 9 said that he listed 14 toll road projects financed in the past dozen years and found a clear tendency to overestimate toll revenues in the traffic and revenue studies. The Georgia 400 and the Illinois North-South were exceptions. Traffic on GA 400 was running 30% above projections, and the IL North-South was 10 to 15% ahead of projections. But 12 of the 14 were underperforming.

Four of the 12 were moderate underestimates:

- Foothill CA—12% below projection;
- Sam Houston TX—about 20% below projection;
- North segment of the Central Florida Greeneway—at predicted levels first two years, but now 25% below projection; and
- Dallas North extension—26% below projection in its first year.

That left eight "disgracefully incompetent estimates, real crocks of forecasts":

- Creek OK—45% below projection;
- Veterans FL—46% below projection;
- Seminole FL—47% below projection;
- South segment of the Central Florida Greeneway—50% below projection;
- Sawgrass FL—60% below projection;
- Southern Connector of the Central Florida Greeneway—60% below projection;
- Kilpatrick OK—70% below projection; and
- Hardy TX—75% below projection.

Toll Roads Newsletter Number 9 went on to say that Muller could have added the Dulles Greenway VA (60% below projection) and the Oseola Parkway FL (70% below projection) to the list of "crock" forecasts, and SR-91 Express CA (the editor's guess was 20% below projection) to the list of moderate underestimates. And the VDOT Dulles Toll Road (25% above projection) could have been added to the two that were underestimated.

Thus, Muller listed:

- underestimates, 2;
- moderate overestimates, 4; and
- "blue sky" overestimates, 8.

With the editor's additions, *Toll Roads Newsletter* Number 9 listed:

- underestimates, 3;
- moderate overestimates, 5; and
- "blue sky" overestimates, 10.

"The pattern is clear. Hire a consultant to do a traffic and revenue study and the odds of getting an overestimate are over 80% and the odds of getting a 'blue sky' crock are over 50%! That's the record. . . . The clear pattern in the mis-estimation of traffic revenues suggests that there is something systematically wrong with the models being used to make these forecasts" (*Toll Roads Newsletter*, Number 9, November 1996).

Toll Roads Newsletter Number 13 (March 1997) reported another traffic forecasting error: as of mid-February 1997, actual traffic on the San Joaquin Hills Corridor turnpike in Orange County, California, was running at a daily average of 44,600 vehicles versus a forecast of 75,000 vehicles per day for the first full year of operation. "By our calculation, the road is running 40% less daily traffic than forecast to be the average for the first full year" (*Toll Roads Newsletter*, Number 13, March 1997). In the revised 1997 traffic and revenue study for the San Joaquin Hills Transportation Corridor, Wilbur Smith Associates admitted that "actual traffic and toll revenue experience during the first few months of operation has been considerably below the forecast prepared in the 1992/93 study. Through July 1997 traffic has been approximately 55 percent of estimate and toll revenue approximately 50 percent." Wilbur Smith Associates attributed most of the under-performance of the San Joaquin Hills Corridor turnpike to the economic downturn and restructuring in Orange County.

Although *Toll Roads Newsletter* Number 9 had already mentioned that the Dulles Greenway was running at 60% below projection, *Toll Roads Newsletter* Number 14 (April 1997) reported that traffic on the Dulles Greenway was now running at an average of 27,300 vehicles per weekday at a toll of $1.00 versus a projection of 30,000 to 40,000 vehicles per weekday at a toll of $2.00. Hence, actual revenues were somewhere between 34.1% and 45.5% of projected revenues. Fulfilling Robert Muller's prediction of March 1996, *Toll Roads Newsletter* Number

14 also reported that the Dulles Greenway had now defaulted on four quarterly debt service payments of $7 million each.

Muller's study and various issues of the *Toll Roads Newsletter* show that there is a very high probability (more than 80%, based on the sample of toll roads included in their analyses) that actual toll revenues during the early years of operation will be anywhere from 10% to 75% below the projected toll revenues in the feasibility study. Unfortunately, there does not appear to be a procedure that can consistently identify when a toll revenue forecast is an overestimate, nor is there a procedure that can determine by how much a toll revenue forecast overestimates actual toll revenues during the early years of operation. Thus, there is no clear guidance regarding how to adjust evaluation procedures and criteria of financial viability to take account of the high probability of a significant overestimate of toll revenues. This degree of uncertainty casts a great deal of doubt over the efficacy of current procedures to evaluate the financial viability of proposed private toll road projects.

Characteristics of Toll Revenue Forecasting Errors

In an attempt to reduce the uncertainty surrounding the accuracy of a given toll revenue forecast, Muller (1996) identified some common characteristics of success and failure. The successful forecasts generally had conservative economic projections with moderate levels of growth anticipated. The highways were generally constructed in corridors which were already built up and generally congested. The time savings were generally in excess of five minutes and, in some cases, more than 10 minutes versus competitive routes. Toll charges were moderate, averaging under eight cents per mile. Another characteristic of success was a revenue growth forecast under 5% per annum during the first four years after opening.

In contrast, according to Muller, many of the forecast failures relied upon projections of economic growth which proved optimistic. Shortfalls in economic growth occurred for a variety of a reasons. In a few cases, the national recession of 1990-1991 occurred coincident with or shortly before opening, thereby dampening growth. This was evident in the initial forecasts for the first two segments of Central Florida GreeneWay. The results for the initial year of 1989-1990 were only slightly below forecast, but results steadily fell farther below projections in the next two years. A drag from the recession may also have hurt the Kilpatrick and Creek toll roads in Oklahoma City and Tulsa which opened in 1991 and 1992.

Muller noted that, while national economic trends were relevant to the success and failure of some forecasts, economic activity within the region and/or project corridor was perhaps even more important. The importance of regional economic trends was strongly evident in Harris County, Texas, where the Hardy and the Sam Houston toll roads were originally financed in 1984. The collapse in oil prices and the sharp economic downturn in the region which began in 1986 left economic growth in the region well below projections. The downtown business district, the primary end destination for many of the vehicles using the Hardy Tollroad, was particularly hard hit. Actual results on the Hardy have averaged more than 70% below projection during its first four years of operation. In contrast to downtown Houston, growth in west Harris County (the area traversed by the Sam Houston) was less affected. The Sam Houston averaged about 20% below original forecast during its first four years. While the overall economic decline and variances within each corridor may explain most of the shortfall for the Sam Houston Tollroad and some of the difference in performance between the two roads, economics do not explain all of the problems with the Hardy.

Muller went on to say that several forecasts missed even when measures of regional economic activity were near original projection. This is because real estate development within the immediate corridor of the toll road did not match the predictions of area developers or county planners. The Sawgrass Expressway in Broward County, Florida, is one example of this problem. Some important developments fell far short of the build-out anticipated by developers and planners. Another example of this problem has been seen in the area of the Southern Connector part of the Central Florida GreeneWay. Regional population and employment have been ahead of projections. Even within the corridor, single-family residential development has been only modestly under forecast. Apartment and nonresidential development however, has been way below projections. Lastly, a slower than expected build-out has also affected the initial years of operations for two new roads built by the Florida Turnpike Authority in Seminole and Hillsborough Counties, despite the regional economic forecasts being essentially correct.

Muller also noted that optimistic economic forecasts at either the regional or corridor level are not the sole reason for some of the forecast errors. With the exception of the Hardy Tollroad, all of the roads which have fallen short of projections also assumed fairly high rates of revenue growth, generally above 6% per year during the first four years of operation.

Muller concluded that the rate of revenue growth seems to provide a key distinction between successful and unsuccessful forecasts. Projected revenue growth for the two successful forecasts was under 20% during the first four years. In contrast, the high rate of revenue growth

assumed on some of the other roads was a clear indication of the dependency of these roads on future growth rather than existing traffic. Risk of overprojection clearly goes up the more the road is dependent upon adjacent real estate development for growth of traffic and toll revenues. In addition, recessions, both national and regional, also seem to play havoc when they occur in advance or coincident with opening.

Conclusions

Muller's analysis identified four characteristics that were associated with overprojections of toll revenue in the feasibility studies he examined: (1) time savings of less than five minutes versus competing routes; (2) toll charges in excess of 10 cents per mile; (3) projected revenue growth rates in excess of 6% per annum during the first four years of operation; and (4) a heavy dependence on real estate development in the corridor and/or adjacent to the project to generate rapid traffic growth in the first four years of operation. This list of characteristics does not provide a specific numeric probability of an overprojection of toll revenues in a feasibility study; at best, it suggests that the more of these characteristics that are true of a project, the higher the probability of a revenue overprojection. More importantly, this list of characteristics cannot tell us how large the overprojection is likely to be with any precision: when overprojections have occurred, actual revenues during the first four years of operation have ranged from 25% of projected revenues to 88% of projected revenues.

In the absence of any other guidance regarding how to avoid the possibility of mistakenly approving a private toll road project that is actually unviable, the Department might be well-advised to adjust the toll revenue projections in each feasibility study to something like 55% (the average overprojection) of the original forecast before applying any criterion of financial viability. This is not a very satisfactory solution, however, because it guarantees that some projects will be rejected that are actually financially viable. A better solution is to seek ways to improve the accuracy of toll revenue forecasts. To do that, we need to examine what is known about the methods traffic consultants use to produce their traffic and revenue forecasts.

CHAPTER 6
METHODOLOGIES CURRENTLY USED TO PROJECT TRAFFIC AND REVENUE FOR TOLL ROADS

Introduction

In essence, Muller's characteristics associated with overprojections of toll revenues are external to the models used by traffic consultants to generate traffic and revenue forecasts. At the same time, both Muller and the traffic consultants are wont to argue that most of the forecasting errors are due to economic causes or factors beyond the control of the forecasters: unanticipated national and/or regional economic downturns, and (in some cases), much slower than anticipated real estate development in the corridor served by the project. The implicit argument is that there is nothing inherently wrong with the methodologies used to forecast traffic and toll revenues. But, as Muller seemed to be asking, can these unanticipated shortfalls of national, regional, and/or corridor-level economic growth explain forecasting errors of 40% or more? Or, as the editor of *Toll Roads Newsletter* put it, is there "something systematically wrong with the models being used to make these forecasts?"

The remainder of this chapter describes what is known about the methodologies currently used by traffic consultants to generate traffic and revenue projections for toll road projects, and argues that there is indeed something systematically wrong with the methodologies used to forecast the diversion rate, and that large revenue forecasting errors are much more likely to be the result of errors in forecasting the diversion rate than errors in forecasting the total traffic in the corridor served by the toll project.

Methodologies Currently Used to Project Traffic and Revenues

While the rhetoric used to describe their methodologies varies from one traffic consultant to another, traffic and revenue projections for toll road projects consist of two fundamental estimates: the volume of traffic in the corridor at any given time (i.e., per hour, per day, or per year), and the share of that traffic that will be captured by the toll road during that time. Some of the traffic consultants appear to compute traffic volumes on all possible routes within the corridor with the toll road initially included as a free link, and then decrease the projected traffic on the toll road by some proportion to account for the fact that a specific toll will be charged, or as one traffic consultant puts it, to take account of the "historical elasticity of demand for tolled traffic." Another traffic consultant claims to use a "capacity-constrained diversion assignment technique"

to distribute traffic between the project and competing routes based on travel time savings, operating costs, and tolls. Another consultant estimates the average daily volume of traffic in the corridor and assigns a share of that traffic to the project based on "standard toll industry diversion curves" (see Figure 1).

On the grounds that their models and methods are proprietary, traffic consultants do not provide all the computations and algorithms they use to estimate total traffic in the corridor in their traffic and revenue studies. At the same time, they do not describe exactly how they have estimated the share of that traffic that will be captured by the new toll road. Many of the investment bankers interviewed for this report said, however, that all of the major traffic consultants are making some use of the diversion curves from the early 1950s shown in Figure 1. These individuals ought to know, because the disclosure rules of the Securities and Exchange Commission (SEC) require that a much more detailed version of the traffic and revenue study be made available to prospective investors and their financial advisors than the version found in the public offering statement or prospectus for the revenue bonds. Thus, while the traffic consultants are probably using realistic and accurate computer models to project total traffic in the corridor and/or traffic on each possible route in the corridor, they are using much less realistic and accurate methods to estimate the share of traffic in the corridor that will be captured by the toll facility at any given time.

The "standard toll industry diversion curves" are a case in point. The curves relate diversion rates to time ratios for a sample of eight roads that were analyzed in the early 1950s. As such, they raise more questions than they answer. Why do the diversion rates differ from one road to another at the same time ratio? The differences clearly indicate that diversion rates are a function of more variables than just the time ratio. Do the indicated diversion rates for the eight different roads apply only to a specific time via the route in question versus a specific time via a competing route, or are we to believe that the diversion rate will be the same whether we are talking about a time ratio of 20 minutes via the route in question to 30 minutes via a competing route or a time ratio of four hours via the route in question to six hours via a competing route? It seems obvious that actual time saved must play some role in determining diversion rates, and time ratios alone cannot be applied uncritically to every type and length of project. Furthermore, these curves do not incorporate information about the effects of toll rates other than those charged by the roads in the sample on diversion rates. Six of the roads in the sample appear to have been free roads at the time they were analyzed, and the two toll roads in the sample (the Maine Turnpike and the Pennsylvania Turnpike) were charging very low tolls by today's standards. Thus these curves do not relate diversion rates to time ratios at the toll rates being

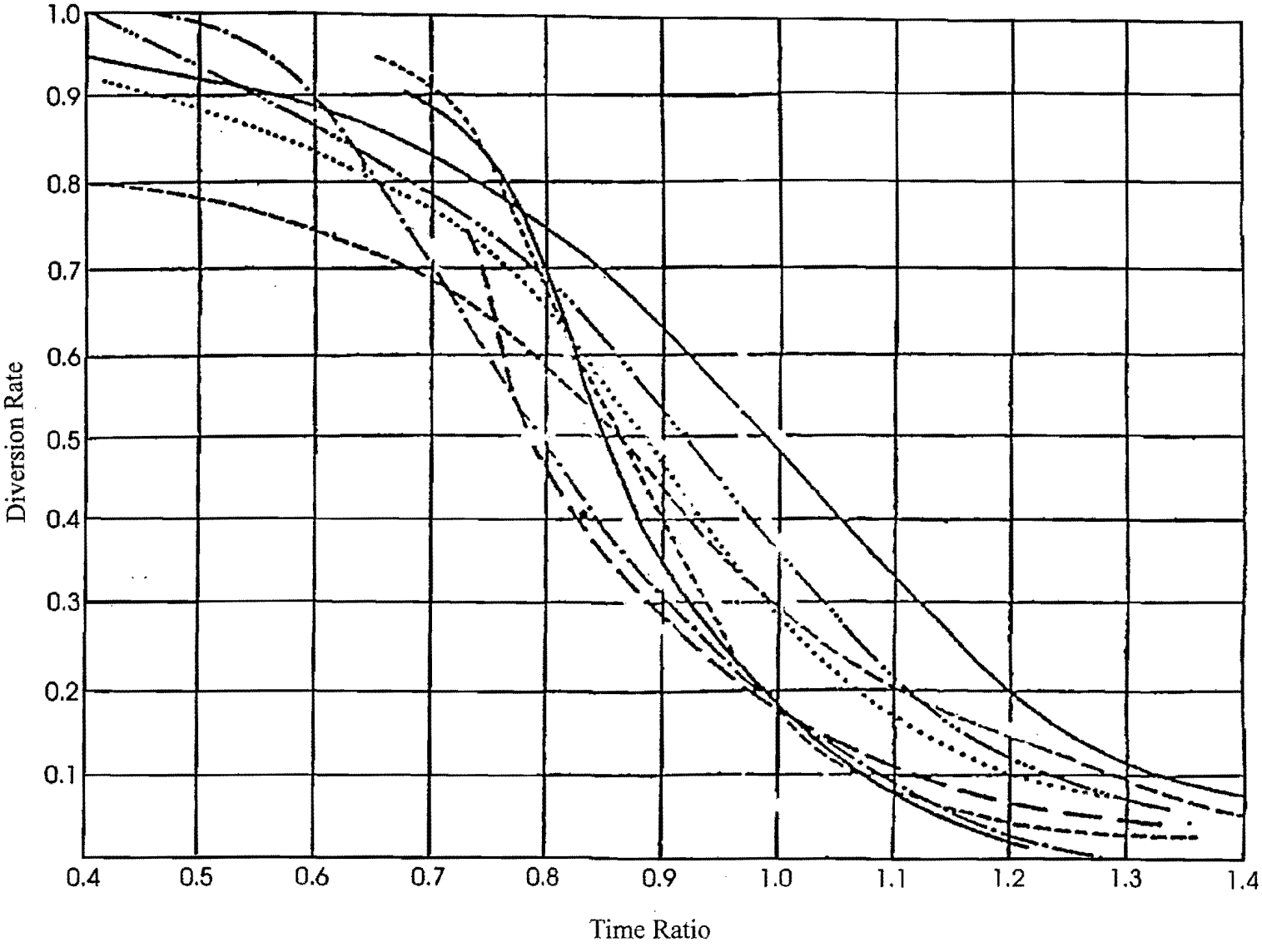

Figure 1. Diversion Curves

charged by recently opened toll roads. In addition, these curves reflect the diversion behavior of automobiles only; they do not represent the diversion behavior of commercial trucks.

Traffic consultants appear to use these diversion curves as a starting point for estimating auto and truck diversion rates for new projects. A time ratio is computed between the project and competing routes, one of the diversion rates or the average diversion rate at that time ratio is selected, and then some downwards adjustment is made to take account of the projected toll charges. At best, the extent of that downwards adjustment represents an educated guess (especially the projected truck diversion rate), because there is nothing in the diversion curves themselves to suggest what the auto and truck diversion rates will be at a given time ratio for a new project charging considerably higher tolls than those charged by the eight roads in the sample.

The "historical elasticity of demand for tolled traffic" is another example of relatively unrealistic and inaccurate methods of estimating the share of total traffic in the corridor that will be captured by the toll project. Elasticity of demand is the ratio of the percentage change in quantity demanded that results from a specific percentage change in price to that specific percentage change in price (i.e., $\Delta q/q$ divided by $\Delta p/p$, where q and p represent the initial quantity and initial price); a computed value is only valid for small changes in price, and it cannot be applied to the case of a new toll road, where both the percentage change in toll rate and the resultant percentage change in traffic are infinite (each going from an initial value of zero to some positive value). Apparently, the traffic consultants that are using this elasticity of demand concept believe that the average elasticity value (roughly -0.33) observed for small increases (typically $0.25) in toll rates on existing toll roads can be applied to reduce the estimated traffic that would use the toll road if it were free to the volume of traffic that will use the toll road when the planned toll rate is charged (several investment bankers reported that consultants using this methodology reduce the volume of traffic projected to use the project if it were free by one-third to account for the impact of tolls, regardless of the time saved and the toll rates to be charged by the project). This is a very questionable application of the concept of elasticity, and it is highly likely to result in large overestimates of the diversion rate.

To summarize this discussion, projected traffic volumes for a project are a product of projected total traffic volume in the corridor and one or more projected diversion rates. The sophistication of the models and techniques used to project the total traffic volume suggests that large errors in this computation are very unlikely in built-up corridors. On the other hand, the questionable methods used to project diversion rates suggest that large errors in this estimate are

very likely. Furthermore, the large overprojections of revenue noted in the preceding chapter are much easier to explain by errors in the estimated diversion rate than by errors in the total corridor traffic projection. For example, if the projected diversion rate was 40 percent and the actual diversion rate is 20 percent, actual traffic diverted to the toll road will be 50 percent of projected traffic. Similarly, if the projected diversion rate was 40 percent and the actual diversion rate is 10 percent, actual traffic diverted to the toll road will be 25 percent of projected traffic. If an overprojection of the diversion rate is not admitted to be the principal cause of a revenue overprojection of 40 percent or more, then the traffic consultants are saying that they somehow overprojected total traffic in the corridor by 40 percent or more. Once again, this seems highly unlikely, even if national and/or regional economic growth is much lower than expected. Unfortunately, Muller's analysis of revenue overprojections did not extend to comparisons of actual traffic in the corridors to projected traffic in the corridors. These comparisons would have clearly shown whether the overprojections were due to errors in the traffic modeling processes or errors in the diversion rates.

There is one exception to the statement that the models and techniques used to project the total traffic volume in a corridor are unlikely to produce large errors. The exception is the methodology typically used to project traffic growth generated by real estate development in an undeveloped corridor (called "development traffic" by some consultants). This methodology requires a long chain of assumptions, and this chain of assumptions creates a high probability of overprojecting development traffic and toll revenues.

In some cases (owing to a lack of data regarding planned construction) traffic consultants must begin with projections of industrial employment, retail sales, and population in the region or corridor. The industrial employment projections are converted into employment projections by industry, and the employment projections by industry are converted into employment projections by occupation utilizing Bureau of Labor Statistics data. The allocation of industrial employment projections to specific industries is based on educated guesses. The next step in the chain converts the projections of employment by occupation, retail sales, and population into square footage of industrial, warehouse and office space, square footage of retail space, and housing units to be developed in the region or corridor. If the initial projections of industrial employment, retail sales, and population were for the region, the next step in the analysis will be the division of the new industrial, warehouse and office space, retail space, and housing units to be developed between the corridor and the remainder of the region. The "capture rates" assumed for the corridor are educated guesses that are subject to large errors. The final step is the subdivision of the projections of new industrial space, new retail space, and new housing units to be developed

in the corridor into categories matching the land use categories of the ITE Trip Generation Manual. New industrial space is subdivided into estimates of new heavy manufacturing space and new light manufacturing space; new retail space is subdivided into estimates of new fast-food restaurant space, new convenience mart space, new shopping center space, new factory outlet center space, and new supermarket space; and new housing units are subdivided into estimates of new single-family units and new multi-family units. Once again, the proportions used to subdivide the initial space and unit estimates into categories matching the land use categories of the ITE Trip Generation Manual are educated guesses.

In some cases, the projections of new warehousing space, new heavy manufacturing space, new light manufacturing space, new office space, new fast-food restaurant space, new convenience mart space, new shopping center space, new factory outlet center space, new supermarket space, new single-family units, and new multi-family units to be built in the corridor are provided by local developers and/or county planners. While new space estimates from local developers and county planners are more reliable than new space estimates derived from regional projections of employment, sales and population, actual construction frequently lags behind the projections of developers and planners.

Given new space projections for the corridor that match the land use categories of the ITE Trip Generation Manual, estimates of the total trips per day that will be generated by real estate development are produced by utilizing the ITE daily trip generation rate per unit of space for each land use category. At this point, the traffic consultant must estimate what percentage of the estimated trips per day that will be generated by each land use category in the corridor will use the project.

If traffic consultants must begin with regional projections of industrial employment, retail sales, and population, the large number of assumptions and/or educated guesses necessary to arrive at predictions of traffic in undeveloped corridors that will be generated by real estate development makes large forecasting errors highly likely. If traffic consultants begin with projections of new space to be built in the corridor from local developers and/or county planners, large forecasting errors are still highly likely because actual construction frequently lags behind projected construction.

Conclusions

The preceding discussion suggests that the highly sophisticated traffic models used by traffic consultants to project total traffic in the corridor served by a proposed project are unlikely to produce large forecasting errors, certainly not overprojections of 40 percent or more. Large overprojections of traffic and revenues are much more likely to be the result of overestimating diversion rates. Hence, the most promising way to improve the accuracy of toll revenue forecasts is to improve the accuracy of estimated diversion rates. On the other hand, there does not appear to be much that can be done to improve the accuracy of development traffic projections. Projects planned for undeveloped corridors are, like real estate development itself, highly speculative undertakings and many of them will not be financially viable.

CHAPTER 7
ALTERNATIVES TO METHODOLOGIES CURRENTLY USED TO PROJECT DIVERSION RATES FOR TOLL ROADS

Introduction

The preceding chapter attempted to document the fact that, in their efforts to estimate the share of total corridor traffic that will be captured by new toll projects, traffic consultants are generalizing from data or measures that may not be applicable to new toll projects. This chapter offers four alternatives to methodologies currently used to project diversion rates, two for intercity projects and two for intracity projects.

The preceding chapter also touched upon the point that both the actual time saved and the time ratio must play a role in determining diversion rates. Neither a given relationship between diversion rates and actual time saved nor a given relationship between diversion rates and time ratios can be rigidly applied to every project. For example, a time savings of 30 minutes out of a trip that would otherwise take 90 minutes via a competing route undoubtedly means more to motorists than a time savings of 30 minutes out of a trip that would otherwise take six hours via a competing route. At the same toll rate for both situations, we should expect the diversion rate in the first case to be higher than the diversion rate in the second case. To take another example, a time ratio of 2/3 versus competing routes for a trip that takes six hours via a competing route undoubtedly means more to motorists than a time ratio of 2/3 versus competing routes for a trip that takes 90 minutes via a competing route. At the same toll rate for both situations, we should expect the diversion rate in the first case to be higher than the diversion rate in the second case. In short, it is dangerous to generalize from one project to another unless the two projects have a great deal in common with one another.

A Typology of Toll Road Projects

For purposes of more accurately estimating diversion rates, toll road projects can be divided into two basic types: intercity projects and intracity projects. Most of the private toll road projects that were chartered in Texas by the deadline set by the 1991 legislation are intercity projects. Most of the toll road projects that will be built under the provisions of ISTEA (such as HOT lanes on urban freeways and expansions and reconstructions of congestion-relieving urban arterials) will be intracity projects, although some (mainly retrofits of Interstate Highways and their conversion to toll roads) may be intercity projects..

Intercity projects, by virtue of a more direct route and/or the absence of competing routes that are also multi-lane divided roads with no signalized intersections, offer a constant time savings at all hours of each day. On the other hand, such projects do not generally serve corridors where there is a large volume of traffic. These projects are not "congestion-relievers" and do not, as a rule, serve daily commuters. While some of the potential users are located in the cities that are the end-points of such projects or in the corridors served by such projects, the majority of potential users may be located well outside the envelope formed by the corridor and its end points. This latter group of potential users are utilizing the corridor as a link in a longer trip. Intercity projects may attract a significant share of the commercial trucks utilizing the corridor, especially if there are weight and/or height restrictions on competing routes and the project offers large time and distance savings.

Intracity projects with competing routes that are also multi-lane divided roads with no signalized intersections (such as HOT lanes and many expansions and conversions of congestion-relieving urban arterials) do not offer a time savings at all hours of each day. They do, however, offer a significant time savings during the peak traffic periods of each day. Intracity projects with competing routes that are all surface streets do offer a time savings at all hours of each day, but the time savings clearly varies from peak traffic hours to off-peak hours. These projects do, as a rule, serve corridors where there is a large volume of traffic on weekdays and they do serve daily commuters. The majority of the potential users are located near one of the end-points of such projects or in the corridor served by such projects. Few of the potential users are utilizing the corridor as a link in a longer trip. These intracity projects will not, as a rule, attract significant numbers of commercial trucks because these vehicles do not have to travel at the peak traffic hours. Hence, the intracity toll project does not offer a time savings to most commercial trucks.

Alternative Methods of Estimating Diversion Rates for Intercity Projects

In one respect, it is simpler to estimate diversion rates for intercity projects than to estimate diversion rates for intracity projects. The constant time savings offered by the typical intercity project at all hours of each day means that traffic consultants can work with average daily traffic volumes rather than hourly traffic volumes, although average daily traffic volumes for weekdays should be separated from average daily traffic volumes for weekends. Similarly, the constant time savings at all hours of every day means that a single daily diversion rate for autos and a single daily diversion rate for each class of trucks should suffice to accurately estimate traffic and revenue for intercity projects. The difficulty presented by the intercity project is the

lack of daily users and the spatial dispersion of potential users. These characteristics of potential users make it very difficult (and hence expensive) to obtain data from a sample of motorists and truckers using the corridor that can be projected to all users of the corridor. Ideally, because of the dangers of attempting to generalize from other projects, a projectable sample of potential users should be interviewed to determine what proportion of automobiles and what proportion of each class of commercial trucks using the corridor will divert to the project, given the time and distance savings and the toll rates to be charged. To obtain such a projectable sample, the traffic consultant would have to conduct intercept interviews 24 hours a day for at least one week on all routes within the corridor, interviewing every xth vehicle in one direction. The principal problem with intercept interviews is that drivers of commercial trucks may not be able to answer questions regarding their willingness to pay a toll because that decision is made by executives of the trucking firm. Those executives could be interviewed by telephone if the traffic consultant has an accurate estimate of the number of that firm's trucks using the corridor per year.

A very useful sort of data can be collected if, instead of asking motorists if they are willing to pay a specific toll rate for the time savings offered by the proposed project, traffic consultants ask motorists what toll rate they would be willing to pay for the time savings offered. This type of data can be used to construct a demand curve relating diversion rates to toll rates for the project by computing the proportion of respondents willing to pay each toll rate under consideration (bearing in mind that an individual willing to pay $2.00 is also willing to pay any lower toll rate). If the sample of respondents is projectable to all users of the corridor, then the proportion willing to pay each toll rate for a given class of vehicle can be multiplied by the total number of that class of vehicle using the corridor in a year to produce the demand curve. The benefits of constructing demand curves for projects are described below.

The alternative to intercept interviews is a new study of the diversion rates being achieved by existing intercity toll roads. This study should provide the following information for each data point: minutes saved by the toll road versus competing routes, length of trip, diversion rate for automobiles, toll rate for automobiles, diversion rate for each truck class, and toll rate for each truck class. The observations from existing intercity toll roads should be grouped into roughly equal trip lengths to incorporate the impact of time ratios on diversion rates. Separate graphs can then be constructed for each vehicle type plotting observed diversion rates against minutes saved for each project and toll rate being charged. The graphs may look somewhat like Figure 2. Data points relating a vehicle type's (e.g., autos, two-axle trucks, etc.) diversion rate to the number of minutes saved at the same toll rate can be connected to form "diversion curves." There may not be enough data points at a given toll rate to legitimately construct a curve; in

those cases, straight line segments connecting the available data points will provide interpolations that should not be too inaccurate for predicting traffic and revenue. Figure 2 illustrates several expectations: (1) for a given number of minutes saved on trips of roughly the same distance, the diversion rate will be higher for lower toll rates; and (2) for a given toll rate on trips of roughly the same distance, the diversion rate will increase as the number of minutes saved increases, but at a diminishing rate. It is essential that these graphs depict data points from existing intercity toll roads of similar lengths; otherwise, any generalizations made from these graphs to a dissimilar project will be prone to error. To create more data points, segments (from one interchange to another) of longer intercity toll roads could be used.

If all of the information shown in Figure 2 is actually collected from existing intercity toll roads, traffic consultants will be able to extract a demand curve for a proposed project relating diversion rates to toll rates at the number of minutes saved by the proposed project versus competing routes. The benefit of extracting such demand curves is the ability to identify the toll rate that will produce the largest possible amount of toll revenue for a given vehicle type. Toll revenues for a given vehicle type will be toll rate multiplied by diversion rate for that toll rate multiplied by the projected volume in the corridor of that vehicle type.

Alternative Methods of Estimating Diversion Rates for Intracity Projects

Intracity projects are inherently more complex to analyze than intercity projects because the time savings offered by an intracity project varies from hour to hour and from weekday to weekend. In addition, there are not enough existing intracity toll roads to make a new study of the diversion rates achieved by these projects worthwhile. On the other hand, the spatial concentration of potential users makes it easier to obtain a projectable sample of potential users. In principle, more accurate estimates of the diversion rates for intracity projects can be achieved by two different procedures, intercept interviews or telephone interviews. In practice, intercept interviews may be impossible to conduct during the crucial peak traffic hours, especially on expressways. If telephone interviews will be conducted, representative samples of respondents by ZIP code or Census Enumeration District (CED) are available from survey sampling. The appropriate ZIP codes or CEDs to be included in the sample may be identified from a map or from maps of the corridor served by the proposed project.

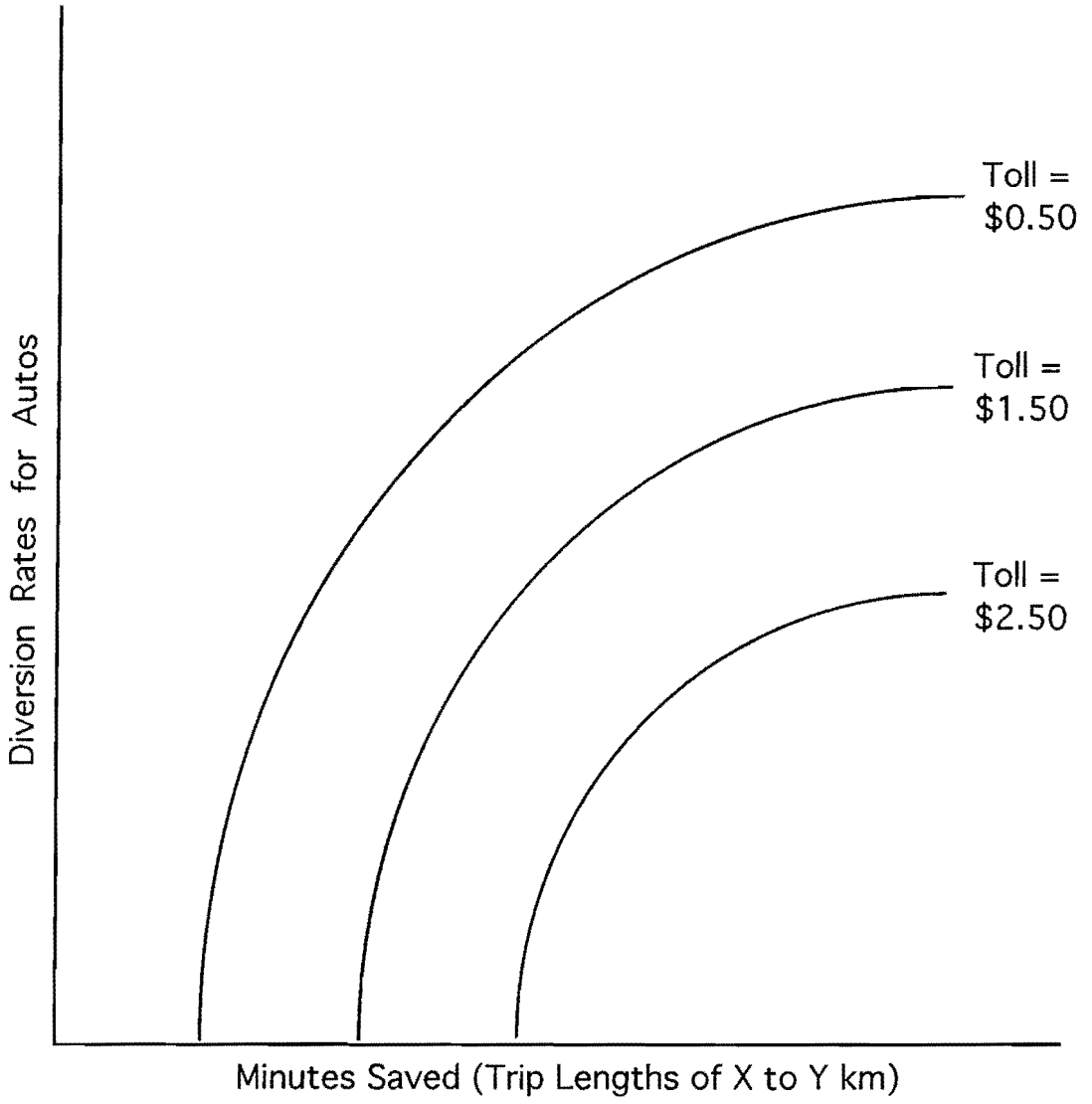

Figure 2: Diversion Curves for Intercity Toll Roads

Traffic consultants need to compute the time savings that will be offered by the proposed project for four specific time periods: the morning and afternoon peak traffic hours and the morning and afternoon rush hours (i.e., the hours immediately before and after the peak traffic hour). In most cities, the time savings will be larger during the morning periods than the corresponding afternoon periods. Interviewers should be instructed to screen for respondents that are daily commuters during the peak traffic hours and respondents that are daily commuters during the rush hours immediately before and after the peak traffic hours. Peak hour commuters can be asked if they are willing to pay the planned peak hour toll rate for the time savings offered by the project during the morning and afternoon peak traffic hours, or they can be asked what they would be willing to pay for the time savings offered by the project during the morning and after-

noon peak traffic hours if the traffic consultant wishes to construct a demand curve for the project. In a similar fashion, rush hour commuters can be asked if they are willing to pay the planed rush hour toll rate for the time savings offered by the project during the morning and afternoon rush hours, or they can be asked what they would be willing to pay for the time savings offered by the project during the morning and afternoon rush hours. Traffic consultants should expect that the diversion rates for the morning rush hours and the morning peak traffic hour will be higher than the diversion rates for the corresponding afternoon traffic periods.

If samples of telephone numbers have been obtained from professional survey sampling firms, the proportions of respondents willing to pay each toll rate under consideration can safely be applied to the traffic consultant's projections of traffic using the corridor during the morning and afternoon rush hours and traffic using the corridor during the morning and afternoon peak traffic hours. The resultant estimate of toll revenues is very likely to be somewhat conservative, partly because respondents to the telephone interview are likely to understate what they are willing to pay (thereby hoping to influence the toll rate that will be chosen by the sponsors of the project) , partly because there may be some off-peak traffic using the corridor that will divert to the project (especially if all of the competing routes are surface streets), and partly because there may be some commercial trucks using the corridor during the rush hours that will divert to the project. These last two groups are not likely to contribute very much to total traffic using the project or to toll revenues, and the cost of trying to identify and interview a representative sample of these groups by telephone is not worthwhile in view of the small gain in the accuracy of diversion rate estimates that will result.

The recommendations that have been made regarding an alternative method of estimating diversion rates for intracity toll projects suggest one possible explanation for some of the over-projections of diversion rates for intracity toll projects: traffic consultants have often used average daily auto and truck traffic volumes as a base for their projections of traffic and revenues for intracity toll projects. Most intracity toll projects do not have a time advantage versus competing routes throughout the day; time savings are realized only during the rush hours and peak traffic hours and therefore apply to roughly 45 percent of the total daily auto traffic in the corridor. In addition, the great majority of commercial trucks avoid the rush hours and peak traffic hours when toll project has a time advantage, and are therefore unlikely to divert to the toll project.

Conclusions

If traffic consultants can be persuaded to adopt these methods of estimating diversion rates, large overprojections of traffic and revenues should become quite rare. In addition, it will be much easier for states and investment bankers to evaluate the reasonableness of the assumptions and computations of the traffic consultants, and this will greatly improve their ability to correctly evaluate the financial viability of future toll road projects.

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