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Procedures and Technical Methods for Transit Project Planning

[Foreword](#)

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Foreword

Project planning is a critical step in the development of transit capital improvements. This step focuses on a specific transportation need, identifies alternative actions to address this need, and generates the information necessary to select an option for implementation. The typical project planning effort addresses such issues as costs, benefits, environmental impacts, and financing to support project selection. It often spans a wide range of technical disciplines, ranging from engineering to patronage forecasting to the natural and social sciences. In many respects, project planning is the key step in project development since the selection of a project for implementation establishes the expectations for the improvements that will be achieved, the costs that will be incurred, and the environmental consequences that will result.

Project planning, as defined above, is often referred to as alternatives analysis. Alternatives analysis has been a key part of the Federal Transit Administration's (FTA) process for advancing local fixed guideway transit projects for over 25 years. 49 USC 5309(e)(1)(A) requires that projects requiring at least \$25 million in discretionary Section 5309 New Starts funding must be based upon the results of an alternatives analysis (and later, preliminary engineering). More importantly, an alternatives analysis has been a part of established planning practice for several decades. At its core, alternatives analysis is about serving local decisionmaking. An effective alternatives analysis answers the questions: What are the problems in a corridor? What are their underlying causes? What are viable options for addressing these problems? What are their costs? What are their benefits? What are the trade-offs among these options? To answer these questions, the alternatives analysis study covers a number of important activities, each of which is guided by a set of key planning and technical principles. It is these principles – and their application - which is the focus of this document.

This document serves as an *in-progress*, chapter-by-chapter update of FTA's (then the Urban Mass Transportation Administration's) seminal 1990 guidance on alternatives analysis, *Procedures and Technical Methods for Transit Project Planning*. As with that guidance, the following chapters provide helpful information on a number of technical activities – definition of alternatives; methods used to support an adequate analysis of capital and O&M costs, travel demand, and environmental impacts; development of a project financial plan – which support the alternatives analysis study process. Most of the information on the planning concepts, principles, and methods contained in the 1990 guidance remains valid today. With the updated chapters contained in this guidance, FTA simply clarifies procedural requirements (alternatives analysis deliverables, approval actions, etc.) which have changed since issuance of the 1990 document, and shares some of the lessons it has learned over the past decade with regard to each of the covered topics. These chapter updates will be posted on [FTA's New Starts web page](#) as they are completed. It is anticipated that revisions to the entire document will be completed by the end of 2003.

It is not FTA's intent to be prescriptive about how alternatives analysis should be performed. Nor is it FTA's desire to stifle creative thought on how to do project planning. This guidance reflects the experiences of a multitude of transportation planners in state and local governments, consulting firms, and the academic community. By bringing this experience together in one document, it is FTA's hope that this guidance will serve as a core resource for assisting local agencies organize and carry out their alternatives analysis study, as well as promote further improvements in technical methods and analysis.

The primary audience of this guidance is local project managers and technical staff involved in a corridor (or subarea) planning analysis in which one or more of the alternatives under study is, or includes, a fixed guideway transit facility. This audience typically includes staffs of metropolitan planning organizations, transit operators, state Departments of Transportation, local

governments, and their consultants. While an alternatives analysis is required for all (non-exempt) New Starts projects, the alternatives analysis process - and the planning and technical principles which support it - is a useful framework for any planning study which seeks to help decisionmakers select an optimal strategy for addressing locally-defined transportation problems. Consequently, this guidance should be of interest to any local agency seeking assistance on the conduct of such a study, and in particular on the technical elements – costing, travel demand forecasting, financial planning – which comprise such a significant amount of the analysis.

This guidance is divided into three major parts:

- Part I: The Major Capital Investment Planning Process. This part provides an overview of the planning process for candidate New Starts projects. It begins with an introduction to FTA statutes, regulations, and policies regarding major investment planning. It contains a chapter on the systems planning process, and establishes the framework for moving from systems planning to a corridor-level alternatives analysis. Part I concludes with a discussion of a framework for the alternatives analysis study, including the scope of project planning and the roles and responsibilities of the principle study participants.
- Part II: Conduct of the Technical Analysis. Part II explains, in summary fashion, methodologies for generating the technical information which typically constitutes an alternatives analysis. It provides guidance on technical elements that are a part of each study, including the management of the study, development of the alternatives, patronage forecasting, estimation of capital and operating costs, financial analysis, environmental impact estimation, and evaluation.
- Part III: The Decisionmaking Process. This part discusses how the technical information generated in the study is put together in a way that will assist project decisionmaking. It also presents procedures for the preparation and circulation of the draft environmental impact statement (EIS) or environmental assessment, should the alternatives analysis be performed under the review process required by the National Environmental Policy Act of 1969 (NEPA). Updated Part III discusses the continuum of decisions which occur during systems and corridor planning and project development, and describes how planning and subsequent NEPA review can be better linked to support decisionmaking.

FTA welcomes any questions and comments on this guidance. FTA policies and procedures - as well as the state of the art in transportation planning - are continually evolving, and FTA intends to continue to update these guidance chapters as necessary. Please address any correspondence to planningmailbox@fta.dot.gov, or:

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1. Introduction to Major Investment Planning

New rail systems, extensions to existing rail systems, busways, and other kinds of fixed guideway transit facilities are developed through a process FTA calls major investment planning and project development. This process begins with the systems planning process and the initial local recognition that a fixed guideway may help solve local problems; continues through an "alternatives analysis" of fixed guideway technologies and alignments (as well as other reasonable non-fixed guideway options) intended to help local decisionmakers select a "design concept and scope" to implement; and concludes with the engineering and design work necessary to finalize project scope, complete NEPA, and develop firm capital and operating cost estimates. The planning process for large-scale transportation projects can be costly and involved. It includes highly complex analyses of potential changes in local travel patterns, economic development, and environmental quality. Furthermore, it is often conducted in a dynamic political and institutional setting. Despite these complexities, the purpose of the planning and project development process is quite straightforward: to develop sound and objective information necessary for informed decisionmaking.

This chapter serves as an introduction to FTA's planning and project development process for major transit capital investments. It begins with a summary of the policy and regulatory background of the New Starts program. This discussion highlights the basic planning tenets which have supported FTA's (and, prior to 1991, the Urban Mass Transportation Administration's) requirements for alternatives analysis for over 25 years. This chapter also describes the alternatives analysis (AA) study process which is the focus of this guidance, as well as the subsequent steps of the New Starts project development process: preliminary engineering (PE) and final design.

1.1 Policy and Regulatory Background

Since the early 1970's, the Federal government has provided a large share of the Nation's capital investment in urban mass transportation, particularly for New Starts projects. Beginning in 1976, the Department of Transportation/ Urban Mass Transportation Administration (UMTA) published a series of policy statements intended to define the local planning and Federal evaluation processes necessary to ensure that available New Starts resources would be used in the most prudent and effective manner as possible. These early policy statements stressed the fundamental role that good planning must necessarily play in the development of major capital transportation improvements. The planning principles conveyed by these statements remain in effect today, and have been incorporated in subsequent Federal legislation. At the same time, several changes to FTA's evaluation procedures for New Starts projects have been articulated by Federal statute and FTA regulation. The following briefly summarizes FTA and Congressional directives in support of major investment planning, project development, and evaluation.

1.1.1 Early Policy Statements (1976, 1978, 1980, 1984)

UMTA's first policy statement on major transit capital investments was issued in 1976 (41 FR 41512 (September 22, 1976)). It introduced a process-oriented approach with the requirement that New Starts projects be subjected to an analysis of alternatives, including a transportation system management (TSM) alternative that uses no- and low-capital measures to make the best use of the existing transportation system. The Statement also required projects to be cost-effective.

This original policy was supplemented in 1978 by a *Policy on Rail Transit* (43 FR 9428 (March 7, 1978)). This statement reiterated the requirement for alternatives analysis, established requirements for local financial commitments to proposed New Starts projects, established the concept of a contract providing for a multi-year commitment of Federal funds, with a maximum limit of Federal participation (the Full Funding Grant Agreement--FFGA), and required that local governments undertake supporting local land use actions. The *Policy on Rail Transit* was supplemented by a 1980 policy statement that linked the alternatives analysis requirement to the Environmental Impact Statement development process (45 FR 71986 (October 30, 1980.))

These principles were reiterated and refined in a May 18, 1984, *Statement of Policy on Major Urban Mass Transportation Capital Investments* (49 FR 21284). The major feature of this policy statement was the introduction of an approach for making comparisons between competing projects. To do so, a rating system was established by UMTA under which projects were evaluated in terms of a cost effectiveness index of forecast incremental cost per incremental rider for the build alternative, compared with the TSM alternative as the base. Other index threshold values were established which projects had to pass in order to be considered for funding. In addition, the criteria to be used to judge local financial commitment were explicitly defined. Finally, the statement provided additional clarity on the project development process for major investment projects, including reconfirming the need for UMTA "consent" to initiate alternatives analysis and preliminary engineering.

Collectively, these UMTA policy statements established the key tenets and principles upon which local alternatives analyses are based. These principles include the following:

- Proposed guideway projects shall be consistent with the area's comprehensive long-range transportation plan which articulates the overall direction for metropolitan development and identifies major transportation corridors.
- Projects must be cost-effective as determined through an analysis of transportation alternatives, including low-cost improvements to the existing infrastructure and better management and operation of existing transportation facilities.
- Project decisions should be based upon realistic cost estimates and financing proposals that take into account the operating expenses of the proposed – and existing – transit system and service.
- Localities should consider a program of local supportive actions to enhance the project's cost effectiveness, patronage, economic vitality, and other measures of performance. These supportive actions include land use planning, zoning, joint development, adequate feeder bus services, adequate parking, pricing and other demand management strategies, and regulatory and enforcement measures.
- There must be a full opportunity for the timely involvement of the public, local elected officials, and all levels of government in the alternatives analysis process.

Taken together, these principles support an objective and defensible process for analyzing and evaluating the costs, benefits, and other impacts of alternative strategies as a means for solving locally-defined transportation problems. In addition to serving local decisionmaking, adherence to these principles also ensures an equitable basis for UMTA/FTA and Congressional understanding of the merits of competing New Starts project proposals as a means of fulfilling their funding allocation responsibilities.

1.1.2 STURAA, ISTEA, and TEA-21

The principles of the 1984 policy statement were later incorporated into law with enactment by Congress of the *Surface Transportation and Uniform Relocation Assistance Act of 1987* (STURAA). This act established in law a set of criteria which New Starts projects had to meet in order to be eligible for Federal discretionary grants. Specifically, projects had to be cost-effective and supported by an adequate degree of local financial commitment. STURAA also added a requirement for an annual report to Congress laying out the Department's recommendations for discretionary funding for New Starts for the subsequent fiscal year.

Subsequent Federal legislation has focused on refinements to FTA's process for evaluating – and rating - candidate New Starts projects. The *Intermodal Surface Transportation Efficiency Act of 1991* (ISTEA) made substantial changes to the legislative basis for the criteria used to evaluate candidate projects. Specifically, the original requirement that a project be cost-effective was expanded; the new requirement specified that projects be justified, based on a comprehensive review of its mobility improvements, environmental benefits, cost-effectiveness, and operating efficiencies. In addition, certain considerations and guidelines were established that were to be taken into account in determining how well a project met the criteria.

On June 9, 1998, the *Transportation Equity Act for the 21st Century* (TEA-21) was enacted. TEA-21 left much of past law and policy regarding the New Starts planning and project development process intact. However, TEA-21 did require FTA approval for a project to advance from preliminary engineering to the final design stage of the project development process, and required that FTA issue regulations on the manner in which candidate New Starts projects will be evaluated and rated.

1.1.3 Final Rule on Major Capital Investment Projects

FTA issued a *Final Rule on Major Capital Investment Projects* on December 7, 2000. The Final Rule did not substantially impact FTA's evaluation and rating process of candidate New Starts projects, nor did it change the major investment planning and project development process in any significant way. However, the Rule did include three important provisions which were intended to both confirm long-standing FTA policy and enhance the measurement of New Starts project impacts.

1.1.3.1 Baseline Alternative

The Final Rule establishes a single "baseline" alternative against which New Starts projects shall be evaluated in terms of cost effectiveness and other justification measures; previous to the Final Rule, project impacts were measured against both a "no-build" and TSM alternative. Under the Final Rule, the TSM will continue to serve as the New Starts baseline for *most* candidate projects. In select cases, the no-build alternative may satisfy the baseline alternative requirement. Additional information on the

development of the no-build and TSM alternatives, and the selection of one of them as the New Starts baseline alternative, is provided in Part II, Chapter 2 *Definition of Alternatives* of this guidance.

1.1.3.2 Transportation System User Benefits Measure

The Final Rule introduced a new measure for New Starts project cost-effectiveness, "Transportation System User Benefits." User benefits are generated as an output of the regional travel demand forecasting process, and reflect the estimated mobility impacts, in terms of weighted travel time and costs, of candidate transit capital investments. Local review of user benefit forecasts is a beneficial analytical and diagnostic exercise, as it provides the project team with insights into market-specific impacts of a proposed investment while at the same time identifying potential weaknesses in the technical work supporting the alternatives analysis study. Additional information on transportation system user benefits is provided in updates to Part II Chapter 6 *Interpretation and Use of Travel Forecasts*.

1.1.3.3 Before and After Study

FTA's *Final Rule on Major Capital Investment Projects* requires that project sponsors seeking Full Funding Grant Agreements submit a complete plan for the collection and analysis of information to identify the impacts of their projects and the accuracy of their forecasts. This requirement originates with the Government Performance and Results Act (GPRA), and reflects FTA's objectives for developing a greater understanding of a) the actualized benefits of New Starts projects, once implemented and in operation and b) the degree to which forecasts prepared as part of project planning and development are realized, and the reasons why.

In order to meet these important objectives, FTA requires that local project sponsors assemble information on project scope, transit service levels, capital costs, O&M costs, and ridership patterns generated during planning and project development, as well as just prior to - and shortly after - implementation and operation of the project. Although a formal plan for the Before and After Study is not required until final design (and only then for projects seeking a FFGA), candidate New Starts project sponsors must be aware that the element of the study relating to predicted project impacts requires that methodologies, assumptions, and resulting information for each of the required characteristics must be documented throughout alternatives analysis (and later, at the conclusion of preliminary engineering). Updated Part I Chapter 3 (*Framework for the Analysis*) of this guidance discusses the necessary preparation for the study during alternatives analysis.

1.2 Major Investment Planning and Project Development Process

TEA-21 and the subsequent *Final Rule on Major Capital Investment Projects* continues FTA's long-standing process for the planning and development of New Starts projects. This process is presented graphically in Figure 1-1 on the following page.

[Figure 1-1 Planning and Project Development Process for New Starts Projects](#)

FTA intends that this process (through the completion of preliminary engineering) be carried out as part of the overall metropolitan planning and environmental review processes, as specified by 23 CFR Part 450 *FTA/FHWA Joint Final Rule on Metropolitan and Statewide Planning* and 23 CFR Part 771 *Final Rule on Environmental Impact and Related Procedures*, respectively. As such, planning and project development activities for New Starts projects should not require any more rigor or detailed technical analysis than would be expected for the adequate study and subsequent development of any major transportation (transit, highway, or multimodal) project in a given corridor. This analysis includes (among other activities) the identification of specific transportation problems in the corridor; the definition of reasonable alternative strategies to address these problems; the development of forecasts for these alternatives in terms of environmental, transportation, and financial impacts; and an evaluation of how each alternative addresses transportation problems, goals, and objectives in the corridor. These analytical activities are intended to provide local decisionmakers with the necessary information on which to base the selection of a specific transportation project design concept and scope for inclusion in the fiscally constrained long range plan and to advance it into preliminary engineering and the completion of the environmental review process.

Taken as a whole, the planning and project development process reflects a continuum of policy development, technical studies, and decisionmaking activities, where broad regional problems are identified and prioritized; options for addressing specific problems in specific corridors are identified, evaluated, and narrowed; and optimal investment strategies are selected and advanced for more detailed analysis and, ultimately, implementation and operation. The following briefly describes the major phases of this process: systems planning; alternatives analysis (AA); preliminary engineering (PE); and final design.

1.2.1 Systems Planning

Systems planning refers to the continuing, comprehensive, and coordinated transportation planning process carried out by metropolitan planning organizations - in cooperation with state Departments of Transportation, local transit operators, and affected local governments - in urbanized areas throughout the country. This planning process results in the development of long range multimodal transportation plans and short term improvement programs, as well as a number of other transportation and air quality analyses.

Many of the activities performed during systems planning necessarily precede a systematic consideration of fixed guideway transit in locally-identified corridors. During systems planning, local agencies examine long range urban development trends, collect travel data, forecast needs, and evaluate regionwide transportation policies and investment options. Based on their assessments of travel patterns and establishment of goals and objectives for regional mobility, local transportation agencies and governments identify transportation problems and needs in priority transportation corridors throughout the metropolitan area. Systems planning further results in the identification of a wide range of conceptual transportation alternatives to advance into a more focused corridor planning effort, such as an alternatives analysis.

Additional information on systems planning is provided in Part I Chapter 2, *Systems Planning*.

1.2.2 Alternatives Analysis

A corridor planning study in which one or more of the alternatives under study is, or includes, a fixed guideway facility is often referred to as an alternatives

analysis. The name "alternatives analysis" has as its basis the New Starts planning provisions contained in Federal legislation; in fact, alternatives analysis is synonymous with multimodal corridor planning consistent with the principles of both the major investment study (MIS) process practiced in many areas around the country, and the Draft Environmental Impact Statement (DEIS) required by the National Environmental Policy Act of 1969 (NEPA). Regardless of what the study is called, its intent is the same: to identify and compare the costs, benefits, and impacts of a range of transportation alternatives as a means of providing local decisionmakers with the information necessary to implement the most appropriate transportation solutions in priority corridors.

Alternatives analysis can be viewed as a bridge between systems planning at a metropolitan scale (which identifies regional travel patterns and transportation corridors in need of improvements) and preliminary engineering (where a project's design is refined sufficiently to incorporate the avoidance, minimization, and mitigations necessary to complete the environmental process). AA is the process for reaching a broad consensus on exactly what type of improvement(s) best meet locally defined goals and objectives for a specified corridor. Because it involves specialized technical analyses and an evaluation of transportation alternatives that have varied effects on the surrounding community, the alternatives analysis is necessarily a collaborative process. The AA study typically involves local transportation planning agencies (including the metropolitan planning organization) and service providers, local governments, state and Federal resource agencies, potential funding partners, and (through a formal citizen participation process) the general public.

As with the MIS, there is a multitude of ways that an alternatives analysis can be coordinated with the environmental review required by NEPA. NEPA itself mandates that the EIS reflect an analysis of all reasonable alternatives, so the careful coordination of the alternatives analysis and NEPA review is essential to the efficiency of the study and to public and interagency understanding of the process. Various coordination methods have been used, such as "incorporation by reference" to carry the alternatives analysis results into a NEPA document, or use of a first-tier or programmatic EIS as an alternatives analysis. While the decision to conduct the AA either "within" or "outside" the NEPA process is an important milestone which should be agreed upon as early as possible within the study process, FTA emphasizes that the appropriate level of analysis is a function of the complexity of the corridor and its transportation needs, not of the regulatory framework. The level of analysis should be commensurate with the planning decision at hand, that is, the analysis of every issue should be carried just far enough to make an intelligent selection of a preferred transportation design concept and scope from the alternatives available. Updated Part III of this guidance provides additional information on the linkage between alternatives analysis and NEPA review and environmental documentation.

1.2.3 Preliminary Engineering

During the preliminary engineering phase of project development, local project sponsors refine the design of the locally preferred alternative to the extent necessary to complete the NEPA process, taking into consideration all reasonable design options. Preliminary engineering results in estimates of project costs, benefits, and impacts for which there is a much higher degree of confidence. The proposed project's New Starts criteria are similarly refined in the preliminary engineering phase of development. In addition, project management plans should be finalized, products of the PE effort that demonstrate the technical

capability of the project sponsor to advance further in development should be substantially completed, and commitments of local funding sources should be firmed up (if not previously committed).

Preliminary engineering for a major capital investment project is considered complete when FTA declares in the environmental Record of Decision (ROD) or Finding of No Significant Impact (FONSI) that the NEPA process has been completed; when the project scope, capital costs estimates, and financial plan are finalized; and when the project sponsor has adequately demonstrated to FTA its technical capability to advance the project into final design and construction.

1.2.4 Final Design

Final design is the last phase of project development, and includes right-of-way acquisition, utility relocation, and the preparation of final construction plans (including construction management plans), detailed specifications, construction cost estimates, and bid documents. The project's financial plan is finalized, and a plan for the collection and analysis of data needed to undertake a Before and After Study is developed.

If proposed for by FTA, New Starts project sponsors may enter into an FFGA during final design. FFGAs between FTA and a grantee are negotiated with a maximum amount of Federal participation in the project and a yearly funding schedule. Local project sponsors are required to complete construction of the project, as defined, to the point of initiating revenue operations, and to absorb any additional costs incurred.

3. FRAMEWORK FOR ALTERNATIVES ANALYSIS

Following systems planning, which results in the identification of transportation problems in priority corridors, the next major phase in the major investment planning process is alternatives analysis (AA). This chapter summarizes the scope of the alternative analysis phase and the steps involved in performing the study. This chapter also describes suggested documentation of the alternatives analysis effort, as well as the roles and responsibilities of the lead local agency performing the study and the Federal Transit Administration (FTA), which provides technical assistance to the study effort.

3.1 Overview of Alternatives Analysis

The AA study process is introduced in Part I Chapter I *Introduction to Major Investment Planning*. During alternatives analysis, the priority corridor identified in systems planning is studied in detail, focusing on the effects of alternative solutions to the corridor's transportation problems. Information on the costs, benefits, and impacts of each alternative is developed to provide a sound technical basis for project decisionmaking. The AA phase, at local discretion, may include the preparation of a draft environmental impact statement (EIS) or (less commonly) environmental assessment (EA) initiating the review process required by the National Environmental Policy Act of 1969 (NEPA); the NEPA decisionmaking process is described in greater detail in Part III Chapter I *The Draft Environmental Impact Statement* (expected to be updated by the end of 2005). At the conclusion of AA, local officials select a preferred mode and general alignment, adopt a plan for financing the project's capital and operating costs, and request FTA's approval to enter preliminary engineering.

The importance of a rigorous and objective AA study process cannot be understated. Alternatives analysis is the earliest, yet arguably most critical, phase of project development. The alternatives analysis study provides the information needed by local decisionmakers to consider the costs and benefits of several proposed strategies to addressing corridor problems, so that they may select a single alternative to advance into implementation. Since alternatives analysis is the forum for understanding the trade-offs inherent in making such a selection, it must provide a sufficient level of technical analyses necessary to support an informed decision. The locally preferred alternative – and all of its costs and benefits - which results from the alternatives analysis

study is THE project that local stakeholders are expecting to implement, and implicitly becomes THE project that FTA may potentially fund. Therefore, the alternatives studied must be objectively-defined, and planning-level predictions of their impacts must be reasonably accurate. The intent of this chapter is to lay the framework for these important local studies.

3.1.1 Corridor Focus

FTA's experience has been that corridor level planning is the most suitable setting for the selection of a preferred mode (e.g., heavy rail, light rail, bus, etc.) and alignment alternative for transit guideways. In contrast to systems planning, corridor planning allows for a more detailed analysis of the costs and benefits necessary to select a mode and alignment. For the most part, each corridor of an urban region has travel patterns that are independent of those in other corridors. Consequently - and unlike systems planning, where highway and transit networks change on a regional scale - corridor planning requires transportation networks to be the same outside of a given corridor so that the costs and benefits of alternatives can be properly identified. By focusing project decisionmaking at the corridor level, sufficient information on the costs and benefits of each mode and alignment alternative can be produced to provide a sound technical basis for selecting a preferred alternative. Accordingly, the selection of a preferred mode and general alignment is best made on a corridor-by-corridor basis.

3.1.2 Set of Promising Alternatives

The alternatives analysis phase examines a set of alternatives that have been shown to be promising solutions to the corridor's transportation problems. These alternatives are initially chosen on the basis of systems planning analyses that provide a preliminary review of, among other things, cost-effectiveness, financial feasibility, and potential fatal flaws.

The development of alternatives is described in great detail in Part II Chapter 2 *Definition of Alternatives*. The range of alternatives includes a no-build (or no-action) alternative, one or more fixed guideway options, such as light rail, heavy rail, or busway (which may include provisions for use by carpools), and at least one non-guideway transportation system management (TSM) alternative that represents the "best you can do without a guideway investment" (or "BycDwagi", for those who enjoy acronyms). The build and TSM alternatives should be structured so as to address the problems in, and goals and objectives for, the corridor and demonstrate the added benefits of higher levels of investment. It is therefore important that the alternatives exhibit a range of capital costs, including the least expensive and shortest guideway capable of addressing the transportation problems in the corridor.

The TSM alternative will normally serve as the baseline for evaluating the added costs and added benefits of a fixed guideway (New Start) facility. The TSM alternative includes such low cost actions as traffic engineering, express or enhanced bus service and other transit operation changes, and modest

capital improvements such as reserved lanes, park-and-ride lots, and transit terminals. It is designed to address specific transportation problems in the corridor and demonstrate the extent to which these problems can be solved without a major investment in new guideway facilities.

While the range of alternatives should include all reasonable and promising choices available to decisionmakers, it is normally desirable to keep the number of alternatives considered in alternatives analysis as small as possible. A large number of alternatives increases the complexity of the analysis process, adding to the time and cost of the study. A large number of alternatives also tends to create a final report which is too large and incomprehensible for the average reader. Where a large number of alternatives are proposed for advancement into alternatives analysis, FTA encourages local sponsoring agencies to perform a preliminary screening task early in the study to reduce the number of alternatives to a manageable few.

3.1.3 Major Steps in the Alternatives Analysis Process.

The alternatives analysis process may be divided into four major steps: Study initiation; development and refinement of alternatives and technical methodologies; analysis and evaluation; and selection of the locally preferred alternative. These steps necessarily follow one another in sequence, with the results of each phase serving as necessary inputs to the following phase.

During the AA study initiation phase, the roles and responsibilities of participating agencies are established, issues to be addressed in the study are defined, and the availability of data and models for addressing these issues is determined. The public involvement process is initiated. If the alternatives analysis study is undertaken concurrent with NEPA, these activities are synonymous with scoping. The study initiation phase typically results in a detailed scope of work, or work plan, for the study; a problem statement and corresponding goals, objectives, and preliminary evaluation measures which guide the subsequent analysis; and a conceptual definition of alternatives to be included in the study. The study initiation process is described in Part II Chapter 1, *Organization and Management* of this guidance.

Once the study has been initiated (and scoping is complete), the next step is to further refine the alternatives and the methods to be used in the analysis. This step is designed to ensure that all participants in the process are in general agreement with the alternatives and analytical methodologies before the technical analysis process is undertaken. This step often includes a preliminary analysis to screen out those alternatives that show the least amount of promise. Further guidance on the development of alternatives and analysis methodologies is contained in Part II Chapters 2 through 8 of this guidance.

The third step - the analysis, evaluation, and final refinement of the alternatives - constitutes the main technical work of the study. This step includes applying the methodologies developed for each of the study's technical functions to

assess the transportation, environmental, and financial impacts of each alternative. Agreement is achieved among the study participants on the technical results of the study. Further guidance on this step may be found throughout Part II of this guidance.

Once the technical results are agreed upon, the final step involves a) preparation of a final alternatives analysis study report (or the draft EIS if the study is undertaken under NEPA) summarizing and interpreting the results of the study; and b) the selection of the locally preferred alternative. The AA final report/draft EIS will pull together in one place all of the technical information deemed relevant to the selection of the preferred alternative; that is, it serves as a vehicle for decisionmaking. This selection process typically includes circulation of a final study report (or draft EIS), a public hearing, a local decision on the preferred alternative, and preliminary adoption of a financing plan for the preferred alternative's capital and operating costs. Part III of this guidance provides additional information on the preparation of the final AA study report/draft EIS and selection of the locally preferred alternative.

The technical elements which support the accomplishment of these steps includes travel demand forecasting; estimation of capital and operating costs; analysis of social, economic, and environmental impacts; and financial analysis. These technical elements are described in Part II of this guidance. Work is performed on each of these elements during each step in the alternatives analysis phase, as data is collected, methods are developed, analyses are performed and documented, and the results are presented for agency and public review, and taken into account in local decisionmaking. A strong documentation effort of these activities provides the detail necessary to manage the study, support the analysis, and present its results.

3.2 Documentation of the Alternatives Analysis

During the course of each alternatives analysis, the preparation of a number of discreet documents supporting the final AA study report is recommended. These include (but are not limited to) a report justifying the need for an improvement, such as a problem statement (or in the case of an alternatives analysis being performed as part of NEPA, project purpose and need); a series of reports describing the conceptual and refined definition of the alternatives under study; a report (or reports) describing the technical methodologies used in the alternatives analysis; and a report (or reports), that summarize the results of the analysis.

These technical documents are important for both internal management of the study and external communication of its analyses and results. Alternatives analysis and other project planning studies often require a large commitment of resources, both in funding and staff time. The effort proceeds most quickly and efficiently when participating agencies – local, State and Federal – reach agreement early in the study on the problem statement, alternatives being

analyzed, and the specific methods and assumptions to be used in the study. This generally helps minimize the chance that participating agencies will take issue with the results of the study because of a disagreement over methods and assumptions, and reduces the chance that part of the study will need to be redone. A robust - and timely - technical documentation effort facilitates this important coordination function.

Moreover, the breadth of the study's technical analyses is best managed and presented when documented separately from the study itself. The final product of the alternatives analysis is a final study report which, if undertaken under NEPA, is typically the draft EIS. Whether performed "inside" or "outside" of NEPA, FTA suggests that the alternatives analysis document be as concise as possible, and written for a broad audience which includes both local decisionmakers and the general public. More detailed information and analysis can be covered in the series of technical reports subsequently made available for review by all interested parties.

Documentation of methodologies, assumptions, and results helps meet other objectives as well. FTA has long believed that a comparison of planning-level *forecasts* of project scope, cost, and performance with the *actual* scope, cost, and performance of implemented New Starts investments would provide the transit and transportation planning communities with a better understanding of the impacts of major transit capital investments and the analytical methods and procedures used to generate the information needed to support local decisionmaking. This enhanced understanding would, in turn, help identify needed improvements to related tools and techniques for corridor planning. As noted in Part I Chapter 1, *Introduction to Major Investment Planning*, the *Final Rule on Major Capital Investment Projects* includes a provision whereby New Starts project sponsors seeking a Full Funding Grant Agreement (FFGA) must submit a complete plan for collection and analysis of information to identify the impacts of their projects and the accuracy of the forecasts that were prepared during project development. This "Before and After Study" collects information on, and analyzes the predicted vs. actual results of, the following five project characteristics:

- *Project Scope* – the physical components of the project, including environmental mitigation;
- *Service Levels* – the operating characteristics of the guideway, feeder bus services, and other transit services in the corridor;
- *Capital Costs* – total costs of construction, vehicles, engineering, management, testing, and other capital expenses;
- *Operation and Maintenance Costs* – incremental operating/maintenance costs of the project and the transit system; and,
- *Ridership Patterns* - origin/destination patterns of transit riders on the project and in the corridor, and farebox revenues for the transit system.

Although a formal plan for the Before and After Study is not required until final design (and only then for projects seeking a FFGA), candidate New Starts project sponsors must be aware that the element of the study relating to predicted project impacts requires that methodologies, assumptions, and resulting information for each of the five characteristics must be fully documented at the conclusion of alternatives analysis (and later, at the conclusion of preliminary engineering) in order to perform an effective and meaningful study. Consequently, a strong documentation effort of the technical work supporting the AA effort is critical to the ultimate success of a Before and After Study.

Figure 3-1 on the following page provides a suggested hierarchy of technical documentation for an alternatives analysis. Following agreement on a study scope of work, initial efforts and documentation are focused on refining a corridor problem statement (or purpose and need, if the study is undertaken under NEPA), goals and objectives, and at least a preliminary set of evaluation factors and conceptual alternatives designed to address identified corridor problems and needs. This is followed by refining the set of alternatives to the point that their implications for the technical work can be identified. Once agreement on a specific definition of alternatives is reached, work can proceed on the preparation of the methodology reports that describe the technical procedures and methods which will support the study. Following the finalization of the methodologies, the heart of the technical work occurs. The results of this work are documented in one or more results reports. Collectively, this body of documentation backs up the alternatives analysis study.

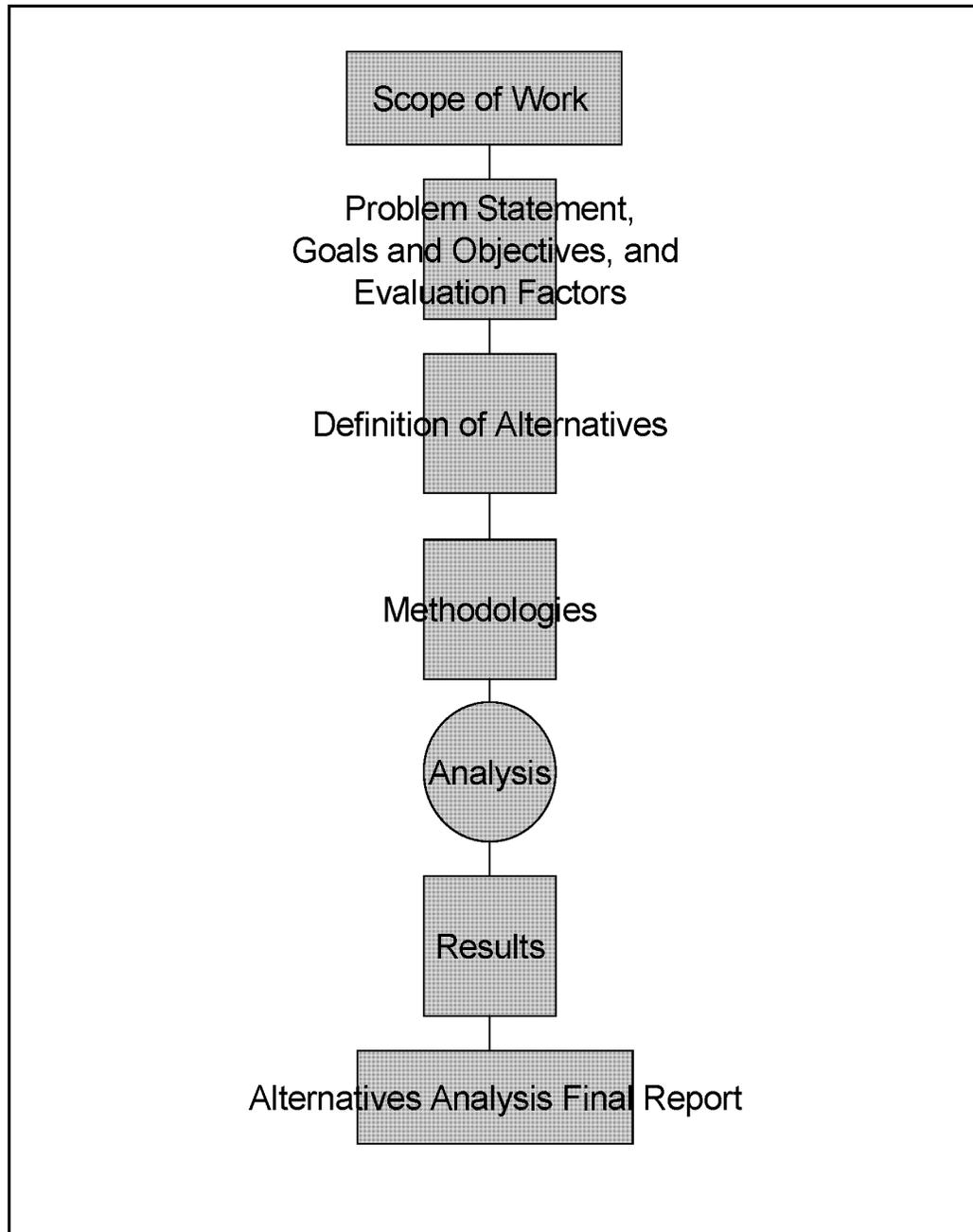
Reports/documentation on a corridor problem statement, range of alternatives, technical methodologies, and analytical results should be reviewed by participating local, state, and Federal agencies, usually through a study advisory committee. To ensure that the study is being conducted in accordance with FTA principles for alternatives analysis, and that the information generated from the study can support a local request to advance a preferred alternative into preliminary engineering, FTA requests the opportunity to review and comment on this documentation as it is being developed. The local lead agency's study schedule should provide sufficient time for these reviews, as well as for possible revisions in response to comments.

3.2.1 Approach to Documentation

The contents of the technical reports and other deliverables described below are discussed in subsequent chapters of this guidance. FTA notes that while the term "report" is applied in this chapter to each of the documents, there is no specific format for them; they may just as easily be titled "technical memoranda." Of the key documentation that FTA requests the opportunity to review (see Section 3.2.1.5 of this chapter), FTA suggests that the technical methodologies be brief, and focus on those aspects of the methodologies that either vary from FTA guidance and/or are necessary to understand the

approach taken (such as assumed parametric capital costs, O&M cost productivities per unit of service, or utility coefficients used in the travel forecast model). Ultimately, the most important point to remember is that

Figure 3-1
Technical Documentation for Alternatives Analysis



agencies should organize and produce their technical documentation in whichever way is most useful to serve the information needs of project staff and decisionmakers, provided that FTA is given an opportunity to review and comment upon information pertaining to the key study milestones described below.

3.2.1.1 Initial Study Products (Problem Statement, Goals and Objectives, and Evaluation Factors)

A clear understanding of transportation problems in a corridor plays a critical role in the AA study. A well-specified statement of the problem(s) for which alternative solutions are being analyzed is therefore a key early step of the corridor planning process. When undertaken as part of the NEPA process, a study “purpose and need” establishes the problems which must be addressed in the analysis; serves as the basis for the development of project goals, objectives, and preliminary evaluation measures; and provides a framework for determining which alternatives should be considered as reasonable options in a given corridor. More fundamentally, the statement of purpose and need serves to articulate why an agency is proposing to spend potentially large amounts of taxpayer’s money to study various alternatives and ultimately implement a project which may result in significant transportation, community, and environmental costs, benefits, and impacts.

For studies performed outside of NEPA, the same type of information should be generated. Like the purpose and need statement, this information provides the context for performing the analysis and for identifying the measures against which alternatives strategies will be evaluated. It also serves as an introduction for decisionmakers and the public to the study area, its transportation needs, and the alternatives which are proposed to address those needs.

Additional information on the development of initial products of the AA study is provided in Part I Chapter I *Organization and Management*.

3.2.1.2 Definition of Alternatives

The development of the various alternatives to be considered in the alternatives analysis process follows closely after the explanation of the corridor problem. The definition of these alternatives is a very important part of the study process. Without a set of alternatives that meet the study’s problem statement and goals and objectives for improvement; which are structured to isolate the differences between potential solutions to an identified transportation problem; and which highlights the trade-offs inherent in the selection of a preferred alternative, even the highest quality technical analysis cannot produce the full set of information needed by decisionmakers.

The development and definition of alternatives is typically an iterative process, and is documented accordingly. Part II Chapter 2 of this guidance, *Definition of Alternatives*, outlines three suggested phases in the development of alternatives. First, a broad *conceptual definition of alternatives* may be developed as early as systems planning. This definition describes the physical and operating characteristics of a broadly identified range of alternatives in

very conceptual terms. Initial activities of the corridor analysis are focused on narrowing this range to a more manageable number to carry forward in the study. This “screening” and further refining of alternatives typically results in a *Detailed (or Draft) Definition of Alternatives Report* which summarizes the detailed parameters of the alternatives to be carried into the heart of the analysis. Ultimately, these surviving detailed alternatives undergo additional refinements - which include the equilibration of bus and rail operating plans to meet demand, agreement on other operating policies, parking capacities and user costs, and other policy and design features (including the development of plan and profile drawings) – and are documented in an update to the Definition of Alternatives Report typically titled the *Final Definition of Alternatives Report*.

Table 3-1 below summarizes characteristics of the *Conceptual, Draft and Final Definition of Alternatives Reports*.

Table 3-1
Definition of Alternatives Reports

<i>Conceptual Definition of Alternatives</i>	<i>Detailed (Draft) Definition of Alternatives Report</i>	<i>Final Definition of Alternatives Report</i>
<ul style="list-style-type: none"> • Definition of corridor; • Identification of technology alternatives; • Preliminary identification of candidate alignments; • General operating strategies 	<ul style="list-style-type: none"> • Location and nature of improvements in the TSM alternative; • Section-by-section description of each guideway alternative; • Typical cross-sections of guideway facilities; • Preliminary drawings of stations types; • Initial specification of design standards; • Design and opening year operating plans including initial estimates of transit network assumptions (routes, link speeds, headways, fares, etc.) 	<ul style="list-style-type: none"> • Plan and Profile drawings for each guideway alternative; • Refined design of stations and guideway facility cross-sections; • Final operating plans based on travel demand forecasts including estimates of service requirements (transit vehicles, vehicle-miles, vehicle hours, etc.) for use in estimating capital and O/M costs.

Additional information on the definition and documentation of alternatives is provided in Part II Chapter 2 of this guidance. FTA requests the opportunity to review the alternatives at each point (conceptual, detailed, and final definition) in their development as a part of its ongoing review of the technical alternatives analysis process and as a basis for its approval of a New Starts baseline alternative.

3.2.1.3 Methodologies

The purpose of the methodology report(s) (or memoranda) is to 1) bring about agreement among the participating agencies with regard to the specific

technical methods and assumptions to be used in the analysis, and 2) document these methods and assumptions for use by others in subsequent analysis (including conduct of the Before and After Study). It must be emphasized that methodology reports are not to be viewed as academic treatises on the various technical analyses. Rather, they serve to document the initial technical work involving data collection, evaluation, and selection of methods and input assumptions, and plans for the application of these methods to the specific characteristics of the corridor and the alternatives. In most cases, these reports should emphasize this last consideration - how the analysis will be focused on the issues that will be important to the selection of a preferred alternative. Consequently, while work on the reports can commence early in the analysis, they are most useful when finalized after agreement is reached on the detailed definition of alternatives.

Thus, the methodology reports are interim documents which define the early technical work for the remainder of the analysis, including the refinement of alternatives. They are working documents designed to set forth guidelines for the remaining work, rather than unfocused, general discussions that contribute little to the conduct of the study.

Examples of specific methodology reports/memoranda include the following:

- Travel Demand Forecasting
- Traffic Impact Analysis
- Noise and Vibration
- Air Quality
- Social and Economic Impact Assessment
- Environmental and Natural Resource Impact Assessment
- Land Use
- Capital Costing
- Operations and Maintenance Costing
- Financial Analysis
- Evaluation of Alternatives
- Public Participation

Agencies may choose to document additional methodologies where local concerns dictate a particular emphasis.

Methodology documents may range in length from a few pages each to several hundred if combined into a single volume. Nothing dictates the length of any report or memoranda except the amount of information necessary to articulate the procedures, tools, and assumptions used to carry out the analysis. FTA notes that, at the discretion of the study sponsor, documentation of the technical methodologies used in the AA study which are submitted to FTA for review (see Section 3.2.1.5) can be limited to a presentation of *how* the

methodologies deviate from FTA guidance, and *why*. Local agencies have full discretion in how they organize the documentation of technical methodologies.

3.2.1.4 Results Reports

The series of results reports/memoranda provides detailed documentation for each of the key technical areas, presenting findings and explanations in detail sufficient to serve as back-up to the alternatives analysis study report. Thus, the results will be more detailed than those included in the final alternatives analysis, and will summarize and explain the analysis results and focus on those findings which are most significant. If necessary, they also highlight any changes in the methods and assumptions presented in the methodology reports.

Topics of results reports are typically aligned with the example technical areas described previously.

3.2.1.5 Key Documentation for FTA Review

While participating local and state agencies are responsible for ensuring that the AA study is conducted in a technically sound manner, FTA, as a key funding partner and advocate for good planning practice, has a strong interest in ensuring the quality of the work. Moreover, Federal law requires that FTA approve project entrance into the preliminary engineering (PE) stage of development, signifying inclusion of a project in the New Starts “pipeline.” FTA bases its decision to advance a project into PE in large part on the information and data developed during alternatives analysis. To ensure that this information satisfies its needs at the time of the PE request, FTA strongly recommends that study sponsors extend to FTA the opportunity to participate in the AA study. FTA believes that such early involvement will assist local agencies in addressing technical and procedural issues early in the study process, rather than at the end when it may be too late to solve them efficiently. Moreover, in order to avoid duplication of effort in subsequent project development activities, and to help ensure that the alternatives analysis process “counts” for the purposes of required NEPA documentation, study sponsors are advised to involve FTA in the AA study.

To that end, FTA strongly encourages study sponsors to prepare and transmit for review a number of key study documents developed throughout the alternatives analysis. These specific documents, and where additional information on their development and content can be found in this guidance, are presented in Table 3-2 on the following page. As previously noted, documentation of the technical methodologies used in the AA study which are submitted to FTA for review may be limited to a presentation of how the methodologies deviate from FTA guidance, and why.

It is FTA’s expectation that a close local-Federal partnership, through the sharing of such study documentation, will expedite, rather than delay, the advancement of well-justified major capital transit investments throughout the project development process; that these proposed projects will better respond to local transportation problems within a fiscally constrained decisionmaking

environment; and that their justification will hold up to the scrutiny placed upon them by local and Federal decisionmakers.

Table 3-2
Key Documentation for FTA Review

Documentation	Where Found in this Guidance
Scope of Work	Part II.1
AA Initiation Package (Problem Statement, Conceptual Alternatives, and Evaluation Measures)	Part II.1
Technical Details	
Detailed Definition of Alternatives	Part II.2
Technical Methodologies	
Capital Costs	Part II.3
O&M Costs	Part II.4
Travel Forecasting	Part II.5
Technical Results	
Final Definition of Alternatives	Part II.2
Capital Cost Estimates	Part II.3
O&M Cost Estimates	Part II.4
Travel Forecasting (Summit) Results and Interpretation	Part II.6
Environmental Considerations	Part II.7
Evaluation of Alternatives	Part II.9
Final Alternatives Analysis Report	

3.3 Agency Roles and Responsibilities

The majority of the work required for the alternatives analysis study is usually performed locally by the transit operator, metropolitan planning organization, or other municipal agencies. The responsibility for the conduct of the study is often shared among several local agencies with one taking a lead role, often overseeing a large consultant staff performing much of the technical work. The following provides guidance on the responsibilities of the local lead agency, on the selection of an agency to be the local lead, and on the technical and procedural support role that FTA can play in the study.

If the AA study is initiated under NEPA, the state or local agency for compliance with NEPA under the Council of Environmental Quality regulations (40 CFR 1501.5 and 40 CFR 1501.6) will develop substantive portions of the environmental document and are expected to sign the document and share responsibility for its scope and content with FTA. At the beginning of the environmental process, FTA will discuss the scope and content of the

appropriate environmental documentation with the state or local agency before decisions are made on the scope and depth of analysis. The state or local agency then carries out these decisions. Regardless of which state or local agency leads the NEPA process, the other agencies involved in the alternatives analysis can, and are encouraged to be, cooperating agencies under NEPA. Additional information on agency roles and responsibilities under NEPA is described in greater detail in Part III Chapter I *The Draft Environmental Impact Statement* (expected to be updated by the end of 2005).

3.3.1 The Local Lead Agency

The local lead agency has the primary responsibility for overseeing the conduct of the alternatives analysis. It ensures that the work is performed in a technically sound manner, and is successfully completed in accordance with the project schedule and budget. The local lead may also perform all of the technical work, share responsibility for the work with other local agencies, or contract out all or part of the work to a consultant. Some of the more important activities involved in properly managing the study are:

- Development of a detailed scope of work/work plan identifying the tasks that will be performed, the sequence in which they will be completed, agency responsibilities for completing the work, and the anticipated cost of the respective study tasks.
- Identifying agency responsibilities for completing assigned tasks, and ensuring that the involved agencies are organized, staffed and supported so as to be able to fulfill their roles in a timely manner. Attention should be paid to ensuring that the staff is technically competent for the assigned tasks, and that interdisciplinary skills are brought to bear where necessary.
- Providing professional management and direction as the work progresses, ensuring that work is done in an efficient manner and that deliverables are obtained in a timely fashion.
- Taking necessary steps, such as establishing a technical advisory committee, to ensure the technical quality of the work.
- Coordinating with local cooperating agencies and FTA by means of study steering committees, monthly/quarterly reports, transmission of key study documents for review, etc.
- Keeping other interested agencies, private operators, and the public informed and seeking their input through established public involvement mechanisms.
- Responding to information requests by decisionmakers during the course of the study.

3.3.2 Choice of a Local Lead Agency

Performing an AA requires a wide range of skills—skills which may not all reside within one agency. In many cities, for example, the metropolitan planning organization may provide expertise in travel demand and land development analyses, but the transit operator will likely have greater experience in transit operations, project design, cost estimation, and financial analysis. Either or both may have project management ability. The distribution of these skills will probably be unique to each specific area contemplating an alternatives analysis study.

Many different kinds of agencies have served as the local lead for alternative analysis studies. These have included transit operators, metropolitan planning organizations, agencies of city government (e.g., departments of public works), state highway and transportation departments, and regional port authorities. From this experience, it is clear that any of these may be qualified to serve as the local lead. The choice will depend upon local conditions. Some questions that might be asked in considering which agency is most suitable are:

- Which agency has the greatest experience in conducting, managing, and administering similar types of corridor or systems level planning studies?
- Which agency has the greatest breadth and depth of technical skills needed for the analysis?
- Which agency tends to have greater credibility with decisionmakers and the public?
- Which agency is most likely to have responsibility for implementing the project that is ultimately selected?
- Do the jurisdictional boundaries of the proposed agency encompass the entire corridor?

Because a wide range of skills must be brought to bear to successfully complete an AA, more than one local agency frequently will play an active role. A memorandum of understanding may be helpful in such cases to clearly define the responsibilities of each participating agency. This might include responsibilities for the conduct of various study tasks, for funding the work, and for the selection of a locally preferred alternative.

3.3.3 FTA Involvement

FTA can play an important role in the alternatives analysis study process. When performed under NEPA, FTA plays a formal oversight role in the draft EIS or EA. As lead (or joint lead) agency for the preparation of the environmental document, FTA is responsible for the scope, content and conclusions of the EIS or EA. FTA makes sure that the environmental

document fulfills Federal requirements and presents a complete and objective basis for mode and alignment decisions.

FTA plays a less formal – though no less important - technical assistance role in “pre-NEPA” AA studies. This role recognizes that FTA has participated in the development of many of the methods and techniques used in the AA study. Over the years, FTA has helped dozens of cities across the country to apply these techniques in previous corridor planning studies. FTA welcomes the opportunity to share this experience with local staff engaged in ongoing and future studies. In addition, FTA must base its approval on project entry into preliminary engineering in part on its finding on the acceptability of the alternatives analysis and the reliability of the information used to support a preferred alternative’s New Starts project justification criteria. FTA’s review of the key documents described in Section 3.2.1.5 of this Chapter facilitates this finding.

AA study sponsors will generally be assigned an FTA contact from the appropriate Regional Office, who is teamed with a counterpart in the Office of Planning and Environment, located in FTA headquarters in Washington DC. These contacts will in turn work with other appropriate FTA technical staff (and, where appropriate, FTA consultants) to provide assistance on specialized areas such as travel demand forecasting, transit service planning, capital costing, financial planning, etc. In general, the Regional Office contact will provide assistance on programmatic procedures and requirements, while the headquarters contact will provide assistance on, and reviews of, the technical activities which make up the study. It is important to keep appropriate FTA staff informed on the status and progress of the local studies, and to seek their assistance in addressing difficult technical and procedural issues. FTA, in turn, strives to provide study sponsors with assistance in a timely manner, and to keep them abreast of emerging agency policies regarding major investment planning and the New Starts program.

3.3.3.1 Role of Regional Offices (TRO)

The FTA Regional Office (TRO) will be the lead point of contact for local agencies on FTA programmatic matters. It handles grantmaking activities, serves as the focal point for contacts and correspondence, represents FTA at meetings, monitors progress, processes the draft EIS, and seeks assistance from the FTA Offices of Planning and Environment (TPE) and Program Management on planning, technical, and programmatic issues. TRO roles in the AA study process are summarized more specifically below:

- **Grantmaking**. TRO staff reviews grant applications, approves grants, and performs typical grant administration functions.
- **Provide Program Guidance**. TRO staff provides study sponsors with basic guidance on the New Starts program, including project

development requirements, project evaluation procedures, and grants requirements.

- **Focus of Contacts and Correspondence**. Incoming correspondence should be directed to the Regional Administrator. Similarly, most outgoing correspondence will be signed at the Regional level (with the exceptions noted in the following section). Regional staff will also normally handle informal requests for guidance and assistance, such as routine telephone calls, although a call within a specific technical focus should be directed to TPE (see Section 3.3.3.2 of this Chapter).
- **Representation at Meetings**. As necessary and to the extent permitted by limited resources, TRO staff will represent FTA staff at technical and policy level meetings that occur during the study. Their role will be to explain overall FTA policies and procedures, to explain FTA positions on specific issues related to the AA study and the process for advancing major transit investments into preliminary engineering, and to provide technical guidance (in conjunction w/ TPE).
- **Metropolitan and Systems Planning Issues**. TRO staff will provide guidance and direction on metropolitan planning requirements and issues which may impact the alternatives analysis study and subsequent project advancement, such as air quality conformity, fiscal constraint, and project programming.
- **NEPA Facilitation**. At the start of the scoping process for alternatives analysis studies performed concurrently with a draft EIS under NEPA, TRO prepares a Notice of Intent (NOI) to prepare an Environmental Impact Statement. TRO staff further facilitates other NEPA procedural requirements. Toward the conclusion of the study, it reviews and (with TPE concurrence) approves the draft EIS.
- **Processing and Approval of the PE Request**. Once the AA study has been completed, the locally preferred alternative has been adopted in the financially constrained regional long range plan, and FTA has determined that the project sponsor has the technical capacity to manage any subsequent project development activities, the lead local agency may request FTA approval to advance the preferred alternative into preliminary engineering. TRO is responsible for making the finding that a project is “ready” for PE (as measured by the conditions described above) and for processing and approving – based on TPE’s evaluation of the project’s New Starts criteria for project justification and local financial commitment, as described in the following section – the request to advance into preliminary engineering.

3.3.3.2 Role of the Office of Planning and Environment (TPE)

TPE is the lead point of contact to local agencies on technical elements of the AA study. TPE develops guidance on the alternatives analysis study process, monitors and reviews key products of individual studies, offers specialized technical assistance on a project-by-project basis, approves a New Starts baseline alternative, and evaluates the project justification and local financial commitment criteria of projects proposed to advance into preliminary engineering. These roles are explained further below.

- **Guidance Development.** TPE oversees a program for the development of procedures and methods for carrying out an alternatives analysis study process. In that capacity it prepares guidance, manuals reports, regulations, software, and other materials on a number of technical and procedural topics. TPE also conducts training courses and workshops and shares good examples from past and current studies on technical analyses and decisionmaking.
- **Reviews Technical Products of the Study.** TPE performs the lead technical review of the documentation suggested in Section 3.2.1.5 of this Chapter.
- **Provide Specialized Technical Assistance.** TPE can provide project-specific technical assistance on a variety of planning methods and concepts, including travel demand forecasting, definition of alternatives, financial planning, costing, environmental analysis, public involvement, and procedural linkages between planning and NEPA. These technical assistance services are provided to any AA study sponsor to the extent possible, given available FTA resources.
- **Approval of a New Starts Baseline Alternative.** TPE provides assistance on the development of alternatives to be carried through the AA study, and will approve one alternative (typically, a properly defined TSM) to serve as the New Starts “baseline” for the purposes of calculating the project’s cost effectiveness, mobility improvements, and environmental benefits. TPE will communicate this selection action to the lead local agency through the appropriate FTA Regional Office.
- **Evaluation and Rating of Candidate New Starts Projects.** TPE evaluates New Starts projects for the purposes of supporting FTA’s decision to advance a project into preliminary engineering. This evaluation is based on the full range of New Starts project justification and local financial commitment criteria and measures. Information which supports each measure is generated as part of the alternatives analysis study. TPE’s evaluation of this information results in criteria-specific and overall project ratings, which are conveyed to the appropriate FTA Regional Office for the formal approval/disapproval action.

1. STUDY INITIATION, ORGANIZATION, AND MANAGEMENT

Corridor planning can be highly complex, particularly when fixed guideway alternatives are involved. Although a number of technical, policy and institutional challenges are inherent in virtually all corridor studies, planning proceeds most smoothly when the work to be done and the time and resources required to do the job are carefully thought out and agreed upon in advance.

This chapter addresses a number of subjects related to managing a corridor or subarea study, with an emphasis on the alternatives analysis (AA) phase for New Starts. The chapter begins by providing guidance on the initiation of the study, including the development of the statement of the problem the study is trying to solve, the conceptual definition of alternatives which will be studied in the AA, and preliminary evaluation measures. Second, it describes several study organizing considerations such as the formation of committees to oversee the study process. Third, it covers study scope, schedule and budget issues including the “scope of work” and quality assurance. The chapter concludes with a discussion of public and agency involvement in the AA study.

When performing an alternatives analysis, it is helpful to keep in mind that these studies serve two purposes. First, they provide information for local decisionmakers to help them select a locally preferred mode and general alignment. Second, they provide information for FTA decisionmaking on whether to participate in subsequent project development. The information needed to support local decisions is determined by local stakeholders and reflects local values and priorities. FTA decisions reflect processes and criteria which are established by Federal law and FTA regulations. Both purposes are well served when critical elements of the study – alternatives definition, travel demand forecasting, financial analysis, evaluation, etc. – are performed in accordance with the principles of good corridor planning that are presented elsewhere in this guidance. Adherence to these planning principles is necessary in order for a major transit investment proposed for discretionary New Starts funding to be advanced into the preliminary engineering phase of project development. Advancement occurs most smoothly when sufficient

time, funding, and technical resources are recognized and anticipated in the management plan, scope of work and budget.

1.1 Initiation of the Study

Local stakeholders initiate an alternatives analysis when regional systems planning indicates that a fixed guideway transit investment may be a promising solution to transportation problems in a corridor. Consequently, the decision to do an AA rests on a solid understanding of corridor mobility problems. From this understanding flows the definition, first at just a conceptual level, of the alternatives that might best address these problems, and the development of evaluation criteria for assessing the relative merits of the alternatives. This section summarizes these initial considerations of the AA study process.

1.1.1 Problem Statements

The definition of the corridor to be analyzed is necessarily one of the first items that must be addressed in the study. “Corridor” in this sense is the travel shed and discreet markets which would be served by a transit improvement. The corridor should be defined in terms of its geographic extent, physical characteristics, and travel patterns.

The transportation “problems” in a corridor might be viewed as the “gap” or difference between the desired level of system performance, often expressed as goals and objectives, and the current and projected level of performance. Goals and objectives are often gleaned from the metropolitan transportation/system planning process, the comprehensive plans of jurisdictions within the corridor, and the transit agencies themselves. Performance is assessed through system monitoring and the forecasting of future conditions (see Chapters II.5 and II.6 for guidance on travel forecasting tools and methods). Depending on local goals and objectives, monitoring of current performance and projections of future performance may include such items as

- Transit service to various markets
- Transit ridership and crowding
- Transit speed, travel time, and on-time performance
- Transit operating costs and farebox recovery
- Highway congestion, auto occupancy, highway speeds, travel time reliability and accident rates
- Air quality
- Economic development

A study’s problem statement should be developed with care. A vague problem statement – for example, the need for additional transportation capacity in a corridor – could result in a very large number of alternatives which could be thought of as being “reasonable”. On the other hand, too narrow a definition might unduly constrain the range of alternatives. In no case should the need for a project be expressed in narrow modal terms (e.g. need to widen the

highway, need for a light rail system). The ideal problem statement results in the development of a manageable number of distinct strategies designed to achieve some level of improvement in forecast conditions.

The discussion of the problems should not only describe the type of problem but also its location (routes, intersections, etc.) and severity (e.g. magnitude and duration). Moreover, the analysis should seek to identify the underlying causes for transportation performance deficiencies, not merely the symptoms, as this provides a firmer foundation for identifying alternatives that may offer effective solutions. The underlying causes can often be discerned by asking “why?” questions – e.g., Why is transit on time performance low? Why is economic development not achieving established goals?

Data collection and technical analyses play an obvious role. Observed patterns of travel, informed by a sound data collection program provide a basis for understanding travel markets, predominant origin and destinations within a corridor, and their mobility constraints. From this, those markets that might lend themselves particularly well to improved transit service can be identified. This might be based, for example, on the volume of trips between certain origin-destination pairs as well as the degree of transit oriented development in these origins and destinations. The results can offer valuable insights for developing a transit service strategy for the corridor, and ultimately, for defining transit operating plans and infrastructure alternatives.

The problem statement provides the context for performing the analysis and for identifying the measures against which alternatives will be evaluated. It may also serve as an introduction for decisionmakers (elected officials, local and state agencies, stakeholders, the general public, FTA) to the study area and its transportation problems and needs. A focused problem statement can help raise community awareness and support for the study. This, in turn, may generate broader support for the findings and recommendations. The problem statement also provides the starting point for the “Making the Case” paper that FTA requires as part of a request for approval to initiate New Starts Preliminary Engineering.

1.1.2 Evaluation Criteria

From the identification of the problem springs the development of evaluation criteria. These criteria specify, in part, the desired outcomes of an improvement, and provide the basis for comparing the performance of the various alternatives. Typically, evaluation measures are selected to assess how well (or poorly) each alternative meets the goals and objectives defined for a transportation improvement in the corridor.

Evaluation criteria may be organized within an overall framework that considers:

- *Effectiveness* – the extent to which alternatives solve the stated transportation problems in the corridor;

- *Impacts* – the extent to which the alternatives impact – positively or negatively – nearby natural resources and neighborhoods, air quality, the adjacent transportation network and facilities, land use, the local economy, etc.;
- *Cost effectiveness* – the extent to which the costs of the alternatives are commensurate with their benefits;
- *Financial feasibility* – the extent that funds required to build and operate the alternatives are likely to be available; and
- *Equity* – that is, the costs and benefits of the alternatives are distributed fairly across different population groups.

Developing at least a preliminary set of evaluation criteria at the beginning of the alternatives analysis helps ensure that the study generates the kinds of information that policymakers need to select a locally preferred alternative, while at the same time limiting the data collection and analysis effort to only information that will be used to support decisionmaking. Part II Chapter 9, *Evaluation*, presents additional guidance on the development of an evaluation framework and evaluation measures.

1.1.3 Conceptual Alternatives

The development of the alternatives to be considered in the alternatives analysis process follows closely after the explanation of the corridor problem and the definition of the study's goals and objectives. The range of alternatives also flows from an understanding of travel patterns and potential transit markets within the corridor.

The development and definition of alternatives is typically an iterative process, as described in Chapter 3 of Part I and Chapter 2 of Part II. The first step in this process is the conceptual definition of a broad range of strategies for improving conditions in the corridor. The conceptual definition includes a preliminary identification of candidate alignments and operating strategies. Defined operating strategies – as distinct from operating plans developed as planning and project development proceeds – give general ideas of overall service levels, service standards, and guideway service options. More basically, they provide the information necessary for decisionmakers and other stakeholders to confirm that no reasonable alternative (in terms of meeting corridor needs) is being excluded.

Subsequent evaluation and screening of these conceptual alternatives will narrow the range of viable alternatives to a manageable number to carry forward into a detailed analysis.

1.1.4 AA Initiation Package

Once a local agency decides to undertake an alternatives analysis that might result in the pursuit of New Starts funding, FTA believes that the work

progresses most smoothly and efficiently when FTA is involved from the beginning. Therefore, FTA suggests that local study sponsors prepare and submit a brief document which summarizes the corridor problems, conceptual alternatives, and preliminary evaluation measures to be used in the study as a means to begin the process of coordination with FTA. This “AA Initiation Package” (or “Scoping Package”) can also help foster coordination among local participating agencies.

The Initiation Package might include:

- Problem statement (3-4 pages)
 - Transportation
 - Other
- Evaluation criteria (2-3 pages)
 - Preliminary listing of information that will be available
 - Highlights on any limitations (detail, uncertainties, etc.)
- Conceptual alternatives (3-4 pages)
 - Initial identification of options
 - Mode, termini, general alignment
 - Operating strategy (line-haul/feeders; park and ride coverage; station/access spacing; express service; downtown circulation; etc.)

FTA published *Additional Information on Local Initiation of Alternatives Analysis Planning Studies* in March 2004, which is available on FTA’s website at http://www.fta.dot.gov/planning/newstarts/planning_environment_2590.html and which provides further guidance on the contents of this suggested document.

1.1.5 Initiation of the NEPA Process

As discussed in Part III of this guidance, AA can precede, or be combined with, the National Environmental Policy Act (NEPA) process. When performed within NEPA, the Environmental Impact Statement or other NEPA document, as appropriate, can serve as the decision-making document that summarizes the analysis results and supports the selection of a locally preferred alternative. Where the local project sponsor chooses to take this approach, the timing of NEPA Scoping will often coincide with the initiation of AA, and the two should be coordinated. The Notice of Intent (NOI) and NEPA Scoping meetings will help to shape the AA scope.

Section 6002 of SAFETEA-LU put in place new requirements that apply when the preparation of an Environmental Impact Statement is initiated. These include:

- Project initiation letter
- Identification of participating agencies
- Coordination plan

Agencies should consult the FHWA/FTA NEPA regulations (23CFR771), including its attachment on Linking Planning and NEPA, as well as the FHWA/FTA SAFETEA-LU Environmental Review Process Final Guidance (November 15, 2006) for more information.

1.2 Organizing to Conduct an Alternatives Analysis

Part I Chapter 3 of this guidance describes the roles and responsibilities of the lead local agency and FTA in an alternatives analysis. The present section builds upon that foundation by describing the committee structure that is often used at the local level to provide clear direction and communication. In nearly all cases, at least two committees are established:

- Steering (or “policy”) committee responsible for providing overall direction on policy aspects of the study and making decisions at key milestones; and
- Technical advisory committee which oversees and coordinates the performance of the technical analysis.

Often, a number of advisory committees are established for discreet study functions such as finance, environmental analysis, transit operations, land use, etc. A citizens advisory committee may also be established as part of the study’s public participation program (see Section 1.4 *Public and Agency Involvement*).

Any organizational structure should establish clear roles and responsibilities, lines of control, and coordination among the entities involved, and provide for timely and authoritative agreement on planning assumptions and methodologies.

1.2.1 Steering (Policy) Committee

Overall direction for the study is normally provided by a policy or steering committee composed of elected officials (or, more often, their designees) from the project area. The committee may also include senior managers from participating agencies and non-elected representatives of affected communities, such as citizens and business leaders. A policy committee will normally, with the assistance of its advisory committees and other project staff, establish project goals and objectives, review and adopt the range of alternatives to be carried through the study, and approve the criteria to be used in the local evaluation of alternatives. This latter function is sometimes omitted from the responsibilities of a project’s steering committee, and left to technical staff to define based on the types of information generated in the preceding technical analysis of alternatives. However, the formal (and early) approval of evaluation criteria helps ensure that the study generates the kinds of information that policy makers feel that they will need when they are called upon to select a locally preferred alternative, while at the same time limiting the data collection and analysis effort to only that information which will be

used to support decisionmaking. Guidance on the evaluation of alternatives is provided in Part II Chapter 9 *Evaluation of the Alternatives*.

The steering committee should also be asked to concur in key input assumptions that will be used in the analysis. This might include such assumptions as growth and development forecasts, operator wage scales, and parking and fare policies. The steering committee may also be called upon to resolve differences of opinion that arise within the various advisory committees.

The policy committee may or may not be the same governmental body (or bodies) that will select the locally preferred alternative and adopt the financing plan at the conclusion of the study. If not, the policy committee should be representative of those who will ultimately make these decisions.

1.2.2 Technical and Other Advisory Committees

A technical advisory committee often reports to the steering committee to oversee the technical analysis and foster interagency coordination. As mentioned previously, several advisory committees or subcommittees may be established to reflect each of the study's technical disciplines, such as operations planning, travel demand forecasting, and financial analysis. Advisory committees tend to be composed of staff from each participating agency and affected jurisdiction. Citizen and business leaders sometimes participate as regular or ad hoc members.

To carry out its responsibilities, the technical advisory committee (or committees) reviews the technical products developed by the lead agency and/or consultant staff, provides comments and suggestions for revising these products, and recommends action by the policy committee. The advisory committee(s) should assess the adequacy of the mode and alignment alternatives being considered in the study, as well as offer comments on the technical methods and assumptions being applied. The technical advisory committee(s) may suggest the consideration of different implementation strategies and funding sources. An active and capable advisory committee structure can be indispensable to ensuring a complete and sound technical analysis and to achieving consensus on the results.

1.2.3 Study Staffing

Corridor planning studies involve a variety of technical analyses, including travel forecasting, environmental analyses, capital and operational costing, and financial planning. These analyses depend on large amounts of data, complex computer software, and, to be successful, professional technical staff with demonstrated experience in such analyses.

It is unlikely that study sponsors will have the expertise in-house to perform all of the technical work required of alternatives analysis studies. Many, if not most, study sponsors are engaged in corridor studies on only an occasional basis, so maintaining such expertise among agency staff may not be the most

optimal staffing strategy. Instead, consultant resources are likely to be procured to perform many of the required analysis. Consultants may also serve as study technical managers, building and overseeing a team of consultants to perform the necessary analyses. Investing in appropriate professional services, then, is an important initial element in the conduct of alternatives analysis studies.

While consultant help of some degree or another will be a part of most AA studies, this does not eliminate the local lead agency's responsibility to direct and manage the study. The "study manager" for the local lead agency will typically be the point of contact for the Advisory Committee(s), and often for the Policy Committee. The agency study manager will also usually be FTA's primary contact. While study managers need not be experts in each of the discreet technical fields, they should have a working knowledge of good planning principles and technical concepts, and should be able to understand the contributions of each discipline to the overall study effort.

1.3 Developing the Scope, Schedule and Budget

One of the responsibilities of the local lead agency is to develop and maintain a comprehensive scope of work describing the steps to be performed in the study. The scope of work will describe the technical activities necessary to perform the study, identify deliverables, and provide a schedule. It may also show the organizational structure and identify key personnel. The scope of work should include quality assurance to ensure that satisfactory technical work and analysis of results has taken place.

A comprehensive scope of work can serve as a study management tool for the conduct of an alternatives analysis. Some local agencies prefer to limit the scope of work to discreet technical tasks performed by their consultants, and to develop a complementary work plan to document the study's organizational structure and schedule. This can be effective so long as the technical activities are linked to and within the context of a broader study organization.

FTA suggests that it be afforded an early opportunity to review and comment upon the work plan for any local corridor planning study which may result in the selection of a project that will be proposed for New Starts funding. This review can help ensure that the technical work meets FTA requirements and facilitate the approval of the project into New Starts preliminary engineering.

The following section describes the purpose, content, and use of the scope of work. The section also identifies factors that can impact the schedules and budgets of alternatives analysis studies.

1.3.1 Purpose of the Scope of Work

Ideally, the scope of work should serve as a management tool throughout the study. Early in the study, a draft scope of work may serve as a vehicle for obtaining agreement among participating agencies on the approach to be followed in the study, the level of effort and funding required, and agency roles

and responsibilities. The study initiation phase also identifies issues which may require specialized technical experience and other resources, thus aiding in preparing the staffing plan and budget for the study.

As the study is initiated and progresses, the scope of work becomes a tool to monitor study progress, particularly adherence to the adopted schedule and budget. The scope of work should further help study participants ensure that input data is available when required, and that local and suggested Federal reviews are obtained, without unnecessarily impeding the progress of the work. The local lead agency should closely monitor the study's progress and regularly identify necessary changes that should be made in the schedule, budget, and task descriptions to meet emerging needs and conditions.

1.3.2 Content of the Scope of Work

A well-crafted scope of work is critical to the success of the planning effort. The scope should describe the technical activities (tasks and subtasks) to be performed in the study, identify the relationship between these activities, and define their deliverables. It should make the responsibilities of participating agencies clear, identify major review and decision points (including those requested by FTA, as identified in Part I Chapter 3 *Framework for the Analysis*), and provide the basis for a realistic schedule and budget.

Typically, the scope of work will include tasks for collecting data and carrying out analyses including:

- Problem definition (purpose and need)
- Alternatives development (screening, operations planning, conceptual engineering)
- Capital and O&M cost estimation
- Travel demand forecasting and estimation of transportation benefits
- Analysis of social, and environmental impacts
- Public involvement
- Funding and financing strategies
- Evaluation

Yet each scope of work is unique and reflects the status of planning in the corridor, the kinds of alternatives to be considered, and other issues of importance to local decisionmakers. Key issues should be apparent from previous systems planning activities, and input from the public and other interested agencies may provide additional opportunities to identify issues and consider how they might be addressed in the study. Once such issues have been identified, the local lead agency should assess the status of travel demand model development and other technical tools for addressing these issues, as well as the availability and age of necessary input data. To the extent that models require further specification, or additional data is needed, the scope, schedule and budget should provide for this.

Five points to consider when developing the scope for an alternatives analysis are:

- 1) The scope of work should be organized around key milestones and decision points rather than technical disciplines.

While alternatives analysis is a process that ultimately leads to mode and alignment decisions, there can be many other decisions during the course of the study – e.g., decisions to screen out unpromising or inferior alternatives, decisions on key policy assumptions, decisions on who will own and operate the project. The scope of work can best serve as a management tool of it identifies these intermediate decision points and describes the work to be done in support of each decision. This will recognize the information that decision-makers want to know at each point, as well as what they may need to know to reach an informed decision that is likely to stand up over time.

- 2) The scope of work and/or work plan should recognize the interrelationships between the tasks.

Many of the tasks are dependent upon the products of previous tasks. Funding and financing strategies cannot be fully assessed until cost estimates are available, for example, and costs cannot be estimated until operations planning and conceptual engineering are well underway. Likewise, technical analysis should not be undertaken until agreement is reached on the technical methods and evaluation measures. A work flow diagram (see Figure II-1.1) can be a useful tool for organizing and scheduling the work tasks and deliverables in a logical and efficient sequence. It also affords a mechanism for identifying and managing the hand offs between different disciplines (e.g., between the cost estimators and the financial planners).

- 3) The scope of work should indicate the level of effort anticipated for each decision point.

Level of effort will be a function of the amount of information needed to support a well-informed local decision on the selection of a locally preferred alternative, and to reach sustainable decisions during the course of the alternatives analysis. Key questions to ask in developing the scope are:

- What do we (and our decision-makers) need to know and when do we need to know it?
- How much is enough?

The answers will go along way toward defining the scope, as well as the schedule and budget. Subsequent chapters of this guidance offer generic advice on these questions in each technical area, but in the end the answer depends on local conditions.

Where New Starts funding is likely to be sought, FTA's requirements and expectations also should be anticipated during the development of the scope of work. Project sponsors will need to establish and document project justification and local financial commitment, in a way that will allow FTA to evaluate and rate the project against the New Starts criteria. For example, the level of effort should account for the calculation of transportation system user benefits, which, in addition to providing enhanced insights into the performance of alternatives, is used by FTA to evaluate the cost effectiveness and anticipated mobility benefits of candidate New Starts projects. It may be necessary to modify the regional travel demand model to produce the set of fixed person trip tables and generalized cost files that are used in FTA's "Summit" software that calculates a project's cost effectiveness. If this is the case, the modification should be included in the scope of work. More importantly, a scope of work should anticipate that the technical staff will use the Summit reports and thematic maps as diagnostic tools for reviewing the completeness (and comparability) of each alternative's operating plan; for identifying potential transportation network coding errors; for re-evaluating model specifications; and to thoroughly examine how the alternatives impact (positively or negatively) discrete travel markets, in terms of transit travel times and costs. Ample time and resources should be provided in the study scope and schedule for this analysis, subsequent corrections, and modifications to the alternatives and/or forecasting tools.

- 4) The scope of work should include procedures for assuring the quality of the technical work.

Quality Assurance (QA) refers to all activities associated with evaluating and ensuring the quality of technical information. While QA is explicitly specified as part of a Project Management Plan for preliminary engineering and final design, quality assurance is an important principle to be incorporated into any planning analysis. Implementing a QA program – and if not a formal program, at least providing for an adequate amount of time and resources to perform reviews and analysis of ongoing technical work – will help to reduce errors in the technical process that may yield unreliable results, cast doubt on local decisions, and/or delay the project's advancement.

A primary objective for a good QA effort is to prevent errors from occurring, or to find errors quickly after they have occurred. Travel demand forecasts, traffic and air quality analysis, and capital and O&M costing involve the processing of an extremely large number of data items; procedures for managing this data need to be developed and applied to ensure the quality of data and to avoid simple data entry errors. For an alternatives analysis, QA also involves the thorough review and reconfirmation of analytical inputs and assumptions to ensure that they are consistent across alternatives where they need to be (network coding errors are a common mistake). Of course, project staff should apply careful attention to the analysis of the results of the demand forecasting process in order to validate the reasonableness of estimated impacts

and to identify deficiencies in the technical work. It is not enough to simply “produce” travel forecasts, for example; rather, the forecasts must be reviewed to ensure that their results are defensible and tell a coherent, cogent story about each of the alternatives being studied. Whether this review is undertaken as part of a formal QA “program” or scoped as another task or sub-task is not important, so long as sufficient time and resources are provided for such an analysis.

In alternatives analysis, QA techniques often include the use of peer reviews or expert panels. These groups may meet for a day or two at key points in the study process to offer general guidance, to offer advice on alternatives and methodology, to help define the appropriate level of detail, and to assess the reasonableness of the results.

The QA program typically includes the establishment of a document control system, and ensure that all relevant documents and information are current and available to all users who require them.

- 5) The scope of work should provide for thorough documentation of the analysis methods and results

Documentation serves multiple purposes. It facilitates communication among local participants, giving them a basis for commenting on and agreeing to the alternatives, the analysis methods, and the analysis results and their interpretation. Documentation also facilitates communication with FTA (see Part I, Chapter 3). Furthermore, it provides a means for communicating with those who will be developing the project in the future. Questions may arise in the subsequent Preliminary Engineering phase, for example, about whether a particular alternative was considered and why it was dismissed.

Documentation is key to efforts to link decisions made in the planning process with subsequent analyses and reviews under the National Environmental Policy Act.

As noted in Part I Chapter 3 of this guidance, a strong documentation effort of the independent variables, assumptions, methodologies, and results of the travel demand forecasting and cost estimating processes will facilitate the conduct of a Before and After Study for projects that eventually receive a New Starts FFGA. This requirement is generally satisfied by an adequate documentation effort (in the form of technical reports or appendices) of the independent variables, assumptions, and methodologies used to define transit service levels and to estimate capital and operating and maintenance (O&M) costs and ridership patterns.

1.3.3 Experience with Study Schedules and Costs

Corridor planning schedules and costs vary widely from one area to the next.

The time required to perform project planning is essentially a local matter.

Many cities are able to complete alternatives analysis in one to two years, although very few are completed in less time. Other alternatives analyses have

continued for five years or more. The time required depends on such factors as:

- Complexity of the local decision-making environment;
- Availability of quality models and data;
- Number of alternatives being studied;
- Complexity of corridor travel patterns;
- Sensitivity of potential environmental impacts;
- Scale of the public involvement process;
- Local technical capabilities; and
- Willingness of participating local agencies to devote the necessary staffing and financial resources.

Similarly, the cost of performing alternatives analysis depends on project-specific conditions. Factors that have been found to influence the cost of an alternatives analysis include:

- Number of alternatives and their lengths;
- Number of sub-alternatives (design options);
- Complexity of travel patterns;
- Number of significant environmental issues;
- Proportion of work done in-house vs. contracted out;
- Data collection requirements;
- Status of model development;

FTA has observed that study schedules and budgets are often overly optimistic. Alternatives analysis can be a process of discovery, and budgets should recognize that unexpected issues are likely to emerge as the study progresses. Alternatives are often refined during the study process. If operating plans, alignments or system access points are modified, additional analysis that was not anticipated in the study schedule or budget may be necessary.

1.4 Public and Agency Participation

Public and agency involvement runs throughout the major investment planning process. It should be initiated at the very outset of the study, and feed the development of the information described above. FTA stresses that while it is important that the alternatives analysis develop sound and unbiased technical information, it is also vital that the study respond to issues of concern to the participating agencies and the public. Technical results should be properly presented to the public and other agencies, including environmental resource and regulatory agencies. Many sound proposals for meritorious projects have never survived public and agency review because public involvement was ignored or left until the end of the study. When the alternatives analysis is combined with the preparation of a NEPA document, NEPA requirements for agency involvement come into play. These include the participating agency

and coordination plan requirements of Section 6002 of SAFETEA-LU when an AA/DEIS is to be prepared.

A successful public involvement program requires a great deal of planning and advanced preparation. Proper coordination requires contacting and involving the public and interested entities early in the process, and maintaining this involvement throughout the study. Studies are more likely to be successful if they gain and keep the confidence of all participants.

1.4.1 Objectives

The citizen and agency participation process has two primary objectives:

- To ensure that information is made available to other agencies and the public throughout the duration of project studies, and that such information is as timely, clear, and comprehensive as practicable;
- To ensure that interested parties – including local governments and metropolitan, regional, state, and Federal agencies, as well as the general public – have an opportunity to participate in an open exchange of views throughout the analysis.

Systems planning and scoping (if the alternatives analysis is undertaken under NEPA) should lay the foundation for a successful process of public and agency involvement that should continue throughout the study and subsequent project development. This continuing process will be multidimensional with a variety of groups and individuals participating in different aspects of the study. By encouraging citizens and agencies to express their opinions and concerns through an open exchange of views, all of the significant issues should be identified. This will help ensure that all impacts are addressed, that all of the information necessary for decisionmaking is developed, and that decisions will be more sustainable as the project progresses.

Each alternatives analysis study should disseminate information on the alternatives being considered, the scope of the analysis, and the methods to be used, as well as estimated costs and impacts. Additional or more detailed information may also have to be developed to respond to concerns of particular groups.

1.4.2 Approach

The citizen and agency participation process normally consists of a mix of formal and flexible techniques. For an alternatives analysis undertaken concurrently with a Draft EIS, the scoping meeting which initiates the study and the public hearing during circulation of the document constitute two of the obvious formal participation mechanisms. Even outside of NEPA, public information meetings, citizen advisory committees, study newsletters, websites, and other media are all critical elements of an ongoing public involvement process. These strategies are further supplemented with extensive personal contacts to agency and community leaders.

The size and composition of the participation group will vary from study to study depending on the characteristics of the local community and the impacts of the alternatives. As noted previously, each study is likely to have a citizen advisory committee, a steering or policy committee, and one or more technical advisory committees. Where the steering and advisory committees include representation from all of the agencies relevant to the actions and decisions they are responsible for, such committees form the basis of agency coordination. In addition, informal groups may be formed to deal with specific issues such as historic preservation, parkland impacts, private sector participation, business disruptions during construction, etc. For example, representatives of the local agency, their consultants, the State Historic Preservation Officer, and other groups interested in historic preservation could meet informally and irregularly concerning impacts on historic properties.

There are several milestones during the course of major investment planning when public and agency involvement is particularly important. Among the milestones where information should be shared and comments requested are:

- Detailed definition of alternatives;
- Methods reports;
- Results of the environmental, patronage, traffic, and financial analyses;
- Results of the capital and operating costs analyses; and
- Evaluation of alternatives.

A plan for informing and involving outside groups should be included in the study scope of work. The plan should identify the techniques to be used as well as the points in the process when public involvement will be solicited. The plan may be flexible, such that it can be modified if some techniques prove to be more effective than others, allowing it to respond to new issues as they emerge.

2 DEFINITION OF ALTERNATIVES

2.1 Introduction

“We must learn to explore all the options and possibilities that confront us in a complex and rapidly changing world.”

- Senator James W. Fulbright, Speech in Senate, March 27, 1964

The selection of the alternatives to be considered in project planning is perhaps the most important activity in the entire effort. Without a set of alternatives that is structured to isolate the differences between options and to highlight the trade-offs inherent in the selection of a preferred alternative, even the highest quality technical analysis cannot produce the full set of information needed by decision-makers.

This guidance gives careful consideration to the development of alternatives to be studied during corridor planning. FTA does not require any specific set of alternatives. Rather, this guidance outlines the steps to be taken (1) in the development of a set of alternatives that respond to the local transportation problem, and (2) in the definition of each alternative to optimize its performance within the limits of its technology and operating characteristics. Following this guidance will help to ensure the development of an appropriate set of transportation alternatives to develop, refine, and evaluate during alternatives analysis. It will also ensure that the alternatives analysis produces an alternative that can serve as the New Starts baseline alternative during project development, if a major transit investment becomes the locally preferred alternative. The guidance further suggests milestones for local and FTA review of the alternatives as they are identified, refined and evaluated.

2.2 Development of Alternatives through a Narrowing of Options

Throughout the planning and project development process – from system planning, through corridor planning and preliminary engineering – the primary nature of the decisions to be made is a narrowing of options toward selection of a specific project. In many cases, decision-makers face initial questions on

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priority corridors, then proceed through the selection of a mode and general alignment, and finally select a set of design standards and a specific alignment.

The planning and project development process is designed around these decisions. It is structured so that the alternatives and the technical work can be focused only on the decision at hand, avoiding unnecessary grappling with issues that are relevant only at later stages. A key part of the planning process is the definition of alternatives only in the detail needed to support decision-making. For decisions on corridor priorities, it is unlikely that the specific location of each station on a guideway alternative is necessary to judge the relative need and potential for improvement in alternative corridors. However, selecting a particular alternative for a corridor requires the evaluation of the cost and the environmental impacts of various station and park/ride options, and consequently, that the stations be defined more specifically.

The technical analysis proceeds from system planning. During system planning, local officials develop and update regional objectives, collect data on regional travel patterns, and project future demographics, land use and travel demand. This effort leads to the identification of current and future transportation problems. Basic planning tools such as regional travel demand forecasting models are developed, revised and refined as part of ongoing system planning. The availability of financial resources is assessed and a range of alternative solutions to the regions problems are examined.

The system planning effort should give adequate consideration to system-wide and regional issues, including:

1. The interdependence of corridors in terms of travel demand, system design, and operations;
2. The feasibility of various mode and alignment combinations in each corridor in terms of engineering, cost, operations, and environmental impacts; and
3. The region-wide financial implications of various investment levels in each corridor.

The system planning effort should recognize the difference between the foregoing of precision and the sacrifice of accuracy in the technical work, so that estimates of costs and impacts, while coarse, are at least approximate indicators of the potential merits of the alternatives. The level of effort must be designed so that additional effort would not result in the choice of a different preferred alternative.

A rigorous system planning effort provides a set of priority corridors and the basis for selecting a small set of alternatives to consider during corridor planning. Without such an effort, the initial phases of alternatives analysis may revert to a reappraisal of system planning issues, redoing much of the

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technical work and delaying the start of corridor planning. Where regional systems are contemplated, a sound system planning effort will have identified considerations beyond the priority corridor and enable the local officials and project staff to avoid alignment and design decisions that preclude future options.

The transition from system planning to project planning does not always proceed along this ideal course. When the system planning effort has dealt with a large number of possible corridors and options, there may have been only limited screening of the mode and alignment possibilities in the corridor ultimately selected for initial project planning efforts. If the remaining screening effort is complex, it may be desirable to do a “transitional” study for the specific purpose of narrowing the range of alternatives for a particular corridor. Where the screening effort is less difficult, it may be carried out as an initial step in project planning. Another situation leading to a sub-optimal sequence is where an alternative is generated outside of the normal planning process. Where a right-of-way becomes available, for example, the idea of reserving it for a transit guideway may be a real but unforeseen option. A transitional study is usually needed in this situation to identify reasonable options for the corridor and get a preliminary indication of the potential merits of investment in a guideway.

The central task in project planning is to identify one or more alternatives that are the most desirable solutions to problems identified in the corridor. Because the analysis will result in the local selection of a preferred alternative, it is necessary to develop reliable information on costs and impacts so that the selection is not affected by errors in the projections. Reasonably detailed analysis of the physical characteristics, operating plans, patronage and revenue implications, and environmental impacts of each option is appropriate.

The alternatives should not be defined in the detail required to advance them into final design and construction, nor to complete the environmental analysis. These tasks are left to preliminary engineering, when detailed specifications for the preferred alternative and the Final EIS are typically developed. Such issues as the specific alignment through downtown (2nd Street versus 3rd Street, for example), may well be resolved in preliminary engineering if they have only minor differences in cost and environmental impact. Unnecessary work may be avoided in project planning with a clear understanding of the difference between issues germane to the selection of an alternative and issues related to its ultimate construction.

In system planning, alternatives are defined only to the level of detail necessary to explore the potential merits of the alternatives in addressing the problems in a corridor. In alternatives analysis, alternatives are defined to the level of detail necessary to support a sufficiently reliable analysis of costs and impacts to support the selection of mode and alignment and a financing plan. In preliminary engineering, alternatives are defined in the detail required to

select the design specifications and operating plan, and to accurately estimate costs in order to obtain the funding commitments required to carry the project into final design and complete the federal environmental process.

2.3 Identifying the Set of Promising Alternatives

Several key principles should be considered to ensure a well-structured set of reasonable alternatives is developed to address identified problems in the corridor.

1) The set of alternatives must address the purpose and need for considering a major transportation investment.

The key principal in the identification of alternatives is that they directly address the stated transportation problem in the corridor. The identification of promising alternatives entails an understanding of the underlying causes of the problems in the corridor, and the potential of particular types of transportation investments to solving those problems.

2) The set of alternatives must include the necessary baseline options.

For studies that will produce an EIS, environmental requirements mandate the consideration of a No-Build alternative as the environmental baseline. Further, any study considering major transit investments must also include an option that optimizes transportation facilities and services in the corridor but stops short of major capital expenditures. This option is called the transportation system management (TSM) alternative, which will usually serve as the basis of comparison during the alternatives analysis and serve as the New Starts baseline alternative during preliminary engineering and final design.

*3) The alternatives should include all **reasonable** modes and alignments.*

This consideration, founded on Council on Environmental Quality regulations (40 CFR Part 1502.14), addresses both the addition and deletion of alternatives. It requires the addition of alternatives that make technical sense in terms of addressing the corridor's transportation problems, even where those alternatives may not be consistent with pre-existing notions on the desired project. Equally important, it provides a basis for excluding alternatives that are simply not appropriate for the setting. Local officials should avoid carrying clearly uncompetitive options through project planning simply because their elimination might be opposed by a few individuals or groups. The postponement of this decision to the end of project planning is unlikely to make it easier, and will increase the time and cost of the analysis. Where sound technical information indicates, and a majority of technical and policy participants agree that an option is undesirable, every effort should be made to eliminate it.

Financial feasibility should be one of the considerations in assessing the reasonableness of an alternative. Where the resources needed to build and

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operate an alternative clearly exceed the amount of funding that can realistically be anticipated, that alternative may be eliminated despite its potential transportation or other merits.

4) Alternatives designed to address differing goals and objectives should be included.

The study area is likely to be composed of a variety of groups and individuals with divergent goals, values, and needs. Some may stress the achievement of mobility goals, while others may emphasize the need for environmental quality of fiscal responsibility. By including alternatives that respond to these different goals, the trade-offs inherent in choosing a preferred alternative that responds to these different goals can be made more explicit, and citizens of varying viewpoints can be brought into the process. Similarly, the corridor is likely to contain a variety of travel markets, such as travel by particular population subgroups, travel within or between specific geographic areas, or travel for particular purposes. No one alternative is likely to serve all of these markets well; so different alternatives should be defined for different travel markets. For example, a rail line with closely spaced stations may be included in corridors with a large number of relatively short trips. A second alternative, perhaps using the same technology and alignment, might be developed with fewer stations to better serve longer distance trips.

5) The set of alternatives should include all options that have a reasonable chance of becoming the locally preferred alternative.

A locally preferred alternative emerges from the evaluation of mode and alignment options in project planning. In cases where an alternative is chosen that is significantly different from any option considered during alternatives analysis, it may be necessary to do additional analysis, and possibly prepare a supplemental DEIS, before proceeding to preliminary engineering. The delay associated with these additional analyses might be avoided if the initial set of alternatives is developed with care. This care extends to the service policies within which the alternatives are defined. For example, if all of the alternatives in the DEIS assume a large system-wide service expansion that increases the operating deficit substantially, the selection of one of the guideway options without the service expansion would require additional analysis since the environmental impacts and cost-effectiveness of the selected alternative may be very different from those of any previously considered option.

6) The alternatives should encompass an appropriate range of options without major gaps in the costs of the alternatives.

The set of alternatives should not include several relatively low cost options, several high cost options, and no intermediate cost alternatives. There are several reasons that this outcome is undesirable. First, it is likely that one or more potentially cost-effective options exist within the gap. Omitting them

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would distort the analysis. Second, the gap limits the flexibility of local decision-makers in choosing an alternative. Third, the exclusion of intermediate-cost options risks a result where no alternative has a significant effect on the problems in the corridor and is financially feasible.

The analysis of shorter (i.e., “minimum operable segment”) options is a ready means of including intermediate-cost alternatives. In alternatives analysis and preliminary engineering, FTA urges consideration of one or more minimum operable segments as separate alternatives to provide flexibility in any full funding negotiations that may follow.

7) Where questions remain on feasibility of specific alternatives, other alternatives should provide related fallback options.

While most questions on feasibility should be resolved before the initiation of project planning, there are cases where alternatives may turn out to be infeasible. In these situations, the set of alternatives should include other options that are derived from the potentially infeasible alternatives but include adjustments that address the source of the potential problem. For example, a busway alternative may lead to a significant increase in the number of buses in the downtown during rush hours and the detailed analysis to establish the capacity of downtown streets to handle the buses will be done during project planning. If it is likely that existing streets do not have sufficient capacity, a second alternative that incorporates dedicated transit lanes or other distribution options should be considered. A second example is uncertainty in the future availability of funds for operations, perhaps where a referendum is needed to expand existing sources of funds. In this case, while some of the alternatives may well exceed the financial capacity of current funding sources, the No-Build alternative and a number of the TSM alternatives should be financially feasible with existing sources of funding.

8) The number of alternatives should be manageable so that decision-makers can realistically be expected to understand the implications of each and make a thoughtful choice.

The number of alternatives can easily reach unmanageable levels when there are a variety of physical and operational elements that can be packaged together in many ways. Testing all the possible combinations and permutations will quickly consume available resources, and may overburden decision-makers with more information than they can comprehend. FTA stresses the analysis of a small set of promising alternatives in order to keep the technical and decision-making process manageable. There is no magic number of alternatives, but experience has shown that the process can become unwieldy when the number of alternatives exceeds ten.

One way to reduce the number of alternatives is to include a screening step early in the process. Clearly inferior combinations can be eliminated without detailed analysis. Another way is to perform a series of sensitivity analyses to

investigate the impacts of changes that may affect several alternatives. By presenting the results of these analyses as variations on a theme, rather than as entirely new alternatives, the number of alternatives can be kept reasonable while still providing decision-makers with necessary and useful information.

2.4 Defining Individual Alternatives

Several key considerations apply to the definition of each alternative. The following considerations can be used to evaluate the adequacy of the alternatives proposed for analysis.

1) The alternatives must, within the limits of their technology, respond to the transportation problems identified in the corridor.

The single most important consideration in the definition of alternatives is that they must address the goals, objectives, and specific transportation problems identified in the corridor. This linkage can be illustrated by examining the likely configuration of a busway alternative in two corridors with very different transportation problems. In one corridor, a strong focus on travel to downtown together with severe peak-direction highway congestion on highway facilities would suggest that a busway alternative be configured to provide one-way service without intermediate stations. In contrast, a corridor with major activity centers outside of downtown and substantial bi-directional highway congestion throughout the corridor would suggest a more elaborate two-way busway with on-line stations.

A target year for the analysis must be chosen as part of the effort to define transportation problems. If too short a planning horizon is used, the project may not be designed with sufficient capacity to accommodate future growth. As the planning horizon is extended, projection of future demographics and traffic congestion levels become increasingly speculative. There is also the question of whether funds should be directed toward solving existing or future problems. A planning horizon of 20 years is used as the primary basis for all alternatives analysis studies and New Starts ratings. This is supplemented with an opening year forecast and ideally with several intermediate year forecasts, often at five-year increments. At local option, other long-range analysis years (beyond 20 years) may be added to the analysis, particularly where the financing strategies are expected to involve longer maturation periods (e.g., a 30-year bond issue).

2) Each alternative should be defined to optimize its performance.

Since different technologies have different strengths and limitations, optimization may lead to alternatives that have different alignments, lengths, and operating plans. For example, in the first corridor used in the previous example, a rail alternative may use a significantly longer alignment to reach a logical terminus point for transfers to feeder buses. Thus the rail alternative would be longer and provide two-way service with intermediate stations while the busway alternative would be relatively short and provide peak-direction

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non-stop service, possibly with High Occupancy Vehicles (HOVs) permitted in addition to buses. The differences between these two alternatives are a direct reflection of the different nature of their basic technologies. These differences do not violate any notions of “comparability” of the alternatives. Indeed, to require the busway in that corridor to mimic the physical and operating characteristics of the rail option would risk a resulting busway alternative that would be significantly less cost-effective than the shorter, one-way facility.

3) The policy and land-use setting in which the alternatives are defined and analyzed must be unbiased and consistent across the alternatives.

Since a primary purpose of the project planning analysis is to select a mode and alignment alternative, it is necessary to hold the policy setting constant so that the impacts of the mode and alignment alternatives can be isolated. Service and fare policies should be defined in broad terms and applied consistently across all alternatives. For example, a fare policy that calls for a \$.25 transfer fare and a \$1.00 fee at park/ride lots means that all alternatives will have these transfer charges and parking fees. If fare policies differed across alternatives, it would be difficult to determine whether an alternative that recovers a higher percentage of costs from the farebox does so because of the operating efficiency and ridership of the alternative, or because it has a different fare structure. Similar considerations exist regarding land use policy. If land use assumptions differ among the alternatives, isolating the effect of the alternatives themselves from the impact of the assumed land use changes would be difficult. Appropriate sensitivity analyses may be included in the study, if desired, to explore the implications of different service, fare, and/or land use policies.

4) The alternative definitions must specify their operating plans, institutional setting, and financing strategy.

In project planning, an alternative is defined in terms of its mode and general alignment as well as its policies, institutions, and financial setting. Table 2-1 identifies these dimensions. Mode is defined to include technology, degree of right-of-way separation, and the operating characteristics of both guideways and feeder services. In addition to the obvious technology differences, alternatives can be different to a very significant extent in their operating policies. Continuing the previous example, the one-way HOV-way would be a distinct alternative from a two-way facility limited to buses only.

General alignment is defined to include the approximate horizontal and vertical alignment, approximate station locations, and length. Thus, major shifts in horizontal alignment, large variations in the lengths of segments with different vertical alignments, significant changes in overall station spacing, and major increments in the length of the facility, would lead to separate alternatives. Some of these variations are less obvious than others, but can lead to

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substantial differences in the alternatives that have caused past studies to expand the set of alternatives fairly late in the effort.

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Table 2-1: Dimensions for Defining Alternatives

Dimension	Characteristics	Options
Mode	<ol style="list-style-type: none"> 1. Technology 2. Degree of right-of-way separation 3. Operating characteristics 	<ul style="list-style-type: none"> ➤ Bus ➤ Rail ➤ Highway ➤ Etc. ➤ Mixed Traffic ➤ Separation except at intersections ➤ Exclusive right-of-way ➤ Local vs. express ➤ Stations vs. no-stop ➤ Integrated feeders vs. transfers ➤ Number of lanes/tracks ➤ Etc.
General alignment	<ol style="list-style-type: none"> 1. Horizontal 2. Vertical 3. Station locations 4. Length 	<ul style="list-style-type: none"> ➤ Streets ➤ Medians ➤ Rights-of-way ➤ Elevated ➤ At-grade ➤ Open cut ➤ Subway ➤ Parking ➤ Intermodal connections ➤ Alternative terminus locations
Policies	<ol style="list-style-type: none"> 1. Operations 2. Fares 	<ul style="list-style-type: none"> ➤ Service standards ➤ Loading standards ➤ Etc. ➤ Flat ➤ Zone ➤ Distance-based ➤ Transfer charges ➤ Parking fees
Institutional arrangements	<ol style="list-style-type: none"> 1. Legislative authorities 2. Labor agreements 3. Private sector participation 	<ul style="list-style-type: none"> ➤ Existing/new agencies ➤ Legislative changes ➤ Existing/new agreements ➤ Design-build arrangements ➤ Contracting out
Financing strategy	<ol style="list-style-type: none"> 1. Capital financing 2. Operating funding 	<ul style="list-style-type: none"> ➤ Pay as you go ➤ Debt ➤ Funding partners ➤ Farebox recovery ➤ Public subsidies

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The institutional setting for project implementation and operation also needs to be defined for each mode and alignment alternative. Institutional factors include the roles and responsibilities of public agencies, the need for new legislative authorities, labor agreements, and the role of the private sector. For the purpose of evaluating mode and alignment alternatives, the institutional setting should be unbiased and consistent across all alternatives. However, there may be a need to consider optional institutional arrangements, and one or more additional alternatives may need to be defined to explore these options. The project planning study may include two alternatives that are identical in terms of mode and alignment, but have different public or private entities responsible for project implementation or operation, or that have different assumptions regarding labor agreements.

While financing plans are not settled during planning, the financing strategy should reflect hard thinking about the potential sources of funding available to provide the local share of project costs. Transit alternatives can be financed through a range of strategies including one or a combination of pay-as-you-go, debt, leasing, intergovernmental grants, and private sector participation. The analysis of optional financing strategies must be performed in such a way that it does not bias the analysis of mode and alignment alternatives, or introduce a large number of new alternatives to be carried through the study. The use of carefully designed sensitivity analyses or special studies may be the most practical approach. Once a financing strategy or combination of strategies has been identified, revenue forecasts for each source should be prepared, the steps required to secure funding commitments from each source should be documented, and an assessment of the likelihood that the source will be available for this project should be provided (see Part II Section 8 *Financial Planning for Transit*).

The dimensions noted above are not necessarily independent of one another. In some urban areas, for example, public agencies have been established with the authority to implement only certain transportation technologies. The need to consider new institutions or legislation would depend upon the range of reasonable alternatives in the corridor. There is also a strong linkage between the alignment and financing options. New financial strategies may be needed if one technology or alignment alternative costs more than another. An agency's ability to finance a portion of a project with joint development revenues may depend upon finding a suitable alignment and station locations. These interrelationships should surface during the project planning phase to ensure that a coordinated package, covering all dimensions, emerges from the study.

5) The alternatives should be designed from the start with environmental considerations in mind.

Certain environmental statutes and executive orders mandate the avoidance of parks, historic sites, wetlands, floodplains, etc., except under specific

conditions. These requirements must be continually considered and reconsidered as candidate alignments and potential station locations are being identified.

In other cases, proper sensitivity to community concerns may suggest that a particular mode and alignment is unreasonable. For example, a rail alignment should not be drawn through a noise-sensitive neighborhood, such as university campus, if it is known that disruptive levels of noise will result. Similarly, a station oriented for feeder bus and park-and-ride access might be unacceptable in a neighborhood with limited street capacity.

Many environmental concerns cannot be taken into account at the early stage of development of the alternatives. A detailed analysis that quantifies the impacts and the costs of avoidance or mitigation may be needed before the alignment is adjusted or other refinements are made to minimize adverse impacts. Such detailed analysis may not occur until preliminary engineering. Nevertheless, as the alternatives advance from the conceptual stage to the final detailed description in project planning, the relevant environmental issues should be considered in refining the alternatives at a level of detail commensurate with the detail of the alternatives.

6) The mode and alignment alternatives must be significantly different.

Judgment and preliminary analysis are needed to determine whether the possible variations in the definition of an alternative should be treated as separate alternatives. For example, where two horizontal alignment options are available for a relative short segment of a particular alternative, preliminary cost estimates and an environmental review might be useful in determining how these options should be included in the alternatives. If the alignments are not likely to be significantly different in cost, ridership, or environmental effect, they might be treated as simple design variations that can be resolved in preliminary engineering. Alternatively, significant differences between the alternatives, where the more costly options also appear to have greater benefits would suggest that the two alignments should be treated as separate, major alternatives. Finally, a large difference between alignments, where higher costs or significant environmental impacts are not accompanied by higher benefits, might suggest that the more expensive or intrusive option be eliminated.

2.5 Issues in the Development of Alternatives

Although the definition of alternatives is determined largely by local conditions and local goals and objectives, there are a number of issues commonly encountered in defining and developing the alternatives. These include the nature of the No-Build and Transportation System Management (TSM) alternatives, and the approach to developing operating plans for guideway alternatives that optimize their performance.

2.5.1 The No-Build Alternative

The No-Build alternative provides the baseline for establishing the environmental impacts of the alternatives, the financial condition of the transit operator, and the cost-effectiveness of the TSM alternative. It also establishes much of the information needed for the DEIS Chapter 1 on Purpose and Need since it examines horizon year travel demand and its impact on a largely unimproved transportation system. This alternative is defined to include those transportation facilities and services that are likely to exist in the forecast year. All elements of the No-Build alternative must be part of each of the other alternatives except where an alternative replaces services or facilities inside the corridor.

To provide a basis of comparison in the EIS that preserves the NEPA requirements to evaluate all federal actions with a significant potential impact on the social, economic or physical environment, the No-Build alternative must include the following features:

- The maintenance of existing facilities and services in the study corridor and region;
- The completion and maintenance of committed projects in the study corridor that have successfully completed their environmental review; and
- The continuation of existing transportation policies.

Within these guidelines, there are two possible definitions of the No-Build option outside the study corridor. Choice among these is determined by the local situation, particularly the degree of certainty that other transportation improvements will be made between now and the horizon year. The possible definitions include:

1. An alternative that incorporates “planned” improvements that are included in the fiscally constrained long-range plan for which need, commitment, financing, and public and political support are identified and may reasonably expected to be implemented.
2. A conservative definition that adds only “committed” improvements – typically those in the annual element of the Transportation Improvement Program or local capital programs – together with minor transit service expansions and/or adjustments that reflect a continuation of existing service policies into newly developed areas. In some metropolitan areas with severe financial constraints, this definition may involve no improvements to transportation facilities or transit services in the corridor beyond routine maintenance and replacement.

The first definition is the typical definition of the No-Build alternative, but it does entail some risk in that the inclusion of “planned” improvements may

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lead to a set of alternatives that incorporate projects that may not happen. The second option recognizes whatever improvements are essentially certain to occur because they are simply incremental responses to growth in the corridor and have been programmed by the region.

The No-Build alternative should generally maintain the current transit operating strategy with a growth in service commensurate with forecast population and employment growth. New bus routes may be added and existing bus routes extended, but the underlying strategy should remain the same. For example, if the current bus system is oriented toward providing radial service to the CBD, that same strategy should be assumed in the No-Build alternative. Changing that strategy to a grid pattern might be considered as part of the TSM alternative. The No-Build alternative can then serve as a basis for evaluating the costs and benefits of a revised operating strategy.

2.5.2 The TSM Alternative(s)

Compared with a fixed guideway investment, transportation system management alternatives are relatively low cost approaches to addressing transportation problems in the corridor. The TSM alternatives provide an appropriate baseline against which all of the major investment alternatives are evaluated. The most cost-effective TSM alternative generally serves as the baseline against which the proposed guideway alternative is compared during the New Starts rating and evaluation process that begins when the project applies to enter preliminary engineering continuing through final design.

The TSM alternative represents the best that can be done for mobility without constructing a new transit guideway. Generally, the TSM alternative emphasizes upgrades in transit service through operational and small physical improvements, plus selected highway upgrades through intersection improvements, minor widenings, and other focused traffic engineering actions. A TSM alternative normally includes such features as bus route restructuring, shortened bus headways, expanded use of articulated buses, reserved bus lanes, contra-flow lanes for buses and HOVs on freeways, special bus ramps on freeways, expanded park/ride facilities, express and limited-stop service, signalization improvements, and timed-transfer operations. Outside the study corridor, the TSM should have the same transit network as the no-build alternative. While the scale of these improvements is generally modest, TSM alternatives may cost tens of millions of dollars when guideway alternatives range up to several hundreds of millions or billions of dollars.

Given the crucial role of the TSM alternative as both a realistic near-term package of improvements and a rational baseline for evaluation of the guideway investments, it deserves significant attention in its definition and refinement. In many respects, the TSM alternative is the most difficult alternative to define and develop. The potential components of the alternative are many and varied, and tend to be small in scale and widely distributed in location. The cumulative contribution of the individual actions can be hard to

measure and translate into changes in travel patterns. Most importantly, since the TSM alternative is designed to represent the “best” that can be done without major new capacity improvements, a wide variety of possible actions need to be sifted to identify a package that approximates an optimum mix. This sifting often leads to several iterations on the definition of the TSM alternative as components are added and deleted during alternatives analysis. In many cases, this iterative process provides a means of sorting out questions on appropriate region-wide transit service levels and fare structure. The results of this analysis provide a sound basis on which to develop the operating plans for the guideway alternatives.

As TSM alternatives are defined, four issues often arise: the treatment of demand management strategies, the feasibility of some TSM strategies, the assumed highway network, and the number of TSM alternatives that should be studied. These issues are discussed in the following sections.

2.5.2.1 Demand Management

Non-capital actions such as staggered work hours, road pricing, parking management, transportation management organizations, employer-based ridesharing incentives, and so forth may have an impact on the use of all transit alternatives. As such, TSM alternatives may include demand management strategies. The analysis of such strategies might be treated as a special study that looks at the applicability of demand management techniques, their potential benefits, and institutional considerations.

2.5.2.2 Technical vs. Political Feasibility

Technical considerations are the primary determinant of feasibility during alternatives analysis. Technical reasons for judging an option infeasible include operational difficulties, high costs relative to expected benefits, and environmental impacts that exceed standards or guidelines. Where local officials view a technically feasible option as politically unacceptable, it may again be useful to include two TSM alternatives in the analysis: one option that includes only those actions judged to be politically feasible, and a second with all technically feasible options. This approach recognizes local policy positions, provides a fair baseline for comparing projects, and permits the project staff and local decision-makers to consider the merits of the actions thought to be politically infeasible with an eye toward their potential merits.

2.5.2.3 Highway Network Assumption

The technical analyses performed during transit project planning try to isolate the costs and benefits of the various alternatives. To meet this objective, the same background highway network is generally assumed for the TSM and other build alternatives. If the fiscally constrained long-range plan provides a set of projects that may be reasonably expected to be implemented, the adopted long-range plan provides a solid basis for the highway network assumptions outside the study corridor. This may not be realistic if there is a significant risk that the cost of the long-range plan could exceed funding availability.

2.5.2.4

Number of TSM Alternatives

Ideally, a single TSM alternative can be agreed upon that represents a comprehensive program of sound, low-cost actions for addressing identified transportation problems. However, there are situations in which more than one TSM alternative is necessary. Some examples follow:

1) The long-range plan may include a major effort to upgrade highways throughout the region, but the funding schedule for this effort is uncertain. The use of two TSM alternatives that differ in their level of highway improvements can be useful in recognizing the uncertainty, determining the interdependence between transit and highway improvements, and possibly setting priorities for the highway upgrades.

2) The optimal operating plan for the TSM alternative may be unclear. One project planning study, for example, was evaluating extensions to a light rail line that ended just a few miles outside downtown. Two bus operating plans were developed for the TSM alternative: one with buses feeding the light rail terminal, the other with buses running all the way downtown. Two TSM alternatives allow for an explicit recognition of the advantages and disadvantages of each operating plan in terms of costs, transit service levels and ridership.

3) There may be legitimate questions regarding the feasibility – operational, political, or financial – of some elements of the TSM alternative. Analysis to assess the feasibility of contra-flow lanes on a freeway that is presently uncongested in the off-peak direction may be required. An expanded bus fleet may require financial resources that are not presently available. In such cases, advancing two or more TSM alternatives may be the best way to answer legitimate questions and keep the analysis process moving forward.

2.5.3

The Fixed Guideway Transit Alternative(s)

No guidance can substitute for the informed judgment of local analysts in the development of guideway alternatives, but past experience leads to several comments and cautions on the development of realistic alternatives.

2.5.3.1

Relationship to the TSM Operating Plan

The operating plans for the guideway alternatives typically are derived from the optimized plan developed for the TSM option. This approach is the best way to ensure a feeder and background bus system that is compatible with the guideway but is also consistent with the overall operating policies governing all of the alternatives. The approach requires a two-step analysis for each guideway alternative. First, the guideway is overlaid on the TSM operating plan. Second, adjustments are made in bus routings to eliminate unnecessary parallel service and to integrate the bus service for possible headway shortening to meet any anticipated increase in volumes.

2.5.3.2 Parallel Bus Services

A trade-off may exist between the desires to integrate on- and off-guideway services. At higher levels of integration, the operating efficiency in the corridor approaches its maximum, usually accompanied by degradation in service levels for some travel markets. For example, a guideway with fairly long station spacing may not provide good service to short trips. Also, areas on the fringe of the corridor with direct express service to the downtown may be less well served if the bus routes are converted into feeders that require a more circuitous route to downtown. These and other markets facing potentially lower service levels warrant particular attention in the development of the alternative. Careful analysis of the implications for service levels and operating efficiencies should precede final selection of the operating plan.

2.5.3.3 Guideway Operations

One of the most difficult aspects in the development of sound guideway alternatives is the selection of an operating plan that optimizes the performance of the alternative. The wide variety of operating possibilities, plus the range of possible TSM improvements that can be incorporated into the guideway alternatives, present a broad array of options. The challenge in this regard is particularly evident for bus/HOV facilities that have a myriad of operational possibilities: one-way vs. two-way service, on-line stations vs. no stations, HOVs vs. bus-only, integrated collector/line-haul service vs. forced transfers from feeders, and so forth. Compounding the challenge, a mix of operations – some express and some “all-stops” services on the busway – is often the optimal operation.

One useful approach to sorting out the various options is to reserve the analysis of busway alternatives until after the analysis of operating plans for rail alternatives (if rail alternatives are being considered). Examination of the transit trip tables and station volumes for the rail options can help distinguish between high volume travel markets in the corridor that may warrant integrated express service on the busway, and lower volume markets that are more appropriately served by feeder services into stations on the busway. This approach can minimize the number of adjustments to the initial operating plan needed to produce a final plan that serves travel demand in the corridor. Where no rail alternatives are being considered, an initial operating plan can be assumed to provide both an “all-stops” service on the busway and integrated feeder/line-haul service from all residential areas to major activity centers in the corridor. This over-supplied operation can then be scaled back in a subsequent iteration to match supply and demand levels.

2.5.3.4 Park/ride Facilities

The success of transit improvements in a corridor depends, in large part, on the accessibility of new guideways to potential transit riders. The level of feeder bus services and the capacity of park/ride lots are key aspects of the alternatives that must be carefully developed. There is usually a trade-off between the bus- and auto-access opportunities. Existing transit guideways show a wide range in the mix of access modes used by their riders. Some have

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very little feeder bus service but attract fairly heavy ridership through walk access or park/ride and kiss/ride access. More commonly, large shares of guideway riders use feeder buses to access the guideway service. The potential trade-offs among ridership attraction, the availability of space for park/ride facilities, and the cost of operating feeder bus services require careful attention during project planning, possibly including a sensitivity analysis of ridership and costs with different access strategies.

Many travel demand models used to estimate patronage for guideway facilities have no automated way to recognize capacity constraints on parking at park/ride stations. Thus, one necessary step in the development of the operating plans is to determine whether the predicted (unconstrained) demand for parking at stations allocated to other park/ride lots, to other access modes, and/or to non-transit travel.

2.5.3.5 **Guideway Design Standards**

There are no widely accepted design standards or specifications upon which to base conceptual engineering project costing. For rail projects, each system ultimately develops its own standards and specifications by drawing upon the work of previous systems and revising it to reflect local conditions. Planning studies assume a set of standards that are representative of operating projects elsewhere in the country and/or the world. These cover such matters as minimum clearances, geometrics, signal systems, and vehicle size and performance (see Exhibit 2-1 and Exhibit 2-2). FTA takes a flexible position on the design standards used in individual studies, provided that the standards proposed for use are proven safe and effective in actual application, and that they are consistent with assumed performance characteristics.

Design standards for busways and HOV lanes have been issued by the American Association of State Highway and Transportation Officials (AASHTO) in the Guide for the Design of High Occupancy Vehicle Facilities (1992)¹. To the extent that the standards proposed for use in a particular situation have been proven safe and effective, FTA will agree to a standard less than that advocated by AASHTO. FTA may even advocate the use of different standards as a cost saving measure. Design standards that have not previously been used may also be acceptable if supported by adequate research.

¹ Another relevant AASHTO guide is the Guide for the Design of Park-and-Ride Facilities (1992).

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Exhibit 2-1: Sample Line Items in Busway Design Specification

[Specifications are presented for each environment: at grade, elevated, tunnel, highway median, on-street, busway stations, access ramps, etc.]

1. Cross-sections
 - lane width
 - shoulder width
 - median
 - drainage control
 - minimum total width (shoulder-to-shoulder/curb-to-curb)
2. Minimum clearances
 - vertical clearances for over-crossings and under-crossings
 - lateral clearances
3. Geometrics
 - design speed
 - horizontal curves
 - minimum radius
 - desirable radius
 - curb radius at intersections
 - vertical curves
 - sag K value
 - crest K value
 - maximum grade
4. Pavement loading standards
5. Vehicles
 - dimensions
 - performance
 - rates of acceleration and deceleration
 - cruising speed
 - passenger capacity: seated plus standing at stated loading standards
6. Fare collection methods
7. Passenger stations
 - platforms
 - access provisions: bus, park n' ride, kiss n' ride

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Exhibit 2-2: Sample Line Items in Rail Design Specification

[Specifications are presented for each environment: at-grade, elevated, tunnel, highway median, on-street, stations, yards etc.]

1. Cross-sections
 - track centers
 - drainage control
 - minimum total width
 - trackwork: direct fixation, ballast, rail, ties, fasteners, turnouts, cross-overs
2. Minimum clearances
 - vertical clearances for over-crossings and under-crossings
 - lateral clearances
3. Geometrics
 - design speed
 - horizontal curves: minimum and desirable radii (degree of curvature?)
 - vertical curves: minimum and desirable radii
 - superelevation and spirals
 - grades
4. Electrification
 - overhead or third rail
 - power substations
5. Signals
 - unsignaled, way signals or cab signals
 - automatic block signaling / centralized train control (commuter rail)
 - automatic train control / communications based train control (rapid rail)
 - street and highway crossing signals and protection
6. Vehicles
 - dimensions
 - performance: acceleration, deceleration, cruising speed
 - passenger capacity: seated plus standing at stated loading standards
7. Fare collection methods
8. Passenger stations
 - platforms
 - access provisions: bus, park n' ride, kiss n' ride

2.5.3.6 Vehicle Loading Standards

Project planning studies often entail comparisons between alternatives with different types and sizes of vehicles. To maintain comparability, consistent vehicle loading standards are used for all alternatives. Headways are set such that, during peak periods, all seats are filled at the maximum load point. To the extent that standees are anticipated, each alternative is designed to provide the same amount of space per standee. The loading standard may be expressed in terms of square feet of standing area (floor area of the vehicle less seating area) per standee.

Questions sometimes arise about whether the loading standards might vary with the type of service (such as local and express) or operating environment (reserved lanes or mixed traffic). Some states, for example, require seated loads on express buses operating on freeways. Different loading standards may be appropriate in such situations provided they are expressed in terms of a regional policy that is consistently applied to all alternatives. The analyst should consider the degree of bias this may introduce into the analysis.

2.5.4 Highway Alternatives

Although transit project planning studies are often undertaken with an eye toward various transit solutions, the transportation problems being addressed are frequently highway problems, such as peak hour traffic congestion. Therefore, highway solutions as well transit solutions may warrant analysis. There may or may not be highway projects that are already being contemplated by the responsible highway agencies.

Where major highway alternatives are contemplated in the corridor, highway and transit corridor studies should be merged or, at a minimum, closely coordinated such that the relative merits and interrelationships of highway and transit options can be explored in the analysis using a consistent set of methods and assumptions. Even if highway improvements are not being contemplated, the initial screening of alternatives should consider the potential for highway solutions to identified problems.

Multi-modal corridor studies can be complicated both technically and institutionally. Technical complications arise from the fact that multi-modal studies have two objectives: to compare highway alternatives with each other, and to compare highway alternatives with transit alternatives. A large number of possible combinations may need to be tested to isolate all of the relevant costs, benefits, and interactions between alternatives. Table 2-2 shows how one project planning study structured its set of alternatives to address the possible highway and transit combinations. Note that the alternatives allow for a comparison of the transit alternatives' relative costs and benefits, keeping the highway network constant, as well as comparisons among highway alternatives and between transit and highways.

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Table 2-2: Example of Multimodal Set of Alternatives

Alternative	Key Components	
	Highway	Transit
1. No Build	Current TIP including completion of Interstate System in Salt Lake area	UTA short range plan and financially attainable service plan to 2010
2. TSM (rehab I-15) - Best bus	Minor operational and safety improvements and rehabilitation of I-15	Expand bus routes to optimize corridor transit service to the urban area for 2010
3. One lane - Best bus	Add one general-purpose lane in each direction to I-15 (in median); selected interchange additions and reconstruction; local street improvement; rehabilitation of I-15; improvements to 2100 South interchange.	Same as Alternative 2
4. Two lanes - Best bus	Add two general-purpose lanes in each direction (one in median, one on outside); selected interchange additions and reconstruction; local street improvement; rehabilitation of I-15; improvements to 2100 South interchange.	Same as Alternative 2
5. One lane plus reversible HOV - Best bus	Same as Alternative 4, except median is reversible HOV lane	Same as Alternative 2
6. One lane plus one HOV - Best bus	Same as Alternative 4, except median lanes are HOV lanes	Same as Alternative 2
7. Highway TSM - UPRR LRT loop	Same as Alternative 2	Light rail on UPRR ROW from 10600 South to CBD with CBD loop
8. Highway TSM - State/main LRT loop	Same as Alternative 2	Light rail on State Street from 10600 South to 4500 South, then transition to Main Street to CBD with CBD loop
9. One lane - UPRR LRT Depot	Same as Alternative 3	Light rail on UPRR ROW from 10600 South to CBD with terminus at Union Station Depot
10. One lane - UPRR LRT Main	Same as Alternative 3	Light rail on UPRR ROW from 10600 South to CBD with terminus on Main Street at South Temple
11. One lane - UPRR LRT loop	Same as Alternative 3	Light rail on UPRR ROW from 10600 South to CBD with terminus a one way loop on 400 South, 200 East, South Temple and West Temple
12. One lane - State/Main LRT loop	Same as Alternative 3	Same as Alternative 8
13. Two lanes - UPRR LRT loop	Same as Alternative 4	Same as Alternative 7
14. Two lanes - State/Main LRT loop	Same as Alternative 4	Same as Alternative 8

2.6 Documentation of the Alternatives

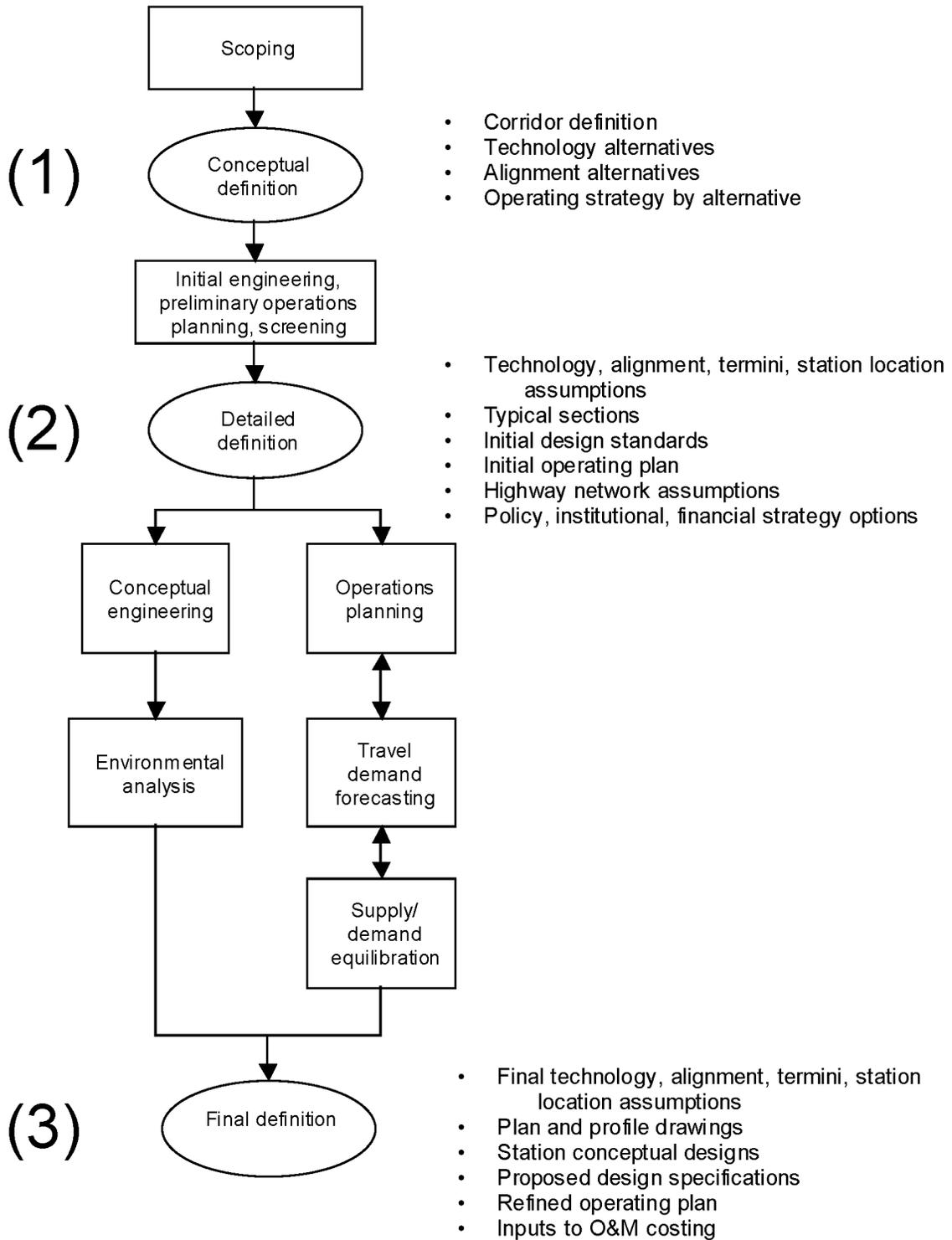
Because of the importance of the careful development of alternatives, an iterative approach with three distinct review points should be used to define alternatives. Exhibit 2-3 summarizes the process that begins with a “conceptual” definition of the alternatives, produces a “detailed” definition that forms the basis for the heart of the technical work, and concludes with a “final” definition that may be summarized in the DEIS. Written documentation of the alternatives is developed at each of the three stages during alternatives analysis.

2.6.1.1 Conceptual Definition

The conceptual definitions of the alternatives are ideally produced in system planning and then reviewed in the early scoping activities during project planning. For each alternative, the conceptual definition includes the preliminary identification of candidate alignments and operating strategies. The operating strategies – as distinct from operating plans developed as planning and project development proceeds – give general ideas of overall bus service levels, service standards, and guideway service options. These definitions are sufficient to address such general concerns as ranges of costs, ridership potential, likely cost-effectiveness, and financial feasibility. They also serve in the initial scoping process to identify the range of options to be considered and to shape the technical work scope.

The subsequent preliminary analysis is focused on narrowing the range of alternatives to a manageable number to carry forward in the detailed analysis. The preliminary analysis may be quite brief or very involved, depending on the complexity of the corridor, the variety of options, and the amount of preliminary screening done during system planning. This analysis employs coarse criteria to sort among the various alignment and operating options, and to develop preliminary definitions of alignments, standards, and operations. This preliminary analysis may begin with a screening effort to sort out the broader issues before work begins on the preliminary specifications and operating plans where large numbers of options remain (often because the prior system planning effort left many system-level issues unresolved).

Exhibit 2-3: Steps in the Development of Alternatives



2.6.1.2 Detailed Definition

The detailed descriptions provide sufficient information for each of the technical disciplines to begin detailed analysis. The engineering and environmental teams are given specific guidance regarding the horizontal and vertical alignments, station locations, typical sections and stations, vehicle loading standards, and initial specifications. At this stage, reference is made to design standards developed by the local transit operator, the State highway agency, AASHTO, APTA, and other sources. Close coordination is necessary between the development of the detailed definition of the alternatives and the capital costing methodology. The definitions provide a description of the standards and design criteria to be used while the capital cost methodology depicts specific cross-sections for segments of the alignment and identify the outlines of the physical items typically covered in the specifications documented in the detailed definition of the alternatives.

The detailed definition of alternatives report describes the transit service currently in the corridor and describes the service levels, operating plans and policies for each alternative in the opening and forecast years. The operating plans describe routing, locations of stations or stops (or average stop spacing), peak and off-peak headways, and peak and off-peak speeds for each bus and/or rail route, including the feeder system. The operating plans should be described in sufficient detail to permit a careful review by participating technical staff and to permit the demand forecasting team to code the transit network for each alternative. Important operating policies include peak and off-peak fares, loading standards, parking charges at park/ride lots in the corridor, and the supply and/or price of CBD parking (if applicable).

Policy options, institutional arrangements, and financial strategies should also be described, providing input to the relevant technical analyses. For example, the detailed definition of alternatives report should identify any travel demand management options to be considered in the service and patronage analysis. Where land-use options are to be evaluated, the report would describe these options in terms of possible differences in the location and scale of new development, to guide the associated ridership, environmental, and financial analyses. As appropriate, the report should also identify the different institutional arrangements and financial strategies to be evaluated in the study. The report should be written in such a way that the reader could appreciate the interrelationships among decisions on the mode, alignment, service and other policies, institutional arrangements, and financing options to be considered.

2.6.1.3 Final Definition

The final definitions of the alternatives consists of the plan and profile drawings, cross-section drawings for various line segments, conceptual drawing of stations and park/ride lots, and proposed specifications developed in the conceptual engineering effort. In addition to the finer detail provided in these materials, the final definitions may also differ from the detailed

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definitions because of changes made in response to cost, operational and environmental considerations. The design specifications are labeled “proposed” because, while providing the basis for the cost estimates, they are subject to further refinement in preliminary engineering.

The final operating plans are likely to differ from the initial plans provided as part of the detailed definition. The final definition reflects the equilibration of transit service levels with travel demand. To the extent that the initial plans anticipated ridership levels accurately, there may be little revision needed to produce the final operating plans.

To document the equilibration process, the final definition of alternatives report should include, for each alternative, and for both the design year and the opening year, tables showing the following:

- each route’s initial headway assumption;
- the initial peak hour peak direction volume (at peak load point);
- the revised headway assumption;
- the final peak hour peak direction volume;
- the resulting peak hour vehicle loadings;
- weekday vehicle miles and hours for each route; and
- the adopted vehicle loading standards.

The final definition of alternatives report also presents inputs to the capital costing and operating and maintenance (O&M) costing tasks. In addition to the plan and profile drawings, the capital costing inputs include the maintenance facility needs and vehicle requirements for each alternative. Information on the service variables to be used for O&M costing is likely to include vehicle-hours, vehicle-miles, and peak vehicles.

2.7 The New Starts Baseline

If the alternatives analysis results in a the locally preferred alternative that is a fixed guideway transit project and will be seeking federal New Starts funding, the FTA must approve or deny entry into preliminary engineering and final design as well as rate and evaluate the proposed New Starts project for the annual (and supplemental) New Starts report. The rating process is crucial to the recommendation of New Starts projects for funding.

FTA requires that the proposed project be evaluated against a “baseline alternative.” The baseline alternative establishes a basis of comparison for project evaluation and provides a consistent framework for estimating the relative merits of proposed projects during project development.

The baseline alternative is drawn from the alternatives defined during alternatives analysis. In almost every case, the best TSM alternative will serve as the New Starts baseline. FTA will approve the choice of a baseline alternative to serve as the basis of comparison for the New Starts project justification measures before a project is allowed to enter preliminary engineering. If alternatives analysis is completed without developing an acceptable New Starts baseline alternative, significant (and avoidable) new work will need to be undertaken before entering preliminary engineering to develop an acceptable New Starts baseline alternative.

2.7.1 Basis of Comparison

A project cannot be evaluated simply by examining the results of a transportation system improvement in isolation. The purpose of the baseline alternative during project development is to provide a basis of comparison to isolate the costs and benefits of the proposed major transit investment relative to what would occur without the investment. Project staff and decision-makers should be interested in the changes brought about by the project. The build alternatives and the baseline alternative are developed to determine these changes.

In response to FTA's legislated responsibilities, a series of project justification measures have been developed to facilitate the national comparison of the relative merits of the proposed New Starts projects. These measures include mobility improvements, cost-effectiveness, environmental benefits, operating efficiencies, transit supportive land use, and other factors and have been explained in detail in other guidance.² Aside from the land use measure and other factors, all of the project justification measures are evaluated based on changes relative to the New Starts baseline alternative.

2.7.2 Consistent Treatment of Projects

The intent of the New Starts evaluation and rating process is to provide Congress, the Administration and other interested parties, information about the relative merits of each proposed New Starts project. Toward that end, FTA must have measures that are based on a fair evaluation of the relative merits of each project and do not penalize projects for good planning practices.

In corridors with minimal existing transit service, a project sponsor may be able to achieve most of the benefits of the proposed rail project with relatively low-cost upgrades to the existing bus service. Proposed projects in corridors with extensive existing transit service would be at an unfair disadvantage if the baseline alternative used to develop New Starts evaluation measures were simply the existing service levels. For instance, a corridor with no transit service that implements a rail system will generate more incremental user benefits than if extensive express bus service were already provided in the

² *Reporting Instructions for the Section 5309 New Starts Criteria*, Federal Transit Administration, US Department of Transportation, published annually.

corridor. In effect, project sponsors who have implemented high quality transit services would be penalized for providing that service when competing for federal funding.

FTA maintains that project sponsors will not be allowed to attribute benefits to a proposed major capital investment that could be achieved with low-cost improvements to the transportation system. By requiring a baseline alternative that includes those low-cost improvements, FTA's New Starts ratings are based on the benefits that are provided only by the proposed project that could not be derived from other low-cost improvements.

2.7.3 Definition of the New Starts Baseline

The features of an acceptable baseline alternative are the defining characteristics of the TSM alternative developed during alternatives analysis. FTA has long standing procedures that specify that the TSM alternative is the basis of comparison when conducting an alternatives analysis and for calculating project justification measures during the New Starts ratings process. This practice has not changed.

The new Rule for Major Capital Investments (49 CFR Part 611) stipulates that grantees will be required to carry forward one baseline alternative and the build alternative after entering preliminary engineering *for the purpose of reporting New Starts project justification measures*. The baseline alternative will be the TSM alternative developed during the alternatives analysis unless all elements of a solid TSM alternative already exist in the No-Build alternative or the TSM alternative is technically infeasible.

Some projects have no obvious TSM alternative. A prime example would be the double tracking of a single-track rail transit line. There are no obvious lower cost alternatives to that proposed project other than the No-Build alternative. Similarly, projects meant to upgrade, improve or repair existing fixed guideway service will usually use the No-Build alternative as the baseline. These examples highlight the need for alternatives to respond directly to the transportation problem rather than carrying forward alternatives that do not make sense.

Project sponsors in certain metropolitan areas with high quality existing and/or planned transit service may also be able to use the No-Build as the baseline alternative. If all or most of the improvements that would conceivably be contained in a TSM alternative are already constructed or are planned and have completed their FEIS, the No-Build could serve as the baseline alternative. FTA expects that only a small number of project sponsors from areas with well established high quality transit services would find that their No-Build is a suitable baseline alternative. An example would be a fixed guideway project proposed to serve a corridor with an existing dedicated express bus service that simply does not have the capacity to serve the transit demand. Under this scenario, the project sponsor is already doing everything possible to solve the transportation system in the corridor, without

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the major capital investment. To prove that the TSM is a redundant alternative, the project sponsor must clearly demonstrate, as a result of the alternatives analysis, that the best possible TSM is not materially different from the No-Build alternative.³ If solid evidence to this effect is presented, the FTA will approve the use of the No-Build alternative as the baseline.

In all other cases, additional cost-effective transit improvements can be made beyond those already on the ground or those to be built in the near future and the baseline will be the TSM alternative developed during alternatives analysis. FTA expects the vast majority of project sponsors will carry the TSM alternative forward as the New Starts baseline.

2.7.3.1 **New Starts Baseline vs. NEPA Baseline**

The No-Build alternative will continue to serve as the NEPA baseline alternative for the Draft and Final EIS's. A corridor study completed according to accepted planning principles would result in a set of alternatives that can be directly applied during project development. There are two possible scenarios for baseline alternatives used in the environmental planning documents (DEIS/FEIS) and for the New Starts project rating process. These are:

- 1) If a project sponsor completes alternatives analysis and the TSM alternative is accepted by FTA as the baseline for the New Starts rating process, the No-Build alternative must be carried forward as the baseline for the Environmental Impact Statement(s). This scenario results in three alternatives carried forward into preliminary engineering: the No-Build as the NEPA baseline, the TSM as the New Starts baseline, and the build alternative.
- 2) If a project sponsor completes alternatives analysis and the No-Build alternative is accepted by FTA as the baseline for the New Starts rating process, the project sponsor may carry forward two alternatives: the No-Build as the NEPA and New Starts baseline and the build alternative.

FTA expects that most project sponsors will fall under scenario 1.

³ In practice, the project sponsor would report FTA's New Start evaluation measures comparing the build alternative to both the No-Build and the TSM and demonstrating that the differences in the measures are insignificant.

4. Operating and Maintenance Costs

The projection of operating and maintenance (O&M) costs is an important part of the planning of New Starts projects. The projections of O&M costs are important for two reasons:

- **Cost Effectiveness Measures.** The projection of design-year O&M costs is a critical input to the determination of the New Starts measures of cost effectiveness.
- **Financial Planning.** The projections of annual O&M costs are vital to the development of financial plans that cover multiple years of construction and operation of the New Starts projects.

O&M costing approaches should be developed and applied to meet the needs of the New Starts analyses. The FTA has two general requirements for O&M costing. First, the approaches used for O&M costing should be consistent with best industry practice. The approaches should reflect the best of the “state-of-the-practice” and need not make advances to the “state-of-the art.” Second, the O&M costing approaches must be clearly documented to provide a clear understanding of the approaches. The documentation will be helpful to the FTA in its review of the projected O&M costs and also to local decision makers and members of the general public who are interested in the details of the projections.

The FTA believes the fully allocated cost model is the appropriate approach for O&M costing because it meets the following key O&M costing objectives:

- **Sensitive to different costs by mode and service type.** It is commonly understood that O&M costing models should be sensitive to differences in costs among transit modes. Bus unit hourly costs, for example, are typically lower than hourly unit costs for light rail and heavy rail systems. However, it also is important that the O&M cost models be sensitive to the types of service being operated within a mode. For example, the operating costs for local bus service can be quite different from those for express bus service or BRT service. These differences may be the result of differences in labor utilization (often measured the ratio of pay hours to vehicle hours), types of vehicles used (e.g., conventional buses, articulated buses), and facilities operated (e.g., separate bus lanes for BRT, park-and-ride lots for express buses).
- **Reflects historic operating experience.** O&M cost models should reflect recent operations and the cost experience of the transit system that will operate the transit service addressed in AA and PE. If the transit system operates the mode being considered, the O&M cost model should be based on its current operating experience. If the transit system does not operate the mode being considered, the O&M cost models should reflect the experience of similar transit operations at other peer transit systems, supplemented, as necessary, by operations and planning judgment.
- **Sensitive to future changes in cost factors.** O&M cost models should have the flexibility to address cost factors that will change in the future. This flexibility is needed particularly when developing financial projections. Examples of cost factors that might

change include inflation, wage changes negotiated in labor agreements, work rules changes which affect the computation of pay time, fringe benefit costs, and fuel costs.

- **Provides a transparent model structure.** It is important that the development and application of the O&M cost models be transparent and supportive of the New Starts review process. O&M cost models can be and typically are developed using microcomputer-based spreadsheet applications like Microsoft Excel or Lotus 1-2-3. With care, these spreadsheet applications can be developed in a manner that allows interested FTA reviewers to probe the models and develop a better understanding than can be gained solely from written documentation.

This chapter discusses the projection of operating and maintenance (O&M) costs for New Starts projects. It is organized in the following sections:

- Section 4.1 *Fully Allocated O&M Costs* describes the structure of a fully allocated cost model and discusses its use in forecasting O&M costs
- Section 4.2 *O&M Costs for Existing Transit Modes* presents the general approaches for model development and forecasting.
- Section 4.3 *O&M Cost Models for New Service Types and New Service Modes* discusses the challenges and possible approaches related to model development for service alternatives not operated now by the existing system.
- Section 4.4 *Documentation Reports* outlines the FTA requirements for two technical memoranda — model development and operating forecasts — for the New Starts service alternatives being evaluated.

4.1 Overview of Fully Allocated O&M Cost Models

This overview covers model structure and use in forecasting O&M costs.

4.1.1 Model Structure

A cost allocation model assumes that each expense incurred by a transit system is “driven” by a key supply variable such as revenue hours, revenue miles, and peak vehicles. A unit cost rate is calculated for each expense line item. For example, in the sample cost model (Exhibit 1), operator wages increase at a rate of \$34.7648 per revenue hour.

The unit rates are estimated by dividing the annual expense for the expense line item by the value of the driving supply variable for that year. For example, the operators wage unit cost of \$34.7648 = \$73,125,275 / 2,103,426 revenue hours.

The unit cost rates for the individual expense line items can be summed by resource variable to produce system resource unit costs. For example, when the individual unit costs are summed for the sample cost model (Exhibit 1), the following model (or formula) results:

$$\text{Annual O\&M Cost} = (\$67.3452 \times \text{Revenue Hours}) + (\$3.4070 \times \text{Revenue Miles}) \\ + (\$33,176.60 \times \text{Peak Vehicles})$$

Exhibit 1				
Sample Bus Fully Allocated Cost Model				
(Consolidated Expense Line Items for Illustration Only¹)				
Expense Line Item	Annual Expenses	Unit Cost Rate		
		Revenue Hours	Revenue Miles	Peak Vehicles
Operations				
Operators Wages	\$73,125,275	\$34.7648		
Operators Fringe Benefits	\$48,454,239	\$23.0359		
Transportation Supervisors	\$11,637,325	\$5.5326		
Supervisor Fringe Benefits	\$7,711,119	\$3.6660		
Contractor Support	\$255,901	\$0.1217		
Fuel and Lubricants	\$7,445,650		\$0.3371	
Tires and Tubes	\$170,560		\$0.0077	
Other Materials and Supplies	\$467,338	\$0.2222		
Utilities Cost	\$4,457	\$0.0021		
Maintenance				
Mechanics Wages	\$25,295,656		\$1.1453	
Mechanics Fringe Benefits	\$16,761,396		\$0.7589	
Mechanics Supervisors	\$1,331,350		\$0.0603	
Supervisor Fringe Benefits	\$882,179		\$0.0399	
Contractor Support	\$1,727,656		\$0.0782	
Fuel and Lubricants	\$1,022,737		\$0.0463	
Vehicle Parts	\$12,059,944		\$0.5460	
Utilities Cost	\$1,418,127		\$0.0642	
Buildings, Grounds, Facilities				
Maintenance Worker Wages	\$1,970,384			\$2,545.72
Worker Fringe Benefits	\$1,305,615			\$1,686.84
Service Supervisors	\$103,704			\$133.98
Supervisor Fringe Benefits	\$68,716			\$88.78
Contractor Support	\$488,579			\$631.24
Administrative Building Materials	\$280,895			\$362.91
Administration				
Administrative Wages/Salaries	\$5,951,103			\$7,688.76
Administration Fringe Benefits	\$3,943,317			\$5,094.72
Contractor Support	\$6,541,070			\$8,450.99
Fuel and Lubricants	\$336,390			\$434.61
Office Supplies	\$1,803,875			\$2,330.59
Utilities Cost	\$607,769			\$785.23
Vehicle Liability Insurance	\$7,132,574		\$0.3229	
Comprehensive Insurance	\$1,258,690			\$1,626.21
Other Insurance	\$1,018,579			\$1,315.99
Totals	\$242,582,169	\$67.3452	\$3.4070	33,176.60
Resource Variable Values		2,103,426	22,085,973	774
Annual O&M Cost = (\$67.3452 x Revenue Hours) + (\$3.4070 x Revenue Miles) + (\$33.176.60 x Peak Vehicles)				

¹ The expense line items are consolidated for illustration. Typically, cost models are developed using significantly more detailed expense line items.

The structure of the fully allocated cost model and the calculation of the variable unit costs make spreadsheets a logical method for model development and calibration. O&M cost models typically are developed using microcomputer-based spreadsheet applications like Microsoft Excel or Lotus 1-2-3.

4.1.2 Use in Forecasting

There are two common issues in forecasting:

- The sources of input supply variables and
- Dealing with uncertainty.

The forecasting of O&M costs is based on the final operating plan that is prepared for each service alternative. This work begins with a detailed definition of each service alternative that includes route layouts, design standards, and a preliminary operating plan. Based on this detailed definition, an analysis of the service and patronage levels for each alternative is performed. The analysis involves detailed coding and analysis of transit networks, patronage estimation, and the balancing of transit supply with transit demand. As part of this analysis, the operating plan is refined to optimize performance.

One product of this effort is the estimation of the operating statistics e.g., vehicle hours, vehicle miles, peak vehicles, which are used as input to the O&M cost models. This work is documented in the required FTA documentation of the travel demand analysis. It is not discussed in detail in the required FTA documentation on O&M costing.

There are two aspects of uncertainty that should be considered when using O&M costs models. The common concern is the reasonableness of operating cost projections into the future — the longer the time period, the more uncertain are the projections. For purposes of project evaluation, the FTA requires the use of constant dollars in the estimation of cost effectiveness measures. This method ignores the impact of inflation in the evaluation of cost effectiveness. While the FTA approach is very appropriate for its evaluation, local communities might conduct a parametric analysis of the forecast O&M costs for the service alternatives being considered. A simplified analysis might look at the impacts of the following three cost scenarios:

- **Low Rate of Cost Increase.** The inflation rate for O&M costs is lower than the assumed general inflation rate for the local area.
- **Cost Increases with the general level of inflation.** The inflation rate for O&M costs is the same as the assumed general inflation rate for the local area.
- **High Rate of Cost Increase.** The inflation rate for O&M costs is higher than the assumed general inflation rate for the local area.

The inclusion of all O&M costs is another uncertainty concern — *Are all O&M costs being considered in the forecasts?* A fully allocated cost model that is based on recent operating experience provides assurance that all expenses now being incurred are being considered. The transparency of the O&M cost model development and documentation allows the FTA and other interested parties to examine the approach and insure that all expenses are treated reasonably.

4.2 O&M Cost Models for Existing Transit Modes

This section presents the general approaches for model development and forecasting.

4.2.1 General Approach for Model Development

The general approach for the development of an O&M cost model is presented for the case in which a model is needed for an existing mode now operated by a transit system. This type of model can be used to forecast O&M costs for an extension or expansion of existing service. Section 4.3 addresses the development of an O&M cost model for a new service or a mode not now operated by the transit system.

The development of an O&M cost model can be broken down into the following five steps:

- Select key driving supply variables.
- Assemble recent operations data.
- Assign a key driving supply variable to each expense line item.
- Assign base year costs for each expense line item to key supply variables and calculate unit costs and productivity ratios for key supply variables.
- Estimate inflation rate for each expense line item resource unit cost and multiply for the forecast year (Financial Planning Only).

The following paragraphs outline these steps and provide an example of how these steps are applied in the development of the sample bus model shown in Exhibit 1.

4.2.1.1 Step 1: Select Key Driving Supply Variables

O&M costs are related to or are “driven” by different supply variables. These supply variables can be considered causal in that increases in the supply variables will drive increases in the related expense items. For example, individual bus O&M costs are driven by supply variables such as:

- **Revenue (Vehicle) hours (peak and off-peak)** drives operator costs.
- **Vehicle (Revenue) miles (by type of vehicle)** drives vehicle maintenance and claims costs
- **Peak vehicles (by type of vehicle)** drives facilities maintenance and some vehicle maintenance costs.
- **Route-miles of busway** drives some maintenance costs and enforcement costs if the transit property is responsible for maintaining and policing the busways.
- **Maintenance facilities** drives facilities maintenance and some supervision costs.
- **Park-and-ride lots or spaces** drives some facilities maintenance costs.

The driving supply variables for rail O&M costs are related, but different from those used for bus O&M cost models. For example, individual rail O&M costs are driven by supply variables such as:

- **Revenue train hours (peak and off-peak)** drives operator costs.
- **Revenue vehicle miles (by type of vehicle)** drives vehicle maintenance and propulsion power costs.
- **Peak vehicles (by type of vehicle)** drives some vehicle maintenance costs and can be applied as a surrogate for system size.
- **Track miles** drives track maintenance costs.
- **Route miles** drives structures costs.
- **Stations** drives station staffing and station and automatic train control maintenance costs
- **Maintenance facilities and yards** drives facilities and building electricity costs.
- **Park-and-ride lots or spaces** drives facilities maintenance costs.
- **Annual passengers** drives fare collection costs.

The selection of the key driving supply variables is important for the next step regarding data assembly because it specifies the data items to be collected. It is important to recognize that these two steps are interactive and not totally sequential since the availability of data limits the key supply variables that can be specified.

For the sample bus fully allocated cost model shown in Exhibit 1, three driving supply variables are selected in this step (Exhibit 2) — revenue hours, revenue miles, and peak vehicles.

4.2.1.2 Step 2: Assemble Recent Operations Data.

O&M cost allocation models are data-intensive in nature. The level of detail applied in these models depends on the amount of available “off-the-shelf” information. It is important that the cost model reflect the current operating characteristics of the transit agency. Frequently used data sources include:

- Recent annual operating statements
- Service statistics
- National Transit Database

Recent Operating Statements. The most current operating statement is the best source of expense data for the current operations of the transit system. Operating statements usually have line-item detail of the expenses for the management centers for different modes.

The expense line items for each management center (e.g., transportation, maintenance, purchasing, human resources) usually provide detailed expense data by typical categories such as wages, salaries, materials and supplies, and fringe benefits. The level of detail may need to be modified to make the development of the O&M cost model easy to follow and understand. Some level of aggregation may be required to collapse detailed reporting. For example, wage expenses for five different levels of mechanics (e.g., Mechanic I through Mechanic V) may be collapsed into a single expense line item *Mechanics Wages* since retaining the more disaggregate cost detail may not add any accuracy or utility to the model.

Exhibit 2				
Sample Bus Fully Allocated Cost Model				
After Completion of Steps 1-3				
(Consolidated Expense Line Items for Illustration Only¹)				
Expense Line Item	Annual Expenses (Base Year)	Revenue Hours	Revenue Miles	Peak Vehicles
Operations				
Operators Wages	\$73,125,275	X		
Operators Fringe Benefits	\$48,454,239	X		
Transportation Supervisors	\$11,637,325	X		
Supervisor Fringe Benefits	\$7,711,119	X		
Contractor Support	\$255,901	X		
Fuel and Lubricants	\$7,445,650		X	
Tires and Tubes	\$170,560			
Other Materials and Supplies	\$467,338	X		
Utilities Cost	\$4,457	X		
Maintenance				
Mechanics Wages	\$25,295,656		X	
Mechanics Fringe Benefits	\$16,761,396		X	
Mechanics Supervisors	\$1,331,350		X	
Supervisor Fringe Benefits	\$882,179		X	
Contractor Support	\$1,727,656		X	
Fuel and Lubricants	\$1,022,737		X	
Vehicle Parts	\$12,059,944		X	
Utilities Cost	\$1,418,127		X	
Buildings, Grounds, Facilities				
Maintenance Worker Wages	\$1,970,384			X
Worker Fringe Benefits	\$1,305,615			X
Service Supervisors	\$103,704			X
Supervisor Fringe Benefits	\$68,716			X
Contractor Support	\$488,579			X
Administrative Building Materials	\$280,895			X
Administration				
Administrative Wages/Salaries	\$5,951,103			X
Administration Fringe Benefits	\$3,943,317			X
Contractor Support	\$6,541,070			X
Fuel and Lubricants	\$336,390			X
Office Supplies	\$1,803,875			X
Utilities Cost	\$607,769			X
Vehicle Liability Insurance	\$7,132,574		X	
Comprehensive Insurance	\$1,258,690			X
Other Insurance	\$1,018,579			X
Totals	\$242,582,169			
Resource Variable Values		2,103,426	22,085,973	774

¹ The expense line items are consolidated for illustration. Typically, cost models are developed using significantly more detailed expense line items.

Some joint expenses, typically fringe benefit expenses and administrative costs, may not be reported by mode. However, the transit system should have reasonable methods for allocating these expenses by mode because it is required to do this when it submits its annual National Transit Database report (see below). Examples of variables that are used to allocate joint expenses by mode include:

- Employee wages and salaries (e.g., allocation of fringe benefit expenses)
- Employee count (e.g., allocation of general administration management expenses)
- Passengers (e.g., allocation of marketing expenses)
- Number of transactions (e.g., allocation of purchasing expenses)
- Claims expenses (e.g., allocation of claims personnel expenses)
- Direct O&M costs (e.g., allocation of general administration management expenses)

These methods should be reviewed for reasonableness and consistency among expense line items. As necessary, these allocations should be adjusted and these adjustments should be documented.

Experience in analyzing and projecting future year transit operating costs indicates that some expense line items may not increase at the same rate as the baseline rate of inflation (often defined as the rate of increase of the local Consumer Price Index). For example, health insurance costs have increased a much higher rate than general inflation in the past few years.

A review of the cost increases for the past three to five annual operating statements can provide guidance and support for using “incremental” differences from the baseline rate of inflation for specific expense line items. This analysis may be needed when the O&M cost model is used to project annual operating expenses for cash flow analysis and financial planning. The data are used in the fifth step *4.2.1.5 Step 5: Estimate Inflation Rate for Each Expense Line Item Resource Unit Cost and Multiply for the Forecast Year*. It is not needed for developing the FTA cost effectiveness measures since the FTA requires the use of constant dollars.

Service Statistics. The service statistics that correspond to the most current operating statement are needed for calibrating the cost model to the base year. These statistics should correspond to the key driving supply variables selected in the previous step *4.2.1.1 Step 1: Select Key Driving Supply Variables*.

The operating statistics maintained by the transit system usually can provide detailed level of service data by:

- Mode
- Type of service (e.g., local, express)
- Time-of-day
- Day-of-week
- Season of the year

These levels of detail are important to the specification of the driving supply variables in the O&M cost model. It is important to recognize that the first two development steps are interactive since the availability of data limits the key supply variables that can be specified.

National Transit Database. The National Transit Database (NTD) is the FTA's primary database for statistics on the transit industry. Recipients of FTA Urbanized Area Formula Program (Section 5307) grants are required by statute to submit annual data to the NTD. Over 600 transit agencies and authorities file annual reports to FTA. The annual reporting period is the local fiscal year (e.g., July 1 to June 30) for each transit system.

Consistency comparisons should be made between the data obtained from the most recent operating statement and associated operating statistics and the data submitted in the most recent NTD report. The NTD, however, is not reported to the level of detail normally used to develop O&M cost models, particularly in the categorization of labor where the NTD has only four separate labor classifications. An O&M cost model developed with only the NTD's four labor classifications (vehicle operations, vehicle maintenance, non-vehicle maintenance, administration), would likely have result in significant aggregation errors. For this reason, operating budgets are a better source of data for developing and calibrating O&M cost models. The NTD data may be used as a consistency check on a more aggregate level and as a source of data for the key driving supply variables.

For the sample bus fully allocated cost model, over \$242 million in operating expenses is shown by expense line item in Exhibit 2. The corresponding annual statistics for the three key supply variables — revenue hours, revenue miles, and peak vehicles — are presented at the bottom of the exhibit.

4.2.1.3 Step 3: Assign a Key Driving Supply Variable to Each Expense Line Item

The primary assumption of a fully allocated cost model is that expense line item is logically linked or driven by one of the key supply variables. Knowledge of how expense line items vary is needed to establish these linkages.

For example, operator labor costs typically are linked to a measure of hours — vehicle/revenue hours for bus service and vehicle/revenue train hours for rail service. For this reason, expense line items such as *Operators Wages* and *Operators Fringe Benefits* are assigned to revenue hours in the sample bus model (Exhibit 2).

Further, most maintenance labor and materials costs as well as fuel expenses and vehicle liability insurance are linked to a measure of miles — vehicle/revenue miles for bus service and vehicle/revenue car miles for rail service. As a result, expense line items such as *Mechanics Wages* and *Vehicle Liability Insurance* are assigned to revenue miles in the sample bus model (Exhibit 2).

Finally, some expense line items such as administrative costs are related to the scale or size of the transit agency and sometimes are linked to peak vehicles — peak buses for bus service and peak cars for rail service. For this reason, expense line items such as *Administrative Salaries/Wages* and *Utilities Costs* are assigned to peak vehicles in the sample bus model (Exhibit 2).

Good judgment and understanding of how expenses are incurred are needed for the assignment of expense line items to the key driving supply variables. A good expense assignment should be:

- Logical and understandable,
- Defensible and able to pass scrutiny from an outside reviewer, and
- Consistent among the service alternatives and modes being evaluated in the alternatives analysis.

4.2.1.4 Step 4: Assign Base Year Costs for Each Expense Line Item to Key Supply Variables and Calculate Unit Costs and Productivity Ratios for Key Supply Variables

Based on the expense line assignments made in Step 3, expenses from the most current operating statement are assigned to the key supply variables. Unit costs by expense line item and by variable are calculated using the annual variable statistics for the operating period (Exhibit 3). For example, in the sample bus fully allocated cost model, the operators wage unit cost of $\$34.7648 = \$73,125,275 / 2,103,426$ revenue hours.

The unit cost rates for the individual expense line items are summed by resource variable to produce system resource unit costs. For example, when the individual unit costs are summed for the sample cost model (Exhibit 3), the following model (or formula) results:

$$\text{Annual O\&M Cost} = (\$67.3452 \times \text{Revenue Hours}) + (\$3.4070 \times \text{Revenue Miles}) \\ + (\$33,176.60 \times \text{Peak Vehicles})$$

This step also includes the derivation of the two basic factors that affect future unit costs — productivity ratios and resource unit costs. When these two factors (1) are substituted in the basic cost allocation model (2), a detailed “resource build-up model” results (3) which represents costs in a series of equations (one for each expense line item).

$$(1) \text{ Cost/Service Variable Unit} = \frac{(\text{Resources/Supply Variable Unit})}{\text{Productivity Ratio}} \times (\text{Cost/Resource Unit}) \\ \text{Resource Unit Cost}$$

$$(2) \text{ O\&M Cost} = (\text{Supply Variable Units}) \times (\text{Cost/Supply Variable Unit})$$

$$(3) \text{ O\&M Cost} = (\text{Supply Variable Units}) \times \frac{(\text{Resources/Supply Variable Unit})}{\text{Productivity Ratio}} \times (\text{Cost/Resource Unit}) \\ \text{Resource Unit Cost}$$

For example, in the sample bus fully allocated cost model, the operators wage unit cost equals the product of: 1) 1.4289 pay hours/revenue hour (productivity ratio) and 2) \$24.3305 per pay hour (resource unit cost). The productivity ratio of $1.4289 = 3,005,496$ pay hours / 2,103,426 revenue hours. The resource unit cost of $\$24.3305 = \$73,125,275 / 3,005,496$ pay hours.

The sample bus fully allocated cost model also shows the difficulty of computing productivity ratios for many expense line items. While some expense line items have natural productivity ratios (e.g., fuel and gallons, operators wages and work hours), many expense line items do not. For example, operations contractor support and vehicle parts and cannot be quantified in a single unit. Their productivity ratios are expressed directly in terms of cost per supply variable (e.g., \$ per revenue hour and \$ per revenue mile, respectively)

The cost model that is derived at the end of this step can be used to forecast O&M costs in constant dollars such as when the FTA cost effectiveness measures are forecast. However, an additional step may be needed for financial planning purposes. The adjustments needed for financial planning are described in the next and final step.

Exhibit 3
Sample Bus Fully Allocated Cost Model
Base Year Calibration
(Consolidated Expense Line Items for Illustration Only¹)

Expense Line Item	Annual Expenses (Base Year)	Supply Variable Unit Cost Rate			Productivity Ratio			Resource Unit Cost
		Revenue Hours	Revenue Miles	Peak Vehicles	Resource Variable	Resource Value	Resource/ Supply	
Operations								
Operators Wages	\$73,125,275	\$34.7648			Work Hours	3,005,496	1.4289	\$24.3305
Operators Fringe Benefits	\$48,454,239	\$23.0359			Work Hours	3,005,496	1.4289	\$16.1219
Transportation Supervisors Wages	\$11,637,325	\$5.5326			Work Hours	333,944	0.1588	\$34.8481
Supervisor Fringe Benefits	\$7,711,119	\$3.6660			Work Hours	333,944	0.1588	\$23.0911
Contractor Support	\$255,901	\$0.1217			Revenue Hours	2,103,426	1.0000	\$0.1217
Fuel	\$7,445,650		\$0.3371		Gallons	7,776,902	0.3521	\$0.9574
Tires and Tubes	\$170,560		\$0.0077		Revenue Miles	22,085,973	1.0000	\$0.0077
Other Materials and Supplies	\$467,338	\$0.2222			Revenue Hours	2,103,426	1.0000	\$0.2222
Utilities Cost	\$4,457	\$0.0021			Revenue Hours	2,103,426	1.0000	\$0.0021
Maintenance								
Mechanics Wages	\$25,295,656		\$1.1453		Work Hours	922,138	0.0418	\$27.4315
Mechanics Fringe Benefits	\$16,761,396		\$0.7589		Work Hours	922,138	0.0418	\$18.1767
Mechanics Supervisors	\$1,331,350		\$0.0603		Work Hours	38,422	0.0017	\$34.6504
Mech Supervisor Fringe Benefits	\$882,179		\$0.0399		Work Hours	38,422	0.0017	\$22.9600
Contractor Support	\$1,727,656		\$0.0782		Revenue Miles	22,085,973	1.0000	\$0.0782
Fuel and Lubricants	\$1,022,737		\$0.0463		Revenue Miles	22,085,973	1.0000	\$0.0463
Vehicle Parts	\$12,059,944		\$0.5460		Revenue Miles	22,085,973	1.0000	\$0.5460
Utilities Cost	\$1,418,127		\$0.0642		Revenue Miles	22,085,973	1.0000	\$0.0642
Buildings, Grounds, Facilities								
Maintenance Worker Wages	\$1,970,384			\$2,545.72	Work Hours	66,701	86.177	\$29.5406
Worker Fringe Benefits	\$1,305,615			\$1,686.84	Work Hours	66,701	86.177	\$19.5742
Maint Worker Supervisors	\$103,704			\$133.98	Work Hours	2,779	3.591	\$37.3143
M Worker Sup Fringe Benefits	\$68,716			\$88.78	Work Hours	2,779	3.591	\$24.7251
Contractor Support	\$488,579			\$631.24	Peak Vehicles	774	1.0000	\$631.24
Administrative Building Materials	\$280,895			\$362.91	Peak Vehicles	774	1.0000	\$362.91
Administration								
Administrative Wages/Salaries	\$5,951,103			\$7,688.76	Work Hours	291,440	376.537	\$20.42
Administration Fringe Benefits	\$3,943,317			\$5,094.72	Work Hours	291,440	376.537	\$13.53
Contractor Support	\$6,541,070			\$8,450.99	Peak Vehicles	774	1.0000	\$8,450.99
Fuel and Lubricants	\$336,390			\$434.61	Peak Vehicles	774	1.0000	\$434.61
Office Supplies	\$1,803,875			\$2,330.59	Peak Vehicles	774	1.0000	\$2,330.59
Utilities Cost	\$607,769			\$785.23	Peak Vehicles	774	1.0000	\$785.23
Vehicle Liability Insurance	\$7,132,574		\$0.3229		Revenue Miles	22,085,973	1.0000	\$0.3229
Comprehensive Insurance	\$1,258,690			\$1,626.21	Peak Vehicles	774	1.0000	\$1,626.21
Other Insurance	\$1,018,579			\$1,315.99	Peak Vehicles	774	1.0000	\$1,315.99
Totals	\$242,582,169	\$67.3452	\$3.4070	\$33,176.60				
Resource Variable Values		2,103,426	22,085,973	774				

¹ The expense line items are consolidated for illustration. Typically, cost models are developed using significantly more detailed expense line items.

4.2.1.5 Step 5: Estimate Inflation Rate for Each Expense Line Item Resource Unit Cost and Multiply for the Forecast Year

O&M cost model estimates need to account for projected inflation in future years. For many expense line items, a general rate of inflation typically is assumed. However, key expenses such as labor costs, health care benefits, fuel prices and the like can deviate significantly from the core rate of inflation and should be evaluated separately. Considering various inflation scenarios and uncertainties for key cost drivers is a normal part of responsible financial analysis for both agency financial planning and for project evaluation. A review of the cost increases for the past three to five annual operating statements may provide guidance and support for using “incremental” differences from the baseline rate of inflation for specific expense line items.

Also, known future changes such as wage increases contained in collective bargaining agreements and rates set in long-term fuel contracts also would provide support.

A general annual inflation rate of 4.0 percent is assumed in the sample bus model shown in Exhibit 4. Most of the resource unit costs, developed in the previous step (Exhibit 3) are increased by 4.0 percent for Year 1. For example, the resource unit cost for the expense line *operators wages* of \$24.3305 per work hour (2005) was increased by 4.0 percent to \$25.0604 for 2006. However, annual inflation rates of 3.0 percent are used for the two expense line items *Operators Wages* and *Mechanics Wages* to reflect provisions of the current collective bargaining agreements. An inflation rate of 5.0 percent is used for the expense line item *tires and tubes* to reflect recent operating experience.

Exhibit 4 Sample Bus Fully Allocated Cost Model FY 2006 and FY2030 Forecasts (Consolidated Expense Line Items for Illustration Only ¹)										
Expense Line Item	Supply Variable	Productivity Ratio			Resource Unit Cost	Annual Inflation	2006		2030	
		Resource Variable	Value	Resource/Supply			Resource Unit Cost	Cost	Resource Unit Cost	Cost
Operations										
Operators Wages	Revenue Hours	Work Hours	3,005,496	1.4289	\$24.3305	3%	\$25.0604	\$784,262	\$52,471.0	\$1,642,071
Operators Fringe Benefits	Revenue Hours	Work Hours	3,005,496	1.4289	\$16.1219	4%	\$16.7668	\$524,713	\$44,697.4	\$1,398,798
Transportation Supervisors Wages	Revenue Hours	Work Hours	333,944	0.1588	\$34.8481	4%	\$36.2421	\$126,021	\$96,615.4	\$335,951
Supervisor Fringe Benefits	Revenue Hours	Work Hours	333,944	0.1588	\$23.0911	4%	\$24.0147	\$83,504	\$64,019.3	\$222,608
Contractor Support	Revenue Hours	Revenue Hours	2,103,426	1.0000	\$0.1217	4%	\$0.1265	\$2,771	\$0.3373	\$7,387
Fuel	Revenue Miles	Gallons	7,776,902	0.3521	\$0.9574	4%	\$0.9957	\$117,698	\$2,654.4	\$313,765
Tires and Tubes	Revenue Miles	Revenue Miles	22,085,973	1.0000	\$0.0077	5%	\$0.0081	\$2,722	\$0.0275	\$9,218
Other Materials and Supplies	Revenue Hours	Revenue Hours	2,103,426	1.0000	\$0.2222	4%	\$0.2311	\$5,061	\$0.6160	\$13,491
Utilities Cost	Revenue Hours	Revenue Hours	2,103,426	1.0000	\$0.0021	4%	\$0.0022	\$48	\$0.0059	\$129
Maintenance										
Mechanics Wages	Revenue Miles	Work Hours	922,138	0.0418	\$27.4315	3%	\$28.2545	\$396,021	\$59,158.6	\$829,180
Mechanics Fringe Benefits	Revenue Miles	Work Hours	922,138	0.0418	\$18.1767	4%	\$18.9037	\$264,959	\$50,394.3	\$706,337
Mechanics Supervisors	Revenue Miles	Work Hours	38,422	0.0017	\$34.6504	4%	\$36.0364	\$21,046	\$96,067.1	\$56,104
Mech Supervisor Fringe Benefits	Revenue Miles	Work Hours	38,422	0.0017	\$22.9600	4%	\$23.8784	\$13,945	\$63,656.0	\$37,176
Contractor Support	Revenue Miles	Revenue Miles	22,085,973	1.0000	\$0.0782	4%	\$0.0814	\$27,310	\$0.2169	\$72,805
Fuel and Lubricants	Revenue Miles	Revenue Miles	22,085,973	1.0000	\$0.0463	4%	\$0.0482	\$16,167	\$0.1284	\$43,099
Vehicle Parts	Revenue Miles	Revenue Miles	22,085,973	1.0000	\$0.5460	4%	\$0.5679	\$190,640	\$1,5139	\$508,214
Utilities Cost	Revenue Miles	Revenue Miles	22,085,973	1.0000	\$0.0642	4%	\$0.0668	\$22,417	\$0.1780	\$59,761
Buildings, Grounds, Facilities										
Maintenance Worker Wages	Peak Vehicles	Work Hours	66,701	86.177	\$29.5406	3%	\$30.4269	\$31,465	\$63,707.1	\$65,881
Worker Fringe Benefits	Peak Vehicles	Work Hours	66,701	86.177	\$19.5742	4%	\$20.3572	\$21,052	\$54,268.9	\$56,121
Maint Worker Supervisors	Peak Vehicles	Work Hours	2,779	3.591	\$37.3143	4%	\$38.8069	\$1,672	\$103,452.9	\$4,458
M Worker Sup Fringe Benefits	Peak Vehicles	Work Hours	2,779	3.591	\$24.7251	4%	\$25.7141	\$1,108	\$68,549.6	\$2,954
Contractor Support	Peak Vehicles	Peak Vehicles	774	1.0000	\$631.24	4%	\$656.4886	\$7,878	\$1,750,091.1	\$21,001
Administrative Building Materials	Peak Vehicles	Peak Vehicles	774	1.0000	\$362.91	4%	\$377.4300	\$4,529	\$1,006,166.5	\$12,074
Administration										
Administrative Wages/Salaries	Peak Vehicles	Work Hours	291,440	376.537	\$20.42	4%	\$21.2364	\$95,956	\$56,612.9	\$255,802
Administration Fringe Benefits	Peak Vehicles	Admin WS	291,440	376.537	\$13.53	4%	\$14.0717	\$63,582	\$37,512.8	\$169,500
Contractor Support	Peak Vehicles	Peak Vehicles	774	1.0000	\$8,450.99	4%	\$8,789.0346	\$105,468	\$23,430,127.8	\$281,162
Fuel and Lubricants	Peak Vehicles	Peak Vehicles	774	1.0000	\$434.61	4%	\$451.9969	\$5,424	\$1,204,949.8	\$14,459
Office Supplies	Peak Vehicles	Peak Vehicles	774	1.0000	\$2,330.59	4%	\$2,423.8114	\$29,086	\$6,461,484.4	\$77,538
Utilities Cost	Peak Vehicles	Peak Vehicles	774	1.0000	\$785.23	4%	\$816.6405	\$9,800	\$2,177,030.0	\$26,124
Vehicle Liability Insurance	Revenue Miles	Revenue Miles	22,085,973	1.0000	\$0.3229	4%	\$0.3359	\$112,749	\$0.8954	\$300,572
Comprehensive Insurance	Peak Vehicles	Peak Vehicles	774	1.0000	\$1,626.21	4%	\$1,691.2630	\$20,295	\$4,508,630.5	\$54,104
Other Insurance	Peak Vehicles	Peak Vehicles	774	1.0000	\$1,315.99	4%	\$1,368.6333	\$16,424	\$3,648,552.3	\$4,783
Totals								\$3,125,793		\$7,641,627
<small>¹The expense line items are consolidated for illustration. Typically, cost models are developed using significantly more detailed expense line items.</small>							Revenue Hours	21,902	Revenue Hours	21,902
							Revenue Miles	335,700	Revenue Miles	335,700
							Peak Vehicles	12	Peak Vehicles	12

4.2.2 General Approach to Forecasting

The general approach involves the direct estimation of O&M costs and consideration of the implicit assumptions involved when using a fully allocated O&M cost model for forecasting.

4.2.2.1 Forecasting Procedure

The forecasting procedure involves two steps:

- Prepare estimates of the key driving supply variables,
- Develop forecasts of inflation rates, and
- Estimate O&M costs

The estimates of the key driving supply variables is an output of the travel demand analysis. The demand analysis involves the refinement of the operating plan with an objective of maximizing performance. The key driving supply variables are an output of this process.

The O&M costs are estimated using the forecasted supply variables and the O&M cost model. The supply variables are multiplied by their corresponding unit costs and the products then are summed.

For example, a local bus service is being considered as one alternative for serving a high density travel corridor. A travel demand analysis has been performed and the following annual operating statistics have been forecast — 21,902 revenue hours, 335,700 revenue miles, and 12 peak vehicles.

The productivity ratios (resource/supply) and resource unit costs for the O&M cost model developed in Section 4.2.1 (Exhibit 4) are multiplied by the appropriate annual operating statistics. For example, the estimated 2006 O&M cost for the expense line item *operators wages* is estimated as follows:

$$2006 \text{ O\&M Cost} = 1.4289 \text{ work hours/revenue hour} \times \$25.064 \text{ /work hour} \times 21,902 \text{ revenue hours}$$

$$2006 \text{ O\&M Cost} = \$784,262$$

The total forecast cost in constant base year dollars is \$3,125,793 for this alternative (Exhibit 4). The estimated 2030 cost for the expense line item *operators wages* is estimated similarly using an inflated 2030 resource unit cost:

$$2030 \text{ O\&M Cost} = 1.4289 \text{ work hours/revenue hour} \times \$52.4710 \text{ /work hour} \times 21,902 \text{ revenue hours}$$

$$2030 \text{ O\&M Cost} = \$1,642,071$$

The forecast O&M cost for 2030 is \$7,641,627 (Exhibit 4). This cost is based on the inflation assumed and shown in Exhibit 4 — an overall annual inflation of 4.0 percent with a 3.0 percent annual increase in operators and mechanics wages and a 5.0 percent annual increase tires and tubes.

4.2.2.2 Implicit Forecasting Assumptions

While the application of the O&M fully allocated cost model is very straightforward and simple, there are two key assumptions that must be carefully considered:

- All costs are variable in the long-term (20 years) and

- Current productivities will continue in the long-term.

All costs are variable in the long-term (20 years).

Fully allocated operating cost analysis is based on the assumption that, in the long-term, all costs, including “fixed” administrative and overhead costs are “variable and directly related to the quantity of service provided. This assumption is strongly supported by the cost experience of transit properties that have implemented new fixed guideway systems. Some may argue that certain costs must remain fixed. For example, the position of the General Manager (GM) is one cost that seems to be fixed. There can only be one GM no matter how large the transit agency becomes. However, it is clearly the case that large agency GM’s earn substantially more money than small agency GM’s. Therefore, it is still reasonable to assume that, in the long term, all costs are variable with the amount of service provided.

For the purposes of a cash flow analysis in financial planning, however, it may be appropriate to consider incremental costing approaches, particularly for near-term operations where some costs may truly be fixed. Incremental costing only includes cost items considered variable in its forecasts. Generally, many administrative and overhead costs are considered fixed in the near-term and only are treated as variable as the analysis period becomes long-term.

Thus, it may be correct to project costs on an incremental basis for an analysis of near-term operational changes. However, from the standpoint of comparing alternatives using a 20 to 30-year planning horizon, all costs should be assumed to be variable and fully-allocated within the costing model.

Current productivities will continue in the long-term. There are two basic factors that affect future unit costs — productivity ratios and resource unit costs.

$$\text{O\&M Cost} = (\text{Supply Variable Units}) \times \frac{(\text{Resources/Supply Variable Unit})}{\text{Productivity Ratio}} \times \frac{(\text{Cost/Resource Unit})}{\text{Resource Unit Cost}}$$

Supply Variable Units are the key driving supply variables and typically include revenue miles, revenue hours, peak vehicles, yards, stations, garages, track miles, and passengers. They are derived from both the final operating plan and from the physical descriptions of the service alternatives.

Cost/Resource Unit or resource unit costs are expressed in such terms as "average annual wages per mechanic" and "average price per gallon of diesel fuel." They are also derived from recent operating records, supplemented where necessary with data from other transit operations. These resource unit costs also are assumed to remain constant in the calibration of the O&M cost model for the base year. However, the resource unit cost may change in the future. This situation is considered and addressed in the use of O&M cost models for financial planning discussed in *Section 4.2.1.5 Step 5: Estimate Inflation Rate for Each Expense Line Item Resource Unit Cost and Multiply for the Forecast Year (Financial Planning Only)*.

Resources/Service Unit is a productivity ratio expressed, for example, in such terms as "mechanic work hours per vehicle mile" for vehicle-mechanic labor and "gallons of diesel fuel per vehicle-mile" for fuel costs. These productivity ratios can be derived from operating records of recent years. These productivity ratios are assumed to remain constant in the calibration of the O&M cost model.

Unlike the case for resource unit costs, the general approach for developing O&M cost models described earlier does not address what should be done if the productivity ratio is expected to

change in the future and “violate” the assumption that the ratio will be constant. Examples of situations when productivity ratio for an expense line item may change in the future include:

- **More peaked service** for the service alternative may require the use of a higher productivity ratio of actual pay hours per revenue hour for the expense line item related to operators’ wages. The service alternative might be considered a new service type
- **Change in type of vehicles operated such as more intensive use of articulated buses** may require use of a lower productivity ratio of gallons per revenue mile for the expense line item related to fuel.
- **Change in technology that improves fuel economy or changes the labor required to provide equivalent service.**
- **Change in operating procedures such as added staff to manage platform crowding on a rail system experiencing ridership growth may require lower labor productivity factors.**
- **The operation of a new mode** such as light rail will require different productivity ratios for maintenance and vehicle operation than those now observed for the bus operation.

The treatment of productivity ratios is the key challenge in the development and application of O&M cost models. The challenge is to answer two key questions:

- Should the existing productivity ratios that are imbedded in the O&M cost models for the current service operations apply to the service alternative being evaluated?
- What should be done for a service alternative when it is expected that the future productivity ratios for selected expense line items will change in the future?

These important questions are discussed in the next section.

4.3 O&M Cost Models for New Service Types and New Service Modes

Many New Starts service alternatives involve transit services that differ either operationally and/or technologically from current services. The O&M cost models for these services should be based on recent operating experience at the transit system, but selected productivity ratios should be modified and, in some cases, new expense line items should be added, to reflect these differences.

This section addresses the development of O&M cost models when it is expected that the O&M cost model based on current operations must be revised. It is organized into three parts:

- Application: New Service Types and New Modes
- General Approach to Model Development
- Key Issues in Model Development

4.3.1 Application: New Service Types and New Modes

The service alternatives can differ from existing services in two basic ways — new service types and new service modes. The most obvious case is when the service alternative involves a **new service mode** not now operated by the transit system. Many transit systems only operate bus and demand response services. However, higher-capacity modes such as light rail, heavy rail, and commuter rail may be considered as service alternatives.

It is obvious that the O&M cost models for these new modes will differ significantly from the operating structure for the current bus service. New functions will need to be performed (e.g., track, signal, and station maintenance) and these expense line items must be estimated. Current expense items (e.g., vehicle maintenance, propulsion power) will have different productivities (e.g., parts/mile) and possibly resource unit costs (e.g., cost per gallon) which must be revised.

Some basic cost relationships are likely to continue such as fringe benefit costs and general administrative overhead. However, in most cases, many changes and enhancements must be made to develop a reasonable O&M cost model.

The less obvious case is when the service alternative involves the same mode now operated by a transit system, but a **new service type** is provided. The most frequent case is bus. The new service type may have a different operating schedule such as more peaked service (affecting the operator productivity ratio) or higher speed operations (affecting productivity ratios related to maintenance and fuel consumption). The service alternative also may involve the operation of vehicles with different operating characteristics such as higher capacity (e.g., articulated buses) or different fuel sources (e.g., hybrid buses).

Most of the cost relationships are likely to be valid for the service alternative since they are based on current operations. However, in most cases, modifications to specific, high cost expense line items such as operator wages must be made to develop a reasonable O&M cost model.

The O&M cost models to evaluate new service types and new service mode alternatives represent a continuum of change from current operations. At one end are models for new service types that require few changes from current operations. At the other end are models for new modes that require many changes from current operations and the addition of new expense line items. In the middle are dramatic new service types for existing modes such as bus rapid transit. Many BRT alternatives are similar to new modes in that new expense line items must be added to the cost model.

4.3.2 General Approach to Model Development

The general approach for the development of an O&M cost model is presented for a new service type or new mode not now operated by the transit system. This presentation assumes that the reader is familiar with the basic steps for developing an O&M cost model as described in Section 4.2.1.

The development of an O&M cost model for a new service type or new mode can be broken down into the following three steps:

- Develop O&M cost models for modes now operated by the transit system.
- Adjust productivity ratios for selected activities that are part of current operations.
- Add expense line item unit costs for activities that are not part of current operations

The following paragraphs outline these steps and use the example presented in Section 4.2 (Exhibit 3) to show how these steps are applied.

4.3.2.1 Step 1: Develop O&M Cost Models for Modes Now Operated by the Transit System

The development of O&M costs models for existing modes is the starting point for costing new service types and new modes. Many of the expense line item costs will be used “as is” in the O&M cost models developed for new service types for an existing mode. Many of the productivity ratios for existing expense line items will be “borrowed” for use in new expense line items in the O&M cost models developed for new modes.

This work follows the development tasks outlined in Section 4.2.1. However, special attention should be given to the first two tasks — select key driving supply variables and assemble recent operations data.

Select Key Driving Supply Variables. This task is particularly important for O&M cost models for new service types for existing modes. If the productivity ratios for selected line item expense ratios are expected to change in the future for the new service type, one solution is to select different key driving supply variables. For example, if the new service type involves more peak service than is now operated, the variable *revenue hours* might be replaced by two new variables *peak revenue hours* and *off-peak revenue hours*. This task, therefore, may be interactive with the next step — *4.3.2.2 Adjust Productivity Ratios for Selected Activities that are Part of Current Operations*.

Assemble Recent Operations Data. The work in this task is expanded because data are needed to calculate the productivity ratios and resource unit costs for key expense line items that will be addressed in the next two steps — *4.3.2.2 Adjust Productivity Ratios for Selected Activities that are Part of Current Operations* and *4.3.2.3 Add Expense Line Items for Activities that are not Part of Current Operations*. This task, therefore, may be interactive with these two steps.

$$\text{Cost/Service Variable Unit} = (\text{Resources/Service Variable Unit}) \times (\text{Cost/Resource Unit})$$

Unit Cost *Productivity Ratio* *Resource Unit Cost*

Data on resources are needed. Examples include employee headcounts, operator pay hours, and gallons of fuel. These data must be obtained from the internal records of the transit system.

4.3.2.2 Step 2: Adjust Productivity Ratios for Selected Activities that are Part of Current Operations

The expense item unit costs for some activities now performed in current operations may not be valid for the service alternative being evaluated. In this step, these unit costs are revised by adjusting their productivity ratios to be consistent with the operational characteristics of the

service alternative. These revisions may be based on detailed analysis of current operations or on experiences at other transit systems.

For example, the sample O&M cost model developed in Section 4.2 is for the current bus operations. This model would need to be revised for a service alternative that involved the provision of BRT service. The proposed BRT service differs from the local system as follows:

- The BRT alternative has more peak service affecting the operator productivity ratio.
- The BRT alternative operates at higher speeds affecting productivity ratios related to maintenance and fuel consumption.

As shown in Exhibit 5, the productivity ratios (or resource unit costs) for the following expense line items were adjusted to reflect the operating differences for the BRT service alternative:

- Operators Wages and Operators Fringe Benefits — 1.4289 (Exhibit 3) to 1.5717 work hours per revenue hour
- Fuel — 0.3521 to 0.3201 gallons per revenue mile
- Tires and Tubes — \$0.0077 to \$0.0081 per revenue mile (resource unit cost)
- Mechanics Wages and Mechanics Fringe Benefits — 0.0418 to 0.0459 work hours per revenue mile
- Mechanics Supervisors and Mechanics Supervisors Fringe Benefits — 0.0017 to 0.0019 work hours per revenue mile
- Vehicle Parts — \$0.5460 to \$0.4478 per revenue mile (resource unit cost)

4.3.2.3 Step 3: Add Expense Line Item Unit Costs for Activities that are not Part of Current Operations

The expense item unit costs for some activities that would be performed for a service alternative may not be part of current of operations. In this step, the expense line item unit costs for these new activities are added to the O&M cost model.

Generally, these new unit costs are based on the operational experience of other transit systems. Sometimes, the new unit costs are based on the current operations, but in a different mode. For example, the current cost experience with station cleaning for an existing heavy rail service may be “borrowed” and used for a light rail service alternative. Also, the productivity ratio of operator fringe benefits to operator wage expenses for current bus operations might be borrowed” and used for a light rail service alternative.

Sometimes, the addition of these expense line items requires the addition of a key service driving variable. For example, miles of busway and stations are examples of key service driving variables that might be added to a conventional bus O&M cost model when that model is adapted for forecasting the O&M costs of a BRT alternative. Passengers might be added as measure as driving variable for automated fare collection costs at transit stations.

This step was applied to the sample O&M cost model for the BRT service alternative discussed in the previous step. The proposed alternative will involve the operation of two stations at the terminal ends of the BRT service. However, no stations are now operated as part of existing bus service.

Exhibit 5									
Sample Bus Fully Allocated Cost Model									
After Completion of Steps 1-4									
(Consolidated Expense Line Items for Illustration Only¹)									
Expense Line Item	Existing Unit Cost Adjusted	New Unit Cost Added	Supply Variable	Productivity Ratio		Resource Unit Cost	Annual Inflation	2006	
				Resource Variable	Resource/Supply			Resource Unit Cost	Cost
Operations									
Operators Wages	X		Revenue Hours	Work Hours	1.5717	\$24,3305	3%	\$25,0604	\$1,315,263
Operators Fringe Benefits	X		Revenue Hours	Work Hours	1.5717	\$16,1219	4%	\$16,7668	\$879,980
Transportation Supervisors Wages			Revenue Hours	Work Hours	0.1588	\$34,8481	4%	\$36,2421	\$192,133
Supervisor Fringe Benefits			Revenue Hours	Work Hours	0.1588	\$23,0911	4%	\$24,0147	\$127,311
Station Agent Wages		X	Stations	Work Hours	5,840	\$20,4352	3%	\$21,0483	\$245,844
Station Agent Fringe Benefits		X	Stations	Work Hours	5,840	\$13,6916	4%	\$14,2393	\$166,315
Contractor Support			Revenue Hours	Revenue Hours	1.0000	\$0,1217	4%	\$0,1265	\$4,225
Fuel	X		Revenue Miles	Gallons	0.3201	\$0,9574	4%	\$0,9957	\$180,915
Tires and Tubes	X		Revenue Miles	Revenue Miles	1.0000	\$0,0079	5%	\$0,0083	\$4,723
Other Materials and Supplies			Revenue Hours	Revenue Hours	1.0000	\$0,2222	4%	\$0,2311	\$7,716
Utilities Cost			Revenue Hours	Revenue Hours	1.0000	\$0,0021	4%	\$0,0022	\$74
Maintenance									
Mechanics Wages	X		Revenue Miles	Work Hours	0.0459	\$27,4315	3%	\$28,2545	\$736,632
Mechanics Fringe Benefits	X		Revenue Miles	Work Hours	0.0459	\$18,1767	4%	\$18,9037	\$492,846
Mechanics Supervisors	X		Revenue Miles	Work Hours	0.0019	\$34,6504	4%	\$36,0364	\$39,147
Mech Supervisor Fringe Benefits	X		Revenue Miles	Work Hours	0.0019	\$22,9600	4%	\$23,8784	\$25,939
Contractor Support			Revenue Miles	Revenue Miles	1.0000	\$0,0782	4%	\$0,0814	\$46,181
Fuel and Lubricants			Revenue Miles	Revenue Miles	1.0000	\$0,0463	4%	\$0,0482	\$27,338
Vehicle Parts	X		Revenue Miles	Revenue Miles	1.0000	\$0,4478	4%	\$0,4657	\$264,343
Utilities Cost			Revenue Miles	Revenue Miles	1.0000	\$0,0642	4%	\$0,0668	\$37,907
Buildings, Grounds, Facilities									
Maintenance Worker Wages			Peak Vehicles	Work Hours	86.177	\$29,5406	3%	\$30,4269	\$31,465
Worker Fringe Benefits			Peak Vehicles	Work Hours	86.177	\$19,5742	4%	\$20,3572	\$21,052
Station Worker Wages		X	Stations	Work Hours	405	\$29,5406	3%	\$30,4269	\$24,646
Station Worker Fringe Benefits		X	Stations	Work Hours	405	\$19,5742	4%	\$20,3572	\$16,489
Maint Worker Supervisors			Peak Vehicles	Work Hours	3.591	\$37,3143	4%	\$38,8069	\$1,672
M Worker Sup Fringe Benefits			Peak Vehicles	Work Hours	3.591	\$24,7251	4%	\$25,7141	\$1,108
Contractor Support			Peak Vehicles	Peak Vehicles	1.0000	\$631,24	4%	\$656,4886	\$7,878
Administrative Building Materials			Peak Vehicles	Peak Vehicles	1.0000	\$362,91	4%	\$377,4300	\$4,529
Administration									
Administrative Wages/Salaries			Peak Vehicles	Work Hours	376.537	\$20,42	4%	\$21,2364	\$95,956
Administration Fringe Benefits			Peak Vehicles	Admin W/S	376.537	\$13,53	4%	\$14,0717	\$63,582
Contractor Support			Peak Vehicles	Peak Vehicles	1.0000	\$8,450,99	4%	\$8,789,0346	\$105,468
Fuel and Lubricants			Peak Vehicles	Peak Vehicles	1.0000	\$434,61	4%	\$451,9969	\$5,424
Office Supplies			Peak Vehicles	Peak Vehicles	1.0000	\$2,330,59	4%	\$2,423,8114	\$29,086
Utilities Cost			Peak Vehicles	Peak Vehicles	1.0000	\$785,23	4%	\$816,6405	\$9,800
Station Utilities		X	Stations	Kilowatt Hours	5,281	\$0,0894	4%	\$0,0930	\$982
Vehicle Liability Insurance			Revenue Miles	Revenue Miles	1.0000	\$0,3229	4%	\$0,3359	\$190,658
Comprehensive Insurance			Peak Vehicles	Peak Vehicles	1.0000	\$1,626,21	4%	\$1,691,2630	\$20,295
Station Insurance		X	Stations	Stations	1.0000	\$5,281,45	4%	\$5,492,7080	\$10,985
Other Insurance			Peak Vehicles	Peak Vehicles	1.0000	\$1,315,99	4%	\$1,368,6333	\$16,424
Totals									\$5,452,331
<small>¹The expense line items are consolidated for illustration. Typically, cost models are developed using significantly more detailed expense line items.</small>								Revenue Hours	33,392
								Revenue Miles	567,664
								Peak Vehicles	12
								Stations	2

It was decided that the key driving supply variable *stations* is the best driver and it was added to the O&M cost model (Exhibit 5). A survey was conducted of similar transit systems with BRT systems and productivity ratios and resource unit costs were added for the following expense line item unit costs:

- Station agent wages
- Station Agent Fringe Benefits
- Station Utilities
- Station Worker Wages (Facility Maintenance)
- Station Worker Fringe Benefits(Facility Maintenance)
- Station Insurance

At the completion of these three steps, the O&M costs for the service alternative can be estimated using the forecasted supply variables and the O&M cost model. The supply variables are multiplied by their corresponding unit costs and the products then are summed.

For example, the BRT service is being considered as one alternative for serving a high density travel corridor. A travel demand analysis has been performed and the following annual operating statistics have been forecast — 33,392 revenue hours, 567,664 revenue miles, 12 peak vehicles, and two stations.

The productivity ratios (resource/supply) and resource unit costs for the O&M cost model (Exhibit 5) are multiplied by the appropriate annual operating statistics. For example, the estimated 2006 O&M cost for the expense line item *operators wages* is estimated as follows:

$$2006 \text{ O\&M Cost} = 1.5717 \text{ work hours/revenue hour} \times \$25.064 \text{ /work hour} \times 33,392 \text{ revenue hours}$$

$$2006 \text{ O\&M Cost} = \$1,315,263$$

The total forecast cost is \$5,452,331 in constant base year dollars for this alternative (Exhibit 5).

4.3.3 Key Issues in Model Development

- The fundamental problem in model development is identifying expenses that will behave differently for the service alternative being analyzed when compared to current operations. O&M cost projections are based on the assumption that the current rates of consumption and productivity will continue in the future. These important assumptions should be reviewed for key cost items.

The analysis should focus on the unit costs for selected expense line items that were derived for the current service operation. Two factors should be examined — the productivity ratio and the resource unit cost. As discussed earlier, the unit cost for an expense line item *i* is the product of these two factors:

$$\text{Cost/Service Variable Unit} = \left(\frac{\text{Resources/Service Variable Unit}}{\text{Productivity Ratio}} \right) \times \left(\frac{\text{Cost/Resource Unit}}{\text{Resource Unit Cost}} \right)$$

The analysis should focus on key functional areas that are most likely to have a material impact on the O&M costs of the agency. This might usefully be defined as any expense that represents more than five percent of total operating expenses of the agency. Expenses that typically fall in this category include:

- Revenue operator wages
- Vehicle maintenance wages
- Revenue vehicle fuel or propulsion power
- Electricity (rail modes)
- Revenue vehicle parts

Finally, expense items that are known to be different than the current service operation should be addressed.

There are two generic remedies for the identified expense line items. The first is a detailed examination of current operations. Different productivity factors may be derived or different key driving supply variables may be specified.

The second remedy is to “borrow” experiences from other transit systems. This remedy generally is used for activities that are not a part of current operations. These borrowed productivities must be adjusted, typically to reflect the local cost environment of the transit system.

The remaining portions of this section outline common expense issues that should be addressed when developing O&M cost models for different service alternatives. Common remedies also are provided. This is not an exhaustive listing of issues or common remedies.

4.3.3.1 Different Service Profiles

The service profile (vehicles in service by time of day) may be different for the service alternative than it is for current operations. The degree of peaking can significantly affect operator cost and can be measured by the peak-base ratio — the maximum number of vehicles operated during morning and evening peak (rush) hours divided by the number of vehicles operated during the midday. The higher the peak-base ratio, generally, the higher is the ratio of operator pay hours to vehicle (revenue) hours operated. This occurs because more drivers are assigned split assignments (runs) that involve spread premium and guarantee payments in addition to platform payments — pay for operating the vehicle. For example, the ratio of scheduled pay hours to platform hours may be 1.08 for one-piece runs and 1.20 for split assignments.

Two approaches have been used to address the peaking problem. One approach is to adjust the unit cost for the expense line item *operators wages* by using a different value for the productivity ratio *pay hours per revenue hour*. For example, the scheduled pay hours/revenue hour ratio of 1.12 for current operations might be adjusted to a projected ratio of 1.21 for the service alternative.

$$\text{Cost/Revenue Hour} = (\text{Scheduled Pay Hours/Revenue Hour}) \times (\text{Cost/Pay Hour})$$

Unit Cost *Productivity Ratio* *Resource Unit Cost*

This adjustment requires the collection of scheduled pay hours as part of the development of the O&M cost model for current operations. It also requires that an operator schedule be cut for the service alternative so that the scheduled pay hours/revenue hour ratio can be estimated.

The second approach is to model peak and off-peak hours separately. In the sample bus O&M cost model shown in Exhibit 3, this would mean replacing the key driving supply variable *revenue hours* by two new variables *peak revenue hours* and *off-peak revenue hours*. This approach typically requires the collection and assignment of scheduled pay hours as part of the development of the O&M cost model for current operations.

4.3.3.2 Operator Wage Differentials

Sometimes, the operators of new service types or new service modes are paid a wage premium. For example, operators on a proposed BRT service might be paid \$1.00 per hour more regular bus operators because they will be operating articulated buses. Or, operators of a new light rail service may be paid \$1.50 per hour more than bus operators.

One common approach to this problem is to adjust the unit cost for the expense line item *operators wages* by using a different value for the resource unit cost *cost per pay hour*. For example, the cost per pay hour of \$24.32 for current operations might be adjusted to a projected unit cost of \$25.82 projected for the service alternative.

$$\text{Unit Cost} = \left(\frac{\text{Scheduled Pay Hours}}{\text{Revenue Hour}} \right) \times \text{Resource Unit Cost}$$

Caution is needed before making these adjustments. There should be some reasonable basis for the assumption of wage differentials such provisions in current labor agreements or stated and approved policy of the transit system.

The adjustment for wage differentials should not be used when it is expected that senior drivers will choose and work on a service alternative only because they feel the job is more desirable than other jobs. While the average wage cost will be higher for the service alternative, there will be a corresponding drop in the average wage costs for existing services. The wage differential adjustment only should used when a specific wage premium is paid to all operators.

4.3.3.3 Different Mix of Vehicles

Some service alternatives may require a different mix of vehicles than are currently operated. For example, a BRT service alternative may call for the use of articulated vehicles while now the transit system operates a mix of conventional and articulated buses.

The use of a different mix of vehicles can affect a number of expense line items related to the following activities:

- Mechanical labor covering inspections, preventive maintenance, and repair,
- Usage or consumption of parts, and
- Fuel consumption.

One common approach to this problem is to model these vehicle-related costs by type of vehicle such as conventional 40-foot buses and articulated buses. Like the problem of different service profiles, the vehicle-specific miles variables are substituted for the general miles variable. In the sample bus O&M cost model shown in Exhibit 3, if there are two types of buses — conventional and articulated, this would mean replacing the key driving supply variable *revenue miles* by two new variables *conventional bus revenue miles* and *articulated revenue miles*. This approach requires the collection of vehicle-specific cost data as part of the development of the O&M cost model for current operations.

4.3.3.4 Activities Not Conducted in Current Operations

Many service alternatives may include activities that are new to the transit system and are not part of current operations. This often is true when the service alternatives involve a new mode,

particularly rail modes. Transit systems that only operate buses generally do not perform capital-intensive activities such as:

- Guideway and structures maintenance
- Signals and vehicle movement control
- Power operations and maintenance
- Station operations and maintenance

The general approach is to base O&M costs for activities new to a transit system on recent operational experience in the transit industry. This experience should be based on the “average” transit system. Usually favorable or unfavorable “outliers” should be avoided. Only when no experience is available, are engineering estimates used.

The costs related to a new activity can be divided into two categories:

- **Direct** expenses that are a function of the key driving supply variables such as hours and miles. Employee wages and commodities consumed such as fuel, track ties, and vehicle parts are examples.
- **Indirect** expenses are a function of the direct expenses. Fringe benefits, supervisory expenses, and administrative support activities are examples.

For direct expenses, the detailed “resource build-up approach” is used to apply industry experience for the new activity to the service alternative. This means using appropriate productivity ratios that relate resources consumed or expended with key driving supply variables. It also means adjusting the industry experience for local conditions such as:

- Labor rates,
- Absenteeism, and
- Local resource unit costs.

For example, the expense item unit cost for station employee wages is based on the industry productivity ratio adjusted for local labor rates and absenteeism.

$$\text{Wages/Station} = \frac{\text{Scheduled Pay Hours/Station}}{\text{Industry Average}} \times \frac{\text{Actual Pay Hours/Scheduled Pay Hours}}{\text{Local Absenteeism}} \times \frac{\text{Cost/Actual Pay Hour}}{\text{Local Labor Rate}}$$

The adjustments of industry experience generally require more detailed analysis during the development of the O&M cost model for current operations. Productivity ratios must be developed, as appropriate, for labor rates, absenteeism, and resource costs.

Indirect expenses for new activities are estimated based on their linkage to the direct expenses. For example, some fringe benefit expenses related to station employees may be driven by employee wages. The indirect expense productivity ratios (e.g., fringe benefits as a percent of wages) are based on analysis of current operations. The indirect expenses are estimated based on the productivity ratio for current operations and the direct expense resource unit cost adjusted for local conditions.

$$\text{Fringes Benefits/Station} = \frac{\text{Fringe Benefits/Wages}}{\text{Local Productivity Ratio}} \times \frac{\text{Wages/Station}}{\text{Direct Expenses}}$$

Again, the estimation of indirect costs generally requires more detailed analysis during the development of the O&M cost model for current operations. Productivity ratios must be developed, as appropriate, for indirect cost drivers.

4.4 Documentation Reports

This section outlines the FTA requirements for two technical memoranda — model development and operating forecasts — for the New Starts service alternatives being evaluated. The FTA emphasis in these memoranda is on content and clear presentation. Long and elaborate memoranda are neither required nor desired.

4.4.1 Memorandum on O&M Cost Models

The memorandum on O&M costing summarizes the development of the cost allocation models for each transit mode and type of service to be considered. The report should summarize the results of each activity that was described in Sections 4.2.1 and 4.3.2.1. The report should be organized as follows:

- **Overview of Service Alternatives Being Evaluated.** This discussion should describe each service alternative being considered in terms of mode, type of service, level of service, vehicle type, important technology, and other characteristics that may be important to development of O&M cost models. The discussion should indicate the modeling approach that was used for each service alternative — either based on existing service or building for a new type of service or new mode. It also should indicate if some alternatives will use the same O&M model because the alternatives employ the same mode and type of service.
- **Development of O&M Cost Model for Existing Service.** One chapter should be prepared for each O&M cost model. This chapter should summarize the model development work outlined in Section 4.2.1 as follows:
 - **Selection of Key Driving Supply Variables (4.2.1.1).** A short rationale should be provided for the key variables and related to how the service alternative relates to the existing service provided.
 - **Data Assembled (4.2.1.2).** A short summary of the data assembled should be provided including any data problems and how they were addressed. Comments should be on how the transit system allocates joint expenses by mode and what adjustments, if any, were made to these allocations.
 - **Assignment of Expense Items (4.2.1.3).** The summary of this work task should focus on the assignment of the expense line items to key supply variables. A complete table should be provided that shows the expense assignment as shown in Exhibit 2. The expense line items should be aggregated to logical categories. For example, wages for individual pay categories of full and part time drivers should be aggregated into two expense line items — full time wages and part time wages.
 - **Calculations of Unit Costs (4.2.1.4).** A table showing the resultant productivity ratios and resource unit costs should be presented as shown in Exhibit 3.

- **Estimation of Inflation Rates (4.2.1.5).** A short rationale should be provided for the general inflation rate and the “incremental” differences from the general rate for specific expense line items. A summary table that shows the inflation rates for each expense line item should be prepared.
- **Development of O&M Cost Model for New Service Types and New Service Modes.** One chapter should be prepared for each O&M cost model. This chapter should summarize the model development work outlined in Section 4.3.2 as follows:
 - **Development of O&M Cost Model for Existing Service. (4.2.1.1).** This summary should reference the development summarized in another chapter and highlight the special attention given to two tasks — *Select Key Driving Supply Variables* and *Assemble Recent Operations Data*.
 - **Adjustment of Productivity Ratios (4.3.2.2) and Addition of New Expense Line Items (4.3.2.3).** The discussion in this section should address how the productivity factors derived for the existing service operation were adjusted, how new expense line items were added to reflect better the service alternative being developed and the resultant revised productivity ratios and resource unit costs. Each adjustment and should be documented including the sources for the expense line item adjustment and additions. A summary table should be prepared as shown in Exhibit 5.

The discussion should specifically address the following expense items:

- Revenue operator wages
- Vehicle maintenance wages
- Revenue vehicle fuel or propulsion power
- Electricity (rail modes)
- Revenue vehicle parts
- Expense line items that exceed five percent of total operating costs

A short rationale should be provided if no adjustments or additions are made to the listed expense items.

- **Estimation of Inflation Rates (4.2.1.5).** A short rationale should be provided for the general inflation rate and the “incremental” differences from the general rate for specific expense line items.

4.4.2 Memorandum on Forecasts of O&M Costs

This memorandum summarizes the forecast of O&M costs for each service alternative development of the cost allocation models for each transit mode and type of service to be considered. The report should summarize the results of each activity that was described in Sections 4.2.2. The report should be organized as follows:

- **Overview of Service Alternatives Being Evaluated.** This overview is the same as is required for the previous memorandum. It should describe each service alternative being considered in terms of mode, type of service, level of service, vehicle type, important technology, and other characteristics that may be important to development of O&M cost models. The discussion should indicate the modeling approach that was used for each

service alternative — either based on existing service or building for a new type of service or new mode. It also should indicate if some alternatives will use the same O&M model because the alternatives employ the same mode and type of service.

- **Summary of Projected Costs for Each Service Alternative.** This summary should provide the following information for each service alternative:
 - Values for key driving supply variables
 - Supply variable unit costs
 - Total cost by supply variable
 - Total cost
 - Cost per revenue hour

The summary should be provided in table format.

- **Discussion of Costs.** The reasonableness of each O&M cost forecasts should be discussed in terms of current operations and in comparison with peer systems. Also, the O&M cost forecasts for the all service alternatives should be compared and contrasted.

8. FINANCIAL PLANNING FOR TRANSIT

8.1 Introduction

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*“Finance is, as it were, the stomach of the country,
from which all other organs take their tone.”*

- W.E. Gladstone, article on Finance (1858)

in Gladstone, by H.C.G. Matthew (1986), Ch. 5.

Constructing transportation facilities, purchasing transit vehicles, providing new transit services, or merely maintaining existing services requires a significant financial commitment. Transit capital investments can last a generation or more and require consistent maintenance and reinvestment as well as continual operating subsidies. Prudent management requires that the decision to build new transit facilities, procure equipment, or make operating changes be supported by sound financial planning. Financial planning is the framework for evaluating the feasibility of any proposed transit improvement in the context of operating and maintaining existing levels of service.

Congress affirms the importance of sound financial planning through legislation that governs the federal transit program. Section 3(a)(2)(a) of the Federal Transit Act states that “No grant or loan shall be provided under this section unless the Secretary determines that the applicant has or will have the legal, financial, and technical capacity to carry out the proposed project”. Section 5309(e)(4) of The Transportation Equity Act for the 21st Century (TEA-21) states that the Federal Transit Administration (FTA) must evaluate proposed major capital investments to ensure that they are supported by an acceptable degree of local financial commitment.

Responding to this legislation, FTA has been helping transit agencies improve their financial planning for many years. Most recently, FTA published the *Guidance for Transit Financial Plans (2000)*, which defines the content, scope and format of a solid financial plan. The intent of that guidance was to explain what a financial plan is. The intent of this *Section* is to provide a “how to” manual on financial planning methods. This *Section* serves to update the previous *Financial Planning Guide for Transit (1990)* in the context of recent legislative initiatives and planning practice. This section on financial planning focuses specifically on the development and use of financial planning models for ongoing transit capital and service planning.

8.1.1 The Role of the Financial Plan

A solid financial plan facilitates the selection and implementation of new services and projects and the ongoing operation and maintenance of the transit system. The financial plan presents the recent financial history of the transit agency, describes its current financial health, documents projected costs and revenues into the future, and demonstrates the reasonableness of key assumptions underlying these projections. The information in the financial plan helps decision-makers choose the best transit investments from the available alternatives.

The basic structure of the financial plan is consistent throughout the planning and development process. However, several key components become more detailed and the confidence in many estimates and forecasts increases as the project advances through the planning and development process. For example, project cost estimates become more reliable as the project scope is defined in detail and engineering studies are completed. Similarly, funding strategies become more certain as funds are committed. The financial plan is prepared during alternatives analysis and updated during preliminary engineering (PE), final design, and construction, as changes occur to project costs, funding, or external factors that affect agency finances.

While financial planning is a necessity for planning major capital investments, it is also a valuable tool for planning the most basic transit operations. Transit agencies that apply “best practice” planning methods will incorporate continuously updated financial models to help them plan ongoing services, vehicle replacements, maintenance and rehabilitation programs, capital investments, and to plan the funding and financing strategies that are the key to implementing the transit agency’s activities. A financial planning model can help ensure the stability of transit agency operations by providing advance warning about potential financial difficulties and can help the agency develop and test realistic strategies to avoid those difficulties.

8.1.2 Organization of this Section

This *Section on Financial Planning for Transit* is designed to go beyond FTA’s previous guides to provide a primer on “best practice” methods for developing key financial planning components. Previous guidance has emphasized the role

of financial planning in the development and implementation of major transit investments. While this function is still vital, FTA now emphasizes the ongoing use of the financial planning model to inform every aspect of transit agency planning. As such, financial planning for project development is a straightforward extension of the everyday financial planning activities of the transit agency.

The contents of this *Section* follow the basic components of the financial planning model culminating in the use of the financial model for financial analysis in support of transit agency planning. The sections are:

8.2 Contents of a Financial Plan – This chapter specifies the components necessary for a solid transit agency financial plan. The chapter describes how each component of the plan is integrated into detailed capital and operating plans and how these plans combine into an agency cash flow projection. The chapter includes numerous examples to demonstrate the level of detail and format of a “best practice” financial plan and describes in detail, the supporting documentation required to substantiate the financial plan components. The remaining chapters detail the methods used to develop each plan component.

8.3 Capital Cost Estimates – This discusses the use of capital cost estimates in the financial planning process. The chapter offers some guidelines to reduce the risk of cost overruns and the methods for accounting for the uncertainty inherent in any cost estimate.

8.4 Operating and Maintenance Cost Estimates – This section includes a detailed discussion on the development of operating and maintenance cost estimates for proposed projects and existing systems.

8.5 Forecasting Revenues – This section describes the methods used to forecast transit system revenues for the existing system and incremental revenues from proposed projects. Also covered are “best practice” methods for forecasting tax revenues and user fees and the planning assumptions necessary to predict intergovernmental grants, subsidies and formula allocations.

8.6 Financial Analysis – This section describes how transit planners bring together all key financial planning inputs into an integrated financial model. Included in this chapter are discussions of the process of projecting capital funding requirements, operating subsidy requirements, managing debt levels, and performing sensitivity analyses. This chapter presents traditional methods of evaluating financial success and the use of the financial planning model to support the ongoing success of the transit agency.

8.2 Contents of a Financial Plan

The primary result of a financial plan is an agency-wide 20-year cash flow projection that includes the capital and operating plans for the agency as a whole and for any proposed projects. The 20-year cash flow projection begins with the current year. The remaining content of a financial plan is the information to

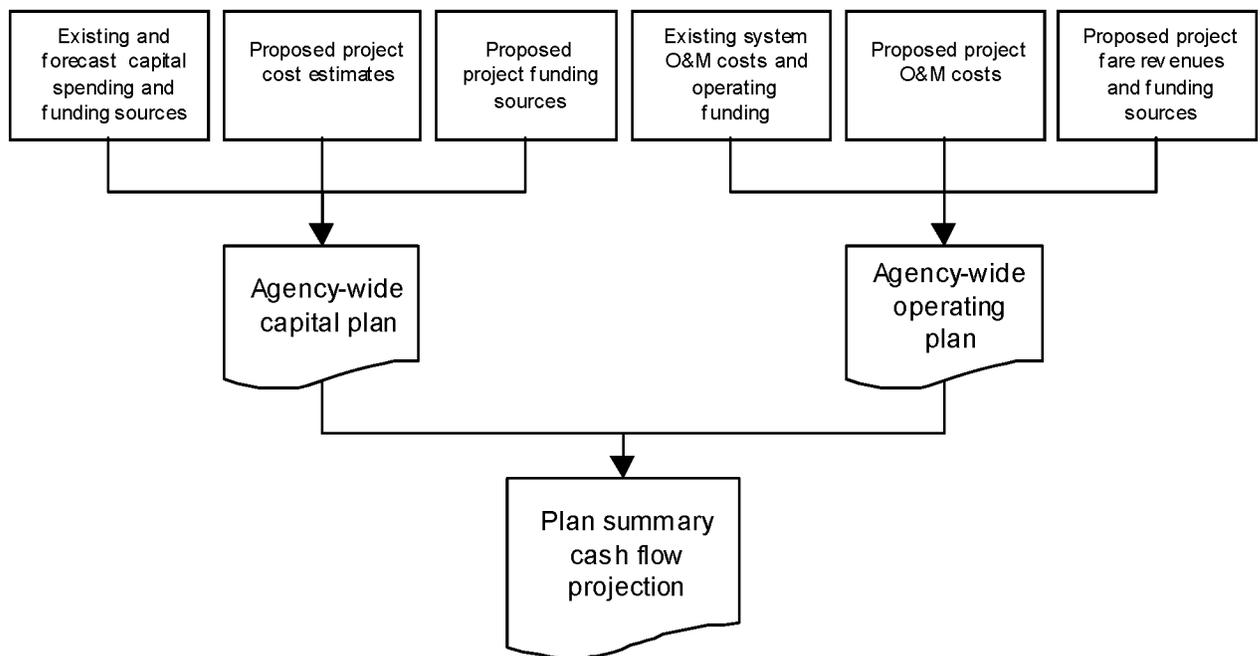
support all the assumptions and inputs that contribute to the cash flow projection and the financial analysis of agencies assumptions, capital and operating plans and financial strategies.

The 20-year cash flow projection is the summary of several elements of a financial plan that includes:

- Funding sources and revenue forecasts;
- Proposed project capital budget (if the plan is designed to support analysis of a particular project);
- Other planned capital projects; and
- Annual operating and maintenance (O&M) expenses for the proposed project and the existing system.

The plan is constructed by bringing several plan elements together into an integrated financial model. Figure 8-1 summarizes the relationships among the plan components.

Figure 8-1: Components of a Financial Plan



The tables and schedules that constitute the financial plan demonstrate how financial and economic assumptions and project cost estimates have been derived, how the resulting forecasts of capital and operating costs of the proposed project fit into the agency-wide capital and operating plans, whether funds have been committed to the project, how the revenue forecasts are developed, and finally, how capital and operating plans impact projected agency cash flow.

8.2.1 Introduction to the Financial Plan

The financial plan begins with a description of the project sponsor and major funding partners. The introduction includes the following elements:

- a description the current transit system and discusses the project sponsor's and partner's capability to fund the construction and operation of the proposed project;
- a description of the proposed project including an explanation of the purpose and need for the project and how it fulfills the project sponsor's objectives;
- a description of the strategy to provide the local share of project funding; and
- a summary of the projected financial position of the project sponsor and the ability of the sponsor to fund planned capital improvements and continue to operate and maintain the existing transit system.

8.2.2 The Capital Plan

The first component of the financial plan is the capital plan, which documents the transit agency's capital spending plans and funding sources and describes in detail the strategy to fund the construction of the proposed project. The capital plan is composed of two elements: (1) the capital plan for the proposed project and, (2) the agency's 20-year capital plan. The project sponsor first develops the capital plan for the project, and then inserts the project into the agency-wide capital plan. The capital plan documentation confirms the stability, reliability, and availability of all capital funding sources and describes the transit agency's capital spending plans 20 years into the future.

8.2.2.1 Proposed Project Capital Plan

The project capital plan provides a high level of detail regarding the agency's plan to fund the construction of the proposed project. The project capital plan includes the cost estimate and schedule for the proposed project, describes the amount and commitment of non-federal funding sources, describes contingencies for cost increases and federal appropriations shortfalls, and details the debt burden on the project sponsor at a level of detail appropriate to the phase of project development.

The components of the project capital plan change considerably as the project moves from alternatives analysis to signing a full funding grant agreement (FFGA) and construction. As the project moves from preliminary engineering (PE) to final design, capital costs become increasingly detailed as the project scope and precise alignment are finalized, non-federal funding sources are committed, environmental mitigation activities and other cost escalation risk areas are more accurately specified and changes to the original design and cost estimates become apparent. By the time a FFGA is signed, all local funds are

committed to the project and cost estimates and schedule are known with a high level of certainty.

Capital Costs and Schedule

A cost estimate and schedule is required at each phase of project development, but the format of the cost estimate changes. In alternatives analysis and PE, project cost estimates and schedules are presented as increasingly detailed unit cost breakdowns of the proposed project. When a project is admitted to final design and seeks to receive a FFGA, the cost estimates are broken into individual contract units that specify the escalated annual cost and schedule for each contract. These cost estimates are updated periodically and tracked as the project is constructed.

Capital cost submissions describe the cost estimation process and segment costs by major cost category (e.g., guideway, facilities, systems, and vehicles). Cost estimates include soft-costs such as PE, final design and construction management as well as set-asides for contingencies. The cost estimate and schedule provide detail to back up the proposed project cost items in the agency-wide capital plan.

The project sponsor documents the current engineering cost estimate for the proposed project, describing each major cost component. A simple project cost estimate is developed in alternatives analysis. This cost estimate, typically including high contingencies to reflect uncertainties in scope and alignment, is used for the financial plan before a project enters PE. During PE, the scope and exact alignment of the project is determined and additional detail added to the cost estimate. As the project moves toward implementation, confidence in the capital cost estimates and schedules increase while cost contingencies decrease. Table 8-1 provides an example cost estimate for a project in PE.

Table 8-1: Detailed Project Cost Estimate in PE, Constant 1999 Dollars (Millions)

Description	Quantity	Cost (Millions of 1999\$)	
Construction Costs			
<i>Site Preparation and Restoration</i>			
Utility relocation - meters	3675	\$	13.2
Street restoration - meters	3675	\$	1.9
Traffic signals - #	7	\$	0.6
Structure mod. and underpinnings - #	2	\$	2.9
Environmental mitigations - #	2	\$	0.8
<i>Maintenance facility and yard</i>	1	\$	25.6
<i>Trackway - meters</i>			
At grade - 2 track	690	\$	0.4
<i>Subway - meters</i>			
Cut/cover - 1 track	593	\$	16.7
Cut/cover - 2 track	1230	\$	79.1
Mined tunnel - 1 track	413	\$	16.5
Mined tunnel - 2 track	749	\$	42.5
Ventilation (cut/cover + mined tunnel)	2985	\$	5.5
<i>Stations - number</i>			
At grade	1	\$	2.6
Underground	4	\$	79.5
<i>Trackwork</i>			
Ballasted - meters	690	\$	0.4
Direct fixation - meters	4964	\$	2.8
Special - turnouts, turnback... etc. - #	1	\$	0.6
<i>Traction power supply - meters</i>	5654	\$	4.6
<i>Signaling and train control - meters</i>	5654	\$	7.2
<i>Communications/fire/safety - meters</i>	5654	\$	2.5
Subtotal Construction Costs		\$	305.8
Non-Construction Costs			
<i>Right-of-way</i>			
Right-of-way - stations - #	5	\$	4.8
Right-of-way - Maintenance facility - #	1	\$	2.2
<i>New Vehicles - #</i>	8	\$	20.1
<i>Preliminary Engineering</i>		\$	10.0
<i>Final engineering/management</i>		\$	39.8
Subtotal Non-Construction Costs		\$	76.9
Contingency		\$	45.9
Total		\$	428.6

The capital cost estimates are initially produced in constant dollars and escalated to the year-of-expenditure. Costs are typically escalated based on distinct inflation forecasts for, at a minimum, construction costs, right-of-way acquisition, labor costs, and general price inflation to account for the wide variability in the inflation characteristics of certain cost components. Costs in constant dollars are budgeted according to the estimated construction schedule. These costs are then escalated to the year-of-expenditure.¹ Table 8-2 is an example of a cost estimate and schedule for a project in PE.

Table 8-2: Cost Estimate and Schedule, Year-of-Expenditure Dollars (Millions)

* Cost Category	Millions of 1999\$	1999	2000	2001	2002	2003	2004	2005	2006	Total Year-of-Expenditure (\$Millions)
1 Inflation (CPI-U)		na	2.34%	2.17%	2.52%	2.63%	2.67%	2.60%	2.48%	
2 Labor Cost Inflation		na	2.53%	2.20%	1.90%	2.03%	2.07%	1.95%	2.15%	
3 Const. Cost Inflation		na	3.55%	2.99%	3.67%	2.22%	1.85%	4.34%	4.77%	
4 Real Estate Inflation		na	2.93%	2.13%	2.96%	1.10%	1.67%	4.27%	4.81%	
2 Preliminary Engineering	\$ 10.0	\$ 1.0	\$ 5.1	\$ 4.2						\$ 10.3
3 Construction	\$ 305.8					\$ 83.5	\$ 99.6	\$ 110.5	\$ 67.2	\$ 360.8
4 Right-of-Way	\$ 7.0				\$ 5.1	\$ 2.5				\$ 7.6
2 Final Engineering/Mgmt	\$ 39.8			\$ 6.9	\$ 5.6	\$ 9.5	\$ 9.6	\$ 8.2	\$ 3.9	\$ 43.7
1 Vehicles	\$ 20.1						\$ 6.1	\$ 11.6	\$ 5.6	\$ 23.3
NA Contingency	\$ 45.9					\$ 12.5	\$ 14.9	\$ 16.6	\$ 10.1	\$ 54.1
Total	\$ 428.6	\$ 1.0	\$ 5.1	\$ 11.1	\$ 10.7	\$ 108.0	\$ 130.2	\$ 146.9	\$ 86.8	\$ 499.8

* These numbers reference the inflation category used to escalate the associated cost category. Inflation assumptions are documented in regional economic forecasts. The source of these inflation assumptions is Standard and Poors DRI, *The US Economy - Winter 2000*.

Cost estimates for projects in final design that are ready to sign a FFGA are broken into contract units. Each of the contract units is a separate contract with a distinct schedule and cost estimate. Each contract is awarded and tracked by the grantee throughout the construction phase. The contracts may contain the project contingency individually or a separate project reserve may be set aside to account for unexpected costs. The initial escalated cost estimate divided into contract units is called the Baseline Project Budget and is developed by the grantee before a FFGA is signed. This estimate may be derived from estimated contract costs escalated to year-of-expenditure or mid-point of construction. An example is provided in Table 8-3.

¹ Year of expenditure cost estimates are derived by multiplying the constant dollar cost estimate for a particular year by the inflation factor calculated for that year. The inflation factor for an expenditure in year t is derived by :

$$i_t = \prod_{n=1}^t (1 + i_n)$$

where *i* is the inflation rate in percent for year n.

Table 8-3: Example Baseline Cost Estimate, Escalated Dollars (Millions)

Contract		Cost (\$Millions)
No.	Description	Escalated*
	Preliminary engineering	\$ 10.3
	Final engineering and project management	\$ 43.8
	Real estate	\$ 7.6
	Vehicles	\$ 23.3
<i>Construction Contracts</i>		
1	Maintenance facility and yard	\$ 34.7
2	Subway cut/cover	\$ 144.1
3	Subway mined tunnel	\$ 90.3
4	Trackwork installation	\$ 5.1
5	Construct stations	\$ 121.2
6	Install traction power system	\$ 6.3
7	Signalling system	\$ 9.8
8	Communications system	\$ 3.4
Total		\$ 499.8

* May be escalated to either year-of-expenditure or mid-point of construction.

The cost estimate changes as bids for each of the contracts come in higher or lower than the baseline and changes to project scope lead to contract amendments. These changes in project costs are tracked on a separate schedule that provides the current budget forecast for the project. *Table 8-4* is an example of the project cost-tracking schedule. As the current budget forecast changes, the project sponsor revises the capital plan to ensure that the grantee maintains a sound financial position. Grantees are subject to financial spot reviews by FTA to ensure they have the capacity to complete the project according to the terms of the FFGA as well as operate and maintain the existing transit system and service levels.

Funding Sources

The project capital plan identifies the proposed sources of funds for constructing the proposed project and details the non-federal share of project costs. The information submitted regarding funding sources provides documentation for FTA to determine the degree of commitment of each funding source and helps ensure that local match requirements are met. As the project advances in the development and implementation process, the level of commitment of non-federal funds increases. To enter PE, a financial plan must identify a “realistic” funding strategy for providing the local share. During PE, the project sponsor is expected to secure committed funds so that the majority of non-federal funds are committed before the project may advance to final design. All non-federal funds must be formally approved and programmed to fund the non-federal share of the proposed project before FTA will recommend or approve a project for a FFGA.

Table 8-4: Project Cost Tracking Schedule, Escalated Dollars (Millions)

No.	Description	Baseline Budget	Contract Award	Approved Changes	Current Contract	Forecasted Changes	Contract to be Awarded	Current Budget Forecast	Expenditures To-Date	
	Preliminary engineering	\$ 10.3	\$ 10.3	\$ -	\$ 10.3		\$ -	\$ 10.3	\$ 10.3	
	Final eng. and mgmnt	\$ 43.8	\$ 42.5	\$ -	\$ 42.5		\$ -	\$ 42.5	\$ 5.5	
	Real estate	\$ 7.6	\$ 7.8	\$ 0.4	\$ 8.2		\$ -	\$ 8.2	\$ 4.9	
	Vehicles	\$ 23.3	\$ 22.5	\$ -	\$ 22.5		\$ -	\$ 22.5	\$ -	
	<i>Construction Contracts</i>									
1	Maintenance facility	\$ 34.7	\$ 32.4	\$ (0.5)	\$ 31.9		\$ -	\$ 31.9	\$ -	
2	Subway cut/cover	\$ 144.1	\$ 148.8	\$ -	\$ 148.8		\$ -	\$ 148.8	\$ 5.2	
3	Subway mined tunnel	\$ 90.3	\$ 94.2	\$ -	\$ 94.2		\$ -	\$ 94.2	\$ 1.5	
4	Trackwork installation	\$ 5.1		\$ -	\$ -		\$ 5.1	\$ 5.1	\$ -	
5	Construct stations	\$ 121.2		\$ -	\$ -	\$ (2.5)	\$ 121.2	\$ 118.7	\$ -	
6	Traction power system	\$ 6.3		\$ -	\$ -		\$ 6.3	\$ 6.3	\$ -	
7	Signalling system	\$ 9.8		\$ -	\$ -		\$ 9.8	\$ 9.8	\$ -	
8	Communications system	\$ 3.4		\$ -	\$ -	\$ (0.2)	\$ 3.4	\$ 3.2	\$ -	
	Total	\$ 499.8	\$ 358.5	\$ (0.1)	\$ 358.4	\$ (2.7)	\$ 145.7	\$ 501.4	\$ 27.4	

The capital plan summarizes the non-federal and federal shares of project costs and references evidence of funding commitment. Evidence of commitment may include legislative documentation, resolutions approving funding, account balances, a bonding prospectus and agency debt covenants, signed joint development agreements or legally binding agreements with state/local agencies committing funds. Table 8-5 presents an example of this type of summary. In the example, the project sponsor would attach legislation or signed local agreements authorizing the dedicated sales tax, MPO commitments for use of Congestion Mitigation Air Quality (CMAQ) funds, the bonding prospectus and evidence of authority to issue debt in the amount planned.

Table 8-5: Sources of Capital Funds, Year-of-Expenditure Dollars (Millions)

Sources of Funds	Funding Level	Funding Share	Evidence of Commitment
Federal Sources			
Section 5309 New Starts	\$ 251.3	50%	NA Attach MPO documents committing use of CMAQ or flexible funding.
CMAQ/STP	\$ 20.0	4%	
Other	\$ -	0%	
Total Federal Funds	\$ 271.3	54%	NA
Non-Federal Sources			
Sales Tax	\$ 148.5	30%	Attach Legislation and Revenue Forecast Attach Debt Coverage Analysis and Rating
Bond Proceeds	\$ 80.0	16%	
Other Sources	\$ -	0%	
Total Non-Federal Funds	\$ 228.5	46%	
Total Project Budget	\$ 499.8	100%	

The accompanying text clearly identifies all local, state, federal and private funding sources, including the name, originating level of government, total dollar amount anticipated, amount currently expended, and the share of total project capital costs in year-of-expenditure dollars. The total dollar amount across funding sources sums to the project's total capital cost.

Funding Source Forecasts

For each funding source, the plan clearly indicates whether the source is an existing source, such as an active local tax from which revenues are currently collected, or a new source requiring legislative approval, referendum, or other governmental action. For existing sources, the plan outlines the conditions of the funding agreement (e.g., funding formula, percent share of total revenues, etc.) and provides at least five years of historical revenue data including the amount

available for transit uses. For major funding sources², the plan includes 10 years of historical revenue data. For new sources, the plan indicates when legislative approval or public referendum is expected and the date the source would become effective. For all sources, the plan contains a 20-year revenue forecast, documentation of any sunset clauses, and provisions to cover project funding beyond the sunset date.

For all revenue projections, the financial plan uses conservative rates of growth that do not exceed historical experience for that source. Table 8-6 presents an example of a forecast for a dedicated local sales tax.

Borrowing, Debt Levels and Ratings

If the financial plan includes debt, a debt proceeds and service plan is included in the financial plan documentation. This schedule presents outstanding debt levels, the gross amount of each debt issuance, net proceeds from each issuance, bond rating for each issuance, debt service requirements, and interest rates for the past five years and 20 years into the future. This schedule monitors on a yearly basis the most restrictive debt covenant of the agency, such as debt service ratio requirements, outstanding debt ceiling, or limits on debt expenditures during a specific time period. In addition, the most recent bonding prospectus is included as supporting documentation.

Contingencies

Cost contingencies provide reserves against any risks of cost increases in the development of the project. These contingencies are separately identified in the project's financial plan and included in the capital cost estimates. The capital cost documentation includes a description of all the cost escalation risks and identifies the range of potential project costs. As a project moves through the engineering and design process, the likelihood of cost increases, and consequently, the contingency declines. After a FFGA is signed, the project sponsor is responsible for any cost increases and for fulfilling the terms of the FFGA. Reduced service, delayed construction, or reductions in project scope are not acceptable contingency plans.

² Defined as sources that contribute more than 25% of agency-wide or New Starts capital or operating funds. The purpose of evaluating ten years of revenue data is to ensure that the forecasts account for a full range of economic conditions.

Table 8-6: Example Funding Source Forecast, Current Dollars (Millions)

Fiscal Year	Retail Sales	Tax Rate	Sales Tax Revenue*	Annual % Chg.
1990	\$11,442.0	0.5%	\$ 57.2	
1991	\$11,918.7	0.5%	\$ 59.6	4.2%
1992	\$12,441.3	0.5%	\$ 62.2	4.4%
1993	\$13,027.5	0.5%	\$ 65.1	4.7%
1994*	\$13,500.0	1.0%	\$ 135.0	107.3%
1995	\$14,720.0	1.0%	\$ 147.2	9.0%
1996	\$15,779.8	1.0%	\$ 157.8	7.2%
1997	\$16,663.5	1.0%	\$ 166.6	5.6%
1998	\$17,696.6	1.0%	\$ 177.0	6.2%
1999	\$18,846.9	1.0%	\$ 188.5	6.5%
2000	\$19,789.3	1.0%	\$ 197.9	5.0%
2001	\$20,580.8	1.0%	\$ 205.3	3.7%
2002	\$21,404.1	1.0%	\$ 212.6	3.6%
2003	\$22,260.2	1.0%	\$ 221.0	3.9%
2004	\$23,150.7	1.0%	\$ 229.9	4.0%
2005	\$24,076.7	1.0%	\$ 239.2	4.1%
2006	\$25,039.7	1.0%	\$ 248.8	4.0%
2007	\$26,041.3	1.0%	\$ 258.5	3.9%
2008	\$27,083.0	1.0%	\$ 268.7	4.0%
2009	\$28,166.3	1.0%	\$ 279.5	4.0%
2010	\$29,293.0	1.0%	\$ 290.8	4.0%
2011	\$30,464.7	1.0%	\$ 302.8	4.1%
2012	\$31,683.3	1.0%	\$ 315.3	4.1%
2013	\$32,950.6	1.0%	\$ 327.9	4.0%
2014	\$34,268.6	1.0%	\$ 341.0	4.0%
2015	\$35,639.4	1.0%	\$ 355.0	4.1%
2016	\$37,064.9	1.0%	\$ 369.6	4.1%
2017	\$38,547.5	1.0%	\$ 384.4	4.0%
2018	\$40,089.4	1.0%	\$ 400.0	4.1%
2019	\$41,693.0	1.0%	\$ 416.2	4.0%

* The tax rate increase of 0.5% approximately doubles the revenue from this source.

** Source: Standard and Poors DRI, *The US Economy - Winter 2000*

Federal Funding Shortfalls

In some cases, project sponsors may assume a higher federal share than is actually provided after the congressional appropriations process. Project sponsors should be prepared to move the full scope of the project forward even if federal funds are less than expected. Evidence of financial capacity to provide additional non-federal funds could be in the form of cash balances, additional debt capacity or commitments of additional funds from new or existing funding sources. Service reductions and deferred maintenance are not acceptable methods of freeing up additional funds.

After a FFGA has established the federal share, federal appropriations may fall short on an annual basis. For instance, the federal commitment to the FFGA funding levels may be satisfied over six years rather than the planned four-year period. The capital plan presents strategies for implementing the project if the annual appropriations are less than planned including short term financing to cover annual funding shortfalls. The capital plan should show adequate cash reserves, construction reserves or debt capacity to complete the full scope of the proposed project if annual appropriations are lower than expected. Service reductions on the existing system, construction delays or reducing the scope or features of the project are not acceptable methods of providing additional funds.

8.2.2.2 Agency-Wide Capital Plan

The components of the project capital plan are summarized and incorporated into the agency-wide capital plan. The agency plan presents capital funding and spending for each individual funding source and each individual capital project for the past five years and planned during the next 20 years. Capital plan documentation includes project names and descriptions, total capital costs and schedules, and proposed federal funding contributions for each existing, proposed, or planned project. Projects included in the long-range plan and transportation improvement program for the metropolitan area are identified. The agency-wide capital plan also includes bus and rail fleet acquisitions, replacement, and major rehabilitation consistent with the fleet management plans prepared by the transit agency.

All capital funding and expenditures are combined into an agency-wide capital plan projection. Agencies with large numbers of transit projects and funding sources may present detailed funding sources or capital projects on a separate schedule (as in Table 8-7) to provide a clearer presentation of the capital funding information. The major funding categories can then be summarized in the agency-wide capital plan projection. Table 8-8 is an example of a 20-year agency capital plan projection.

Fiscal Year	Actual 1994	Actual 1995	Actual 1996	Actual 1997	Actual 1998	Budget 1999	2000	2001	2002	2003	2004	2005	2006
Non-Federal Capital Funds													
Balance from Operations (see Table 11)	\$ (4.6)	\$ (1.4)	\$ 0.6	\$ 5.2	\$ 9.4	\$ 14.2	\$ 11.8	\$ 11.5	\$ 11.2	\$ 10.8	\$ 10.1	\$ 9.5	\$ 12.1
Sales Tax - 50% Capital (see Table 6)	\$ 67.5	\$ 73.6	\$ 78.9	\$ 83.3	\$ 88.5	\$ 94.2	\$ 98.9	\$ 102.6	\$ 106.3	\$ 110.5	\$ 114.9	\$ 119.6	\$ 124.4
Net Bond Proceeds	\$ -	\$ 60.0	\$ 105.0	\$ 90.0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 40.0	\$ 20.0	\$ 20.0	\$ -
Investment Income	\$ 24.2	\$ 13.0	\$ 13.4	\$ 13.9	\$ 13.8	\$ 11.0	\$ 11.5	\$ 12.0	\$ 11.9	\$ 12.8	\$ 14.7	\$ 15.7	\$ 15.6
Total Non-Federal Sources	\$ 87.1	\$ 145.2	\$ 197.9	\$ 192.5	\$ 111.7	\$ 119.4	\$ 122.2	\$ 126.1	\$ 129.5	\$ 174.1	\$ 159.8	\$ 164.8	\$ 152.0
Federal Funds													
Section 5307 - Formula Funds	\$ 19.8	\$ 22.1	\$ 24.2	\$ 32.2	\$ 34.4	\$ 36.8	\$ 39.4	\$ 41.8	\$ 44.3	\$ 25.0	\$ 25.0	\$ 25.0	\$ 25.0
Section 5309 - FFGA Attachment 6	\$ 67.3	\$ 44.0	\$ 51.8	\$ 48.5	\$ 48.5	\$ 32.3	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Section 5309 - Bus	\$ 10.4	\$ 9.9	\$ 13.2	\$ 13.5	\$ 14.0	\$ 12.0	\$ 10.5	\$ 9.0	\$ 9.0	\$ 9.0	\$ 9.0	\$ 9.0	\$ 9.0
Section 5309 - Rail Modernization	\$ -	\$ -	\$ -	\$ -	\$ 15.5	\$ 16.2	\$ 17.5	\$ 18.5	\$ 19.0	\$ 20.0	\$ 20.0	\$ 20.0	\$ 20.0
Section 5309 - Proposed New Start	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 1.0	\$ 2.0	\$ 8.0	\$ 51.0	\$ 66.5	\$ 74.7	\$ 48.1
CMAQ/STP Flexible Funds	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 10.0	\$ 10.0	\$ -	\$ -
Total Federal Funds	\$ 97.5	\$ 76.0	\$ 89.2	\$ 94.2	\$ 112.4	\$ 97.3	\$ 68.4	\$ 71.3	\$ 80.3	\$ 115.0	\$ 130.5	\$ 128.7	\$ 102.1
2007 - 2019													
Fiscal Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Non-Federal Capital Funds													
Balance from Operations (see Table 11)	\$ 6.3	\$ 8.0	\$ 7.4	\$ 6.9	\$ 6.5	\$ 6.0	\$ 5.3	\$ 4.5	\$ 3.8	\$ 3.0	\$ 2.0	\$ 1.1	\$ 0.0
Sales Tax - 50% Capital (see Table 6)	\$ 129.2	\$ 134.4	\$ 139.8	\$ 145.4	\$ 151.4	\$ 157.6	\$ 164.0	\$ 170.5	\$ 177.5	\$ 184.8	\$ 192.2	\$ 200.0	\$ 208.1
Net Bond Proceeds	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Investment Income	\$ 15.1	\$ 16.3	\$ 17.2	\$ 17.0	\$ 16.8	\$ 16.8	\$ 16.8	\$ 16.6	\$ 16.6	\$ 16.8	\$ 16.9	\$ 16.8	\$ 16.8
Total Non-Federal Sources	\$ 150.6	\$ 158.7	\$ 164.4	\$ 169.4	\$ 174.6	\$ 180.5	\$ 186.0	\$ 191.5	\$ 197.8	\$ 204.7	\$ 211.1	\$ 217.9	\$ 224.9
Federal Funds													
Section 5307 - Formula Funds	\$ 25.0	\$ 25.0	\$ 25.0	\$ 25.0	\$ 25.0	\$ 25.0	\$ 25.0	\$ 25.0	\$ 25.0	\$ 25.0	\$ 25.0	\$ 25.0	\$ 25.0
Section 5309 - FFGA Attachment 6	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Section 5309 - Bus	\$ 9.0	\$ 9.0	\$ 9.0	\$ 9.0	\$ 9.0	\$ 9.0	\$ 9.0	\$ 9.0	\$ 9.0	\$ 9.0	\$ 9.0	\$ 9.0	\$ 9.0
Section 5309 - Rail Modernization	\$ 20.0	\$ 20.0	\$ 20.0	\$ 20.0	\$ 20.0	\$ 20.0	\$ 20.0	\$ 20.0	\$ 20.0	\$ 20.0	\$ 20.0	\$ 20.0	\$ 20.0
Section 5309 - Proposed New Start	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
CMAQ/STP Flexible Funds	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total Federal Funds	\$ 54.0												

Fiscal Year	Actual 1994	Actual 1995	Actual 1996	Actual 1997	Actual 1998	Budget 1999	2000	2001	2002	2003	2004	2005	2006
Capital Expenditures													
1 Rail System Phase B	\$ 140.0	\$ 150.3	\$ 186.5	\$ 156.0	\$ 125.6	\$ 72.7	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2 Proposed New Start (see Table 2)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 1.0	\$ 5.1	\$ 11.1	\$ 10.7	\$ 108.0	\$ 130.2	\$ 146.9	\$ 86.8
3 Rail System Rehabilitation	\$ -	\$ -	\$ -	\$ -	\$ 20.2	\$ 21.1	\$ 26.3	\$ 27.8	\$ 24.7	\$ 26.0	\$ 26.4	\$ 27.0	\$ 27.8
4 Bus Purchases/Overhaul	\$ 8.4	\$ 9.2	\$ 17.4	\$ 38.7	\$ 28.4	\$ 32.3	\$ 68.0	\$ 69.4	\$ 70.7	\$ 46.0	\$ 34.0	\$ 34.7	\$ 35.4
5 Other Capital	\$ -	\$ 12.4	\$ 24.2	\$ 36.5	\$ 32.5	\$ 25.0	\$ 26.5	\$ 32.2	\$ 33.2	\$ 22.2	\$ 22.9	\$ 23.6	\$ 48.6
Total Capital Expenditures	\$ 148.4	\$ 171.9	\$ 228.1	\$ 231.2	\$ 206.7	\$ 152.1	\$ 125.9	\$ 140.4	\$ 139.3	\$ 202.2	\$ 213.5	\$ 232.1	\$ 198.6
Debt Service Costs	\$ 39.8	\$ 44.0	\$ 51.4	\$ 57.7	\$ 60.5	\$ 61.9	\$ 63.3	\$ 63.3					
Capital Funding Sources													
Total Non-Federal Sources (see Table 7)	\$ 87.1	\$ 145.2	\$ 197.9	\$ 192.5	\$ 111.7	\$ 119.4	\$ 122.2	\$ 126.1	\$ 129.5	\$ 174.1	\$ 159.8	\$ 164.8	\$ 152.0
Total Federal Funds (see Table 7)	\$ 97.5	\$ 76.0	\$ 89.2	\$ 94.2	\$ 112.4	\$ 97.3	\$ 68.4	\$ 71.3	\$ 80.3	\$ 115.0	\$ 130.5	\$ 128.7	\$ 102.1
Total Capital Revenue	\$ 184.6	\$ 221.2	\$ 287.1	\$ 286.7	\$ 224.1	\$ 216.8	\$ 190.6	\$ 197.4	\$ 209.7	\$ 289.1	\$ 290.3	\$ 293.5	\$ 254.1
Beginning Cash Balance	\$ 189.9	\$ 186.3	\$ 191.6	\$ 199.3	\$ 197.1	\$ 156.9	\$ 164.0	\$ 171.0	\$ 170.4	\$ 183.1	\$ 209.6	\$ 224.5	\$ 222.7
Change to Cash Balance	\$ (3.6)	\$ 5.3	\$ 7.6	\$ (2.2)	\$ (40.2)	\$ 7.1	\$ 7.1	\$ (0.7)	\$ 12.8	\$ 26.4	\$ 14.9	\$ (1.8)	\$ (7.7)
Closing Cash Balance	\$ 186.3	\$ 191.6	\$ 199.3	\$ 197.1	\$ 156.9	\$ 164.0	\$ 171.0	\$ 170.4	\$ 183.1	\$ 209.6	\$ 224.5	\$ 222.7	\$ 215.0
Capital Expenditures													
1 Rail System Phase B	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2 Proposed New Start	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
3 Rail System Rehabilitation	\$ 32.0	\$ 33.9	\$ 36.0	\$ 38.1	\$ 40.4	\$ 42.8	\$ 45.4	\$ 48.1	\$ 51.0	\$ 54.1	\$ 57.3	\$ 60.7	\$ 64.4
4 Bus Purchases/Overhaul	\$ 36.1	\$ 36.8	\$ 52.4	\$ 52.5	\$ 48.0	\$ 49.0	\$ 49.9	\$ 50.9	\$ 52.0	\$ 53.0	\$ 54.1	\$ 55.1	\$ 56.2
5 Other Capital	\$ 55.2	\$ 66.0	\$ 69.3	\$ 72.8	\$ 76.4	\$ 80.2	\$ 84.2	\$ 88.4	\$ 92.9	\$ 97.5	\$ 102.4	\$ 107.5	\$ 112.9
Total Capital Expenditures	\$ 123.3	\$ 136.7	\$ 157.7	\$ 163.4	\$ 164.8	\$ 172.0	\$ 179.6	\$ 187.5	\$ 195.8	\$ 204.6	\$ 213.8	\$ 223.4	\$ 233.5
Debt Service Costs	\$ 63.3	\$ 58.0	\$ 52.8	\$ 52.8	\$ 52.8	\$ 43.5							
Capital Funding Sources													
Total Non-Federal Sources (see Table 7)	\$ 150.6	\$ 158.7	\$ 164.4	\$ 169.4	\$ 174.6	\$ 180.5	\$ 186.0	\$ 191.5	\$ 197.8	\$ 204.7	\$ 211.1	\$ 217.9	\$ 224.9
Total Federal Funds (see Table 7)	\$ 54.0	\$ 54.0	\$ 54.0	\$ 54.0	\$ 54.0	\$ 54.0	\$ 54.0	\$ 54.0	\$ 54.0	\$ 54.0	\$ 54.0	\$ 54.0	\$ 54.0
Total Capital Revenue	\$ 204.6	\$ 212.7	\$ 218.4	\$ 223.4	\$ 228.6	\$ 234.5	\$ 240.0	\$ 245.5	\$ 251.8	\$ 258.7	\$ 265.1	\$ 271.9	\$ 278.9
Beginning Cash Balance	\$ 215.0	\$ 233.1	\$ 245.8	\$ 243.3	\$ 240.0	\$ 240.6	\$ 239.8	\$ 237.0	\$ 237.0	\$ 240.3	\$ 241.6	\$ 240.3	\$ 240.3
Change to Cash Balance	\$ 18.1	\$ 12.7	\$ (2.5)	\$ (3.3)	\$ 0.6	\$ (0.8)	\$ (2.8)	\$ 0.0	\$ 3.2	\$ 1.4	\$ (1.4)	\$ (0.0)	\$ 1.9
Closing Cash Balance	\$ 233.1	\$ 245.8	\$ 243.3	\$ 240.0	\$ 240.6	\$ 239.8	\$ 237.0	\$ 237.0	\$ 240.3	\$ 241.6	\$ 240.3	\$ 240.3	\$ 242.2

Notes:

- 1 Funded with FFGA Attachment 6 plus local funds.
- 2 Proposed to be funded with Section 5309 New Starts, federal CMAQ funds, and local funds.
- 3 Funded with Section 5309 Rail Modernization and local funds.
- 4 Funded with Section 5309 Bus and local funds.
- 5 Funded with Section 5307 Formula grants and local funds.

8.2.3 The Operating Plan

The project sponsor supplies an operating plan to document how the agency intends to fund and operate the proposed project and the existing transit system. The operating plan documents five years of historical data and presents 20 years of projected system operating revenues and operating and maintenance (O&M) costs to demonstrate the capability of the agency to operate and maintain the proposed project while providing existing levels of transit service.

Projections of operating costs, ridership, and fares for the proposed project and existing system are often estimated as part of the alternatives analysis and refined in the DEIS/FEIS. The values reported for ridership and service levels are consistent with the forecasts documented in the MPO's constrained long-range plan. The number of rail vehicles and buses in service, vehicle retirements, acquisitions and overhauls and the associated annual costs are documented in the bus and rail fleet management plans. Information unavailable from any of these sources is generated specifically for the financial plan.

8.2.3.1 Operating Revenues

The operating plan demonstrates the ability to rely on non-federal funding sources to operate and maintain the entire transit system after the proposed project is in revenue service. The operation and maintenance of the proposed project is likely to place additional burden on the agency's local funding sources. Transit agencies usually need to develop new funding sources if they do not have existing sources that provide sufficient extra operating revenues to fund the proposed project.

The operating plan incorporates fare revenue forecasts for the proposed project and the existing transit system. Fare revenue forecasts are based on ridership forecasts and assumptions regarding fare levels.³ The project sponsor should include a summary of prior fare increases and characterize the fare increase approval process. For simplicity of presentation, the project sponsor may develop the fare revenue forecasts as a separate schedule as shown in Table 8-9.

The plan also provides historical revenue figures and forecasts for all other operating revenue sources and the assumptions used to develop the revenue forecasts. Inflation assumptions are critical to revenue forecasts and are explicitly documented in the financial plan. Often, a source such as a local sales tax that is used for local capital funding may also be used for O&M expenses. In the example provided in this guidance, sales tax revenue is divided equally between capital and operations so that the forecast given in Table 8-6 is adequate to document the revenue forecast. The plan includes documentation proving that the proposed operating funds are committed to their intended purpose.

³ The MPO's constrained long-range plan contains transit ridership and revenue forecasts. The ridership forecasts used to develop the financial plan need to be consistent with the MPO's forecasts.

Fiscal Year	Actual		Budget												
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006		
Trips - Existing Bus	38.2	39.3	40.3	40.8	41.9	43.1	39.7	39.4	39.8	39.0	39.7	40.9	39.3		
Trips - Existing Rail	4.8	5.0	5.2	5.3	5.6	5.7	14.7	16.1	17.0	19.1	19.4	19.2	21.8		
Trips - New Start	-	-	-	-	-	-	-	-	-	-	-	-	0.9		
Total Ridership	43.0	44.3	45.5	46.1	47.5	48.8	54.4	55.5	56.8	58.1	59.1	60.1	62.0		
Annual % Change		3.0%	2.7%	1.3%	3.0%	2.7%	11.5%	2.0%	2.3%	2.3%	1.7%	1.7%	3.2%		
Fare Revenues - Existing Bus	\$ 30.7	\$ 31.6	\$ 32.7	\$ 34.6	\$ 36.1	\$ 38.1	\$ 32.8	\$ 33.7	\$ 34.8	\$ 33.1	\$ 35.0	\$ 37.6	\$ 37.6		
Fare Revenues - Existing Rail	\$ 4.8	\$ 5.0	\$ 5.2	\$ 5.6	\$ 5.9	\$ 6.0	\$ 16.2	\$ 17.8	\$ 18.7	\$ 22.0	\$ 22.3	\$ 22.1	\$ 25.1		
Fare Revenues - New Start	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 1.0		
Total Fare Revenue	\$ 35.5	\$ 36.6	\$ 37.9	\$ 40.2	\$ 42.0	\$ 44.1	\$ 49.0	\$ 51.4	\$ 53.5	\$ 55.1	\$ 57.3	\$ 59.6	\$ 63.7		
Annual % Change		3.2%	3.4%	6.0%	4.6%	5.1%	11.0%	5.0%	4.0%	3.0%	4.0%	4.0%	6.8%		
Average Fare	\$ 0.83	\$ 0.83	\$ 0.83	\$ 0.87	\$ 0.88	\$ 0.90	\$ 0.90	\$ 0.93	\$ 0.94	\$ 0.95	\$ 0.97	\$ 0.99	\$ 1.03		
Annual % Change		0.2%	0.7%	4.4%	1.5%	2.2%	0.0%	2.8%	1.6%	0.7%	2.2%	2.2%	3.4%		
Fiscal Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019		
Trips - Existing Bus	38.9	38.5	38.5	39.2	39.6	40.0	40.5	41.0	41.5	42.1	42.7	43.4	44.0		
Trips - Existing Rail	22.8	23.7	25.0	25.7	26.6	27.6	28.5	29.5	30.4	31.4	32.3	33.3	34.2		
Trips - New Start	6.3	6.5	6.7	6.9	7.1	7.3	7.5	7.8	8.0	8.2	8.5	8.7	9.0		
Total Ridership	68.0	68.7	70.2	71.7	73.3	74.9	76.6	78.3	80.0	81.7	83.5	85.4	87.3		
Annual % Change	9.7%	1.0%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%		
Fare Revenues - Existing Bus	\$ 33.4	\$ 37.1	\$ 38.3	\$ 40.3	\$ 38.7	\$ 40.5	\$ 42.4	\$ 44.4	\$ 42.8	\$ 45.0	\$ 47.4	\$ 47.8	\$ 50.4		
Fare Revenues - Existing Rail	\$ 28.5	\$ 29.7	\$ 31.2	\$ 32.1	\$ 35.9	\$ 37.2	\$ 38.5	\$ 39.8	\$ 44.1	\$ 45.5	\$ 46.9	\$ 49.9	\$ 51.4		
Fare Revenues - New Start	\$ 7.9	\$ 8.1	\$ 8.4	\$ 8.6	\$ 9.6	\$ 9.9	\$ 10.2	\$ 10.5	\$ 11.6	\$ 11.9	\$ 12.3	\$ 13.1	\$ 13.5		
Total Fare Revenue	\$ 69.8	\$ 74.9	\$ 77.9	\$ 81.0	\$ 84.2	\$ 87.6	\$ 91.1	\$ 94.7	\$ 98.5	\$ 102.5	\$ 106.6	\$ 110.8	\$ 115.3		
Annual % Change	8.8%	7.2%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%		
Average Fare	\$ 1.03	\$ 1.09	\$ 1.11	\$ 1.13	\$ 1.15	\$ 1.17	\$ 1.19	\$ 1.21	\$ 1.23	\$ 1.25	\$ 1.28	\$ 1.30	\$ 1.32		
Annual % Change	0.0%	5.8%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%		

Table 8-9: Fare Revenue Forecasts for Proposed Project and Existing System, Current Dollars (Millions)

8.2.3.2 Operating Costs

System-wide O&M expenses typically increase after a transit project goes into revenue service requiring additional subsidies to continue operating and maintaining the transit system. FTA needs to determine whether the project sponsor has the financial capacity to fund these additional subsidies without reducing existing service levels. Consequently, the operating plan clearly identifies how existing operations will be affected by the proposed project. Fixed guideway projects often result in significant service realignments. The operating plan details:

- How the project will impact existing operations, revenues and O&M costs;
- How bus routes will be realigned;
- What bus routes will be dropped; and
- What new feeder routes are planned?

presents an example of a schedule of O&M costs for the proposed project and the existing transit system with supporting service statistics.

The accompanying text documents the O&M cost estimation methodology, preferably resource cost build-up, and describes the service plans for the proposed project and existing transit system. The cost estimation documentation provides details regarding operating labor, maintenance labor, fuel, supplies, administration and other relevant cost categories.

Changes in O&M costs have three components: (1) inflation for labor and materials, (2) service/operating changes, and (3) changes in productivity. The plan documents the inflation assumptions, the planned system-wide operating and service characteristics, and productivity assumptions to demonstrate that the agency is not paying for the proposed project's O&M costs through reductions in service or deferred maintenance on the existing system.

8.2.3.3 Agency-Wide Operating Plan

The operating revenues and O&M cost estimates are combined in the agency-wide operating plan. The operating plan demonstrates that adequate additional funds are available to operate and maintain the proposed project and the rest of the transit system. The operating plan calculates the additional subsidy required to operate and maintain the proposed project. The operating plan shows the availability of additional operating revenues to cover the additional expenses. Table 8-11 presents an example of an operating plan. In this example, the transit agency forecasts operating surpluses large enough to easily absorb the subsidy using existing funding sources.

Fiscal Year	Actual 1994	Actual 1995	Actual 1996	Actual 1997	Actual 1998	Budget 1999	2000	2001	2002	2003	2004	2005	2006
<u>Vehicle Revenue Miles (million)</u>													
Bus	25.2	25.5	26.1	26.0	25.4	25.5	27.7	25.8	26.4	24.3	24.7	25.7	24.0
Existing Rail	2.8	2.9	3.0	3.0	3.0	3.0	5.0	5.5	6.0	6.0	6.0	6.0	6.0
Proposed New Start	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
<u>Directional Route Miles</u>													
Bus	1885.0	1890.0	1880.0	1850.0	1826.0	1838.0	1658.0	1725.0	1720.0	1750.0	1780.0	1850.0	1720.0
Rail	50.4	50.4	50.4	50.4	50.4	50.4	70.1	70.1	70.1	70.1	70.1	70.1	76.0
<u>Vehicles in Maximum Service</u>													
Bus	584	585	582	573	565	569	513	534	533	542	551	573	533
Rail	60	60	62	68	66	68	96	94	99	100	99	102	125
<u>Operating & Maintenance Expenses</u>													
Existing Bus O&M	\$ 97.9	\$ 102.4	\$ 106.9	\$ 110.8	\$ 115.5	\$ 121.0	\$ 121.7	\$ 124.3	\$ 126.3	\$ 131.6	\$ 137.8	\$ 144.4	\$ 145.9
Existing Rail O&M	\$ 14.0	\$ 14.9	\$ 15.9	\$ 16.4	\$ 16.9	\$ 17.4	\$ 29.9	\$ 34.0	\$ 38.3	\$ 39.6	\$ 40.9	\$ 42.3	\$ 43.8
Proposed New Start O&M	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 3.6
Total O&M Expenses	\$ 111.9	\$ 117.3	\$ 122.8	\$ 127.2	\$ 132.4	\$ 138.4	\$ 151.6	\$ 158.3	\$ 164.6	\$ 171.2	\$ 178.8	\$ 186.7	\$ 193.4
Annual % Change		4.9%	4.7%	3.6%	4.1%	4.5%	9.5%	4.4%	4.0%	4.0%	4.4%	4.4%	3.6%
Fiscal Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
<u>Vehicle Revenue Miles (million)</u>													
Bus	24.5	25.0	25.5	26.0	26.5	27.1	27.6	28.2	28.7	29.3	29.9	30.5	31.1
Existing Rail	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Proposed New Start	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
<u>Directional Route Miles</u>													
Bus	1,754	1,789	1,825	1,862	1,899	1,937	1,976	2,015	2,056	2,097	2,139	2,181	2,225
Rail	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0
<u>Vehicles in Maximum Service</u>													
Bus	543	554	565	576	588	600	612	624	636	649	662	675	689
Rail	125	126	128	130	130	130	130	130	130	130	130	130	130
<u>Operating & Maintenance Expenses</u>													
Existing System - Bus	\$ 123.7	\$ 129.6	\$ 135.8	\$ 142.3	\$ 149.1	\$ 156.2	\$ 163.7	\$ 171.5	\$ 179.6	\$ 188.1	\$ 197.1	\$ 206.4	\$ 216.2
Existing System - Rail	\$ 67.9	\$ 70.2	\$ 72.6	\$ 75.1	\$ 77.6	\$ 80.3	\$ 83.0	\$ 85.8	\$ 88.7	\$ 91.7	\$ 94.9	\$ 98.1	\$ 101.4
Proposed New Start O&M	\$ 18.9	\$ 19.5	\$ 20.2	\$ 20.9	\$ 21.6	\$ 22.3	\$ 23.1	\$ 23.8	\$ 24.6	\$ 25.5	\$ 26.4	\$ 27.2	\$ 28.2
Total O&M Expenses	\$ 210.4	\$ 219.3	\$ 228.6	\$ 238.2	\$ 248.3	\$ 258.8	\$ 269.7	\$ 281.1	\$ 293.0	\$ 305.4	\$ 318.3	\$ 331.7	\$ 345.8
Annual % Change	8.8%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%

Table 8-10: Operating and Maintenance Expenses, Year-of-Expenditure Dollars (Millions)

Fiscal Year	Actual 1994	Actual 1995	Actual 1996	Actual 1997	Actual 1998	Budget 1999	2000	2001	2002	2003	2004	2005	2006
Operating Revenue													
Existing System Fares (see Table 9)	\$ 35.5	\$ 36.6	\$ 37.9	\$ 40.2	\$ 42.0	\$ 44.1	\$ 49.0	\$ 51.4	\$ 53.5	\$ 55.1	\$ 57.3	\$ 59.6	\$ 62.6
Proposed New Start Fares (see Table 9)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 1.0
Other Operating Revenue	\$ 4.3	\$ 5.7	\$ 6.6	\$ 8.9	\$ 11.3	\$ 14.2	\$ 15.4	\$ 15.7	\$ 16.0	\$ 16.3	\$ 16.7	\$ 17.0	\$ 17.3
Total System Revenue	\$ 39.8	\$ 42.3	\$ 44.5	\$ 49.1	\$ 53.3	\$ 58.3	\$ 64.4	\$ 67.2	\$ 69.5	\$ 71.5	\$ 74.0	\$ 76.6	\$ 81.0
Sales Tax - 50% (see Table 6)	\$ 67.5	\$ 73.6	\$ 78.9	\$ 83.3	\$ 88.5	\$ 94.2	\$ 98.9	\$ 102.6	\$ 106.3	\$ 110.5	\$ 114.9	\$ 119.6	\$ 124.4
Total Operating Revenues	\$ 107.3	\$ 115.9	\$ 123.4	\$ 132.4	\$ 141.8	\$ 152.6	\$ 163.3	\$ 169.8	\$ 175.8	\$ 181.9	\$ 188.9	\$ 196.2	\$ 205.4
Annual % Change		8.0%	6.4%	7.3%	7.1%	7.6%	7.1%	4.0%	3.6%	3.5%	3.8%	3.9%	4.7%
Operating & Maintenance Expenses													
Existing System O&M (see Table 10)	\$ 111.9	\$ 117.3	\$ 122.8	\$ 127.2	\$ 132.4	\$ 138.4	\$ 151.6	\$ 158.3	\$ 164.6	\$ 171.2	\$ 178.8	\$ 186.7	\$ 189.7
New Start O&M (see Table 10)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 3.6
Total O&M Expenses	\$ 111.9	\$ 117.3	\$ 122.8	\$ 127.2	\$ 132.4	\$ 138.4	\$ 151.6	\$ 158.3	\$ 164.6	\$ 171.2	\$ 178.8	\$ 186.7	\$ 193.4
Balance from Existing Operations	\$ (4.6)	\$ (1.4)	\$ 0.6	\$ 5.2	\$ 9.4	\$ 14.2	\$ 11.8	\$ 11.5	\$ 11.2	\$ 10.8	\$ 10.1	\$ 9.5	\$ 14.7
New Start Subsidy Requirement	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 2.6
Balance from Operations	\$ (4.6)	\$ (1.4)	\$ 0.6	\$ 5.2	\$ 9.4	\$ 14.2	\$ 11.8	\$ 11.5	\$ 11.2	\$ 10.8	\$ 10.1	\$ 9.5	\$ 12.1
Operating Ratio	35.6%	36.1%	36.2%	38.6%	40.3%	42.2%	42.5%	42.4%	42.2%	41.7%	41.4%	41.0%	41.9%
Fiscal Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Operating Revenue													
Existing System Fares (see Table 9)	\$ 62.0	\$ 66.7	\$ 69.5	\$ 72.4	\$ 74.6	\$ 77.7	\$ 80.9	\$ 84.3	\$ 86.9	\$ 90.5	\$ 94.3	\$ 97.7	\$ 101.8
Proposed New Start Fares (see Table 9)	\$ 7.9	\$ 8.1	\$ 8.4	\$ 8.6	\$ 9.6	\$ 9.9	\$ 10.2	\$ 10.5	\$ 11.6	\$ 11.9	\$ 12.3	\$ 13.1	\$ 13.5
Other Operating Revenue	\$ 17.7	\$ 18.0	\$ 18.4	\$ 18.8	\$ 19.1	\$ 19.5	\$ 19.9	\$ 20.3	\$ 20.7	\$ 21.1	\$ 21.6	\$ 22.0	\$ 22.4
Total System Revenue	\$ 87.5	\$ 92.9	\$ 96.3	\$ 99.7	\$ 103.4	\$ 107.1	\$ 111.0	\$ 115.1	\$ 119.2	\$ 123.6	\$ 128.1	\$ 132.8	\$ 137.7
Sales Tax - 50% (see Table 6)	\$ 129.2	\$ 134.4	\$ 139.8	\$ 145.4	\$ 151.4	\$ 157.6	\$ 164.0	\$ 170.5	\$ 177.5	\$ 184.8	\$ 192.2	\$ 200.0	\$ 208.1
Total Operating Revenues	216.76	227.28	236.03	245.15	254.75	264.75	274.97	285.56	296.73	308.42	320.31	332.83	345.78
Annual % Change	5.5%	4.9%	3.8%	3.9%	3.9%	3.9%	3.9%	3.8%	3.9%	3.9%	3.9%	3.9%	3.9%
Operating & Maintenance Expenses													
Existing System O&M (see Table 10)	\$ 191.6	\$ 199.8	\$ 208.4	\$ 217.4	\$ 226.7	\$ 236.5	\$ 246.7	\$ 257.3	\$ 268.3	\$ 279.9	\$ 291.9	\$ 304.5	\$ 317.6
New Start O&M (see Table 10)	\$ 18.9	\$ 19.5	\$ 20.2	\$ 20.9	\$ 21.6	\$ 22.3	\$ 23.1	\$ 23.8	\$ 24.6	\$ 25.5	\$ 26.4	\$ 27.2	\$ 28.2
Total O&M Expenses	\$ 210.4	\$ 219.3	\$ 228.6	\$ 238.2	\$ 248.3	\$ 258.8	\$ 269.7	\$ 281.1	\$ 293.0	\$ 305.4	\$ 318.3	\$ 331.7	\$ 345.8
Balance from Existing Operations	\$ 17.3	\$ 19.3	\$ 19.2	\$ 19.2	\$ 18.4	\$ 18.4	\$ 18.1	\$ 17.8	\$ 16.8	\$ 16.6	\$ 16.1	\$ 15.2	\$ 14.7
New Start Subsidy Requirement	\$ 11.0	\$ 11.4	\$ 11.8	\$ 12.2	\$ 12.0	\$ 12.4	\$ 12.9	\$ 13.4	\$ 13.1	\$ 13.5	\$ 14.1	\$ 14.1	\$ 14.7
Balance from Operations	\$ 6.3	\$ 8.0	\$ 7.4	\$ 6.9	\$ 6.5	\$ 6.0	\$ 5.3	\$ 4.5	\$ 3.8	\$ 3.0	\$ 2.0	\$ 1.1	\$ 0.0
Operating Ratio	41.6%	42.4%	42.1%	41.9%	41.6%	41.4%	41.2%	40.9%	40.7%	40.5%	40.3%	40.0%	39.8%

8.2.4 The Cash Flow Analysis

The overall objective of preparing a financial plan is to demonstrate that the agency has the financial resources to successfully construct the proposed project while adequately operating, maintaining, and recapitalizing the existing and planned transit system. The cash flow statement combines the results of the capital plan and the operating plan to summarize the year-by-year financial condition of the project sponsor throughout the 20-year analysis period.

Cash flow analysis is a valuable tool for project planning. Its application permits project sponsors to develop and test funding strategies, test alternative assumptions, and conduct risk analysis as part of the agency's continuing financial planning activities. The cash flow statement includes at least five prior years of actual costs and revenues to provide a clear picture of the historical financial position of the agency and to substantiate the growth rates assumed in future years. Table 8-12 is an example of a 20-year cash flow summary.

The example is not meant to mandate how a transit agency accounts for agency cash flow. The agency in the example carries a large cash balance that is available for operating shortfalls as well as capital projects while operating surpluses can be used for capital expenditures. This is not legally possible for some agencies that must maintain separate funds for operations and capital. In the example, the primary non-federal funding source is the sales tax, which is divided equally between operating and capital expenses. Some transit agencies have the freedom to use dedicated funding sources for any transit activity while others are restricted to using them for a particular purpose or to allocate them between purposes based on a formula. The agency's financial plan identifies and reflects all of the restrictions and covenants that determine how funds are allocated and used.

The cash flow statements are structured in a way that reflects the agency's restrictions on operating and capital funds. Many agencies have restrictions on the use of cash balances such as debt retirement, contractual obligations, lease deposits, uninsured losses or reserve accounts for specific projects. If an agency is subject to any of these restrictions, balances in these restricted accounts are identified in the cash flow statement and not included as "available" cash.

8.2.4.1 Financial Evaluation

The cash flow projection demonstrates that the agency has adequate resources to complete the project as planned and continue to operate the existing transit service. Evidence of this financial capacity could be cash balances or debt service ratios. In general, cash balances should be sufficient to fund at least three months of operations. In the example cash flow projection, the transit agency maintains a working capital fund adequate to fund about one year of operations. The bond market typically requires gross debt service ratios to exceed 150 percent, which means that revenues pledged to cover debt service must exceed 150 percent of annual debt service. Many transit agencies are subject to more stringent debt ratio requirements.

The cash flow projection is often evaluated to determine the sensitivity of an agency's financial health to changes in the assumptions underlying the financial plan. If small changes in the financial planning or economic assumptions, such as economic growth, transit ridership or interest rates, result in financial difficulties for the agency, the financial capacity of the agency may be questionable.

Fiscal Year	Actual 1994	Actual 1995	Actual 1996	Actual 1997	Actual 1998	Budget 1999	2000	2001	2002	2003	2004	2005	2006
Operating													
Operating Revenue (see Table 11)	\$ 107.3	\$ 115.9	\$ 123.4	\$ 132.4	\$ 141.8	\$ 152.6	\$ 163.3	\$ 169.8	\$ 175.8	\$ 181.9	\$ 188.9	\$ 196.2	\$ 205.4
O & M Expenses (see Table 10)	\$ 111.9	\$ 117.3	\$ 122.8	\$ 127.2	\$ 132.4	\$ 138.4	\$ 151.6	\$ 158.3	\$ 164.6	\$ 171.2	\$ 178.8	\$ 186.7	\$ 193.4
Balance from Operations	\$ (4.6)	\$ (1.4)	\$ 0.6	\$ 5.2	\$ 9.4	\$ 14.2	\$ 11.8	\$ 11.5	\$ 11.2	\$ 10.8	\$ 10.1	\$ 9.5	\$ 12.1
Capital													
Capital Revenue (see Table 8)	\$ 189.2	\$ 222.6	\$ 286.5	\$ 281.5	\$ 214.7	\$ 202.6	\$ 178.8	\$ 185.9	\$ 198.5	\$ 278.3	\$ 280.1	\$ 284.0	\$ 242.1
Capital Expenditures (see Table 8)	\$ 148.4	\$ 171.9	\$ 228.1	\$ 231.2	\$ 206.7	\$ 152.1	\$ 125.9	\$ 140.4	\$ 139.3	\$ 202.2	\$ 213.5	\$ 232.1	\$ 198.6
Debt Service Costs (see Table 8)	\$ 39.8	\$ 44.0	\$ 51.4	\$ 57.7	\$ 57.7	\$ 57.7	\$ 57.7	\$ 57.7	\$ 57.7	\$ 60.5	\$ 61.9	\$ 63.3	\$ 63.3
Change in Capital Funds	\$ 1.0	\$ 6.7	\$ 7.1	\$ (7.4)	\$ (49.6)	\$ (7.2)	\$ (4.7)	\$ (12.2)	\$ 1.5	\$ 15.7	\$ 4.7	\$ (11.3)	\$ (19.7)
Cash Balance													
Beginning Cash Balance	\$ 189.9	\$ 186.3	\$ 191.6	\$ 199.3	\$ 197.1	\$ 156.9	\$ 164.0	\$ 171.0	\$ 170.4	\$ 183.1	\$ 209.6	\$ 224.5	\$ 222.7
Change to Cash Balance	\$ (3.6)	\$ 5.3	\$ 7.6	\$ (2.2)	\$ (40.2)	\$ 7.1	\$ 7.1	\$ (0.7)	\$ 12.8	\$ 26.4	\$ 14.9	\$ (1.8)	\$ (7.7)
Closing Cash Balance	\$ 186.3	\$ 191.6	\$ 199.3	\$ 197.1	\$ 156.9	\$ 164.0	\$ 171.0	\$ 170.4	\$ 183.1	\$ 209.6	\$ 224.5	\$ 222.7	\$ 215.0
Fiscal Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Operating													
Operating Revenue (see Table 11)	\$ 216.8	\$ 227.3	\$ 236.0	\$ 245.2	\$ 254.7	\$ 264.8	\$ 275.0	\$ 285.6	\$ 296.7	\$ 308.4	\$ 320.3	\$ 332.8	\$ 345.8
O & M Expenses (see Table 10)	\$ 210.4	\$ 219.3	\$ 228.6	\$ 238.2	\$ 248.3	\$ 258.8	\$ 269.7	\$ 281.1	\$ 293.0	\$ 305.4	\$ 318.3	\$ 331.7	\$ 345.8
Balance from Operations	\$ 6.3	\$ 8.0	\$ 7.4	\$ 6.9	\$ 6.5	\$ 6.0	\$ 5.3	\$ 4.5	\$ 3.8	\$ 3.0	\$ 2.0	\$ 1.1	\$ 0.0
Capital													
Capital Revenue (see Table 8)	\$ 198.3	\$ 204.7	\$ 211.0	\$ 216.4	\$ 222.2	\$ 228.5	\$ 234.7	\$ 241.1	\$ 248.1	\$ 255.6	\$ 263.1	\$ 270.8	\$ 278.9
Capital Expenditures (see Table 8)	\$ 123.3	\$ 136.7	\$ 157.7	\$ 163.4	\$ 164.8	\$ 172.0	\$ 179.6	\$ 187.5	\$ 195.8	\$ 204.6	\$ 213.8	\$ 223.4	\$ 233.5
Debt Service Costs (see Table 8)	\$ 63.3	\$ 63.3	\$ 63.3	\$ 63.3	\$ 63.3	\$ 63.3	\$ 63.3	\$ 58.0	\$ 52.8	\$ 52.8	\$ 52.8	\$ 48.6	\$ 43.5
Change in Capital Funds	\$ 11.8	\$ 4.7	\$ (9.9)	\$ (10.2)	\$ (5.9)	\$ (6.8)	\$ (8.1)	\$ (4.4)	\$ (0.5)	\$ (1.7)	\$ (3.4)	\$ (1.1)	\$ 1.9
Cash Balance													
Beginning Cash Balance	\$ 215.0	\$ 233.1	\$ 245.8	\$ 243.3	\$ 240.0	\$ 240.6	\$ 239.8	\$ 237.0	\$ 237.0	\$ 240.3	\$ 241.6	\$ 240.3	\$ 240.3
Change to Cash Balance	\$ 18.1	\$ 12.7	\$ (2.5)	\$ (3.3)	\$ 0.6	\$ (0.8)	\$ (2.8)	\$ 0.0	\$ 3.2	\$ 1.4	\$ (1.4)	\$ (0.0)	\$ 1.9
Closing Cash Balance	\$ 233.1	\$ 245.8	\$ 243.3	\$ 240.0	\$ 240.6	\$ 239.8	\$ 237.0	\$ 237.0	\$ 240.3	\$ 241.6	\$ 240.3	\$ 240.3	\$ 242.2

8.3 Capital Cost Estimates

This section describes the major cost inputs to the financial planning process. One of the initial and perhaps most important activities in the development of a financial plan is the estimation of capital and operating costs of the proposed project and existing system. These estimates determine the funding requirements to build new projects as well as the ongoing funding requirements to operate and maintain proposed projects in the context of the existing transit system. Forecasting costs takes on great importance since: 1) it provides the target for securing funding commitments; 2) any significant mistake could harm the ability of the project sponsor to implement the project or other planned projects; and 3) cost overruns can force major reductions in service on the existing system.

Transit agencies generally rely on engineering consultants to provide cost estimates for major capital projects. Therefore, this section emphasizes the use of cost estimates in the financial planning process rather than the development of capital cost estimates themselves.

The transportation industry's history of underestimation of capital costs has diminished the credibility of planning efforts across the country. Large cost increases late in the planning process have resulted in loss of funding, delayed construction for proposed projects as well as other planned initiatives, and a loss of public trust in the development and implementation of highway and transit improvements. While there may be incentives to use the lowest reputable cost estimates in developing capital improvement programs, it is not a prudent approach to transportation planning. Careful, conservative estimation of project costs must be a priority in the development of transportation capital improvement programs.

In addition to the development of construction cost estimates, the ongoing rehabilitation of capital equipment is a hallmark of good planning. Depending on the useful life of key assets and the performance of regular maintenance, most elements of a transit system will require periodic rehabilitation and replacement. The experience of rail systems built in the 1970's, where delayed capital rehabilitation resulted in degraded service and required the expenditure of billions of dollars, emphasizes the need to plan for capital rehabilitation. Capital rehabilitation projects involve large expenditures that are vital to the continued efficient operation of transit systems and must be programmed into the agency-wide capital plan.

8.3.1 Project Development and Capital Costing

The actual estimation of capital costs involves different techniques depending on the type of cost under consideration and the phase of project development. Prudent financial planning requires that all potential projects with a reasonable chance of implementation in the foreseeable future be evaluated to determine their financial feasibility and to identify future funding needs. Transit agencies may want to incorporate projects in their financial planning activities that have not been the subject of any significant engineering work if they have a reasonable

expectation that those projects will be implemented during the relevant planning horizon. The financial plan will certainly contain all transit related projects found in the MPO's long-range plan. In addition, the rehabilitation and replacement of existing and planned facilities and vehicles must be scheduled based on their useful lives.

8.3.1.1 Rehabilitation and Replacement

The rehabilitation and replacement (R&R) of capital resources is needed for several reasons. First, capital resources wear out. Stations, maintenance facilities, track-way, signal systems, propulsion systems, and vehicles all have distinct useful lives. These assets must be re-capitalized before deterioration leads to service disruptions. Second, technological obsolescence due to the availability of parts or technological advances may spur the replacement of various systems. Old rail cars may become increasingly difficult to maintain and require replacement or agencies may wish to implement communications based train control, automatic train stop, or passenger information systems to improve system reliability and safety. Third, changes in operating or safety policies may require new capital investment. One example is station or vehicle enhancements to assure compliance with the American's with Disabilities Act (ADA).

Prudent capital planning requires an inventory of the agency's assets and an evaluation of the expected useful life of each major component. An R&R cycle is assumed for each of the major assets and annual costs are projected at least 20 years into the future. Agencies planning major capital investments need to incorporate the R&R of those assets in the later years of the capital plan in addition to the ongoing R&R of the existing asset base.⁴

In most cases, the capital costs for R&R will vary markedly from one year to the next due to different cycles and widely varying costs for the numerous components. Agencies typically establish reserve accounts, sometimes called sinking funds, to provide the funds for sudden increases in capital spending. Occasionally, agencies smooth out the R&R cost swings by using a multi-year rolling average as the annual cost estimate.

8.3.1.2 Major Capital Investments

Estimating the construction costs of major capital investments requires a different approach than estimating rehabilitation and replacement costs. The phase of project development as well as the type of investment determines the appropriate level of effort and detail for the cost estimation efforts. While planners may have a rough idea of the costs of various projects, the first substantial cost estimation effort is undertaken during alternatives analysis.

⁴ The Government Accounting Standards Board (GASB) Statement No. 34 mandates that all government entities are required to report all capital assets, including infrastructure, and related depreciation expenses in government financial statements. For agencies with more than \$100 million in annual revenues, prospective reporting (new assets) of infrastructure assets was required as of June 15, 2001. For agencies with between \$10 and \$100 million in annual revenue, prospective reporting was required as of June 15, 2002. Agencies with less than \$10 million in annual revenues must apply prospective reporting after June 15, 2003. Retroactive reporting (pre-existing assets) is required four years after the prospective reporting deadlines.

The level of effort expended during alternatives analysis must be adequate to ensure that the evaluation of the relative costs and benefits of the alternatives is not skewed by any cost estimation errors. Clearly, the level of effort and detail of the engineering and costing efforts will depend on the type and complexity of the proposed project. A commuter rail project on existing tracks without any tunnels or bridges can get by with much less effort than a proposed subway project through a central business district because of the uncertainties inherent in tunnel construction in difficult environments. During preliminary engineering, cost estimates must be refined to a level of confidence that allows the grantee to line up funding for the project without exposing themselves to an unreasonable risk of any significant cost increase. Standard industry practice has been to define the level of engineering effort in PE to be a certain percentage of the total design activity (i.e. 30%). However, the level of effort required in PE cannot be defined by a percentage. Grantees must expend whatever level of effort is required to get accurate cost estimates in preliminary engineering. In final design, construction drawings are finalized and bid documents prepared. Cost estimates should not change appreciably in final design or during construction.

8.3.2 Overview of Capital Cost Estimation Methods

The intent of this section is not to provide a methodology for project sponsors to estimate the cost of proposed projects, which is provided in Chapter 3. Rather, the intent is to describe how cost estimates generated in planning studies and during project development are used in the transit agency's financial planning activities. Hopefully, by understanding the proper use of cost estimates in financial planning, project sponsors may also demand better information regarding the potential uncertainties surrounding cost estimates for major capital investments.

During project planning, two levels of engineering effort are used to build capital cost estimates, one for "typical" facilities and another for "special" situations. A "typical cross-section" is defined for the portion of a project that can be analyzed at an aggregate level. Detailed unit costs are applied to the quantities in the typical sections to estimate capital costs per linear foot. A similar approach is used for stations by type (at-grade, elevated, subway, or terminal). Plan and profile drawings are prepared and quantities computed for each alternative. Segment costs are computed to estimate the capital costs for each segment, exclusive of system-wide elements and add-on items.

Certain costs cannot be estimated using the typical segment approach. Special conditions such as major structures (bridges, tunnels) or uncertain alignments in areas with major existing structures or uncertain terrain or soil conditions represent major areas of cost uncertainty and are subject to a more detailed engineering effort. Additional drawings, quantities and unit costs are developed for these special segments and cost estimates derived exclusive of system-wide elements and add-ons.

System-wide elements include vehicles, electrification, signalization and train control systems. The quantities and characteristics of these elements are determined by the service standards defined for the system. The costs of these items are estimated by multiplying the associated unit costs by system-wide quantities. Add-ons refer to contingency allowances, engineering, insurance, and management services. The cost of these items is typically expressed as a percentage of the other estimated capital costs.⁵

Items that are not functionally part of the project, but that are necessitated by the project must be included in the cost estimates. Some examples of this type of project cost include environmental mitigation such as noise barriers and creation of new wetlands, as well as beautification projects, utility relocation, and rebuilding streetscapes torn up by project construction. All these items must be identified and included in cost estimates at the very beginning of the planning process. To the extent that the costs associated with these items is unknown, a reasonable attempt must be made to make an educated guess regarding what types of auxiliary project elements will be required.

8.3.3 Dealing with Financial Risk to the Cost Estimates

Financial risk is generally defined as the likelihood of financial losses due to uncertainty. Implementing major transportation projects is subject to risks that need to be accounted for in the financial plan. The financial plan accounts for risks that costs and revenues may both deviate from the most careful projections. This section addresses the financial risks to the cost estimates and how the financial plan can minimize those risks. Financial risk to revenue forecasts will be addressed in section 8.5.

The sources of financial risk related to project cost estimates include the following:

- uncertainty in the inflation assumptions;
- changes in project design standards;
- changes in project scope (or omitting key project elements);
- changes in the project schedule;
- uncertainty in the unit cost assumptions; and
- unforeseen construction problems.

The numerous areas of uncertainty highlight the potential for significant cost estimation problems. Any systematic bias toward underestimating the potential of these risks to increase costs can have a compounding effect that amplifies the size of the potential cost overrun.

⁵ *Financial Planning Guide for Transit*, UMTA, April 1990, p. 66.

A common misconception is that the contingency line item in the cost estimate mitigates all of these areas of financial risk. The contingency set aside in a cost estimate should account for unforeseen construction problems and, perhaps, the uncertainty in unit cost estimates. It does not address the full range of uncertainties driving financial risk in the project.

Complicating the effort to account for and express the level of financial risk in a cost estimate is the desire to attach a single price tag to major capital investments. In reality, there is a wide range of potential costs for most projects. Project planning studies need to identify the full range of potential costs and evaluate the likelihood of the various estimates. Consider a project that has a range of cost estimates from \$300 million to \$1 billion with a best guess of \$500 million. In addition to evaluating a \$500 million project, the project sponsor needs to consider the implications of building a potential \$1 billion project. What is the likelihood of the project costing \$1 billion? Would it still be feasible? Would the scope need to be reduced? Would the project need to be delayed? Would it still be the preferred alternative? These questions should be the basis for evaluating the financial feasibility of any major capital investment.

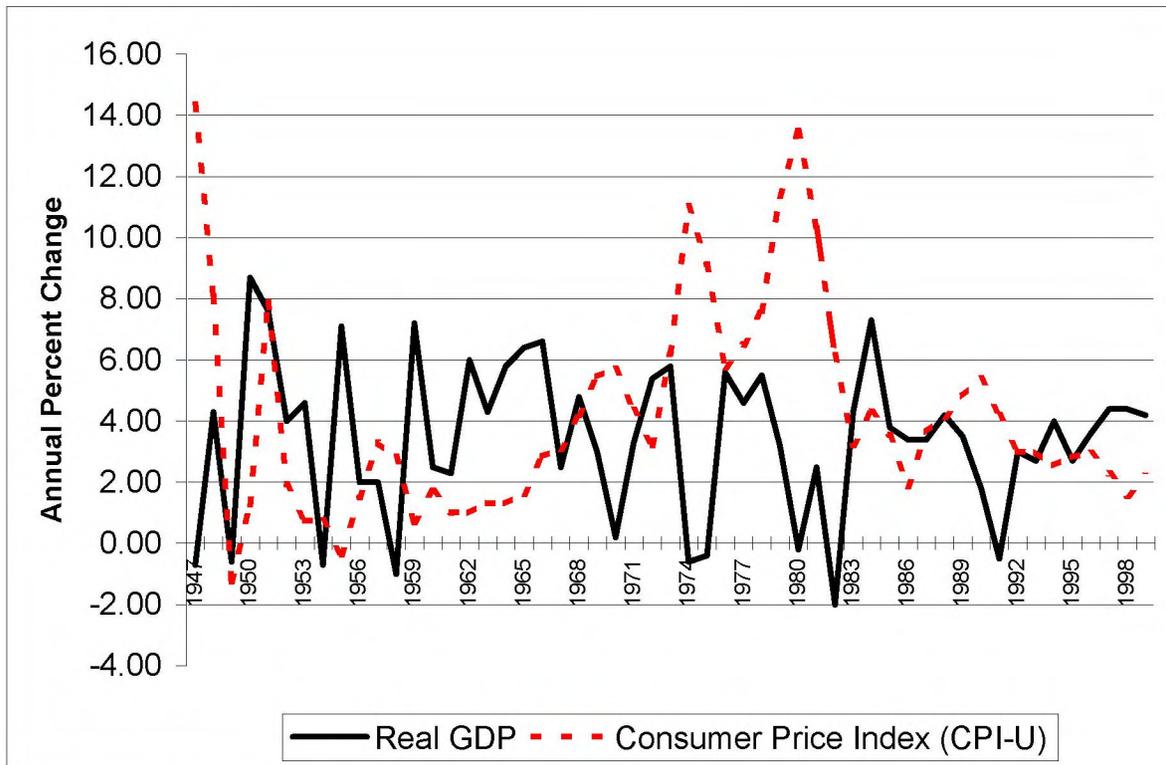
8.3.3.1 Inflation Risk

The financial plan documents the cash flow requirements to fund construction of the proposed project. A major step in the development of the cash flow requirements is the conversion of constant dollar cost estimates to year of expenditure dollars. This conversion requires a series of assumptions regarding inflation expectations between the base year of the constant dollar engineering cost estimate and the last year of construction. Construction costs can also be quite volatile year-to-year creating the potential for significant risk of actual costs deviating from earlier estimates.

Defensible inflation forecasts are available from many sources. Agencies typically use long-range forecasts from professional economic forecasting firms or forecasts developed by local universities. Forecasts of construction cost and building cost inflation are usually available from these same sources. The inflation associated with construction costs are more volatile than general price inflation and have the potential to escalate very rapidly if labor or material shortages occur. Agencies should use forecasts specific to their own regional economy since regional differences in economic performance can be large.

Economic forecasting, especially when looking beyond one or two years, is highly uncertain. These forecasts really provide alternative scenarios, each with a varying likelihood of occurring. The only thing that is certain about economic forecasts is that the forecasts will be wrong. Economic models can identify various relationships, but random events and circumstances ensure that reality will deviate from expectations to some degree. Figure 8-2 displays the US economy's consumer price inflation and growth in real GDP since 1947. The average annual rate of inflation over this period was 4.2% with some years as high as 14.4 % and others as low as -1.2 %.

Figure 8-2: Annual Percent Change in CPI-U and "Real" GDP



Source: Bureau of Labor Statistics

Effectively dealing with uncertainty means that the financial plan is based on conservative economic assumptions that are consistent throughout the analysis. By consistent, we mean that the same inflation assumptions are applied to the cost side as to the revenue side.

From the perspective of cost estimates, conservative inflation assumptions would mean that inflation assumptions used in the analysis are higher than expected. However, higher inflation might be associated with an optimistic higher growth economic scenario. Faster economic growth may well be associated with higher construction costs due to labor and material shortages.

8.3.3.2 Scope and Design Risk

Two common and related causes of cost increases during project development are scope changes and design changes. Scope changes may include changing the project length or number of stations along a transit line. Design changes result from changes in the specific design elements of the project.

Uncertainty about specific design elements is a critical source of risk to project cost estimates. Significant design changes occur on an all too regular basis requiring additional funding or reductions in the project scope to maintain financial feasibility. Design changes are often driven by technical factors surrounding a variety of design alternatives. Only after some amount of engineering work will the definitive design choice be made. Sometimes, design

choices are driven by political considerations, financial constraints, or the need to minimize or mitigate environmental impacts.

As an example, consider a segment of a rail transit project with three possible design options to deal with grade crossings: full grade separation, grade separation at key crossings, and upgraded crossing protection. Upgraded crossing protection is the cheapest option, but may be unsightly, disruptive to traffic, and more dangerous. Providing grade separation at key crossings seeks to improve safety and reduce disruption at the most critical points at some added expense. The full grade separation option is very expensive, but provides the best transit operating characteristics, is the safest, and least disruptive to traffic. The costs could range from \$75 million for crossing protection upgrades to \$100 million for key crossing separation to \$150 million for full grade separation. The choice of design will depend on political considerations regarding the affected corridor and the amount of funding available. Technical considerations may also drive the design choice if site conditions prevent certain construction activities or if utility relocation problems preclude some grade crossing separations.

The temptation for a planner is to assume the cheapest option. The lowest possible cost estimate makes the project more politically appealing, easier to fit into long range plans and TIP's, and more popular with the public. This would be imprudent and misleading since there is a real possibility that the segment could be 100% more expensive. Using the lowest cost estimate would be a critical mistake. Cost increases later in project development breed distrust among voters, strain local resources and can cause political support for projects to evaporate. There are many examples of projects that have been brought to the beginning of construction only to collapse under cost overruns. Opponents of transportation projects, both transit and highways have been using the dismal cost estimation record to date to argue against critical projects. If citizens and political leaders believe that costs generated in corridor planning are likely to double by the time construction starts, many will be unwilling to support planned projects.

A prudent approach is to estimate the expected value of the segment cost by assigning probabilities to each design option. The intent is to develop segment cost estimates where there is a 50 percent chance of exceeding the cost estimate and a 50 percent chance falling below the cost estimate. If every segment cost estimate is developed this way, cost overruns on one segment will be balanced by lower costs on other segments. In addition, the foundation for developing cost ranges is readily available.

In the example, consider the following calculation where the probability of crossing protection upgrades is 10 percent, 50 percent for the key crossing separation approach, and 40 percent for the full separation option. The expected value of the cost for this segment is as follows:

$$\begin{aligned}
E(C_i) &= P[cp] \times C_{cp} + P[kc] \times C_{kc} + P[gs] \times C_{gs} \\
&= 10\% \times \$75,000,000 + 50\% \times \$100,000,000 + 40\% \times \$150,000,000 \\
&= \$117,500,000
\end{aligned}$$

where

- C_i is the capital cost of segment i
- cp indicates crossing protection upgrades
- kc indicates key crossing separation
- gs indicates full grade separation
- P is an probability operator
- E is an expected value operator

In this example, the cost estimate for this segment is \$117.5 million, but could cost as much as \$150 million (a significant probability) or as little as \$75 million (which is unlikely). It is crucial for financial planning to understand both the probability of achieving a particular outcome and the likelihood of the other possibilities. The critical factor in developing these estimates is the probabilities assigned to each design or scope option. As projects move toward implementation, some design options are rejected and the probabilities of choosing particular options change. As this information becomes available, cost estimates must be refined to reflect current realities.

8.3.3.3 Construction Risk

Uncertainty regarding unit costs and unforeseen construction problems may be termed construction risk. Within the construction risk category, unit cost estimates are generally the most certain. Engineers know what a ton of ballast costs, how much a rail tie or a mile of 136 lb. rail costs. These costs are relatively easy to obtain and change only slightly year to year. The main source of construction risk is related to unforeseen construction problems that in turn cause scheduling delays compounding the cost overrun.

Many examples of project cost overruns have been caused by construction difficulties associated with right-of-way acquisition, utility relocation, and unforeseen soil problems. Right-of-way cost increases can stem from the erratic nature of the real estate market with rapidly increasing prices under certain market conditions. Some rail projects are planned with minimal need for right of way such as a surface street light rail line, but small changes in design or alignment can necessitate the acquisition of expensive property parcels. In older cities, the utility maps may be incorrect leading to surprise relocations of sewer and water lines or other infrastructure. Poor soil conditions can also require large expenditures for stabilization.

Potential construction cost risk can be minimized by focusing extensive engineering effort on areas with the most uncertainty, testing for utility locations,

taking numerous soil samples, etc. However, the level of engineering effort needs to match the level of project development and prudent decisions need to be made about focusing engineering effort on the areas of highest risk.

In corridor planning, cost estimates should begin with the early development of rough capital cost estimates for each alternative. These cost estimates are developed within a cost structure where each project segment and broad cost category is defined and carried through the project planning and development process. At the earliest possible stage, the areas of greatest construction risk and their likely locations should be identified including:

- right-of-way;
- tunnels and elevated structures;
- bridges;
- utility relocations;
- environmental mitigation; and
- any other area where construction difficulties could significantly affect the final cost.

Cost ranges should be applied to each project segment based on the amount of uncertainty involved. For each segment, a best case cost estimate and a worst-case cost estimate should be prepared. For instance, if the segment in question is a tunnel, the range of potential construction costs needs to be estimated including a cost estimate that considers the conditions that would produce the highest conceivable cost, a “median” or “expected” cost estimate, and the cost that would result if no problems arise.

The variation in the potential construction cost due to random or unexpected factors is handled by contingency. Contingency is based on construction risk. This is the construction budget line item that is set aside for unexpected or incidental project costs. Construction cost contingency is traditionally applied as a fixed percentage of the various cost categories with varying percentages depending on the category. For instance, right-of-way acquisition may have one contingency percentage, while construction may have another, while vehicles may have another still. This practice is meant to capture the underlying risk of various cost categories.

8.3.3.4 Schedule Slippage

Aggressive scheduling of the initiation of project construction is common in transit planning. Grantees with proposed projects in alternatives analysis and preliminary engineering occasionally present financial plans that assume construction beginning as soon as two or three years in the future. As projects move through the project development process, the planned construction date

frequently becomes later and later. Fairly typical is a 10 to 15-year process between initial planning study and the initiation of revenue service. For instance, St. Louis Metrolink planning began in 1981, the Draft Environmental Impact Statement (DEIS) finished in 1984, the FEIS was completed in 1987, construction began in 1990, and the initial segment completed in 1994. That project, which is typical, took 13 years from the beginning of project planning to initiation of revenue service.

Unrealistic assumptions about project scheduling can cause undue apparent cost escalation. If cost estimates are presented in constant dollars, every year will result in higher costs as the inflation experienced in the past year is reflected in new project costs. FTA suggests that project sponsors present capital cost estimates in year of expenditure dollars to avoid the appearance of continual cost increases that are not real. In addition, any schedule slippage appears as a cost increase, even if the constant dollar cost estimate remains the same. For this reason, conservative assumptions about planning, design, and construction schedules will pay off later in terms of fewer apparent cost increases and the potential for lower costs if the project sponsor actually beats the assumed schedule.

8.3.4 Cash Flow Requirements

The financial analysis of a proposed transit project requires an estimate of the funding stream needed to implement the project. The key inputs to this analysis are the cost estimate in as much detail as is available, a reasonable schedule for initiating construction, the length of the construction period, the distribution of costs over the construction period, and forecasts of the relevant inflation rates between the base year of the cost estimate and the end of the construction period.

Once a project begins construction, the schedule is quite well defined by the engineering work and contracts that govern construction. Financial plans that include proposed major capital investments must take the proposed schedules and costs and project the cash flow needs of the project sponsor to meet the schedule.

8.4 Operating and Maintenance Cost Estimates

This section briefly summarizes the process of estimating operating and maintenance (O&M) costs for both the existing system and the proposed project and describes how O&M costs are incorporated into the financial plan. Many transit agencies utilize detailed O&M cost models for budgeting purposes that can be readily extended to project O&M costs over the longer periods of time covered by the financial plan. Transit agencies can utilize a variety of methods for projecting O&M costs depending on the specific circumstances of the agency and the nature of the projects that are included in the financial plan.

8.4.1 Service Planning

Any acceptable O&M cost estimation methodology links costs to transit service levels. Regardless of the level of disaggregation, acceptable O&M cost models depend on assumptions about a set of service level indicators to calculate

operating and maintenance costs. Expectations about the level of service in future transit operations is likely to be the most important driver of future O&M costs. Possible future operating scenarios could be the continuation of current services and service policies, major service redesign, and/or include the implementation of major capital investments.

Key level of service variables useful for projecting O&M costs are:

- number, type, and age of vehicles;
- platform hours;
- vehicle hours;
- vehicle miles;
- annual passengers;
- number of maintenance facilities/yards;
- number and type of stations;
- number of park and ride lots and spaces; and
- route miles.

These service variables can be accounted for by mode and time of day (at least peak/off peak). The service level variables are then combined with productivity factors or unit costs and summed to estimate operating and maintenance expenses. Clearly, the estimation of the service levels that are planned in the future is just as important as knowing the unit costs and productivity factors.

Estimates of these service variables draw on a number of sources including transit network representations and ridership forecasts from travel demand models, service plans, capital improvement programs, and rail and bus fleet management plans. At a minimum, the assumptions in the financial plan must be consistent with the assumptions used to derive regional travel demand estimates both for system planning and project planning.

8.4.2 O&M Cost Estimation Methodologies

Several O&M cost estimation methodologies are available depending on the data availability and the required specificity of the outputs. There is a trade-off between model specificity and the time and effort required to produce the results so special care must be taken to employ the methods that are adequate to the needs of the financial plan. For annual budgeting that requires a great deal of precision, the most detailed costing methods are usually appropriate. For long-range forecasts of up to 20 years, the uncertainty in the level of service forecasts can become more important than the errors inherent in a more aggregate approach. For long range forecasting, detailed O&M cost models may even

provide a false sense of certainty when in fact they may turn out to be quite inaccurate.

All else being equal, the more disaggregate the O&M cost model, the more accurate the results. In addition, highly disaggregate cost models are far more useful for evaluating potential changes in the operating environment and circumstances of the transit agency. For some limited applications, simpler methods with less detail can give useful results and require much less effort and model maintenance. It is possible to forecast operating costs for a stable and steadily growing system using fairly aggregate cost models and still produce reasonably accurate forecasts. However, the introduction of new modes and major investments in vehicles and facilities generally require more detailed analysis.

8.4.2.1 Cost Allocation Models

An aggregate cost model that has been commonly applied in the past is the cost-allocation approach. Cost allocation models assign each line item of O&M costs from recent budgets to one of several service level variables. The costs assigned to each variable are summed and divided by the annual total for that service variable to produce a set of aggregate unit costs. The aggregate unit costs are applied to expected future service levels to estimate future O&M costs. Cost allocation models typically take the form:

$$C_t = c_{vm}(\text{vehicle_miles}) + c_{vh}(\text{vehicle_hours}) + c_{pv}(\text{peak_vehicles})$$

where C_t is total O&M cost and the c_x are unit costs associated with the various service factors. The benefit of this model is the ease with which it can be constructed and calibrated. The problem with this approach stems from the highly aggregate nature of the resulting model. Any changes in the service conditions on which the model was calibrated will create errors in future cost estimates. With a model that is highly aggregated, nearly any significant change can produce large errors. For instance, changes in the fuel economy of buses would be obscured by this model since all maintenance, fuel, and other mileage related costs are aggregated into the unit cost on vehicle miles.

Another example could be the change in the average speed of buses due to a busway project. Increased speeds can have multiple and complex effects on operating and maintenance costs, both in terms of fuel economy and, most importantly, in labor and capital productivity. Increasing bus speeds reduces the labor and capital requirements to provide a given service level since fewer buses and drivers can offer the same level of service. All productivity factors are combined in the unit costs on vehicle hours in the cost allocation model so that the impact of a change in one of those factors cannot be reflected in the aggregate model.

8.4.2.2 Regression Analysis

Regression analysis is an aggregate approach to forecasting costs that is technically similar to the cost allocation approach described below. This method uses a time series of data on total O&M costs and variables that influence those costs such as vehicle hours, wage rates, route miles, etc. and uses the information to estimate the causal relationship between the cost drivers and total O&M costs. A time-series regression analysis could look like the following example:

$$c_t = a + b_1(\text{vehicle_miles}_t) + b_2(\text{route_miles}_t) + b_3(\text{average_wage}_t) + \varepsilon$$

where

c	is O&M cost
a	is the estimated regression constant
b ₁ , b ₂ , b ₃	are parameters to be estimated
t	indexes the year
ε	is the residual or error term.

Specialized statistical software⁶ is usually employed to perform regression analysis using as much historical data as is available. Various combinations of variables are tested to find the model that “fits” the data the best. Then a forecast of future service levels is prepared based on service plans. The estimated causal relationships between service levels and costs are assumed to stay the same in the future, allowing the analyst to forecast total O&M costs based on expected future values for the service levels chosen for the particular regression model.

The analyst could use this method to produce more detailed information by preparing separate regression equations for each mode. This added level of detail would account for planned changes in the relative service levels of each mode. This method will still be inappropriate if other major changes, such as major new vehicle purchases, capital rehabilitation projects, or new labor agreements, have the effect of changing the past observed relationships between service levels and O&M costs. The regression analysis method is generally best when the agency is stable and changes little from year to year.

The simplest form of the regression analysis method is trend analysis. Trend analysis does not attempt to break down O&M costs by components or unit costs, but simply observes past O&M cost growth and assumes continued growth in the future. Often, a trend analysis separates the impact of inflation from “real” growth in O&M costs and forecasts these impacts individually. This method

⁶ EVIEW, LIMDEP, SPSS, and SAS are a few of the packages available for performing regression analysis and many other types of statistical analyses.

requires no statistical software to perform, but it remains a regression analysis of the form:

$$c_t = b(c_{t-1}) + \varepsilon$$

where c_t is total O&M costs (in real terms⁷) in year t and b is the growth factor estimated from historical data. If expenses have been observed to grow at 3 percent per year, b would equal about 1.03. The equation above states that O&M costs in year t equal the previous year's O&M cost plus 3 percent. This approach is only useful for projecting very stable future operating scenarios. If service levels are growing or any new projects are planned, this approach is too simplistic to be useful.

8.4.2.3 Resource Build-Up Models

The class of models referred to as “resource build-up” or “causal factors” models are a disaggregate method that allows the evaluation of O&M costs in great detail. Cost projections are made by estimating actual quantities of items required to provide the projected service levels, such as labor, fuel, and tires, and multiplying these quantities by productivity ratios and unit costs. At the most detailed level, a resource build-up model is akin to preparing an operating budget for the years that the projections are made. Resource build-up models provide the most accurate and defensible cost estimates and are preferred by the FTA for project and transit agency planning. The method is time-consuming and data-intensive and requires a reliable source of detailed cost and productivity information as well as reliable projection of service levels.

A resource build-up model represents O&M costs in a series of equations of the form:

$$c_{it} = \text{service_units} \times (\text{resources} / \text{service_unit}) \times \text{resource_unit_cost}$$

where c_{it} is the O&M cost for category i in year t . Service units could include vehicle miles, vehicle hours, peak vehicles, yards, stations, garages, track or route miles, and passengers. Productivity measures are expressed as the number of a particular resource needed to provide one unit of service. These productivity measures are given by measures such as “number of mechanics per vehicle mile” or “gallons of fuel per vehicle mile”. The unit cost is expressed in terms such as “annual wage per mechanic” or “average cost per gallon of fuel”.

When forecasting costs for existing services, resource build-up models can be very accurately calibrated to existing service levels, productivity levels, and unit costs experienced by the transit agency. New modes require some “borrowing” of productivity and unit cost data from similar projects in other areas and some extrapolation of costs based on the existing system. When cost data is used from other agencies, it is important that the O&M cost model make use of data from

⁷ adjusted to remove the impact of inflation.

agencies that can be reasonably expected to experience similar expenses. For instance, the “borrowing” of productivity measures must account for site-specific factors that impact productivity, such as weather, age of the system, technical specifications and service levels. Resource unit costs such as wage rates and fuel costs vary depending on location and must be adjusted accordingly.

Productivity Ratios

Productivity ratios are critical to the resource build-up approach. These ratios describe the how labor and materials vary with service levels. The financial planner must recognize that operating conditions and vehicle types have a major impact on productivity ratios. Average speed can be a critical factor in forecasting changes in productivity rates over time. If future congestion levels slow down bus routes by 10 percent, the productivity of the bus operator and the vehicle itself declines by 10 percent because to maintain the same level of service with slower speeds requires additional buses and drivers. In addition to the need for more drivers and equipment, fuel consumption rates also change with average speed. Different vehicle types also have different productivity ratios.

Productivity ratios change as vehicles and infrastructure age and require more maintenance to maintain a constant level of service. The preferred approach for resource build-up models is to model each vehicle type separately so that these differences can be explicitly accounted for in the projections. If vehicles are combined into a “composite” vehicle type, the productivity ratios associated with that vehicle must change with projected changes in the mix of vehicles in the fleet.

In the short run, productivity ratios can take three forms: continuously variable, step-wise variable, and fixed. The marginal cost of a continuously variable item is directly related to the level of service and remains the same over the range of service levels. Continuously variable productivity ratios include fuel use, electric power, and mileage-based maintenance among others.

Some items vary in steps rather than continuously with the level of service. The marginal cost function of these variables looks like a staircase. A good example of a step-wise variable is building maintenance. Regardless of the level of service, the maintenance expenses of a particular building remain largely the same. However, at some level of service an additional building is required and additional maintenance expenses are incurred, which produces a “step” up in building maintenance expenses. These step-wise productivity ratios change with specific increments of service, such as the peak vehicle requirement, where the specific increment is determined by the number of additional peak vehicles that would require an additional maintenance facility.

Fixed costs are those items that have a marginal cost of zero over the expected range of service variables. Some administrative functions, such as the general manager’s office, personnel, and legal services, may fall within this category.

In the long run, almost all costs are likely to be continuously variable. The reason is that service expansion necessarily creates additional responsibilities for existing staff. Leaving staff levels constant in the face of service expansion means that less attention is paid to prior responsibilities. This will cause some additional costs, through lower efficiency, to be incurred by the transit agency. Costs incurred may only become apparent in the long term. For instance, multiple service expansions in the future will undoubtedly cause higher staffing. The cost of these new staff positions can be partially attributed to the first service expansion, even though staffing did not expand until later. Finally, service expansions can cause long-term escalation in salaries net of inflation to account for the additional productivity demanded by the higher levels of service. Cumulatively, these impacts mean that nearly all productivity ratios should be treated as continuously variable in the long run.

Unit Costs

Unit costs are generally derived from well-established experience of the transit agency and comparable figures from other transit agencies when required. However, operating conditions can have a major impact on unit costs, particularly in the areas of labor. One of the most important categories of unit costs is operator wages and benefits. These items usually constitute 50 percent or more of total operating costs and are difficult to model accurately. If the type of service, composition of the workforce (full-time, part-time, over-time, and extra-board operators) and the peak to base ratio of the service in the future is similar to the calibration period, then the labor cost projections can be fairly accurate. However, any changes in these factors can be a major source of error in the O&M cost projections. The O&M cost model should account for expected changes in the factors such as peak to base ratios and the labor agreements that affect the unit cost of labor inputs.

Uncertainty in future unit costs cannot be eliminated, but a solid O&M cost model will make assumptions about operating practices and labor agreements explicit. A solid financial plan will include a sensitivity analysis on all factors that are subject to significant uncertainty to understand the range of possible outcomes or each possible course of action given a clear set of assumptions.

8.4.3 Existing System Operating and Maintenance Costs

Funding decisions and the FTA's project rating and evaluation process rely on detailed financial information on proposed projects separate from the existing transit systems. In addition, FTA must evaluate the financial capability of the transit agency to continue to operate and maintain the existing system. For this reason, the financial plan must treat the existing system separately from any proposed major projects. O&M costs for any proposed major project must be developed and presented separately from the O&M costs of the existing transit network.

The operating characteristics of the existing system may change significantly as a result of a major capital investment. Bus service may be rearranged into feeder

service. Headways might be shortened or different types of buses used for new or existing routes. All these changes must be documented and the impact on operating costs for the transit system estimated.

For the existing system, the resource build-up approach is the preferred method of forecasting O&M costs. The resource build-up approach can be supported by actual experience and existing plans and policies that dictate future services. Most of the components of resource build-up O&M cost models can be based on the standard cost and service factors tracked and reported by transit agencies for the National Transit Database. Existing labor and capital productivity can be expressed in terms of past operations and related to observable service levels. Projections about future expenses should be quite accurate in the immediate future for O&M costs associated with the existing system and expansions of that system that match the existing transit technology. Long term changes in productivity, unit costs, and service levels are very difficult to predict and quantify, but the resource build-up approach ensures that assumptions regarding these long-term changes are made explicit rather than hidden within the components of an aggregate cost model.

8.4.4 Project Operating and Maintenance Costs

Transit agencies planning major projects must prepare O&M cost estimates for the proposed project distinct from the existing transit system or other planned projects. FTA has long required that all major capital project planning use the resource build-up approach for the estimation of O&M costs because it offers the most detailed and accurate means of projecting O&M costs. The resource build-up approach has the benefit of making assumptions regarding productivity, staffing and unit costs explicit and comparable to the experience of other transit agencies.

O&M cost estimates for the proposed expansion of existing modes can rely on existing cost, productivity, and service data from the existing system. However, introduction of new modes requires that the experience of the existing agency be combined with the experience of similar operations at peer transit agencies. Cost data from other agencies must be appropriate to the proposed project and differences in agency operations clearly understood. If a project is proposed in the northeast, O&M costs should not be derived from projects in the southwest that do not have the freeze/thaw cycle that tends to increase maintenance of way expenses. Similarly, the age of the system and degree of deferred maintenance has an impact on the O&M costs of transit systems. The degree of outsourcing also impacts the labor productivity figures derived by transit agencies. Judgment is required in deciding which systems or mix of systems on which to base the O&M cost model and it is vital that these issues and the rationale for using specific peer agency data are documented before they are used in the financial model.

8.5 Forecasting Revenues

*“Financial forecasting appears to be a science
that makes astrology look respectable.”*

Burton Malkiel, *A Random Walk Down Wall Street*, (1985), p.152.

This section describes the projection of revenues and the use of revenue forecasts in the development of the financial plan. Transit agency revenues can be grouped into seven major revenue categories, each with a different policy environment requiring different methods for projecting future revenues. These are:

1. operating revenues (fares and other);
2. dedicated tax and user fee revenues;
3. federal formula funds;
4. state and local appropriations;
5. capital grants;
6. borrowing; and
7. other sources.

Forecasting revenues for some sources is a highly structured statistical exercise, while others require only “reasonable” assumptions. Some revenue sources enter long-range plans temporarily, only to be replaced by other sources, or failing that, result in the cancellation of projects. The closer to actual construction, the more certain and committed the revenue source must be. In the long term, the financial plan is just that, a plan. The plan is not to be confused with certainty at one extreme nor a wish list at the other. The financial plan is a ***reasonable and defensible expectation*** of the future revenues and expenses of the transit agency.

8.5.1 Forecasting Operating Revenues

Operating revenues are revenues collected by the transit agency as a result of being the owner and operator of a transit system. The largest operating revenue category, by far, is fare revenues. However, numerous other operating revenue sources can be observed at various transit agencies, though these sources are generally a small proportion of total revenues. These other operating revenues include parking, advertising, concessions, and contract services.

8.5.1.1 Fare Revenues

The fare revenue projection is used to estimate the amount of revenue the transit agency will collect from user fees. Fare revenues are projected based on

ridership forecasts and assumptions about fare levels for the existing and proposed system, and the structure of the fare system.

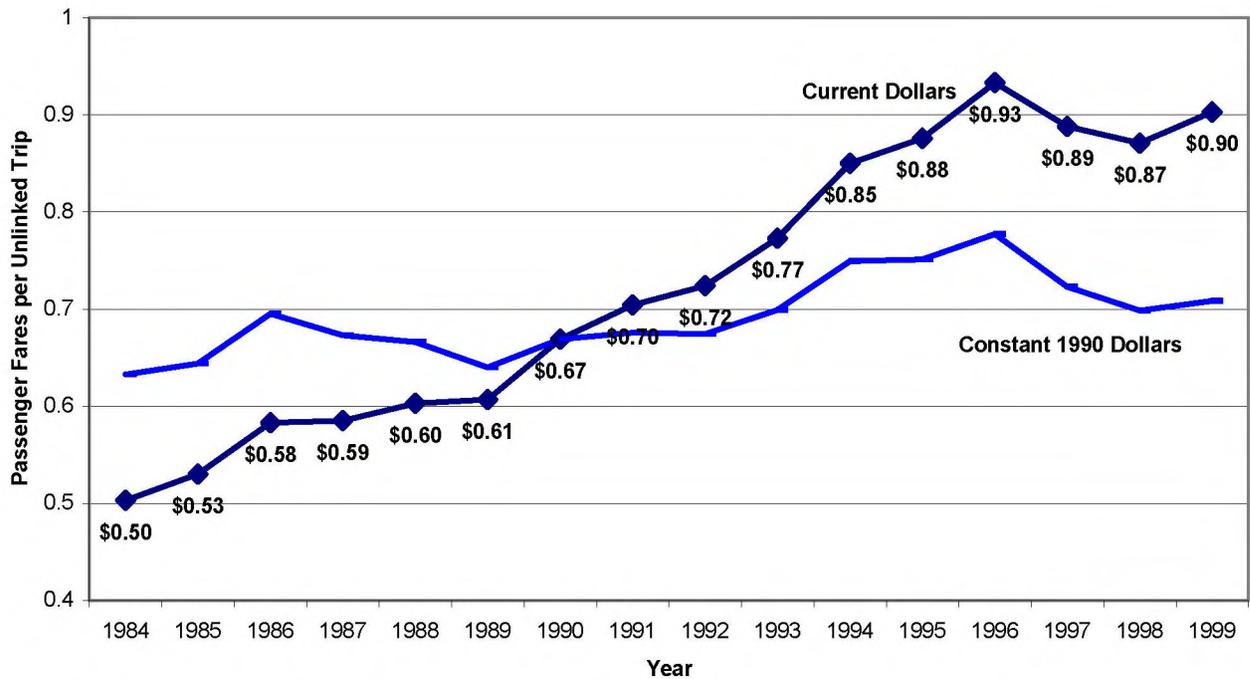
Fare Policy

Assumptions about future fare levels and the structure of the fare system are critical to forecasting operating revenues. Traditionally, fares are assumed to increase with the adopted inflation forecast. This assumption is quite likely a good one. Nationwide, increases in base fares have exceeded inflation by a solid margin. Between 1984 and 1999, APTA estimates that base fares have increased 91 percent compared to 60 percent for the Consumer Price Index for urban consumers (CPI-U).

APTA calculates fare revenues per unlinked trip that account for the impact of discounts and better reflect the actual fare structure than base fares. Average fare revenue per unlinked trip increased 80 percent between 1984 and 1999 implying that, on average, the fare structure of APTA members has been moving toward the increased use of fare discounting. Still, growth in fare revenues per unlinked trip exceeds the rate of inflation over much of the past two decades. Figure 8-3 shows that fare revenues per unlinked trip have increased in real terms (adjusted for inflation) with two multi-year periods of declining fares in real terms.

Transit agencies do not generally increase fares every year. Fares may go many years before finally moving in one large adjustment to a new level to compensate for inflation. If the financial plan assumes annual increases to keep pace with inflation, fare revenues will be overestimated. The financial plan should project fare increases at increments that reflect the historic time lag between fare increases for the transit agency in question. For long range financial planning and in the absence of any other plans to the contrary, assuming a constant fare structure and periodic fare increase to keep pace with inflation is likely to be a good assumption.

Figure 8-3: Growth in Fare Revenue per Unlinked Trip, 1984-1999



Source: APTA for fare data, Bureau of Labor Statistics for CPI-U.
 Note: Figures based on unweighted sample of 300 APTA members.

The degree of detail applied to the revenue forecasting exercise depends on the nature and scope of the change under consideration. Evaluating a change of fare policy, either fare structure, fare levels, or both requires a fairly detailed analysis of the revenue impacts. If the financial plan is supporting the introduction of a new transit capital investment under an existing fare structure, the forecasting of fare revenues can be quite simple.

Evaluating a change in the fare structure or the short run impacts of a fare increase should be supported by a thorough evaluation of the following:

- change in the proposed fare structure;
- the nature of the target market segments;
- special subsidies for specific groups (elderly, students, handicapped, etc.);
- peak period fares or premium priced services;
- transfer policies;
- pricing of multiple use fare instruments;

- the price sensitivity of riders in each target market segment; and
- ridership for each of the target market segments.

The fare structure defines the target market segments and specifies the relative fare level paid by each group. Cash fares are established for each fare category (e.g. express, peak, off-peak, elderly, etc.) Then a fairly detailed analysis of travel demand is required for each target market segment.

Travel Demand Estimates

Travel demand must be forecast for the existing and proposed system to derive fare revenue forecasts. Ridership is based on fare policy, service levels, and regional demographic changes. Fare policy and service levels are frequently developed through an iterative process accounting for the expected ridership and revenue impacts and subject to local political and financial considerations.

The regional travel demand model is not run for every year in the forecast period because data on population and employment is not available annually. The regional travel demand model is generally run for some base year, the opening years of any major capital investments, and for a forecast year, typically 20 to 25 years in the future. In some cases, forecasts for 5 or 10-year increments are available. Most regional travel demand models assume riders pay the full cash fare and almost always assume that fares are constant in inflation adjusted terms.

If the agency is interested in long range planning or project level evaluation within an existing fare policy, the financial plan will generally use the output of the regional travel demand model, or the network model used in project planning, to get point estimates of system-wide and project level ridership. Regional network models generally are disaggregated by market sector (usually income or auto ownership is the stratification) so that ridership estimates are available by market sector. The agency then may “fill in the blanks” between the available estimates through trend analysis (interpolation).

If the agency is planning to change the fare structure or level, the transit agency must typically apply a separate model to prepare annual ridership estimates that are sensitive to the projected fare policy changes. Elasticity models are normally used to estimate ridership changes resulting from changes in fare policy. Elasticity models require previous (or current period) ridership and fare policy information to forecast future conditions, unlike network models that “build up” ridership forecasts based on population, employment, land use, and the relative cost of transportation. Elasticity models should be disaggregated by time of day (peak, off-peak), income strata, and mode (bus and rail) if possible, since evidence suggests that fare elasticities are significantly different between these distinct transit markets. Ideally, elasticity estimates will be determined using data from the specific region where they are being applied. A detailed discussion and guide to using fare elasticity models to forecast transit ridership can be found

in the APTA report, *Fare Elasticity and Its Application to Forecasting Travel Demand (1991)*.

Preparing Fare Revenue Forecasts

After fare policy assumptions and annual travel demand estimates are complete, fare revenues forecasts may be prepared. The first step is to project fare revenue based on assumed fare policies and travel demand estimates, preferably disaggregated by travel market (user groups and time periods) to achieve the most accurate forecasts. Gross fare revenue is found by summing across market segments.

Complicating matters is the fact that travel demand models use the actual cash fare to describe the price of a trip rather than the actual revenue per trip. Monthly, weekly or daily passes, student or senior citizen discounts, special promotions, and fare evasion will make the average revenue per trip significantly lower than the cash fare. To account for this effect, the fare revenue forecasts should be multiplied by a “discount factor” calculated from existing revenue and ridership data.

It is possible to develop an average system-wide discount factor that converts the cash fare into average fare paid per rider by dividing existing fare revenues by the revenue that would be generated if all passengers paid full fare for their route. Fare revenue forecasts are calculated by multiplying the projected ridership by the cash fare assumption and multiplying again by the discount factor. This factor can be applied to other alternatives and proposed projects to generate revenue forecasts.

An average discount factor applied across all transit markets could distort fare revenues to the extent that new projects or future services serve travel markets different from base year conditions. If the population is aging, senior citizen discounts may be relatively more important. Low-income travelers making non-work trips tend to use cash fares more frequently than other market sectors. If this market sector becomes more or less important relative to other markets, the average discount factor may introduce added distortions.

For the best results, the financial planner would estimate a set of discount factors for each distinct market sector in the travel demand forecast and explicitly account for changes in the type of trips attracted to future services. These discount factors would be applied to the fare revenue forecasts for each market sector, then summed to calculate fare revenues. The disaggregate method generally requires on board surveys that include detailed fare payment and demographic information.

The operating financial plan should document the base fare, the average fare paid per rider (accounting for the discount factor), and the ridership forecast. Annual fare revenue forecasts are shown as the product of average fare and ridership within the financial plan. Documentation of the methods and procedures used to

estimate ridership, average fares, the fare discount factor and the level of disaggregation should be referenced and available.

8.5.1.2 Other Operating Revenues

Other operating revenues, including parking, advertising, concessions and contract services, are generally a small portion of most operating budgets. For example, the New York MTA collects about 2.5 percent of all revenue from non-fare operating revenues. MARTA in Atlanta receives about 1.25 percent of all revenue from non-fare operating revenues. Some of these revenues are generally sensitive to passenger loads, such as parking and some advertising and concessions, while others such as contract services and external vehicle advertising, may be unresponsive to passenger volumes.

Vehicle advertising revenues can be extrapolated from past experience or, in the case of introduction of a new mode, comparable transit agency data may be used. Station advertising can be extrapolated from past experience or peer transit agencies with adjustments for the strength of the local outdoor advertising market. Concession revenues can be estimated from past experience or from peer transit agencies with adjustments for passenger volumes at the concession facilities. Forecasts of contract service revenues should only be based on past agency experience.

Other operating revenues are generally a consistently growing, yet small amount of revenue. The financial plan should break out each revenue category and forecast growth separately for each if significant revenues are anticipated from one of these sources in the future. However, if these revenues are expected to remain generally trivial amounts, they may be aggregated into a single category and inflated based on historical growth patterns.

8.5.2 Forecasting Tax and User Fee Revenues

Dedicated taxes and user fees are an increasingly common way to fund transit operations and projects. Examples include general sales taxes, property taxes, targeted taxes (gas tax, rental car tax, hotel tax, etc.), vehicle license fees, and tolls. These types of funding sources can provide a great deal of revenue that can be stable and grow with regional population and economic activity. The transit agency can have a good deal of confidence in yearly funding levels in comparison to depending on annual appropriations from state or local governments. In general, the broader the tax, the more dependable and predictable the revenue stream. General sales taxes are the most stable and dependable widely used tax revenue source.

Dedicated taxes and user fees are usually major revenue generators for the agencies that have them. These revenues can support pay-as-you-go financing for major projects, serve as collateral for bonds issued to fund major projects, and provide a large percentage of the operating budget of many transit agencies. The importance of these revenues to the financial structure and health of many transit agencies demands a detailed and defensible forecast of future revenues.

Tax and user fee forecasts are generally produced using trend analysis or regression analysis. Trend analysis is easy to understand and apply, requires little data beyond historical revenue figures, and is relatively accurate for short range forecasting. Trend analysis is performed by calculating past revenue growth rates, preparing some assumptions about likely future revenue growth based on past experience, and using these growth assumptions to estimate future revenues.

Multiple regression models are more complex but produce better long range forecasts and provide a much deeper understanding of the factors that drive revenue growth. Regression analysis is a statistical technique that allows the analyst to estimate the sensitivity of various revenue streams to regional economic conditions or other factors that influence revenues. Financial analysts not already familiar with multivariate regression techniques are directed to other guidance⁸ or a good econometrics textbook.⁹ ***The Technical Addendum to this chapter provides a detailed example of the development of a regression model and forecasts for retail sales.***

The regression based forecasting process consists of the following steps:

1. Collect historical data on regional economic indicators and revenues;
2. Develop or purchase long term economic forecasts for the region to serve as the base assumptions for revenue forecasts;
3. Estimate the relationship between some of the economic indicators and the tax base of the revenue source using statistical techniques (multiple regression analysis) and historical economic and revenue data; and
4. Calculate the resulting tax revenue for each year in the analysis period using the estimated statistical relationships and the forecasted regional economic indicators.

⁸ Such as *Transportation Revenue Forecasting Guide*, US Department of Transportation, 1987 or *State Revenue Forecasting and Estimation Practices*, Federation of Tax Administrators, March 1993.

⁹ Such as Frank, Howard A., *Budgetary Forecasting in Local Government: New Tools and Techniques*, Quorem Books, 1993 or Newbold, P. and Bos, T., *Introductory Business and Economic Forecasting*, Southwestern Publishing Co., 1994.

While not prohibiting the use of trend analysis for financial planning, the US Department of Transportation has long cautioned against using trend analysis in long range forecasts in transportation plans.

“Because trend analysis is unable to objectively account for changes in trends and ultimately in turning points, its usefulness (accuracy) deteriorates with the length of the forecast....While this criticism actually applies to all forecasting techniques, it particularly applies to straight line extrapolations. The forecaster then is advised to be extremely careful in applying this technique to any long term forecast.” Page 5-8 in *Transportation Revenue Forecasting Guide, FHWA/UMTA, US Department of Transportation, 1987.*

In choosing a forecasting method, the financial analyst should consider the importance of the funding source to the financial success of the agency and the importance of forecast accuracy to supporting the financial plan. If the revenue source is not a critical element of the financial plan or if even the most pessimistic assumptions regarding revenue trends still produce revenue forecasts that easily exceed planned expenditures, trend analysis may be sufficient.

In cases where a tax or user fee is a critical element of the long term health of the transit agency and the success of the transit agency’s financial plan hinges on realizing continued growth in that revenue source, regression analysis is the preferred method for forecasting these revenues. Regression analysis allows the forecaster to understand the factors that drive revenue growth and can use this information to inform the financial planning process.

In the past, some areas have experienced wide variations in their revenues from sales taxes. Understanding the impact of economic conditions on local tax and user fee revenues can provide advance information about the expected change in revenues in the short term and help agencies plan accordingly. For instance, some transit agencies rely on taxes linked to visitor travel (such as hotel taxes or car rental surcharges). If trend analysis is used to forecast these revenues, the financial analyst will most likely not have a good idea about how much revenues would decline if visitor travel declined suddenly due to economic or other factors. A regression model would allow the financial analyst to anticipate the magnitude of the expected revenue decline much more rapidly and accurately because the causal link between visitor travel and tax revenues would be known.

Regardless of the method used, there is a good deal of inherent uncertainty in any forecasting exercise. The economic forecasts that serve as the drivers of the tax revenue forecasts are uncertain. The statistical relationships between tax revenues and economic indicators are uncertain. Future policy changes, such as changes to the tax rate or tax base, can also cause actual revenues to deviate from expectations. The financial plan should include a detailed sensitivity analysis to understand the impact of the range of economic and policy scenarios on the expected revenue stream.

8.5.3 Economic Forecasts

Economic indicators are external to the transit operator, but affect service needs and revenues. Forecasts of economic conditions are used for planning future service levels, for generating travel demand forecasts, for preparing revenue forecasts, and for estimating certain future costs. Useful economic indicators include interest rates, inflation rates, employment and population growth and their spatial distribution, income growth, and certain types of economic activity. Service levels and travel demand forecasts depend on the level and distribution of population and employment. Labor costs depend on service levels and inflation forecasts. Debt service costs depend on interest rate forecasts. Tax and user fee revenues depend on some or all of these economic variables.

Economic forecasts come from a variety of sources. They may be purchased from economic forecasting firms, or obtained from economists at local universities or government agencies. Any reputable, unbiased source is acceptable.

Regardless of the source chosen, transit agencies should follow three basic principles in their use of economic forecasts:

1. Identify the source for all forecasts;
2. Use the same economic forecasts in all areas of transit planning; and
3. Develop a range of internally consistent economic scenarios.

The benefit of using a complete set of economic forecasts from a single source is that all of the data will be consistent. A set of economic forecasts will be based on a single economic forecasting model and all the economic indicators will at least be related to each other in ways that make theoretical sense. Higher inflation means that interest rates will be higher, labor costs may rise faster with low unemployment, while rapid employment growth usually accompanies rapid population growth. Using a consistent set of economic indicators ensures that forecasts based on different indicators are economically coherent.

The transit agency must also ensure that all areas of transit planning make use of the same set of forecasts. If the service plans use different economic forecasts than the regional travel demand forecasts, decisions could be made based on contradictory information. The transit financial plan must be based on the same information used to develop ridership forecasts and service plans. These forecasts should be consistent with the forecasts used in the metropolitan planning process to prepare the long-range transportation plan.

Economic forecasting firms and universities will usually provide a set of economic scenarios to represent a range of possibilities. These scenarios almost always include a high growth and a low growth scenario. These alternative scenarios should be the basis on which sensitivity analysis is performed with respect to economic conditions. These scenarios are superior to simply altering

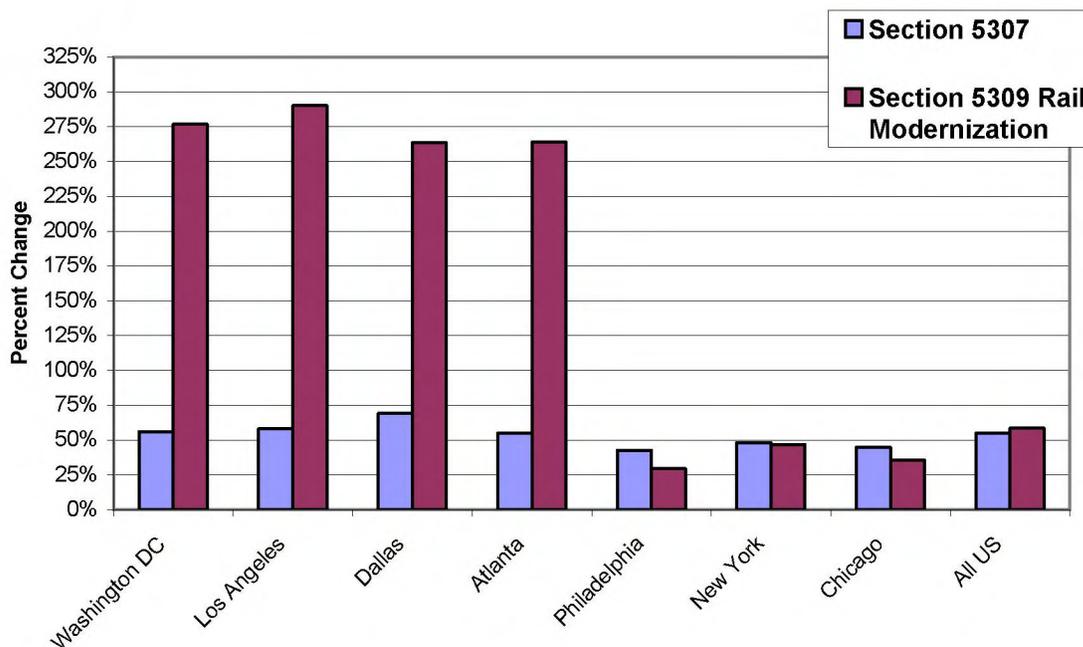
economic indicators on an ad hoc basis since they present coherent sets of economic information with a firm theoretical foundation.

8.5.4 Projecting Federal Formula Fund Revenues

Federal formula funds provide a significant amount funding for the capital maintenance and project funding needs of transit agencies. Depending on the transit agency, federal formula funds can provide more than half the total capital budget. Projecting the revenues from federal formula programs can go a long way toward nailing down the revenue forecasts for the transit agency. Since these funds are subject to annual appropriations and not directly tied to economic conditions, the methods used to forecast revenues from these sources is much more ad hoc.

Moreover, the revenues from the formula programs cannot be projected only by projecting the future size of the federal program. The recipient must also ascertain the relative standing of the region compared to other regions around the country. Figure 8-4 displays the change in transit formula funding for a selection of metropolitan areas and total formula program growth between 1996 and 2001. The characteristics of the metropolitan area and the transit system have a major impact on the growth in federal formula funding to specific regions.

Figure 8-4: Total Growth in Formula Funding Allocations for Selected Metropolitan Areas (1996-2001)



The following sections describe the funding programs and the methods used to develop funding assumptions for the future. The focus is federal programs for urbanized areas, though transit agencies in non-urbanized areas could apply the principles contained here to develop funding assumptions for the Section 5311 Non-Urbanized Area Formula program.

8.5.4.1 Section 5307 Urbanized Area Formula Program

The Section 5307 Urbanized Area Formula Program makes Federal resources available to urbanized areas and to Governors for transit capital and operating assistance in urbanized areas¹⁰ and for transportation related planning. Eligible purposes include planning, engineering design and evaluation of transit projects and other technical transportation-related studies; capital investments in bus and bus-related activities such as replacement of buses, overhaul of buses, rebuilding of buses, crime prevention and security equipment and construction of maintenance and passenger facilities; and capital investments in new and existing fixed guideway systems including rolling stock, overhaul and rebuilding of vehicles, track, signals, communications, and computer hardware and software. All preventive maintenance and some Americans with Disabilities Act complementary paratransit service costs are considered capital costs.¹¹

The preferred method for estimating future revenues from federal formula allocations would begin with the agency's past formula allocation and related growth. An estimate of the future growth of the federal transit program should be prepared based on growth trends of past funding levels. The formula used to distribute funds should be assumed to remain constant.

The funding is not distributed evenly among transit agencies as shown in Figure 8-4. Dallas increased its Section 5307 apportionments by 70 percent between 1996 and 2001, while Philadelphia's allocation increased less than 45 percent. The Section 5307 formula program is based primarily on fixed guideway vehicle revenue and route miles, bus revenue vehicle miles, population, and population times density. The growth of a given metropolitan area's transit service levels, population and population density relative to all other metropolitan areas of a certain size, largely determines the magnitude of the allocation of Section 5307 formula funds. For example, Dallas, with a rapidly growing transit system and region, received a growing share of the Section 5307 formula program while Philadelphia, with a slowly growing transit system and region, lost ground. The development of reasonable forecasts for future Section 5307 formula allocations requires some idea of the relative growth of a given region and its transit system relative to the national average.

Generally speaking, transit agencies in rapidly growing cities with rapidly growing transit systems will find that their formula funding grows slightly faster than the projected growth in the federal program, while slower growing metropolitan areas with large, established transit systems may find that their formula funding grows slower than the projected growth in the federal program.

¹⁰ An urbanized area is an incorporated area with a population of 50,000 or more that is designated as such by the U.S. Department of Commerce, Bureau of the Census. Areas with a population of more than 200,000, may not use Section 5307 funds for operating expenses.

¹¹ In addition to Section 5307, the ELDERLY AND PERSONS WITH DISABILITIES program (Section 5310) provides formula funding to States for the purpose of assisting private nonprofit groups in meeting the transportation needs of the elderly and persons with disabilities when the transportation service provided is unavailable, insufficient, or inappropriate to meeting these needs. Funds are apportioned based on each State's share of population for these groups of people.

8.5.4.2 Section 5309 Fixed Guideway Modernization

A “fixed guideway” refers to any transit service that uses exclusive or controlled rights-of-way or rails, entirely or in part. The term includes heavy rail, commuter rail, light rail, monorail, trolleybus, aerial tramway, inclined plane, cable car, automated guideway transit, ferryboats, that portion of motor bus service operated on exclusive or controlled rights-of-way, and high-occupancy-vehicle (HOV) lanes.

Eligible purposes for Section 5309 Fixed Guideway Modernization funds are capital projects to modernize or improve existing fixed guideway systems, including purchase and rehabilitation of rolling stock, track, line equipment, structures, signals and communications, power equipment and substations, passenger stations and terminals, security equipment and systems, maintenance facilities and equipment, operational support equipment including computer hardware and software, system extensions, and preventive maintenance.

These funds are allocated by a statutory formula to urbanized areas with rail systems that have been in revenue service for at least seven years. The formula is based on the revenue vehicle miles and route miles of the fixed guideway transit system that have been in operation for at least seven years.

Transit agencies that have built large transit systems and extensions to existing systems in the last seven years will continue to take an increasing percentage of future rail modernization funding as the recently build sections reach seven years of age. The larger the recent investments that an agency makes relative to the size of the previously existing system, the greater the annual percent growth in formula allocations from Section 5309 Fixed Guideway Modernization, which is clearly evident in Figure 8-4.

Los Angeles, Dallas, Washington DC, and Atlanta all had very large gains in Section 5309 Fixed Guideway Modernization allocations while Philadelphia and New York were below the national average.¹² These allocations result from the relative size of the transit systems and the relative growth in service. New York Metropolitan Transit Authority (NY MTA) operates over 1,600 fixed guideway route miles compared to 103 for the Washington Metropolitan Area Transit Authority (WMATA). A 10-mile extension would increase NY MTA’s system by just over 0.5 percent while the same 10-mile extension would increase WMATA’s system by nearly 10 percent.

8.5.4.3 Incorporate Formula Funds into the Financial Plan

Traditionally, financial plans have assumed that federal formula funds grow at the rate of inflation. Under TEA-21, the funding levels for all major transportation programs were “guaranteed”, providing a level of certainty in the annual funding stream that had previously been lacking. Federal program

¹² The figures for the high growth areas exceed the average by a large amount due to the small size of their transit systems relative to New York. The magnitude of the New York system and their resulting formula allocation for Section 5309 Rail Mod is so large that it dominates the “All US” growth figures.

funding levels throughout TEA-21 exceeded the rate of inflation. Funding levels for authorization periods after TEA-21 are usually assumed to continue growing at the rate of inflation.

Every Metropolitan Planning Organization (MPO) prepares a Transportation Improvement Program (TIP) and a Long-Range Transportation Plan. The TIP describes the funding levels, sources and construction schedules for projects to be constructed over the next three to five years. The Long Range Transportation Plan describes the proposed projects and assumed funding levels from all sources over the next 20 years. The TIP and Long Range Plan are reviewed by FHWA and FTA to ensure that they are “fiscally constrained”, which means that they are based on reasonable assumptions for all project costs, schedules and funding sources including federal formula funds. The financial plan for the transit agency should assume the same formula funding levels as those found in the local MPO’s TIP and Long Range Plan.

8.5.5 Assumptions for Federal Grants

Capital grants are provided to fund some percentage of a planned project. The federal government provides capital grants in the form of Full Funding Grant Agreements (FFGAs) through the Section 5309 New Starts program. The Section 5309 Bus program provides capital grants for bus purchases and other bus related projects. Sometimes, state or local governments provide capital grants as lump sum appropriations to fund some share of planned transit projects. State and local governments rarely have dedicated grant programs, though there are exceptions. Consequently, state and local grants are generally secured as separate appropriations.

8.5.5.1 Section 5309 New Starts

This program provides funds for construction of new fixed guideway systems or extensions to existing fixed guideway systems. Eligible purposes are light rail, rapid rail (heavy rail), commuter rail, monorail, automated fixed guideway system (such as a “people mover”), ferries, busway/high occupancy vehicle (HOV) facilities, or an extension of any of these. Projects become candidates for funding under this program by successfully completing the appropriate steps in the major capital investment planning and project development process.

Major new fixed guideway projects or extensions to existing systems financed with New Starts funds, typically receive these funds through a FFGA that defines the scope of the project and specifies the total multi-year federal commitment¹³ to fund the project. Funding allocation recommendations are made in a report to Congress called the *Annual Report on New Starts*.

Funding Amount

Theoretically, an agency planning a rail project could assume that 80 percent of the capital cost of the project will be funded by the federal government through

¹³ subject to annual appropriations.

the Section 5309 New Starts program. Project sponsors are generally required to fund at least 20 percent of the project cost with non-federal funds. However, very few project sponsors receive a FFGA for 80 percent of the cost of a project. Proposed New Starts funding averages about 50 percent of total project costs with state, local, or other federal funding comprising the other half (see Table 8-13). Various proposals to legislate a maximum share of between 50 and 60 percent have been put forward.

Table 8-13: Funding Shares by Source for New Starts Projects, FY 2001

Phase	Federal 5309	Other Federal	Total Federal	State	Local	Total Non-Federal	Total (\$M YOE)
Pre Eng.	50.6%	3.8%	54.4%	17.3%	28.3%	45.6%	\$21,715
Final Design	62.0%	15.6%	77.5%	12.7%	9.8%	22.5%	\$2,762
All Projects	51.9%	5.1%	57.0%	16.8%	26.3%	43.0%	\$24,477

Current trends suggest continued pressure to reduce the share of project costs borne by the Section 5309 New Starts program so that more projects can be supported within federal resource constraints. Realistic financial planning will acknowledge these federal financial pressures and plan accordingly. Project sponsors should not generally assume 80 percent New Starts funding.

Payout Schedule

Even if a FFGA is signed specifying the funding amounts to be provided by the Section 5309 New Starts program, Congress does not always provide appropriations exactly according to the schedule set forth in the FFGA. To date, Congress has always provided the total federal share specified in the FFGA, but often does not provide those funds as planned by the project sponsor and set out in Attachment 6 (payout schedule) of the FFGA (see Table 8-14).

Table 8-14 clearly shows that funds do not always flow according to the payout schedule of a negotiated FFGA. Transit agencies need to expect and plan for deviations in the annual funding stream. Financial planners should note that several of these projects have a final FFGA payment year of FY 2002, yet do not receive the amount of the final payment. In particular, the Los Angeles North Hollywood extension was completed and operating during 2001, yet has about \$40 million remaining to be paid in FY 2003 and beyond.

Table 8-14: Scheduled FFGA Payout vs. Actual Appropriations, FY 2002

Project	FY 2002 Proposed Budget	Final FFGA Payment Year	Final FY02 Appropriations	Difference from FFGA Payout Schedule
BART Extension to the SFO Airport	80,610,000	FY 2006	75,673,790	(4,936,210)
Los Angeles- North Hollywood	49,686,469	FY 2002	9,289,557	(40,396,912)
Sacramento- LRT Extension	328,810	FY 2002*	328,000	(810)
San Diego-Mission Valley East LRT Extension	65,000,000	FY 2005	60,000,000	(5,000,000)
San Jose Tasman West LRT Project	113,336	FY 2002*	113,336	0
Denver- Southeast Corridor LRT	71,800,000	FY 2008	55,000,000	(16,800,000)
Denver- Southwest Corridor LRT	192,492	FY 2002*	192,492	0
Ft. Lauderdale-Tri-Rail Commuter Rail Upgrade	84,829,566	FY 2002	27,000,000	(57,829,566)
Atlanta- North Springs	25,072,274	FY 2003	25,000,000	(72,274)
Chicago- Douglas Branch Reconstruction	35,000,000	FY 2006	32,750,000	(2,250,000)
Boston- S. Boston Piers Transitway	11,203,169	FY 2002*	10,631,245	(571,924)
Washington, DC/MD- Largo Extension	60,000,000	FY 2005	55,000,000	(5,000,000)
Minneapolis- Hiawatha Corridor LRT	50,000,000	FY 2005	50,000,000	0
St. Louis- Metrolink St. Clair Extension	31,088,422	FY 2002	28,000,000	(3,088,422)
Hudson-Bergen MOS-1	151,327,655	FY 2003	141,000,000	(10,327,655)
Hudson-Bergen LRT MOS-2	0	FY 2008	0	0
Newark Rail Link (MOS-1)	20,000,000	FY 2004	20,000,000	0
Portland-Interstate MAX LRT Extension	80,085,904	FY 2005	64,000,000	(16,085,904)
Pittsburgh- Stage II LRT Reconstruction	20,000,000	FY 2004	18,000,000	(2,000,000)
San Juan- Tren Urbano	50,159,703	FY 2004	40,000,000	(10,159,703)
Memphis- Medical Center Extension	20,000,000	FY 2003	19,170,000	(830,000)
Dallas- North Central LRT Extension	71,200,000	FY 2004	70,000,000	(1,200,000)
Houston- Regional Bus Plan	95,459	FY 2002*	0	(95,459)
Salt Lake City- CBD to University LRT	15,000,000	FY 2003	14,000,000	(1,000,000)
Salt Lake City-South LRT	718,006	FY 2002*	0	(718,006)
Seattle- Central Link LRT-MOS-1	0	FY 2006	0	0
Total	\$993,511,265		\$815,148,420	(\$178,362,845)

Delays in receiving anticipated funding can cause delays during construction, cost overruns, and financial uncertainty for the project sponsor. For this reason, a solid financial plan will specify how the project sponsor will move the project forward even if federal funding is delayed. Short-term borrowing is one mechanism for smoothing out the funding stream. Other options include a

locally funded construction reserve large enough to handle delays in receiving federal funds.

Many project sponsors worry that demonstrating they have adequate financial resources to fund a proposed project, even when federal funds are less than anticipated, may signal that they do not “need” the federal funding to construct the proposed project. Some grantees worry that this demonstration of strong financial position will ultimately result in lower federal funding for their projects. However, TEA-21 requires FTA to evaluate the financial capacity and capability of project sponsors to minimize risks to the completion and operation of federally funded projects. The determination of financial capacity and capability often depends on the ability of the project sponsor to demonstrate access to resources in excess of those required to fund planned construction costs.

Incorporate New Starts Grants into the Financial Plan

Section 5309 New Starts funding for a planned project should enter the financial plan according to three basic elements which are initially defined in alternatives analysis: the planned funding sources; the amount required from each source; and the anticipated project construction schedule. Early in project planning, these items may be uncertain, but cost estimates, implementation schedules, and the rough outline of the funding strategy will be complete at the end of alternatives analysis since this information is required before a project can be included in a regional Long Range Transportation Plan.¹⁴

The assumed Section 5309 New Starts funding (as well as other sources) should be included in the financial plan in the manner in which it is anticipated to be available. Often, only a rough idea of the funding amount is known early in the planning process. In this case, the percentage of total project costs anticipated to be borne by Section 5309 New Starts funding is calculated and applied to the annual construction expenses developed during capital cost estimation as shown in Table 8-15.

¹⁴ Inclusion in the regional Long Range Plan prepared by the Metropolitan Planning Organization is required before FTA will approve any potential New Starts project to enter PE.

Table 8-15: Example Funding Schedule and Amount by Source

FISCAL YEAR	FEDERAL		LOCAL (26%)	TOTAL
	New Starts FFGA (50%)	CMAQ (24%)		
FY 00	\$40,000,000	\$19,200,000	\$20,800,000	\$80,000,000
FY 01	\$55,000,000	\$26,400,000	\$28,600,000	\$110,000,000
FY 02	\$60,000,000	\$28,800,000	\$31,200,000	\$120,000,000
FY 03	\$65,000,000	\$31,200,000	\$33,800,000	\$130,000,000
FY 04	\$72,500,000	\$34,800,000	\$37,700,000	\$145,000,000
FY 05	\$67,500,000	\$32,400,000	\$35,100,000	\$135,000,000
FY 06	\$60,000,000	\$28,800,000	\$31,200,000	\$120,000,000
FY 07	\$45,000,000	\$21,600,000	\$23,400,000	\$90,000,000
FY 08	\$35,000,000	\$16,800,000	\$18,200,000	\$70,000,000
TOTAL	\$500,000,000	\$240,000,000	\$260,000,000	\$1,000,000,000

As details about each funding source become known and precise amounts are committed, the annual funding stream from each source is adjusted. For instance, the CMAQ funding might be available in a constant annual payment of \$30 million between FY 01 and FY 07. The demands for funding from the other sources must be balanced to reflect what is known about available CMAQ funding.

When an FFGA is signed, these funding amounts are set in the agreement. The Section 5309 New Starts payout should be included in the financial plan precisely as stated in the FFGA. As annual appropriations come in, the financial plan is updated to reflect actual receipts and funding amounts from other sources adjusted to maintain the project schedule.

8.5.5.2 Section 5309 Bus and Bus Related

Eligible project expenses for Section 5309 Bus funds include acquisition of buses for fleet and service expansion, construction of bus maintenance and administrative facilities, transfer facilities, bus malls, transportation centers, intermodal terminals, park-and-ride stations, acquisition of replacement vehicles, bus rebuilds, bus preventive maintenance, passenger amenities such as passenger shelters and bus stop signs, accessory and miscellaneous equipment such as mobile radio units, supervisory vehicles, fareboxes, computers, shop and garage equipment, and costs incurred in arranging innovative financing for eligible projects. Congress has allocated most of the Section 5309 Bus funds to specific states, localities, and transit agencies.

Incorporate Other Federal Grants into the Financial Plan

Section 5309 Bus funding is allocated to specific projects or to states for “statewide bus and bus facilities” in the annual FTA appropriation. Project sponsors have three years to obligate the Section 5309 Bus allocation or the funds revert to the federal government. Like other federal transportation

programs, these funds require a minimum 20 percent local match. Transit agencies should include Section 5309 Bus funding in their financial plan if they have specified a project that can reasonably be expected to receive such funds and the transit agency has identified the source of the local match required to receive the Section 5309 Bus funds. The financial plan incorporates the federal funding and specifies the source and amount for the local match on an annual basis according to the project implementation schedule.

8.5.6 State and Local Appropriations

The large sums of money needed to fund major transit investments can make securing appropriated funds very difficult due to intense competition for limited resources. However, many projects have been constructed using non-federal capital grants for a significant share of project costs. For operating revenue, transit agencies without dedicated funding sources beyond fares and other operating revenues usually need to seek annual appropriations from state or local governments.

8.5.6.1 State and Local Capital Grants

Many transportation projects are paid for using state or local appropriations rather than dedicated funding sources. Sometimes, states or local governments have transportation improvement funds, transportation trust funds, or other entities set up to provide local funding for projects on a discretionary basis. These funds are usually appropriated for specific projects through the state or local political process. Generally, the project must be included in a state or local budget that directs spending from various transportation funds. These funds must be legislatively approved or included in an approved capital improvement program before they can be considered committed to a specific project.

Good examples of state and local appropriated funding sources include the Maryland Transportation Trust Fund, which has been used to fund the local share of numerous transportation projects in Maryland, including the WMATA Largo Extension, the Maryland Mass Transit Administration's Central Light Rail Double Track Project, and numerous others. Another example of this type of funding source is California's Traffic Congestion Relief program funded from a sales tax on gasoline. The law that enabled this program was enacted in July 2000, and will sunset in July 2006. The funding source was established because of large budget surpluses for the State of California, which enabled additional transportation investments. The San Fernando Valley BRT and San Diego Mission Valley East LRT are two of the many projects proposed to be funded through this source.

Incorporate Non-Federal Grants into the Financial Plan

The financial plan identifies all state and local appropriations and incorporates them into the financial plan according to the anticipated annual funding amounts. Specific project funding is a line item in the capital plan. During planning and early project development, these funds are usually un-committed.

Every state and local government is different and funds transportation projects in a different way. The financial plan accounts for these local funding realities. Financial plans should include both committed and planned funds as long as the funds can “reasonably” be expected to be available and committed in the years for which they are required. If the state or local funding for the proposed project is not committed, the source should be identified and a strategy to secure the funding described. If the state or local capital grant is committed, evidence and details of the commitment agreement must be referenced and should be included as an attachment to the financial plan.

8.5.6.2 State and Local Operating Assistance

Most all transit agencies receive state or local assistance to cover operating expenses. Sometimes that assistance is from a dedicated tax as described in section 8.5.2. In many cases, the state or local assistance is provided on an annual basis through a direct appropriation. The New Jersey Transit Corporation, the Massachusetts Bay Transportation Authority in Boston, and WMATA in Washington DC among many others, depend on state or local appropriations to cover annual operating deficits (sometimes including debt service). Often the funding burdens are distributed by statutory formulas to the jurisdictions that benefit from the transit service. The funding jurisdictions typically have representatives that serve on the regional transit governing board giving them significant influence over how the transit system is operated.

Depending on the institutional arrangements, local funding formulas can ensure operating funding stability for transit systems. While dedicated taxes or user fees usually provide a higher level of funding stability, this is not universally true. Many states and localities provide consistent funding levels using annual appropriations. However, absent specific guarantees, local funding levels can fall victim to the budget pressures of state or local governments.

Incorporate Local Operating Assistance into the Financial Plan

Operating assistance provided by state or local governments is a line item under operating revenues determined by the specific relationship established between the local funding partners and the transit agency. The financial plan should document the history of state and local operating assistance levels and track the annual growth in funding to support the assumptions about future levels of operating assistance. Generally speaking, operating assistance should not be assumed to grow faster than historical experience unless an agreement to increase operating assistance has been completed. In addition, if one funding source is assumed to take a significantly higher proportion of total operating expenses in future years, the soundness of the financial plan may be questionable.

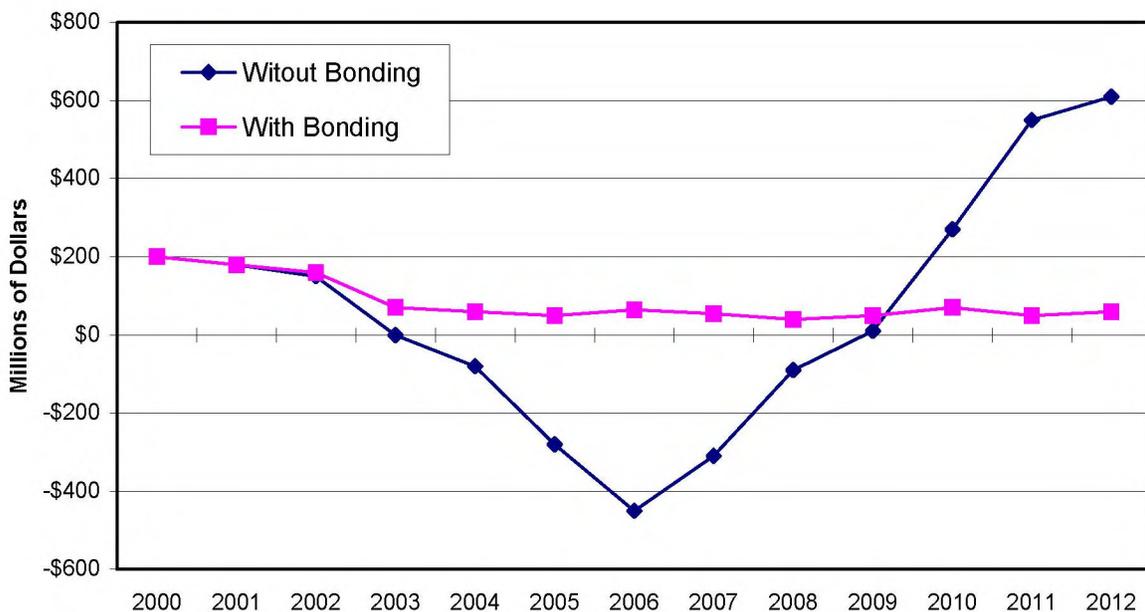
8.5.7 Borrowing and Debt Financing

“You can pay me now, or pay me later.”

Television advertisement for FRAM Oil Filters, 1971

A transit system with insufficient cash flow to cover the cost of capital projects as well as operating and maintenance expenses must generally incur debt to advance its capital program on a reasonable schedule (see Figure 8-5). Assuming that the transit agency is capable of paying the debt service after paying for all operating and maintenance expenses, the agency must determine the level and form of debt that is most appropriate. Generally, the transit agency should maximize the net present value of the financing arrangement within the budgetary constraints imposed on the transit agency. The methods used to evaluate financing strategies are discussed in Section 8.6.

Figure 8-5: Comparison of Ending Cash Balances, With/Without Bonding

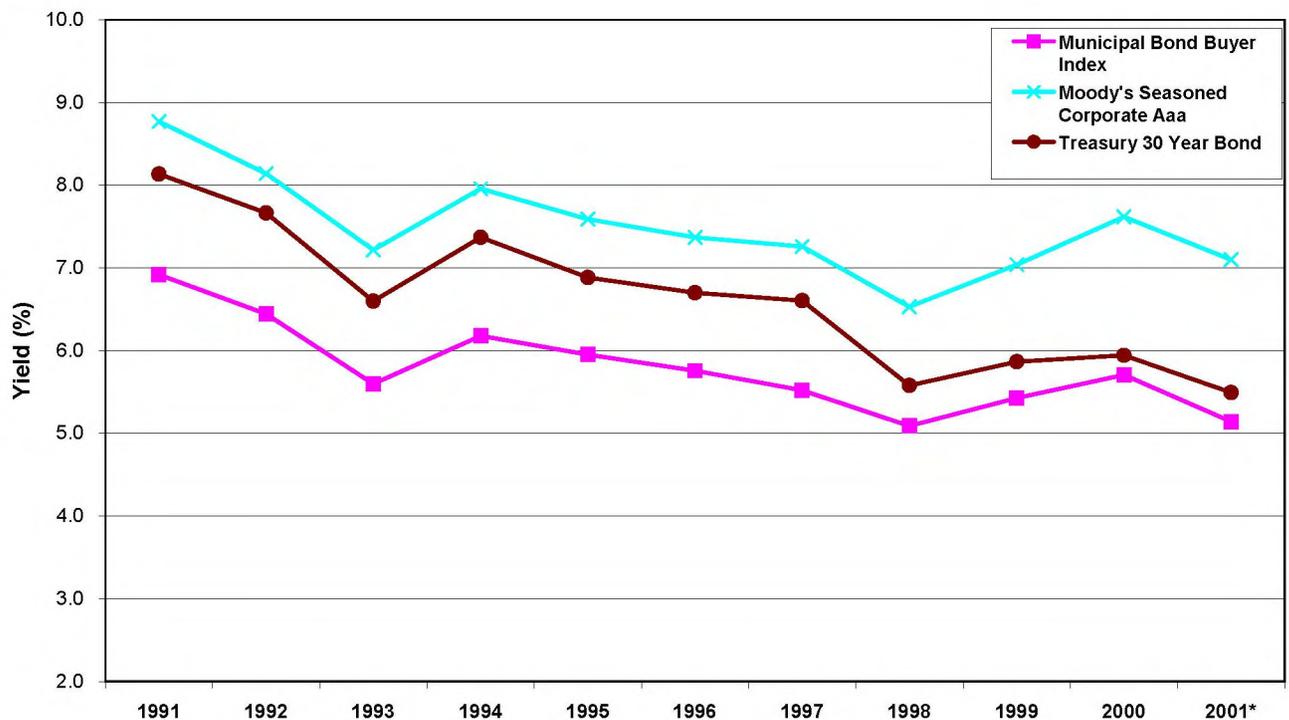


As demands for transportation improvements have grown, the use of debt financing has also increased to fund additional projects. Debt financing can be used to advance projects that otherwise would take much longer to construct using pay as you go funding. For agencies with dependable and growing existing revenue sources that would experience deficits only during construction of proposed major capital investments, debt financing may be the solution to funding needed capital projects. If an agency expects operating deficits after

completion of the proposed project (s), the bond market will generally demand high interest costs or the agency may be unable to market the bonds at all.

Tax-free municipal bonds are usually preferred mechanisms for municipal finance since the yields are lower than almost any other debt instrument (see Figure 8-6) presuming the bonds are rated investment grade. In some instances, vendor financing or leasing arrangements may offer terms advantageous to the transit agency. The TIFIA program offers another potential source of credit that may be used for major capital investments and can be competitive with some investment grade municipal debt (see Section 8.5.7.2).

Figure 8-6: Annual Percentage Yields on Selected Securities, 1991-2001



* 2001 figures calculated as of 12/01/01
 Source: Federal Reserve Board of Governors

8.5.7.1 Tax Free Municipal Bonds¹⁵

The tax-exempt bond market has become a major funding source for transportation investments. The amount of debt issued fluctuates by multiple billions of dollars based on market conditions and investment needs, but the trend over the last two decades has been of increasing reliance on the municipal bond market to fund the local share of major investments (see Figure 8-7). State and local governments have increasingly utilized the tax-free municipal bond market

¹⁵ Borrowing liberally from the Federal Transit Administration's, *Financial Planning Guide for Transit*, US Department of Transportation, 1990, pp. 100-05

to fund needed projects far in advance of when they could be constructed using the pay-as-you-go approach.

Long-term bond repayment schedules typically require a principal and interest payment in the range of 8 percent to 11 percent of the par (face value) of the bonds issued.¹⁶ The repayment of any bond issue and any outstanding debt must be factored into the transit agency financial plan. Debt service costs may be accounted for as an agency operating expense or as a debt service payment in a separate capital plan. The latter treatment is more common since most debt service has a dedicated funding source outside of the revenues from operations. Investors in the bond market will examine the agency's financial statements and plan in great detail to judge the financial capability of the agency, and consequently, the likelihood of being paid on time.

One of the primary factors in the evaluation of any bond issuance is the coverage ratio and the security of the bonds. The coverage ratio is the annual pledged revenues divided by the debt service payment. The coverage ratio measures the ability of the historical, current, and future revenues to meet debt service requirements. Security is the funding source pledged as collateral for repayment of the bonds.

A coverage ratio of 1.0 means that revenues pledged to pay debt service are equal to the debt service payment, which would not be looked at favorably by the bond market because any unexpected adverse occurrence would make the debt service levels too high to pay. The bond market generally requires a debt coverage ratio greater than one by a margin large enough to ensure that there will remain (within tolerable risk levels) enough revenue to pay the debt service regardless of the economic conditions affecting the issuer. Coverage ratios may be based on only those revenues pledged as security for the bonds (a gross coverage ratio), or may include all revenues available to the issuer net of operating expenses (a net coverage ratio).

Historical coverage ratios calculate the measure based on known quantities from previous years. For a new bond issue, prospective coverage ratios must be forecasted into the future. Debt service requirements are quite well known in advance since the terms of the bond are specified at the issuance. Revenue projections must be prepared, either by a respected private forecasting firm, or internally using well documented and state of the practice forecasting methods as described in Section 8.5.2.

¹⁶ Assuming 20-year municipal bond paying 5 percent coupon rate for the low estimate to 9 percent coupon rate at the higher end. Interest rates depend on the market conditions and quality of the bonds.

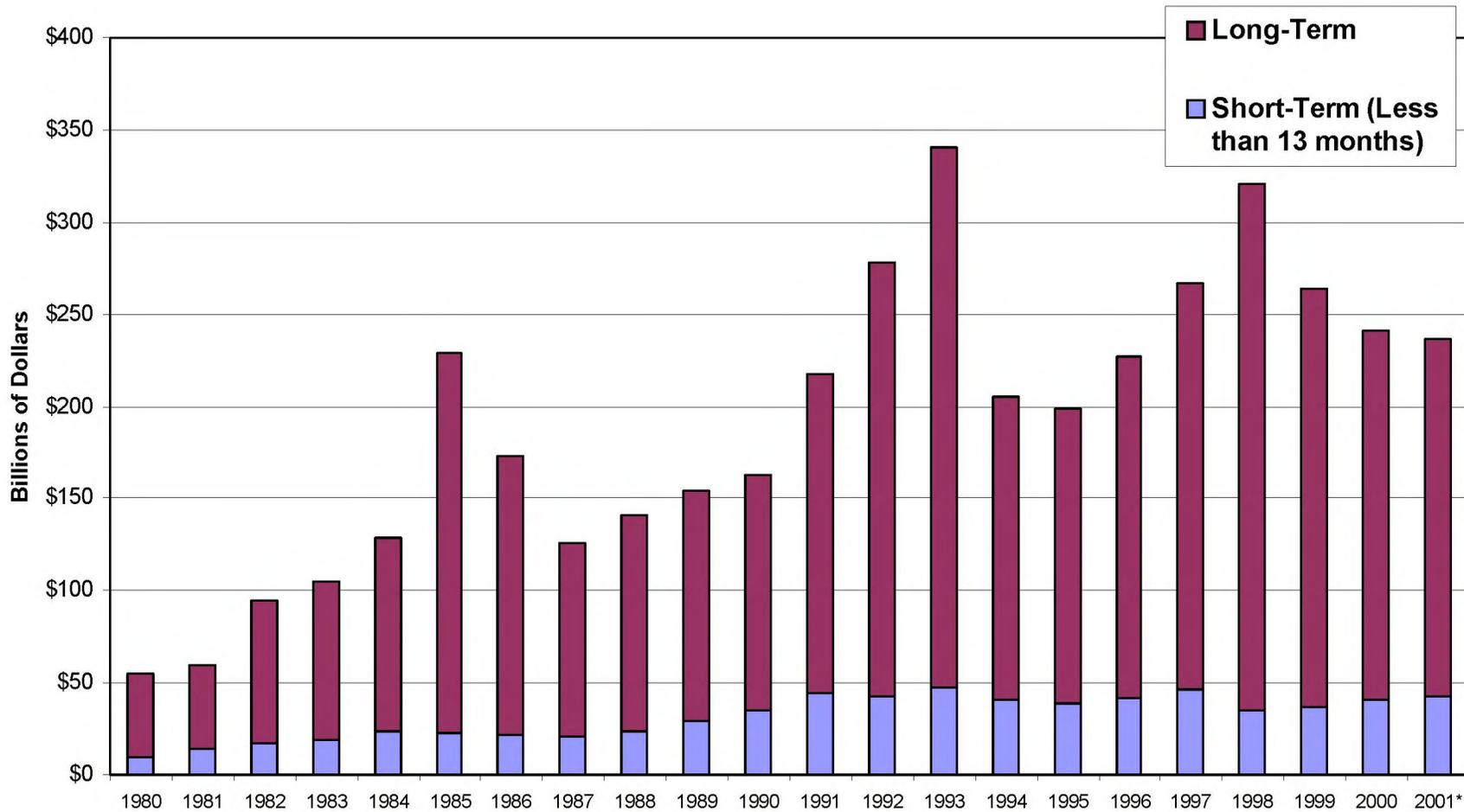


Figure 8-7: Tax-Free Municipal Debt Issuance in the US

* 2001 figures calculated as of 12/01/01

Selling bonds requires that the seller pledge a stream of revenues for repayment of the bonds. These revenues are the collateral that must provide the bondholder with reasonable certitude that the bonds will be repaid according to the debt service schedule provided at issuance. Whatever revenue source is provided, it must be stable and committed to debt service over the full term of the bonds. Usually, a sales tax, income tax, property tax, fuel tax, or the full faith and credit of the state or federal government are required as collateral for municipal bonds. After the passage of TEA-21, the added stability of the federal funding sources has allowed the development and use of bonds backed by anticipated federal grants, adding a new and important way to service municipal debt. Tax increment financing and farebox revenues have been successfully used as collateral on rare occasions.

Debt issuance limitations may be imposed on bond issuers by state or local governments. Typically, local debt limitations require conservative debt ratios, often 2.0 or greater, to ensure the long-term creditworthiness of local government entities. In many cases, the debt limit is a preset debt level that the issuer is legally required to remain below. Similarly, some bond covenants require that additional bonds maintain both historical and prospective debt ratios, usually 1.5 and 2.0 respectively.

The net coverage ratio, based on all revenues net of expenses, reflects the issuer's financial capability more accurately than the gross coverage ratio, which is based only on pledged revenues. The gross coverage ratio ignores non-pledged revenues and the ongoing operating and maintenance expense of the transit system. While technically, only the pledged revenues are relevant to the ability to make debt service payments, a system that cannot cover both operations and maintenance and debt service is not likely to remain financially viable. For this reason, bond rating agencies and potential bondholders will carefully inspect agency financial statements and financial plans to ensure the financial capability of all agency revenues to meet all projected financial obligations.

The different types of municipal bonds are described in the following sections.

General Obligation (GO) Bonds

General obligation securities are bonds backed by the "full faith and credit" of state or local governments. The taxing authority used to service GO bonds is not subject to constitutional or statutory limitations. Consequently, GO bonds are the most secure credit instruments among municipal securities. These bonds tend to receive the highest credit ratings available to a particular municipal agency and, if the agency is credit worthy, can carry exceptionally low yields.

GO bonds often require voter approval in a public referendum. These bonds take two particular forms with different levels of financial security. The most secure type is the unlimited tax (ULT) general obligation bond, which is secured by a tax that is not limited in rate or amount. A less secure GO bond is the limited tax (LT) general obligation bond, which is backed by a specific tax such as a sales

tax, fuel tax or an income tax. The limitation on the revenue source securing the bond results in higher risk to the bondholders, lower bond ratings, and higher yields. Limited tax general obligation bonds have been used in numerous cities to fund transportation investments after the successful passage of dedicated transportation taxes.

Revenue Bonds

Revenue bonds help to finance infrastructure projects such as bridges, toll roads, water and sewer facilities, airports, subsidized housing, and occasionally public transit projects. Revenue bonds are generally payable from specific revenue sources related to the operation of the facility being constructed. For instance, toll road and bridge bonds would be paid by the resulting tolls. Revenue bonds are not backed by the full faith and credit of the issuer. Rather, revenue bonds are secured by a specific revenue pledge to assure the adequacy of the revenue source. Since the payment sources are limited, a financial feasibility study that analyzes the projected revenues and operations of the facility to be financed is required to market the bonds.¹⁷

Since no transit agency collects enough in fare revenue to pay even the operating expenses of the systems, there are generally not enough revenues net of costs to dedicate toward debt service. However, some transit agencies have other revenue sources to fund operations such that fare revenues can be dedicated to pay off revenue bonds. New York MTA was a regular issuer of fare-backed bonds during the 1980's and 1990's.

GANs (or GARVEEs)¹⁸

Transit agencies can borrow against future Federal-aid funding using Grant Anticipation Notes (GANs), sometimes called Grant Anticipation Revenue Vehicles (GARVEEs). The agency issues bonds secured with a pledge of federal-aid assistance, thus amassing up-front capital, and pays down the bonds over a period of time as the federal funds are received. The agency is not able to make an enforceable pledge of future federal grants since there can be no guarantee that those funds will arrive. The bond market seems to be willing to accept this pledge, assuming that the likelihood of continuing federal grant is very high. GANs are short term notes usually used to initiate construction prior to the receipt of federal grants.

TEA-21 contained certain provisions that enhanced transit agencies' ability to borrow against future federal aid. For example, the additional security of TEA-21 "firewall" provisions (separating transportation funding from appropriations for other domestic purposes) was one factor that helped make it possible for transit agencies to pledge federal aid as the sole source of repayment, without having to encumber other transit revenue sources.

¹⁷ Federal Transit Administration, *Introduction to Public Finance and Public Transit*, US DOT, 1993, p. 54.

¹⁸ Paraphrased from *Innovative Finance Quarterly*, Winter/Spring 2000, Federal Highway Administration, US Department of Transportation, vol. 6, no. 1.

While transit agencies may use the discretionary funds provided through FFGAs to repay debt, these funds are not guaranteed to arrive on schedule because they are subject to annual appropriations. Because discretionary funds provided under an FFGA are project-specific, there is limited ability to shift funds between projects in the event of a shortfall. Thus, the credit risks for a transit GAN backed by a discretionary FFGA may be higher than for a transit GAN backed by formula funding at an equivalent coverage level. A grantee can increase coverage levels by borrowing less than the FFGA amount (essentially providing the coverage required for a good rating opinion) so that even if Congress appropriates significantly less than the budget request, there is likely to be enough funding appropriated to at least cover required debt service.

The Hudson-Bergen Light Rail project in Northern New Jersey explicitly relied on a pledge of future FFGA funding to secure construction financing. The project was supported primarily by a transit GAN, issued against anticipated discretionary funding. As a secondary pledge, the financing was also backed by a pledge from the state's Transportation Trust Fund, in the event that FFGA funds were not forthcoming. New Jersey Transit re-financed the initial debt with new GAN's to allow them to shed the added security of the Transportation Trust Fund. Market conditions allowed both reduced interest costs and additional bonding capacity for the New Jersey Treasury.

Tax-Exempt Commercial Paper

Tax-exempt commercial paper is a mechanism that provides a short-term (maximum maturity of 270 days) tax-free debt instrument to fund working capital for a transit agency. Transit agencies may receive the bulk of their operating subsidies at specific times of the year, which may require them to use short term financing to pay for ongoing operations. The terms available to transit agencies through tax-exempt commercial paper are generally better than could be obtained via a private line of credit from a bank. Usually, liquidity for a tax-exempt commercial paper program is provided through a letter of credit, a revolving credit agreement, or a line of credit.

8.5.7.2 TIFIA

The Transportation Infrastructure Finance and Innovation Act of 1998 (TIFIA) established a new federal credit program under which the U.S. Department of Transportation (DOT) may provide three forms of credit assistance – secured (direct) loans, loan guarantees, and standby lines of credit – for surface transportation projects of national or regional significance. TIFIA credit assistance can be more advantageous than tax free municipal debt.

One benefit of the TIFIA instrument is that the maximum maturity of all TIFIA credits is 35 years after a project's substantial completion. Municipal bonds usually have a 20-year term. At the end of the 20-year period, new bonds can be issued to pay the old ones, but there are costs associated with this transaction and the associated annual payment is somewhat higher for shorter-term debt instruments. If the interest rates are "close", it is quite possible that the net

present value of the financing arrangement under a TIFIA loan could be more advantageous than the municipal bond market.

Another benefit is that the TIFIA credit instrument may be junior (i.e., subordinate) to the project's capital market debt in its priority claim on the project's cash flow. In some circumstances, this feature will allow the borrower to maintain a higher credit rating on senior project debt than would otherwise be possible.

A TIFIA loan, loan guarantee, or line of credit could be a cost saving strategy for funding the local share for some projects. TIFIA is a credit program rather than a grant program so it does not provide incremental funding other than the potential savings associated with TIFIA credit terms compared to the terms available to project sponsors in the tax-free municipal bond market. If an agency's revenue bonds are rated BBB+, the yield in November 2001 was a little under 6 percent. The interest rate floor for TIFIA loans was 5.25 percent¹⁹ at that time. While the interest rate difference is not great, the judicious use of TIFIA loans could reduce interest expenses by significant sums if the financing period is long.

8.5.7.3 Vendor Financing

Vendor financing refers to credit offered to a transit system from an equipment vendor with the potential for advantageous payment terms for equipment or services. Vendor financing is most commonly used for vehicle purchases, but could be used for the purchase of vehicle control systems, fare collection, security or any other major equipment type. Vendor financing is usually either an extended payment schedule, or when the vendor acts as a conduit for financing through a third party. Extended payment schedules imply that the vendor defers sales revenue while third party financing means that a financial institution is providing the credit to the transit agency through the vendor.

At one time, vendor financing was a major part of the purchase decision since numerous vendors competed by offering the most generous (i.e. below market) interest rates. The low rates offered by the vendors reduced the total cost of procuring the various equipment packages and improved the net present value of the financial arrangement. However, domestic vendors complained that below market financing was an unfair trade practice and persuaded Congress in 1986 to prohibit the offering of below market interest rates. Now, the interest rates depend solely on the credit rating of the vendor. The market rates available to private vendors will very likely be higher than the terms available through a municipal bond issuance. The use of vendor financing has declined markedly since 1986.²⁰

¹⁹ Based on the rate for State and Local Government Securities (SLGS) of similar maturity plus five basis points (October 31, 2001).

²⁰ International vendor financing may offer more advantageous terms. For more information in international vendor financing, see *Introduction to Public Finance and Public Transit*, Federal Transit Administration, US Department of Transportation, 1993.

Today, the primary benefit of vendor financing is the simplicity of the transaction. Equipment features, price, financing arrangements, and payment schedules are all negotiated with a single entity. This financing mechanism is usually applicable only to purchases of vehicles and other equipment so it can only be a relatively small part of the financing strategy for a major investment.

8.5.7.4 Leasing

Leasing provides for the use of an asset without the need to make a large cash payment that most purchase agreements require. A lease is a rental agreement where a lessee (transit agency) agrees to make rental payments to the lessor (owner) in exchange for the use of the asset. Leasing allows the transit agency to reduce current year expenditures on new equipment by spreading the cost over a number of years as specified in the lease. Lease obligations are considered a form of municipal debt and can be tax-exempt if structured properly.

There are two main lease types: operating leases and capital leases. Operating leases are generally short term and cancelable. The risks and rewards of ownership of the leased asset are not transferred to the lessee. The lessor does not generally expect to recover the whole cost of the asset during the lease period which is generally much shorter than the useful life of the asset. Operating leases are generally confined to assets for which an established secondary market exists.

Capital leases are financing arrangements for acquiring assets and are generally non-cancelable financial obligations that are a form of debt. To be a capital lease, a lease agreement must meet one of the following criteria:

- The lease transfers title of the leased asset to the lessee at the end of the lease term. The lessee becomes the owner of the leased asset.
- The lease contains a “bargain purchase option” where the lessee can be expected to purchase the leased asset and become the owner.
- The lease term is at least 75 percent of the useful life of the leased asset.
- The present value of the least payments is at least 90 percent of the market value of the leased asset.²¹

Transit vehicles and specialized building and plant assets used by the transit agency are often accounted for as capital leases. Short term leasing of buses for special events, for instance, would be accounted for as operating leases. Rental of office space for the transit agency could be accounted for as a capital lease or and operating lease depending on the terms of the lease.

²¹ Harrison, W.T., and C.T. Horngren, Financial Accounting, Fourth Edition, Prentice Hall: New Jersey, 2001, pp. 383-4.

Leasing Arrangements

There are a variety of leasing arrangements commonly used by transit agencies for structuring capital leases. The two primary options are certificates of participation (or COPs) and sale-leaseback arrangements. The cross-border lease is a complicated form of the sale-leaseback arrangement designed to take advantage of foreign tax laws to improve the lease terms for the lessee. The reader interested in cross-border lease arrangements should refer to *Introduction to Public Finance and Public Transit*, Federal Transit Administration, US Department of Transportation, 1993.

COPs are used to finance equipment purchases by dividing the cost of the asset among many investors. Each investor owns some percentage of the asset and agrees to lease that percentage back to the transit agency. The transit agency uses COPs through a trustee bank that issues the debt and holds title to the equipment on behalf of the investors and administers the lease arrangement with the transit agency. Lease payments made by the transit agency to the trustee bank are “passed through” to the investors as principal and interest payments. COPs generally have 10-year terms, though the terms can be much longer.

The key to a COP arrangement is the marketability of the shares to investors. The interest rates offered on the certificates must be competitive in order to attract investors. The debt is usually structured as tax-exempt, but the lease obligations may not have the same level of security as revenue or GO bonds. Some transit agencies have offered a guaranteed repurchase price for the assets (vehicles normally), which has the effect of guaranteeing the principal amount of the certificates. Financially weak agencies would generally enter into these agreements for buses rather than rail vehicles since there is a more established secondary market for used buses.

Sale-leaseback arrangements are usually used to raise capital by basically selling assets to private investors who then lease the equipment back to the transit agency. The transit agency uses the arrangement to reduce their asset base in exchange for up front capital while still maintaining use of the asset. Sale-leaseback arrangements are much like a secured loan using the equipment itself as collateral.

The tax treatment of sale-leaseback arrangements is complex, but can provide terms competitive with tax-free municipal debt. A sale-leaseback can be structured in two ways:

1. Taxable interest if the lessor uses accelerated depreciation; or
2. Tax-exempt interest if the lessor uses straight-line depreciation.

Tax-free financing cannot be combined with accelerated depreciation. However, if structured properly, sale-leaseback arrangements can offer attractive terms to the lessee. It may be advisable to seek the advice of a tax attorney on structured

leasing transactions due to the complex nature of the financial arrangements required to execute a sale-leaseback financing.

The Benefits of Leasing

Leasing has proven to be a valuable financing alternative for state and local governments generally and transit agencies in particular. A variety of benefits have driven the expanded use of lease obligation financing, including:

- leasing allows the agency to spread the cost of equipment and capital assets over many years;
- lease obligation financing can provide advantageous credit terms competitive with other tax free municipal debt;
- the period of the lease can be tied to the useful life of the asset;
- leasing does not usually require voter approval, while municipal bond issuance usually does;
- leasing can provide up to 100 percent of the cost of the equipment;
- leasing preserves liquidity since it does not tie up other working capital or credit lines;
- leasing provides cost certainty for a known period;
- leasing can avoid loan covenants or debt limitations since it is accounted for as an operating expense; and
- with the exception of cross-border transactions, leasing is easy, minimizes administrative expenses, and simplifies tax and accounting procedures, as asset depreciation is the responsibility of the lessor.

Leasing has become a widespread approach to financing equipment and facility procurement by public entities, as it has for private firms. Though leasing can take several forms, they all provide some benefits over bond financing at similar interest rates. The most important advantages over bond financing are the ability to secure financing without voter approval and the ability to leverage existing assets. Transit agencies should note that FTA will not reimburse for more than the depreciated value of a leased asset in a given period. For example, on a ten-year lease of a bus with a twelve-year useful life, FTA will only reimburse 80 percent of 1/12th of the asset's value each year rather than 80 percent of the lease payment. This may require the grantee to front-load the lease by several months, which reduces the benefit to the grantee.

8.5.7.5 Incorporate Debt into the Financial Plan

Existing debt is incorporated into the financial plan as stipulated in the debt agreement. Municipal bonds are sold based on a pre-determined payout

schedule. The proceeds from the bond issuance vary with the willingness of bond buyers to pay for the right to receive the payments pledged by the issuer. The annual debt service on any existing bond is specified in the debt service schedule. Existing TIFIA loans or credits, vendor financing, or leasing arrangements also have well defined payment schedules, which are included in the financial plan.

Transit agencies with significant debt must provide financial details of their debt program (including lease obligations) within the financial plan. The purpose of the debt analysis is to define the long-term cash requirements of the agency. The ability to cover these long-term recurring obligations will be reflected in the agency's ability to provide consistent level of transit service.

The financial plan should include the following items to allow the close monitoring of the agency's debt load:

- Municipal debt (if any)
 - Outstanding long-term bond debt
 - Statutory debt limitation (if any)
 - Debt service on outstanding bonds
 - Principal
 - Interest
 - Debt issuance and net proceeds
 - Proposed project (if financial plan is supporting project planning)
 - Other capital projects
 - Debt service on New Bonds
 - Principal
 - Interest
- TIFIA debt by project (if any)
 - Outstanding balance
 - Debt service on TIFIA instrument
 - Principal
 - Interest
- Leasehold obligations (if any)
- Other loans or debt financings (if any)
- Financial Ratios
 - Debt service coverage ratio (pledged revenues/annual debt service)

- Debt service as a percent of revenues
- Long-term debt as a percent of total assets
- Operating ratio with debt service (operating revenues/operating expenses)
- Operating ratio without debt service [(operating revenues – debt service)/operating expenses]

Other long-term obligations that require monitoring are employee benefits for pensions and accrued vacation or other benefit time. These accounts should be treated on an accrual basis to recognize the potential liability. If these liabilities are un-funded, the agency’s finances could face severe disruption in the future.

8.5.8 Other Funding Sources

With the declining share of project costs for major transit investments borne by the New Starts program, along with the added flexibility in some of the other federal funding sources, many transit agencies have secured funds from a much wider array of sources than in the past. Since the passage of ISTEA, the Congestion Mitigation Air Quality (CMAQ) program and the Surface Transportation Program (STP) have been available to provide funds for transit investments. A recent trend to extend fixed guideway service to airports has allowed transit projects to use airport passenger facility charges for transit access improvements. Property development and other innovative financing mechanisms have also been used to generate additional funding for transit operations and capital projects. Lastly, direct private sector participation can provide funding in certain cases. This section describes these other sources and provides guidelines for incorporating these revenues into the transit agency financial plan.

8.5.8.1 Flexible Funds²²

Flexible funds are federal transportation funds that may be used either for transit or highway purposes. The flexible funding provision was first included in the Intermodal Surface Transportation Efficiency Act of 1999 (ISTEA) and continued with the Transportation Equity Act for the 21st Century (TEA-21). A local area can choose to use certain Federal surface transportation funds based on local planning priorities, not on a restrictive definition of program eligibility. Flexible funds include Federal Highway Administration (FHWA) Surface Transportation Program (STP) funds and Congestion Mitigation and Air Quality Improvement Program (CMAQ) and Federal Transit Administration (FTA) Urban Formula Funds. In addition, some transit related projects are eligible to be funded through the FHWA’s National Highway System (NHS) program.

Since the enactment of ISTEA, FHWA funds transferred to the FTA have provided a substantial new source of funds for transit projects. When FHWA funds are transferred to FTA they can be used for any eligible expense identified

²² Section paraphrased from Buffkin, T. and K. Johnson, “Flexible Funding: Trends and Possibilities”, FTA, 2001.

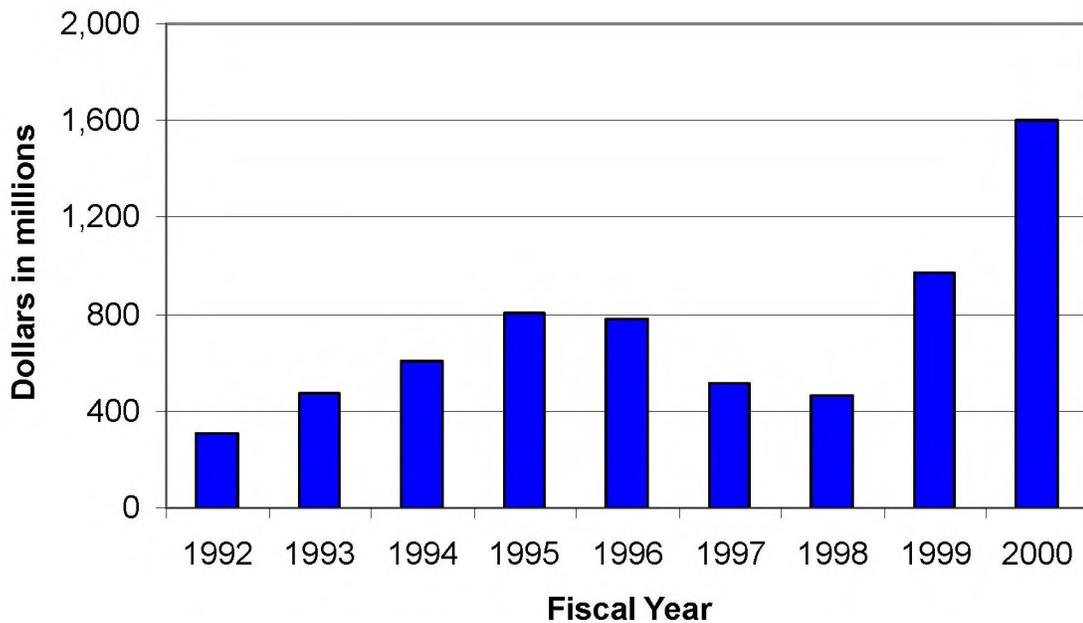
in the FTA program that receives the funds. When FHWA funds are transferred to FTA they are transferred to one of the following three programs:

1. Urbanized Area Formula Program (Section 5307);
2. Non-urbanized Area Formula Program (Section 5311); and
3. Elderly and Persons with Disabilities Program (Section 5310).

Once they are transferred to FTA, the funds are administered as FTA funds and take on all the requirements of the FTA program.

The trends in the use of flexible funding indicate that it is a popular mechanism for funding local transportation priorities. Since the beginning of ISTEA when the flexible funding mechanism was established, local transportation agencies have transferred \$6.5 billion from FHWA to FTA, and \$20.2 million from FHWA to FTA. After a downturn in the use of flexible fund in FY1997 and FY1998, local transportation agencies have dramatically increased their use of this funding mechanism in recent years. Annual flexible funds transfers to FTA reached the highest level ever at \$1.6 billion in FY 2000 (see Figure 8-8).

Figure 8-8: Flexible Funding Transfers for Transit Projects by Year



About 80% of funds transferred have been used for capital projects. The most common type of capital project (about 1/3 of the total) has been for vehicle purchases. Other common capital projects include: major capital investments (New Starts, etc.), station improvements, parking expansion, bicycle racks on

buses, and bus stop shelters. Flexible funds have also been used for operations and planning/engineering. The types of operations funded include new or demonstration services, air quality mitigation services, and shuttle services. Flexible funds have been used for planning and engineering of many different types of projects, from Environmental Impact Statements to design of pedestrian malls around stations.

Flexible funds are incorporated into transit agency financial plans like any other federal capital grant. The financial plan must document the agreement between the project sponsor, the MPO and the state department of transportation to initiate and complete the funding transfer. The funding amounts and schedule are negotiated among these various agencies and included as a line item in the transit agency capital plan.

8.5.8.2 Airport Funds

Transit agencies have increasingly partnered with local airport authorities to fund rail transit projects that directly serve airports. Airport revenues from passenger facilities charges (PFCs) are the primary source of funds. Some of the projects recently completed or currently under construction using Airport funds for a portion of their construction costs are:

- AirTrain at Newark International Airport;
- Hiawatha LRT at Minneapolis/St. Paul International Airport;
- BART/Caltrain access to San Francisco International Airport;
- Airport MAX to Portland (OR) International Airport; and
- AirTrain at JFK in New York City.

The difficulty with using funding provided by the airport authority is the restrictions imposed on the projects. PFCs can only be used for funding facilities on airport property or for transit facilities that only serve passengers whose origin or destination is the airport. The Federal Aviation Administration (FAA) must make a determination of eligibility to use airport PFCs for transit projects.

Securing airport funding can be difficult because of the incentive structure of airport revenues. Airports make money on parking revenues. Therefore, every added transit rider means lower airport revenues. Transit access can also use valuable airport space that could be used as parking or curbside taxi space, which is rented and provides the airport authority with additional revenue. In essence, the airport may look at funding transit access as paying millions of dollars for the privilege of reducing airport revenues. On the other hand, airports with significant congestion or that lack space for additional parking may value transit access as a means to bring in more passengers that could not otherwise be accommodated. That said, PFCs are a very large, growing and attractive revenue source that count toward local match required for federal funding.

8.5.8.3 Property Development

Transit agencies can and do generate revenue through the lease, development or sale of property or property rights, otherwise known as the all-encompassing term “joint development”. The air rights over a station, yard or terminal, or other real estate procured in the process of constructing a transit project, may be sold or leased to a private developer who agrees to construct a building or collection of buildings. The rent can be a contractually fixed fee or a percentage of the gross lease income produced by the tenants. Joint development projects have included hotels, office space, apartment buildings, homes, and shopping areas.

Joint development near transit stations can also increase transit ridership and operating revenues. When transit agencies weigh development proposals for their property, the additional ridership generated by the uses should be explicitly considered. Even if a proposal for a warehouse was the highest bid for a transit owned parcel near a rail station, apartments may provide the higher total return if significant numbers of additional transit riders result.

Another potential arrangement through which a transit agency could realize benefits from its real estate holdings is to establish a real estate development subsidiary to develop land directly. The subsidiary’s profits would then flow to the transit agency as other operating income. The benefits of this approach would be the shorter time to develop the properties as well as the ability to specifically direct the type of development activities that take place on agency-owned land.

Property development projects can provide a one time cash gain or provide a dependable stream of income that helps to offset the operating losses of the transit operation. While these revenues will probably not amount to more than a small percentage of the total operating budget, the revenue can amount to millions of dollars per year, which can be used for a variety of capital or operating needs.

Transit agencies should not assume that property development activities will provide significant funds. The Washington Metropolitan Area Transportation Authority (WMATA) is generally regarded as one of the most aggressive practitioners of transit joint development. WMATA received \$6.4 million in joint development revenues for FY 2000 out of a total \$684 million budget. While property development revenues provide valuable additional resources for WMATA and, importantly, ensure the type of development that supports the transit system, property development activities bring WMATA less than 1 percent of their system operating expenses. Most other transit agencies are unlikely to generate much more revenue than WMATA.

8.5.8.4 Innovative Finance

"Innovative finance" for transit is a broadly defined term that encompasses a combination of techniques and specially designed mechanisms to supplement traditional financing sources and methods. Most of the programs and tools of innovative finance have been enabled by ISTEA and TEA-21. Many of the

financing mechanism already described, such as TIFIA, GANs (GARVEEs), and leasing, are considered “innovative finance”. While these mechanisms are not much more “innovative” than the techniques used by average citizens to buy a house or lease an automobile, their use in the funding of transportation projects, where pay-as-you-go funding is the norm, is relatively innovative.

Traditionally, the government has financed transportation infrastructure primarily through a combination of state and local taxes and fees, and federal grants. These resources typically funded projects on a "pay-as-you-go" basis, meaning that projects were built in phases or increments as funds became available over a period of years. Project funding has been tied closely to Federal and state funding availability. While the pay-as-you-go approach has the benefit of simplicity and avoids interest costs associated with indebtedness, it involves the hidden costs associated with inflation and foregone economic development, especially for projects delayed several years. In addition, delaying projects that provide significant public benefits, reduce emissions or eliminate safety hazards also has obvious negative political and economic effects.

This section only addresses those “innovative” financing techniques not previously discussed. These include the use of State Infrastructure Banks (SIBs) and advance construction.

State Infrastructure Banks (SIBs)

The National Highway System (NHS) Act established the SIB pilot program. A SIB is a state (or multi-state) revolving fund that, much like a private bank, can offer a range of loans and credit assistance enhancement products to public and private sponsors of highway or transit capital projects. Under the initial pilot program, states were authorized to use a portion of their FY 1996 and FY 1997 federal funds as "seed" money, matched with non-federal funds. The 1997 USDOT appropriations act provided \$150 million in Federal general revenue funds for SIB capitalization. TEA-21 extended Federal funding for SIBs in four states - California, Florida, Missouri, and Rhode Island - by allowing them to capitalize their banks with funds authorized by TEA-21 through FY 2003. As of October 2001, 32 states have entered into 245 loan agreements with a dollar value of nearly \$2.9 billion.

The types of assistance that may be provided by SIBs include loans (which may be at or below market rates), loan guarantees, lines of credit, letters of credit, certificates of participation, debt service reserve funds, bond insurance, and other forms of non-grant assistance. As loans or other credit assistance forms are repaid, a SIBs initial capital is replenished and can be used to support a new cycle of projects.

By obtaining SIB support for a project, the sponsor may be able to attract private, local, and additional state financial resources. Alternatively, SIB capital can be used as collateral to borrow in the bond market or to establish a guaranteed

reserve fund. Loan demand, timing of needs, and debt financing considerations are factors to be considered by states in evaluating a leveraged SIB approach.

While the state SIBs authorized by the USDOT under the pilot program began with an initial infusion of federal funds and non-federal matching contributions, states have the opportunity to contribute additional state or local funds beyond the required non-federal match.

Advance Construction

Under advance construction, a grantee may use non-federal funds to advance a federally supported project while preserving its eligibility to receive Federal reimbursements in the future. Advance construction eliminates the need to set aside full obligation authority before starting projects. As a result, a grantee can undertake a greater number of concurrent projects than would otherwise be possible. In addition, advance construction helps facilitate construction of large projects, while maintaining obligation authority for smaller ones. Advance construction allows a grantee to conserve obligation authority and maintain flexibility in its transportation funding program. For transit facilities, a "letter of no prejudice" (LONP) follows similar procedures to advance construction, but also applies to non-construction-related activities (e.g., vehicle procurement).

Partial conversion of advance construction is a somewhat different approach, in which the grantee converts, obligates, and receives reimbursement for only a portion of the federal share of project costs. This removes any requirement to wait until the full amount of obligation authority is available. The grantee can therefore convert an advance-constructed project to a federally funded project in stages, based on cash flow requirements and availability of obligation authority, rather than all at once on a single future date. This flexibility enables a grantee to begin some projects earlier, delivering the benefits to the public sooner.

For example, the Massachusetts Bay Transportation Authority (MBTA) used advance construction authority to fund the Boston Engine Terminal project. The Federal Transit Act requires agencies to resubmit proposals to FTA for advance construction authority with every subsequent transit authorizing legislation (*i.e.*, ISTEA, TEA-21, *etc.*). In addition, agencies using advance construction must apply each year for federal funds to pay for the project.

The flow of funds under advance construction authority is quite complex. In the case of the MBTA project, the contractor invoices the transit agency. MBTA pays for the local share and submits receipts to FTA for reimbursement of the federal share. Because each year's invoices exceed the total local and federal share, MBTA issues short-term debt to cover the remainder. Twice a year, MBTA issues long-term general obligation bonds to retire this short-term debt. These bonds are not specific to the Boston Engine Terminal project, but are for the entire capital program.

In calculating the federal share of interest expenses, MBTA employs a weighted average. MBTA tracks the progress payments from FTA and ties them to specific bond issues.

MBTA notes several key advantages to advance construction authority over traditional funding methods for large, expensive projects:

- expenses can be incurred immediately;
- construction can be consolidated into one contract; and
- 80% of the bond interest for all expenses incurred above the FTA allocation is reimbursable by FTA.

With advance construction authority, a transit agency can spend the money necessary for a major contract immediately. Thus for projects that exceed an agency's annual FTA capital allocation, a transit agency can build them immediately without having to wait to collect multiple years of allocations and realize the benefits of the project sooner. If MBTA had to wait until it had cash on hand for the \$235 million Boston Engine Terminal renovation, the facility would have been out of service for 19 years. Under advance construction authority, the Boston Engine Terminal was rebuilt in 6 years, but the financing is accomplished through 19 years of debt service repayment. After completing the Engine Terminal, MBTA refinanced the bonds at more favorable interest rates, using the proceeds for other capital needs.

Advance construction authority allowed MBTA to consolidate its large construction project into one contract and incur all expenses up-front. Otherwise, multiple small contracts, and therefore numerous procurements, would have been necessary. The single contract saves time and eases project management by eliminating quality control issues related to multiple contracts.

The disadvantages to advance construction are: 1) if FTA funds were discontinued, the agency would be responsible for all project expenses; 2) a portion of future capital grants must be dedicated to paying off the interest for the project. Between FY 2000 and 2013, MBTA must dedicate \$16 million in federal capital grants and \$4 million of its own revenues to pay the principal and interest on bonds for the Boston Engine Terminal project.²³

8.5.8.5 Private Sector Participation

Since no US public transit projects actually produce enough revenue to offset their operating costs let alone cover the cost of capital, private sector funding will not usually be forthcoming. The exception is when private firms can benefit from the public investment and may be willing to contribute to the cost of the

²³ Paraphrased from MBTA Advance Construction Authority case study (available on NCHRP sponsored site - http://www.innovativefinance.org/topics/finance_mechanisms/pdfs/tcrp_31_mbta.pdf)

transit project. Two types of situations lend themselves to private sector participation:

1. railroad improvements on lines shared with freight railroads, and
2. property owners near transit stations that benefit from the improvements in accessibility for their properties.

Investments in rail infrastructure to provide capacity for commuter rail on existing freight lines usually produces some benefit for the freight operator, either in terms of higher quality infrastructure, higher capacity, or more operating flexibility, especially during the hours when the commuter rail service is not running. In a few instances, transit agencies have been able to secure private sector contributions from private railroads for capacity expansion and rail upgrades that benefit freight railroads.

Private sector contributions from property owners are another possibility. In cases where property values will clearly increase significantly from direct access to the transit project, property owners may be willing to offer significant amounts of funding. Examples include two recent projects. The Las Vegas monorail project is being partially funded by local property owners through the Las Vegas Monorail Corporation. Another example is the New York Avenue infill station in Washington DC. This project is receiving \$25 million in private sector funding through a special assessment district made up of several large property owners within a half-mile of the station.

Private sector funding is incorporated into the financial plan according to the terms of the agreement. The funds are not considered committed until a signed contract between the funding partners is executed. The agreement will stipulate the funding arrangement, which will be incorporated into the financial plan as a line item in the capital budget with supporting documentation.

8.6 Financial Analysis

This section describes the procedures, assumptions, and analytical tools required for developing and analyzing the financial plan. After all the components of the financial plan have been developed, the financial analyst must combine this information into a coherent financial plan. Financial models are prepared to assist in the analysis and development of sound financial strategies.

A financial model attempts to accurately represent the financial position of the transit agency to allow for the systematic evaluation of the potential financial strategies in support of long-term agency goals. The financial model is designed to allow assumptions and inputs to vary in order to support an evaluation of risks to the financial plan, and to determine the sensitivity of the financial condition of the agency to changes in circumstance. The financial model is not the financial plan. It is a tool that assists the financial analyst in evaluating and devising financial strategies that ultimately make up the financial plan.

8.6.1 Analyzing Financial Capacity

The financial model is a valuable tool for evaluating financial strategies. The financial analysis seeks to understand the impact of constructing and operating new projects on the ability of the transit agency to operate and maintain the existing and planned system.

8.6.1.1 Assessment of Financial Condition

The assessment of financial condition considers a variety of factors that may affect the transit agency's ability to construct and operate planned projects as well as the existing transit system. The assessment of financial condition generally looks at historical data to support the findings. The indicators of financial condition fall into three general categories:

1. Economic condition of the region
 - a. Appraised value of real property
 - b. Building permits issued
 - c. Business licenses issued
 - d. Development patterns supportive of transit
 - e. Population and employment growth
 - f. Personal income growth
 - g. Bond ratings for regional governments
2. Results of transit operations
 - a. Audited financial statements
 - b. Ridership growth
 - c. O&M cost trends
 - d. Capital expenditures
 - e. Farebox revenue/recovery ratio trends
 - f. Non-fare revenue trends
 - g. Working capital
3. Fiscal burden of transit expenditures on the region
 - a. Transit subsidy/personal income
 - b. Transit subsidy/taxable property value
 - c. Long term debt as percent of total assets
 - d. Long term debt per capita
 - e. Debt service as percent of revenue
 - f. Coverage ratios

The indicators of economic condition provide a sense of the economic health of the community and its ability to support a growing transit system. The transit operation measures track the financial performance of the transit agency. The fiscal burden measures indicate the degree to which transit expenditures in the region are growing or declining relative to available funding sources and the capacity of the region to dedicate additional resources to the transit system.

Securing non-federal funding sources often hinges on the ability of the transit agency to convince local decision-makers and voters to dedicate new sources of funding. This action may involve public referenda or through convincing public officials of the need for additional resources. For this reason, it is important to gauge the public's willingness to approve additional funding for transit projects. These judgments can be made on the basis of the indicators listed above and on the basis of market research.

8.6.1.2 Assessment of Financial Capability

The assessment of financial capability is based on the cash flow analysis which compares current and projected estimates of pledged revenues to planned expenditures. The cash flow analysis is the culmination and combination of all of the components of the financial analysis into a coherent statement of financial position.

The cash flow analysis supports the determination of the transit system's ability to continue to operate and maintain the existing system with the additional costs associated with proposed or planned projects. The cash flow analysis reveals the extent of any predictable revenue shortfalls. The magnitude of the shortfall (if any) will dictate the funding strategies that will be considered. The agency may be able to fund its proposed projects by using "pay-as-you-go" financing, employing a debt instrument, or securing a lease.

The demonstration of financial capability will ensure that the agency can be expected to maintain adequate cash or reserve fund balances while meeting all existing and planned financial obligations over the forecast period. The agency must also meet the minimum required coverage ratios for any debt financing and maintain compliance with any locally or legislatively mandated objectives or limits.

8.6.2 Developing a Financial Model

The financial model is a tool that is helpful in the development of the financial plan. A financial plan can present and combine all the information required using the outputs from other analyses as described in Sections 8.3 through 8.5 without developing a financial model. The financial model is developed as a tool to allow input assumptions to change and to evaluate the impact of those changes on the financial position of the transit agency without having to go through the trouble of recalculating every forecast and cost estimate from scratch.

The financial model is a valuable tool that combines all relevant financial information (the development of which has been detailed in previous sections)

into a detailed statement of financial position and links the financial inputs to a series of planning and financial assumptions. Altering various input parameters independently or in combination may expose critical information that was not readily apparent. The ultimate goal of the financial analysis is to develop an affordable and financially feasible strategy for constructing proposed projects while providing for the capital and operating needs of the existing transit system.

The first step in the development of the model is to establish the base modeling assumptions and inputs. This set of inputs should, to the maximum extent possible, contain all the information to support the calculation of the forecasts contained in the model. Year-by-year entry of inputs should be avoided in favor of formula calculations based on modeling inputs and base year information wherever possible. In some cases, such as the development of travel demand forecasts and O&M costs, internal calculation of some forecasts is not possible due to the complexity of the models that produce these forecasts. Special care is required to ensure that internally consistent scenarios are evaluated when external models supply some of the inputs.

The components usually required to populate a financial model include:

- Economic conditions
 - forecasts for various inflation rates (CPI, construction, labor, materials, real estate...etc.)
 - population, employment, and income growth
- Financial information
 - Interest rates
 - real and nominal rates
 - taxable yields
 - tax-exempt yields
 - long term and short term rates
 - Term of each debt issuance
 - Timing of each issuance
 - Issuance costs
 - Debt service reserve requirements
 - Other reserve fund requirements
 - Reinvestment rates
 - Issuance restrictions
- Revenue Forecasts
 - Ridership (growth)
 - Ridership elasticities
 - Fares
 - Federal grants
 - State grants

- Local grants
- Tax revenues or user fees
- Other subsidies
- Other operating revenues
- Expenses
 - Operations and Maintenance
 - Service levels (vehicles, vehicle miles, vehicle hours, track miles, etc.)
 - Labor
 - Materials
 - Fuel
 - Utilities
 - Replacement and rehabilitation
 - Special programs
 - Administration
 - Other
 - Capital
 - Proposed project
 - Right-of-way
 - Construction
 - System-wide elements
 - Vehicles
 - Shops
 - Stations
 - Other proposed or ongoing projects
- Sensitivity factors
 - Inflation
 - Population, employment and income growth
 - Tax revenues
 - Ridership
 - Grants
 - Service levels/operating costs
 - Capital costs and schedules

Creating a base table for all assumptions in the financial model instead of entering values on a year-by-year basis minimizes the amount of work associated with evaluating alternative scenarios with the model. Most importantly, it facilitates the financial evaluation by allowing systematic variations in the assumptions and their financial impacts. The financial model should carefully link parameters and inputs that are interrelated to ensure that the financial scenario presented is reasonable and consistent. For instance, the model should ensure that a rapid economic growth scenario not only corresponds to more rapid

ridership and tax revenue growth, but also results in faster labor cost growth and higher costs for constructing major investments.

8.6.2.1 Structure of a Financial Model

To ease understanding and presentation, the financial model should be structured in separate modules. The modules should include focused financial information that can be combined into summary tables and a cash flow statement. Separate tables should be prepared for revenues and funding sources, operating and maintenance costs, capital costs, debt financing, and economic and planning assumptions. The financial model can combine this information in two ways: 1) as individual operating and capital plans which are combined into a cash flow statement, or 2) as individual schedules of sources and uses of funds which are combined into a cash flow statement.

The financial model then links changes in costs and revenues to changes in planning and financial assumptions. Since re-running the travel demand model and most O&M cost models every time a financial scenario is evaluated would be impractical and time consuming, travel demand estimates and O&M costs should be linked to service and economic factors using simple parametric relationships that are as consistent as possible with the relationships (elasticities) in the external models.

An example of a financial planning model for a large transit agency is presented on the following pages.

8.6.2.2 Modeling Assumptions

The financial analyst must be cautious to avoid being overly presumptuous of accuracy in forecasts of future conditions. Very few forecasters would have predicted the exceptionally low inflation and interest rate environment combined with rapid economic growth experienced in the late 1990's or the exceptionally high inflation and interest rates seen in the early 1980's. The responsible analyst will develop a variety of scenarios to represent the range of financial possibilities as well as developing a "best guess" scenario.

Scrupulous documentation of inflation assumptions is critical in the development and analysis of a financial plan. There are significant differences between measures of general price inflation like the Consumer Price Index (CPI) and the measures of inflation that represent the "basket" of inputs used in transit operations or construction. The seriousness of these differences compound over time. To minimize these potential errors, the financial model should accurately reflect the mix of labor, materials, fuel/power, real estate, and equipment used to operate and construct transit systems.

Economic forecasts drive a variety of items that affect the financial health of transit agencies. Ridership levels, service levels, and tax revenues depend on regional population, employment and income growth. These factors help determine major portions of the transit agency's revenue stream and the operating and maintenance costs of the transit system.

Input Parameters	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Years 10-20
Inflation Assumptions										
CPI	2.25%	2.25%	2.25%	2.25%	2.25%	2.25%	2.25%	2.25%	2.25%	2.25%
Labor	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%
Fuel/Power	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Materials	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Construction	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%
Real estate	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
<i>Inflation Factors (calculated)</i>										
CPI	1.0225	1.0455	1.0690	1.0931	1.1177	1.1428	1.1685	1.1948	1.2217	
Labor	1.0300	1.0609	1.0927	1.1255	1.1593	1.1941	1.2299	1.2668	1.3048	
Fuel/Power	1.0200	1.0404	1.0612	1.0824	1.1041	1.1262	1.1487	1.1717	1.1951	
Materials	1.0250	1.0506	1.0769	1.1038	1.1314	1.1597	1.1887	1.2184	1.2489	
Construction	1.0400	1.0816	1.1249	1.1699	1.2167	1.2653	1.3159	1.3686	1.4233	
Real estate	1.0500	1.1025	1.1576	1.2155	1.2763	1.3401	1.4071	1.4775	1.5513	
<i>Incremental Funding Growth over/under CPI</i>										
Section 5307 Formula	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Section 5309 Rail Mod	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%
Local funding compact	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
<i>Funding Growth Factors (calculated)</i>										
Section 5307 Formula	1.0225	1.0455	1.0690	1.0931	1.1177	1.1428	1.1685	1.1948	1.2217	
Section 5309 Rail Mod	1.0275	1.0558	1.0848	1.1146	1.1453	1.1768	1.2091	1.2424	1.2765	
Local funding compact	1.0225	1.0455	1.0690	1.0931	1.1177	1.1428	1.1685	1.1948	1.2217	
Growth Rates										
Real income growth	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Real economic growth	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%
Population growth	0.75%	0.75%	0.75%	0.75%	0.75%	0.75%	0.75%	0.75%	0.75%	0.75%
Employment growth	0.90%	0.90%	0.90%	0.90%	0.90%	0.90%	0.90%	0.90%	0.90%	0.90%
Economic Conditions										
Real Personal Income (mil\$)	159,120	162,302	165,548	168,859	172,237	175,681	179,195	182,779	186,434	
Population	3,929,250	3,958,719	3,988,410	4,018,323	4,048,460	4,078,824	4,109,415	4,140,236	4,171,287	
Employment	2,361,060	2,382,310	2,403,750	2,425,384	2,447,213	2,469,237	2,491,461	2,513,884	2,536,509	

Table 8-16: Example Financial Model - Inflation and Growth Inputs

Input Parameters	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Years 10-20
O&M Model Inputs										
Peak buses	1055	1062	1070	1077	1085	1092	1100	1107	1115	
Bus vehicle miles	27,055,617	27,258,534	27,462,973	27,668,945	27,876,462	28,085,536	28,296,177	28,508,398	28,722,211	
Bus garages	5	5	5	5	5	5	5	5	5	
Direct Bus O&M (base yr\$)	288,637,668	290,802,450	292,983,468	295,180,844	297,394,701	299,625,161	301,872,350	304,136,392	306,417,415	
% O&M Labor	79.50%	79.50%	79.50%	79.50%	79.50%	79.50%	79.50%	79.50%	79.50%	
% O&M Util/Fuel	10.20%	10.20%	10.20%	10.20%	10.20%	10.20%	10.20%	10.20%	10.20%	
Peak rail vehicles	666	666	666	666	666	666	666	666	666	
Rail veh miles	42,568,210	42,568,210	42,568,210	42,568,210	42,568,210	42,568,210	42,568,210	42,568,210	42,568,210	
Rail track miles	274	274	274	274	274	274	274	274	274	
Rail yards/shops	4	4	4	4	4	4	4	4	4	
Direct Rail O&M (base yr\$)	395,489,120	395,489,120	395,489,120	395,489,120	395,489,120	395,489,120	395,489,120	395,489,120	395,489,120	
% O&M Labor	73.20%	73.20%	73.20%	73.20%	73.20%	73.20%	73.20%	73.20%	73.20%	
% O&M Util/Fuel	8.10%	8.10%	8.10%	8.10%	8.10%	8.10%	8.10%	8.10%	8.10%	
Project vehicles	0	0	0	0	0	0	30	30	30	
Project veh miles	-	-	-	-	-	-	-	-	-	3,417,885
Project track miles	-	-	-	-	-	-	-	-	-	22
Project yards/shops	-	-	-	-	-	-	-	-	-	-
Direct Project O&M (base yr\$)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 31,754,596
% O&M Labor	73.20%	73.20%	73.20%	73.20%	73.20%	73.20%	73.20%	73.20%	73.20%	73.20%
% O&M Util/Fuel	8.10%	8.10%	8.10%	8.10%	8.10%	8.10%	8.10%	8.10%	8.10%	8.10%
Gen & Admin (base yr\$)	\$ 54,730,143	\$ 54,903,326	\$ 55,077,807	\$ 55,253,597	\$ 55,430,706	\$ 55,609,142	\$ 55,788,918	\$ 55,970,041	\$ 58,692,891	
Travel Demand Scenario										
<i>Inputs from Travel Demand Model</i>										
TDM Bus ridership	116,740,014	117,790,674	118,850,790	119,920,447	120,999,731	122,088,728	123,187,527	124,296,215	125,414,881	
TDM Rail Ridership	184,719,476	187,490,269	190,302,623	193,157,162	196,054,519	198,995,337	201,980,267	205,009,971	208,085,121	
TDM Project Ridership										3,600,000
TDM Employment growth	1.20%	1.20%	1.20%	1.20%	1.20%	1.20%	1.20%	1.20%	1.20%	1.20%
Calculations										
Employment elasticity	1.00									
Bus Fare Elasticity	0.40									
Bus fares	\$ 1.00	\$ 1.00	\$ 1.00	\$ 1.10	\$ 1.10	\$ 1.10	\$ 1.10	\$ 1.10	\$ 1.10	\$ 1.10
Bus Ridership Scenario	116,392,917	117,094,399	117,803,232	118,521,486	119,249,740	119,978,004	120,706,268	121,434,532	122,162,796	122,891,060
Employment elasticity	1.00									
Rail Fare Elasticity	0.20									
Rail fares	\$ 1.60	\$ 1.60	\$ 1.60	\$ 1.75	\$ 1.75	\$ 1.75	\$ 1.75	\$ 1.75	\$ 1.75	\$ 1.75
Rail Ridership Scenario	184,173,508	186,391,779	188,644,958	190,927,137	193,219,316	195,511,495	197,803,674	200,095,853	202,388,032	204,680,211
Employment elasticity	1.00									
Project Fare Elasticity	0.20									
Proposed Project Fares	\$ 1.60	\$ 1.60	\$ 1.60	\$ 1.75	\$ 1.75	\$ 1.75	\$ 1.75	\$ 1.75	\$ 1.75	\$ 1.75
Project Ridership Scenario	-	-	-	-	-	-	-	-	-	3,600,000

Table 8-17: O&M Costs and Travel Demand Inputs

System Costs	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Years 10-20
Operations and Maintenance										
Existing Bus O&M - Direct	\$ 296,779,415	\$ 307,443,168	\$ 318,493,916	\$ 329,945,817	\$ 341,813,553	\$ 354,112,345	\$ 366,857,974	\$ 380,066,804	\$ 393,755,802	
Existing Rail O&M - Direct	\$ 406,478,774	\$ 417,779,230	\$ 429,399,405	\$ 441,348,470	\$ 453,635,867	\$ 466,271,309	\$ 479,264,791	\$ 492,626,600	\$ 506,367,320	
New Project O&M - Direct	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 40,657,224	
Gen & Admin	\$ 56,372,047	\$ 58,246,938	\$ 60,185,007	\$ 62,188,410	\$ 64,259,380	\$ 66,400,224	\$ 68,613,332	\$ 70,901,173	\$ 76,580,910	
Vehicle Costs										
Beginning buses	1,247	1,256	1,265	1,274	1,283	1,292	1,301	1,310	1,319	
Bus retirements	103	104	105	106	106	107	108	109	109	
Bus vehicle purchases	112	113	114	115	115	116	117	118	118	
Year end bus fleet	1,256	1,265	1,274	1,283	1,292	1,301	1,310	1,319	1,328	
Beginning rail vehicles	855	855	855	855	855	855	855	855	855	
Rail vehicle retirements	20	10	60	10	5	10	15	10	10	
Rail vehicle purchases	20	10	60	10	5	10	15	10	10	
Year end rail fleet	855	855	855	855	855	855	855	855	855	
Average bus cost	\$ 357,875	\$ 365,927	\$ 374,161	\$ 382,579	\$ 391,187	\$ 399,989	\$ 408,989	\$ 418,191	\$ 427,600	
Average rail vehicle cost	\$ 2,454,000	\$ 2,509,215	\$ 2,565,672	\$ 2,623,400	\$ 2,682,426	\$ 2,742,781	\$ 2,804,494	\$ 2,867,595	\$ 2,932,116	
Annual bus purchase costs	\$ 40,082,000	\$ 41,349,772	\$ 42,654,303	\$ 43,996,604	\$ 44,986,527	\$ 46,398,713	\$ 47,851,673	\$ 49,346,526	\$ 50,456,823	
Annual rail vehicle purchase costs	\$ 49,080,000	\$ 25,092,150	\$ 153,940,340	\$ 26,234,000	\$ 13,412,132	\$ 27,427,811	\$ 42,067,405	\$ 28,675,947	\$ 29,321,156	
Project vehicle purchases	-	-	-	-	-	-	30	-	-	
Year end vehicle fleet	-	-	-	-	-	-	30	30	30	
Existing System Capital Costs										
Bus facilities	\$ 6,500,000	\$ 6,760,000	\$ 7,030,400	\$ 7,311,616	\$ 7,604,081	\$ 7,908,244	\$ 8,224,574	\$ 8,553,557	\$ 8,895,699	
Rail facilities	\$ 23,400,000	\$ 24,336,000	\$ 25,309,440	\$ 26,321,818	\$ 27,374,690	\$ 28,469,678	\$ 29,608,465	\$ 30,792,804	\$ 32,024,516	
Other facilities										
Capital improvement program								\$ 157,911,814	\$ 164,228,286	
Major Rehabilitation Project	\$ 155,000,000	\$ 166,000,000	\$ 175,000,000	\$ 150,000,000	\$ 45,000,000					
Rail Extension										
Proposed Project Capital Costs										
Right-of-way				\$ 75,969,141	\$ 79,767,598					
Construction				\$ 96,470,046	\$ 300,986,545	\$ 313,026,007	\$ 217,031,365	\$ 112,856,310		
Vehicles				\$ -	\$ -	\$ -	\$ 84,134,809	\$ -		
Engineering and Management				\$ 79,339,896	\$ 68,100,077	\$ 56,114,464	\$ 43,348,423	\$ 29,765,917		
Contingency				\$ 50,018,741	\$ 90,937,596	\$ 68,216,648	\$ 47,741,115	\$ 25,547,854		
Total Cost (Base year \$/YOY\$)				\$ 301,797,824	\$ 539,791,816	\$ 437,357,118	\$ 392,255,712	\$ 168,170,081		

Table 8-18: Financial Model Cost Inputs

System Revenues	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Years 10-20
Operating Revenues										
Existing Bus Ridership	116,392,917	117,094,399	117,803,232	113,821,486	114,559,306	115,304,625	116,057,510	116,818,025	117,586,237	
Existing Rail Ridership	184,173,508	186,391,779	188,644,958	187,407,081	189,742,217	192,113,808	194,522,397	196,968,533	199,452,777	
New Project Ridership	-	-	-	-	-	-	-	-	3,600,000	
Average bus fare	\$ 1.00	\$ 1.00	\$ 1.00	\$ 1.10	\$ 1.10	\$ 1.10	\$ 1.10	\$ 1.10	\$ 1.10	\$ 1.10
Bus fare discount factor	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Average rail fare	\$ 1.60	\$ 1.60	\$ 1.60	\$ 1.75	\$ 1.75	\$ 1.75	\$ 1.75	\$ 1.75	\$ 1.75	\$ 1.75
Rail fare discount factor	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Bus system revenues	\$ 77,983,255	\$ 78,453,247	\$ 78,928,165	\$ 83,886,435	\$ 84,430,208	\$ 84,979,509	\$ 85,534,385	\$ 86,094,885	\$ 86,661,057	
Rail system revenues	\$ 250,475,970	\$ 253,492,820	\$ 256,557,143	\$ 278,768,033	\$ 282,241,548	\$ 285,769,289	\$ 289,352,065	\$ 292,990,694	\$ 296,686,006	
New project revenues	-	-	-	-	-	-	-	-	5,355,000	
Other operating revenues	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	
Dedicated Revenues										
Regression: $\ln(\text{tax base}) = a \cdot \ln(\text{population}) + b \cdot \ln(\text{per capita income}) + e$										
Regression Parameters	a	0.85	estimated							
	b	1.12	estimated							
Tax base forecast (mil\$)	59,584	62,166	64,859	67,669	70,601	73,659	76,851	80,180	83,654	
Tax rate	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%
Tax revenue	\$ 609,248,919	\$ 649,946,229	\$ 693,362,084	\$ 739,678,082	\$ 789,087,949	\$ 841,798,353	\$ 898,029,768	\$ 958,017,393	\$ 1,022,012,140	
Federal Funding										
Section 5307	\$ 85,123,125	\$ 87,038,395	\$ 88,996,759	\$ 90,999,186	\$ 93,046,668	\$ 95,140,218	\$ 97,280,873	\$ 99,469,693	\$ 101,707,761	
Section 5309 Bus										
Section 5309 Rail Mod	\$ 67,280,700	\$ 69,130,919	\$ 71,032,020	\$ 72,985,400	\$ 74,992,499	\$ 77,054,792	\$ 79,173,799	\$ 81,351,079	\$ 83,588,233	
Section 5309 New Starts				\$ 80,000,000	\$ 80,000,000	\$ 80,000,000	\$ 80,000,000	\$ 80,000,000		
Flexible Funds										
State Grants	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Local Grants	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Local funding compact	\$ 97,137,500	\$ 99,323,094	\$ 101,557,863	\$ 103,842,915	\$ 106,179,381	\$ 108,568,417	\$ 111,011,206	\$ 113,508,958	\$ 116,062,910	

Table 8-19: Financial Planning Model - System Revenues and Funding Sources

Debt Financing	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Years 10-20
Existing Debt										
Short Term Obligations										
Long Term Obligations	\$ 3,093,656,000	\$ 2,930,832,000	\$ 2,768,008,000	\$ 2,605,184,000	\$ 2,442,360,000	\$ 2,279,536,000	\$ 2,116,712,000	\$ 1,953,888,000	\$ 1,791,064,000	
Short Term Debt Rate	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%
Long Term Debt Rate	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%
Short Term Principal Payment	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Short Term Interest Payment	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Long Term Principal Payment	\$ 162,824,000	\$ 162,824,000	\$ 162,824,000	\$ 162,824,000	\$ 162,824,000	\$ 162,824,000	\$ 162,824,000	\$ 162,824,000	\$ 162,824,000	\$ 162,824,000
Long Term Interest Payment	\$ 185,619,360	\$ 175,849,920	\$ 166,080,480	\$ 156,311,040	\$ 146,541,600	\$ 136,772,160	\$ 127,002,720	\$ 117,233,280	\$ 107,463,840	
Reserve Balance	\$ 300,000,000	\$ 300,000,000	\$ 300,000,000	\$ 300,000,000	\$ 300,000,000	\$ 300,000,000	\$ 300,000,000	\$ 300,000,000	\$ 300,000,000	\$ 300,000,000
Debt Retirement	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 22,241,799
Financing Requirements	\$ 154,309,434	\$ 123,709,342	\$ 237,640,740	\$ 268,021,608	\$ 372,379,821	\$ 230,683,782	\$ 174,300,311	\$ 59,730,292	\$ -	\$ -
New Long Term Debt										
Bond Rate	6.00% Market									
Term	30 Determined by debt structure									
Interest only (yrs)	-									
Issue costs	2.00% % of principal									
Debt service factor	9.33% Calculated (1 year of P&I)									
Timing	1 Month of issuance									
Reinvestment rate	5.91% Rate on State and Local Government Securities (SLGS) from US Dept. of Treasury									
Debt Issuance	\$ 156,151,657	\$ 174,033,196	\$ 139,521,814	\$ 268,015,873	\$ 302,280,009	\$ 419,977,242	\$ 260,169,679	\$ 196,579,298	\$ 67,364,991	
Financing Costs	\$ 3,123,033	\$ 3,480,664	\$ 2,790,436	\$ 5,360,317	\$ 6,045,600	\$ 8,399,545	\$ 5,203,394	\$ 3,931,586	\$ 1,347,300	
Debt Service Reserves	\$ 14,574,155	\$ 16,243,098	\$ 13,022,036	\$ 25,014,815	\$ 28,212,801	\$ 39,197,876	\$ 24,282,503	\$ 18,347,401	\$ 6,287,399	
Net Proceeds	\$ 138,454,469	\$ 154,309,434	\$ 123,709,342	\$ 237,640,740	\$ 268,021,608	\$ 372,379,821	\$ 230,683,782	\$ 174,300,311	\$ 59,730,292	
Principal outstanding	\$ -	\$ 174,033,196	\$ 307,753,904	\$ 565,317,943	\$ 848,212,256	\$ 1,238,727,802	\$ 1,455,436,543	\$ 1,599,882,581	\$ 1,608,561,668	
Principal Payment	\$ 5,205,055	\$ 5,801,107	\$ 4,650,727	\$ 8,933,862	\$ 10,076,000	\$ 13,999,241	\$ 8,672,323	\$ 6,552,643	\$ 2,245,500	
Interest Payment	\$ -	\$ 10,441,992	\$ 18,465,234	\$ 33,919,077	\$ 50,892,735	\$ 74,323,668	\$ 87,326,193	\$ 95,992,955	\$ 96,513,700	
Total payment	\$ -	\$ 16,243,098	\$ 28,917,068	\$ 53,304,773	\$ 80,354,432	\$ 117,784,606	\$ 139,459,453	\$ 154,678,859	\$ 157,445,104	
Reserve Balance	\$ 14,574,155	\$ 16,243,098	\$ 29,265,134	\$ 54,279,949	\$ 82,492,750	\$ 121,690,626	\$ 145,973,129	\$ 164,320,530	\$ 170,607,930	

Transit Operations Plan	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Years 10-20
OPERATING REVENUES										
<i>Passenger Revenues</i>										
Bus	\$ 77,983,255	\$ 78,453,247	\$ 78,928,165	\$ 83,886,435	\$ 84,430,208	\$ 84,979,509	\$ 85,534,385	\$ 86,094,885	\$ 86,661,057	
Rail	\$ 250,475,970	\$ 253,492,820	\$ 256,557,143	\$ 278,768,033	\$ 282,241,548	\$ 285,769,289	\$ 289,352,065	\$ 292,990,694	\$ 296,686,006	
Project	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 5,355,000
<i>Other Operating Revenues</i>	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	
TOTAL TRANSPORTATION REVENUES	\$ 345,335,727	\$ 348,822,569	\$ 352,361,810	\$ 379,530,970	\$ 383,548,258	\$ 387,625,300	\$ 391,762,952	\$ 395,962,080	\$ 405,578,565	
OPERATING EXPENSES										
<i>Direct Operating and Maintenance</i>										
Bus	\$ 296,779,415	\$ 307,443,168	\$ 318,493,916	\$ 329,945,817	\$ 341,813,553	\$ 354,112,345	\$ 366,857,974	\$ 380,066,804	\$ 393,755,802	
Rail	\$ 406,478,774	\$ 417,779,230	\$ 429,399,405	\$ 441,348,470	\$ 453,635,867	\$ 466,271,309	\$ 479,264,791	\$ 492,626,600	\$ 506,367,320	
Project	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 40,657,224
TOTAL DIRECT TRANSIT O&M COSTS	\$ 703,258,188	\$ 725,222,398	\$ 747,893,320	\$ 771,294,287	\$ 795,449,420	\$ 820,383,653	\$ 846,122,765	\$ 872,693,404	\$ 940,780,346	
<i>General and Administrative Expenses</i>	\$ 56,372,047	\$ 58,246,938	\$ 60,185,007	\$ 62,188,410	\$ 64,259,380	\$ 66,400,224	\$ 68,613,332	\$ 70,901,173	\$ 76,580,910	
TOTAL TRANSIT O&M COSTS	\$ 759,630,236	\$ 783,469,336	\$ 808,078,327	\$ 833,482,698	\$ 859,708,800	\$ 886,783,878	\$ 914,736,097	\$ 943,594,577	\$ 1,017,361,256	
OPERATING SURPLUS (DEFICIT)	(\$414,294,509)	(\$434,646,767)	(\$455,716,517)	(\$453,951,728)	(\$476,160,542)	(\$499,158,577)	(\$522,973,145)	(\$547,632,497)	(\$611,782,691)	
NON-OPERATING REVENUES										
Sales Tax Revenue	\$ 609,248,919	\$ 649,946,229	\$ 693,362,084	\$ 739,678,082	\$ 789,087,949	\$ 841,798,353	\$ 898,029,768	\$ 958,017,393	\$ 1,022,012,140	
Local Funding Compact	\$ 97,137,500	\$ 99,323,094	\$ 101,557,863	\$ 103,842,915	\$ 106,179,381	\$ 108,568,417	\$ 111,011,206	\$ 113,508,958	\$ 116,062,910	
Interest Earnings	\$ 29,473,657	\$ 29,913,504	\$ 31,035,329	\$ 32,877,302	\$ 34,920,028	\$ 37,624,114	\$ 39,459,244	\$ 40,956,569	\$ 41,754,539	
TOTAL NON-OPERATING REVENUES	\$ 735,860,076	\$ 779,182,826	\$ 825,955,277	\$ 876,398,300	\$ 930,187,358	\$ 987,990,884	\$ 1,048,500,218	\$ 1,112,482,920	\$ 1,179,829,589	
TOTAL AVAILABLE FOR CAPITAL PROJECTS	\$ 321,565,567	\$ 344,536,059	\$ 370,238,759	\$ 422,446,572	\$ 454,026,816	\$ 488,832,306	\$ 525,527,073	\$ 564,850,423	\$ 568,046,898	
OPERATING RATIOS										
Farebox Recovery Ratio	43.2%	42.4%	41.5%	43.5%	42.7%	41.8%	41.0%	40.2%	38.2%	
Gross Operating Ratio	45.5%	44.5%	43.6%	45.5%	44.6%	43.7%	42.8%	42.0%	39.9%	
% of Non-Operating Revenues used for Operations	56.3%	55.8%	55.2%	51.8%	51.2%	50.5%	49.9%	49.2%	51.9%	

Table 8-21: Financial Planning Model - Transit Operations

Transit Capital Program	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Years 10-20
Revenues										
Operating Revenues Available for Capital Projects										
Federal Grants	\$ 321,565,567	\$ 344,536,059	\$ 370,238,759	\$ 422,446,572	\$ 454,026,816	\$ 488,832,306	\$ 525,527,073	\$ 564,850,423	\$ 568,046,898	
Section 5307	\$ 85,123,125	\$ 87,038,395	\$ 88,996,759	\$ 90,999,186	\$ 93,046,668	\$ 95,140,218	\$ 97,280,873	\$ 99,469,693	\$ 101,707,761	
Section 5309 Bus	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
Section 5309 Rail Mod	\$ 67,280,700	\$ 69,130,919	\$ 71,032,020	\$ 72,985,400	\$ 74,992,499	\$ 77,054,792	\$ 79,173,799	\$ 81,351,079	\$ 83,588,233	
Section 5309 New Starts	\$ -	\$ -	\$ -	\$ 80,000,000	\$ 80,000,000	\$ 80,000,000	\$ 80,000,000	\$ 80,000,000	\$ 80,000,000	
Flexible Funds	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
TOTAL FEDERAL GRANTS	\$ 152,403,825	\$ 156,169,315	\$ 160,028,779	\$ 243,984,586	\$ 248,039,167	\$ 252,195,010	\$ 256,454,672	\$ 260,820,771	\$ 185,295,994	
State Grants	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
Local Grants	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
TOTAL GRANTS	\$ 152,403,825	\$ 156,169,315	\$ 160,028,779	\$ 243,984,586	\$ 248,039,167	\$ 252,195,010	\$ 256,454,672	\$ 260,820,771	\$ 185,295,994	
TOTAL CAPITAL REVENUES	\$ 473,969,392	\$ 500,705,374	\$ 530,267,538	\$ 666,431,158	\$ 702,065,983	\$ 741,027,317	\$ 781,981,745	\$ 825,671,194	\$ 753,342,892	
Expenditures										
Bus System Expenditures										
Vehicles	\$ 40,082,000	\$ 41,349,772	\$ 42,654,303	\$ 43,996,604	\$ 44,986,527	\$ 46,398,713	\$ 47,851,673	\$ 49,346,526	\$ 50,456,823	
Facilities	\$ 6,500,000	\$ 6,760,000	\$ 7,030,400	\$ 7,311,616	\$ 7,604,081	\$ 7,908,244	\$ 8,224,574	\$ 8,553,557	\$ 8,895,699	
Other	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
TOTAL BUS SYSTEM CAPITAL	\$ 46,582,000	\$ 48,109,772	\$ 49,684,703	\$ 51,308,220	\$ 52,590,608	\$ 54,306,957	\$ 56,076,246	\$ 57,900,083	\$ 59,352,522	
Rail System Expenditures										
Vehicles	\$ 49,080,000	\$ 25,092,150	\$ 153,940,340	\$ 26,234,000	\$ 13,412,132	\$ 27,427,811	\$ 42,067,405	\$ 28,675,947	\$ 29,321,156	
Facilities	\$ 23,400,000	\$ 24,336,000	\$ 25,309,440	\$ 26,321,818	\$ 27,374,690	\$ 28,469,678	\$ 29,608,465	\$ 30,792,804	\$ 32,024,516	
Capital Improvement Program	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 157,911,814	\$ 164,228,286	
Major Rehabilitation Project	\$ 155,000,000	\$ 166,000,000	\$ 175,000,000	\$ 150,000,000	\$ 45,000,000	\$ -	\$ -	\$ -	\$ -	
Rail Extension	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
TOTAL RAIL SYSTEM CAPITAL	\$ 227,480,000	\$ 215,428,150	\$ 354,249,780	\$ 202,555,817	\$ 85,786,823	\$ 55,897,489	\$ 71,675,870	\$ 217,380,565	\$ 225,573,958	
Other Facility Expenses	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
Project Expenses	\$ -	\$ -	\$ -	\$ 301,797,824	\$ 539,791,816	\$ 437,357,118	\$ 392,255,712	\$ 168,170,081	\$ -	
TOTAL CAPITAL EXPENDITURES	\$ 274,062,000	\$ 263,537,922	\$ 403,934,483	\$ 555,661,861	\$ 678,169,246	\$ 547,561,563	\$ 520,007,828	\$ 443,450,728	\$ 284,926,480	
Debt/Cash Management										
Beginning Cash	\$ 184,134,092	\$ 189,907,559	\$ 195,867,334	\$ 202,019,582	\$ 208,370,674	\$ 214,927,200	\$ 221,695,969	\$ 228,684,024	\$ 235,898,644	
Surplus (Deficit)	\$ 199,907,392	\$ 237,167,451	\$ 126,333,055	\$ 110,769,297	\$ 23,896,736	\$ 193,465,753	\$ 261,973,917	\$ 382,220,466	\$ 468,416,412	
Debt Service	\$ (348,443,360)	\$ (354,917,018)	\$ (357,821,548)	\$ (372,439,813)	\$ (389,720,032)	\$ (417,380,766)	\$ (429,286,173)	\$ (434,736,139)	\$ (427,732,944)	
Balance before Financing	\$ 35,598,125	\$ 72,157,992	\$ (35,621,159)	\$ (59,650,934)	\$ (157,452,621)	\$ (8,987,813)	\$ 54,383,713	\$ 176,168,352	\$ 276,582,113	
Reserve Req. (3 months Operations)	\$ 189,907,559	\$ 195,867,334	\$ 202,019,582	\$ 208,370,674	\$ 214,927,200	\$ 221,695,969	\$ 228,684,024	\$ 235,898,644	\$ 254,340,314	
Net Financing Requirement	\$ 154,309,434	\$ 123,709,342	\$ 237,640,740	\$ 268,021,608	\$ 372,379,821	\$ 230,683,782	\$ 174,300,311	\$ 59,730,292	\$ (22,241,799)	

Table 8-22: Financial Planning Model - Capital Program

Summary Results	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Years 10-20
BEGINNING CASH	\$ 184,134,092	\$ 189,907,559	\$ 195,867,334	\$ 202,019,582	\$ 208,370,674	\$ 214,927,200	\$ 221,695,969	\$ 228,684,024	\$ 235,898,644	→
SOURCES OF FUNDS										
Passenger Revenues	\$ 328,459,225	\$ 331,946,067	\$ 335,485,308	\$ 362,654,468	\$ 366,671,756	\$ 370,748,798	\$ 374,886,450	\$ 379,085,578	\$ 388,702,063	
Other Operating Revenues	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	\$ 16,876,502	
Sales Tax Revenue	\$ 609,248,919	\$ 649,946,229	\$ 693,362,084	\$ 739,678,082	\$ 789,087,949	\$ 841,798,353	\$ 898,029,768	\$ 958,017,393	\$ 1,022,012,140	
Local Funding Compact	\$ 97,137,500	\$ 99,323,094	\$ 101,557,863	\$ 103,842,915	\$ 106,179,381	\$ 108,568,417	\$ 111,011,206	\$ 113,508,958	\$ 116,062,910	
Interest Earnings	\$ 29,473,657	\$ 29,913,504	\$ 31,035,329	\$ 32,877,302	\$ 34,920,028	\$ 37,624,114	\$ 39,459,244	\$ 40,956,569	\$ 41,754,539	
Total Grants	\$ 152,403,825	\$ 156,169,315	\$ 160,028,779	\$ 243,984,586	\$ 248,039,167	\$ 252,195,010	\$ 256,454,672	\$ 260,820,771	\$ 185,295,994	
<i>Total Funds Available</i>	\$ 1,417,733,721	\$ 1,474,082,269	\$ 1,534,213,199	\$ 1,701,933,438	\$ 1,770,145,457	\$ 1,842,738,394	\$ 1,918,413,811	\$ 1,997,949,796	\$ 2,006,602,792	
USES OF FUNDS										
<i>Operating Expenses</i>										
Transit System O&M	\$ 703,258,188	\$ 725,222,398	\$ 747,893,320	\$ 771,294,287	\$ 795,449,420	\$ 820,383,653	\$ 846,122,765	\$ 872,693,404	\$ 940,780,346	
General and Administrative	\$ 56,372,047	\$ 58,246,938	\$ 60,185,007	\$ 62,188,410	\$ 64,259,380	\$ 66,400,224	\$ 68,613,332	\$ 70,901,173	\$ 76,580,910	
<i>Capital Expenditures</i>										
Bus Vehicles	\$ 40,082,000	\$ 41,349,772	\$ 42,654,303	\$ 43,996,604	\$ 44,986,527	\$ 46,398,713	\$ 47,851,673	\$ 49,346,526	\$ 50,456,823	
Bus Facilities	\$ 6,500,000	\$ 6,760,000	\$ 7,030,400	\$ 7,311,616	\$ 7,604,081	\$ 7,908,244	\$ 8,224,574	\$ 8,553,557	\$ 8,895,699	
Rail Vehicles	\$ 49,080,000	\$ 25,092,150	\$ 153,940,340	\$ 26,234,000	\$ 13,412,132	\$ 27,427,811	\$ 42,067,405	\$ 28,675,947	\$ 29,321,156	
Rail Facilities	\$ 23,400,000	\$ 24,336,000	\$ 25,309,440	\$ 26,321,818	\$ 27,374,690	\$ 28,469,678	\$ 29,608,465	\$ 30,792,804	\$ 32,024,516	
Capital Improvement Program	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 157,911,814	\$ 164,228,286	
Major Rehabilitation Project	\$ 155,000,000	\$ 166,000,000	\$ 175,000,000	\$ 150,000,000	\$ 45,000,000	\$ -	\$ -	\$ -	\$ -	
Proposed Project	\$ -	\$ -	\$ -	\$ 301,797,824	\$ 539,791,816	\$ 437,357,118	\$ 392,255,712	\$ 168,170,081	\$ -	
<i>Total Uses of Funds</i>	\$ 1,033,692,236	\$ 1,047,007,258	\$ 1,212,012,810	\$ 1,389,144,559	\$ 1,537,878,047	\$ 1,434,345,441	\$ 1,434,743,925	\$ 1,387,045,305	\$ 1,302,287,736	
FUNDS AVAILABLE BEFORE FINANCING	\$ 384,041,485	\$ 427,075,010	\$ 322,200,389	\$ 312,788,879	\$ 232,267,411	\$ 408,392,953	\$ 483,669,886	\$ 610,904,491	\$ 704,315,056	
DEBT FINANCING										
Total Outstanding Debt	\$ 3,093,656,000	\$ 3,104,865,196	\$ 3,075,761,904	\$ 3,170,501,943	\$ 3,290,572,256	\$ 3,518,263,802	\$ 3,572,148,543	\$ 3,553,770,581	\$ 3,399,625,668	
Short Term Financing Proceeds	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
Long Term Financing Proceeds	\$ 154,309,434	\$ 123,709,342	\$ 237,640,740	\$ 268,021,608	\$ 372,379,821	\$ 230,683,782	\$ 174,300,311	\$ 59,730,292	\$ -	
Debt Service Requirements	\$ (348,443,360)	\$ (354,917,018)	\$ (357,821,548)	\$ (372,439,813)	\$ (389,720,032)	\$ (417,380,766)	\$ (429,286,173)	\$ (434,736,139)	\$ (427,732,944)	
Transfer to Debt Reduction	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ (22,241,799)	
<i>Net Effect of Financing</i>	\$ (194,133,926)	\$ (231,207,676)	\$ (120,180,808)	\$ (104,418,204)	\$ (17,340,211)	\$ (186,696,984)	\$ (254,985,862)	\$ (375,005,846)	\$ (449,974,742)	
ENDING CASH BALANCE	\$ 189,907,559	\$ 195,867,334	\$ 202,019,582	\$ 208,370,674	\$ 214,927,200	\$ 221,695,969	\$ 228,684,024	\$ 235,898,644	\$ 254,340,314	
Debt Ratios										
Minimum Coverage Ratio	1.50									
Pledged Funds (Gross Tax)	\$ 609,248,919	\$ 649,946,229	\$ 693,362,084	\$ 739,678,082	\$ 789,087,949	\$ 841,798,353	\$ 898,029,768	\$ 958,017,393	\$ 1,022,012,140	
Pledged Funds (Net Tax)	\$ 444,495,735	\$ 470,791,870	\$ 499,232,209	\$ 633,553,856	\$ 667,145,954	\$ 703,403,203	\$ 742,522,501	\$ 784,714,625	\$ 711,588,353	
Debt Service Requirements	\$ (348,443,360)	\$ (354,917,018)	\$ (357,821,548)	\$ (372,439,813)	\$ (389,720,032)	\$ (417,380,766)	\$ (429,286,173)	\$ (434,736,139)	\$ (427,732,944)	
Coverage Ratio (Gross Tax)	1.75	1.83	1.94	1.99	2.02	2.02	2.09	2.20	2.39	
Rem. Debt Capacity (Gross)	\$ 794,541,649	\$ 1,078,893,901	\$ 1,437,321,488	\$ 1,661,124,802	\$ 1,876,677,821	\$ 1,979,632,362	\$ 2,331,767,059	\$ 2,807,228,891	\$ 3,490,877,950	
Coverage Ratio (Net Tax)	1.28	1.33	1.40	1.70	1.71	1.69	1.73	1.81	1.66	
Remaining Debt Capacity (Net)	\$ (717,324,855)	\$ (565,125,767)	\$ (344,121,812)	\$ 687,270,097	\$ 757,670,508	\$ 709,641,779	\$ 904,746,216	\$ 1,216,906,668	\$ 642,257,276	

Table 8-23: Financial Planning Model - Summary Results

8.6.2.3 Evaluation of Cash Flows

The evaluation of cash flows, whether using the financial model or not, is based on a variety of financial indicators which may be agency specific. The evaluation criteria used to evaluate financial capability could include:

- Ending cash balances;
- Operating and/or capital reserves;
- Net financing requirements;
- Gross or net coverage ratios for debt;
- Farebox recovery ratios;
- Debt ceilings or other debt limitations;
- Cost of capital; and/or
- Other objectives that may be locally mandated.

Any violations of the established financial capability criteria should be calculated and readily apparent from the financial plan or financial model. The transit agency can evaluate its options to address the funding shortfall, additional financing requirements, failure to comply with local mandates or any other violation of established financial criteria.

The first item to check when evaluating financial capability is the annual operating results. The figures in question appear at the bottom of the cash flow statement and represent the agency's ability to cover operating and capital costs and, if applicable, debt service with revenues received during the year in question. If the annual operating results are positive throughout the 20-year planning period and the agency maintains a cash balance sufficient to cover operating and capital requirements, the financial plan demonstrates solid financial capacity to build the proposed project and operate and maintain the existing and planned system. If the annual operating results are negative, different financial strategies must be explored.

The capital costs of major transit projects are usually so great and concentrated in a short period of time, that most transit agencies will need to specify a new funding source or draw additional funds from an existing source to maintain financial viability. The need for additional local funds has intensified as the share of project costs covered by federal Section 5309 New Starts funding declines.

To implement a major transit project, most transit agencies will need to employ one or more of the following strategies:

- issue bonds/other borrowing;
- reduce other costs; and/or
- secure new funding sources.

8.6.2.4 Debt Financing

In addition to securing federal, state or local grants, many transit agencies have entered the municipal bond market for capital to build major transit projects. As detailed in Section 8.5.7, issuing debt (or TIFIA loans, vendor financing, or leasing) spreads the cost of capital improvements over longer periods of time bringing annual capital expenses within the financial capability of the issuing authority. If the financial model projects funding shortfalls only during the construction period with annual operating results becoming positive after completion, debt financing may offer a financially attractive solution to funding the proposed project (see Figure 8-9, Figure 8-10, and Figure 8-11). If operating deficits continue after construction, expenses must be reduced or new funding sources secured to construct and operate the proposed project and the existing transit system.

To illustrate financial capability to implement a major capital investment using debt financing, the transit agency must demonstrate that its bonds (or other debt instrument) will be well received by the financial markets. A solid long range financial plan and model that forecasts debt coverage ratios that meet or exceed those required by the bond markets, under conservative planning assumptions, is generally required to successfully market long-term debt.

Debt issuance limitations may prevent agencies from issuing debt even when the financial markets would favorably receive additional bonds. Sometimes, the legislation that authorizes the creation of a transit agency also limits the ability of the transit agency to issue debt. Typically, the total amount of debt outstanding is limited to a specific amount. Other limits can include limits on the amount of debt as a percentage of certain regional indicators such as assessed property values. Some agencies can have the debt limits changed by governing boards, while others may need voter approval.

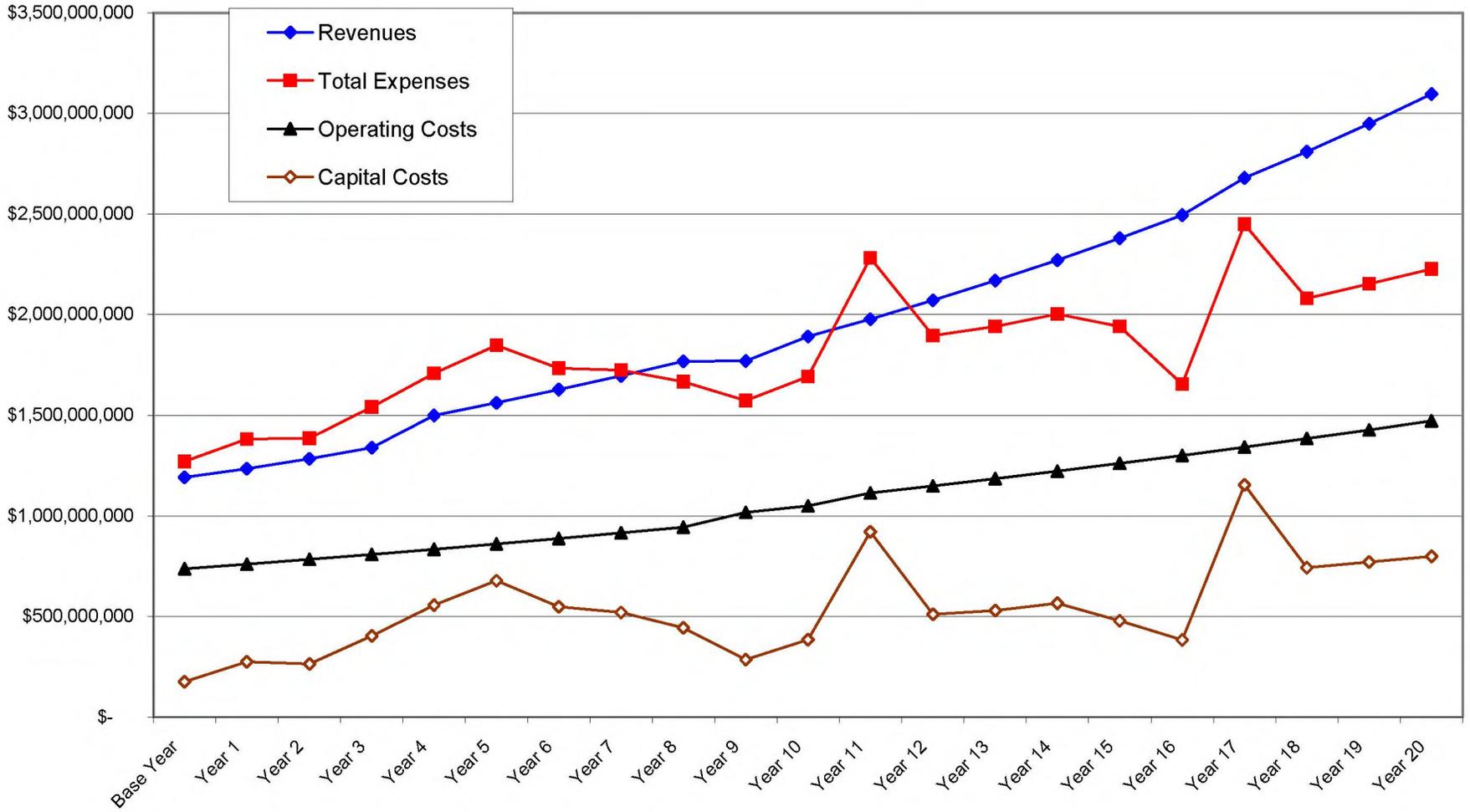


Figure 8-9: Revenues and Expenses without Bonding

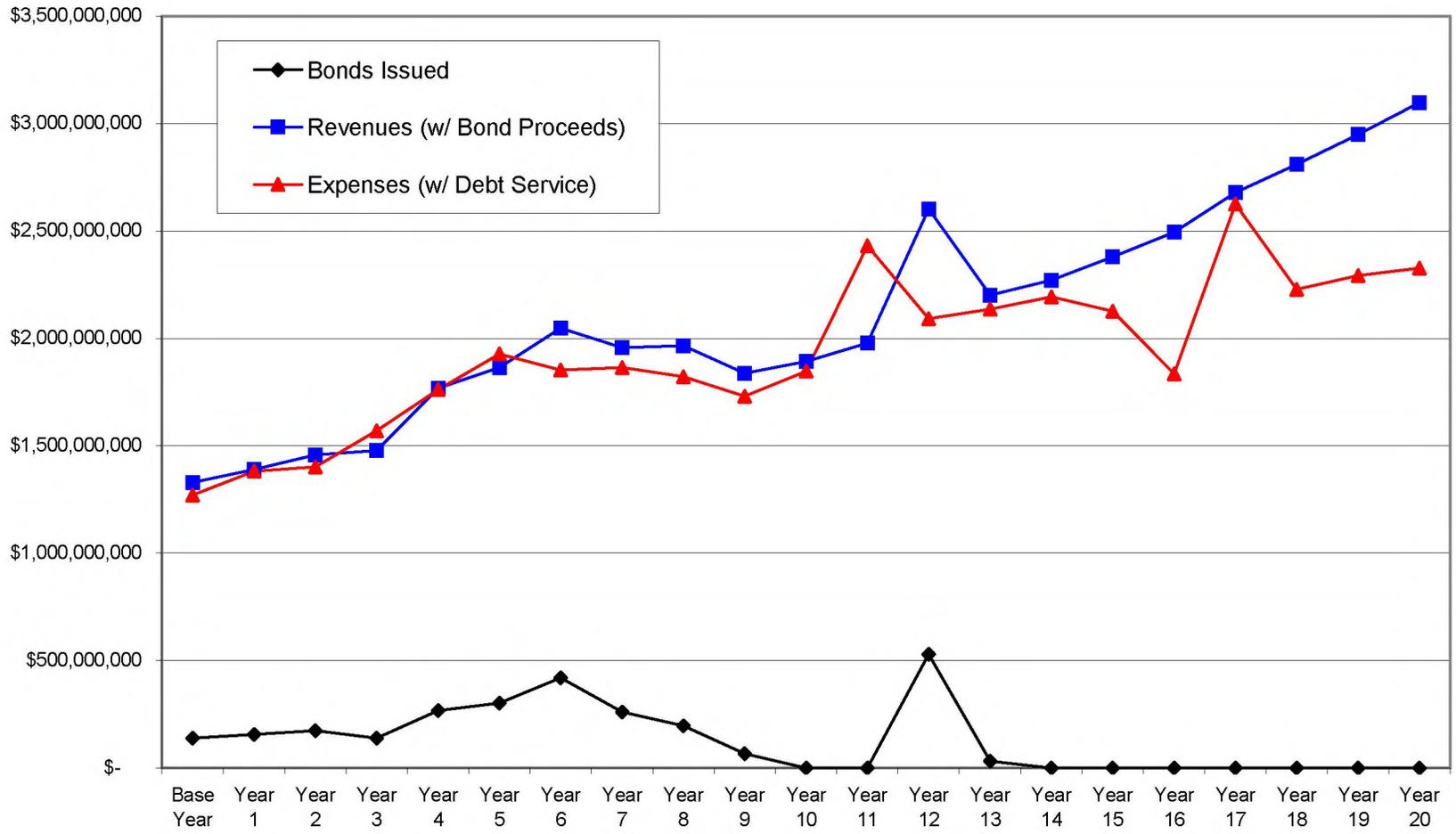


Figure 8-10: Revenues and Expenses including Debt

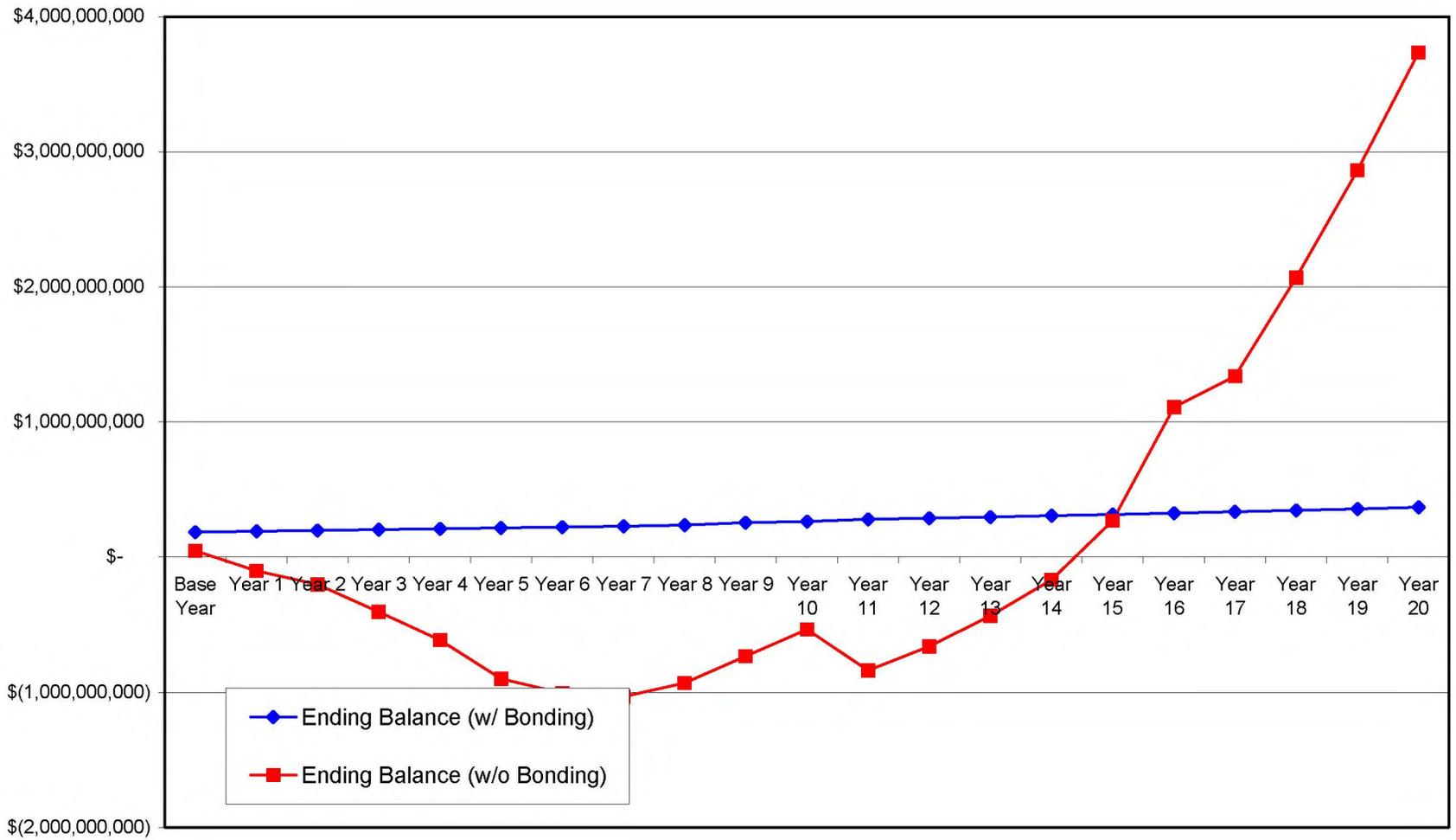


Figure 8-11: Ending Balances - Bonding and Without

8.6.2.5 Identifying Alternative Funding Options

If the transit agency has an insufficient revenue stream to meet its financial requirements, either to cover ongoing pay-as-you-go expenses or to cover debt service, the agency must secure additional resources if its proposed capital investments are to be implemented.

New revenue sources generally require a local political consensus about the need for the proposed investments (or the continuing need for existing transit services). Strong local political support can result in major state or local grants or assist in the passage of local funding referenda.

From a financial perspective, broad based, dedicated taxes (e.g. sales or gas taxes, user fees, property or income taxes) are the most reliable funding sources for major transit investments. While certainly not required, the high cost of most fixed guideway transit systems means that few transit agencies in the US have built major capital investments without access to these types of revenue sources. Also, the detailed records kept regarding the historical bases for these taxes enable detailed and relatively accurate forecasts of future revenues. Financial markets look favorably on these sources as solid security for debt issuance.

If the financial needs are more modest, the transit agency should explore some other revenue sources as detailed in 8.5.8. These can include innovative financing techniques, flexible funds, airport improvement funds, and joint development among others.

Another potential source of revenue is fare increases. However, fare increases of the magnitude required to support major new investments will likely generate significant local opposition.

8.6.2.6 Reducing Costs

Another alternative to predicted financial deficiencies is cost cutting. Strategies to reduce costs can include restructuring the transit agency to reduce labor costs, privatization of key agency functions, rescheduling of project construction activities or rescheduling other planned capital investments.

Reducing needed operations or maintenance activities for the existing transit system is NOT an acceptable method for freeing up additional resources if the agency is seeking federal funding for a proposed major transit investment. The criteria for receiving federal capital grants attempt to ensure that agencies are capable of adequately operating and maintaining existing transit services into the foreseeable future.

If financial deficiencies are identified, the construction period for the proposed project will need to be stretched out over a longer period of time. This method is occasionally necessary but can result in higher construction

costs for the project and will delay the generation of transportation benefits provided by the project.

8.6.3 Risk and Sensitivity Analysis

An understanding of the uncertainty surrounding any financial or economic forecast is crucial to a financial analysis. The primary benefit of building an integrated financial model is the ability to test the sensitivity of the agency's financial position to variations in the modeling inputs. While a financial plan might indicate adequate financial capability to implement the proposed capital and operating plan under current assumptions, the financial analyst will want to understand how that financial capability could change under a variety of potential scenarios.

Responsible financial planning requires that transit agencies proceed with a complete understanding of the uncertainties in its financial plan, the problems that may arise, and some idea about the strategy that will need to be employed if its financial capability is threatened.

Unfortunately, uncertainty underlies most inputs to the financial model. The areas most prone to uncertainty can be categorized as:

- risk to project cost estimates and schedules;
- risk to economic conditions; and
- risk to the political environment.

Despite these uncertainties, financial planners must make reasonable, conservative estimates of future economic conditions, rely on well documented and competent cost estimates for capital and operating and maintenance expenses, and have a contingency plan to deal with potentially erratic funding from federal, state, or local funding partners. The financial model should be revisited, worst case assumptions tested, and strategies developed to deal with unanticipated future conditions.

8.6.3.1 Analyzing the Range of Possibilities

Sensitivity analysis is a vital component of responsible financial planning. Sensitivity analysis should be performed on all-important variables separately and in tandem to determine the sensitivity of the financial position of the transit agency with respect to each. Perhaps the most enlightening analysis is the construction of optimistic and pessimistic scenarios to test the range of financial possibilities. Most economic forecasts have a baseline forecast that is considered the most likely with high growth and low growth scenarios presented. Often, a separate "recession" scenario is developed to illustrate a very negative possibility. A final analysis, a stress test, should be performed to gauge the ability of the transit agency to deal with the cumulative effects of compounding unfortunate circumstances. The stress test seeks to answer the question, "How bad could it get?"

The important variables to evaluate in a sensitivity analysis are inflation, interest rates, economic growth, ridership, grant availability, O&M costs, and capital costs. While there is value in testing variations in each variable in isolation, some variables are not isolated from each other. Higher population growth leads to higher ridership growth. Rising inflation leads to higher interest rates. The range of possibilities is defined by developing internally coherent scenarios that represent positive and negative economic possibilities and then testing the impact of variations in key variables that are unrelated to the economic climate.

Table 8-24 provides a possible array of scenarios that can be tested to provide an analytical foundation for the assessment of risk in the financial plan. Clearly a few key scenarios are the most relevant (see **bold** elements in Table 8-24). Lower than expected economic growth combined with lower than expected federal share, extended payout period, and higher than expected construction costs/delays are the key risk factors. The other scenario combinations complete the range of possibilities.

Table 8-24: Possible Sensitivity Analysis Framework

		MAJOR RISK ELEMENTS			
		Inflation	Federal/Local Grants	Federal New Starts Share/Schedule	Capital Costs/Delays
ECONOMIC SCENARIOS	High Growth	High	Historical Growth	As proposed	Best Guess
		Best Guess	Constant or declining	Lower share	High cost scenario
		Low		Extended payout	
	"Best Guess"	High	Historical Growth	As proposed	Best Guess
		Best Guess	Constant or declining	Lower share	High cost/Delay scenario
		Low		Extended payout	
	Low Growth/ Recession	High	Historical Growth	As proposed	Best Guess
		Best Guess	Constant or declining	Lower share	High cost/Delay scenario
		Low		Extended payout	

In actual practice, inflation has less impact than may be expected. It tends to affect many elements of the financial plan in offsetting ways. For instance, high cost inflation may be balanced by fare increases that keep pace with inflation and tax revenues that follow inflation upwards. The major exception to this balancing of inflation impacts occurs when agencies have variable rate debt or need to issue significant debt in the future. In the case of debt, an

increase in the interest rate from 5 to 10 percent is a 50 percent increase in debt service costs. For agencies relying on a significant amount of debt, inflation can erode the financial capability of the system.

One of the most powerful effects revealed in a sensitivity analysis is the compounding of initially minor problems. A small change in an early year of the plan may not cause immediate financial difficulty, but can lead to diverging trends between revenues and costs in future years. Depending on the statistical relationships, if real economic growth turns out to average 1 percent rather than 2 percent, revenues from a sales tax could be 25 percent lower after 20 years. That could have a severe impact on the financial capability of the transit agency. The lower growth scenario also leads to lower ridership and fare revenues, the effects of which compound over time.

Another key source of funding uncertainty is the federal payout envisioned for proposed New Starts projects. Budget pressures and an increasing number of projects seeking federal funds have placed downward pressure on the federal share provided to new projects. The law still allows 80 percent federal funding, but the average federal New Starts funding share has declined to around 50 percent in recent years. Recent initiatives have indicated that future New Starts funding shares may be limited to 60 percent and below.

Another major source of uncertainty with respect to the federal New Starts payment is the payout schedule. While the federal government has always provided the total amount specified in the FFGA, the payout is often made over a longer period of time than specified in the FFGA. To maintain the planned construction schedule, project sponsors often need to self finance a larger than anticipated proportion of project costs during construction and receive additional payments from the federal government after the project has been completed. The net effect of this is to increase financing expenses for the project sponsor and increase the cash flow burden during peak construction.

While many transportation projects have been constructed on time and within budget, it is no secret that many other projects have been delayed and/or have experienced significant cost overruns during construction. The more complex the project, the more serious the financial risk. A major problem is that financial planners are not generally in the position to assess the likelihood of a cost overrun. The financial planner needs to rely on cost numbers produced during the engineering and design process. Financial planners need to insist that cost estimates be accompanied by some analysis that describes the risks and the construction cost implications of those risks.

Project cost estimates should be reported as ranges with a “best guess”, an upper estimate that assumes the worst, and a lower estimate that assumes the best. Cost estimates reported as a range provide the analytical basis for testing the impact of a cost overrun on the financial capability of the transit agency.

Transit agencies should carefully weigh the risks of embarking on construction projects that could not be completed if costs were to rise to the upper bound estimate.

8.6.3.2 Performing the Stress Test (“How Bad Could it Get?”)

The “Stress Test” is an enlightening exercise to define the conditions under which the financial plan for the transit agency becomes unviable. The stress test assumes that all of the bad things that could happen actually do. The financial analyst attempts to mitigate the financial impact through means at the agency’s disposal. If the financial capability to implement the proposed project cannot be salvaged using strategies available to the transit agency, specific actions should be identified that would need to be implemented under the worst case scenario.

The stress test will generally combine all negative possibilities. For example, most stress test scenarios would combine the low growth/recession scenario with high inflation, constant or declining nominal growth in federal formula funding, 50 percent or less New Starts funding paid over two to three more years than planned, and the upper bound cost estimate. The initial result may be a financially debilitated agency.

The strategy to deal with the stress test case might include additional bonding, delay or cancellation of other capital projects, delay of the proposed project, or redesign/reduced scope of the proposed project. If all of these actions cannot make the transit agency financially capable of implementing the proposed project, alternative strategies need to be identified. Options might include raising the debt limit, raising fares, or securing additional funding sources. Reducing the required operating and maintenance expenses through reduced service or deferred maintenance on the existing transit system are not acceptable strategies. Local decision-makers should be aware of the results of the stress test so that local decisions to proceed with major projects can be made with an understanding of the risks involved.

8.6.4 Update the Financial Plan

All transit agencies should maintain a current long-range financial plan to assist in the development of new services and projects and identify future funding needs before potential problems become acute. The need for a periodically updated financial plan increases during the planning of major capital projects. The financial plan supports the development of funding strategies at every stage of project planning including supporting the federal funding application process and the issuance of debt on financial markets.

At a minimum, the financial plan is updated every year as new budget information becomes available. Actual financial results replace forecasts from the previous year. Forecasting equations are re-estimated with another year of data and the resulting forecasts updated. Any policy changes or changes to any cost drivers or revenues are made to reflect current reality.

In addition, any event that has a material impact on current or future financial results should engender a revision in the financial plan. Events such as increases in the debt ceiling, passage or loss of funding referenda, a labor strike, changes in the schedule or cost estimates of proposed projects or other such events should be reflected in the current long range financial plan.

8.7 Concluding Remarks

This section on financial planning for transit agencies has sought to describe the role of financial planning in the context of transit planning, project development and implementation. This section is not simply a guide to developing plans to satisfy federal requirements, but a guide for best practice financial planning for any transit agency. The descriptions of the procedures and methods involved in the development and presentation of financial plans and information should be useful to any transit agency interested in financial planning. Transit agency managers, planners, local decision-makers, financial institutions, and federal transportation funding partners will all benefit from financial plans and analysis created in accordance with the practices described in this chapter.

Technical Addendum: Principles and Best Practices for Regression Analysis

High quality revenue forecasting models use time series regression analysis to estimate the relationship between “explanatory” variables and a “dependent” variable. The explanatory variables can be nearly any economic indicator or other factor that could impact the dependent variable, but should be selected from the economic indicators provided by the economic forecast for the region. The dependent variable is the item for which a forecast is being prepared, in this case, the tax base of the dedicated transit tax or user fee. Specialized software such as Eviews, LIMDEP, SAS, and SPSS among others is used to prepare a regression analysis and forecasts, though even a spreadsheet such as Microsoft Excel has some limited regression functions.

A regression analysis begins by collecting relevant sets of data on the dependent variable and a series of potential independent variables. Tax revenue forecasts involve the construction of a data series on the tax base and a set of explanatory variables that will be tested for predictive power.

Model Design and Specification

Model design begins with the definition of the dependent variable. If the financial analyst is interested in forecasting revenues from an existing local sales tax, the analyst must construct the retail sales variable by dividing tax revenues by the tax rate for each year to construct the tax base. The tax base is the dependent variable because the tax rate is a policy variable that tends to change periodically. If the financial plan contains a referendum to increase the tax rate, the easiest way to forecast the revenue stream is to multiply the new tax rate by the forecasted tax base.

The explanatory variables are chosen based on knowledge of simple economic relationships and experience. Explanatory variables are generally chosen from the set of variable provided by the economic forecast to ensure that long-range forecasts of the explanatory variables are available. If the financial

analyst is forecasting retail sales, the set of explanatory variables must include those things that influence demand for taxable items. These variables will generally include population and income as the primary drivers of retail sales, though other factors such as employment, wages, and interest rates, among others could be tested for their explanatory power.

The regression equation for retail sales could be expressed as:

$$\text{retail_sales} = \alpha + \beta_1(\text{population}) + \beta_2(\text{per_capita_income}) + \varepsilon$$

Where α is the regression constant, β 's are parameters to be estimated, and ε is the error term.

If the financial analyst is interested in car registration fee revenues, the explanatory variables may include average car prices, population, auto ownership rates, and income.

Various other variables are tested and the regression statistics evaluated to identify the functional form that “fits the data” better than any other. The test statistic that measures goodness of fit is R^2 , also called the coefficient of determination. This test statistic expresses the percentage of the variation in the dependent variable that is explained by the explanatory variables. The closer R^2 is to 1.0, the better the explanatory variables are at “explaining” the **past** variation in the dependent variable.

The development of good forecasting equations is a process of trial and error and requires experience to identify the preferred regression equation. While high a R^2 is a plus when evaluating a regression analysis, it does not in itself indicate that the best model specification has been found. Regression models must also be inspected to ensure that all the variables included in the model are statistically significant and have the expected sign and reasonable magnitude. A regression equation with a high R^2 that exhibits unexplainable statistical relationships among the variables, is flawed and can produce biased results. The section at the end of this addendum details some of the basic principles of developing regression-based forecasts and highlights best practices in these areas.

Preparing the Forecast

After developing and testing a good regression model that produces accurate forecasts of the dependent variable, the actual tax revenue forecast may be constructed. The number of steps required to accomplish this depends on the construction of the model and how the variables were transformed, but will generally involve the following steps:

1. Make sure forecasts of the explanatory variables are entered into the statistical software program. Most statistical software will include a forecasting routine that allows the user to enter this data directly. The

regional economic forecast should provide this information. In rare cases where the statistical software lacks this capability, the analyst may need to use a spreadsheet to construct the forecasting model.

2. Prepare the dependent variable forecast for the analysis period. The result is a forecast of the tax base in constant dollars, likely expressed as a logarithm.
3. Exponentiate the series to convert the dependent variable from a natural log to its original state.
4. Apply the inflation forecasts to convert the constant (real) dollar tax base forecast to nominal (current) dollars.
5. Multiply the inflated tax base forecast by the expected tax rate to generate the tax revenue forecast.

Developing a set of forecasting equations in the manner described here allows the easy update for future years. As new data for the current period becomes available, the data can be updated, the equations re-estimated, and new forecasts prepared using the most current data. These revenue forecasts are entered into the financial plan as revenue source line items by year.

Example Regression Application

The following example retail sales examples were developed with national data from the Bureau of Labor Statistics, the Bureau of Economic Analysis and the Census Bureau. The data was scaled by $1/50^{\text{th}}$ to reflect an average US State.

Regression techniques can be used to estimate a simple trend line as well as estimate statistical relationships between key variables. The trend line estimation is simple and is a useful place to start when developing a forecasting model.

Before beginning any forecasting exercise, the data should be transformed in several ways to maximize the usefulness of the data in a regression equation. The initial data transformations are:

- from nominal to real dollars (see Principle 1 in next section);
- from total income to income per capita (see Principle 2 in next section); and
- logarithmic transformations of all likely dependent and independent variables (see Principle 3 in next section).

The data for the example regression application is given in Table 8-25.

Table 8-25: Data for Regression Analysis of Retail Sales

YEAR	Retail Sales	Population	Employment	Personal Income	CPI	Real Retail Sales	Real Personal Income	Real Per Capital Income
1983	23,403	4,686,140	1,803,040	58,938	99.6	23,497.2	59,174.7	12,627.6
1984	25,738	4,726,960	1,888,160	65,496	103.9	24,772.2	63,037.5	13,335.7
1985	27,501	4,769,320	1,947,740	70,300	107.6	25,558.1	65,334.6	13,698.9
1986	28,993	4,813,020	1,986,880	74,248	109.6	26,453.2	67,744.5	14,075.3
1987	30,826	4,856,080	2,039,160	79,250	113.6	27,135.5	69,762.3	14,366.0
1988	33,124	4,900,420	2,104,180	85,442	118.3	28,000.0	72,224.9	14,738.5
1989	35,179	4,946,840	2,157,680	91,996	124.0	28,370.5	74,190.3	14,997.5
1990	36,892	4,962,860	2,188,060	98,064	130.7	28,226.6	75,029.8	15,118.3
1991	37,119	5,039,100	2,164,980	101,708	136.2	27,253.1	74,675.5	14,819.2
1992	39,032	5,111,710	2,172,020	107,808	140.3	27,820.2	76,841.1	15,032.3
1993	41,642	5,181,370	2,214,260	112,200	144.5	28,818.2	77,647.1	14,985.8
1994	44,964	5,246,360	2,283,260	117,760	148.2	30,340.1	79,460.2	15,145.8
1995	47,180	5,309,440	2,343,820	124,018	152.4	30,958.2	81,376.6	15,326.8
1996	50,047	5,371,640	2,392,160	130,948	156.9	31,897.6	83,459.5	15,537.1
1997	52,211	5,436,380	2,453,800	138,740	160.5	32,530.4	86,442.4	15,900.7
1998	54,912	5,500,800	2,517,300	148,520	163.0	33,688.3	91,116.6	16,564.2
1999	59,899	5,563,910	2,578,320	155,730	166.6	35,953.5	93,475.4	16,800.3
2000	64,641	5,628,440	2,634,400	168,132	172.2	37,538.3	97,637.6	17,347.2
2001	69,771	5,695,940	2,638,440	173,706	177.1	39,396.4	98,083.6	17,219.9

A regression fits a line that best represents all the data by minimizing the sum of squared residuals (the vertical distance between the linear trend line and the actual data) through method called least squares estimation. Estimating a trend line using regression is accomplished by simply including a constant term and a trend variable as regressors. The trend variable used in the example is the year. The regression equation used to estimate the trend in retail sales is:

$$\text{Log}(\text{retail_sales}) = \alpha + \beta(\text{year}) + \varepsilon$$

where α is the constant term, β is the coefficient on the trend variable, and ε is the error term.

The regression output is given in Exhibit 8-1. The results suggest that trend alone explains almost 93 percent ($R^2 = .927$) of the variation in retail sales. Both the constant term and the trend variable are highly significant at the 99 percent level and the Durbin-Watson (D-W) statistic indicates that the regression residuals are autocorrelated (see Principle 7 in the next section). Figure 8-12 confirms that the regression residuals display a noticeable pattern and could benefit from applying some autocorrelation correction techniques.

A nice feature of regressions that use logarithmic transformations is that the coefficient estimates can be interpreted as percent changes or “elasticities”. In

the trend regression, the coefficient estimate for year is 0.024 or 2.4 percent. The trend line for retail sales is estimated to increase 2.4 percent annually.

Exhibit 8-1: Regression Estimate for Trend in Real Retail Sales

```

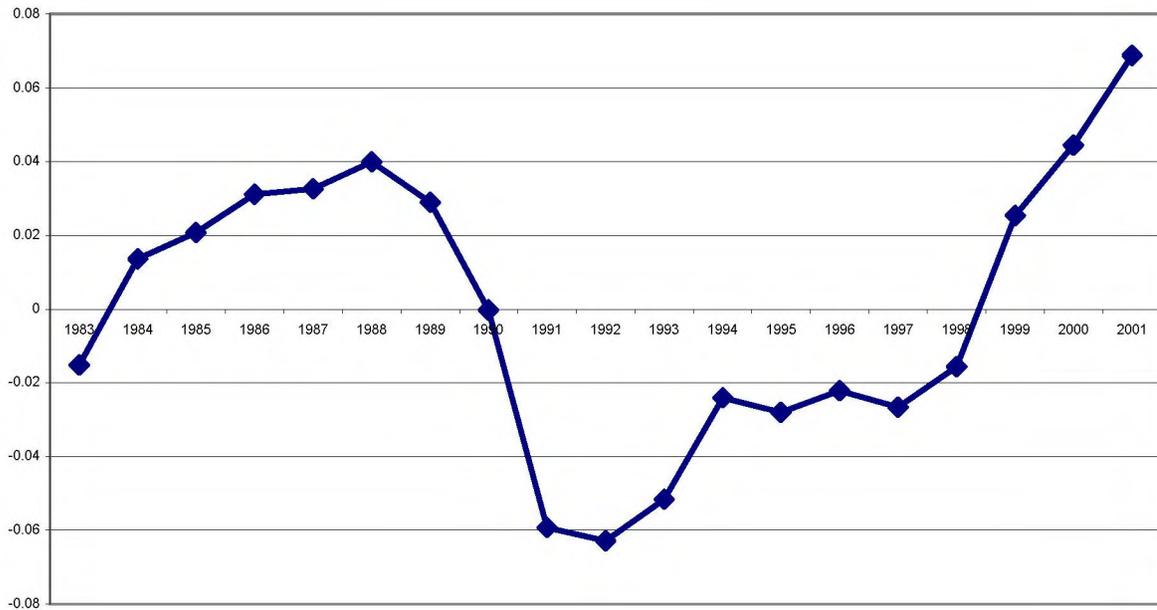
+-----+
| Ordinary least squares regression   Weighting variable = none
| Dep. var. = Log(RetSal) Mean=      10.29626918 , S.D.=      .1404632916
| Model size: Observations =         19, Parameters =      2, Deg.Fr.=      17
| Residuals: Sum of squares= .2557718290E-01, Std.Dev.=      .03879
| Fit:      R-squared=      .927980, Adjusted R-squared =      .92374
| Model test: F[ 1,      17] = 219.04, Prob value =      .00000
| Diagnostic: Log-L =      35.8399, Restricted(b=0) Log-L =      10.8472
|              LogAmemiyaPrCrt.= -6.399, Akaike Info. Crt.=      -3.562
| Autocorrel: Durbin-Watson Statistic =      .36060, Rho =      .81970
+-----+
|Variable | Coefficient | Standard Error | t-ratio | P[|T|>t] | Mean of X|
+-----+
| Constant | -37.60204780 | 3.2363497 | -11.619 | .0000 |
| YEAR     | .02404533985 | .16246674E-02 | 14.800 | .0000 | 1992.0000
+-----+

```

Predicted Values (* => observation was not in estimating sample.)

Observation	Observed Y	Predicted Y	Residual	95% Lower Bound	95% Upper Bound
1	10.065	10.08	-0.0152	9.9904	10.1693
2	10.117	10.104	0.0136	10.016	10.1922
3	10.149	10.128	0.0208	10.041	10.2153
4	10.183	10.152	0.0311	10.066	10.2384
5	10.209	10.176	0.0326	10.09	10.2617
6	10.24	10.2	0.0399	10.115	10.2852
7	10.253	10.224	0.029	10.14	10.3087
8	10.248	10.248	-0.0002	10.164	10.3324
9	10.213	10.272	-0.0593	10.188	10.3563
10	10.234	10.296	-0.0628	10.212	10.3802
11	10.269	10.32	-0.0516	10.236	10.4043
12	10.32	10.344	-0.0241	10.26	10.4286
13	10.34	10.368	-0.028	10.284	10.453
14	10.37	10.392	-0.0222	10.307	10.4775
15	10.39	10.416	-0.0266	10.331	10.5022
16	10.425	10.441	-0.0156	10.354	10.527
17	10.49	10.465	0.0254	10.377	10.5519
18	10.533	10.489	0.0445	10.4	10.577
19	10.581	10.513	0.0688	10.423	10.6021

Figure 8-12: Regression Residuals - Trend of Log(RetailSales)



Once an acceptable regression equation has been estimated, the revenue forecast can be prepared. The forecast is prepared by substituting the forecast year independent variables into the regression equation and adjusting the constant term by the final regression residual. The constant term is adjusted to ensure that the forecast is based on the last actual observed value for the dependent variable rather than the forecast value. This is accomplished by adding the final residual (0.0688) to the regression constant (-37.6). If the constant were not adjusted in this way, the first year of the forecast would be based on the predicted value for 2001 rather than the actual known value. The preparation of the revenue forecast is detailed in the following table.

Table 8-26: Trend Forecast of Retail Sales Tax Revenue

Year	Log (Retail Sales)	Real Retail Sales (\$mil)	CPI	Retail Sales (\$mil)	% Subject to Tax	Tax Rate (%)	Tax Revenue (\$mil)
1983	10.0646	23,496	99.6	23,402	42.3	4.5	445.46
1984	10.1175	24,773	103.9	25,739	42.2	4.5	488.78
1985	10.1487	25,558	107.6	27,500	42.3	4.5	523.47
1986	10.1831	26,452	109.6	28,992	41.5	4.5	541.42
1987	10.2086	27,136	113.6	30,826	42.2	4.5	585.39
1988	10.24	28,001	118.3	33,125	42.5	4.5	633.52
1989	10.2531	28,370	124.0	35,179	41.1	4.5	650.64
1990	10.248	28,226	130.7	36,891	41.9	4.5	695.59
1991	10.2129	27,252	136.2	37,118	42.0	4.5	701.53
1992	10.2335	27,820	140.3	39,031	42.1	4.5	739.44
1993	10.2688	28,819	144.5	41,644	41.9	4.5	785.20
1994	10.3202	30,339	148.2	44,963	41.7	4.5	843.73
1995	10.3404	30,958	152.4	47,181	41.7	4.5	886.12
1996	10.3703	31,898	156.9	50,048	41.7	4.5	939.14
1997	10.3899	32,529	160.5	52,210	41.7	4.5	978.84
1998	10.4249	33,688	163.0	54,912	41.6	4.5	1,028.59
1999	10.49	35,954	166.6	59,900	41.6	4.5	1,121.04
2000	10.5331	37,538	172.2	64,640	41.6	4.5	1,208.69
2001	10.5814	39,395	177.1	69,769	41.5	4.5	1,303.44
2002	10.6055	40,357	181.9	73,424	41.5	4.5	1,371.19
2003	10.6296	41,339	186.3	77,020	41.5	4.5	1,438.35
2004	10.6536	42,345	190.7	80,748	41.5	5.5	1,843.06
2005	10.6777	43,376	195.1	84,611	41.5	5.5	1,931.25
2006	10.7017	44,431	199.4	88,615	41.5	5.5	2,022.64
2007	10.7257	45,513	203.8	92,764	41.5	5.5	2,117.33
2008	10.7498	46,622	208.2	97,061	41.5	5.5	2,215.43
2009	10.7738	47,757	212.7	101,514	41.5	5.5	2,317.05
2010	10.7979	48,927	217.2	106,125	41.5	5.5	2,422.31
2011	10.8219	50,108	221.8	110,901	41.5	5.5	2,531.31
2012	10.8460	51,327	226.5	115,846	41.5	5.5	2,644.19
2013	10.8700	52,576	230.1	120,992	41.5	5.5	2,761.07
2014	10.8941	53,856	234.5	126,268	41.5	5.5	2,882.06
2015	10.9181	55,167	238.8	131,755	41.5	5.5	3,007.31
2016	10.9422	56,509	243.2	137,435	41.5	5.5	3,136.95
2017	10.9662	57,884	247.6	143,313	41.5	5.5	3,271.12
2018	10.9902	59,293	252.0	149,396	41.5	5.5	3,409.96
2019	11.0143	60,736	256.3	155,690	41.5	5.5	3,553.62
2020	11.0383	62,214	260.7	162,202	41.5	5.5	3,702.26

Forecast Period

Regression Parameters

Intercept = (37.6020)
 Coefficient = 0.0240
 Last Residual = 0.0688

Forecast Equations

Retail sales = exp((Intercept + Last residual) + (coefficient * year))*(CPI / 100)
 Tax Revenue = (Retail sales) * (% subject to tax) * (Tax rate)

While regression models can be used to estimate simple trend lines like the previous example, the major strength of multiple regression models is the ability to quantify causal relationships. For retail sales, the most likely causal

variables are population, employment, and income (see Principle 4 in the following section).

Once the primary causal variables of interest are identified, an initial regression model can be quickly specified and tested. The following example regression includes a constant term, log of population, log of income, and log of employment as explanatory variables for retail sales. This specification performs fairly well, explaining over 96 percent ($R^2 = .964$) of the variation in retail sales.

Exhibit 8-2: Example Regression Model Output for Real Retail Sales

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+-----+
| Ordinary least squares regression      Weighting variable = none
| Dep. var. = Log(RetSal) Mean= 10.29626918 , S.D.= .1404632916
| Model size: Observations = 19, Parameters = 4, Deg.Fr.= 15
| Residuals: Sum of squares= .1282863927E-01, Std.Dev.= .02924
| Fit: R-squared= .963877, Adjusted R-squared = .95665
| Model test: F[ 3, 15] = 133.42, Prob value = .00000
| Diagnostic: Log-L = 42.3951, Restricted(b=0) Log-L = 10.8472
|              LogAmemiyaPrCrt.= -6.873, Akaike Info. Crt.= -4.042
| Autocorrel: Durbin-Watson Statistic = .59419, Rho = .70291
+-----+
+-----+-----+-----+-----+-----+-----+
| Variable | Coefficient | Standard Error | t-ratio | P[|T|>t] | Mean of X |
+-----+-----+-----+-----+-----+-----+
| Constant | -1.649975403 | 6.9794061 | -.236 | .8163 |
| Log(pop) | .2956528846 | .60211573 | .491 | .6305 | 15.451594
| Log(inc) | 1.092841303 | .60837137 | 1.796 | .0926 | 11.257811
| Log(emp) | -.3369919360 | .78879657 | -.427 | .6753 | 14.614784
+-----+-----+-----+-----+-----+-----+

```

Unfortunately, the coefficient estimates suggest problems with this regression. The negative coefficient on the employment variable is clearly wrong, since more employment will result in more, not less, retail sales. In addition, the coefficient on the population variable is too low. Recall that a regression with logarithmic transformations of all the variables allows the coefficient estimates to be interpreted as elasticities. Therefore, the coefficient on population suggests that a 1 percent increase in population would cause a 0.29 percent increase in retail sales. A more sensible value would be much closer to 1. The cause of this problem is multicollinearity between the causal variables (see Principle 2 in the next section). The following table is the correlation matrix for all the potential causal variables in the example.

Table 8-27: Correlation Matrix for Causal Variables

	POP	EMPLOY	INC	INCP
POP	1.00	0.98566	0.98427	0.95002
EMPLOY	0.98566	1.00	0.99571	0.98394
INC	0.98427	0.99571	1.00	0.9891
INCP	0.95002	0.98394	0.9891	1.00

All the variables are highly correlated with each other, with correlation coefficients that exceed 95 percent in all cases. It is unlikely that these variables can be combined in the same regression without causing problems with multicollinearity. This is a critical problem for the model since

multicollinearity causes the coefficient estimates and t-statistics to be unstable. To fix this problem, the regression should be re-estimated with a single causal variable. The following three regression outputs display the results for the retail sales regression using population, employment and real income as single regressors along with a constant term.

Exhibit 8-3: Example Single Variable Regression Outputs

```

-----
Ordinary least squares regression Weighting variable = none
Dep. var. = log(Retsal) Mean= 10.29626918 , S.D.= .1404632916
Model size: Observations = 19, Parameters = 2, Deg.Fr.= 17
Residuals: Sum of squares= .2272403867E-01, Std.Dev.= .03656
Fit: R-squared= .936014, Adjusted R-squared = .93225
Model test: F[ 1, 17] = 248.68, Prob value = .00000
Diagnostic: Log-L = 36.9635, Restricted(b=0) Log-L = 10.8472
LogAmemiyaPrCrt.= -6.517, Akaike Info. Crt.= -3.680
Autocorrel: Durbin-Watson Statistic = .43612, Rho = .78194
-----

```

Variable	Coefficient	Standard Error	t-ratio	P[T >t]	Mean of X
Constant	-23.28240372	2.1293400	-10.934	.0000	
Log(pop)	2.173152690	.13780607	15.770	.0000	15.451594

```

-----
Ordinary least squares regression Weighting variable = none
Dep. var. = log(Retsal) Mean= 10.29626918 , S.D.= .1404632916
Model size: Observations = 19, Parameters = 2, Deg.Fr.= 17
Residuals: Sum of squares= .1618160697E-01, Std.Dev.= .03085
Fit: R-squared= .954436, Adjusted R-squared = .95176
Model test: F[ 1, 17] = 356.10, Prob value = .00000
Diagnostic: Log-L = 40.1892, Restricted(b=0) Log-L = 10.8472
LogAmemiyaPrCrt.= -6.857, Akaike Info. Crt.= -4.020
Autocorrel: Durbin-Watson Statistic = .38191, Rho = .80904
-----

```

Variable	Coefficient	Standard Error	t-ratio	P[T >t]	Mean of X
Constant	-7.534325645	.94491320	-7.974	.0000	
Log(emp)	1.220038179	.64652798E-01	18.871	.0000	14.614784

```

-----
Ordinary least squares regression Weighting variable = none
Dep. var. = log(Retsal) Mean= 10.29626918 , S.D.= .1404632916
Model size: Observations = 19, Parameters = 2, Deg.Fr.= 17
Residuals: Sum of squares= .1312234897E-01, Std.Dev.= .02778
Fit: R-squared= .963050, Adjusted R-squared = .96088
Model test: F[ 1, 17] = 443.08, Prob value = .00000
Diagnostic: Log-L = 42.1800, Restricted(b=0) Log-L = 10.8472
LogAmemiyaPrCrt.= -7.067, Akaike Info. Crt.= -4.229
Autocorrel: Durbin-Watson Statistic = .53525, Rho = .73238
-----

```

Variable	Coefficient	Standard Error	t-ratio	P[T >t]	Mean of X
Constant	-.4734111606	.51167513	-.925	.3678	
Log(inc)	.9566407220	.45447151E-01	21.050	.0000	11.257811

Each regression performs quite well, but real income appears to perform slightly better than the other variables based on the R^2 value. In addition, the Durbin-Watson statistic indicates less serial correlation of the error terms when income is the regressor. However, the answer here is not as clear as it may first appear. A solid argument can be made for using employment since the data is usually tracked more carefully and frequently than either population or income. State employment offices and the US Bureau of Labor Statistics track employment figures carefully and updated employment figures

are generally available before population or income estimates. The quality and timeliness of updated data and forecasts is vital to the usefulness of the regression model, so employment could be the best choice in this example.

The Durbin-Watson statistic indicates serial correlation of the error terms, so some corrective action may be justified to derive better estimates (see Principle 6 in the next section). Most econometric software packages can correct for serial correlation automatically. Below is the output for the employment regression including the corrective first order autoregressive term AR(1). The AR(1) term is significant at the 99 percent level and the resulting Durbin-Watson statistic of 1.29 indicates that we cannot reject the null hypothesis of no first order autocorrelation at the 95 percent level.²⁴ The inclusion of the autoregressive term has improved the model.

Exhibit 8-4: Example Autoregressive Model Output

```

+-----+
| AR(1) Model:      e(t) = rho * e(t-1) + u(t) |
| Initial value of rho      =      .80904 |
| Iter= 6, SS=      .006, Log-L= 48.822249 |
| Final value of Rho      =      .89010 |
| Durbin-Watson:  e(t) =      .21980 |
| Std. Deviation: e(t) =      .04124 |
| Std. Deviation: u(t) =      .01880 |
| Durbin-Watson:  u(t) =      1.29353 |
| Autocorrelation: u(t) =      .35324 |
| N[0,1] used for significance levels |
+-----+

```

Variable	Coefficient	Standard Error	b/St.Er.	P[Z >z]	Mean of X
Constant	-8.525992053	1.9607706	-4.348	.0000	
Log(emp)	1.289517644	.13423099	9.607	.0000	14.614784
RHO	.8900993672	.10742520	8.286	.0000	

The resulting regression suggests that retail sales is quite sensitive to changes in employment. A 1.0 percent increase in employment is estimated to cause a 1.29 percent increase in retail sales. Generating a forecast from a model with an autoregressive term is similar to the trend example. The suggested forecasting equation can be written as:

$$\text{Retail sales} = \exp((\text{Intercept} + \text{Last residual}) + (\text{Coefficient} * \text{Employment})) * \text{CPI} / 100$$

The key issue in developing out of sample forecasts from autoregressive models is whether and how to include the autoregressive term. Since there is no actual data from which to calculate a forecasting error, there would seem to be no basis for including it in the forecasting equation. This guidance generally suggests ignoring the autoregressive term in out of sample forecasts. However, various techniques have been developed for using the autoregressive term in out of sample forecasts, but whether employing these terms is preferable to simply using the forecasting equation above, is unclear.²⁵ This topic is complex and beyond the scope of this guidance, so the

²⁴ The confidence interval for the Durbin-Watson statistic can be found in almost any statistics textbook or the manual that comes with most econometric software packages.

²⁵ Greene, William H., *Econometric Forecasting*, 1990.

reader is referred to a good econometric textbook if more information is desired. Nevertheless, the use of the autoregressive term in the model provides superior estimates for the coefficients for the constant term and employment, so the use of these coefficients from the autoregressive model should be used to generate the out of sample forecast.

An example forecast is presented below. The results highlight the benefits of using a regression model with causal variables. Since retail sales is causally related to employment in the model, information about the growth in employment in the near term allows the forecast for retail sales to adjust accordingly. The simple trend analysis provides no quantitative basis for adjusting the forecast.

In the example in Table 8-28, employment growth in 2002 was assumed to be zero to reflect the slowing economy, then continue its past trend in future years. The regression based forecast for 2002 is about \$33 million less under this scenario than the forecast that simply extrapolates past trends. The cumulative difference in the forecasts is about \$1.2 billion over the forecast period. The much larger differences over the long term reflect the importance of incorporating updated information as quickly as possible. Forecasting errors in early years compound over time and become much larger as the length of the forecast increases.

Table 8-28: Sales Tax Revenue Forecast - Regression with Causal Variables

Year	Log (Employ)	Log (Retail Sales)	Real Retail Sales (\$mil)	CPI	Retail Sales (\$mil)	% Subject to Tax	Tax Rate (%)	Tax Revenue (\$mil)
1983	14.4050	10.0646	23,496	99.6	23,402	42.3	4.5	445.46
1984	14.4511	10.1175	24,773	103.9	25,739	42.2	4.5	488.78
1985	14.4822	10.1487	25,558	107.6	27,500	42.3	4.5	523.47
1986	14.5021	10.1831	26,452	109.6	28,992	41.5	4.5	541.42
1987	14.5280	10.2086	27,136	113.6	30,826	42.2	4.5	585.39
1988	14.5594	10.24	28,001	118.3	33,125	42.5	4.5	633.52
1989	14.5845	10.2531	28,370	124.0	35,179	41.1	4.5	650.64
1990	14.5985	10.248	28,226	130.7	36,891	41.9	4.5	695.59
1991	14.5879	10.2129	27,252	136.2	37,118	42.0	4.5	701.53
1992	14.5912	10.2335	27,820	140.3	39,031	42.1	4.5	739.44
1993	14.6104	10.2688	28,819	144.5	41,644	41.9	4.5	785.20
1994	14.6411	10.3202	30,339	148.2	44,963	41.7	4.5	843.73
1995	14.6673	10.3404	30,958	152.4	47,181	41.7	4.5	886.12
1996	14.6877	10.3703	31,898	156.9	50,048	41.7	4.5	939.14
1997	14.7131	10.3899	32,529	160.5	52,210	41.7	4.5	978.84
1998	14.7387	10.4249	33,688	163.0	54,912	41.6	4.5	1,028.59
1999	14.7626	10.49	35,954	166.6	59,900	41.6	4.5	1,121.04
2000	14.7842	10.5331	37,538	172.2	64,640	41.6	4.5	1,208.69
2001	14.7857	10.5814	39,395	177.1	69,769	41.5	4.5	1,303.44
2002	14.7857	10.5814	39,396	181.9	71,676	41.5	4.5	1,338.55
2003	14.7985	10.5979	40,052	186.3	74,622	41.5	4.5	1,393.56
2004	14.8125	10.6500	40,780	190.7	77,762	41.5	5.5	1,774.92
2005	14.8322	10.6914	41,833	195.1	81,601	41.5	5.5	1,862.54
2006	14.8520	10.7269	42,913	199.4	85,586	41.5	5.5	1,953.50
2007	14.8718	10.7692	44,021	203.8	89,723	41.5	5.5	2,047.92
2008	14.8915	10.7100	44,150	208.2	94,016	41.5	5.5	2,145.91
2009	14.9113	10.7434	44,278	212.6	98,470	41.5	5.5	2,247.59
2010	14.9311	10.7689	47,000	216.9	103,000	41.5	5.5	2,353.09
2011	14.9508	10.7944	48,746	221.3	107,808	41.5	5.5	2,462.55
2012	14.9706	10.8199	50,005	225.6	112,366	41.5	5.5	2,576.08
2013	14.9904	10.8454	51,296	230.1	118,000	41.5	5.5	2,693.84
2014	15.0102	10.8709	52,621	234.5	123,000	41.5	5.5	2,815.96
2015	15.0299	10.8964	53,979	238.8	128,920	41.5	5.5	2,942.60
2016	15.0497	10.9218	55,373	243.2	134,672	41.5	5.5	3,073.89
2017	15.0695	10.9473	56,803	247.6	140,635	41.5	5.5	3,210.00
2018	15.0892	10.9728	58,270	252.0	146,817	41.5	5.5	3,351.10
2019	15.1090	10.9983	59,774	256.3	153,224	41.5	5.5	3,497.33
2020	15.1288	11.0238	61,317	260.7	159,864	41.5	5.5	3,648.89

Forecast Period

Regression Parameters

Intercept (8.52599)
 Employment Coefficient 1.28952
 Last Residual 0.04100

Forecast Equation

Retail sales = exp((Intercept + Last residual) + (Coefficient * Employment)) * CPI / 100
 Tax Revenue = (Retail sales) * (% subject to tax) * (Tax rate)

Key Principles for Developing Regression Models

Principle 1: For regression analysis, use real rather than nominal variable constructions.

Generally speaking, all variables in a regression equation should be adjusted for inflation. The reason is that inflation is not a “real” factor. Rather it is purely a monetary scaling of all variables that are expressed in dollar amounts. If a monetary series exhibits a trend, the analyst does not know whether this is the result of actual growth or a purely nominal phenomenon that can be attributed to inflation, unless inflation is removed from the equation by expressing all monetary variables in constant dollars.

If inflation is not removed from the analysis, regression equations tend to have higher than justified R^2 . The reason being that the portion of the variation of the dependent variable that is attributable to inflation is known with certainty. That is, that portion of the variation in the explanatory variables that is attributable to inflation is perfectly correlated with the inflation in the dependent variable. The effect of that perfect correlation is to inflate the R^2 statistic. A regression analysis for revenue forecasting should express all forecasts in constant dollars. At the end of the forecasting process, these constant dollar revenue forecasts are inflated based on the inflation rate assumptions from the economic forecast and included in the agency financial plan, which is expressed in inflated dollars.

Principle 2: Fewer variables is better (most of the time).

“...any time series regression containing more than four independent [explanatory] variables results in garbage.”

Zvi Griliches, “Comments on Sims,” in *Frontiers of Quantitative Economics*, vol.2, 1974, p. 335.

In most cases, a regression equation should have as few explanatory variables as possible. Simplicity in modeling is a virtue. Simple models have more clearly defined statistical relationships among variables and are easier to validate. Simple models are also easier to explain to non-modelers. Most importantly, models with too many variables run the risk of including variables that are correlated with each other. This problem is termed multicollinearity. One of the assumptions of regression analysis is that all explanatory variables are independent of one another. If they are in fact, correlated, the coefficients on the explanatory variables become unstable and forecasts will be biased.

Before including a set of variables in an equation, the analyst should produce a correlation matrix to test which variables are correlated with each other and by how much. Generally speaking, most variables will display some amount of correlation, but if the correlation coefficient comes close to or exceeds 0.7,

the two variables in question should not usually appear in the same equation. The result of a regression analysis when the explanatory variables are correlated can be unsettling. Coefficients can display the wrong sign, the t-statistics on the explanatory variables can be impossibly large, removing or adding a variable to the regression can make all the coefficients change dramatically. These impacts can make forecasts based on a multi-collinear regression unstable and theoretically unsound.

The most common method of dealing with this problem is to drop explanatory variables from the regression equation. This works well, as long as the regression equation still performs well and the model is fully specified. If the model is degraded, the other option is to transform some of the variables to remove the source of the collinearity. One common example of this approach is to transform an income variable to per capita income so that it can be used in an equation with population. By dividing income by population to get a per capita income value, one source of the collinearity with population is removed. This approach only works in specific cases where the source of the collinearity is clearly identifiable.

Principle 3: Use logarithmic transformations.

To ease the interpretation of results, economists often transform all their data series' in a regression equation using natural logs. The usual revenue forecasting equation is a non-linear regression of the form:

$$y = \alpha \prod_k X_k^{\beta_k} e^{\varepsilon}$$

where

- y is the dependent variable
- X is a vector of k independent variables
- α is the regression constant
- β are parameters to be estimated
- ε is the error term

When natural logs are applied to both sides of this equation, the result is:

$$\ln y = \ln \alpha + \sum_k \beta_k \ln X_k + \varepsilon$$

which is linear in its components. This model is called the log-linear model since it is a non-linear regression that is linear in log form. In this specification, the coefficients are interpretable as elasticities:

$$\frac{\partial \ln y}{\partial \ln X_k} = \beta_k$$

which can be interpreted to mean the percent change in the dependent variable y given a percent change in the explanatory variable X . This is the definition of an elasticity.

A good test of a regression model forecasting retail sales from population and income would be to estimate the log-linear form of the regression model and ensure that the coefficients on population and income are in the neighborhood of 1. A coefficient of 1.0 for population means that a 1 percent increase in population leads to a 1 percent increase in retail sales, which is expected. A coefficient of 1.0 for per capita income means that a 1 percent increase in average income leads to a 1 percent increase in retail sales, which is also expected. The analyst will expect some deviation from 1.0 for population due to the reality that population growth may occur among groups that consume more or less than average. A similar explanation can be offered for average income where people's propensity to consume taxable items from income growth may be more or less than the sample average.

A side note to logarithmic transformations is that they reduce the variance for each of the variables in the model. The effect of this is to raise the R^2 statistic in the final regression model. This benefit is illusory because to get usable forecasts, the analyst must exponentiate the model results to generate forecasts in actual dollars. This reintroduces the wider variances and the final forecasts are not any better than they would be if they were prepared without the log transformation.

Other non-linear functional forms can be checked, but they will generally not be suitable for revenue forecasting where the relationships are often consistent and stable under the assumptions of the linear model. A good econometrics textbook should be consulted for suggestions about functional form. In addition, some econometric software packages will have a variety of non-linear regression specifications built into them.

Principle 4: The model should make theoretical sense.

Regression models that are used to forecast demand, such as the retail sales example, should have a sound theoretical basis behind the functional form. This means applying the basic principles of economics to the development of the functional form. For instance, demand is a function of the number of consumers, their income and the price of the product. This suggests that a

model to forecasts new car sales (for a registration fee revenue forecast) would include population, income per capita, and the average price of a new car to conform to what economists believe about the structure of demand.

Once a model is defined that makes economic sense and performs well, the coefficients that are estimated should also make sense. The magnitude of the impact of a change in an explanatory variable should be reasonable and the coefficients must have the correct sign. If either of these problems arises, the most likely problem is multi-collinearity (see Principle 2). Other potential problems can be poor data or mistakes made when constructing the data series.

Many models should be estimated without a regression constant. The regression constant indicates the level of the dependent variable if the explanatory variables were zero. The dependent variable in many tax revenue forecasting models would be zero if, for instance, population and income were zero. The regression equation should be tested without the constant to attempt to find a specification that performs well without it. If a constant term is required to achieve adequate fit with the data, the likely problem is a non-linearity in the modeling relationships that occurs well outside the available data set. Non-linear regressions can be estimated, but in many cases, a constant term will need to be included despite theoretical misgivings. The modeler should ensure that if a constant term is included, it is statistically significant at the 95 percent level.

Principle 5: Test lagged variable specifications.

Sometimes, financial reactions to economic indicators are delayed. The most common instance of delayed reaction is related to investment, whether business investment or real estate, in response to changes in interest rates. The delayed reaction is most evident if quarterly data are available, but yearly data can also display lagged reactions. Lagged variable specifications should be tested for a variety of different periods by using the prior period value of the explanatory variables in the regression.

Often, the best explanatory variable in a time series regression is the lagged dependent variable. The rationale for this type of regression is that the best predictor of future conditions is often current conditions. Cyclical impacts can be modeled by using more than one lagged dependent variable. The following regression model was developed to forecast construction activity (*const*), as a tax base for development fees:

$$\ln(const) = \alpha + \beta_1 \ln(prime_rate_{-1}) + \beta_2 \ln(const_{-1}) + \beta_3 \ln(const_{-2}) + \varepsilon$$

Where $_{-1}$ indicates the prior period value and $_{-2}$ indicates a value from two periods earlier. This model postulates that construction activity depends on the prime interest rate from the prior period, construction activity in the two

previous periods, and a constant term. This model was found to explain 95 percent of past variation in construction activity in one metropolitan area.

Principle 6: Account for serial correlation.

One of the assumptions of multiple regression analysis is that the error terms of the regression equations are uncorrelated with each other through time. If this assumption is violated, the model is said to display serial correlation of the disturbances. In simple terms, the error terms display an observable pattern, and are therefore, not random.

The Durbin-Watson (DW) statistic, which is calculated automatically in the regression routine of all statistical software packages, is used to detect the existence of serial correlation. The rule of thumb is that when error terms are uncorrelated with each other, the DW statistic equals 2. The analyst should consult the table of critical values for the DW statistic for the relevant confidence interval given the specific regression model in question.

Time series forecasting models often violate this assumption. Modelers account for this problem by including an “autoregressive” form of the error term as follows:

$$\varepsilon_t = \rho\varepsilon_{t-1} + u_t$$

This formulation states that the error term is a function of the error term from the previous period plus a random component. This is called a first-order autoregressive term. A class of models called ARIMA (autoregressive integrated moving average) models combine several auto regressive and moving average terms to generate models that rely on no explanatory variables except constructions of the dependent variable itself and the error terms of the regression. These models are a rather complex form of trend analysis.

Principle 7: Test for structural stability.

Structural change in the relationships estimated in a regression model can be the source of bias in the forecasting process. Two common tests of structural instability are the Chow breakpoint test and the Chow forecast test. These tests are performed by splitting the data at some year T and performing tests on the structural change between these two periods.

In the Chow breakpoint test, separate regressions are estimated using all data before year T and after year T. The hypothesis that the coefficients are equal in both time periods is tested using a F-test. There is no hard and fast rule for choosing T except to choose years where the analyst suspects some change in the economic relationships may have occurred, such as recessions or periods of economic instability. Often, the midpoint of the time series is chosen in

case there is a consistent structural change that is occurring over the entire period. Some statistical software packages can perform the Chow breakpoint test automatically.

The Chow forecast test is similar to the Chow breakpoint test. The data before year T is used to prepare a forecast for the years after year T. An F-test is used to test the hypothesis that the forecast values are equal to the actual values. The test compares the prediction errors to the variance that is expected if the null hypothesis were true. Failure to reject the null hypothesis (the forecast errors are zero) suggests that the model shows no evidence of structural instability over the forecast period.

An example of structural instability in revenue forecasting can be seen in certain forecasts of retail sales used to estimate sales tax revenue. Sales taxes are generally levied on only a subset of goods and services. Most services, such as medical care or legal services, are untaxed. If the percentage of income spent on taxable items is changing over time, this effect can introduce structural instability into sales tax revenue forecasts. The best way to deal with structural instability is to include a variable that accounts for the effect. In this case, the percent of personal income spent on goods (as opposed to services), can be calculated from economic data and most detailed economic forecasts. Including the percent of personal income spent on goods as an explanatory variable generally removes the structural instability from sales tax forecasting models.

Another source of structural instability might be long-run changes in the age distribution of regional population, which can affect sales and income tax revenues. Changes in vehicle ownership rates can affect forecasts of licensing or registration fees. All revenue sources can be impacted by shifts in the regional economic base. Forecasts are improved when these trends are identified and incorporated into the financial forecasts.

9. EVALUATION OF ALTERNATIVES

9.1 Introduction

“There 's small choice in rotten apples.”

- from The Taming of the Shrew. Act i. Sc. 1.

by William Shakespeare

The nature of project planning – a detailed assessment of complex project alternatives in several technical aspects – risks an overabundance of information that loses its usefulness in decision-making. The evaluation of alternatives is a critical part of alternatives analysis, and of a Draft Environmental Impact Statement (DEIS), in which the information is sifted and organized, and key differences between the alternatives are highlighted.

This chapter outlines a framework for this evaluation that attempts to structure the information in a way that can be understood by the many non-technical readers of the alternatives analysis and/or DEIS. It must be noted that the framework suggested here simply provides a skeleton on which the evaluation is built. The goals, objectives, evaluation criteria, and discussions that make up the evaluation are necessarily determined by local officials, project staff, and the general public to focus on the local decisions that must be made.

9.2 Framework

There are several possible approaches that might be considered in the evaluation of major transit alternatives. They range from a free-form discussion of the options to a very structured and elaborate analysis complete with weighting and scoring of project attributes. A review of the evaluation efforts in previous alternatives analyses suggests two conclusions:

1. the lack of some basic structure for the evaluation risks a rambling, unfocused discussion that more often repeats rather than interprets the data; and
2. complex “weighting and rating” schemes tend to confuse rather than illuminate the issues and are often only tenuously related to the realities of decision-making.

As a result, some combination of the of structured analysis and informed judgment of local project staff and Technical Advisory Committees is advantageous to focus the evaluation on the key issues.

One suggested approach is to identify and display the key measures against which each alternative is evaluated in a small, one or two-page table. The evaluation measures should be quantitative rather than qualitative if at all possible. The goals and objectives of most transportation projects typically call for five classes of evaluation measures in a desirable project:

1. Effectiveness – the extent to which the project solves the stated transportation problems in the corridor;
2. Impacts – the extent to which the project supports economic development, environmental or local policy goals;
3. Cost-effectiveness (or cost-benefit analysis) – that the costs of the project, both capital and operating, be commensurate with its benefits;
4. Financial feasibility – that funds for the construction and operation of the alternative be readily available in the sense that they do not place undue burdens on the sources of those funds; and
5. Equity – that the costs and benefits be distributed fairly across different population groups.

The evaluation framework must be focused on the transportation problems identified during system planning, which guide the alternatives analysis. The evaluation method should begin with the statement of goals and objectives for transportation improvements. Where existing statements are available, they should be organized into the structure that will be used for the evaluation. Where new or revised statements of goals and objectives are prepared, the perspectives provide a useful starting point for identifying and organizing local concerns.

It is useful to recognize that the evaluation phase of project planning – and of any assessment of complex options – is not restricted to the final phase of the analysis. Rather, it is a continuous and comprehensive process within which the technical work proceeds. The process is continuous in that there is a series of decisions that must be made through the analysis – alignment variations,

design standards, operating policies, etc. – that together shape the nature and performance of each alternative. It is comprehensive in that the final evaluation of an alternative considers a broad range of criteria – transportation, environment, costs, finances, etc. – that require a broad perspective in the assessment of design decisions. Clearly, the ongoing decision-making should be carried out with regard to its ultimate impact on the evaluation of each alternative.

It is also important to reemphasize that the evaluation is primarily focused on local decision-making. While this should be obvious, particularly for projects that are not subject to FTA’s New Starts evaluation and rating process, there have been cases in which the entire evaluation has focused on “qualifying” for Federal funding rather than on identifying transportation needs and solutions. Emphasis on the Federal decision is not consistent with the intent or nature of FTA’s New Starts program. The FTA Final Rule for Major Capital Investments recognizes that legitimate differences often exist between the local and Federal views of major transit projects. It specifically identifies the Federal interest in transit and outlines the standards against which funding proposals will be measured. The intention is that local officials examine the transit alternatives against their own objectives, so that an agreement can be reached on the aspects of a project that are consistent with Federal goals (and attractive for Federal investment) and those that are primarily local objectives that should be funded locally. Therefore, the evaluation process should consider all perspectives from which the alternatives will be examined.

9.3 Understanding the Problem

The evaluation measures chosen to evaluate the relative merits of transportation alternatives spring directly from the local problems the alternatives analysis is designed to solve. While many transportation projects have similar objectives, such as improved mobility and accessibility and economic development, local conditions should drive the development and evaluation of alternatives.

Local conditions may focus the evaluation on environmental concerns, capacity constraints, congestion relief, social policy goals, mobility of transit dependent populations, land use impacts, or any other local concern. The decision to select a project as the locally preferred alternative should spring from local needs and concerns rather than the evaluation criteria used for the federal funding decision.

However, the conduct of the alternatives analysis where a fixed guideway transit investment could become the locally preferred alternative should produce the inputs required for the federal rating and evaluation process to avoid the possibility that significant new work would be required before entering PE. The measures used in the federal evaluation for New Starts projects is found in *Reporting Instructions for the Section 5309 New Starts Criteria*, published every year by the Federal Transit Administration.

9.4 Identifying Measures

The measures selected to guide the evaluation of the alternatives should be focused on solving the specific problems in the corridor. Most of the commonly used measures are discussed in the following sections and fall under the general categories of transportation effectiveness, impacts, cost-effectiveness, financial feasibility and equity.

There are several considerations in the selection of evaluation measures related to the assessment of alternative investments:

1) The measures should be developed early in the analysis with appropriate input from local decision-makers.

The review is an obvious step to ensure the relevance and usefulness of the information. The evaluation methodology should be a high priority item in the early stages of the analysis. Development of a written explanation of the evaluation process is often the catalyst for local officials to come to grips with the specific measures that are of importance for local decision-making.

2) The measures should be comprehensive in that they address all of the stated objectives, but they should be structured to avoid simple restatements of the same benefits.

Many potential effectiveness and impact measures are interrelated. In some cases, there is good reason to include measures of the same impact that portray the impact from different perspectives. For example, the increased development potential of an area may be due primarily to the improvement in transit accessibility to that site. While including both measures of accessibility and measures of development potential double-counts some benefits, both may be of sufficient interest to warrant their use in the analysis. This is in contrast to the subsequent cost-effectiveness analysis where double-counting the same benefits would be an error. In other cases, two candidate measures can be purely redundant. For example, it is unnecessary to include both “total transit trips” and “transit trips diverted from autos” since the second measure is a direct mathematical derivation from the first.

3) To the extent possible, the measures should quantify the impacts rather than express subjective judgments on the nature of the impact.

Many of the important objectives of an improvement can be difficult to quantify and the consequent temptation is to use subjective evaluation measures: significant or not significant, desirable or not desirable, and so forth. However, it is usually more useful to provide measurements rather than judgments to local officials and the public. There is an adage to the effect that the relocation of a single residence for a major project is not “significant” unless it is your residence. Useful quantified measures can usually be identified for most objectives. For example, the impacts of street closings on

neighborhoods can be addressed with such measures as the number of local streets closed to traffic and the number of residences and business.

4) *The measures should provide the proper perspective on the magnitude of the impacts.*

Many of the impacts of a transportation improvement occur in terms of numbers that are large in an absolute sense but are relatively small when placed in perspective. For example, travel time savings of 1,000 hours a day represents 3 minutes per trip when spread over 20,000 transit trips. However, 1,000 hours is only 14 seconds per trip if spread over 250,000 drivers, which is not likely to be noticed. Also, the relocation of one million square feet of new office space to station areas may appear quite significant when presented by itself, but is more meaningful when also shown as the percentage (say three percent) of total development expected in the corridor over the study period. Similarly, pollutant reductions expressed in terms of thousands of pounds per day is misleading in terms of region-wide air quality impacts if the reduction constitutes a tiny fraction of total emissions in the region.

5) *Finally, discussion of the measures should reflect the magnitude of differences in the measures compared to the likely error levels they may contain.*

Varying degrees of uncertainty exist in all information used in project planning. The presentation of evaluation measures should be accompanied by a well-written discussion that both highlights the major differences between alternatives and indicates where the differences are small given the levels of uncertainty. Minor differences in transit ridership, for example, are usually within the error of the estimates.

Within these general guidelines, the identification of specific measures depends only on the locally identified goals and objectives, together with the judgment of local analysts and officials on the most useful ways of portraying the relative merits and trade-offs involved with each alternative. The following sections describe the range of evaluation measures commonly used to evaluate alternatives.

9.4.1 Effectiveness

Goals and objectives related to effectiveness both establish the reasons for which major transit improvements are being considered, and identify ancillary concerns that constrain the options. Transportation concerns – congestion, mobility, etc. – are usually the primary basis for consideration of a major action in the corridor.

Effectiveness measures may include, but are not limited to:

- travel costs/user benefits;

- transportation system capacity;
- accidents and incidents;
- level of service/volumes/trips on key facilities;
- accessibility measures (number of jobs or households within specific travel times to destinations by mode);
- system redundancy (travel reliability measures); and
- any other quantifiable transportation system impact.

These effectiveness measures, with the exception of accidents and incidents, are generally the direct result of the travel demand forecasting process. Most of these measures are an output of the regional travel demand model and their calculation covered in Part I Chapter 6 *Interpretation and Use of Travel Forecast Data* of this guidance.

9.4.2 Impact Measures

Transportation projects create numerous secondary impacts that must typically be evaluated during alternatives analysis. The predominant secondary impacts that are commonly used to evaluate transportation alternatives are environmental considerations and economic development impacts. In some cases, these impacts are the focus of the locally defined evaluation if they respond directly to the primary problem in the corridor.

The menu of impact measures generally includes, but is not limited to:

- Regional economic impacts:
 - jobs added;
 - tax base;
 - redevelopment of distressed areas;
 - national competitive standing; and
 - distribution of economic impacts across jurisdictions.
- Effects on the human environment:
 - residential/business/farm property takings;
 - impacts on nearby residences/businesses/farms;
 - community impacts of facilities, disruption or barriers;
 - parks and recreation areas - number, acreage or proximity effects; and
 - historic and archeological sites – number, acreage, or proximity effects.
- Effect on the natural environment:

- streams, wetland, floodplains – number, nature, likely impacts, implications for approvals;
 - water quality;
 - aquifers;
 - rare, threatened or endangered species and related habitat;
 - forests; and
 - air quality.
- Consistency with local or state plans and policies:
 - comprehensive plans;
 - proximity and impact on priority development areas; and
 - land use and zoning policies.

9.4.3 Comparison of Benefits and Costs

Two common methods are used to evaluate the benefits of transportation improvements in the context of their relative costs. These are cost-effectiveness and cost-benefit analysis. These measures help identify the most efficient use of public resources to achieve the projected transportation benefits or other impacts.

Three primary issues arise in any attempt to fashion cost-benefit measures or measures of cost-effectiveness:

- the overall structure of the analysis and resulting measures;
- the baseline against which the alternatives are compared; and
- the measures used to quantify costs and benefits.

FTA has identified an approach used to support Federal decision-making. Local officials may choose a different approach, so long as it is technically sound and can accurately measure project merit relative to the purpose and need for the project. The results of both approaches may be presented in the environmental document produced by the study.

9.4.3.1 Structure of the Evaluation of Benefits and Costs

A major question in evaluation is the way in which the trade-off between costs and benefits is portrayed. One option is the standard cost-effectiveness approach in which a required performance level is stated and alternatives are evaluated for the least cost option that achieves this performance. This approach is very useful where the performance requirements are easily stated and measured. Unfortunately for transportation planning, the objectives for urban transportation investments are usually so many, so varied, and perhaps so unclearly defined that they defy statement in terms of specific performance levels.

The conventional approach to comparing the costs and benefits of transportation investments is to estimate resource cost savings resulting from a

proposed project relative to a baseline scenario. For instance, an investment in a new light rail transit system will create benefits for existing transit riders who take advantage of the new system and to those who switch from auto or HOV to the new rail line. These user benefits (costs) are generally:

- time-savings;
- out-of-pocket cost savings (parking, tolls, fares);
- vehicle operating cost savings (fuel, oil, tires, insurance, depreciation); and
- safety benefits (reduced accidents, injuries and fatalities).

In addition to user benefits (costs), there are a several categories of benefits (costs) that accrue to society at large rather than to users of the transportation system. These so-called non-user benefits (costs) include, but are not limited to:

- environmental benefits (costs); and
- resource savings for transportation operations and maintenance (infrastructure unit costs).

These benefits and costs are driven primarily by changes in travel demand and the generalized cost of travel caused by the project. Each of the benefit measures can usually be related in some way to changes in travel demand and the relative costs of each unit of that demand.

A cost-benefit analysis requires each of these impacts to be monetized to compare the value of the project to its costs. Monetizing these benefits is very difficult and occasionally controversial since this step requires assigning a value to, for instance, a ton of a particular pollutant or greenhouse gas and valuing a person's life and time.

A cost-benefit analysis begins with forecasts of total monetized benefits and annual capital and operating and maintenance costs for the evaluation period which is typically 20 years, but can be longer due to the long useful life of most transportation investments. These streams of benefits and costs are discounted to reflect the time value of money and summed to reflect the total present value of the stream of costs and benefits. The discount factor is $1/(1+i)^n$ where i is the discount rate and n is the year of analysis. Traditionally the discount rate is between 7% and 10%.

The most common cost-benefit measures are

1. Net Present Value (NPV) = [PV of Benefits (\$) – PV of Costs (\$)]
2. Internal Rate of Return (IRR) = Discount rate at which NPV=0

3. Benefit/Cost ratio (B/C) = PV of Benefits (\$)/PV of Costs (\$)

Assuming all benefits and costs are counted, the project with the highest (positive) NPV is the preferred project. The alternative with the highest Internal Rate of Return is the most economically efficient project, but may not be preferred if it does not adequately solve the transportation problem. The B/C ratio expresses the dollars of benefit per dollar of cost and will result in the same ranking as the NPV measure. A B/C ratio over 1.0 implies that benefits exceed costs.

Unfortunately, all of the benefits and costs cannot be counted so the highest NPV may not be the preferred project. There are numerous impacts of transportation project alternatives that are very difficult or impossible to measure and the process of attaching monetary values to several of the known impacts is uncertain at best. Transportation projects long term effect on land use; transit service reducing auto-ownership rates; and the value of transit service as a back-up mode, among others have been suggested as benefits or costs of transportation investments that are very difficult or impossible to measure let alone value.

Other even more vexing factors might be the distribution of benefits and costs to low-income or mobility-constrained communities, access to jobs and welfare to work initiatives, and economic development benefits. These types of benefits represent a transportation investment's contribution to social policy goals as opposed to transportation user benefits. There is no clear way to monetarily value these benefits.

Another option is to select a measure of benefits that captures, both directly and indirectly, as large a share of the expected benefits as possible without trying to express the benefits in monetary terms. A ratio between this measure and a measure of costs then provides an index of the cost-effectiveness of an alternative. For example, an index expressed in terms of cost-per-unit-of-benefit can be computed as:

$$\text{Cost-Effectiveness Index} = \text{Cost measure (\$/Benefit measure}$$

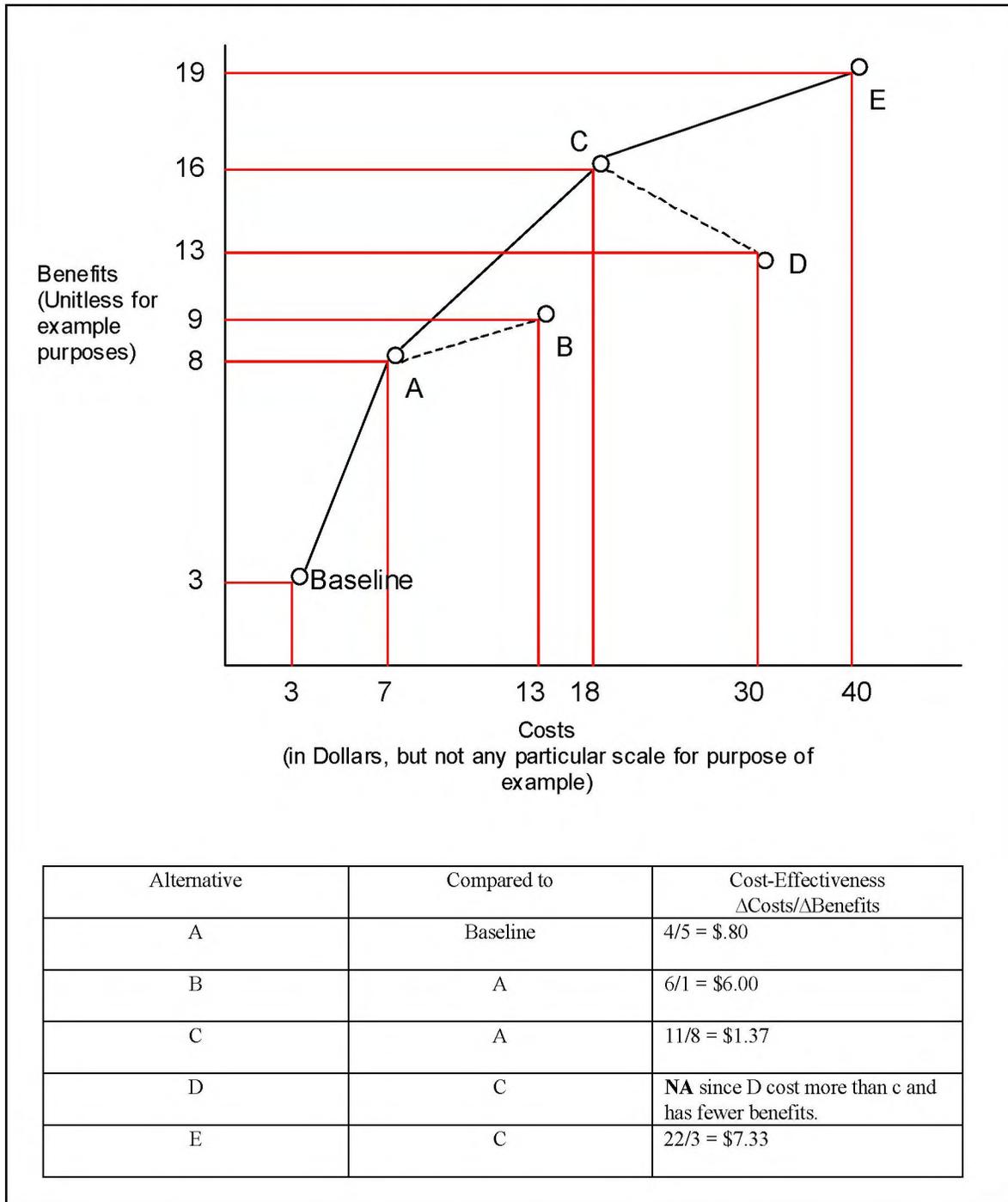
where the benefit measure is not expressed in terms of dollars. Since many benefits and costs of transit and highway projects are unknown and unknowable, it is possible to calculate cost-benefit measures that indicate negative net benefits, even though the alternatives may be beneficial. Cost-effectiveness measures are not expressed in terms of absolute economic benefit, but in the cost per unit of the benefit being measured. The alternative with the lowest cost per unit of benefit is most cost-effective **at providing that benefit**. The most cost-effective project is not necessarily the preferred option. For instance, a very cost-effective project may be identified that does not come close to solving the primary transportation problem in a given corridor and should not be the preferred alternative.

Since cost-effectiveness explicitly focuses on single benefit categories, the analysis should be explicit about what the cost-effectiveness index is measuring. Options may include measures like: cost-effectiveness at reducing travel time; cost-effectiveness at increasing transit ridership; cost-effectiveness at increasing accessibility; cost-effectiveness at concentrating economic development in a corridor; or cost-effectiveness at reducing harmful emissions.

Regardless of the specific method used, it is clear that the approach should examine the incremental costs and benefits of alternatives. One illuminating approach is to array alternatives graphically in terms of their costs and benefits. Figure 9-1 reveals three types of alternatives. First, alternatives A, C, and E define the cost-benefit frontier with increasing levels of investment. It represents the best possible return for each level of investment with decreasing returns as costs rise. Alternative B is not on the frontier, but provides additional benefits compared to alternative A. If budget realities preclude implementing alternative C, alternative B may be a viable fallback option. Alternative D is clearly a poor option since it provides fewer benefits than C at higher cost.

This graphical analysis suggests a method for computing measures of incremental cost-effectiveness. Each alternative is compared to the next lower cost option that lies on the frontier as summarized in the table below Figure 9-1.

Figure 9-1: Graphical Analysis of Incremental Costs and Benefits



The measure for incremental cost effectiveness for alternative n, where alternative m is the next lower cost alternative on the frontier, is as follows:

$$\text{Cost_Effectiveness}_n = \frac{\Delta\text{Incremental_Costs}_{n-m}}{\Delta\text{Incremental_Benefits}_{n-m}}$$

Arraying alternatives according to their next lower cost alternative allows the analyst to construct a cost-effectiveness frontier and clearly see how the rate of benefits per unit of cost tends to decline as costs increase. This is the principle of diminishing returns. The TSM alternative should be the most cost-effective alternative relative to the no-build. If the TSM alternative is not the most cost-effective alternative relative to the no-build, the TSM alternative is poorly specified and needs to be re-defined to be a cost-effective alternative.

The build alternatives can then be evaluated against a baseline alternative, which allows each build alternative to be ranked according to their cost-effectiveness. The preferred alternative is not necessarily the alternative with the lowest cost per unit of benefit. If this were the case, the TSM would always be the preferred alternative by its definition.

Cost-effectiveness must be balanced with effectiveness and impact measures as well as financial and equity considerations. Cost-effectiveness is one piece of information that decision-makers must weight to determine the locally preferred alternative.

One way to think of cost-effectiveness measures is as an investment rate of return. An investor may be confronted with a range of investments that can be ranked according to their expected rate of return with each added increment of cost likely providing diminishing returns. However, the wise investor does not stop investing at the level that produces the highest rate if the next level of investment also produces an attractive rate. Investors generally have a “hurdle” rate of return and should continue investing until any additional investment fails to reach the “hurdle”, subject to the availability of funds.

Just like an investor, local decision-makers should have some idea about what they are willing to pay to achieve a unit of transportation benefits. The cost-effectiveness analysis should identify the set of alternatives that provide an attractive rate of return on the funds dedicated to build operating and maintain the project. Cost-effectiveness is not the factor that determines the choice of a locally preferred alternative.

9.4.3.2 Choice of a Baseline Alternative

All comparisons of costs and benefits necessarily begin with some baseline alternative that provides a starting point for the analysis. There are two candidates for use as a baseline: the No-Build and TSM alternatives. Much discussion has occurred on the merits of each option as the baseline. This section discusses the advantages of each and presents a recommendation.

Three advantages can be cited for using the No-Build alternative. First, it has intuitive appeal as a baseline since the alternative is usually defined as an extrapolation of current operating policies and improvement programs. Thus, it is a logical baseline on which all improvements will be based. Second, its use as the baseline makes clearer that the TSM alternative is real option for solving problems and is not simply an artificial construct invented to serve as a

baseline. The TSM alternative therefore would be a more competitive alternative for consideration by local officials. Third, an evaluation that uses the No-Build as the baseline can detect proposed TSM alternatives that are not cost effective. Thus, errors in development of the TSM alternative can be identified and corrected so that the final definition of that option in fact represents an attractive, low-cost alternative.

The advantage of using the TSM alternative as the baseline is that it better isolates the benefits and costs of the major investment alternatives. In many cases, the TSM alternative presents an opportunity to identify improvements that are desirable **today**. Therefore, potentially large benefits are available from making changes in a No-Build alternative that is largely based on today's situation. Since these benefits are independent of any major investment, they should not be attributed to the guideway options. This problem is avoided if the TSM alternative serves as the baseline since the benefits produced by the TSM actions are not attributed to the Build alternative.

In FTA's view, the careful accounting of benefits possible with the TSM baseline is crucial in assessing cost-effectiveness or conducting a cost benefit analysis. While the TSM baseline is preferred, this conclusion is clearly a difficult choice between two reasonable options. Recognizing the arguments for using a No-Build baseline, it is important to treat the TSM alternative in a way that emphasizes its role as a real option, and that detects TSM alternatives that are not competitive. Two steps can be taken towards this end. First, the TSM alternative should be described simply as a viable, low-cost option. References to its role as a baseline should be made only where it is necessary in the cost-effectiveness analysis. Second, the TSM baseline should be treated only as another alternative that has both costs and benefits compared to the No-Build alternative.

Local decision-makers and project staff should understand that the purpose of the federal grant decision-making process is different from the local decision-making process. The federal process for providing New Starts mandates a particular set of evaluation criteria and a specific definition for a baseline alternative that focus on the federal interest in transit funding. The local issues and problems that the alternatives are designed to address may be very different from the federal interest and may demand different measures of project worth.

9.4.3.3 Quantification of Costs and Benefits

Given a structure and baseline for the assessment of cost-effectiveness or cost-benefit analysis, all that remains to be selected are the specific measures of costs and benefits. Calculations on the cost side are reasonably simple in that all measures are expressed in a common unit – the dollar – and basic techniques of engineering economics are available to put one-time capital costs and recurring operating and maintenance cost on a common annual basis.

This section outlines a direct method for translating capital costs into their uniform annual equivalent. This annualized cost can then be summed with the operating cost estimated for the forecast year to represent the total annual cost of the alternative. Present value calculations used in cost-benefit analysis are also summarized.

The evaluation of the cost-effectiveness of each alternative requires that all evaluation measures (capital costs, operating costs, non-Federal funding, and user benefits) be expressed in annual terms. Since the capital cost estimate is expressed as a total expenditure of constant (base year) dollars or inflated year of expenditure dollars, it is necessary to compute an annual payment that would be equivalent to what is in reality a one-time expenditure of capital funds.

Direct Annualization of Capital Costs

The conversion of capital costs into an equivalent annual payment is easily accomplished with basic techniques of engineering economics. The approach requires only the estimated cost in constant dollars and the lifetime of each line item in the cost estimate, plus a discount rate that reflects the time-value of money. For each capital cost item, the annualized equivalent is computed through application of an annualization factor computed as:

Equation 9-1:
$$AF = \frac{i(1+i)^n}{(1+i)^n - 1}$$

where

n = economic life;

i = discount rate.

The annualized cost of the line item is simply the total capital cost of that line item multiplied by its annualization factor. The summation of all annualized line item costs gives the overall annualized cost for the alternative.

For the evaluation of any project advanced for Federal funding, the traditional discount rate is 10 percent. Since this rate is used with costs expressed in constant dollars, it represents a rate of return net of inflation. A 10 percent return in this setting may appear somewhat higher than that commonly used in the private sector. This is done purposely provide a margin of safety in computing the cost-effectiveness of publicly funded projects whose merits are based on forecasts of such difficult-to-predict measures as transit ridership, time savings, and operating costs.

Table 9-1 summarizes values of the annualization factor for various economic lives. One indication from the table is that there is little variation in the annualization factor for economic lives exceeding 25 years. For example, the

annualized value of a \$100 million item over 25 years would be \$11.0 million. The same item annualized over 40 years would have an equivalent annual cost of \$10.2 million, a change of about 7 percent. This suggests that precise identification of economic lifetimes of various capital items is not critical to the evaluation. Therefore, standard assumptions are used for all computations of annualized costs in alternatives analysis.

Table 9-1: Assumptions of Economic Life

Capital Cost Element	Economic Life
Right-of-way	100 years
Right-of-way preparation (major grading, etc.)	100 years
Structures	30 years
Trackwork	30 years
Signals, electrification	20 years
Pavement, parking lots, grade crossings	25 years
Rail vehicles	25 years
Buses	12 years
Contingencies	item-specific
Engineering, construction management	allocated

The last two items are typically included as add-ons in the estimation of capital costs. In computing annualized costs, contingencies are easily dealt with since they are available on a line-item basis. However, add-ons for engineering and construction management are available only on a project-wide basis and must be allocated to individual line items. As a simplifying assumption, the same factor used to compute the project-wide allowance for these costs is applied to each line item, giving it a share of the project's engineering and a management costs equal to its share to total capital costs. Table 9-2 depicts the annualization of capital costs for a sample alternative.

Figure 9-2: Annualization Factors

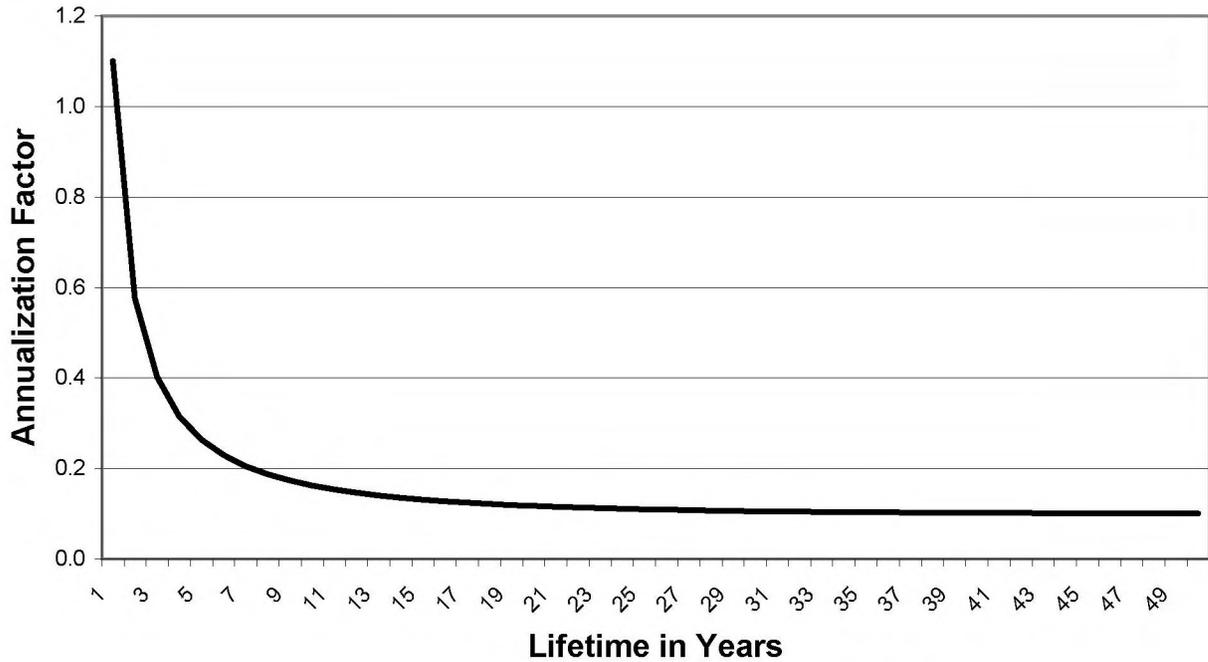


Table 9-2: Example: Annualization of Capital Costs

Corridor:		Southwest		
Alternative:		10 Mile LRT, Subway		
Discount Rate:		10%		
Item	Cost	Lifetime	Annualization Factor	Annualized Cost
Right-of-Way	\$ 65,000	100	0.100	\$ 6,500
Structures	\$ 225,000	30	0.106	\$ 23,868
Trackwork	\$ 90,000	30	0.106	\$ 9,547
Signals/Electrification	\$ 75,000	30	0.106	\$ 7,956
Vehicles				
Rail	\$ 40,000	25	0.110	\$ 4,407
Bus	\$ 15,000	12	0.147	\$ 2,201
Total	\$ 510,000			\$ 54,480

Present Value Calculations

The approach outlined above is different from what might be termed the classical approach to computing an annualized capital cost, an approach that was used in most alternatives analysis prior to 1984 and still used when preparing a cost-benefit analysis. The classical approach starts with a time stream of capital costs over a predefined analysis period – up to 50 years for major construction projects. Within this time stream, capital costs are assigned

to specific years, both during the construction period and for any replacement costs in later years. The cost in each year is then converted to its present value with a present value factor computed as:

Equation 9-2:
$$PV = \frac{1}{(1+i)^n}$$

where n and i are the project life and discount rate, respectively.

For cost-benefit analysis, the summation of the present values over the entire analysis period is, therefore, the present value of the project's capital and operating costs over its lifetime. This present value of costs is compared to the present value of benefits over the entire analysis period.

The present value calculation is the correct method for constructing the cost portion of the cost-benefit measures: NPV, Internal Rate of Return, and B/C ratio. This method is correct for cost-benefit analysis because both costs and benefits are expressed in present value dollars.

For cost-effectiveness, the cost measure is less clear. The annualized cost of the project could be calculated with an annualization factor computed with Equation 9-1, using the assumed 50-year project lifetime and expressed as a present value using Equation 9-2. This approach accurately reflects the lower annualized cost that results from construction costs over a construction period of several years. Expenditures that occur later in the period have a lower present value than those occurring in the first year and therefore contribute less to the annualized costs. As a result, the classical approach gives a more accurate portrayal of equivalent annual costs.

The problem with using this method to construct cost-effectiveness measures is that, while it correctly recognizes the scheduling of capital costs over time, it has usually been used in an analysis that ignores the scheduling of benefits. Typically, the capital cost stream has been discounted back to a present value, while benefits (ridership, time savings, user benefits... etc.) are fixed at their value in the forecast year. The error biases the analysis towards alternatives with longer construction periods since it discounts their out-year costs quite heavily but does not discount the delayed benefits. The error also invites game-playing with construction schedules, since stretching or delaying the construction period makes the project appear less expensive with no attendant decrease in benefits.

Two alternative approaches are available to correct this problem for cost-effectiveness calculations. The first, and "best," is to construct time streams of all items (costs, patronage, time savings) and discount everything to a present value. The second is to ignore the scheduling of capital costs, just as the scheduling of benefits have been ignored.

The “best” approach is superior in the sense that it provides the most accurate accounting of costs and benefits, and yields an evaluation closest to the true trade-off between the investment and its transportation returns. This approach recognizes that benefits from any project begin to accrue only after the construction period is completed. It also specifically examines the growth rates over time for such benefit measures as transit patronage, travel time savings, consumer surplus, and operating cost savings. Unfortunately, the results of this approach are highly dependent on assumptions (guesses) made for the out-years of the time streams of costs, ridership and time savings. Even with the heavy discounting of these out-year values, they are able to influence the indices significantly, particularly for projects that have relatively small benefits.

The local study team is free to choose the method that works best for their own application. The method that FTA uses to support the federal grant decision essentially ignores timing on both sides – costs as well as benefits. The need for FTA to fairly evaluate different projects around the country with very different schedules drives the selection of the cost annualization method. FTA does not want projects to “appear” preferable to potentially better projects simply based on their construction schedule or level of project development.

The FTA New Starts evaluation approach implicitly assumes that capital costs and benefits occur at the same time. Since the benefits always occur after the construction costs, there remains some understating of the relative costs of projects with long construction periods. This approach yields evaluation results that are somewhere between the old method and the “best” method.

Measuring Benefits

Calculations on the benefits side are made difficult by the wide range of benefits associated with major transit projects – congestion relief, improved travel times, fewer accidents/injuries/fatalities, energy conservation, pollutant reductions, economic development, and so forth. No single measure of benefits is readily apparent.

Since the major purpose of transit investments is improved mobility, it is clear that the most useful proxy measures will be travel related. There are several measures of travel impacts that might be considered for use as an overall indicator of benefits. Changes in total transit ridership, travel times, ridesharing, highway congestion, and so forth are all possible candidates. The challenge is to select a measure that represents, either directly or indirectly, the wide range of benefits and that avoids a systematic bias towards or against any particular kind of alternative.

Transportation System User Benefits. One potentially useful measure can be termed “user benefits”, though it is more commonly called “consumer surplus” in microeconomic theory. It is computed simply as the aggregate difference in “user costs” between a pair of alternatives, summed over all

existing and new users of the transportation system. User costs are defined in terms of a generalized price of transit, including both out-of-pocket costs – fares, parking fees at park/ride lots – and time costs – walking, waiting, riding, and transferring. Thus, this generalized price is a measure of the level of mobility provided by the transportation system to individual users, and total user benefits indicate the overall improvement in regional mobility provided by an alternative. Happily, an excellent measure of transit price is used routinely in the mode choice analysis done as part of travel demand forecasting. Thus, the evaluation can proceed using data already developed in the study. FTA's *Reporting Instructions for the Section 5309 New Starts Criteria* outlines the calculation of a measure of user benefits in terms of hours of travel time.

User Benefits as Proxy Measure. Obvious questions arise on the extent to which a single measure, no matter how broadly defined, can capture the wide variety of benefits resulting from a major transportation investment. To the extent that user benefits do not include all the benefits of a particular alternative, some may question whether user benefits is a sound basis for gauging cost effectiveness or for developing cost-benefit measures.

The potential problem with using user benefits as a proxy for total benefits of an alternative is minimal if the alternatives analysis is only concerned with transit alternatives. The direct benefits of a transit improvement are improvements in travel times and increases in transit ridership, and the indirect benefits are consequences of these mobility and ridership changes. For example, where significantly improved transit service attracts substantial numbers of new riders, there will be associated benefits – economic development impacts, lower energy consumption and pollutant emissions, and so forth – whose magnitude depends directly on the magnitude of the ridership gain and associated user benefits. Further, the analysis of user benefits accruing to different travel markets within a region can provide excellent indicators of improved mobility for the transit dependent and increased accessibility to employment locations. Therefore, when an alternatives analysis includes only transit alternatives, there is every reason to believe that the ranking of projects based on cost-effectiveness or cost-benefit measures would be exactly the same even if all benefits were incorporated into the cost-benefit or cost-effectiveness analysis.

Even such an indirect impact as economic development is related to changes in user benefits. The likelihood that a transit project will have significant impacts on development patterns is largely determined by its ability to provide significant increases in accessibility and ridership. As a result, a project with little or no service and ridership impacts will likely have similarly modest development impacts. Thus, the proxy measure does reflect, at least in a general sense, differences between alternatives in terms of their overall impacts on development. Development impacts at individual sites, of course, require

site-specific analysis of changes in accessibility and other incentives for development.

The second key is that in most cases, the purpose of the evaluation is to rank alternatives against each other. This task requires only the ordering of projects according to their relative merits rather than calculation of their absolute merits. Since the transportation benefits of an alternative are proportional to overall benefits, the ordering of alternatives based on transportation benefits alone is very likely to be the same ordering that would result if the secondary benefits were measured as well. Consequently, the indirect measurement of secondary benefits is quite adequate for the purposes of the evaluation. Direct measurement of the secondary benefits would become critical only if the evaluation were designed to judge the absolute merits of each alternative – whether its total benefits exceed its costs.

Multimodal Considerations. The evaluation of multimodal alternatives adds a new wrinkle to the analysis since the secondary impacts of investments in different modes can be offsetting rather than complimentary. Many transportation planners presume that new freeways result in higher emissions while transit projects reduce them, added freeway capacity results in different development patterns than transit investments, travel via automobile results in higher accident/injury/fatality rates while transit is a relatively safer mode, and so on. For this reason, the analysis may not be able to rank the alternatives using user benefits as a proxy for total benefits when alternatives of different modes are compared to each other. Multimodal alternatives require an approach that considers multiple measures of project merit to allow decision-makers to weigh the broad impacts of each alternative.

In FTA's view, user benefits are superior to other candidate measure of the overall benefits of an alternative. This measure can be defined broadly so that it captures directly a large share of likely transportation benefits. It is also a good proxy measure of a wide range of indirect benefits, since many of the secondary impacts of a transportation improvement are directly dependent on the degree to which it increases mobility. Regarding the specific definition of the user benefits measure, FTA's view is that it should be defined as broadly as necessary to capture all expected travel benefits.

9.4.4 Summary of the Recommended Approach to Cost-Effectiveness Calculation

Cost-effectiveness can be adequately addressed with two measures that are based on a simple ratio between the costs of building and operating an alternative, and the user benefits accruing from that alternative. These measures are computed with the aid of a graphical representation of the costs and benefits of the alternatives, illustrated in Figure 9-1. The calculations use the TSM alternative as a baseline for the assessment.

The first measure is incremental in that it examines the cost-effectiveness of each alternative in comparison with the next less costly option:

$$\text{Incremental Cost-Effectiveness Measure} = \frac{\Delta \$\text{CAP} + \Delta \$\text{O\&M}}{\Delta \text{USER BENEFITS}}$$

Where the Δ 's represent incremental costs and benefits between the pair of alternatives considered, and where:

\$CAP	is total capital costs, annualized over the life of the project;
\$O&M	is annual operating and maintenance costs; and
USER BENEFITS	is annual benefits, expressed in terms of hours of travel time, for all users of the transportation system.

This incremental measure can be expressed in terms of \$/hour of user benefits. The second measure examines the cost-effectiveness of a build alternative relative to the TSM alternative, reflecting the total cost-effectiveness of alternative rather than the last increment only.

FTA's *Reporting Instructions for the Section 5309 New Starts Criteria* provides additional guidance on the calculation of project cost effectiveness.

9.5 Financial Feasibility

Part II Chapter 8 *Financial Planning for Transit* of this guidance outlines the financial analysis appropriate to this stage of project planning. The financial analysis establishes 1) the funding requirements for both the capital and operating costs of each alternative, 2) the projected revenues from existing sources of funds used to support transit, 3) the potential revenues from other possible funding sources in cases where existing resources are not sufficient, and 4) assesses of the feasibility of the alternative funding packages.

The task remaining for the evaluation of the alternatives is to use the measures of financial feasibility to examine the likelihood that sufficient existing and, where necessary, additional funding sources would be available to cover the capital and operating costs of each alternative. The selected measures should be a relatively few key indicators of financial impacts. Three kinds of indicators can be used in this analysis.

1. For existing sources that are dedicated entirely to transit, the surplus or deficit of projected funds compared to projected needs is likely the best indicator of financial capability.
2. For new sources, discussion of the steps necessary to develop the source is a primary concern. This discussion would identify the necessary major actions – referenda, local legislation, State legislation, etc. – and, to the extent possible, the likelihood of success given past experience with similar efforts. Levels of risk can be defined and assigned to each source as an indicator of its feasibility.

3. For new sources or for existing sources that are not dedicated entirely to transit, ratios can be constructed to illustrate the size of the transit requirement in comparison with various measures of financial capability. For example, where transit is currently funded as a budget line item of local government, a useful measure is the current and projected percentage of the total budget necessary for transit. This measure reflects the need for transit assistance, the total resources available to the local government, and the needs of other local governmental functions. A second example would be measures of the financial feasibility of value capture mechanisms that indicate the fractional change in profitability of development within a value capture district.

In sum, the evaluation of financial feasibility presents measures of the impact of projected transit assistance needs on existing and potential sources of funds. While the measures themselves are rarely conclusive indicators of financial feasibility, they help to define for local and federal decision-makers the financial context in which the selection of an alternative is made.

9.6 Equity

Equity issues (sometimes called environmental justice) are those concerned with the distribution of the costs and benefits of an alternative across the various subgroups in the region. Equity considerations generally fall within three classes.

1. The extent to which the transit investments improve transit service to various population segments, particularly those that tend to be transit-dependent;
2. The distribution of the costs of the project across the population through whatever funding mechanism is used to cover the local contribution to construction and operation; and
3. The incidence of significant environmental impacts.

Each of these classes of impacts should be pursued to the extent that they are identified as areas of concern by study team, local decision-makers or by other groups contacted through the study's public participation process. Where appropriate, there are analytical techniques available to quantify several measures of the distribution of costs and benefits. For the distribution of service improvements, the demographic data and transit network information developed in the travel forecasting work provide a wealth of data on service changes for individual market segments. Finally, the environmental analysis provides an inventory of likely impacts on neighborhoods, residences, and businesses that can be used to quantify the extent to which specific population groups would be adversely affected by any of the alternatives.

9.7 Trade-Off Analysis

Thus far, the evaluation has proceeded sequentially through five perspectives, examining each alternative in turn. The purpose of the trade-off analysis is to pull together the key differences among the alternatives across all of the perspectives. It is designed to take the broadest view possible, highlighting for decision-makers the advantages and disadvantages of each option and pointing out the key trade-offs of costs and benefits that must be made in choosing a course of action.

As in much of the evaluation, the content and approach to the analysis is dependent upon local goals and objectives and the nature of the alternatives. Perhaps the most important component of a successful trade-off analysis is its assignment to an analyst who is able to take a broad perspective on the purpose of the transportation improvement and the merits of the alternatives, and who has strong writing skills. Together with reviews by the Technical Advisory Committee, the analyst's insight and reasoning are indispensable to a result that aids local officials in the choice of an alternative.

Several examples can be used to illustrate the kinds of trade-offs that might be found in a set of alternatives. One frequently-found trade-off is that between effectiveness and cost-effectiveness. One alternative may yield a modest level of transit improvement at a highly cost-effective return on the investment, while a second may yield greater improvements at such a high cost that its overall cost-effectiveness is lower. In this case, the trade-off analysis should point out that the second alternative provides a higher level of benefits, but that the marginal benefits are purchased at a diminishing rate of return.

Another frequent example is the trade-off between effectiveness and financial feasibility. Often, the alternative providing the greatest improvements in transit service is also the most costly and would require a significant increase in the annual investment made by the local area. The trade-off analysis should highlight the additional commitment by the local governments – and possibly the equity implications of the means used to finance this commitment – necessary to implement this alternative.

The major task of the trade-off analysis, then, is to reduce (to the extent possible) the vast amount of information developed during the analysis to those essential differences between the alternatives. Its purpose is to frame the decision on a preferred alternative in terms of the advantages of choosing one option compared to the foregone advantages of the other options.

The recommended approach is to display key characteristics of the alternatives and the evaluation measures in clear tables that allow comparisons among alternatives within the context of their characteristics for each evaluation factor. A summary table that presents the highlights of the evaluation results should be prepared with the goal of presenting a one to two-page table highlighting the main trade-offs among the alternatives.

Some trade-off analyses have used purely qualitative judgments regarding the evaluation measures. Sometimes these are rated in terms of high, medium, and low or use “Harvey Balls” (e.g. comparison charts used by Consumer Reports™) to offer a qualitative assessment of each evaluation measure. FTA cautions against using these qualitative measures in the trade-off analysis since the scope, complexity, and the number of evaluation measures can result in trade-off analyses that are unclear, unfocused, and do not easily expose the most promising alternatives. To provide the most useful information to decision-makers, the measures should be quantitative rather than qualitative if at all possible and be expressed within a context that exposes the relative magnitude of the measures. An example trade-off analysis is provided in Table 9-3.

Table 9-3: Example Trade-Off Analysis Summary

Measure	No Build – Planned expansion of existing service	TSM – Express bus with park and ride lots	LRT Build 1 – 13 mile at grade line, 3 miles street running in CBD	LRT Build 2 – 12.5 mile at grade line, 2.5 mile tunnel in CBD
Project Cost (\$YOE)	\$45 million	\$125 million	\$750 million	\$950 million
Annual operating and maintenance costs	\$2.5 million	\$14 million	\$ 18 million	\$17.5 million
Annualized Cost	\$11.5 million	\$35 million	\$136 million	\$153 million
MEASURES OF EFFECTIVENESS				
Daily ridership in study corridor	24,000	32,000	41,000	44,000
Daily system-wide transit ridership (forecast year)	85,000	92,000	103,000	106,000
Annual user benefits (hrs of travel time)				
Vs. No-Build	NA	6,200,000 hrs	13,300,000 hrs	14,000,000 hrs
Vs. TSM	NA	NA	7,100,000 hrs	7,800,000 hrs
Average transit trip time in corridor	37 minutes	31 minutes	24 minutes	20 minutes
Accessibility: Jobs within 30 minutes travel time				
Highway	180,000	195,000	198,000	199,000
Transit	95,000	120,000	130,000	133,000
PROJECT IMPACTS				
Value of added development in corridor over 20 years	\$2.2 billion	\$2.25 billion	\$2.35 billion	\$2.5 billion
Property takings	0	45 homes 1 commercial	125 homes 13 commercial 2 industrial sites	45 homes 5 commercial 2 industrial sites
Noise and vibration	NA	Localized noise impacts on 58 properties	Localized noise impacts on 40 properties 10 structures within	Localized noise impacts on 25 properties 8 structures within

Pollutant emissions reduction vs. no-build	NA	0.2% reduction	vibration screening distance 0.3% reduction	vibration screening distance 0.35% reduction
Consistency with local land-use policies	Not consistent with local plans which recommend fixed guideway transit connection in corridor.	Consistent with local plans to improve transit service in corridor	Supports local plans to improve transit service and concentrate economic development in planned station areas.	Supports local plans to improve transit service and concentrate economic development in planned station areas.
MEASURE OF COST-EFFECTIVENESS				
Cost-effectiveness (\$Annual/user benefits)				
vs. No-Build	NA	\$5.65	\$10.22	\$10.93
vs. TSM	NA	NA	\$19.15	\$19.61
FINANCIAL FEASIBILITY				
Available funds	\$ 250 million (local)	\$ 250 million (local)	\$ 625 million (local plus 50% federal)	\$ 725 million (local plus 50% federal)
Additional funding required	NA	NA	\$125 million	\$225 million
Source of additional funds	NA	NA	Tax referendum	Tax referendum
EQUITY CONSIDERATIONS				
Characteristics of affected communities	Middle/upper income	Middle/upper income	Middle/upper income	Middle/upper income
Travel benefits by income group/location	Lower cost buses serve predominantly lower and middle income passengers	Slightly higher costs to existing lower/middle income riders, additional middle income riders drawn to improved service	Middle/upper income suburban communities benefit most, higher costs for existing riders, improved suburban job access for city residents	Middle/upper income suburban communities benefit most, higher costs for existing riders, improved suburban job access for city residents
Distribution of funding costs between users and non-users	Users pay 25% of costs General sales tax – 75%	Users pay 30% of costs General sales tax – 70%	Users pay 35% of costs General sales tax – 65%	Users pay 35% of costs General sales tax – 65%

Table 9-3: Example Trade-Off Analysis Summary

9.8 Documenting the Evaluation Methodology

The purpose of documenting the evaluation methodology is simply to outline the measures that will be used to quantify the degree to which each alternative meets the stated goals and objectives. The evaluation measures and methodology must be defined at the beginning of alternatives analysis to respond to the problems in the corridor. If the evaluation measures are created after the technical work has been done, they are prone to being manipulated to support a predetermined conclusion. The alternatives analysis should specify at the outset, each objective, identify the measure(s) proposed for each objective, and describes the source of the measure. This step provides a means for local decision-makers and technical staff to agree on a meaningful set of measures, and alert the responsible technical staff of the evaluation data needed from the analysis.

While the evaluation of alternatives in the alternatives analysis does not need to use the same measures required for FTA's New Starts rating and evaluation process, the study should be sure to produce the information required for the federal process. Otherwise, significant additional work may be required if a major capital investment becomes the locally preferred alternative and the project sponsor intends to seek federal funding.

